2015
Kentucky Ambient Air Monitoring Five-Year Network Assessment

Commonwealth of Kentucky
Energy & Environment Cabinet
Department for Environmental Protection
Division for Air Quality
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KENTUCKY DIVISION FOR AIR QUALITY

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Certification

By the signatures below, the Kentucky Division for Air Quality certifies that the information contained in this Network Assessment document is complete and accurate at the time of submittal to EPA Region 4. However, due to circumstances that may arise during the sampling year, some network information may change.

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Executive Summary

In accordance with 40 CFR § 58.10(d), *Annual monitoring network plan and periodic network assessment,* KDAQ respectfully submits this network assessment for EPA review. The major findings of the assessment are summarized below:

- **<u>Ozone:</u>**

- The ozone monitoring network meets or exceeds the minimum number of monitors required in each MSA. However, three MSAs have never had a maximum concentration site formally established. As such KDAQ intends to make the following modifications to monitor metadata in AQS, as well as in the Annual Network Plan:
  - Elizabethtown-Ft Knox, KY MSA: KDAQ will designate the Elizabethtown monitor (21-093-0006) as the maximum concentration site in AQS, as it is the only site in the MSA.
  - Huntington-Ashland, WV-KY-OH MSA: KDAQ will designate the FIVCO monitor (21-019-0017) as the maximum concentration site, as it is the highest reading monitor in the MSA; however, KDAQ will notify agencies in Ohio and West Virginia prior to making any changes in AQS.
  - Bowling Green, KY MSA: KDAQ recommends that the CASTNET ozone monitor located at the Mammoth Cave site (21-061-0501) be the designated maximum concentration site, if this is agreeable to the National Park Service and the EPA
- The evaluation of spatial scales of representativeness indicates that two ozone monitors likely have monitoring scales that differ from the metadata established in AQS. As such KDAQ intends to make the following changes:
  - Middlesboro (21-013-0002): The monitoring scale will be changed from regional to neighborhood.
  - Grayson Lake (21-043-0500): The monitoring scale will be changed from urban to regional

- **<u>$PM_{2.5}$:</u>**

- The $PM_{2.5}$ monitoring network in Kentucky meets or exceeds the minimum number of stations required by 40 CFR 58, Appendix D. However, KDAQ did not meet the requirement to have 80% of the collocated monitors located at sites with annual averages or daily concentrations estimated to be within 20% of the NAAQS.
- Based upon the annual average at each site, KDAQ has only one collocated sampler (21-093-0006) located at a site within 20% NAAQS. KDAQ would need to have all two collocated samplers located at sites with annual averages within 20% of the NAAQS to meet the requirement. KDAQ will correct this deficiency in the 2016 Network Plan.

•**Lead:**

•Due to a predicted maximum 3-month rolling average above one-half the lead NAAQS at the AK Steel facility in Boyd County, the Division recommends lead monitoring in the proximity of maximum ambient air impact. The full results of the modeling demonstration, as well as the lead monitoring waiver request is located in Appendix B of this assessment.

•**PM_{10}:**

•KDAQ collects 24-hour PM_{10} samples that run between midnight-midnight local time, in observance of Daylight Savings. There is a contradiction in the CFR regarding the use of local time versus local standard time. 40 CFR 50, Appendix K defines a "Daily Value for PM_{10}" as "the 24-hour average concentration of PM_{10} calculated or measured from midnight to midnight (local time)." Meanwhile, 40 CFR 58.12 states that "a 24-hour sample must be taken from midnight to midnight (local standard time) in order to ensure national consistency." KDAQ is considering changing operating procedures so that samples are collected on local standard time, but will need to further discuss potential implications with EPA Region 4.

•**Siting Criteria:**

•The Ashland Primary site (21-019-0017) in Boyd County is partially obstructed. A complete account of the issues with siting are included in Appendix D of this assessment.

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Introduction

The Kentucky Division for Air Quality (KDAQ) has operated an air quality monitoring network in the Commonwealth since July 1967. The Louisville Metro Air Pollution Control District (LMAPCD), a local agency, has maintained a sub-network in its area of jurisdiction since January 1956. Since that time, the networks have been expanded in accordance with United States Environmental Protection Agency U.S.EPA's (U.S.EPA) regulations.

In October 1975, the U.S.EPA established a work group to critically review and evaluate current air monitoring activities at that time. This group was named the Standing Air Monitoring Working Group (SAMWG). The review by the SAMWG indicated several areas where deficiencies existed which needed correction. The principal areas needing correction were: an excess of monitoring sites in some areas to assess air quality; existing regulations did not allow for flexibility to conduct special purpose monitoring studies; data reporting was untimely and incomplete, caused by a lack of uniformity in station location and probe siting, sampling methodology, quality assurance practices, and data handling procedures.

In August 1978, recommendations developed by SAMWG, to remedy the deficiencies in the existing monitoring activities, were combined with the new requirements of Section 319 of the Clean Air Act. Section 319 provided for the development of uniform air quality monitoring criteria and methodology; reporting of a uniform air quality index in major urban areas; and the establishment of an air quality monitoring system nationwide which utilized uniform monitoring criteria and provides for monitoring stations in major urban areas that supplement State monitoring. The combination of the recommendations and requirements were included in a proposed revision to the air monitoring regulations.

In May 1979, air monitoring regulations were finalized by the U.S.EPA requiring certain modifications and additions to be included in the State Implementation Plan for air quality surveillance. These regulations require each state to operate a network of monitoring stations designated as State and Local Air Monitoring Stations (SLAMS) that measure ambient concentrations of air pollutants for which standards have been established. The SLAMS designation contains provisions concerning the conformity to specific siting and monitoring criteria not previously required. The regulations also provide for an annual review of the monitoring network to ensure objectives are being met and to identify needed modification.

The current overall network consists of 34 air monitoring stations, operated by KDAQ, LMAPCD, and the National Park Service (NPS). The Commonwealth's SLAMS air monitoring network monitors criteria pollutants for which the National Ambient Air Quality Standards (NAAQS) have been issued. In addition to a SLAMS network, KDAQ's air monitoring network includes special purpose monitors (SPM) for air toxics, $PM_{2.5}$ speciation, and meteorological data.

According to 40 CFR § 58.10(d), *Annual monitoring network plan and periodic network assessment,* state and/or local air agencies are required to perform a periodic network assessment every five years to determine whether:

- the network meets the monitoring objectives defined in 40 CFR 58, Appendix D;
- new monitoring sites are needed;
- existing sites are no longer needed and can be terminated;
- new technologies are appropriate for incorporation into the air monitoring network;
- the network sufficiently supports characterization of air quality in areas with large populations of susceptible individuals; and,
- whether the discontinuance of a monitoring site would have an adverse impact on other data users or health studies.

Additionally, the EPA requires that the five-year network assessment identify:

- any necessary changes for population-oriented $PM_{2.5}$ sites; and,
- whether monitoring is required near any additional lead sources with emissions greater than 0.5 tons per year (tpy), as determined by the most recent National Emissions Inventory.

Finally, the EPA requires that any waiver of the regulatory requirements stated in 40 CFR Parts 50 and 58 must be renewed during each five-year network assessment, unless otherwise specified to be addressed during the annual network plan process. Such waivers include:

- monitoring waivers for lead sources emitting more than 0.5 tpy;
- requests for the exclusion of continuous $PM_{2.5}$ Federal Equivalent Method (FEM) data from comparisons against the NAAQS;
- waivers from the monitoring probe siting criteria stated in 40 CFR 58, Appendix D; and,
- any additional waiver from 40 CFR Parts 50 and 58 that may be required.

The five-year network assessment primarily focuses on the $PM_{2.5}$ and ozone monitoring networks, as these pollutants are of greatest concern in the state of Kentucky. The NO_2, SO_2, PM_{10}, lead and meteorological networks are also included in the assessment.

The following document constitutes the Kentucky ambient air monitoring five-year network assessment and is organized into **three** main parts:

- Pollutant Network Analysis: Each criteria pollutant network is analyzed to ensure that the CFR requirements are fulfilled. Pollutant networks, especially $PM_{2.5}$ and ozone, are also analyzed spatially to ensure adequate network coverage.

- Sensitive Population Analysis: Sensitive populations in the state are spatially analyzed to identify the geographic areas that are in greatest need of protection.

- Appendices: Waivers from monitoring requirements and siting criteria are included in the appendices at the end of the document. The appendices contain analysis and information regarding the monitoring network for non-criteria parameters, such as the meteorological network, as well as identification of data users.

This Five-Year Network Assessment must be submitted to the EPA by July 1, 2015. If the assessment identifies that modifications to the network are required in order to meet minimum monitoring requirements, those changes must be established in the Annual Network Plan due to the EPA by July 1, 2016.

Ozone Monitoring Network

Ozone Monitoring Network History (2009-Present)

The Kentucky ozone monitoring network currently consists of 26 monitors, of which KDAQ operates 22 monitors and LMAPCD operates three monitors. Additionally, there are four CASTNET monitors in the state, one of which, is operated by the NPS at Mammoth Cave National Park.

Since 2009, the ozone monitoring network has changed little; KDAQ has discontinued only two ozone monitors and has established one ozone monitor. The map and chart on the following page shows all ozone monitors in operation during this time-period; the chart displays certain metadata from AQS.

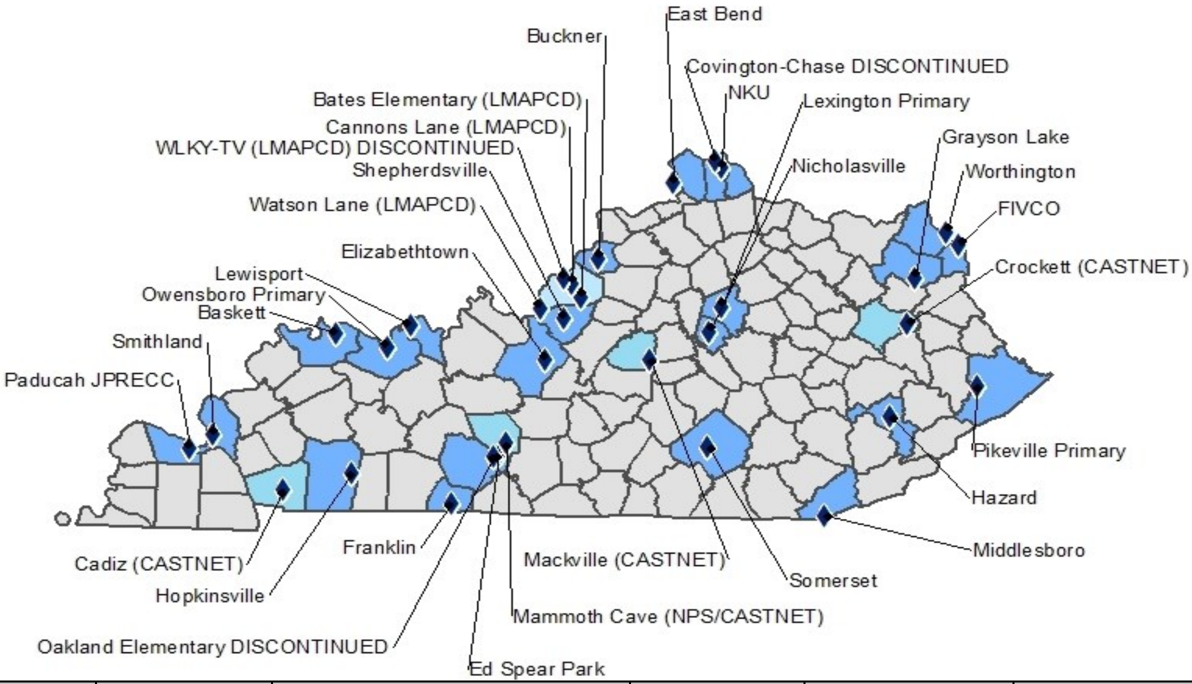
Of the monitors operated by KDAQ, the Covington-Chase site (21-117-0007) in Kenton County was discontinued in June 2010 due to development of the property into condos. KDAQ decided to not re-establish a site in Kenton County based upon the results of the 2010 Network Assessment, which showed that the Covington-Chase monitor was redundant when compared to the data collected by the NKU monitor (21-037-0002) in neighboring Campbell County.

Additionally, the Oakland Elementary site (21-227-0008) in Warren County was discontinued in May 2012 because the site was located within the doline (depression) of a sinkhole. KDAQ established the Ed Spear Park site (21-229-0009) in Warren County as a replacement. The Ed Spear Park site is located approximately 3.5 kilometers from the location of the former Oakland Elementary site.

EPA Region 4 staff were initially concerned that the former Oakland Elementary site was redundant when compared to the data collected from the ozone monitor at Mammoth Cave National Park (21-061-0501), since the two monitors were only 14.0 kilometers apart; thus, EPA reasoned that the Ed Spear Park would also be redundant. Instead, EPA Region 4 staff suggested that the replacement site be located further away from the park. However, the 2010 Network Assessment showed that the ozone monitor located at Oakland was unique (correlation of r=0.6) when compared to the monitor at Mammoth Cave, which tended to record higher ozone concentrations. Most ozone monitors showed much stronger correlations due to the nature of ozone as a regional pollutant. Thus, KDAQ decided to find a site close to Oakland Elementary.

The Ed Spear Park site is located approximately 3.5 kilometers from the location of the former Oakland Elementary site and 11.0 kilometers from the Mammoth Cave site. As a side note, it was hypothesized that the Mammoth Cave site is unique in the network due to its location atop the Mammoth Cave Escarpment, which is approximately 200 feet higher in elevation than the surrounding area. Additionally, the area is heavily forested and it is assumed that biogenic isoprene emissions are contributing to ozone formation. As a part of this network assessment, KDAQ again ran correlation matrices, the results of which are discussed later in this section.

Map & Chart: KDAQ, NPS, & LMAPCD Ozone Monitoring Network (2009-Present)



County	Site ID	Site Name	Monitor Type	Monitoring Scale	Operation Dates
Bell	21-013-0002	Middlesboro	SPM	Regional	02/14/1992 - Present
Boone	21-015-0003	East Bend	SLAMS	Urban	01/01/1977 - Present
Boyd	21-019-0017	FIVCO	SLAMS	Neighborhood	08/14/2001 - Present
Bullitt	21-029-0006	Shepherdsville	SLAMS	Urban	01/30/1992 - Present
Campbell	21-037-3002	NKU	SLAMS	Urban	07/01/2007 - Present
Carter	21-043-0500	Grayson Lake	SPM	Urban	01/01/1983 - Present
Christian	21-047-0006	Hopkinsville	SLAMS	Regional	03/04/2008 - Present
Daviess	21-059-0005	Owensboro Primary	SLAMS	Neighborhood	08/02/1978 - Present
Edmonson	21-061-0501	Mammoth Cave (NPS/CASTNET)	Non-EPA	Regional	08/01/1997 - Present
Fayette	21-067-0012	Lexington Primary	SLAMS	Neighborhood	12/05/1979 - Present
Greenup	21-089-0007	Worthington	SLAMS	Neighborhood	04/03/1981 - Present
Hancock	21-091-0012	Lewisport	SLAMS	Urban	09/01/1980 - Present
Hardin	21-093-0006	Elizabethtown	SLAMS	Urban	03/01/2000 - Present
Henderson	21-101-0014	Baskett	SPM	Urban	02/27/1992 - Present
Jefferson	21-111-0027	Bates Elementary (LMAPCD)	SLAMS	Urban	01/01/1976 - Present
Jefferson	21-111-0051	Watson Lane (LMAPCD)	SLAMS	Neighborhood	07/16/1992 - Present
Jefferson	21-111-0067	Cannons Lane (LMAPCD)	SLAMS	Urban	01/01/2010 - Present
Jefferson	21-111-1021	WLKY-TV (LMAPCD)	SLAMS	Neighborhood	06/01/1975 - 12/31/2009
Jessamine	21-113-0001	Nicholasville	SLAMS	Urban	05/23/1991 - Present
Kenton	21-117-0007	Covington-Chase	SLAMS	Neighborhood	06/19/1980 - 06/06/2010
Livingston	21-139-0003	Smithland	SLAMS	Urban	01/01/1981 - Present
McCracken	21-145-1024	Paducah Primary JPRECC	SLAMS	Neighborhood	10/01/1980 - Present
Morgan	21-175-9991	Crockett (CASTNET)	EPA	Regional	04/01/2011 - Present*
Oldham	21-185-0004	Buckner	SLAMS	Urban	05/01/1981 - Present
Perry	21-193-0003	Hazard	SPM	Neighborhood	06/01/2000 - Present
Pike	21-195-0002	Pikeville Primary	SPM	Urban	12/08/1993 - Present
Pulaski	21-199-0003	Somerset	SPM	Urban	02/14/1992 - Present
Simpson	21-213-0004	Franklin	SPM	Urban	05/21/1991 - Present
Trigg	21-221-9991	Cadiz (CASTNET)	EPA	Regional	03/01/2011 - Present*
Warren	21-227-0008	Oakland Elementary	SPM	Urban	12/15/1999 - 05/10/2012
Warren	21-227-0009	Ed Spear Park	SLAMS	Urban	05/10/2012 - Present
Washington	21-229-9991	Mackville (CASTNET)	EPA	Regional	03/01/2011 - Present*

Start dates are from AQS. Monitors were in operation prior to dates listed.

Evaluation of Minimum Monitoring Requirements

According to 40 CFR 58, Appendix D, state, and where appropriate, local agencies must operate ozone sites in various locations depending upon area size (in terms of population and geographic characteristics) and typical peak concentrations (expressed in percentages below, or near the ozone NAAQS).

Table D-2 of Appendix D to Part 58— SLAMS Minimum O_3 Monitoring Requirements		
MSA population[1 2]	**Minimum Number of Monitors Required**	
	Most recent 3-yr DV ≥85% of any NAAQS[3]	Most recent 3-yr DV <85% of any O_3 NAAQS[3 4]
>10 million	4	2
4-10 million	3	1
350,000-<4 million	2	1
50,000-<350,000[5]	1	0

[1]Minimum monitoring requirements apply to the metropolitan statistical area.
[2]Population based on latest available census figures.
[3]The ozone National Ambient Air Quality Standards levels and forms are defined in 40 CFR 50.
[4]These minimum monitoring requirements apply in the absence of a design value.
[5]Metropolitan statistical areas must contain an urbanized area of 50,000 or more population.

Additionally, at least one ozone site for each metropolitan statistical area (MSA), or combine statistical area (CSA) if multiple MSAs are involved, must be designed to record the maximum concentration for that particular metropolitan area. More than one maximum concentration site may be necessary in some areas.

The minimum monitoring requirements for Kentucky MSAs (including MSAs that cross state-borders) are evaluated in Table 1 of this chapter. The table uses 2013 population estimates and three-year design values to determine the minimum number of monitors required in each MSA. The table then compares the number of monitors required to the number of monitors that are actually present in the MSA (2014 monitors). Additionally, Table 1 includes the maximum concentration ozone site for each MSA, as designated in AQS.

Ultimately, the analysis shows that the number of ozone monitors present in each MSA either meets or exceeds the minimum number required. However, KDAQ did identify a deficit in the identification of maximum concentration ozone sites in AQS for three MSAs. In the Elizabethtown-Ft Knox, KY MSA, KDAQ will designate the Elizabethtown monitor (21-093-0006) as the maximum concentration site in AQS, as it is the only site in the MSA. In the Huntington-Ashland, WV-KY-OH MSA, KDAQ will designate the FIVCO monitor (21-019-0017) as the maximum concentration site, as it is the highest reading monitor in the MSA; however, KDAQ will notify agencies in Ohio and West Virginia prior to making any changes in AQS. Finally, in the Bowling Green, KY MSA, KDAQ recommends that the CASTNET ozone monitor located at the Mammoth Cave site (21-061-0501) be the designated maximum concentration site. The NPS has been contacted and has taken our recommendation under advisement.

Table 1: Ozone Minimum Monitoring Requirements For Metropolitan Statistical Areas (MSAs)												
CBSA Code	**State/ County Code**	**Area Name**	**2013 Population Estimate**	**2010-2013 8-Hr O_3 DV**	**3-Yr DV Valid**	**2011-2014 8-Hr O_3 DV**	**3-Yr DV Valid**	**Above 85% of the NAAQS**	**2014 # O_3 Sites**	**# Sites Required in MSA**	**# Met by KDAQ Sites**	**AQS Designated Maximum Conc Site for MSA**
14540	21003	Allen County, KY	20,311									
14540	21031	Butler County, KY	12,793									
14540	21061	Edmonson County, KY	12,062	**0.071**	Y	**0.069**	Y	Y	1			
14540	21227	Warren County, KY	118,370	0.069	Y	0.067	Y	Y	1			
14540	**Bowling Green, KY MSA**		**163,536**	**0.071**	**Y**	**0.069**	**Y**	**Y**	**2**	**1**	**Y**	**21-227-0009**
17140	18029	Dearborn County, IN	49,904									
17140	18115	Ohio County, IN	5,994									
17140	18161	Union County, IN	7,277									
17140	21015	Boone County, KY	124,442	0.067	Y	0.065	Y	Y	1			
17140	21023	Bracken County, KY	8,416									
17140	21037	Campbell County, KY	90,988	0.078	Y	0.075	Y	Y	1			
17140	21077	Gallatin County, KY	8,474									
17140	21081	Grant County, KY	24,753									
17140	21117	Kenton County, KY	163,145									
17140	21191	Pendleton County, KY	14,570									
17140	39015	Brown County, OH	44,264									
17140	39017	Butler County, OH	371,272	0.077	Y	0.074	Y	Y	3			
17140	39025	Clermont County, OH	200,218	0.079	Y	**0.075**	Y	Y	1			
17140	39061	Hamilton County, OH	804,520	**0.081**	Y	**0.075**	Y	Y	2			
17140	39165	Warren County, OH	219,169	0.076	Y	0.072	Y	Y	1			
17140	**Cincinnati, OH-KY-IN MSA**		**2,137,406**	**0.081**	**Y**	**0.075**	**Y**	**Y**	**9**	**2**	**Y**	**39-165-0007**
17300	21047	Christian County, KY	74,167	0.069	Y	0.067	Y	Y	1			
17300	21221	Trigg County, KY	14,293	**0.070**	Y	**0.069**	Y	Y	1			
17300	47125	Montgomery County,	184,119									
17300	**Clarksville, TN-KY MSA**		**272,579**	**0.070**	**Y**	**0.069**	**Y**	**Y**	**2**	**1**	**Y**	**Not Designated**
21060	21093	Hardin County, KY	108,191	**0.070**	Y	**0.067**	Y	Y	1			
21060	21123	Larue County, KY	14,064									
21060	21163	Meade County, KY	29,210									
21060	**Elizabethtown-Ft Knox, KY MSA**		**151,465**	**0.070**	**Y**	**0.067**	**Y**	**Y**	**1**	**1**	**Y**	**Not Designated**
21780	18129	Posey County, IN	25,486	0.070	Y	0.066	Y	Y	1			
21780	18163	Vanderburgh County, IN	181,398	0.074	Y	0.071	Y	Y	2			
21780	18173	Warrick County, IN	61,049	0.073	Y	0.071	Y	Y	3			
21780	21101	Henderson County, KY	46,347	**0.076**	Y	**0.074**	Y	Y	1			
21780	**Evansville, IN-KY MSA**		**314,280**	**0.076**	**Y**	**0.074**	**Y**	**Y**	**7**	**1**	**Y**	**21-101-0014**

Table 1: Ozone Minimum Monitoring Requirements For Metropolitan Statistical Areas (MSAs) (Continued)													
CBSA Code	State/ County Code	Area Name	2013 Population Estimate	2010-2013 8-Hr O_3 DV	3-Yr DV Valid	2011-2014 8-Hr O_3 DV	3-Yr DV Valid	Above 85% of the NAAQS	2014 # O_3 Sites	# Sites Required in MSA	# Met by KDAQ Sites	Designated Max Conc. Site for MSA
26580	21019	Boyd County, KY	48,886	**0.069**	Y	**0.068**	Y	Y	1			
26580	21089	Greenup County, KY	36,519	**0.069**	Y	0.065	Y	Y	1			
26580	39087	Lawrence County, OH	61,917	0.068	Y	0.066	Y	Y	2			
26580	54011	Cabell County, WV	97,133	**0.069**	Y	0.065	Y	Y	1			
26580	54043	Lincoln County, WV	21,559									
26580	54079	Putnam County, WV	56,650									
26580	54099	Wayne County, WV	41,437									
26580	**Huntington-Ashland, WV-KY-OH MSA**		**364,101**	**0.069**	**Y**	**0.068**	**Y**	**Y**	**5**	**2**	**Y**	**Not Designated**
30460	21017	Bourbon County, KY	19,998									
30460	21049	Clark County, KY	35,614									
30460	21067	Fayette County, KY	308,428	**0.071**	Y	**0.067**	Y	Y	1			
30460	21113	Jessamine County, KY	50,173	0.070	Y	**0.067**	Y	Y	1			
30460	21209	Scott County, KY	49,947									
30460	21239	Woodford County, KY	25,275									
30460	**Lexington-Fayette, KY MSA**		**489,435**	**0.071**	**Y**	**0.067**	**Y**	**Y**	**2**	**2**	**Y**	**21-067-0012**
31140	18019	Clark County, IN	112,938	0.078	Y	0.072	Y	Y	1			
31140	18043	Floyd County, IN	76,244	0.078	Y	0.073	Y	Y	1			
31140	18061	Harrison County, IN	39,163									
31140	18143	Scott County, IN	23,972									
31140	18175	Washington County, IN	27,780									
31140	21029	Bullitt County, KY	76,854	0.072	Y	0.069	Y	Y	1			
31140	21103	Henry County, KY	15,445									
31140	21111	Jefferson County, KY	756,832	0.081	Y	**0.075**	Y	Y	3			
31140	21185	Oldham County, KY	62,364	**0.082**	Y	0.074	Y	Y	1			
31140	21211	Shelby County, KY	44,216									
31140	21215	Spencer County, KY	17,637									
31140	21223	Trimble County, KY	8,816									
31140	**Louisville/Jefferson County, KY-IN MSA**		**1,262,261**	**0.082**	**Y**	**0.075**	**Y**	**Y**	**7**	**2**	**Y**	**21-185-0004**
36980	21059	Daviess County, KY	98,218	**0.077**	Y	**0.072**	Y	Y	1			
36980	21091	Hancock County, KY	8,687	0.073	Y	0.070	Y	Y	1			
36980	21149	McLean County, KY	9,496									
36980	**Owensboro, KY MSA**		**116,401**	**0.077**	**Y**	**0.072**	**Y**	**Y**	**2**	**1**	**Y**	**21-091-0012**

Source: USCB , CBSA-EST2013. http://www.census.gov/popest/data/metro/totals/2013/CBSA-EST2013-alldata.html. Last accessed: March 12, 2015.

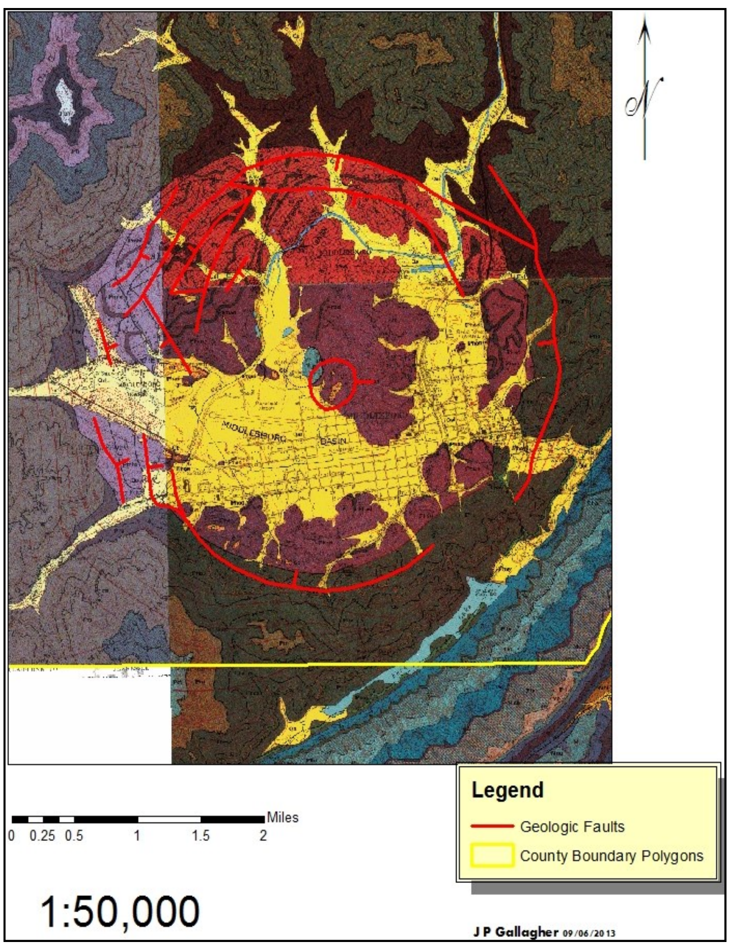
Evaluation of Spatial Scales of Representativeness

The spatial scale of representativeness (also called monitoring scale and spatial scale) describes the physical dimensions of a parcel of air, which has reasonably similar concentrations throughout. According to 40 CFR 58, Appendix D, the appropriate spatial scales for ozone sites are neighborhood, urban, and regional. Ozone requires appreciable formation time since the mixing of reactants and products occurs over large volumes of air, all of which reduces the importance of monitoring small scale spatial variability.

Spatial Scales of Representativeness 40 CFR 58, Appendix D	
Scale of Representativeness (Monitoring Scale)	**Physical Dimensions**
Microscale	Up to 100 meters
Middle scale	100 meters to 0.5 kilometers
Neighborhood scale	0.5 to 4.0 kilometers
Urban scale	4.0 to 50.0 kilometers
Regional Scale	Tens to hundreds of kilometers

During this network assessment, the appropriateness of the monitoring scale was considered for each monitor operated by KDAQ. In reviewing annual siting criteria evaluations, KDAQ personnel have repeatedly questioned the use of a regional monitoring scale for the ozone monitor at the Middlesboro air monitoring station (21-013-0002). The city of Middlesboro, including the monitoring station, is located within a large meteor impact crater, which is further surrounded by mountainous terrain. Areas of extremely complex terrain tend to limit the appropriateness of larger spatial scales of representativeness.

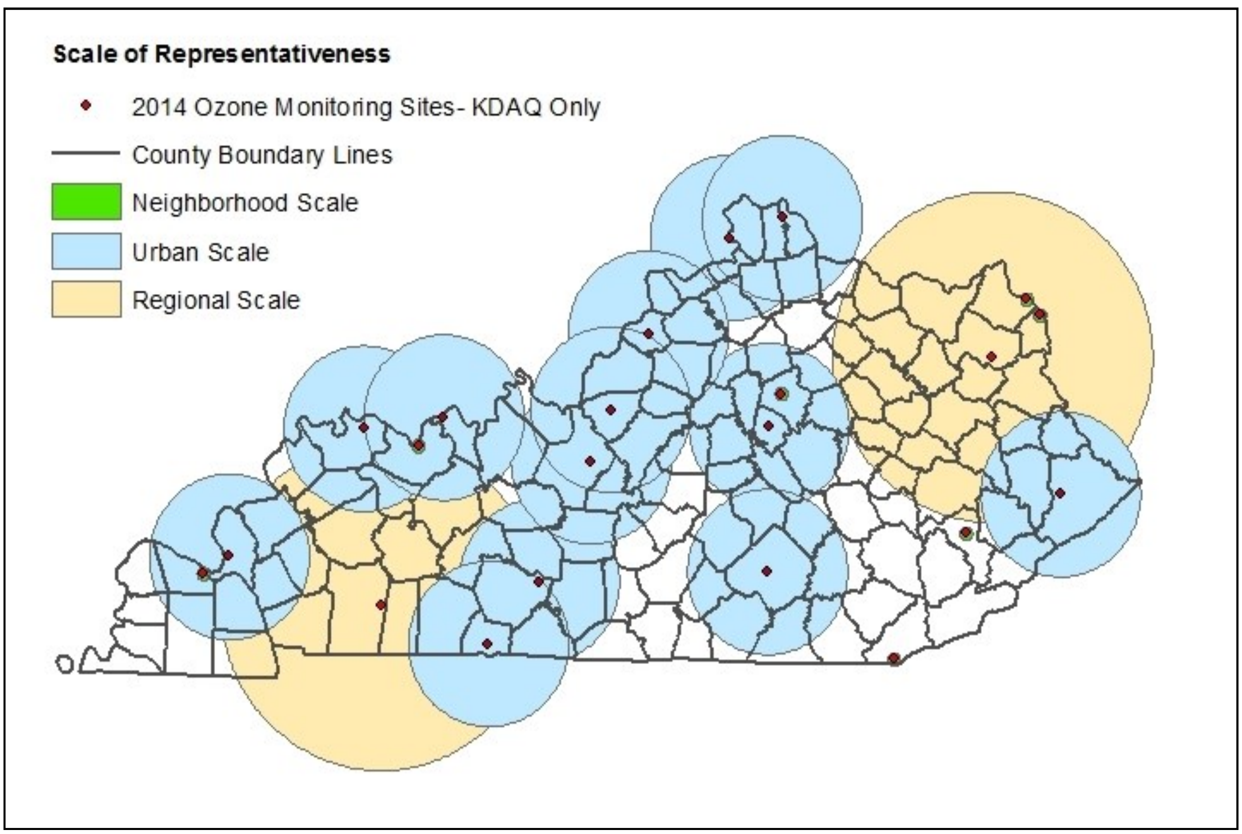
KDAQ also ran correlation matrices for ozone to look for sites that are unique. KDAQ did note that the Middlesboro ozone monitor did correlate well to the ozone monitor located at the Hazard air monitoring station (21-193-0003), which is geographically the closest site. Nonetheless, KDAQ recommends that the scale of representativeness be reduced from regional to neighborhood.



Geologic map of the Middlesboro crypto-explosive structure in Bell County, KY. Source: JP Gallagher, KDNR, Division of Oil and Gas, 2013

KDAQ also believes that the if any monitor in the network should be designated as regional scale, it is the ozone monitor located at the Grayson Lake background site (21-043-0500) in Carter County, KY. The scale of representativeness is currently listed as urban, but the monitor far exceeds the minimum distance to roads for an urban scale monitor, as set forth in 40 CFR 58, Appendix D.

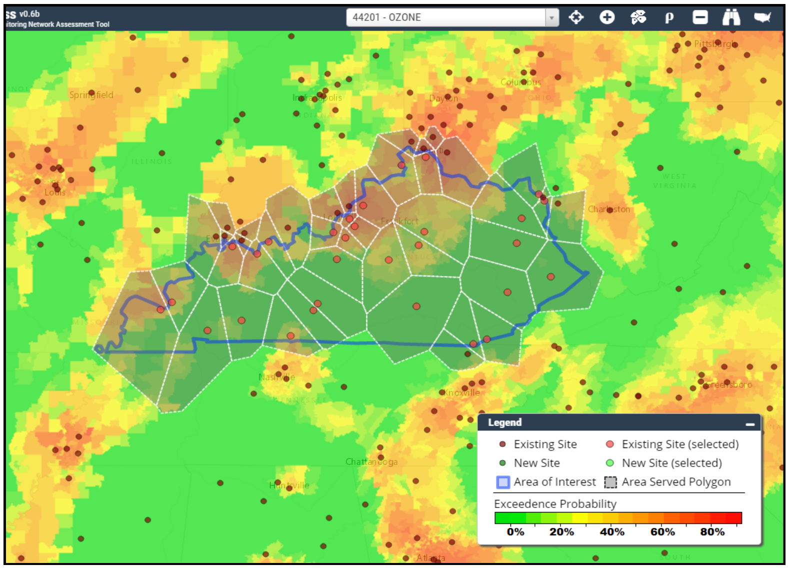
Finally, it should be noted that all equipment including the ozone monitor at the Ashland Primary site (21-019-0017) in Boyd County may be partially obstructed. A complete account of these siting issues is provided in Appendix D of this Network Assessment.



Scales of representativeness for ozone monitors operated by KDAQ. Monitoring scales for the Middlesboro and Grayson Lake sites reflect recommended changes.

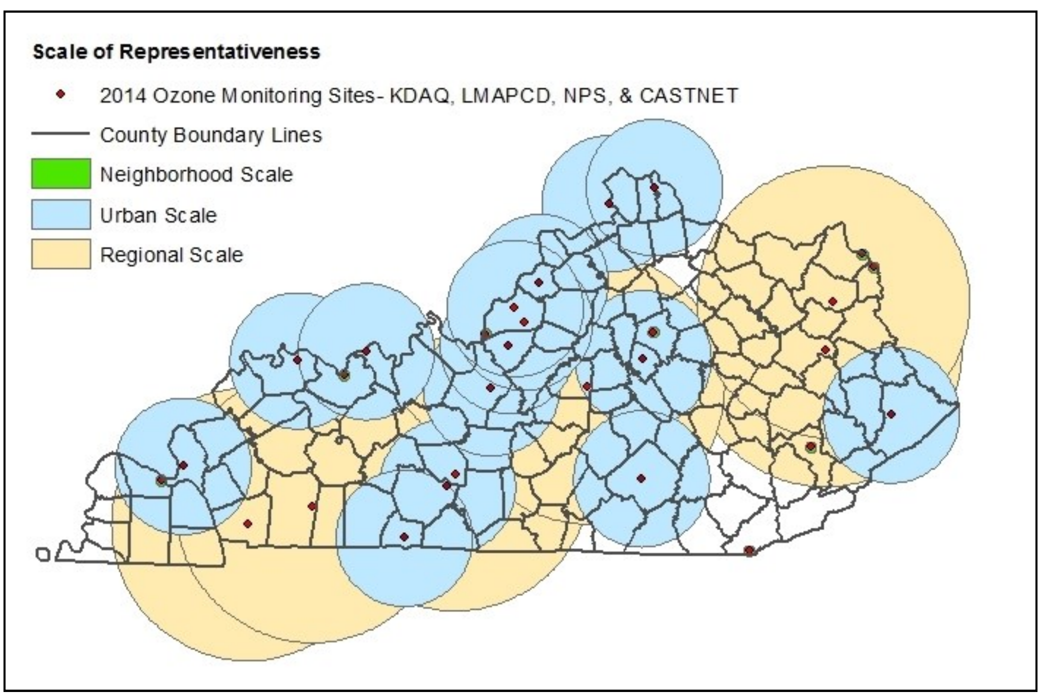
Evaluation of Network Coverage

Initially, KDAQ used the Areas Served Tool from LADCO to generate voronoi polygons in order to visually evaluate the amount of area served by each ozone monitor in Kentucky. The results of the Areas Served Tool are shown below. Considering the lack spatially variability for ozone, the large coverage area for certain monitors is acceptable.



Areas served by each ozone monitor in Kentucky.
Source: LADCO Ambient Air Monitoring Network Assessment Tools, NetAssess v0.6b. Last accessed: June 2015

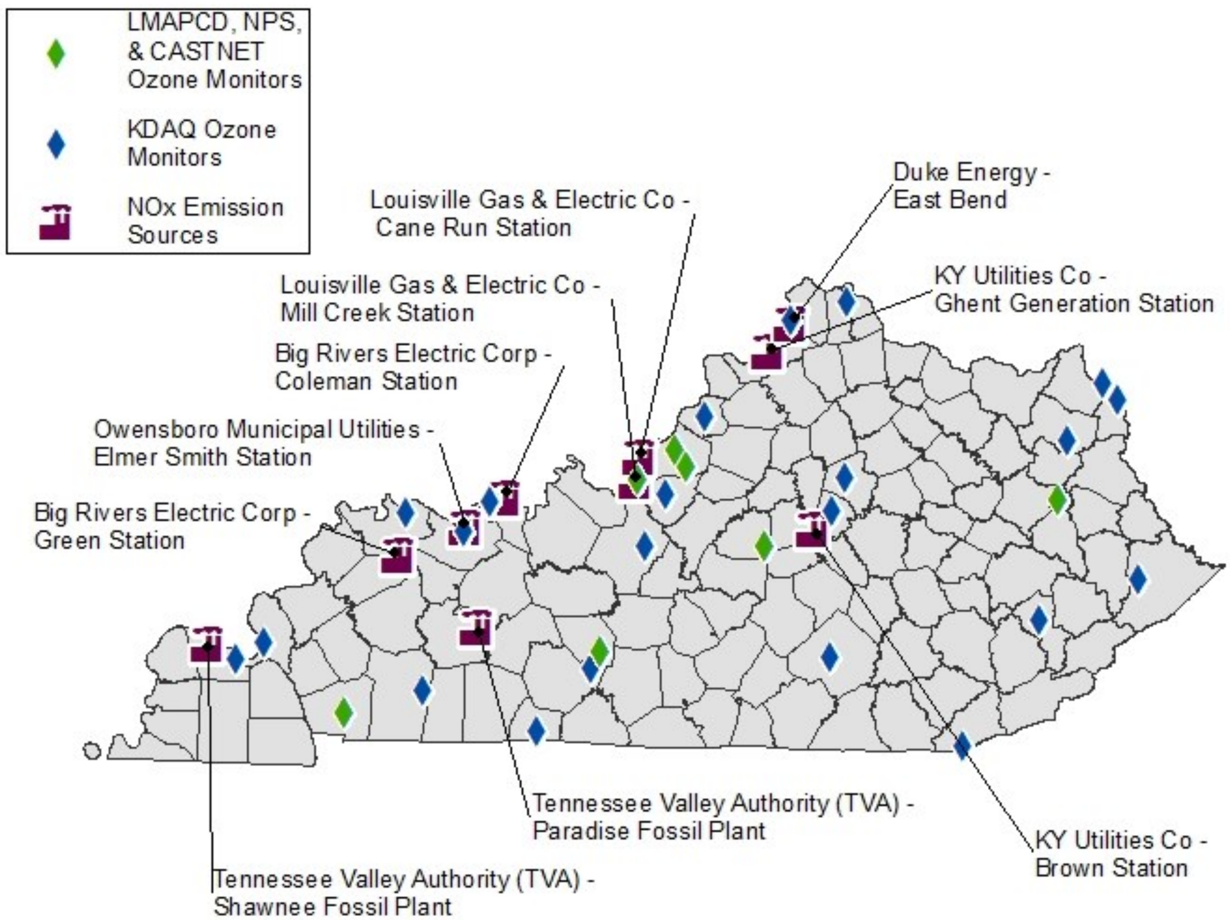
Ultimately, KDAQ relied upon spatial scales of representativeness for ozone monitors in Kentucky, including those operated by the NPS, LMAPCD, and CASTNET. Assuming that the Middlesboro ozone monitor is a neighborhood scale monitor, the map at the bottom of this page indicates that extreme southeastern Kentucky is not well represented by any of the ozone monitors currently in operation. However, the area in question is also characterized by mountainous terrain and low population density, as such establishment of additional ozone monitors would be unlikely to truly improve network coverage.



Scales of representativeness for all ozone monitors in Kentucky. Monitoring scales for the Middlesboro and Grayson Lake sites reflect recommended changes.

Finally, KDAQ looked at the locations of the top ten NO_x emission sources in the State, in relation to the location of current ozone monitors, as is shown by the map and chart below. Of those sources, TVA Paradise in Muhlenberg County is the only source that does not have a corresponding ozone monitor downwind. KDAQ has not operated an ozone monitor downwind of TVA Paradise since 2006; that monitor was located at the former Echols site (21-183-0032) in Ohio County.

Top Ten NO_x Sources and Kentucky Ozone Monitors



Top Ten NO_x Sources & 2013 Actual Emissions

Rank	Facility ID	Facility Name	County	2013 Actual Emissions (tpy)
1	3073	Tennessee Valley Authority - Shawnee Fossil Plant	McCracken	12094.7
2	704	KY Utilities Co - Ghent Generation Station	Carroll	12043.8
3	127	Louisville Gas & Electric Co - Mill Creek Station	Jefferson	9049.2
4	3239	Tennessee Valley Authority - Paradise Fossil Plant	Muhlenberg	7737.0
5	942	Owensboro Municipal Utilities - Elmer Smith Station	Daviess	7131.7
6	1640	Big Rivers Electric Corp - Coleman Station	Hancock	6097.6
7	126	Louisville Gas & Electric Co - Cane Run Station	Jefferson	4630.3
8	44411	Big Rivers Electric Corp - Green Station	Webster	4183.0
9	3148	KY Utilities Co - Brown Station	Mercer	3516.2
10	176	Duke Energy KY - East Bend	Boone	3491.3

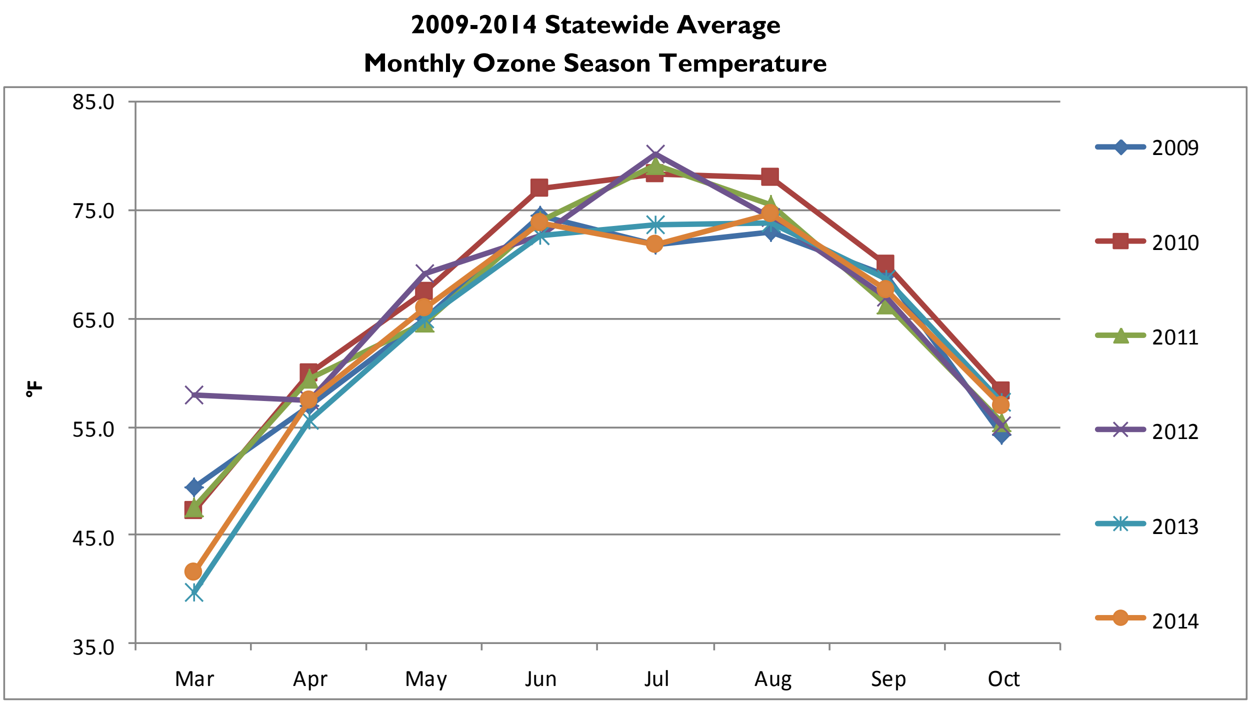
Source: KDAQ & LMAPCD Emissions Inventory Systems, February 2015

Evaluation of Concentration Trends

In order to analyze concentration trends, KDAQ analyzed 2009-2014 annual design values for each site in Kentucky. KDAQ also used the LADCO Network Assessment Tool in order to analyze the likeliness of an area experiencing at least one 8-hour ozone concentration greater than certain thresholds.

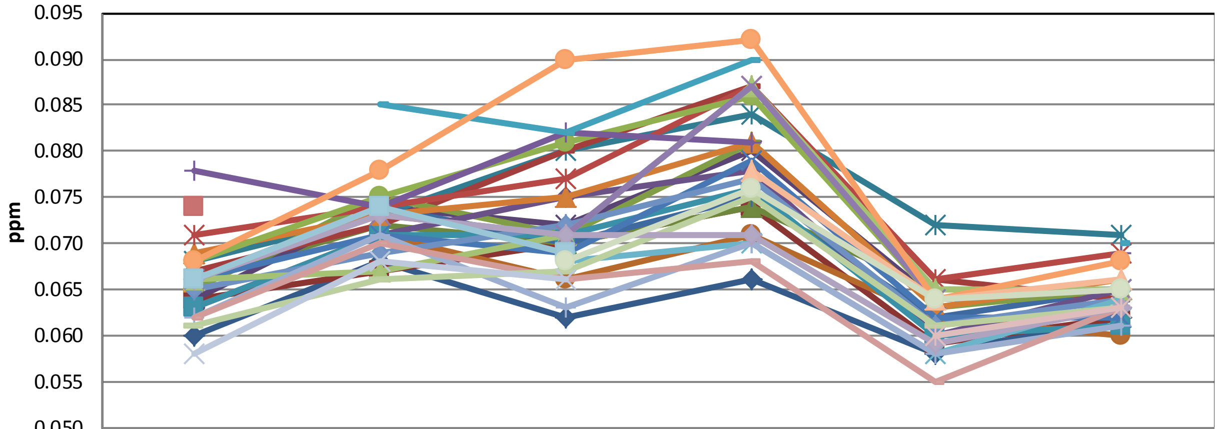
In analyzing 2009-2014 annual design values, ozone trends in the state have largely followed summer temperature trends, as expected. The chart below shows the statewide average monthly temperature during ozone season, aggregated by year (2009-2014), while the chart and table on the following page shows the annual fourth maximum ozone concentration for each monitor in the state during the 2009-2014 time-period.

Record-breaking temperatures in the summer of 2012 contributed to abnormally high ozone readings across the state (and nation). The effect of cooler summer temperatures that occurred in 2009, 2013, and 2014 can also be clearly seen in annual design values.



Source: Kentucky Mesonet. Monthly Data Summaries. http://www.kymesonet.org/index.html. Last accessed: May 25, 2015

Annual Fourth Highest Daily Maximum 8-Hour Ozone Concentration (2009-2014)



	2009	2010	2011	2012	2013	2014
21_013_0002	0.06	0.068	0.062	0.066	0.058	0.062
21_015_0003	0.064	0.067	0.07	0.074	0.059	0.062
21_019_0017	0.066	0.072	0.07	0.074	0.065	0.065
21_029_0006	0.064	0.074	0.072	0.08	0.064	0.065
21_037_3002	0.068	0.073	0.08	0.084	0.072	0.071
21_043_0500	0.063	0.071	0.066	0.071	0.062	0.06
21_047_0006	0.066	0.074	0.07	0.075	0.062	0.065
21_059_0005	0.067	0.072	0.08	0.087	0.066	0.064
21_061_0501	0.065	0.075	0.071	0.081	0.063	0.065
21_067_0012	0.063	0.071	0.075	0.078	0.06	0.065
21_089_0007	0.063	0.071	0.071	0.076	0.06	0.061
21_091_0012	0.069	0.073	0.075	0.081	0.063	0.066
21_093_0006	0.066	0.071	0.069	0.079	0.062	0.062
21_101_0014	0.071	0.074	0.077	0.087	0.066	0.069
21_111_0027	0.068	0.075	0.081	0.086	0.064	0.065
21_111_0051	0.078	0.074	0.082	0.081		0.069
21_111_0067		0.085	0.082	0.09		0.07
21_111_1021	0.065					
21_113_0001	0.065	0.069	0.072	0.077	0.061	0.064
21_117_0007	0.074					
21_139_0003	0.066	0.067	0.071	0.087	0.065	0.065
21_145_1024	0.066	0.073	0.071	0.087	0.064	0.065
21_175_9991			0.068	0.07	0.058	0.064
21_185_0004	0.068	0.078	0.09	0.092	0.064	0.068
21_193_0003	0.062	0.071	0.063	0.07	0.058	0.061
21_195_0002	0.062	0.07	0.066	0.068	0.055	0.063
21_199_0003	0.061	0.066	0.067	0.075	0.061	0.063
21_213_0004	0.066	0.073	0.071	0.071	0.059	0.063
21_221_8001	0.066	0.074	0.069			
21_221_9991				0.078	0.064	0.066
21_227_0008	0.058	0.068	0.066			
21_227_0009					0.06	0.063
21_229_9991			0.068	0.076	0.064	0.065

Data obtained from AQS on March 26, 2015. 2014 data is preliminary.
Invalid annual design values have been excluded.

The Exceedance Probabilities Tool was used to calculate the likeliness of an area experiencing at least one 8-hour ozone concentration above a chosen threshold in any one year. KDAQ used three different thresholds for its analysis, the results of which can be seen on the following page.

The first map was generated using the current level of the NAAQS (0.075 ppm). As can be seen, the areas most likely to experience one 8-hour ozone concentration in any given year above this set threshold are primarily located along the Ohio River. Eight of the top ten NO_x emitters in Kentucky are located in counties along the Ohio River, as such the results of the tool are not surprising.

The second and third images were generated using two of the proposed levels of NAAQS: 0.070 ppm and 0.065 ppm). A lowering of the NAAQS to 0.070 ppm would likely cause every metropolitan statistical area to be in non-attainment for the ozone standard

While the tool is only intended to predict whether or not an area would measure one 8-hour concentration above these thresholds, as opposed an actual violation of the 4th highest daily maximum 8-hour concentration, KDAQ is aware that lowering of the NAAQS to 0.065 could cause every monitor in the State, into non-compliance with the NAAQS, especially if seasonal summer temperatures rise.

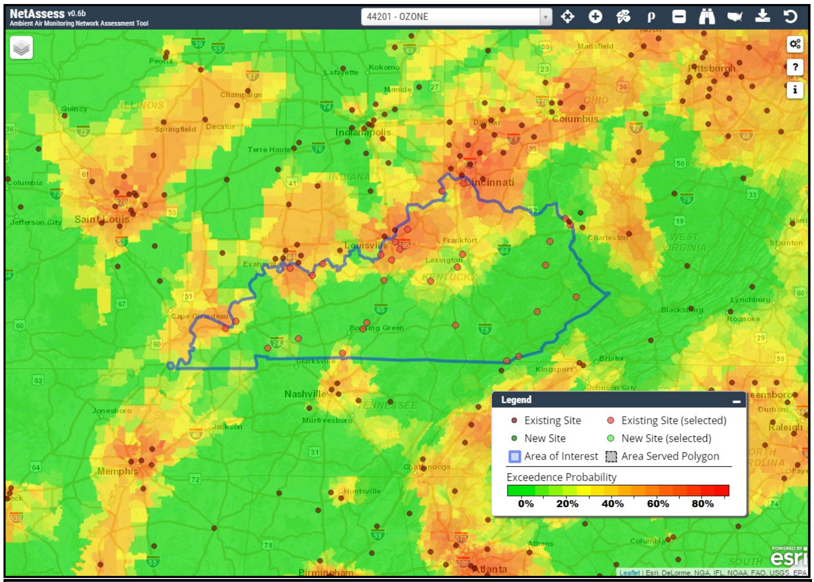
Three-year ozone design values for 2013 & 2014 are shown by the chart to the right. All design values exceeding the current level of the NAAQS (0.075 ppm) are highlighted red. All design values exceeding the proposed standard of 0.070 ppm are highlighted orange, while those exceeding the proposed standard of 0.065 ppm are highlighted yellow.

Three-Year Ozone Design Values

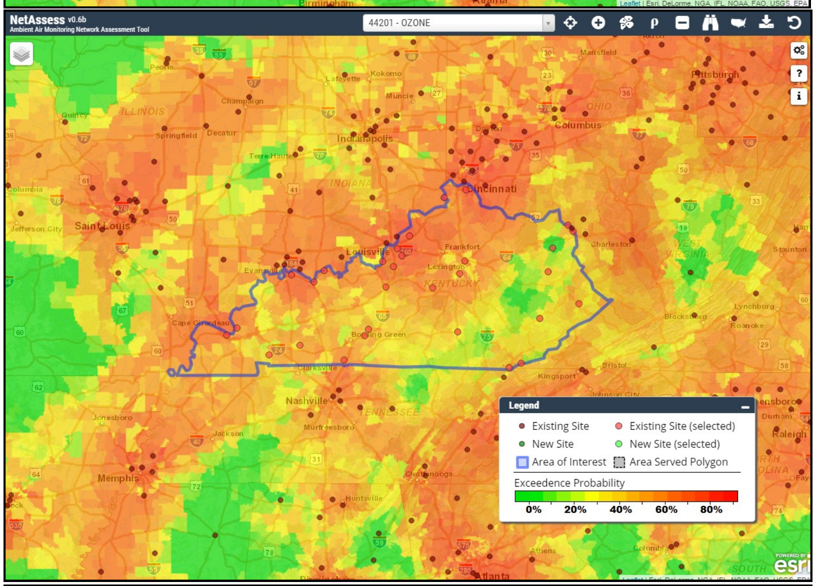
Site ID	County	2013	2014
21_013_0002	Bell	0.060	0.062
21_015_0003	Boone	0.070	0.065
21_019_0017	Boyd	0.070	0.068
21_029_0006	Bullitt	0.070	0.069
21_037_3002	Campbell	**0.080**	**0.075**
21_043_0500	Carter	0.070	0.064
21_047_0006	Christian	0.070	0.067
21_059_0005	Daviess	**0.080**	**0.072**
21_061_0501	Edmonson	0.070	0.069
21_067_0012	Fayette	0.070	0.067
21_089_0007	Greenup	0.070	0.065
21_091_0012	Hancock	0.070	0.070
21_093_0006	Hardin	0.070	0.067
21_101_0014	Henderson	**0.080**	**0.074**
21_111_0027	Jefferson	**0.080**	**0.071**
21_111_0051	Jefferson	**0.081***	**0.075***
21_111_0067	Jefferson	0.070*	0.066*
21_113_0001	Jessamine	0.070	0.067
21_139_0003	Livingston	0.070	**0.072**
21_145_1024	McCracken	0.070	**0.072**
21_175_9991	Morgan	0.070	0.064
21_185_0004	Oldham	**0.080**	**0.074**
21_193_0003	Perry	0.060	0.063
21_195_0002	Pike	0.060	0.062
21_199_0003	Pulaski	0.070	0.066
21_213_0004	Simpson	0.070	0.064
21_221_9991	Trigg	0.070*	0.069
21_227_0008	Warren	0.060*	0.058*
21_227_0009	Warren	0.070*	0.067
21_229_9991	Washington	0.070	0.068
Greater than	**0.075 ppm**		
Greater than	**0.070 ppm**		
Greater than	0.065 ppm		
Less than or equal to	0.065 ppm		

Ozone Exceedance Probabilities

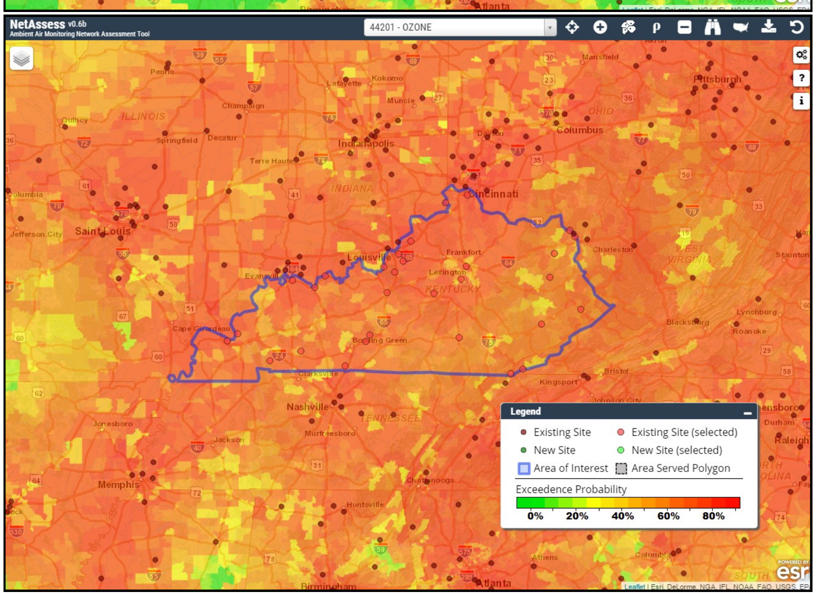
Source: LADCO Ambient Air Monitoring Network Assessment Tools, NetAssess v0.6b. Last accessed: March 2015



Probability of an area experiencing at least one 8-hour ozone concentration greater than 0.075 ppm in one year.



Probability of an area experiencing at least one 8-hour ozone concentration greater than 0.070 ppm in one year.



Probability of an area experiencing at least one 8-hour ozone concentration greater than 0.065 ppm in one year.

Evaluation of Network Correlation

The LADCO Ambient Air Monitoring Network Assessment Tool (NetAssess v0.6b) was used to evaluate the correlation and removal bias between ozone monitors. While a Pearson correlation of 0.6 (R=0.6) is typically considered good correlation between monitors, KDAQ believes that a stronger R value is required to qualify as "good correlation" between ozone monitors due to the fact that ozone is a regional pollutant with little spatial variability. As such, KDAQ used a Pearson correlation of R=0.8 as an indicator of good correlation across the network. Correlation greater than R=0.9 was considered excellent correlation.

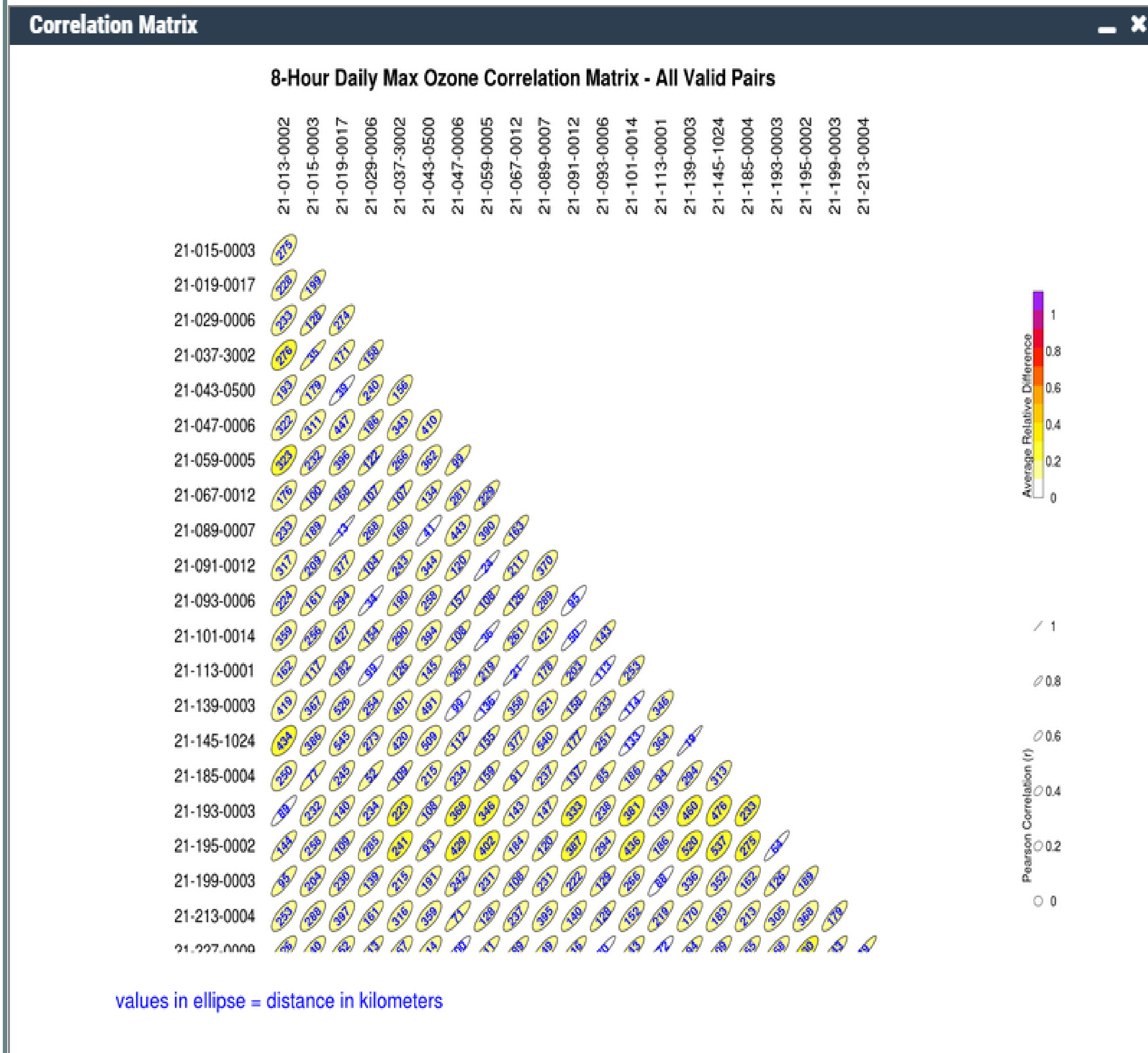
Because the correlation tool limits the number of sites that can be correlated during one run, one matrix was generated for all monitors operated by KDAQ. A separate matrix was generated for all monitors located in the Bowling Green, Elizabethtown, and Jefferson County MSAs, in order to compare monitors to those operated by the NPS at Mammoth Cave and LMAPCD in Jefferson County. Aside from the Mammoth Cave monitors, CASTNET monitors were not used in correlation site-pairs. Finally, all KDAQ monitors that had correlations greater than R=0.9 and distances less than 100 km between site pairs were further evaluated to determine if the correlations were a reliable estimation of redundancy.

While the new Ed Spear Park site (21-227-0009) appears to have stronger correlation (r=0.9) to the Mammoth Cave site (21-061-0501) than the original Oakland Elementary station (21-227-0008), the site has only been collecting data since May 2012; thus, further data collection is required to truly analyze the potential redundancy of monitors located in the Bowling Green MSA, as well as potential redundancy with the Franklin site.

The Smithland (21-139-0003) and JPRECC (21-145-1024) ozone monitors, in the Paducah micropolitan statistical area, also showed strong correlations. While the Smithland monitor is located downwind of Paducah, it is only 19 km from the JPRECC site, which may be an insufficient amount of time for photochemical formation of ozone to occur. Both sites recorded the same fourth highest daily maximum 8-hour ozone concentrations in 2009, 2011, 2012, and 2014. JPRECC recorded a significantly greater fourth highest 8-hour daily maximum in 2010 (0.073 vs 0.067 ppm), while Smithland recorded a marginally higher concentration in 2013 (0.064 vs 0.065 ppm).

The Lexington Primary (21-067-0012) and Nicholasville (21-113-0001) ozone monitors also displayed excellent correlation. The two monitors are only 21 miles apart, with the Nicholasville monitor located upwind of the MSA's population core. As such the, Lexington Primary monitor is the design value monitor for the Lexington MSA.

Within the Owensboro MSA, the Owensboro Primary (21-059-0005) and Lewisport (21-091-0001) monitors showed strong correlations. The Lewisport monitor is located approximately 24 km downwind from the Owensboro Primary site, which may not be sufficient time for photochemical ozone formation. The Owensboro Primary site is the design value monitor for the MSA.



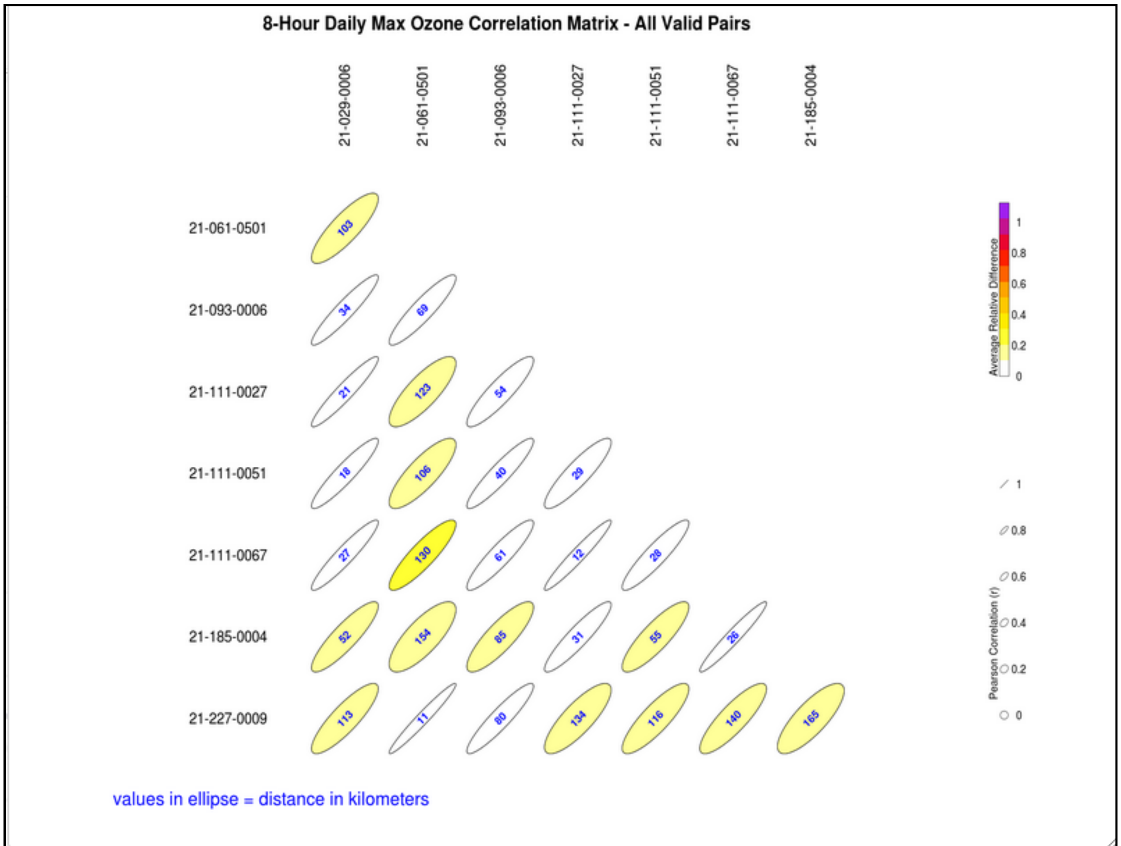
Correlation matrix between ozone monitors operated by KDAQ

Source: LADCO Ambient Air Monitoring Network Assessment Tool, NetAssess v0.6b. Last accessed: March 2015

Correlations between ozone monitors operated by KDAQ from NetAssess v0.6b											
Site 1	Site 2	Corr.	n	Rel. Diff	Distance (km)	Site 1	Site 2	Corr.	n	Rel. Diff	Distance (km)
21-013-0002	21-015-0003	0.605	721	0.175	275	21-093-0006	21-101-0014	0.855	667	0.109	143
21-013-0002	21-019-0017	0.699	722	0.15	228	21-093-0006	21-113-0001	0.905	662	0.085	113
21-013-0002	21-029-0006	0.668	723	0.164	233	21-093-0006	21-139-0003	0.809	646	0.124	233
21-013-0002	21-037-3002	0.568	723	0.201	276	21-093-0006	21-145-1024	0.818	671	0.126	251
21-013-0002	21-043-0500	0.755	708	0.127	193	21-093-0006	21-185-0004	0.842	671	0.113	85
21-013-0002	21-047-0006	0.671	722	0.176	322	21-093-0006	21-193-0003	0.723	660	0.173	238
21-013-0002	21-059-0005	0.6	721	0.201	323	21-093-0006	21-195-0002	0.7	660	0.192	294
21-013-0002	21-067-0012	0.686	723	0.162	176	21-029-0006	21-043-0500	0.732	710	0.157	240
21-013-0002	21-089-0007	0.694	718	0.158	233	21-029-0006	21-047-0006	0.816	724	0.142	186
21-013-0002	21-091-0012	0.599	707	0.185	317	21-029-0006	21-059-0005	0.87	723	0.138	122
21-013-0002	21-093-0006	0.717	672	0.149	224	21-029-0006	21-067-0012	0.883	725	0.106	107
21-013-0002	21-101-0014	0.589	721	0.194	359	21-029-0006	21-089-0007	0.758	720	0.157	268
21-013-0002	21-113-0001	0.716	716	0.146	162	21-029-0006	21-091-0012	0.872	709	0.116	104
21-013-0002	21-139-0003	0.571	700	0.197	419	21-029-0006	21-093-0006	0.935	669	0.076	34
21-013-0002	21-145-1024	0.58	723	0.202	434	21-029-0006	21-101-0014	0.849	723	0.133	154
21-013-0002	21-185-0004	0.608	725	0.195	250	21-029-0006	21-113-0001	0.905	718	0.097	99
21-013-0002	21-193-0003	0.895	714	0.095	89	21-029-0006	21-139-0003	0.78	702	0.154	254
21-013-0002	21-195-0002	0.833	712	0.134	144	21-029-0006	21-145-1024	0.78	727	0.152	273
21-013-0002	21-199-0003	0.84	726	0.109	95	21-029-0006	21-185-0004	0.876	727	0.124	52
21-013-0002	21-213-0004	0.716	704	0.15	253	21-029-0006	21-193-0003	0.714	716	0.176	234
21-013-0002	21-227-0009	0.755	400	0.167	226	21-029-0006	21-195-0002	0.705	715	0.191	285
21-015-0003	21-019-0017	0.797	722	0.133	199	21-029-0006	21-199-0003	0.808	728	0.127	139
21-015-0003	21-029-0006	0.844	723	0.117	128	21-029-0006	21-213-0004	0.813	706	0.128	161
21-015-0003	21-037-3002	0.924	723	0.109	35	21-029-0006	21-227-0009	0.855	404	0.13	113
21-015-0003	21-043-0500	0.761	709	0.142	179	21-037-3002	21-043-0500	0.748	710	0.163	156
21-015-0003	21-047-0006	0.71	722	0.176	311	21-037-3002	21-047-0006	0.68	724	0.169	343
21-015-0003	21-059-0005	0.79	721	0.164	232	21-037-3002	21-059-0005	0.781	723	0.144	266
21-015-0003	21-067-0012	0.851	723	0.124	100	21-037-3002	21-067-0012	0.864	725	0.115	107
21-015-0003	21-089-0007	0.785	718	0.143	189	21-037-3002	21-089-0007	0.792	720	0.152	160
21-015-0003	21-091-0012	0.813	707	0.139	209	21-037-3002	21-091-0012	0.797	709	0.141	243
21-015-0003	21-093-0006	0.805	667	0.133	161	21-037-3002	21-093-0006	0.786	672	0.14	190
21-015-0003	21-101-0014	0.792	722	0.156	256	21-037-3002	21-101-0014	0.758	723	0.149	290
21-015-0003	21-113-0001	0.844	717	0.119	117	21-037-3002	21-113-0001	0.851	718	0.116	126
21-015-0003	21-139-0003	0.733	700	0.17	367	21-037-3002	21-139-0003	0.718	702	0.164	401
21-015-0003	21-145-1024	0.72	723	0.174	386	21-037-3002	21-145-1024	0.703	725	0.175	420
21-015-0003	21-185-0004	0.9	725	0.134	77	21-037-3002	21-185-0004	0.892	727	0.109	109
21-015-0003	21-193-0003	0.678	714	0.173	232	21-037-3002	21-193-0003	0.644	716	0.211	223
21-015-0003	21-195-0002	0.685	712	0.187	258	21-037-3002	21-195-0002	0.659	714	0.223	241
21-015-0003	21-199-0003	0.723	726	0.153	204	21-037-3002	21-199-0003	0.726	728	0.161	215
21-015-0003	21-213-0004	0.706	704	0.16	288	21-037-3002	21-213-0004	0.686	706	0.174	316
21-015-0003	21-227-0009	0.742	406	0.164	240	21-037-3002	21-227-0009	0.757	404	0.149	267
21-019-0017	21-029-0006	0.77	724	0.148	274	21-043-0500	21-047-0006	0.645	709	0.178	410
21-019-0017	21-037-3002	0.809	724	0.146	171	21-043-0500	21-059-0005	0.65	708	0.193	362
21-019-0017	21-043-0500	0.905	709	0.088	39	21-043-0500	21-067-0012	0.784	710	0.137	134
21-019-0017	21-047-0006	0.66	723	0.186	447	21-043-0500	21-089-0007	0.889	705	0.099	41
21-019-0017	21-059-0005	0.712	722	0.189	396	21-043-0500	21-091-0012	0.664	694	0.176	344
21-019-0017	21-067-0012	0.851	724	0.119	168	21-043-0500	21-093-0006	0.711	660	0.154	258
21-019-0017	21-089-0007	0.968	719	0.057	13	21-043-0500	21-101-0014	0.643	708	0.184	394
21-019-0017	21-091-0012	0.712	708	0.174	377	21-043-0500	21-113-0001	0.79	703	0.129	145
21-019-0017	21-093-0006	0.735	668	0.154	294	21-043-0500	21-139-0003	0.588	688	0.196	491
21-019-0017	21-101-0014	0.695	722	0.183	427	21-043-0500	21-145-1024	0.589	710	0.2	509
21-019-0017	21-113-0001	0.832	717	0.123	182	21-043-0500	21-185-0004	0.704	712	0.176	215
21-019-0017	21-139-0003	0.636	705	0.198	526	21-043-0500	21-193-0003	0.838	701	0.121	108
21-019-0017	21-145-1024	0.641	724	0.198	545	21-043-0500	21-195-0002	0.839	699	0.14	93
21-019-0017	21-185-0004	0.769	726	0.169	245	21-043-0500	21-199-0003	0.776	713	0.126	191
21-019-0017	21-193-0003	0.788	715	0.138	140	21-043-0500	21-213-0004	0.658	692	0.166	359
21-019-0017	21-195-0002	0.832	713	0.14	109	21-043-0500	21-227-0009	0.716	399	0.171	314
21-019-0017	21-199-0003	0.767	727	0.137	230	21-047-0006	21-059-0005	0.853	722	0.102	99
21-019-0017	21-213-0004	0.678	705	0.168	397	21-047-0006	21-067-0012	0.767	724	0.15	281

Correlations between ozone monitors operated by KDAQ from NetAssess v0.6b (Continued)											
Site 1	Site 2	Corr.	n	Rel. Diff	Distance (km)	Site 1	Site 2	Corr.	n	Rel. Diff	Distance (km)
21-019-0017	21-227-0009	0.728	407	0.17	352	21-047-0006	21-089-0007	0.679	719	0.18	443
21-029-0006	21-037-3002	0.828	725	0.137	158	21-047-0006	21-091-0012	0.814	708	0.118	120
21-047-0006	21-195-0002	0.651	713	0.228	429	21-047-0006	21-093-0006	0.879	668	0.103	157
21-047-0006	21-199-0003	0.791	727	0.132	242	21-047-0006	21-101-0014	0.849	722	0.107	108
21-047-0006	21-213-0004	0.875	705	0.108	71	21-047-0006	21-113-0001	0.805	717	0.129	265
21-047-0006	21-227-0009	0.889	401	0.094	100	21-047-0006	21-139-0003	0.857	701	0.1	99
21-059-0005	21-067-0012	0.826	723	0.142	229	21-047-0006	21-145-1024	0.846	724	0.114	112
21-059-0005	21-089-0007	0.709	718	0.188	390	21-047-0006	21-185-0004	0.735	726	0.146	234
21-059-0005	21-091-0012	0.947	707	0.074	24	21-047-0006	21-193-0003	0.673	715	0.206	368
21-059-0005	21-093-0006	0.875	667	0.111	108	21-093-0006	21-199-0003	0.847	672	0.106	129
21-059-0005	21-101-0014	0.942	721	0.068	36	21-093-0006	21-213-0004	0.857	652	0.102	128
21-059-0005	21-113-0001	0.841	716	0.127	219	21-093-0006	21-227-0009	0.923	347	0.082	80
21-059-0005	21-139-0003	0.884	701	0.095	136	21-101-0014	21-113-0001	0.814	719	0.129	253
21-059-0005	21-145-1024	0.868	723	0.116	155	21-101-0014	21-139-0003	0.906	700	0.085	114
21-059-0005	21-185-0004	0.846	725	0.116	159	21-101-0014	21-145-1024	0.891	723	0.097	133
21-059-0005	21-193-0003	0.625	714	0.23	346	21-101-0014	21-185-0004	0.814	725	0.126	186
21-059-0005	21-195-0002	0.629	712	0.247	402	21-101-0014	21-193-0003	0.623	714	0.22	381
21-059-0005	21-199-0003	0.738	726	0.158	231	21-101-0014	21-195-0002	0.627	713	0.236	436
21-059-0005	21-213-0004	0.803	706	0.141	128	21-101-0014	21-199-0003	0.711	726	0.158	266
21-059-0005	21-227-0009	0.859	407	0.115	111	21-101-0014	21-213-0004	0.761	704	0.145	152
21-067-0012	21-089-0007	0.846	720	0.122	163	21-101-0014	21-227-0009	0.83	401	0.123	143
21-067-0012	21-091-0012	0.817	710	0.132	211	21-113-0001	21-139-0003	0.76	695	0.141	346
21-067-0012	21-093-0006	0.876	669	0.102	126	21-113-0001	21-145-1024	0.755	718	0.151	364
21-067-0012	21-101-0014	0.807	723	0.14	261	21-113-0001	21-185-0004	0.86	720	0.118	94
21-067-0012	21-113-0001	0.963	718	0.059	21	21-113-0001	21-193-0003	0.773	709	0.158	139
21-067-0012	21-139-0003	0.756	702	0.154	358	21-113-0001	21-195-0002	0.762	707	0.177	186
21-067-0012	21-145-1024	0.755	725	0.159	377	21-113-0001	21-199-0003	0.879	721	0.092	88
21-067-0012	21-185-0004	0.868	727	0.122	91	21-113-0001	21-213-0004	0.82	699	0.12	219
21-067-0012	21-193-0003	0.751	716	0.169	143	21-113-0001	21-227-0009	0.876	399	0.1	172
21-067-0012	21-195-0002	0.753	714	0.182	184	21-139-0003	21-145-1024	0.97	702	0.053	19
21-067-0012	21-199-0003	0.838	728	0.114	108	21-139-0003	21-185-0004	0.776	704	0.142	294
21-067-0012	21-213-0004	0.776	707	0.139	237	21-139-0003	21-193-0003	0.585	693	0.226	460
21-067-0012	21-227-0009	0.853	403	0.117	189	21-139-0003	21-195-0002	0.582	691	0.243	520
21-089-0007	21-091-0012	0.712	704	0.174	370	21-139-0003	21-199-0003	0.684	705	0.163	336
21-089-0007	21-093-0006	0.744	665	0.154	289	21-139-0003	21-213-0004	0.752	683	0.145	170
21-089-0007	21-101-0014	0.697	718	0.183	421	21-139-0003	21-227-0009	0.832	399	0.125	194
21-089-0007	21-113-0001	0.822	713	0.129	178	21-145-1024	21-185-0004	0.769	727	0.148	313
21-089-0007	21-139-0003	0.65	697	0.193	521	21-145-1024	21-193-0003	0.589	716	0.228	476
21-089-0007	21-145-1024	0.67	720	0.189	540	21-145-1024	21-195-0002	0.587	715	0.24	537
21-089-0007	21-185-0004	0.766	722	0.164	237	21-145-1024	21-199-0003	0.686	728	0.169	352
21-089-0007	21-193-0003	0.783	711	0.15	147	21-145-1024	21-213-0004	0.751	706	0.147	183
21-089-0007	21-195-0002	0.826	711	0.152	120	21-145-1024	21-227-0009	0.828	405	0.13	209
21-089-0007	21-199-0003	0.759	723	0.144	231	21-185-0004	21-193-0003	0.662	718	0.218	233
21-089-0007	21-213-0004	0.683	702	0.17	395	21-185-0004	21-195-0002	0.681	716	0.233	275
21-089-0007	21-227-0009	0.76	399	0.163	349	21-185-0004	21-199-0003	0.749	730	0.157	162
21-091-0012	21-093-0006	0.865	653	0.099	95	21-185-0004	21-213-0004	0.755	709	0.152	213
21-091-0012	21-101-0014	0.923	707	0.079	50	21-185-0004	21-227-0009	0.795	404	0.14	165
21-091-0012	21-113-0001	0.832	702	0.12	203	21-193-0003	21-195-0002	0.926	705	0.092	64
21-091-0012	21-139-0003	0.873	686	0.103	158	21-193-0003	21-199-0003	0.854	719	0.126	126
21-091-0012	21-145-1024	0.863	709	0.112	177	21-193-0003	21-213-0004	0.7	698	0.174	305
21-091-0012	21-185-0004	0.869	711	0.109	137	21-193-0003	21-227-0009	0.766	407	0.191	268
21-091-0012	21-193-0003	0.636	700	0.209	333	21-195-0002	21-199-0003	0.803	717	0.158	189
21-091-0012	21-195-0002	0.64	701	0.225	387	21-195-0002	21-213-0004	0.685	695	0.193	368
21-091-0012	21-199-0003	0.734	713	0.148	222	21-195-0002	21-227-0009	0.733	401	0.222	330
21-091-0012	21-213-0004	0.788	690	0.13	140	21-199-0003	21-213-0004	0.834	709	0.113	179
21-091-0012	21-227-0009	0.837	399	0.121	116	21-199-0003	21-227-0009	0.87	405	0.114	143
						21-213-0004	21-227-0009	0.922	393	0.101	49

Chart & Table: Correlation matrix between KDAQ, NPS, & LMAPCD site pairs in the Bowling Green, Elizabethtown, & Jefferson County MSAs.
Source: LADCO Ambient Air Monitoring Network Assessment Tool, NetAssess v0.6b. Last accessed: March 2015



Correlations between KDAQ, NPS, & LMAPCD Site Pairs in the Bowling Green, Elizabethtown, & Jefferson County MSAs from NetAssess v0.6b					
Site 1	**Site 2**	**Corr.**	**n**	**Rel. Diff**	**Distance (km)**
21-029-0006	21-093-0006	0.935	669	0.0761	34
21-029-0006	21-111-0027	0.944	724	0.0774	21
21-029-0006	21-111-0051	0.926	484	0.0843	18
21-029-0006	21-111-0067	0.937	512	0.0907	27
21-029-0006	21-185-0004	0.876	727	0.124	52
21-029-0006	21-227-0009	0.855	404	0.13	113
21-061-0501	21-093-0006	0.909	657	0.0994	69
21-061-0501	21-111-0027	0.804	712	0.13	123
21-061-0501	21-111-0051	0.82	474	0.134	106
21-061-0501	21-111-0067	0.878	783	0.211	130
21-061-0501	21-185-0004	0.774	715	0.134	154
21-061-0501	21-227-0009	0.972	399	0.0541	11
21-093-0006	21-111-0027	0.89	668	0.0928	54
21-093-0006	21-111-0051	0.923	427	0.0756	40
21-093-0006	21-111-0067	0.91	454	0.0975	61
21-093-0006	21-185-0004	0.842	671	0.113	85
21-093-0006	21-227-0009	0.923	347	0.0824	80
21-111-0027	21-111-0051	0.886	485	0.098	29
21-111-0027	21-111-0067	0.962	510	0.0662	12
21-111-0027	21-185-0004	0.917	726	0.0893	31
21-111-0027	21-227-0009	0.816	402	0.122	134
21-111-0051	21-111-0067	0.912	484	0.0912	28
21-111-0051	21-185-0004	0.851	486	0.125	55
21-111-0051	21-227-0009	0.847	171	0.131	116
21-111-0067	21-185-0004	0.962	514	0.0929	26
21-111-0067	21-227-0009	0.849	200	0.154	140
21-185-0004	21-227-0009	0.795	404	0.14	165

Evaluation of Monitor Redundancy based upon Correlations from NetAssess v0.6b: Includes all KDAQ monitors with correlation greater than 0.9 and distance less than 100 km between site-pairs.								
Site 1		**Site 2**		**Corr.**	**n**	**Rel. Diff.**	**Distance (km)**	**Redundancy**
Mammoth Cave (NPS)	21-061-0501	Ed Spear Park	21-227-0009	0.972	399	0.0541	11	Potentially redundant: Insufficient Sample Size; Separate PQAO.
Smithland	21-139-0003	JPRECC	21-145-1024	0.97	702	0.053	19	Yes: Similar DVs for micro area.
FIVCO	21-019-0017	Worthington	21-089-0007	0.968	719	0.057	13	Potentially redundant: complex terrain may limit scale.
Lexington	21-067-0012	Nicholasville	21-113-0001	0.963	718	0.059	21	Yes: Lexington is DV for MSA.
Cannons Ln (LMAPCD)	21-111-0067	Buckner	21-185-0004	0.962	514	0.0929	26	No: Buckner is maximum conc. Site for MSA. Separate PQAO.
Owensboro	21-059-0005	Lewisport	21-091-0012	0.947	707	0.074	24	Yes: Owensboro is DV for MSA.
Shepherdsville	21-029-0006	Bates Elem (LMAPCD)	21-111-0027	0.944	724	0.0774	21	No: Shepherdsville is upwind of MSA. Separate PQAO.
Owensboro	21-059-0005	Baskett	21-101-0014	0.942	721	0.068	36	No: Each is downwind of separate MSAs.
Shepherdsville	21-029-0006	Cannons Lane (LMAPCD)	21-111-0067	0.937	512	0.0907	27	No: Shepherdsville is upwind of MSA. Separate PQAO.
Shepherdsville	21-029-0006	Elizabethtown	21-093-0006	0.935	669	0.0761	34	No: Most likely same volume of air, but separate MSAs.
Shepherdsville	21-029-0006	Watson (LMAPCD)	21-111-0051	0.926	484	0.0843	18	No: Shepherdsville is upwind of MSA. Separate PQAO.
Hazard	21-193-0003	Pikeville	21-195-0002	0.926	705	0.092	64	Potentially redundant: complex terrain may limit scale.
East Bend	21-015-0003	NKU	21-037-3002	0.924	723	0.109	35	Yes: Both sites are upwind of the population core of MSA.
Elizabethtown	21-093-0006	Ed Spear Park	21-227-0009	0.923	347	0.0824	80	No: Bowling Green MSA likely contributor to E-town, but separate MSAs.
Elizabethtown	21-093-0006	Watson (LMAPCD)	21-111-0051	0.923	427	0.0756	40	No: Separate MSAs.
Lewisport	21-091-0012	Baskett	21-101-0014	0.923	707	0.079	50	No: Separate MSAs.
Franklin	21-213-0004	Ed Spear Park	21-227-0009	0.922	393	0.101	49	No: Franklin is upwind of /not included in the Bowling Green MSA. Ed Spear Park may have
Bates Elem (LMAPCD)	21-111-0027	Buckner	21-185-0004	0.917	726	0.0893	31	No: Buckner is maximum conc. site for MSA. Separate PQAO.
Elizabethtown	21-093-0006	Cannons Lane (LMAPCD)	21-111-0067	0.91	454	0.0975	61	No: Separate MSA; Separate PQAO.
Mammoth Cave (NPS)	21-061-0501	Elizabethtown	21-093-0006	0.909	657	0.0994	69	No: Bowling Green MSA likely contributor to E-town, but separate MSAs.
FIVCO	21-019-0017	Grayson Lake	21-043-0500	0.905	709	0.088	39	No: Grayson Lake is the background site. Complex terrain may limit scale.
Shepherdsville	21-029-0006	Nicholasville	21-113-0001	0.905	718	0.097	99	No: Upwind of separate MSAs.
East Bend	21-015-0003	Buckner	21-185-0004	0.9	725	0.134	77	No: Most likely same volume of air, but separate MSAs.

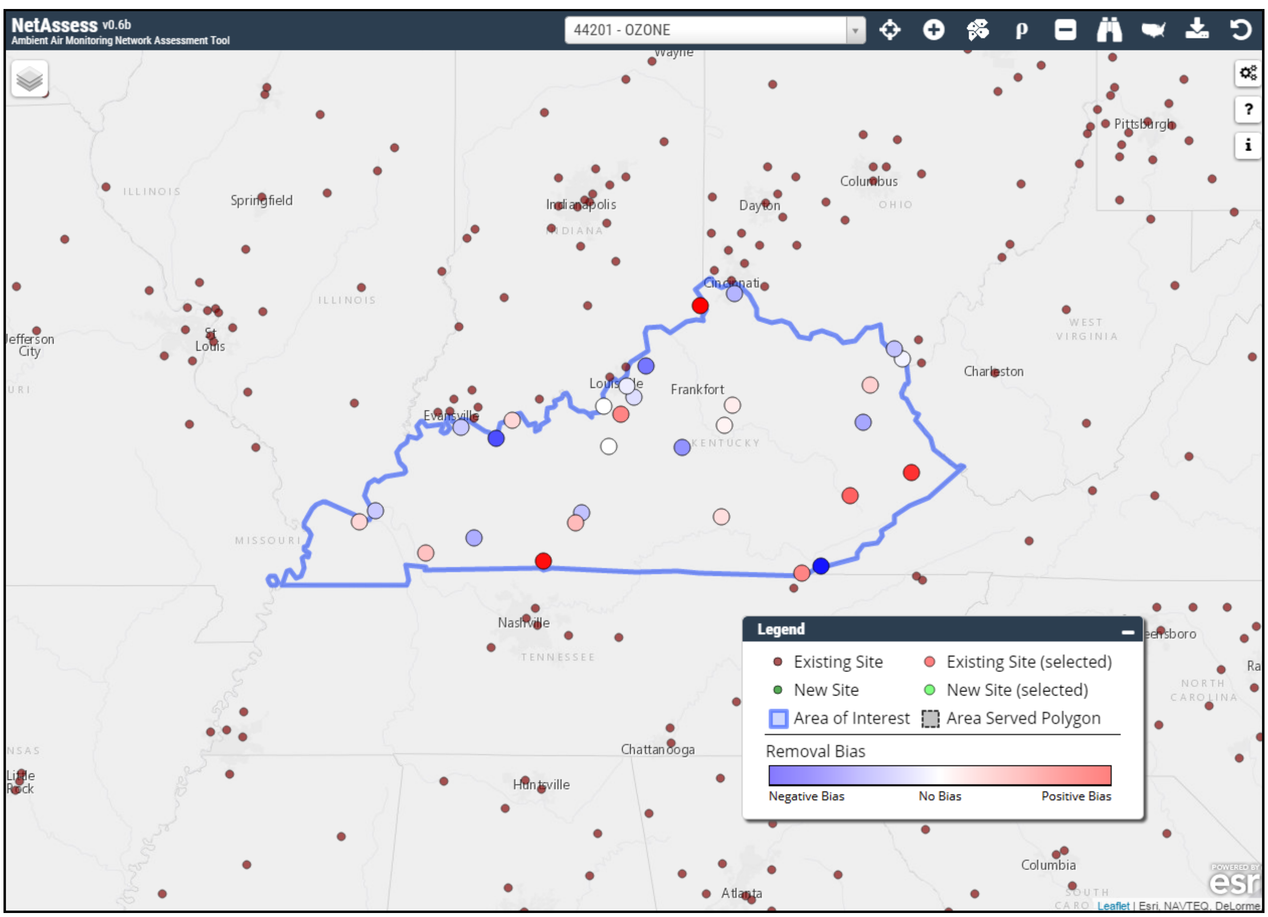
Evaluation of Removal Bias

The Smithland, Nicholasville, and Lewisport sites were identified as being redundant during the analysis with the Correlation Tool. These three sites were further evaluated with the Removal Bias Tool to determine if they are good candidates for discontinuance.

Ultimately, the Nicholasville (21-113-0001) site was shown to have little to no bias, indicating that the ozone monitor is indeed redundant and removal of the monitor would have little effect on the overall network.

The Lewisport site (21-091-0012) was shown to have a small degree of positive bias, indicating that the monitor tends to read lower than it's neighbors. As such, the Lewisport is another choice for shutdown, should discontinuance be needed due to budget constraints.

For Smithland (21-139-0003), the Removal Bias tool indicated that the monitor reads marginally higher than JPRECC, as the dataset used in the analysis was limited to 2011-2013. While shutdown would have a minimal effect on the network, especially since no ozone monitors are currently required, KDAQ will need to evaluate future data to ensure that Smithland is not the design value monitor for the micropolitan statistical area. If Smithland is shown to not be the design value site, KDAQ could either shut the ozone monitor down or move it to the nearby Bloodworth air toxics site (21-139-0004).



Statewide ozone monitor removal bias. Monitors that record higher concentrations have negative bias (blue). Source: LADCO Ambient Air Monitoring Network Assessment Tools, NetAssess v0.6b. Last accessed: June 2015

Ozone Monitoring Network Conclusions

The ozone monitoring network meets or exceeds the minimum number of monitors required in each MSA. However, three MSAs have never had a maximum concentration site formally established. As such KDAQ intends to make the following modifications to monitor metadata in AQS, as well as in the Annual Network Plan:

- Elizabethtown-Ft Knox, KY MSA: KDAQ will designate the Elizabethtown monitor (21-093-0006) as the maximum concentration site in AQS, as it is the only site in the MSA.
- Huntington-Ashland, WV-KY-OH MSA: KDAQ will designate the FIVCO monitor (21-019-0017) as the maximum concentration site, as it is the highest reading monitor in the MSA; however, KDAQ will notify agencies in Ohio and West Virginia prior to making any changes in AQS.
- Bowling Green, KY MSA: KDAQ recommends that the CASTNET ozone monitor located at the Mammoth Cave site (21-061-0501) be the designated maximum concentration site, if this is agreeable to the National Park Service and the EPA

The evaluation of spatial scales of representativeness indicates that two ozone monitors likely have monitoring scales that differ from the metadata established in AQS. As such KDAQ intends to make the following changes:

- Middlesboro (21-013-0002): The monitoring scale will be changed from regional to neighborhood.
- Grayson Lake (21-043-0500): The monitoring scale will be changed from urban to regional.

KDAQ identified extreme southeastern Kentucky as potentially being under-represented by the ozone monitoring network. However, KDAQ doubts that addition of additional monitors would make a significant impact considering the low population of the areas and the rough terrain. Any monitor established would protect few people and would likely be of a smaller monitoring scale.

While KDAQ is not proposing to discontinue any ozone monitor at this time, the analysis did show that the Nicholasville site (21-113-0001) in Jessamine County is redundant; shutdown would have little effect on the effectiveness of the ozone network.

The Lewisport monitor (21-091-0012) in Hancock County is also redundant and records concentrations slightly below those recorded by neighboring sites. As such, Lewisport may also be a candidate for shutdown, should budget constraints require monitor reductions.

The ozone monitor at the Smithland site (21-139-0003) may also be a good candidate for shutdown, but further data will need to be evaluated to ensure that the monitor is truly redundant. As opposed to complete shutdown, KDAQ could instead move the monitor to the nearby Bloodworth site (21-139-0004), which would be representative of impacts from the Paducah urbanized area, as well as the Calvert City Industrial Complex.

Particulate Matter ($PM_{2.5}$) Monitoring Network

$PM_{2.5}$ Monitoring Network History (2009-Present)

The Kentucky $PM_{2.5}$ monitoring network currently consists of 23 intermittent samplers and 15 continuous monitors located in 17 counties throughout Kentucky. Of those, KDAQ operates 18 intermittent samplers and ten continuous monitors. Additionally, LMAPCD operates five intermittent samplers and four continuous samplers, while the NPS operates a continuous monitor at Mammoth Cave National Park.

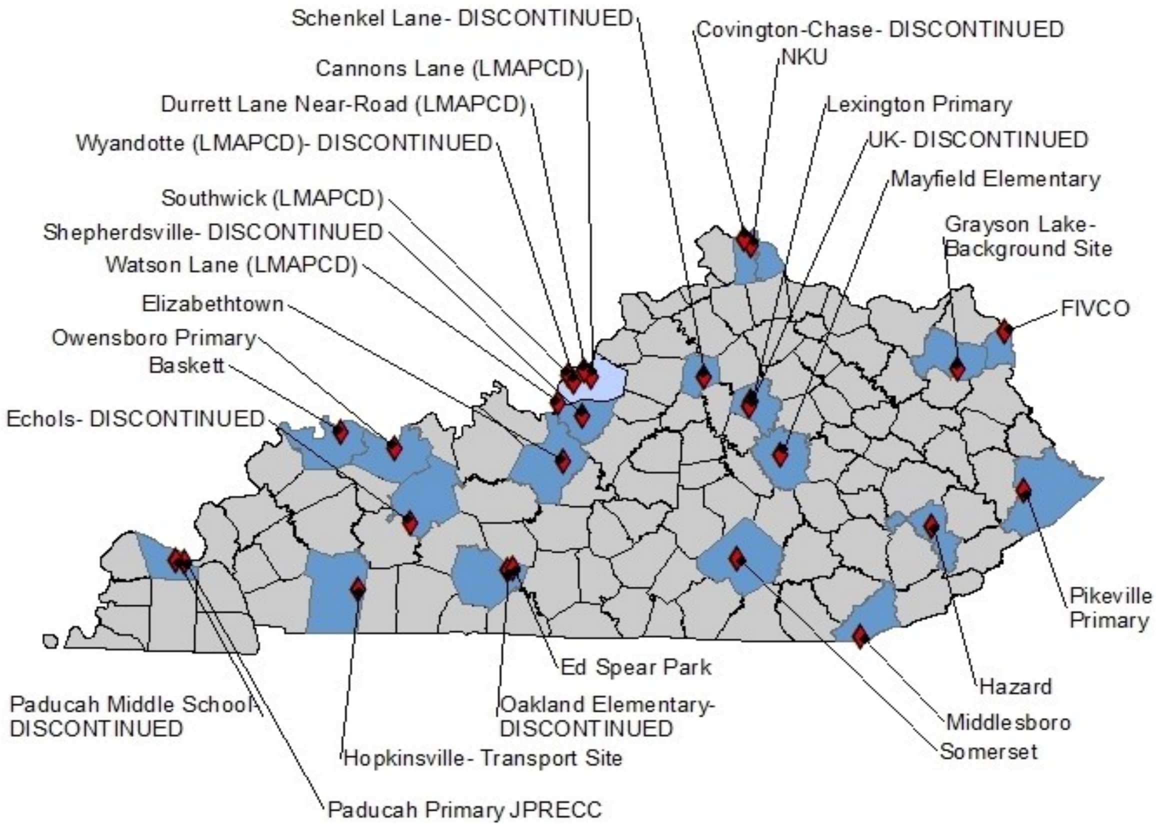
Since 2009, the $PM_{2.5}$ monitoring network has changed significantly. The most significant changed involved a shift away from TEOMs towards Beta Attenuation Monitors (BAMs). KDAQ established BAMs at four sites: NKU (21-037-3002), Elizabethtown (21-093-0006), Pikeville Primary (21-195-0002), and Somerset (21-199-0003). KDAQ ultimately kept the BAMs at each for a period no longer than two years. If KDAQ had kept the monitors at the sites for longer than two years, the data could have been eligible for NAAQS determinations, as the BAMs have FEM status. FRM comparison tests performed by KDAQ showed that the BAMs did not compare well. Ultimately, KDAQ re-established TEOMs at the NKU, Elizabethtown, and Pikeville sites. The BAM at Somerset was replaced with a FRM intermittent sampler.

It should be noted that LMAPCD also established BAM monitoring in Jefferson County. Instead of shutting the monitors down at the end of each two-year period, LMAPCD petitioned to have the data excluded from NAAQS comparisons. Ultimately, EPA has determined that the data collected from LMAPCD BAMs are comparable to FRM data; as such, the data is usable for NAAQS comparisons.

Some changes to the KDAQ $PM_{2.5}$ network were a direct result of analysis performed during the 2010 Network Assessment. That assessment showed a number of samplers to be redundant. Resultantly, KDAQ discontinued $PM_{2.5}$ sampling at the Shepherdsville (21-029-0006), UK (21-067-0014), and Schenkel Lane (21-073 -0006) sites.

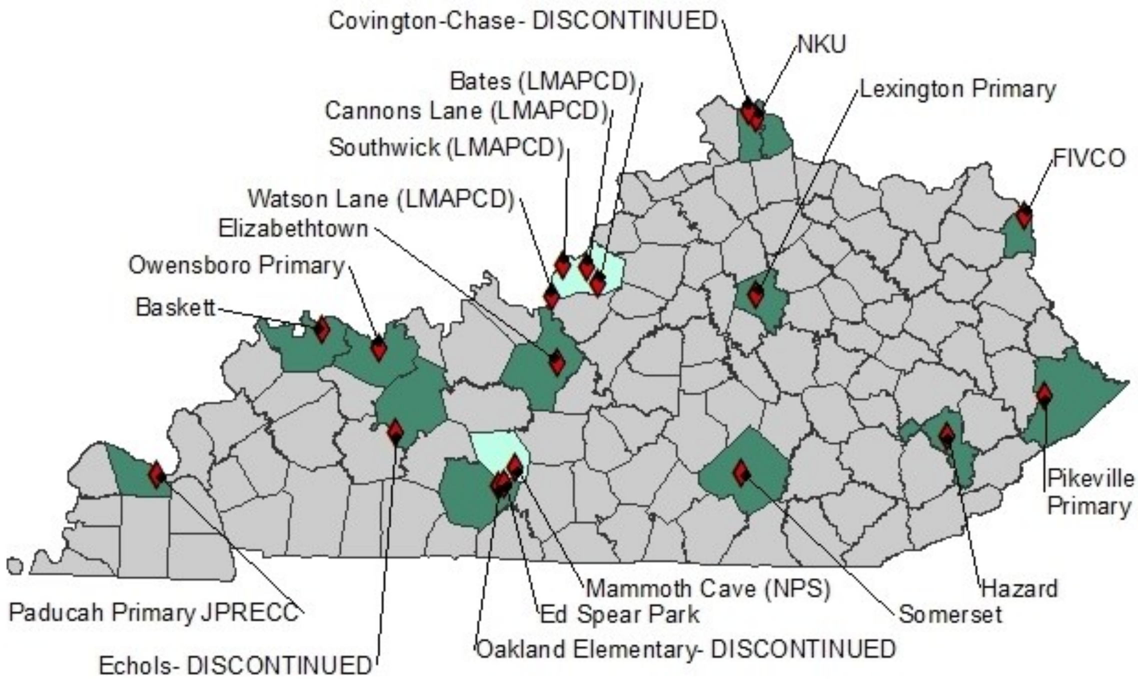
During the analysis period, KDAQ was also forced to shutdown the Covington site (21-117-0007) due to the property being developed for condos. At the Paducah Middle School site (21-145-1004), the school system asked KDAQ to remove samplers from the roof of the school. KDAQ moved the sampler to the Paducah Primary site (21-145-1024). Finally, KDAQ moved the Oakland Elementary School site (21-227-0008) to nearby Ed Spear Park (21-227-0009). The Oakland shelter was found to be sitting within the doline of a sinkhole during a routine siting inspection.

Map & Chart: KDAQ & LMAPCD Intermittent $PM_{2.5}$ Monitoring Network (2009-Present)



County	Site ID	Site Name	Monitor Type	Scale	Operation Dates
Bell	21-013-0002	Middlesboro	SPM	Neighborhood	07/15/1997- Present
Boyd	21-019-0017	FIVCO	SLAMS	Neighborhood	01/01/1999- Present
Bullitt	21-029-0006	Shepherdsville	SLAMS	Neighborhood	01/01/1999- 11/10/2011
Campbell	21-037-3002	NKU	SLAMS	Neighborhood	08/01/2007- Present
Carter	21-043-0500	Grayson Lake - Background Site	SLAMS	Urban	01/01/1999- Present
Christian	21-047-0006	Hopkinsville - Transport Site	SLAMS	Regional	01/01/1999- Present
Daviess	21-059-0005	Owensboro Primary	SLAMS	Neighborhood	01/01/2005- Present
Fayette	21-067-0012	Lexington Primary	SLAMS	Neighborhood	01/01/1999- Present
Fayette	21-067-0014	UK	SLAMS	Neighborhood	12/21/1998- 11/09/2011
Franklin	21-073-0006	Schenkel Lane	SLAMS	Neighborhood	01/01/1999- 11/10/2011
Hardin	21-093-0006	Elizabethtown	SLAMS	Neighborhood	01/01/2000- Present
Henderson	21-101-0014	Baskett	SLAMS	Neighborhood	04/01/2003- Present
Jefferson	21-111-0043	Southwick (LMAPCD)	SLAMS	Neighborhood	06/15/1998- Present
Jefferson	21-111-0044	Wyandotte (LMAPCD)	SLAMS	Neighborhood	06/15/1998- 12/31/2013
Jefferson	21-111-0051	Watson Lane (LMAPCD)	SLAMS	Neighborhood	06/15/1998- Present
Jefferson	21-111-0067	Cannons Lane (LMAPCD)	SLAMS	Neighborhood	01/01/2009- Present
Jefferson	21-111-0075	Durrett Lane Near-Road (LMAPCD)	SLAMS	Middle	01/01/2014- Present
Kenton	21-117-0007	Covington-Chase	SLAMS	Neighborhood	01/01/1999- 06/10/2010
McCracken	21-145-1004	Paducah Middle School	SLAMS	Neighborhood	01/01/1999- 08/08/2013
McCracken	21-145-1024	Paducah Primary JPRECC	SLAMS	Neighborhood	08/11/2013- Present
Madison	21-151-0003	Mayfield Elementary	SLAMS	Neighborhood	06/15/1998- Present
Ohio	21-183-0032	Echols	SPM	Urban	02/01/2005- 06/08/2008
Perry	21-193-0003	Hazard	SPM	Neighborhood	11/01/2013- Present
Pike	21-195-0002	Pikeville Primary	SLAMS	Neighborhood	01/01/1999- Present
Pulaski	21-199-0003	Somerset	SPM	Neighborhood	01/01/2012- Present
Warren	21-227-0008	Oakland Elementary	SLAMS	Neighborhood	09/06/2007- 04/30/2012
Warren	21-227-0009	Ed Spear Park	SLAMS	Neighborhood	05/01/2012- Present

Map & Chart: KDAQ, NPS, & LMAPCD Continuous $PM_{2.5}$ Monitoring Network (2009-Present)



County	Site ID	Site Name	Scale	Method	Monitor Type	Operation Dates
Boyd	21-019-0017	FIVCO	Neighborhood	TEOM	SPM	01/01/2007- Present
Campbell	21-037-3002	NKU	Neighborhood	TEOM	SPM	05/14/2010- Present*
				BAM	SPM	08/01/2010- 06/20/2012
Daviess	21-059-0005	Owensboro Primary	Neighborhood	TEOM	SPM	01/01/2007- Present
Edmonson	21-061-0501	Mammoth Cave (NPS)	Urban**	TEOM	EPA	09/04/1991- Present
Fayette	21-067-0012	Lexington Primary	Neighborhood	TEOM	SPM	01/01/2007- Present
Hardin	21-093-0006	Elizabethtown	Neighborhood	TEOM	SPM	10/26/2007- Present*
				BAM	SPM	09/01/2011- 08/12/2013
Henderson	21-101-0014	Baskett	Neighborhood	TEOM	SPM	01/01/2008- Present
Jefferson	21-111-0027	Bates (LMAPCD)	Neighborhood	TEOM	SPM	04/01/2003- Present
Jefferson	21-111-0043	Southwick (LMAPCD)	Neighborhood	BAM	SLAMS	08/15/2012- Present
				TEOM	Other	04/01/2003- 08/15/2012
Jefferson	21-111-0051	Watson Lane (LMAPCD)	Neighborhood	BAM	SLAMS	04/07/2012- Present
				TEOM	Other	04/01/2003- 04/11/2012
Jefferson	21-111-0067	Cannons Lane (LMAPCD)	Neighborhood	BAM	SLAMS	01/24/2011- Present
				TEOM	SLAMS	01/01/2009- 01/12/2011
Kenton	21-117-0007	Covington-Chase- DISCONTINUED	Neighborhood	TEOM	SPM	06/08/2010- Present
McCracken	21-145-1024	Paducah Primary JPRECC	Neighborhood	TEOM	SPM	01/01/2007- Present
Ohio	21-183-0032	Echols- DISCONTINUED	Urban	TEOM	SPM	01/01/2007-06/08/2010
Perry	21-193-0003	Hazard	Neighborhood	TEOM	SPM	01/01/2009- Present
Pike	21-195-0002	Pikeville Primary	Neighborhood	TEOM	SPM	01/01/2007- Present*
				BAM	SPM	08/01/2012- 07/15/2014
Pulaski	21-199-0003	Somerset	Neighborhood	BAM	SPM	10/28/2010- 06/24/2011
Warren	21-227-0008	Oakland Elementary- DISCONTINUED	Neighborhood	TEOM	SPM	01/01/2007- 05/10/2012
Warren	21-227-0009	Ed Spear Park	Neighborhood	TEOM	SPM	05/10/2012- Present

TEOM not in operation during period of BAM operation.

*****A scale is not designated in AQS. Scale inferred based upon siting criteria evaluations.***

Evaluation of Minimum Monitoring Requirements

40 CFR 58, Appendix D, requires that State, and where applicable local, agencies must operate the minimum number of $PM_{2.5}$ SLAMS sites as listed in Table D-5 below.

Table D-5 of Appendix D to Part 58— $PM_{2.5}$ Minimum Monitoring Requirements		
MSA population[1 2]	Most recent 3-year design value ≥85% of any $PM_{2.5}$ NAAQS[3]	Most recent 3-year design value <85% of any $PM_{2.5}$ NAAQS[3 4]
>1,000,000	3	2
500,000-1,000,000	2	1
50,000-<500,000[5]	1	0

[1]*Minimum monitoring requirements apply to the Metropolitan statistical area (MSA).*
[2]*Population based on latest available census figures.*
[3]*The $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) levels and forms are defined in 40 CFR part 50.*
[4]*These minimum monitoring requirements apply in the absence of a design value.*
[5]*Metropolitan statistical areas (MSA) must contain an urbanized area of 50,000 or more population.*

In addition to the minimum number of required monitors:

- At least one monitoring station is to be sited at neighborhood or larger scale in an area of expected maximum concentration.
- For CBSAs with a population of 1,000,000 or more persons, at least one $PM_{2.5}$ monitor is to be collocated at a near-road NO_2 station.
- For areas with additional required SLAMs monitoring, a station is to be sited in an area of poor air quality

These minimum monitoring requirements are evaluated in the chart on the following pages. The evaluation shows that all MSAs either meet or exceed the minimum number of stations required. The evaluation also shows that the Cincinnati and Louisville MSAs each have a $PM_{2.5}$ monitor located at their near-road sites and have at least one of the required additional monitors located in an area of poor air quality. Additionally, all MSA-based $PM_{2.5}$ samplers are located in an area of expected maximum concentration. It should be noted that if the Lexington MSA reaches a population of 500,000, it could require a second $PM_{2.5}$ sampler if design values are 85% of the NAAQS. Additionally, KDAQ could require a near-road site.

40 CFR 58, Appendix D, also states that each State shall install and operate at least one $PM_{2.5}$ site to monitor for regional background and at least one $PM_{2.5}$ site to monitor regional transport. The Grayson Lake site (21-043-0500) in Carter County is designated at the regional background site. The Hopkinsville site in Christian County (21-047-0006) is designated as the transport site.

40 CFR 58, Appendix D, states that agencies shall continue to conduct chemical speciation monitoring and analyses at sites designated to be part of the $PM_{2.5}$ Speciation Trends Network (STN). The modification of these STN sites must be approved by the Administrator. KDAQ discontinued $PM_{2.5}$ speciation sampling in December 2014 after KDAQ was notified of a loss of federal funding. The funding loss was a result of an EPA assessment which showed the Grayson Lake, Lexington Primary, and Ashland Primary sites had a low value in the overall network. Speciation sampling continues at the LMAPCD NCore site: Cannons Lane. No further analysis of STN sites is conducted in this assessment.

$PM_{2.5}$ Minimum Monitoring Requirements For Metropolitan Statistical Areas											
CBSA Code	State/ County Code	Area Name	2013 Population Estimate	2012-2014 Annual DV	3-Yr DV Valid	2012-2014 24-Hour DV	3-Yr DV Valid	Above 85% of either NAAQS	2014 # Sites Required in MSA	2014 # $PM_{2.5}$ Sites Present	# Met by KDAQ Sites
14540	21003	Allen County, KY	20,311								
14540	21031	Butler County, KY	12,793								
14540	21061	Edmonson County, KY	12,062								
14540	21227	Warren County, KY	118,370	9.8	N	20	N			1	
14540	**Bowling Green, KY MSA**		**163,536**	**9.8**	**N**	**20**	**N**	**N**	**0**	**1**	**1**
17140	18029	Dearborn County, IN	49,904								
17140	18115	Ohio County, IN	5,994								
17140	18161	Union County, IN	7,277								
17140	21015	Boone County, KY	124,442								
17140	21023	Bracken County, KY	8,416								
17140	21037	Campbell County, KY	90,988	11.5	Y	25	Y			1	
17140	21077	Gallatin County, KY	8,474								
17140	21081	Grant County, KY	24,753								
17140	21117	Kenton County, KY	163,145								
17140	21191	Pendleton County, KY	14,570								
17140	39015	Brown County, OH	44,264								
17140	39017	Butler County, OH	371,272	11.2	Y	24	Y			3	
17140	39025	Clermont County, OH	200,218								
17140	39061	Hamilton County, OH	804,520	12.9	N	28	N			6 (Poor AQ) (Near-Rd)	
17140	39165	Warren County, OH	219,169								
17140	**Cincinnati, OH-KY-IN MSA**		**2,137,406**	**12.9**	**N**	**28**	**N**	**Y**	**3**	**10**	**1***
17300	21047	Christian County, KY	74,167	9.9	Y	22	Y			1	
17300	21221	Trigg County, KY	14,293								
17300	47125	Montgomery County, TN	184,119	9.2	N	21	N			1	
17300	**Clarksville, TN-KY MSA**		**272,579**	**9.9**	**Y**	**22**	**Y**	**N**	**0**	**2**	**1**
21060	21093	Hardin County, KY	108,191	10.6	N	21	N			1	
21060	21123	Larue County, KY	14,064								
21060	21163	Meade County, KY	29,210								
21060	**Elizabethtown-Ft Knox, KY MSA**		**151,465**	**10.6**	**N**	**21**	**N**	**Y**	**1**	**1**	**1**
21780	18129	Posey County, IN	25,486								
21780	18163	Vanderburgh County, IN	181,398	10.9	N	25	N			3	
21780	18173	Warrick County, IN	61,049								
21780	21101	Henderson County, KY	46,347	10.6	Y	22	Y			1	
21780	**Evansville, IN-KY MSA**		**314,280**	**10.9**	**N**	**25**	**N**	**Y**	**1**	**4**	**1**

PM$_{2.5}$ Minimum Monitoring Requirements For Metropolitan Statistical Areas (Continued)											
CBSA Code	**State/ County Code**	**Area Name**	**2013 Population Estimate**	**2012-2014 Annual DV**	**3-Yr DV Valid**	**2012-2014 24-Hour DV**	**3-Yr DV Valid**	**Above 85% of either NAAQS**	**2014 # Sites Required in MSA**	**2014 # Sites Present**	**# Met by KDAQ Sites**
26580	21019	Boyd County, KY	48,886	9.5	Y	21	Y			1	
26580	21089	Greenup County, KY	36,519								
26580	39087	Lawrence County, OH	61,917	9.2	Y	18	Y			1	
26580	54011	Cabell County, WV	97,133	9.8	Y	21	Y			1	
26580	54043	Lincoln County, WV	21,559								
26580	54079	Putnam County, WV	56,650								
26580	54099	Wayne County, WV	41,437								
26580	**Huntington-Ashland, WV-KY-OH MSA**		**364,101**	**9.8**	**Y**	**21**	**Y**	**N**	**0**	**3**	**1**
30460	21017	Bourbon County, KY	19,998								
30460	21049	Clark County, KY	35,614								
30460	21067	Fayette County, KY	308,428	**9.5**	Y	**20**	Y			1	
30460	21113	Jessamine County, KY	50,173								
30460	21209	Scott County, KY	49,947								
30460	21239	Woodford County, KY	25,275								
30460	**Lexington-Fayette, KY MSA**		**489,435**	**9.5**	**Y**	**20**	**Y**	**N**	**0**	**1**	**1**
31140	18019	Clark County, IN	112,938	11.8	N	24	Y			2	
31140	18043	Floyd County, IN	76,244	10.4	Y	21	Y			1	
31140	18061	Harrison County, IN	39,163								
31140	18143	Scott County, IN	23,972								
31140	18175	Washington County, IN	27,780								
31140	21029	Bullitt County, KY	76,854								
31140	21103	Henry County, KY	15,445								
31140	21111	Jefferson County, KY	756,832	12.5	N	26	N			4 (Poor AQ) (Near-Rd)	
31140	21185	Oldham County, KY	62,364								
31140	21211	Shelby County, KY	44,216								
31140	21215	Spencer County, KY	17,637								
31140	21223	Trimble County, KY	8,816								
31140	**Louisville/Jefferson County, KY-IN MSA**		**1,262,261**	**12.5**	**N**	**26**	**N**	**Y**	**3**	**7**	**0 ***
36980	21059	Daviess County, KY	98,218	10.7	Y	23	Y			1	
36980	21091	Hancock County, KY	8,687								
36980	21149	McLean County, KY	9,496								
36980	**Owensboro, KY MSA**		**116,401**	**10.7**	**Y**	**23**	**Y**	**Y**	**1**	**1**	**1**

Monitoring requirement fulfilled via MOA

Source: USCB , CBSA-EST2013. http://www.census.gov/popest/data/metro/totals/2013/CBSA-EST2013-alldata.html. Last accessed: March 12, 2015.

Evaluation of Minimum Monitoring Requirements: Continuous Network

State (or local) agencies must operate continuous $PM_{2.5}$ analyzers equal to at least one-half (round up) the minimum required sites listed in Table D-5. At least one required continuous analyzer in each MSA must be collocated with one of the required FRM/FEM monitors, unless at least one of the required FRM/FEM monitors is itself a continuous FEM monitor in which case no collocation requirement applies.

KDAQ found during this assessment that all MSAs meet the minimum monitoring requirements for continuous $PM_{2.5}$ monitors. The results of the analysis are outlined in the chart below and on the following page.

Continuous $PM_{2.5}$ Minimum Monitoring Requirements								
CBSA Code	State/ County Code	Area Name	2013 Population Estimate	# Continuous Sites Present in MSA	One Collocated	2014 # Intermittent Sites Required in MSA	# Continuous Sites Required in MSA	# Met by KDAQ Sites
14540	21003	Allen County, KY	20,311					
14540	21031	Butler County, KY	12,793					
14540	21061	Edmonson County, KY	12,062	1 TEOM				
14540	21227	Warren County, KY	118,370	1 TEOM				
14540		**Bowling Green, KY MSA**	**163,536**	**2**	**Y**	**0**	**0**	**1**
17140	18029	Dearborn County, IN	49,904					
17140	18115	Ohio County, IN	5,994					
17140	18161	Union County, IN	7,277					
17140	21015	Boone County, KY	124,442					
17140	21023	Bracken County, KY	8,416					
17140	21037	Campbell County, KY	90,988	1 TEOM				
17140	21077	Gallatin County, KY	8,474					
17140	21081	Grant County, KY	24,753					
17140	21117	Kenton County, KY	163,145					
17140	21191	Pendleton County, KY	14,570					
17140	39015	Brown County, OH	44,264					
17140	39017	Butler County, OH	371,272					
17140	39025	Clermont County, OH	200,218					
17140	39061	Hamilton County, OH	804,520	1 BAM				
17140	39165	Warren County, OH	219,169					
17140		**Cincinnati, OH-KY-IN MSA**	**2,137,406**	**2**	**Y**	**3**	**2**	**1***

Continuous $PM_{2.5}$ Minimum Monitoring Requirements (Continued)								
CBSA Code	State/ County Code	Area Name	2013 Population Estimate	# Continuous Sites Present in MSA	One Collocated	# Intermittent Sites Required in MSA	# Continuous Sites Required in MSA	# Met by KDAQ Sites
17300	21047	Christian County, KY	74,167					
17300	21221	Trigg County, KY	14,293					
17300	47125	Montgomery County, TN	184,119					
17300		**Clarksville, TN-KY MSA**	**272,579**	**0**	**n/a**	**0**	**0**	**0**
21060	21093	Hardin County, KY	108,191	1 TEOM				
21060	21123	Larue County, KY	14,064					
21060	21163	Meade County, KY	29,210					
21060		**Elizabethtown-Ft Knox, KY MSA**	**151,465**	**1**	**Y**	**1**	**1**	**1**
21780	18129	Posey County, IN	25,486					
21780	18163	Vanderburgh County, IN	181,398	1 BAM				
21780	18173	Warrick County, IN	61,049					
21780	21101	Henderson County, KY	46,347	1 TEOM				
21780		**Evansville, IN-KY MSA**	**314,280**	**2**	**Y**	**1**	**1**	**1**
26580	21019	Boyd County, KY	48,886	1 TEOM				
26580	21089	Greenup County, KY	36,519					
26580	39087	Lawrence County, OH	61,917					
26580	54011	Cabell County, WV	97,133					
26580	54043	Lincoln County, WV	21,559					
26580	54079	Putnam County, WV	56,650					
26580	54099	Wayne County, WV	41,437					
26580		**Huntington-Ashland, WV-KY-OH MSA**	**364,101**	**1**	**Y**	**0**	**0**	**1**
30460	21017	Bourbon County, KY	19,998					
30460	21049	Clark County, KY	35,614					
30460	21067	Fayette County, KY	308,428	1 TEOM				
30460	21113	Jessamine County, KY	50,173					
30460	21209	Scott County, KY	49,947					
30460	21239	Woodford County, KY	25,275					
30460		**Lexington-Fayette, KY MSA**	**489,435**	**1**	**Y**	**0**	**0**	**1**
31140	18019	Clark County, IN	112,938					
31140	18043	Floyd County, IN	76,244	1 BAM				
31140	18061	Harrison County, IN	39,163					
31140	18143	Scott County, IN	23,972					
31140	18175	Washington County, IN	27,780					
31140	21029	Bullitt County, KY	76,854					
31140	21103	Henry County, KY	15,445					
31140	21111	Jefferson County, KY	756,832	1TEOM/3BAM				
31140	21185	Oldham County, KY	62,364					
31140	21211	Shelby County, KY	44,216					
31140	21215	Spencer County, KY	17,637					
31140	21223	Trimble County, KY	8,816					
31140		**Louisville/Jefferson County, KY-IN MSA**	**1,262,261**	**5**	**Y**	**3**	**2**	**0***
36980	21059	Daviess County, KY	98,218	1 TEOM				
36980	21091	Hancock County, KY	8,687					
36980	21149	McLean County, KY	9,496					
36980		**Owensboro, KY MSA**	**116,401**	**1**	**Y**	**1**	**1**	**1**

Monitoring requirement fulfilled via MOA

Evaluation of $PM_{2.5}$ Collocation Requirements and Sampling Frequencies

40 CFR 58, Appendix A, requires that $PM_{2.5}$ monitoring networks have at least 15% of the stations collocated or at least one station collocated, whichever is greater. Additionally, monitors must meet the following criteria:

- One primary FRM monitor must be collocated with an audit monitor having the same designation.
- Each FEM model used as a primary monitor by the PQAO must have 50% collocated with audit monitors having the same method designation and 50% collocated with audit monitors having FRM designations.
- 80% of the collocated monitors should be deployed at sites with annual averages or daily concentrations estimated to be within 20% of the NAAQS and the remainder at sites designated as high value by the monitoring organization.

With regards to sampling frequencies, 40 CFR 58.12, states that manual $PM_{2.5}$ SLAMS stations must collect at least one sample every three days. Requirements for collocated sampling frequencies are stated in 40 CFR 58, Appendix A, which states: "Sample the collocated audit monitor for SLAMS sites on a 12-day schedule."

Collocation requirements are evaluated in the chart on the following page. KDAQ meets the minimum number of collocated $PM_{2.5}$ stations required by Appendix A. All KDAQ primary samplers collect one sample every three days, with the exception of the special purpose monitors located at Middlesboro (21-013-0002) and Hazard (21-193-0003). Additionally, collocated monitors collect one sample every six days, which exceeds the requirement of collecting one sample every twelve days.

However, KDAQ did not meet the requirement to have 80% of the collocated monitors located at sites with annual averages or daily concentrations estimated to be within 20% of the NAAQS. Based upon the annual average at each site, KDAQ has only one collocated sampler (21-093-0006) located at a site within 20% NAAQS. KDAQ would need to have all two collocated samplers located at sites with annual averages within 20% of the NAAQS to meet the requirement.

3 Collocated Sites X 0.8 = 2.4

The change in required collocation stations is a result of the lowering of the annual NAAQS since the last network assessment from 15.0 ug/m^3 to 12.0 ug/m^3, as well as changing design values. Both the Pikeville (21-195-0002) and Warren County (21-227-0008) collocated samplers are candidates for movement to another site. Because KDAQ has been attempting to eliminate all roof-top samplers from the network, it is most logical to move the Pikeville sampler to a site that can accommodate collocated sampling at ground-level, such as NKU (21-037-3002).

In order to accomplish this goal and maintain the FRM-FRM method collocation, KDAQ may replace the primary sampler at NKU with an FRM method and then locate the FRM from Pikeville to that site. As such, the primary Pikeville sampler would be replaced with an FEM method.

PQAO Level $PM_{2.5}$ Collocation Requirements (KDAQ Monitors)

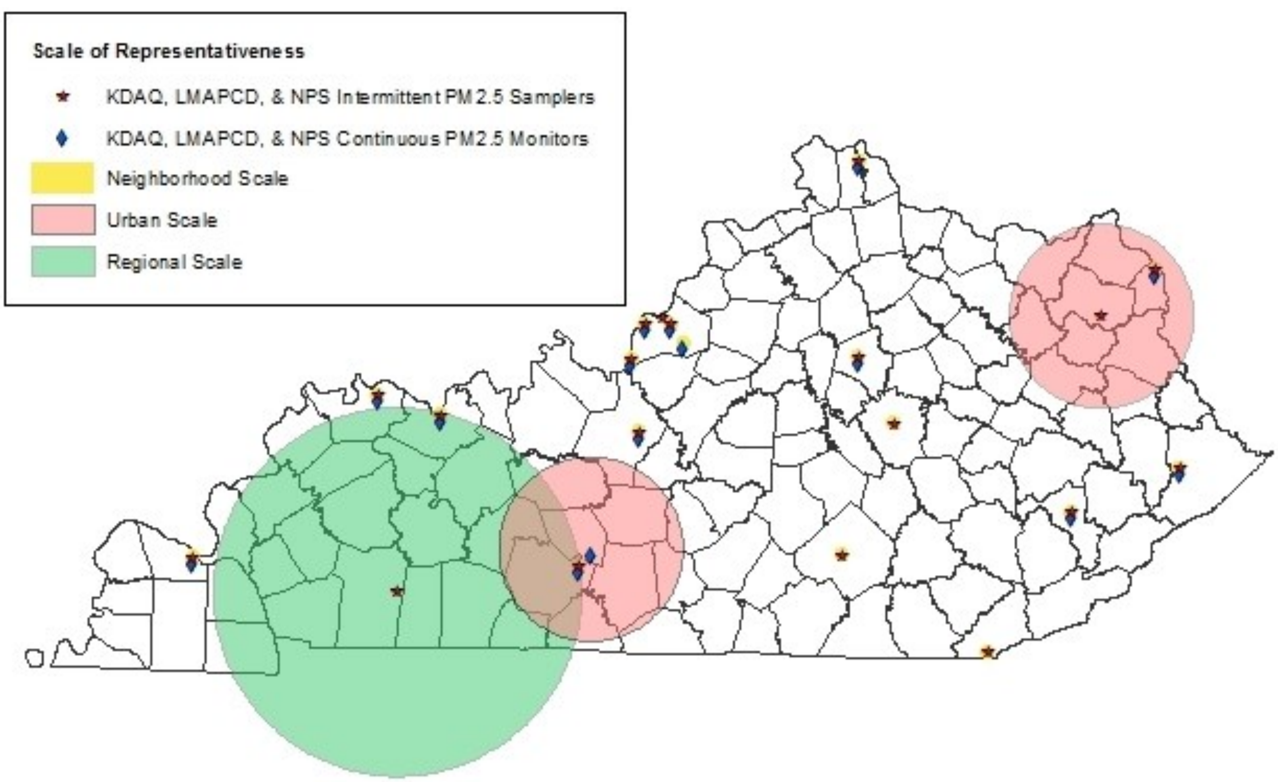
Site ID	County	Type	Primary Method	Collocated Method	2014 Three-Year Design Values		% Annual NAAQS	% 24-Hour NAAQS	Sample Frequency
					Annual DV	24-Hour DV			
21_013_0002	Bell	SPM	118 FRM		9.4	18	78.3	51.4	1/6
21_019_0017	Boyd	SLAMS	118 FRM		9.5	21	79.2	60.0	1/3
21_037_3002	Campbell	SLAMS	145 FEM		9.6	22	80.0	62.9	1/3
21_043_0500	Carter	SLAMS	145 FEM		7.9	17	65.8	48.6	1/3
21_047_0006	Christian	SLAMS	145 FEM		9.9	22	82.5	62.9	1/3
21_059_0005	Daviess	SLAMS	145 FEM		10.7	23	89.2	65.7	1/3
21_067_0012	Fayette	SLAMS	145 FEM		9.5	20	79.2	57.1	1/3
21_093_0006	Hardin	SLAMS	145 FEM	145 FEM	10.6	21	88.3	60.0	1/3, 1/6
21_101_0014	Henderson	SLAMS	145 FEM		10.6	22	88.3	62.9	1/3
21_145_1024	McCracken	SLAMS	145 FEM		10.7	23	89.2	65.7	1/3
21_151_0003	Madison	SLAMS	118 FRM		8.5	17	70.8	48.6	1/3
21_193_0003	Perry	SPM	145 FEM		7.2	14	60.0	40.0	1/6
21_195_0002	Pike	SLAMS	118 FRM	118 FRM	8.5	17	70.8	48.6	1/3, 1/6
21_199_0003	Pulaski	SPM	145 FEM		9.2	20	76.7	57.1	1/3
21_227_0008	Warren	SLAMS	145 FEM	118 FRM	8.2	17	68.3	48.6	1/3, 1/6
Monitor Counts			**15**	**3**					
Total Percent Collocated			**20%**						
Percent at Sites within 20% NAAQS			**33.3%**						

Evaluation of Spatial Scales of Representativeness

The spatial scale of representativeness (also called monitoring scale and spatial scale) describes the physical dimensions of a parcel of air, which has reasonably similar concentrations throughout. According to 40 CFR 58, Appendix D, the appropriate spatial scales for characterizing both mobile and stationary sources is the neighborhood scale. Larger scale sites are also needed to characterize larger areas of homogeneity.

Spatial Scales of Representativeness 40 CFR 58, Appendix D	
Scale of Representativeness (Monitoring Scale)	**Physical Dimensions**
Microscale	Up to 100 meters
Middle scale	100 meters to 0.5 kilometers
Neighborhood scale	0.5 to 4.0 kilometers
Urban scale	4.0 to 50.0 kilometers
Regional Scale	Tens to hundreds of kilometers

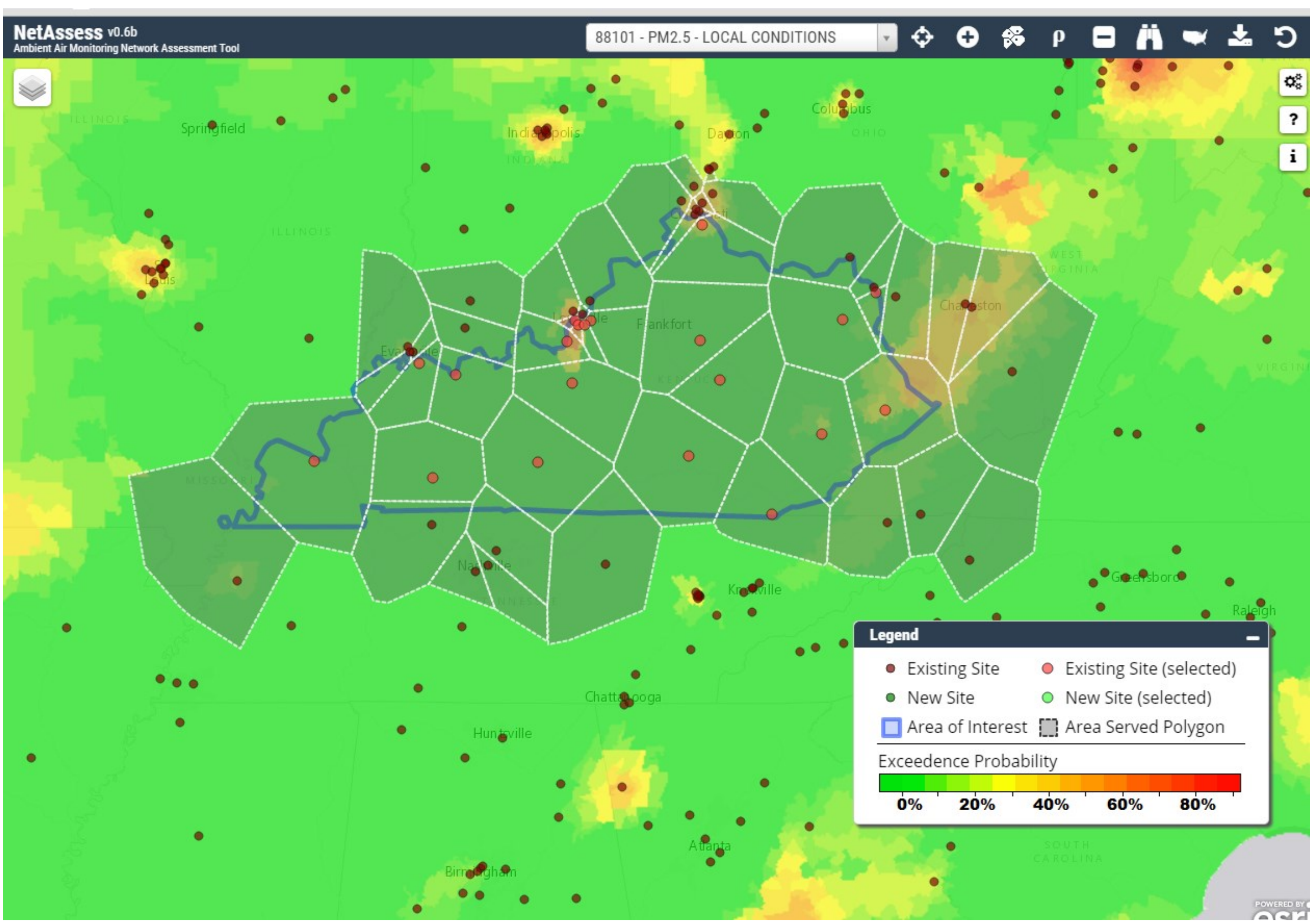
KDAQ reviewed annual siting criteria evaluations to ensure that the designated spatial scales for each $PM_{2.5}$ monitor were appropriate. Most of KDAQ's $PM_{2.5}$ network is appropriately sited to measure the intended spatial scales. However, KDAQ is aware that equipment at the Ashland Primary (21-019-0017) is partially obstructed. KDAQ has included a complete account of these issues in Appendix D.



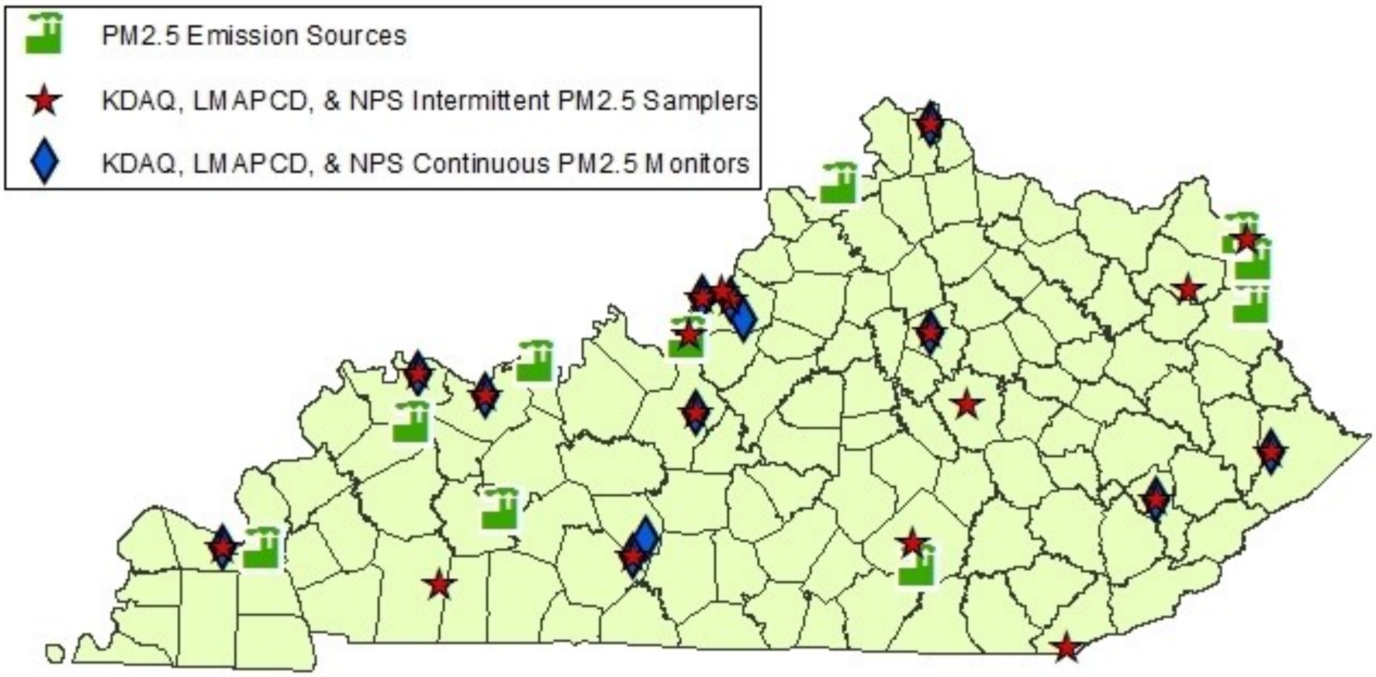
Evaluation of Network Coverage

Initially, KDAQ used the Areas Served Tool from LADCO to generate voronoi polygons in order to visually evaluate the amount of area served by each $PM_{2.5}$ monitor in Kentucky. The results of the Areas Served Tool are shown below. KDAQ believes that the tool shows that the area covered by each monitor is appropriate.

KDAQ also mapped the top ten $PM_{2.5}$ point sources in Kentucky, along with the locations of $PM_{2.5}$ monitoring stations. Most major facilities have a $PM_{2.5}$ monitoring station in close proximity, if not directly downwind. As with other pollutants, the map shows that the TVA Paradise facility in Muhlenberg County is not well represented by the current network. However, KDAQ did have a sampler located at the former Echols site (21-183-0032) until 2008.



Top Ten $PM_{2.5}$ Sources and Kentucky $PM_{2.5}$ Monitors



Rank	Facility ID	Facility Name	County	2013 Actual Emissions (tpy)
1	3239	Tennessee Valley Authority - Paradise Fossil Plant	Muhlenberg	1131.5
2	127	Louisville Gas & Electric Co - Mill Creek Station	Jefferson	994.2
3	307	AK Steel Corp - West Works	Boyd	638.1
4	704	KY Utilities Co - Ghent Generation Station	Carroll	480.5
5	2930	CC Metals and Alloys LLC	Marshall	292.1
6	1634	Century Aluminum of KY LLC	Hancock	279.1
7	2610	KY Power Co - Big Sandy Plant	Lawrence	271.9
8	1788	Century Aluminum Sebree LLC	Henderson	246.1
9	339	Marathon Petroleum Co LLC - Catlettsburg Refining	Boyd	218.0
10	3808	East KY Power - Cooper Station	Pulaski	217.3

Source: KDAQ & LMAPCD Emissions Inventory Systems, February 2015

Evaluation of Concentration Trends

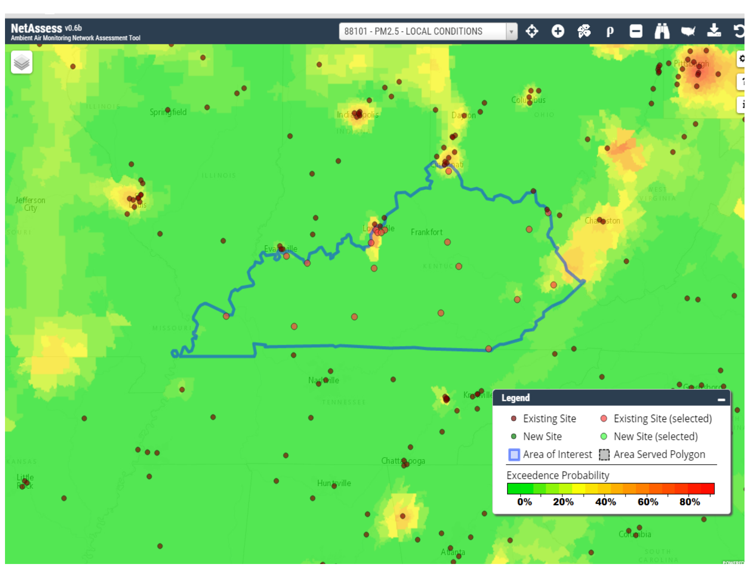
Three-year design values are shown by the chart right. Additionally, the graph on the following page shows the deign value recorded annually by each Kentucky monitor for the 24-Hour and Annual NAAQS. When compared against design values, all Kentucky monitors are well below the level of the 24-Hour NAAQS. Most Kentucky monitors are approaching the level of the Annual NAAQS

While not performed specifically for this network assessment, KDAQ periodically analyzes trends in the state, as shown by the graph at the bottom of the following page. When graphed, $PM_{2.5}$ shows a strong photochemical influence, as expected. This likely explains stronger correlations between $PM_{2.5}$ monitors with larger distances between site pairs. Correlation is analyzed in the following section.

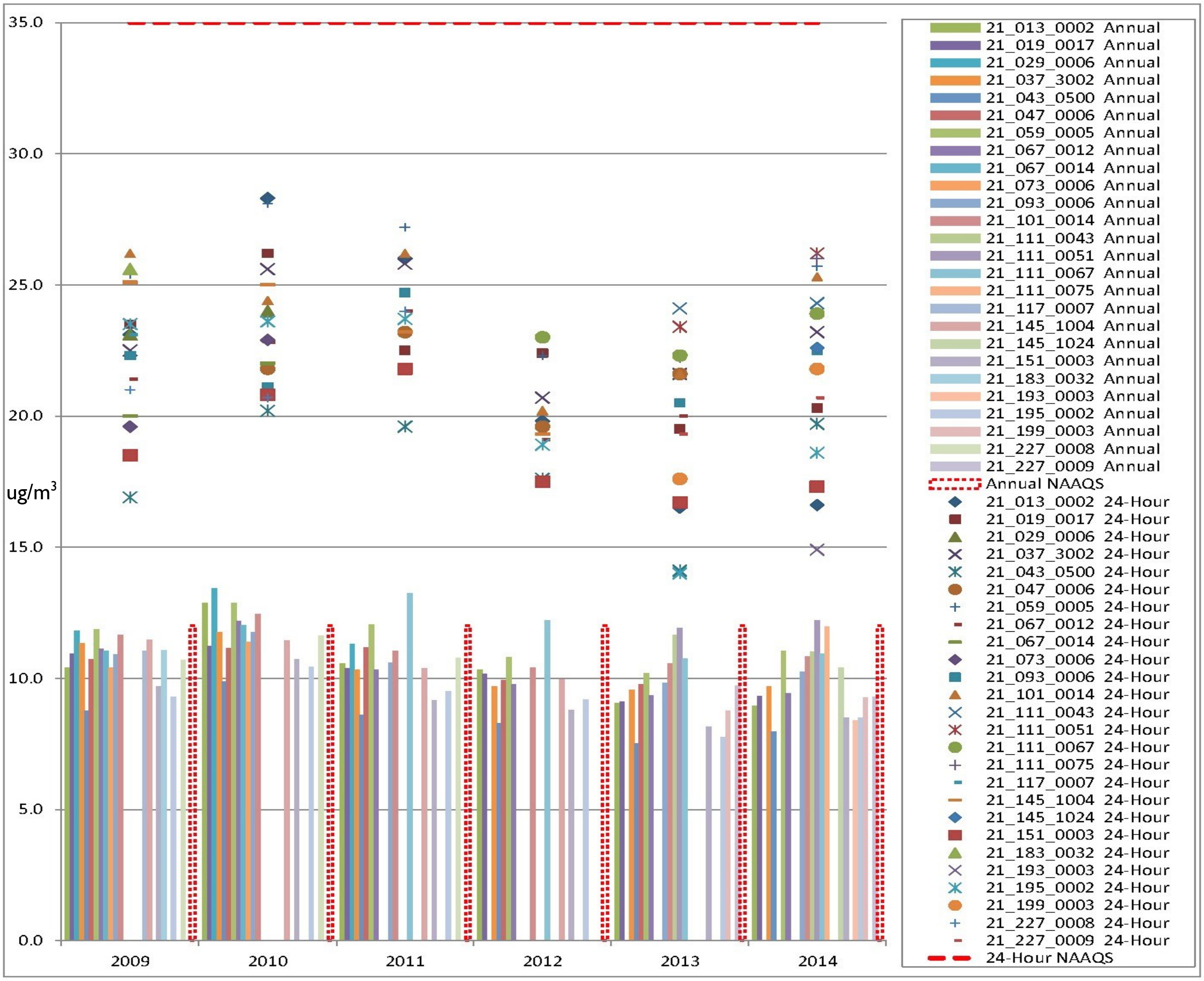
Three-Year $PM_{2.5}$ Design Values					
AQS ID	County	Three-Year Annual Design Values		Three-Year 24-Hour Design Values	
		2013	2014	2013	2014
21-227-0009	Warren	10.0 *	9.8 *	19 *	20 *
21-037-3002	Campbell	9.9	9.6	23	22
21-047-0006	Christian	10.3	9.9	21	22
21-093-0006	Hardin	10.7 *	10.6 *	22 *	21 *
21-101-0014	Henderson	10.7	10.6	23	22
21-019-0017	Boyd	9.9	9.5	21	21
21-067-0012	Fayette	9.8	9.5	21	20
21-111-0043	Jefferson	12.0*	11.7*	24 *	24*
21-111-0051	Jefferson	12.6 *	12.5*	25 *	25*
21-111-0067	Jefferson	12.1	11.3	26	23
21-111-0075	Jefferson	x	12.0*	x	26*
21-013-0002	Bell	10.0	9.4	21	18
21-059-0005	Daviess	11.0	10.7	24	23
21-145-1024	McCracken	10.9 *	10.7*	23 *	23*
21-151-0003	Madison	8.7	8.5	19	17
21-199-0003	Pulaski	9.2 *	9.2	19 *	20
21-043-0500	Carter	8.1	7.9	17	17
21-193-0003	Perry	5.9 *	7.2*	12 *	14*
21-195-0002	Pikeville	8.8	8.5	19	17

***Incomplete Dataset**

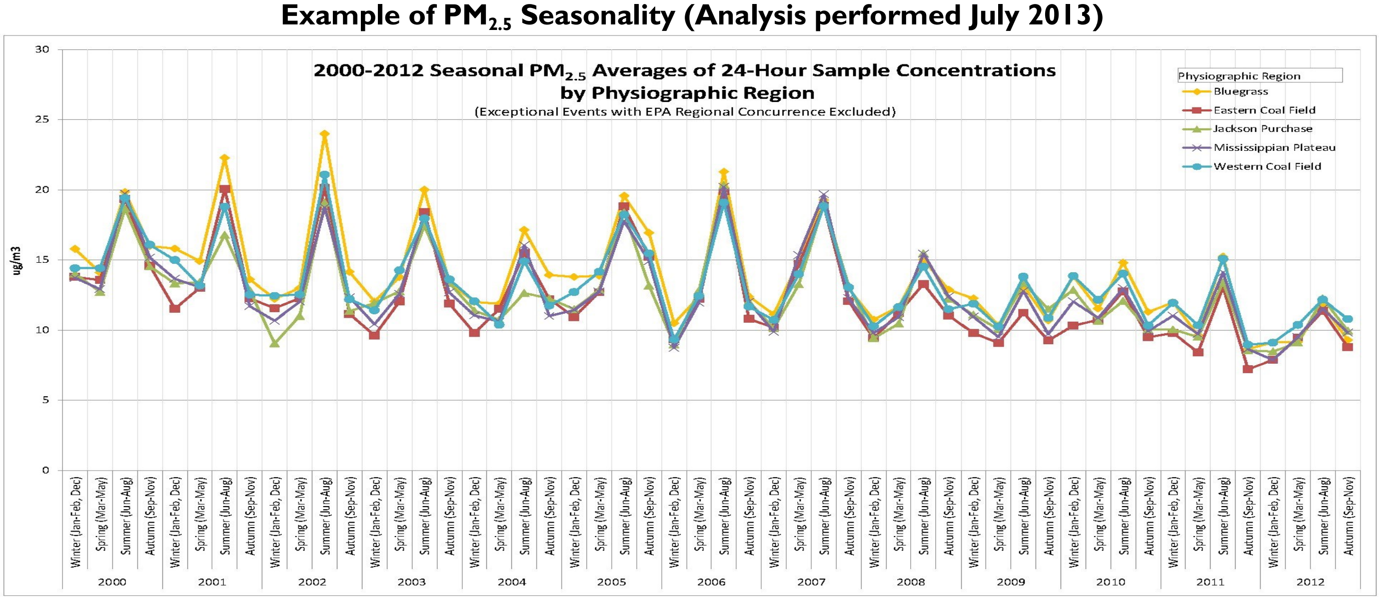
KDAQ used the LADCO Network Assessment Tool in order to evaluate the likeness that each area in Kentucky might experience at least one 24-hour concentration above the level of the NAAQS. As expected, the areas of concern are primarily located near urban cores, such as Louisville and Cincinnati., with mobile sources as the driver of concentration trends. While KDAQ did not expect the analysis to show that eastern Kentucky was a potential area of concern, KDAQ does have the Pikeville Primary station located in the area. As such, KDAQ believes the area is protected.



Annual $PM_{2.5}$ Design Values for the 24-Hour and Annual NAAQS



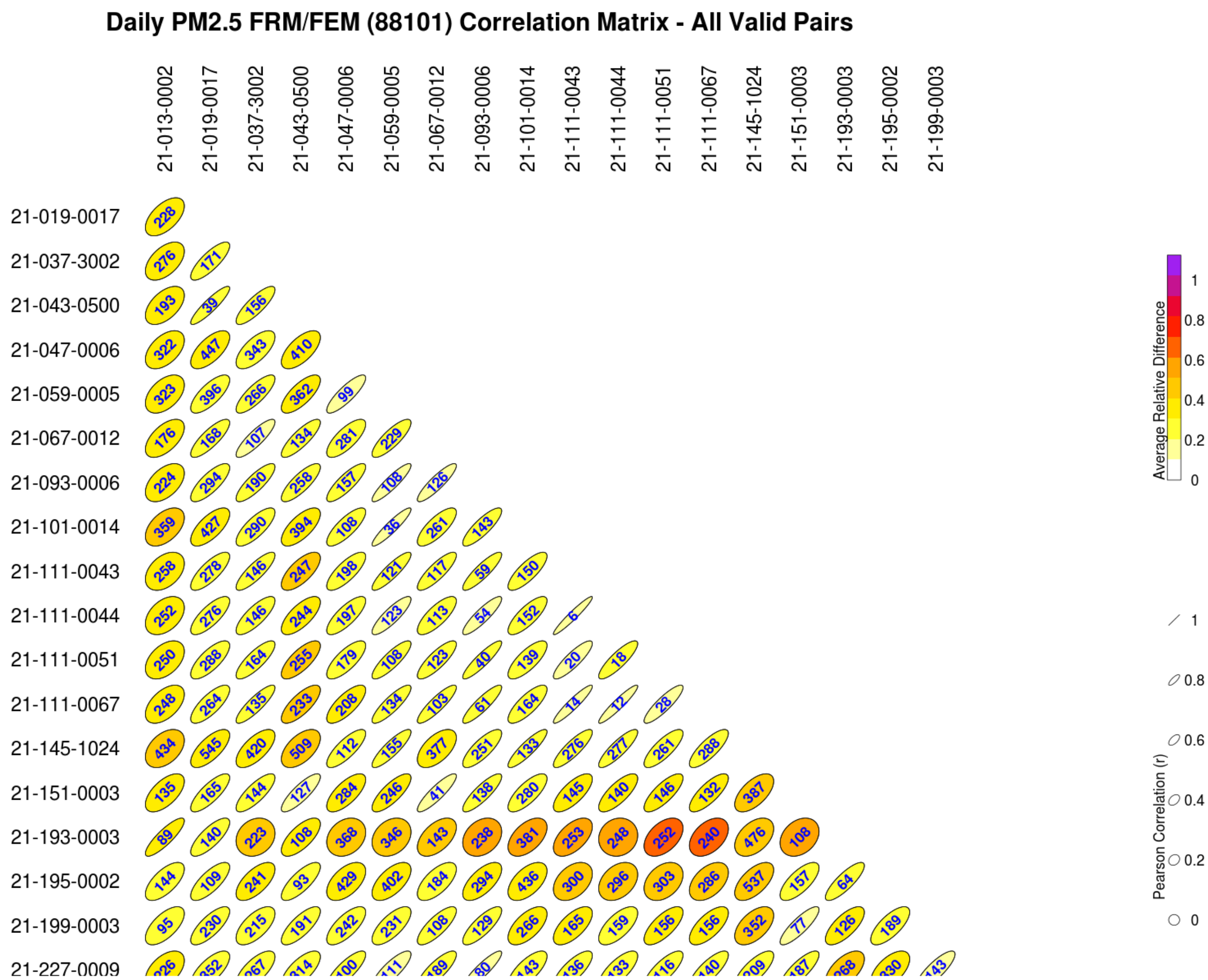
Example of $PM_{2.5}$ Seasonality (Analysis performed July 2013)



Evaluation of Network Correlation

The LADCO Ambient Air Monitoring Network Assessment Tool (NetAssess v0.6b) was used to evaluate the correlation and removal bias between $PM_{2.5}$ monitors. KDAQ used a Pearson correlation of 0.6 (R=0.6) to indicate good correlation.

The results of the correlation analysis are shown by the matrix below, as well as the charts an the following pages. While a number of monitors showed strong correlations, due to the larger scale influences of photochemistry, KDAQ ultimately did not find that any monitors are redundant.



values in ellipse = distance in kilometers

Site 1	Site 2	Corr.	n	Rel. Diff	Distance (km)
21-013-0002	21-019-0017	0.566	161	0.302	228
21-013-0002	21-037-3002	0.518	150	0.346	276
21-013-0002	21-043-0500	0.527	156	0.347	193
21-013-0002	21-047-0006	0.498	157	0.389	322
21-013-0002	21-059-0005	0.475	160	0.39	323
21-013-0002	21-067-0012	0.575	160	0.32	176
21-013-0002	21-093-0006	0.497	152	0.352	224
21-013-0002	21-101-0014	0.489	156	0.402	359
21-013-0002	21-111-0043	0.41	79	0.388	258
21-013-0002	21-111-0044	0.413	51	0.357	252
21-013-0002	21-111-0051	0.449	98	0.396	250
21-013-0002	21-111-0067	0.522	158	0.383	248
21-013-0002	21-145-1024	0.43	22	0.449	434
21-013-0002	21-151-0003	0.608	161	0.303	135
21-013-0002	21-193-0003	0.857	10	0.327	89
21-013-0002	21-195-0002	0.662	168	0.252	144
21-013-0002	21-199-0003	0.64	95	0.278	95
21-013-0002	21-227-0009	0.501	95	0.346	226
21-019-0017	21-037-3002	0.805	322	0.222	171
21-019-0017	21-043-0500	0.902	331	0.228	39
21-019-0017	21-047-0006	0.656	333	0.308	447
21-019-0017	21-059-0005	0.739	336	0.281	396
21-019-0017	21-067-0012	0.817	333	0.216	168
21-019-0017	21-093-0006	0.778	317	0.244	294
21-019-0017	21-101-0014	0.684	324	0.302	427
21-019-0017	21-111-0043	0.777	159	0.298	278
21-019-0017	21-111-0044	0.765	96	0.271	276
21-019-0017	21-111-0051	0.747	201	0.3	288
21-019-0017	21-111-0067	0.767	328	0.294	264
21-019-0017	21-145-1024	0.698	42	0.339	545
21-019-0017	21-151-0003	0.795	339	0.241	165
21-019-0017	21-193-0003	0.772	9	0.291	140
21-019-0017	21-195-0002	0.75	342	0.242	109
21-019-0017	21-199-0003	0.757	197	0.229	230
21-019-0017	21-227-0009	0.703	189	0.244	352
21-037-3002	21-043-0500	0.826	313	0.268	156
21-037-3002	21-047-0006	0.672	313	0.3	343
21-037-3002	21-059-0005	0.804	317	0.25	266
21-037-3002	21-067-0012	0.859	315	0.183	107
21-037-3002	21-093-0006	0.829	302	0.21	190
21-037-3002	21-101-0014	0.77	305	0.264	290
21-037-3002	21-111-0043	0.839	157	0.272	146
21-037-3002	21-111-0044	0.785	93	0.234	146
21-037-3002	21-111-0051	0.812	199	0.28	164
21-037-3002	21-111-0067	0.866	317	0.263	135
21-037-3002	21-145-1024	0.67	40	0.309	420
21-037-3002	21-151-0003	0.795	320	0.234	144
21-037-3002	21-193-0003	0.198	10	0.488	223
21-037-3002	21-195-0002	0.644	327	0.305	241
21-037-3002	21-199-0003	0.639	182	0.271	215
21-037-3002	21-227-0009	0.697	179	0.259	267
21-043-0500	21-047-0006	0.644	324	0.355	410
21-043-0500	21-059-0005	0.728	327	0.375	362
21-043-0500	21-067-0012	0.833	323	0.254	134
21-043-0500	21-093-0006	0.809	312	0.286	258
21-043-0500	21-101-0014	0.689	313	0.37	394
21-043-0500	21-111-0043	0.697	151	0.441	247
21-043-0500	21-111-0044	0.706	95	0.381	244
21-043-0500	21-111-0051	0.742	193	0.431	255
21-043-0500	21-111-0067	0.751	318	0.431	233
21-043-0500	21-145-1024	0.554	41	0.473	509
21-043-0500	21-151-0003	0.84	325	0.198	127
21-043-0500	21-193-0003	0.691	10	0.376	108
21-043-0500	21-195-0002	0.768	334	0.238	93
21-043-0500	21-199-0003	0.763	191	0.246	191
21-043-0500	21-227-0009	0.701	178	0.295	314
21-047-0006	21-059-0005	0.848	327	0.199	99
21-047-0006	21-067-0012	0.745	326	0.259	281
21-047-0006	21-093-0006	0.833	309	0.204	157
21-047-0006	21-101-0014	0.792	314	0.229	108
21-047-0006	21-111-0043	0.775	154	0.278	198
21-047-0006	21-111-0044	0.78	94	0.264	197
21-047-0006	21-111-0051	0.752	195	0.277	179
21-047-0006	21-111-0067	0.747	318	0.301	208
21-047-0006	21-145-1024	0.79	43	0.275	112
21-047-0006	21-151-0003	0.7	326	0.309	284
21-047-0006	21-193-0003	0.256	10	0.485	368
21-047-0006	21-195-0002	0.539	331	0.359	429
21-047-0006	21-199-0003	0.713	193	0.258	242
21-047-0006	21-227-0009	0.811	183	0.204	100
21-059-0005	21-067-0012	0.821	330	0.237	229
21-059-0005	21-093-0006	0.903	315	0.177	108
21-059-0005	21-101-0014	0.924	323	0.135	36
21-059-0005	21-111-0043	0.879	161	0.21	121

Site 1	Site 2	Corr.	n	Rel. Diff	Distance (km)
21-059-0005	21-111-0044	0.859	100	0.199	123
21-059-0005	21-111-0051	0.847	201	0.216	108
21-059-0005	21-111-0067	0.858	323	0.218	134
21-059-0005	21-145-1024	0.867	43	0.223	155
21-059-0005	21-151-0003	0.783	331	0.302	246
21-059-0005	21-193-0003	0.27	10	0.492	346
21-059-0005	21-195-0002	0.61	340	0.365	402
21-059-0005	21-199-0003	0.713	198	0.279	231
21-059-0005	21-227-0009	0.827	188	0.199	111
21-067-0012	21-093-0006	0.889	308	0.17	126
21-067-0012	21-101-0014	0.768	317	0.253	261
21-067-0012	21-111-0043	0.838	159	0.271	117
21-067-0012	21-111-0044	0.768	97	0.241	113
21-067-0012	21-111-0051	0.826	199	0.279	123
21-067-0012	21-111-0067	0.876	325	0.261	103
21-067-0012	21-145-1024	0.572	40	0.362	377
21-067-0012	21-151-0003	0.883	334	0.186	41
21-067-0012	21-193-0003	0.526	9	0.47	143
21-067-0012	21-195-0002	0.65	332	0.293	184
21-067-0012	21-199-0003	0.788	193	0.205	108
21-067-0012	21-227-0009	0.814	188	0.204	189
21-093-0006	21-101-0014	0.843	301	0.214	143
21-093-0006	21-111-0043	0.877	151	0.231	59
21-093-0006	21-111-0044	0.885	100	0.192	54
21-093-0006	21-111-0051	0.901	180	0.222	40
21-093-0006	21-111-0067	0.886	305	0.25	61
21-093-0006	21-145-1024	0.794	43	0.271	251
21-093-0006	21-151-0003	0.851	313	0.213	138
21-093-0006	21-193-0003	0.286	10	0.514	238
21-093-0006	21-195-0002	0.652	323	0.301	294
21-093-0006	21-199-0003	0.801	183	0.207	129
21-093-0006	21-227-0009	0.899	164	0.147	80
21-101-0014	21-111-0043	0.796	151	0.251	150
21-101-0014	21-111-0044	0.787	94	0.258	152
21-101-0014	21-111-0051	0.762	189	0.245	139
21-101-0014	21-111-0067	0.784	311	0.268	164
21-101-0014	21-145-1024	0.883	41	0.203	133
21-101-0014	21-151-0003	0.748	318	0.298	280
21-101-0014	21-193-0003	0.516	10	0.516	381
21-101-0014	21-195-0002	0.554	324	0.362	436
21-101-0014	21-199-0003	0.617	183	0.315	266
21-101-0014	21-227-0009	0.727	177	0.245	143
21-111-0043	21-111-0044	0.958	109	0.118	6
21-111-0043	21-111-0051	0.865	478	0.159	20
21-111-0043	21-111-0067	0.933	469	0.134	14
21-111-0043	21-145-1024	0.855	47	0.25	276
21-111-0043	21-151-0003	0.727	154	0.38	145

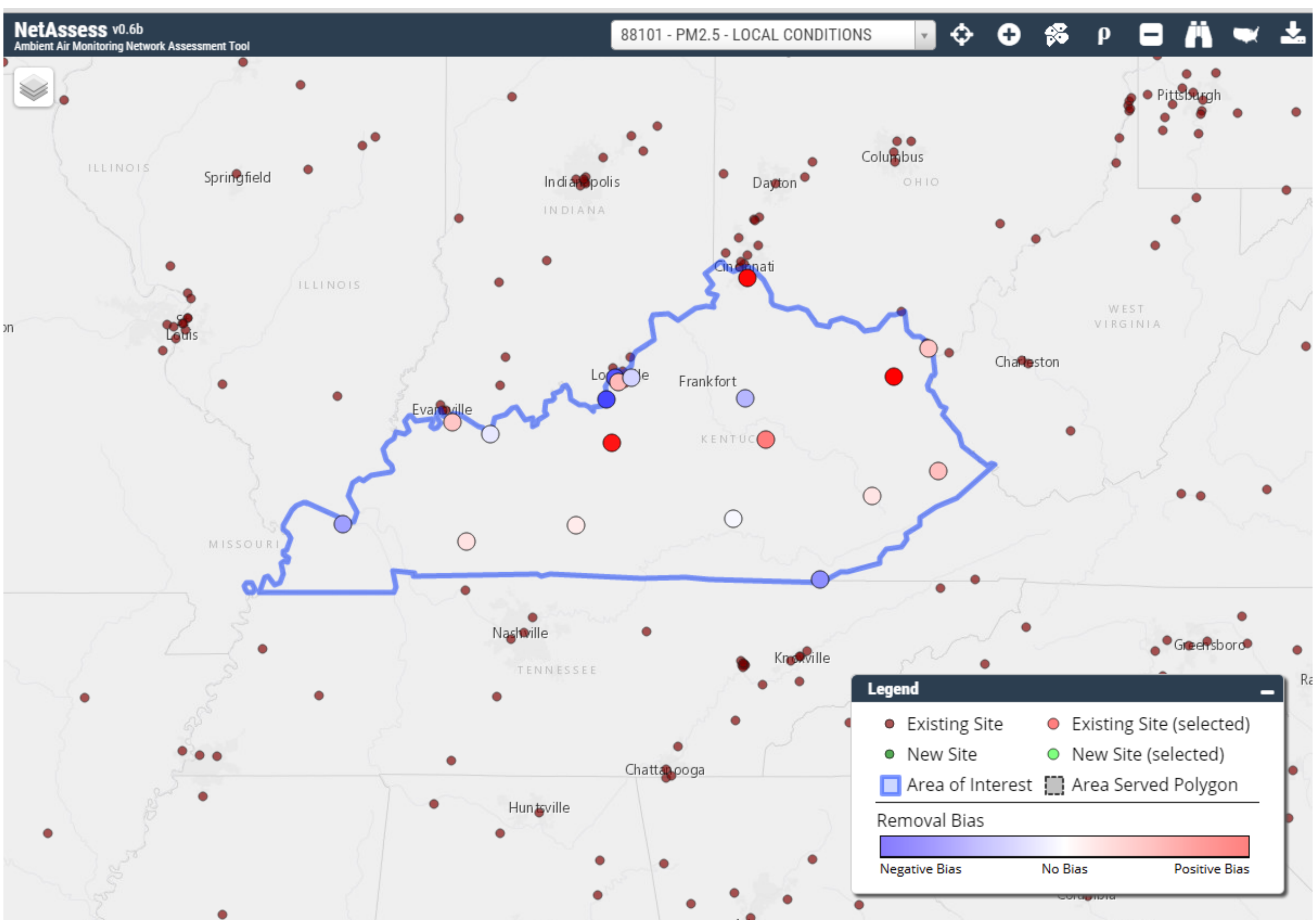
Site 1	Site 2	Corr.	n	Rel. Diff	Distance (km)
21-111-0044	21-111-0067	0.939	109	0.117	12
21-111-0044	21-145-1024	0.861	40	0.217	277
21-111-0044	21-151-0003	0.755	96	0.335	140
21-111-0044	21-193-0003	0.101	8	0.584	248
21-111-0044	21-195-0002	0.362	109	0.437	296
21-111-0043	21-193-0003	0.555	10	0.545	253
21-111-0043	21-195-0002	0.407	458	0.448	300
21-111-0043	21-199-0003	0.651	150	0.329	165
21-111-0043	21-227-0009	0.77	163	0.28	136
21-111-0044	21-111-0051	0.854	109	0.201	18
21-111-0044	21-199-0003	0.667	96	0.29	159
21-111-0044	21-227-0009	0.74	99	0.263	133
21-111-0051	21-111-0067	0.878	588	0.167	28
21-111-0051	21-145-1024	0.794	47	0.276	261
21-111-0051	21-151-0003	0.778	194	0.374	146
21-111-0051	21-193-0003	0.468	10	0.616	252
21-111-0051	21-195-0002	0.36	507	0.448	303
21-111-0051	21-199-0003	0.708	182	0.327	156
21-111-0051	21-227-0009	0.781	198	0.265	116
21-111-0067	21-145-1024	0.799	47	0.25	288
21-111-0067	21-151-0003	0.771	320	0.37	132
21-111-0067	21-193-0003	0.44	10	0.611	240
21-111-0067	21-195-0002	0.472	627	0.421	286
21-111-0067	21-199-0003	0.677	210	0.31	156
21-111-0067	21-227-0009	0.792	199	0.247	140
21-145-1024	21-151-0003	0.609	37	0.426	387
21-145-1024	21-193-0003	0.447	10	0.442	476
21-145-1024	21-195-0002	0.606	46	0.42	537
21-145-1024	21-199-0003	0.541	40	0.404	352
21-145-1024	21-227-0009	0.76	42	0.289	209
21-151-0003	21-193-0003	0.302	6	0.554	108
21-151-0003	21-195-0002	0.716	335	0.249	157
21-151-0003	21-199-0003	0.852	192	0.195	77
21-151-0003	21-227-0009	0.811	184	0.235	187
21-193-0003	21-195-0002	0.831	10	0.201	64
21-193-0003	21-199-0003	0.707	10	0.359	126
21-193-0003	21-227-0009	0.589	10	0.451	268
21-195-0002	21-199-0003	0.721	205	0.245	189
21-195-0002	21-227-0009	0.585	194	0.307	330
21-199-0003	21-227-0009	0.834	163	0.183	143

Evaluation of Monitor Redundancy based upon Correlations from NetAssess v0.6b:
Includes all KDAQ monitors with correlation greater than 0.6 and distance less than 100 km between site-pairs.

Site 1		Site 2		Corr.	n	Rel. Diff	Distance (km)	Redundancy
21-059-0005	Owensboro Primary	21-101-0014	Baskett	0.924	323	0.135	36	No: Likely same volume of air. Different CBSAs.
21-019-0017	Ashland Primary	21-043-0500	Grayson Lake	0.902	331	0.228	39	No: Grayson Lake is a background site. Complex terrain may limit scale.
21-093-0006	Elizabethtown	21-111-0051	Watson Lane (LMAPCD)	0.901	180	0.222	40	No: Likely same volume of air. Different CBSAs.
21-093-0006	Elizabethtown	21-227-0009	Ed Spear Park	0.899	164	0.147	80	No: Likely same volume of air. Different CBSAs.
21-093-0006	Elizabethtown	21-111-0067	Cannons Lane (LMAPCD)	0.886	305	0.25	61	No: Likely same volume of air. Different CBSAs.
21-067-0012	Lexington Primary	21-151-0003	Mayfield Elem	0.883	334	0.186	41	No: Likely same volume of air. Different CBSAs.
21-093-0006	Elizabethtown	21-111-0043	Southwick (LMAPCD)	0.877	151	0.231	59	No: Likely same volume of air. Different CBSAs.
21-013-0002	Middlesboro	21-193-0003	Hazard	0.857	10	0.327	89	No: Separate CBSAs. Complex terrain
21-151-0003	Mayfield Elem	21-199-0003	Somerset	0.852	192	0.195	77	No: Likely same volume of air. Different CBSAs.
21-047-0006	Hopkinsville	21-059-0005	Owensboro Primary	0.848	327	0.199	99	No: Likely same volume of air. Different CBSAs.
21-193-0003	Hazard	21-195-0002	Pikeville	0.831	10	0.201	64	Potentially Redundant: Complex terrain may limit scale.
21-047-0006	Hopkinsville	21-227-0009	Ed Spear Park	0.811	183	0.204	100	No: Separate CBSAs. Complex terrain may limit scale.
21-043-0500	Grayson Lake	21-195-0002	Pikeville	0.768	334	0.238	93	No: Separate CBSAs. Complex terrain.
21-013-0002	Middlesboro	21-199-0003	Somerset	0.64	95	0.278	95	No: Separate CBSAs. Complex terrain.

Evaluation of Removal Bias

While KDAQ did generate removal biases with the LADCO tools, the results were not used and are shown below for documentation purposes only. Ultimately, KDAQ is operating a lean $PM_{2.5}$ network and does not plan on discontinuing any $PM_{2.5}$ monitor.



$PM_{2.5}$ Monitoring Network Conclusions

The $PM_{2.5}$ monitoring network in Kentucky meets or exceeds the minimum number of stations required by 40 CFR 58, Appendix D. However, KDAQ did not meet the requirement to have 80% of the collocated monitors located at sites with annual averages or daily concentrations estimated to be within 20% of the NAAQS.

Based upon the annual average at each site, KDAQ has only one collocated sampler (21-093-0006) located at a site within 20% NAAQS. KDAQ would need to have all two collocated samplers located at sites with annual averages within 20% of the NAAQS to meet the requirement. KDAQ will correct this deficiency in the 2016 Network Plan.

It should be noted that if the Lexington MSA reaches a population of 500,000, it could require a second $PM_{2.5}$ sampler if design values are 85% of the NAAQS. Additionally, KDAQ could require a near-road site if the near-road requirements are not revised.

Lead Monitoring Network

The current lead monitoring network in Kentucky currently consists of three sites; two of which, are operated by KDAQ in Madison County. The third site is operated by LMAPCD in Jefferson County. KDAQ sites are equipped with high volume TSP samplers that collect samples on quartz fiber filters (AQS parameter code 14129). Meanwhile, the LMAPCD site is equipped with a low volume PM_{10} sampler that collects a sample on a Teflon filter (AQS parameter code 85129).

KDAQ and LMAPCD began establishing the lead monitoring network in 2010, as a result of a strengthening of the lead NAAQS and associated monitoring rules. While the lead NAAQS and new monitoring rules were initially promulgated in 2008, the EPA issued revised lead monitoring requirements in January 2010.

Ultimately, 40 CFR 58, Appendix D, requires that:

- One lead monitor be established at each non-airport point source emitting more than 0.5 tpy, based upon the most recent NEI or other scientifically justifiable data.
- The lead monitor must be stationed in the area of maximum concentration.
- The EPA Regional Administrator may waive the monitoring requirement for near-source monitoring if an agency can demonstrate that a source will not contribute to a lead concentration in excess of 50% of the NAAQS, based upon historical data, modeling, or other means. This waiver must be renewed during each five-year network assessment.
- State, or local, agencies are required to conduct non-source oriented monitoring at each NCore site in CBSAs of 500,000 or more.

During the modeling demonstrations in 2011, KDAQ identified three sources that required lead monitoring:

- Calgon Carbon, Boyd County
- Superior Battery, Russell County
- EnerSys Inc., Madison County

As a result KDAQ established the following lead monitors:

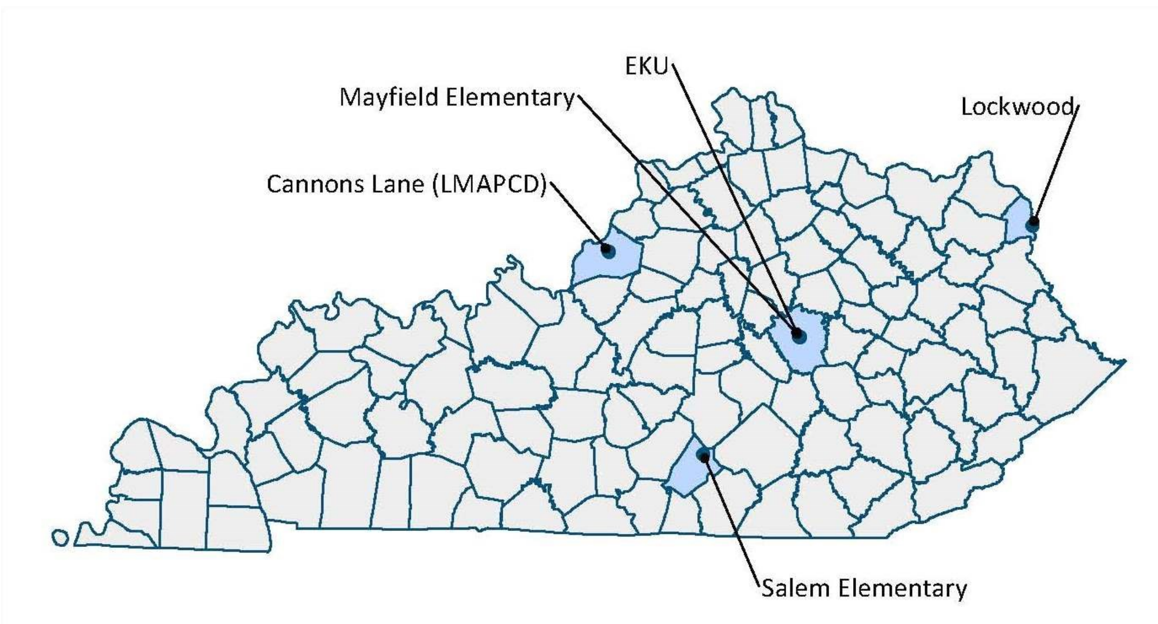
- Lockwood, Boyd County
- Salem Elementary, Russell County
- Mayfield Elementary, Madison County
- LMAPCD also established low volume lead monitoring at the Cannons Lane NCore site in Jefferson County.

The Lockwood and Salem Elementary sites each collected more than 38 months of data that showed no violations of the NAAQS. However, EPA expressed concerns regarding the location of the Mayfield

Elementary site due to its location outside the area of maximum deposition, as demonstrated by modeling. Because the modeled area of maximum deposition was located on the athletic fields at Eastern Kentucky University, KDAQ established a sampler on EKU's campus. While the Mayfield Elementary sampler began collecting data in January 2010, the EKU site was not established until March 2012.

The EKU site was originally intended to be a temporary special study to confirm that appropriateness of the Mayfield Elementary site. The site was established with the cooperation of EPA Region 4.

Map & Chart: KDAQ & LMAPCD Lead Monitoring Network (2009-Present)



County	Site ID	Site Name	Sampling Method	Operation Dates
Russell	21-207-0001	Salem Elementary-DISCONTINUED	TSP High Volume (LC)-Quartz Filter	07/13/2010- 12/31/2014
Madison	21-151-0003	Mayfield Elementary-Collocated Site	TSP High Volume (LC)-Quartz Filter	01/02/2010- Present
Madison	21-151-0005	EKU	TSP High Volume (LC)-Quartz Filter	03/10/2012- Present
Jefferson	21-111-0067	Cannons Lane (LMAPCD)	PM_{10} Low Volume (LC)-Teflon Filter	01/04/2012- Present
Boyd	21-019-0016	Lockwood-DISCONTINUED	TSP High Volume (LC)-Quartz Filter	4/14/2010-08/19/2013

Evaluation of Concentration Trends and Siting Criteria

As stated previously, the Lockwood and Salem Elementary showed no violations during their time in operation; in fact, data was extremely low at both sites. The Lockwood site was not located in the area of maximum modeled deposition, as indicated by modeling. The actual area of maximum deposition was located in the Ohio River, as such the monitor was placed in one of the few surrounding locations with accessible terrain.

While the Salem Elementary site was located in the modeled area of maximum concentration, the data collected at the site was still much lower than the NAAQS. While the CFR only requires 38 months of clean data prior to discontinuation of a lead site, KDAQ decided to keep the Salem Elementary site operational for an additional year in order to ensure continued NAAQS compliance.

KDAQ fully expected to see data below the level of the NAAQS at the EKU and Mayfield Sites in Madison County. However, in May 2012, KDAQ received the analytical results from the laboratory for samples collected in February and March, which included the first month of sampling from the newly established EKU site. The data showed that both the Mayfield Elementary and the EKU sites recorded extremely high 24-hour sample concentrations. At EKU, a sample collected on March 28, 2012, showed a 24-hour sample concentration of 5.647 ug/m^3. At Mayfield Elementary, the site recorded the first three month rolling average (January-March 2012) with data above the level of the NAAQS.

The chart and graph on the following page summarize the sample concentration data, as well as the trend in three-month rolling averages. Ultimately, KDAQ is working to establish a collocated monitor at the EKU site, as required by 40 CFR 58, Appendix A, since it is by far the highest reading site in the network.

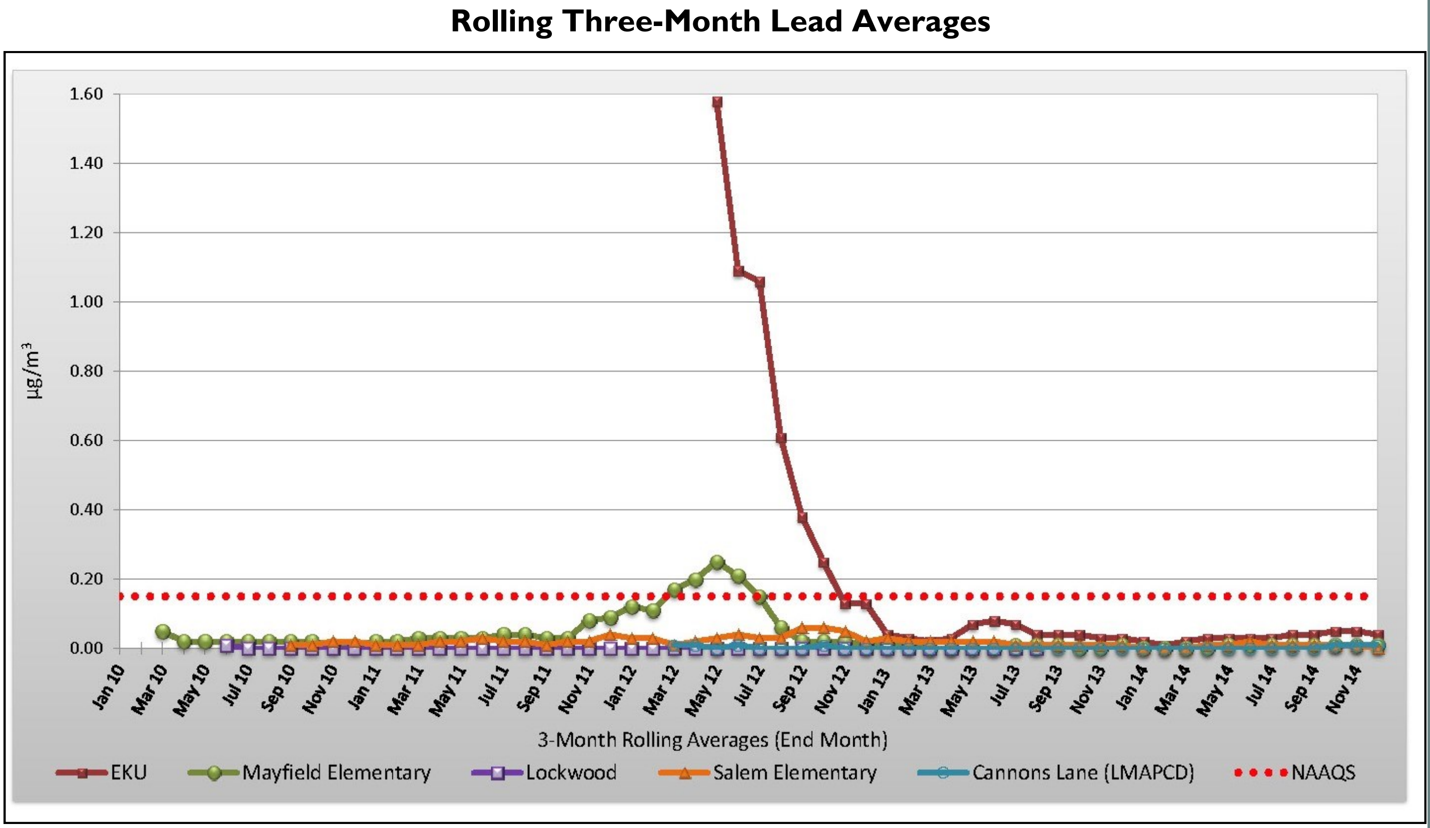
As of the date of this assessment, KDAQ had installed new fencing at the EKU site and is preparing to build a second deck for the collocated sampler. Facilities Management at EKU have been cooperative in the endeavor.

Source-Oriented Lead Monitoring Waivers

As required by 40 CFR 58, Appendix A, KDAQ has prepared a modeling demonstration. This modeling has demonstrated that a waiver from monitoring lead at Calgon Carbon, Kentucky Utilities – Ghent, Kentucky Power – Big Sandy, Blue Grass Army Depot, CC Metals & Alloy, Tennessee Valley Authority – Shawnee and Tennessee Valley Authority Paradise can be requested based upon a maximum 3-month rolling average below one-half the lead NAAQS.

The Enersys facility in Madison County exhibited a predicted impact concentration greater than fifty percent of the lead NAAQS and is currently monitored for Pb emissions. Due to a predicted maximum 3-month rolling average above one-half the lead NAAQS at the AK Steel facility boundary in Boyd County, the Division recommends Pb monitoring in the proximity of maximum ambient air impact. The full results of the modeling demonstration, as well as the lead monitoring waiver request is located in Appendix B of this assessment.

Descriptive Statistics: 2010-2014 KDAQ Lead Sample Concentrations (ug/m³)				
	Lockwood	**Mayfield Elem**	**EKU**	**Salem Elem**
	21_019_0016	***21_151_0003***	***21_151_0005***	***21_207_0001***
Mean	0.004	0.037	0.178	0.019
Standard Error	0.000	0.006	0.047	0.003
Median	0.003	0.008	0.022	0.005
Mode	0.002	0.005	0.011	0.004
Std Dev.	0.003	0.104	0.671	0.041
Sample Var.	0.000	0.011	0.451	0.002
Kurtosis	14.428	32.526	51.814	18.948
Skewness	2.750	5.385	6.787	4.126
Range	0.023	0.856	6.021	0.286
Minimum	0.000	0.001	0.001	0.001
Maximum	**0.024**	**0.857**	**6.023**	**0.287**
Count	197	285	200	263



Nitrogen Dioxide Monitoring Network

Nitrogen Dioxide Monitoring Network History (2009-Present)

The NO_2 monitoring network in Kentucky currently consists of seven monitors located in six Kentucky counties. LMAPCD operates two NO_2 sites in Jefferson County, one of which is a near-road monitor. KDAQ operates the remaining five sites.

The number of NO_2 monitors in operation has remained relatively stable over the last few years. While LMAPCD discontinued one monitor in 2009, KDAQ has neither established nor discontinued any monitor since 2009.

The most significant changes to the network involved the establishment of a national near-road monitoring network. On February 9, 2010, the EPA released a new NO_2 Final Rule and a new set of monitoring requirements. Under the new monitoring requirements, State and Local agencies were required to establish NO_2 near-road monitoring stations based upon core based statistical area (CBSA) populations and traffic metrics.

In March 2013, the EPA finalized the use of a "phased" approach for establishing NO_2 near-road monitoring sites across the Nation. The phased approach necessitated:

- One required near-road monitor in CBSAs with a population of 1,000,000 or more be established by January 1, 2014.
- Any second required near-road monitor in CBSAs that have a population greater than 2,500,000, or have a population of 500,000 or greater and have a traffic segment with an AADT of 250,000 or more, be established by January 1, 2015.
- Required sites in remaining CBSAs with populations of 500,000 or more to be established by January 1, 2017.

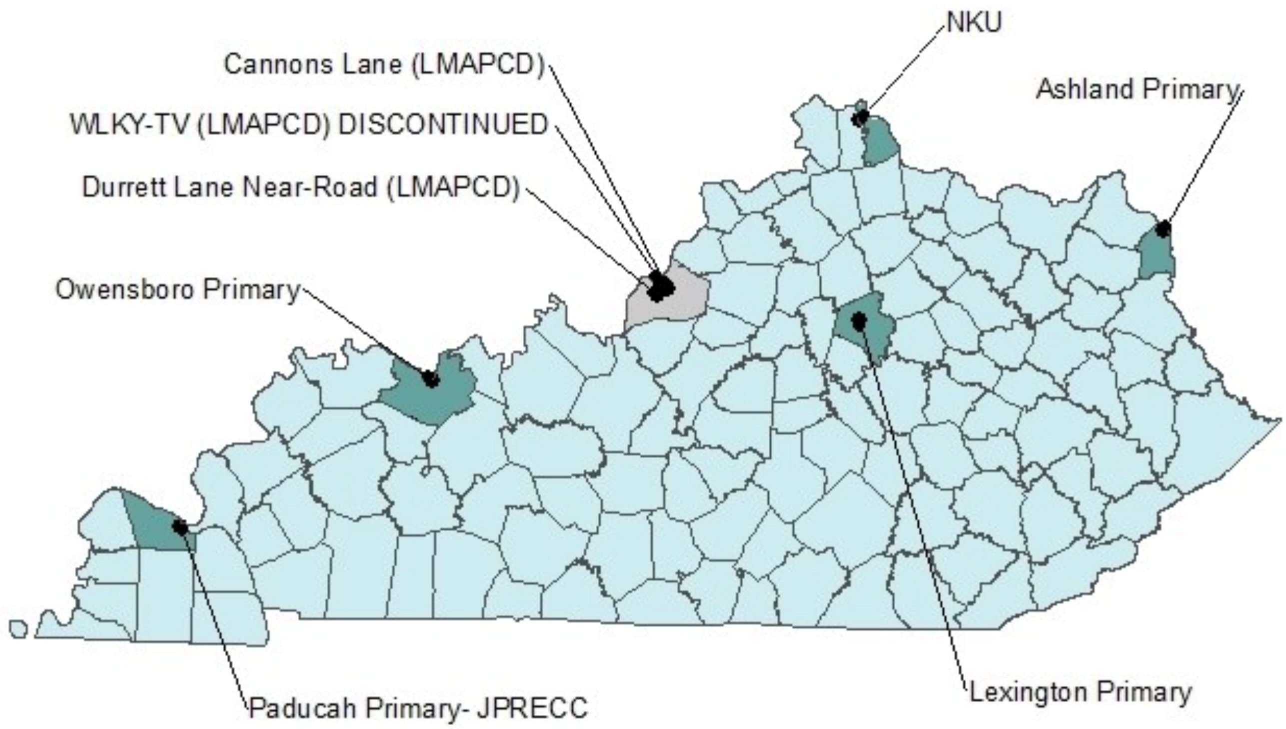
Based upon the original analysis performed in 2012, it was determined that the Cincinnati-Middletown, OH-KY-IN and the Louisville-Jefferson County, KY-IN MSAs each required one near-road NO_2 monitor. The determination of the final locations of near-road monitoring locations was a cooperative effort between multiple State and Local Agencies. Potential near-road sites were evaluated with a number of criteria, including fleet mix adjusted traffic counts (FE-AADT), roadway design, traffic congestion patterns, local topography, meteorology, population exposure, and logistics; of which, FE-AADT was the driving factor.

In the Louisville MSA, the road segment with the largest fleet-mix adjusted was located in Jefferson County. As such, LMAPCD established the Durrett Lane (21-111-0075) site, which began collecting data in February 2014.

In the Cincinnati MSA, KDAQ's analysis showed that the road segment with the largest fleet-mix adjusted AADT was a Kentucky portion of the I-75/I-71 corridor. However, the EPA distributed funds to the Southwest Ohio Air Quality Agency (SWOAQA) based upon an erroneous assumption that the road segment with the largest FE-AADT would be located in Ohio.

After discussions between KDAQ, SWOAQA, EPA Region 4, and EPA Region 5, it was determined that it was acceptable for the near-road site to be located in Ohio. Ultimately, the requirement for a near-road site in the Cincinnati, OH-KY-IN MSA is fulfilled by a Memorandum of Agreement (MOA) with SWOAQA (also known as HC-DOES).

Map & Chart: KDAQ & LMAPCD NO_2 Monitoring Network (2009-Present)



County	Site ID	Site Name	Monitor Type	Scale	Operation Dates
Boyd	21-019-0017	Ashland Primary	SLAMS	Urban	8/14/2010- Present
Campbell	21-037-3002	NKU	SLAMS	Urban	07/02/2007- Present
Daviess	21-059-0005	Owensboro Primary	SLAMS	Urban	07/25/1978- Present
Fayette	21-067-0012	Lexington Primary	SLAMS	Urban	12/05/1979- Present
Jefferson	21-111-0067	Cannons Lane (LMAPCD)	SLAMS	Urban	01/01/2010- Present
Jefferson	21-111-0075	Durrett Lane Near-Road (LMAPCD)	SLAMS	Neighborhood	02/19/2014- Present
Jefferson	21-111-1021	WLKY-TV (LMAPCD)	SLAMS	Urban	06/15/1993- 12/31/2009
McCracken	21-145-1024	Paducah Primary- JPRECC	SLAMS	Urban	11/01/1980- Present

**** A NO/NOY only monitor is located at Mammoth Cave NP.***

Evaluation of Minimum Monitoring Requirements

Appendix D to 40 CFR 58, requires that area-wide NO_2 monitors be established in each CBSA with a population of one million or more in order to monitor the expected highest concentrations representing the neighborhood or larger scales. The minimum monitoring requirements for area-wide monitors are evaluated in the chart on the following page. Kentucky has only two CBSAs with populations greater than one million or more people.

In the Louisville-Jefferson County, KY-IN CBSA, the area-wide NO_2 monitor is located at the Cannons Lane site (21-111-0067) which is operated by LMAPCD. In the Cincinnati, OH-KY-IN CBSA, KDAQ operates one area-wide NO_2 monitor at the NKU site (21-037-3002). Additionally, the Southwest Ohio Air Quality Agency (SWOAQA) operates two area-wide NO_2 monitors in Ohio.

In addition to area-wide monitors, 40 CFR 58, Appendix D requires one near-road monitor in CBSAs with a population of 1,000,000 or more. A second near-road monitor is required in CBSAs that have a population greater than 2,500,000, or have a population of 500,000 or greater and have a traffic segment with an AADT of 250,000 or more.

In the Louisville-Jefferson County, KY-IN CBSA, the near-road monitor is located at the Durrett Lane site (21-111-0075), which is operated by LMAPCD. In the Cincinnati, OH-KY-IN CBSA, the near-road monitor is located at the Cinci Near-Road site (39-061-0048) on Colerain Avenue in Ohio, which is operated by SWOAQA.

The Louisville and Cincinnati CBSAs neither have populations that exceed 2,500,000 people nor to either have any road segment with a traffic count greater than 250,000, as such only one monitor is required. The road segments with the largest traffic counts for each of these CBSAs are listed in the chart below.

State	County	Rank	Station ID	Route Name	Traffic Count Year	AADT
Kentucky	Kenton	1	59792	I-75/I-71	2014	193,399
Kentucky	Jefferson	1	56777	I-264 (@I-65)	2013	166,432

Source: KYTC Traffic Database. http://datamart.business.transportation.ky.gov/EDSB_SOLUTIONS/CTS/

While KDAQ does not currently operate any near-road NO_2 sites, it should be noted that the population of the Lexington-Fayette, KY MSA is currently 489,435. Under the current regulations, the MSA will be required to have a near-road site if it reaches a population of 500,000. Population growth in the MSA has been slow. KDAQ is hopeful that the requirement for a near-road site at this population threshold will be revoked during the next review of the of the NAAQS and before the population of the MSA reaches 500,000. KDAQ believes near-road monitors are a low value network and federal funding is currently not provided for sites that were not apart of the initial phase 1 and phase 2 implementation plan.

Finally, in addition to area-wide and near-road monitors, the EPA Regional Administrator, in collaboration with States, must require an additional 40 monitors nationwide. RA-40 NO_2 monitors may be established in any area and have a primary focus of protecting vulnerable populations.

In Kentucky, the NO_2 monitor at the Lexington Primary site (21-067-0012) in Fayette County has been designated as a RA-40 monitor. The demographics of the area surrounding the Lexington Primary site is predominantly low-income and minority. As such, classification as a RA-40 monitor is appropriate. Vulnerable and susceptible population are further analyzed in the section dedicated to sensitive populations in Kentucky.

Area-Wide NO_2 Minimum Monitoring Requirements for CBSAs

CBSA	Name	LSAD	2013 USCB Population Estimate	2014 # Area-Wide Monitors Required	2014 Total # Area-Wide Monitors Present	2014 # KDAQ Area-Wide Monitors Present
12680	Bardstown, KY	Micropolitan SA	44,540	0	0	0
14540	Bowling Green, KY	Metropolitan SA	163,536	0	0	0
15820	Campbellsville, KY	Micropolitan SA	24,649	0	0	0
17140	Cincinnati, OH-KY-IN	Metropolitan SA	2,137,406	1	3	1
17300	Clarksville, TN-KY	Metropolitan SA	272,579	0	1	0
19220	Danville, KY	Micropolitan SA	53,383	0	0	0
21060	Elizabethtown-Fort Knox, KY	Metropolitan SA	151,465	0	0	0
21780	Evansville, IN-KY	Metropolitan SA	314,280	0	1	0
23180	Frankfort, KY	Micropolitan SA	71,459	0	0	0
23980	Glasgow, KY	Micropolitan SA	53,010	0	0	0
26580	Huntington-Ashland, WV-KY-OH	Metropolitan SA	364,101	0	1	1
30460	Lexington-Fayette, KY	Metropolitan SA	489,435	0	1	1
30940	London, KY	Micropolitan SA	127,119	0	0	0
31140	Louisville/Jefferson County, KY-IN	Metropolitan SA	1,262,261	1	1	0
31580	Madisonville, KY	Micropolitan SA	46,634	0	0	0
32460	Mayfield, KY	Micropolitan SA	37,451	0	0	0
32500	Maysville, KY	Micropolitan SA	17,278	0	0	0
33180	Middlesborough, KY	Micropolitan SA	27,885	0	0	0
34460	Mount Sterling, KY	Micropolitan SA	45,500	0	0	0
34660	Murray, KY	Micropolitan SA	37,657	0	0	0
36980	Owensboro, KY	Metropolitan SA	116,401	0	1	1
37140	Paducah, KY-IL	Micropolitan SA	98,137	0	1	1
40080	Richmond-Berea, KY	Micropolitan SA	102,283	0	0	0
43700	Somerset, KY	Micropolitan SA	63,907	0	0	0
46460	Union City, TN-KY	Micropolitan SA	37,516	0	0	0

Source: USCB , CBSA-EST2013. http://www.census.gov/popest/data/metro/totals/2013/CBSA-EST2013-alldata.html. Last accessed: March 12, 2015.

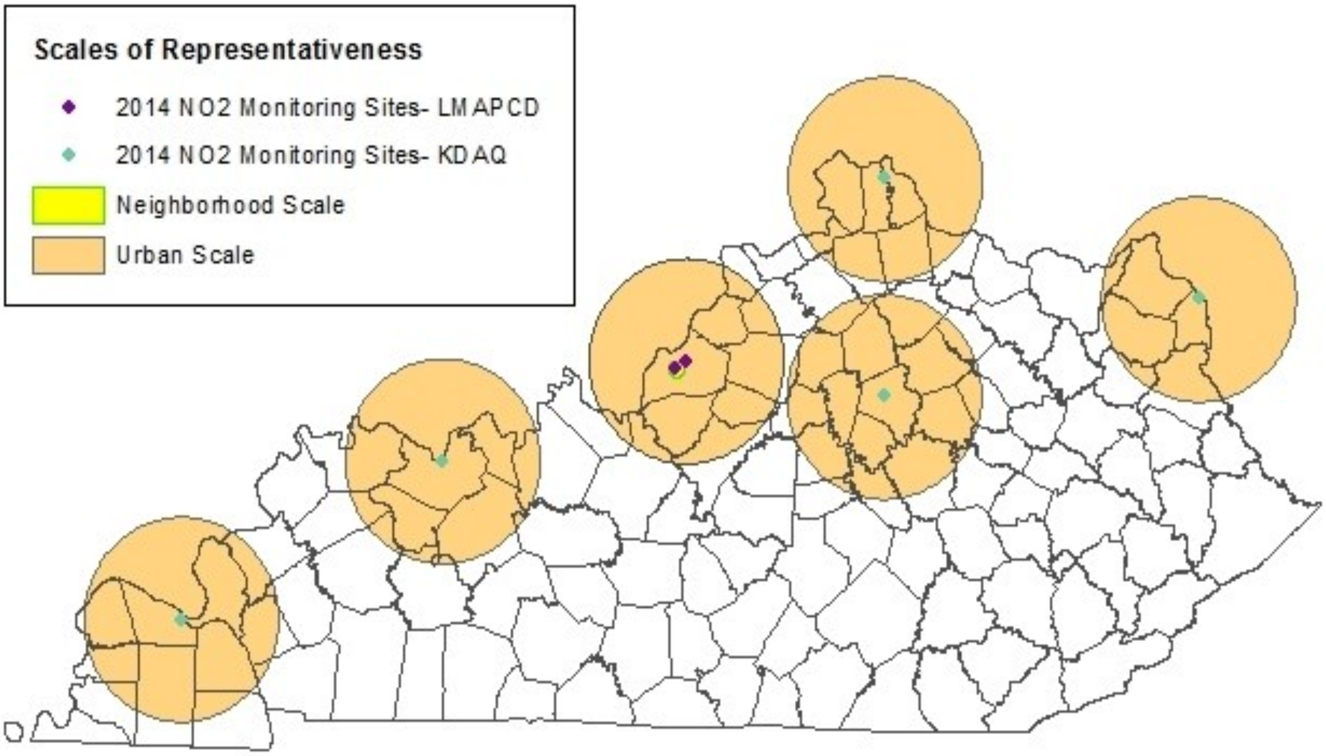
Evaluation of Spatial Scales of Representativeness

The spatial scale of representativeness (also called monitoring scale and spatial scale) describes the physical dimensions of a parcel of air, which has reasonably similar concentrations throughout. According to 40 CFR 58, Appendix D, area-wide NO_2 monitoring must be conducted at the neighborhood or larger scale.

Spatial Scales of Representativeness 40 CFR 58, Appendix D	
Scale of Representativeness (Monitoring Scale)	**Physical Dimensions**
Microscale	Up to 100 meters
Middle scale	100 meters to 0.5 kilometers
Neighborhood scale	0.5 to 4.0 kilometers
Urban scale	4.0 to 50.0 kilometers
Regional Scale	Tens to hundreds of kilometers

All KDAQ-operated area-wide NO_2 monitors are established at the either neighborhood or urban scales. Spatial scales of representativeness for all NO_2 monitors in Kentucky are shown by the map on the following page.

Siting criteria evaluations have shown that siting is acceptable for neighborhood and urban scale NO_2 monitoring at all sites, with the exception of the Ashland Primary site (21-019-0017). All equipment at the Ashland Primary site is partially obstructed. A complete description of the issues surrounding siting at Ashland Primary is included in Appendix D.



Scales of representativeness for Kentucky NO_2 monitors.

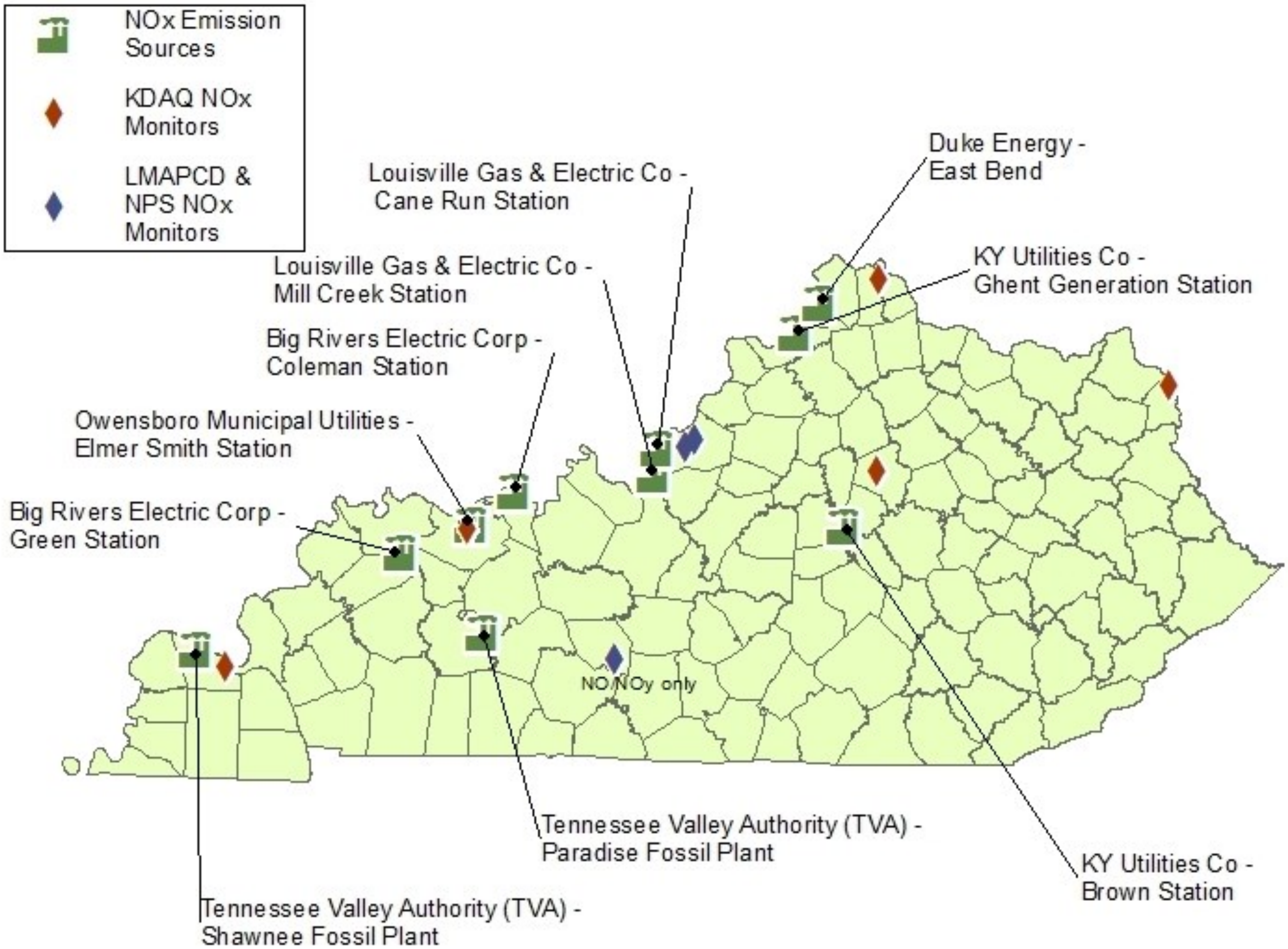
Evaluation of Network Coverage

In order to evaluate network coverage, KDAQ compared the locations of the top ten NO_x sources in the State to the locations of NO_2 monitors. As can be seen by the map on the following page, most of the facilities have a NO_2 monitor located downwind.

As with other pollutants, the TVA Paradise Facility in Muhlenberg County does not have a NO_2 monitor located downwind. While KDAQ did previously have a site located downwind of the facility in Ohio County, the site was not equipped with a NO_2 monitor. In fact, KDAQ hasn't operated a NO_2 monitor in Ohio County since 1984.

While the area downwind of TVA Paradise is not well represented by the current network, data collected at other locations throughout the State shows concentrations that are well below the level of the NAAQS.

Top Ten NO_x Sources and Kentucky NO_2 Monitors



Top Ten NO_x Sources & 2013 Actual Emissions				
Rank	**Facility ID**	**Facility Name**	**County**	**2013 Actual Emissions (tpy)**
1	3073	Tennessee Valley Authority - Shawnee Fossil Plant	McCracken	12094.7
2	704	KY Utilities Co - Ghent Generation Station	Carroll	12043.8
3	127	Louisville Gas & Electric Co - Mill Creek Station	Jefferson	9049.2
4	3239	Tennessee Valley Authority - Paradise Fossil Plant	Muhlenberg	7737.0
5	942	Owensboro Municipal Utilities - Elmer Smith Station	Daviess	7131.7
6	1640	Big Rivers Electric Corp - Coleman Station	Hancock	6097.6
7	126	Louisville Gas & Electric Co - Cane Run Station	Jefferson	4630.3
8	44411	Big Rivers Electric Corp - Green Station	Webster	4183.0
9	3148	KY Utilities Co - Brown Station	Mercer	3516.2
10	176	Duke Energy KY - East Bend	Boone	3491.3

Source: KDAQ & LMAPCD Emissions Inventory Systems, February 2015

Evaluation of Concentration Trends

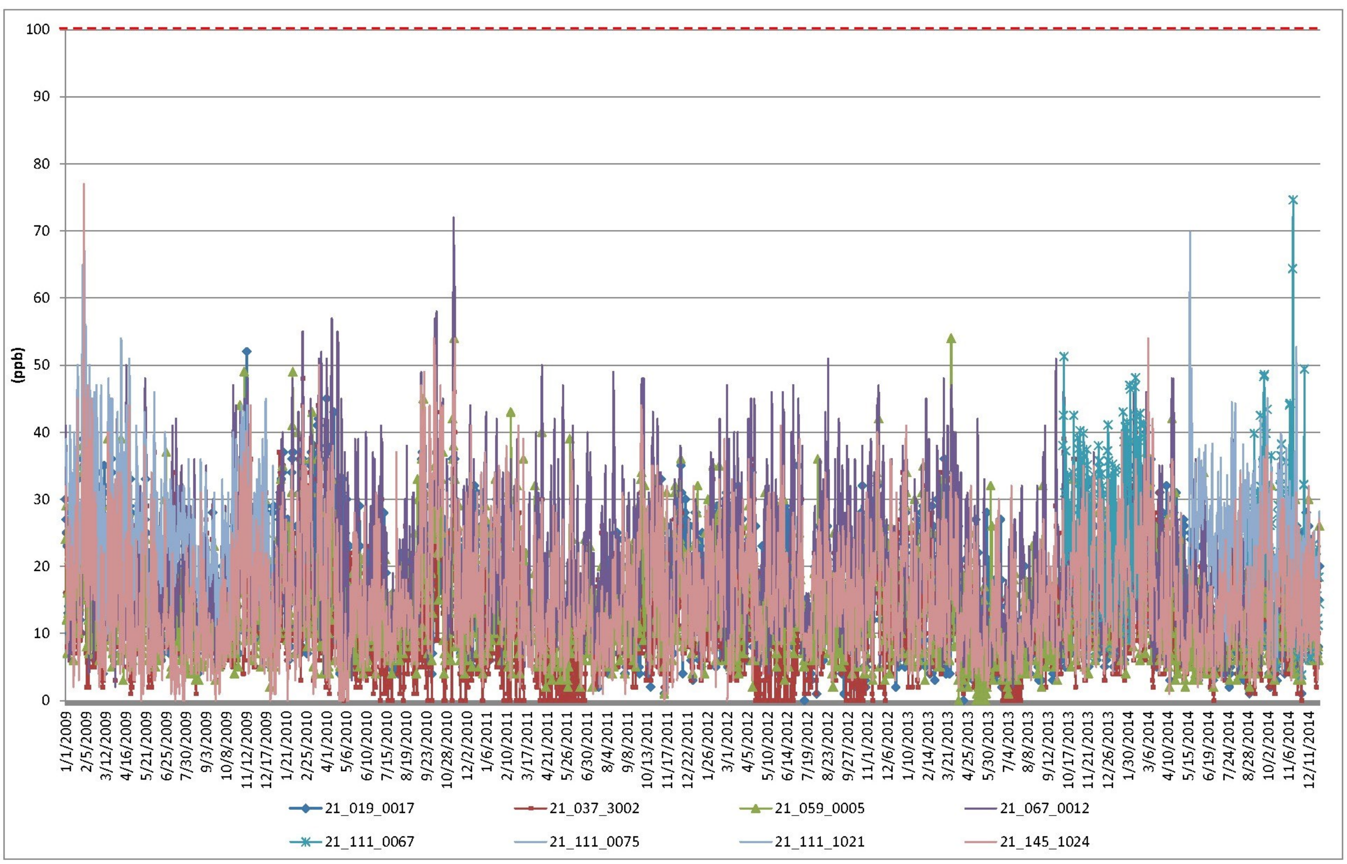
Data collected at all NO_2 monitoring sites in the State are currently well below the levels of the annual average NAAQS and the 1-Hour NAAQS. The graph on the following page shows the design value measured annually for each of the NO_2 standards. Additionally, three-year design values for the 1-Hour NAAQS are listed in the chart to the right

As shown by the graph below, no site in Kentucky recorded any daily maximum 1-hour NO_2 concentration above the level of the NAAQS over the time-period covered by this assessment.

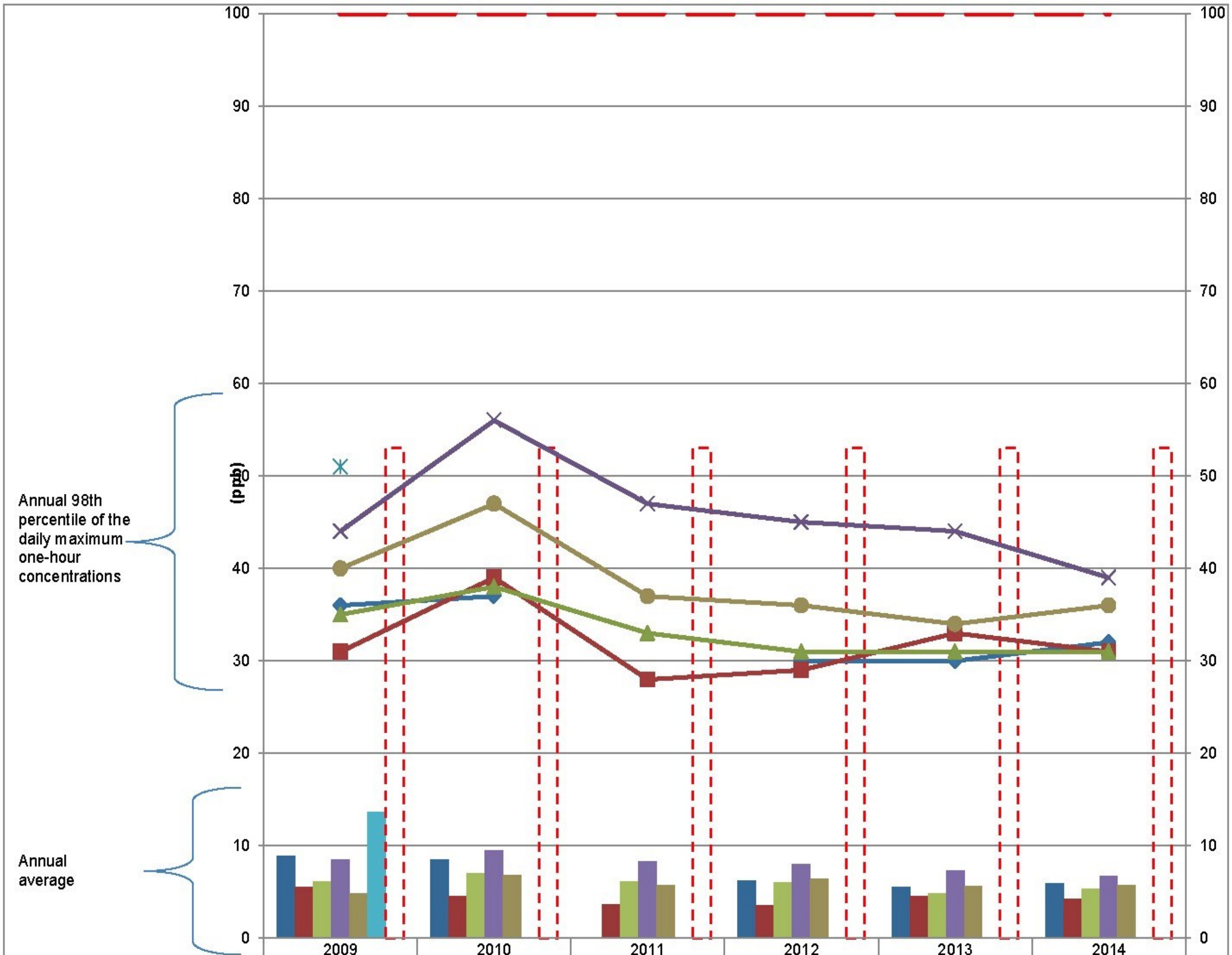
Three-Year 1-Hour NO_2 Design Values

Site ID	2013	2014
21_019_0017	30*	31
21_037_3002	30	31
21_059_0006	32	31
21_067_0012	45	43
21_111_0067	43*	46*
21_111_0075		45*
21_145_1024	36	35

Daily Maximum 1-Hour NO_2 Concentrations (2009-Present)



Annual Averages and 98th Percentile Daily Maximum One-Hour NO_2 Concentrations



	2009	2010	2011	2012	2013	2014
21_019_0017 ANNUAL	8.88	8.46		6.23	5.57	5.9
21_037_3002 ANNUAL	5.55	4.52	3.62	3.58	4.51	4.29
21_059_0005 ANNUAL	6.16	7.06	6.12	6.03	4.82	5.31
21_067_0012 ANNUAL	8.48	9.46	8.33	8.05	7.35	6.74
21_145_1024 ANNUAL	4.86	6.87	5.69	6.41	5.68	5.75
21_111_1021 ANNUAL	13.61					
Annual NAAQS	53	53	53	53	53	53
21_019_0017 1HR	36	37		30	30	32
21_037_3002 1HR	31	39	28	29	33	31
21_059_0005 1HR	35	38	33	31	31	31
21_067_0012 1HR	44	56	47	45	44	39
21_145_1024 1HR	40	47	37	36	34	36
21_111_1021 1HR	51					
1-Hour NAAQS	100	100	100	100	100	100

NO_2 Monitoring Network Conclusions

The NO_2 monitoring network meets or exceeds all minimum monitoring requirements, as stated in 40 CFR 58, Appendix D. The area immediately downwind of the TVA Paradise facility in Muhlenberg County is not well represented by the current network. However, data collected throughout the State, including near facilities with larger NO_x emissions than TVA Paradise, show data well below NAAQS-levels. As such, KDAQ does not believe that additional monitoring is warranted.

Particulate Matter (PM_{10}) Monitoring Network

PM_{10} Monitoring Network History (2009-Present)

The Kentucky PM_{10} monitoring network currently consists of 12 samplers located in nine counties throughout the state. Of those, KDAQ currently operates eight intermittent PM_{10} samplers, while LMAPCD operates four continuous PM_{10} monitors in Jefferson County.

Since 2009, the PM_{10} network has changed significantly considering the relatively small size of the network. The map and chart on the following page shows all PM_{10} monitors in operating since 2009. Of those monitors, KDAQ has discontinued four samplers and has established three samplers.

A new PM_{10} sampler was established at the Baskett site (21-101-0014) in 2009. Despite an existing MOA with the State of Indiana, the monitor was established so that KDAQ could meet the minimum monitoring requirements of the Evansville, IN-KY MSA.

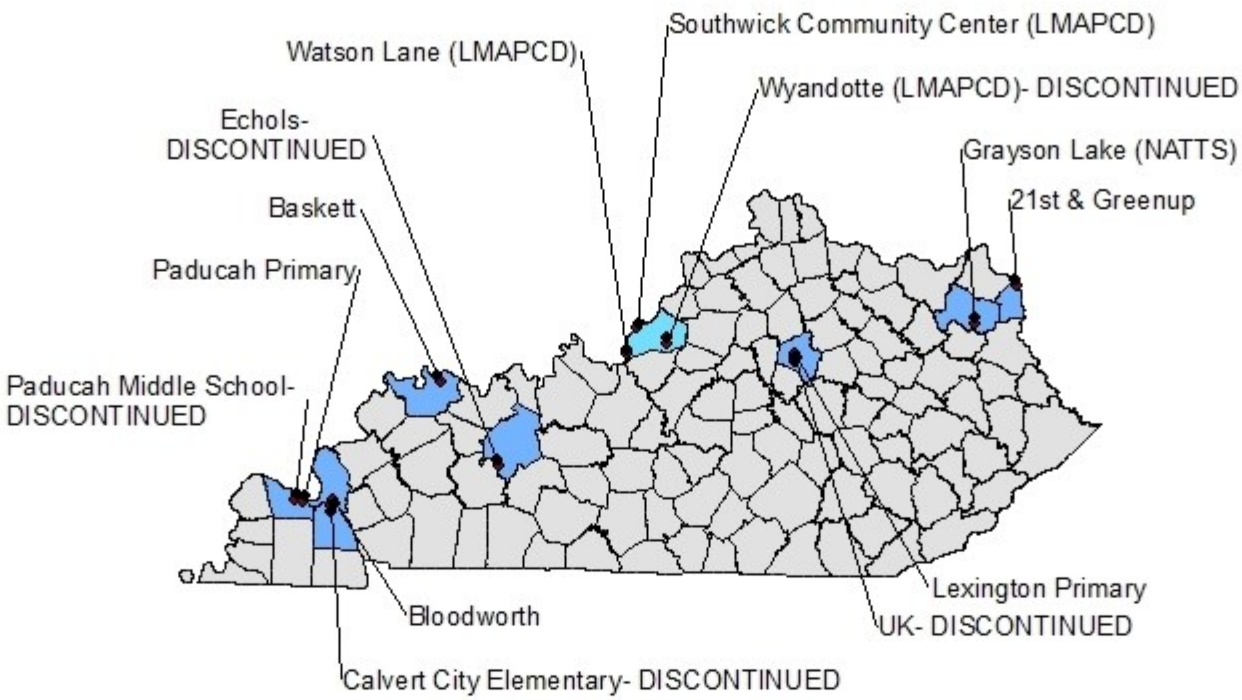
In 2010, KDAQ discontinued the Echols air monitoring station (21-183-0032) as a cost-saving measure. The special purpose monitor was originally established to evaluate a number of nearby industrial sources and was not needed to meet minimum monitoring requirements.

In 2011, KDAQ discontinued the University of Kentucky (UK) air monitoring site (21-067-0014) in Fayette County as a cost-saving measure. The PM_{10} sampler at that site was moved to the Lexington Primary station (21-067-0012), which is also located in Fayette County.

In August 2013, the Paducah Public School System asked KDAQ to vacate the site located on the roof of the Paducah Middle School (21-145-1004). As such, KDAQ promptly moved the PM_{10} sampler to the Paducah Primary site (21-145-1024) located at the Jackson Purchase Rural Electric Cooperative Corporation (JPRECC).

In October 2014, KDAQ discontinued the Calvert City Elementary site (21-157-0018) and moved the PM_{10} sampler to the nearby Bloodworth air monitoring station (21-139-0004). While the Calvert City Elementary site was discontinued primarily as a cost-saving measure, KDAQ believes the Bloodworth site will provide data that is more representative of impacts from the Calvert City industrial complex, as the site is located downwind of the majority of the sources.

Map & Chart: KDAQ & LMAPCD PM_{10} Monitoring Network (2009-Present)



County	Site ID	Site Name	Samplers	Monitor Type	Scale	Operation Dates
Boyd	21-019-0002	21st & Greenup	Intermittent	SLAMS	Middle	06/01/1987- Present
			Collocated	SLAMS	Middle	01/01/2006- Present
Carter	21-043-0500	Grayson Lake (NATTS)	Intermittent	SLAMS	Urban	07/01/2008- Present
			Collocated	SLAMS	Urban	07/01/2008- Present
Fayette	21-067-0012	Lexington Primary	Intermittent	SLAMS	Neighborhood	01/01/2012- Present
Fayette	21-067-0014	UK	Intermittent	SLAMS	Neighborhood	04/01/1991- 12/29/2011
Henderson	21-101-0014	Baskett	Intermittent	SLAMS	Neighborhood	12/01/2009- Present
Jefferson	21-111-0043	Southwick Comm. Center	Continuous	SLAMS	Neighborhood	01/01/2003- Present
		(LMAPCD)	Collocated	SLAMS	Neighborhood	01/01/2003- Present
Jefferson	21-111-0051	Watson Lane (LMAPCD)	Continuous	SLAMS	Neighborhood	01/10/2014- Present
Jefferson	21-111-0044	Wyandotte (LMAPCD)	Continuous	SLAMS	Neighborhood	08/01/2002- 01/15/2014
Livingston	21-139-0004	Bloodworth	Intermittent	SPM	Neighborhood	10/19/2014- Present
Marshall	21-157-0018	Calvert City Elementary	Intermittent	SPM	Neighborhood	10/11/2005- 10/03/2014
McCracken	21-145-1004	Paducah Middle School	Intermittent	SLAMS	Neighborhood	04/01/1991- 08/08/2013
McCracken	21-145-1024	Paducah Primary (JPRECC)	Intermittent	SPM	Neighborhood	08/14/2013- Present
Ohio	21-183-0032	Echols	Intermittent	SPM	Urban	06/01/2006- 06/08/2010

*LMAPCD also operates an intermittent PM_{10}LC (local conditions) sampler at Cannons Lane for $PM_{10-2.5}$ & Pb measurements.

Evaluation of Minimum Monitoring Requirements

40 CFR 58, Appendix D establishes the minimum number of PM_{10} stations required in MSAs, based upon the MSA's current population and monitored concentrations. The requirements are outlined by Table D-4 of Appendix D, as shown below:

Table D-4 of Appendix D to Part 58—PM_{10} Minimum Monitoring Requirements (Approximate Number of Stations Per MSA)[1]			
Population category	**High concentration[2]** (>120% of the NAAQS)	**Medium concentration[3]** (80-119% of the NAAQS)	**Low concentration[4 5]** (<79% of the NAAQS)
>1,000,000	6-10	4-8	2-4
500,000-1,000,000	4-8	2-4	1-2
250,000-500,000	3-4	1-2	0-1
100,000-250,000	1-2	0-1	0

[1]***Selection of urban areas and actual numbers of stations per area will be jointly determined by EPA and the State agency.***

[2]***High concentration areas are those for which ambient PM_{10} data show ambient concentrations exceeding the PM_{10} NAAQS by 20 percent or more (120% NAAQS= 180 ug/m3).***

[3]***Medium concentration areas are those for which ambient PM_{10} data show ambient concentrations exceeding 80 percent of the PM_{10} NAAQS (80% NAAQS= 120 ug/m3).***

[4]***Low concentration areas are those for which ambient PM_{10} data show ambient concentrations less than 80 percent of the PM_{10} NAAQS .***

[5]***These minimum monitoring requirements apply in the absence of a design value.***

These minimum monitoring requirements for Kentucky MSAs (including MSAs that cross state borders) are evaluated by the table on the following page. The table uses 2013 population estimates from the US Census Bureau, as well as the maximum 24-hour concentration recorded in 2014 to determine the number of stations required in each MSA, which is then compared to the number of stations that actually exist in the MSA. Maximum annual 24-hour concentrations for 2009-2013 are included to ensure that the 2014 maximum are representative of previous data.

Of the entire 2009-2014 dataset, only one annual maximum 24-hour concentration (in 2012) exceeded the NAAQS by more than 20% (high concentration classification). The monitor that recorded the violation is located in the Ohio portion of the Cincinnati, OH-KY-IN MSA. Even if this high value is used to calculate minimum monitoring requirements, the MSA meets the number of PM_{10} stations needed.

The Huntington-Ashland, WV-KY-OH MSA recorded one annual maximum 24-hour concentration (also in 2012) between 80-119% of the NAAQS (medium concentration classification). All other annual maximums between 2009-2014 were less than 80% of the NAAQS. Even if the medium concentration classification is used, the MSA still meets minimum monitoring requirements.

PM$_{10}$ Minimum Monitoring Requirements For Metropolitan Statistical Areas (MSAs)											
MSA	**2013 Population Estimate**	**Historical Maximum Annual 24-Hour Concentration (ug/m3)**					**2014 Maximum Annual 24-Hour Conc. (ug/m3)**	**2014 Highest Site**	**2014 Conc. Class**	**2014 Number Stations Required**	**2014 Number Stations Present**
		2009	**2010**	**2011**	**2012**	**2013**					
Bowling Green, KY	163,536	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	0
Cincinnati, OH-KY-IN	2,137,406	66	61	57	193	110	82	39-017-0012	Low	2-4	7
Clarksville, TN-KY	272,579	30	36	45	30	30	26	47-125-0006	Low	0-1	1
Elizabethtown-Ft Knox, KY	151,465	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	0
Evansville, IN-KY	314,280	41	42	43	33	30	41	18-163-0021	Low	0-1	2
Huntington-Ashland, WV-KY-OH	364,101	100	94	101	155	77	38	21-019-0002	Low	0-1	3
Lexington-Fayette, KY	489,435	32	37	36	41	40	32	21-067-0014	Low	0-1	1
Louisville/Jefferson County, KY-IN	1,262,261	52	79	114	56	40	91	21-111-0043	Low	2-4	4
Owensboro, KY	116,401	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	0

Evaluation of Collocation Requirements

According to 40 CFR 58, Appendix E, each network of manual intermittent PM_{10} methods, 15% of the monitoring sites must be collocated, with a minimum of one collocated site in the network. The sites selected for collocation should be among the highest 25% of sites in the network, based upon annual mean concentrations. Collocation requirements are based upon PQAO.

The chart below shows 2009-2014 annual mean concentrations for each manual PM_{10} sampler currently in the KDAQ network. KDAQ operates six PM_{10} sites, as such only one collocated site is required. KDAQ actually operates two collocated stations: 21st & Greenup (21-019-0002) and Grayson Lake (21-043-0500). Based upon annual mean concentrations, the 21st and Greenup site is the highest reading site in the network. Grayson Lake is collocated for participation in the NATTS PM_{10} metals program.

2009-2014 Manual Method PM_{10} Annual Means and Collocations

Site ID	Site Name	Monitor	POC	Method Code	Annual Mean (ug/m3)						2009-2014 Average (ug/m3)
					2009	2010	2011	2012	2013	2014	
21-019-0002	21st & Greenup	Primary	1	127 *	24.0	30.2	28.1	27.0	22.4	19.0	25.1
		Collocated	2	127 *	24.1	29.2	28.1	30.9	22.7	19.9	25.8
21-043-0500	Grayson Lake (NATTS)	Primary	1	126	11.6	13.6	11.4	11.2	10.1	10.3	11.4
		Primary	2	126	11.5	13.0	11.2	11.6	10.5	10.9	11.5
21-067-0012	Lexington Primary	Primary	1	126	n/a	n/a	n/a	17.0	15.7	15.5	16.1
21-101-0014	Baskett	Primary	1	126	17.4	19.5	16.3	17.3	14.3	17.1	17.0
21-139-0004	Bloodworth	Primary	1	126	n/a	n/a	n/a	n/a	n/a	12.2	12.2
21-145-1024	Paducah Primary (JPRECC)	Primary	1	126	n/a	n/a	n/a	n/a	19.2	18.1	18.7

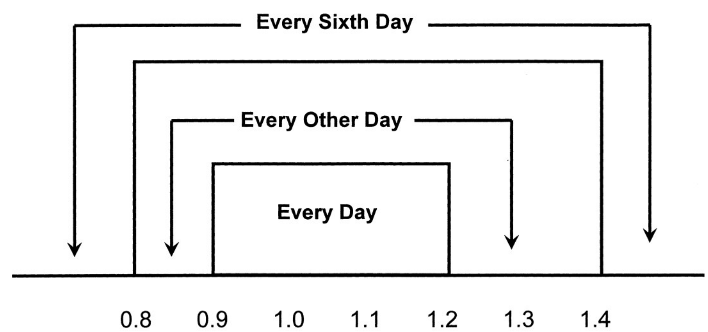
**** Method code 127 used since August 2012. Method code 126 used previously.***

Annual arithmetic means obtained directly from AQS on June 15, 2015.

Evaluation of Sampling Frequencies

According to 40 CFR 58.12, the minimum monitoring frequency for a PM_{10} sampler is based on the relative level of the maximum sample concentration compared to the NAAQS. The graph below shows the required sampling frequencies based upon this ratio.

PM_{10} Concentration to PM_{10} NAAQS Ratio and Required Sampling Frequency



No less frequently than each five-year assessment, agencies must compare the most recent year of in order to estimate the air quality status of the area. Multi-year data comparisons can be used if using the most recent year of data biases the sampling frequency high based upon anomalous data.

All primary PM_{10} samplers operated by KDAQ collect one sample every six days. Based upon 2014 data, KDAQ can maintain this schedule at all PM_{10} samplers. KDAQ engaged in daily sampling at the 21st & Greenup following an exceedance in 2012. The site has experienced no further violations. All collocated samplers collect one sample every 12 days.

2009-2014 Annual Maximum PM_{10} Concentration and Required Sample Frequency

Site ID	Site Name	Maximum Annual 24-Hour Concentration (ug/m3)						NAAQS Ratio	Required Frequency
		2009	2010	2011	2012	2013	2014		
21-019-0002	21st & Greenup	100	94	101	155	77	38	0.3	1-in-6
21-043-0500	Grayson Lake (NATTS)	22	39	23	24	17	24	0.2	1-in-6
21-067-0012	Lexington Primary	n/a	n/a	n/a	41	40	32	0.2	1-in-6
21-101-0014	Baskett	38	37	34	31	27	36	0.2	1-in-6
21-139-0004	Bloodworth	n/a	n/a	n/a	n/a	n/a	23	0.2	1-in-6
21-145-1024	Paducah Primary (JPRECC)	n/a	n/a	n/a	n/a	39	34	0.2	1-in-6

Data obtained from AQS on June 15, 2015.

Finally, it should be noted that KDAQ collects 24-hour PM_{10} samples that run between midnight-midnight local time, in observance of Daylight Savings. Unfortunately, there is a contradiction in the CFR regarding the use of local time versus local standard time. 40 CFR 50, Appendix K defines a "Daily Value for PM_{10}" as "the 24-hour average concentration of PM_{10} calculated or measured from midnight to midnight (local time)." Meanwhile, 40 CFR 58.12 states that "a 24-hour sample must be taken from midnight to midnight (local standard time) in order to ensure national consistency."

Evaluation of Spatial Scales of Representativeness

The spatial scale of representativeness (also called monitoring scale and spatial scale) describes the physical dimensions of a parcel of air, which has reasonably similar concentrations throughout. According to 40 CFR 58, Appendix D, the most important spatial scales for PM_{10} monitoring are middle and neighborhood scales, in order to accurately characterize the emissions of PM_{10} from both mobile and stationary sources.

Spatial Scales of Representativeness 40 CFR 58, Appendix D	
Scale of Representativeness (Monitoring Scale)	**Physical Dimensions**
Microscale	Up to 100 meters
Middle scale	100 meters to 0.5 kilometers
Neighborhood scale	0.5 to 4.0 kilometers
Urban scale	4.0 to 50.0 kilometers
Regional Scale	Tens to hundreds of kilometers

All of KDAQ's PM_{10} samplers, currently in operation, are designated as either middle or neighborhood scale, with the exception of the samplers at Grayson Lake, which are classified as urban scale. The Grayson Lake site is representative of rural background concentrations; thus, KDAQ believes that the use of an urban scale is appropriate.

As a part of this network assessment, KDAQ reviewed annual siting criteria evaluations and attempted to address any concerns regarding measurement scale. For the 21st & Greenup site (21-019-00019), KDAQ staff have questioned the use of a middle scale. KDAQ suspects that the sampler may actually be a microscale monitor, due to the proximity of a metals recycling facility to the site. However, the use of a middle scale is likely appropriate within the lower end of middle scale range of (100 m to 0.5 km). Since the only way to determine the correct scale with certainty is to establish a second PM_{10} site slightly further from the location of the 21st & Greenup site, KDAQ will continue to consider middle scale to be acceptable.

It should also be noted that the Teflon filters from the 21st & Greenup site are sent to a contract lab for metals analysis. The metals parameters are classified as neighborhood scale, while the PM_{10} measurements are classified as middle. KDAQ realizes this is a discrepancy and will change the measurement scale of PM_{10} metals parameters to middle scale.

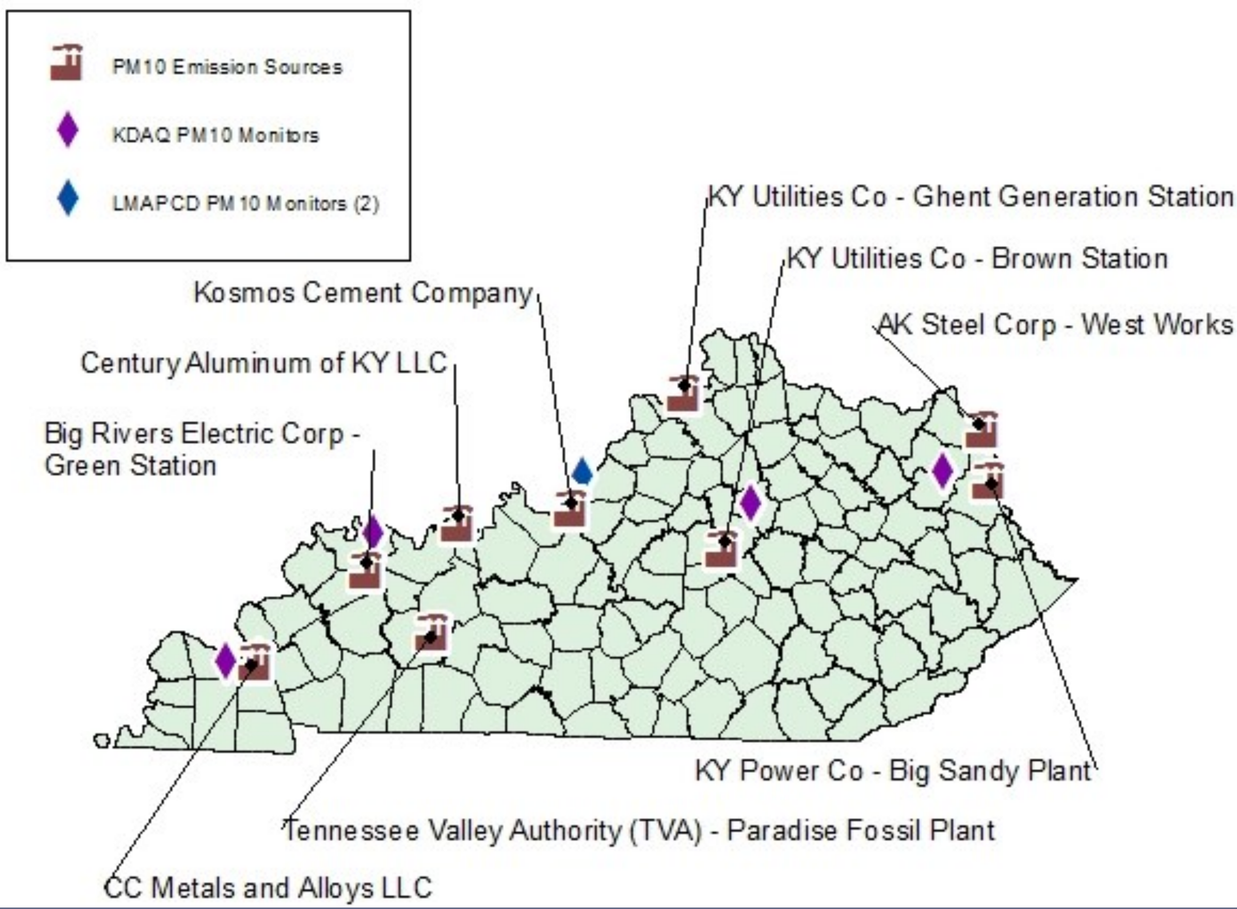
Evaluation of Network Coverage

Due to the relatively small monitoring scale of PM_{10}, KDAQ used the locations of populated areas and major sources to gage network coverage. As shown by the map on the following page, PM_{10} samplers are located near, and typically downwind of, major emission sources. Major urban areas are also covered.

TVA Paradise in Muhlenberg County and Kentucky Utilities Ghent in Carroll County, do not currently have a KDAQ-operated PM_{10} station located nearby. However, a PM_{10} monitor had previously been located at the Echols site in Ohio County (21-183-0032), which is downwind of the TVA Paradise Station. The Echols site was discontinued in 2010 with data showing no violations.

While KDAQ does not operate a PM_{10} monitor downwind of the Kentucky Utilities Ghent facility, KDAQ does operate a $PM_{2.5}$ sampler at the NKU (21-037-3002) site. Additionally, there are seven PM_{10} stations located in the Ohio portion of the Cincinnati MSA.

Top Ten PM_{10} Sources and Kentucky PM_{10} Monitors



Top Ten PM_{10} Sources & 2013 Actual Emissions

Rank	Facility ID	Facility Name	County	2013 Actual Emissions (tpy)
1	3239	Tennessee Valley Authority - Paradise Fossil Plant	Muhlenberg	2318.8
2	127	Louisville Gas & Electric Co - Mill Creek Station	Jefferson	1390.3
3	2930	CC Metals and Alloys LLC	Marshall	842.7
4	704	KY Utilities Co - Ghent Generation Station	Carroll	817.0
5	307	AK Steel Corp - West Works	Boyd	716.0
6	2610	KY Power Co - Big Sandy Plant	Lawrence	611.7
7	3148	KY Utilities Co - Brown Station	Mercer	412.7
8	1634	Century Aluminum of KY LLC	Hancock	383.7
9	60	Kosmos Cement Company	Jefferson	364.7
10	44411	Big Rivers Electric Corp - Green Station	Webster	339.4

Source: KDAQ & LMAPCD Emissions Inventory Systems, February 2015

Evaluation of Concentration Trends

The time-series graphs on the following page show all valid 24-hour sample concentrations recorded by the primary sampler located at all KDAQ sites in operation during the 2009-2014 time-period. The first graph reflects all KDAQ air monitoring stations, with the exception of 21st & Greenup (21-019-0002), which is depicted separately in the second graph.

Since 2009, PM_{10} concentration trends, as recorded by KDAQ intermittent samplers, have been relatively constant, with little spatial or temporal variation. However, as shown by the first graph, the PM_{10} sampler located on the roof of the former Paducah Middle School (21-145-1004) experienced slightly elevated PM_{10} concentrations during the summers of 2011-2012. These elevated concentrations were a result of construction of a new school and athletic fields directly adjacent to the location of the old school building. Once the majority of the major construction and demolition activities concluded, sample concentrations normalized.

On March 22, 2012, the 21st & Greenup site (21-019-0002) in Boyd County measured a 24-hour sample concentration of 155 ug/m^3, which is above the level of the PM_{10} NAAQS. Prior to this, only two exceedances of the NAAQS had been recorded by any PM_{10} sampler in the entire state. The first occurred in at a LMAPCD site (21-111-0043) in 2000. The other exceedance was recorded at the former 9th & Carter site (21-019-0003), which was located approximately 0.5 km away from 21st & Greenup.

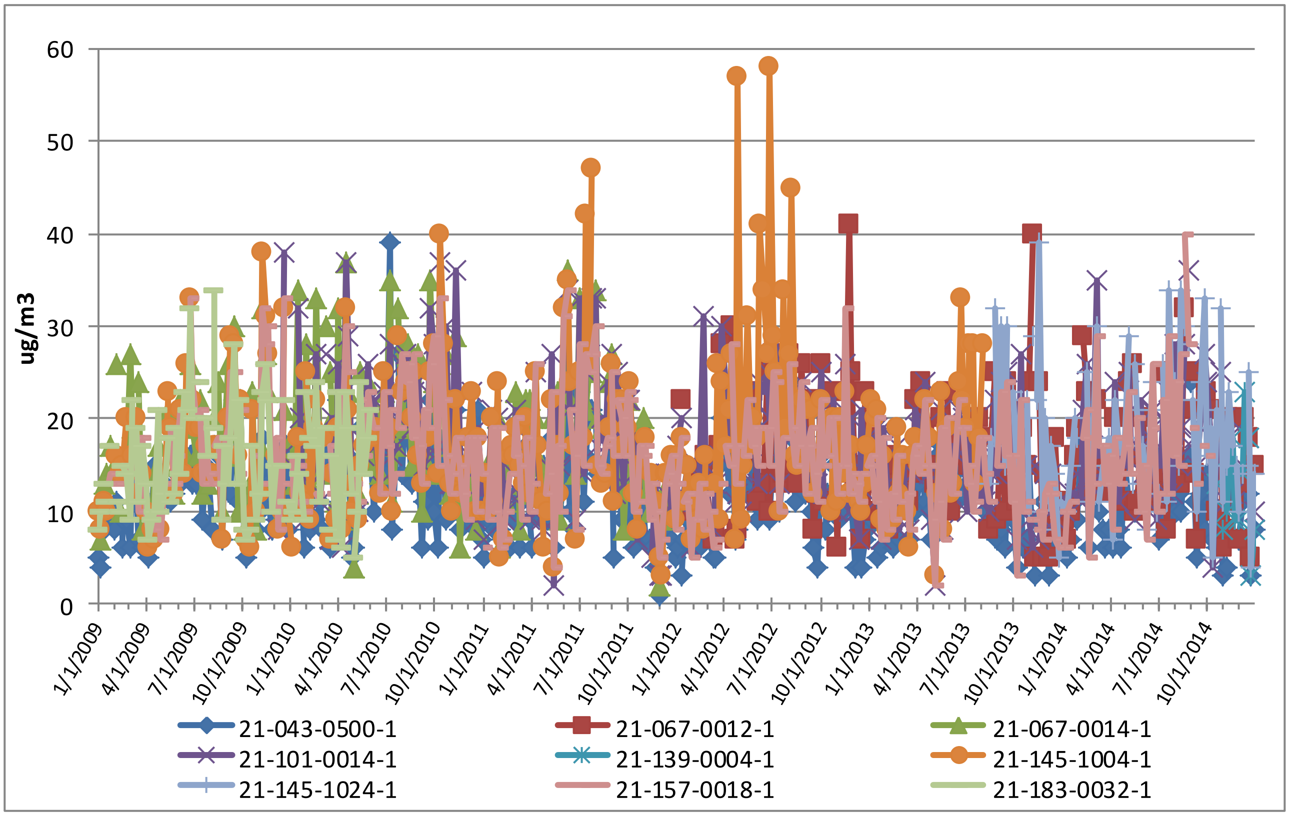
Once the data from the March exceedance had been validated, KDAQ began daily sampling on August 11, 2012, and continued daily sampling until September 30, 2013. After that time, the sampler reverted back to a 1-in-6 day schedule.

Ultimately, KDAQ believes that the 21st & Greenup site was impacted by the Mansbach metals recycling facility, which is adjacent to the site. Sample concentrations have dropped significantly since the facility was contacted regarding the exceedance. KDAQ believes this was an isolated incident.

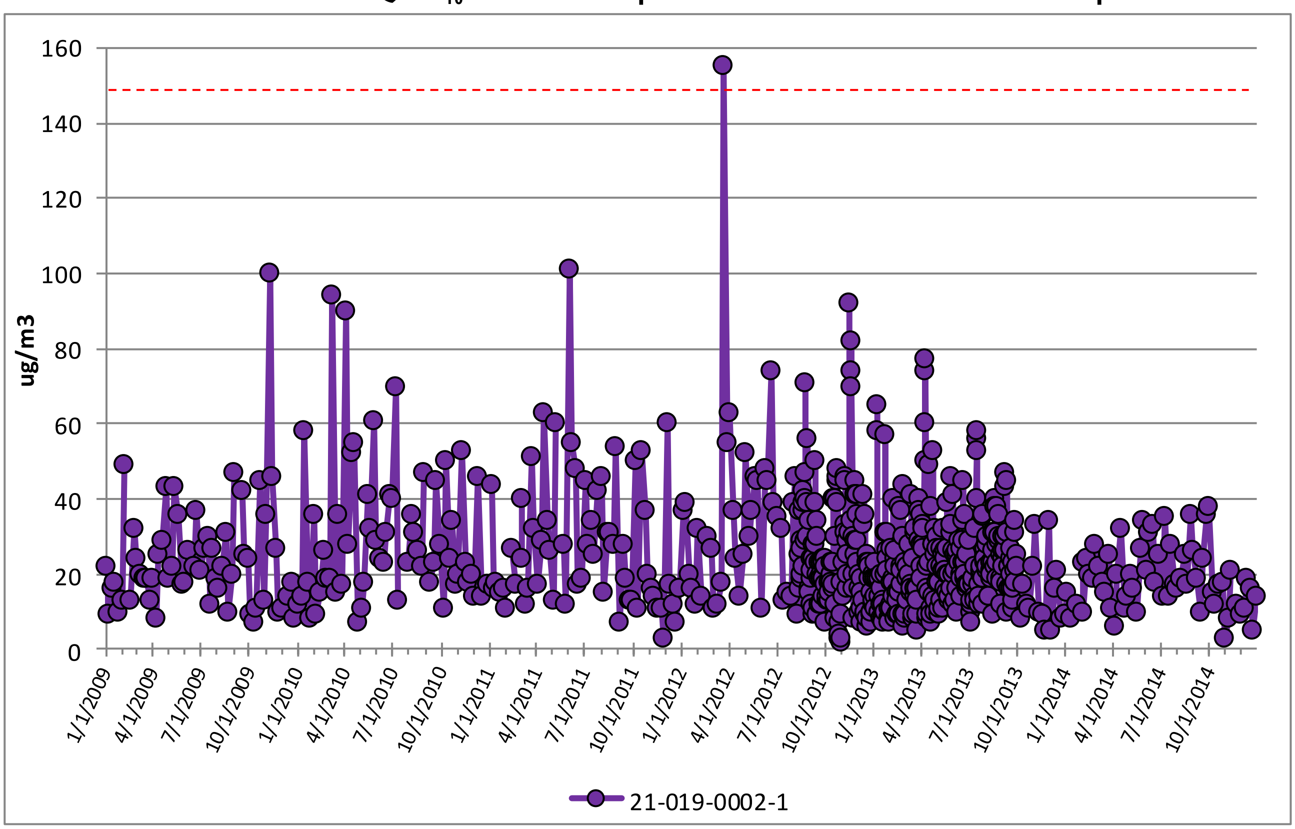
The table below shows selected measures of central tendency, as well as measures of data variability and range, based upon all valid 24-hour samples collected by the primary intermittent sampler at each KDAQ site:

2009-2014 24-Hour PM_{10} Concentrations	21-019-0002-1	21-043-0500-1	21-067-0012-1	21-067-0014-1	21-101-0014-1	21-139-0004-1	21-145-1004-1	21-145-1024-1	21-157-0018-1
Mean (ug/m3)	24.27149	11.28133	15.95146	17.68047	16.95614	12.25000	17.47148	18.54762	15.95480
Median	21	11	15	16	16	11.5	16	17	15
Std Dev	15.18767	4.84664	6.46473	7.25913	6.85680	5.40732	8.43148	7.65935	6.40893
Minimum	2	1	5	2	2	3	3	4	2
Maximum	155	39	41	37	38	23	58	39	40
Range	153	38	36	35	36	20	55	35	38
Sample Count	733	391	206	169	342	24	263	126	354

2009-2014 KDAQ PM_{10} 24-Hour Sample Concentrations



2009-2014 KDAQ PM_{10} 24-Hour Sample Concentrations at 21st & Greenup



PM_{10} Monitoring Network Conclusions

The PM_{10} network meets or exceeds minimum monitoring requirements.. While there are no KDAQ operated PM_{10} samplers downwind of the KY Utilities Co - Ghent Generation Station in Carrol County, there is a $PM_{2.5}$ sampler located at the NKU site (21-037-3002); there are also several PM_{10} monitors located in the Ohio portion of the MSA.

The TVA Paradise facility in Muhlenberg County also lacks a downwind PM_{10} monitor. However, a PM_{10} sampler was located at the former Echols site (21-183-0032) in Ohio County from 2006-2010. The monitor did not record any exceedance of the NAAQS during its time in operation.

At the 21st & Greenup site, PM_{10} Teflon filters are sent to a contract lab for metals analysis. In the Annual Network Plan, the metals parameters are classified as neighborhood scale, while the PM_{10} measurements are classified as middle. KDAQ will change the measurement scale of the metals parameters to middle scale in order to correct this discrepancy.

KDAQ collects 24-hour PM_{10} samples that run between midnight-midnight local time, in observance of Daylight Savings. There is a contradiction in the CFR regarding the use of local time versus local standard time. 40 CFR 50, Appendix K defines a "Daily Value for PM_{10}" as "the 24-hour average concentration of PM_{10} calculated or measured from midnight to midnight (local time)." Meanwhile, 40 CFR 58.12 states that "a 24-hour sample must be taken from midnight to midnight (local standard time) in order to ensure national consistency." KDAQ is considering changing operating procedures so that samples are collected on local standard time, but will need to further discuss potential implications with EPA Region 4.

Sulfur Dioxide Monitoring Network

Sulfur Dioxide Monitoring Network History (2009-Present)

The Kentucky SO_2 monitoring network currently consists of 12 monitors, of which KDAQ operates eight monitors. LMAPCD operates three monitors in Jefferson County, while the NPS operates one monitor at Mammoth Cave National Park.

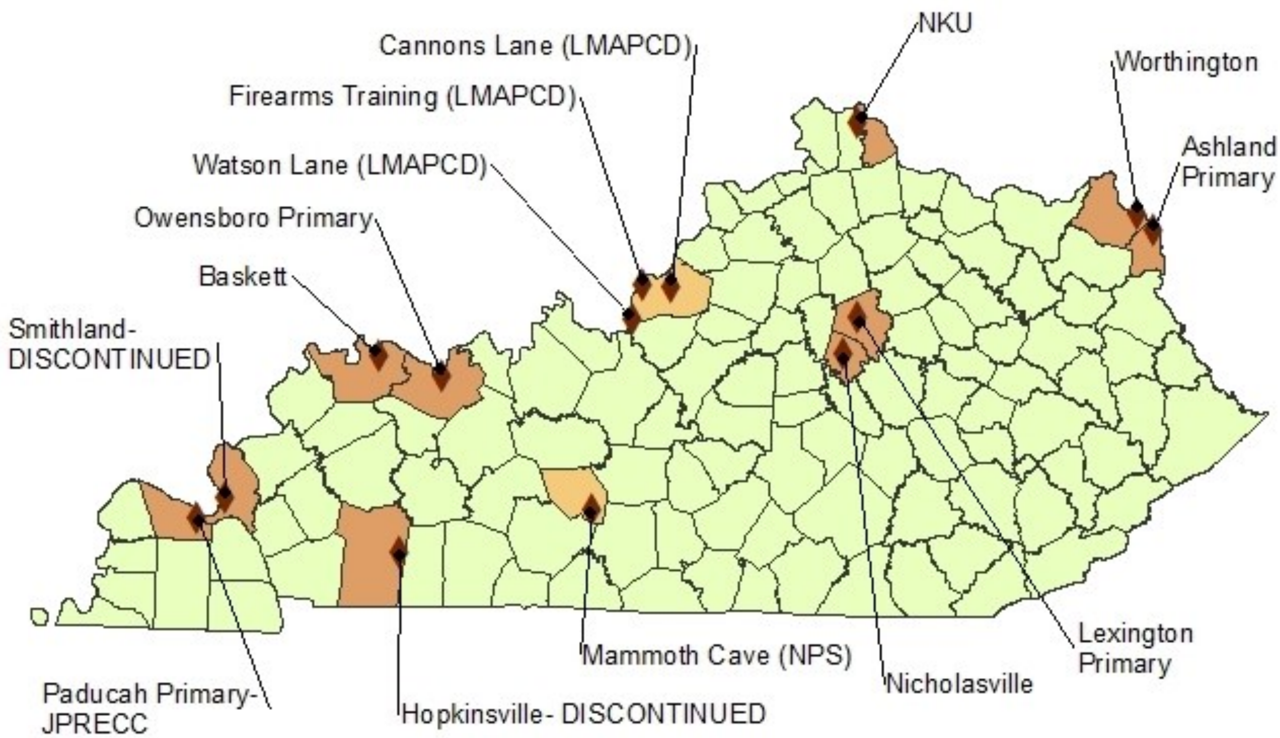
Since 2009, the SO_2 monitoring network has remained relatively stable. KDAQ discontinued monitoring at one site and established monitoring at one site during the time-period, but that monitor was subsequently shutdown. LMAPCD established one monitor during the period of this network assessment. The map and chart on the following page shows all SO_2 monitors in operation since 2009, along with key monitor metadata.

Of the sites operated by KDAQ, SO_2 monitoring was established at the Hopkinsville site (21-047-0006) in March 2012. The Hopkinsville monitor was initially established due to new SO_2 monitoring requirements that were promulgated in 2010. The new monitoring rules required at least one SO_2 monitor to be established in any CBSA with a calculated Population Emissions Index (PWEI) equal to or greater than 5,000 million person-tons per year.

In March 2011, EPA released preliminary SO_2 PWEI values, which indicated that the Clarksville, TN-KY MSA required one SO_2 monitor. However, EPA issued revised PWEIs in May 2011, which showed that the Clarksville, TN-KY PWEI was well below the 5,000 million person-tons per year threshold that would require monitoring. Unfortunately, KDAQ had already released the 2011 Annual Network Plan for a 30-day public comment period. As such, KDAQ proceeding with establishment of monitoring at the Hopkinsville site, but removed its PWEI designation. The Hopkinsville monitor remained in operation until November 2014, when it was discontinued due to consistently low SO_2 concentration data.

KDAQ also discontinued SO_2 monitoring at the Smithland site (21-139-0003) in December 2011. The monitor was originally established at the site April 2008 to supplement KDAQ's mercury monitoring network. Thus, the SO_2 monitor was subsequently discontinued once the mercury monitoring network was terminated.

Map & Chart: KDAQ, NPS, & LMAPCD SO_2 Monitoring Network (2009-Present)



County	Site ID	Site Name	Monitor Type	Scale	Operation Dates
Boyd	21-019-0017	Ashland Primary	SLAMS	Neighborhood	8/14/2001- Present
Campbell	21-037-3002	NKU	SLAMS	Urban	07/08/2007- Present
Christian	21-047-0006	Hopkinsville	SPM	Urban	03/01/2012- 11/01/2014
Daviess	21-059-0005	Owensboro Primary	SLAMS	Neighborhood	01/04/1972- Present
Edmonson	21-061-0501	Mammoth Cave (NPS)	Non-EPA	Urban *	05/21/2009- Present
Fayette	21-067-0012	Lexington Primary	SLAMS	Neighborhood	12/18/1979- Present
Greenup	21-089-0007	Worthington	SPM	Neighborhood	04/01/1991- Present
Henderson	21-101-0014	Baskett	SLAMS	Neighborhood	03/04/2003- Present
Jefferson	21-111-0051	Watson Lane (LMAPCD)	SLAMS	Neighborhood	07/16/1992- Present
Jefferson	21-111-0067	Cannons Lane (LMAPCD)	SLAMS	Urban	06/01/2010- Present
Jefferson	21-111-1041	Firearms Training (LMAPCD)	SLAMS	Neighborhood	04/01/1978- Present
Jessamine	21-113-0001	Nicholasville	SPM	Urban	01/01/1978- Present
Livingston	21-139-0003	Smithland	SPM	Urban	04/01/2008- 12/02/2011
McCracken	21-145-1024	Paducah Primary- JPRECC	SLAMS	Neighborhood	01/01/2000- Present

** The Mammoth Cave monitor does not have a measurement scale established in AQS. The scale listed is inferred, based upon annual siting criteria evaluations.*

Evaluation of Minimum Monitoring Requirements

Section 4.4 of Appendix D to 40 CFR Part 58, requires that a population weighted emissions index (PWEI) be calculated by States for each core based statistical area (CBSA) in order to determine the minimum number of monitors required. Monitors satisfy minimum requirements if the monitor is sited within the boundaries of the CBSA and is one of the following site types: population exposure, maximum concentration, source-oriented, general background, or regional transport.

The PWEI is calculated by multiplying the population of each CBSA and the total amount of SO_2, in tons per year, that is emitted within the CBSA, based upon aggregated county level emissions data from the National Emissions Inventory (NEI). The result is then divided by one million to provide the PWEI value, which is expressed in a unit of million persons-tons per year.

The minimum number of monitors required are:

- 3 monitors in CBSAs with index values of 1,000,000 or more;
- 2 monitors in CBSAs with index values less than 1,000,000 but greater than 100,000; and
- 1 monitor in CBSAs with index values greater than 5,000.

PWEI based monitors were originally required to be established in the Annual Network Plan, which was to be submitted to the EPA no later than July 1, 2011. KDAQ's 2011 Network Plan identified five CBSAs with PWEI required monitoring, as shown by the table below.

Kentucky CBSAs	2011 PWEI (million persons -tons per year)	Number of SO_2 Monitors Required	Number of SO_2 Monitors Present	Site Name	Site ID
Cincinnati-Middletown, OH-KY-IN	253,862	2	2*	NKU	21-037-3002
Louisville-Jefferson County, KY-IN	110,765	2	2	Firearms Training (LMAPCD) Watson Lane (LMAPCD)	21-111-1041 21-111-0051
Evansville, IN-KY	41,320	1	1	Baskett	21-101-0014
Lexington-Fayette, KY	6,401	1	1	Lexington Primary	21-067-0012
Paducah, KY-IL	6,607	1	1	Paducah Primary- JPRECC	21-145-1024

***Monitoring requirement partially fulfilled by a MOA.**

As a part of this network assessment, KDAQ calculated new SO_2 PWEI values for Kentucky CBSAs, the results of which are documented in the chart on the following two pages. The analysis shows that all CBSAs meet or exceed the minimum number of PWEI SO_2 monitors required. Additionally, all KDAQ monitors meet site-type requirements necessary to be counted towards minimum monitoring requirements.

Finally, the EPA Regional Administrator (RA) may at their discretion require additional SO_2 monitors, beyond the minimum number required by PWEI calculations. Additional monitors may be required in situations where an area has the potential to violate or contribute to a violation, in areas that are impacted by sources that cannot be modeled, and in areas with sensitive populations. Kentucky currently does not have any Regional Administrator required SO_2 monitors.

Kentucky CBSA SO_2 PWEI Calculations

CBSA Code	State-County Code	Area Name	LSAD	2013 USCB Population Estimate	County Level SO_2 Emissions	CBSA Total SO_2 Emissions	PWEI (10^6 person-tons/year	# PWEI Monitors Required	# PWEI Monitors Present
12680	21179	Nelson County, KY	County	44540	246.88114				
12680		**Bardstown, KY**	**Micropolitan SA**	**44540**		**246.88114**	**11.0**	**0**	
14540	21003	Allen County, KY	County	20311	7.0083154				
14540	21031	Butler County, KY	County	12793	22.31545				
14540	21061	Edmonson County, KY	County	12062	9.7969351				
14540	21227	Warren County, KY	County	118370	61.213205				
14540		**Bowling Green, KY**	**Metropolitan SA**	**163536**		**100.33391**	**16.4**	**0**	
15820	21217	Taylor County, KY	County	24649	13.006602				
15820		**Campbellsville, KY**	**Micropolitan SA**	**24649**		**13.006602**	**0.3**	**0**	
17140	18029	Dearborn County, IN	County	49904	28321.195				
17140	18115	Ohio County, IN	County	5994	6.4596354				
17140	18161	Union County, IN	County	7277	9.9667864				
17140	21015	Boone County, KY	County	124442	2184.0815				
17140	21023	Bracken County, KY	County	8416	8.643618				
17140	21037	Campbell County, KY	County	90988	35.051419				
17140	21077	Gallatin County, KY	County	8474	86.296611				
17140	21081	Grant County, KY	County	24753	26.578434				
17140	21117	Kenton County, KY	County	163145	53.990767				
17140	21191	Pendleton County, KY	County	14570	869.66688				
17140	39015	Brown County, OH	County	44264	51.692776				
17140	39017	Butler County, OH	County	371272	5792.8941				
17140	39025	Clermont County, OH	County	200218	109009.32				
17140	39061	Hamilton County, OH	County	804520	31503.251				
17140	39165	Warren County, OH	County	219169	114.93863				
17140		**Cincinnati, OH-KY-IN**	**Metropolitan SA**	**2137406**		**178074.03**	**380,616.5**	**2**	**2**
17300	21047	Christian County, KY	County	74167	76.716342				
17300	21221	Trigg County, KY	County	14293	30.970352				
17300	47125	Montgomery County, TN	County	184119	478.64566				
17300		**Clarksville, TN-KY**	**Metropolitan SA**	**272579**		**586.33235**	**159.8**	**0**	
19220	21021	Boyle County, KY	County	29013	10.564349				
19220	21137	Lincoln County, KY	County	24370	26.738799				
19220		**Danville, KY**	**Micropolitan SA**	**53383**		**37.303149**	**2.0**		
21060	21093	Hardin County, KY	County	108191	71.259184				
21060	21123	Larue County, KY	County	14064	43.153683				
21060	21163	Meade County, KY	County	29210	103.09856				
21060		**Elizabethtown-Fort Knox, KY**	**Metropolitan SA**	**151465**		**217.51142**	**32.9**	**0**	
21780	18129	Posey County, IN	County	25486	10705.755				
21780	18163	Vanderburgh County, IN	County	181398	49.802586				
21780	18173	Warrick County, IN	County	61049	9718.0335				
21780	21101	Henderson County, KY	County	46347	4254.0979				
21780		**Evansville, IN-KY**	**Metropolitan SA**	**314280**		**24727.689**	**7,771.4**	**1**	**1**
23180	21005	Anderson County, KY	County	21811	11.931404				
23180	21073	Franklin County, KY	County	49648	20.859873				
23180		**Frankfort, KY**	**Micropolitan SA**	**71459**		**32.791277**	**2.3**	**0**	
23980	21009	Barren County, KY	County	43027	19.533562				
23980	21169	Metcalfe County, KY	County	9983	15.345365				
23980		**Glasgow, KY**	**Micropolitan SA**	**53010**		**34.878927**	**1.8**	**0**	
26580	21019	Boyd County, KY	County	48886	1500.0619				
26580	21089	Greenup County, KY	County	36519	1596.3494				
26580	39087	Lawrence County, OH	County	61917	74.532862				
26580	54011	Cabell County, WV	County	97133	424.16713				
26580	54043	Lincoln County, WV	County	21559	39.222498				
26580	54079	Putnam County, WV	County	56650	8780.7944				
26580	54099	Wayne County, WV	County	41437	89.66427				
26580		**Huntington-Ashland, WV-KY-OH**	**Metropolitan SA**	**364101**		**12504.792**	**4,553.0**	**1**	**1**

Kentucky CBSA SO_2 PWEI Calculations (Continued)

CBSA Code	State-County Code	Area Name	LSAD	2013 USCB Population Estimate	County Level SO_2 Emissions	CBSA Total SO_2 Emissions	PWEI (10^6 person-tons/year	# PWEI Monitors Required	# PWEI Monitors Present
30460	21017	Bourbon County, KY	County	19998	24.159885				
30460	21049	Clark County, KY	County	35614	6249.0163				
30460	21067	Fayette County, KY	County	308428	581.69589				
30460	21113	Jessamine County, KY	County	50173	14.552787				
30460	21209	Scott County, KY	County	49947	19.033385				
30460	21239	Woodford County, KY	County	25275	308.23379				
30460		**Lexington-Fayette, KY**	**Metropolitan SA**	**489435**		**7196.6921**	**3,522.3**	**1**	**1**
30940	21121	Knox County, KY	County	31790	107.45965				
30940	21125	Laurel County, KY	County	59563	70.635725				
30940	21235	Whitley County, KY	County	35766	155.64686				
30940		**London, KY**	**Micropolitan SA**	**127119**		**333.74223**	**42.4**	**0**	**0**
31140	18019	Clark County, IN	County	112938	1578.3752				
31140	18043	Floyd County, IN	County	76244	3027.4955				
31140	18061	Harrison County, IN	County	39163	30.55711				
31140	18143	Scott County, IN	County	23972	12.384952				
31140	18175	Washington County, IN	County	27780	24.268568				
31140	21029	Bullitt County, KY	County	76854	446.90414				
31140	21103	Henry County, KY	County	15445	12.400431				
31140	21111	Jefferson County, KY	County	756832	39230.782				
31140	21185	Oldham County, KY	County	62364	14.915414				
31140	21211	Shelby County, KY	County	44216	15.62962				
31140	21215	Spencer County, KY	County	17637	6.9297441				
31140	21223	Trimble County, KY	County	8816	3157.4652				
31140		**Louisville/Jefferson County, KY-IN**	**Metropolitan SA**	**1262261**		**47558.108**	**60,030.7**	**1**	**2**
31580	21107	Hopkins County, KY	County	46634	39.246842				
31580		**Madisonville, KY**	**Micropolitan SA**	**46634**		**39.246842**	**1.8**	**0**	**0**
32460	21083	Graves County, KY	County	37451	36.113638				
32460		**Mayfield, KY**	**Micropolitan SA**	**37451**		**36.113638**	**1.4**	**0**	**0**
32500	21161	Mason County, KY	County	**17278**	6351.7714				
32500		**Maysville, KY**	**Micropolitan SA**	**17278**		**6351.7714**	**109.7**	**0**	**0**
33180	21013	Bell County, KY	County	27885	86.309658				
33180		**Middlesborough, KY**	**Micropolitan SA**	**27885**		**86.309658**	**2.4**	**0**	**0**
34460	21011	Bath County, KY	County	11961	11.231323				
34460	21165	Menifee County, KY	County	6288	6.9352972				
34460	21173	Montgomery County, KY	County	27251	9.5523926				
34460		**Mount Sterling, KY**	**Micropolitan SA**	**45500**		**27.719012**	**1.3**	**0**	**0**
34660	21035	Calloway County, KY	County	37657	13.635175				
34660		**Murray, KY**	**Micropolitan SA**	**37657**		**13.635175**	**0.5**	**0**	**0**
36980	21059	Daviess County, KY	County	98218	9013.692				
36980	21091	Hancock County, KY	County	8687	10083.878				
36980	21149	McLean County, KY	County	9496	18.911994				
36980		**Owensboro, KY**	**Metropolitan SA**	**116401**		**19116.482**	**2,225.2**	**0**	**0**
37140	17127	Massac County, IL	County	15073	27279.203				
37140	21007	Ballard County, KY	County	8332	572.41263				
37140	21139	Livingston County, KY	County	9359	20.182425				
37140	21145	McCracken County, KY	County	65373	28316.552				
37140		**Paducah, KY-IL**	**Micropolitan SA**	**98137**		**56188.35**	**5,514.2**	**1**	**1**
40080	21151	Madison County, KY	County	85590	276.24925				
40080	21203	Rockcastle County, KY	County	16693	34.908147				
40080		**Richmond-Berea, KY**	**Micropolitan SA**	**102283**		**311.1574**	**31.8**	**0**	**0**
43700	21199	Pulaski County, KY	County	63907	18481.392				
43700		**Somerset, KY**	**Micropolitan SA**	**63907**		**18481.392**	**1,181.1**	**0**	**0**
46460	21075	Fulton County, KY	County	6385	42.235882				
46460	47131	Obion County, TN	County	31131	65.993008				
46460		**Union City, TN-KY**	**Micropolitan SA**	**37516**		**108.22889**	**4.1**	**0**	**0**

Sources: EPA, 2011 NEI version 2. http://www.epa.gov/ttn/chief/net/2011inventory.html. Last accessed: May 22, 2015.

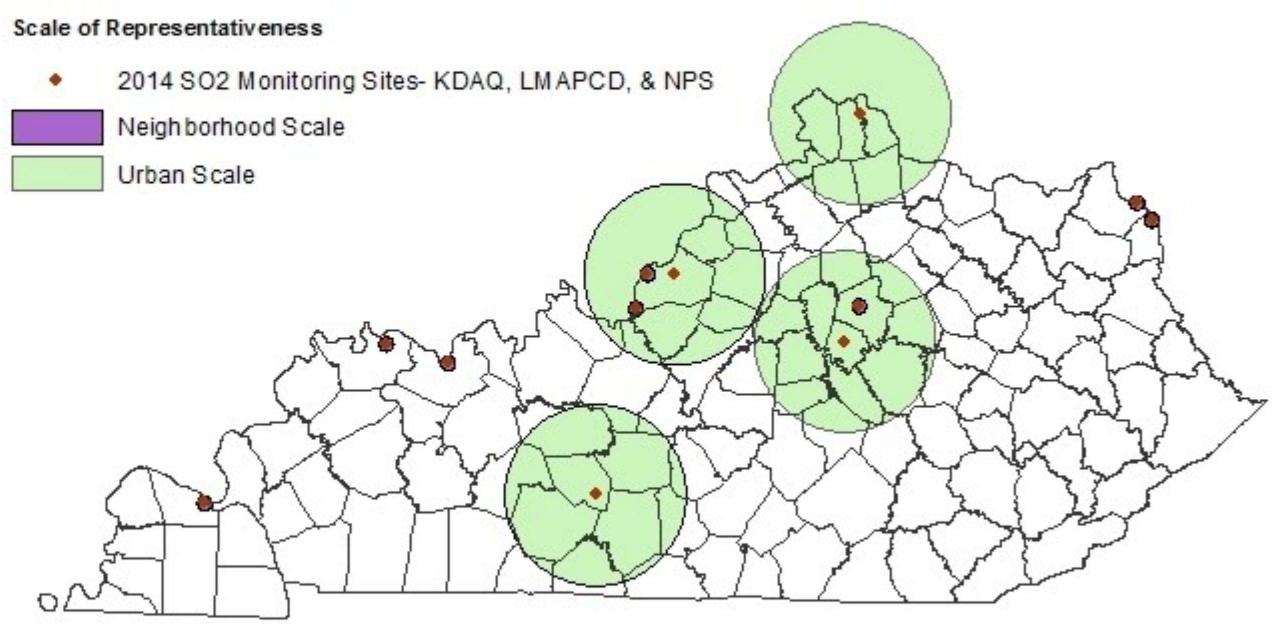
USCB , CBSA-EST2013. http://www.census.gov/popest/data/metro/totals/2013/CBSA-EST2013-alldata.html. Last accessed: March 12, 2015.

Evaluation of Scales of Representativeness

The spatial scale of representativeness (also called monitoring scale and spatial scale) describes the physical dimensions of a parcel of air, which has reasonably similar concentrations throughout. According to 40 CFR 58, Appendix D, the most important spatial scales for determining maximum hourly SO_2 concentrations are the micro, middle, and neighborhood scales. All KDAQ monitors are sited at either the urban or neighborhood scales.

Spatial Scales of Representativeness 40 CFR 58, Appendix D	
Scale of Representativeness (Monitoring Scale)	**Physical Dimensions**
Microscale	Up to 100 meters
Middle scale	100 meters to 0.5 kilometers
Neighborhood scale	0.5 to 4.0 kilometers
Urban scale	4.0 to 50.0 kilometers
Regional Scale	Tens to hundreds of kilometers

As a part of this assessment, KDAQ reviewed siting criteria evaluations to determine if SO_2 monitors are correctly sited in order to accurately reflect the spatial scale designated in AQS. KDAQ believes all spatial scales are appropriate considering siting criteria, with the exception of the SO_2 monitor at the Ashland Primary air monitoring station (21-019-0017). As mentioned previously in this assessment, KDAQ believes the Ashland Primary site is partially obstructed. A complete account of the siting issues are presented in Appendix D to this assessment.



Scales of representativeness for all SO_2 monitors in Kentucky.

Evaluation of Network Coverage

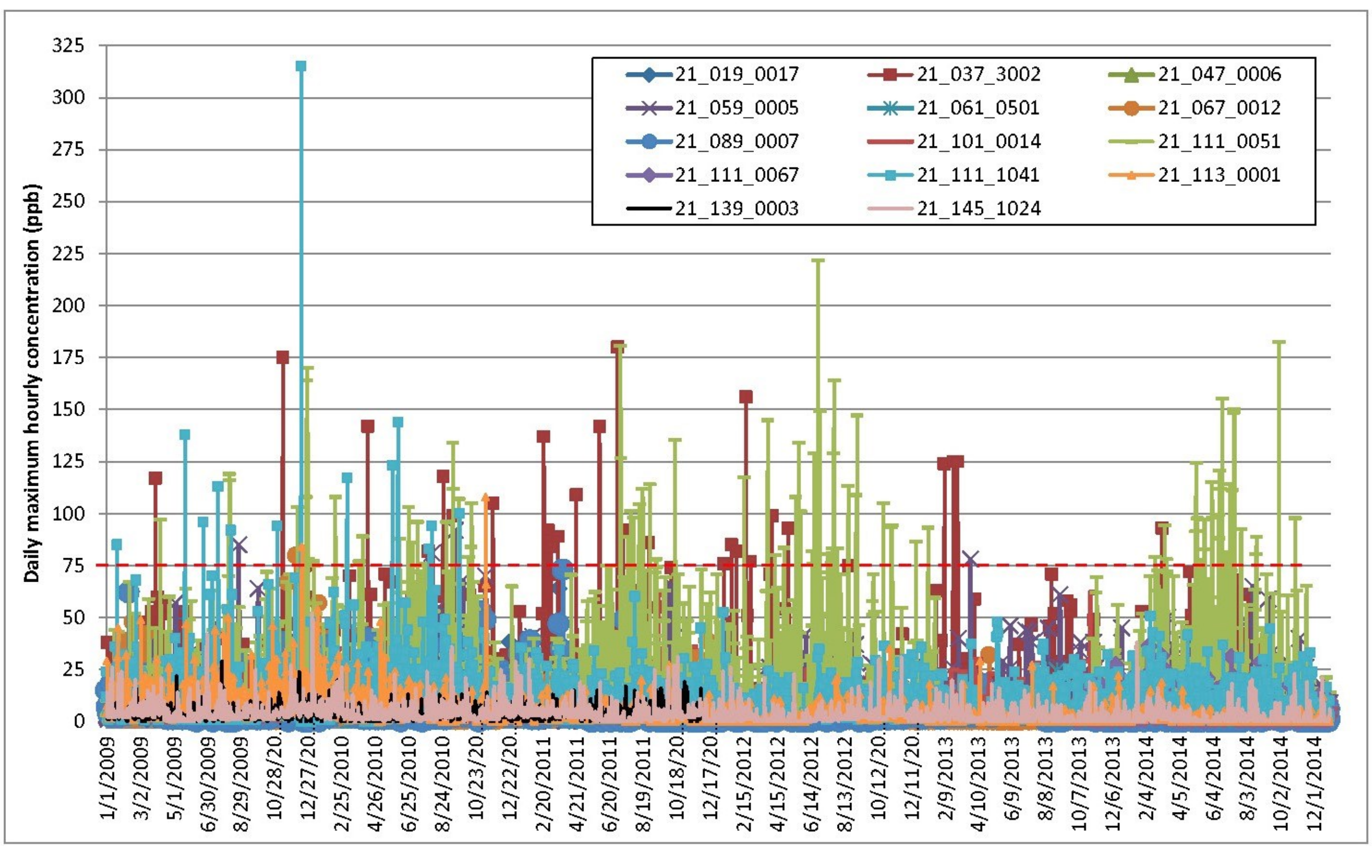
Due to the nature of SO_2 as a point-source driven pollutant, KDAQ relied upon the locations of the top ten SO_2 emitters in relation to location of SO_2 monitors in Kentucky. As shown by the map on the following page, most major SO_2 facilities have a SO_2 monitor located nearby; of those, most are located directly downwind of their respective facilities.

A cluster of three major sources is located along the border of Muhlenberg and Ohio Counties. While KDAQ does not currently have a monitor located downwind of this cluster, KDAQ did operate a SO_2 monitor at the former Echols site (21-183-0032) from 2005-2007. The monitor did not record a violation of the current hourly standard (75 ppb) during its time in operation.

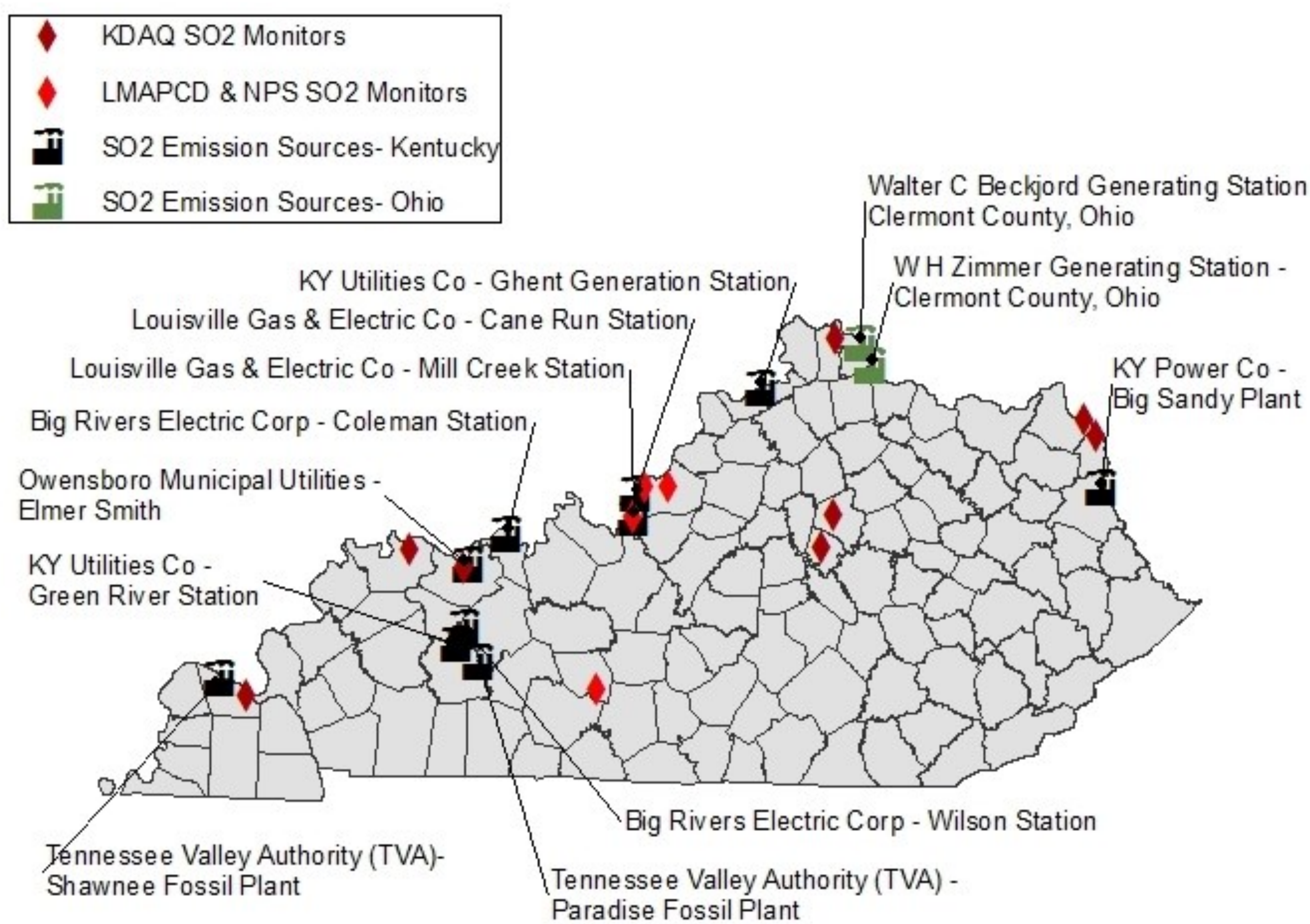
Evaluation of Concentration Trends

As shown by the graph below, SO_2 monitors located in Jefferson County and in Campbell County have consistently recorded maximum hourly concentrations significantly above other monitors in Kentucky since 2009, as a result of close proximity to nearby sources. The impact of these facilities has created a seasonality to the data collected, as monitors located to the east-northeast of their respective sources tend to record higher concentrations in the summer, while monitors that are located to the west of sources record higher concentrations in the winter.

Daily-Maximum Hourly SO_2 Concentrations (2009-2014)



Top Ten Kentucky SO_2 Sources & Kentucky SO_2 Monitors with Selected Clermont County, Ohio SO_2 Sources



Top Ten SO_2 Sources & 2013 Actual Emissions				
Rank	**Facility ID**	**Facility Name**	**County**	**2013 Actual Emissions (tpy)**
1	127	Louisville Gas & Electric Co - Mill Creek Station	Jefferson	29447.4
2	3073	Tennessee Valley Authority - Shawnee Fossil Plant	McCracken	27211.1
3	3239	Tennessee Valley Authority - Paradise Fossil Plant	Muhlenberg	21523.8
4	3228	KY Utilities Co - Green River Station	Muhlenberg	19998.6
5	2610	KY Power Co - Big Sandy Plant	Lawrence	18749.0
6	704	KY Utilities Co - Ghent Generation Station	Carroll	13424.1
7	1640	Big Rivers Electric Corp - Coleman Station	Hancock	8145.9
8	942	Owensboro Municipal Utilities - Elmer Smith	Daviess	8063.6
9	3319	Big Rivers Electric Corp - Wilson Station	Ohio	7607.4
10	126	Louisville Gas & Electric Co - Cane Run Station	Jefferson	6268.0
Major SO_2 Sources in Clermont County, OH				
*	2830	Walter C Beckjord Generating Station	Clermont, OH	51900.3
*	6019	W H Zimmer Generating Station	Clermont, OH	18457.0

Source: KDAQ & LMAPCD Emissions Inventory. February 2015.

**** Source: CAMD: Air Markets Program Data Query. Last accessed: June 12, 2015***

Of the monitors operated by KDAQ, the NKU monitor (21-037-3002) in Campbell County was repeatedly impacted by the Beckjord Electric Generating Station in Clermont County, OH. The NKU monitor resultantly violated three-year SO_2 design values in 2011-2013.

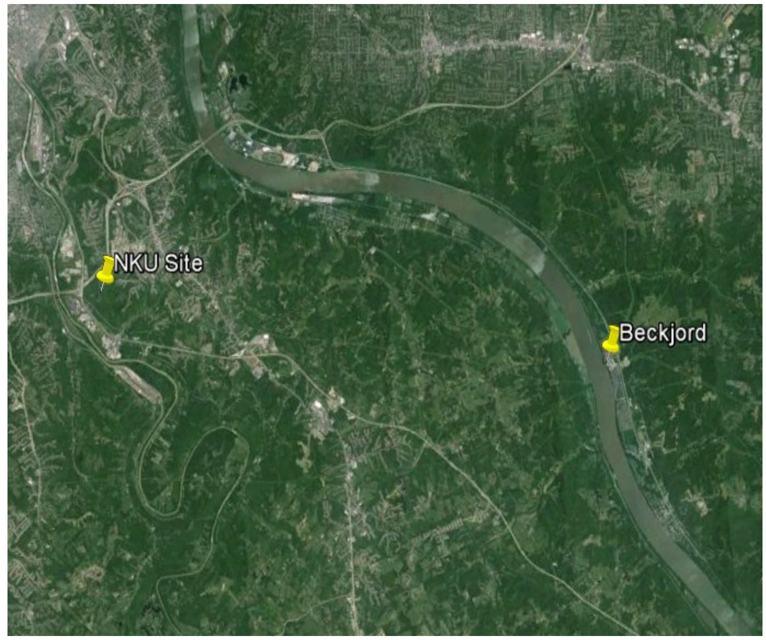
The Beckjord Station is located approximately 15.8 km to the east of the EKU site. KDAQ was able to identify Beckjord as the impact-source with the use of meteorological data which showed a high degree of correlation between winds from the east and high hourly SO_2 data.

While certainly not exclusive to the winter months, the NKU site tended to record more SO_2 data above the level of the NAAQS during the late winter and early spring months when winds were more likely to be out of the east. KDAQ ran a number of HYSPLIT trajectories, which typically also identified Beckjord as the impacting source.

While the Beckjord Station was scheduled to be decommissioned in January 2015, the facility was shut-down in August 2014 after an accidental spill released fuel-oil into the Ohio River. Duke Energy decided to begin decommissioning at that time.

Ultimately, the effect of the facility shutdown can be seen in the graph on the following page, which shows a steep decline in daily maximum hourly SO_2 concentrations at NKU in August 2014. All other KDAQ-operated SO_2 monitors have three-year design values below the level of the NAAQS.

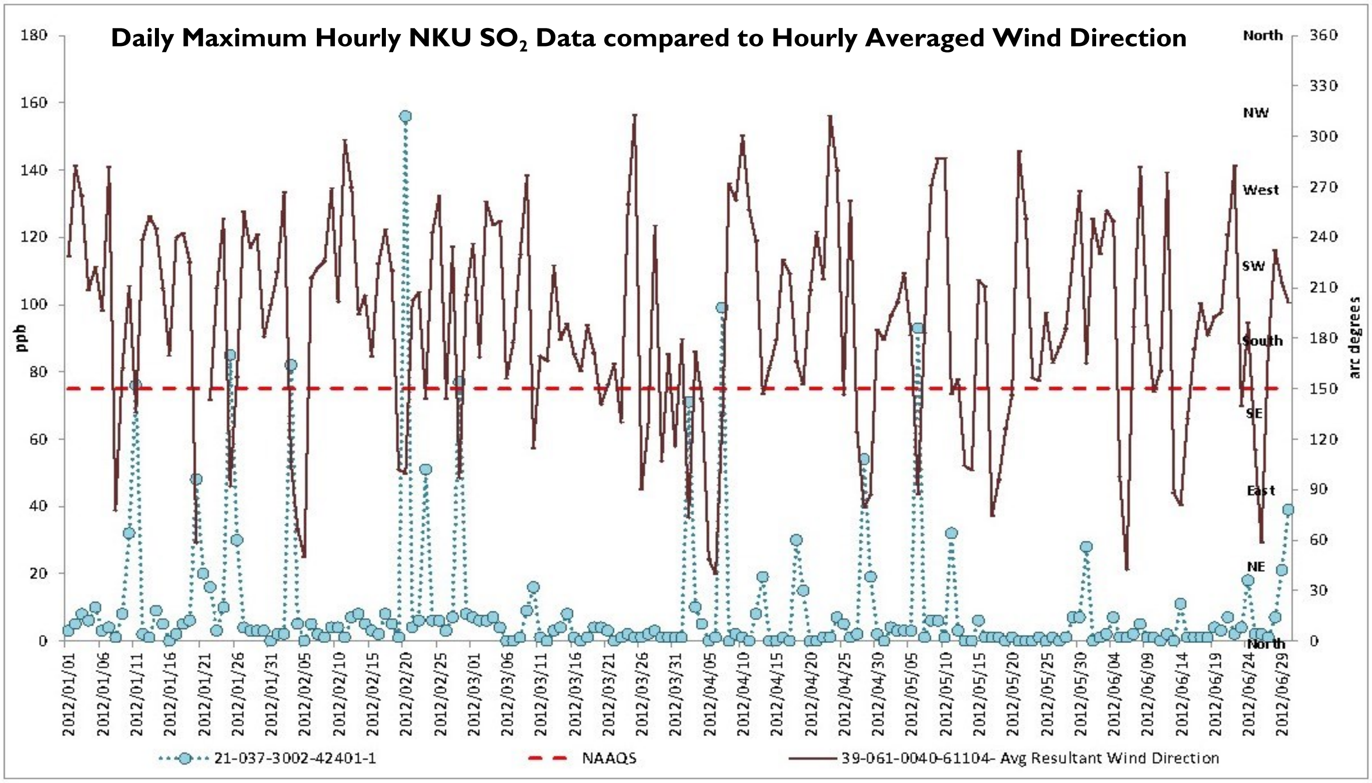
Three-Year SO_2 Design Values: NKU	2009	2010	2011	2012	2013	2014
21_037_3002	63	70	89	98	88	72



Kentucky Three -Year SO2 Design Values (2013 & 2014)			
Site ID	**County**	**2013**	**2014**
21_019_0017	Boyd	21	16
21_037_3002	Campbell	88	72
21_047_0006	Christian	13*	14*
21_059_0005	Daviess	41	43
21_061_0501	Edmonson	10	10
21_067_0012	Fayette	17	13
21_089_0007	Greenup	25	14
21_101_0014	Henderson	27	27
21_111_0051	Jefferson	118*	130*
21_111_0067	Jefferson	27*	28*
21_111_1041	Jefferson	36*	38*
21_113_0001	Jessamine	16	15
21_139_0003	Livingston	17*	
21_145_1024	McCracken	23	21

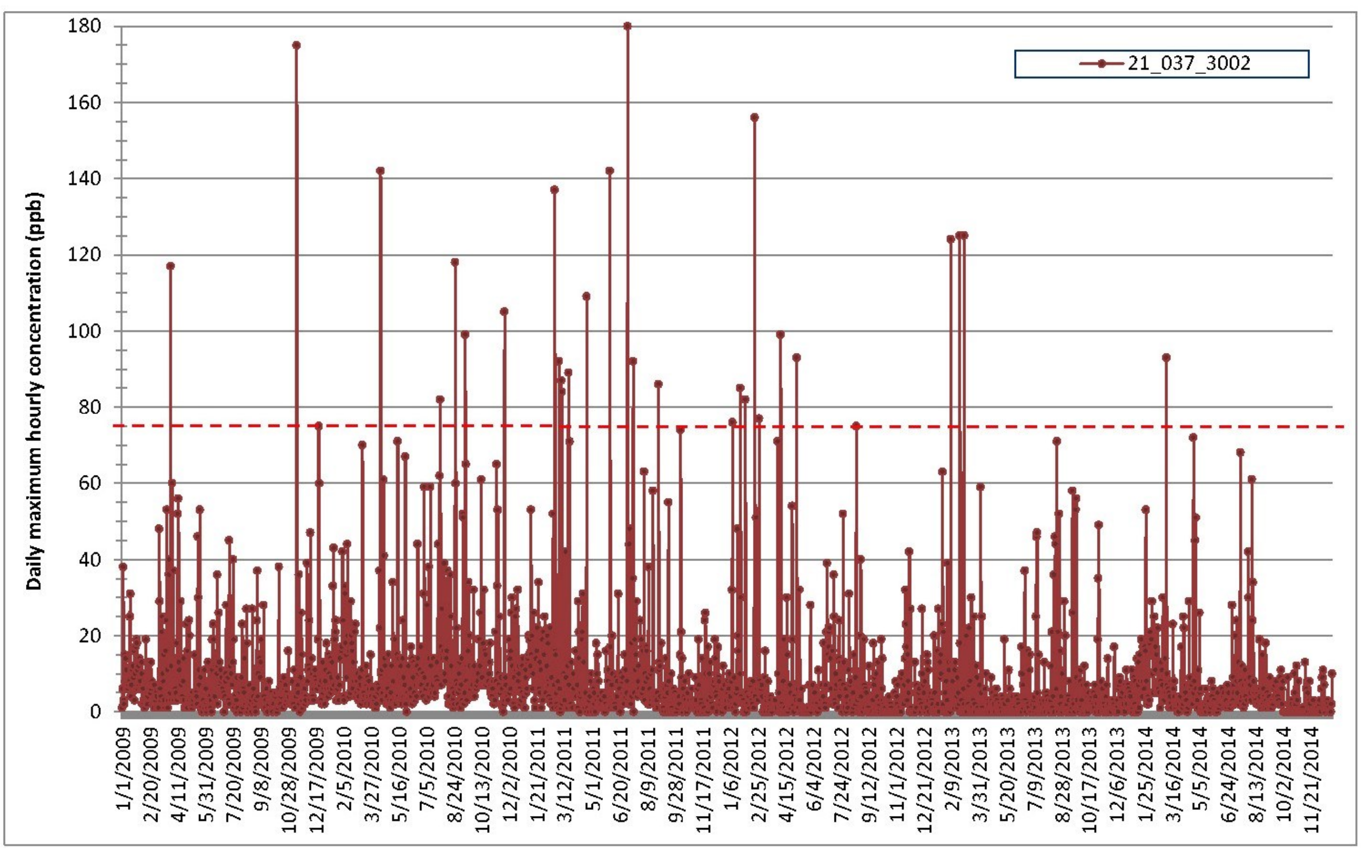
Incomplete Dataset

Data obtained from AQS on June 5, 2015



Example of the relationship between the daily maximum hourly SO_2 concentrations recorded at the NKU site and hourly averaged wind direction data from a Hamilton County, OH meteorological station, 1/1/12-6/31/2012. All data previously downloaded and analyzed in 2013.

Daily Maximum Hourly SO_2 Concentrations at the NKU site (2009-2014)



SO_2 Monitoring Network Conclusions

The network meets or exceeds all minimum monitoring requirements. While there are currently no plans to expand the size of the network, KDAQ is aware of the proposed SO_2 Data Requirements Rule that was released in April 2014. If finalized, the Data Requirements Rule could require the State to either monitor or model in order to characterize air quality around sources above a certain emissions-threshold. KDAQ will re-evaluate the network once the rule is finalized.

Finally, KDAQ did not run network-wide correlations for SO_2. However, KDAQ did run statistics on the Lexington Primary (21-067-0014) monitor and the Nicholasville monitor (21-113-0001), with the assumption that the analysis would show that the Nicholasville SO_2 monitor is redundant to the Lexington Primary monitor.

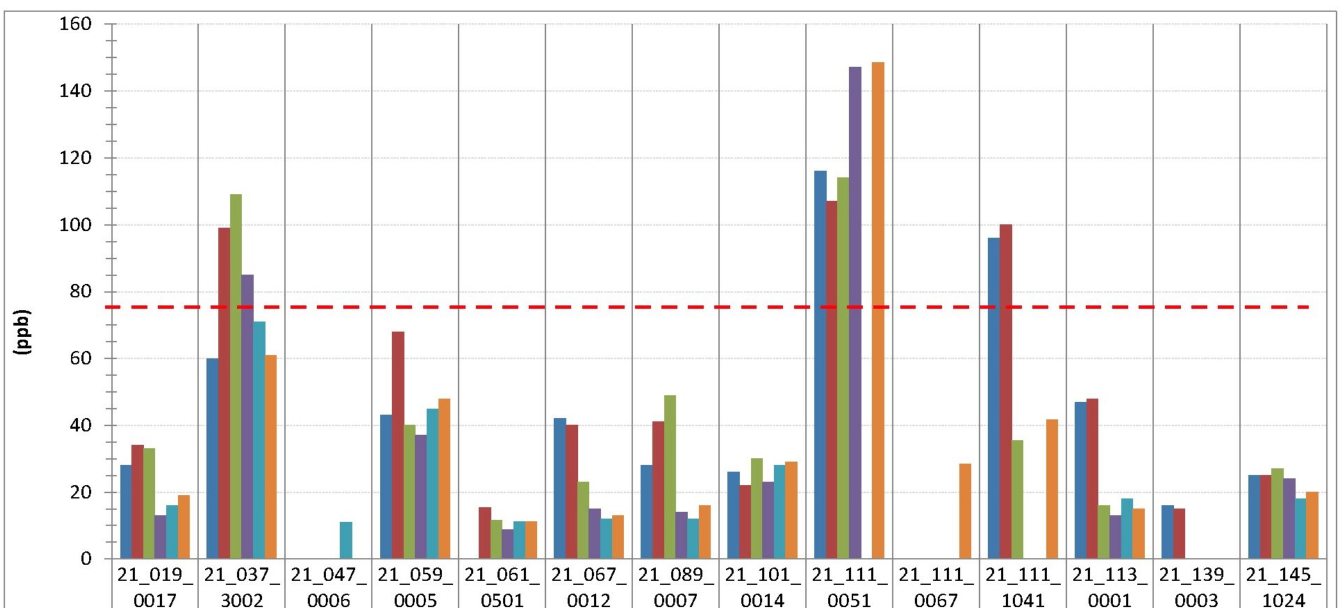
However, as shown by the chart on the right, the analysis showed a very low correlation between the two monitors, indicating that the volumes of air sampled are unique; additionally, the Nicholasville monitor was shown to have more variability in the dataset.

Since the statistics were generated using the 2009-2014 daily maximum hourly SO_2 concentrations from each site, KDAQ reran the correlations using 2009-2014 hourly raw data to check the original results; the correlation was similar. Thus, KDAQ does not believe shut-down is warranted based upon redundancy alone. However, the monitor may still be candidate for discontinuation in the future, should budget-constraints necessitate a reduction in the network.

Selected Statistics for the Nicholasville & Lexington Primary SO_2 Monitors (2009-2014)

2009-2014 Statistics	21_067_0012	21_113_0001
Mean	4.853	4.706
Standard Err.	0.128	0.145
Median	3	3
Mode	0	1
Standard Dev.	5.972	6.750
Sample Var.	35.666	45.556
Kurtosis	26.364	45.371
Skewness	3.705	4.963
Minimum	-1	0
Maximum	80	108
Correlation	**0.385**	

Kentucky Annual SO_2 Design Values (2009-2014)



	21_019_ 0017	21_037_ 3002	21_047_ 0006	21_059_ 0005	21_061_ 0501	21_067_ 0012	21_089_ 0007	21_101_ 0014	21_111_ 0051	21_111_ 0067	21_111_ 1041	21_113_ 0001	21_139_ 0003	21_145_ 1024
2009	28	60		43		42	28	26	116		96	47	16	25
2010	34	99		68	15.4	40	41	22	107		100	48	15	25
2011	33	109		40	11.6	23	49	30	114		35.4	16		27
2012	13	85		37	8.7	15	14	23	147.1			13		24
2013	16	71	11	45	11.1	12	12	28				18		18
2014	19	61		48	11.1	13	16	29	148.6	28.5	41.6	15		20

Incomplete datasets are omitted.

Data obtained from AQS on June 5, 2015

Sensitive Populations

Under 40 CFR Part 58.10(d), the five-year network assessment is required to consider the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals, such as children with asthma.

While all people are susceptible to the adverse effects of air pollution, certain subpopulations are especially susceptible and can experience more severe reactions at lower levels of a pollutant. Nationally, the two pollutants that are considered to be the greatest threats to human health are ozone and particulates.

Ground-level ozone can irritate the respiratory system, causing coughing, wheezing, painful respiration, shortness of breath, and irritation of the throat. Ozone reduces lung function, which can trigger asthma attacks. Additionally, ozone exposure can increase the risk of premature death due to heart or lung disease. People who are active outdoors are also susceptible to the effects of ozone.

Particulate matter, particularly in the size-range of 2.5 microns or less, can cause irritation of the eyes, nose, and throat, as well as, shortness of breath and a sensation of chest tightness. Particulate pollution exposure can increase the risk of hospitalization, and even death; at greatest risk are people with heart or lung disease, older adults, and children.

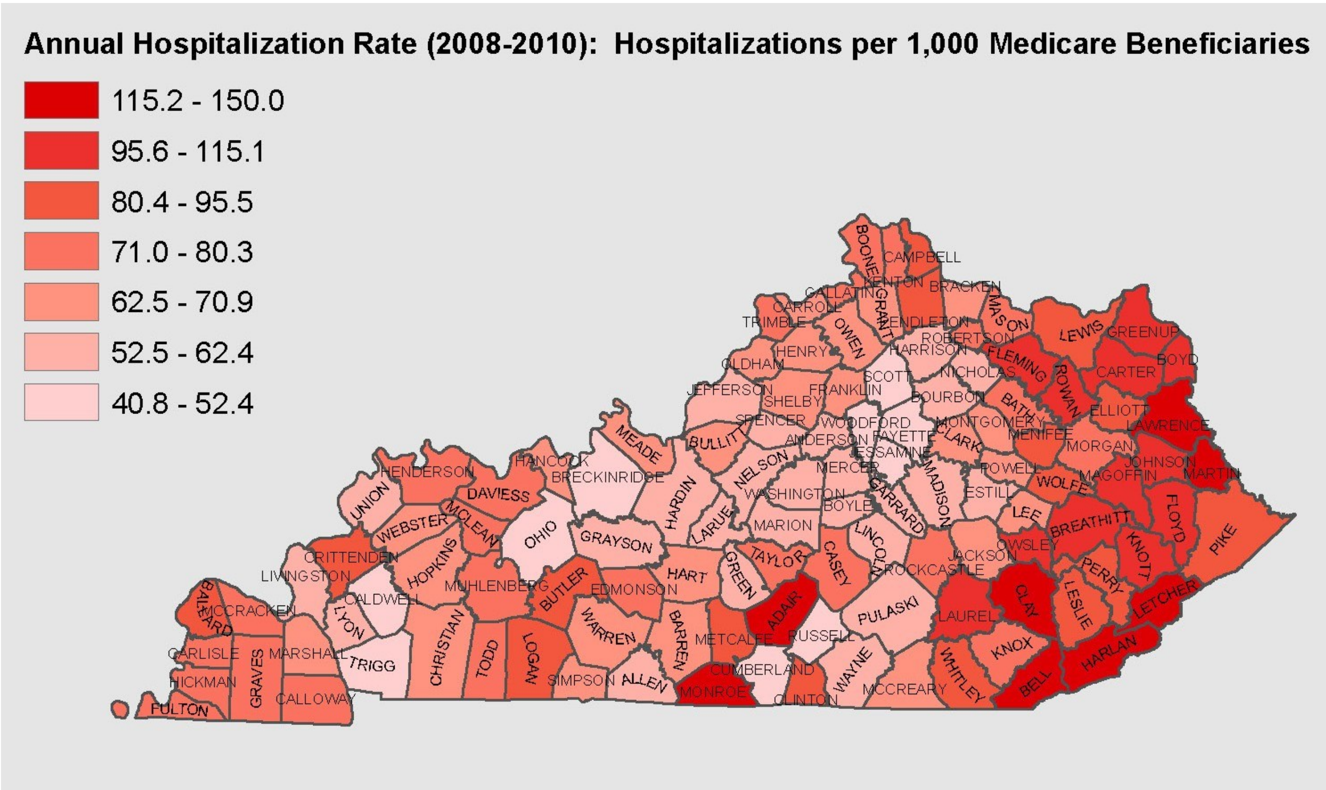
For the purpose of this five-year network assessment, sensitive populations were defined as:

- any person (regardless of age) with lung & bronchus cancers
- any person (regardless of age) with heart disease
- children and adults with asthma

Additionally, people living below the federal poverty level were included as a members of a sensitive population, since these people are less likely to have access to quality healthcare.

As expected, the review of sensitive populations in Kentucky revealed that the most vulnerable counties are primarily located in Eastern Kentucky. It should be noted that extreme Western Kentucky showed vast improvement in the statistics indicative of sensitive populations, since the last assessment in 2010. Selected indicators of the analysis are included in the following pages.

Kentucky County Hospitalization Rate: All Heart Disease



Heart Disease Hospitalization Rate per 1,000 Medicare Beneficiaries, 65+,
All Race, All Gender, 2008-2010

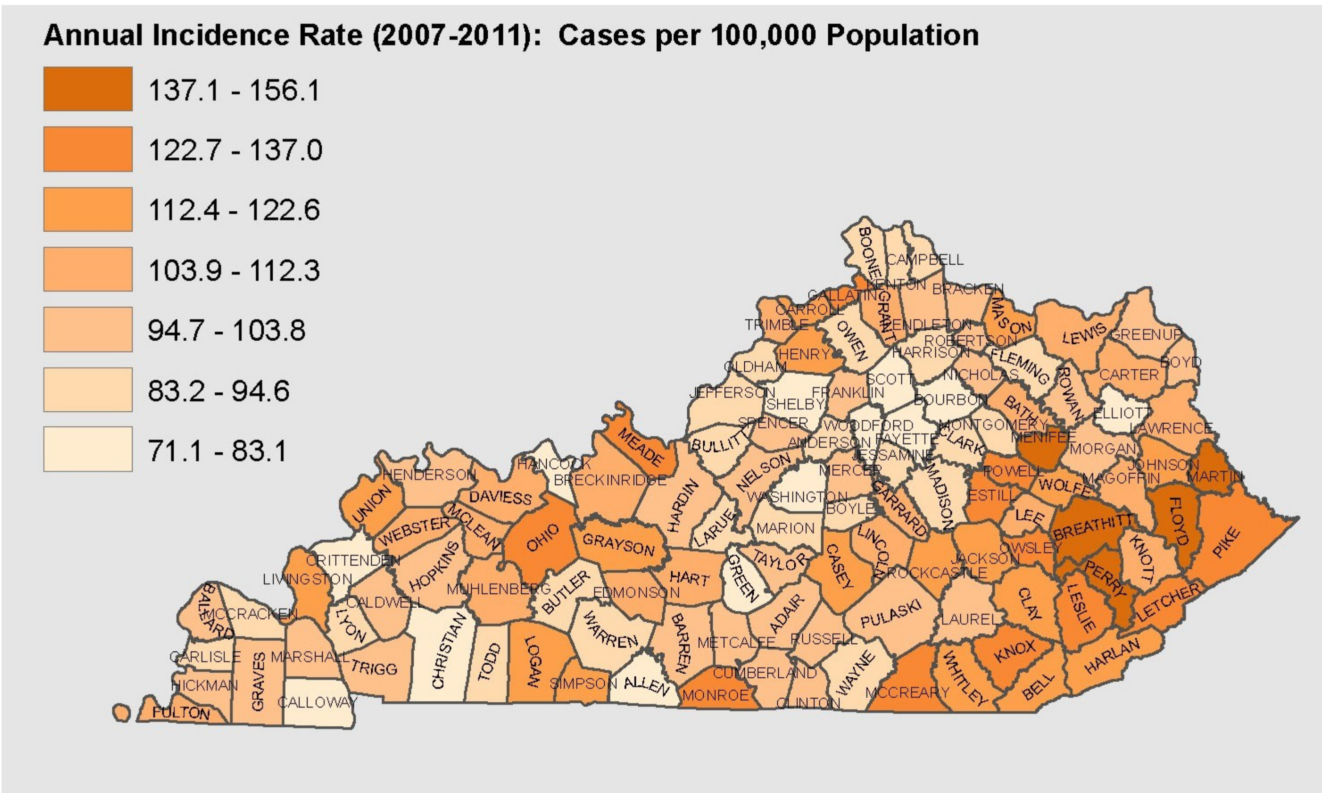
Spatially smoothed

Source: CDC Interactive Atlas of Heart Disease and Stroke Tables

http://nccd.cdc.gov/DHDSPAtlas/reports.aspx geographyType=county&state=KY&themeSubClassId=2&filterIds=6,3,5,7,10,1&filterOptions=1,1,1,1,1,1#report

Last Accessed: March 23, 2015

Kentucky County Incidence Rate: Lung & Bronchus Cancers

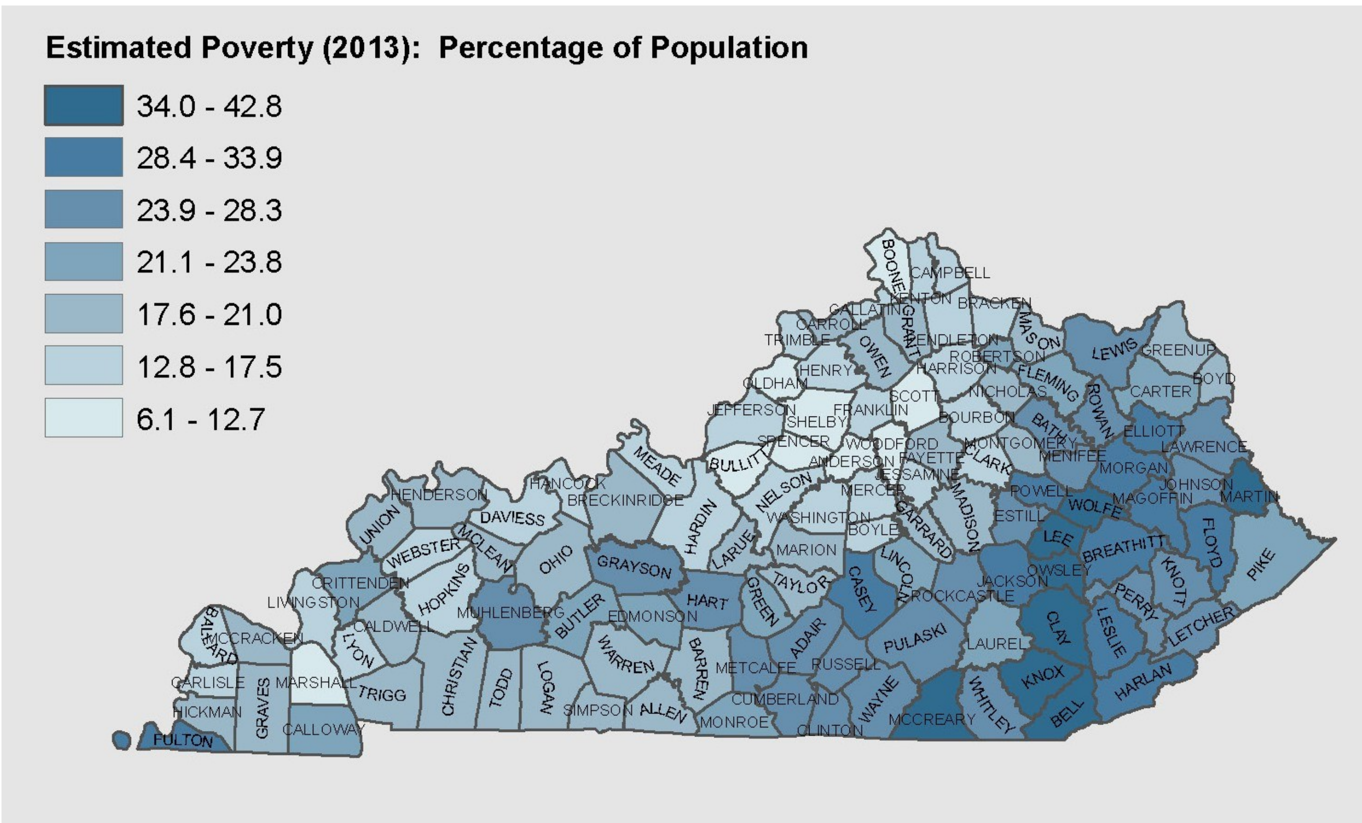


All Races (includes Hispanic), Both Sexes, Lung & Bronchus, All Ages

- *† Incidence rates (cases per 100,000 population per year) are age-adjusted to the 2000 US standard population (19 age groups: <1, 1-4, 5-9, ... , 80-84, 85+). Rates are for invasive cancer only (except for bladder cancer which is invasive and in situ) or unless otherwise specified. Rates calculated using SEER*Stat. Population counts for denominators are based on Census populations as modified by NCI. The 1969-2012 US Population Data File is used for SEER and NPCR incidence rates.*
- *Interpret Rankings provides insight into interpreting cancer incidence statistics. When the population size for a denominator is small, the rates may be unstable. A rate is unstable when a small change in the numerator (e.g., only one or two additional cases) has a dramatic effect on the calculated rate.*
- *Data not available for some combinations of geography, cancer site, age, and race/ethnicity.*
- *Suppression is used to avoid misinterpretation when rates are unstable.*

Source: CDC State Cancer Profiles. statecancerprofiles.cancer.gov
Last Accessed: March 12, 2015

Kentucky County Estimates: Percentage of Population in Poverty



All ages in poverty.

Source: USCB 2013 Small Air Income and Poverty Estimates Interactive Data Viewer.
http://www.census.gov/did/www/saipe/data/interactive/#view=StateAndCounty&utilBtn=CSV&yLB=0&stLB=18&cLB=0&dLB=0&gLB=0&usSts_cbSelected=false&usTot_cbSelected=false&stateTot_cbSelected=true&pLB=0&multiYearSelected=false&multiYearAlertFlag=false&prStateFlag=false&invalidSDYearsFlag=false
Last Accessed: March 12, 2015

Estimated Prevalence and Incidence of Lung Disease (Population Counts)

State/County	Population	Pediatric Asthma	Adult Asthma	COPD
Kentucky	4,380,415	103,927	371,982	377,984
Adair	18,675	422	1,611	1,670
Allen	20,210	488	1,712	1,784
Anderson	21,728	548	1,815	1,854
Ballard	8,333	191	719	775
Barren	42,631	1,026	3,619	3,798
Bath	11,802	298	987	1,035
Bell	28,183	636	2,441	2,567
Boone	123,316	3,486	9,844	9,686
Bourbon	19,978	480	1,701	1,801
Boyd	49,164	1,069	4,305	4,560
Boyle	28,658	619	2,506	2,623
Bracken	8,494	218	708	739
Breathitt	13,635	318	1,171	1,221
Breckinridge	20,071	485	1,713	1,839
Bullitt	75,896	1,863	6,391	6,474
Butler	12,840	309	1,090	1,152
Caldwell	12,935	296	1,118	1,203
Calloway	37,655	696	3,372	3,294
Campbell	90,908	2,084	7,788	7,817
Carlisle	5,034	114	437	475
Carroll	10,900	283	900	922
Carter	27,348	637	2,340	2,420
Casey	16,082	381	1,372	1,454
Christian	75,427	2,126	5,918	5,417
Clark	35,787	841	3,062	3,194
Clay	21,556	484	1,852	1,827
Clinton	10,285	246	877	937
Crittenden	9,280	211	805	872
Cumberland	6,819	153	594	650
Daviess	97,847	2,426	8,218	8,529
Edmonson	12,071	262	1,058	1,130
Elliott	7,780	153	696	725
Estill	14,493	332	1,253	1,326
Fayette	305,489	6,568	26,332	24,750
Fleming	14,560	363	1,223	1,280
Floyd	38,949	891	3,359	3,483
Franklin	49,804	1,082	4,349	4,480
Fulton	6,525	137	577	618
Gallatin	8,479	231	690	704
Garrard	16,913	385	1,465	1,547
Grant	24,485	683	1,965	1,956
Graves	37,544	943	3,144	3,318
Grayson	25,964	629	2,201	2,302
Green	11,315	254	985	1,065
Greenup	36,707	826	3,189	3,419
Hancock	8,677	222	723	760
Hardin	107,025	2,761	8,821	8,702
Harlan	28,543	665	2,454	2,579
Harrison	18,624	445	1,590	1,681
Hart	18,366	451	1,554	1,644
Henderson	46,513	1,116	3,954	4,111
Henry	15,318	378	1,296	1,371
Hickman	4,754	98	425	473
Hopkins	46,718	1,095	4,003	4,215
Jackson	13,331	314	1,139	1,177
Jefferson	750,828	17,585	63,974	64,758
Jessamine	49,635	1,287	4,083	4,057
Johnson	23,383	530	2,022	2,103
Kenton	161,711	4,088	13,432	13,322
Knott	16,124	351	1,412	1,469
Knox	31,735	784	2,665	2,772
Larue	14,151	334	1,210	1,278
Laurel	59,462	1,458	5,005	5,110
Lawrence	15,848	375	1,354	1,408
Lee	7,706	151	691	706
Leslie	11,170	249	973	1,020
Letcher	23,952	540	2,081	2,191
Lewis	13,835	330	1,180	1,240
Lincoln	24,461	606	2,058	2,158
Livingston	9,423	195	842	924
Logan	26,646	650	2,256	2,385
Lyon	8,351	130	792	879
Madison	84,786	1,829	7,312	6,976
Magoffin	13,041	311	1,111	1,146
Marion	20,090	496	1,686	1,719
Marshall	31,344	660	2,781	3,052
Martin	12,743	273	1,109	1,088
Mason	17,512	430	1,480	1,558
McCracken	65,549	1,471	5,695	6,066
McCreary	18,069	404	1,555	1,548
McLean	9,506	224	814	875
Meade	29,237	784	2,379	2,350
Menifee	6,220	140	540	575
Mercer	21,261	499	1,828	1,965
Metcalfe	9,969	240	849	906
Monroe	10,821	252	932	1,001
Montgomery	26,902	672	2,248	2,282
Morgan	13,668	281	1,206	1,207
Muhlenberg	31,181	675	2,728	2,868
Nelson	44,319	1,144	3,674	3,736
Nicholas	7,000	168	596	633
Ohio	24,075	613	2,006	2,102
Oldham	61,412	1,656	5,032	5,113
Owen	10,765	262	913	964
Owsley	4,722	110	407	433
Pendleton	14,604	352	1,242	1,283
Perry	28,241	641	2,440	2,514
Pike	64,178	1,414	5,594	5,800
Powell	12,483	314	1,043	1,070
Pulaski	63,593	1,469	5,474	5,799
Robertson	2,188	42	199	220
Rockcastle	17,006	398	1,458	1,532
Rowan	23,447	461	2,064	1,958
Russell	17,497	395	1,519	1,633
Scott	49,057	1,316	3,980	3,845
Shelby	43,614	1,106	3,633	3,696
Simpson	17,538	433	1,476	1,536
Spencer	17,416	443	1,454	1,478
Taylor	24,691	557	2,131	2,222
Todd	12,651	348	1,023	1,056
Trigg	14,447	325	1,260	1,388
Trimble	8,787	218	739	766
Union	14,850	342	1,269	1,281
Warren	117,110	2,688	9,919	9,402
Washington	11,833	276	1,017	1,074
Wayne	20,824	473	1,802	1,914
Webster	13,583	326	1,154	1,205
Whitley	35,499	863	2,990	3,044
Wolfe	7,164	177	607	654
Woodford	25,077	593	2,152	2,269

American Lung Association, Epidemiology and Statistics Unit
Research and Health Education
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Appendix A

Renewal of Waivers from the Requirements of 40 CFR 58, Appendix E: Probe and Monitoring Path Siting Criteria For Ambient Air Quality Monitoring

Appendix A
Introduction

Appendix E of 40 CFR 58 establishes specific probe siting criteria that are applicable to SLAMS air monitoring stations, based upon the monitoring objectives and spatial scales of representativeness, as outlined in Appendix D. The Kentucky Division for Air Quality (KDAQ) conducts siting criteria evaluations of each air monitoring station in the state-network annually and makes every effort to resolve deviations from specified siting requirements. All air monitoring equipment operated by KDAQ meets the necessary provisions set forth in Appendix E, with the exception of some of the equipment located at the Jackson Purchase Rural Electric Cooperative Corporation (RECC) site in McCracken County and the Baskett site in Henderson County (21-145-1024 and 21-101-0014, respectively).

According to Section 10.0 of 40 CFR 58, Appendix E, the EPA will consider written requests for a waiver from one or more siting criteria for certain monitoring sites. In order for waiver of an existing monitoring site to be approved, the air agency must demonstrate that the site is representative of the monitoring area as it would be if the siting criteria were met; and, that the monitor or probe can not reasonably be relocated so as to meet siting criteria.

EPA Region 4 previously approved siting criteria waivers for both the JPRECC and Baskett air monitoring stations. KDAQ respectfully requests a renewal of those siting criteria waivers as a part of this five -year network assessment.

Appendix A- Part 1
Jackson Purchase RECC (21-145-1024)

The Jackson Purchase RECC site is equipped with continuous nitrogen dioxide, sulfur dioxide, ozone, and $PM_{2.5}$ TEOM monitors, as well as an intermittent $PM_{2.5}$ sampler and an intermittent PM_{10} sampler. The site is located on a gravel storage lot of the Jackson Purchase RECC at 2901 Powell Street in Paducah, KY, and is comprised of an 8 x 12 ft. EKTO® shelter. All continuous monitors are located within the shelter, while the intermittent samplers are located on the roof of the shelter (see Figures 1, 2, & 3).

The intermittent $PM_{2.5}$ and PM_{10} samplers were previously located on the roof of the former Paducah Middle School site (21-145-1004). In August 2013, Paducah Public Schools asked KDAQ to remove the equipment; at which point, the samplers were relocated to their current location at the Jackson Purchase site.

According to Table E-1 of 40 CFR 58, Appendix E, the inlets for all urban and neighborhood scale ozone and nitrogen dioxide monitors must be a minimum of ten meters away from any road; however, the required clearances increase with increasing average daily traffic counts (ADT) above 1,000 vehicles per day. Additionally, Figure E-1 of 40 CFR 58, Appendix E, requires that neighborhood scale particulate inlets be at least 15 meters away from a road. Appendix E does not specify minimum road clearances for sulfur dioxide inlets.

Powell Street is the nearest road to the air monitoring station. While traffic counts are not available for Powell Street, the road is a small side-street that is only used for local traffic; traffic counts are certainly less than 1,000 ADT (see Figure 3). Nonetheless, all inlets are closer to Powell Street than the allowable road clearances specified by Appendix E, with the exception of sulfur dioxide. The exact distances from the road for each inlet, as well as each monitor's designation and spatial scale of representativeness, are outlined in the Table 1 below.

Monitor	Sampling Frequency	Designation	Spatial Scale	Minimum Required Road-Clearance	Measured Probe-Distance from Road
NO_2	Continuous	SLAMS, EPISODE	Urban	10 meters	9.6 meters
SO_2	Continuous	SLAMS, PWEI, AQI, EPISODE	Neighborhood	Not Applicable	9.5 meters
O_3	Continuous	SLAMS, AQI, EPISODE	Neighborhood	10 meters	9.6 meters
$TEOM_{2.5}$	Continuous	SPM, AQI	Neighborhood	15 meters	8.2 meters
FRM $PM_{2.5}$	24-hours every third day	SLAMS	Neighborhood	15 meters	10.0 meters
FEM PM_{10}	24-hours every sixth day	SLAMS	Neighborhood	15 meters	10.6 meters

Table 1: Monitor designations, sampling frequencies, spatial scales of representativeness, and measured road distances, as compared to the requirements of Appendix E, for the Jackson Purchase RECC air monitoring station.

In an effort to increase the distance between the probes and Powell Street, KDAQ moved the nitrogen dioxide, sulfur dioxide, and ozone inlets to another portion of the air monitoring shelter. KDAQ did not attempt to move the continuous $PM_{2.5}$ TEOM inlet, as that would have required an additional hole to be cut into the roof of the shelter. The intermittent $PM_{2.5}$ and PM_{10} samplers are located on the side of the shelter furthest from the road.

KDAQ is unable to move the entire shelter further from the road, as that would block a drive used by the electric cooperative. Furthermore, moving the shelter to a new location off the grounds of the electric cooperative would be very costly. More importantly, the Jackson Purchase RECC site has been located at the electric cooperative since 1980; movement of the entire site would represent the loss of a station with a long monitoring history. KDAQ believes the impact from vehicles traveling on Powell Street to be minimal and requests a waiver from the minimum road distances stated in 40 CFR 58, Appendix E, for the nitrogen dioxide, ozone, and $PM_{2.5}$ TEOM monitors, as well as the intermittent $PM_{2.5}$ and PM_{10} samplers.

Figure 1: Picture of the Jackson Purchase RECC site on October 6, 2014.

Figure 2: Picture of the intermittent $PM_{2.5}$ and PM_{10} samplers, as well as the inlet of the $PM_{2.5}$ TEOM, on the roof of the Jackson Purchase RECC shelter on October 6, 2014.

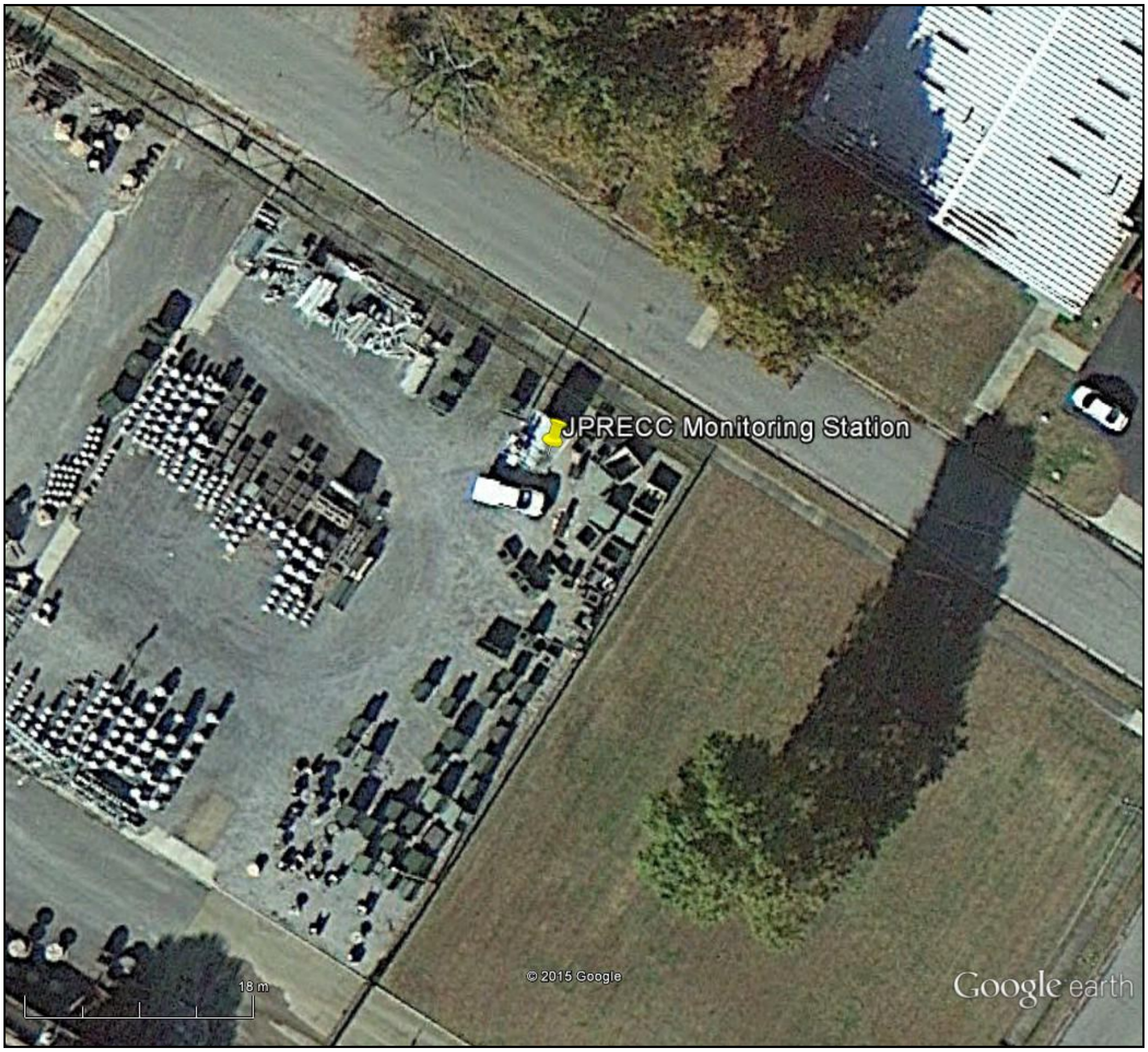


Figure 3: Google Earth image of the Jackson Purchase RECC air monitor station.

Figure 4: KYTC Traffic Counts for roads near the Jackson Purchase RECC air monitoring station.

Appendix A- Part 2

Baskett (21-101-0014)

The Baskett site is equipped with continuous ozone, sulfur dioxide, and $PM_{2.5}$ TEOM monitors, as well as an intermittent FEM $PM_{2.5}$ sampler and an intermittent FRM PM_{10} sampler. Filters collected from the PM_{10} sampler are sent to a contract laboratory for metals analysis following gravimetric analysis by KDAQ. The continuous monitors are located within an 8 x 10 ft. EKTO® shelter; the particulate samplers are positioned on the roof of the EKTO® shelter. The site is located in a grassy area near the Baskett Fire Department at 7492 Dr. Hodge Road in Baskett, KY (see Figures 1, 2, & 3).

All inlets at the site are closer to Dr. Hodge Road than the allowable minimum road distances stated in 40 CFR 58, Appendix E, with the exception of the sulfur dioxide inlet. According to Appendix E, all urban scale ozone monitors should be at least ten meters from the neighboring roads. All neighborhood scale particulate matter monitors/samplers should be at least 15 meters from nearby roads; the required distance from the road increases with daily traffic count.

Dr. Hodge Road is a narrow street in a small rural community. While official traffic count data is not available, the vehicle count via observation is substantially less than 1,000 ADT (see Figure 4). The measured distances from the road for each inlet, as well as each monitor's designation and spatial scale of representativeness, are outlined in Table 1 below.

Monitor	Sampling Frequency	Designation	Spatial Scale	Minimum Required Road-Clearance	Measured Probe-Distance from Road
SO_2	Continuous	SLAMS, PWEI	Neighborhood	Not Applicable	6.9 meters
O_3	Continuous	SPM	Urban	10 meters	6.9 meters
$TEOM_{2.5}$	Continuous	SPM	Neighborhood	15 meters	6.9 meters
FRM $PM_{2.5}$	24-hours every third day	SLAMS	Neighborhood	15 meters	6.1 meters
FEM PM_{10}	24-hours every sixth day	SLAMS, (SPM metals analysis)	Neighborhood	15 meters	6.9 meters

Table 1: Monitor designations, sampling frequencies, spatial scales of representativeness, and measured road distances, as compared to the requirements of Appendix E, for the Baskett air monitoring station.

KDAQ had investigated the possibility of moving the Baskett air monitoring station due to the proximity of a nearby railroad track and the potential impacts on sulfur dioxide data. KDAQ was unable to find a more suitable location; much of the area surrounding Baskett is in a flood plain and catastrophic flooding is not uncommon.

KDAQ believes that the impact of vehicle traffic from Dr. Hodge Road is minimal. KDAQ respectfully requests a waiver from the minimum road distances stated in 40 CFR 58, Appendix E for the ozone and continuous $PM_{2.5}$ TEOM monitors, as well as the intermittent $PM_{2.5}$ and PM_{10} samplers.

Figure 1: Picture of the Baskett site taken from the Baskett Fire Department's parking lot on November 25, 2014.

Figure 2: Picture of the Baskett site taken from Dr. Hodge Road on November 25, 2014.

Figure 3: Google Earth image of the Baskett air monitoring station.

Figure 4: KYTC traffic counts for roads near the Baskett air monitoring station.

Appendix B

Renewal of Waiver from the Requirements of 40 CFR 58, Appendix D: Lead Network Design Criteria

Appendix B

Renewal of Waiver from the Requirements of 40 CFR 58, Appendix D: Lead Network Design Criteria

Section 4.5(ii) of Appendix D to 40 CFR 58 states: "The Regional Administrator may waive the requirement in paragraph 4.5(a) for monitoring near lead sources if the State or, where appropriate, local agency can demonstrate the Pb source will not contribute to a maximum Pb concentration in ambient air in excess of fifty percent of the NAAQS (based on historical monitoring data, modeling, or other means). The waiver must be renewed once every 5 years as part of the network assessment required under Section 58.10 (d)." In order to determine the status of lead monitoring waivers, the Kentucky Division for Air Quality (Division) modeled facilities meeting specific criteria using the near field regulatory model AERMOD (14134).

The Division identified ten sources with Pb emissions over 0.50 tpy in KY-EIS. Those facilities include:

- Newpage Corp
- AK Steel West Works
- Calgon Carbon
- KY Utilities - Ghent
- KY Power Big Sandy
- Blue Grass Army Depot
- Enersys
- CC Metals & Alloys
- TVA Shawnee
- TVA Paradise

Ultimately, the modeling demonstrated that a waiver from monitoring is appropriate for eight sources:

- Newpage Corp
- Calgon Carbon
- KY Utilities - Ghent
- KY Power Big Sandy
- Blue Grass Army Depot
- CC Metals & Alloys
- TVA Shawnee
- TVA Paradise

The modeling demonstrated that a new monitoring is required at the AK Steel West Works facility in Boyd County. The monitoring also showed that the Enersys Inc. facility in Madison County requires monitoring; however, monitoring is ongoing at this site.

AERMOD Modeling Analysis in Support of the Lead NAAQS Waiver Requests for the State of Kentucky

Contents

Introduction

On November 12, 2008, the United States Environmental Protection Agency (EPA) strengthened the National Ambient Air Quality Standard (NAAQS) for lead (Pb). The revised standard is now set at 0.15 µg/m3 for the primary (health-based) and secondary (welfare-based) standards. In conjunction with the revision of the lead NAAQS, the EPA promulgated new network design criteria, which can be found in 40 CFR Part 58, Appendix D, paragraph 4.5. Source-oriented monitoring is required for those facilities which emit 0.5 ton per year (tpy) or more of lead to the air.

Section 4.5(ii) of Appendix D to 40 CFR 58 states: "The Regional Administrator may waive the requirement in paragraph 4.5(a) for monitoring near lead sources if the State or, where appropriate, local agency can demonstrate the Pb source will not contribute to a maximum Pb concentration in ambient air in excess of fifty percent of the NAAQS (based on historical monitoring data, modeling, or other means). The waiver must be renewed once every 5 years as part of the network assessment required under Section 58.10(d)." In order to determine the status of lead monitoring waivers, the Kentucky Division for Air Quality (Division) modeled facilities meeting specific criteria using the near field regulatory model AERMOD (14134).

Selection Criteria for the Modeled Facilities

In accordance with the revisions to Lead Ambient Air Monitoring requirements, the Division compiled a list of facilities that emitted over 0.5 tpy of lead. Each facility's emissions data was acquired from the 2009-2013 Kentucky Division for Air Quality Emissions Inventory System (KY-EIS), National Emission Inventory (NEI), and the Toxics Release Inventory (TRI). The values used in the model were accepted based on best science and conservatism toward human health approach.

Lead Emission Sources

The Division identified ten sources with Pb emissions over 0.50 tpy in KY-EIS. Those facilities include: Newpage in Wickliffe, KY; AK Steel -West Works in Ashland, KY ; Calgon Carbon in Catlettsburg, KY; Kentucky Utilities Company-Ghent Generation Station in Ghent, KY; Kentucky Power – Big Sandy Plant (Big Sandy), in Louisa, KY; Blue Grass Army Depot in Richmond, KY; Enersys Incorporated in Richmond, KY; CC Metals & Alloys LLC in Calvert City, KY; Tennessee Valley Authority (TVA) Shawnee Fossil Plant in West Paducah, KY; and Tennessee Valley Authority (TVA) Paradise Fossil Plant in Drakesboro, KY. Table 1.0 provides a summary of the ten facilities identified as meeting the lead monitoring criteria.

Table 1.0 Kentucky Lead Emission Sources 2009-2013 above 0.50 TPY

Facility	Functionality
Newpage Corp	Operates an integrated pulp and paper mill producing high-grade coating paper.
AK Steel West Works	Operates an integrated steel mill converting raw materials into steel.
Calgon Carbon	Activates primary carbon and regenerates recycled carbon.
KY Utilities - Ghent	Operates four (4) pulverized coal-fired, dry bottom boilers for electricity generation.
KY Power Big Sandy	Operates two coal-fired steam generators for electricity production.
Blue Grass Army Depot	Neutralizes chemical weapons, conventional munitions and agent stockpiles on-site.
Enersys	Manufactures industrial lead-acid batteries.
CC Metals & Alloys	Produces ferrosilicon and various ferroalloy specialty products.
TVA Shawnee	Operates ten coal-fired boilers for electricity generation.
TVA Paradise	Operates three cyclone-furnaces, coal-fired boiler units for electricity production.

Emissions Inventory Data

Statewide KY-EIS actual Pb emissions data was assembled for the years 2009–2013, which indicated the ten facilities emitting more than 0.5 tpy of lead. The year with the maximum actual emissions would be used in the modeling demonstration over a five year period. The KY-emissions data collected for the period of 2009-2013 is tabulated in Table 2.0.

The Division examined the 2009-2013 KY-EIS, NEI and TRI values for the ten Pb sources. Under further examination, Newpage demonstrated a lower emission factor than supplied to the KY EIS for the years of 2009-2013. The maximum TRI emission data submitted by Newpage (0.37 tpy) was below the lead monitor criteria. Therefore, Newpage Corporation was excluded from further analysis. In addition, Calgon Carbon and AK Steel West Works also provided additional emissions factors significantly lower than the KY-EIS factors. The Division utilized the 2009-2013 TRI values from the sources. Although lower than the KY-EIS ton per year values, both sources emitted above 0.50 tpy and were included in the modeling demonstration. The TRI emissions data collected for the period of 2009-2013 is tabulated in Table 3.0.

Table 2.0 Kentucky Emissions Inventory Data 2009-2013

Facility Name	2009 Actual Emissions (tpy)	2010 Actual Emissions (tpy)	2011 Actual Emissions (tpy)	2012 Actual Emissions (tpy)	2013 Actual Emissions (tpy)
Newpage Corp	1.800157	2.794773	0.552680	**3.143330***	2.033632
AK Steel West Works	0.225644	0.273888	1.002160	**2.308392****	0.877391
Calgon Carbon	**5.589247****	5.530410	0.678377	0.001087	0.000961
KY Utilities - Ghent	0.534632	0.631246	**0.660377**	0.625764	0.629734
KY Power Big Sandy	0.542943	0.008022	**0.640878**	0.280241	0.224242
Blue Grass Army Depot	**0.570104**	0.208965	0.171634	0.420903	0.386399
Enersys	1.301323	1.451120	**1.567149**	1.539218	0.547436
CC Metals & Alloys	0.417592	**0.628552**	0.040854	0.047552	0.074724
TVA Shawnee	4.409528	4.477465	**4.614475**	4.170683	4.260245
TVA Paradise	1.230250	**1.278959**	0.939598	1.145613	1.050875

Bolded values are the maximum actual emission values of the five years.
***Excluded from further analysis based on an evaluation of the corresponding TRI emissions data.**
****KY EIS emission data replaced by TRI emissions data in the model waiver demonstration.**

Table 3.0 Toxic Release Inventory (TRI) Data 2009-2013

Facility Name	2009 Actual Emissions (tpy)	2010 Actual Emissions (tpy)	2011 Actual Emissions (tpy)	2012 Actual Emissions (tpy)	2013 Actual Emissions (tpy)
Newpage Corp	0.018	0.02	**0.37**	0.33	0.30
AK Steel West Works	0.22	1.01	**1.07***	0.57	.058
Calgon Carbon	0.02	0.021	**1.12***	0.019	0.016

Bolded values are the maximum actual emission values of the five years.
*** TRI emissions data in the model waiver demonstration.**

The emissions data and years utilized in the modeling analysis for sources with emissions above 0.50 TPY can be found in Appendix A.

Nearby Sources

Nearby lead sources within a 50km diameter of the nine modeled facilities were examined for background contributions. The emissions data from nearby lead sources was acquired from the 2009-2013 Kentucky Emission Inventory System. Table 4.0 provides a summary of the KY-EIS data collected for nearby sources from 2009-2013. The year with the maximum actual emissions was modeled for all nearby sources except Aleris. The TRI values for Aleris were incorporated into the modeling demonstration due to changes in emission factors. The Aleris TRI emissions data collected for the period of 2009-2013 is tabulated in Table 5.0.

Table 4.0 Kentucky Emissions Inventory Data for Nearby Sources

Facility Name	2009 Actual Emissions (tpy)	2010 Actual Emissions (tpy)	2011 Actual Emissions (tpy)	2012 Actual Emissions (tpy)	2013 Actual Emissions (tpy)
North American Stainless	.04908978	.07338135	.07613301	**.08162523**	.0759426
Aleris Recycling Inc.	.06676968	**.11489789***	.099236	.09415385	.08606267
Gallatin Steel Co.	.04513237	.05912264	**.05977537**	.00043143	.00045033
Kentucky Utilities Co. - Green River Station	.02378004	.03427812	.03115668	.03654338	**.03774483**

Bolded values are the maximum actual emission values of the five years.
***KY EIS emissions data replaced by TRI emissions data in the model waiver demonstration.**

Table 5.0 Toxic Release Inventory (TRI) Data for Nearby Sources

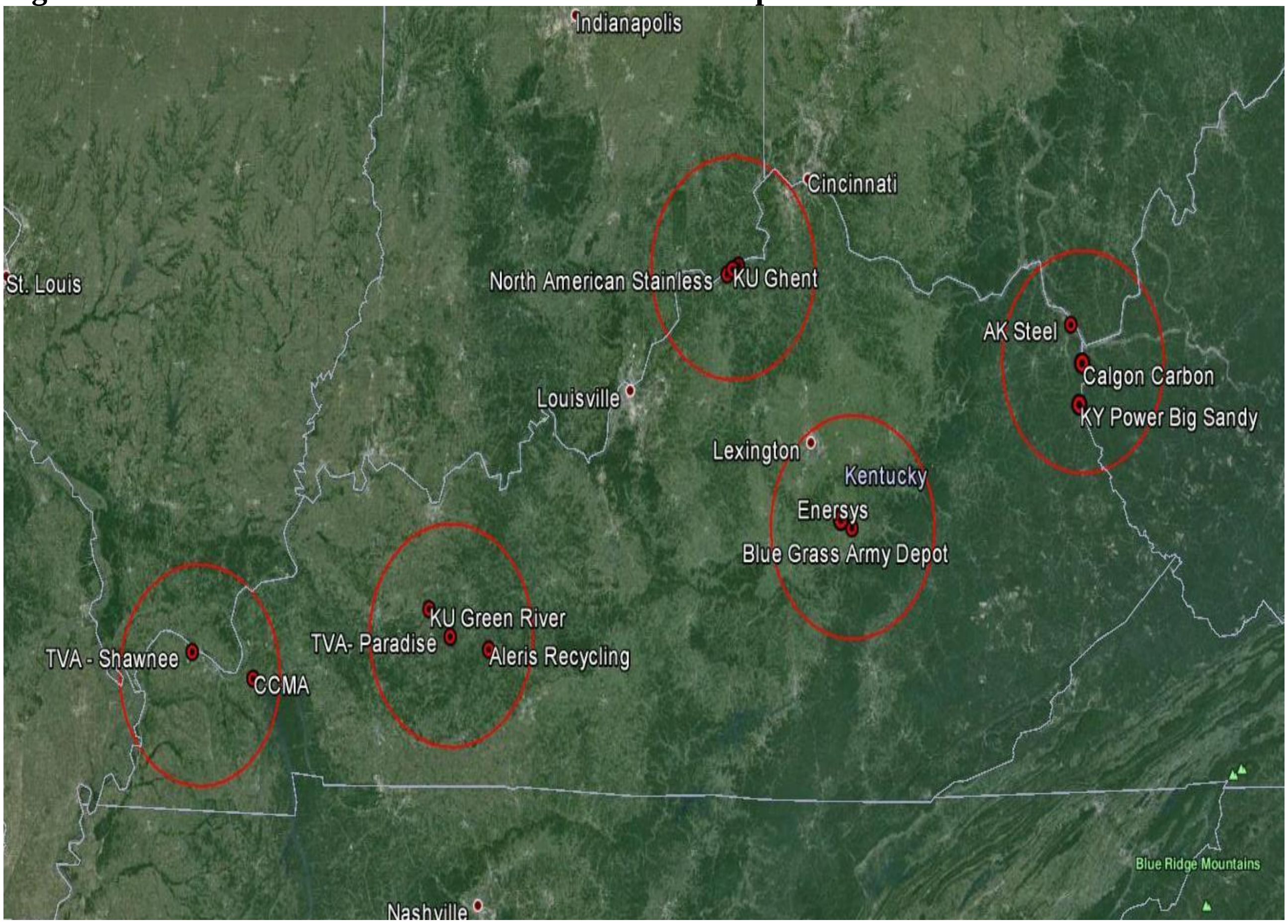
Facility Name	2009 Actual Emissions (tpy)	2010 Actual Emissions (tpy)	2011 Actual Emissions (tpy)	2012 Actual Emissions (tpy)	2013 Actual Emissions (tpy)
Aleris Recycling Inc.	.00035	.0055	**.0065**	.0045	.003

Bolded value is the maximum actual emission value of the five years.

The emissions data and year utilized in the modeling analysis for nearby sources can be found in Appendix B.

In order to evaluate the Pb impact of the nearby sources, the Division created 50km radius source groups. The sources over 0.50 tpy and nearby sources were assigned to five source groups across Kentucky. The 50km radial plots of the five source groups are depicted in Figure 1.0. Each modeled source group predicted a maximum monthly impact, 3-month rolling average and contribution concentrations for included sources. The default source group (all) represents the combined facilities in the model run. In addition, each facility was given a source group identity to distinguish the driver of the significant impact area (SIA). The facility and modeling parameters for each source group are tabulated in Appendix C.

Figure 1.0 50km Radial Plots of Statewide Source Groups



The 50km diameter radial plots representing each source group can be found in Appendix D.

Model Parameters

Urban versus Rural Determination

The facilities modeled in this analysis were all modeled as rural. The rural setting was chosen based on the population density procedure as stated in Section 7.2.3(d) of 40 CFR 51 Appendix W. In addition, none of the facilities modeled fall into a highly industrialized category as mentioned subsequently in Section 7.2.3(e) of Appendix W.

Meteorological Data

In compliance with the EPA air quality modeling guideline found in Section 8.3 of 40 CFR Part 51 Appendix W, the modeling performed for each facility relied on five years of consecutive meteorological data taken from the most representative surface and upper air meteorological stations. ASOS 1-minute wind data was utilized in conjunction with the surface air station data in Aerminute (14237) and AERMET (14134). The meteorological data years, 2009 to 2013, were chosen in part due to their availability and the completeness of the data. Table 6.0 provides a brief summary of processed meteorological data utilized in the modeling demonstration for each source group.

Table 6.0 Meteorological Data for Each Source Group

Source Group	Met Years	Surface Air Station/ 1-min ASOS	Upper Air Station
Calgon Carbon	2009-2013	HTS Huntington Tri-State Airport	ILN Wilmington, Ohio
TVA Paradise	2009-2013	BWG Bowling Green/Warren Co Airport	BNA Nashville, Tennessee
Enersys	2009-2013	LEX Blue Grass/Lexington	ILN Wilmington, Ohio
KY Utilities - Ghent	2009-2013	CVG Cincinnati/Greater Airport	ILN Wilmington, Ohio
TVA Shawnee	2009-2013	PAH Paducah / Barkley Field	BNA Nashville, Tennessee

Representativeness/Surface Characteristics

According to the AERMOD Implementation Modeling Guidelines, the meteorological stations should be representative of the facility. The National Weather Service (NWS) meteorological stations chosen for each facility depended on the facility's location, topography, land use, and surface characteristics in reference to each facility. In AERSURFACE (13016), the default 1 km radius was chosen, temporal resolution was set to "monthly", twelve 30º sectors and average surface moisture were used throughout the analysis. The land use was classified based on the 1992 National Land Cover Data (NLCD 92) which is available from the United States Geological Survey (USGS). The NLCD 92 contains a 21-category land cover classification, which is based on Landsat imagery.

Pollutant Averaging

The pollutant averaging time was set to 1-month. The 1-month average was converted to a 3-month rolling average using the lead post processor, which is available from EPA at http://www.epa.gov/ttn/amtic/pb-monitoring.html. In addition to the 3-month rolling average, individual source contributions are included for each month composing the 3-month rolling average. The post processor folder containing the 3-Month Processor Output File (.out), Plot File (.plt), and a Post File (.pos) are included in the source modeling folder (.AD).

Building Downwash

Building downwash was considered in each modeling demonstration. The Building Profile Input Program algorithm (04274) was used to process building inputs for AERMOD. The actual facility stack heights were utilized in each modeling demonstration.

Receptors/Terrain

The location of emission sources, structures, and receptors for all modeling analyses were represented in the Universal Transverse Mercator (UTM) coordinate system. The datum utilized was located between UTM Zone 16 and 17 of World Geodetic System 1984 (WGS84).

National Elevation Data (NED) maps available from the USGS were used in the AERMAP (11103) processor for each modeling demonstration. Although the "Flat" & "Elevated" non-default option was chosen, the emission sources, structures, and receptor elevation/hill heights were derived using the Aermap receptor output file (.ROU).

As stated in Section 8.2.2 of Appendix A to Appendix W of 40 CFR 51, "Receptor sites for refined modeling should be utilized in sufficient detail to estimate the highest concentration and possible violations of a NAAQS or PSD increment. In designing a receptor network, the emphasis should be placed on receptor resolution and location, not total number of receptors. The selection of receptor sites should be a case-by-case determination taking into consideration the topography, the climatology, monitor sites, and the results of the initial screening procedure."

In accordance with this principal, spacing and number of receptors in the grid were chosen in a way to encompass a majority of the plume as well as the significant impact area, in which the maximum impact occurs. The receptor grids are optimized to have the maximum concentration occur within a 100 by 100 meter grid. This was achieved by including additional discrete Cartesian receptors to cover the significant impact area. Table 7.0 outlines a general receptor summary by source group. A general receptor summary representing additional modeling runs is detailed in Table 7.1. Both summaries include the number and distance between the domain receptors and SIA receptors, number of boundaries receptors, and total receptors utilized per group.

Table 7.0 Modeling Receptor General Summary

Group	Domain Receptors	SIA Discrete Receptors	Plant Boundaries Receptors	Total Receptors
Calgon Carbon	40 km radius uniform polar grid 1000m spacing – 2880 discrete receptors	100m spacing around SIA – 4523 receptors	Cartesian boundary receptors – 552 receptors	7955
TVA Paradise	40 km radius uniform polar grid 1000m spacing – 2880 discrete receptors	100m spacing around SIA – 3603 receptors	Cartesian boundary receptors – 655 receptors	7138
Enersys	40 km radius uniform polar grid	100m spacing	Cartesian boundary	8651

	1000m spacing – 2880 discrete receptors	around SIA – 5044 receptors	receptors – 727 receptors	
KU Ghent	40 km radius uniform polar grid 1000m spacing – 2880 discrete receptors	100m spacing around SIA – 6363 receptors	Cartesian boundary receptors – 549 receptors	9792
TVA Shawnee	40 km radius uniform polar grid 1000m spacing – 2880 discrete receptors	100m spacing around SIA – 10882 receptors	Cartesian boundary receptors – 280 receptors	14042

Table 7.1 Additional Modeling Receptor General Summary

Model Run	Domain Receptors	SIA Discrete Receptors	Plant Boundaries Receptors	Total Receptors
Calgon Carbon/ 11aks - aer 11aks - pr	3000m at 100m spacing 5000m at 250m spacing 7500m at 500m spacing 10000m at 1000m spacing – 5525 uniform Cartesian receptors	None	Cartesian boundary receptors – 223 receptors	5748
Calgon Carbon/ 11aks - pb	3000m at 100m spacing 5000m at 250m spacing 7500m at 500m spacing 10000m at 1000m spacing – 5345 uniform Cartesian receptors	None	Cartesian boundary receptors – 223 receptors	5568
TVA Shawnee/ 11shaw - fl	40 km radius uniform polar grid 1000m spacing – 2880 discrete receptors	100m spacing around SIA – 10825 receptors	Cartesian boundary receptors – 303 receptors	14008

In the interest of being conservative towards human health, all receptors in the modeling demonstrations are assumed to be ambient air. When the SIA exceeded half the Pb NAAQS on facility property, additional modeling runs were performed to resemble public access to the property. The receptor domains utilized in the modeling can be found in Appendix E. The facility fence lines / boundaries are depicted with red outlines and Cartesian receptors.

Non-Default Regulatory Option

The Division used non-default options in the control pathway. The "Flat & Elevated" non-default option was chosen to access the total deposition output. In the source pathway, particulate was selected for gas and particle deposition. Method 2 was selected for handling particle deposition by total particulate mass. Particle inputs for Method 2 consisted of the fine particle fraction equaling 0.75 and the mass mean particle diameter equaling 0.5 microns. These values were selected from Appendix B of the AERMOD Deposition Algorithms - Science Document (Revised Draft) found on EPA's Support Center for Regulatory Air Models (SCRAM) website at http://www.epa.gov/scram001/7thconf/aermod/aer_scid.pdf.

In order to reduce modeling analysis run times, the Division utilized a parallel processing version of Aermod 14134. To demonstrate equivalency between the single and multi-processor model runs, the Division has performed additional modeling of the AK Steel facility with 1 year of meteorological data (2009). The model aks-aer represents the single processor executable 14134 and model aks-pr represents the parallel processor executable MPI 14134. Table 8.0 provides the percent difference between the single and multi-processor receptor concentrations for the 20 highest impacts. To demonstrate equivalency, the Division utilized a two percent or less difference between the executable impact concentrations ($\mu g/m^3$) as mentioned in Section 3.2.2 (c) of Appendix W. In the aforementioned demonstration, the difference between the executable impact concentrations is not significant.

Table 8.0 Ranked Impact Concentrations (Month avg.) for Equivalency Demonstration

	Single Processor 14134 Executable _ aks-aer				**Parallel Processor 14134 Executable_aks-pr**				
Rank	**X**	**Y**	**Average Conc.**	**Date / Time**	**X**	**Y**	**Average Conc.**	**Date / Time**	**% Difference**
1st	355098.53	4261787.00	1.49068	09093024	355098.53	4261787.00	1.49068	09093024	0.00%
2nd	355081.10	4261733.15	1.22810	09093024	355081.10	4261733.15	1.22810	09093024	0.00%
3rd	355039.81	4261759.97	1.20663	09093024	355039.81	4261759.97	1.20663	09093024	0.00%
4th	355098.53	4261787.00	1.16015	09103124	355098.53	4261787.00	1.16015	09103124	0.00%
5th	355122.38	4261706.32	1.15856	09093024	355122.38	4261706.32	1.15856	09093024	0.00%
6th	355098.53	4261887.00	1.07932	09083124	355098.53	4261887.00	1.07932	09083124	0.00%
7th	354998.53	4261787.00	1.05674	09093024	354998.53	4261787.00	1.05674	09093024	0.00%
8th	354998.53	4261786.80	1.05611	09093024	354998.53	4261786.80	1.05611	09093024	0.00%
9th	355098.53	4261787.00	1.03940	09083124	355098.53	4261787.00	1.03940	09083124	0.00%
10th	355098.53	4261687.00	1.03147	09093024	355098.53	4261687.00	1.03147	09093024	0.00%
11th	355098.53	4261787.00	1.01542	09113024	355098.53	4261787.00	1.01542	09113024	0.00%
12th	355163.67	4261679.49	0.97687	09093024	355163.67	4261679.49	0.97687	09093024	0.00%
13th	355198.53	4261787.00	0.94658	09083124	355198.53	4261787.00	0.94658	09083124	0.00%
14th	355198.53	4261887.00	0.91798	09073124	355198.53	4261887.00	0.91798	09073124	0.00%
15th	355098.53	4261787.00	0.90390	09053124	355098.53	4261787.00	0.90390	09053124	0.00%
16th	355198.53	4261687.00	0.89461	09093024	355198.53	4261687.00	0.89461	09093024	0.00%
17th	355198.53	4261887.00	0.88145	09083124	355198.53	4261887.00	0.88145	09083124	0.00%
18th	355098.53	4261887.00	0.86132	09073124	355098.53	4261887.00	0.86132	09073124	0.00%
19th	355098.53	4261887.00	0.86044	09103124	355098.53	4261887.00	0.86044	09103124	0.00%
20th	354957.83	4261814.80	0.85636	09093024	354957.83	4261814.80	0.85636	09093024	0.00%

The concentration impact plots and receptor grid plot for the equivalency demonstration can be found in Appendix F.

Results

Using the parameters discussed above, the model demonstrations were completed and the resulting 3-month rolling average concentrations were compared to fifty percent of the NAAQS (0.075µg/m^3). The outcomes for each source group are tabulated in Table 9.0.

Table 9.0 Maximum 3-Month Rolling Average Concentrations

Group (All)	Number of Facilities in Group	One-half Lead NAAQS (µg/m3)	3-Month Rolling Average Concentration (µg/m3)	Exceed Lead Waiver Criteria
Calgon Carbon	3	0.075	1.23946	**Yes**
TVA Paradise	3	0.075	.009360	No
Enersys	2	0.075	.113923	**Yes**
KY Utilities - Ghent	3	0.075	.001957	No
TVA Shawnee	2	0.075	.095337	**Yes**

Upon review, the output concentrations from the models show that the maximum 3-month rolling averages for source groups TVA Paradise and Ghent are substantially below one-half the lead NAAQS. The predicted maximum 3-month rolling average concentrations for the source groups Calgon Carbon, Enersys and TVA Shawnee show a predicted impact above the lead waiver criteria.

In the Calgon Carbon source group, AK Steel was the driver of the 3-month rolling average with a predicted concentration of 1.23958µg/m^3. The predicted maximum concentration impact occurred on facility property. Sub-group (11aks-pb) was created and additional modeling was performed removing all receptors from within the facility boundary. At the property boundary, AK Steel exhibited a predicted impact concentration greater than fifty percent of the Lead NAAQS. The predicted maximum 3-month rolling average for Sub-group (11aks-pb) was .87937µg/m^3.

In the Enersys source group, Enersys was the driver of the 3-month rolling average with a predicted concentration of 0.113923µg/m^3. The predicted maximum concentration impact did not occur on facility property and additional modeling was not performed. Enersys exhibited a predicted impact concentration greater than fifty percent of the Lead NAAQS and is currently monitored for Pb emissions.

In the TVA Shawnee source group, CCMA was the driver of the 3-month rolling average with a predicted concentration of 0.095290/m^3. The predicted maximum concentration impact occurred on facility property. Sub-group (11shaw-fl) was created and additional modeling was performed removing all receptors from within the facility fence line. At the facility fence line, CCMA exhibited a predicted impact concentration less than fifty percent of the Lead NAAQS. The predicted maximum 3-month rolling average for Sub-group (11shaw-fl) was 0.0421467µg/m^3.

Tables containing the maximum impact monthly contributions and 3-month rolling average concentrations of the modeled source groups can be found in Appendix G.

Modeled Contour Plots

The contour plots resulting from the modeling demonstrations include high first high (H1H) monthly impact and the 3-month rolling average for the domain and SIA.

Contour plots of the five source groups modeled can be found in Appendix H.

Contour plots of the additional modeling impacts of the Calgon Carbon and TVA Shawnee source groups are provided in Appendix I.

Conclusion

As mentioned previously, modeling has demonstrated that a waiver for monitoring lead at Calgon Carbon, Kentucky Utilities – Ghent, Kentucky Power – Big Sandy, Blue Grass Army Depot, CC Metals & Alloy, Tennessee Valley Authority – Shawnee and Tennessee Valley Authority Paradise can be requested based upon a maximum 3-month rolling average below one-half the lead NAAQS. Enersys exhibited a predicted impact concentration greater than fifty percent of the lead NAAQS and is currently monitored for Pb emissions. Due to a predicted maximum 3-month rolling average above one-half the lead NAAQS at the AK Steel facility boundary, the Division recommends Pb monitoring in the proximity of maximum ambient air impact.

Additional Information

Data utilized in this document have been compiled for each facility and is available on the attached compact disc (DVD) labeled KY DAQ Lead Modeling Data 2015. The DVD file index can be found in Appendix J.

Appendices

Appendix A. Kentucky Facilities Modeled with Lead Emissions over 0.5TPY

Facility	County	State	Lead Emissions (tpy)	Data Source
AK Steel Corporation – West Works	Boyd	Kentucky	1.07	2011 TRI
Calgon Carbon Corporation	Boyd	Kentucky	1.12	2011 TRI
Kentucky Utilities Company – Ghent Generation Station	Carroll	Kentucky	.66	2011 KY EIS Actual Emissions
Kentucky Power Company – Big Sandy Plant	Lawrence	Kentucky	.64	2011 KY EIS Actual Emissions
Blue Grass Army Depot	Madison	Kentucky	.57	2009 KY EIS Actual Emissions
Enersys Incorporated	Madison	Kentucky	1.57	2011 KY EIS Actual Emissions
CC Metals & Alloys LLC	Marshall	Kentucky	.63	2010 KY EIS Actual Emissions
Tennessee Valley Authority (TVA) Shawnee Fossil Plant	McCracken	Kentucky	4.61	2011 KY EIS Actual Emissions
Tennessee Valley Authority (TVA) Paradise Fossil Plant	Muhlenburg	Kentucky	1.28	2010 KY EIS Actual Emissions

Appendix B. Facilities Modeled as Nearby Sources

Facility	County	State	Lead Emissions (tpy)	Data Source
North American Stainless	Carroll	Kentucky	.08163	2012 KY EIS Actual Emissions
Aleris Recycling Inc.	Butler	Kentucky	.0065	2011 TRI
Gallatin Steel Co.	Gallatin	Kentucky	.05978	2011 KY EIS Actual Emissions
Kentucky Utilities Co. - Green River Station	Muhlenburg	Kentucky	.03774	2013 KY EIS Actual Emissions

Appendix C. Source Group Lead Emissions Parameters

1a. Source Group 11cal

Facility	X Coord. [m]	Y Coord. [m]	Base Elevation [m]	Release Height [m]	Emission Rate [g/s]	Gas Exit Temperature [K]	Gas Exit Velocity [m/s]	Inside Diameter [m]	Description
Calgon Carbon	360962.20	4244570.72	168.29	29.87	.03212946	435.93	23.5123	.8534	Reactivation Furnace
AK Steel Corp. – West Works	354786.32	4262128.33	166.65	27.13	0.002242006	408.15	17.0688	5.4864	BO Shop
	354770.10	4262282.03	166.56	47.85	0.00013403	343.15	28.956	2.1946	BO Shop Blowing 1
	354814.51	4262222.39	166.67	47.85	0.00012046	343.15	28.956	2.1946	BO Shop Blowing 2
	354939.04	4262152.02	166.84	28.96	1.13571E-05	533.15	19.2634	2.2342	#13 Boiler
	354108.69	4262820.91	164.86	24.08	6.66236E-06	533.15	14.1427	2.4384	#5 Boiler
	354118.16	4262810.44	164.93	24.08	7.76413E-06	533.15	14.1427	2.4384	#6 Boiler
	354127.58	4262799.98	164.94	24.08	3.07114E-05	533.15	14.1427	2.4384	#7 Boiler
	354223.73	4262638.77	165.49	27.43	.001043				Amanda Cast House

	354968.35	4261884.57	166.69	6.096	.009042				BO Slag Processing
	354840.08	4262206.98	166.74	32	.01619				BO Shop Egress
Kentucky Power Co. – Big Sandy Plant	358228.42	4226040.50	172.24	250.9	.018435947	430.93	29.8704	8.5954	Indirect Heat Exchanger

1b. Source Group 11cal, Sub-group 11aks

Facility AK Steel Corp. – West Works	X Coord. [m]	Y Coord. [m]	Base Elevation [m]	Release Height [m]	Emission Rate [g/s]	Gas Exit Temperature [K]	Gas Exit Velocity [m/s]	Inside Diameter [m]	Description
boshop	354786.32	4262128.33	166.65	27.13	0.002242006	408.15	17.0688	5.4864	BO Shop
	354770.10	4262282.03	166.56	47.85	0.00013403	343.15	28.956	2.1946	BO Shop Blowing 1
	354814.51	4262222.39	166.67	47.85	0.00012046	343.15	28.956	2.1946	BO Shop Blowing 2
	354840.08	4262206.98	166.74	32	.01619				BO Shop Egress
boilers	354939.04	4262152.02	166.84	28.96	1.13571E-05	533.15	19.2634	2.2342	#13 Boiler
	354108.69	4262820.91	164.86	24.08	6.66236E-06	533.15	14.1427	2.4384	#5 Boiler
	354118.16	4262810.44	164.93	24.08	7.76413E-06	533.15	14.1427	2.4384	#6 Boiler
	354127.58	4262799.98	164.94	24.08	3.07114E-05	533.15	14.1427	2.4384	#7 Boiler
amandaca	354223.73	4262638.77	165.49	27.43	.001043				Amanda Cast House
boslangp	354968.35	4261884.57	166.69	6.096	.009042				BO Slag Processing

2. Source Group 10para

Facility	X Coord. [m]	Y Coord. [m]	Base Elevation [m]	Release Height [m]	Emission Rate [g/s]	Gas Exit Temperature [K]	Gas Exit Velocity [m/s]	Inside Diameter [m]	Description
Tennessee Valley Authority – Paradise Fossil Plant	501894.78	4123820.84	122	182.9	0.014324321	324.82	22.1285	7.9248	Stack 1
	501687.98	4123696.11	122	182.9	0.007052269	328.71	15.3741	11.278	Stack 3
	501855.36	4123771.48	122	182.9	0.015129331	324.82	22.1285	7.9248	Stack 2
Aleris Recycling Inc.	524590.40	4117667.92	152.19	9.144	0.002746754	294.26	10.9728	0.9144	Salt Cake Cooling Plant
	525336.74	4116985.90	152.6	0.305	.0005587				Landfill
Kentucky Utilities Co. – Green River Station	489188.50	4135190.73	122.19	60.05	0.000493169	422.04	18.8976	3.4138	COMB003
	489229.51	4135189.46	121.06	75.29	0.000592626	422.04	28.4074	3.048	COMB004

3. Source Group 11ener

Facility	X Coord. [m]	Y Coord. [m]	Base Elevation [m]	Release Height [m]	Emission Rate [g/s]	Gas Exit Temperature [K]	Gas Exit Velocity [m/s]	Inside Diameter [m]	Description
Blue Grass Army Depot	746119.24	4172291.04	284.13	112.5	.0164				OB/OD
Enersys Incorporated	738497.46	4179831.584	303.63	18.288	0.0105	319.26	19.895	1.3462	Grid Casting Baghouse
	738627.2167	4179734.602	301.59	18.288	0.012	303.71	21.72	1.3716	Assembly & Small Parts Baghouse
	738629.0468	4179740.188	301.55	18.288	0.012	300.93	21.978	1.4224	Plate Finishing Baghouse
	738493.1301	4179801.205	304.21	18.288	0.00252	300.93	18.4	1.143	Ironclad Filling Baghouse
	738530.0939	4179820.852	304.23	18.288	0.001108781	367.59	19.959	0.3556	Oxide Mill Baghouse #1
	738522.4709	4179823.45	304.17	18.288	0.000378	370.93	9.107	0.381	Oxide Mill Baghouse #2
	738629.7833	4179750.961	301.82	18.288	0.00353	299.82	19.596	0.9906	Assembly Baghouse
	738628.43	4179759.633	302.11	4.8768	0.000252	356.48	18.474	0.2794	Central Vacuum System
	738502.22	4179829.95	303.62	18.288	0.016	316.48	17.076	1.524	Pasting Baghouse

Enersys Incorporated	738508.03	4179826.79	303.83	14.3256	0.000378	359.82	0.001	0.508	Oxide Mill Baghouse #3
	738345.42	4179854.17	306.18	12.192	0.000126	307.59	13.04	0.254	Distribution Center Casting
	738343.35	4179850.27	306.34	12.192	0.000126	304.26	11.177	0.254	Distribution Center Casting
	738595.37	4179826.60	304.34	18.288	0.00392	319.26	21.56	0.9144	Grid Casting Baghouse
	738549.05	4179681.77	303.2	12.192	0.0000252	299.82	3.726	0.254	Cable Mfg. Flux Operation (Lead Pot)
	738528.03	4179828.46	304.31	17.3736	0.000277195	299.82	9.62	0.5588	Oxide Roof Exhaust HV-1
	738526.65	4179823.03	304.25	17.3736	0.000277195	299.82	9.62	0.5588	Oxide Roof Exhaust HV-2
	738514.39	4179828.69	303.98	17.3736	0.000277195	299.82	9.62	0.5588	Oxide Roof Exhaust HV-3
	738516.07	4179833.77	304.02	17.3736	0.000277195	299.82	9.62	0.5588	Oxide Roof Exhaust HV-4
	738517.54	4179839.30	304.07	17.3736	0.000277195	299.82	9.62	0.5588	Oxide Roof Exhaust HV-5

4. Source Group 11ghent

Facility	X Coord. [m]	Y Coord. [m]	Base Elevation [m]	Release Height [m]	Emission Rate [g/s]	Gas Exit Temperature [K]	Gas Exit Velocity [m/s]	Inside Diameter [m]	Description
Gallatin Steel	673971.34	4291852.90	143.07	27.1272	0.00171949	355.37	125.8824	2.98704	Melt shop
Kentucky Utilities Company – Ghent Generation Station	670783.44	4290834.18	147.91	176.8	0.0096524	324.82	7.0104	11.278	Units 1
	670555.83	4290714.92	147.77	201.2	0.007008	422.04	14.539	9.144	Units 2 and 3
	670328.40	4290544.30	148.75	201.2	0.001245	422.04	15.2705	9.144	Unit 4
North American Stainless	666721.40	4287631.69	148.48	65	0.001132	353	28.7396	4.572	EAF #2
	666782.95	4287555.60	147.53	65	0.000849	408	19.4706	4.572	AOD #1
	666530.10	4287820.00	145.45	50	4.36394E-06	477.59	4.02336	1.9995	Reheat Furnace
	667011.87	4288299.47	144.41	29.87	1.01086E-05	477.59	10.2413	0.9144	Anneal Furnace #1
	666758.13	4287592.00	147.57	65	0.000351	392.67	14.3165	4.572	EAF #1
	666797.10	4287511.86	147.53	64.92	1.09256E-06	408.15	19.4767	4.572	AOD #2
	667041.06	4288324.41	144.54	29.87	4.48124E-06	477.59	10.2413	0.9144	Anneal Furnace #2

5. Source Group 11shaw and Sub-group 11shaw-fl

Facility	X Coord. [m]	Y Coord. [m]	Base Elevation [m]	Release Height [m]	Emission Rate [g/s]	Gas Exit Temperature [K]	Gas Exit Velocity [m/s]	Inside Diameter [m]	Description
Tennessee Valley Authority - Shawnee Fossil Plant	342377.91	4113168.19	104.52	243.8	0.066371614	429.82	29.428	8.534	Units 1-5
	342055.53	4113371.15	104.27	243.8	0.066371614	422.04	29.632	8.53	Units 6-10
CC Metals & Alloys LLC	380141.25	4101942.92	105.04	27.55	0.001028872	338.70556	0.89611	7.4798	#6 APC-1
	380134.68	4101943.41	105.03	27.55	0.001028872	338.70556	0.89611	7.4798	#6 APC-2
	380147.20	4101942.85	105.05	27.55	0.001028872	338.70556	0.89611	7.4798	#6 APC-3
	380159.75	4101941.77	105.09	27.55	0.001028872	338.70556	0.89611	7.4798	# 6 APC-4
	380153.86	4101942.06	105.06	27.55	0.001028872	338.70556	0.89611	7.4798	#6 APC -5
	380166.09	4101941.22	105.11	27.55	0.001028872	338.70556	0.89611	7.4798	#6 APC -6
	380184.24	4102110.39	103.61	27.81	0.000992345	338.70556	1.5179	7.4798	15/16-1
	380184.48	4102115.78	103.55	27.81	0.000992863	338.71	1.5179	7.4798	15/16-2
	380184.00	4102105.36	103.67	27.81	0.000992863	338.71	1.5179	7.4798	15/16-3
	380202.70	4102109.07	103.62	27.81	0.000992863	338.71	1.5179	7.4798	15/16-4
	380203.18	4102114.35	103.56	27.81	0.000992863	338.71	1.5179	7.4798	15/16-5
	380202.46	4102103.80	103.68	27.81	0.000992863	338.71	1.5179	7.4798	15/16-6
	380221.87	4102107.40	103.69	27.81	0.000992863	338.71	1.5179	7.4798	15/16-7
	380222.23	4102112.55	103.6	27.81	0.000992863	338.71	1.5179	7.4798	15/16-8
	380221.52	4102102.24	103.78	27.81	0.000992863	338.71	1.5179	7.4798	15/16-9
	380241.05	4102105.84	103.71	27.81	0.000992863	338.71	1.5179	7.4798	15/16-10
	380241.17	4102110.99	103.6	27.81	0.000992863	338.71	1.5179	7.4798	15/16-11
	380240.81	4102100.80	103.81	27.81	0.000992863	338.71	1.5179	7.4798	15/16-12

Appendix D. 50km Source Group Radial Plot

Figure 1.0 Calgon Carbon Group

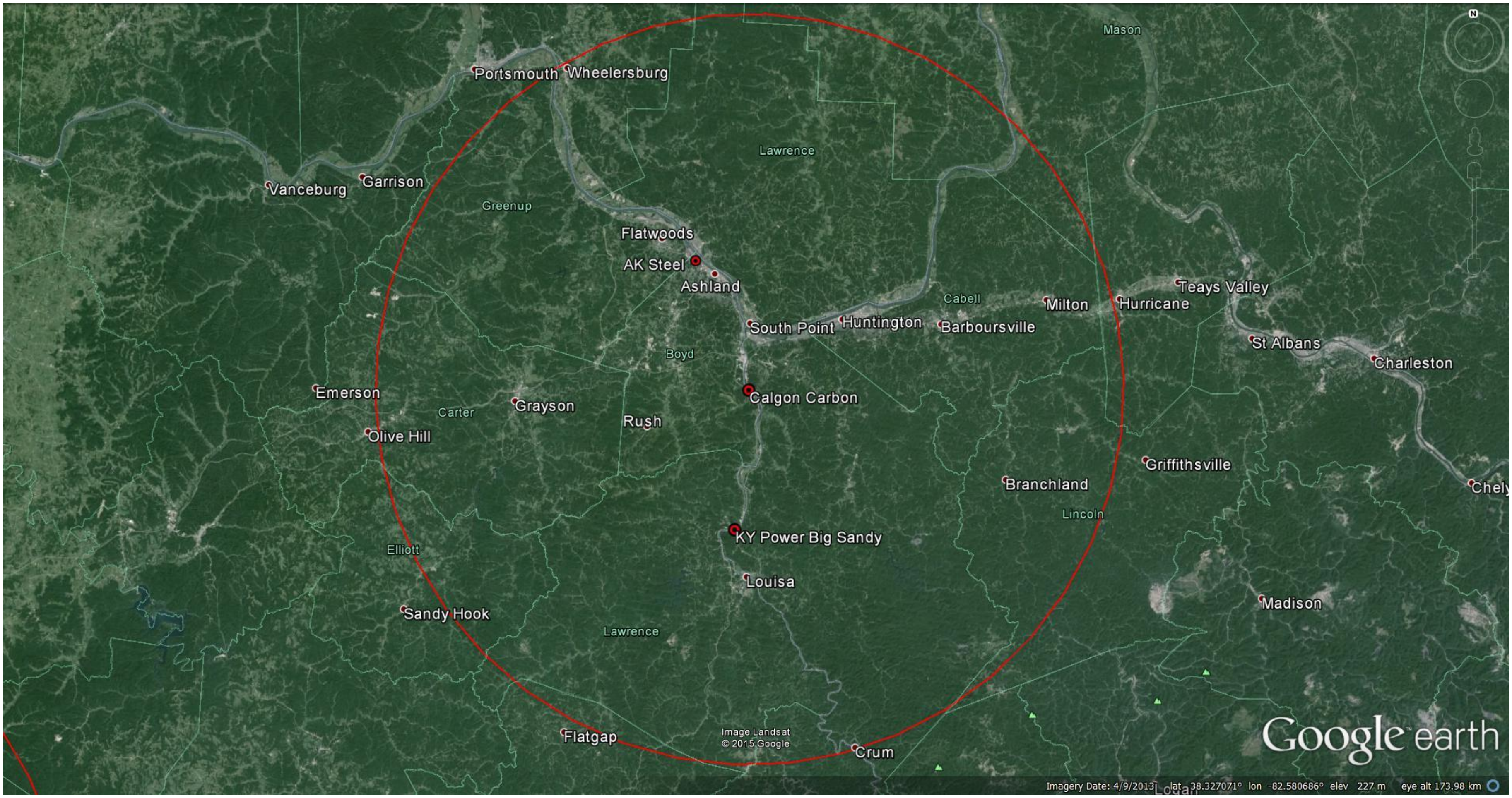


Figure 2.0 Tennessee Valley Authority– Paradise Fossil Plant Group

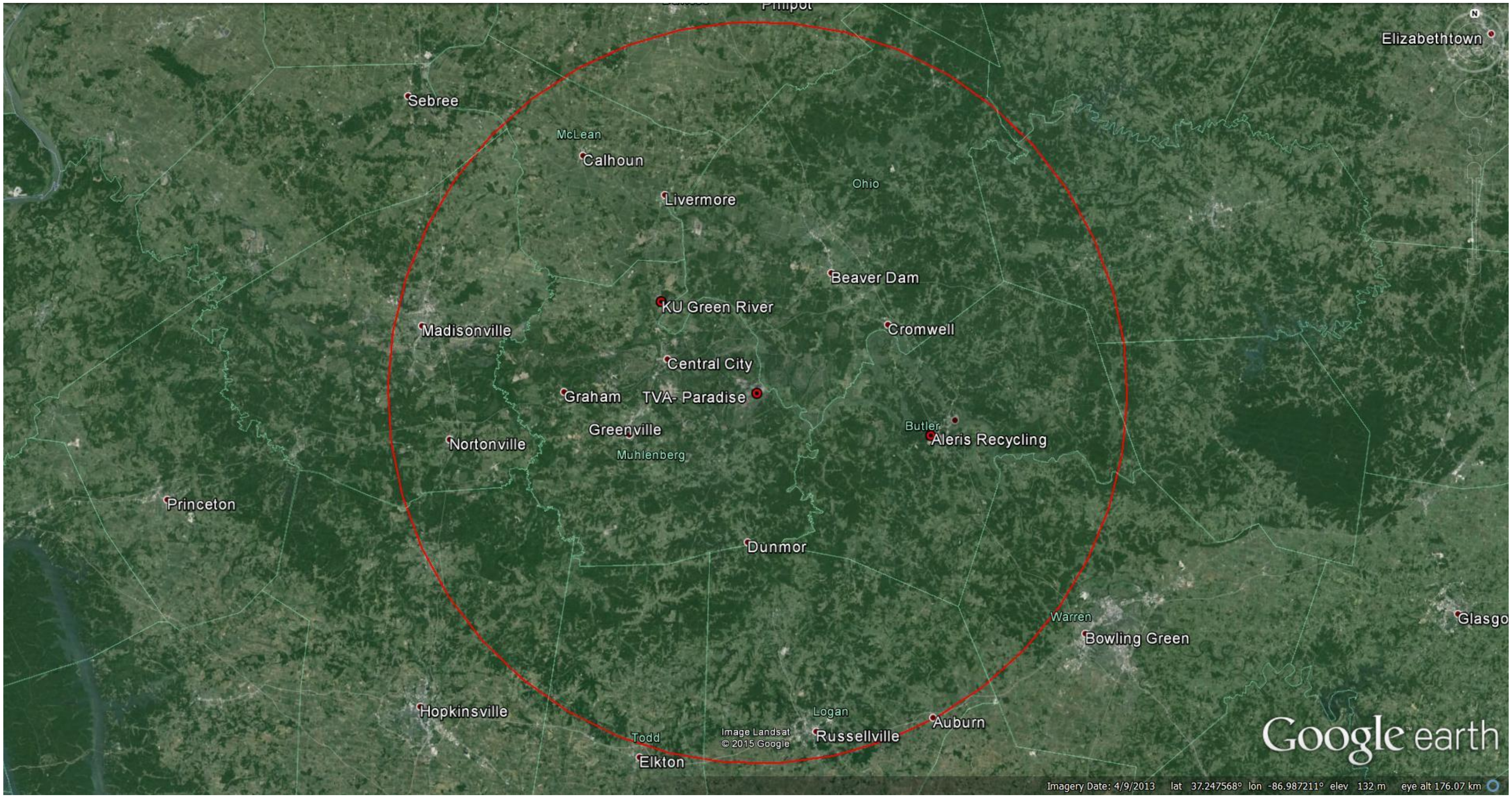


Figure 3.0 Enersys Incorporated Group

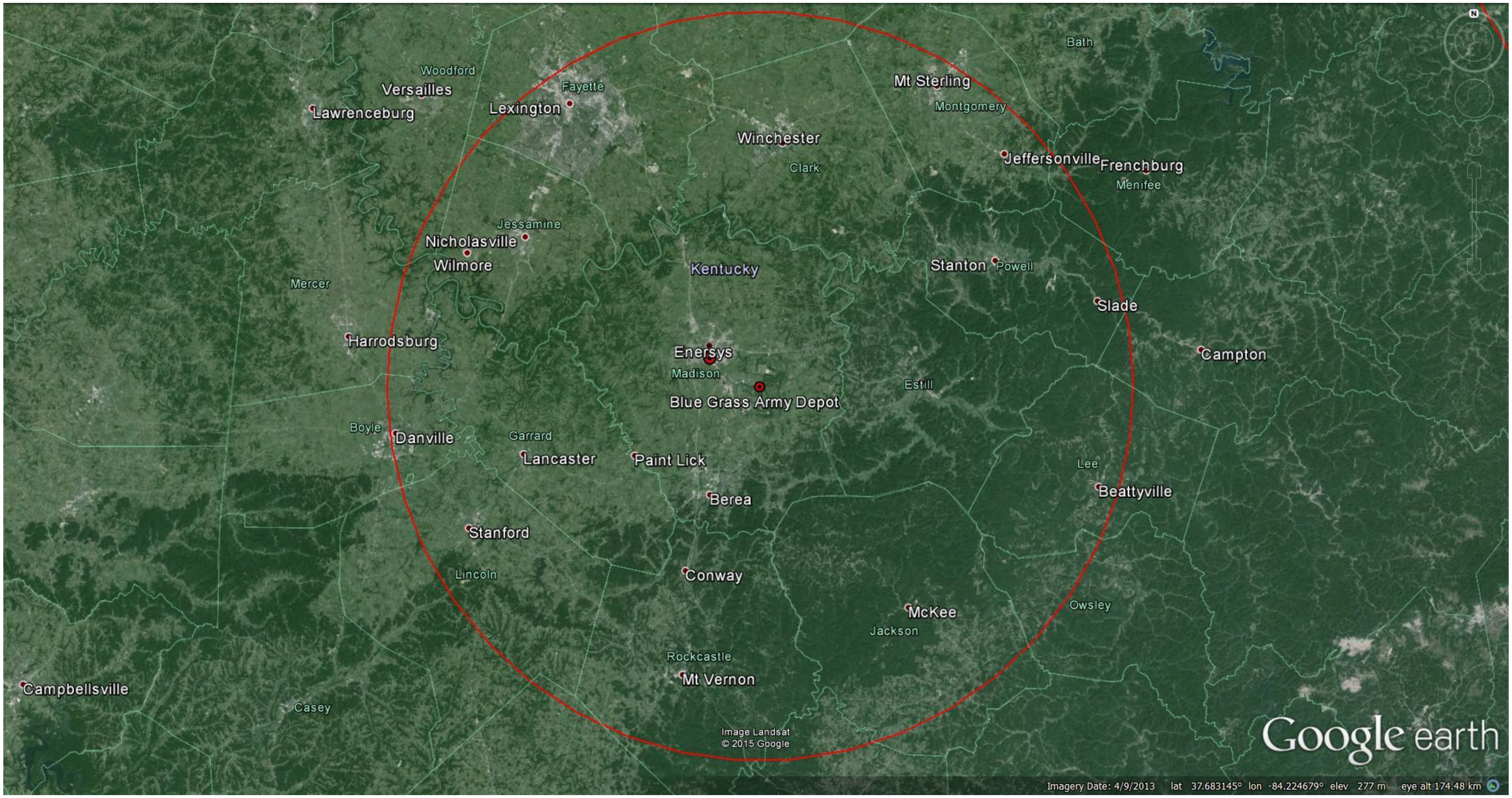


Figure 4.0 Kentucky Utilities Company – Ghent Generation Station Group

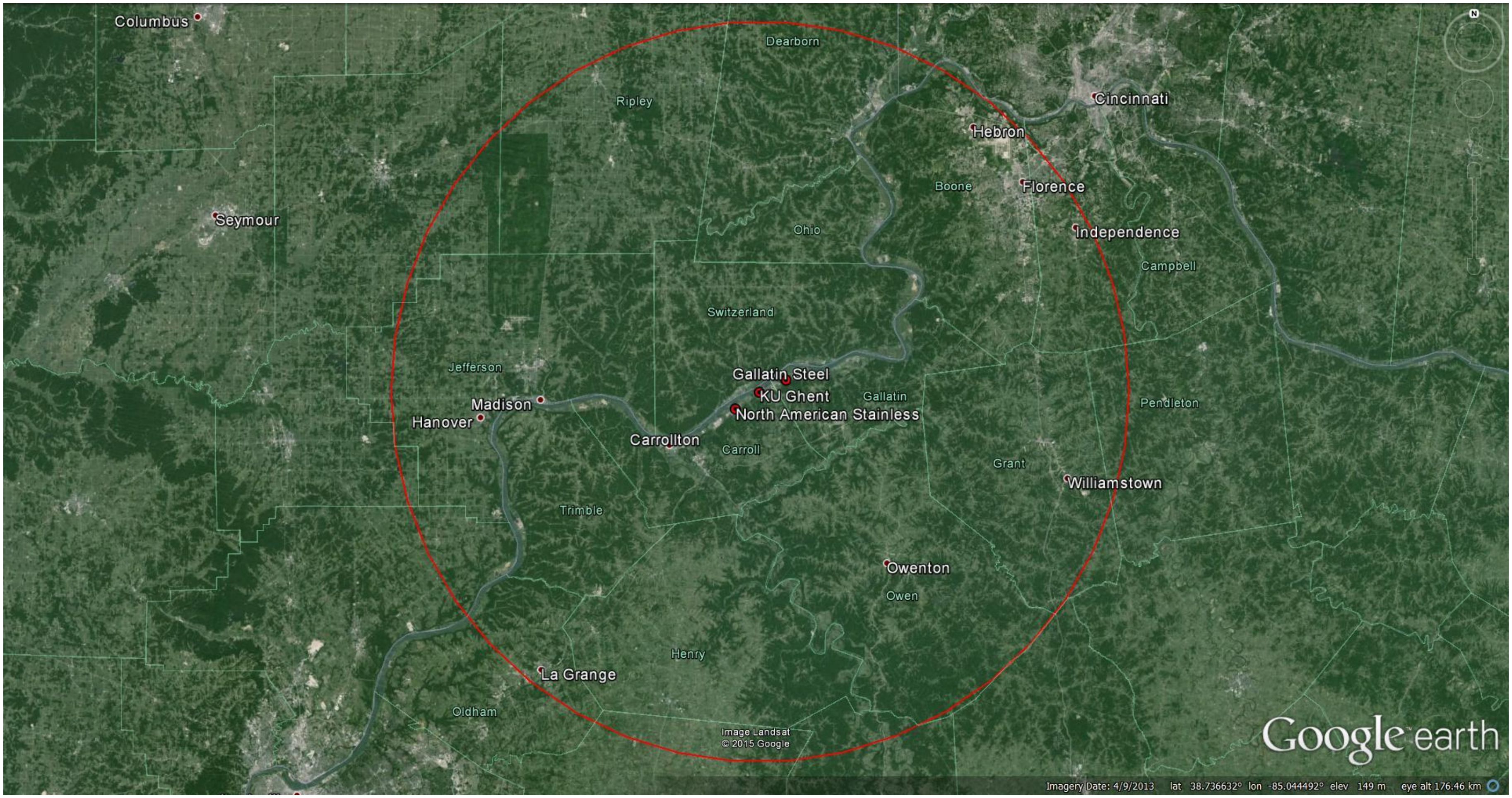
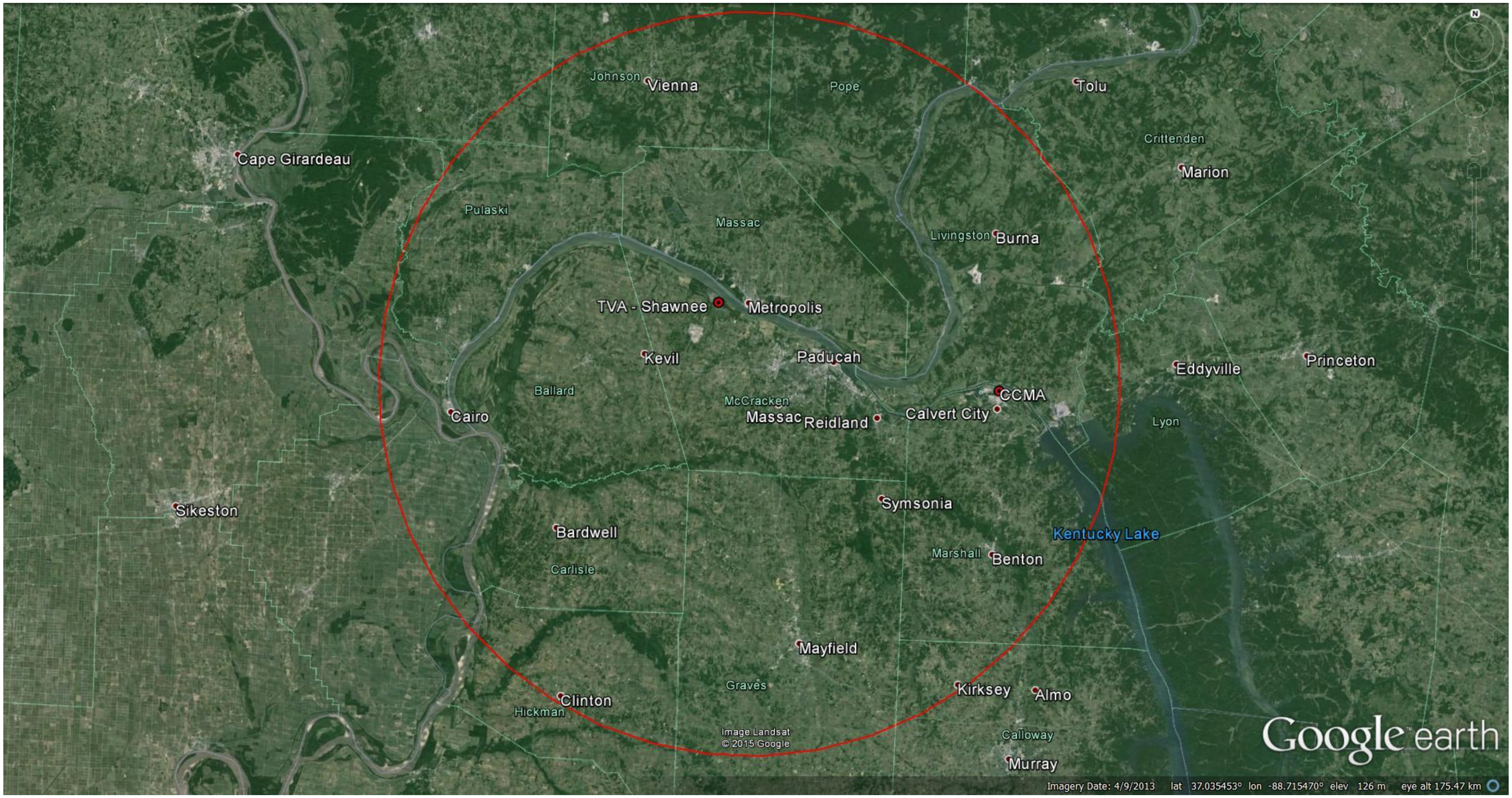


Figure 5.0 Tennessee Valley Authority - Shawnee Fossil Plant Group



Appendix E. Receptor Domain

Figure1.0 Calgon Carbon Group

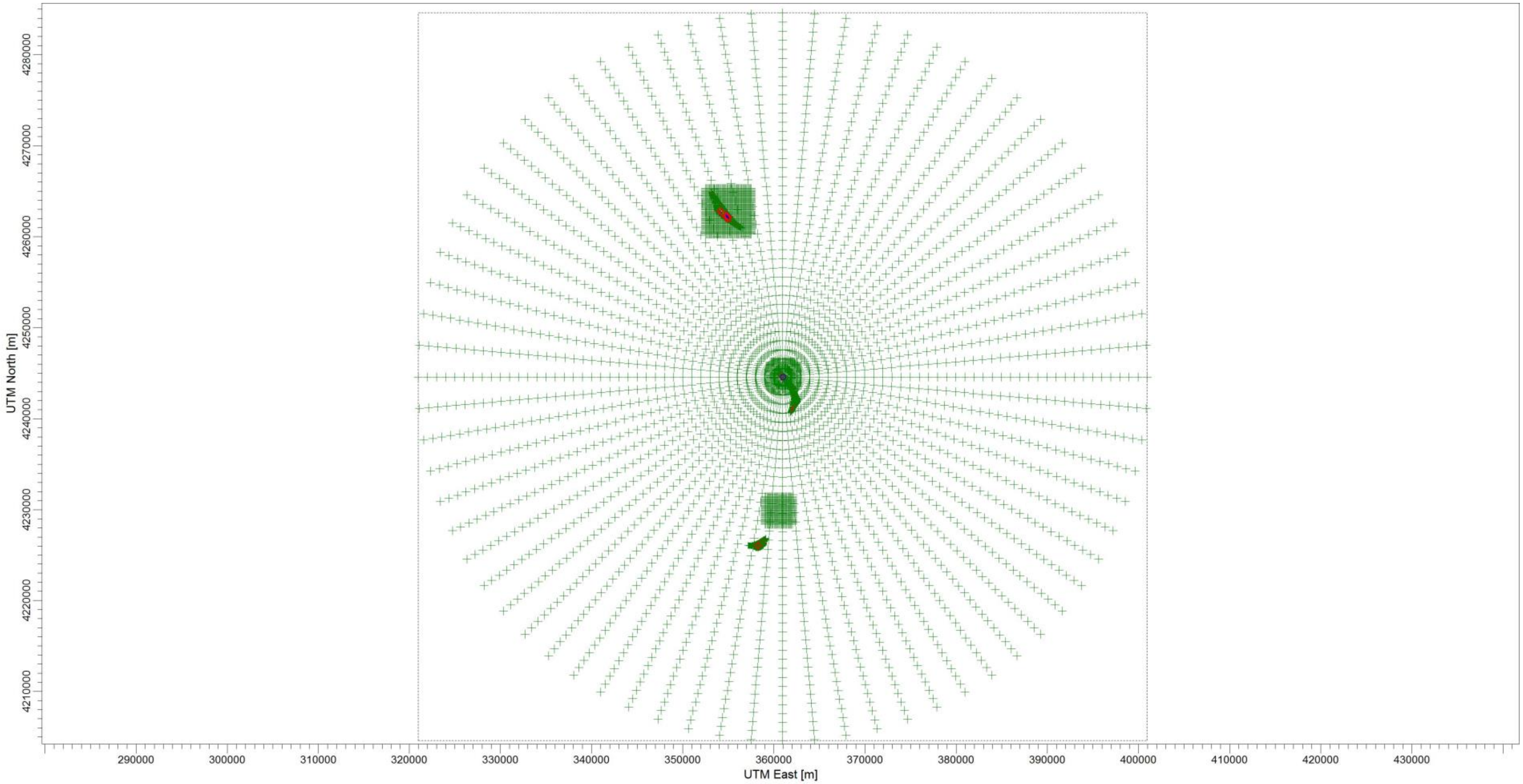


Figure1.1 Calgon Carbon Group – AK Steel (Plant Boundary)

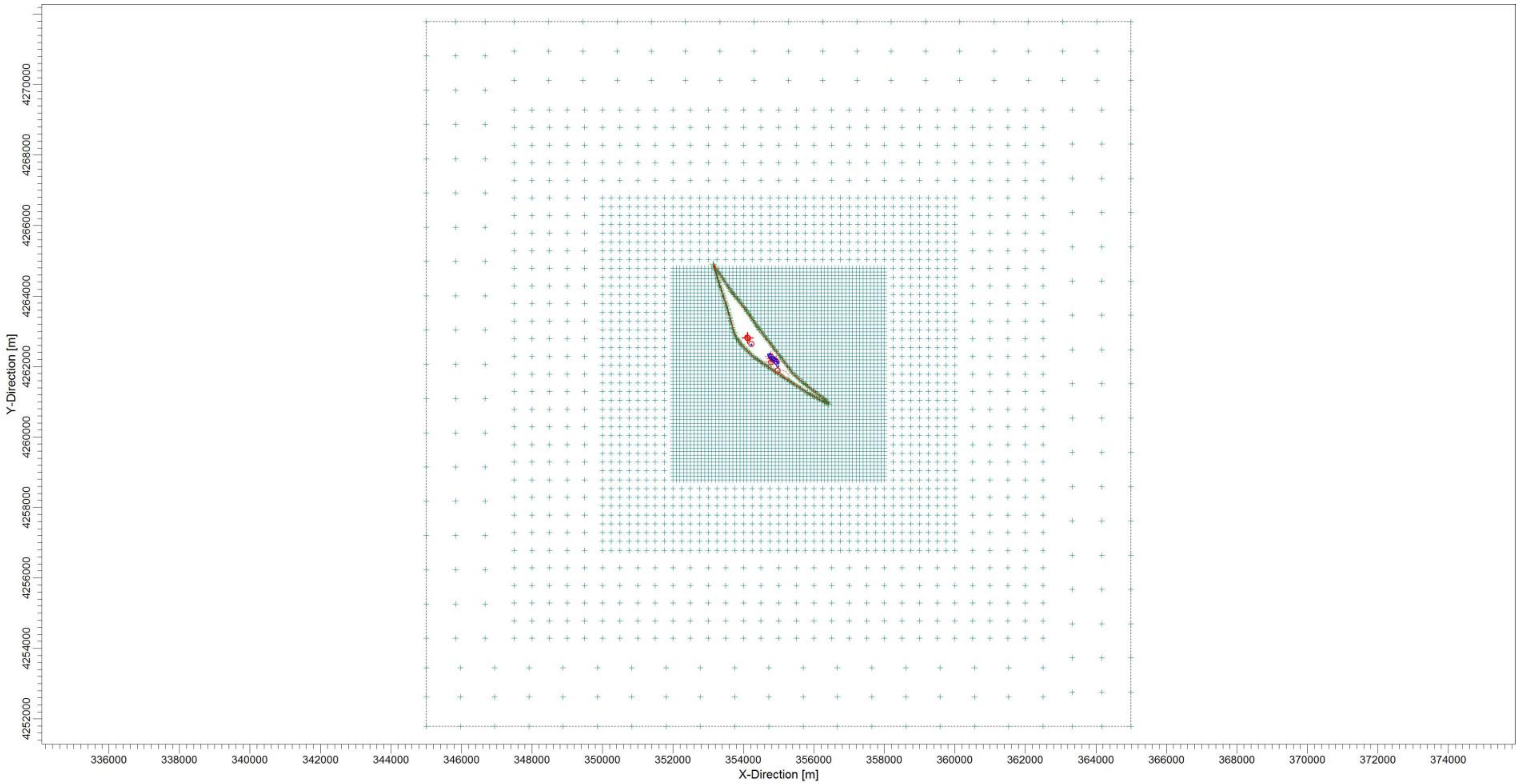


Figure 2.0 Tennessee Valley Authority – Paradise Fossil Plant Group

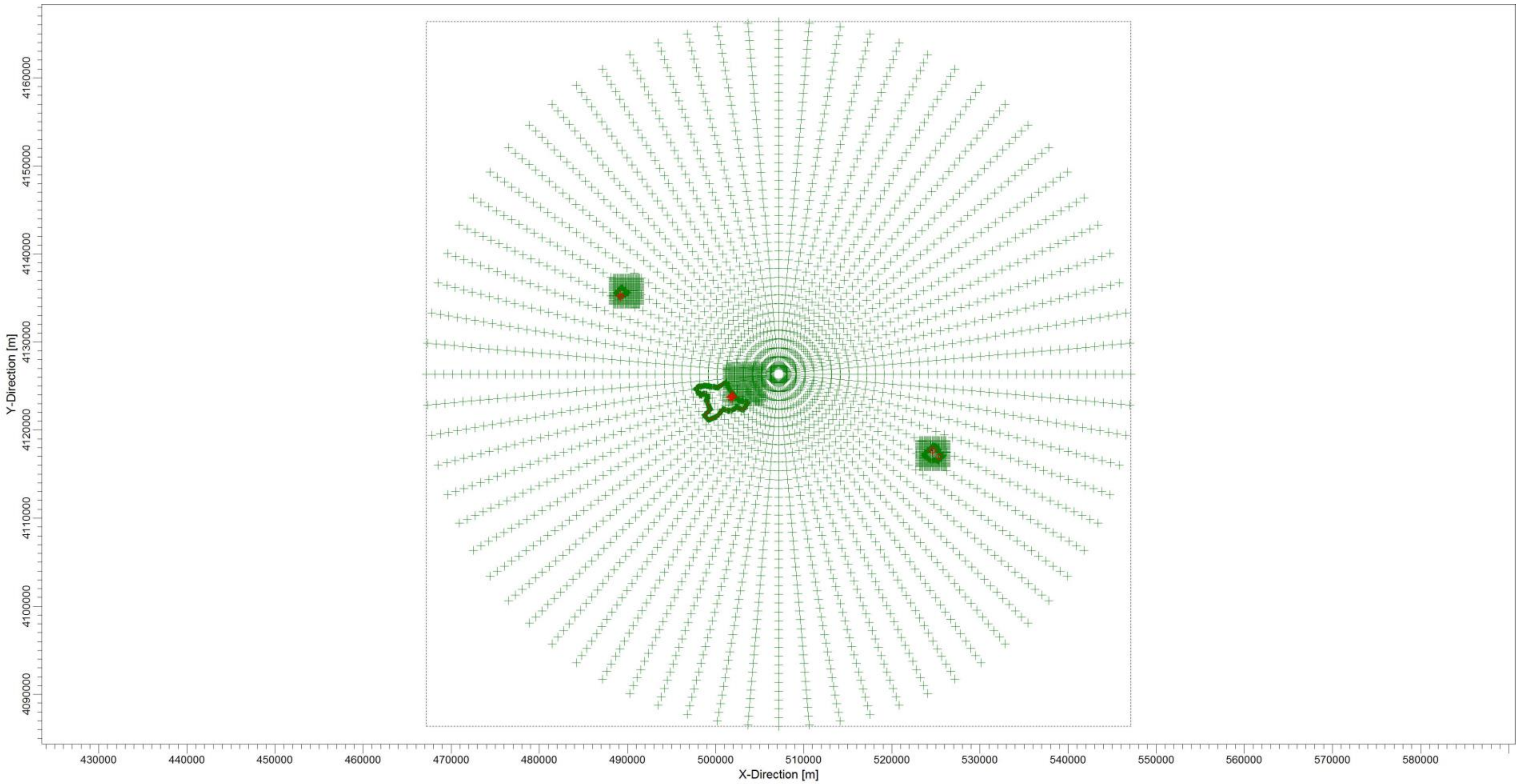


Figure 3.0 Enersys Incorporated Group

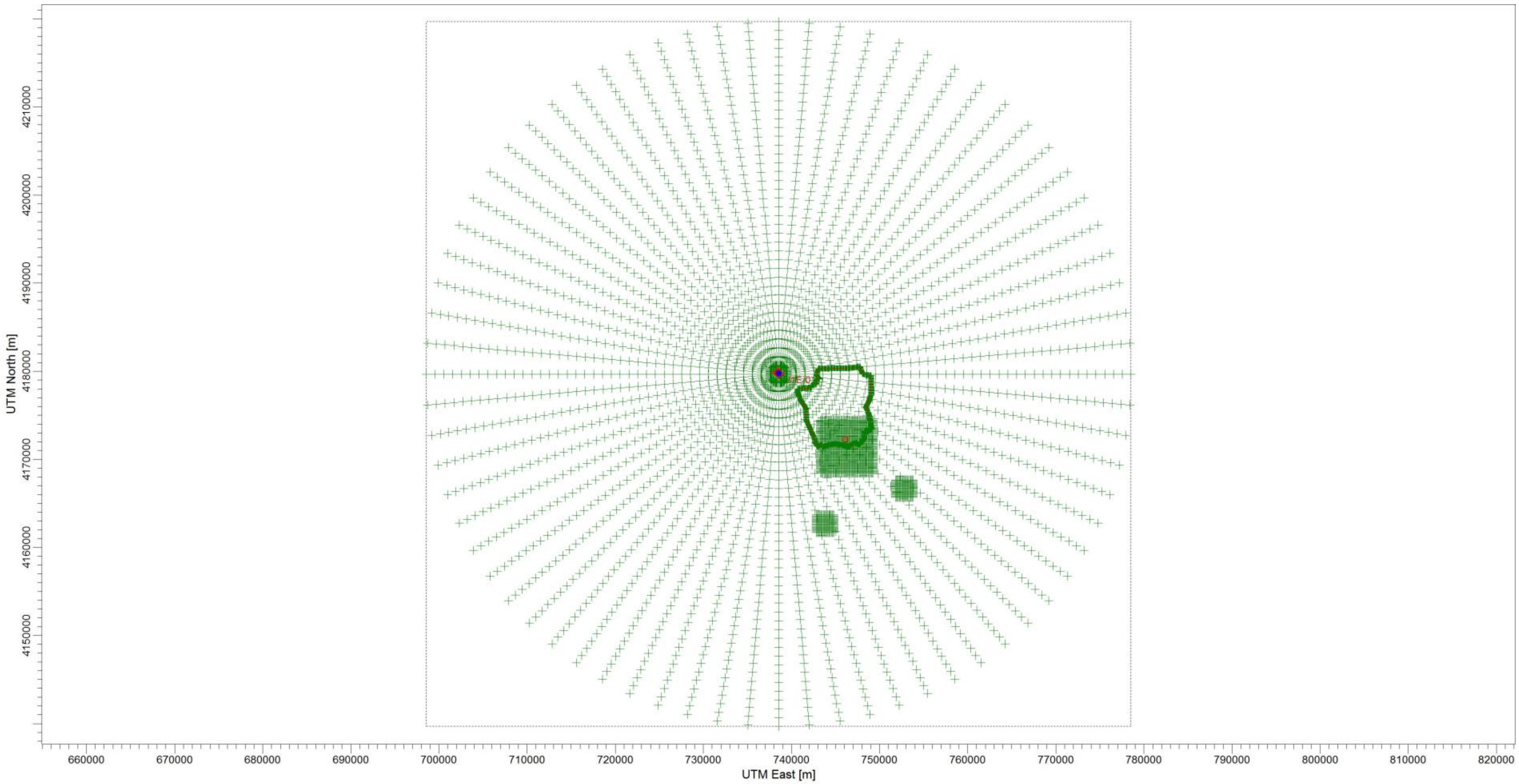


Figure 4.0 Kentucky Utilities Company – Ghent Generation Station Group

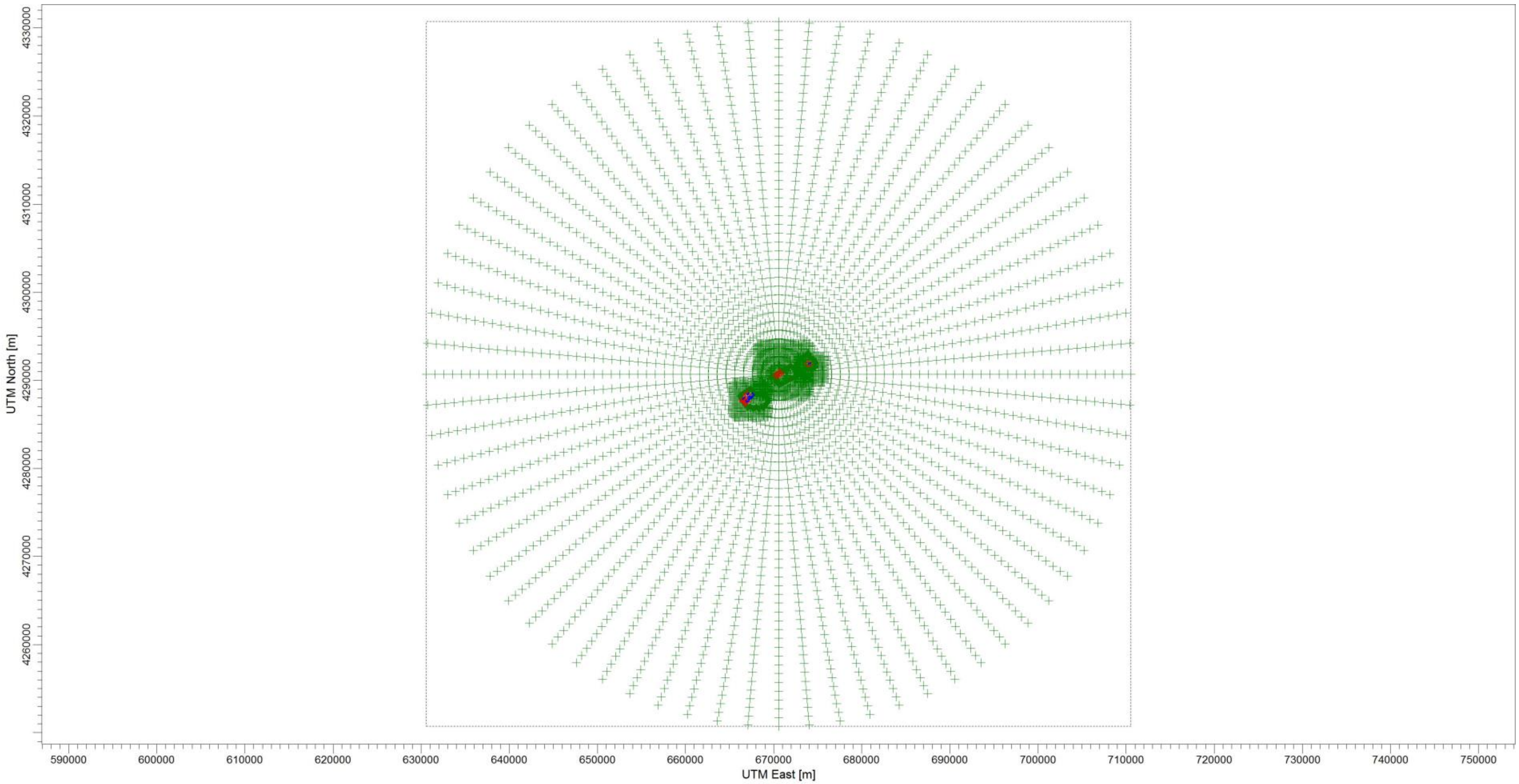


Figure 5.0 Tennessee Valley Authority - Shawnee Fossil Plant Group

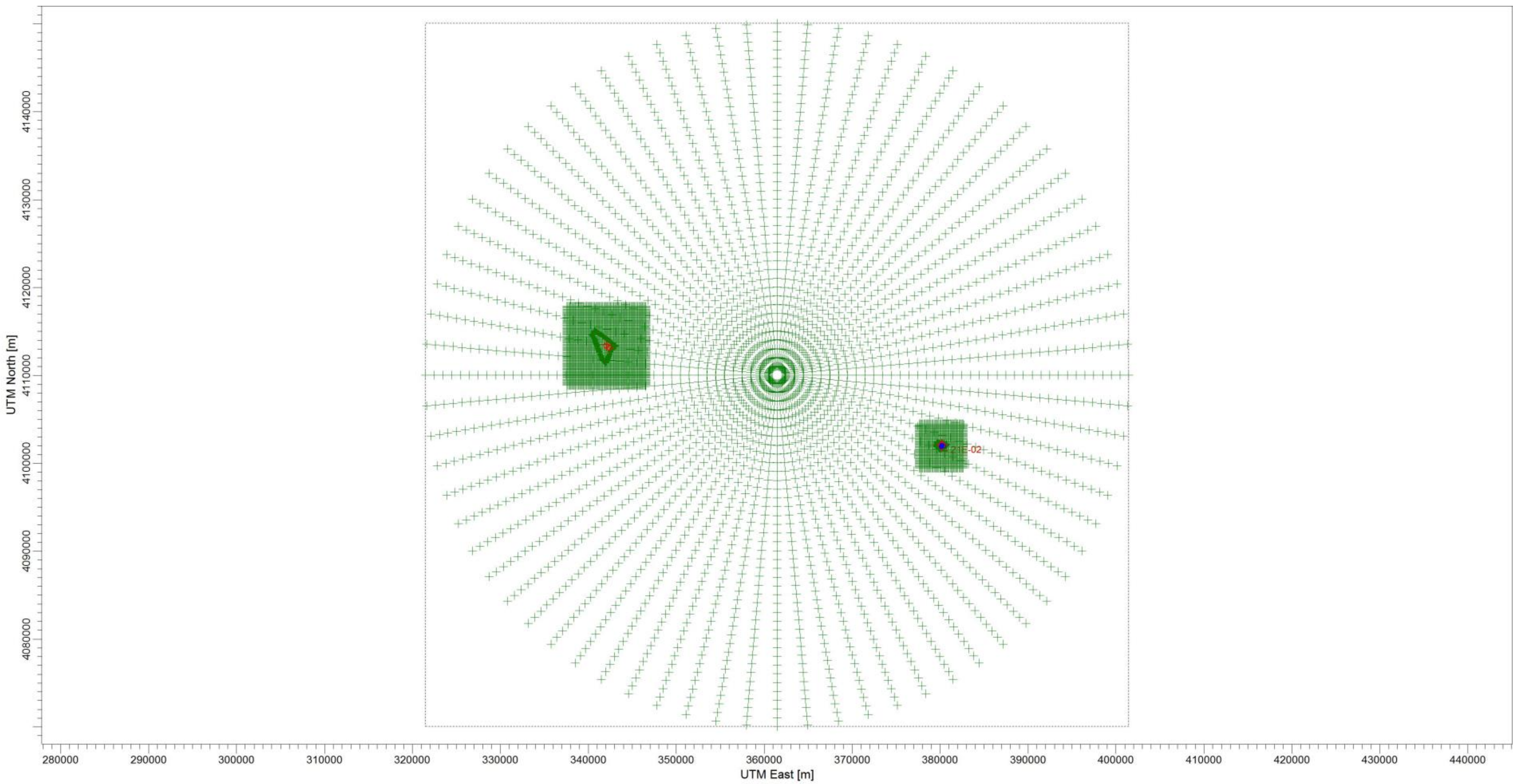
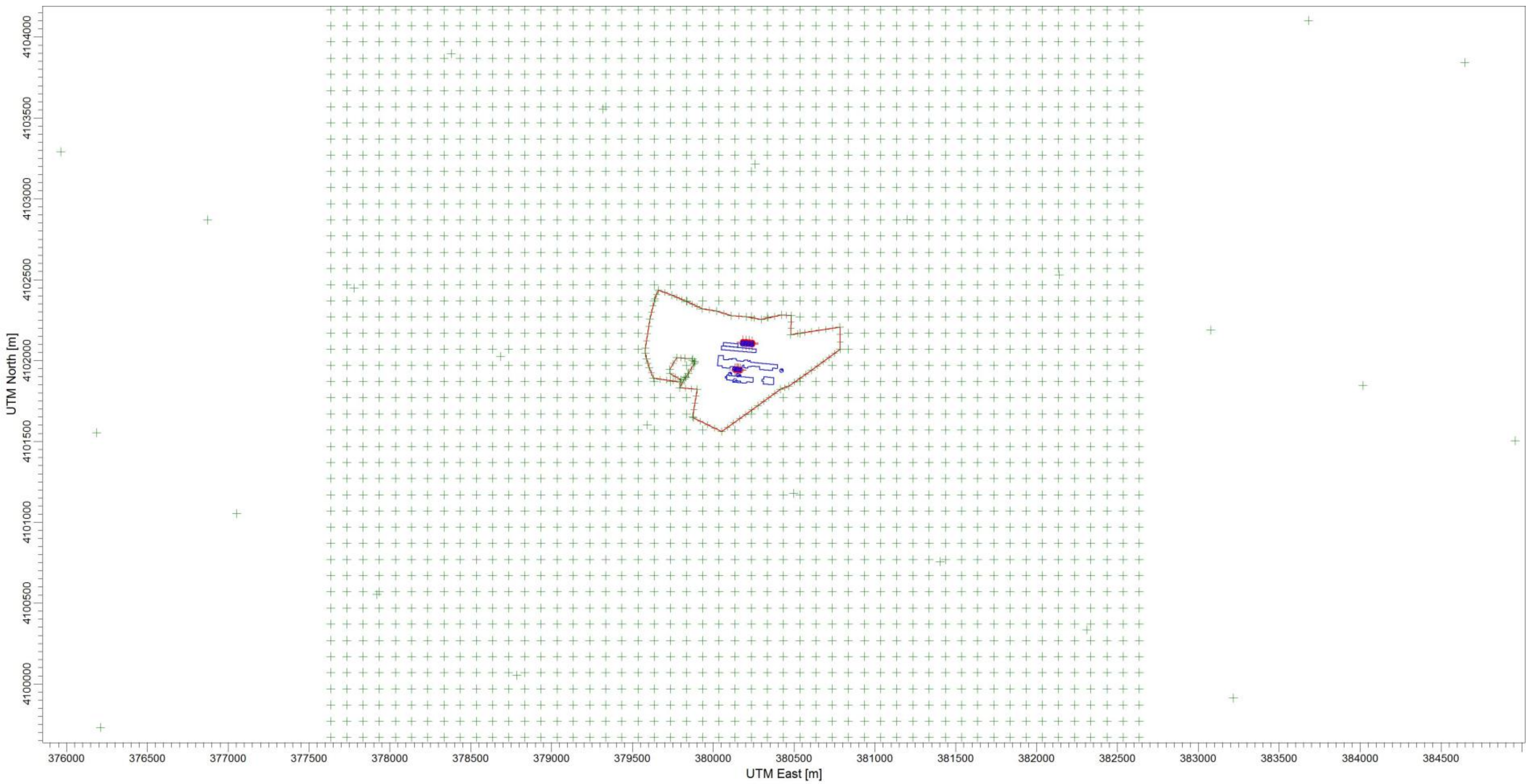


Figure 5.1 Tennessee Valley Authority – Shawnee Fossil Plant Group, CCMA (Fence Line)



Appendix F. Equivalency Demonstration

Figure 1.0 Calgon Carbon Group – AK Steel (Equivalency Demonstration) Receptor Grid

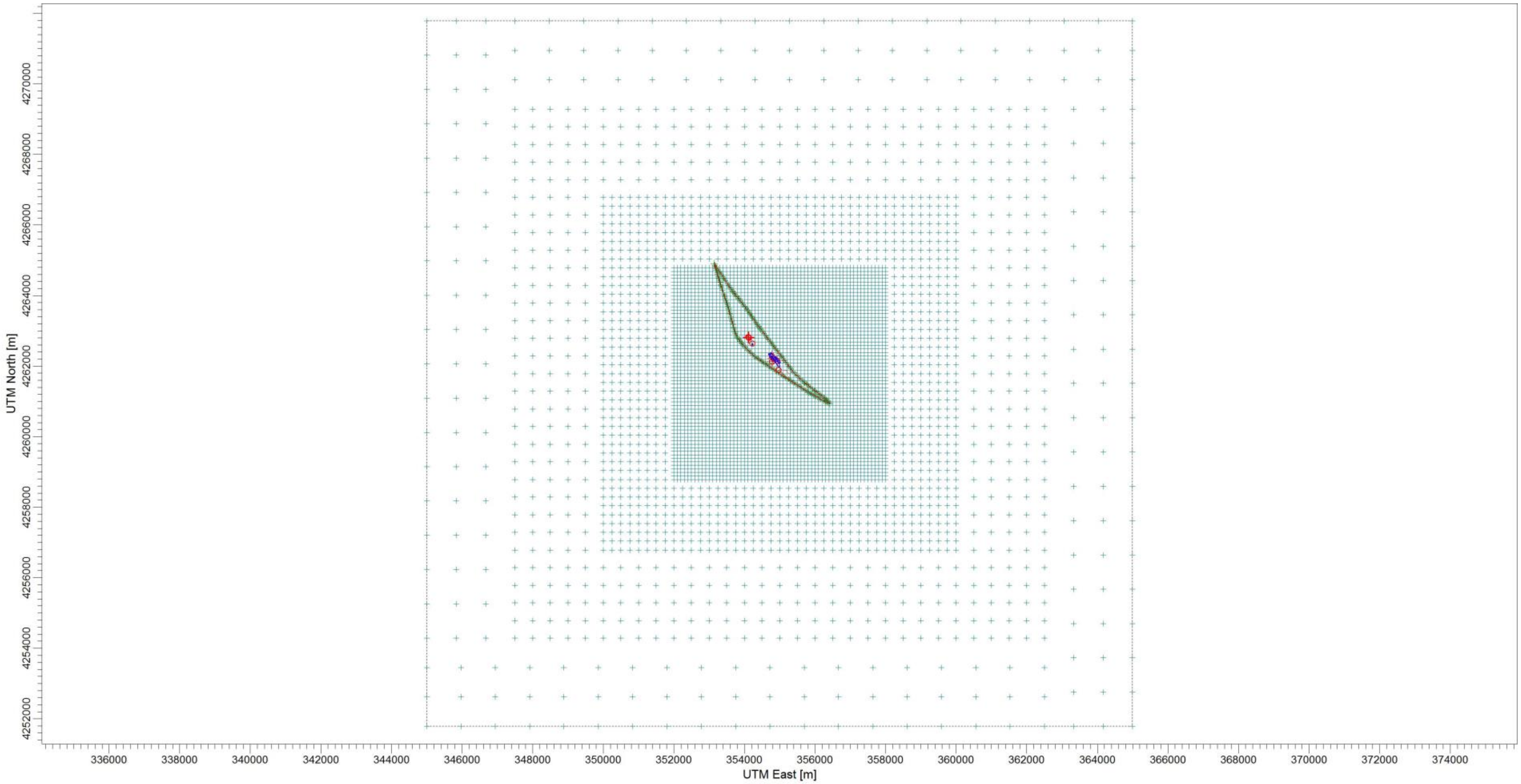


Figure 2.0 AK Steel_aer - High 1st High Monthly Average Concentration, Domain

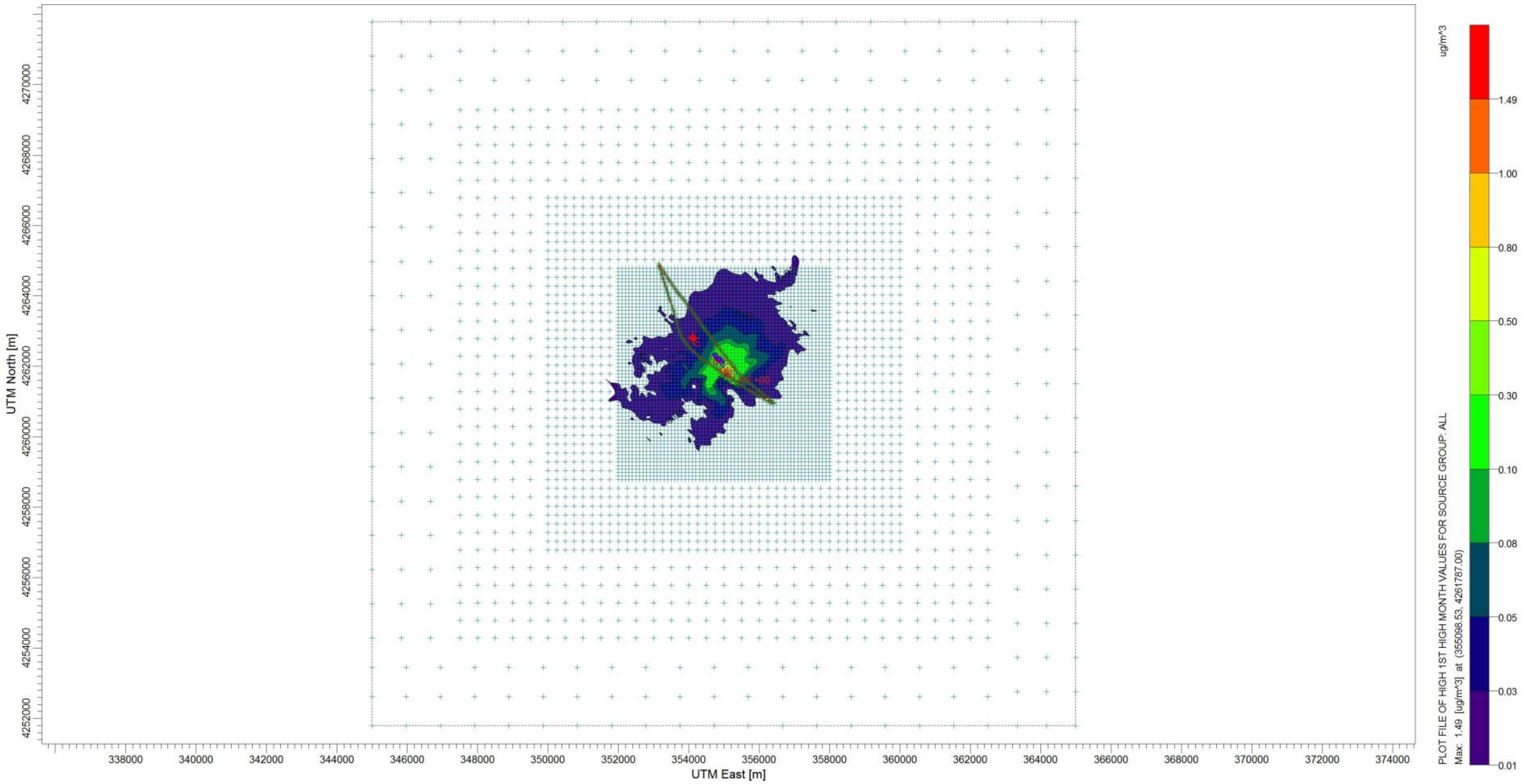


Figure 2.1 AK Steel_aer - High 1st High Monthly Average Concentration, SIA

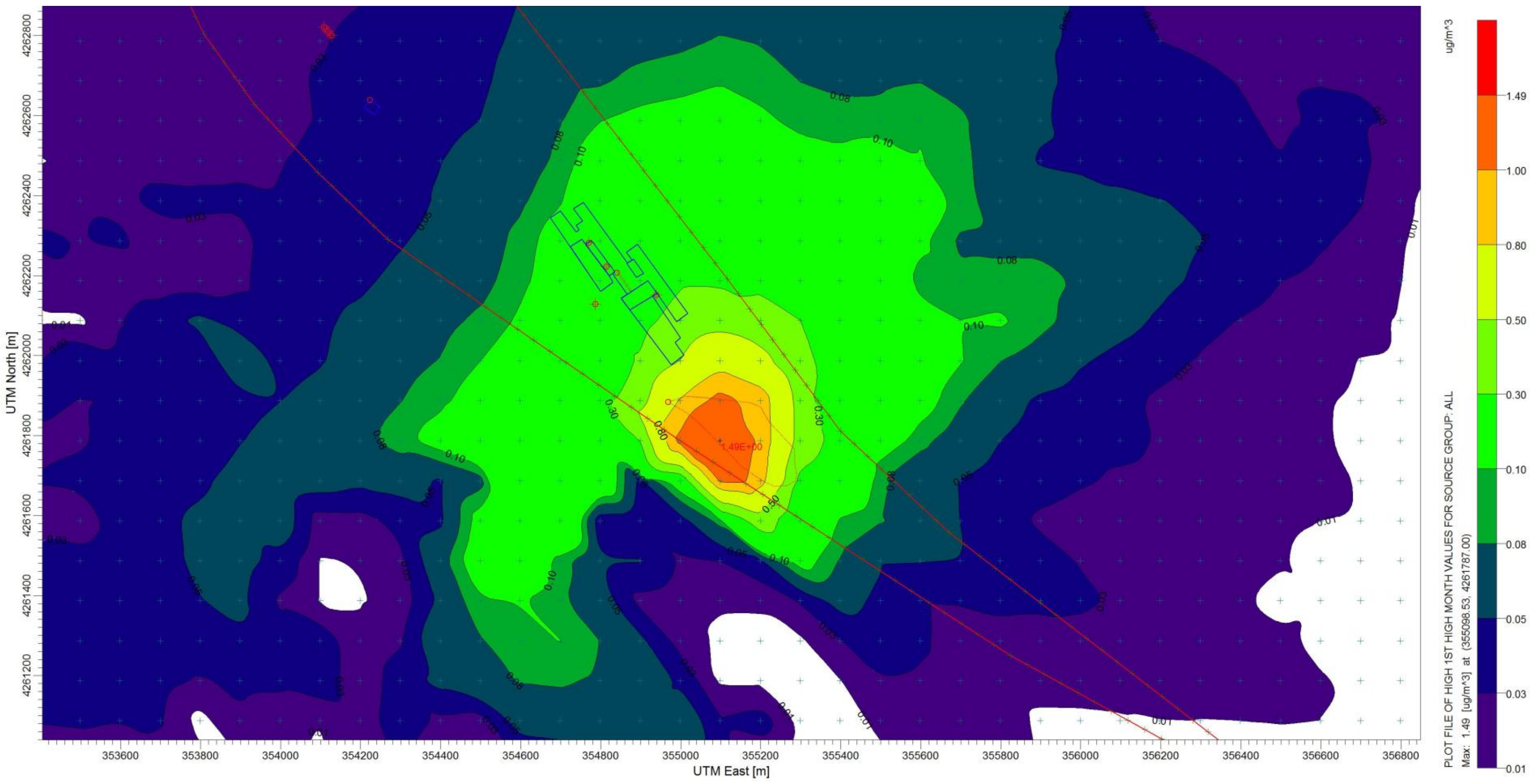


Figure 2.2 AK Steel_aer - 3 Month Rolling Average Concentration, Domain

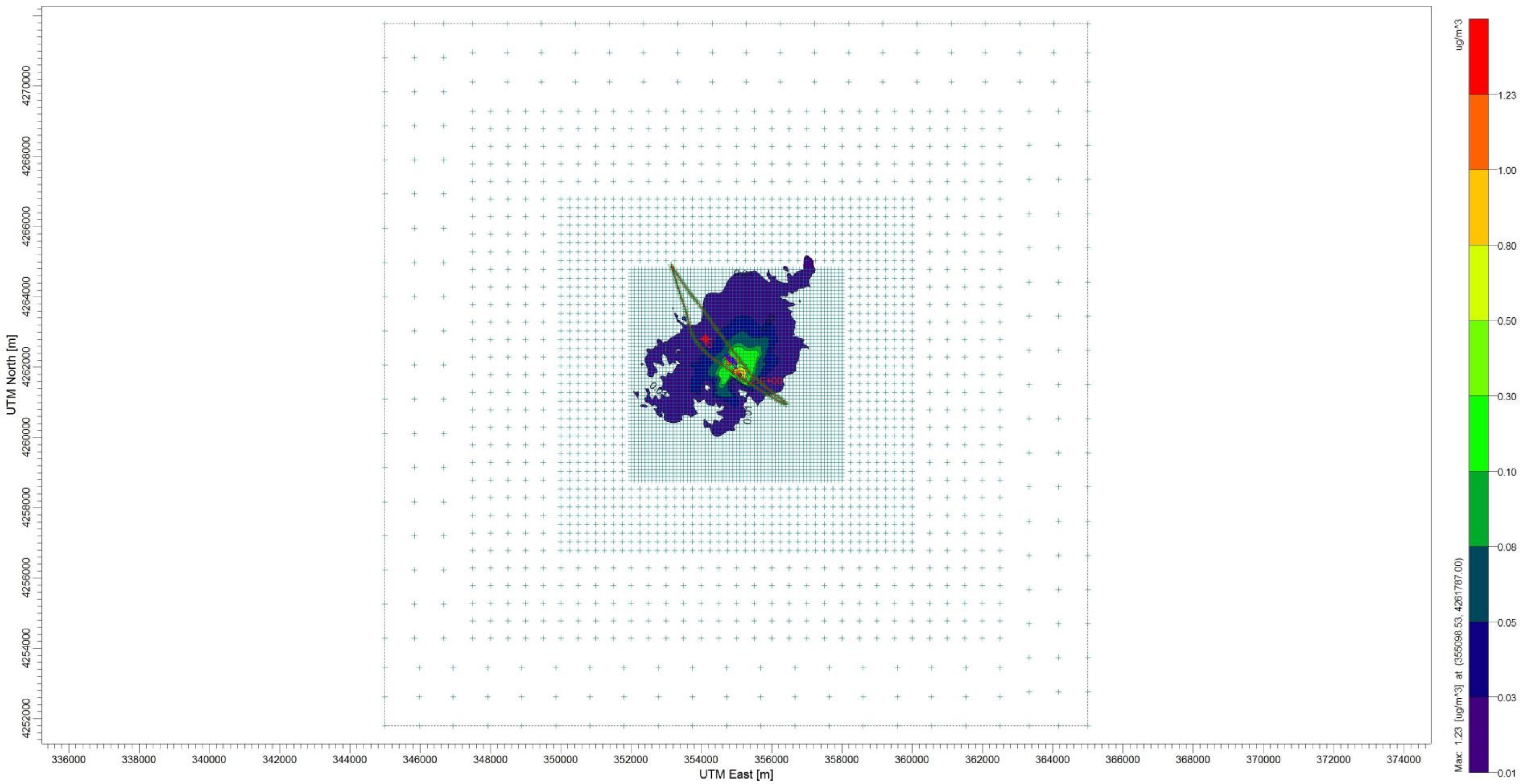


Figure 2.3 AK Steel_aer - 3 Month Rolling Average Concentration, SIA

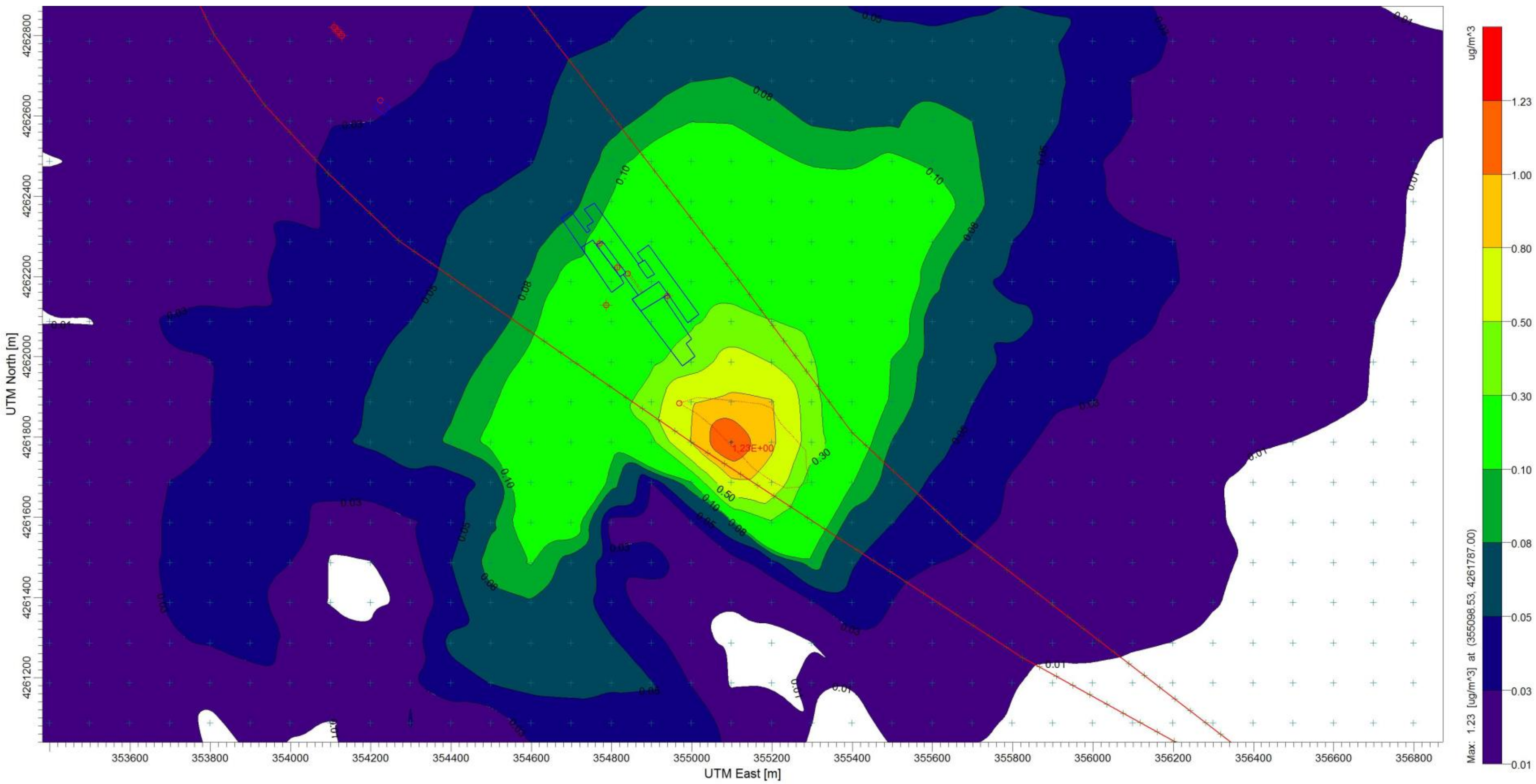


Figure 3.0 AK Steel_pr - High 1st High Monthly Average Concentration, Domain

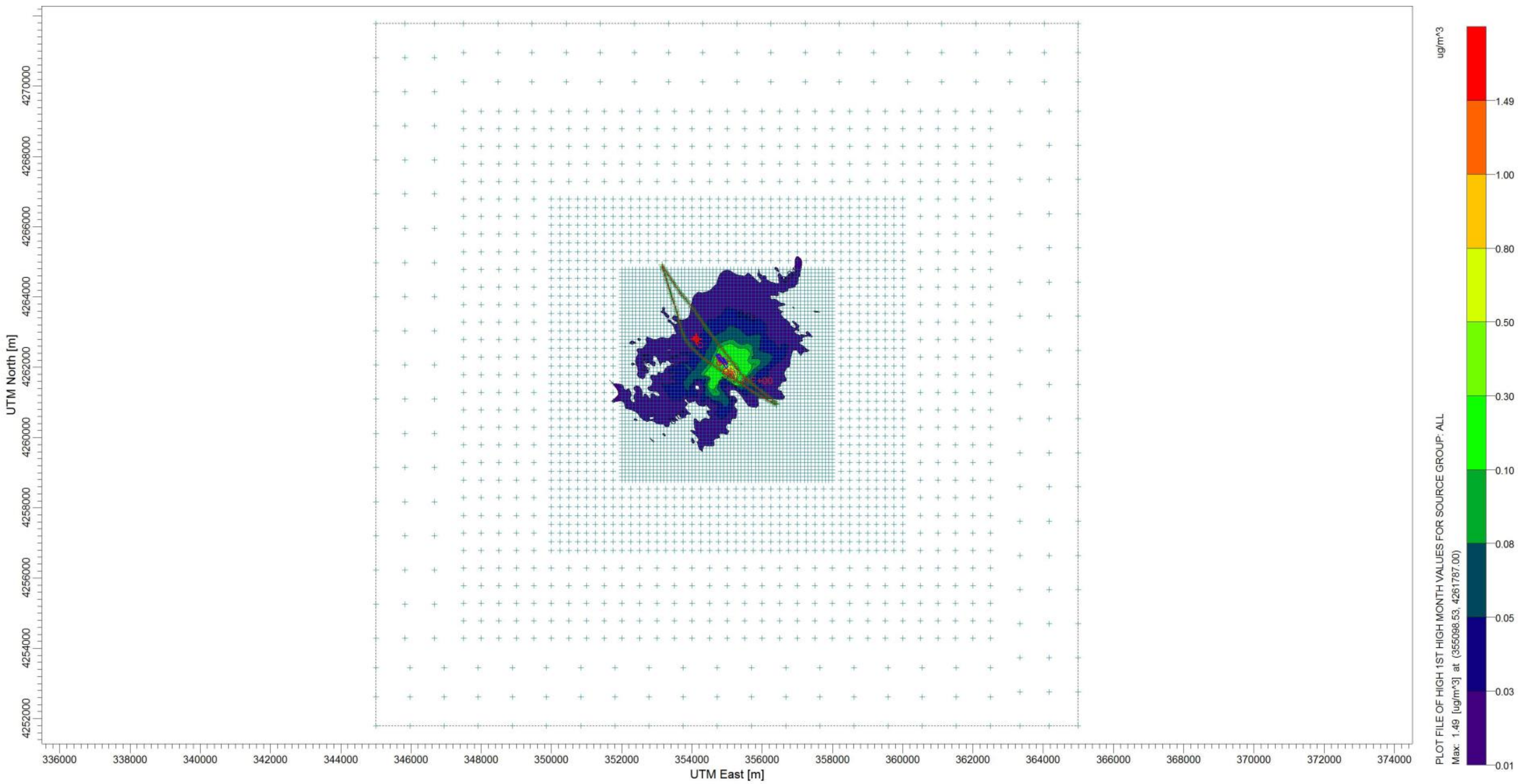


Figure 3.1 AK Steel_pr - High 1st High Monthly Average Concentration, SIA

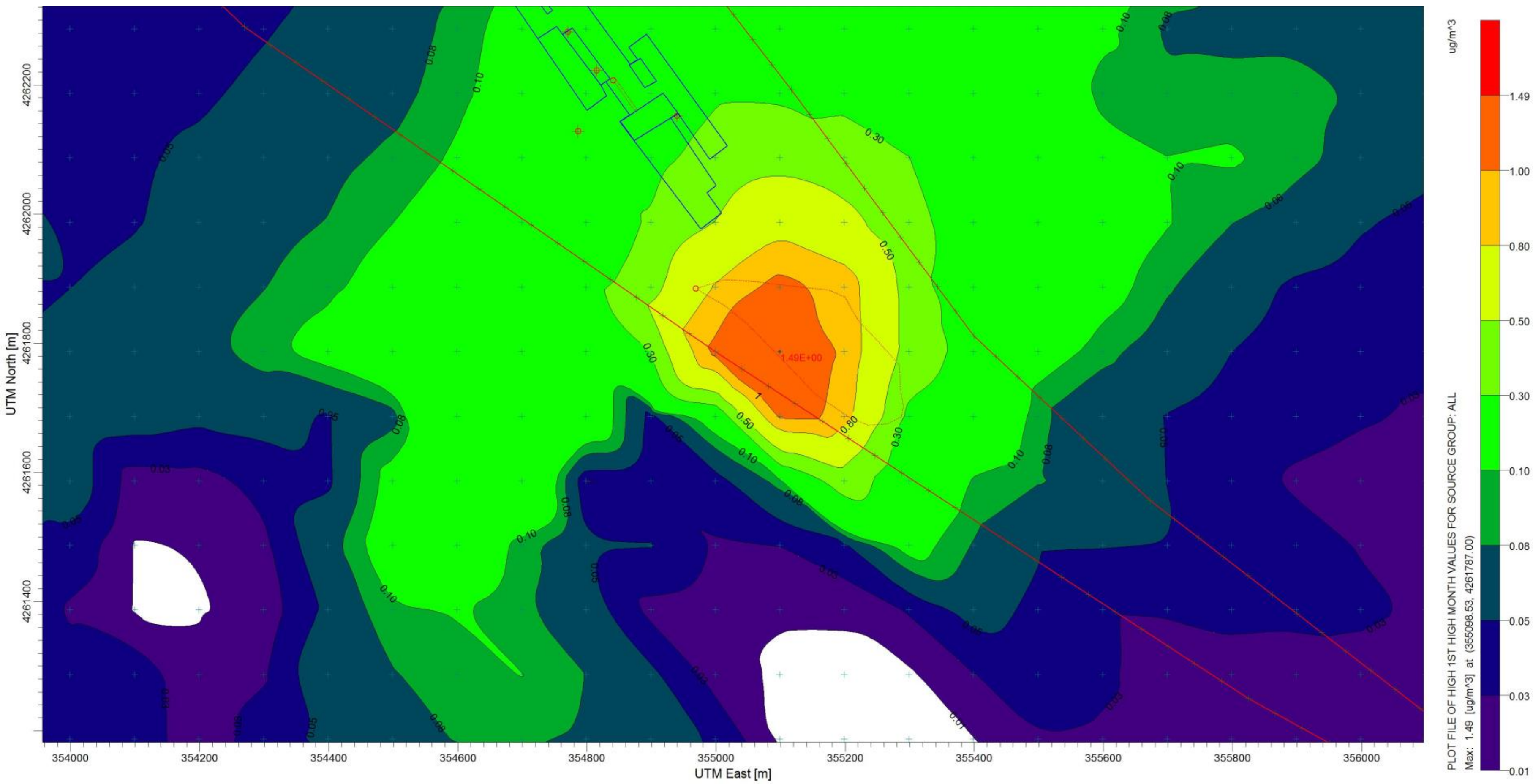


Figure 3.2 AK Steel_pr - 3 Month Rolling Average Concentration, Domain

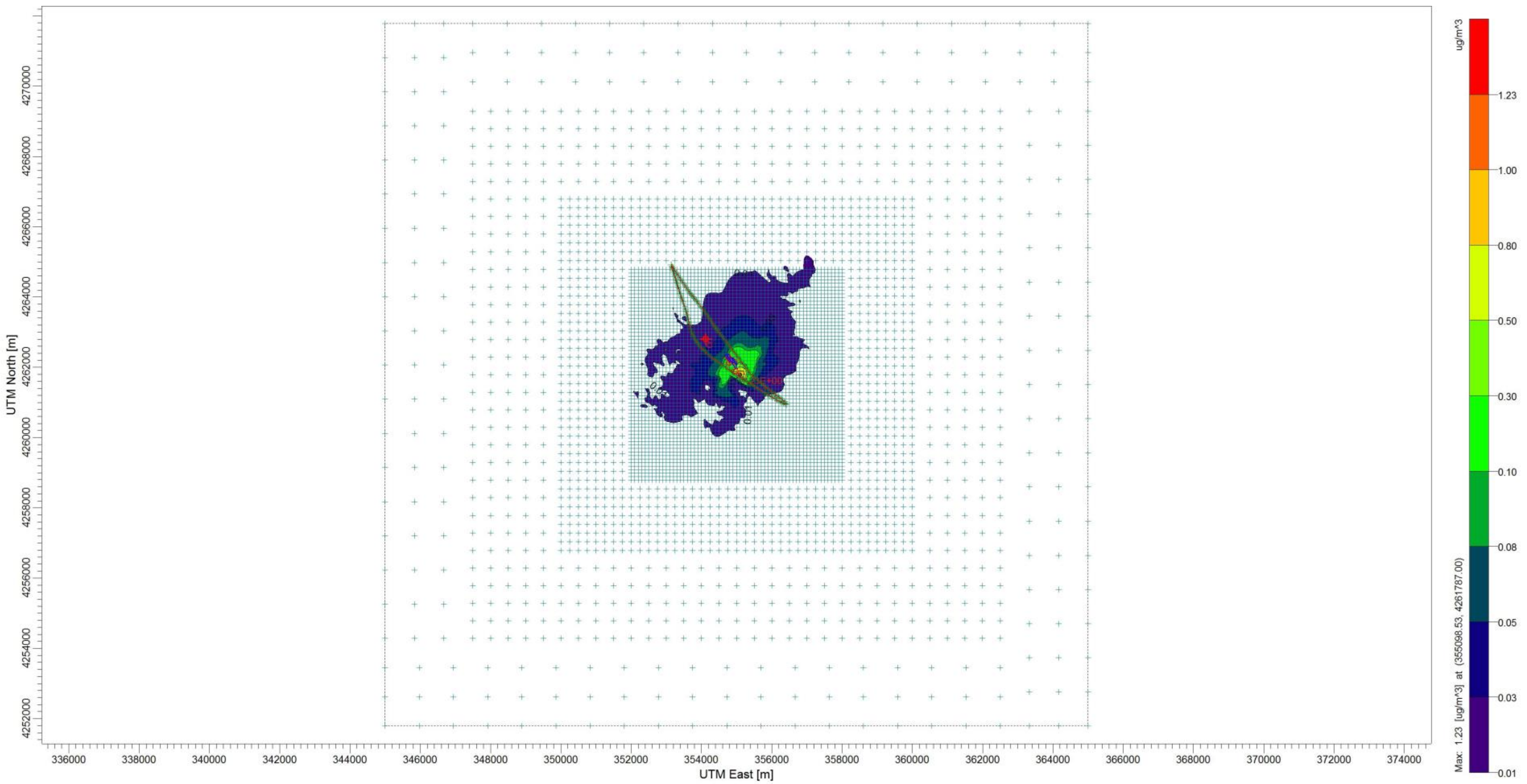
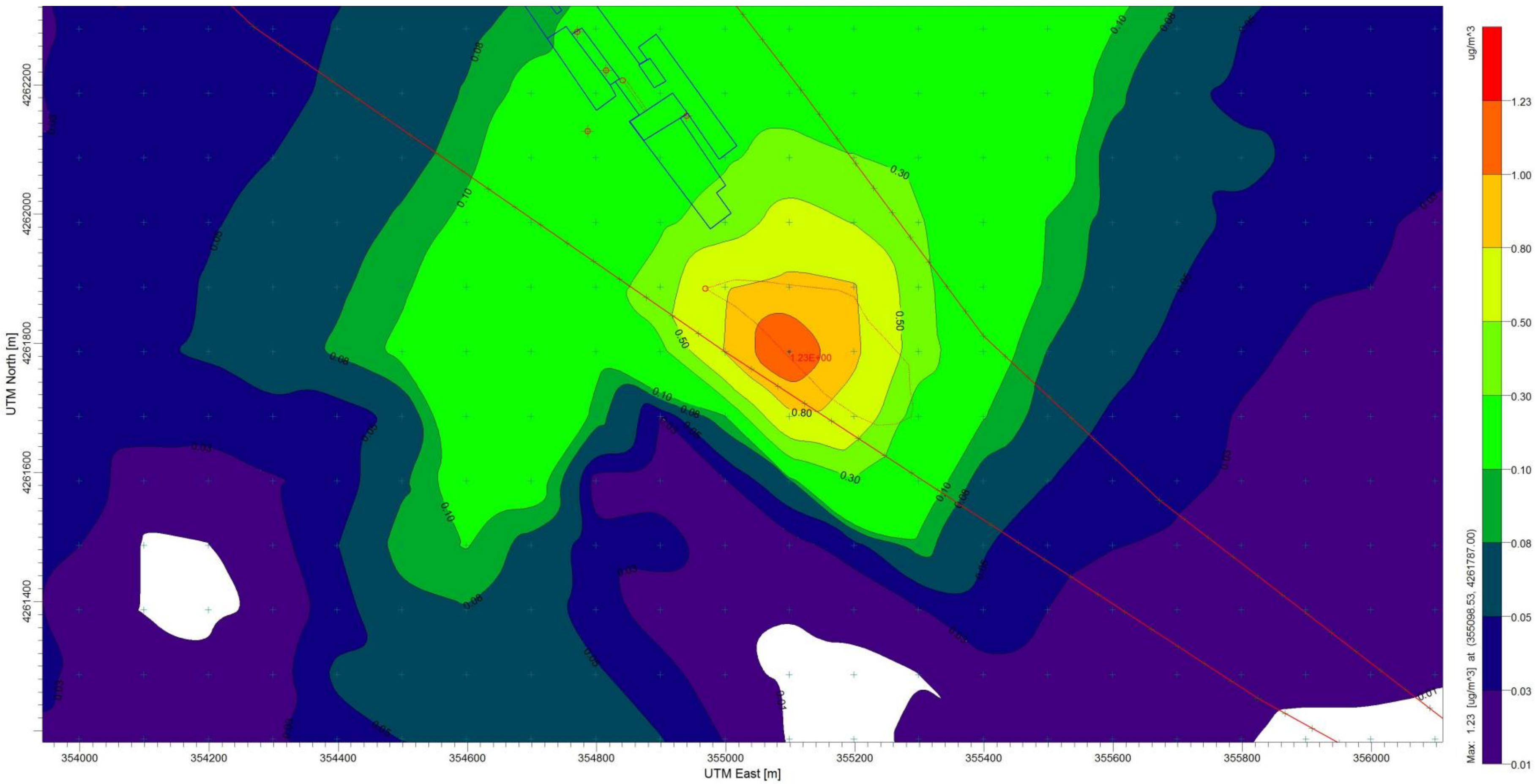


Figure 3.3 AK Steel_pr - 3 Month Rolling Average Concentration, SIA



Appendix G. Predicted Maximum Impact Monthly Contributions and 3-Month Rolling Average Concentrations

Table 1.0 Calgon Carbon Group

Modeled Facilities	UTM (X) coordinates	UTM (Y) coordinates	1/2 half Pb NAAQS (µg/m^3)	August 2009 Monthly Average Concentration (µg/m^3)	September 2009 Monthly Average Concentration (µg/m^3)	October 2009 Monthly Average Concentration (µg/m^3)	October 2009 Maximum Rolling 3-Month Average Concentration (µg/m^3)	Exceed Lead Waiver Criteria
AK Steel	355098.53125	4261787.00000	7.50E-02	0.104770E+01	0.150232E+01	0.116835E+01	**0.123946E+01**	**Yes***
Big Sandy				0.100000E-04	0.000000E+00	0.100000E-04	0.666667E-05	No
Calgon Carbon				0.110000E-03	0.120000E-03	0.130000E-03	0.120000E-03	No
All				0.104782E+01	0.150244E+01	0.116848E+01	**0.123958E+01**	**Yes**

***AK Steel maximum rolling 3-month concentration impact exceeds the waiver criteria and will be a candidate for lead monitoring. AK Steel was re-modeled as a subgroup excluding receptors within the property boundary.**

Table 1.1 Calgon Carbon Group _ 11aks-pb Sub-group

Modeled Facilities	UTM (X) coordinates	UTM (Y) coordinates	1/2 half Pb NAAQS (µg/m^3)	September 2009 Monthly Average Concentration (µg/m^3)	October 2009 Monthly Average Concentration (µg/m^3)	November 2009 Monthly Average Concentration (µg/m^3)	November 2009 Maximum Rolling 3-Month Average Concentration (µg/m^3)	Exceed Lead Waiver Criteria
AK Steel-All	355081.09375	4261733.00000	7.50E-02	0.116355E+01	0.734790E+00	0.739770E+00	**0.879370E+00**	**Yes***

***AK Steel maximum rolling 3-month concentration impact at the property boundary.**

Table 2.0 TVA Paradise Group

Modeled Facilities	UTM (X) coordinates	UTM (Y) coordinates	50% of Pb NAAQS (µg/m³)	October 2012 Monthly Average Concentration (µg/m³)	November 2012 Monthly Average Concentration (µg/m³)	December 2012 Monthly Average Concentration (µg/m³)	December 2012 Maximum Rolling 3-Month Average Concentration (µg/m³)	Exceed Lead Waiver Criteria
Aleris	525246.56250	4117029.25000	7.50E-02	0.705000E-02	0.121000E-01	0.884000E-02	0.933000E-02	No
Paradise				0.200000E-04	0.300000E-04	0.200000E-04	0.233333E-04	No
Green				0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	No
All				0.707000E-02	0.121400E-01	0.887000E-02	0.936000E-02	No

Table 3.0 Enersys Incorporated Group

Modeled Facilities	UTM (X) coordinates	UTM (Y) coordinates	50% of Pb NAAQS (µg/m³)	August 2012 Monthly Average Concentration (µg/m³)	September 2012 Monthly Average Concentration (µg/m³)	October 2012 Monthly Average Concentration (µg/m³)	October 2012 Maximum Rolling 3-Month Average Concentration (µg/m³)	Exceed Lead Waiver Criteria
Enersys	738549.12500	4179982.50000	7.50E-02	0.114690E+00	0.114970E+00	0.112020E+00	**0.113893E+00**	**Yes***
BGAD				0.300000E-04	0.500000E-04	0.300000E-04	0.366667E-04	No
All				0.114710E+00	0.115010E+00	0.112050E+00	**0.113923E+00**	**Yes**

***Lead monitoring is currently in progress at the Enersys facility.**

Table 4.0 KU Ghent Group

Modeled Facilities	UTM (X) coordinates	UTM (Y) coordinates	50% of Pb NAAQS (μg/m³)	November 2011 Monthly Average Concentration (μg/m³)	December 2011 Monthly Average Concentration (μg/m³)	January 2012 Monthly Average Concentration (μg/m³)	January 2012 Maximum Rolling 3-Month Average Concentration (μg/m³)	Exceed Lead Waiver Criteria
NAS	666982.50000	4287712.00000	7.50E-02	0.207000E-02	0.164000E-02	0.211000E-02	0.194000E-02	No
Ghent				0.100000E-04	0.200000E-04	0.200000E-04	0.166667E-04	No
Gallatin				0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	No
All				0.208000E-02	0.166000E-02	0.213000E-02	0.195667E-02	No

Table 4.0 TVA Shawnee Group

Modeled Facilities	UTM (X) coordinates	UTM (Y) coordinates	50% of Pb NAAQS (μg/m³)	April 2011 Monthly Average Concentration (μg/m³)	May 2011 Monthly Average Concentration (μg/m³)	June 2011 Monthly Average Concentration (μg/m³)	June 2011 Maximum Rolling 3-Month Average Concentration (μg/m³)	Exceed Lead Waiver Criteria
CCMA	380134.62500	4101969.50000	7.50E-02	0.979900E-01	0.820400E-01	0.105840E+00	**0.952900E-01**	**Yes***
Shawnee				0.300000E-04	0.700000E-04	0.400000E-04	0.466667E-04	No
All				0.980200E-01	0.821100E-01	0.105880E+00	**0.953367E-01**	**Yes**

***The maximum rolling 3-month concentration impact from CCMA is located onsite (Appendix F, Figure 5.4). The TVA Shawnee group was re-modeled excluding receptors within the CCMA fence line.**

Table 4.1 TVA Shawnee Group _ 11shaw-fl Sub-group

Modeled Facilities	UTM (X) coordinates	UTM (Y) coordinates	50% of Pb NAAQS (µg/m³)	April 2010 Monthly Average Concentration (µg/m³)	May 2010 Monthly Average Concentration (µg/m³)	June 2010 Monthly Average Concentration (µg/m³)	June 2010 Maximum Rolling 3-Month Average Concentration (µg/m³)	Exceed Lead Waiver Criteria
CCMA	380251.59375	4102261.75000	7.50E-02	0.484500E-01	0.256100E-01	0.522500E-01	0.421033E-01	No
Shawnee				0.500000E-04	0.400000E-04	0.400000E-04	0.433333E-04	No
All				0.484900E-01	0.256600E-01	0.522900E-01	0.421467E-01	No

Appendix H. Modeled Impacts

Figure 1.0 Calgon Carbon Group - High 1st High Monthly Average Concentration, All Sources

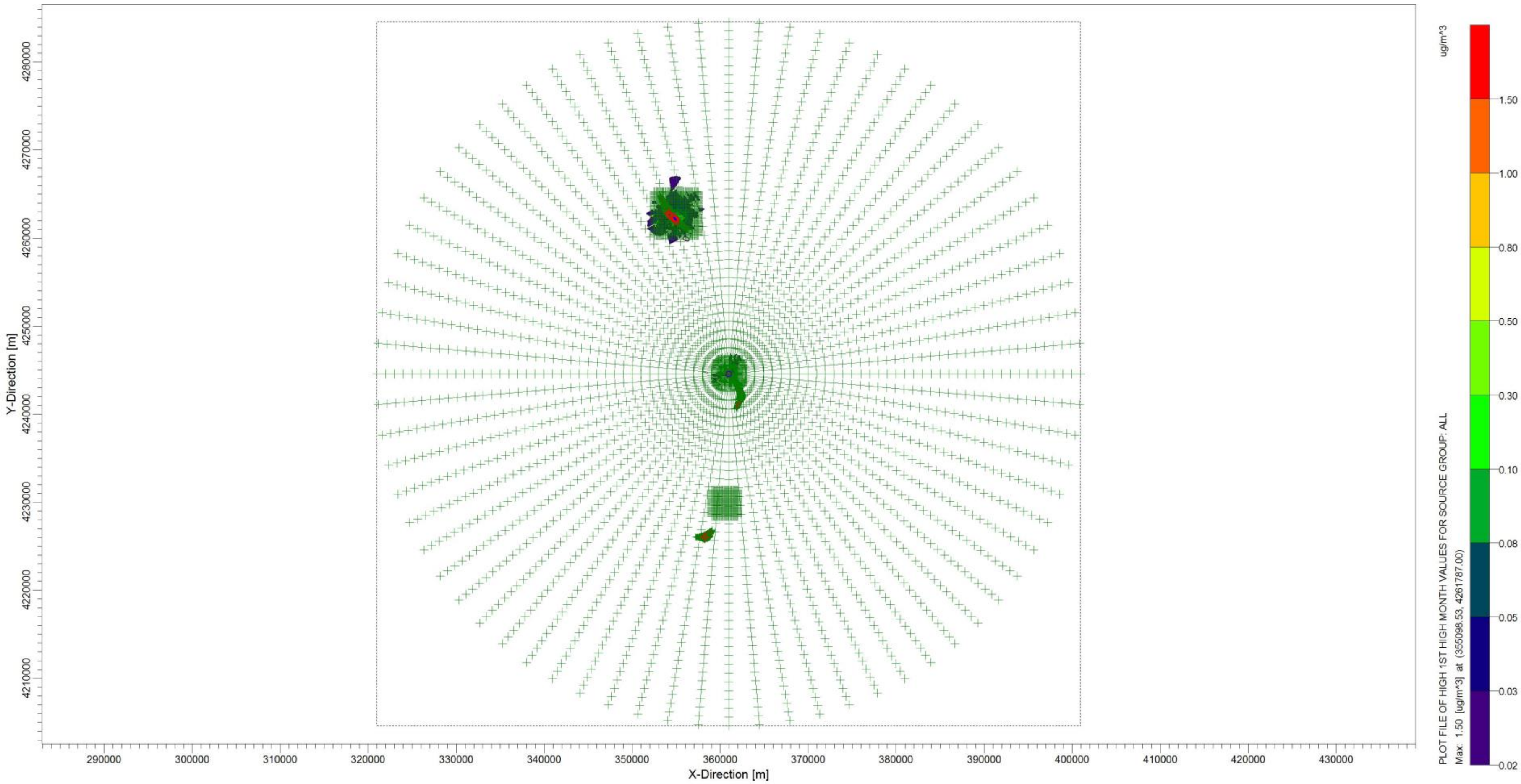


Figure 1.1 Calgon Carbon Group - High 1st High Monthly Average Concentration, AK Steel Source

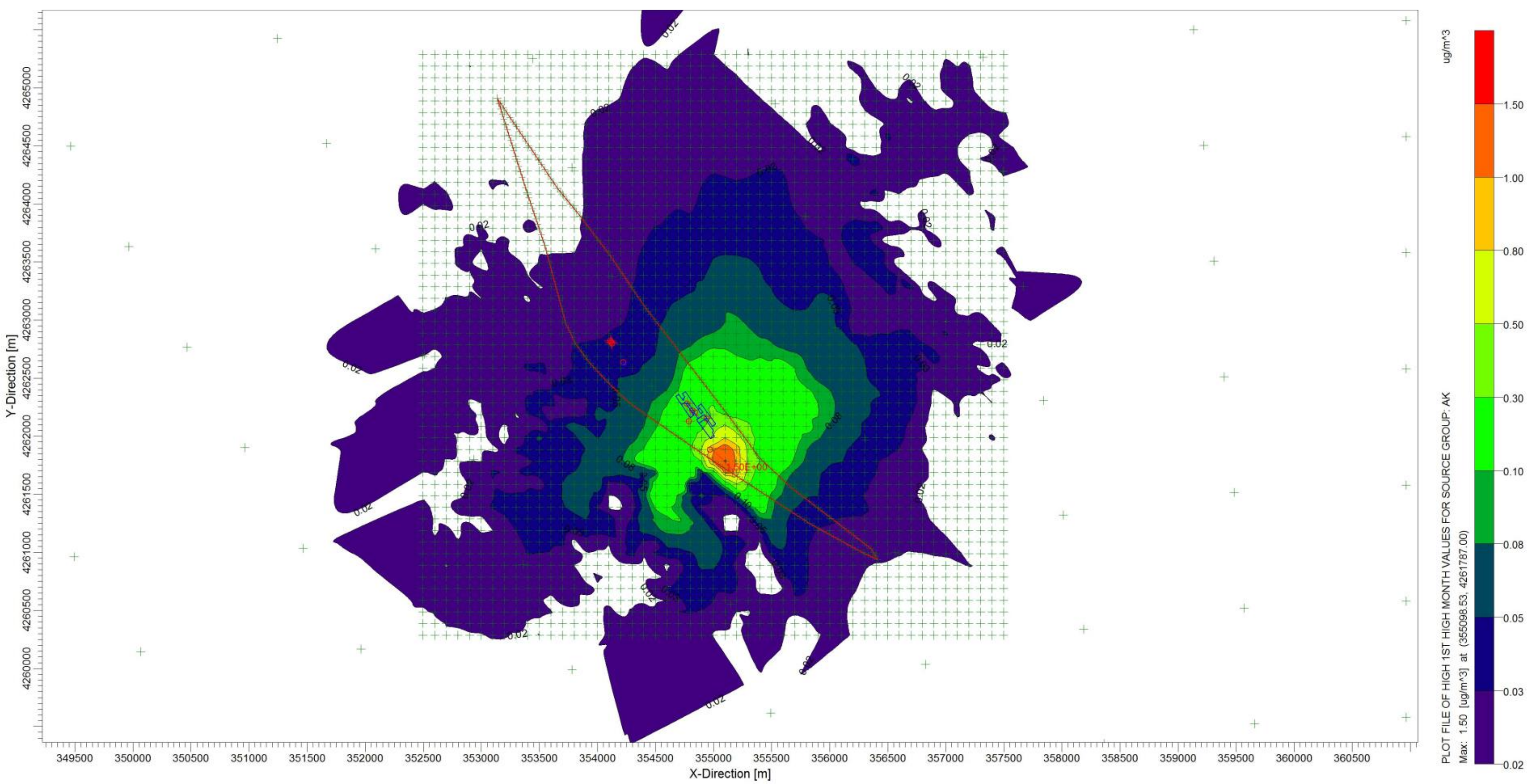


Figure 1.2 Calgon Carbon Group - High 1st High Monthly Average Concentration, Big Sandy Source

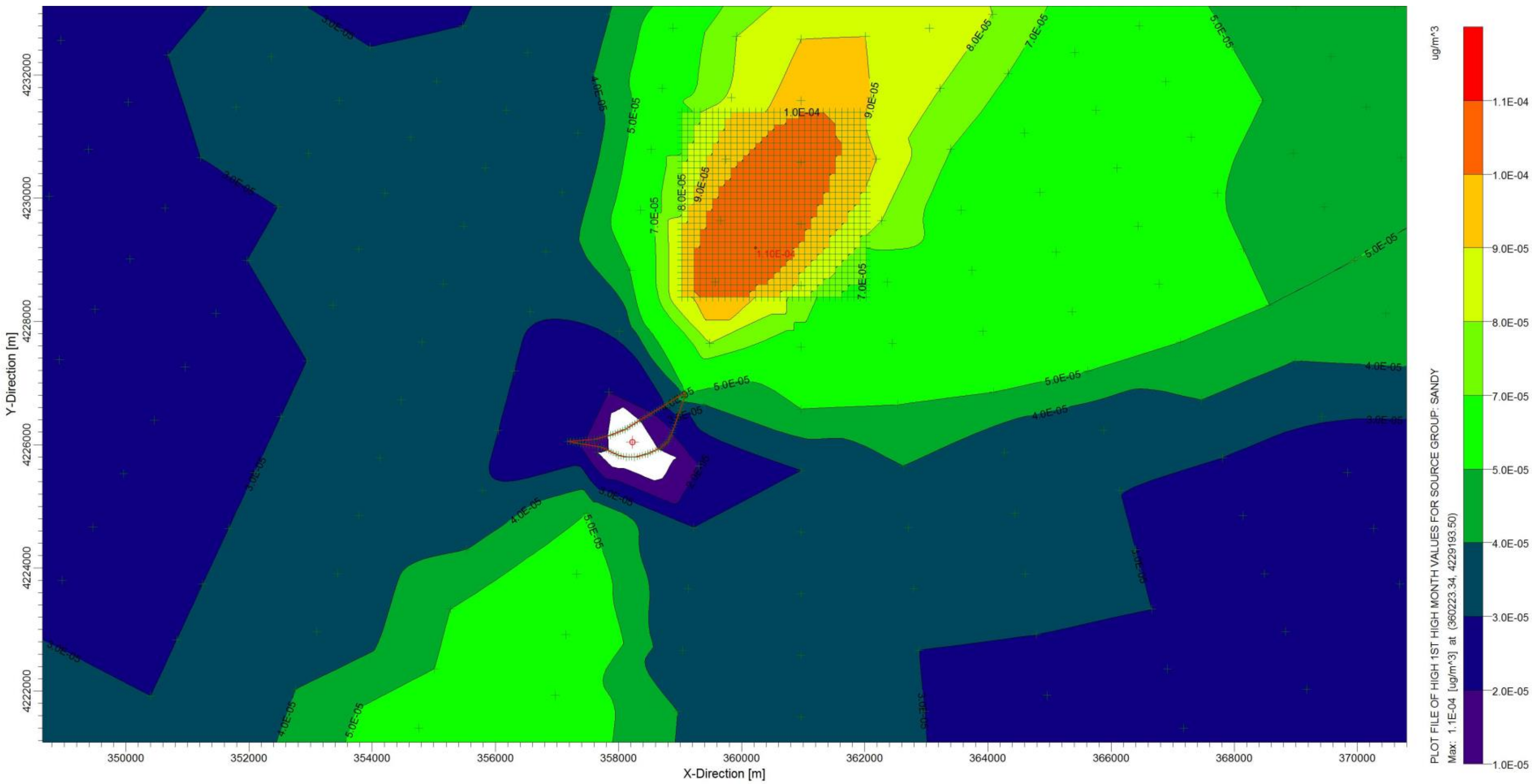


Figure 1.3 Calgon Carbon Group - High 1st High Monthly Average Concentration, Calgon Carbon Source

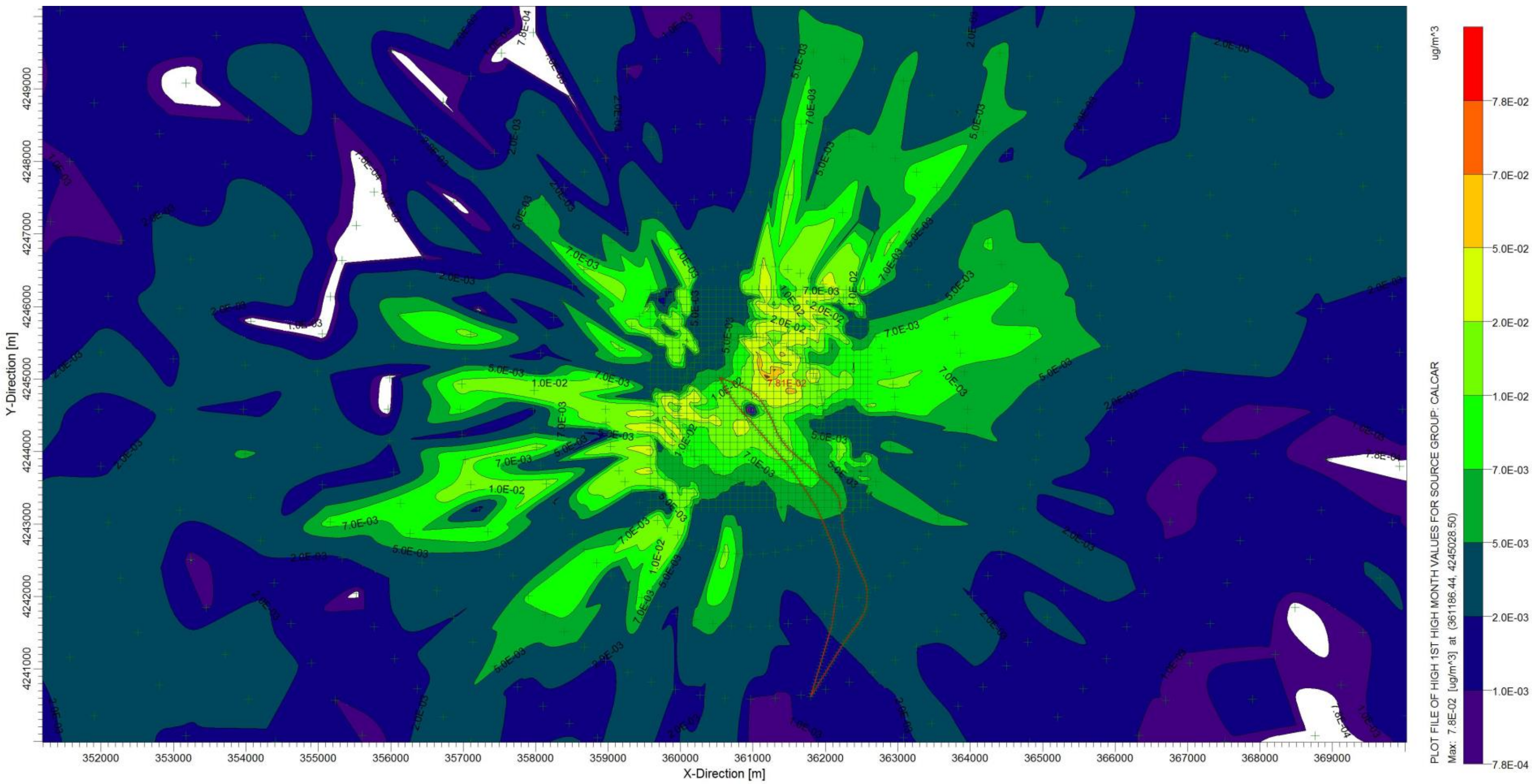


Figure 1.4 Calgon Carbon Group - 3 Month Rolling Average Concentration, Domain

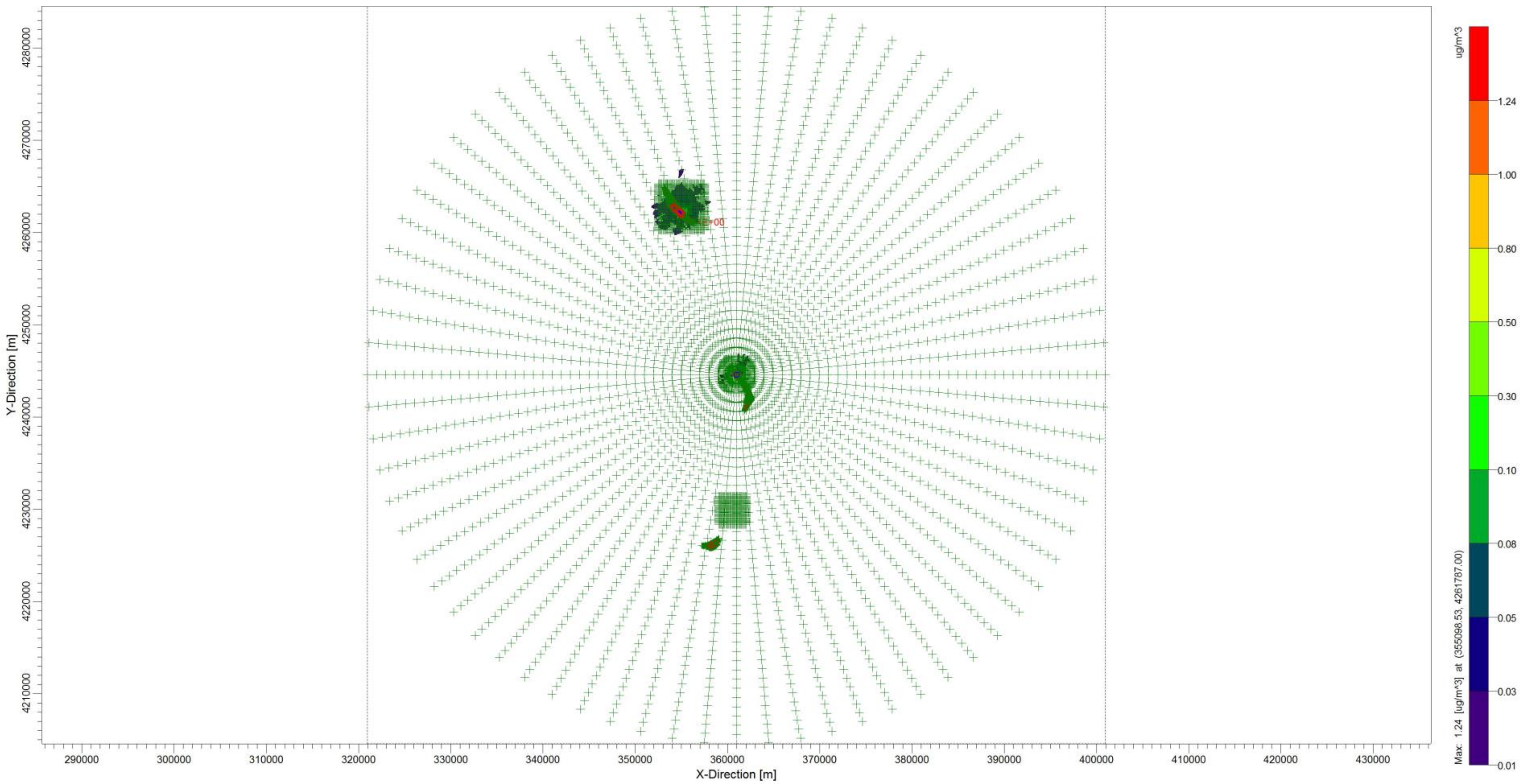


Figure 1.5 Calgon Carbon Group - 3 Month Rolling Average Concentration, SIA

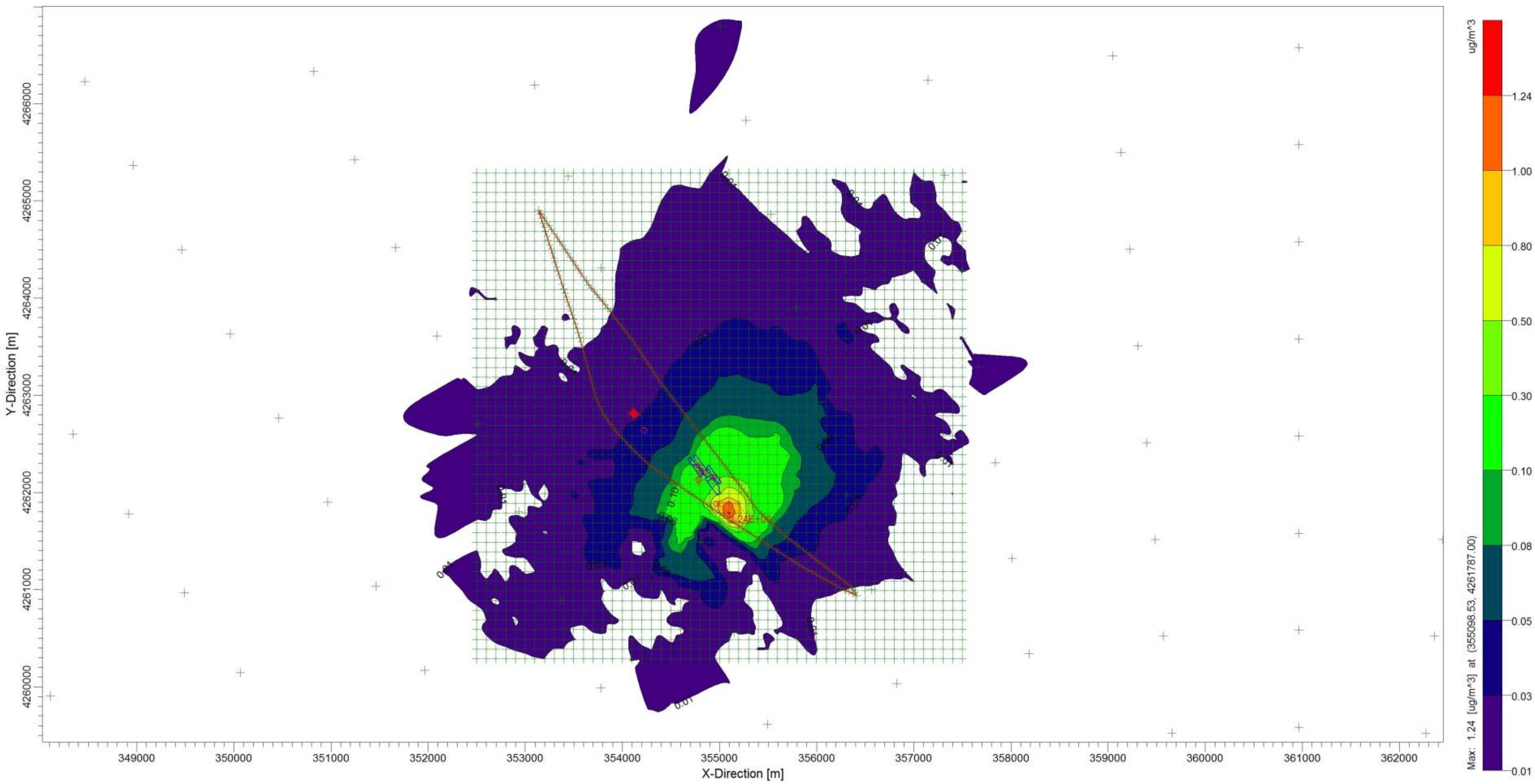


Figure 2.0 TVA Paradise Group - High 1st High Monthly Average Concentration, All Sources

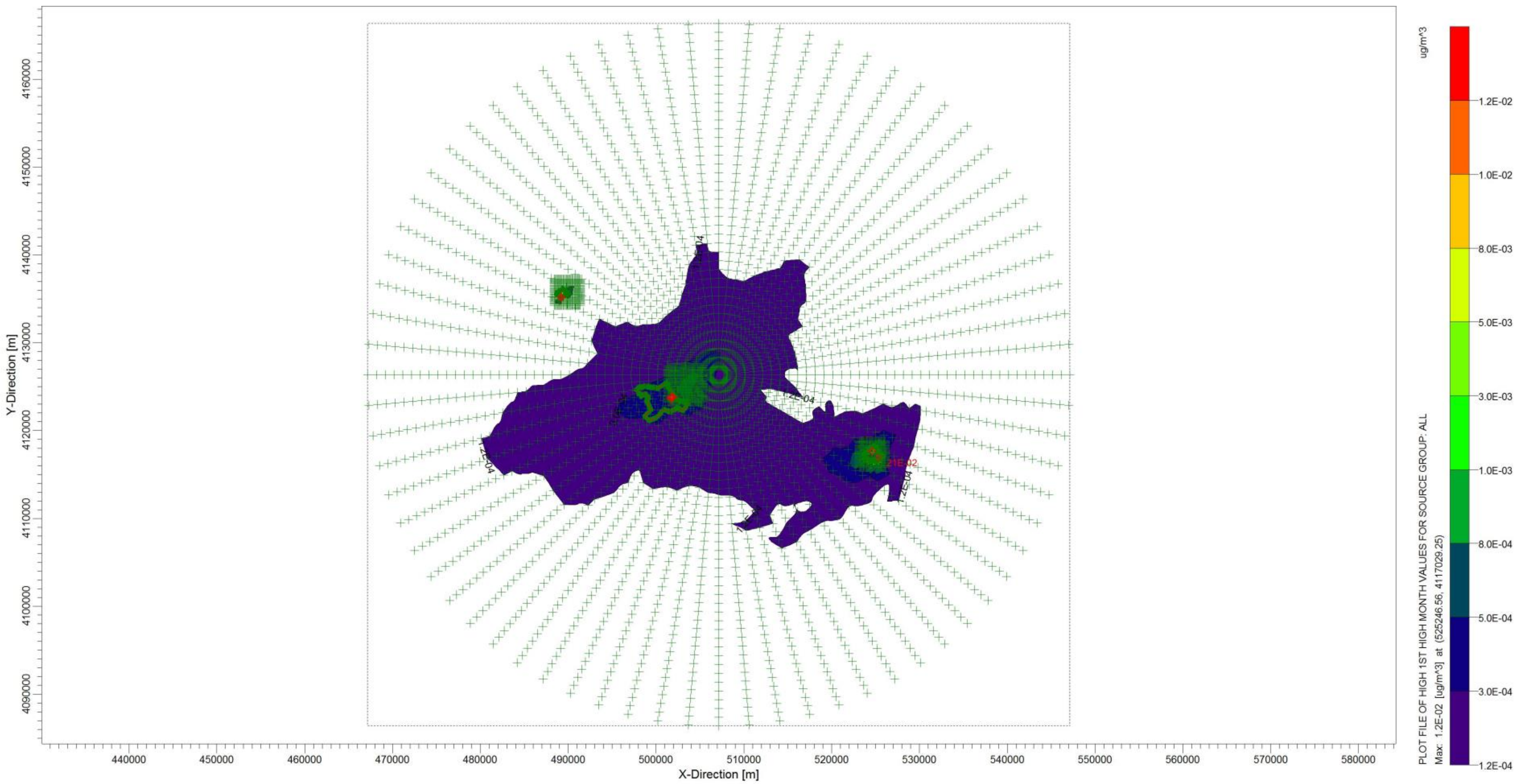


Figure 2.1 TVA Paradise Group - High 1st High Monthly Average Concentration, Aleris Recycling Source

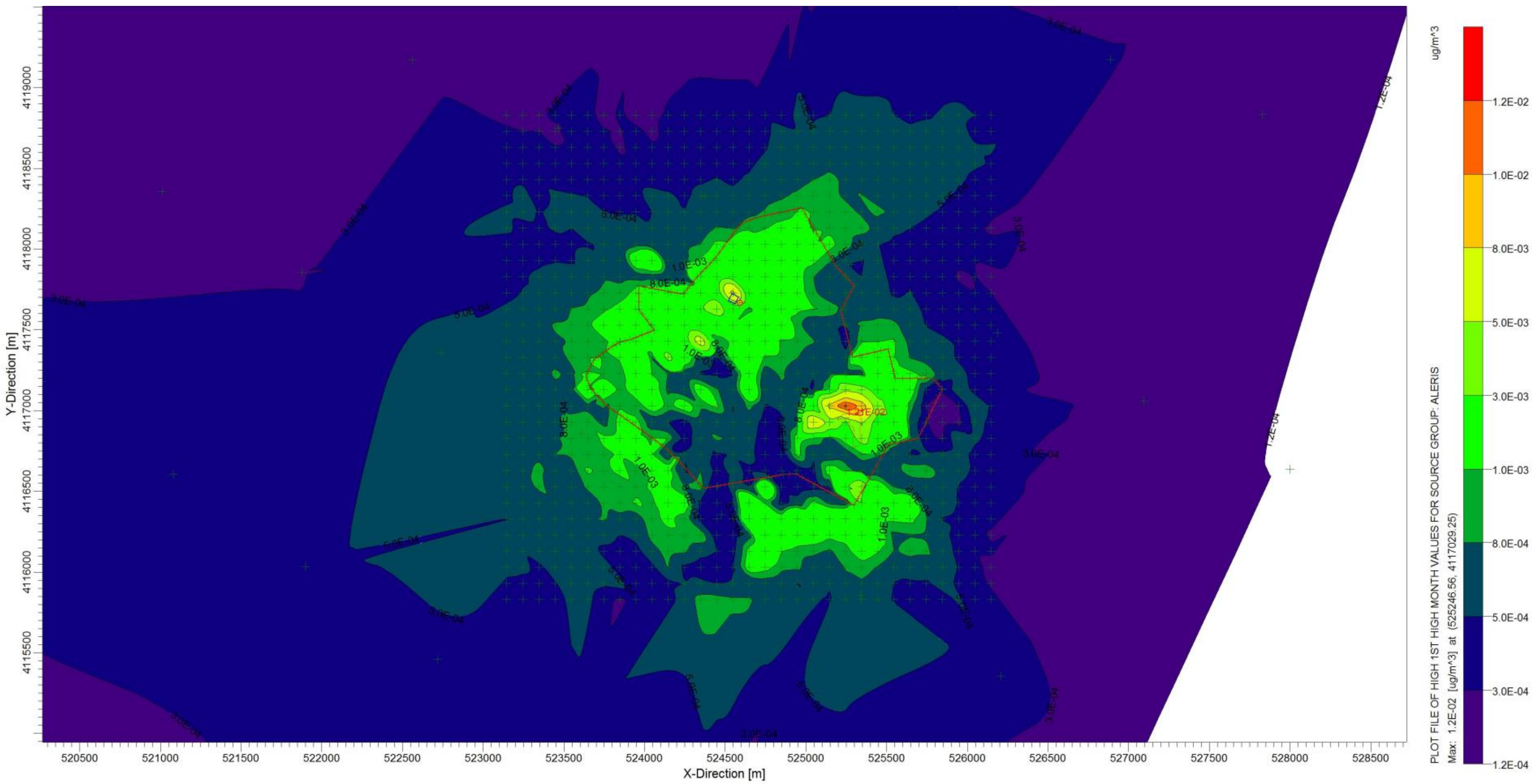


Figure 2.2 TVA Paradise Group - High 1st High Monthly Average Concentration, Green River Source

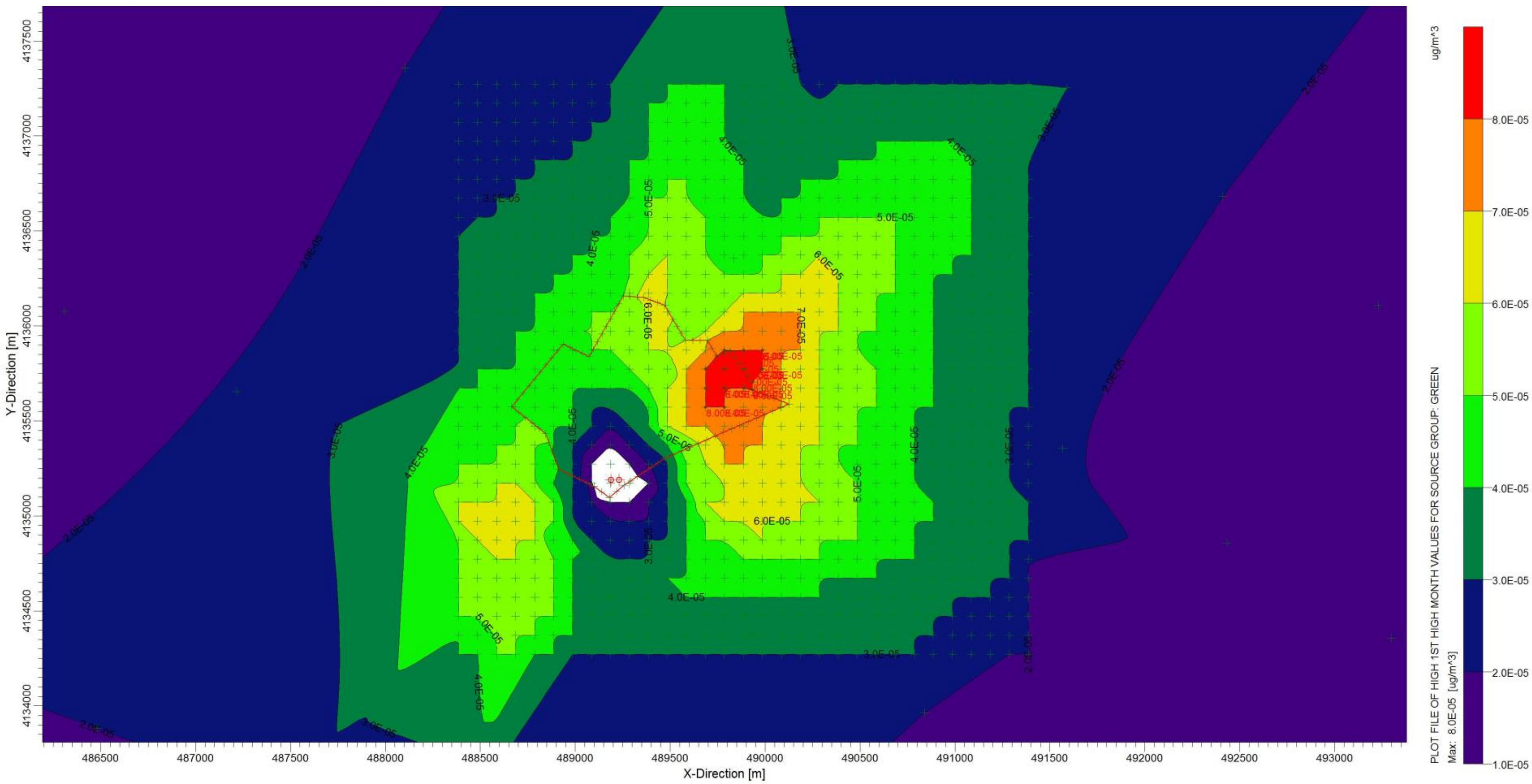


Figure 2.3 TVA Paradise Group - High 1st High Monthly Average Concentration, TVA Paradise Source

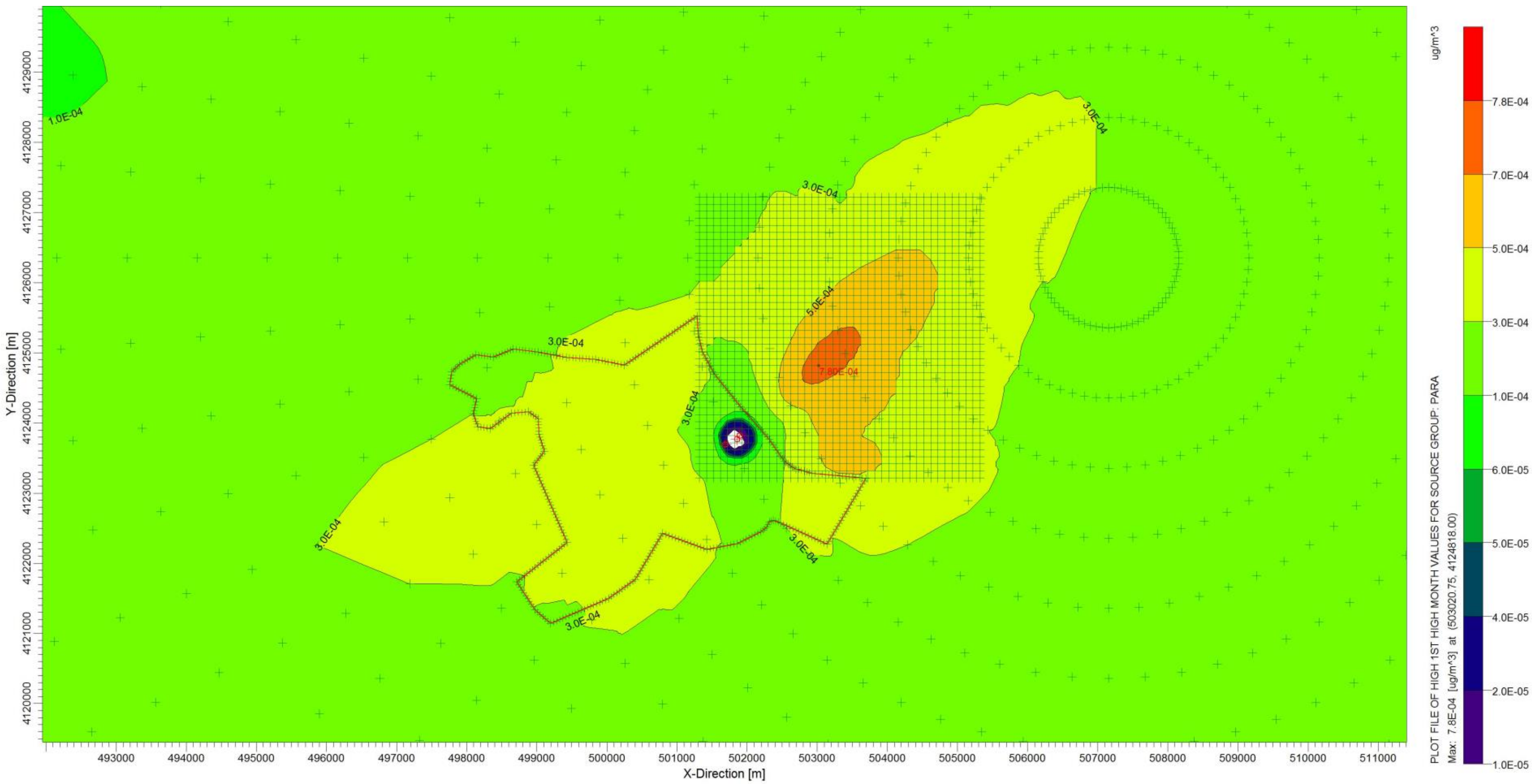


Figure 2.4 TVA Paradise Group - 3 Month Rolling Average Concentration, Domain

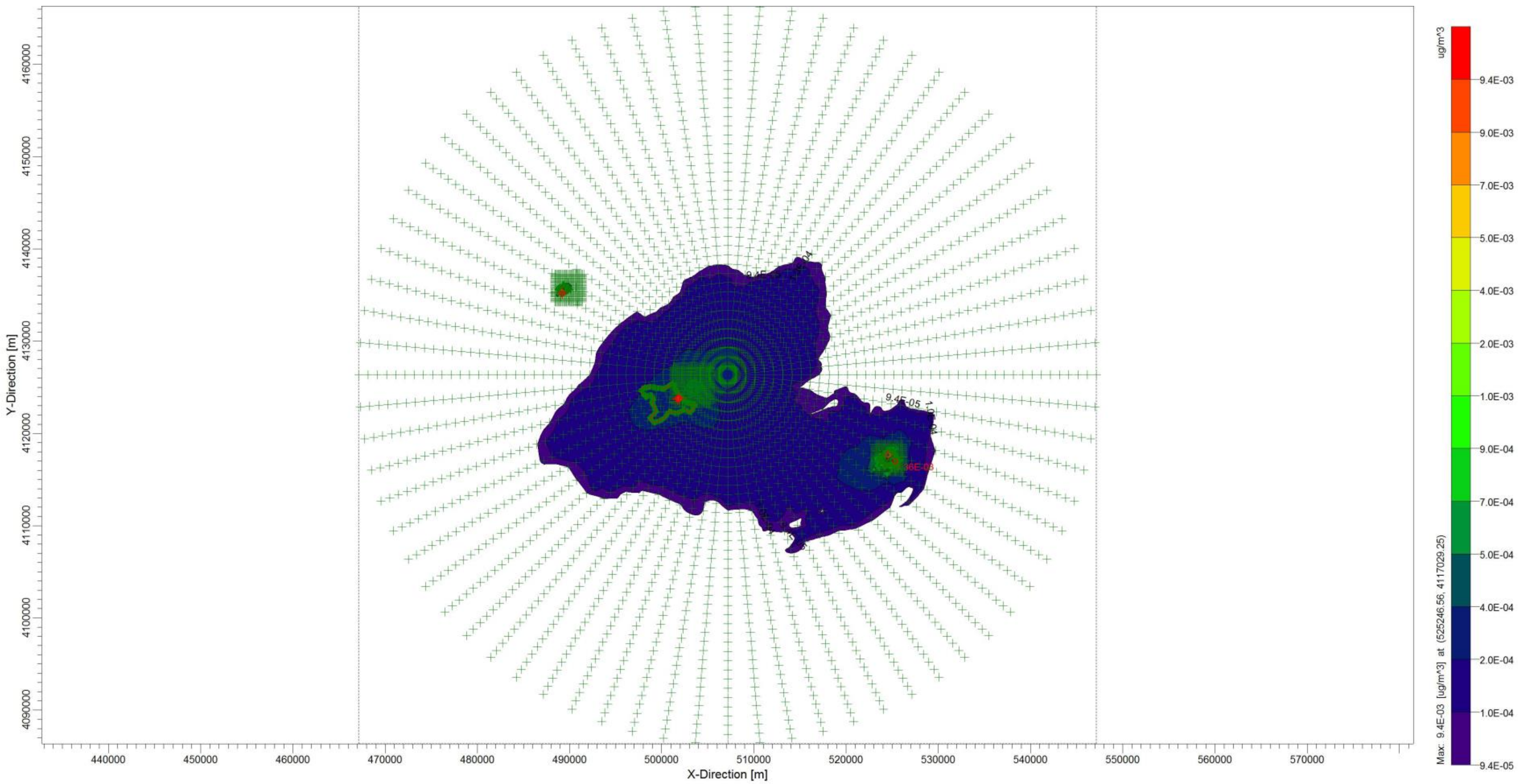


Figure 2.5 TVA Paradise Group - 3 Month Rolling Average Concentration, SIA

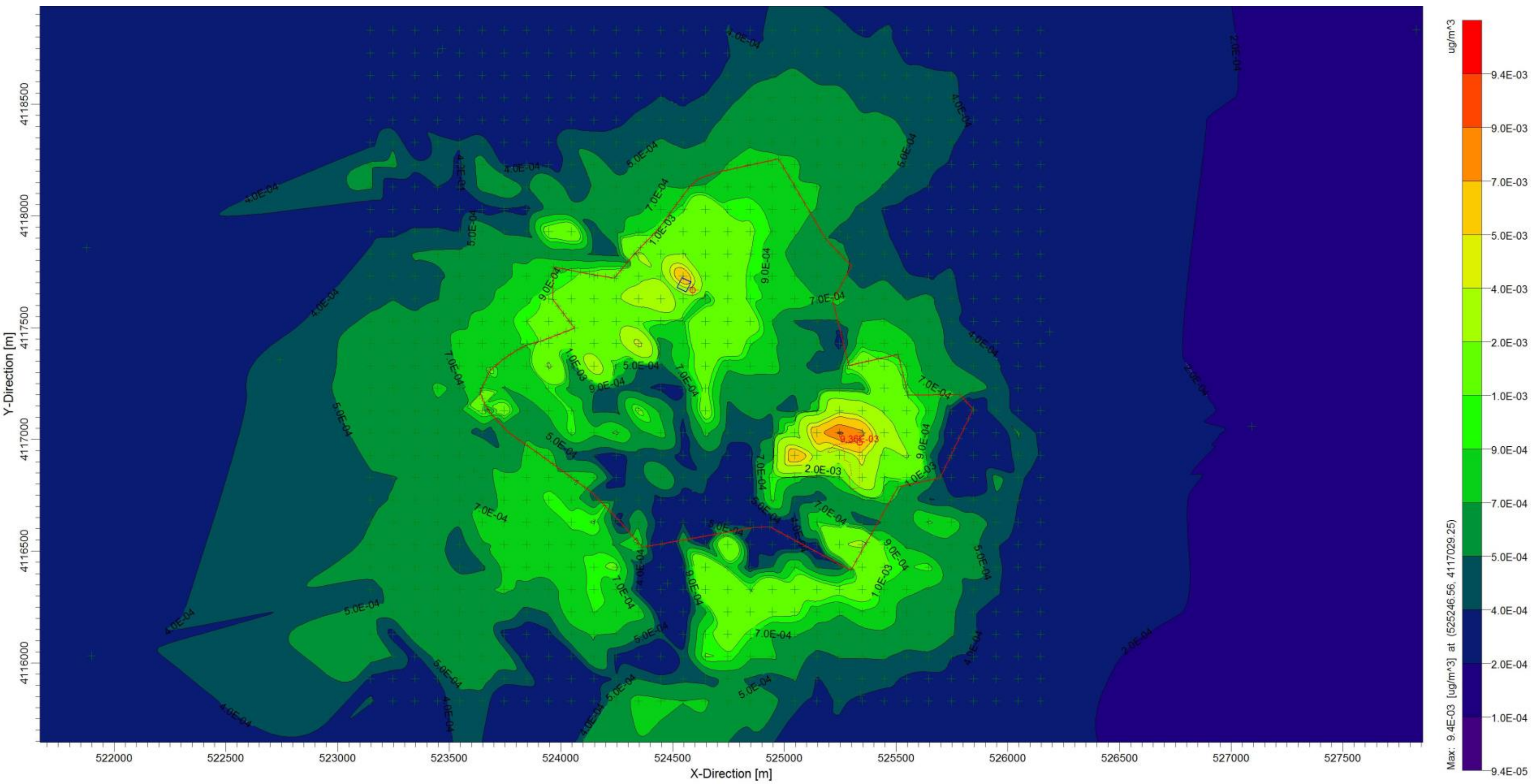


Figure 3.0 Enersys Group - High 1st High Monthly Average Concentration, All Sources

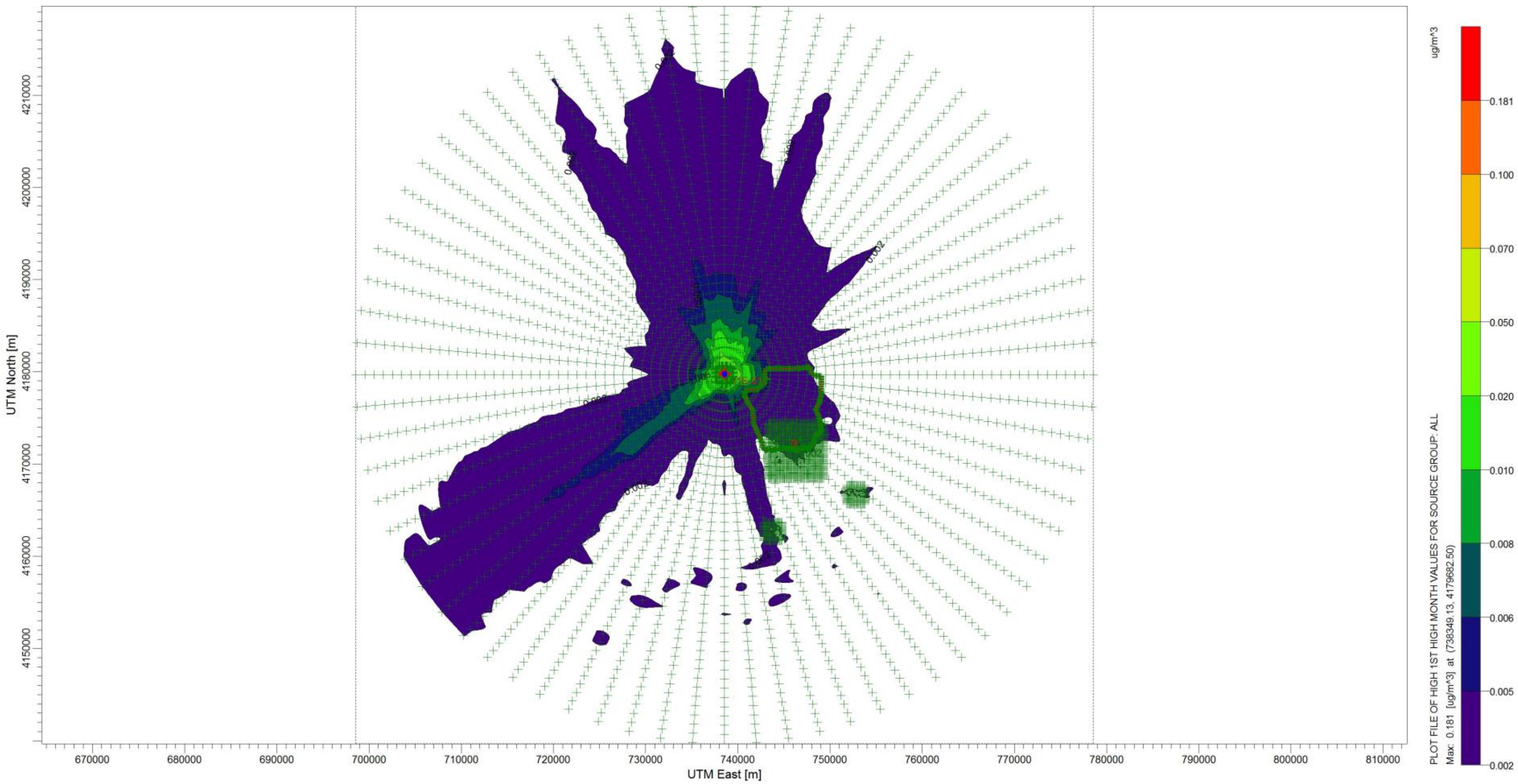


Figure 3.1 Enersys Group - High 1st High Monthly Average Concentration, BGAD Source

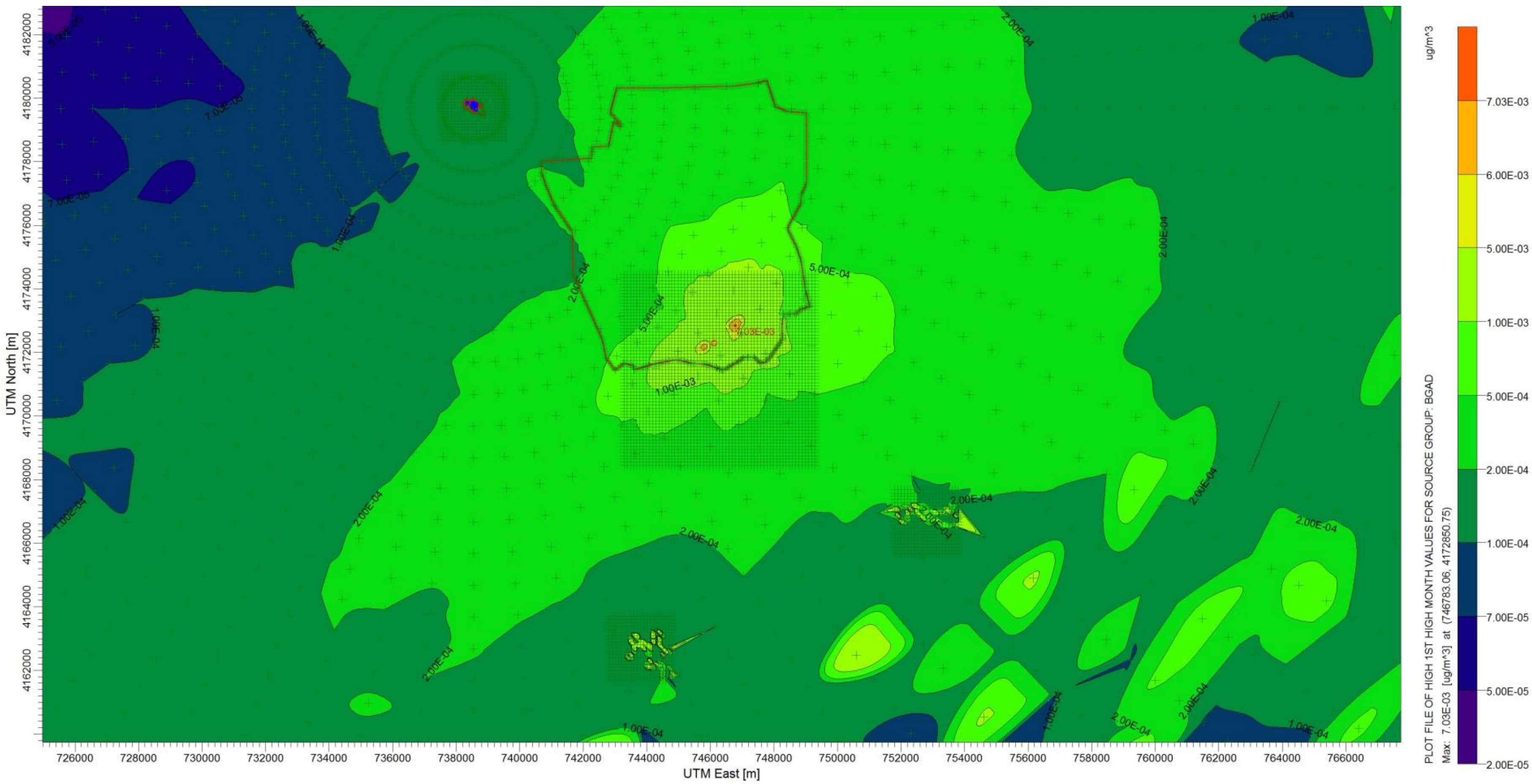


Figure 3.2 Enersys Group - High 1st High Monthly Average Concentration, Enersys Source

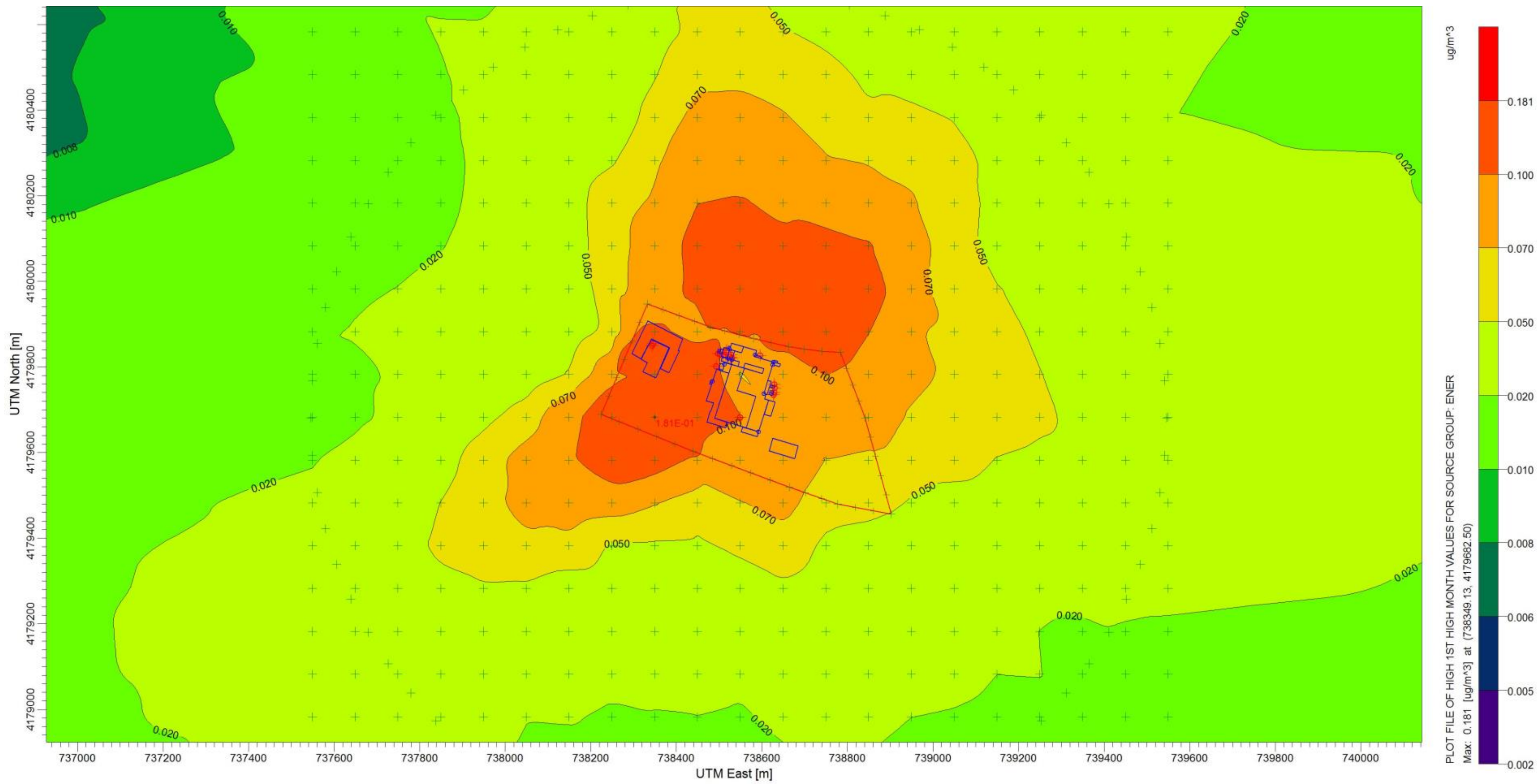


Figure 3.3 Enersys Group - 3 Month Rolling Average Concentration, Domain

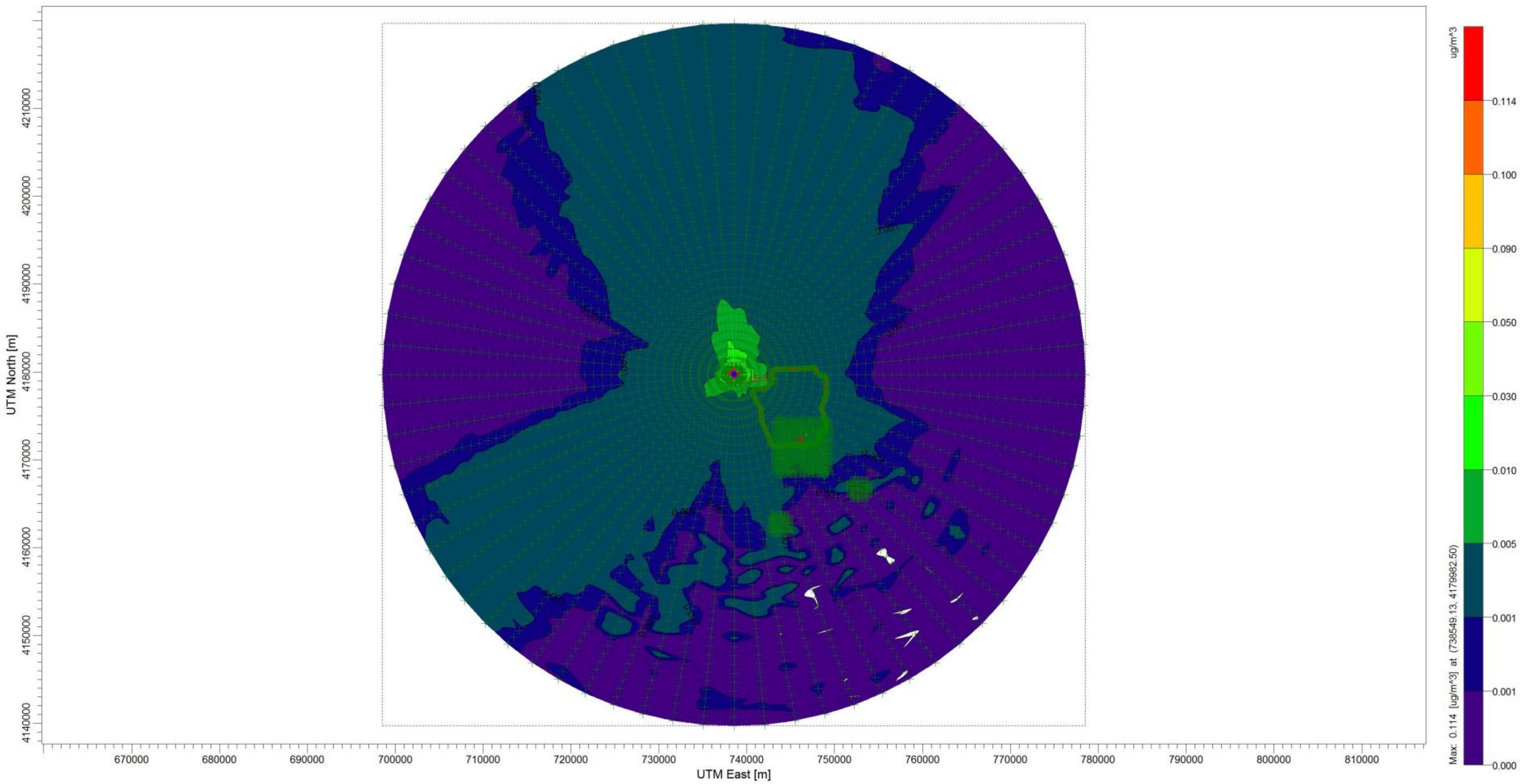


Figure 3.4 Enersys Group - 3 Month Rolling Average Concentration, SIA

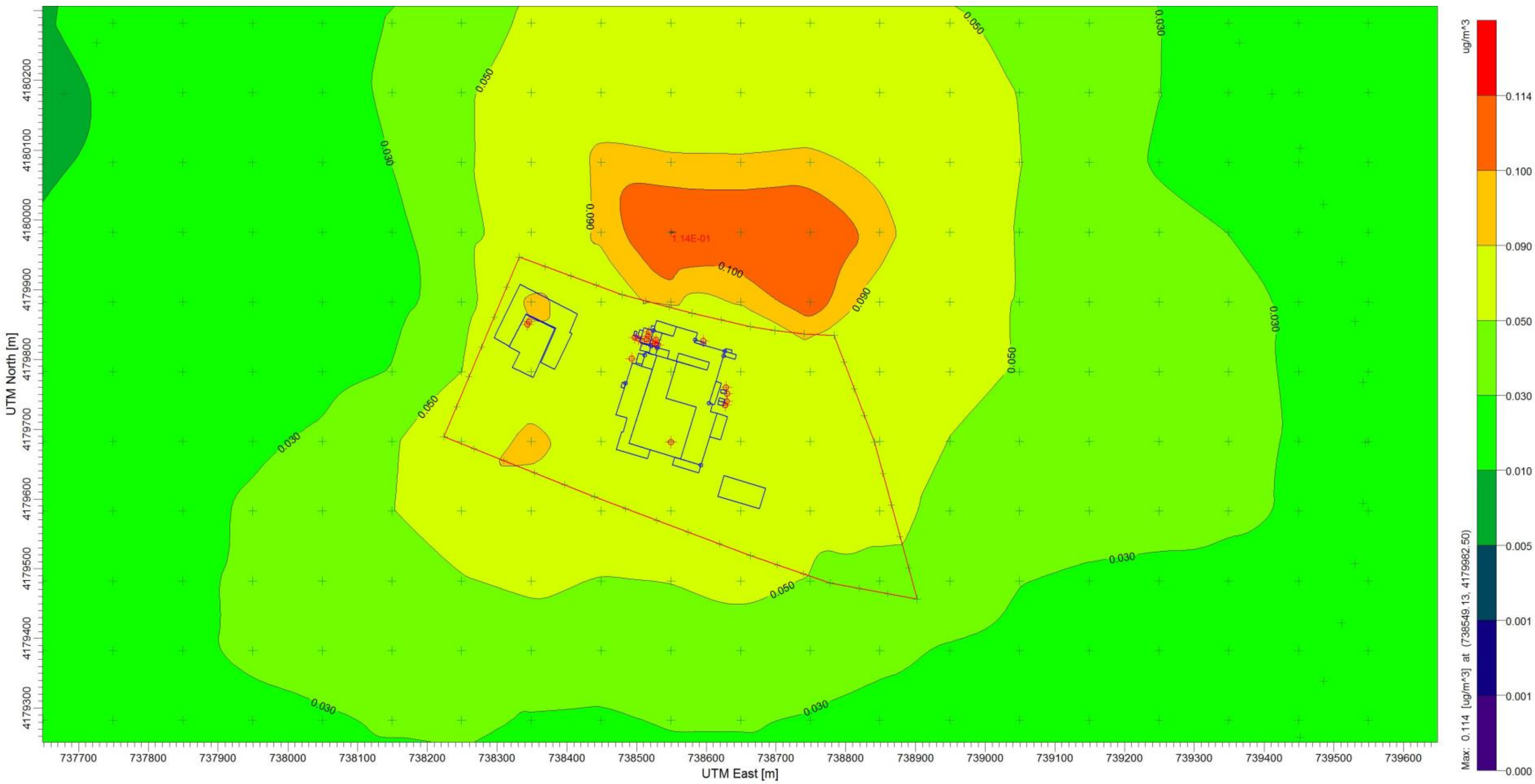


Figure 4.0 KU Ghent Group - High 1st High Monthly Average Concentration, All Sources

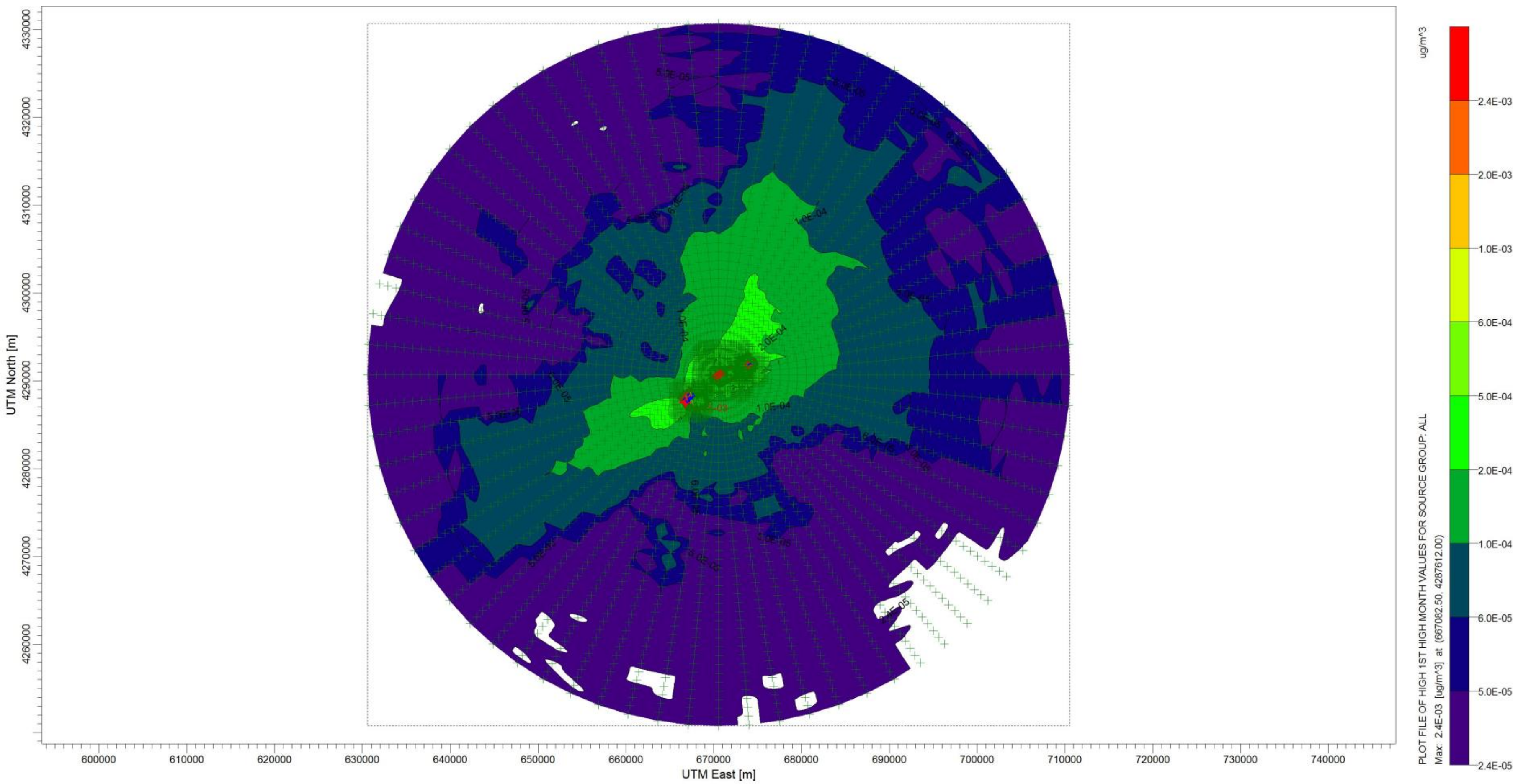


Figure 4.1 KU Ghent Group - High 1st High Monthly Average Concentration, Gallatin Steel Source

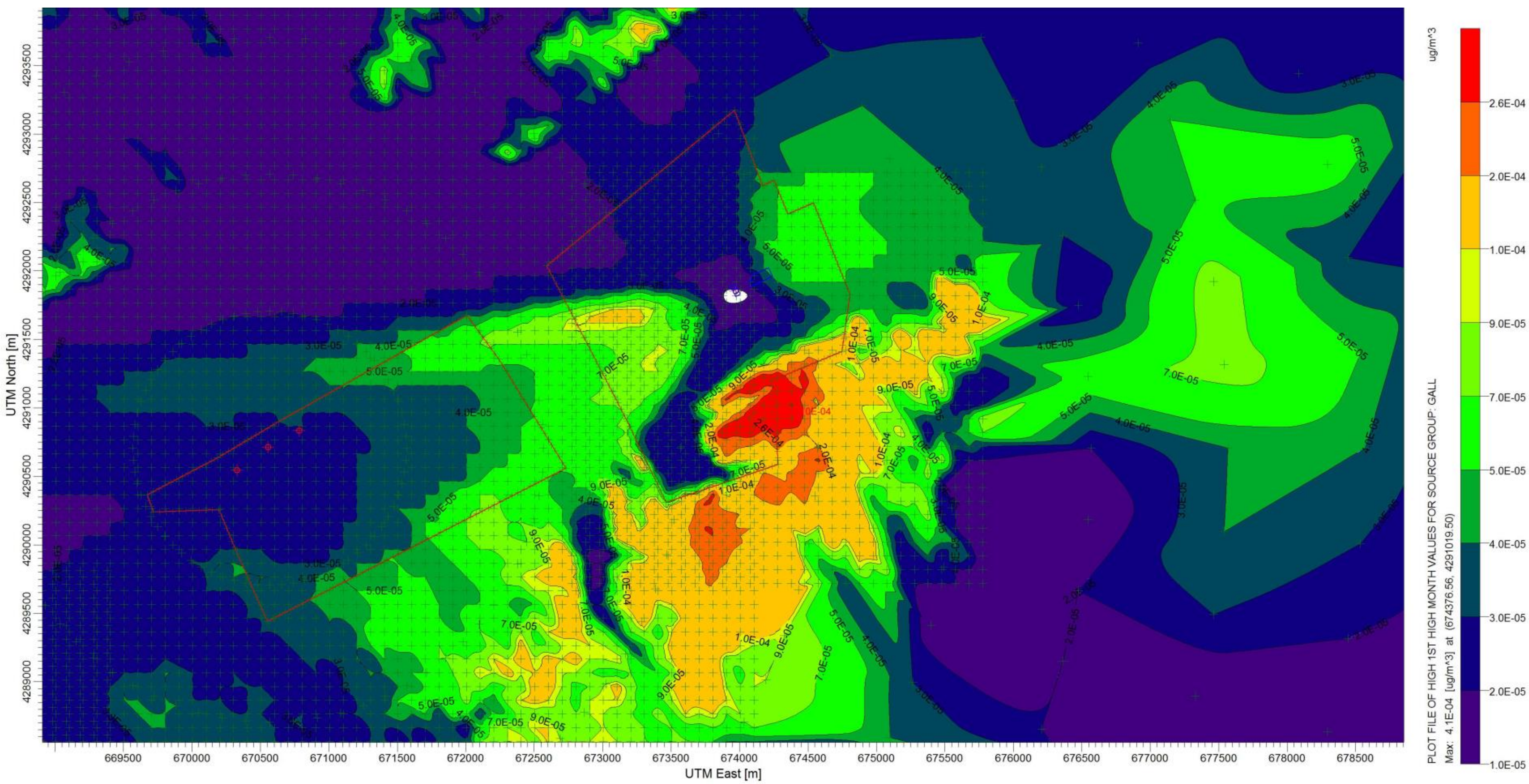


Figure 4.2 KU Ghent Group - High 1st High Monthly Average Concentration, North American Stainless Source

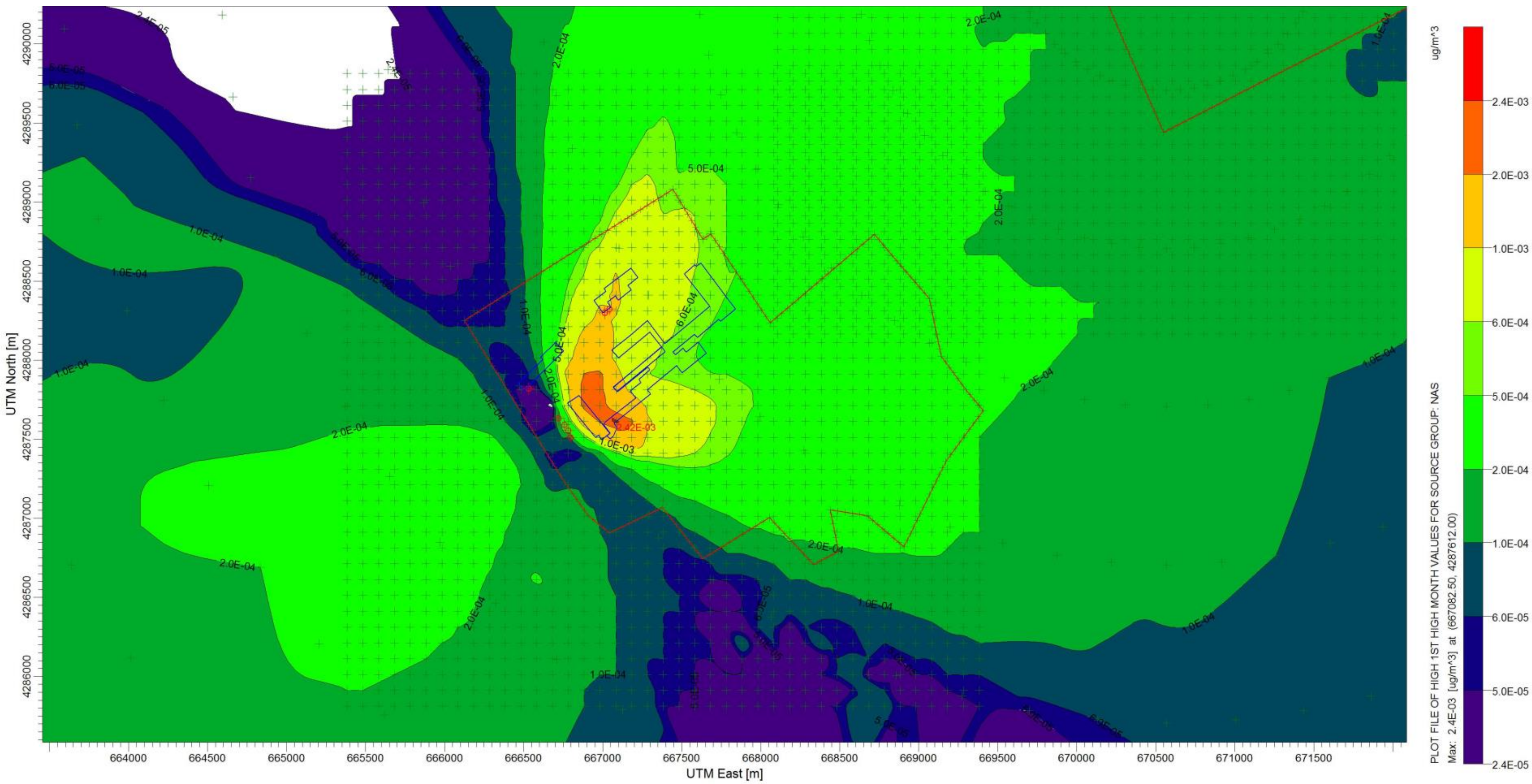


Figure 4.3 KU Ghent Group - High 1st High Monthly Average Concentration, KU Ghent Source

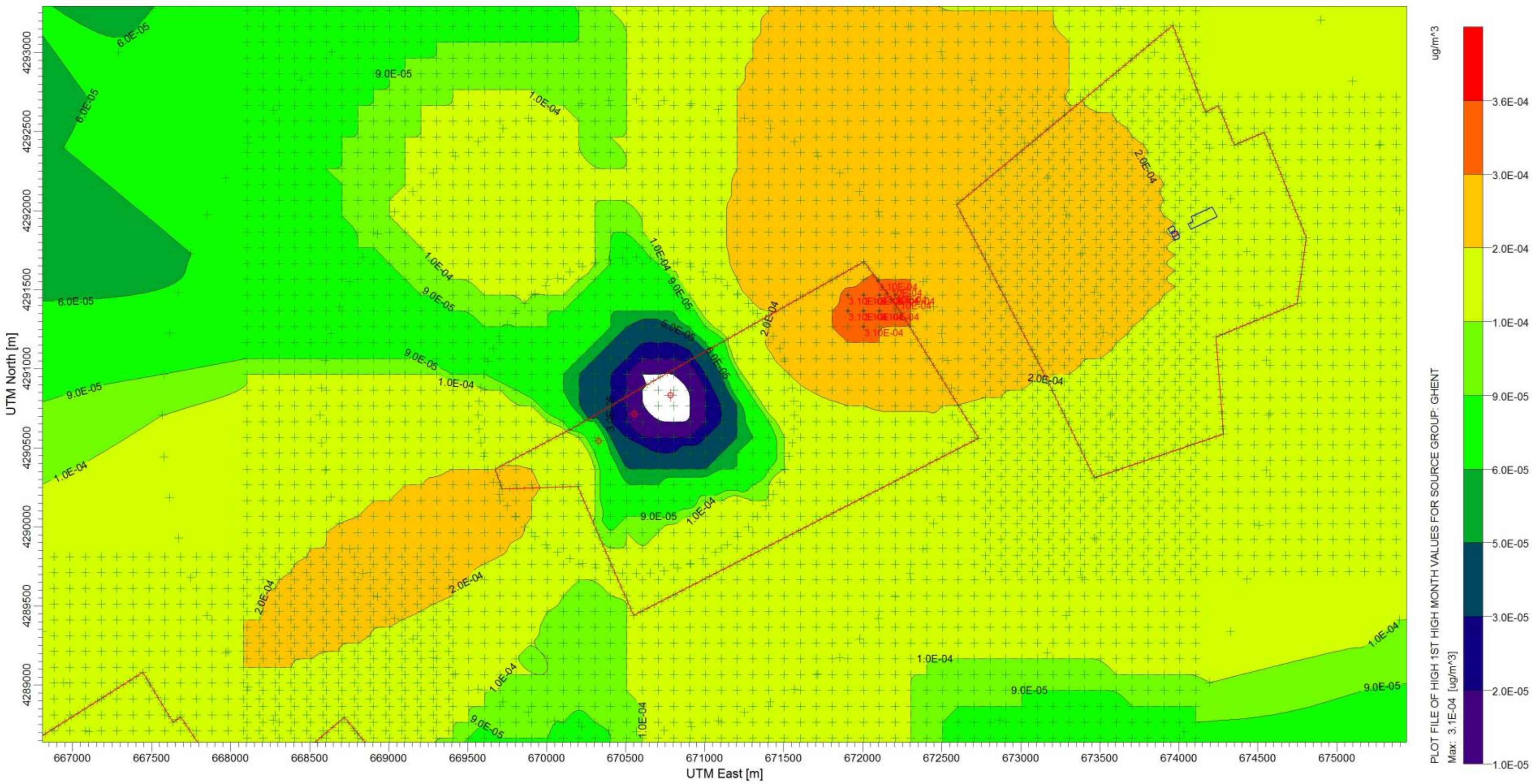


Figure 4.4 KU Ghent Group - 3 Month Rolling Average Concentration, Domain

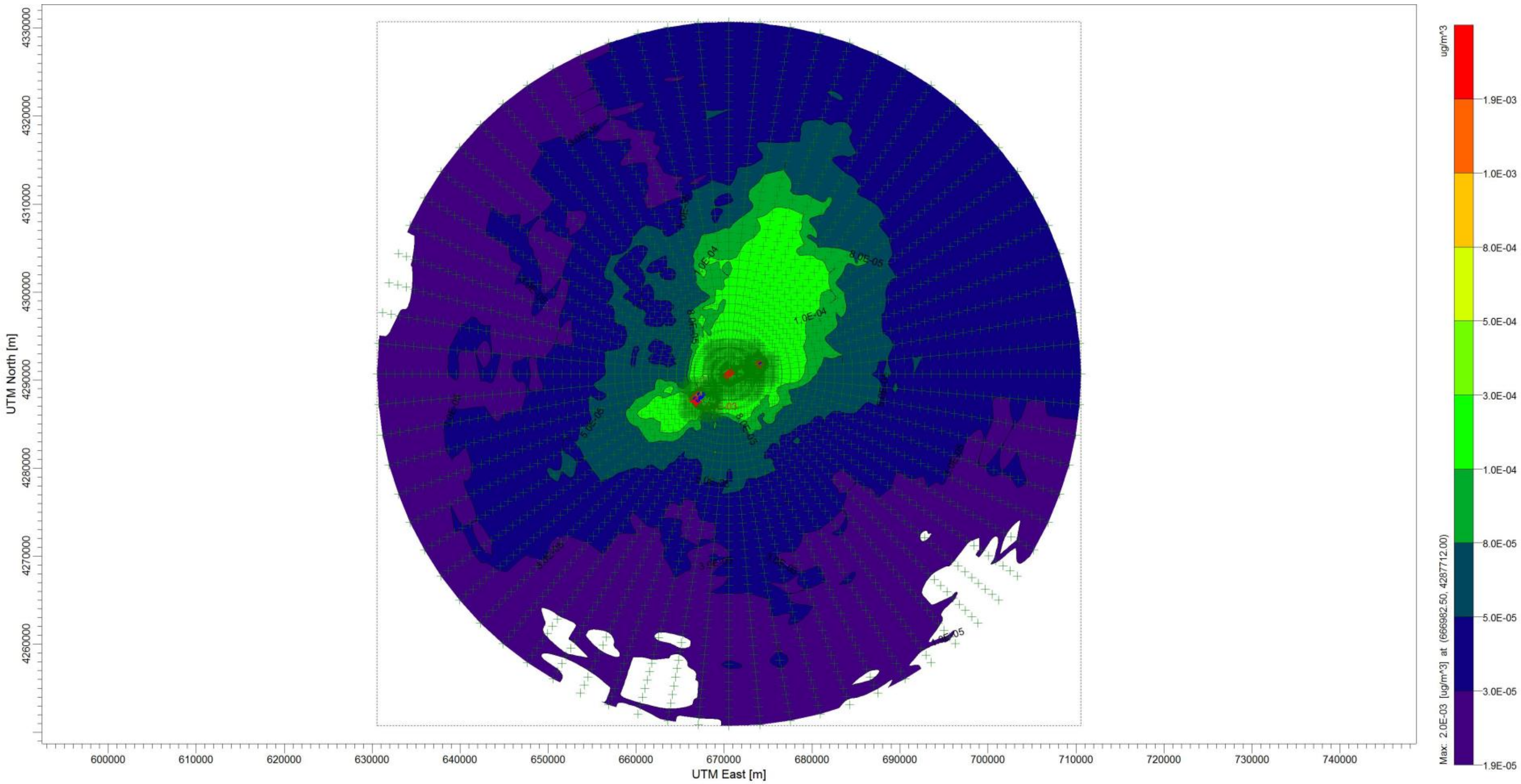


Figure 4.5 KU Ghent Group - 3 Month Rolling Average Concentration, SIA

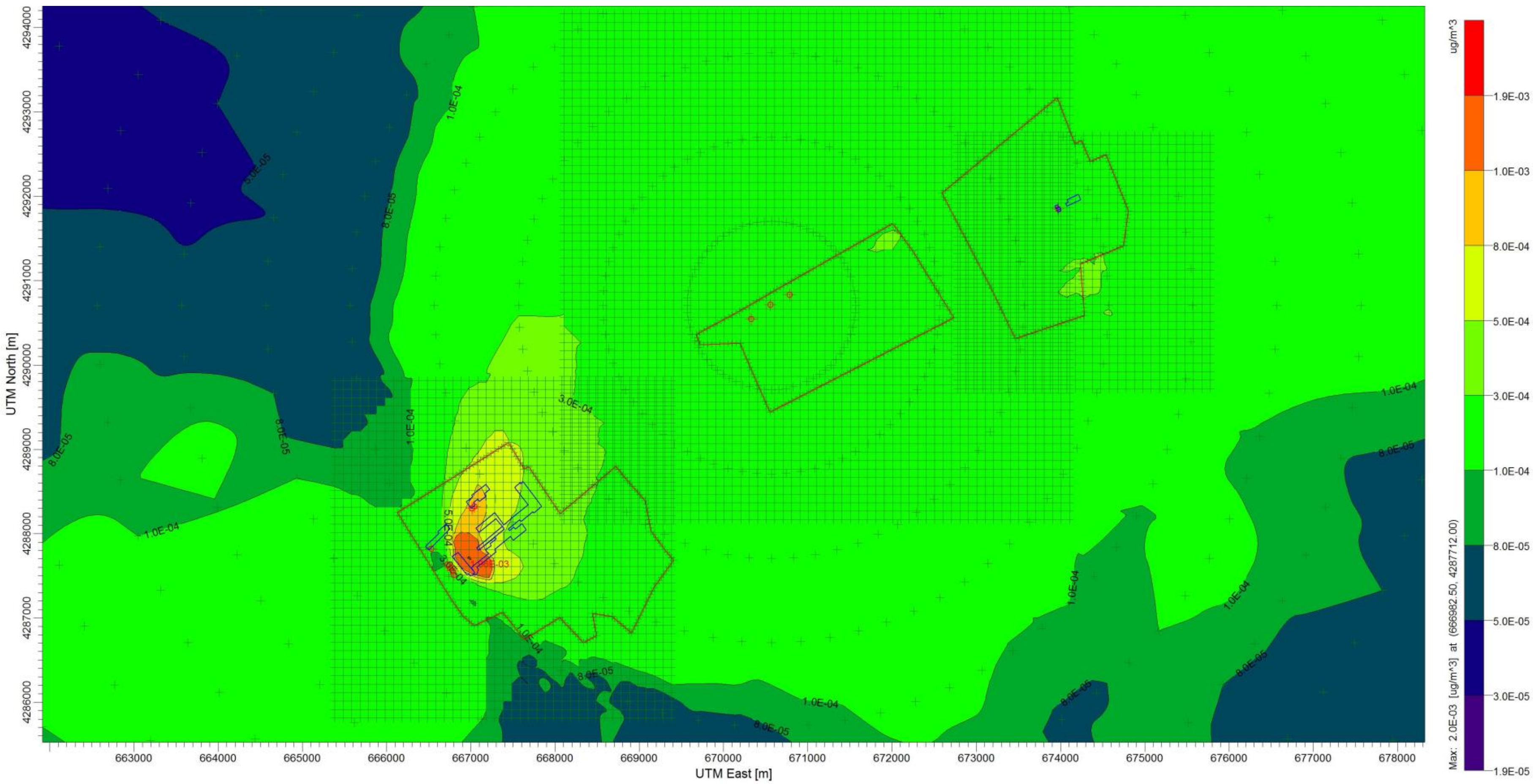


Figure 5.0 TVA Shawnee Group - High 1st High Monthly Average Concentration, All Sources

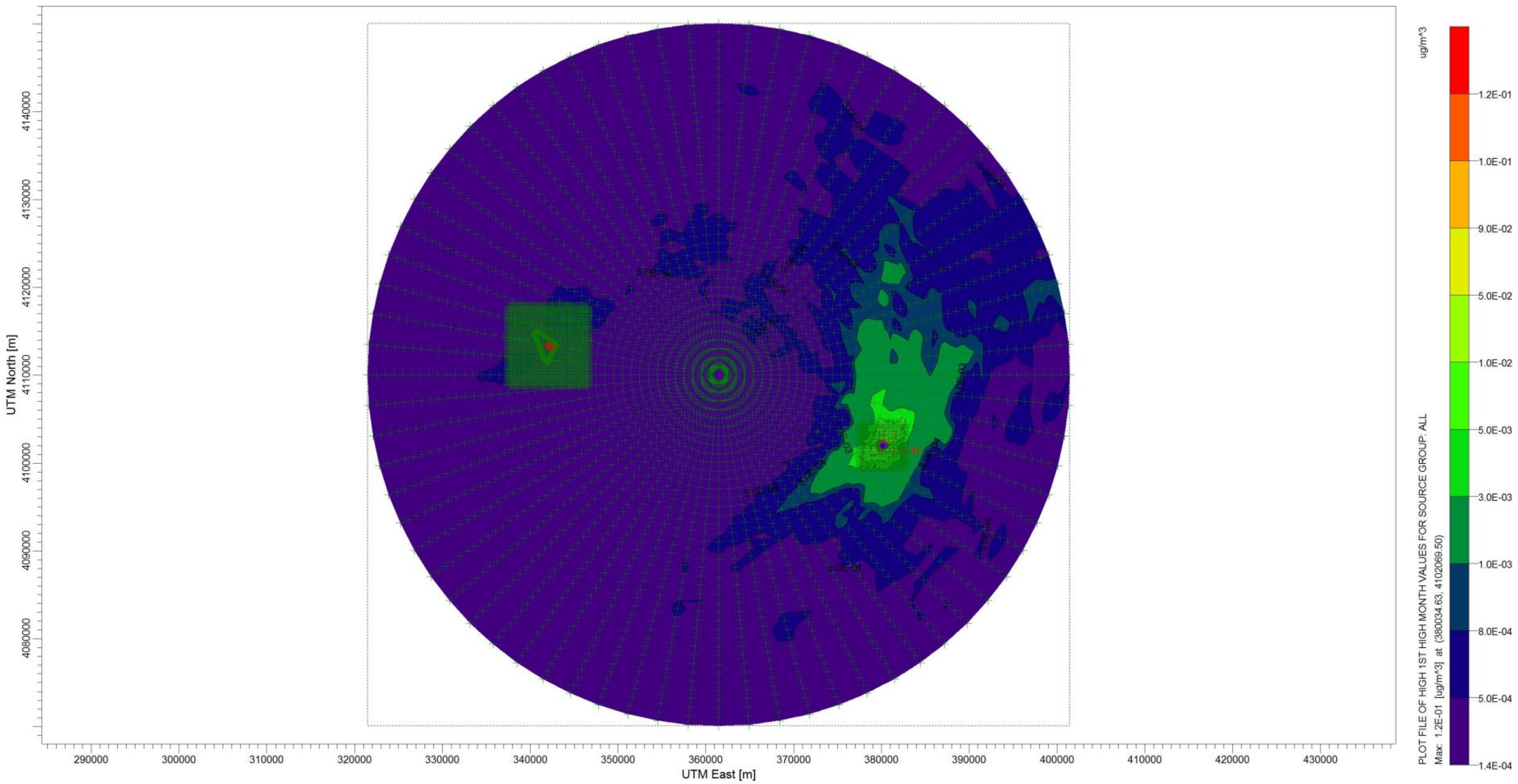


Figure 5.1 TVA Shawnee Group - High 1st High Monthly Average Concentration, CCMA Recycling Source

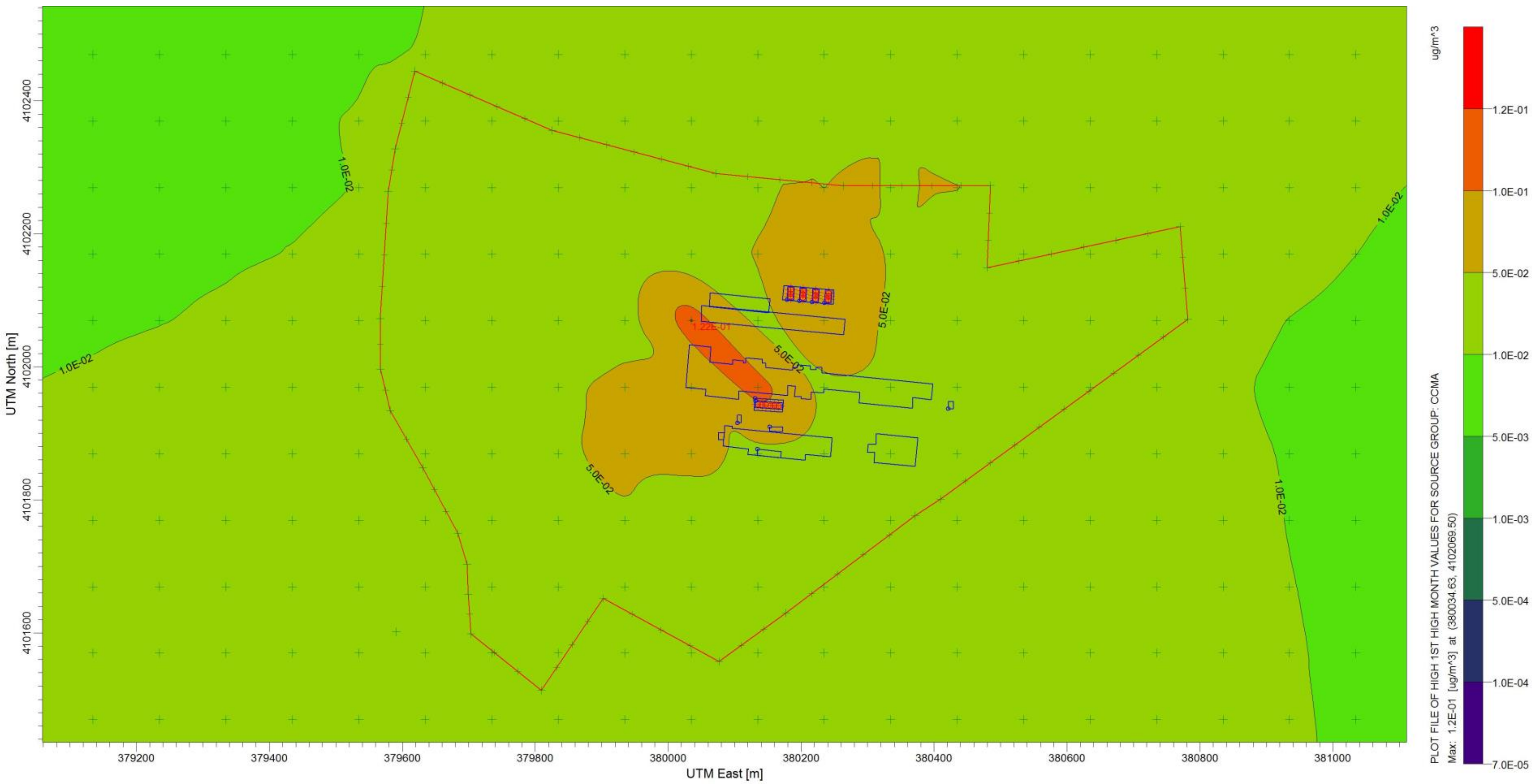


Figure 5.2 TVA Shawnee Group - High 1st High Monthly Average Concentration, TVA Shawnee Source

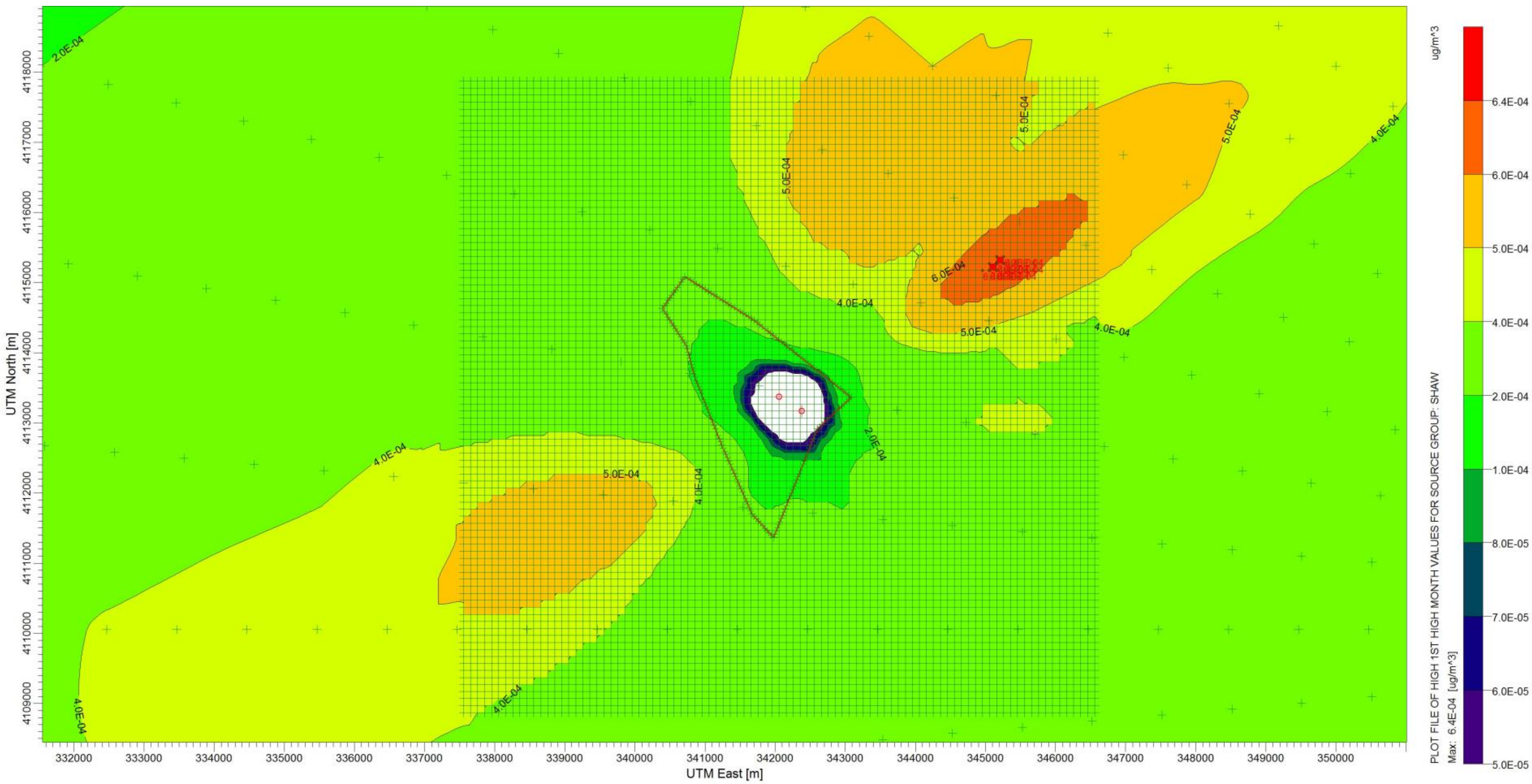


Figure 5.3 TVA Shawnee Group - 3 Month Rolling Average Concentration, Domain

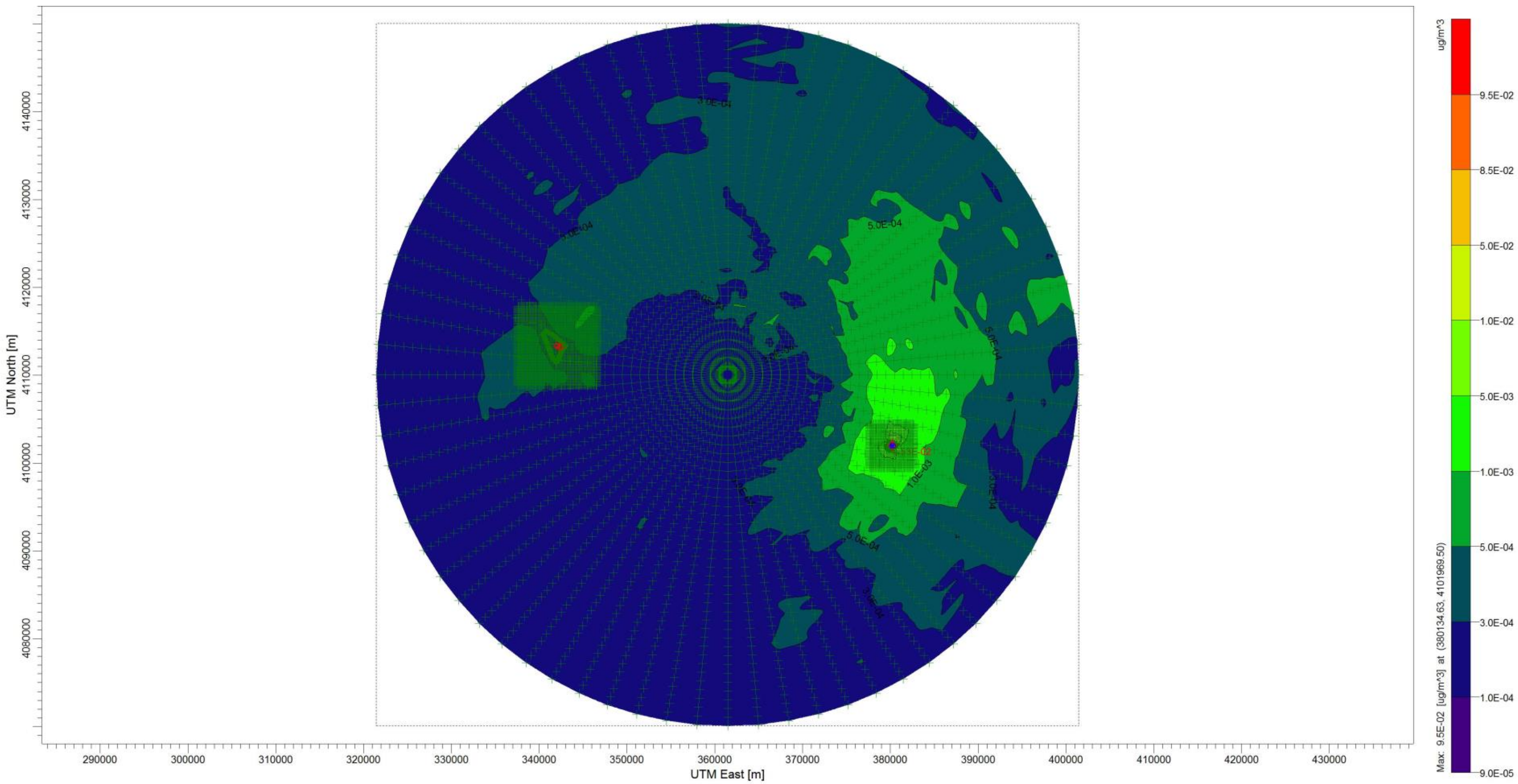
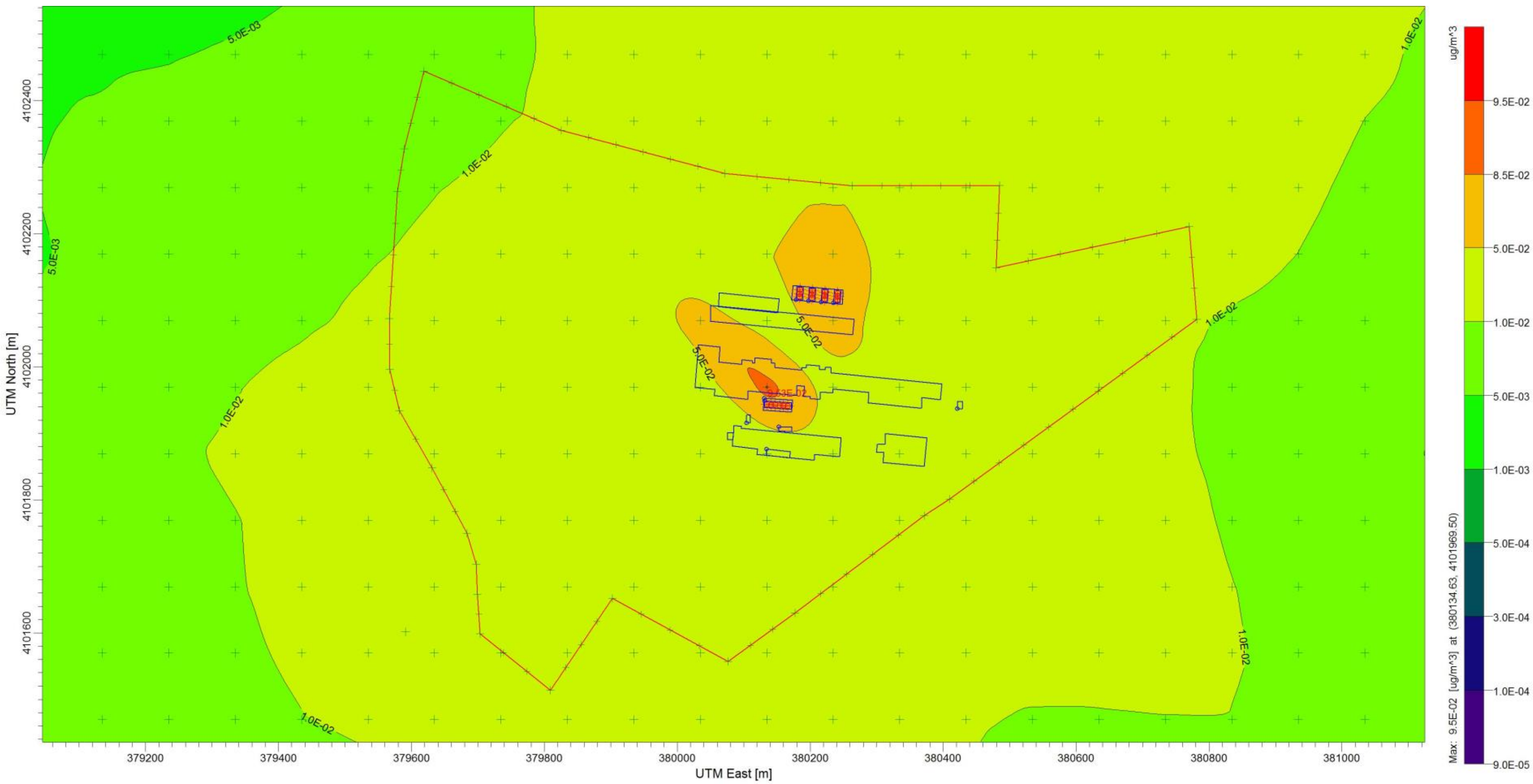


Figure 5.4 TVA Shawnee Group - 3 Month Rolling Average Concentration, SIA



Appendix I. Additional Modeled Impacts

Figure 1.0 AK Steel_pb - High 1st High Monthly Average Concentration, Domain

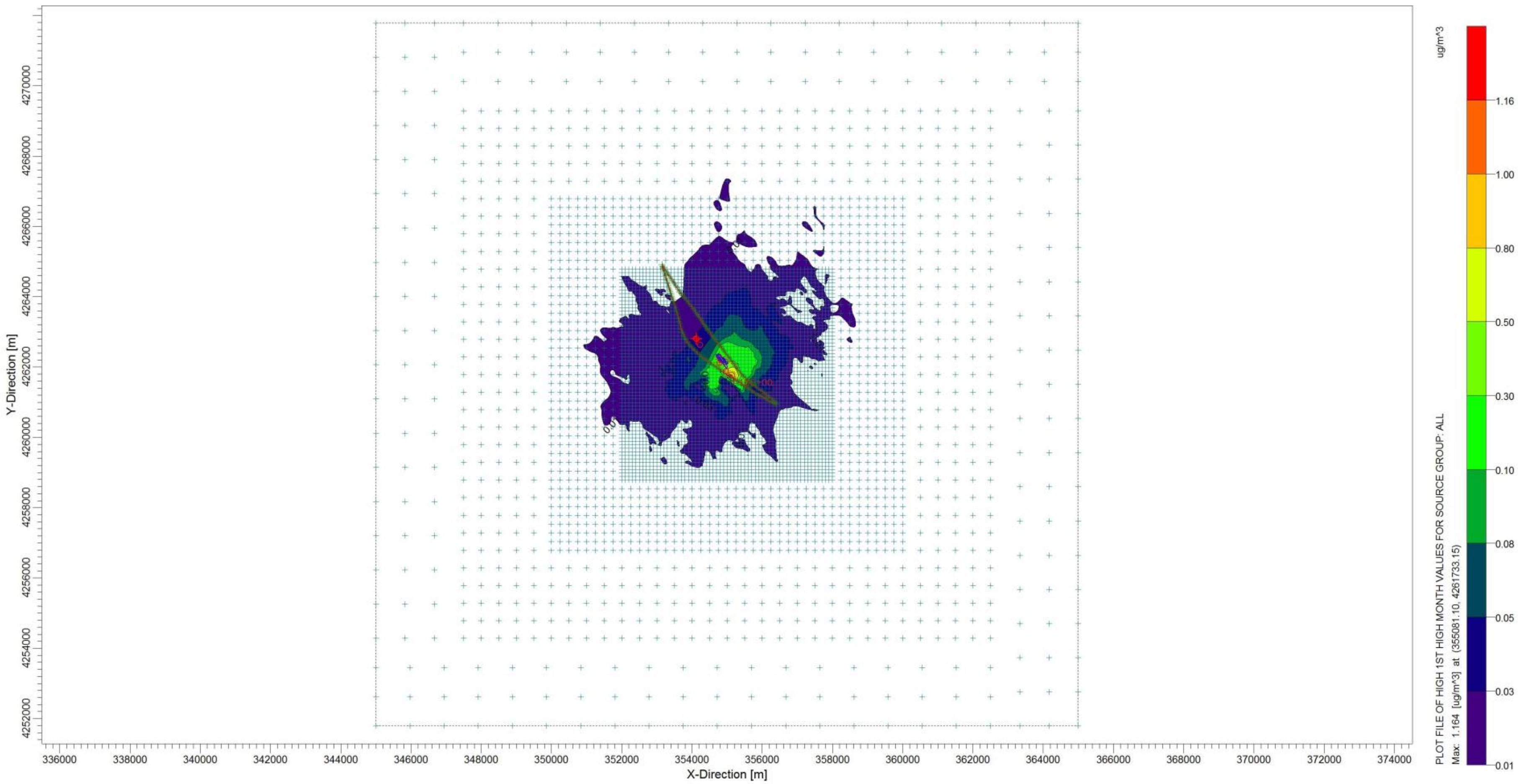


Figure 1.1 AK Steel_pb - High 1st High Monthly Average Concentration, SIA

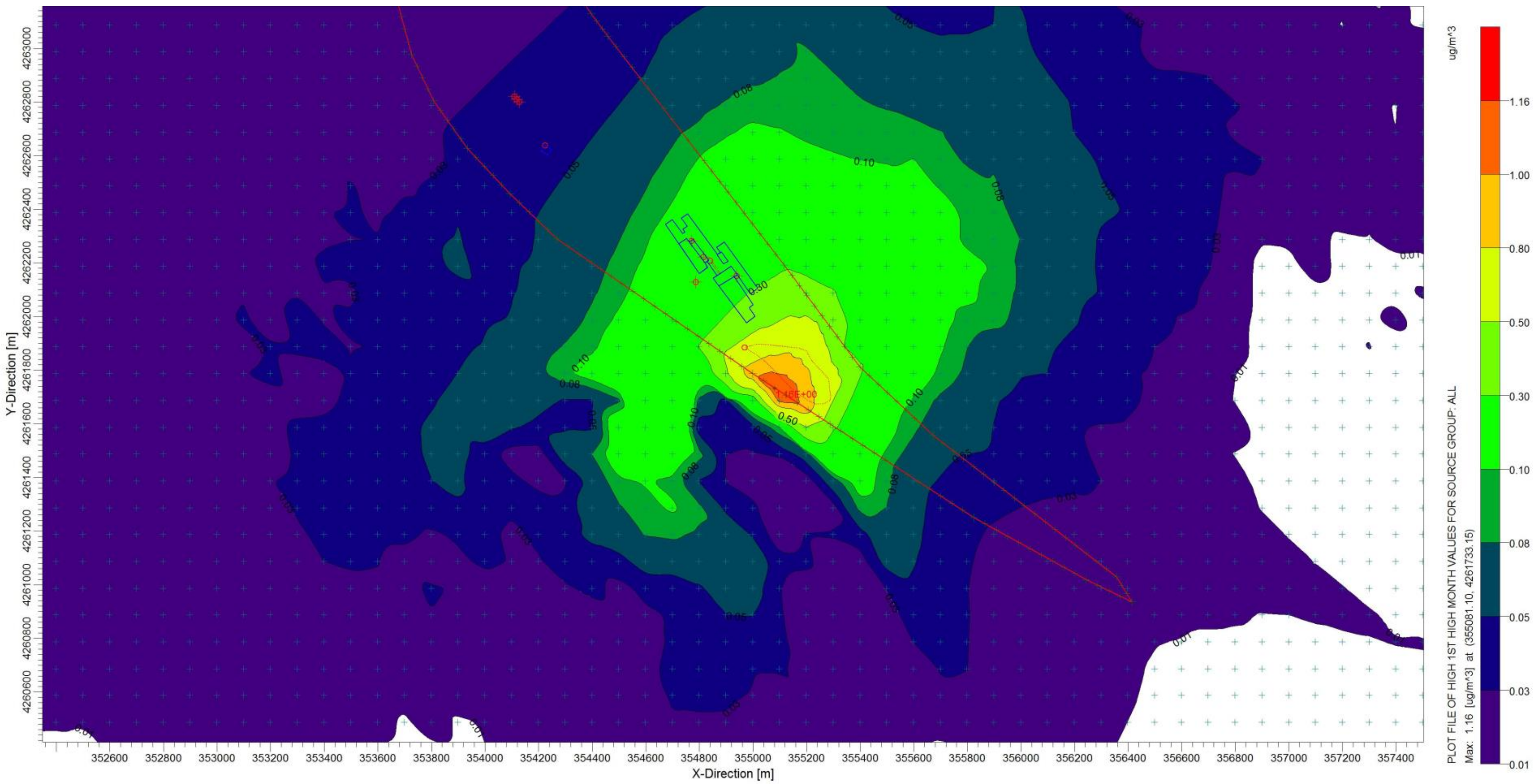


Figure 1.2 AK Steel_pb - 3 Month Rolling Average Concentration, Domain

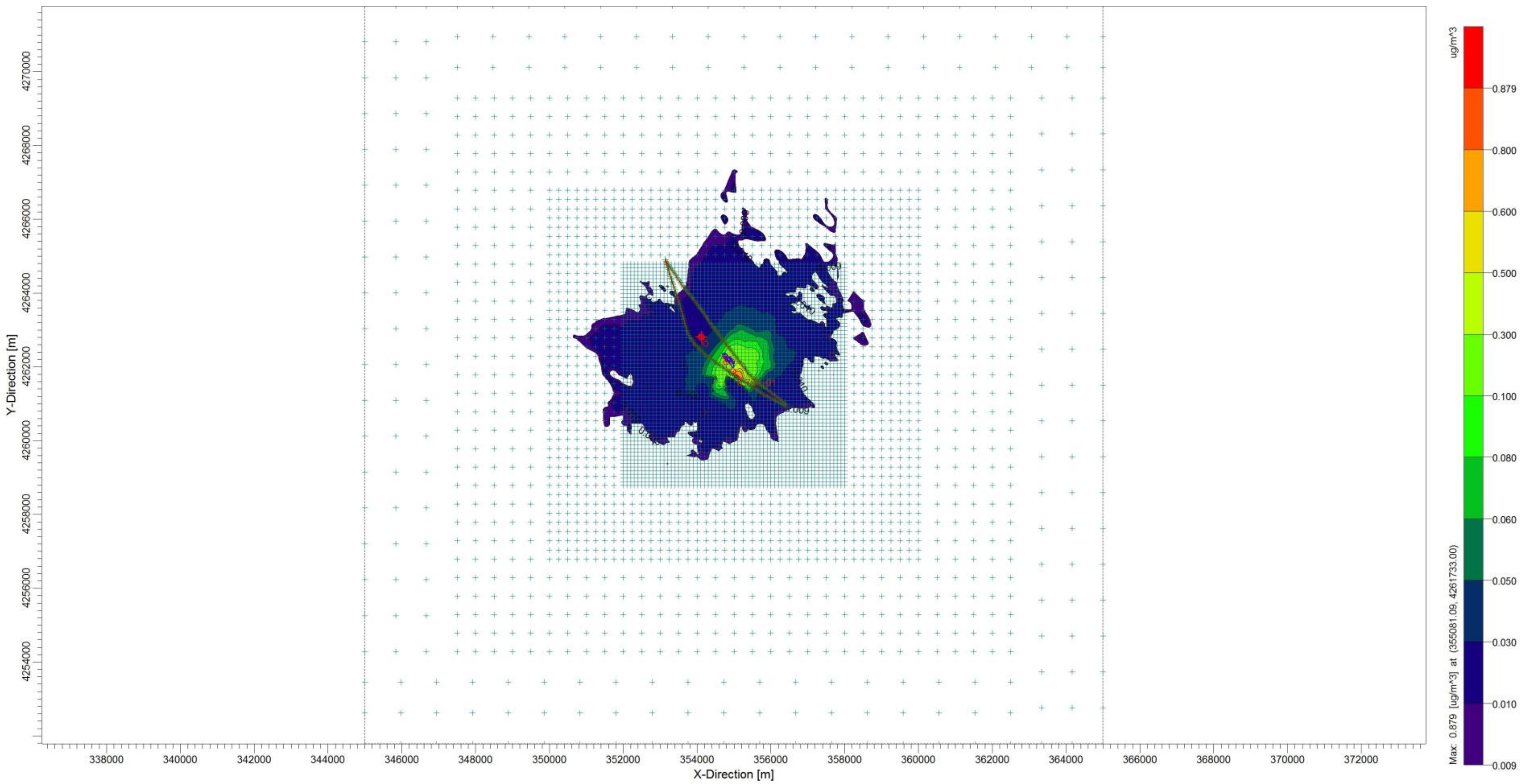


Figure 1.3 AK Steel_pb - 3 Month Rolling Average Concentration, SIA

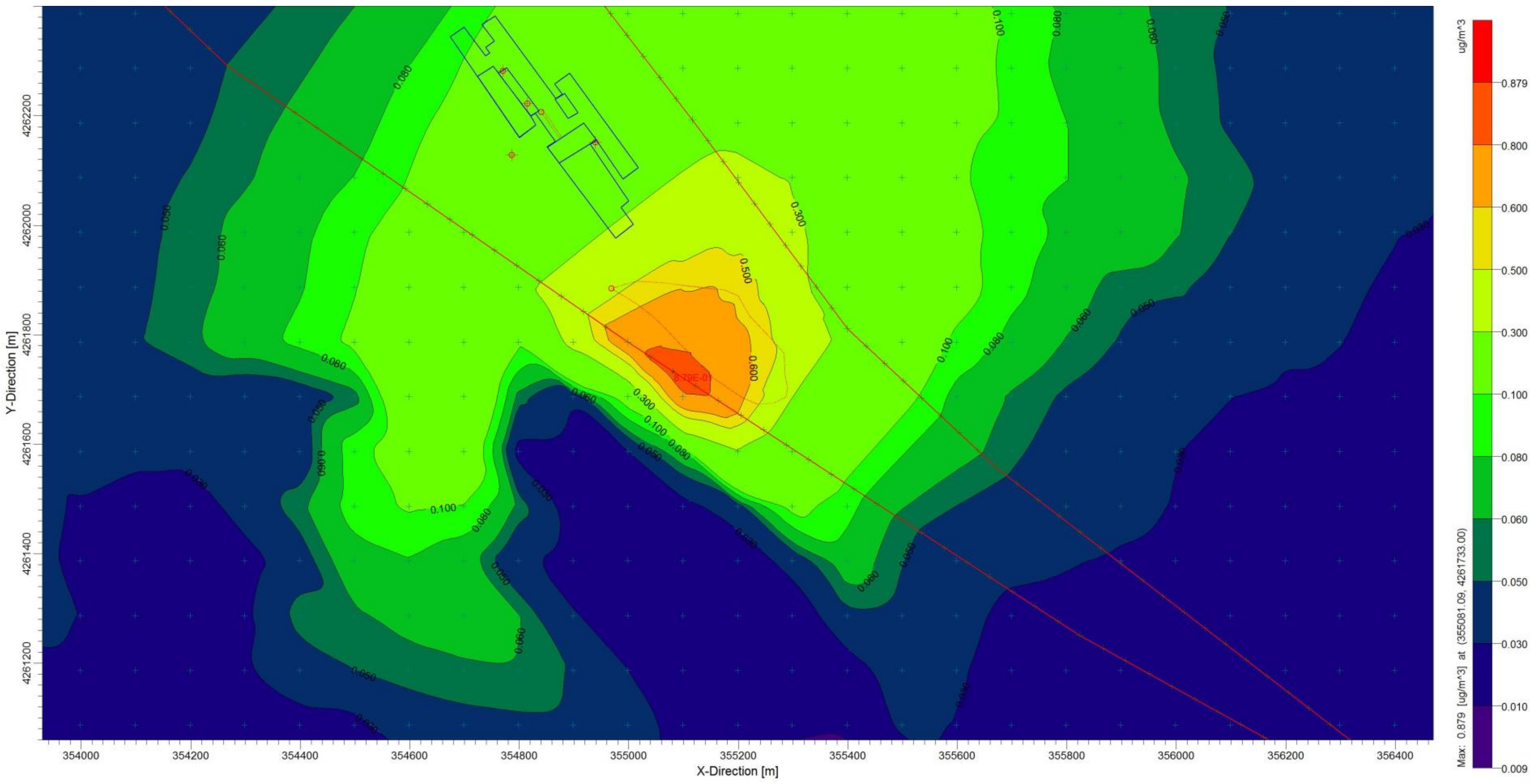


Figure 2.0 TVA Shawnee_fl - High 1st High Monthly Average Concentration, All Sources

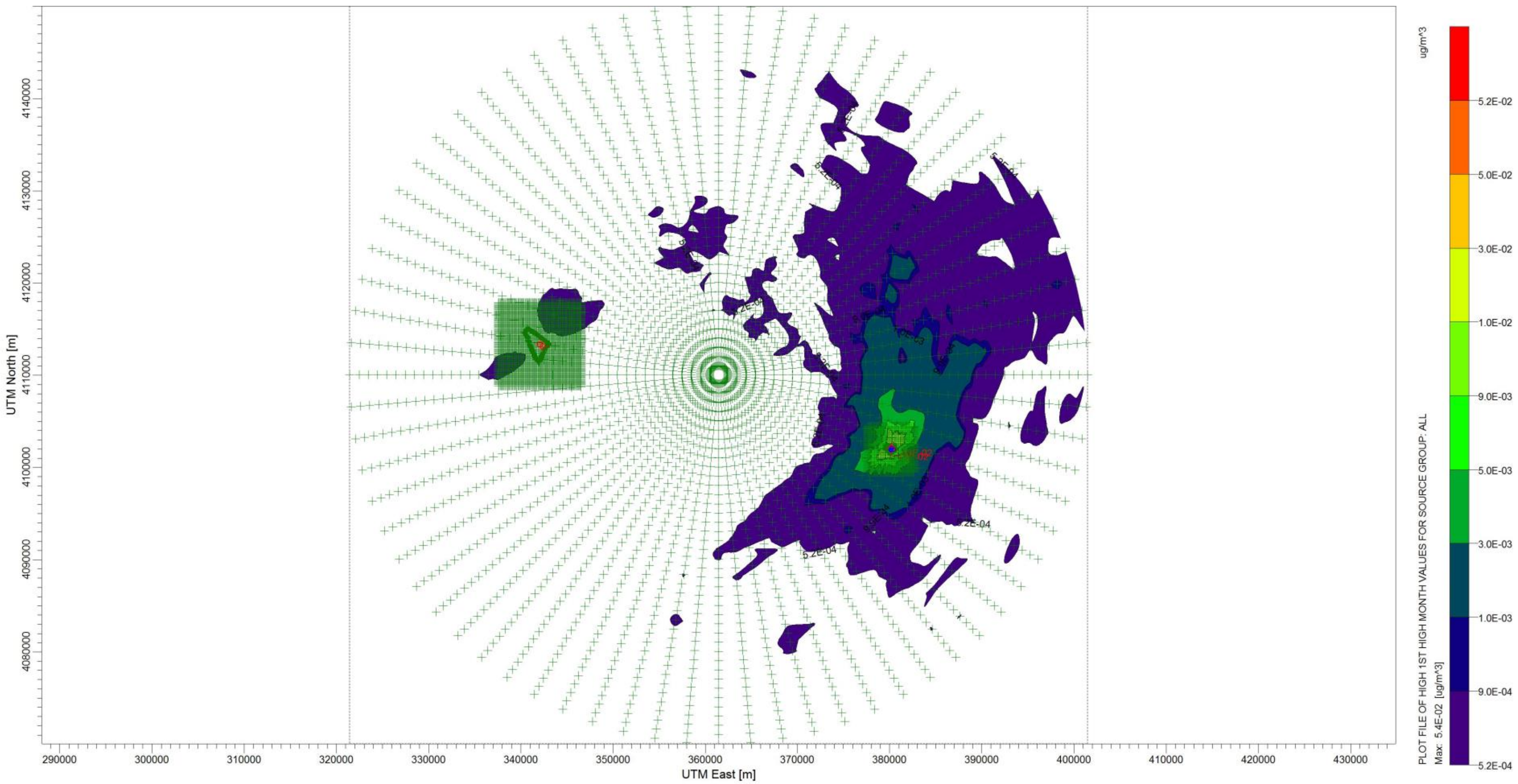


Figure 2.1 TVA Shawnee_fl - High 1st High Monthly Average Concentration, CCMA Recycling Source

Figure 2.2 TVA Shawnee_fl - High 1st High Monthly Average Concentration, TVA Shawnee Source

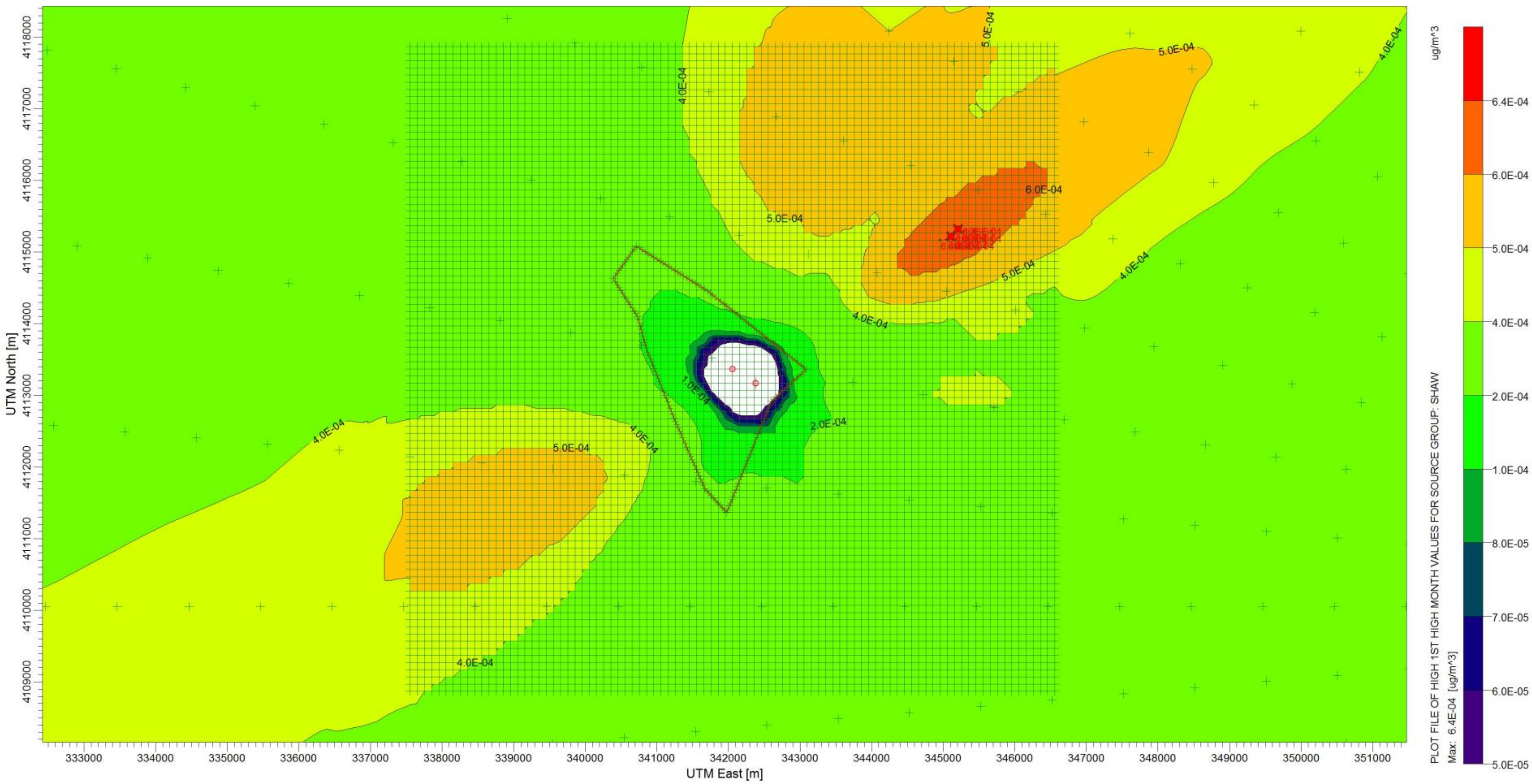


Figure 2.3 TVA Shawnee_fl - 3 Month Rolling Average Concentration, Domain

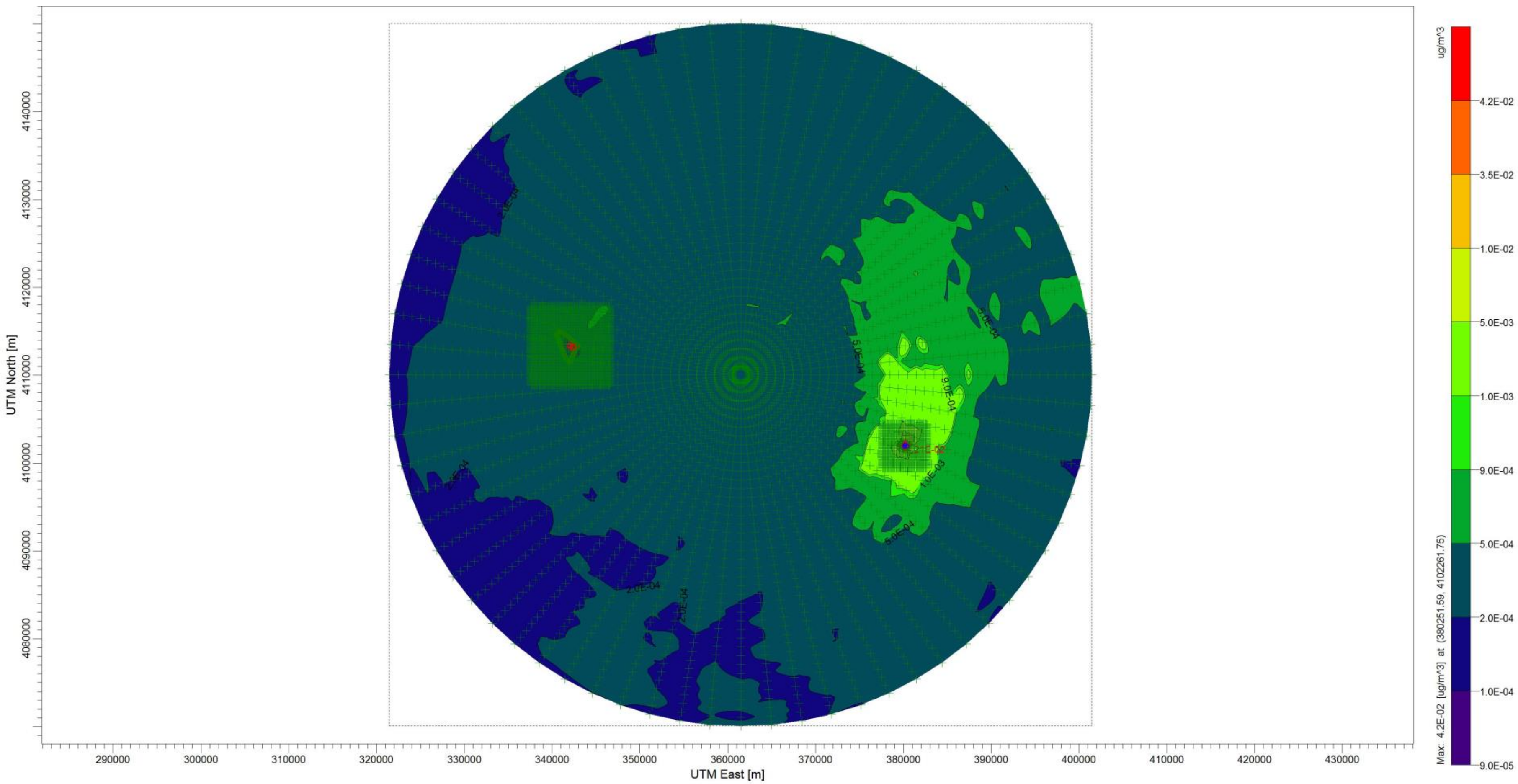
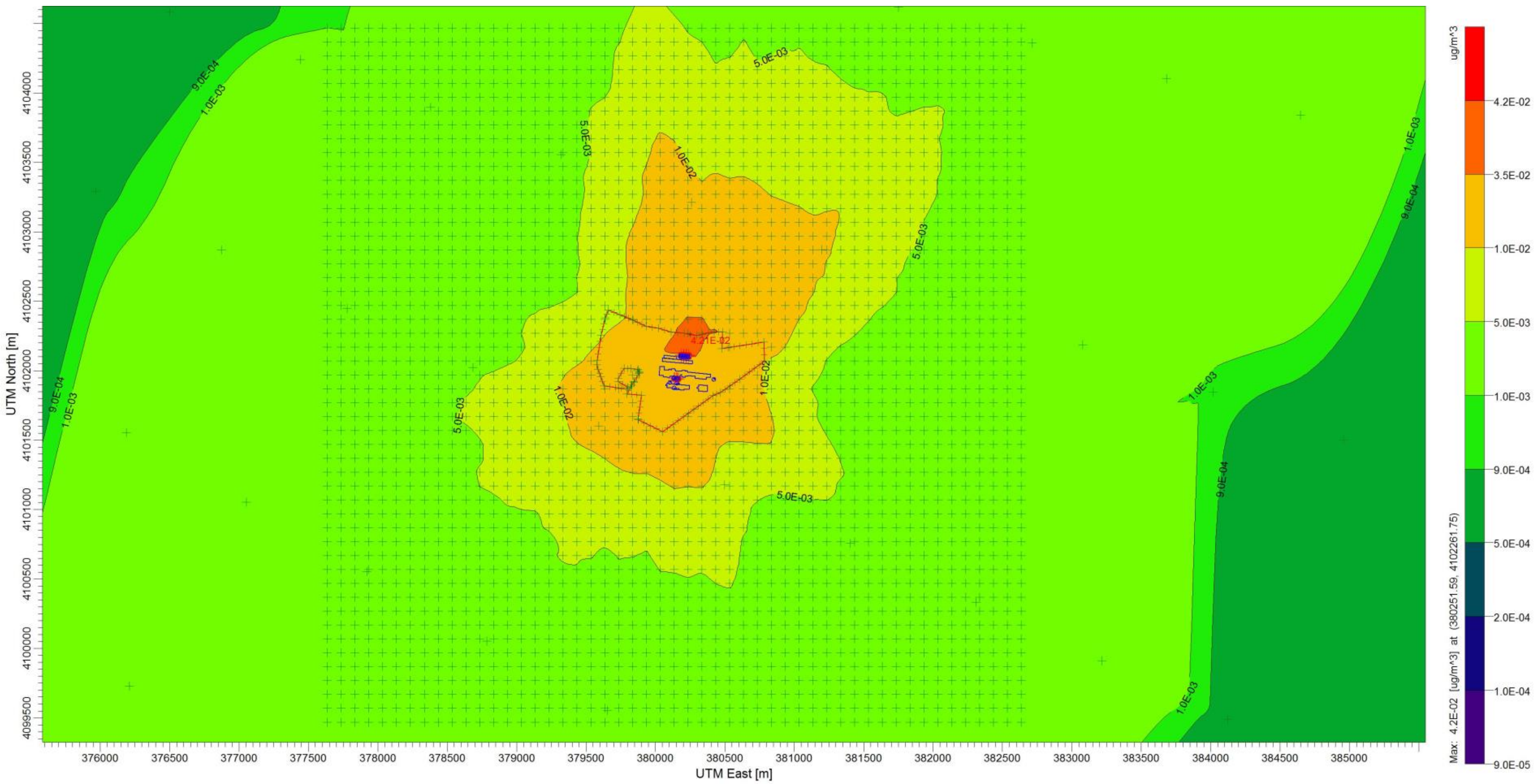


Figure 2.4 TVA Shawnee_fl - 3 Month Rolling Average Concentration, SIA



Appendix J. Files on CD

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2015.doc
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 Directory of H:\System Volume Information

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06/15/2015  02:27 AM    <DIR>          ..
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               1 File(s)             76 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
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06/12/2015  03:39 PM    <DIR>          01 - Modeling
06/05/2015  12:46 PM    <DIR>          02 - Additional Modeling
06/05/2015  12:55 PM    <DIR>          03 - Equivalency Demonstration
06/05/2015  02:07 PM    <DIR>          04 - Images
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-Permits

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06/03/2015  04:53 PM    <DIR>          shaw group
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\cal group

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/05/2015  09:15 AM    <DIR>          aks
06/05/2015  09:18 AM    <DIR>          bs
06/05/2015  09:19 AM    <DIR>          cal
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\cal group\aks

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
```

```
06/16/2015  09:56 AM         1,176,049 aks.rar
               1 File(s)      1,176,049 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\cal group\bs

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  09:57 AM           359,547 bs.rar
               1 File(s)        359,547 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\cal group\cal

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  09:57 AM         1,453,029 cal.rar
               1 File(s)      1,453,029 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\para group

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/05/2015  09:22 AM    <DIR>          aler
06/05/2015  09:23 AM    <DIR>          green
06/05/2015  09:29 AM    <DIR>          para
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\para group\aler

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  10:09 AM           877,239 aler.rar
               1 File(s)        877,239 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\para group\green

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  10:10 AM           348,751 green.rar
               1 File(s)        348,751 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\para group\para

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  10:10 AM         1,645,020 para.rar
               1 File(s)      1,645,020 bytes
```

```
 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\ener group

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/05/2015  09:38 AM    <DIR>          bgad
06/05/2015  10:45 AM    <DIR>          ener
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\ener group\bgad

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  10:06 AM         1,766,038 bgad.rar
               1 File(s)      1,766,038 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\ener group\ener

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  10:07 AM           876,202 ener.rar
               1 File(s)        876,202 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\ghent group

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/05/2015  10:46 AM    <DIR>          gall
06/05/2015  10:49 AM    <DIR>          ghent
06/05/2015  10:51 AM    <DIR>          nas
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\ghent group\gall

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  10:07 AM         1,297,558 gall.rar
               1 File(s)      1,297,558 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\ghent group\ghent

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  10:07 AM           889,883 ghent.rar
               1 File(s)        889,883 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\ghent group\nas
```

```
06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  10:09 AM         1,478,019 nas.rar
               1 File(s)      1,478,019 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\shaw group

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/05/2015  10:54 AM    <DIR>          ccma
06/05/2015  10:57 AM    <DIR>          shaw
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\shaw group\ccma

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  10:10 AM           712,243 ccma.rar
               1 File(s)        712,243 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\05 - KY_EIS-
Permits\shaw group\shaw

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
06/16/2015  10:11 AM           884,583 shaw.rar
               1 File(s)        884,583 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 - Modeling

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
05/28/2015  04:25 PM    <DIR>          10para
05/27/2015  01:43 PM    <DIR>          11cal
05/26/2015  04:14 PM    <DIR>          11ener
06/05/2015  05:36 PM    <DIR>          11ghent
05/29/2015  04:34 PM    <DIR>          11shaw
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 - Modeling\10para

06/15/2015  02:29 AM    <DIR>          .
06/15/2015  02:29 AM    <DIR>          ..
05/12/2015  02:29 PM            19,027 10para.ADI
05/12/2015  03:44 PM         5,251,902 10para.ADO
05/11/2015  01:02 PM           281,647 10para.api
05/11/2015  01:13 PM           285,835 10para.ast
02/05/2015  01:27 PM               851 10para.bpi
05/12/2015  03:44 PM           177,069 10para.ERR
06/10/2015  06:08 PM             4,192 10para.isc
02/05/2015  01:27 PM            16,172 10para.pro
05/12/2015  03:44 PM               619 10para.rdf
```

```
05/11/2015  01:13 PM           442,979 10PARA.ROU
02/02/2015  03:19 PM             2,111 10para.rpb
05/11/2015  01:13 PM               972 10PARA.SOU
05/12/2015  03:44 PM            15,322 10para.SUM
02/05/2015  01:27 PM            55,472 10para.sup
05/11/2015  01:13 PM           339,121 10para_AERMAP.log
02/06/2015  04:22 AM            85,904 10para_AERMOD.log
02/05/2015  01:27 PM             2,089 10para_BPIP.log
02/02/2015  03:19 PM         2,936,208 bowling green-
nashville09_13.PFL
02/02/2015  03:19 PM         7,800,818 bowling green-
nashville09_13.SFC
05/11/2015  01:02 PM             5,891 MAPDETAIL.OUT
05/11/2015  01:04 PM             9,289 MAPPARAMS.OUT
05/12/2010  03:12 PM        79,121,327 NED_03419465.tif
05/12/2010  03:12 PM        79,148,895 NED_21382258.tif
05/12/2010  03:29 PM        79,148,895 NED_96854853.tif
05/29/2015  02:54 PM    <DIR>          10para.AD
05/29/2015  04:53 PM    <DIR>          10para.dat
              24 File(s)    255,152,607 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\10para\10para.AD

06/15/2015  02:30 AM    <DIR>          .
06/15/2015  02:30 AM    <DIR>          ..
05/29/2015  02:54 PM       321,267,104
01_2009_12_2013_3_month_concs.txt
05/29/2015  02:54 PM         1,384,772
01_2009_12_2013_3_month_max_concs_rec.txt
05/29/2015  02:54 PM                58 inputfiles.txt
05/29/2015  02:54 PM             4,761 lead.log
05/29/2015  02:54 PM             1,113 lead.out
05/12/2015  03:44 PM           950,343 MOH1G001.PLT
05/12/2015  03:44 PM           950,343 MOH1G002.PLT
05/12/2015  03:44 PM           950,343 MOH1G003.PLT
05/12/2015  03:44 PM           950,343 MOH1GALL.PLT
05/12/2015  03:44 PM        52,679,329 MO_GALERIS.POS
05/12/2015  03:44 PM        52,679,329 MO_GALL.POS
05/12/2015  03:44 PM        52,679,329 MO_GGREEN.POS
05/12/2015  03:44 PM        52,679,329 MO_GPARA.POS
05/11/2015  12:32 PM    <DIR>          Percentile
              13 File(s)    537,176,496 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\10para\10para.AD\Percentile

06/15/2015  02:31 AM    <DIR>          .
06/15/2015  02:31 AM    <DIR>          ..
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\10para\10para.dat
```

```
06/15/2015  02:31 AM    <DIR>          .
06/15/2015  02:31 AM    <DIR>          ..
06/16/2015  12:24 PM        40,356,088 10para.dat.rar
               1 File(s)     40,356,088 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 - Modeling\11cal

06/15/2015  02:33 AM    <DIR>          .
06/15/2015  02:33 AM    <DIR>          ..
05/12/2015  09:41 AM            28,018 11cal.ADI
05/12/2015  02:11 PM         5,896,830 11cal.ADO
05/11/2015  02:14 PM           313,927 11cal.api
05/11/2015  02:29 PM           317,759 11cal.ast
05/12/2015  09:40 AM             4,229 11cal.bpi
05/12/2015  02:11 PM           203,479 11cal.err
06/07/2015  05:54 PM             1,858 11cal.isc
05/12/2015  09:40 AM            23,129 11cal.pro
05/12/2015  02:11 PM               129 11cal.rdf
05/11/2015  02:29 PM           493,632 11CAL.ROU
05/11/2015  02:29 PM             1,366 11CAL.SOU
05/12/2015  02:11 PM            15,322 11cal.SUM
05/12/2015  09:40 AM           206,226 11cal.sup
05/11/2015  02:29 PM           371,519 11cal_AERMAP.log
05/12/2015  09:41 AM             2,977 11cal_AERMOD.log
05/12/2015  09:40 AM             2,137 11cal_BPIP.log
02/02/2015  11:17 AM         2,936,208 huntington-wilmington09_13.PFL
02/02/2015  11:17 AM         7,800,818 huntington-wilmington09_13.SFC
05/11/2015  02:14 PM             3,987 MAPDETAIL.OUT
05/11/2015  02:15 PM             6,599 MAPPARAMS.OUT
05/12/2010  03:13 PM        81,190,415 NED_36592253.tif
05/12/2010  03:28 PM        81,190,415 NED_90570001.tif
05/29/2015  01:37 PM    <DIR>          11cal.AD
06/01/2015  09:12 AM    <DIR>          11cal.dat
              22 File(s)    181,010,979 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11cal\11cal.AD

06/15/2015  02:33 AM    <DIR>          .
06/15/2015  02:33 AM    <DIR>          ..
05/29/2015  01:37 PM       190,092,680
01_2009_12_2013_3_month_concs.txt
05/29/2015  01:37 PM           819,365
01_2009_12_2013_3_month_max_concs_rec.txt
05/29/2015  01:36 PM                57 inputfiles.txt
05/29/2015  01:37 PM             4,759 lead.log
05/29/2015  01:37 PM             1,113 lead.out
05/12/2015  02:11 PM         1,059,004 MOH1G001.PLT
05/12/2015  02:11 PM         1,059,004 MOH1G002.PLT
05/12/2015  02:11 PM         1,059,004 MOH1G003.PLT
05/12/2015  02:11 PM         1,059,004 MOH1GALL.PLT
05/12/2015  02:11 PM        58,708,789 MO_G0AK.POS
05/12/2015  02:11 PM        58,708,789 MO_GALL.POS
05/12/2015  02:11 PM        58,708,789 MO_GCALCAR.POS
```

```
05/12/2015  02:11 PM        58,708,789 MO_GSANDY.POS
05/11/2015  12:34 PM    <DIR>          Percentile
              13 File(s)    429,989,146 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11cal\11cal.AD\Percentile

06/15/2015  02:34 AM    <DIR>          .
06/15/2015  02:34 AM    <DIR>          ..
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11cal\11cal.dat

06/15/2015  02:34 AM    <DIR>          .
06/15/2015  02:34 AM    <DIR>          ..
06/16/2015  12:36 PM        40,760,649 11cal.dat.rar
               1 File(s)     40,760,649 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 - Modeling\11ener

06/15/2015  02:36 AM    <DIR>          .
06/15/2015  02:36 AM    <DIR>          ..
05/11/2015  09:55 PM            52,918 11ener.ADI
05/12/2015  12:07 AM         5,121,330 11ener.ADO
05/11/2015  11:58 AM           342,061 11ener.api
05/11/2015  12:41 PM           346,605 11ener.ast
02/05/2015  10:33 AM             9,420 11ener.bpi
05/12/2015  12:07 AM            78,269 11ener.ERR
06/07/2015  06:10 PM             3,193 11ener.isc
02/05/2015  10:33 AM            46,319 11ener.pro
05/11/2015  04:28 PM               368 11ener.rdf
05/11/2015  12:41 PM           536,785 11ENER.ROU
02/02/2015  03:03 PM             3,434 11ener.rpb
05/11/2015  12:41 PM             1,999 11ENER.SOU
05/12/2015  12:07 AM            15,330 11ener.SUM
02/05/2015  10:33 AM           675,573 11ener.sup
05/11/2015  12:42 PM           401,675 11ener_AERMAP.log
02/05/2015  10:33 AM             2,137 11ener_BPIP.log
02/02/2015  03:03 PM         2,936,208 lexington-wilmington09_13.PFL
02/02/2015  03:03 PM         7,800,818 lexington-wilmington09_13.SFC
05/11/2015  11:58 AM             7,795 MAPDETAIL.OUT
05/11/2015  12:01 PM            12,183 MAPPARAMS.OUT
05/12/2010  03:28 PM        81,190,415 NED_02881991.tif
05/12/2010  03:13 PM        81,190,415 NED_71412103.tif
05/12/2010  03:28 PM        81,190,415 NED_90570001.tif
05/12/2010  03:29 PM        81,190,415 NED_93146364.tif
05/29/2015  04:54 PM    <DIR>          11ener.AD
05/29/2015  05:05 PM    <DIR>          11ener.dat
              24 File(s)    343,156,080 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11ener\11ener.AD
```

```
06/15/2015  02:36 AM    <DIR>          .
06/15/2015  02:36 AM    <DIR>          ..
05/29/2015  04:54 PM       292,023,156
01_2009_12_2013_3_month_concs.txt
05/29/2015  04:54 PM         1,678,294
01_2009_12_2013_3_month_max_concs_rec.txt
05/29/2015  04:54 PM                41 inputfiles.txt
05/29/2015  04:54 PM             4,648 lead.log
05/29/2015  04:54 PM               965 lead.out
05/12/2015  12:07 AM         1,151,534 MOH1G001.PLT
05/12/2015  12:07 AM         1,151,534 MOH1G002.PLT
05/12/2015  12:07 AM         1,151,534 MOH1GALL.PLT
05/12/2015  12:07 AM        63,845,269 MO_GALL.POS
05/12/2015  12:07 AM        63,845,269 MO_GBGAD.POS
05/12/2015  12:07 AM        63,845,269 MO_GENER.POS
05/11/2015  03:31 PM    <DIR>          Percentile
              11 File(s)    488,697,513 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11ener\11ener.AD\Percentile

06/15/2015  02:38 AM    <DIR>          .
06/15/2015  02:38 AM    <DIR>          ..
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11ener\11ener.dat

06/15/2015  02:38 AM    <DIR>          .
06/15/2015  02:38 AM    <DIR>          ..
06/16/2015  12:38 PM        40,968,581 11ener.dat.rar
               1 File(s)     40,968,581 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 - Modeling\11ghent

06/15/2015  02:39 AM    <DIR>          .
06/15/2015  02:39 AM    <DIR>          ..
06/05/2015  01:49 PM            31,557 11ghent.ADI
06/05/2015  02:48 PM         7,242,667 11ghent.ADO
05/11/2015  10:08 AM           385,413 11ghent.api
05/11/2015  10:39 AM           389,245 11ghent.ast
02/24/2015  05:53 PM             5,197 11ghent.bpi
06/05/2015  02:48 PM            60,409 11ghent.ERR
06/07/2015  06:14 PM             3,516 11ghent.isc
02/24/2015  05:53 PM            27,767 11ghent.pro
06/05/2015  02:48 PM               323 11ghent.rdf
05/11/2015  10:39 AM           607,528 11GHENT.ROU
02/02/2015  02:28 PM             4,022 11ghent.rpb
05/11/2015  10:39 AM             1,289 11GHENT.SOU
06/05/2015  02:48 PM            15,514 11ghent.SUM
02/24/2015  05:53 PM           258,982 11ghent.sup
05/11/2015  10:39 AM           448,023 11ghent_AERMAP.log
02/24/2015  05:53 PM             2,137 11ghent_BPIP.log
12/11/2014  05:39 PM         2,936,208 cincinnati-wilmington09_13.PFL
```

```
12/11/2014  05:39 PM         7,800,818 cincinnati-wilmington09_13.SFC
05/11/2015  10:08 AM             3,987 MAPDETAIL.OUT
05/11/2015  10:10 AM             6,805 MAPPARAMS.OUT
05/12/2010  03:28 PM        81,190,415 NED_01758718.tif
05/12/2010  03:28 PM        81,157,263 NED_70270543.tif
06/05/2015  02:50 PM    <DIR>          11ghent.AD
06/05/2015  05:24 PM    <DIR>          11ghent.dat
              22 File(s)    182,579,085 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11ghent\11ghent.AD

06/15/2015  02:39 AM    <DIR>          .
06/15/2015  02:39 AM    <DIR>          ..
06/05/2015  02:50 PM       440,718,336
01_2009_12_2013_3_month_concs.txt
06/05/2015  02:50 PM         1,899,648
01_2009_12_2013_3_month_max_concs_rec.txt
06/05/2015  02:50 PM                55 inputfiles.txt
06/05/2015  02:50 PM             4,757 lead.log
06/05/2015  02:50 PM             1,113 lead.out
06/05/2015  02:48 PM         1,303,325 MOH1G001.PLT
06/05/2015  02:48 PM         1,303,325 MOH1G002.PLT
06/05/2015  02:48 PM         1,303,325 MOH1G003.PLT
06/05/2015  02:48 PM         1,303,325 MOH1GALL.PLT
06/05/2015  02:48 PM        72,265,849 MO_GALL.POS
06/05/2015  02:48 PM        72,265,849 MO_GGALL.POS
06/05/2015  02:48 PM        72,265,849 MO_GGHENT.POS
06/05/2015  02:48 PM        72,265,849 MO_GNAS.POS
05/11/2015  02:51 PM    <DIR>          Percentile
              13 File(s)    736,900,605 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11ghent\11ghent.AD\Percentile

06/15/2015  02:41 AM    <DIR>          .
06/15/2015  02:41 AM    <DIR>          ..
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11ghent\11ghent.dat

06/15/2015  02:41 AM    <DIR>          .
06/15/2015  02:41 AM    <DIR>          ..
06/16/2015  12:39 PM        39,974,158 11ghent.dat.rar
               1 File(s)     39,974,158 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 - Modeling\11shaw

06/15/2015  02:43 AM    <DIR>          .
06/15/2015  02:43 AM    <DIR>          ..
05/11/2015  05:50 PM            55,161 11shaw.ADI
05/11/2015  09:55 PM         8,232,079 11shaw.ADO
05/11/2015  01:24 PM           551,671 11shaw.api
```

```
05/11/2015  02:38 PM           555,147 11shaw.ast
02/05/2015  01:22 PM             7,659 11shaw.bpi
05/11/2015  09:55 PM           137,739 11shaw.ERR
06/07/2015  06:44 PM             2,902 11shaw.isc
02/05/2015  01:22 PM            48,638 11shaw.pro
05/11/2015  04:23 PM               373 11shaw.rdf
05/11/2015  02:38 PM           871,027 11SHAW.ROU
05/11/2015  02:38 PM             1,999 11SHAW.SOU
05/11/2015  09:55 PM            15,072 11shaw.SUM
02/05/2015  01:22 PM           667,955 11shaw.sup
05/11/2015  02:38 PM           637,382 11shaw_AERMAP.log
02/05/2015  01:22 PM             2,137 11shaw_BPIP.log
05/11/2015  01:24 PM             2,083 MAPDETAIL.OUT
05/11/2015  01:25 PM             2,583 MAPPARAMS.OUT
02/09/2012  10:23 AM        83,594,363 NED_63619997.tif
02/02/2015  03:32 PM         2,936,208 paducah-nashville09_13.PFL
02/02/2015  03:32 PM         7,800,818 paducah-nashville09_13.SFC
05/29/2015  04:31 PM    <DIR>          11shaw.AD
06/02/2015  02:37 PM    <DIR>          11shaw.dat
              20 File(s)    106,122,996 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11shaw\11shaw.AD

06/15/2015  02:43 AM    <DIR>          .
06/15/2015  02:43 AM    <DIR>          ..
05/29/2015  04:31 PM       474,001,752
01_2009_12_2013_3_month_concs.txt
05/29/2015  04:30 PM         2,724,148
01_2009_12_2013_3_month_max_concs_rec.txt
05/29/2015  04:30 PM                41 inputfiles.txt
05/29/2015  04:31 PM             4,648 lead.log
05/29/2015  04:31 PM               965 lead.out
05/11/2015  09:55 PM         1,868,542 MOH1G001.PLT
05/11/2015  09:55 PM         1,868,542 MOH1G002.PLT
05/11/2015  09:55 PM         1,868,542 MOH1GALL.PLT
05/11/2015  09:55 PM       103,630,854 MO_GALL.POS
05/11/2015  09:55 PM       103,630,854 MO_GCCMA.POS
05/11/2015  09:55 PM       103,630,854 MO_GSHAW.POS
05/11/2015  03:29 PM    <DIR>          Percentile
              11 File(s)    793,229,742 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11shaw\11shaw.AD\Percentile

06/15/2015  02:45 AM    <DIR>          .
06/15/2015  02:45 AM    <DIR>          ..
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\01 -
Modeling\11shaw\11shaw.dat

06/15/2015  02:45 AM    <DIR>          .
06/15/2015  02:45 AM    <DIR>          ..
```

```
06/16/2015  12:40 PM        40,309,040 11shaw.dat.rar
               1 File(s)     40,309,040 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling

06/15/2015  02:46 AM    <DIR>          .
06/15/2015  02:46 AM    <DIR>          ..
06/05/2015  12:54 PM    <DIR>          aks
06/05/2015  12:54 PM    <DIR>          shaw
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\aks

06/15/2015  02:46 AM    <DIR>          .
06/15/2015  02:46 AM    <DIR>          ..
06/05/2015  12:55 PM    <DIR>          plant boundary
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\aks\plant boundary

06/15/2015  02:46 AM    <DIR>          .
06/15/2015  02:46 AM    <DIR>          ..
06/01/2015  02:42 PM    <DIR>          11aks - pb
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\aks\plant boundary\11aks - pb

06/15/2015  02:46 AM    <DIR>          .
06/15/2015  02:46 AM    <DIR>          ..
03/27/2015  04:41 PM            22,529 11aks.ADI
03/30/2015  04:22 AM         5,028,944 11aks.ADO
03/10/2015  04:55 PM           220,386 11aks.api
03/10/2015  05:03 PM           223,862 11aks.ast
03/10/2015  05:18 PM             2,856 11aks.bpi
03/30/2015  04:22 AM           203,479 11aks.err
06/08/2015  03:23 PM             1,211 11aks.isc
03/10/2015  05:18 PM            18,491 11aks.pro
03/30/2015  07:41 PM               246 11aks.rdf
03/10/2015  05:03 PM           345,638 11AKS.ROU
03/10/2015  05:03 PM             1,208 11AKS.SOU
03/30/2015  04:22 AM            15,590 11aks.SUM
03/10/2015  05:18 PM           155,168 11aks.sup
03/10/2015  05:03 PM           259,422 11aks_AERMAP.log
03/10/2015  05:18 PM             2,137 11aks_BPIP.log
03/10/2015  04:17 PM         2,936,208 huntington-wilmington09_13.PFL
03/10/2015  04:17 PM         7,800,818 huntington-wilmington09_13.SFC
03/10/2015  04:56 PM             2,083 MAPDETAIL.OUT
03/10/2015  04:56 PM             2,583 MAPPARAMS.OUT
05/12/2010  03:13 PM        81,190,415 NED_36592253.tif
05/12/2010  03:28 PM        81,190,415 NED_90570001.tif
```

```
06/01/2015  02:42 PM    <DIR>          11aks.AD
06/02/2015  05:54 PM    <DIR>          11aks.dat
              21 File(s)    179,623,689 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\aks\plant boundary\11aks - pb\11aks.AD

06/15/2015  02:47 AM    <DIR>          .
06/15/2015  02:47 AM    <DIR>          ..
03/31/2015  10:00 AM       313,255,680
01_2009_12_2013_3_month_concs.txt
03/31/2015  10:00 AM         1,080,192
01_2009_12_2013_3_month_max_concs_rec.txt
03/31/2015  10:00 AM                80 inputfiles.txt
03/31/2015  10:00 AM             4,888 lead.log
03/31/2015  10:00 AM             1,261 lead.out
03/30/2015  07:41 PM           741,531 MOH1G001.PLT
03/30/2015  07:41 PM           741,531 MOH1G002.PLT
03/30/2015  07:41 PM           741,531 MOH1G003.PLT
03/30/2015  07:41 PM           741,531 MOH1G004.PLT
03/30/2015  07:41 PM           741,531 MOH1GALL.PLT
03/30/2015  04:22 AM        41,092,727 MO_GALL.POS
03/30/2015  04:22 AM        41,092,727 MO_GAMANDACA.POS
03/30/2015  04:22 AM        41,092,727 MO_GBOILERS.POS
03/30/2015  04:22 AM        41,092,727 MO_GBOSHOP.POS
03/30/2015  04:22 AM        41,092,727 MO_GBOSLAG.POS
03/11/2015  11:23 PM        41,092,727 MO_GBOSLANGP.POS
03/31/2015  10:09 AM    <DIR>          Percentile
              16 File(s)    564,606,118 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\aks\plant boundary\11aks - pb\11aks.AD\Percentile

06/15/2015  02:48 AM    <DIR>          .
06/15/2015  02:48 AM    <DIR>          ..
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\aks\plant boundary\11aks - pb\11aks.dat

06/15/2015  02:48 AM    <DIR>          .
06/15/2015  02:48 AM    <DIR>          ..
06/16/2015  12:42 PM        23,944,130 11aks-pb.dat.rar
               1 File(s)     23,944,130 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\shaw

06/15/2015  02:49 AM    <DIR>          .
06/15/2015  02:49 AM    <DIR>          ..
06/12/2015  03:41 PM    <DIR>          fenceline
               0 File(s)              0 bytes
```

```
 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\shaw\fenceline

06/15/2015  02:49 AM    <DIR>          .
06/15/2015  02:49 AM    <DIR>          ..
06/01/2015  06:58 PM    <DIR>          11shaw - fl
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\shaw\fenceline\11shaw - fl

06/15/2015  02:49 AM    <DIR>          .
06/15/2015  02:49 AM    <DIR>          ..
06/01/2015  02:51 PM            55,231 11shaw - fl.ADI
06/01/2015  06:58 PM         8,209,322 11shaw - fl.ADO
06/01/2015  01:39 PM           550,385 11shaw - fl.api
06/01/2015  02:10 PM           553,861 11shaw - fl.ast
06/01/2015  02:50 PM             7,662 11shaw - fl.bpi
06/01/2015  06:58 PM           137,739 11shaw - fl.ERR
06/08/2015  03:31 PM             2,864 11shaw - fl.isc
06/01/2015  02:50 PM            48,638 11shaw - fl.pro
06/01/2015  06:58 PM               383 11shaw - fl.rdf
06/01/2015  02:10 PM           868,924 11SHAW - FL.ROU
06/01/2015  02:10 PM             2,004 11SHAW - FL.SOU
06/01/2015  06:58 PM            15,042 11shaw - fl.SUM
06/01/2015  02:50 PM           667,955 11shaw - fl.sup
06/01/2015  02:10 PM           639,672 11shaw - fl_AERMAP.log
06/01/2015  02:50 PM             2,137 11shaw - fl_BPIP.log
06/01/2015  01:39 PM             2,083 MAPDETAIL.OUT
06/01/2015  01:40 PM             2,583 MAPPARAMS.OUT
02/09/2012  10:23 AM        83,594,363 NED_63619997.tif
06/01/2015  01:29 PM         2,936,208 paducah-nashville09_13.PFL
06/01/2015  01:29 PM         7,800,818 paducah-nashville09_13.SFC
06/02/2015  02:09 PM    <DIR>          11shaw - fl.AD
06/02/2015  05:08 PM    <DIR>          11shaw - fl.dat
              20 File(s)    106,097,874 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\shaw\fenceline\11shaw - fl\11shaw - fl.AD

06/15/2015  02:50 AM    <DIR>          .
06/15/2015  02:50 AM    <DIR>          ..
06/02/2015  02:09 PM       472,854,048
01_2009_12_2013_3_month_concs.txt
06/02/2015  02:09 PM         2,717,552
01_2009_12_2013_3_month_max_concs_rec.txt
06/02/2015  02:08 PM                41 inputfiles.txt
06/02/2015  02:09 PM             4,650 lead.log
06/02/2015  02:09 PM               965 lead.out
06/01/2015  06:58 PM         1,864,053 MOH1G001.PLT
06/01/2015  06:58 PM         1,864,053 MOH1G002.PLT
06/01/2015  06:58 PM         1,864,053 MOH1GALL.PLT
06/01/2015  06:58 PM       103,379,929 MO_GALL.POS
06/01/2015  06:58 PM       103,379,929 MO_GCCMA.POS
```

```
06/01/2015  06:58 PM       103,379,929 MO_GSHAW.POS
06/01/2015  06:58 PM    <DIR>          Percentile
              11 File(s)    791,309,202 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\shaw\fenceline\11shaw - fl\11shaw - fl.AD\Percentile

06/15/2015  02:51 AM    <DIR>          .
06/15/2015  02:51 AM    <DIR>          ..
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\02 - Additional
Modeling\shaw\fenceline\11shaw - fl\11shaw - fl.dat

06/15/2015  02:51 AM    <DIR>          .
06/15/2015  02:51 AM    <DIR>          ..
06/16/2015  12:43 PM        40,309,542 11shaw - fl.dat.rar
               1 File(s)     40,309,542 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\03 - Equivalency
Demonstration

06/15/2015  02:53 AM    <DIR>          .
06/15/2015  02:53 AM    <DIR>          ..
06/08/2015  09:31 AM    <DIR>          11aks - aer
06/08/2015  11:47 AM    <DIR>          11aks-pr
06/16/2015  12:19 PM            15,513 Equivalency Demonstration Rank
Summary.rar
               1 File(s)         15,513 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\03 - Equivalency
Demonstration\11aks - aer

06/15/2015  02:53 AM    <DIR>          .
06/15/2015  02:53 AM    <DIR>          ..
06/07/2015  04:58 PM            23,458 11aks-aer.ADI
06/08/2015  04:59 AM        19,581,938 11aks-aer.ADO
06/07/2015  04:51 PM           227,560 11aks-aer.api
06/07/2015  04:51 PM           231,392 11aks-aer.ast
06/07/2015  04:57 PM             2,856 11aks-aer.bpi
06/08/2015  04:59 AM            33,619 11aks-aer.err
06/08/2015  03:53 PM             1,848 11aks-aer.isc
06/07/2015  04:57 PM            18,491 11aks-aer.pro
06/08/2015  04:59 AM               376 11aks-aer.rdf
06/07/2015  04:51 PM           356,798 11aks-aer.ROU
06/07/2015  04:51 PM             1,208 11aks-aer.SOU
06/08/2015  04:59 AM            19,760 11aks-aer.SUM
06/07/2015  04:57 PM           155,168 11aks-aer.sup
06/07/2015  04:57 PM             2,137 11aks-aer_BPIP.log
06/07/2015  04:51 PM         2,936,208 huntington-wilmington09_13.PFL
06/07/2015  04:51 PM         7,800,818 huntington-wilmington09_13.SFC
06/08/2015  09:31 AM    <DIR>          11aks-aer.AD
06/08/2015  09:32 AM    <DIR>          11aks-aer.dat
              16 File(s)     31,393,635 bytes
```

```
 Directory of H:\KY DAQ Lead Modeling Data 2015\03 - Equivalency
Demonstration\11aks - aer\11aks-aer.AD

06/15/2015  02:53 AM    <DIR>          .
06/15/2015  02:53 AM    <DIR>          ..
06/08/2015  04:59 AM             2,944 AKS-AER.RNK
06/08/2015  04:59 AM           765,471 MO10GALL.PLT
06/08/2015  04:59 AM           765,471 MOH11GALL.PLT
06/08/2015  04:59 AM           765,471 MOH12GALL.PLT
06/08/2015  04:59 AM           765,471 MOH13GALL.PLT
06/08/2015  04:59 AM           765,471 MOH14GALL.PLT
06/08/2015  04:59 AM           765,471 MOH15GALL.PLT
06/08/2015  04:59 AM           765,471 MOH16GALL.PLT
06/08/2015  04:59 AM           765,471 MOH17GALL.PLT
06/08/2015  04:59 AM           765,471 MOH18GALL.PLT
06/08/2015  04:59 AM           765,471 MOH19GALL.PLT
06/08/2015  04:59 AM           765,471 MOH1GALL.PLT
06/08/2015  04:59 AM           765,471 MOH20GALL.PLT
06/08/2015  04:59 AM           765,471 MOH2GALL.PLT
06/08/2015  04:59 AM           765,471 MOH3GALL.PLT
06/08/2015  04:59 AM           765,471 MOH4GALL.PLT
06/08/2015  04:59 AM           765,471 MOH5GALL.PLT
06/08/2015  04:59 AM           765,471 MOH6GALL.PLT
06/08/2015  04:59 AM           765,471 MOH7GALL.PLT
06/08/2015  04:59 AM           765,471 MOH8GALL.PLT
06/08/2015  04:59 AM           765,471 MOH9GALL.PLT
06/08/2015  04:59 AM         8,484,935 MO_GALL.POS
06/08/2015  03:33 PM                13 inputfiles.txt
06/08/2015  03:33 PM             2,078 lead.log
06/08/2015  03:33 PM               630 lead.out
06/08/2015  03:33 PM        11,151,120
01_2009_12_2009_3_month_concs.txt
06/08/2015  03:33 PM         1,115,112
01_2009_12_2009_3_month_max_concs_rec.txt
06/08/2015  09:32 AM    <DIR>          Percentile
              27 File(s)     36,066,252 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\03 - Equivalency
Demonstration\11aks - aer\11aks-aer.AD\Percentile

06/15/2015  02:53 AM    <DIR>          .
06/15/2015  02:53 AM    <DIR>          ..
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\03 - Equivalency
Demonstration\11aks - aer\11aks-aer.dat

06/15/2015  02:53 AM    <DIR>          .
06/15/2015  02:53 AM    <DIR>          ..
06/16/2015  12:45 PM        23,980,807 11aks-aer.dat.rar
               1 File(s)     23,980,807 bytes
```

```
 Directory of H:\KY DAQ Lead Modeling Data 2015\03 - Equivalency
Demonstration\11aks-pr

06/15/2015  02:54 AM    <DIR>          .
06/15/2015  02:54 AM    <DIR>          ..
06/08/2015  09:50 AM            23,439 11aks-pr.ADI
06/08/2015  11:47 AM        19,581,954 11aks-pr.ADO
06/07/2015  06:52 PM           227,560 11aks-pr.api
06/07/2015  06:52 PM           231,392 11aks-pr.ast
06/07/2015  06:53 PM             2,858 11aks-pr.bpi
06/08/2015  11:47 AM            33,619 11aks-pr.err
06/08/2015  04:15 PM             1,848 11aks-pr.isc
06/07/2015  06:53 PM            18,491 11aks-pr.pro
06/08/2015  11:47 AM               381 11aks-pr.rdf
06/07/2015  06:52 PM           356,798 11aks-pr.ROU
06/07/2015  06:52 PM             1,208 11aks-pr.SOU
06/08/2015  11:47 AM            19,760 11aks-pr.SUM
06/07/2015  06:53 PM           155,168 11aks-pr.sup
06/07/2015  06:53 PM             2,137 11aks-pr_BPIP.log
06/07/2015  06:52 PM         2,936,208 huntington-wilmington09_13.PFL
06/07/2015  06:52 PM         7,800,818 huntington-wilmington09_13.SFC
06/08/2015  09:50 AM    <DIR>          11aks-pr.AD
06/08/2015  11:59 AM    <DIR>          11aks-pr.dat
              16 File(s)     31,393,639 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\03 - Equivalency
Demonstration\11aks-pr\11aks-pr.AD

06/15/2015  02:55 AM    <DIR>          .
06/15/2015  02:55 AM    <DIR>          ..
06/08/2015  11:47 AM             2,944 AKS-PR.RNK
06/08/2015  11:47 AM           765,471 MO10GALL.PLT
06/08/2015  11:47 AM           765,471 MOH11GALL.PLT
06/08/2015  11:47 AM           765,471 MOH12GALL.PLT
06/08/2015  11:47 AM           765,471 MOH13GALL.PLT
06/08/2015  11:47 AM           765,471 MOH14GALL.PLT
06/08/2015  11:47 AM           765,471 MOH15GALL.PLT
06/08/2015  11:47 AM           765,471 MOH16GALL.PLT
06/08/2015  11:47 AM           765,471 MOH17GALL.PLT
06/08/2015  11:47 AM           765,471 MOH18GALL.PLT
06/08/2015  11:47 AM           765,471 MOH19GALL.PLT
06/08/2015  11:47 AM           765,471 MOH1GALL.PLT
06/08/2015  11:47 AM           765,471 MOH20GALL.PLT
06/08/2015  11:47 AM           765,471 MOH2GALL.PLT
06/08/2015  11:47 AM           765,471 MOH3GALL.PLT
06/08/2015  11:47 AM           765,471 MOH4GALL.PLT
06/08/2015  11:47 AM           765,471 MOH5GALL.PLT
06/08/2015  11:47 AM           765,471 MOH6GALL.PLT
06/08/2015  11:47 AM           765,471 MOH7GALL.PLT
06/08/2015  11:47 AM           765,471 MOH8GALL.PLT
06/08/2015  11:47 AM           765,471 MOH9GALL.PLT
06/08/2015  11:47 AM         8,484,935 MO_GALL.POS
06/08/2015  03:54 PM                13 inputfiles.txt
06/08/2015  03:54 PM             2,078 lead.log
```

```
06/08/2015  03:54 PM               630 lead.out
06/08/2015  03:54 PM        11,151,120 
01_2009_12_2009_3_month_concs.txt
06/08/2015  03:54 PM         1,115,112 
01_2009_12_2009_3_month_max_concs_rec.txt
06/07/2015  06:55 PM    <DIR>          Percentile
              27 File(s)     36,066,252 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\03 - Equivalency 
Demonstration\11aks-pr\11aks-pr.AD\Percentile

06/15/2015  02:55 AM    <DIR>          .
06/15/2015  02:55 AM    <DIR>          ..
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\03 - Equivalency 
Demonstration\11aks-pr\11aks-pr.dat

06/15/2015  02:55 AM    <DIR>          .
06/15/2015  02:55 AM    <DIR>          ..
06/16/2015  12:49 PM        23,981,797 11aks-pr.dat.rar
               1 File(s)     23,981,797 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/12/2015  03:46 PM    <DIR>          equivalency demonstration
06/12/2015  04:06 PM    <DIR>          3 month rolling
06/12/2015  04:05 PM    <DIR>          50km plot
06/12/2015  04:05 PM    <DIR>          H1H
06/12/2015  04:06 PM    <DIR>          receptor grid
06/16/2015  12:13 PM    <DIR>          additional modeling
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - 
Images\equivalency demonstration

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/12/2015  04:09 PM    <DIR>          H1H
06/12/2015  04:09 PM    <DIR>          3 month rolling
06/12/2015  04:09 PM    <DIR>          receptor
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - 
Images\equivalency demonstration\H1H

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/16/2015  12:13 PM         1,200,234 H1H.rar
               1 File(s)      1,200,234 bytes
```

```
 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\equivalency demonstration\3 month rolling

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/16/2015  12:12 PM         1,110,610 3 month rolling.rar
               1 File(s)      1,110,610 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\equivalency demonstration\receptor

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/02/2015  05:55 PM           600,476 aks entire receptor.JPG
               1 File(s)        600,476 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\3 month rolling

06/16/2015  12:07 PM    <DIR>          .
06/16/2015  12:07 PM    <DIR>          ..
06/16/2015  12:16 PM         3,362,114 3 month rolling.rar
               1 File(s)      3,362,114 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\50km plot

06/16/2015  12:07 PM    <DIR>          .
06/16/2015  12:07 PM    <DIR>          ..
06/16/2015  12:16 PM         1,988,854 50km plot.rar
               1 File(s)      1,988,854 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\H1H

06/16/2015  12:07 PM    <DIR>          .
06/16/2015  12:07 PM    <DIR>          ..
06/16/2015  12:17 PM         7,232,188 H1H.rar
               1 File(s)      7,232,188 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\receptor grid

06/16/2015  12:07 PM    <DIR>          .
06/16/2015  12:07 PM    <DIR>          ..
06/16/2015  12:17 PM         1,303,302 receptor grid.rar
               1 File(s)      1,303,302 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\additional modeling

06/16/2015  12:13 PM    <DIR>          .
06/16/2015  12:13 PM    <DIR>          ..
06/12/2015  03:48 PM    <DIR>          11aks-pb
06/12/2015  03:44 PM    <DIR>          11shaw-fl
               0 File(s)              0 bytes
```

```
 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\additional
modeling\11aks-pb

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/12/2015  03:57 PM    <DIR>          3 month rolling
06/12/2015  03:58 PM    <DIR>          H1H
06/12/2015  03:58 PM    <DIR>          receptor grid
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\additional
modeling\11aks-pb\3 month rolling

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/16/2015  12:14 PM           601,769 3 month rolling.rar
               1 File(s)        601,769 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\additional
modeling\11aks-pb\H1H

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/16/2015  12:14 PM           664,985 H1H.rar
               1 File(s)        664,985 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\additional
modeling\11aks-pb\receptor grid

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/02/2015  05:26 PM           591,233 aks-pb entire receptor.JPG
               1 File(s)        591,233 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\additional
modeling\11shaw-fl

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/12/2015  03:59 PM    <DIR>          receptor grid
06/12/2015  03:59 PM    <DIR>          3 month rolling
06/12/2015  04:00 PM    <DIR>          H1H
               0 File(s)              0 bytes

 Directory of H:\KY DAQ Lead Modeling Data 2015\04 - Images\additional
modeling\11shaw-fl\receptor grid

06/15/2015  02:56 AM    <DIR>          .
06/15/2015  02:56 AM    <DIR>          ..
06/03/2015  12:37 PM           610,282 shaw - ccma receptor.JPG
               1 File(s)        610,282 bytes
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Appendix C
Analysis of the KDAQ Meteorological Network

Introduction

KDAQ currently operates a total of 11 meteorological stations across the state ambient air monitoring network. Each region within the monitoring network operates one meteorological station at a minimum, with the Ashland, Frankfort, and Paducah Regions responsible for two stations each.

In addition to the 11 meteorological stations operated by the KDAQ, the National Park Service (NPS) operates a meteorological station at the Houchins Meadow site at Mammoth Cave National Park. The Louisville Metro Air Pollution Control District (LMAPCD) also operates several meteorological stations within its network located in Jefferson County.

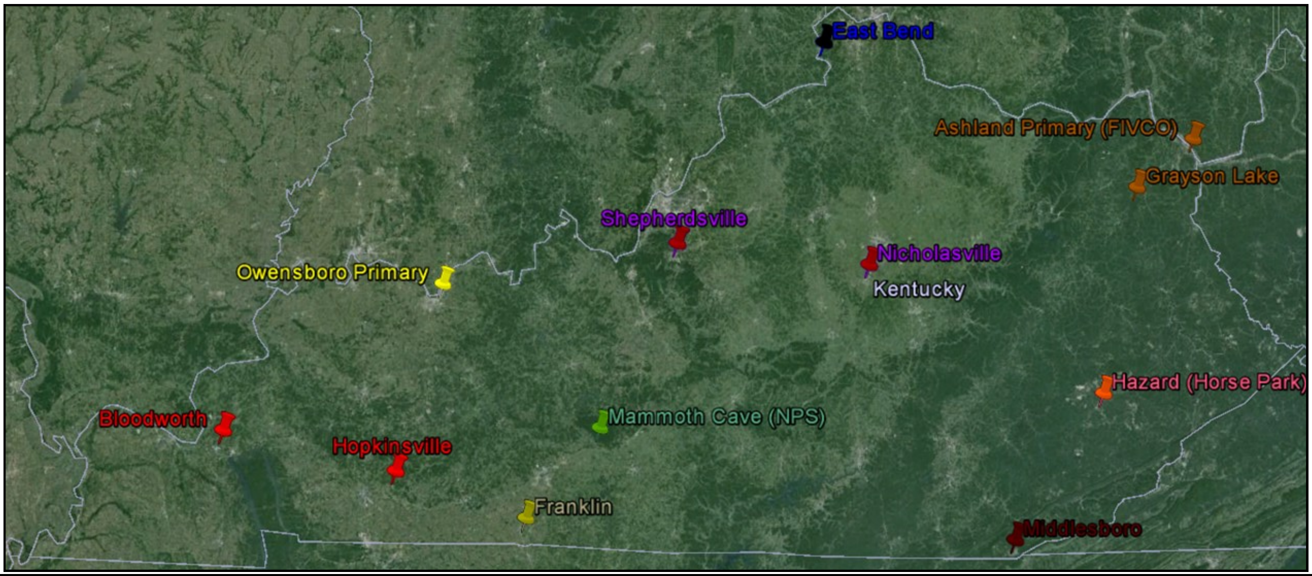
For this network assessment, KDAQ meteorological stations were assessed based upon each site's individual monitoring objectives, local topography, and area representativeness in terms of the monitoring scale for various pollutants. While the meteorological station located at Mammoth Cave was included in this assessment, LMAPCD stations were not included. Due to limited access to a previous database, only 2014 data was available at the time the assessment was conducted.

The scale used for the assessment is as follows:

Excellent	The site is well-positioned to meet its monitoring objectives, to avoid significant interference from local topography, and to represent the local natural landscape and/or population at an exemplary level.
Appropriate	The site is adequately positioned to meet its monitoring objectives, to marginally prevent interference from local topography, and to adequately represent the local natural landscape and/or population.
Sufficient	The site is decently positioned to meet its monitoring objectives, to potentially prevent interference from local topography, and/or to decently represent the local natural landscape and/or population.
Insufficient	The site is not well positioned to meet its monitoring objectives, to prevent interference from local topography, and/or to represent the local natural landscape and/or population.
Detrimental	The site fails to meet its monitoring objectives, prevent interference from local topography, and/or to represent the local natural landscape and/or population.

Questions regarding the assessment of the meteorological network should be addressed to Anthony Bedel, Quality Assurance Section Supervisor.

Map & Chart: Kentucky Meteorological Network



AQS ID/ Region	Site Address	Tower	Meteorological Parameters Recorded
21-013-0002 London	1420 Dorchester Ave, Middlesboro Airport Middlesboro (Bell)	Mast	Wind speed & direction, temperature, RH
21-015-0003 Florence	KY-338 & Lower River Rd East Bend (Boone)	Mast	Wind speed & direction, temperature, RH
21-019-0017 Ashland	2924 Holt St, Ashland Health Department Ashland (Boyd)	Mast	Wind speed & direction, temperature, RH
21-029-0006 Frankfort	2nd St & Carpenter St Shepherdsville (Bullitt)	Mast	Wind speed & direction, temperature, RH
21-043-0500 Ashland	1486 Camp Webb Rd Grayson (Carter)	Open-Grid (Tower)	Wind speed & direction, temperature, RH, dew point temperature, barometric pressure, solar radiation
21-047-0006 Paducah	10800 Pilot Rock Rd Hopkinsville (Christian)	Mast	Wind speed & direction, temperature, RH
21-059-0005 Owensboro	716 Pleasant Valley Rd Owensboro (Daviess)	Mast	Wind speed & direction, temperature, RH
21-113-0001 Frankfort	260 Wilson Dr, KY DOT Garage Nicholasville (Jessamine)	Mast	Wind speed & direction, temperature, RH
21-139-0004 Paducah	763 Bloodworth Rd Livingston County	Mast	Wind speed & direction, temperature, RH
21-193-0003 Hazard	354 Perry Park Rd, Perry County Horse Park Hazard (Perry)	Open-Grid (Tower)	Wind speed & direction, temperature, RH
21-213-0004 Bowling Green	KY-1008, KY DOT Garage Franklin (Simpson)	Mast	Wind speed & direction, temperature, RH
21-111-0043 LMAPCD	3621 Southern Ave Louisville (Jefferson)	Open-Grid (Tower)	Wind speed & direction, temperature, RH, barometric pressure, precipitation
21-111-0067 LMAPCD	2730 Cannons Ln, Bowman Field Louisville (Jefferson)	Open-Grid (Tower)	Wind speed & direction, temperature, RH, solar radiation, precipitation
21-111-0073 LMAPCD	1517 Durrett Ln Louisville (Jefferson)	Open-Grid (Tower)	Wind speed & direction, temperature, RH, barometric pressure
21-061-0501 NPS	Alfred Cook Rd Mammoth Cave (Edmonson)	Open-Grid (Tower)	Wind speed & direction, temperature, RH, barometric pressure, solar radiation, precipitation

1. East Bend (Boone County; Cincinnati, OH-KY-IN MSA)

Figure 2: Location of the East Bend meteorological station in Boone County.

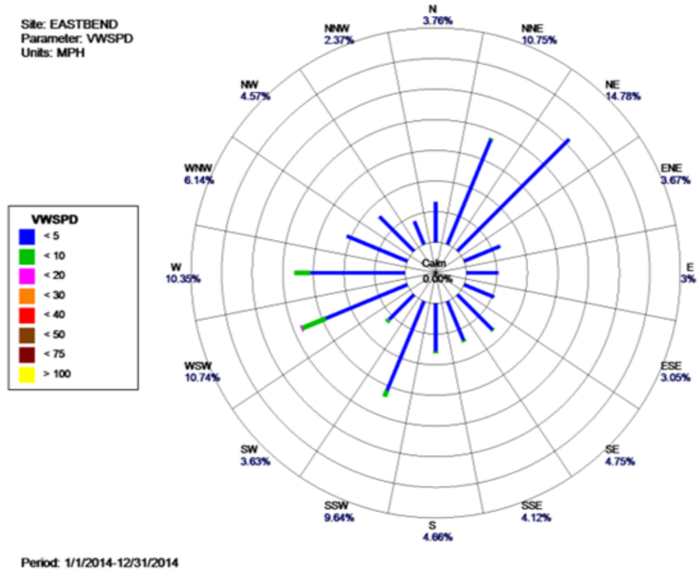


Figure 9: Wind rose plot for the EastBend site using 2014 site data.

Monitoring Objective:

- The monitoring objective is to determine compliance with National Ambient Air Quality Standards. This site also represents upwind background levels of ozone on an urban scale. Additionally, Duke Energy operates a 648-megawatt, single turbine power plant 1.5 km due south of the meteorological station.

Site Location Assessment: **Appropriate**

- The site is well-suited to assess background ozone levels for the Cincinnati MSA, especially for the northern Kentucky population. In 2014, the dominant prevailing wind directions at this site were out of the SW quadrant of the wind rose about 40% of the time, placing this site generally upwind of the Cincinnati MSA. It should be noted that light winds were not uncommon (25%) out of the NNE or NE directions, given the influence of local topography on the site (i.e., forested land NW, N, and E of the site).

- *Despite the marginal influence of local topography on the site, East Bend is appropriately positioned for background ozone levels upwind of the Cincinnati MSA. In addition, the site is appropriately positioned to monitor the potential influence of the Duke Energy power plant located to its south.*

2. Hopkinsville (Christian County; Clarksville, TN-KY MSA)

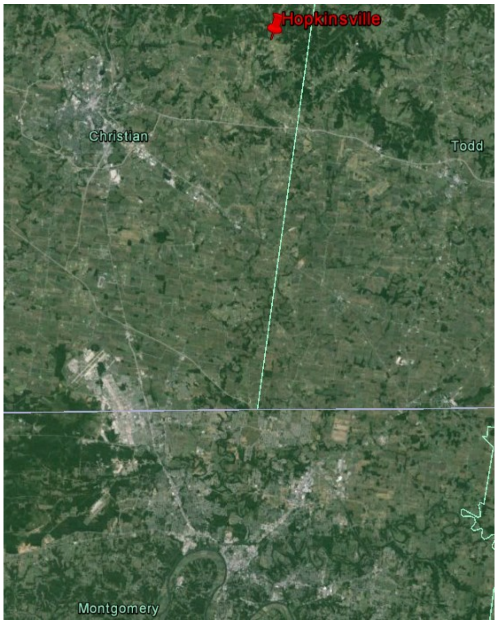


Figure 4: Location of the Hopkinsville Meteorological Station in Christian County

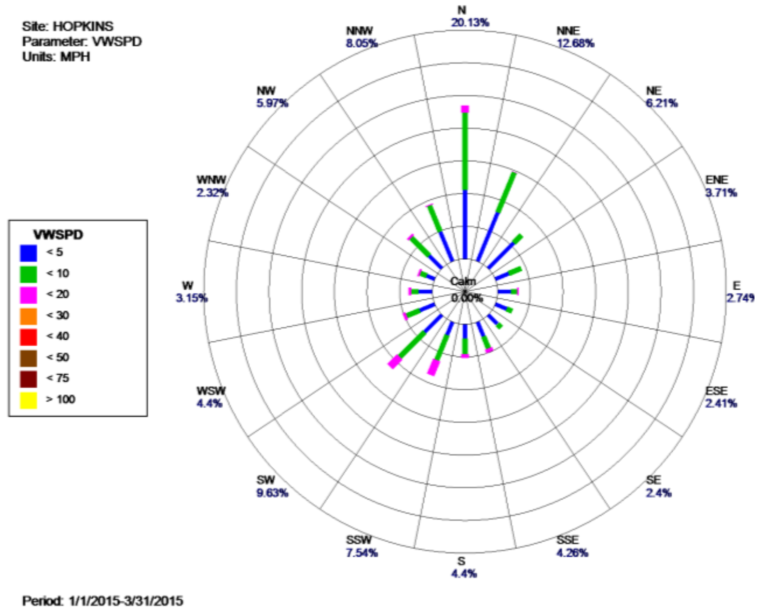


Figure 5: Wind rose plot for the Hopkinsville site using Jan-Mar 2015 site data.

Note: The meteorological equipment on site was installed in November 2014.

Monitoring Objective:

- The monitoring objectives are to determine compliance with National Ambient Air Quality Standards and to determine levels of interstate regional transport of fine particulate matter and ozone. This site also represents population exposure for ozone and $PM_{2.5}$ on a regional scale.

Site Location Assessment: **Appropriate**

- The site is well-suited to assess the interstate regional transport of ozone and particulate matter for the Clarksville MSA, especially for the Hopkinsville and surrounding population in southern Kentucky. Although the dominant prevailing wind directions at this site were out of the N or NNE about 33% of the time in the wind rose presented here, there is insufficient data to adequately assess a full year of wind data for this site at this time. Having said that, local topography does not appear to pose any significant threat to data integrity, and the site is just 30 km north of the Tennessee border.

- *Despite insufficient wind data due to the meteorological instrumentation recently installed on site, Hopkinsville is appropriately positioned for the regional transport and population exposure of ozone and particulate matter in the area.*

3. Ashland Primary (Boyd County; <u>Huntington-Ashland, WV-KY-OH</u> MSA)

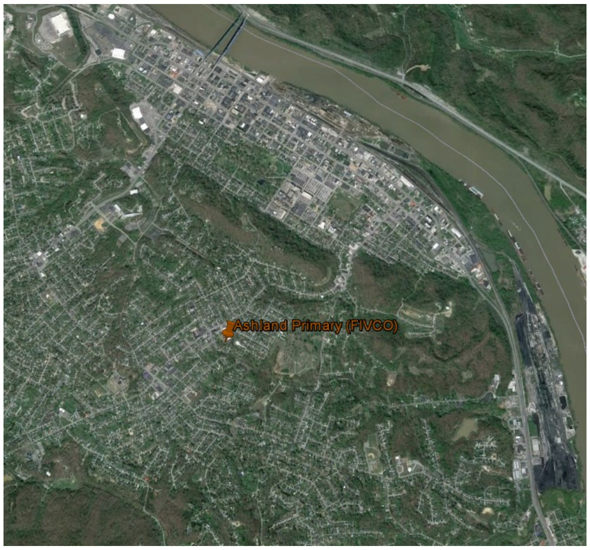


Figure 6: Location of the Ashland Primary meteorological station in Boyd County.

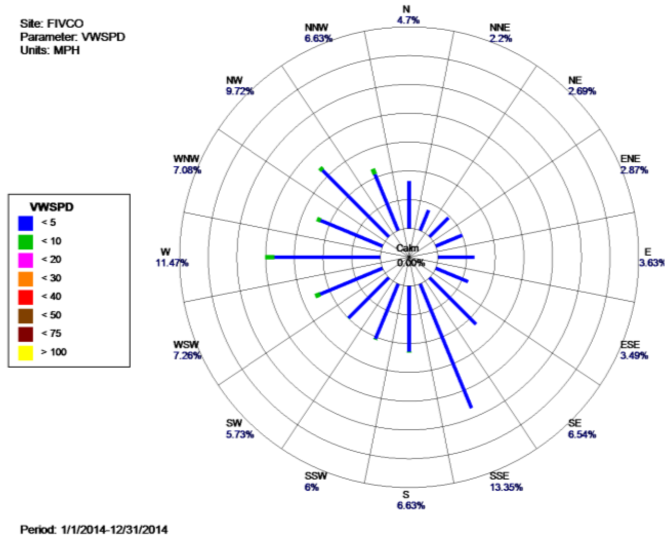


Figure 7: Wind rose plot for the Ashland Primary site using 2014 site data.

Monitoring Objective:

- The monitoring objectives are to determine compliance with National Ambient Air Quality Standards; to detect elevated pollutant levels for activation of emergency control procedures for nitrogen dioxide, ozone, and sulfur dioxide; and to provide pollutant levels for daily air quality index reporting. This site represents population exposure on a neighborhood scale for air toxics, ozone, and sulfur dioxide. This site also represents maximum concentrations on a middle scale for particulates, as well as an urban scale for nitrogen dioxide.

Site Location Assessment: **<u>Detrimental</u>**

- The site is not ideally-suited for the assessment of the monitoring objectives listed above for the Huntington-Ashland MSA, especially for the Ashland and surrounding population in northeastern Kentucky. This site is influenced by local topography as it is situated near the base of a hill on the property of the local health department. Surrounding trees and the health department buildings themselves may act as barriers to wind flow over this site given their higher elevation relative to the site shelter. The dominant prevailing wind directions indicated in the wind rose draw attention to the narrow gaps between the tree lines and the buildings on site. Furthermore, data quality assurance procedures begun in 2013 have led to the conclusion that the meteorological equipment on site may not be capturing the true wind flow in the area, as the reported hourly average wind speed on site rarely tops 5 mph at any point during the year.

- *The Ashland Primary site is satisfactory for pollution monitoring on a micro- or possibly middle scale. The current site location is not suitable for monitoring pollutant levels for emergency control procedures or AQI reporting for the area, nor is it acceptable for maximum concentrations of nitrogen dioxide on an urban scale. Monitoring for* *population exposure of air toxics, ozone, and sulfur dioxide, and for maximum concentrations of particulate matter at this site would seem to be sufficient for the area in terms of scale only; however, several primary source emissions (e.g., AK Steel, metal scrapyard and railyard along the Ohio River in downtown Ashland) in the area are not adequately assessed by the site where it is currently located. In summary, the Ashland Primary site is considered detrimental at its current location to the local population and the site's designated monitoring objectives. The site should be relocated to an area within the Ashland city limits that is not at all or only slightly influenced by local topography (ideally in an elevated area) so that the site may adequately meet its many monitoring objectives.*

- *A complete discussion regarding the siting issues at the Ashland Primary-FIVCO air monitoring station is included in Appendix D.*

4. Nicholasville (Jessamine County; Lexington-Fayette, KY MSA)

Figure 8: Location of the Nicholasville meteorological station in Jessamine County

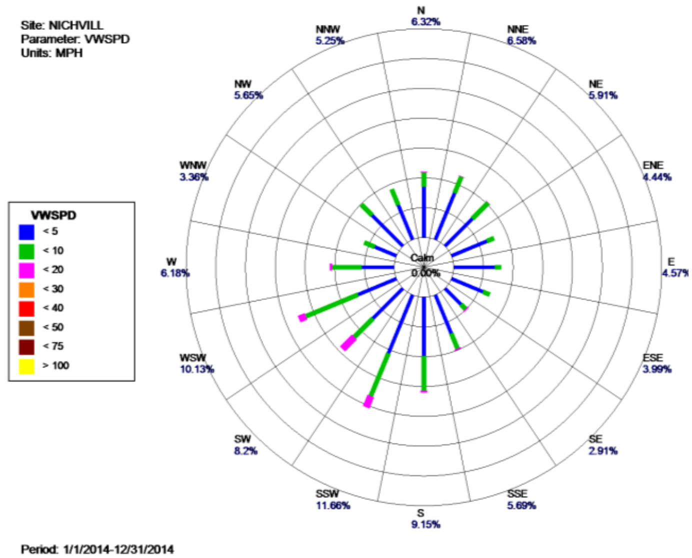


Figure 9: Wind rose plot for the Nicholasville site using 2014 site data.

Monitoring Objective:

- The monitoring objectives are to determine compliance with National Ambient Air Quality Standards and to provide ozone data upwind of the Lexington area. This site represents population exposure on an urban scale.

Site Location Assessment: **Excellent**

- The site is well-suited to assess upwind ozone levels for the Lexington-Fayette MSA. In 2014, the dominant prevailing wind directions at this site were out of the SW quadrant of the wind rose over 45% of the time, placing this site generally upwind of Lexington. The site is located in the middle of an open field with virtually no topographic influence on wind flow around the site.

- *Nicholasville is well-positioned to assess upwind ozone levels for population exposure within the Lexington-Fayette MSA.*

5. Shepherdsville (Bullitt County; Louisville/Jefferson County, KY-IN MSA)

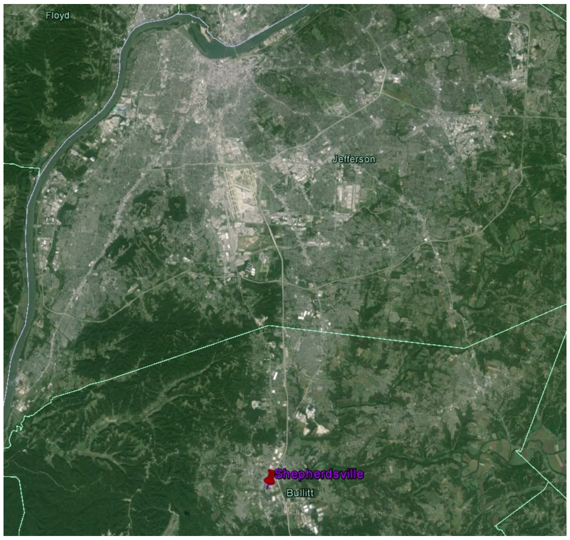


Figure 10: Location of the Shepherdsville meteorological station in Bullitt County

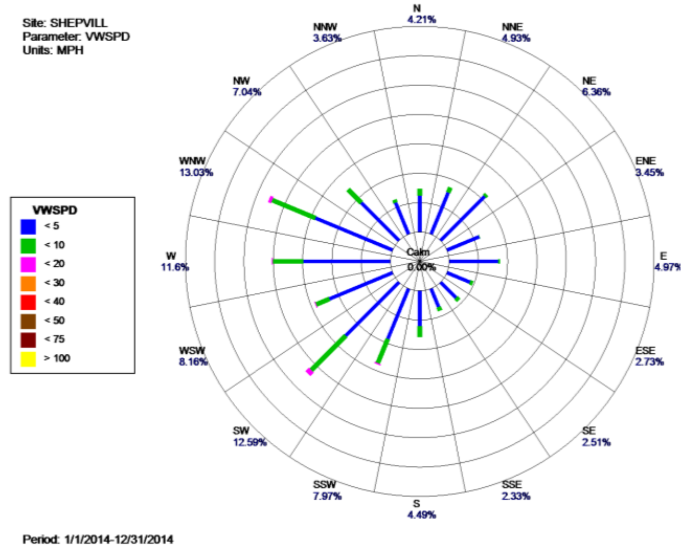


Figure 11: Wind rose plot for the Shepherdsville site using 2014 site data.

Monitoring Objective:

- The monitoring objectives are to determine compliance with National Ambient Air Quality Standards. This site represents population exposure for ozone on an urban scale.

Site Location Assessment: **Sufficient**

- The site is satisfactory for assessing the population exposure of ozone levels for the Louisville/Jefferson County MSA from sources upwind of the site; however, 2014 prevailing wind data indicates that this site does not at all capture ozone transport from the Louisville Metropolitan area to surrounding population areas downwind of the city.

- *The Shepherdsville site is adequately located to assess the population exposure of the city of Shepherdsville and northern and eastern Bullitt County of ozone. Except on days with uncommonly strong northerly winds (especially given the location of the DOT building on site), this site does not capture the downwind impact of ozone created within Jefferson County by the variety of human sources located there.*

- *The meteorological equipment on site could be better utilized at the Buckner site in Oldham County. Assuming that the dominant prevailing winds throughout the Louisville/Jefferson County MSA are reflected in the wind rose presented here, the Buckner site is located generally downwind of the Louisville Metropolitan area. The Buckner site is considered the network's "design value site" for ozone given its generally high ozone concentrations relative to all other KDAQ ozone monitors.*

Note: As a result of this network assessment, KDAQ has included these changes in the 2015 Annual Network Plan, which must submitted to the EPA by July 1, 2015.

6. Owensboro Primary (Daviess County; Owensboro, KY MSA)

Figure 12: Location of the Owensboro Primary meteorological station in Daviess County.

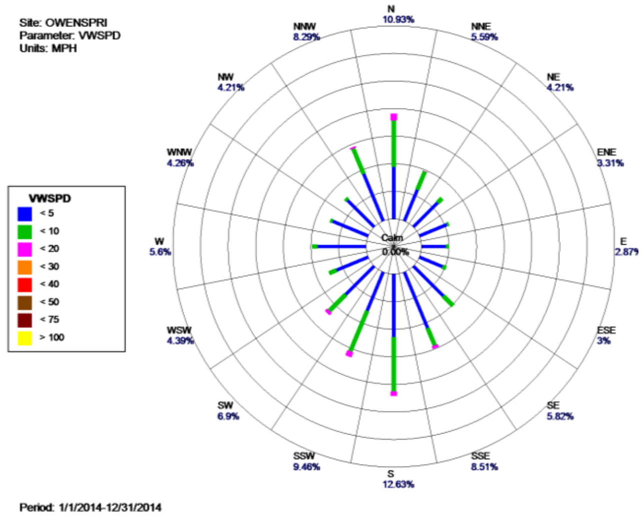


Figure 13: Wind rose plot for Owensboro Primary using 2014 site data.

Monitoring Objective:

- The monitoring objectives are to determine compliance with National Ambient Air Quality Standards; to detect emergency pollution levels of criteria pollutants for activation of emergency control procedures. While not required for the CBSA, the site also reports the AQI. This site represents population exposure on a neighborhood scale for particulates, ozone, and sulfur dioxide. This site also represents population exposure on an urban scale for nitrogen dioxide. Additionally, Owensboro Municipal Utilities (OMU) operates a power plant about 2 km NE of the meteorological station along the Ohio River.

Site Location Assessment: **Appropriate**

- The site is well-suited to assess population exposure for particulates, ozone, and sulfur dioxide for the Owensboro MSA on a neighborhood scale, as well as nitrogen dioxide on an urban scale. In 2014, the dominant prevailing wind directions at this site were out of the SW or S about 30% of the time, placing this site generally upwind of the city of Owensboro. However, winds were observed to blow out of the NW or N nearly 25% of the time, indicating that the strip mall located to the north of the site does not appear to significantly inhibit wind flow in the immediate vicinity of the shelter. Since prevailing winds in 2014 were generally out of the SW through SE directions, this site location is considered generally upwind of the OMU power plant, meaning that the plant's emissions of such pollutants as sulfur dioxide are not adequately assessed by this site.

- *Owensboro Primary is well-positioned for population exposure of particulates, ozone, sulfur dioxide, and nitrogen dioxide for the Owensboro MSA from all significant emission sources in the area with the exception of the OMU power plant NE of the site. The site is located generally upwind of this plant and is not adequately sited to assess its emissions over the population within the city of Owensboro and in much of the Owensboro MSA. Having said that, the wind data presented in the wind rose indicates that it is uncommon (<14% of the time in 2014) for the winds in the area to carry pollutants from OMU towards the city of Owensboro and surrounding areas.*

7. Middlesboro (Bell County; Middlesborough, KY Micropolitan Statistical Area)

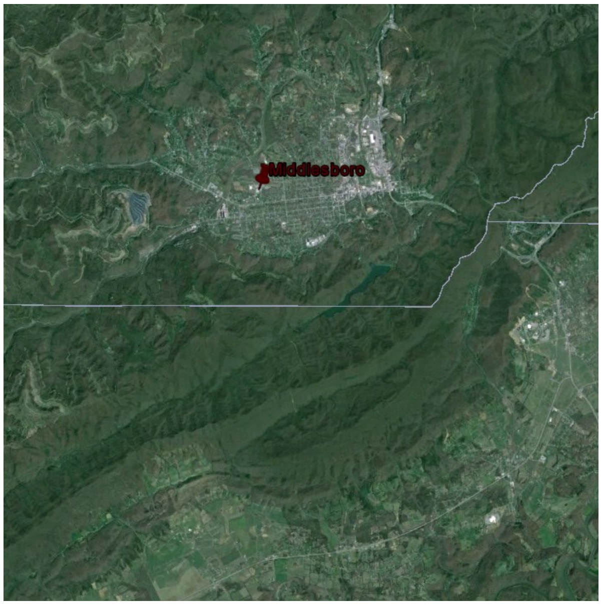


Figure 14: Location of the Middlesboro meteorological station in Bell County.

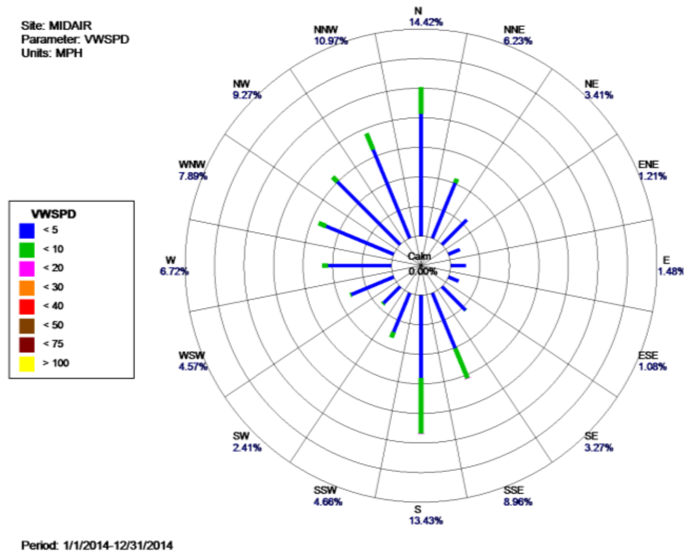


Figure 15: Wind rose plot for Middlesboro using 2014 site data.

Monitoring Objective:

- The monitoring objectives are to determine compliance with National Ambient Air Quality Standards and to provide information on the regional transport of ozone into the area. The site represents population exposure on a neighborhood scale for particulates.

Site Location Assessment: **Sufficient**

- The site is well-suited to assess the population exposure of particulates for the city of Middlesboro on a neighborhood scale, but only marginally adequate at assessing the transport of ozone on a regional scale. The city of Middlesboro lies within a crater surrounded by hills and mountains; thus, local topography plays a significant role in determining the meteorological data collected at this site. The mountains act as an obstacle to prevailing winds in the area, meaning that wind data collected at this site are valid on a small – perhaps no more than neighborhood – scale at best. Additionally, the mountains aid in the formation of temperature inversions within the crater, especially at night when relatively cooler air tends to pool down into the valley. Unfortunately, these impacts are the norm and not the exception in eastern Kentucky, where predominantly mountainous terrain effectively reduces practical meteorological observations to a relatively small scale in terms of population and landscape representation.

- *Due to the significant influence of local topography on the site, Middlesboro is adequate at best at providing information on the transport of ozone on a regional scale into the area; however, this same topography actually aids in the assessment of population exposure to particulates on a neighborhood scale as the mountains act to inhibit the transport of particulates out of the crater. Considering the influence of the mountainous topography throughout eastern Kentucky, this site is sufficient where it is currently located and would likely not better assess such monitoring objectives elsewhere.*

8. Bloodworth (Livingston County; Paducah, KY-IL Micropolitan Statistical Area)

Figure 16: Location of the Bloodworth meteorological station in Livingston County.

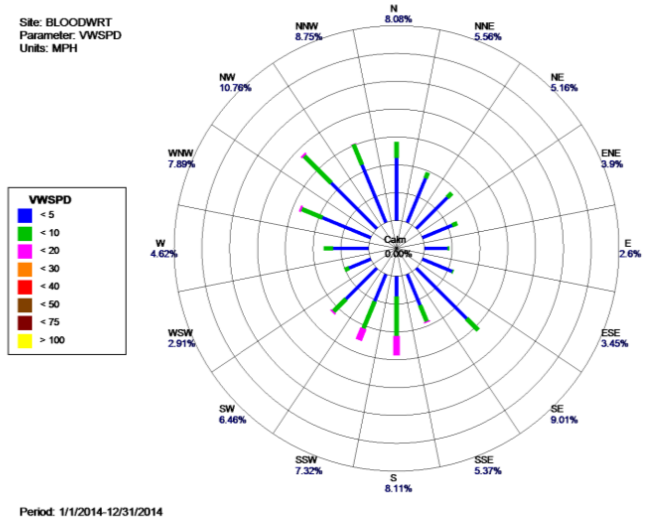


Figure 17: Wind rose plot for Bloodworth using 2014 site data.

Monitoring Objective:

- The monitoring objective is to detect and quantify air toxics in ambient air and to provide meteorological data for data analysis. The site represents source impacts on a neighborhood scale.

Site Location Assessment: **Appropriate**

- The site is positioned nicely to assess upwind air toxics data for the Paducah MSA, especially in Livingston County. In 2014, the dominant prevailing wind directions at this site were out of the N-NW (35%) and S-SW (22%), placing this site generally upwind of the Calvert City industrial complex across the Tennessee River nearly a quarter of the time annually. Although the most dominant winds appear to be out of the N and NW, the highest wind speeds tend to blow out of the S and SSW, making this site location ideal for neighborhood scale impacts from the Calvert City industrial complex. Additionally, the site is located in an open field with very little topographic influence (i.e., a couple of small residential buildings and a few trees) on wind flow around the site, making it an ideal spot for the analysis of local meteorological data.

- *Although the most dominant prevailing winds were out of the N and NW in 2014, significant S and SSW wind speeds suggest that Bloodworth is appropriately positioned to assess upwind air toxics data – specifically from the Calvert City industrial complex – on a neighborhood scale for the Paducah MSA, especially in Livingston County. Additionally, minimal topographical influence makes this site ideal for the analysis of quality meteorological data in the area.*

9. Grayson Lake (Carter County; Not in a MSA)

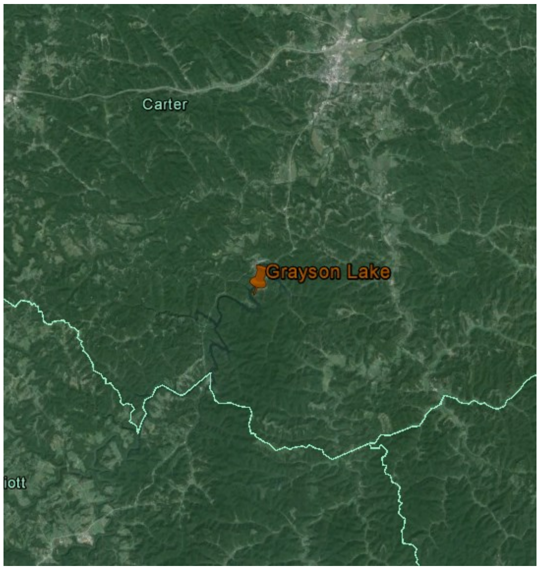


Figure 18: Location of the Grayson Lake meteorological station in Carter County

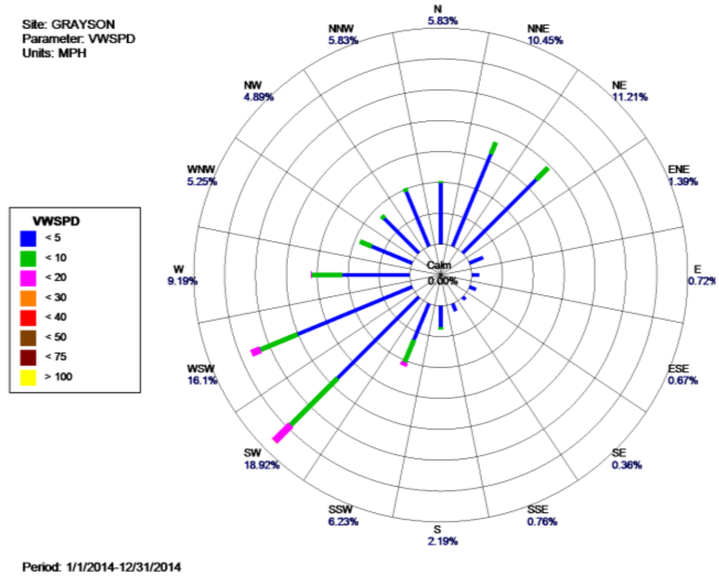


Figure 19: Wind rose plot for Grayson Lake using 2014 site data.

Monitoring Objective:

- The monitoring objectives are to determine compliance with National Ambient Air Quality Standards; to determine background levels of $PM_{2.5}$ and PM_{10}; to provide ozone data upwind of the Ashland area; and to measure rural concentrations of a sub-group of air toxics for use in national air toxics assessment (NATTS). The site represents background levels on an urban scale for particulates and air toxics. This site also represents upwind/background levels on an urban scale for ozone.

Site Location Assessment: **Excellent**

- The site is well-suited to assess background/upwind levels of ozone, $PM_{2.5}$, PM_{10}, and air toxics for the Ashland area and for use in the NATTS program. In 2014, the dominant prevailing wind directions at this site were out of the WSW-SSW over 40% of the time, placing this site generally upwind of the Grayson and Ashland populations and firmly within a rural location in terms of the surrounding landscape. The site is located in the middle of an open field, and the meteorological sensors are mounted on an open-grid tower, meaning that there is virtually no topographic influence on wind flow around the sensors.

- *Grayson is located in an excellent spot to assess background/upwind levels of ozone, $PM_{2.5}$, PM_{10}, and air toxics for the Ashland area and for use in the NATTS program. Furthermore, the meteorological sensors are mounted near the top of an open-grid tower, where local topography has minimal impact on the quality of the meteorological data collected.*

10. Hazard (Perry County; Not in a MSA)

Figure 20: Location of the Hazard meteorological station in Perry County.

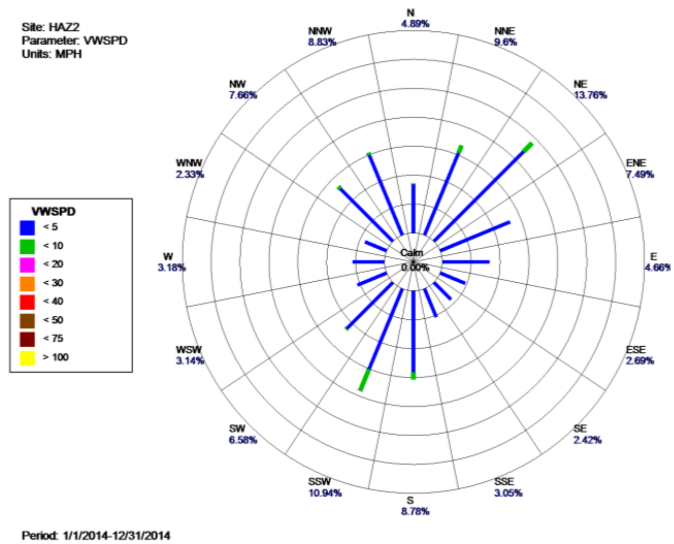


Figure 21: Wind rose plot for Hazard using 2014 site data.

Monitoring Objective:

- The monitoring objectives are to determine compliance with National Ambient Air Quality Standards and to detect elevated pollutant levels for emergency activation control procedures for ozone. The site represents population exposure on a neighborhood scale.

Site Location Assessment: **<u>Sufficient</u>**

- The site is well-suited to assess the population exposure of ozone for the city of Hazard and surrounding communities on a neighborhood scale. The site lies within a valley surrounded by hills and mountains; thus, local topography plays a significant role in determining the meteorological data collected at this site. The mountains to the west and east of the site act as a natural "wind tunnel" for prevailing winds in the area (note the predominantly SSW and NE wind directions in the wind rose), meaning that wind data collected at this site are valid on a small – perhaps no more than neighborhood – scale at best. Additionally, the mountains aid in the formation of temperature inversions within the valley, especially at night when relatively cooler air tends to pool down into the valley. These impacts are the norm in eastern Kentucky, where predominantly mountainous terrain effectively reduces practical meteorological observations to a relatively small scale in terms of population and landscape representation.

- *Due to the significant influence of local topography on the site, Hazard is adequate at providing information on the population exposure and detection of elevated pollutant levels of ozone in the area on a relatively small (neighborhood) scale only. Considering the influence of the mountainous topography throughout eastern Kentucky, this site is sufficient where it is currently located and would likely not better assess such monitoring objectives elsewhere.*

11. Franklin (Simpson County; Not in a MSA)

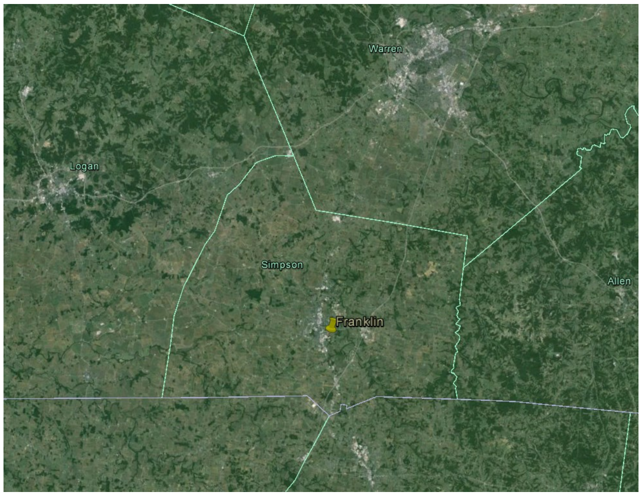


Figure 22: Location of the Franklin meteorological station in Simpson County.

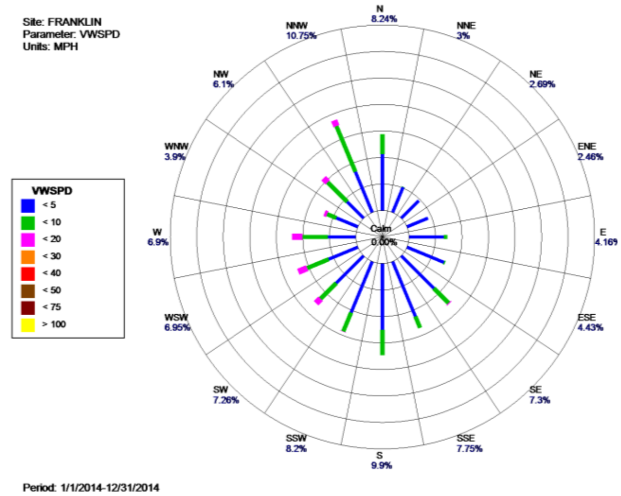


Figure 23: Wind rose plot for Franklin using 2014 site data.

Monitoring Objective:

- The monitoring objectives are to determine compliance with National Ambient Air Quality Standards; to measure ozone levels upwind of Bowling Green; and to provide data on interstate ozone transport. The site represents population exposure on an urban scale.

Site Location Assessment: **Appropriate**

- The site is well-suited to assess the interstate transport of ozone across the border between Kentucky and Tennessee, especially for the south-central Kentucky and north-central Tennessee population. In 2014, the dominant prevailing wind directions appeared to be fairly well spread throughout the SW quadrant of the wind rose, placing this site generally upwind of the Bowling Green area; however, it is not uncommon to see winds out of the NNW and N that could transport ozone created naturally or by human impacts within the cities of Franklin and Bowling Green into north-central Tennessee. Although the location is great, buildings located on the DOT complex near the site (especially the shelter 20 m NE of the site) in addition to larger structures W and NW of the site across the road act as obstacles to prevailing wind flow in the area.

- *Despite the marginal influence of local topography (i.e., structures) on and near the site, Franklin is appropriately positioned for the upwind and interstate transport monitoring of ozone levels for the south-central Kentucky population, including Bowling Green.*

12. Mammoth Cave (NPS) (Edmonson County; Bowling Green, KY MSA)

Figure 24: Location of the NPS Houchins Meadow meteorological station at Mammoth Cave.

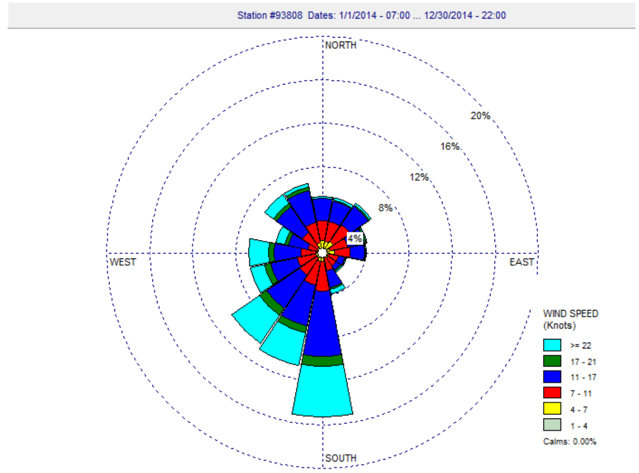


Figure 25: Wind rose plot for the Bowling Green Reg. Airport using 2014 ASOS data.

Monitoring Objective:

- Mammoth Cave National Park was established as one of 156 mandatory Federal Class I Areas nationwide under the Clean Air Act Amendments of 1977. Class I Areas are imparted with the highest level of air quality protections, especially regarding visibility degradation (haze). The Division maintains a cooperative relationship with Mammoth Cave National Park and frequently includes the site's data in air quality analyses; however, the Division does not operate the site nor certify the annual data. While the park conducts a variety of air quality studies, only certain data is reported to the EPA's AQS database.

Site Location Assessment: **Excellent**

- The site is well-suited to assess the general air quality for the Bowling Green and south-central Kentucky population. In 2014, the dominant prevailing wind direction at the Bowling Green-Warren County Regional Airport (approximately 30 km SW of the site) appeared to be out of the S through SW, placing this site generally on the upwind (south) side of the national park; thus, it is well-placed to assess the transport of pollutants into the area that may degrade air quality or visibility. Additionally, the local topography does not appear to significantly inhibit wind flow around the site, as the nearest tree lines are beyond 40 m from the open-grid tower on which the meteorological sensors are mounted at a significant height above the ground.

- *The Houchins Meadow site at the Mammoth Cave National Park is well-positioned for the monitoring of air quality and visibility for the south-central Kentucky population, including Bowling Green.*

New technology considerations for the KDAQ meteorological network:

- Currently, the KDAQ meteorological sensors utilized at the network sites are manufactured by the R.M. Young Company. The wind sensors are 05305V (voltage output) model AQ (air quality) wind monitors designed for high resolution air quality applications. Priced at $1404 (current as of April 2015), these instruments offer reliable wind speed (0-50 m s^{-1}) and direction (0-360°) measurements at an accuracy of ±0.2 m s^{-1} and ±3°, respectively. The relative humidity & temperature sensors are 41382VC (voltage output in °C) model relative humidity & temperature probes designed for high accuracy relative humidity and temperature measurements combined in one probe. Priced at $804 (current as of April 2015), these instruments offer reliable relative humidity (0-100%) and temperature (-50 to 50°C) measurements at an accuracy of ±1% and ±0.3°C at 23°C, respectively.

- The Technical Support staff within the Technical Services Branch is responsible for the acquisition, inventory, and maintenance of these meteorological sensors in the KDAQ network. Typically, a new wind monitor is purchased on a roughly annual basis, and Technical Support staff makes every attempt to hold one or two wind monitors in addition to the field instruments as "back-ups". Technical Support staff rarely purchase additional relative humidity & temperature probes given their tested long-term durability.

- Other vendors of meteorological sensory equipment include Climatronics, Vaisala, and Coastal Environmental Systems, among others. Although some relative humidity & temperature probes offer slightly better temperature accuracy (i.e., down to 0.1°C), there is little else that could be gained in terms of accuracy from meteorological sensors manufactured by other vendors. Additionally, the R.M. Young sensors have proven to be reliable in all types of extreme weather conditions that occur in Kentucky on an annual basis. Furthermore, the KDAQ meteorological network is universally set-up with R.M. Young instrumentation, meaning that the acquisition of meteorological sensors from other vendors would necessitate a complete overhaul of the system in place, which may not even gain any significant quality in terms of the data collected. Thus, there are no substantial reasons at this time to warrant a change in the meteorological sensors utilized within the KDAQ network.

Potential site for additional meteorological sensors within the KDAQ network:

- Lexington Primary (Fayette County Health Department; Lexington-Fayette, KY MSA)

    - The primary monitoring objectives at this site are for the activation of emergency control procedures for nitrogen dioxide, ozone, particulates, and sulfur dioxide, and to provide pollutant levels for daily air quality index reporting for the Lexington population. Additionally, the nitrogen dioxide monitor has been approved as a RA-40 monitor, which means that its primary focus is to protect susceptible and vulnerable populations. Given the volume of monitoring objectives assigned to this site, this site should add meteorological sensors equivalent to those used elsewhere in the KDAQ network. The only potential obstacle in terms of local topography would be the health department building roughly 60 m SW of the site. Regardless, it is believed that this site should yield quality meteorological data for air quality analyses.

Appendix D

Analysis of Siting Issues at the Ashland Primary-FIVCO Air Monitoring Station

Appendix D
Analysis of Siting Issues at the Ashland Primary-FIVCO Air Monitoring Station

As mentioned previously in this assessment, KDAQ believes that the Ashland Primary-FIVCO site (21-019-0017) in Boyd County is obstructed and that siting is not appropriate to accomplish monitoring objectives. The Ashland Primary station sits in a topographic depression, which is further surrounded by tall trees and buildings (see figure 1). As such, the airflow at the site is likely partially obstructed. Obstructions, especially vegetation, have the potential to scavenge pollutants and impact the scale of representativeness of the site.

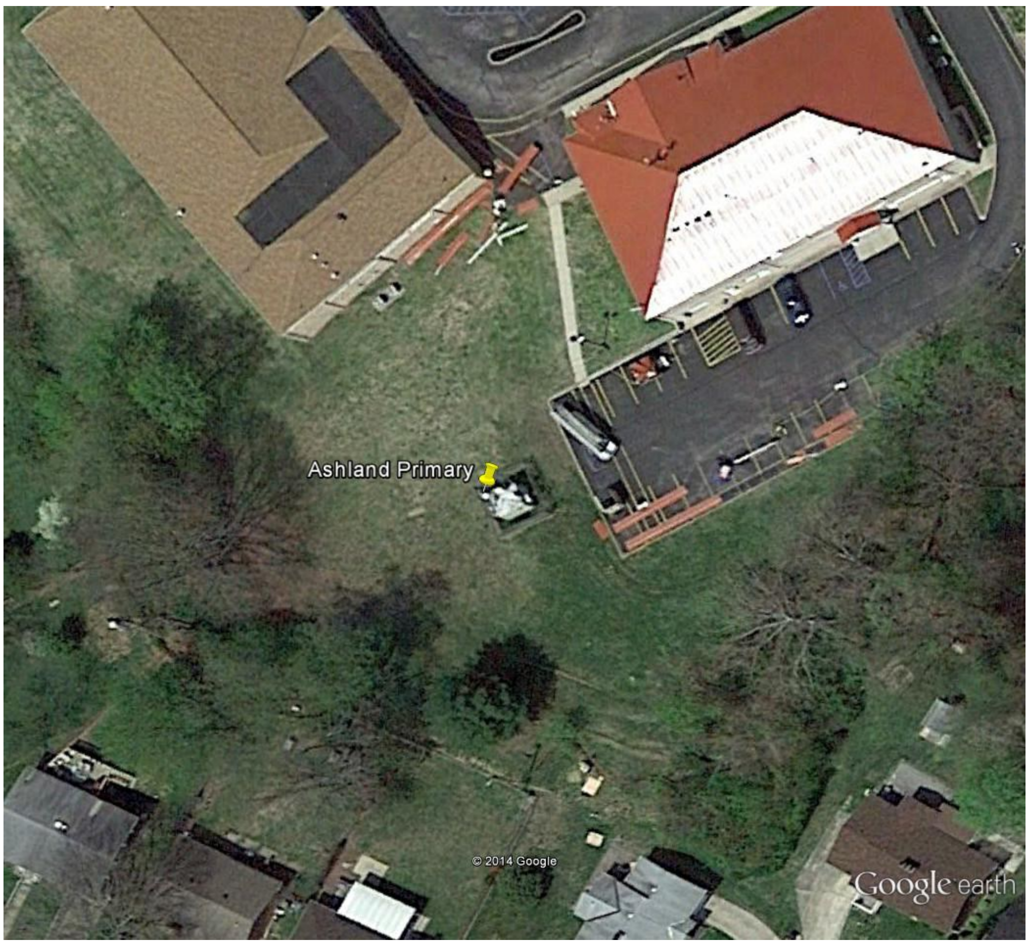


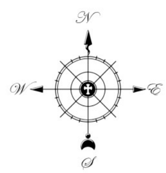
Figure 1: Google Earth image of the Ashland Primary air monitoring station.

Towards the western side of the site, the property is flanked by a stand of tall trees. The trees due west of the air monitoring station are approximately 18 meters tall. Using the two times the height differential rule, the inlets would need to be at least 28 meters away from the tree drip-line. However, the inlets are only 24 meters from the tree drip-line. Because the topography slopes downward as the tree-line moves south, the trees do not fully obstruct the site.

Additionally, the buildings to the north of the air monitoring station are approximately 6 meters in height, including the increase in topographic elevation. Technically, the building is not an obstruction because the inlets of the air monitoring equipment are positioned at distances greater than two times the height differential away. However, the unique topography of the area immediately surrounding the site appears to be impacting airflow at the site regardless. An assessment of the meteorological network, as shown in Appendix C, identified the Ashland Primary site as not being representative of the specific spatial scales stated in the Annual Network Plan.

While KDAQ is concerned about the location of the Ashland Primary site, concerns also exist in regards to trying to find a new site. The terrain at the Ashland Primary site is not unique for the region, which is marked by steep ridgelines and low valleys. KDAQ has performed some preliminary scouting trips to investigate potential new locations, but has not found any suitable sites. As such, KDAQ is concerned that a new site may not be found; or, if a new site is found that the improvement in data quality would only be marginal, when compared to the extreme cost involved with establishing air monitoring stations.

KDAQ requests guidance from EPA Region 4 on this matter. The following pages contain pictures of the Ashland Primary site, as well as the siting criteria field form, from the 2014 annual siting criteria evaluations. Not only do the logistics of site relocation need to be considered, KDAQ also needs to know if a waiver from siting criteria should be requested. KDAQ welcomes EPA Region 4 input.



Approximate
Cardinal
Direction

Siting Evaluation Field Form

Site Name:	FIVCO	Date:	11/20/2014
AQS I.D.:	21-019-0017	Inspected by:	J. Miller
Coordinates:	38.45934, -82.64041 (Decimal Degrees; WGS 84/NAD 83)		

Particulates

What is the particulate monitoring scale? Middle Scale

What is the lead monitoring scale, if different? n/a

Particulates	PM2.5	PM2.5 Collocated	PM10	PM10 Collocated	TEOM	TEOM Collocated
Probe Height	4.8 m				4.7 m	
Probe Height Limits	2-15 m				2-15 m	
Distance to Nearest Road	67.5 m				67.5 m	
Road Distance Limits	15.0 m				15.0 m	
Tree Obstruction Height	Approx. 18.0 m				Approx. 18.0 m	
Tree Obstruction Distance	24.0 m				24.0 m	
Tree Ob. Dist. Limit (2 x height differential)	26.4 m				26.6 m	
Other Obstruction Type	Building				Building	
Obstruction Height	5.7 m				5.7 m	
Distance to Obstruction	23.5 m				23.5 m	
Ob. Distance Limit (2 x height differential)	1.8 m				2.0 m	
Collocated Distance						

Particulates Continued	SASS	Carbon Speciation	Lead	Lead Collocated	Other	Other
Probe Height	4.5 m	4.5 m				
Probe Height Limits	2-15 m	2-15 m				
Distance to Nearest Road	67.5 m	67.5 m				
Road Distance Limits	15.0 m	15.0 m				
Tree Obstruction Height	18.0 m	18.0 m				
Tree Obstruction Distance	24.0 m	24.0 m				
Tree Ob. Dist. Limit (2 x height differential)	27.0 m	27.0 m				
Other Obstruction Type	Building	Building				
Obstruction Height	5.7 m	5.7 m				
Distance to Obstruction	23.5 m	23.5 m				
Ob. Distance Limit (2 x height differential)	2.4 m	2.4 m				
Collocated Distance		2.3 m				

Are all probes at least 1 meter apart? Yes

Are all collocated low-vol samplers b/w 1-4 meters apart? Yes

Are all collocated high-vol samplers b/w 2-4 meters apart? n/a

Are all probes located in an area that is paved or has vegetative ground cover? Yes

Are all rooftop samplers located at least 2 meters away from any structure? Yes

Continuous

What is the continuous monitoring scale? O3, SO2: Neighborhood Scale; NO2: Urban Scale

What is the CO monitoring scale, if different? n/a

Continuous	O3	SO2	NO2	NOy	CO	Other
Probe Height	3.9 m	3.9 m	3.9 m			
Probe Height Limits	2-15 m	2-15 m	2-15 m			
Distance to Nearest Road	67.5 m	67.5 m	67.5 m			
Road Distance Limits	10 m	n/a	10 m			
Distance to Tree Drip Line	24.0 m	24.0 m	24.0 m			
Tree Distance Limits	10 meters				n/a	
Tree Obstruction Height	18.0 m	18.0 m	18.0 m			
Tree Ob. Dist. Limit (2 x height differential)	28.2 m	28.2 m	28.2 m			
Other Obstruction Type	Building	Building	Building			
Obstruction Height	5.7 m	5.7 m	5.7 m			
Distance to Obstruction	23.5 m	23.5 m	23.5 m			
Ob. Distance Limit (2 x height differential)	3.6 m	3.6 m	3.6 m			

Air Toxics

What is the air toxics monitoring scale? Neighborhood Scale

Air Toxics	VOC	VOC Collocated	Carbonyl	PUF	Other	Other
Probe Height	3.7 m		4.1 m			
Distance to Nearest Road	67.5 m		67.5 m			

Other

If applicable, what is the monitoring scale? n/a

Additional	Met Tower		Precipitation	Solar Radiation	RadNet	Other	Other
	Wind Gauge	Amb. Temp					
Probe Height	5.7 m	5.2 m					
Distance to Nearest Road	67.5 m	67.5 m					

All Criteria Pollutants

For any microscale source-oriented monitor, are any trees or shrubs located between the probe and the source? n/a

Does each probe have a 270 deg. arc of unrestricted airflow (or 180 deg. if located on the side of a building) and include the predominant wind direction? No *

Are all probes at least 2 meters away from any high-vol inlet (Lead, Radnet)? n/a

Are all probes clean? ☑ Yes ☐ No Are the spatial scales in the Network Plan appropriate? ☑ Yes ☐ No Is the physical address in the Network Plan correct? ☑ Yes ☐ No

Comments

Geographic coordinates, road & tree distances confirmed via Google Earth. Moore Street was used as the nearest road. 29th Street (KYTC 2011 AADT= 7230) is 140.7 m from the site.

Sample lines for continuous monitors, VOCs, & carbonyls are very close together (approx. 0.3 m apart). * Site is most likely partially obstructed by trees and surrounding buildings.

The site sits in a small topographic depression, which likely influences airflow. Area of complex terrain makes site alternatives difficult.

Appendix E

Data Users

Appendix E
Data Users

According to 40 CFR 58.10(d), each state agency, or where applicable local agency, is required to consider the effects on data users, other than the agency itself, for any site that is being considered for discontinuance. While there is currently no established method of tracking the use of ambient air monitoring data on either a state or federal level, KDAQ is able to make generalizations about users of our network data, based upon knowledge of federal public access databases and the inquiries that KDAQ receives.

Common data users may be generally categorized as the following:

- Other State Agencies
- Metropolitan Planning Organizations (MPOs)
- Health Studies
- Enforcement
- K-12 Educators & Students
- Academia (Researchers & Students)
- EPA
- National Park Service (Ambient Air Monitoring, Regional Haze)
- Other Federal Agencies
- Prescribed Fire Practitioners
- Citizen Groups & Individual Citizens
- Consultant Groups
- Facilities

As a result of this network assessment, KDAQ is not formally committing to discontinuation of any site or monitor. However, KDAQ did identify the ozone monitor at the Nicholasville site (21-113-0001) as redundant, when compared to the data collected at the Lexington Primary (21-067-0012) site. KDAQ is aware that the Lexington Area Metropolitan Planning Organization regularly requests ozone data from the Nicholasville and Lexington Primary sites in order to validate ambient air quality forecasts. As such, KDAQ would need to consult with the MPO prior to any decision regarding discontinuance.

Appendix F

Reporting of the AQI

&

Forecasting

Appendix F
Reporting of the AQI & Forecasting

The AQI is a method of reporting that converts pollutant concentrations to a simple number scale of 0-500. Intervals on the AQI scale are related to potential health effects of the daily measured concentrations of major pollutants. 40 CFR 58, Appendix G, requires that the AQI be reported for all metropolitan statistical areas with a population exceeding 350,000. However, KDAQ provides this service to the general public for multiple areas within the state.

Core-Based Statistical Area	2013 USCB Population Estimate	AQI Required MSA	AQI Reported					
			$PM_{2.5}$	PM_{10}	SO_2	NO_2	CO	O_3
Metropolitan Statistical Area								
Bowling Green, KY	163,536		X					X
Cincinnati-Middletown, OH-KY-IN	2,137,406	X	X		X	X		X
Clarksville, TN-KY	272,579							
Elizabethtown, KY	151,465							
Evansville, IN-KY	314,280							
Huntington-Ashland, WV-KY-OH	364,101	X	X		X	X		X
Lexington-Fayette, KY	489,435	X	X		X	X		X
Louisville-Jefferson County, KY-IN*	1,262,261	X	X	X	X	X	X	X
Owensboro, KY	116,401		X		X	X		X
Micropolitan Statistical Area								
Paducah, KY-IL	98,137		X		X	X		X
Somerset, KY	63,907							
Middlesboro, KY	27,885							
Richmond-Berea, KY	102,283							
Not in a CBSA								
Carter County	27,202							
Marshall County	31,107							
Perry County	28,010							
Pike County	63,380		X					X
Simpson County	17,793							

**Includes LMAPCD*

KDAQ prepares the index twice daily for release to the public from the pollutant data reported from the Field Offices. The ambient air data establishing the AQI is subject to quality assurance procedures and is not considered official. KDAQ reports nearly real-time AQI values on our website at air.ky.gov.

40 CFR 58, Appendix E, states that agencies "should forecast the AQI to provide timely air quality information to the public, but this is not required." Forecasted AQI data is generated using a combination of forecasted weather data and known pollution emission values. KDAQ does not forecast for air pollution; however, the LMAPCD does provide ozone and $PM_{2.5}$ forecasts for residents of Jefferson County. LMAPCD's forecasts can be accessed on their website at www.louisvilleky.gov/APCD. Nationwide near real-time and forecasted AQI data can be accessed at the EPA's AIRNow website at airnow.gov.

Appendix G
New Monitoring Technologies

Appendix G
New Monitoring Technologies

As a part of this network assessment, KDAQ considered the need to integrate new technologies into the current air monitoring system. Overall, KDAQ continues to operate a modern network; however, a few improvements could be useful.

The KDAQ air monitoring program is continuing to strive toward a 100% digital communication environment. Recent improvement to the network now allows for remote access to most field computers, samplers and analyzers allowing for faster downloads of data and making it possible for technicians to perform 1st level diagnostic evaluations prior to deploying personnel into the field.

In the coming months KDAQ will continue modernization efforts related to the air monitoring telemetry system. Plans for the coming year include upgrading the ESC 8832 site data loggers, which are being discontinued by the manufacturer, to the more modern and completely digital Agilaire 8872 logger.

Additionally, KDAQ understands the need to integrate more advanced data analysis techniques and tools. KDAQ currently relies heavily upon pivot tables and charts, as well as the Data Analysis package, in Excel. While the skills required to use Excel for data analysis are lower, thus making Excel very accessible, these methods are labor intensive requiring some amount of pre-processing of the dataset.

KDAQ does use several pre-built web tools also, such as the Navigator tool on the AirNow Tech website and the HYSPLIT tool on the NOAA ARL website. For meteorological assessments, KDAQ relies heavily upon Lakes Environmental WRPLOT View to generate wind-roses.

There are many additional pre-built data analysis tool packages available, such as the new Data Analysis and Reporting Tool (DART), that KDAQ should begin to rely upon more heavily upon in order to better understand air pollution behavior in our State. Additionally, KDAQ should begin to invest more time into spatially analyzing air monitoring data via GIS.

Finally, KDAQ is acutely aware that more and more agencies are developing their own tools. Often, these tools are generated using the "R" programming language. According to the R-Project website, "R provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, …) and graphical techniques, and is highly extensible." (http://www.r-project.org/about.html)

The "R" programming language is open-source and free, which allows air agencies to easily collaborate in order to build applications. As such, it is widely used throughout EPA Region 4. Ultimately, applications built with "R" often require a significant investment of time on the frontend, but KDAQ understands that the investment saves time and resources throughout the total lifespan of a project. Unfortunately, KDAQ staff do not currently possess the skillset necessary to use "R", which is a significant obstacle .

Appendix H
About the LADCO Ambient Air Monitoring Network Assessment Application (NetAssess v0.6b)

For certain analyses in this assessment, KDAQ used the Ambient Air Monitoring Network Assessment Tools Application (NetAssess v0.6b), which was developed by a LADCO workgroup consisting of people from Indiana, Minnesota, and Michigan to aid in their 2015 Network Assessment. The LADCO workgroup graciously made the tool available to states associated with other regional planning organizations. KDAQ thanks LADCO for their generosity.

This application is an update to the original 2010 Network Assessment tools developed by Mike Rizzo for the 2010 5-year Network Assessment. The tool can be accessed at: http://ladco.github.io/NetAssessApp/ The following information about the tools is extracted directly from the NetAssess application's website.

Software

- All software used to develop the NetAssess App is free and open source. All code for the app as well as this website describing it are available on GitHub.
    - R is the backbone of the NetAssess app. Most calculations and spatial statistics are done on the serverside inside R.
    - Shiny is what makes the NetAssess app possible. It is an R package that makes it easy to create interactive websites using R on the server to handle processing of data.
        - Leaflet is a javascript library that makes making online interactive maps easier. It is the basis for all the map features within NetAssess. There are also many plugins that extend the capabilities of leaflet.
        - Leaflet.draw is used to draw and manipulate polygons on a Leaflet map. NetAssess uses it to allow the user to draw their own area of interest.
        - Leaflet.contextmenu is used by NetAssess to add custom right-click menus to the site markers, allowing the user to select/deselect or hide individual monitors.
        - leaflet-sidebar is used to create the sidebars that contain additional options and information in the app.
        - Leaflet.EasyButton is used to create the buttons that control the sidebars.
        - esri-leaflet provides the basemaps for NetAssess
    - jQuery simplifies coding of several aspects of NetAssess and is a required component for Shiny.
    - Select2 is a jQuery plugin that makes select boxes (dropdowns) more useful. It was used for the parameter of interest dropdown in the menubar and the predefined area of interest dropdown.
    - Font Awesome is an icon font that was used for several of the icons in the menu bar and elsewhere.
    - Glyphicons is another icon pack that was used for the draw area of interest buttons.

Tools

- Area Served
    - The area served tool uses a spatial analysis technique known as Voronoi or Thiessen polygons to show the area represented by a monitoring site. The shape and size of each polygon is dependent on the proximity of the nearest neighbors to a particular site. All points within a polygon are closer

to the monitor in that polygon than to any other monitor. Once the polygons are calculated, data from the 2010 decennial census are used to find the census tract centroids within each polygon. The population represented by the polygon is calculated by summing the populations of these census tracts.

- Within the program, polygons are displayed by selecting a pollutant and area of interest, then pressing the Area Served icon. Once the polygons are displayed, clicking on a polygon displays an information popup box that lists both the area served, in square miles and square kilometers, and the population within the polygon. In addition, the popup box displays charts of the population breakdown by age and sex. The charts can be enlarged by clicking on them. The area and population data for the selected polygons can be downloaded as a comma-delimited file (.csv) by clicking the Download icon.
- Because census tract centroids were used to assign whole tracts to a particular Voronoi polygon, a few polygons which do not have a tract centroid within them do not have population information. If necessary, information for these cases can be estimated from the statistics of surrounding sites.

- <u>Correlation Matrices</u>
  - The Correlation Matrix tool calculates and displays the correlation, relative difference, and distance between pairs of sites within a user selected set of air monitoring sites. Within the NetAssess App the Correlation Matrix Tool generates a graphical display and a downloadable CSV file which summarize the results for each selected site pair. The purpose of this tool is to provide a means of determining possible redundant sites that could be removed. Possible redundant sites would exhibit fairly high correlations consistently across all of their pairings and would have low average relative difference despite the distance. Usually, it is expected that correlation between sites will decrease as distance increases. However, for a regional air pollutant such as ozone, sites in the same air shed can have very similar concentrations and be highly correlated. More unique sites would exhibit the opposite characteristics. They would not be very well correlated with other sites and their relative difference would be higher than other site to site pairs.
  - The Correlation Matrix tool generates a graphical display that summarizes the correlation, relative difference and distance between pairs of monitoring sites. Within the graphical display, the shape of the ellipses represents the Pearson correlation between sites. Circles represent zero correlation and straight diagonal lines represent a perfect correlation.
  - The correlation between two sites quantitatively describes the degree of relatedness between the measurements made at two sites. That relatedness could be caused by various influences including a common source affecting both sites to pollutant transport caused meteorology. The correlation, however, may indicate whether a pair of sites is related, but it does not indicate if one site consistently measures pollutant concentrations at levels substantially higher or lower than the other. For this purpose, the color of the ellipses represents the average relative difference between sites where the daily relative difference is defined as:

$$\frac{abs(s1 - s2)}{avg(s1, s2)}$$

where s1 and s2 represent the ozone concentrations at sites one and two in the pairing, abs is the absolute difference between the two sites and avg is the average of the two site concentrations.

- The average relative difference between the two sites is an indicator of the overall measurement similarity between the two sites. Site pairs with a lower average relative difference are more similar to each other than pairs with a larger difference. Both the correlation and the relative difference between sites are influenced by the distance by which site pairs are separated. Usually, sites with a larger distance between them will generally be more poorly correlated and have large differences in the corresponding pollutant concentrations. The distance between site pairs in the correlation matrix graphic is displayed in kilometers in the middles of each ellipse.
- The accompanying CSV file provides information about the individual site pairings including the summary statistics for the Pearson squared correlation (r), the number of valid pairs used in the analysis, the average relative difference calculations, and the distance between the sites.
- The Correlation Matrix tool uses daily summary pollutant concentration data for ozone and fine particles collected between January 1, 2011 and December 31, 2013. Data was retrieved using the AQS AMP 435 Daily Summary Report.
    - For ozone, the correlation matrix tool calculates a Pearson Correlation (r) for all valid 8-hour average ozone concentration pairs (DURATION CODE=W, DAILY CRITERIA IND=Y). In the AMP 435 Report, the daily maximum 8-hour ozone concentration is stored in the field labeled "MAX VALUE". Individual monitoring sites are identified using the AQS Site ID, which is a combination of the STATE CODE, COUNTY CODE, and SITE ID fields (XX-XXX-XXXX). If a site has more than one monitor collecting ozone data, the daily maximum 8-hour ozone concentration is the average of all valid results for that site on that date.
    - For PM2.5, the correlation matrix tool calculates Pearson Correlations (r) for all valid 24-hour fine particle concentration pairs stored under AQS parameter codes 88101 (PM2.5 Local Conditions - FRM/FEM/ARM) or 88502 (Acceptable PM2.5 AQI & Speciation Mass). The correlation matrix tool allows users to calculate correlations between all monitors reporting data under parameter code 88101 or 88502. The tool does not allow users to calculate correlations across these parameter codes. For parameter code 88101, within the settings menu of the NetAssess app, users can select whether correlations should be calculated using data from FRM monitors only, FEM monitors only, or all available data stored under parameter code 88101 (FRM and FEM data). Individual monitoring sites are identified using the AQS Site ID, which is a combination of the STATE CODE, COUNTY CODE, and SITE ID fields (XX-XXX-XXXX). If a site has more than one monitor collecting PM2.5 data, the daily average PM2.5 concentration is the average of all valid results for that site on that date.

- <u>Surface Probability</u>
    - One objective of the network assessment is to determine if new sites are needed. In order to make that decision, it is helpful to have some estimation of the extreme pollution levels in areas where no monitors currently exist. NetAssess provides ozone and $PM_{2.5}$ maps of the contiguous US that can be used to make spatial comparisons regarding the probability of daily values exceeding a certain threshold. For ozone, three different thresholds can be selected. The $PM_{2.5}$ map has a threshold of 35 $\mu g/m^3$.

- To clarify, these maps do not show the probability of violating the National Ambient Air Quality Standards (NAAQS). They provide information about the spatial distribution of the highest daily values for a pollutant (not, for example, the probability of the 4th highest daily 8-hour ozone maximum exceeding a threshold).
- These maps are intended to be used as a spatial comparison and not for probability estimates for a single geographic point or area. The probability estimates alone should not be used to justify a new monitor. The maps should be used in conjunction with existing monitoring data. If a monitor has historically measured high values, then the probability map gives an indication of areas where you would expect to observe similar extreme values. This information, along with demographic and emissions data, could be used in a weight of evidence approach for proposing new monitor locations.

- The surface probability maps were created by using EPA/CDC downscaler data. Downscaler data are daily estimates of ground level ozone and $PM_{2.5}$ for every census tract in the continental US. These are statistical estimates from "fusing" photochemical modeling data and ambient monitoring data using Bayesian space-time methods. For more details on how the data were generated, see the meta data document on the EPA website.
  - Daily downscaler estimates for 8-hour maximum ozone and 24-hour mean $PM_{2.5}$ for the years 2007 and 2008 were obtained from the EPA website. Years 2009-2011 were obtained from the CDC's Environmental Public Health Tracking Program.
- An extreme value distribution was fit for each census tract centroid in the continental United States. That is, for each census tract, yearly maxima were obtained and a distribution of those maxima was estimated.
  - In the simplest case, an extreme value distribution would be fit using just one maximum value for each year. For example, daily precipitation values from a rain gauge over 100 years would provide about 36,500 daily values. The maximum precipition level for each year over a span of 100 years would give 100 values (each a maximum for a year), and an extreme value distribution could be estimated using those 100 values. That distribution could be used to find the probability of an extreme flood event.

- Removal Bias
  - The removal bias tool is meant to aid in determining redundant sites. The bias estimation uses the nearest neighbors to each site to estimate the concentration at the location of the site if the site had never existed. This is done using the Voronoi Neighborhood Averaging algorithm with inverse distance squared weighting. The squared distance allows for higher weighting on concentrations at sites located closer to the site being examined. The bias was calculated for each day at each site by taking the difference between the predicted value from the interpolation and the measured concentration. A positive average bias would mean that if the site being examined was removed, the neighboring sites would indicate that the estimated concentration would be larger than the measured concentration. Likewise, a negative average bias would suggest that the estimated concentration at the location of the site is smaller than the actual measured concentration.

Appendix I

EPA Region 4 Guidance List:

Five-Year Network Assessment

5-Year Periodic Network Assessment: CFR requirements & Regional Recommendations

The following guidance was provided by EPA Region 4 on December 15, 2014.

The five year air quality monitoring network assessment is required to determine at a minimum:

1) If the network meets the monitoring objectives defined in Appendix D.
2) Whether new monitoring sites are needed.
3) Whether existing sites are no longer needed and can be terminated.
4) Whether new technologies are appropriate for incorporation into the air monitoring network.
5) Whether the network sufficiently supports characterization of air quality in areas with large populations of susceptible individuals.
6) Whether discontinuance of a monitoring site would have an adverse impact on other data users or health studies.
7) For PM2.5 the assessment must identify needed changes to population oriented sites.
8) If monitoring is required near any additional Pb sources according to the most recent National Emissions Inventory. (Monitoring is required near sources with Pb emissions greater than 0.5 tons per year.)
9) Any waiver of 40 CFR Parts 50 and/or 58 regulatory requirements must be renewed during each 5-Year Assessment unless otherwise specified to be renewed annually during the network plan process.

    a. Pb source monitoring waivers
    b. Continuous PM2.5 FEM Comparability (NAAQS Exclusion).
    c. Siting criteria
    d. Any additional waiver of Part 50 and/or 58 regulatory requirements.

For specific language addressing #1-7, see 40 CFR § 58.10(d).
For specific language addressing #8-9a, see 40 CFR Part 58 Appendix D, Section 4.5.
For specific language addressing #9b, see 40 CFR § 58.11(e).
For specific language addressing #9c, see 40 CFR Part 58 Appendix E, Section 10.

In order to assess the network's suitability for the seven objectives listed above the State agency will need to consider the following information:

1) Statewide and local level population statistics.
2) Statewide ambient air monitoring network pollutant concentration measurement trends for the past 5-years.
3) Network suitability to measure the appropriate spatial scale of representativeness for selected pollutants.
4) Monitoring data spatial redundancy or gaps that need to be eliminated.
5) Programmatic trends or shifts in emphasis or funding that lead toward different data needs.

State and local agencies are also encouraged to consider the following information, which would enrich the network assessment:

1) Statewide and local level emission source trends, characteristics, and inventory.
2) Statewide plans to modify, add, or remove emission sources.
3) Statewide and local level meteorological impacts on pollutant concentrations.
4) Potential impacts of precursor chemical emissions on pollutant concentrations.
5) Potential impacts of pollutant and precursor transport on measured concentrations.
6) Atmospheric dispersion modeling output generated as part of a permit application or control strategy effectiveness demonstration.

A wide variety of data analysis methods may be used in the network assessments. Agencies should consider the following types of tools:

1) Statistical tools and methods
    a) Trend analysis of line charts and bar graphs of historical pollutant concentration trends in comparison with the NAAQS.
    b) Correlation analysis to discern the similarity of measurements between individual monitoring stations on a single pollutant basis.
    c) Principal component analysis, if applicable for a given agency.
2) Graphical tools and methods
    a) Maps with multiple layers and overlays depicting:
        i. Monitor locations
        ii. Emission inventory data
        iii. Population data
        iv. Effects of either adding or deleting a monitor from the network
        v. Spatial area served by a monitoring site for a given pollutant

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