THUNDER MOUTAIN ENVIRONMENTAL SERVICES LLC
MODELING REPORT

Project name	**Air Dispersion Modeling Report**
Project no.	**1139560\1940103088**
Recipient	**West Virginia DEP – Division of Air Quality**
Document type	**Modeling Report**
Version	**1**
Date	**December 14, 2022**
Prepared by	**Helena Kubarycz**
Checked by	**Abhishek Bhat**
Approved by	**Matthew Traister, P.E.**

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Introduction

On June 3, 2022, Thunder Mountain Environmental Services, LLC (TMES) submitted an application for a minor New Source Review (NSR) Permit for the construction of a new regulated medical waste (RMW) treatment facility located in Jackson County, West Virginia. On August 25, 2022, Mr. Edward Andrews of the West Virginia Department of Environmental Protection (WVDEP) requested TMES submit an air dispersion modeling protocol for evaluation of the impacts from the affected facility to further support the siting analysis required pursuant to 40 Code of Federal Regulations (CFR) Subpart 60.54c(a). The modeling protocol was developed to satisfy the WVDEP's request and submitted on October 10, 2022. A revised modeling protocol was submitted on November 10, 2022 to address WVDEP's comments.

This modeling report outlines the methodologies that were used to conduct the air dispersion modeling analysis required by WVDEP. As requested, compliance will be demonstrated by meeting the National Ambient Air Quality Standards (NAAQS) for criteria pollutants, nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}), and particulate matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$), lead, and ozone.

1.1 Project Discussion

TMES is proposing to construct a new solid RMW gasification waste to energy facility. This facility will consist of a single thermal gasification system, a Vista Thermal Gasifier, that will be used for the treatment of RMW. The thermal gasification system will convert the RMW into high British Thermal Unit (BTU) synthetic gas (syngas).

To demonstrate that the impacts from the facility will not be a potential risk to public health or the environment, TMES conducted air dispersion modeling for nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2), PM_{10}, $PM_{2.5}$ and lead. Impacts for these criteria pollutants were compared to their respective NAAQS to show compliance with the requirement.

1.2 Site Location and Description

The waste to energy facility will lease space in an existing industrial building located at 5334 Point Pleasant Road, Ravenswood, West Virginia. A site location map is provided in **Figure 1**. The site is bounded by a mix of undeveloped herbaceous land and rural residential homes. The Ohio River is located approximately 0.45 km to the northeast.

1.3 Stack Parameters and Buildings

Preliminary stack parameters for the emission point that were used in the modeling analysis are provided in **Table 1** (English Units) and **Table 2** (Metric Units). A site layout map with building heights and stack location is included in **Figure 2**. Base elevations for the building and sources were based on the grade elevation of the existing facility. Please note emissions from material handling will be exhausted through the same emission point as the emissions from the thermal gasifier (EP-001).

Please note, there is an emergency generator that will be limited to emergency and maintenance use only and a maximum of 100 hours per year. However, the affected facility to which 40 CFR 60.54c applies is the individual waste incinerators. Emissions from the emergency generator are not considered part of the affected facility under 40 CFR 60.54c and therefore, were not included in the modeling analysis.

The emergency bypass vent is a damper that will be open in an emergency situation when there is power failure and failure of the backup emergency generator. The emergency vent will only be utilized in an emergency overpressure situation which otherwise can cause severe damage to process equipment. The emergency vent is a pressure relief valve which will not be activated in the process of maintenance, startup, or shutdown purposes. In the event the emergency release is required, the situation will qualify for accidental release and would release in excess emissions. For the purposed of demonstrating compliance with 40 CFR 60.54c, malfunctions which may result in excess emissions are not considered to be a normal operating condition. If such an event occurred, the WVDEP can request the excess emissions be modeled at that time.

1.4 Emission Rates

A summary of emission rates used in the modeling analysis is provided in **Table 3**. Please note the same emission rates were previously provided in Table 9.2.1 and Table 9.4.1 of the submitted permit application.

2. Air Dispersion Modeling Methodology

This section of the modeling protocol describes the procedures and data resources that were used in the air quality modeling analyses. In general, the air dispersion modeling analyses was conducted in accordance with the following guidance documents:

- United States (US) Environmental Protection Agency's (EPA) Guideline on Air Quality Models 40 CFR 51, Appendix W (Revised, January 17, 2017), herein referred to as Appendix W
- USEPA's AERMOD Implementation Guide (Revised June 1, 2022)
- USEPA, Office of Air Quality Planning and Standards, Memorandum from Mr. Tyler Fox to Regional Air Division Directors. Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard (March 1, 2011)
- USEPA, Office of Air Quality Planning and Standards. Guidance for Ozone and Fine Particulate Matter Permit Modeling. EPA-454/R-22-005. (July 29, 2022)
- USEPA, Office of Air Quality Planning and Standards. Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier I Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program. EPA-454/R-19-003. (April 30, 2019)

2.1 Air Dispersion Model Selection

Air dispersion models predict pollutant concentrations downwind of a source by simulating the evolution of the pollutant plume over time and space given data inputs that include the quantity of emissions and the initial exhaust release conditions (*e.g.*, velocity, flow rate, and temperature). The latest version of the AERMOD model (Version 22112) was utilized for the modeling demonstration. AERMOD is a refined, steady-state, multiple source dispersion model and was promulgated in December 2005 as the preferred model to use for industrial sources in this type of air quality analysis. The AERMOD analysis was conducted using the regulatory default options as provided in Appendix W. The final modeling analysis was performed using the single processor model executable code provided by USEPA without modification to the code for parallel processing.

2.2 Urban/Rural Classification

USEPA guidance in 40 CFR 51, Appendix W, Section 7.2.3 allows for either a land use procedure or a population density procedure to evaluate whether urban or rural dispersion coefficients will be used in a modeling analysis. Appendix W also states that the land use procedure is considered more definitive. Therefore, the land use procedure was chosen for this analysis.

The land use procedure involves evaluating the presence of various industrial, commercial, residential and agricultural/natural areas within a three-kilometer radius circle centered on the site (Auer scheme). If more than fifty percent of the area within this circle were designated industrial, commercial and compact residential, urban dispersion parameters would be used; otherwise, the modeling would use rural dispersion parameters. Based on the 2016 National Land Cover Data (NLCD), the majority of the surrounding area is categorized as rural. Therefore, rural dispersion curves were used in the analysis.

2.3 Good Engineering Practice Stack Height Analysis

USEPA provides specific guidance for calculating Good Engineering Practice (GEP) stack height and for evaluating whether building downwash will occur (USEPA, 2003). GEP stack height is defined by USEPA as the height of the structure plus 1.5 times the lesser of the structure height or projected width. If the stack height for a source is less than the height identified using GEP guidelines, based on the dimensions of nearby buildings, then the potential for building downwash to occur exists and is to be considered in the modeling analysis. The stacks to be modeled in this analysis will be less than GEP stack height.

The AERMOD model incorporates Plume Rise Modeling Enhancements (PRIME) to account for downwash. The direction-specific building downwash dimensions were used as inputs to the latest version (04274) of the Building Profile Input Program, PRIME (BPIP-PRIME). BPIP-PRIME uses building downwash algorithms incorporated into AERMOD to account for the plume dispersion effects of the aerodynamic wakes and eddies produced by buildings and structures.

2.4 Meteorological Data

The closest National Weather Service (NWS) station to the TMES facility is the Mason County Airport (K3I2), which is located approximately 26 km to the west of the facility. However, this station is not considered to have suitable meteorological data for air quality analyses since the station does not have an automated surface observing station (ASOS) and therefore one-minute data are not available.

The remaining nearest NWS stations with the appropriate ASOS is the Parkersburg Mid-Ohio Valley Airport (KPKB), located approximately 43 km to the northeast. Figures of the area surrounding the TMES facility and the Parkersburg NWS are provided in **Figure 3** and **Figure 4**. Both the sites are located in rural areas in rolling terrain. **Table 4** presents a comparison of the albedo, Bowen ratio, and surface roughness for each location. The albedo and Bowen ratio are similar at both sites. The surface roughness varies between the two sites, which is typical when comparing undeveloped herbaceous land to airports. Based on review of the terrain and land use surrounding the Parkersburg NWS and the TMES facility, meteorological conditions at the Parkersburg NWS are considered representative of those expected at the TMES facility. Preprocessed, AERMOD-ready meteorological station data was obtained from Lakes Software for the most recent full five years (2017-2021).

When processing the meteorological data for KPKB, it was identified that the third quarter (Q3) of 2018 has 18.3% missing hours. However, this does not affect the completeness of the data set. The total number of missing hours from 2018 is 5.5%, which is less than 10%. Furthermore, the overall missing data of the five-year data set is 4.03% which meets the completeness requirement provided in the USEPA's Meteorological Monitoring Guidance for Regulatory Modeling Application (February 2000), which states that meteorological data must be 90% complete in order to be acceptable for use in regulatory dispersion modeling[1].

The meteorological data were processed by Lakes Software using AERMET Version 22112, AERMINUTE Version 15272, and AERSURFACE Version 20060. The base elevation for the surface station was set to 263.3 m.

2.5 Coordinate System

The location of emission sources, building structures, and receptors was represented in the Universal Transverse Mercator (UTM) coordinate system. The datum for the modeling analysis is based on North American Datum 1983 (NAD 83). UTM coordinates for this analysis reside within UTM Zone 17 which serves as the reference point for regional receptors and sources.

2.6 Receptor Locations

The modeling analysis utilized a set of nested Cartesian grids of receptors with a spacing of 50, 100, and 500, meters extending to a distance of 1, 3, and 5 kilometers, respectively, from the facility. The facility will not have restricted access; therefore, on-site receptors inside the property boundary were included in this analysis. If there was an instance where the maximum concentrations occurred beyond 1 km from the facility, an additional grid would have been placed around the maximum concentration with receptors spaced 50 meters apart. Additionally, if the concentration contours display higher gradient towards the edge of the receptor grid, the receptor grid would have been expanded. However, this was not the case for the TMES modeling analysis. Each maximum concentration occurred within 1 km of the facility and concentration contours displayed lower gradient towards the edge of the receptor grid. Therefore, it was not necessary for additional receptor grids for this modeling analysis.

The current version of the AERMOD terrain preprocessor called AERMAP (version 18081) was used to calculate the receptor elevations and appropriate hill height values. Ten-meter resolution National Elevation Dataset (NED) data was used in the analysis.

3. NAAQS Analysis

To assess compliance with the NAAQS, sources at the facility will be modeled and a representative background concentration were added to the modeled concentrations and compared against the applicable NAAQS. **Table 5** summarizes the specific model output for each pollutant and averaging periods that was used for assessing compliance with the NAAQS.

3.1 Background Concentrations

For the NAAQS analysis, background monitoring data were used for NO_2, PM_{10}, $PM_{2.5}$, SO_2, CO, and ozone. Monitoring data were collected from monitoring sites in West Virginia, Kentucky, and Ohio were used to estimate background concentrations. Monitoring data used for the analysis are summarized in **Table 6**. A discussion of the monitor selection for each pollutant can be found in the TMES Modeling Protocol submitted November 10, 2022.

---

[1] According to a telephone conversation, regarding the number of missing hours in Q3 of 2018, between Mr. Jon McClung of WVDEP and Ms. Helena Kubarycz of Ramboll on October 5, 2022, the 2017-2021 meteorological data for KPKB are acceptable.

3.2 NO_2 Modeling Approach

The modeling analysis used the Tier 2 ARM2 NO_2 modeling approach using the regulatory-approved default settings. The minimum NO_2/NO_X Ratio was set to the default of 0.5. The maximum NO_2/NO_X ratio was set to the default of 0.9.

3.3 $PM_{2.5}$ Modeling Approach

USEPA's guidance document *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program* (April 30, 2019) provides a detailed framework for permit applicants to estimate single source impacts of secondary pollutants.

To assess compliance with the $PM_{2.5}$ NAAQS, the USEPA's MERPs VIEW Qlik application was used to estimate secondarily formed $PM_{2.5}$ concentrations from NO_X and SO_2 emissions. A summary of secondarily formed $PM_{2.5}$ concentrations are provided in **Table 7**. MERP values provided in **Table 7** are for the hypothetical single source located in West Virginia with a stack height of 10 ft and emission rate of 500 tpy. The secondary concentrations will be added to the modeled concentrations and the representative background concentrations to compare to the NAAQS in the modeling results tables.

3.4 Ozone Modeling Approach

USEPA's guidance document *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program* (April 30, 2019) provides a detailed framework for permit applicants to estimate single source impacts on secondary pollutants.

To assess compliance with the ozone NAAQS, the USEPA's MERPs VIEW Qlik application was used to estimate secondarily formed ozone concentrations from NO_X and volatile organic compound (VOC) emissions. A summary of secondarily formed ozone concentrations are provided in **Table 8**. MERP values provided in **Table 8** are for the hypothetical single source located in West Virginia with a stack height of 10 ft and emission rate of 500 tpy. The secondary concentrations will be added to the representative background concentrations to compare to the NAAQS in the modeling results tables.

4. Modeling Results

The results of the modeling analysis are provided in **Table 9** for NO_2, CO, PM_{10}, SO_2, and lead. Results of the modeling analysis for PM2.5 is provided in **Table 10**. Results of the modeling analysis for ozone is provided in **Table 11**. Figures of the concentration contours for each pollutant and averaging period are provided in **Figure 5** through **Figure 13**. The figures display the extent of the air quality impacts. As shown in **Table 9** through **Table 11**, the TMES facility will not cause or contribute to an exceedance of the NAAQS.

Electronic files of AERMOD input and output files, BPIP input and output files, AERMAP input and output files, and meteorological data files are provided via OneDrive file sharing. Meteorological data processing control input, output, and the raw data files used to process the meteorological data were requested from Lakes Software and will be provided when received.

TABLES

Table 1

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Stack Parameter Table (English Units)

Emission Point	Emission Point Description	Stack Location X-Coordinate (m)	Stack Location Y-Coordinate (m)	Release Type	Base Elevation (ft)	Stack Height[(a)] (ft)	Inside Diameter[(a)] (in)	Inside Diameter (ft)	Exit Temperature[(a)] (°F)	Flowrate[(a)] (cfm)
EP-001	Thermal Gasifier & Material Handling	431,034	4,308,611	Vertical	600	60.0	26.0	3.00	200	6,000

Notes:

(a) Stack parameters provided by Iron Construction and provided in the air permit application submitted June 2022

Source: Ramboll

Table 2

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Stack Parameter Table (Metric Units)

Emission Point	Emission Point Description	Stack Location X-Coordinate (m)	Stack Location Y-Coordinate (m)	Release Type	Base Elevation (m)	Stack Height[(a)] (m)	Inside Diameter[(a)] (m)	Exit Temperature[(a)] (°C)	Flowrate[(a)] (m^3/s)
EP-001	Thermal Gasifier & Material Handling	431,034	4,308,611	Vertical	183	18.3	0.914	93	2.83

Notes:

(a) Stack parameters provided by Iron Construction and provided in the air permit application submitted June 2022

Source: Ramboll

Table 3

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Summary of Emission Rates (a)

Emission Point	Emission Point Description	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	CO (lb/hr)	SO_2 (lb/hr)	NO_X (lb/hr)	Lead (lb/hr)	VOC (lb/hr)
EP-001	Thermal Gasifier	0.0870	0.0870	0.286	0.00146	0.0693	5.03E-07	0.880
EP-001	Material Handling	0.0739	0.0261	--	--	--	--	--
		0.161	***0.113***					

Notes:

(a) Emission rate calculations were developed by Iron Construction and provided in the air permit application submitted June 2022

Source: Ramboll

Table 4

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Comparison of Land Use Parameters - TMES Facility vs. Parkersburg Airport

Sector	TMES Facility			Parkersburg NWS			Percent Difference(a)		
	Albedo	Bowen Ratio	Surface Roughness (meters)	Albedo	Bowen Ratio	Surface Roughness (meters)	Albedo	Bowen Ratio	Surface Roughness
1	0.160	0.580	0.0170	0.160	0.660	0.209	0%	-14%	-1129%
2	0.160	0.580	0.0170	0.160	0.660	0.132	0%	-14%	-676%
3	0.160	0.580	0.0160	0.160	0.660	0.0690	0%	-14%	-331%
4	0.160	0.580	0.155	0.160	0.660	0.109	0%	-14%	30%
5	0.160	0.580	0.235	0.160	0.660	0.125	0%	-14%	47%
6	0.160	0.580	0.341	0.160	0.660	0.180	0%	-14%	47%
7	0.160	0.580	0.0940	0.160	0.660	0.404	0%	-14%	-330%
8	0.160	0.580	0.131	0.160	0.660	0.338	0%	-14%	-158%
9	0.160	0.580	0.145	0.160	0.660	0.230	0%	-14%	-59%
10	0.160	0.580	0.123	0.160	0.660	0.223	0%	-14%	-81%
11	0.160	0.580	0.171	0.160	0.660	0.256	0%	-14%	-50%
12	0.160	0.580	0.0500	0.160	0.660	0.285	0%	-14%	-470%
Average(b)(c)	0.160	0.580	0.125	0.160	0.660	0.213	0%	-14%	-71%

Notes:

(a) Percent Difference = (TMES Facility - Parkersburg NWS) / TMES Facility

(b) Average = average land use parameter averaged over the 12 sectors

(c) Average Percent Difference = (average TMES facility surface roughness - average Parkersburg NWS surface roughness) / average TMES facility surface roughness

Table 5

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Summary of Modeling Output for NAAQS Compliance Demonstration

Pollutant	Averaging Period	Design Standard	AERMOD Output
Nitrogen dioxide (NO_2)	1-Hour	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years	Maximum 5-year daily average of the 8th highest concentration, on a receptor-by-receptor basis
	Annual	Annual mean	Maximum annual average across 5-year period
Carbon monoxide (CO)	1-Hour	Not to be exceeded more than once per year	2nd highest across 5-year period
	8-Hour	Not to be exceeded more than once per year	2nd highest across 5-year period
Particulate matter 2.5 ($PM_{2.5}$)	24-Hour	98th percentile, averaged over 3 years	8th highest 24-hour concentration in a given year, averaged across 5-year period
	Annual	Annual mean, averaged over 3 years	Average across 5-year period
Particulate matter 10 (PM_{10})	24-Hour	Not to be exceeded more than once per year on average over 3 years	6th highest across 5-year period (a)
Sulfur dioxide (SO_2)	1-Hour	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years	Maximum 5-year daily average of the 4th highest concentration, on a receptor-by-receptor basis
	3-Hour	Not to be exceeded more than once per year	2nd high across 5 year period
Lead	3-Month	Rolling 3-month average, not to be exceeded	Monthly average output will be used to calculate the rolling 3-month average across 5- year period

Notes:

Table 6

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Summary of Background Concentrations for NAAQS Analysis(a)

Pollutant	Averaging Period	Design Value(b)	Units of Measure	AQS Site ID	City
Nitrogen dioxide (NO_2)	1-Hour	26.7	ppb	21-019-0017	Ashland, KY
	Annual	5.23	ppb		
Carbon monoxide (CO)	1-Hour	1.00	ppm	54-039-0020	Charleston, WV
	8-Hour	0.600	ppm		
Particulate Matter 2.5 ($PM_{2.5}$)	24-Hour	17.0	μg/m^3	54-107-1002	Vienna, WV
	Annual	7.53	μg/m^3		
Particulate Matter 10 (PM_{10})	24-Hour	30.0	μg/m^3	54-011-0007	Ironton, OH
Sulfur dioxide (SO_2)	1-Hour	19.0	ppb	54-107-1002	Vienna, WV
	3-Hour	22.0	ppb		
Ozone	8-Hour	0.0600	ppm	54-107-1002	Vienna, WV

Notes:

(a) A discussion of the monitor selection for each pollutant can be found in the Modeling Protocol submitted November 10, 2022.

(b) Design Values were provided on EPA's Outdoor Air Quality Data Monitor Values Report.

Table 7

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Summary of Secondarily Formed $PM_{2.5}$

PM2.5 Precursor	Averaging Period	MERP[(a)] (tpy)	TMES Potential Emissions[(b)] (tpy)	Secondary Impact[(c)] ($\mu g/m^3$)
Nitrogen oxides (NO_X)	24-Hour	18,362	0.304	1.98E-05
	Annual	66,695	0.304	9.10E-07
Sulfur dioxide (SO_2)	24-Hour	3,071	0.00639	2.50E-06
	Annual	27,661	0.00639	4.62E-08

Notes:

(a) Values provided are from EPA's MERPs View Qlik database. MERP provided is for a hypothetical single source located in West Virginia, 500 tpy & 10 ft stack height.

(b) TMES Potential Emissions (tpy) = Hourly Emission Rate (lb/hr)[as provided in **Table 3**] * 8,760 (hr/yr) / 2,000 (lb/ton)

(c) Secondary Impact ($\mu g/m^3$) = TMES Potenital Emissions (tpy) / MERP (tpy) * PM2.5 SIL ($\mu g/m^3$)

Table 8

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Summary of Secondarily Formed Ozone

PM2.5 Precursor	Averaging Period	MERP[(a)] (tpy)	TMES Potential Emissions[(b)] (tpy)	Secondary Impact[(c)] (ppb)
Nitrogen oxides (NO_X)	8-Hour	259	0.304	1.17E-03
Volatile Organic Compound (VOC)	8-Hour	5,170	3.85	7.46E-04

Notes:

(a) Values provided are from EPA's MERPs View Qlik database. MERP provided is for a hypothetical single source located in West Virginia, 500 tpy & 10 ft stack height.

(b) TMES Potential Emissions (tpy) = Hourly Emission Rate (lb/hr)[as provided in **Table 3**] * 8,760 (hr/yr) / 2,000 (lb/ton)

(c) Secondary Impact (ppb) = TMES Potenital Emissions (tpy) / MERP (tpy) * Ozone SIL (ppb)

Table 9

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Summary of AERMOD Results

Pollutant	Averaging Period	AERMOD Concentration (µg/m^3)	Background Concentration(a) (ppb)	Background Concentration(a) (µg/m^3)	Predicted Concentraiton(b) (µg/m^3)	NAAQS (ppb)	NAAQS(c) (µg/m^3)	Percent of NAAQS Standard (%)
Nitrogen dioxide (NO_2)	1-Hour	1.91	26.7	50.1	52.1	100	188	28%
	Annual	0.101	5.23	9.83	9.94	53.0	100	10%
Carbon monoxide (CO)	1-Hour	9.48	1,000	1,145	1,154	35,000	40,071	3%
	8-Hour	4.86	600	687	692	9,000	10,304	7%
Particulate Matter 10 (PM_{10})	24-Hour	1.88	--	30.0	31.9	--	150	21%
Sulfur dioxide (SO_2)	1-Hour	0.0461	19.0	49.8	49.8	75.0	196	25%
	3-Hour	0.0404	22.0	57.6	57.7	500	1,309	4%
Lead(d)	3-Month	0.00E+00	--	--	0.00E+00	--	0.150	0%

Notes:

(a) Information on source of background concentrations can be found in **Table 6**. Units converted from ppb to µg/m^3 using the following formula: (100 [ppb] ÷ 1000 [ppb/ppm]) * (molecular weight [g/mol] ÷ 1000 [µg/g]) ÷ (82.057338 [atm*cm3/mol-K] * 298.15 [K] ÷ 1 [atm]) * 1000000 [cm3/m3] * 1000 [µg/mg]

(b) Predicted Concentration (µg/m^3) = AERMOD Concentration (µg/m^3) + Background Concentration (µg/m^3)

(c) NAAQS converted from ppb to µg/m^3 using the following formula: (100 [ppb] ÷ 1000 [ppb/ppm]) * (molecular weight [g/mol] ÷ 1000 [µg/g]) ÷ (82.057338 [atm*cm^3/mol-K] * 298.15 [K] ÷ 1 [atm]) * 1000000 [cm^3/m^3] * 1000 [µg/mg]

(d) The highest first high 1-month concentration for lead was predicted to be 0 µg/m^3. Therefore, the 3-month rolling average was calculated to be 0 µg/m^3

Table 10

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Summary of $PM_{2.5}$ Results

Pollutant	Averaging Period	AERMOD Concentration ($\mu g/m^3$)	Background Concentration[a] ($\mu g/m^3$)	Secondarily Formed $PM_{2.5}$[b] ($\mu g/m^3$)	Predicted Concentraiton[c] ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS Standard (%)
Particulate Matter 2.5 ($PM_{2.5}$)	24-Hour	0.909	17.0	2.23E-05	17.9	35.0	51%
	Annual	0.183	7.53	9.56E-07	7.72	12.0	64%

Notes:

(a) Background concentration from the Vienna, WV monitoring site from 2018, 2020, and 2021

(b) Secondarily Formed $PM_{2.5}$ ($\mu g/m^3$) = NO_X Secondary Impact ($\mu g/m^3$) [as provided in **Table 8**] + SO_2 Secondary Impact ($\mu g/m^3$) [as provided in **Table 8**]

(c) Predicted Concentration ($\mu g/m^3$) = AERMOD Concentration ($\mu g/m^3$) + Background Concentration ($\mu g/m^3$) + Secondarily Formed $PM_{2.5}$ ($\mu g/m^3$)

Table 11

Thunder Mountain Environmental Services LLC
Ravenswood, West Virginia

Summary of Ozone Results

Pollutant	Averaging Period	Background Concentration[a] (ppb)	Secondarily Formed Ozone[b] (ppb)	Predicted Concentraiton[c] (ppb)	NAAQS (ppb)	Percent of NAAQS Standard (%)
Ozone	8-Hour	60.0	1.92E-03	60.0	70	86%

Notes:

(a) Background concentration from the Vienna, WV monitoring site from 2018-2020

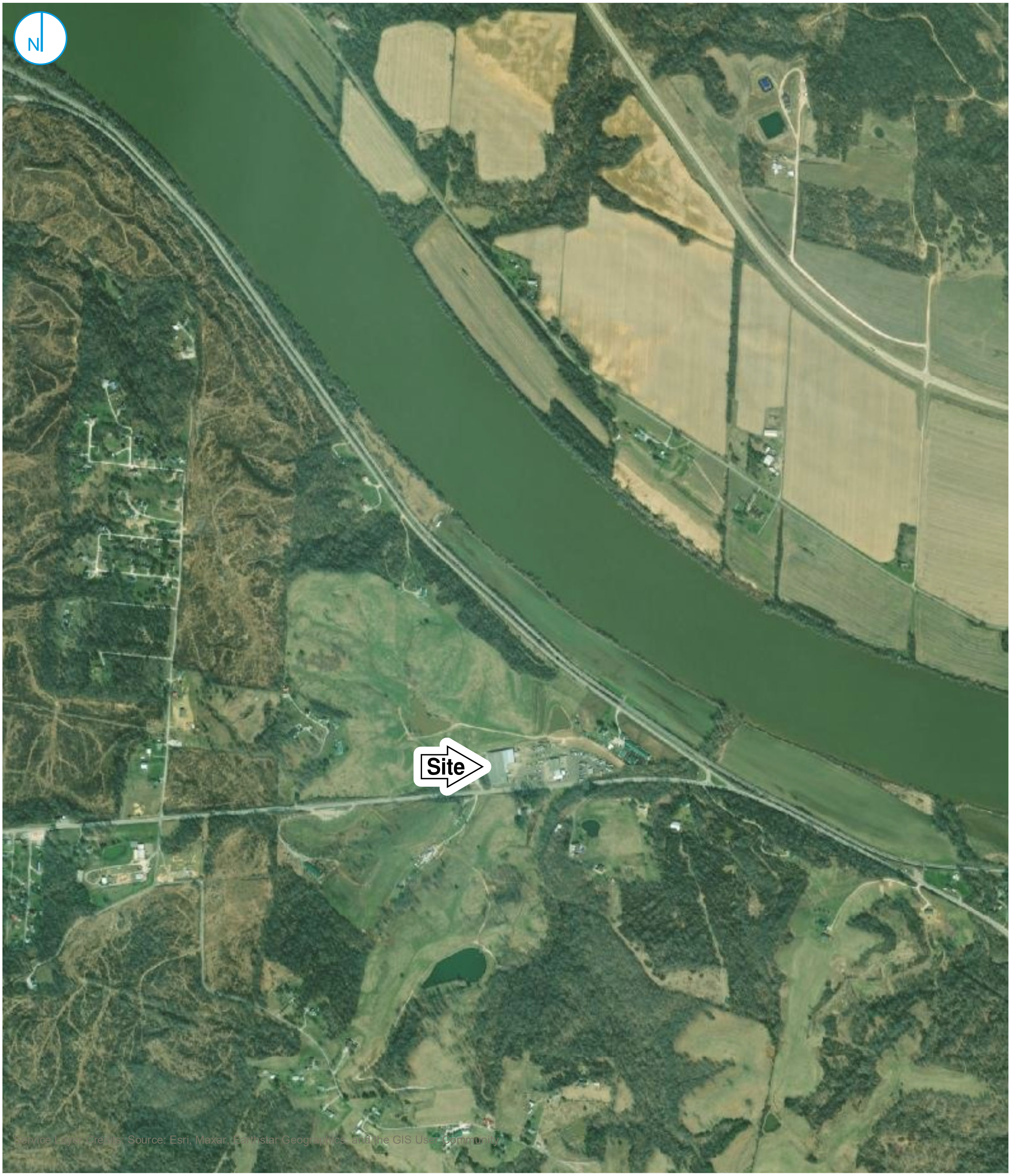
(b) Secondarily Formed Ozone (ppb) = NO_X Secondary Impact (ppb) [as provided in **Table 10**] + VOC Secondary Impact (ppb) [as provided in **Table 10**]

(c) Predicted Concentration (ppb) = Background Concentration (ppb) + Secondarily Formed Ozone (ppb)

FIGURES

K:\Renaissance-Env.1139560\1940101897.RES---Permitting-New\Docs\Sheets_Figures\WV-Figure_1.mxd

PROJECT: 1940103088 | DATED: 10/5/2022 | DESIGNER: YOUNGAS



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Map Scale: 1:20,000 | Map Center: 80°12'46"W 38°44'47"N

SITE LOCATION

FIGURE 01

KEY MAP

0 1,000 2,000 Feet

Thunder Mountain Environmental Services LLC
5334 Point Pleasant Rd,
Ravenswood, WV 26164

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

PROJECT TITLE:

Figure 2 - Site Layout Map

SOURCES:

1

RECEPTORS:

5233

SCALE: 1:1,000

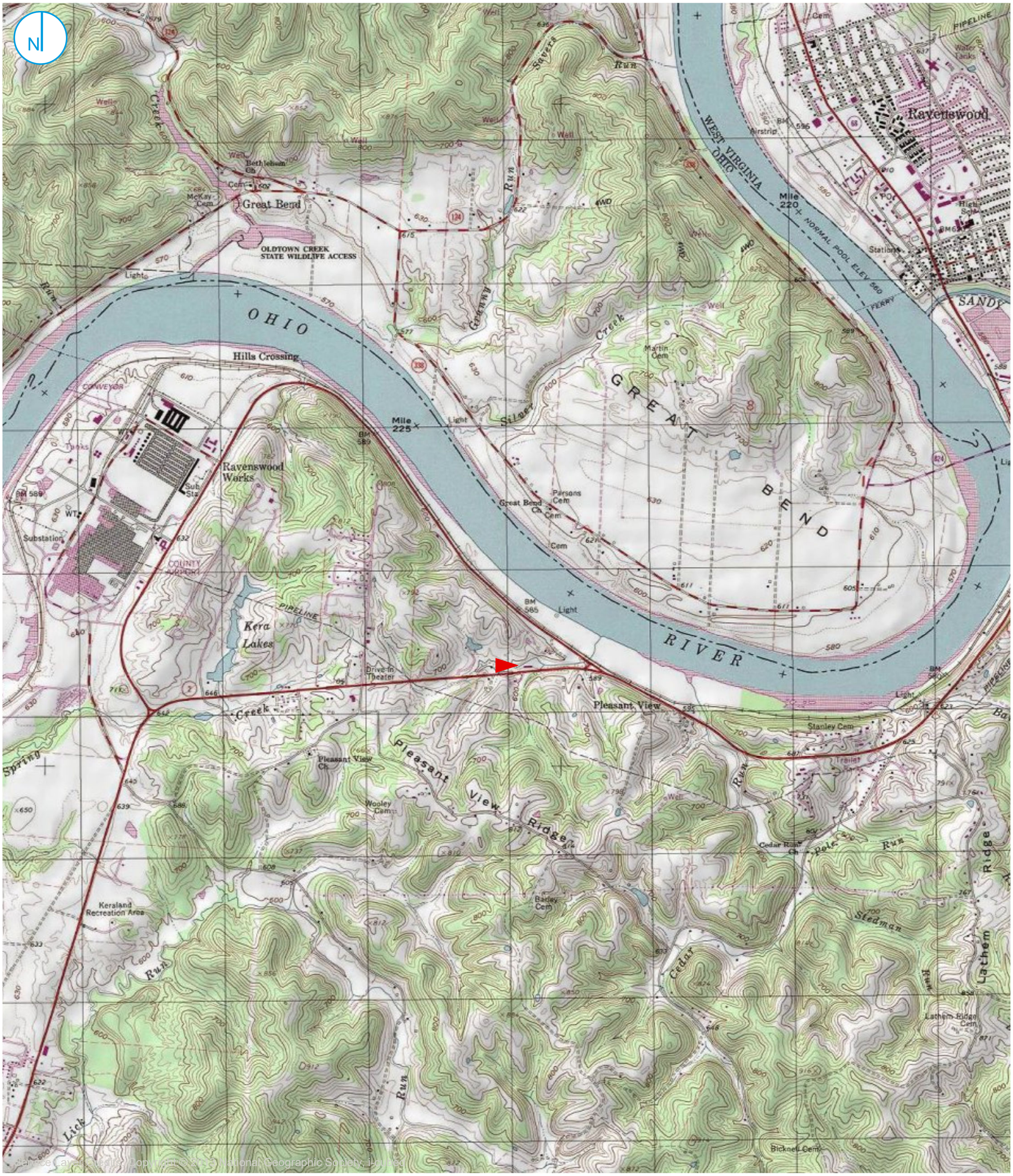
0 0.03 km

DATE:

10/10/2022

K:\Renaissance-Env.11395601940101897.RES---Permitting-New\Docs\Sheets_Figures\WV-Figure_3.mxd

PROJECT: 1940103088 | DATED: 10/5/2022 | DESIGNER: YOUNGAS



0 2,000 4,000
Feet

TOPOGRAPHIC MAP
FACILITY

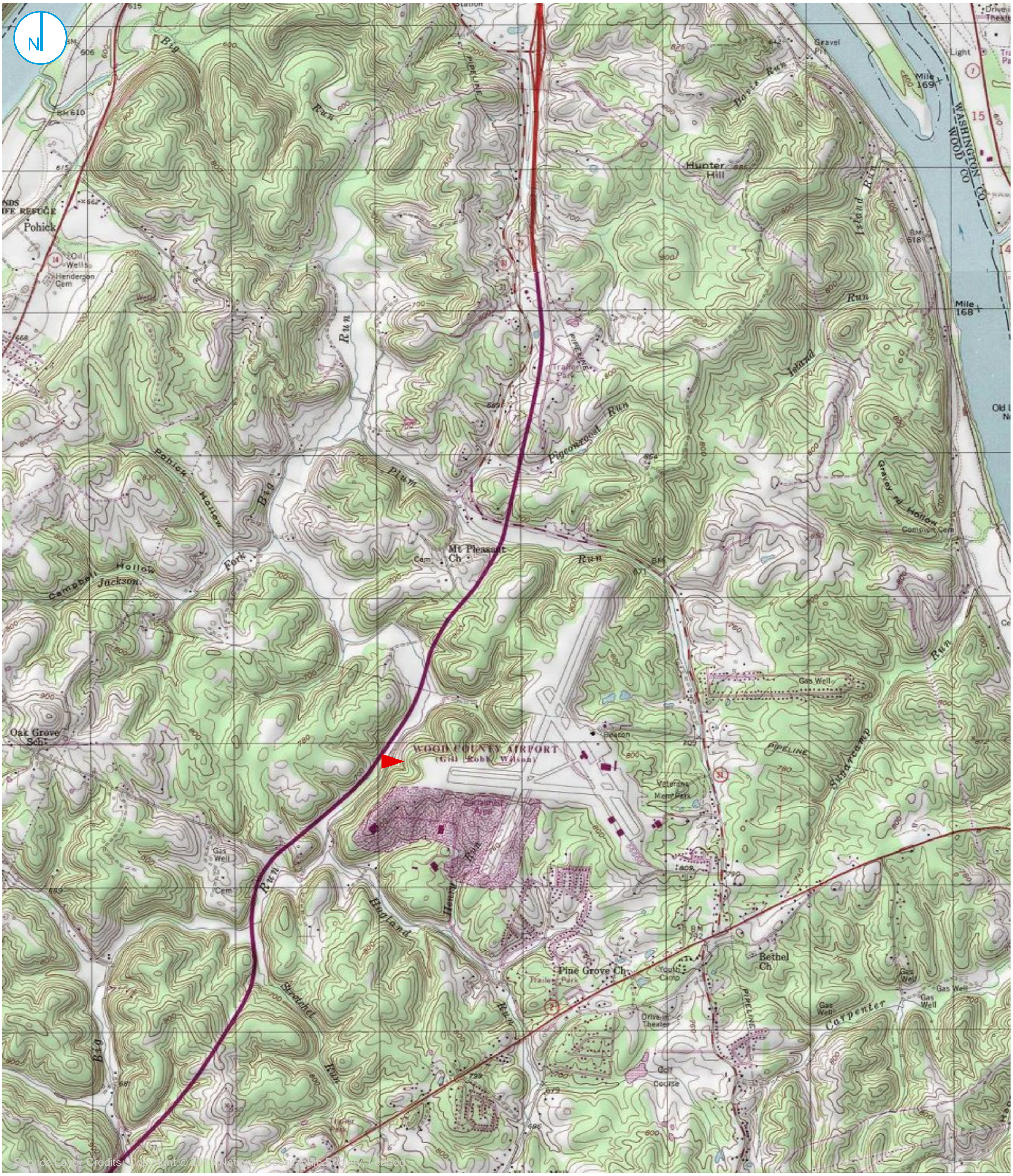
Thunder Mountain Environmental Services LLC
5334 Point Pleasant Rd,
Ravenswood, WV 26164

FIGURE 03

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

K:\Renaissance-Env.1139560\1940101897.RES---Permitting-New\Docs\Sheets_Figures\WV-Figure_4.mxd

PROJECT: 1940103088 | DATED: 10/5/2022 | DESIGNER: YOUNGAS



0 2,000 4,000
Feet

TOPOGRAPHIC MAP
AIRPORT

FIGURE 04

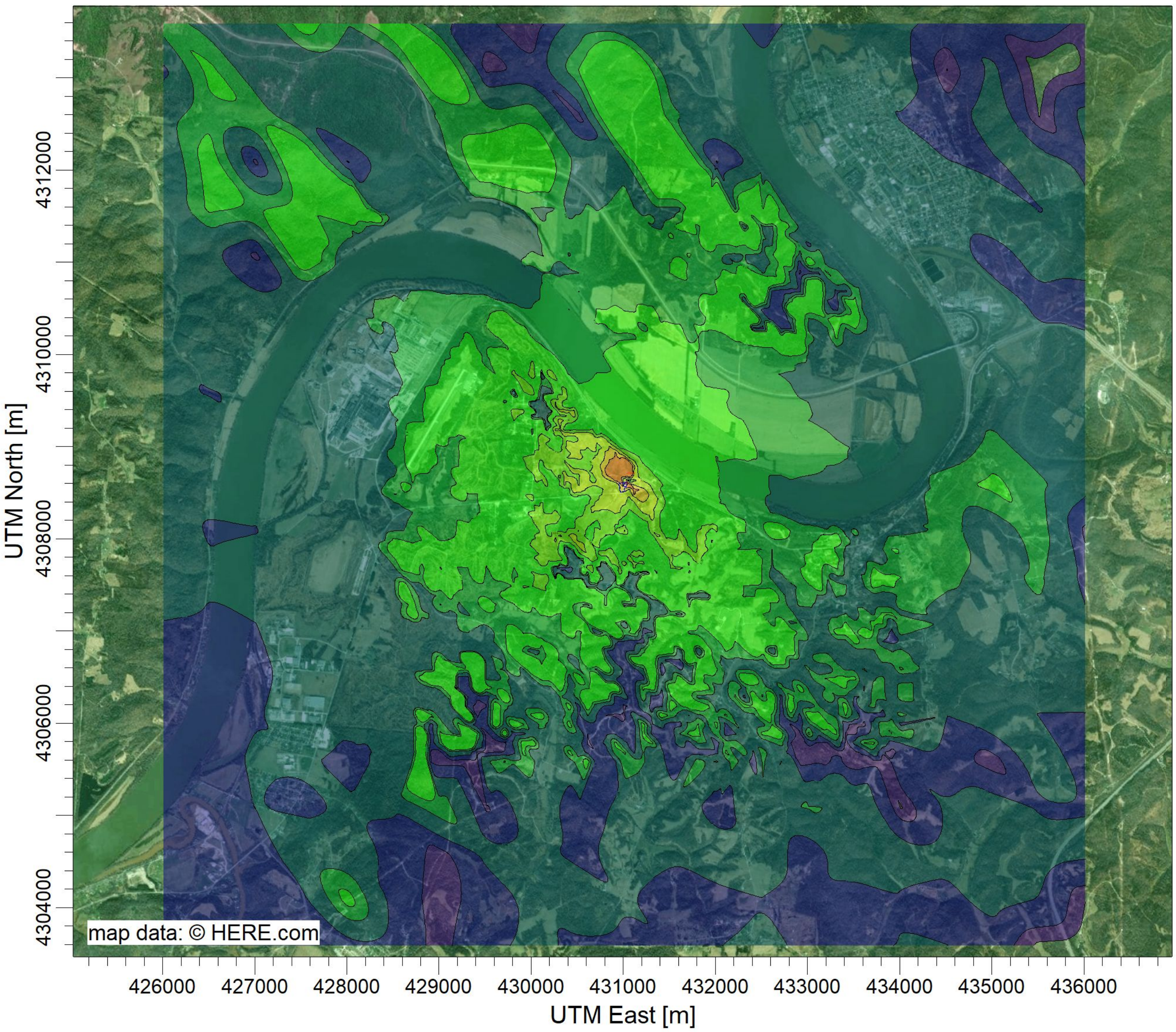
RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

Mid-Ohio Valley Regional Airport
543 Co Rte 31/1,
Williamstown, WV 26187

RAMBOLL

PROJECT TITLE:

Figure 5
NO2 1-Hour Predicted Concentration



PLOT FILE OF 8TH-HIGHEST MAX DAILY 1-HR VALUES AVERAGED OVER 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

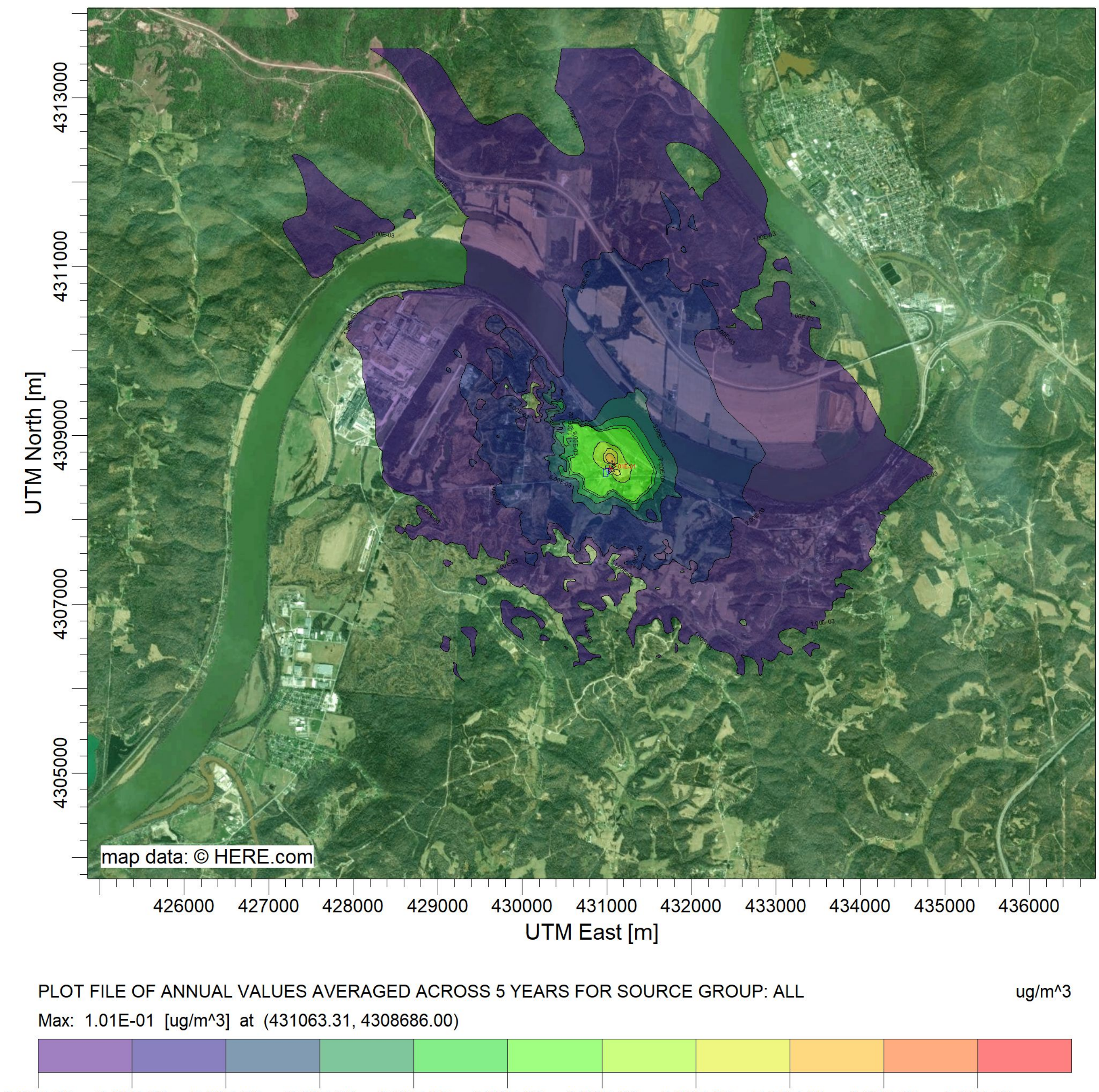
Max: 1.91 [ug/m^3] at (431013.31, 4308736.00)

🟪	🟦	▨	🟩	🟩	🟩	🟨	🟨	🟧	🟥
0.02	0.03	0.05	0.08	0.10	0.30	0.50	0.80	1.00	1.91

	SOURCES: **1**		
	RECEPTORS: **5230**		
	OUTPUT TYPE: **Concentration**	SCALE: 1:75,000 0 3 km	
	MAX: **1.91 ug/m^3**	DATE: **11/21/2022**	

PROJECT TITLE:

Figure 6
NO2 Annual Predicted Concentration



PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL

Max: 1.01E-01 [ug/m^3] at (431063.31, 4308686.00)

SOURCES:
1

RECEPTORS:
5230

OUTPUT TYPE:
Concentration

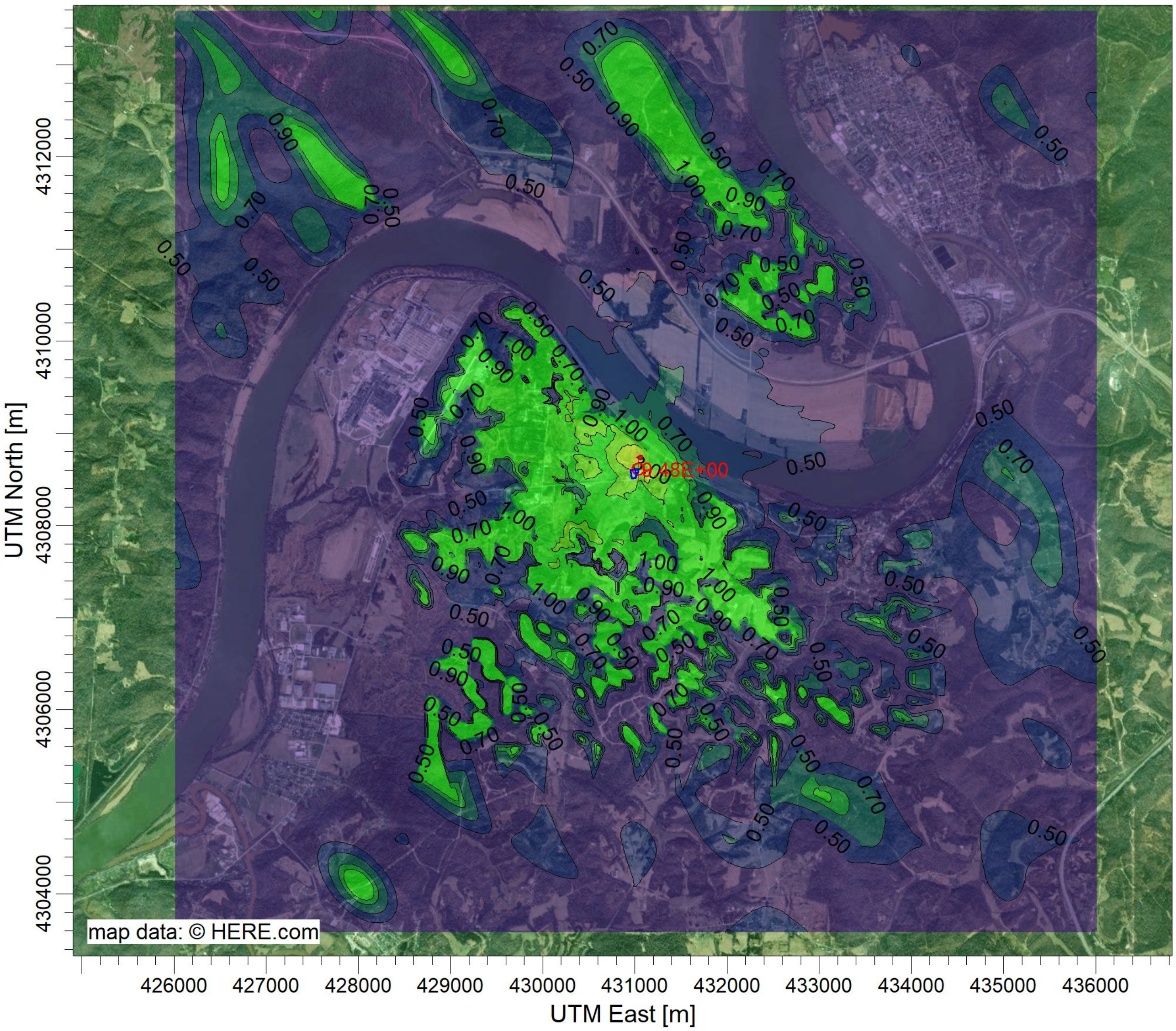
SCALE: 1:75,000
0 3 km

MAX:
1.01E-01 ug/m^3

DATE:
11/21/2022

PROJECT TITLE:

Figure 7
CO 1-Hour Predicted Concentrations



PLOT FILE OF HIGH 2ND HIGH 1-HR VALUES FOR SOURCE GROUP: ALL ug/m^3

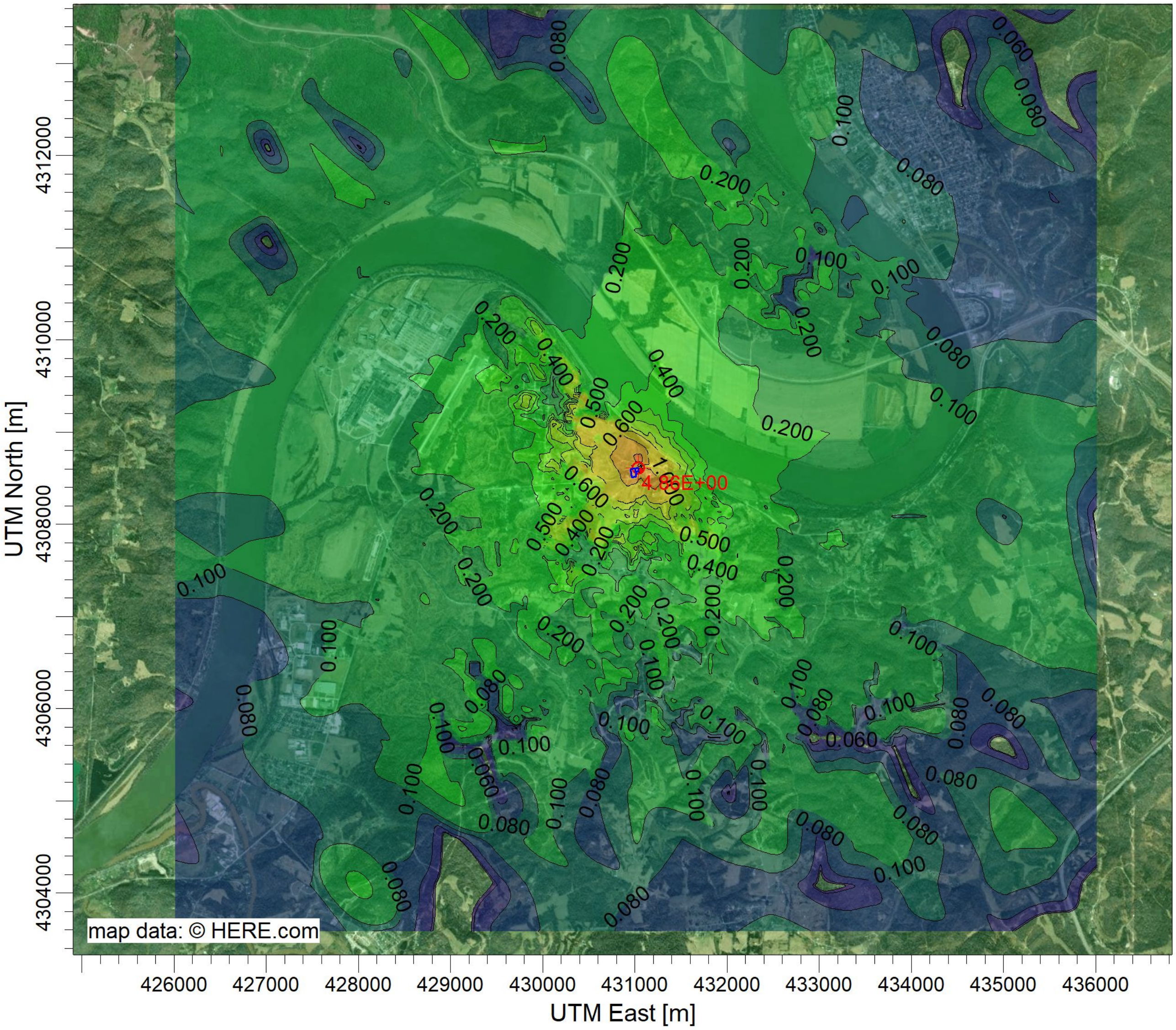
Max: 9.48 [ug/m^3] at (431063.31, 4308736.00)

0.11 0.50 0.70 0.90 1.00 3.00 5.00 7.00 9.00 9.48

SOURCES: **1**		
RECEPTORS: **5230**		
OUTPUT TYPE: **Concentration**	SCALE: 1:75,000 0 3 km	
MAX: **9.48 ug/m^3**	DATE: **11/21/2022**	

PROJECT TITLE:

Figure 8
CO 8-Hour Predicted Concentrations



PLOT FILE OF HIGH 2ND HIGH 8-HR VALUES FOR SOURCE GROUP: ALL ug/m^3

Max: 4.860 [ug/m^3] at (431063.31, 4308586.00)

0.049 0.050 0.060 0.080 0.100 0.200 0.400 0.500 0.600 0.800 1.000 2.000 4.000 4.860

SOURCES:
1

RECEPTORS:
5230

OUTPUT TYPE:
Concentration

SCALE: 1:75,000

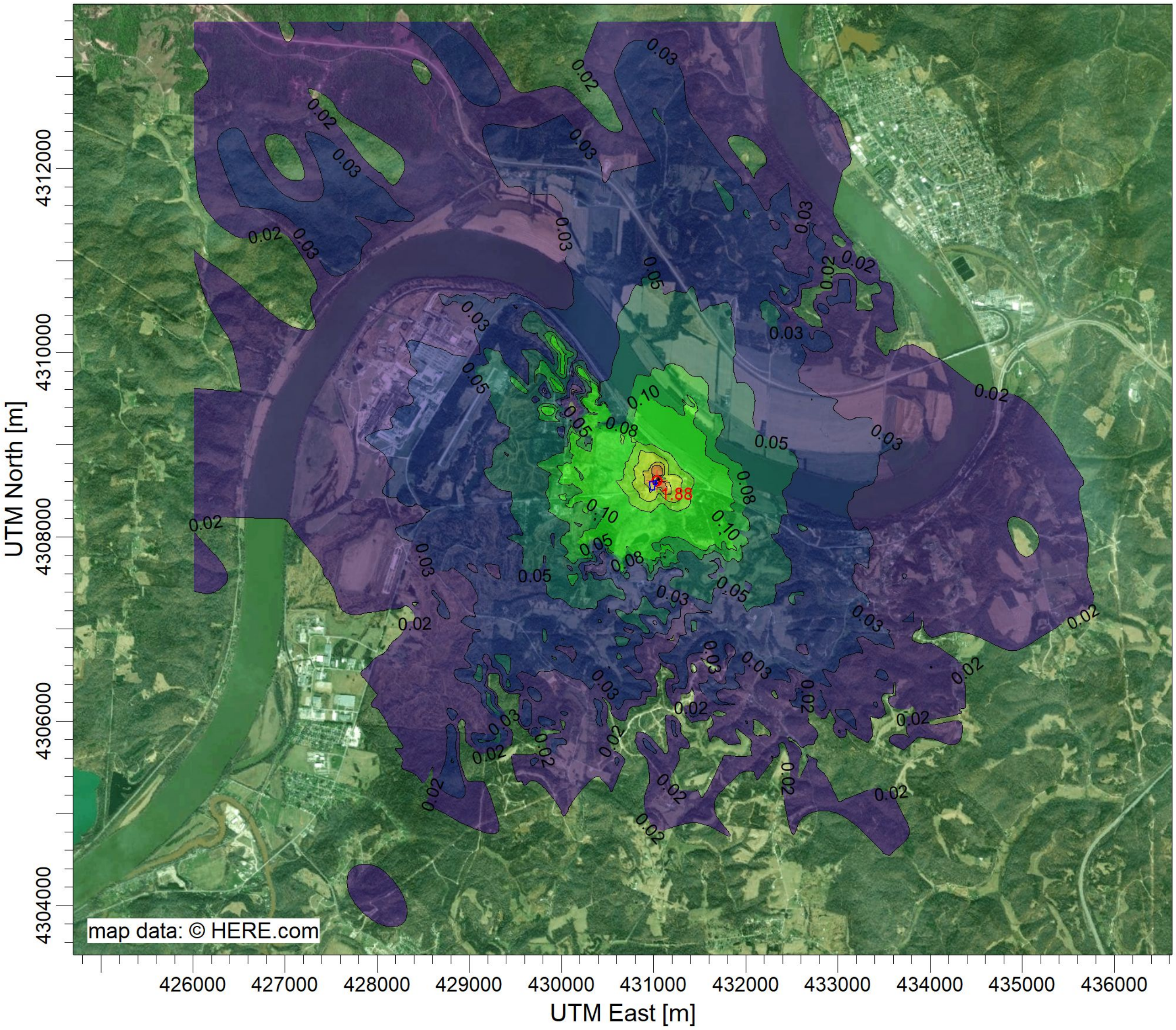
0 3 km

MAX:
4.860 ug/m^3

DATE:
11/21/2022

PROJECT TITLE:

Figure 9
PM10 24-Hour Predicted Concentrations



PLOT FILE OF HIGH 6TH HIGH 24-HR VALUES FOR SOURCE GROUP: ALL

ug/m^3

Max: 1.88 [ug/m^3] at (431063.31, 4308586.00)

0.02	0.03	0.05	0.08	0.10	0.30	0.50	0.80	1.00	1.88
🟪	🟦	▨	🟩	🟩	🟩	🟨	🟨	🟧	🟥

SOURCES:

1

RECEPTORS:

5230

OUTPUT TYPE:

Concentration

SCALE: 1:75,000

0 3 km

MAX:

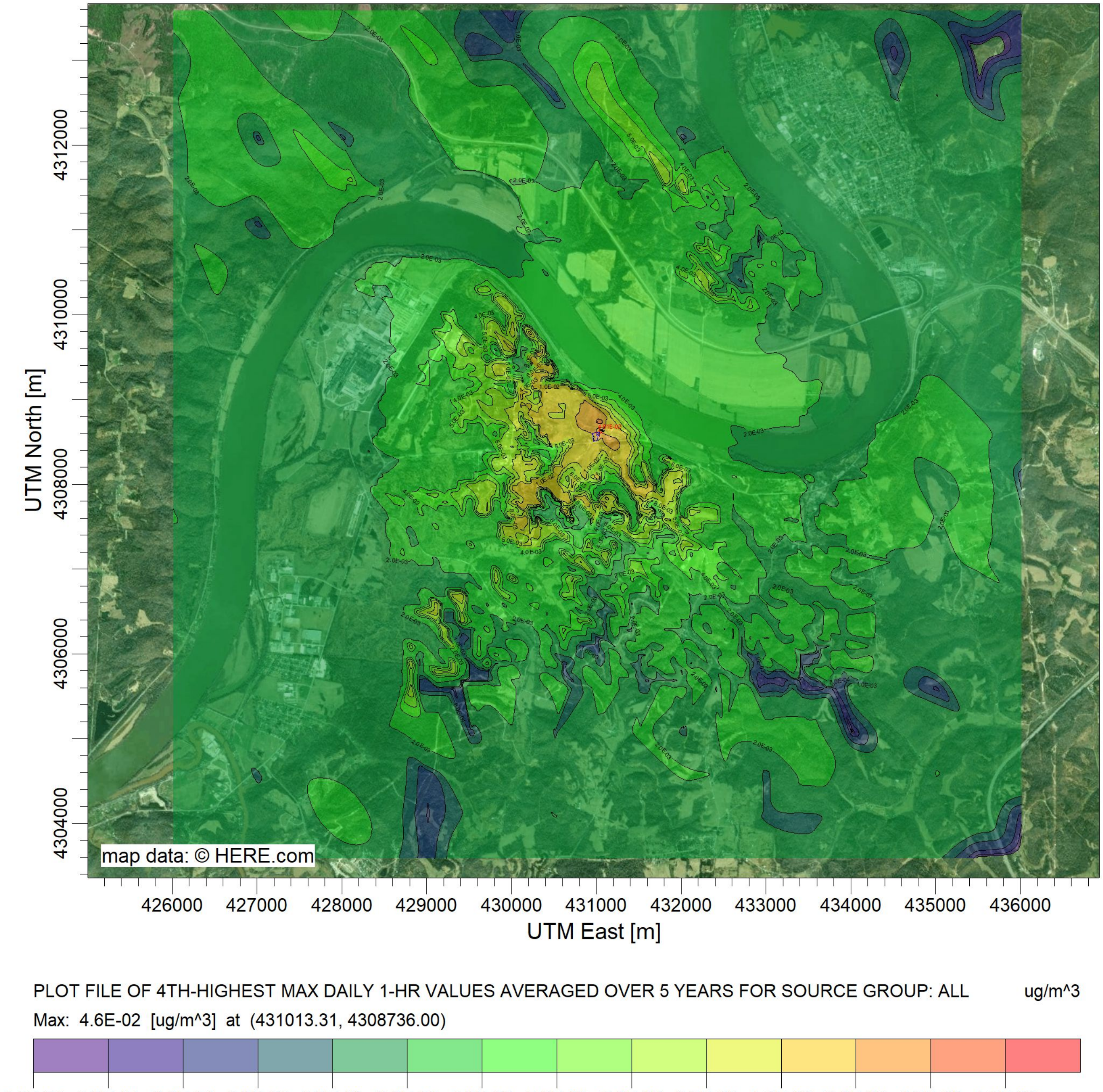
1.88 ug/m^3

DATE:

11/21/2022

PROJECT TITLE:

Figure 10
SO2 1-Hour Predicted Concentration



PLOT FILE OF 4TH-HIGHEST MAX DAILY 1-HR VALUES AVERAGED OVER 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

Max: 4.6E-02 [ug/m^3] at (431013.31, 4308736.00)

SOURCES:
1

RECEPTORS:
5230

OUTPUT TYPE:
Concentration

SCALE: 1:75,000
0 3 km

MAX:
4.6E-02 ug/m^3

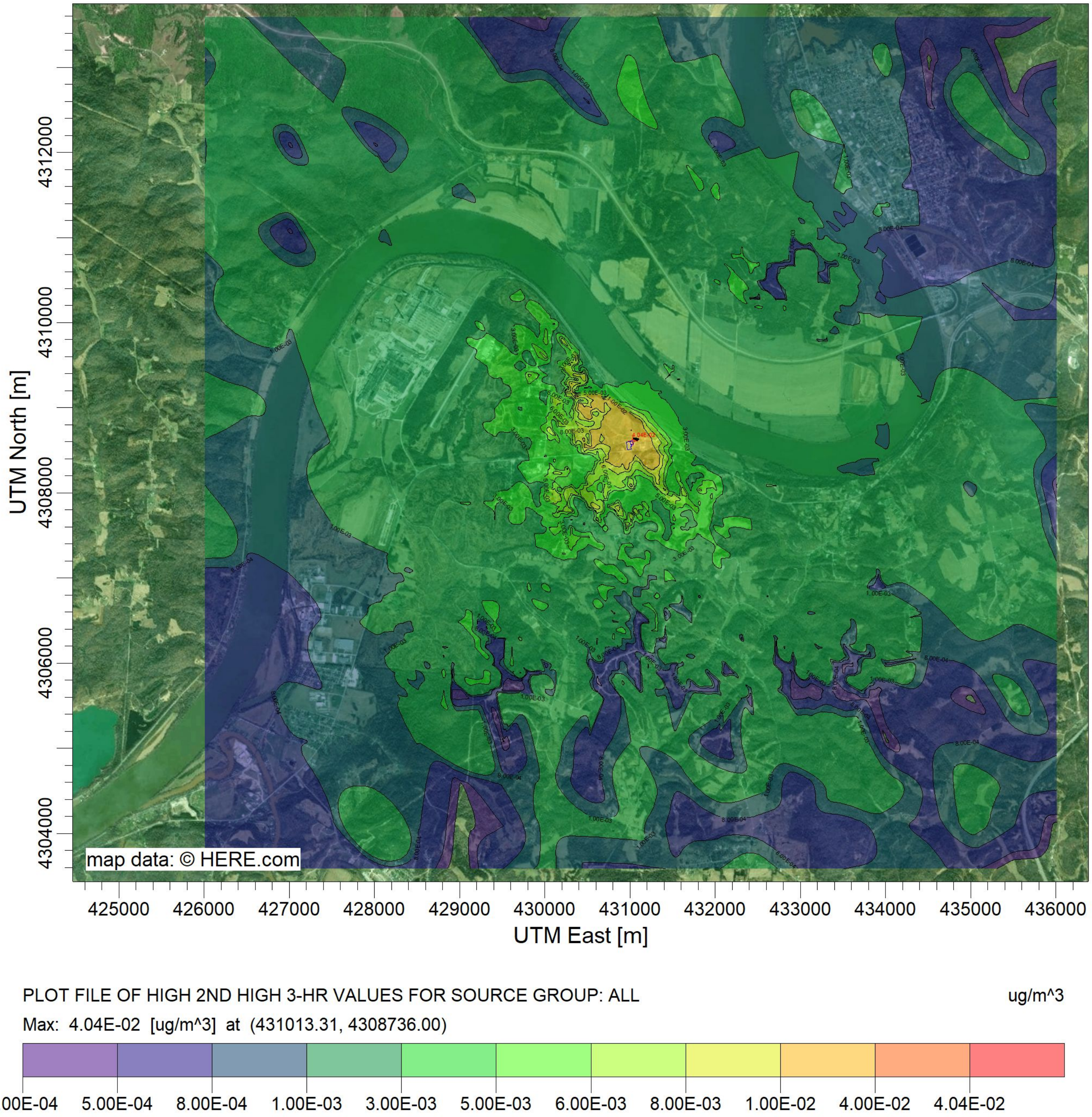
DATE:
11/21/2022

AERMOD View - Lakes Environmental Software

C:\Personal (C drive)\RES_WV\NAAQS_Rev\SO2_1-Hour\SO2_1-Hour.isc

PROJECT TITLE:

Figure 11
SO2 3-Hour Predicted Concentration



PLOT FILE OF HIGH 2ND HIGH 3-HR VALUES FOR SOURCE GROUP: ALL

Max: 4.04E-02 [ug/m^3] at (431013.31, 4308736.00)

SOURCES:

1

RECEPTORS:

5230

OUTPUT TYPE:

Concentration

SCALE: 1:75,000

0 3 km

MAX:

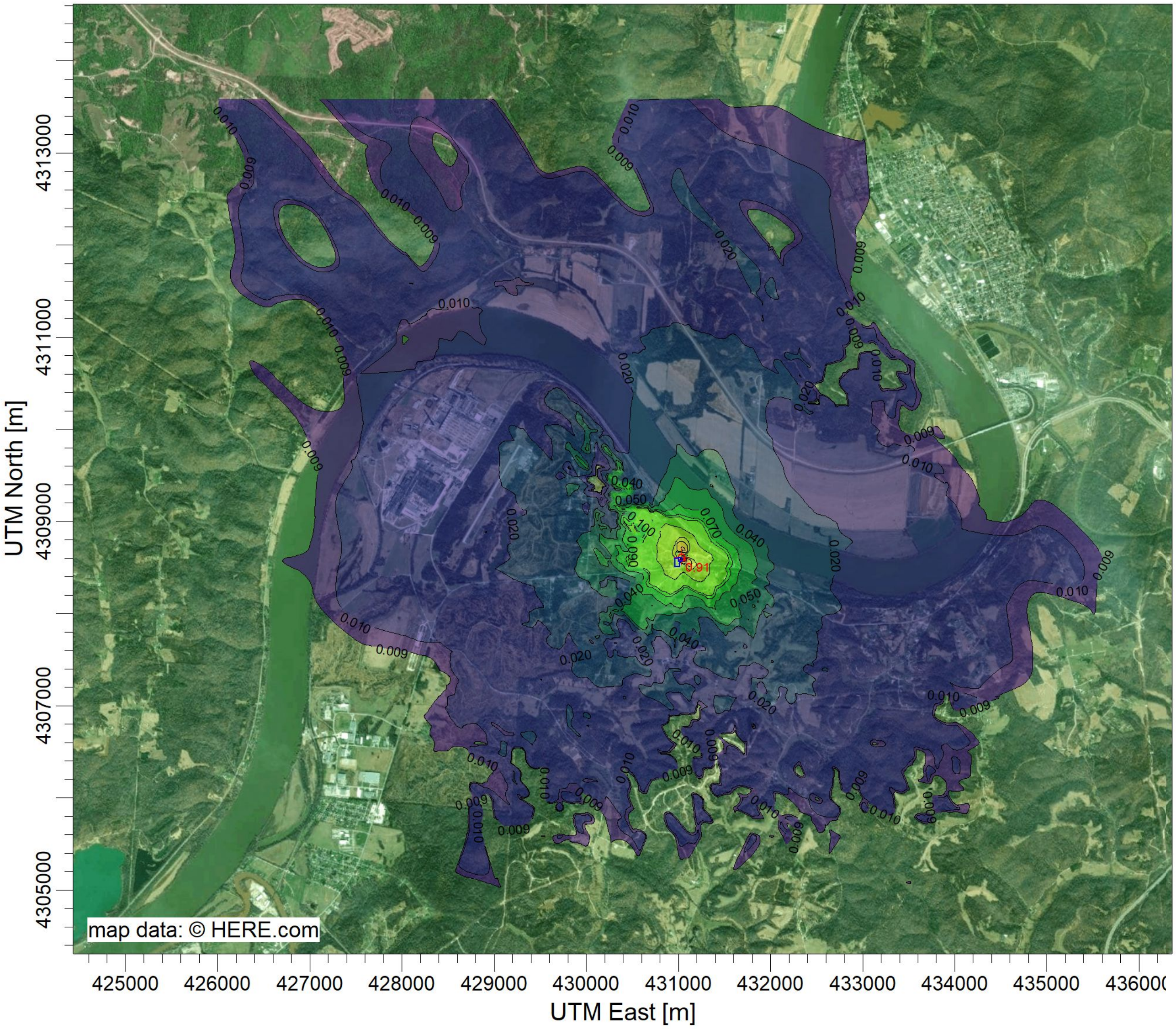
4.04E-02 ug/m^3

DATE:

11/21/2022

PROJECT TITLE:

Figure 12
PM2.5 24-Hour Predicted Concentrations



PLOT FILE OF 8TH-HIGHEST MAX DAILY 24-HR VALUES AVERAGED OVER 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

Max: 0.909 [ug/m^3] at (431063.31, 4308586.00)

0.009	0.010	0.020	0.040	0.050	0.070	0.090	0.100	0.200	0.400	0.500	0.700	0.900	0.909

SOURCES:

1

RECEPTORS:

5230

OUTPUT TYPE:

Concentration

SCALE: 1:75,000

0 3 km

MAX:

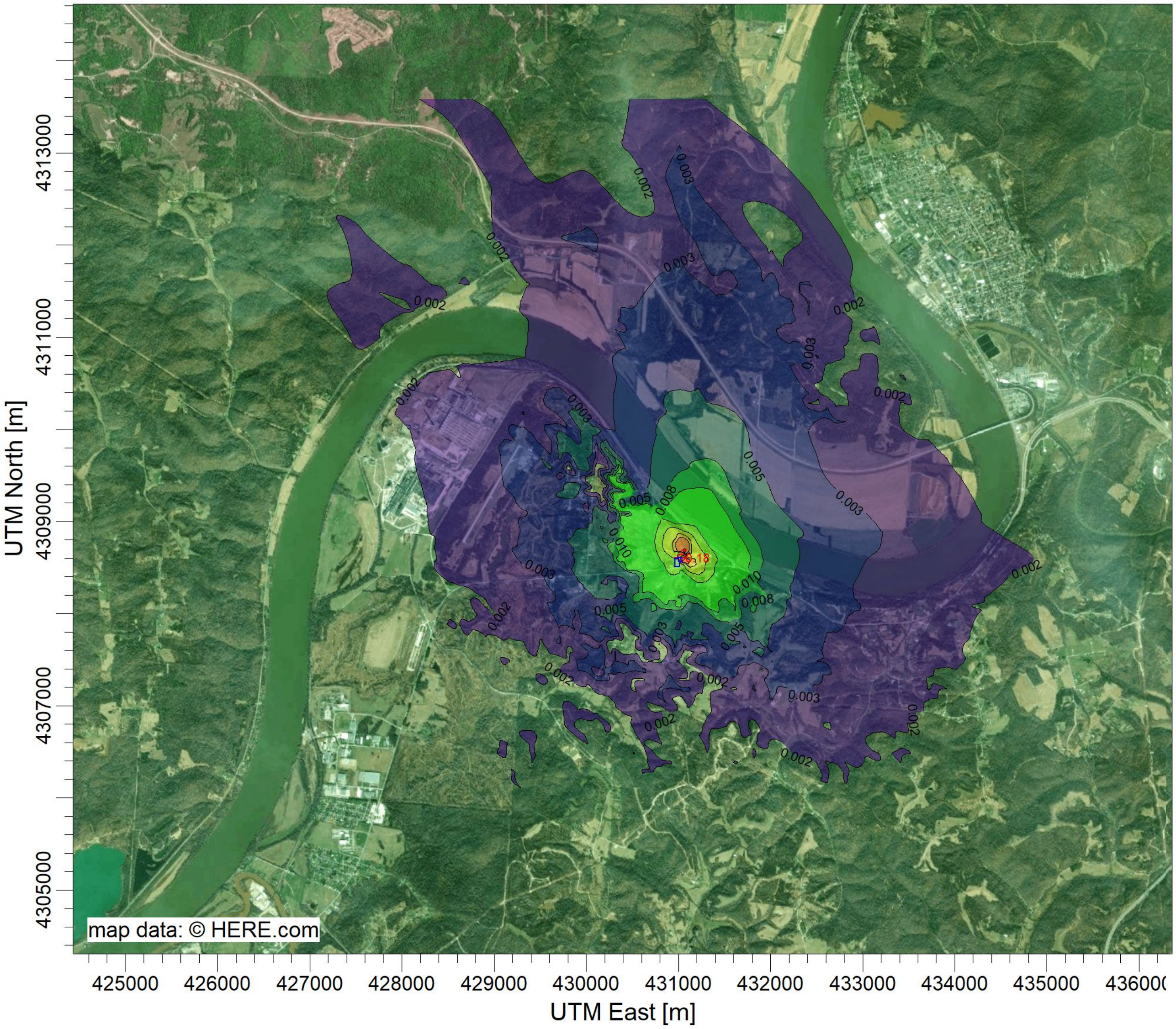
0.909 ug/m^3

DATE:

11/21/2022

PROJECT TITLE:

Figure 13
PM2.5 Annual Predicted Concentrations



PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

Max: 0.183 [ug/m^3] at (431063.31, 4308686.00)

0.002	0.003	0.005	0.008	0.010	0.030	0.050	0.080	0.100	0.183

SOURCES:

1

RECEPTORS:

5230

OUTPUT TYPE:

Concentration

SCALE: 1:75,000

0 3 km

MAX:

0.183 ug/m^3

DATE:

11/21/2022