APPENDIX D-3B

DISPERSION MODELING ANALYSIS FOR THE INHALATION RISK ASSESSMENT FOR SHELL POLYMERS MONACA BEAVER COUNTY, PENNSYLVANIA

September 2024 (Revised May 2025, September 2025, October 2025)

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1.0 INTRODUCTION

This document presents the procedures used in the dispersion modeling analysis conducted to calculate the ground-level concentrations that were employed in the inhalation risk assessment for Shell Polymers Monaca (SPM), owned and operated by Shell Chemical Appalachia LLC (Shell) located in Beaver County, Pennsylvania. An initial analysis was submitted to the Pennsylvania Department of Environmental Protection (DEP) in January of 2015. At DEP's request, revisions to the 2015 analysis were made to account for updates to the facility configuration and emissions, as well as updates to the EPA-approved dispersion model, supporting software, and modeling procedures. The first update was submitted in February of 2020. The second update, submitted in September 2020, incorporated corrections to the modeled hexane emission rate, exit diameters for the facility cooling towers, and included removal of a diesel fired emergency generator. In response to DEP comments, this is a revision to the third update that was submitted in September 2024 to address the Plan Approval Reconciliations, Wastewater Treatment Plant (WWTP) Permanent Controls Project, and Ethylene Maximum Achievable Control Technology (EMACT) Project at SPM. The assessment evaluates the potential cancer and non-cancer inhalation risks from the compounds of potential concern (COPCs) emitted from SPM. The air quality dispersion modeling conforms with the modeling procedures outlined in Appendix W to 40 Code of Federal Regulations (CFR) 51, also referred to as the Environmental Protection Agency's (EPA's) Guideline on Air Quality Models (Guideline), and associated EPA modeling policy and guidance.[1]

[1] *Guidelines on Air Quality Models*, Appendix W to 40 CFR Part 51, U.S. Environmental Protection Agency, November 2024

2.0 FACILITY AND PROJECT DESCRIPTION

SPM consists of an ethylene manufacturing unit, three polyethylene manufacturing units, three cogeneration units (Cogen Units), and a variety of ancillary equipment required to support its operations. The major sources of emissions include ethane cracking furnaces, diesel engines that drive emergency generators and fire water pumps, flares, thermal oxidizers, cooling towers, catalyst activation heaters, and combustion turbines with heat recovery systems that provide steam and electricity to SPM and electricity for sale.

This inhalation risk assessment has been prepared in support of the plan approval application submitted by Shell to DEP in accordance with the Pennsylvania Air Pollution Control Act and 25 Pa. Code §127.12 for the following changes.

- The Wastewater Treatment Plant (WWTP) Permanent Controls Project, which will improve the oils, grease, and volatile organic compound (VOC) removal efficiency of the primary treatment section of SPM's WWTP. Shell is currently using temporary equipment to achieve improved removal efficiencies and is now proposing to install permanent equipment.

- The Ethylene Maximum Achievable Control Technology (EMACT) Project, which is necessary to comply with the 40 Code of Federal Regulations (CFR) 63 Subpart YY pressure-assisted multi-point flare minimum net heating value of flare combustion zone gas (NHV_{cz}) requirement that recently became applicable to the Totally Enclosed Ground Flare (TEGF) A and TEGF B. Supplemental gas will be utilized as necessary in order to achieve compliance with the minimum NHV_{cz} currently required by 40 CFR 63 Subpart YY for the two TEGFs.

- After a thorough review of SPM's as-built operations and plan approval source inventory, potential emissions calculations, and conditions, Shell is proposing to reconcile specific plan approval source descriptions, conditions, and supporting potential to emit calculations. These proposed reconciliations are collectively referred to by Shell as the "Plan Approval Reconciliations." A detailed description of all proposed reconciliations is provided in the plan approval application.

Shell has retrospectively evaluated the Plan Approval Reconciliations and WWTP Permanent Controls Project together as part of the initial construction of SPM for the following reasons:

- The relatively close timing between the Plan Approval Reconciliations and WWTP Permanent Controls Project and the recently completed initial construction of the facility;
- The Plan Approval Reconciliations represent as-built changes to the facility's initial construction plan approvals; and
- The WWTP Permanent Controls Project represents needed improvements to the initial construction of the facility's WWTP.

For purposes of this inhalation risk assessment, the proposed facility-wide emissions are evaluated, including the revisions associated with the Plan Approval Reconciliations and WWTP Permanent Controls Project and emissions increases associated with the EMACT Project.

3.0 SITE DESCRIPTION

SPM occupies approximately 400 acres adjacent to the Ohio River in the Center and Potter Townships, Pennsylvania in Beaver County. The approximate Universal Transverse Mercator ("UTM") coordinates of the facility are 556,129 meters east and 4,502,450 meters north (UTM Zone 17, NAD 83). Figure 1 shows the general location of the facility.

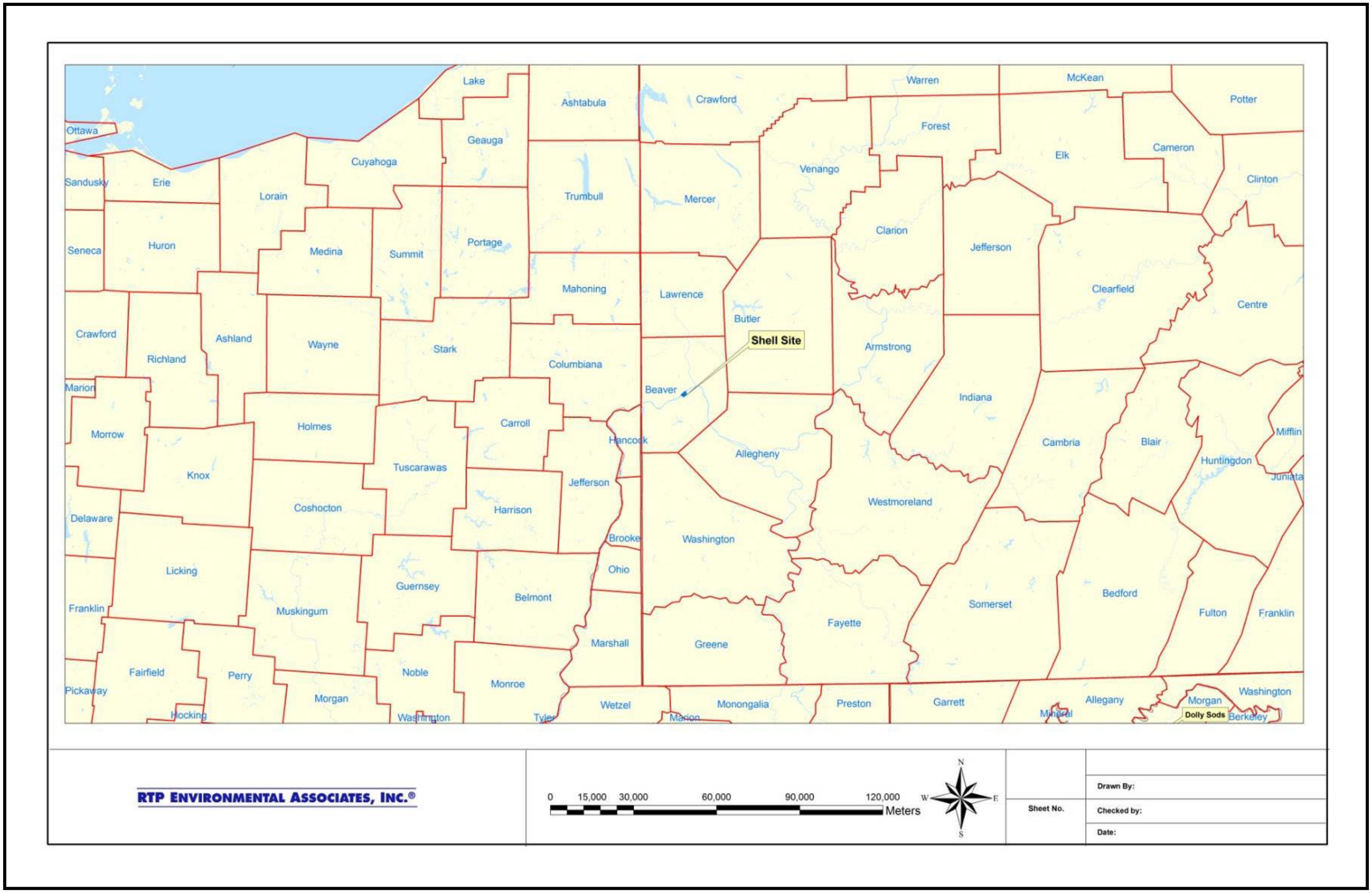

Figure 1. General Location of SPM

4.0 MODEL SELECTION AND MODEL INPUT

4.1 Model Selection

The latest version of the AMS/EPA Regulatory Model (AERMOD, Version 24142) was used to conduct the dispersion modeling analysis. AERMOD is a Gaussian plume dispersion model that is based on planetary boundary layer principles for characterizing atmospheric stability. The model evaluates the non-Gaussian vertical behavior of plumes during convective conditions with the probability density function and the superposition of several Gaussian plumes. AERMOD is a modeling system with three components: AERMAP is the terrain preprocessor program, AERMET is the meteorological data preprocessor and AERMOD includes the dispersion modeling algorithms.

AERMOD is the most appropriate model for calculating ambient concentrations near SPM based on the model's ability to incorporate multiple sources and source types. The model can also account for convective updrafts and downdrafts and meteorological data throughout the plume depth. The model also provides parameters required for use with up-to-date planetary boundary layer parameterization. The model also has the ability to incorporate building wake effects and to calculate concentrations within the cavity recirculation zone. All model options were selected as recommended in the EPA Guideline on Air Quality Models (Appendix W to 40 CFR 51).[2] Model runs were completed using the EPA executable available for download from the Support Center for Regulatory Atmospheric Modeling (SCRAM).[3]

4.2 Model Control Options and Land Use

AERMOD was run in the regulatory default mode. The default rural dispersion coefficients in the model were used. This is supported by the Land Use Procedure consistent with subsection 7.2.1.1 of the Guideline and Section 5.1 of the AERMOD

[2] *Guidelines on Air Quality Models*, Appendix W to 40 CFR Part 51, U.S. Environmental Protection Agency, November 2024.
[3] https://www.epa.gov/scram

Implementation Guide.[4,5]

The USGS 2021 National Land Cover Data ("NLCD") within 3 km of SPM were converted to Auer 1978 land use types. NLCD Categories 23 and 24, were considered as urban.[6] It was determined that the land use in the vicinity of SPM is predominantly rural (22% of the area is classified as urban, Figure 2). A spreadsheet providing the results of the landuse analysis is provided with the modeling input and output files electronically. The potential for urban heat island affects, which are regional in character, was considered and determined not to be of concern.

4.3 Source Data

Source Characterization

Point Sources

Most emission sources at SPM vent to stacks with a well defined opening. These sources were modeled as point sources in AERMOD. The model source characteristics for the point sources are presented in Table 1. The emission rates evaluated for each point source can be found in Tables 2a and 3a of Appendix D-3A. The location of each point source is shown in Figure 3.

[4] *Guidelines on Air Quality Models*, Appendix W to 40 CFR Part 51, U.S. Environmental Protection Agency, November 2024.
[5] *AERMOD Implementation Guide*, EPA-454-B-23-009, October 12, 2023.
[6] Auer, Jr., A.H. "*Correlation of Land Use and Cover with Meteorological Anomalies*." Journal of Applied Meteorology, 17:636-643, 1978.

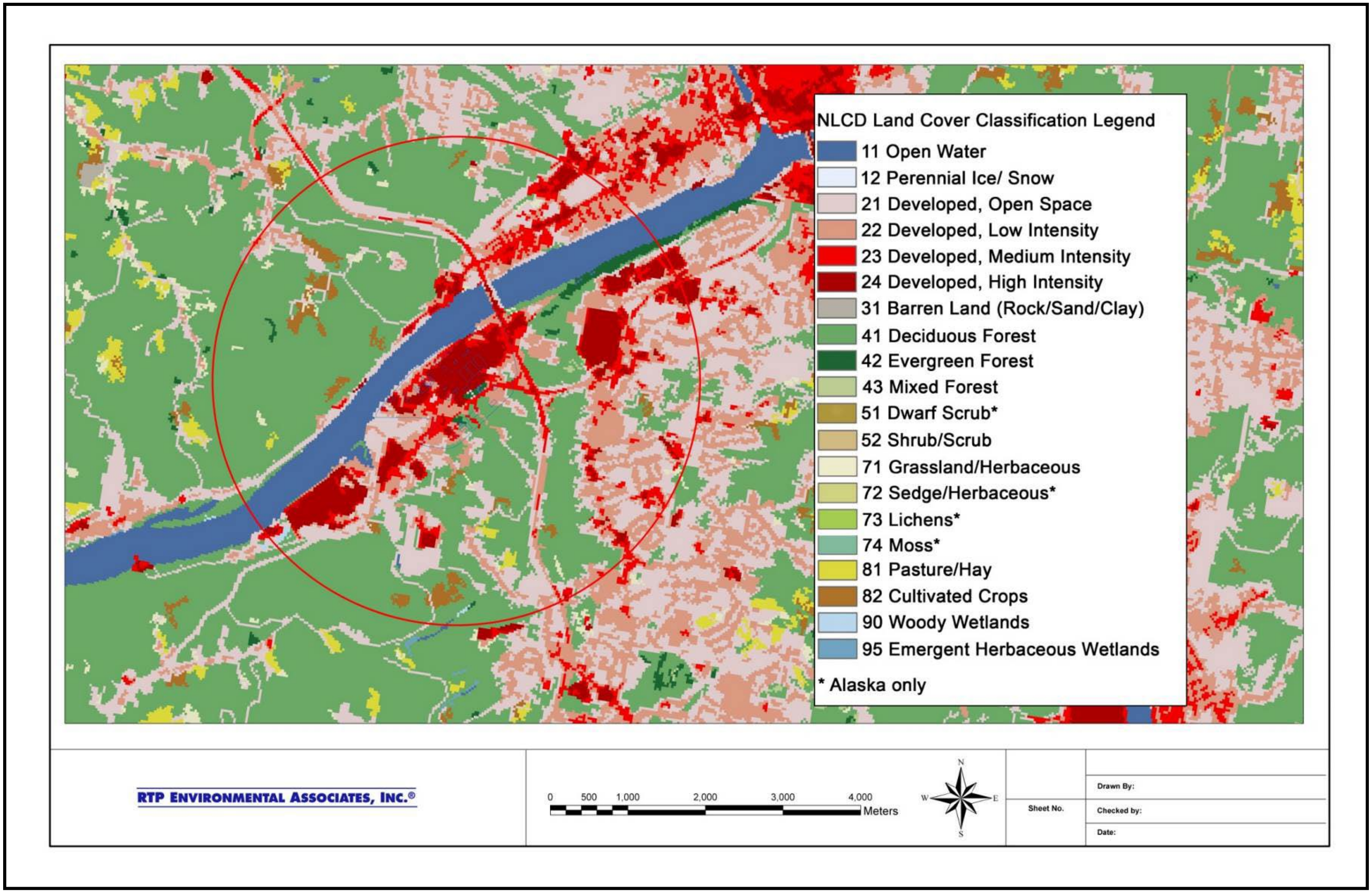

Figure 2. Land Use within Three Kilometers of SPM

Table 1. Modeled Point Source Parameters

AERMOD ID	Description	UTM Easting[1] (m)	UTM Northing[1] (m)	Elevation (m)	Stack Height (m)	Stack Temp. (K)	Exit Velocity (m/s)	Stack Diameter (m)
EC#1	Ethane Cracking Furnace #1	555502.11	4502199.00	242.32	83.82	396.26	12.25	2.59
EC#2	Ethane Cracking Furnace #2	555512.76	4502186.65	242.32	83.82	396.26	12.25	2.59
EC#3	Ethane Cracking Furnace #3	555534.48	4502160.24	242.32	83.82	396.26	12.25	2.59
EC#4	Ethane Cracking Furnace #4	555545.98	4502148.32	242.32	83.82	396.26	12.25	2.59
EC#5	Ethane Cracking Furnace #5	555561.73	4502131.29	242.32	83.82	396.26	12.25	2.59
EC#6	Ethane Cracking Furnace #6	555572.81	4502118.51	242.32	83.82	396.26	12.25	2.59
EC#7	Ethane Cracking Furnace #7	555590.27	4502098.92	242.32	83.82	396.26	12.25	2.59
CT1	Combustion Turbine/Duct Burner Unit #1	555945.76	4502058.51	242.32	64.92	428.15	24.08	3.05
CT2	Combustion Turbine/Duct Burner Unit #2	555991.73	4502098.68	242.32	64.92	428.15	24.08	3.05
CT3	Combustion Turbine/Duct Burner Unit #3	556038.01	4502138.02	242.32	64.92	428.15	24.08	3.05
GFLARE1	TEGF A	555472.50	4502011.25	237.74	82.66	1273.15	20.00	10.96
GFLARE2	TEGF B	555421.71	4502085.72	237.74	82.66	1273.15	20.00	10.96
HPFLARE	HP Elevated Flare	555385.33	4502007.13	237.74	151.24	1273.15	20.00	10.96
MPFLARE	MPGF	556083.87	4502666.73	242.32	4.46	1273.15	20.00	0.27
INCIN	CVTO	556066.31	4502619.14	242.32	76.20	1144.26	56.76	1.37
COI	SCTO	555256.39	4502075.62	217.63	60.96	1144.26	13.71	0.61
FWP1	Fire Water Pump 1	556126.22	4501713.44	259.08	9.97	692.59	36.88	0.30
FWP2	Fire Water Pump 2	556118.30	4501706.53	259.08	9.97	692.59	36.88	0.30
GEN1	Diesel-Fired Emergency 1 - Parking Garage	556228.46	4501766.08	259.08	1.52	687.59	68.82	0.08
GEN2	Diesel-Fired Emergency Generator 2 - Telecom Hut	556275.53	4501732.18	259.08	1.83	763.15	42.62	0.06
GEN3	Natural Gas-Fired Emergency Generator 3 - Lift Station	556186.33	4502105.90	242.32	1.83	949.82	90.66	0.09
GEN4	Natural Gas-Fired Emergency Generator 4 - Lift Station	555907.33	4502035.53	242.32	1.83	960.93	37.26	0.06
COLTW1a	Process Cooling Tower	555788.46	4502467.84	242.32	21.64	294.82	7.88	11.20
COLTW1b	Process Cooling Tower	555799.66	4502454.71	242.32	21.64	294.82	7.88	11.20
COLTW2a	Process Cooling Tower	555801.28	4502478.95	242.32	21.64	294.82	7.88	11.20
COLTW2b	Process Cooling Tower	555812.45	4502465.82	242.32	21.64	294.82	7.88	11.20
COLTW3a	Process Cooling Tower	555814.09	4502490.07	242.32	21.64	294.82	7.88	11.20
COLTW3b	Process Cooling Tower	555825.24	4502476.93	242.32	21.64	294.82	7.88	11.20
COLTW4a	Process Cooling Tower	555826.90	4502501.19	242.32	21.64	294.82	7.88	11.20

AERMOD ID	Description	UTM Easting[1] (m)	UTM Northing[1] (m)	Elevation (m)	Stack Height (m)	Stack Temp. (K)	Exit Velocity (m/s)	Stack Diameter (m)
COLTW4b	Process Cooling Tower	555838.03	4502488.04	242.32	21.64	294.82	7.88	11.20
COLTW5a	Process Cooling Tower	555839.72	4502512.30	242.32	21.64	294.82	7.88	11.20
COLTW5b	Process Cooling Tower	555850.81	4502499.15	242.32	21.64	294.82	7.88	11.20
COLTW6a	Process Cooling Tower	555852.53	4502523.42	242.32	21.64	294.82	7.88	11.20
COLTW6b	Process Cooling Tower	555863.60	4502510.26	242.32	21.64	294.82	7.88	11.20
COLTW7a	Process Cooling Tower	555865.34	4502534.53	242.32	21.64	294.82	7.88	11.20
COLTW7b	Process Cooling Tower	555876.39	4502521.37	242.32	21.64	294.82	7.88	11.20
COLTW8a	Process Cooling Tower	555878.16	4502545.65	242.32	21.64	294.82	7.88	11.20
COLTW8b	Process Cooling Tower	555889.18	4502532.48	242.32	21.64	294.82	7.88	11.20
COLTW9a	Process Cooling Tower	555890.97	4502556.77	242.32	21.64	294.82	7.88	11.20
COLTW9b	Process Cooling Tower	555901.97	4502543.59	242.32	21.64	294.82	7.88	11.20
COLTW10a	Process Cooling Tower	555903.79	4502567.88	242.32	21.64	294.82	7.88	11.20
COLTW10b	Process Cooling Tower	555914.76	4502554.70	242.32	21.64	294.82	7.88	11.20
COLTW11a	Process Cooling Tower	555916.60	4502579.00	242.32	21.64	294.82	7.88	11.20
COLTW11b	Process Cooling Tower	555927.55	4502565.81	242.32	21.64	294.82	7.88	11.20
COLTW12a	Process Cooling Tower	555929.41	4502590.12	242.32	21.64	294.82	7.88	11.20
COLTW12b	Process Cooling Tower	555940.34	4502576.92	242.32	21.64	294.82	7.88	11.20
COLTW13a	Process Cooling Tower	555942.23	4502601.23	242.32	21.64	294.82	7.88	11.20
COLTW13b	Process Cooling Tower	555953.12	4502588.03	242.32	21.64	294.82	7.88	11.20
CAH1	PE Unit 1 Catalyst Vent Filter Vent	556294.39	4502493.32	242.32	45.72	473.15	10.67	0.41
CAH2	PE Unit 2 Catalyst Vent Filter Vent	556289.38	4502488.95	242.32	45.72	473.15	10.67	0.41
CAA	PE Unit 3 Catalyst Activator A Filter (External) Vent	556151.78	4502347.60	242.32	23.87	473.15	7.20	0.20
CAB	PE Unit 3 Catalyst Activator B Filter (External) Vent	556158.86	4502339.25	242.32	23.87	473.15	7.20	0.20

[1]UTM NAD83, Zone 17.

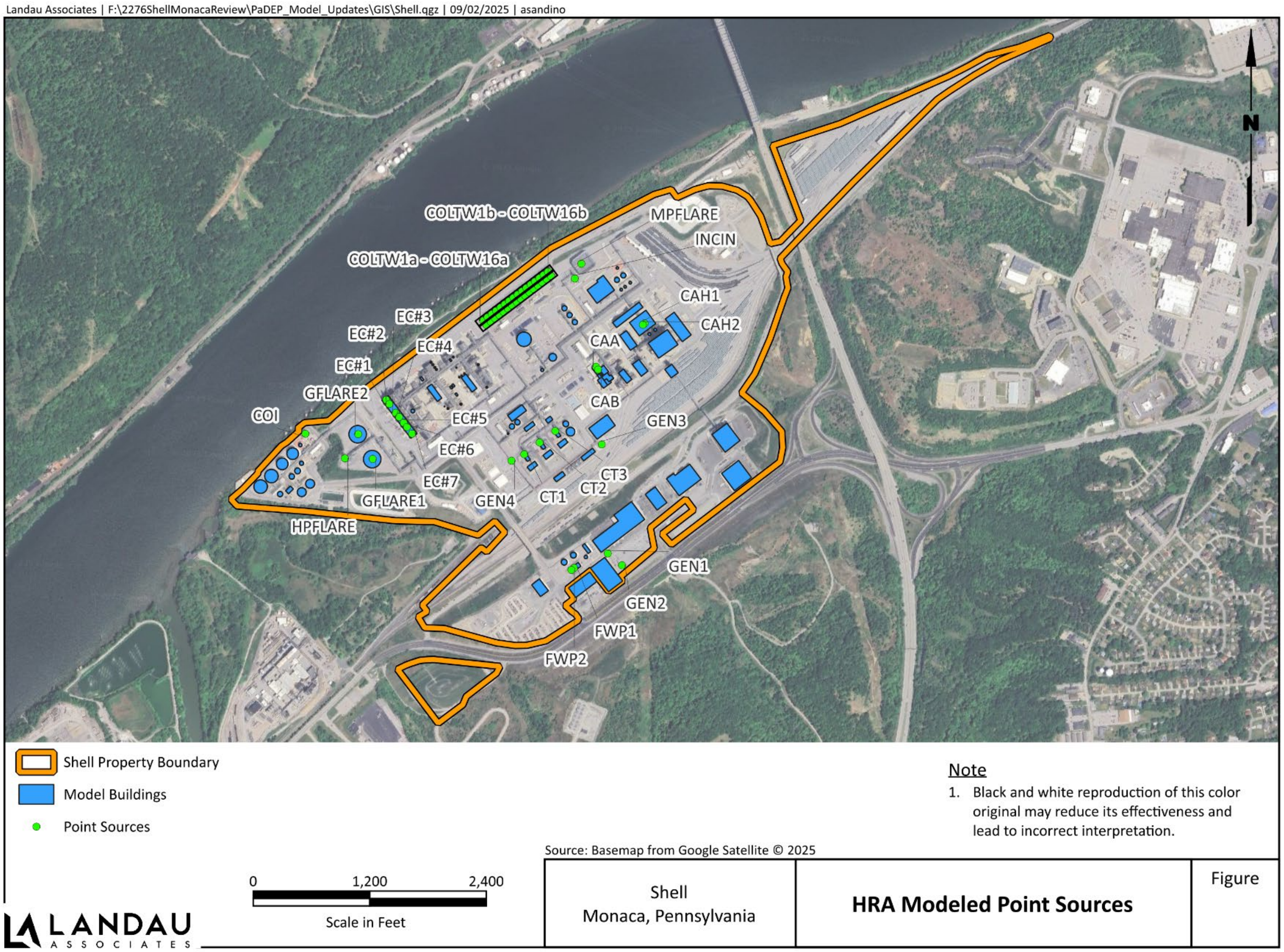

Figure 3. Modeled Point Source Locations

Flares

There is an elevated high pressure candlestick flare, two TEGFs, and an MPGF. These flares were modeled using the procedures outlined below as presented in Section 2.1.2 of the AERSCREEN User's Guide.[7]

The effective flare diameter (D, in meters) and height (h_{eff}, in meters) were computed as a function of heat release rate according to the following equations, where HR is the heat release rate of the flare in calories per second, HL is the heat loss fraction, and H_S is the physical height of the flare in meters:

$$D = 9.88 \times 10^{-4} \times \sqrt{HR \times (1 - HL)}$$

$$h_{eff} = H_s + 4.56 \times 10^{-3} \times HR^{0.478}$$

The MPGF was represented by one flare stack. The effective flare diameter and height for an individual flare was used for the representative flare stack and was calculated using the equivalent individual heat release rate, which was estimated as the total heat release rate (88.4 MMBtu/hr) divided by the total number of flare heads (38).

An exit temperature of 1273 Kelvin (K) and velocity of 20 meters per second (m/s) were assumed, consistent with the AERSCREEN default values.[8]

Fugitive Emissions from Tanks and Equipment Leaks

Fugitive emissions from tanks and equipment leaks were modeled as volume sources. For equipment leaks, the emission rate for a given COPC was determined by applying process area component speciation data to the VOC emission rate associated with the equipment components contained within known process areas. The initial dispersion coefficients (sigma y and sigma z) were calculated based upon the dimensions of the area of release and the equations contained in Table 3-3 of the AERMOD User's

[7] *AERSCREEN User's Guide*, EPA-454/B-21-005, April 2021.
[8] Ibid.

Guide.[9]

The volume source parameter calculations can be found in Table 2. The emission rates evaluated for each volume source are presented in Tables 2b and 3b of Appendix D-3A. The location of each modeled volume source is shown in Figure 4. All source locations are based on a NAD83, UTM Zone 17 projection. Source elevations were determined from facility survey data, not from AERMAP.

[9] *AERMOD User's Guide*, EPA-454-B-24-007, November 2024.

Table 2. Non-Road Volume Source Parameter Calculations

AERMOD ID	Source Description	Length (ft)	Width (ft)	Square Root of Area (ft)	Structure Height/Vertical Dimension (ft)	Release Height (ft)	Initial Horizontal Dimension s_Y (ft)	Initial Vertical Dimension s_Z (ft)	Footnote
C3RAIL	Liquid Loadout (C3+, Butene, Isopentane, Isobutane, C3 Ref)	98.8	345.1	184.6	14.0	7.0	42.93	6.51	1, 2
ROTRUCK	Liquid Loadout (Recovered Oil)	73.8	28.5	45.9	12.0	6.0	10.67	5.58	1, 2
ECFUG1	Equipment Components: Ethane Cracking	492.0	78.7	196.8	140.0	70.0	45.77	65.12	1, 2
ECFUG2	Equipment Components: Precooling and Drying/Fuel Gas System	300.0	300.0	300.0	82.0	41.0	69.77	38.14	1, 2
ECFUG3	Equipment Components: Wash Water System/Analyzer House	300.0	300.0	300.0	82.0	41.0	69.77	38.14	1, 2
ECFUG4	Equipment Components: Cracked Gas Compression	387.2	387.2	387.2	82.0	41.0	90.05	38.14	1, 2
ECFUG5	Equipment Components: Caustic Scrubbing/Spent Caustic Treatment/Chemicals and Wash Oil	231.8	231.8	231.8	82.0	41.0	53.91	38.14	1, 2
ECFUG6	Equipment Components: Process Steam System/Gasoline Redistillation/Slop and Sewer System	300.0	300.0	300.0	82.0	41.0	69.77	38.14	1, 2
ECFUG7	Equipment Components: C2/C3 Separation	261.3	261.3	261.3	82.0	41.0	60.77	38.14	1, 2
ECFUG8	Equipment Components: C2 Hydrogenation/Methanol System	300.0	300.0	300.0	82.0	41.0	69.77	38.14	1, 2
ECFUG9	Equipment Components: Low Temperature Section/C1/C2 Separation/Refrigerant System/PSA Unit	413.6	413.6	413.6	82.0	41.0	96.19	38.14	1, 2
ECFUG10	Equipment Components: Spent Caustic Treatment	300.0	300.0	300.0	40.0	20.0	69.77	18.60	1, 2
ECFUG11	Equipment Components: Feed Preheating/Blow Down System	300.0	300.0	300.0	82.0	41.0	69.77	38.14	1, 2
ECFUG12	Equipment Components: Flare System	266.5	266.5	266.5	15.0	7.5	61.98	6.98	1, 2
PE3FUG2	Equipment Components: Low Pressure and Solvent Recovery System/Catalyst Activation System	217.9	217.9	217.9	14.0	7.0	22.07	6.51	1, 2
OSBLFUG1	Equipment Components: Wastewater Collection/Wastewater Treatment	300.0	300.0	300.0	48.0	24.0	69.77	22.33	1, 2
OSBLFUG2	Equipment Components: Cogen	625	625	625	52.0	26.0	145.3	24.19	1, 2

Table 2. Non-Road Volume Source Parameter Calculations

AERMOD ID	Source Description	Length (ft)	Width (ft)	Square Root of Area (ft)	Structure Height/Vertical Dimension (ft)	Release Height (ft)	Initial Horizontal Dimension s_Y (ft)	Initial Vertical Dimension s_Z (ft)	Footnote
OSBLFUG3	Equipment Components: Fire Pump Diesel	300.0	300.0	300.0	52.0	26.0	69.77	24.19	1, 2
OSBLFUG4	Equipment Components: Butene, Hexene, Isopentane, Isobutane, and PE3 Heavies Storage	227.2	227.2	227.2	83.0	41.5	52.8	38.60	1, 2
OSBLFUG5	Equipment Components: Railcar Loading	500.0	50.0	158.1	40.0	20.0	36.77	18.60	1, 2
OSBLFUG6	Equipment Components: Pipeline Interconnect	200.0	200.0	200.0	15.0	7.5	46.51	6.98	1, 2
OSBLFUG7	Equipment Components: C3+, Ethylene, Methanol, and PFO/LGO Storage	176.6	176.6	176.6	82.0	41.0	41.1	38.14	1, 2
OSBLFUG8	Equipment Components: Pipe Rack Segment 1	640.0	40.0	160.0	35.0	17.5	37.21	16.28	1, 2
OSBLFUG9	Equipment Components: Pipe Rack Segment 2	475.0	40.0	137.8	35.0	17.5	32.06	16.28	1, 2
OSBLFUG10	Equipment Components: Pipe Rack Segment 3	150.0	40.0	77.5	35.0	17.5	18.01	16.28	1, 2
OSBLFUG11	Equipment Components: Pipe Rack Segment 4	450.0	40.0	134.2	35.0	17.5	31.20	16.28	1, 2
OSBLFUG12	Equipment Components: Pipe Rack Segment 5	480.0	40.0	138.6	35.0	17.5	32.22	16.28	1, 2
OSBLFUG13	Equipment Components: Pipe Rack Segment 6	630.0	40.0	158.7	35.0	17.5	36.92	16.28	1, 2
OSBLFUG14	Equipment Components: Pipe Rack Segment 7	510.0	40.0	142.8	35.0	17.5	33.22	16.28	1, 2
WWTP	Waste Water Treatment Plant	225.0	225.0	225.0	30.0	30.0	52.33	13.95	1, 2, 3

[1] Sigma Y value calculated as the square root of the area divided by 4.3 (Table 3-3 of AERMOD User's Guide for single volume source).
[2] Sigma Z values for elevated sources on or adjacent to a building calculated as the building height divided by 2.15 (Table 3-3 of AERMOD User's Guide for Elevated Source on or Adjacent to Building). Sigma Z values for surface-based source calculated as the vertical dimension of source divided by 2.15 (Table 3-3 of AERMOD Manual for Surface Based Source).
[3] Release height equal to top of structure as process is aspirated and emissions occur at the top of the structure.

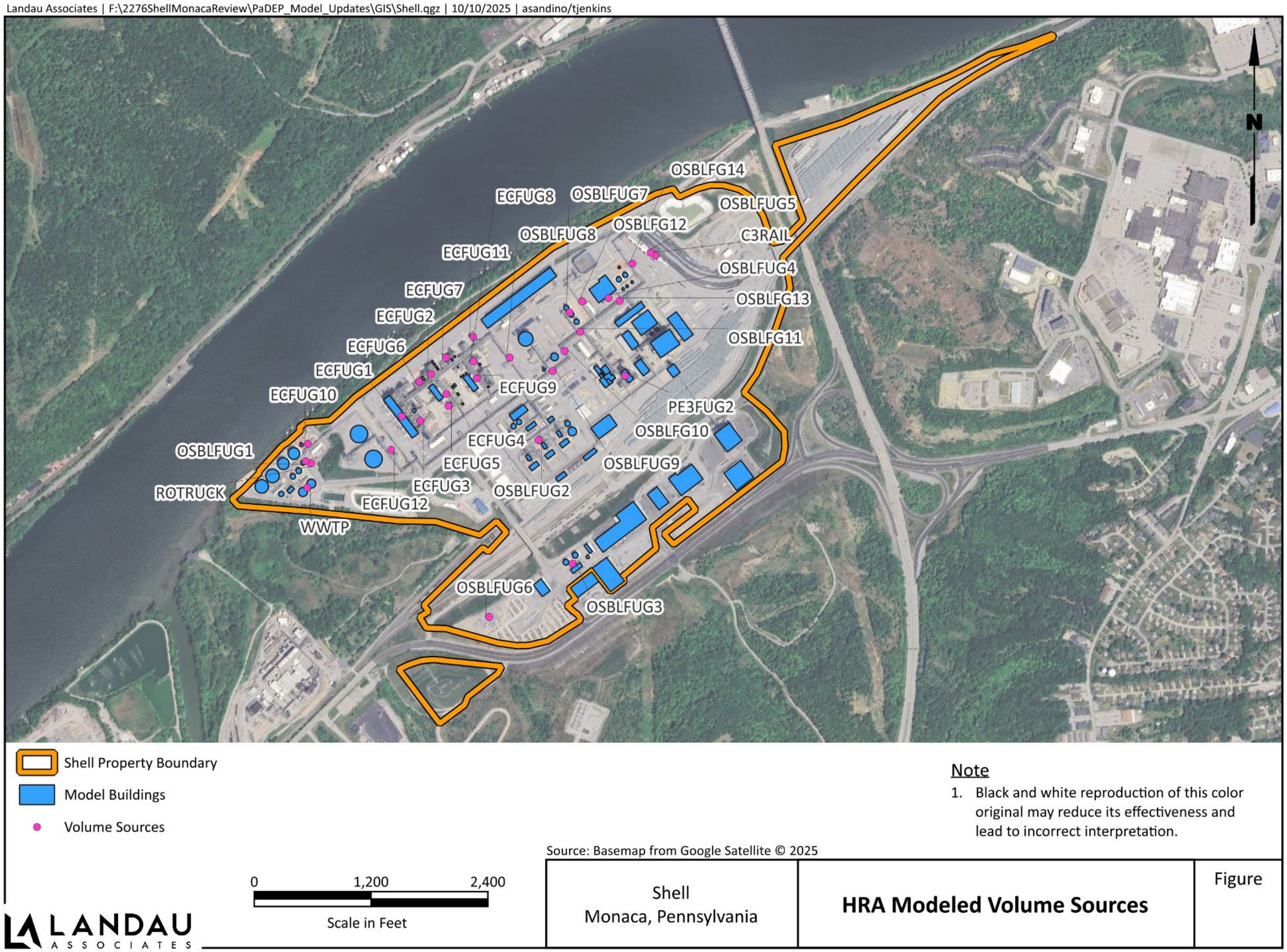

Figure 4. Modeled Volume Source Locations

Combustion Turbine Loads

Refer to Section 5.2 of Appendix D-1 for a discussion of the load conditions that were evaluated for the combustion turbines at SPM to identify the load condition resulting in the worst-case impact for each averaging period of concern. The load condition resulting in the worst-case impacts (i.e., 100% load) was carried forward for the final AERMOD runs. The results of the load analysis are presented in Section 5.1 and supporting AERMOD input and output files will be provided electronically.

Good Engineering Practice Stack Height Analysis

A Good Engineering Practice (GEP) stack height evaluation was conducted to determine the direction-specific building dimensions to include in the model. Since flares are not subject to the GEP regulations, there is no requirement to calculate the GEP formula stack height for flares. The formula height is used to justify stack height credit for stacks constructed in excess of 65 m. Procedures used were in accordance with those described in the EPA Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations-Revised).[j] GEP formula stack height, as defined in 40 CFR 51, is expressed as GEP = $H_b + 1.5L$, where H_b is the building height and L is the lesser of the building height or maximum projected width. Point source and building/structure locations were determined from a facility plot plan. The locations and heights were input to the EPA's Building Profile Input Program (BPIP-PRIME) computer program to calculate the direction-specific building dimensions needed for AERMOD. Multi-tiered buildings (i.e PE12, PE3, PERAIL) were represented as multi-tiered structures in the BPIP-PRIME input file, consistent with the EPA User's Guide to the Building Profile Input Program[k]. A plot plan for SPM is shown in Figure 5. A three dimensional rendering of the facility is shown in Figure 6. Downwash parameters for all point sources were included in the model runs.

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[j] *Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for Stack Height Regulations (Revised)*. EPA-450/4-80-023R, U.S. Environmental Protection Agency, June 1985.

[k] *User's Guide to the Building Profile Input Program. EPA-454/R-93-038, U.S. Environmental Protection Agency, April 2004*

Figure 5. SPM Plot Plan

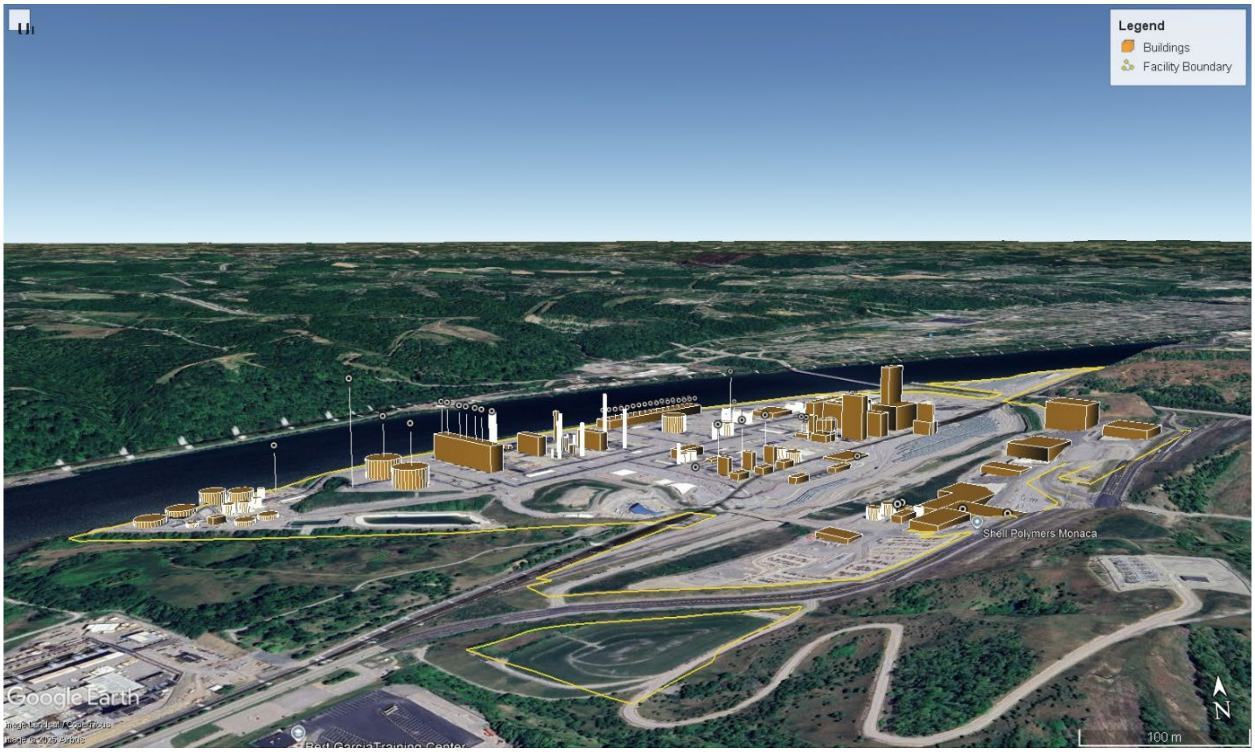


Figure 6. SPM Three-Dimensional Plot Plan (View from SW)

4.4 Receptor Data

Two receptor grids were developed for this analysis: one for assessing acute impacts and one for assessing chronic impacts. For the acute impacts assessment, modeled receptors were placed in all areas considered "ambient air" pursuant to 40 CFR 50.1(e) and the EPA's December 2, 2019 "Revised Policy on Exclusions from Ambient Air".[12]. Ambient air is defined as that portion of the atmosphere, external to buildings, to which the general public has access. There is a fence which precludes public access to the entire SPM property. The fencing is placed around the entire facility perimeter as well as along each side of the railroad track that transects the facility. Entrances are secured by gate with cameras and remote-controlled access for truck deliveries. Gate, guard shack, and cameras are used for contractor and personnel vehicle entrances. In addition, security maintains a 24/7 presence on-site to ensure that unauthorized public

[12] *Revised Policy on Exclusions from "Ambient Air"*, memorandum from Andrew Wheeler to Regional Administrators, EPA, December 2, 2019.

access is not permitted.

The receptor grid consisted of three Cartesian grids and receptors spaced at 25 m intervals along SPM's fenceline and the railroad that transects the facility. The first cartesian grid extends approximately 1 km from the fence in all directions. Receptors in this region were spaced at 50 m intervals. The second grid extends to 3 km. Receptor spacing in this region is 100 m. The third grid extends to approximately 5 km with a spacing of 500 m. Receptors with flagpole elevations were also placed along the Highway 376 bridge east of SPM. The receptor grid was designed such that maximum facility impacts fall within the 50 m spacing of receptors. The receptor grid spacing is presented in Table 3.

Table 3. Receptor Grid Spacing

Receptor Spacing (m)	Distance from Facility Fence (m)
50	1,000
100	3,000
500	5,000

A second grid was used for assessment of chronic impacts. This grid does not include receptors located on the Ohio River, facility property adjacent to the river, the Highway 376 bridge, or the railroad that transects the facility. These receptors were excluded from the assessment of chronic impacts as exposure in these areas is limited to the short-term.

SPM is located in western Pennsylvania. Terrain within 5 km of the site is gently rolling; however, there is terrain in excess of stack top elevation. Receptor elevations and hill height scale factors were calculated with AERMAP (version 24142). The elevation data were obtained from the USGS 1/3 arc second Three-Dimensional Elevation Program (3DEP) data obtained from the National Map from the USGS. Locations were based on a NAD83, UTM Zone 17 projection. The near-field receptor grids used in the acute and chronic assessments are shown in Figures 7 and 8, respectively.

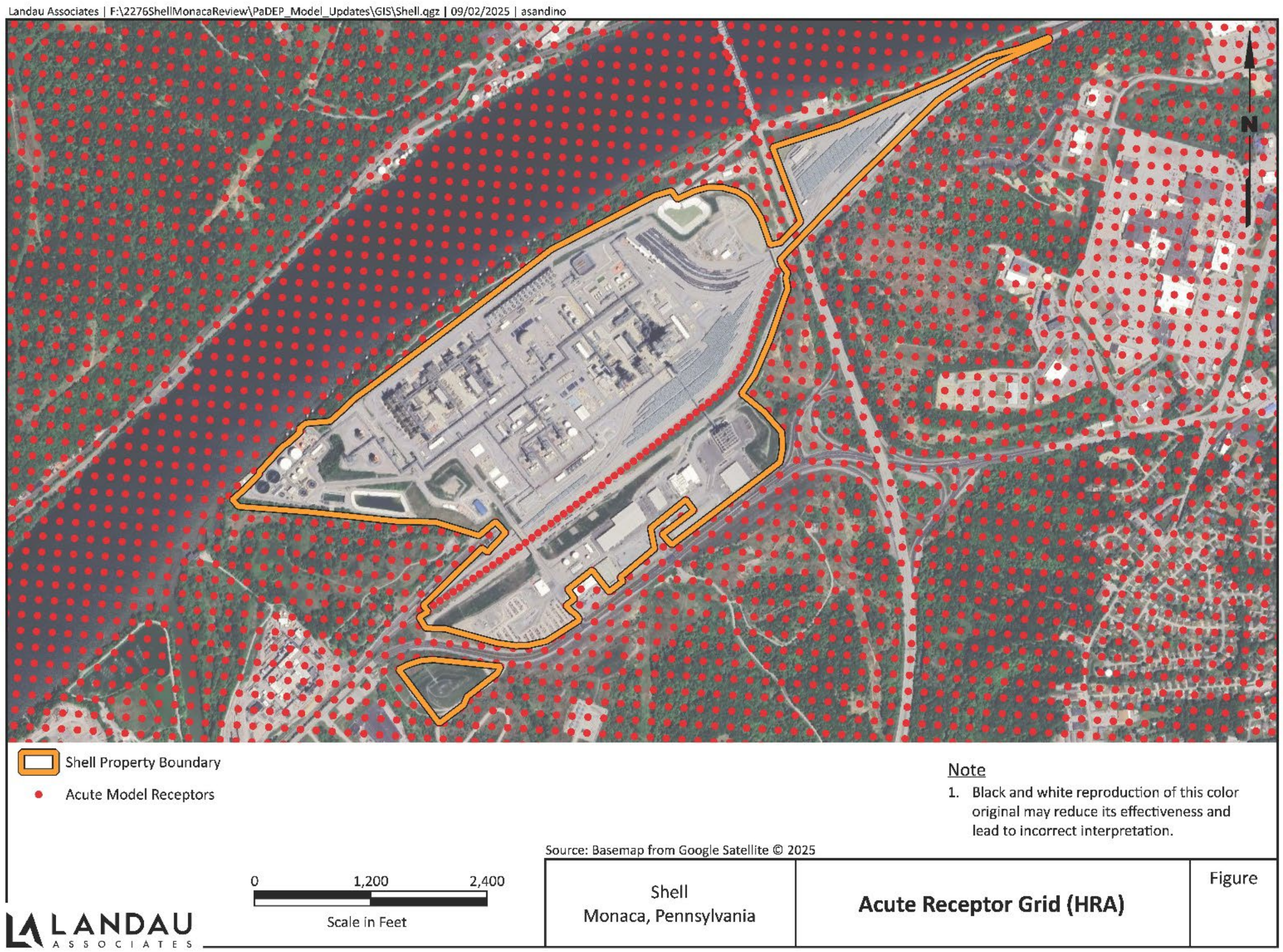


Figure 7. SPM Acute Analysis Receptor Grid

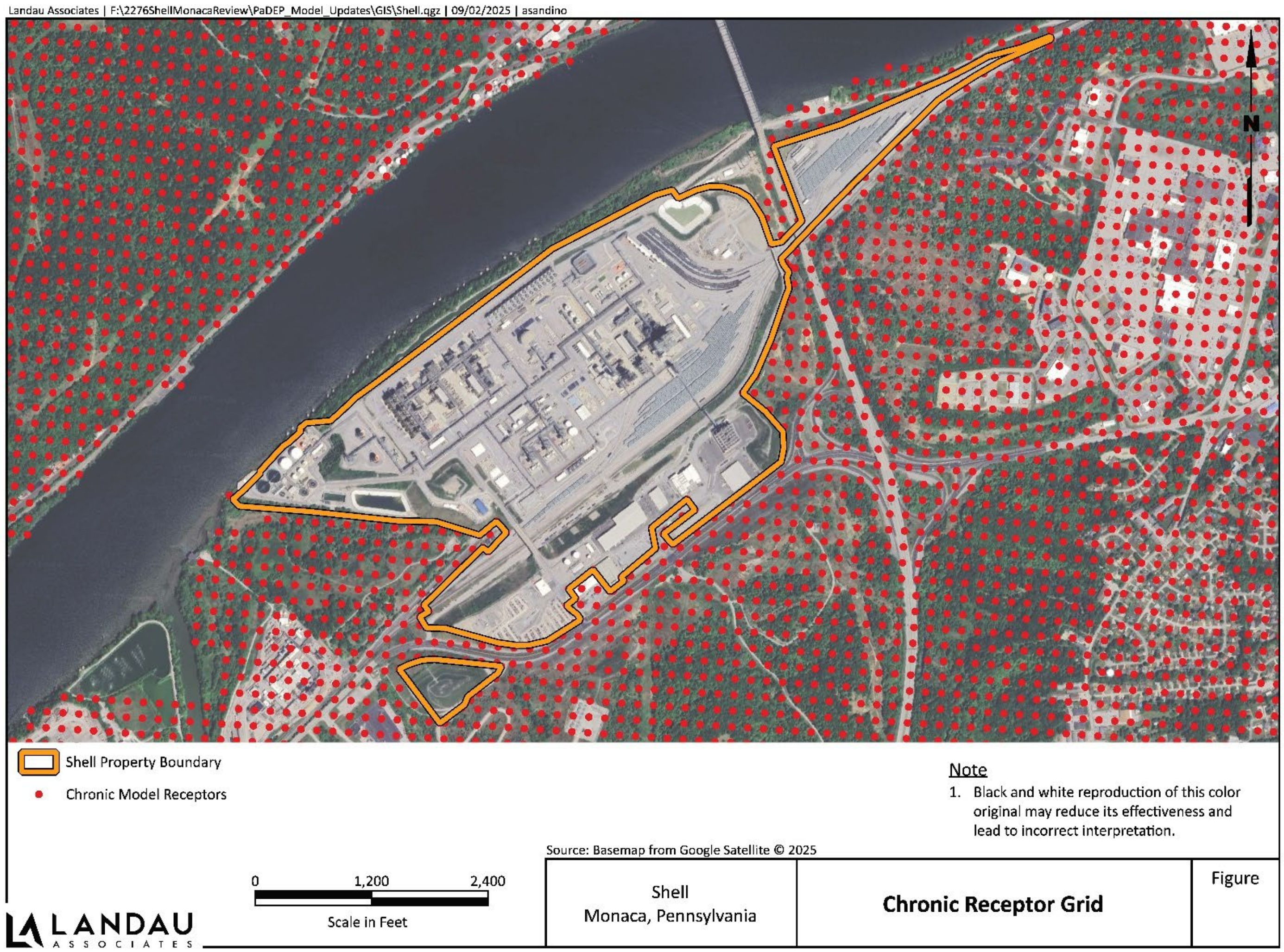


Figure 8. SPM Chronic Analysis Receptor Grid

4.5 Meteorological Data

Data Selection and Representativeness

The 2018-2022, 5-year sequential hourly surface meteorological data collected at the Vistra Beaver Valley Nuclear Generating Station (Beaver Valley) and supplemental surface and upper air data from the Pittsburgh International Airport (KPIT, WBAN 94823) were used in the analysis. The Beaver Valley meteorological station surface data were collected as part of a continuous data collection program required by the U.S. Nuclear Regulatory Commission and were processed under the ONSITE pathway in Stage 1 of AERMET. For reasons discussed below, the Beaver Valley meteorological station data adequately represent atmospheric boundary layer conditions within the SPM analysis domain for AERMOD to properly characterize the transport and dispersion of plumes from SPM. A profile base elevation of 228.6 m (750 feet) was employed which corresponds to the base elevation of the Beaver Valley meteorological station tower.

The Beaver Valley meteorological station is located approximately 8 km downstream of SPM, also on the Ohio River. This meteorological station and SPM also share a similar orientation in relation to the Ohio River (Figure 9). The river flows from the northeast to southwest relative to both the Beaver Valley meteorological station and SPM. The topography is also similar at each location. The wind patterns are therefore expected to be similar at each location. Wind speed and direction are measured at three levels at the Beaver Valley meteorological station (10.7 m, 45.7 m, and 152.4 m) (See the wind roses for each level in Figure 10). Temperature is also measured at the 10.7 m level. These three levels provide adequate representation of plume behavior at the various release heights at SPM. The adjust u* option was applied in Stage 2 of AERMET because there is no measured on-site turbulence data.

According to the EPA AERMOD Implementation Guide, the surface characteristics should be similar for the meteorological station and the study site.[13] As a result, Shell performed a comparison of the surface characteristics at the Beaver Valley

[13] *AERMOD Implementation Guide*, EPA-454-B-23-009, October 12, 2023.

meteorological station and SPM. The AERSURFACE program (version 24142) was run to determine the characteristics for comparison. The results of the albedo and Bowen ratio comparison by month are shown in Figure 11. The surface roughness comparison, by season, are shown in Figure 12.

The Pittsburgh International Airport meteorological station is located approximately 21 km southeast of SPM. Station pressure, cloud cover, and twice daily sounding data from this meteorological tower were used. These meteorological parameters are of synoptic scale and are adequately representative of the Beaver Valley area. Upper air data are also collected at the Pittsburgh International Airport meteorological station (Figure 9).

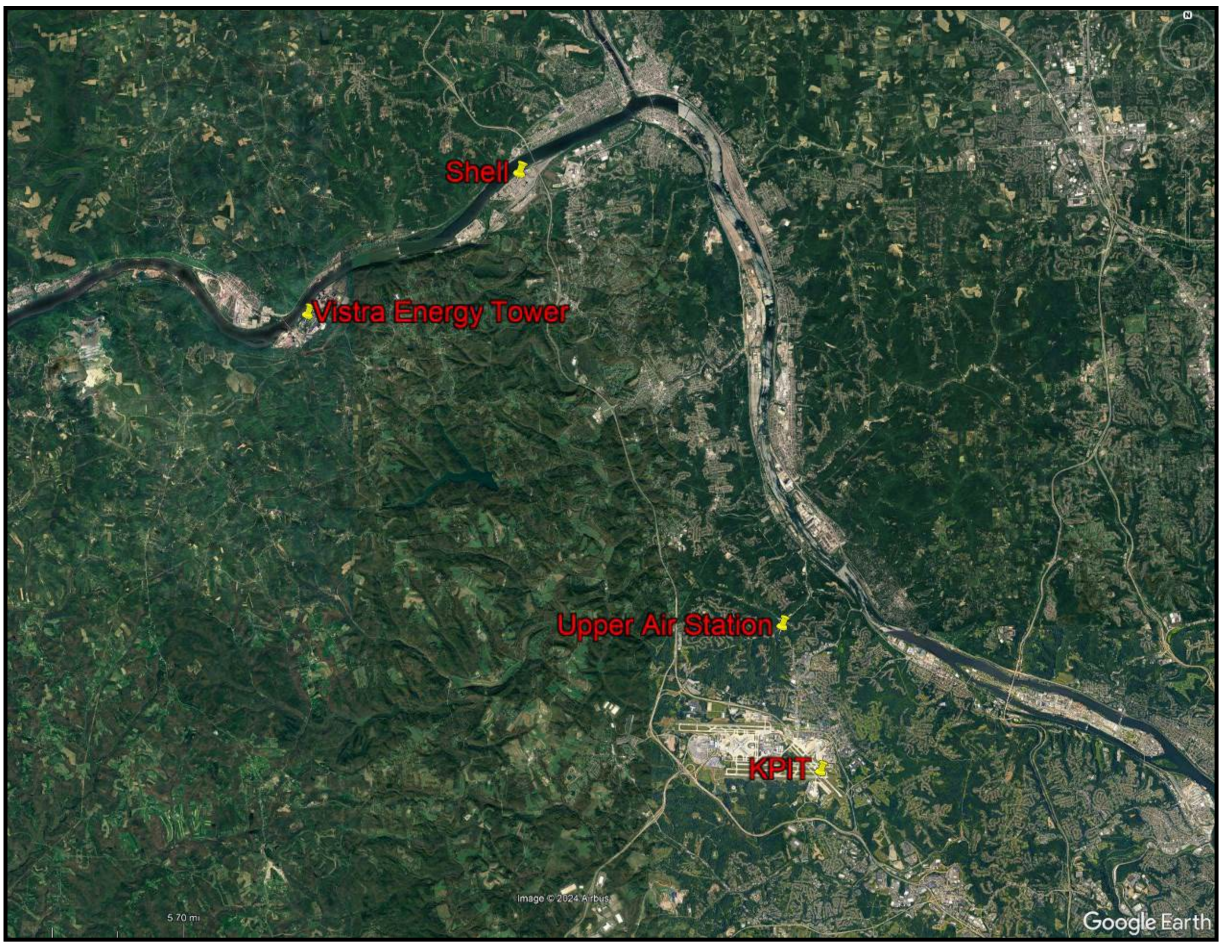


Figure 9. Beaver Valley (Vistra) Meteorological Tower and Pittsburgh Surface and Upper Air Station Locations Relative to SPM

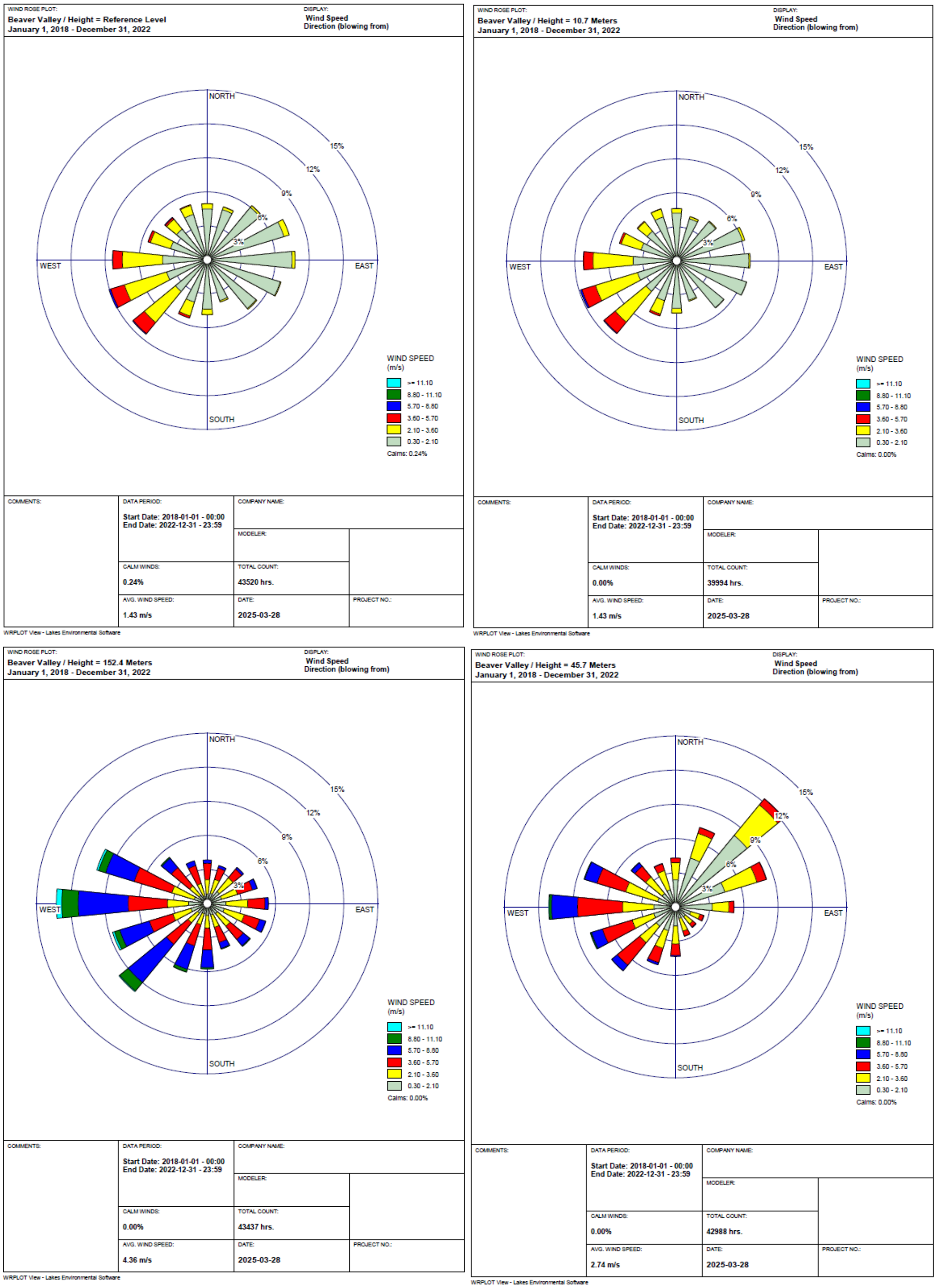
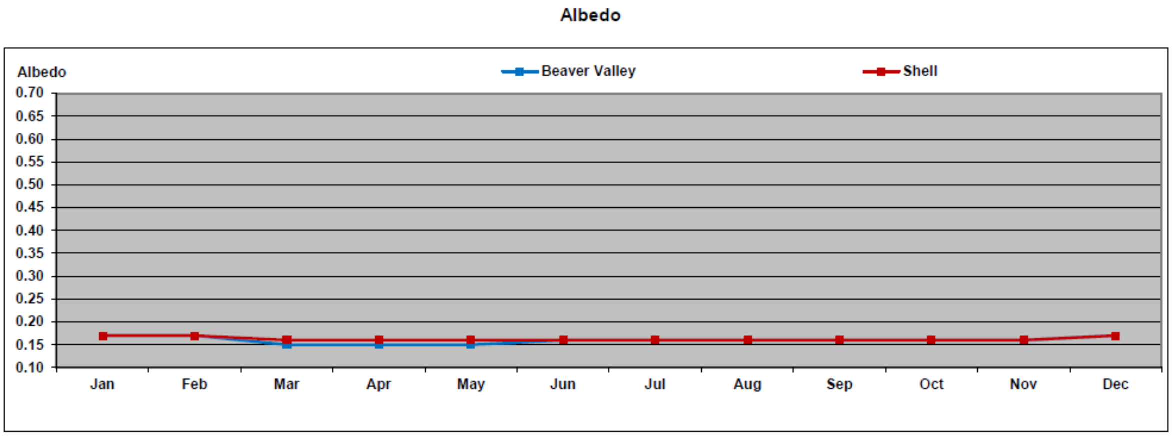


Figure 10. Beaver Valley Windrose 2018-2022



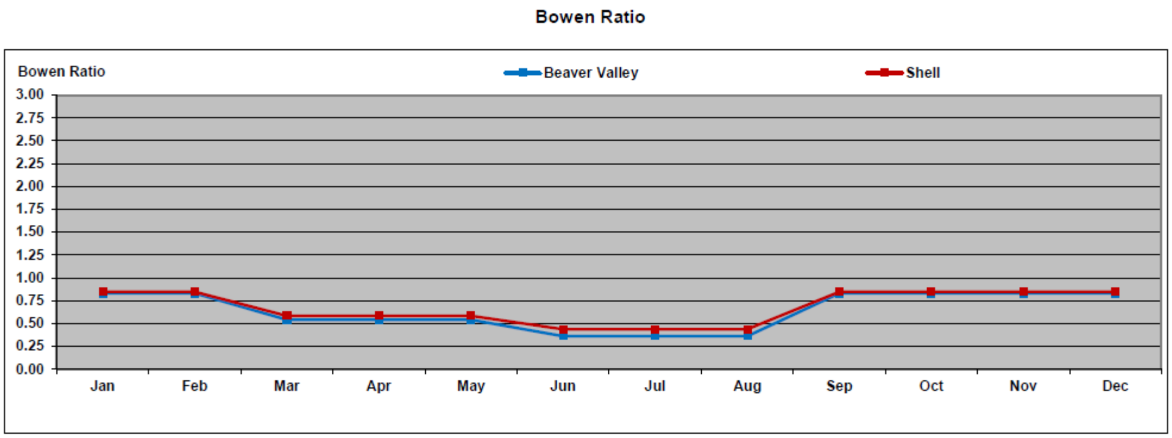


Figure 11. Albedo and Bowen Ratio Comparison Results

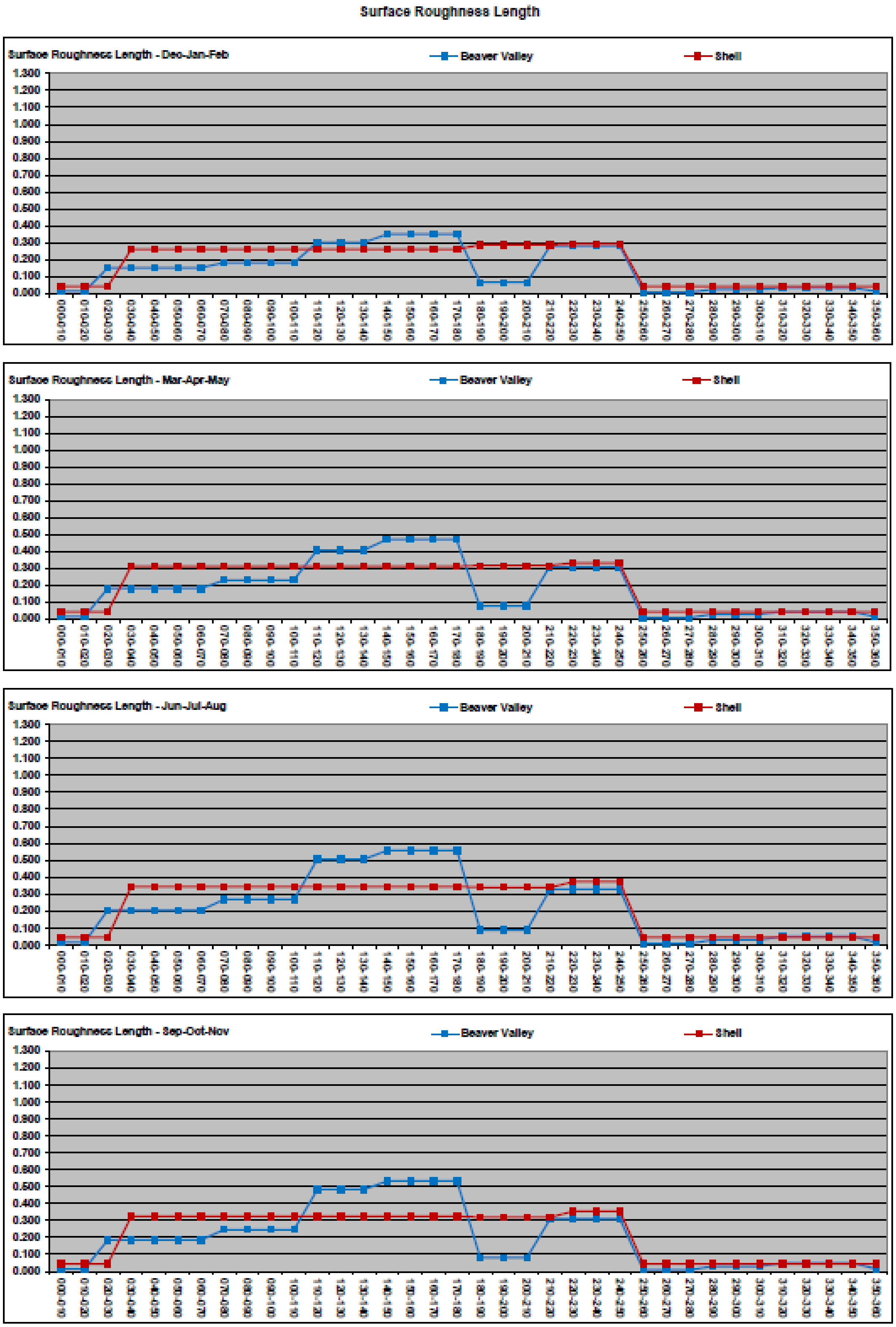


Figure 12. Surface Roughness Comparison Results

Data Processing

The meteorological data were provided to Landau Associates, Inc. (Landau) by DEP. DEP processed the Beaver Valley surface data, Pittsburgh International Airport (KPIT) surface data, and KPIT upper air data using the meteorological preprocessor AERMET (version 24142). In AERMET Stage 1, KPIT surface meteorological data in the Integrated Surface Data (ISD) format were extracted. KPIT upper air meteorological data in the Integrated Global Radiosond Archive (IGRA) format were also extracted.

Also, the MODIFY keyword was entered to fill missing temperatures in the upper air data with interpolated values. In AERMET Stage 2, values of the surface characteristics (noon-time albedo, Bowen ratio, and surface roughness length) representative of the Beaver Valley surface meteorological site were entered. These surface characteristics values were calculated by AERSURFACE (version 24142) using USGS National Land Cover Database (NLCD) land cover, impervious surface, tree canopy cover data for 2018, 2019, 2020, and 2021.[14] The following options were selected in AERSURFACE: default 1-km radius and ten user-defined sectors defined as “High Z0” for developed areas and “Low Z0” for undeveloped areas for the surface roughness length study area, the default method for determining surface roughness length (ZORAD), monthly temporal resolution with default season assignment, and non-arid region.

AERSURFACE was executed for each surface moisture condition (average, dry, and wet), assuming both no continuous snow cover and continuous snow cover during the winter (i.e., AERSURFACE was executed six times). AERMET Stage 2 was then executed for each set of surface characteristics to produce six surface (.sfc) files. The final AERMET surface file was assembled by month based on actual estimates of surface moisture condition and snow cover during the meteorological data period. Estimates of surface moisture condition were based on precipitation data for Pennsylvania Climate Division 9. Snow cover was based on National Centers for Environmental Information (NCEI) Local Climatological Data from KPIT.

[14] 2018 NLCD data was used for processing meteorological data from 2018, 2019 NLCD data was used for processing meteorological data from years 2019, 2020 NLCD data was used for processing meteorological data from years 2020, and 2021 NLCD data was used for processing meteorological data from years 2021 and 2022.

4.6 Output Options

Modeling was conducted using a unit emission rate of 1 pound per hour (lb/hr), with the exception of the cooling towers. The cooling towers were modeled with thirteen pairs of cells using 0.5 lb/hr per pair cell (equivalent to 1 lb/hr for each cooling tower cell pair) to match the output formats from the previous modeling analysis. The output options were specified to generate plot files of dispersion factors having the unit of microgram per cubic meter (µg/m^3) per lb/hr for each emission source for each averaging period. Acute impacts are based on the maximum 1-hour concentrations from the five years of meteorology. To assess the potential for acute impacts, the resulting 1-hour dispersion factor for each emission source at each receptor was then multiplied by the source's estimated hourly emission rate to obtain pollutant-specific concentrations for each source, for each COPC, at each receptor. The resulting pollutant-specific concentration for each source was then summed on a receptor-by-receptor basis to obtain the total facility-wide 1-hour concentration at each receptor for each COPC. This approach is conservative because it assumes that for each receptor, the maximum impact from each emission source occurs during the same hour, which it does not. Although this results in an overestimate of the acute health effects, this conservative assumption eliminates the need to perform an individual AERMOD run for each of the individual COPCs that has an acute inhalation reference concentration.

The chronic impacts are based on the maximum annual average across the five year period. Dispersion factors having the unit of µg/m^3 per lb/hr for each receptor were determined by modeling a unit emission rate of 1 lb/hr from each emission source at SPM with the exception of the cooling towers The cooling towers were modeled in thirteen pairs of cells using 0.5 lb/hr per pair cell (equivalent to 1 lb/hr for each cooling tower cell pair) to match the output formats from the previous modeling analysis. The resulting dispersion factors were then multiplied by the estimated annual average emissions rate in lb/hr for each COPC from each emission source to obtain pollutant-specific concentrations. In assessing chronic cancer and non-cancer risks, the 5-year average impacts and subsequent risk for each pollutant were summed for each receptor, and the receptor with the maximum total (i.e., aggregate) excess lifetime cancer risk (ELCR) was determined.

5.0 RESULTS

5.1 Combustion Turbine Load Analysis Results

The results of the combustion turbine load analysis are presented in Table 4. As shown, the 100% load scenario for each turbine was found to generate the highest impacts. The 100% load case was therefore used in the final AERMOD runs for the risk assessment.

Table 4. Combustion Turbine Load Analysis Results

Averaging Period	Source Name	Modeled Concentration (μg/m^3)	Source Description
1-hr	CT1_100	**1.41**	Turbine 1, 100% load
	CT1_75	1.20	Turbine 1, 75% load
	CT1_45	0.85	Turbine 1, 45% load
	CT2_100	**1.46**	Turbine 2, 100% load
	CT2_75	1.24	Turbine 2, 75% load
	CT2_45	0.86	Turbine 2, 45% load
	CT3_100	**1.47**	Turbine 3, 100% load
	CT3_75	1.26	Turbine 3, 75% load
	CT3_45	0.91	Turbine 3, 45% load
Annual	CT1_100	**0.014**	Turbine 1, 100% load
	CT1_75	0.013	Turbine 1, 75% load
	CT1_45	0.009	Turbine 1, 45% load
	CT2_100	**0.013**	Turbine 2, 100% load
	CT2_75	0.012	Turbine 2, 75% load
	CT2_45	0.009	Turbine 2, 45% load
	CT3_100	**0.013**	Turbine 3, 100% load
	CT3_75	0.012	Turbine 3, 75% load
	CT3_45	0.009	Turbine 3, 45% load

5.2 Acute Pollutant Results

A Python script was used to combine the dispersion factors, emission rates, and health risk values. Spreadsheet files summarizing the calculated 1-hour concentrations, as well as all AERMOD input and output files will be provided electronically. The calculated 1-hour concentrations and resulting acute hazard quotients (HQ) for each COPC are summarized in Appendix D-3C. Supporting calculations will also be provided electronically.

5.3 Chronic Pollutant Results

A Python script was used to combine the dispersion factors, emission rates, and health risk values. Spreadsheet files summarizing the calculated concentrations, as well as all AERMOD input and output files will be provided electronically. The calculated ELCRs, HQs, and hazard index (HI) are presented in Appendix D-3C.