

Appendix F
Air Quality Modeling Protocol



Appalachian Shale Cracker Enterprise
(ASCENT)

FINAL

Air Quality Modeling Protocol

Washington, Wood County, West Virginia

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1.0 INTRODUCTION

The Appalachian Shale Cracker Enterprise (ASCENT) Project (the “Project”) respectfully submits this air quality modeling protocol to support an air quality permit application that is concurrently being submitted to the West Virginia Department of Environmental Protection (WVDEP). The application has been prepared and submitted to authorize the development of a new polyethylene facility in Wood County, West Virginia. A general area map showing the proposed location of the facility is provided in Appendix A of this protocol. The assumptions in this protocol were discussed at a meeting with WVDEP, Project representatives, and Environmental Resources Management (ERM) on December 4, 2013. A first draft of the protocol was submitted to WVDEP on December 20, 2013. Verbal comments were received from WVDEP shortly after submittal, and written comments were received from WVDEP on April 9, 2014. The present version of the protocol has been modified based on the comments received, and also provides updates to source information including stack characteristics and emission rates.

1.1 PROJECT OVERVIEW

The proposed Project will consist of an ethane “cracker” and associated utilities including combined cycle combustion turbines, boilers, a cooling tower, flares, and three (3) polyethylene plants on a site of approximately 376 acres. A more complete project description can be found in Section 2.1 of this protocol. The Project will be located in Washington, Wood County, West Virginia approximately 10 kilometers southwest of Parkersburg, West Virginia.

1.2 OVERVIEW OF METHODOLOGY

Table 1-1 provides a summary of the attainment status of Wood County, West Virginia. The attainment status determines which regulatory programs new major sources or modifications to existing sources must address in the context of obtaining an air quality construction permit. Table 1-2 provides a summary of the regulatory program(s) that must be addressed for each regulated compound that will be emitted by the Project. Although plant-wide total emissions are still under development, Table 1-2 provides the initial assumptions regarding regulatory program applicability. Compounds with emission levels that trigger Non-attainment New Source Review (NA-NSR) requirements are subject to additional control (Lowest Achievable Emission Rate, LAER) and emissions offset requirements but are not required to conduct air quality dispersion modeling. Compounds from this Project do not trigger NA-NSR requirements. In attainment areas, compounds that trigger the significant emission rate (SER) must address requirements of the Prevention of Significant Deterioration (PSD) program.

Table 1-1 *Attainment Status of Wood County, West Virginia*

Compound	Attainment Status of Wood County, West Virginia
SO ₂ (annual)	Unclassifiable/ Attainment
SO ₂ (1-hr)	Unclassifiable/ Attainment
CO	Unclassifiable/ Attainment
Pb	Unclassifiable/ Attainment
O ₃ (1-hr)	Unclassifiable/ Attainment
PM ₁₀	Unclassifiable/ Attainment
NO ₂ (annual)	Unclassifiable/ Attainment
NO ₂ (1-hr)	Unclassifiable/ Attainment
O ₃ (8-hr)	Unclassifiable/ Attainment
PM _{2.5} (annual)	Attainment (1997 standard)
PM _{2.5} (24-hr)	Unclassifiable/ Attainment (2006 standard)

Table 1-2 *Applicability of Regulatory Air Programs to the Project*

Compound	Project Emissions (tons/yr)	PSD	NA-NSR
NO _x	1414.9	Yes	No
CO	650.3	Yes	No
SO ₂	35.7	No	No
PM ₁₀	88.6	Yes	No
PM _{2.5}	76.6	Yes	No
VOC	400.7	Yes	No
GHGs	1,790,588	Yes	n/a

Dispersion modeling will be performed for the above compounds to assess the ambient air impacts resulting from the Project emissions. The modeling analysis will address compliance with the National Ambient Air Quality Standards (NAAQS) and PSD increments, as applicable. The modeling analyses described in this protocol will conform to Appendix W of 40 CFR Part 51 (Guideline on Air Quality Models) and to guidance supplied by WVDEP. The key elements of the modeling analysis will include:

- Use of the latest version of AERMOD (version 13350) with default settings except for (optionally) the LOWIND1 or LOWIND2 beta options that are designed to produce improved predictions in complex terrain;
- The surface meteorological data were obtained from Mid-Ohio Valley Regional Airport, also known as Wood County Airport (PKB) for the five years 2009-2013. Wood County Airport is located less than 23 kilometers to the NE of the proposed Project site;
- Use of upper air data from Pittsburgh, PA;

- Use of the latest version of AERMET (version 13350) with default settings except for (optionally) the USTAR-adjust beta options that are designed to produce improved predictions in complex terrain;
- Application of the latest version of AERSURFACE as recommended in the USEPA AERMOD Implementation Guidance (USEPA 2009);
- Develop a comprehensive receptor grid designed to identify maximum modeled concentrations;
- Conduct air quality modeling to determine the magnitude and location of ambient concentrations due to emissions from the Project;
- Utilize the USEPA Tier II NO_x to NO₂ conversion as an initial assumption, utilize the OLM and/or PVMRM and/or the ARM2 beta option within AERMOD as a secondary assumption, if required;
- Qualitatively assess the proposed Project's potential to contribute to ozone formation;
- In accordance with PSD requirements, determine whether emissions from the Project that are subject to PSD will have an effect on growth, soils, vegetation, and visibility in the vicinity of the Project;
- Compare maximum predicted impacts to relevant Significant Impact Levels (SILs) and Significant Monitoring Concentrations (SMCs) to determine if additional modeling or monitoring is required; address a recent court decision related to the SILs and SMCs for PM_{2.5}.

If any of the non-default options (LOWWIND1, LOWWIND2, USTAR-adjust, ARM2) are utilized, additional justification will be provided.

2.0 PROJECT EMISSIONS AND SOURCE CHARACTERIZATION

2.1 PROJECT DESCRIPTION

The proposed ASCENT facility will be located at the previous SABIC plastic manufacturing site in Washington, Wood County West Virginia; adjacent to the Ohio River southeast of Parkersburg. The site is zoned for industrial use, and provides multiple strategic advantages for the processing of raw ethane captured from Appalachian Shale. The Project intends to construct and operate one Ethane Cracker Plant, three polyethylene plants, associated support utilities, process and storage tanks, and other miscellaneous sources. The design information discussed in this application is based on best available design information provided by vendors at the time of this application. The following section identifies the primary equipment and operations that will contribute to the facility-wide air emissions.

The Project ASCENT emissions sources include;

- Six (6) Pyrolysis Cracking Furnaces fired on a fuel mixture of recycled tail gas and natural gas;
- One (1) natural gas fired GE 7EA Combustion Turbine with a natural gas-fired duct burner;
- Two (2) natural gas-fired auxiliary boilers;
- One (1) natural gas-fired thermal oxidizer used to control various product, recycle, and waste streams from the Cracker Plant;
- One (1) natural gas-fired Regenerative Thermal Oxidizer (RTO) used to control streams from one of the polyethylene (PE) plants;
- Five (5) flares equipped with natural gas piloted burners;
- One (1) natural gas-fired catalyst activator heater from a PE plant;
- Nine (9) Ultra Low Sulfur Diesel (ULSD) fired emergency generators;
- Three (3) ULSD-fired emergency fire water pump engines;
- One (1) cooling tower for non-contact cooling;
- One (1) Wastewater Treatment Plant (WWTP);
- Storage tanks and loading racks; and
- Material handling operations.

2.1.1 *Ethane Cracker Plant*

The ethane feedstock for the Ethane Cracker Plant will consist of Appalachian Shale ethane, supplied via pipeline, and recycled hydrocarbon feeds. The ethane feedstock coming from the pipeline is handled and condensed inside a storage unit. The ethane storage consists of three storage ‘bullet’ tanks to store the ethane feed for the Cracker Plant in case of unavailability of straight-run feedstock from the upstream gas pipeline. The ‘cracking’ process refers to the thermal breakdown of large complex organic molecules, such as ethane, into smaller organic constituents, such as ethylene and propylene. A process flow diagram for the Ethane Cracker Plant is presented in Figure 2-1, which outlines all major processes and equipment, including cracking furnaces, a quench tower, a compressor section, a caustic removal section, an ethylene recovery section, and the thermal oxidizer.

2.1.1.1 *Pyrolysis Furnaces*

The Project is for the construction of six pyrolysis (i.e., cracking) furnaces, each with a maximum heat input rating of 396.8 MMBtu/hr, in order to thermally ‘crack’ the ethane feedstock into ethylene and other products. In normal steady state operations, five cracking furnaces are fired to process the ethane feedstock (1,984 MMBtu/hr at 100% load) while one cracking furnace will be maintained

on hot stand-by. All six furnaces will be identically designed to crack the mixture of ethane and recycled hydrocarbon streams.

Each furnace will consist of a single cell radiant section (i.e., firebox) with bottom and side fired burners, a convection section, and an induced draft fan. The fuel source used by the furnaces will consist of a blend of natural gas and recycled tail gas. The fuel blend will be a hydrogen rich gas mixture with an estimated heating value of 523 Btu per standard cubic foot (scf). The fuel combustion will take place in two firing zones for each furnace, one on either end of the firebox. An induced draft fan, located on top of the convection section, will be driven by a variable speed electric motor to produce draft in the furnace.

All bottom and side burners associated with the six furnaces will utilize Ultra-low NO_x Burners (ULNB) with vendor guaranteed control efficiencies on total NO_x emissions. Each furnace will have its own exhaust stack and each stack is expected to be at least 65 meters above grade. The furnaces are designed with the intention to operate on a continual basis.

2.1.1.2 *Coke Formation and Removal*

The actual “cracking” of ethane and hydrocarbon feeds involves the dehydrogenation and condensation of ethane, such that only olefins are produced in the radiant coils. Because of this thermal reaction, the radiant tubes gradually become coated with an internal layer of coke, causing an increase in metal temperature and an increase in pressure drop through the radiant coils. This coke layer tends to retard the heat transfer from the tube walls of the radiant coil to the feed passing through it, which adversely affects the pyrolysis yield pattern.

The coke accumulation on the radiant coils necessitates periodic cleaning, referred to as “decoking”, with one cleaning event typically occurring every 60 to 70 days per furnace, in order to prevent overheating and to restore the original yield pattern. The cleaning of the coke deposits is achieved by lowering the firing rate to thirty percent normal firing rate (approximately 119 MMBtu/hr) and injecting a steam/air mixture into the tubes to burn off the coke, a procedure known as decoking. During the decoking procedure, the furnace effluent from the radiant tubes is routed back to the firebox for additional pollutant destruction. To control the burning of the coke, a sample point for CO₂ analyses is installed on the decoking effluent to ensure full oxidation of the coke material occurs. Figure 2-2 depicts the decoking procedures used for each of the six pyrolysis furnaces.

Figure 2-1 Ethane Cracker Process Flow Diagram

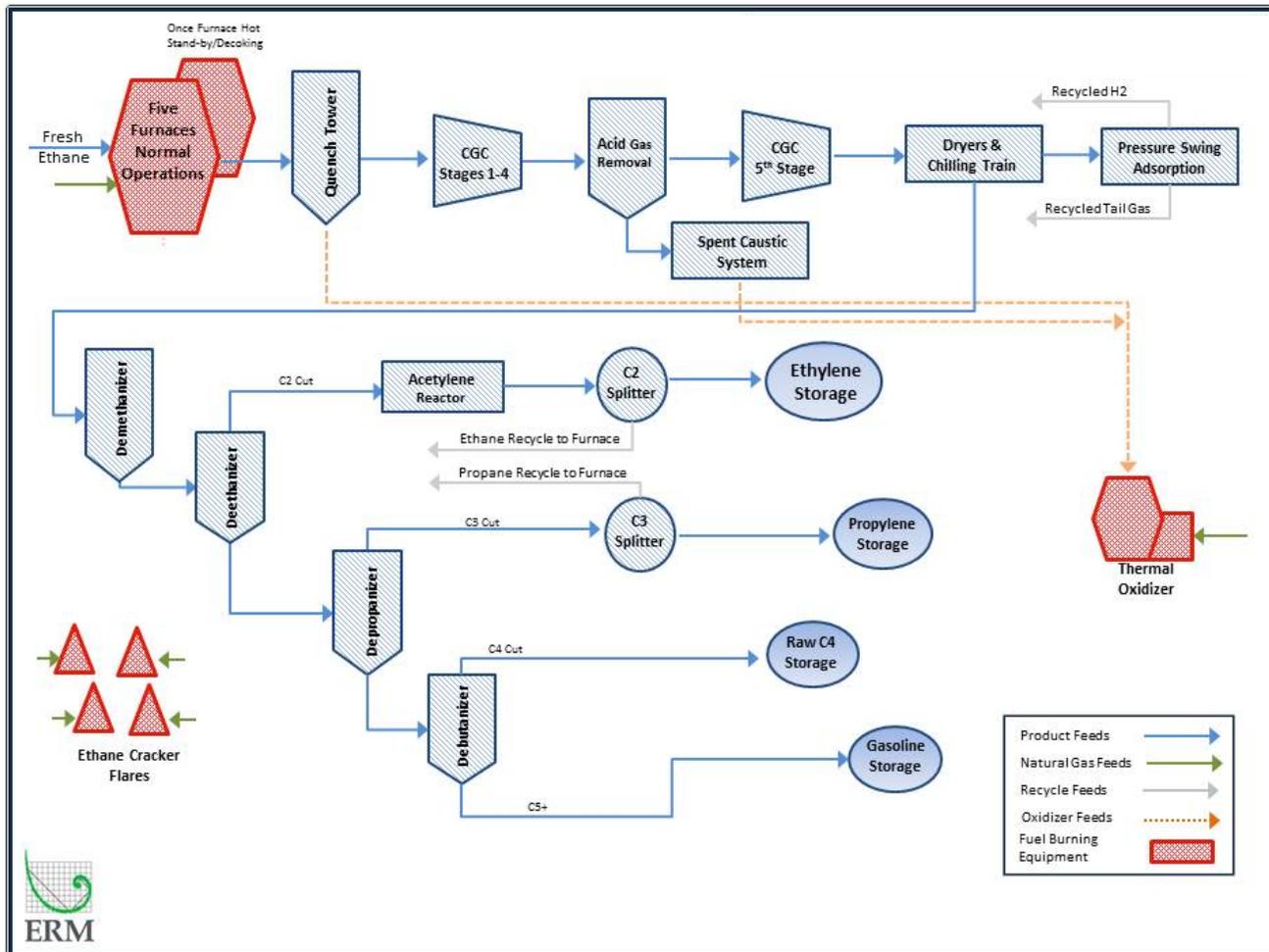
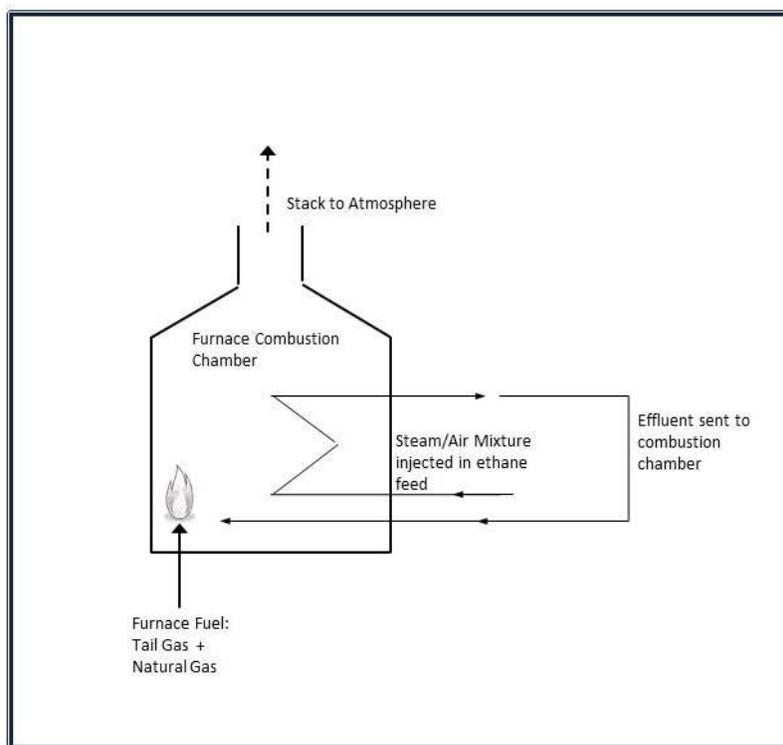


Figure 2-2 *Pyrolysis Furnace Decoking Operations*



2.1.1.3 *Quench Tower*

The cracked gases leaving the pyrolysis furnaces are cooled by direct contact with circulating quench water within the quench water tower. The purpose of the quench tower is to reduce the cracked gas temperature to an acceptable level for compression, to treat the process water, and to generate dilution steam. After the circulating quench water encounters the cracked gas streams, it is pumped into cyclones designed to remove tar and coke particles. In normal operation, two cyclones will be in service and a third one will be used as a backup.

2.1.1.4 *Cracked Gas Compressor (CGC)*

Cracked gases from the quench water tower are fed to the Cracked Gas Compressor (CGC). The CGC is a five-stage centrifugal machine arranged in three casings. It is driven by a steam turbine using high-pressure steam produced by the cracking furnaces. The gases pass through each CGC stage, successively being cooled to an appropriate pressure and temperature.

2.1.1.5 *Caustic Removal and Gas Drying*

Between the fourth and fifth stages of the CGC, the cracked gas product feed will be routed to an acid gas removal section (caustic soda scrubber) to eliminate excess carbon dioxide and hydrogen sulfide. All spent caustic solution will be

withdrawn from the column and be sent to the spent caustic treatment, where it will undergo a partial degasification of the volatile hydrocarbons. The chilled gas leaving the fifth stage of the CGC is routed to one of two cracked gas driers (one in operation and one in stand-by mode). The gas flows from the top to the bottom of the drier, while the water content of the gas is successively reduced to less than 1 ppm or less. The driers use regeneration gas, sent in a counter current direction (bottom to top), to release the adsorbed water from the cracked gas.

2.1.1.6 *Ethylene Recovery and Purification*

The final recovery of ethylene is achieved by condensation in a chilling section and a series of purification steps. Processed gases leave the driers and pass through a gas filter before entering the chilling section. Ethylene and heavier hydrocarbons are condensed progressively by chilling the gases in steps at below freezing temperatures. Condensation is achieved by the use of a mixed refrigerant through an open loop type refrigeration system. After being chilled, the cracked gases are then routed for separation and purification. Ethylene is separated from recycled hydrocarbons in a series of distillation steps. First, the cracked gasses are routed to a demethanizer where light components such as methane, are extracted from the overhead product and routed back to the CGC for recycle. The bottom product is reheated and transferred to the deethanizer. The overhead product of the deethanizer (C2 stream) is sent to the acetylene reactor and the bottom product is sent to the depropanizer and the debutanizer. Ethylene is sent to a double-walled refrigerated storage tank. Propylene, raw mix C4s (mostly butadiene), and pyrolysis gasoline are final products sent to storage tanks from the process. Propylene, raw mix C4s, and pyrolysis gasoline are transferred as final product off site via loading racks. Ethylene is sent as the primary input to the polyethylene plants.

2.1.1.7 *Thermal Oxidizer*

One thermal oxidizer will be constructed and operated for the control of organic vapor and liquid streams generated by the Ethane Cracker Plant. The thermal oxidizer is equipped with a radiant section and a natural gas burner rated at 130 MMBtu/hr. ASCENT is coordinating with the design technology vendors to properly identify all streams to the thermal oxidizer. The potential streams sent to the oxidizer include slop oil, tar water, wet flare condensates and hydrocarbons. Liquid streams generated by the Ethane Cracker Plant not sent to the thermal oxidizer will be sent to the WWTP for treatment and final disposal, described in more detail below. All product and recycle feeds associated with the Ethane Cracker Plant will also be connected to the main flare inlet feeds in the event of any unplanned over pressuring event.

The thermal oxidizer is designed to achieve a Destruction and Removal Efficiency (DRE) of 99.9% for all VOC and organic HAP constituents.

2.1.1.8

Ethane Cracker Flares

Four flare stacks will be designed and constructed for the Ethane Cracker operations; the main flare, oxygen flare, ethylene storage flare and product storage flare. Each flare will be equipped with a primary natural gas pilot and an identical backup natural gas pilot. All four flares will have a 98 % DRE for all streams sent for combustion.

The main flare will be constructed and operated for any unplanned over pressuring emergency event. The main flare is also connected to the three polyethylene plants. The main flare pilots will have a combined heat input of 0.82 MMBtu/hr.

The oxygen flare will be constructed to control pressure relief from the thermal oxidizer. The oxygen flare pilots will have a combined heat input of 0.2 MMBtu/hr. The ethylene storage flare will be constructed to control any flammable gases generated from the ethylene storage silos. The product storage flare will be constructed to control any flammable gases generated from the propylene and gasoline storage tanks. These two flare stacks will each be identically designed with natural gas pilots, each having a total heat input of 0.4 MMBtu/hr. This heat input incorporates natural gas backup pilots.

2.1.2

Polyethylene (PE) Plants

The final polyethylene pellets will be produced by three independent PE plants; Plant A, Plant B, and Plant C. Each plant will utilize a slightly altered manufacturing process to produce three types of polyethylene pellets. The three units will share a common ethylene feed but all other operations will be independent and separate. Each PE plant will be connected to main flare for any unplanned over pressuring event. One Regenerative Thermal Oxidizer (RTO) will be used to treat waste streams generated by Plant C and one low pressure flare will be used control any off-gases generated by Plant B. Figure 2-3A, Figure 2-3B, and Figure 2-3C depict process flow diagrams for each polyethylene plant.

Plant A will consist of four main sections associated with the following operations; purification, polymerization, purging and vent recovery, and extrusion and pelletizing. The purification section will include the use of one natural gas-fired heater, rated at 10 MMBtu/hr, in order to heat up the catalyst to an appropriate temperature. All pellets will be stored in storage silos before being transported offsite via rail or trucks.

Plant B will consist of four main sections associated with the following operations; purification, polymerization, purging and vent recovery, and extrusion and pelletizing. The polymerization section will be comprised of a series of compressors and pumps that will transfer raw ethylene and a comonomer catalyst to the polymerization reactor. After polymerization, the product streams will be sent to purging and vent recovery, to recover all excess

hydrocarbon streams. All purged gasses will be sent to the recovery system, where it will be eventually recycled back into the polymerization. All pellets will be stored in storage silos before being transported offsite via rail or trucks.

Plant C will consist of the following operational sections; compression, polymerization, separation, extrusion and pelletizing, pellet handling, and degassing. Ethylene is combined with the catalyst in the compression section before being sent to reactors for polymerization. The product stream is then sent to the separation section to recover excess hydrocarbon streams for recycle. The product stream then undergoes extrusion, pelletizing, and pellet handling before a final degassing section. All pellets will be stored in storage silos before being transported offsite via rail or trucks.

2.1.2.1 *Regenerative Thermal Oxidizer (RTO)*

One Regenerative Thermal Oxidizer (RTO) will be constructed to treat gas streams generated by Plant C operations. The RTO will destruct excess hydrocarbon gas emissions. The gas streams sent to the RTO will originate from Plant C's waste oil storage and extrusion section. The RTO will treat the streams through high temperature oxidation. A natural gas burner, with a maximum rating of 20 MMBtu/hr will be designed to supply the start-up heat and the heat necessary to sustain high enough temperatures for the oxidation chamber. After passing through the oxidation chamber, the purified air will be emitted through a stack to the atmosphere.

The RTO will be equipped with a Low NO_x Burner and at a minimum, will have a DRE of 99% for all VOC and organic HAP constituents.

2.1.2.2 *Polyethylene Plant Flares*

The three polyethylene plants will all be connected to the main flare for the entire facility in the event of any unplanned over pressuring event. A low pressure flare will be constructed to control any flammable gases generated from the Plant B storage silos. The low pressure flare will be designed with a natural gas pilot and a backup pilot, with a total heat input of 0.4 MMBtu/hr. The flare will have a 98% DRE for all gas streams sent to the flare for combustion.

2.1.2.3 *Material Handling Operations*

Particulate emissions can occur from material handling operations at any of the three polyethylene plants including, but not limited to, the following operations: extrusion, silo storage, additive feed, additive tanks, blending, and loading. Control of these emissions will be obtained through the use cyclones, baghouses, fabric filters or equivalent controls with an expected DRE greater than 99.9 percent or have an exhaust particulate concentration of less than 0.01 grain/scf. Best management practices for controlling particulate matter will be implemented.

Figure 2-3A PE Plant A Process Flow Diagram

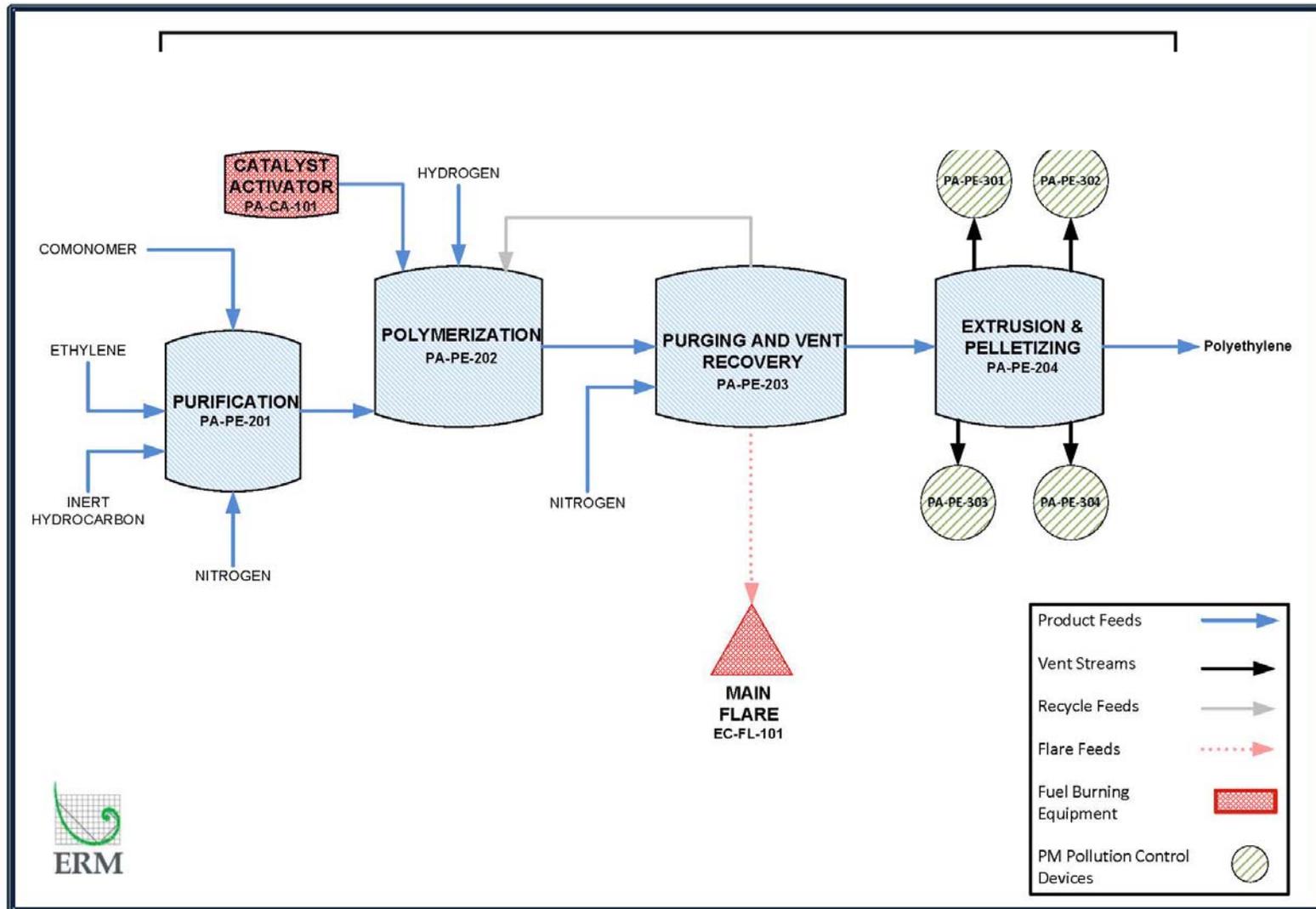


Figure 2-3B PE Plant B Process Flow Diagram

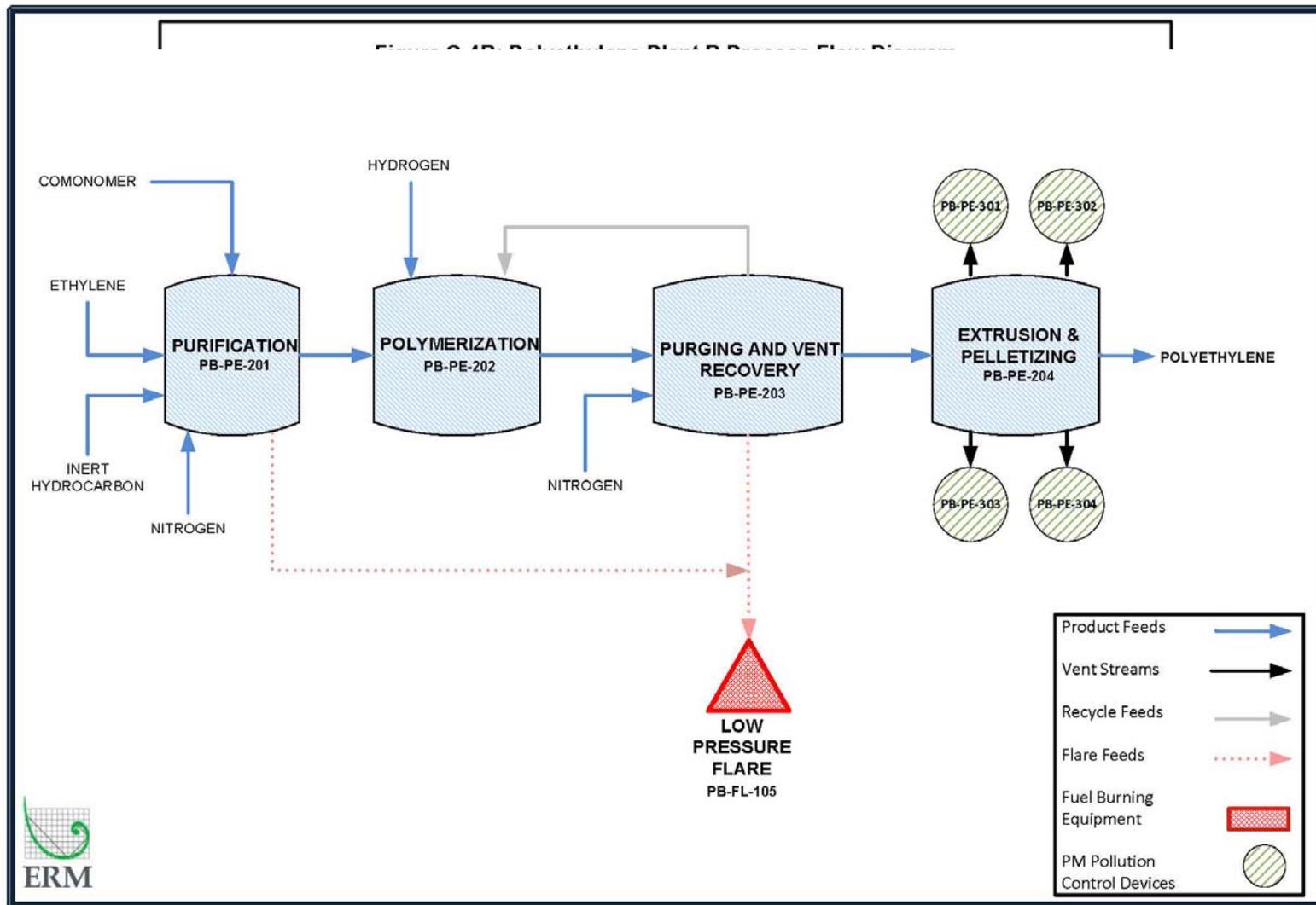
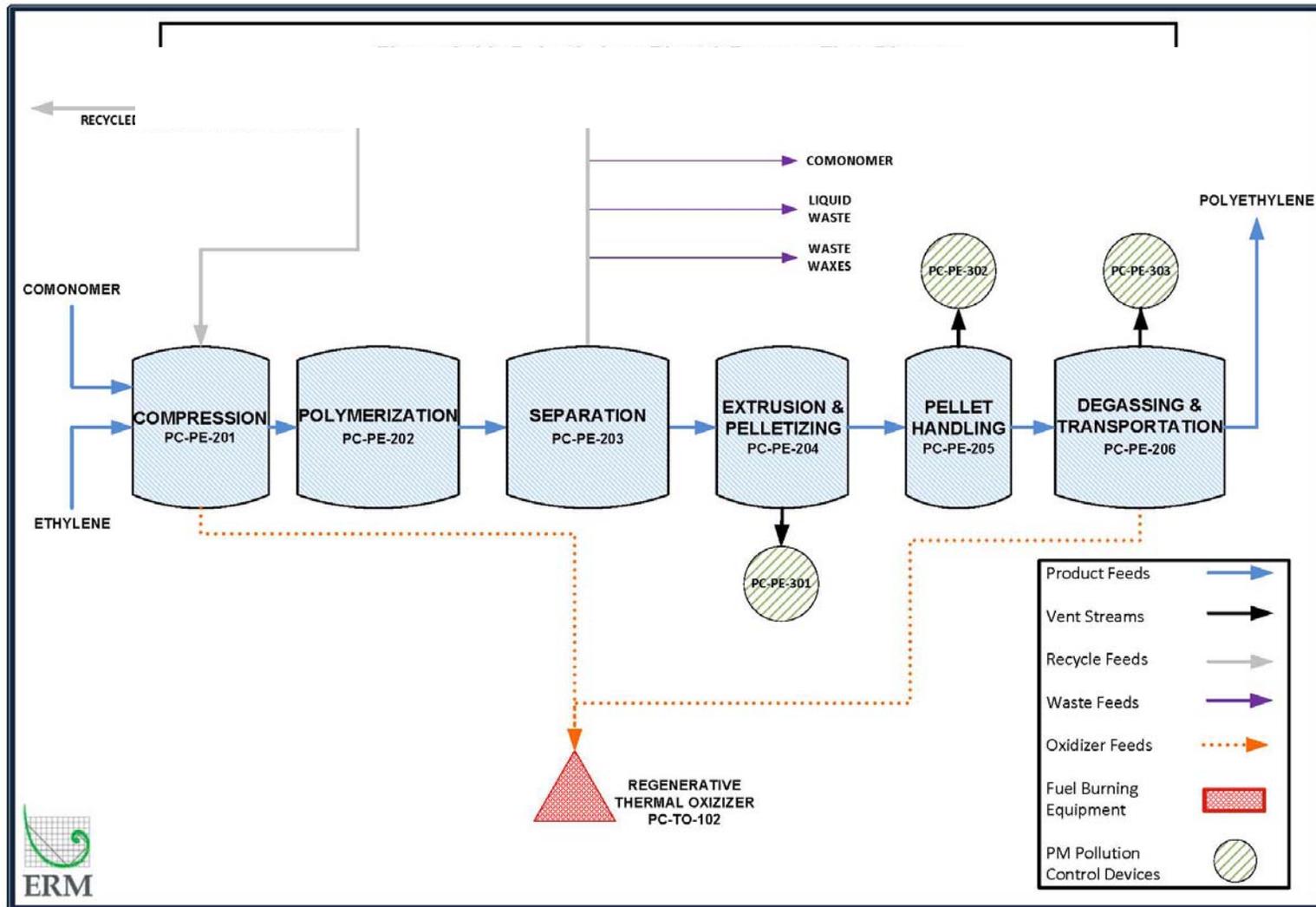


Figure 2-3C PE Plant C Process Flow Diagram



2.1.3 *Support Utilities*

2.1.3.1 *Power Generation*

The Project includes the construction and operation of one on site combustion turbine that will supply some or all of the necessary electricity for the facility. The plant will generate electricity by one natural gas fired GE 7EA combustion turbine, rated at 942.6 MMBtu/hr and an additional Heat Recovery Steam Generation (HRSG) unit, equipped with a steam turbine. An additional duct burner will be constructed for optional firing at a heat input of 346 MMBtu/hr. The HRSG unit will help recover heat from the combustion turbine exhaust gas and produce steam, which is sent to the steam turbine generator to produce additional electric power output.

The combustion turbine and the HRSG duct burner will share a common stack and will be equipped with a Selective Catalytic Reduction (SCR) system, at 80% control efficiency, to control all nitrogen oxide (NO_x) emissions. The combustion turbine will also incorporate a dry low-NO_x combustor into the final design. The SCR involves the injection of aqueous ammonia (NH₃) into the exhaust gas streams. The ammonia reacts with NO_x in the exhaust gas streams and reduces it to elemental nitrogen (N₂) and water vapor (H₂O). The aqueous ammonia will be stored on site in storage tanks. The aqueous ammonia storage tanks will not normally vent to the atmosphere. They will be equipped with pressure relief valves that will only vent to atmosphere in the event of an emergency. An oxidation catalyst will also be used to control carbon monoxide (CO) and volatile organic compounds (VOC) emissions from the combustion turbine and HRSG combined. The oxidation catalyst will have a CO DRE of at least 80%. The combustion turbine and HRSG are assumed to operate continuously (8,760 hr/yr).

2.1.3.2 *Auxiliary Boilers*

Two natural gas-fired auxiliary boilers, each with a 206 MMBtu/hr rating, will be constructed and operated continuously (8,760 hr/yr) to supply any additional heat needed for operations at the ASCENT facility. The auxiliary boilers will be equipped with Ultra Low NO_x Burners to control emissions.

2.1.3.3 *Storage Tanks*

The proposed facility will utilize a number of storage tanks for solid, liquid, and gaseous storage for process operations and material storage. The material stored in each tank will include, but not be limited to, caustic soda, sulfuric acid, 1-hexene, raw pyrolysis gas, ethane, propylene, inert hydrocarbons (e.g., isopentane), comonomers (e.g., vinyl acetate), diesel fuel, wastewater, ammonia, and compressor wash oil. A number of the storage tanks will be pressurized and will not have any associated emissions. All volatile organic liquids are controlled

by either the cold flare or warm flare with a 98% VOC DRE. Storage tanks containing volatile liquids with a maximum true vapor pressure at storage conditions greater than or equal to 76.6 kPa will be provided with a closed vent system and control devices.

2.1.3.4 *Cooling Tower*

A wet, mechanical draft Cooling Tower will be used. Make-up water is added to the Cooling Tower as necessary to account for water evaporation. High efficiency drift eliminators are used to control particulate matter (PM) emissions from the Cooling Tower, with a maximum drift rate of 0.0005% of the total circulation rate. The make-up cooling water for the Cooling Tower will come from the adjacent Ohio River. The Cooling Tower will operate continuously.

2.1.3.5 *Wastewater Treatment Plant*

The WWTP can be divided into three blocks: wastewater collection, effluent treatment plant (ETP), and waste reuse system and final discharge. All wastewater streams will be transferred by means of collection and lifting systems (effluent basins and pumping stations). All effluent pumps and equipment will be driven by electrical motors; therefore, they will be dependent on a continuous electricity supply.

The ETP will consist of the following main sections:

- Primary Treatment (De-Oiling and Chemical-Physical (CPI) Treatment);
- Secondary Treatment (Biological Treatment);
- Sludge Dewatering;
- Treated Water Reuse;
- Salt Concentration (Optional); and
- Sludge Drying.

The ETP is fed by seven separate influent streams: oily wastewater from the Cracker Plant, cooling water blow-down streams, pretreated spent caustic, flare hydraulic seal from outside battery limits, wastewater from warehouse and workshop facility, sanitary sewage, and oily rain water. The CPI receives all wastewater influent streams except the sanitary sewage. Oily water influents are first collected in an open sump before transfer to the CPI. During peak flows or rain events, excess flows are diverted to the oily water storage tanks where

cooling water blow-down is also stored. The oily water storage tanks aid in flow equalization to prevent surge through the CPI.

Once oil is separated from the water in the CPI, skimmed oil is collected for disposal, sludge is sent to the sludge drying unit, and wastewater is routed to the dissolved air flotation (DAF). A coagulant is added in a mixing zone at the start of the DAF unit to promote solids removal. Sludge collected from the DAF is skimmed and sent to the sludge drying unit. Wastewater from the DAF is sent to an equalization tank prior to entering biological treatment. Sanitary sewage is introduced at the biological treatment system. A two-stage biological treatment system is utilized, aerated biological treatment and membrane biological reactor (MBR). Sludge from the MBR is sent to the sludge drying unit. The final treated effluent from the MBR is discharged to the river.

2.1.3.6 *Emergency Generators*

The proposed facility will include the use up to nine (9) emergency generators to act as a backup energy supply. There will be seven (7) generators rated at 2800 kW and two (2) generators rated at 350 kW. The Ethane Cracker Plant and each polyethylene plant will have one dedicated 2800 kW emergency generator. The other 2800 kW emergency generators are meant to support the combustion turbine, boilers, and wastewater treatment plant. All nine generators are fired on Ultra Low Sulfur Diesel (ULSD) fuel with a maximum sulfur content of 15 ppm. The smaller 350 kW generators will act as a backup power supply for utility operations such as product storage and the cooling water area.

The emergency generators will only be used for unplanned emergencies or power curtailment and will be limited to 100 hours of non-emergency use for maintenance and testing.

2.1.3.7 *Fire Water Pump Engines*

The proposed facility will include three (3) emergency Fire Water Pump engines associated with the planned fire water suppression system. The emergency engines will have a maximum rating of 485 kW and will burn ULSD. The engines will be limited to 100 hours of non-emergency use (e.g., maintenance and testing).

2.1.3.8 *Loading Racks*

Bulk loading racks will be used for the loading and unloading of all material for the proposed facility. The loading racks will control VOC and HAPS emissions using the cold flare or warm flare depending on the type of liquid transfer. Cold and warm liquid storage will be managed via separate loading/unloading racks.

2.2

PROJECT EMISSIONS

The following sections provide a summary of the Project emissions sources. The emissions described below are based on projections of plant operation as reflected in the permit application, and are subject to revision prior to the submittal of a modeling report.

Emission Rates and Stack Parameters

Project emissions, or inputs required to calculate emissions, have been provided by the Project and are based on projected operating parameters and equipment manufacturer information.

Source parameters used in the modeling are based on equipment manufacturer information and data provided by the Project. The primary emission-generating equipment includes six pyrolysis furnaces (including one back-up furnace), combustion turbines, two auxiliary boilers, internal combustion engines for essential and emergency power, fire water pumps, cooling tower and flares. All of these emissions sources, except for the flares, are vented through a stack. For modeling purposes, all stacks are assumed to have a vertical orientation and are unobstructed (e.g. no rain caps).

Emissions Estimates

The Project has provided calculated projected maximum hourly and annual emissions from the proposed project activities. The emissions were prepared for each of the following sources: six pyrolysis furnaces (including one back-up furnace), combustion turbines, two auxiliary boilers, internal combustion engines for essential and emergency power, fire water pumps, cooling tower and flares. The emissions associated with these sources were then assigned to specific stacks for input into the model.

Maximum hourly emissions reflect each source operating at full capacity. For most sources continuous operation was assumed, i.e. 8760 hours per year. The maximum hourly emissions will be then used in the model to predict maximum concentrations for comparison to short-term (up to 24 hours) and annual average air quality guidelines and standards.

Emission rates and stack parameters for normal operations, continuous sources (for short-term and long-term modeling), are presented in Table 2-1 in model units. Emission rates and stack parameters are also presented in Table 2-2 in English units.

Table 2-1 Stack Parameters and Emission Rates in Model Units

UTM Easting	UTM Northing	Unit ID	Source Name	Stack Height	Exit Gas Temp.	Exit Velocity	Stack Diameter	NOx	SO2	CO	PM10	PM2.5
m	m			m	K	m/s	m	g/s	g/s	g/s	g/s	g/s
Stacks												
440750.1	4345811.2	EC_PF_101	Cracker Furnace#1	65.0	405.15	12.39	2.23	3.000	0.057	0.615	0.500	0.500
440739.5	4345795.3	EC_PF_102	Cracker Furnace#2	65.0	405.15	12.39	2.23	3.000	0.057	0.615	0.500	0.500
440729.6	4345778.2	EC_PF_103	Cracker Furnace#3	65.0	405.15	12.39	2.23	3.000	0.057	0.615	0.500	0.500
440719.1	4345759.8	EC_PF_104	Cracker Furnace#4	65.0	405.15	12.39	2.23	3.000	0.057	0.615	0.500	0.500
440709.2	4345745.3	EC_PF_105	Cracker Furnace#5	65.0	405.15	12.39	2.23	3.000	0.057	0.615	0.500	0.500
440698.0	4345730.1	EC_PF_106	Cracker Furnace#6	65.0	405.15	12.39	2.23	0.900	0.017	0.184	0.150	0.150
440881.3	4345344.0	SU_CT_101	Cooling Tower	18.3	310.93	11.26	9.8	n/a	n/a	n/a	0.133	0.00353
440704.7	4345519.3	SU_GT_101/102	GE 7EA Gas Turbine	65.0	375.93	58.77	2.70	0.808	0.026	0.808	0.325	0.325
440730.3	4345500.1	SU_AB_101	Aux Boiler #1	65.0	432.04	11.00	2.70	0.519	0.015	0.908	0.052	0.052
440763.3	4345479.0	SU_AB_102	Aux Boiler #2	65.0	432.04	11.00	2.70	0.519	0.015	0.908	0.052	0.052
441123.0	4345011.4	EC_TO_101	Thermal Oxidizer Burner	50.0	623.15	10.00	3.20	0.655	0.010	0.655	0.122	0.122
441203.6	4345358.5	PC_TO_102	RTO Burner	50.0	623.15	10.00	3.20	0.101	0.001	0.208	0.019	0.019
441254.4	4345318.9	PA_CA_101	Catalyst Activator	50.0	623.15	10.00	3.20	0.007	0.000	0.038	0.002	0.002
Flares (Normal Operations)												
441127.7	4346459.0	EC_FL_101	Main Flare Pilot	100.0	1273.00	20.00	0.16	3.43E-03	2.96E-05	1.84E-02	9.58E-04	9.58E-04
440952.4	4346182.2	EC_FL_102	Ethylene Storage Flare Pilot	33.0	1273.00	20.00	0.11	3.43E-03	2.96E-05	1.84E-02	9.58E-04	9.58E-04
440953.7	4346154.5	EC_FL_103	Cracker Storage Flare Pilot	33.0	1273.00	20.00	0.11	1.71E-03	1.48E-05	9.22E-03	4.79E-04	4.79E-04
441098.7	4346506.4	EC_FL_104	Oxygen Flare	33.0	1273.00	20.00	0.08	3.43E-03	2.96E-05	1.84E-02	9.58E-04	9.58E-04
441127.7	4346487.9	PB_FL_105	Low Pressure Flare Pilot	100.0	1273.00	20.00	0.11	6.17E-02	7.41E-04	1.04E-01	9.39E-03	9.39E-03

Table 2-2 Stack Parameters and Emission Rates in English Units

UTM Easting mt	UTM Northing mt	Unit ID	Source Name	Stack Height ft	Exit Gas Temp. F	Exit Flow acfm	Stack Diameter ft	NOx lbs/hr	SO2 lbs/hr	CO lbs/hr	PM10 lbs/hr	PM2.5 lbs/hr
Stacks												
440750.1	4345811.2	EC_PF_101	Cracker Furnace#1	213.3	269.60	102,040	7.30	23.808	0.455	4.881	3.9680	3.9680
440739.5	4345795.3	EC_PF_102	Cracker Furnace#2	213.3	269.60	102,040	7.30	23.808	0.455	4.881	3.9680	3.9680
440729.6	4345778.2	EC_PF_103	Cracker Furnace#3	213.3	269.60	102,040	7.30	23.808	0.455	4.881	3.9680	3.9680
440719.1	4345759.8	EC_PF_104	Cracker Furnace#4	213.3	269.60	102,040	7.30	23.808	0.455	4.881	3.9680	3.9680
440709.2	4345745.3	EC_PF_105	Cracker Furnace#5	213.3	269.60	102,040	7.30	23.808	0.455	4.881	3.9680	3.9680
440698.0	4345730.1	EC_PF_106	Cracker Furnace#6	213.3	269.60	102,040	7.30	7.142	0.137	1.464	1.1904	1.1904
440881.3	4345344.0	SU_CT_101	Cooling Tower	60.0	100.00	1,782,789	32.00	n/a	n/a	n/a	1.0588	0.0280
440704.7	4345519.3	SU_GT_101/102	GE 7EA Gas Turbine	213.3	217.00	713,040	8.86	6.4140	0.2035	6.4140	2.5780	2.5780
440730.3	4345500.1	SU_AB_101	Aux Boiler #1	213.3	318.00	133,449	8.86	4.1200	0.1212	7.2100	0.4120	0.4120
440763.3	4345479.0	SU_AB_102	Aux Boiler #2	213.3	318.00	133,449	8.86	4.1200	0.1212	7.2100	0.4120	0.4120
441123.0	4345011.4	EC_TO_101	Thermal Oxidizer Burner	164.0	662.00	170,410	10.50	5.2000	0.0765	5.2000	0.9686	0.9686
441203.6	4345358.5	PC_TO_102	RTO Burner	164.0	662.00	170,410	10.50	0.8000	0.0118	1.6471	0.1490	0.1490
441254.4	4345318.9	PA_CA_101	Catalyst Activator	164.0	662.00	170,410	10.50	0.0558	0.0005	0.3001	0.0156	0.0156
Flares (Normal Operations)												
441127.7	4346459.0	EC_FL_101	Main Flare Pilot	328.1	1831.73	n/a	0.52	2.72E-02	2.35E-04	1.46E-01	7.60E-03	7.60E-03
440952.4	4346182.2	EC_FL_102	Ethylene Storage Flare Pilot	108.3	1831.73	n/a	0.36	2.72E-02	2.35E-04	1.46E-01	7.60E-03	7.60E-03
440953.7	4346154.5	EC_FL_103	Cracker Storage Flare Pilot	108.3	1831.73	n/a	0.36	1.36E-02	1.18E-04	7.32E-02	3.80E-03	3.80E-03
441098.7	4346506.4	EC_FL_104	Oxygen Flare	108.3	1831.73	n/a	0.26	2.72E-02	2.35E-04	1.46E-01	7.60E-03	7.60E-03
441127.7	4346487.9	PB_FL_105	Low Pressure Flare Pilot	328.1	1831.73	n/a	0.36	4.90E-01	5.88E-03	8.24E-01	7.45E-02	7.45E-02

Table 2-3 Calculation of Effective Stack Diameter for Flares

Description	Model i.d.	Total heat release	Total heat release	Sensible heat release	Effective stack diameter
		MMBtu/hr	cal/sec	cal/sec	m
Main Flare Pilot	EC_FL_101	0.82	5.74E+04	2.58E+04	0.159
Ethylene Storage Flare Pilot	EC_FL_102	0.40	2.80E+04	1.26E+04	0.111
Cracker Storage Flare Pilot	EC_FL_103	0.40	2.80E+04	1.26E+04	0.111
Oxygen Flare	EC_FL_104	0.20	1.40E+04	6.30E+03	0.078
Low Pressure Flare Pilot	PB_FL_105	0.40	2.80E+04	1.26E+04	0.111

The exhaust parameters for the flares were developed based on a methodology used in both the SCREEN3 and AERSCREEN user’s guides. Using this methodology is necessary since flares cannot be characterized as point sources with a fixed diameter, exit velocity, and exhaust temperature. AERMOD is not capable of modeling the unique characteristics of flares directly, thus flares must be modeled as “pseudo stacks” with exhaust parameters adjusted to match the buoyancy inherent in the hot flare plume. The methodology involves setting the exhaust temperature and exit velocity to 1273K and 20 m/s, respectively. An effective diameter is then calculated which, when used in AERMOD with the exhaust temperature and velocity indicated, results in the correct buoyancy flux. The calculations starts with the total heat released by the flare (the heat contained in the flare gas), then calculates the sensible heat release (Hs, the heat not lost to

radiation) as 45% of the total heat release. The effective diameter (D_e) is then calculated by the following formula:

$$D_e = 9.88E-4 \times H_s^{0.5}$$

USEPA guidance addresses intermittent operations such as emergency generators. For emergency units, the Project will exclude these emissions from the modeling for NO_2 1-hour averages, but will include them for other averaging periods and other pollutants. Excluding these units from the modeling analysis accounts for the fact that brief periods of emissions from these units could occur at any time during the year, but the emissions would be unlikely to significantly contribute to the probabilistic form of the 1-hr standards. This approach is consistent with EPA guidance on intermittent sources. A number of smaller sources controlled by baghouses associated with materials handling for the PE plants will be configured and included in the modeling for PM_{10} and $PM_{2.5}$.

2.3 BUILDING WAKE EFFECTS

The USEPA's Building Profile Input Program (BPIP), Version 04274, will be used to calculate downwash effects for the modeled emission sources. Building, structure, and tank configurations and locations relative to the modeled sources will be obtained from the Project. The construction of the stacks will not exceed the greater of the GEP formula height calculated by BPIP or 65 m (213 feet). A preliminary plot plan is included in Appendix B of this protocol.

3.0 MODELING METHODOLOGY

3.1 MODEL SELECTION AND APPLICATION

The latest version of USEPA's AERMOD model (version 13350) will be used for predicting ambient impacts for each modeled compound. Regulatory default options will be used in the analysis. The highest predicted impacts (H1H) will be used as the design concentrations in the SIL analyses described in this protocol; for 1-hour averages, an average over five years will be used. The design concentrations for the NAAQS and PSD increment modeling analyses, if necessary, will follow the form of the NAAQS or PSD increment for each applicable compound and averaging time.

3.2 AMBIENT AIR QUALITY STANDARDS

Table 3-1 presents a summary of the air quality standards that will be addressed for NO_2 , PM_{10} , $PM_{2.5}$, and CO. The SILs are presented, along with the SMCs, PSD increments, and NAAQS. If Project impacts are shown to be less than the SILs and SMCs, then no further analysis is required. If the SILs are exceeded, additional analysis will be necessary including the development of a background source inventory and background measured concentrations. It should be noted

that the 1-hr SIL for NO₂ is an interim SIL based on USEPA guidance, and has been adopted by WVDEP based on WVDEP's concurrence with USEPA that modeled concentrations less than the 1-hr SIL for NO₂ represent a de minimis level of concentration and would not be expected to contribute to violations of the 1-hr NO₂ NAAQS.

Table 3-1 Ambient Air Quality Standards

	Averaging Period	SIL	SMC	PSD Increment	NAAQS
NO ₂	1 Hour	7.5	-	-	188
	Annual	1	14	25	100
PM ₁₀	24 Hour	5	10	30	150
	Annual	1	-	17	-
PM _{2.5}	24 Hour	1.2	-	9	35
	Annual	0.3	-	4	12
CO	1 Hour	2000	-	-	40,000
	8 Hour	500	575	-	10,000

NOTE: All concentrations are shown in micrograms/cubic meter ($\mu\text{g}/\text{m}^3$)

The NAAQS for ozone (8-hour average) is 75 ppb. Ozone is a pollutant that is not emitted directly from sources but is formed in the atmosphere due to photochemical reactions involving precursors that include NO_x and VOCs. NO_x and VOCs will be emitted by the proposed facility; Section 3.10 of this protocol describes the approach for evaluating the effect of project emissions on the NAAQS for ozone.

3.3 *PM_{2.5} CONSIDERATIONS*

In January 2013, the Significant Monitoring Concentrations (SMCs) for PM_{2.5} were vacated by the DC Circuit Court. The SMCs are concentrations that are used to determine if a project subject to PSD regulations needs to determine existing ambient air quality levels at the site, possibly including preconstruction ambient monitoring. Preconstruction monitoring may be required when a project's modeled impacts exceed the SMCs and the existing air quality monitoring network in the region is inadequate to characterize existing air quality. The Ascent project is located less than 13 km WSW of an existing ambient monitor that measures PM_{2.5}. This monitor, Neale Elementary School, Vienna (ID 54-107-1002) has been collecting PM_{2.5} data since 1999. The Project believes that this monitor is representative of the air quality of the project site, due to the very close proximity to the proposed project location. Therefore, preconstruction monitoring should not be required for the Project, due to existing representative PM_{2.5} ambient air quality data.

In addition to the SMC vacature in January 2013, USEPA also remanded the Significant Impact Level (SIL) for PM_{2.5}. USEPA intends to revise the approach to how the SIL is implemented. In the interim, widely accepted practice for PSD permitting is to continue to use the PM_{2.5} SILs as benchmarks to determine a project's de-minimis standing with respect to the PM_{2.5} NAAQS, but also to ensure that a project's modeled impacts do not exceed the NAAQS (despite being less than the SIL) when added to an existing representative background value of PM_{2.5}. The Project intends to employ this practice as part of the air quality modeling analysis, specifically, that the project's modeled concentrations of directly emitted PM_{2.5} are both less than the levels of the SIL, but also less than the NAAQS when added to a representative background PM_{2.5} concentration, obtained from the PM_{2.5} monitor in Vienna, WV.

3.3.1 *Representative Background Concentrations of PM_{2.5}*

Table 3-2 presents the current design values for the Vienna PM_{2.5} monitor. Wood County was recently (September 30, 2013) designated as an attainment area for the 1997 annual NAAQS for PM_{2.5} of 15 µg/m³. The annual NAAQS for PM_{2.5} was lowered from to 12 µg/m³ in 2012. West Virginia is required to submit initial designations (attainment or nonattainment) with the 2012 NAAQS to EPA by December 31, 2013; EPA is required to finalize these designations by December 31, 2014.

Table 3-2 *Vienna PM_{2.5} Monitor Design Values*

Monitor	2011-2013 24-hr Design Value (µg/m³)	2011-2013 Annual Design Value (µg/m³)
Vienna (54-107-1002)	22	10.4

It should be noted that the annual design value is below the 2012 annual PM_{2.5} NAAQS of 12 µg/m³. The Project anticipates that the maximum modeled concentrations of PM_{2.5} due to the proposed sources may exceed the SILs for both the 24-hr and annual averaging periods, but that the Project's maximum modeled concentration at any receptor, added to the design value and incorporating impacts from other regional sources, will be less than the NAAQS for both the annual and 24-hour averaging periods. This approach ensures that the modeled concentrations will be protective of the NAAQS. If the Project is able to demonstrate compliance with the SILs, the measured design values provide sufficient room for a demonstration of NAAQS compliance in lieu of cumulative modeling for PM_{2.5}.

3.3.2 *Secondary Formation of PM_{2.5}*

Recent USEPA guidance for PM_{2.5} permit modeling (USEPA 2013a) calls for PSD applications to address the potential for secondary formation of PM_{2.5} due to emissions of PM_{2.5} precursors, namely NO_x and SO₂. Since the emissions of

direct PM_{2.5} emissions from the Project are greater than the SER, these emissions will be explicitly modeled as described in Section 3.3.1. The emissions from the proposed project are also greater than the SER for NO_x. The USEPA guidance suggests that a qualitative or hybrid qualitative/quantitative approach should be sufficient to address how the Project's emissions of NO_x may impact secondary formation of PM_{2.5}.

It is reasonable to assume that the maximum modeled direct PM_{2.5} concentrations are unlikely to occur where secondary PM_{2.5} impacts due to Project emissions would theoretically occur. The emissions of NO_x from the Project would require some time in the atmosphere to form particulate nitrate, and this is unlikely to occur close to the Project where the maximum direct PM_{2.5} impacts are expected to occur. Therefore, this analysis does not focus on deriving a theoretical maximum possible secondary PM_{2.5} value and adding that to a maximum modeled direct PM_{2.5} concentration, as that would grossly overstate the overall impact of the proposed facility for PM_{2.5}. Instead, in the rest of this section the Project discusses the role that nitrate plays in the total formation of PM_{2.5} in the region, and also discusses how regional emissions of NO_x have historically been predicted to have an insignificant effect on monitored or modeled values of PM_{2.5}.

The PM_{2.5} species that account for the total mass of PM_{2.5} typically measured at the monitors in West Virginia are heavily biased towards sulfate and organic carbon aerosols. The 2005 WVDEP air quality report (WVDEP 2005) shows that 31-39% of the PM_{2.5} speciation mass at West Virginia monitors that record speciated data is sulfate; 21-26% is organic carbon, and nitrate is only 4-6%. Similarly, the 2008 WVDEP air quality report (WVDEP 2008) shows that the PM_{2.5} speciation mass is 31-34 % sulfate, 17-27% organic carbon, and 4-6% nitrate. The remaining PM_{2.5} speciation mass is comprised of ammonium, crustal material, elemental carbon, and other aerosols. These speciation summaries compiled by WVDEP illustrate that nitrate does not play a significant role in ambient levels of PM_{2.5} in the region.

The recent redesignation request and maintenance plan published by WVDEP (WVDEP 2012) for the redesignation of the West Virginia portion of the Wheeling PM_{2.5} nonattainment area contains a summary of NO_x emissions from Marshall County for the years 2005 and 2008. The total emissions of NO_x from all sources in Marshall County in 2005 were 36,375 tons. The total NO_x emissions in 2008 were 23,269 tons. The decrease in NO_x emissions from 2005 to 2008 was 9,335 tons. The PM_{2.5} annual monitored concentration at the Moundsville, West Virginia monitor for 2005 was 16.2 ug/m³ and for 2008 was 13.1 ug/m³. The difference between these two values is 3.1 ug/m³. It should be noted that in addition to the decrease in NO_x between 2005 and 2008, SO₂ emissions also dramatically decreased in Marshall County, from 115,641 tons in 2005 to 51,658 tons in 2008. Since sulfate plays a much more dominant role in the formation of PM_{2.5} in the region, it follows that the decrease in SO₂ was much more responsible for the noted decrease in PM_{2.5} at the Moundsville monitor. Based on the nitrate contribution to PM_{2.5} of 6% for the 2005 and 2008 annual

concentrations, as presented in the WVDEP 2005 and 2008 air quality reports, the decrease in nitrate concentration (as a portion of the 3.1 ug/m³ decrease) was 0.19 ug/m³. If the ratio of the proposed project's NO_x emissions to the noted NO_x emissions decrease from 2005 to 2008 is calculated and applied to the PM_{2.5} nitrate concentration reduction, a theoretical maximum concentration due to secondary formation from the proposed project can be estimated.

$$(683 \text{ tons}) / (9,335 \text{ tons}) \times 0.19 \text{ } \mu\text{g} / \text{m}^3 = 0.013 \text{ } \mu\text{g} / \text{m}^3$$

The PM_{2.5} concentration calculated here is 4.6% of the annual PM_{2.5} SIL of 0.3 ug/m³. Even though this analysis was conducted for a monitor in a different county, the Project believes that it is applicable regionally and therefore applicable to the Parkersburg area, and that the analysis serves to illustrate that the proposed increase of NO_x associated with the Project is not expected to cause significant formation of secondary PM_{2.5} in the region. This conclusion was reached based on the qualitative assessment that nitrate plays a minor role in the total PM_{2.5} speciation mass for this region, and the semi quantitative assessment that considers the magnitude of the proposed project's emissions in relation to known emissions decreases of regional NO_x emissions and subsequent decreases in monitored PM_{2.5} values.

The conclusion that secondary formation of PM_{2.5} due to the Project will be insignificant can be further supported by reviewing regional scale modeling analyses conducted to support states in their various SIP responsibilities. A report produced by Environ (ENVIRON 2008) that included West Virginia suggests that the nitrate component of modeled PM_{2.5} concentrations is generally insensitive to modeled NO_x decreases in this region. Model results for monitors in West Virginia on page 4-42 of the Environ report suggest that the modeled nitrate component is relatively steady across various emissions scenarios, despite appreciable decreases (tens of thousands of tons statewide) of NO_x emissions in the model inputs. For reference, the modeled emissions used in the analysis described in the Environ report can be found on page 2-36.

The WV 1997 PM_{2.5} SIP for Charleston (WVDEP 2009) also contained regional air quality modeling results that support the conclusion that NO_x emissions play a minor role in PM_{2.5} formation in the region. The modeling analysis described in this document considered a 30% emissions decrease from regional NO_x sources. Page B-20 of Appendix B of this document notes that "The model projects very little benefit of reducing emissions of nitrogen oxides from either ground or point sources in West Virginia." Page B-27 of this document displays model reductions in PM_{2.5} at the Wood County PM_{2.5} monitor. This graphical presentation illustrates that WV NO_x point sources account for a negligible amount of PM_{2.5} reduction, despite the appreciable emissions reduction assumed in the SIP modeling. The Project believes that the various parts of this analysis, taken together, offer conclusive evidence that NO_x emissions from the proposed project will not cause significant formation of PM_{2.5} in the region, which satisfies USEPA's requirements to address secondary PM_{2.5} formation due to NO_x emissions increases.

3.4 *NO_x TO NO₂ CONVERSION*

The Project proposes to make use of the USEPA Tier II assumption to account for the formation of NO₂ from the emissions of NO_x from the Project sources as a conservative first step. USEPA's recommendation is to apply an 80% conversion assumption to modeled concentrations of NO_x to estimate NO₂ concentrations on a 1-hr average basis, and to apply a 75% conversion assumption to concentrations of NO_x on an annual average basis. The Project will use these recommended conversion factors for the modeled 1-hr and annual NO₂ concentrations.

If the Tier II assumptions prove to be overly conservative, the Project proposes to employ the Tier III NO₂ modeling assumption, either the Ozone Limiting Method (OLM) or the Plume Volume Molar Ratio Method (PVMRM) to account for the formation of NO₂ from NO_x. Alternatively, with approval of WVDEP, the new ARM2 method in AERMOD might be used to estimate NO to NO₂ conversion. A modeling protocol for the optional Tier III modeling assumptions is included in Appendix C of this protocol.

3.5 *GEOGRAPHIC SETTING*

3.5.1 *Land Use Characteristics*

The proposed facility will be located in a predominately rural setting along the Ohio River. Therefore, AERMOD will be used in the default (rural) mode. The Project has analyzed the land use classifications within an area defined by a 3 km radius from the approximate center of the site, and has determined that the land use within this area is approximately 5% urban classification. This determination was used by analyzing the USGS NLCD 1992 data, where urban classifications were assumed to be category 21 (high intensity residential) and category 23 (commercial/industrial/transportation). A graphical representation of this land use analysis will be provided in the modeling report to WVDEP.

3.5.2 *Terrain*

The terrain in the vicinity of the proposed facility is characterized by a river valley surround by elevated terrain. Terrain elevations and hill scales will be determined for use in this analysis. The latest version of USEPA's AERMAP program (version 11103) will be used to determine the ground elevation and hill scale for each receptor, based on data obtained from the USGS National Elevation Database (NED). The NED files accessed to provide elevations have a horizontal resolution of 10 meters.

3.5.3 *Effects on Growth, Soils, Vegetation, and Visibility*

PSD requirements include an evaluation of the effects of growth due to a project, and an evaluation of the effects of project emissions on soils, vegetation, and

visibility. The Project will perform this review as part of the modeling report. The impacts of the Project on growth will not be significant. The Project further anticipates that the impacts of all criteria pollutants will be below the SILs or NAAQs, and that consequently impacts on soils, vegetation, and visibility will be minimal. It should be noted that the Project emissions units will comply with the applicable West Virginia visible emissions regulations.

3.6 *RECEPTOR GRIDS*

For this modeling analysis, a total of five (5) separate receptor grids will be combined to create an overall grid pattern:

- 50-meter spacing along the fence line and extending to 1km from the facility;
- 100-meter spacing from 1km to 2.5 km from the facility;
- 250-meter spacing from 2.5km to 5km from the facility;
- 500-meter spacing from 5km to 10km from the facility; and
- 1000-meter spacing from 10km to 25km from the facility;

As noted previously, AERMAP will be used to define ground elevations and hill scales for each receptor. The Project will analyze isopleths of modeled concentrations due to the proposed project, and determine if the proposed receptor grid adequately accounts for the worst case impacts. For example, if it is determined that the concentration gradient is not decreasing at the edge of the proposed grid, the grid will be expanded to ensure that the gradient is decreasing at the edge of the grid.

3.7 *METEOROLOGY*

USEPA policies on air quality modeling recommend the use of five consecutive years of representative meteorological data. The meteorological data will be processed using the meteorological pre-processor AERMET (version 13350). Five years of meteorological data (2009-2013) from the Mid-Ohio Valley Regional Airport (WBAN: 03804; also called Wood County Airport) will be used to provide the surface data; upper air data from the Pittsburgh, PA will be used to provide the required morning sounding. AERMET is the recommended processor for developing inputs to AERMOD. AERMET requires, at a minimum, hourly surface data and once-daily upper air sounding profiles. The AERMINUTE utility was also applied as appropriate for these data as part of the AERMET analysis, and included a 1-minute ASOS threshold wind speed of 0.5 m/s.

The processing program produces two files for input to AERMOD: 1) a surface file containing calculated micrometeorological variables (heat flux, stability, and turbulence parameters) that represent the dispersive potential of the atmosphere, and 2) a file that provides vertical profiles of wind speed, wind direction, and temperature. In the case of meteorological data files developed from National

Weather Service data, the profiles contain only one level (the surface level) and a meteorological interface within AERMOD generates profiles of wind, temperature, and turbulence from the input data files.

Both EPA and WVDEP guidelines for determining meteorological inputs to AERMOD require that the user evaluate data representativeness for the project site being modeled. This representativeness is a function of land use and terrain near the measurement site (Mid-Ohio Valley Regional Airport) compared to land use and terrain in the vicinity of the project site. Differences are expected between airport land use and land use surrounding almost any application site, and frequently there are differences in terrain between measurement and application sites. Neither EPA nor WVDEP have established quantitative criteria for assessing whether differences are significant; therefore, this comparison is made based on a qualitative assessment and consideration of the importance of the land use and terrain differences to the analysis. An additional comparison is made between the calculated roughness length using AERSURFACE for both the project site and airport locations. The micrometeorological variables will be derived for the location of the Airport.

Figure 3-1 Land use Characteristics surrounding Project Site and Airport

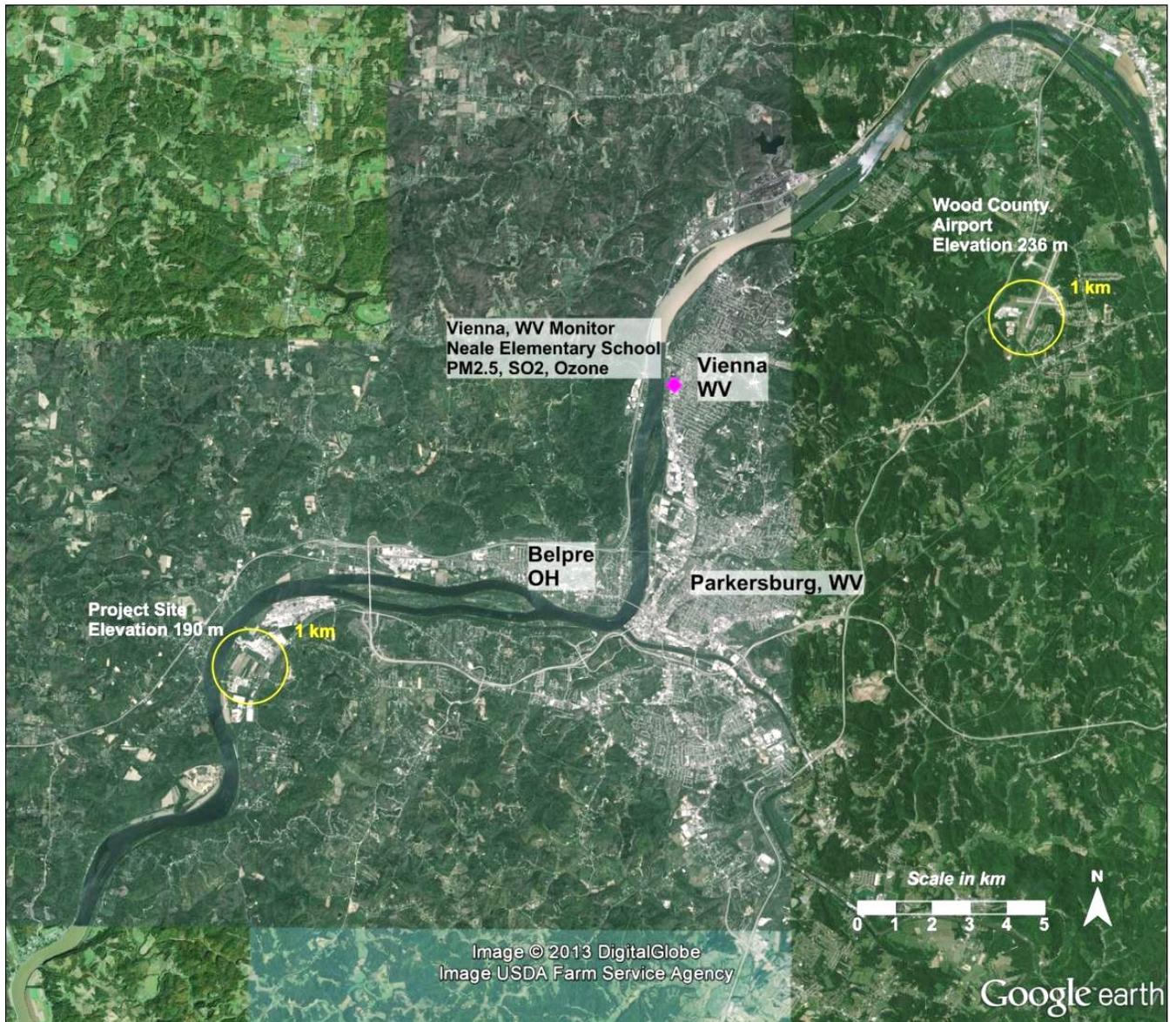


Figure 3-1 was reviewed to qualitatively assess land use in the vicinity (within a radius of approximately 3 km) of the project site and the airport, respectively. The single most important land use characteristic for input to AERMET is the roughness length, z_0 , a measure of the degree to which obstructions to the wind flow (e.g., buildings and trees) contribute to the formation of turbulence and to the vertical profile of wind speed. Turbulence calculations in AERMOD are based on the surface parameters estimated by AERMET (friction velocity and Monin-Obukhov length¹) and z_0 . Generally, larger values of z_0 (associated with roughness elements such as trees and buildings) result in larger values of turbulence and lower concentration estimates for low-level sources, including short stacks. Conversely, smaller values of z_0 (associated with fewer roughness

¹ The Monin-Obukhov length scale is a parameter calculated by AERMET that reflects the stability of the atmosphere.

elements) yield smaller turbulence estimates and consequently higher concentrations for low-level sources and short stacks. A review of Figure 3-1 indicate that while there are more roughness elements within 3 km of the project site than surrounding the airport, there are a similar number of roughness elements within 1 km of both the airport and the project site.

AERSURFACE uses a 1km radius to assess surface roughness. For comparison purpose, AERSURFACE program was used to calculate z_0 for the project site and the Mid-Ohio Valley Regional Airport, without directional or seasonal variations. Table 3-3 presents the input and output of albedo, Bowen ratio, and surface roughness for both the airport and the Project site. The values of albedo and Bowen ratio are identical between the two sites. However, the values of surface roughness do show some variation between the sites. This analysis resulted in a roughness length of 0.154 m for the project site and 0.210 m for the airport. This is due largely to the location of the project site nearly adjacent to the edge of the Ohio River. The airport estimate is likely low because AERSURFACE treats “developed” land use as flat to account for runways. Some of the developed land within 1 km of the airport is associated with buildings and structures that would increase the estimate of z_0 . Therefore the ranges of surface roughness values between the two sites are similar.

Table 3-3 *AERSURFACE Inputs and Results*

Postal Code	WV	WV
Output File	ASC_LU.INP	PKB_LU.INP
Coordinate Type	LATLON	LATLON
Latitude	39.2567	39.3394
Longitude	-81.6816	-81.4437
Datum	NAD83	NAD83
Study Radius for Surface Roughness (km)	1	1
Sector Variation	None	None
# of Sectors	1	1
Temporal resolution	Annual	Annual
Continuous Winter Snow Cover	No	No
Re-assign Seasonal Months	No	No
Airport	Non-Airport	Airport
Arid Region	Non-Arid	Non-Arid
Surface Moisture	Average	Average
Albedo (%)	0.16	0.16
Bowen Ratio	0.5	0.65
Roughness Height (m)	0.154	0.21

Although there are differences in land use and terrain between the measurement site (Mid-Ohio Valley Regional Airport) and the permit application site, for purposes of the modeling analysis it has been assumed that the land use characteristics within 1 km of each site are similar, in particular z_0 , for input to AERMET. The Project concludes that the met data from Mid-Ohio Valley Regional Airport is sufficiently representative of the land use surrounding the

Project site. Appendix D depicts a wind rose based on measured wind speeds and directions from 2009-2013 at the Wood County Airport.

3.8

BACKGROUND MONITORING DATA FOR CUMULATIVE MODELING

As discussed earlier, if the impacts from the Project sources exceed the SILs for any compound, cumulative modeling analysis will need to be conducted. As a part of cumulative modeling analysis, the impacts from the Project would need to be added to other sources in the vicinity of the site and the background ambient monitoring data. In the event that cumulative modeling analysis is required to be conducted for NO₂, the Project reviewed available monitoring data sites which would be considered representative of the background conditions for the Project site.

Two sources of NO₂ monitoring data are about 200 km of the proposed Project site, namely, monitor 42-125-0005 in Washington County, PA and monitor 42-007-0014 in Beaver County, PA. The Washington County monitor is located 182 km to the east-northeast of the proposed Project site, and the Beaver County monitor is located to 203 km to the north-northeast. Table 3-4 presents the recent design values from these monitors for the annual and 1-hr averaging periods, as well as emissions and population data from both Pennsylvania counties and Wood County, West Virginia.

Table 3-4 NO₂ Design Values, NO_x Emissions, and Population Data

NO ₂ Monitor Design Values, Population, and County Emissions Data					
Wood County, WV, Beaver and Washington Counties, PA					
	Monitor ID	2010 Annual Design Value	2011 Annual Design Value	2012 Annual Design Value	2010-2012 1-hr Design Value
		ppb	ppb	ppb	ppb
Beaver County, PA	42-007-0014	11	10	10	40
Washington County, PA	42-125-0005	11	10	8	38
	Population	NO _x Emissions - 2008 NEI			
	2012 Estimate	Biogenic	Stationary	Mobile	Total
Beaver County, PA	170,245	70.38	30,773.70	5,989.94	36,834.01
Washington County, PA	208,716	164.62	7,538.82	6,594.39	14,297.83
Wood County, WV	86,701	59.68	1,161.82	3,512.14	4,733.64

The NO₂ design values for both the annual and 1-hr NO₂ NAAQs are similar between the two sites. It should be noted that Wood County is much less populated than the two Pennsylvania Counties. This fact is reflected in all source categories of NO_x emissions in the 2008 NEI data. The Project notes that the 1-hr design value from the Beaver County monitor is flagged as incomplete, in Table 5b of the NO₂ design value spreadsheet for 2012 available from USEPA at <http://www.epa.gov/airtrends/values.html>.

Although Beaver County has higher stationary source emissions of NO_x than Washington County, the design values in Washington County are only slightly lower. It is important to note that in a cumulative modeling analysis, nearby large stationary sources will be explicitly accounted for as modeled sources. The background will be used to account for less quantifiable sources such as mobile sources. In the case of Washington County, the effect of mobile sources on the monitor values appears to be conservative when compared to Wood County. Also, due to the completeness issue of the 1-hr design value for the Beaver County site, the Project concludes that the Washington County monitor represents the best option as a source of background NO₂ concentrations.

The Project will follow the USEPA recommendations in the March 1, 2011 NO₂ modeling guidance memo (USEPA 2011) to develop the 1-hr background concentrations for input into AERMOD. Specifically, the Project will calculate multiyear averages of the 98th percentile NO₂ 1-hr concentrations by season and hour of day. The multiyear average will account for 2010-2012 1-hr monitor data from the Washington County Monitor. USEPA recommends that the 3rd highest value for each season and hour of day combination be used to represent the 98th percentile value. For the annual average, the Project will rely on the average annual design value from 2010 to 2012. If multi-source modeling for PM_{2.5} is required, the Project will use design values calculated based on measurements taken at the Wood County monitor in Vienna, West Virginia for 2011-2013.

3.9

REGIONAL INVENTORY FOR CUMULATIVE MODELING ANALYSES

The Project anticipates that impacts from the facility will likely exceed the SIL for NO₂, 1-hour, thus development of a multi-source inventory for NO_x will be required. For the 1-hour NAAQS, the Project will rely on guidance described in the USEPA NO₂ modeling memo (USEPA 2011). Page 4 of the USEPA modeling memo states that the area of interest for a cumulative modeling analysis for the 1-hr NO₂ standard should be focused “on the area within about 10 -km of the project site”. Considering this guidance, the Project will conservatively consider the inventory of sources within 20 km of the proposed project, and will also consider sources that may be close to this distance from the project. the Project further anticipates that impacts from the facility may exceed the SIL for PM_{2.5}. If a SIL exceedance cannot be avoided, the Project is prepared to conduct multi-source modeling for PM_{2.5} in addition to the multi-source modeling for NO₂. Recommendations for sources to consider for PM_{2.5} are presented along with recommendations for NO_x sources.

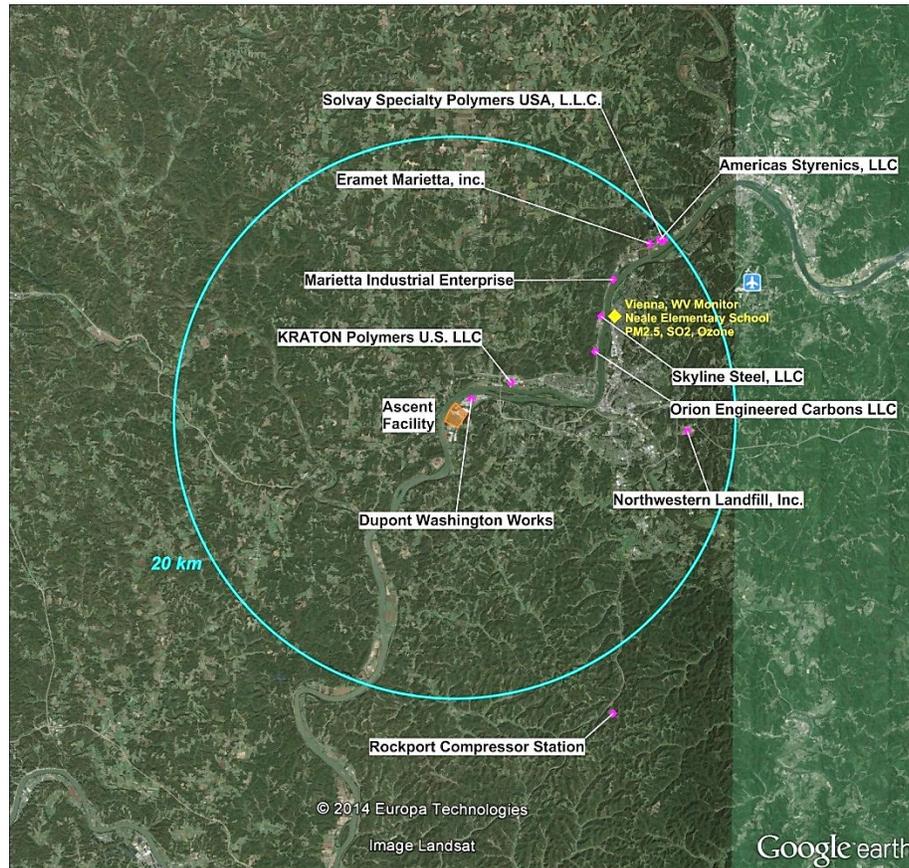
The Project has extracted NO_x and PM_{2.5} emissions and stack characteristics from the latest version of EPA’s National Emissions Inventory (NEI). This inventory includes individual point source characteristics for various emissions units at each listed facility, and emission rates that reflect 2011 annual emissions. The Project will develop allowable short term emissions for these facilities and emissions units to the fullest extent possible. The exact methodologies employed to develop the allowable emissions will be noted in the modeling report to WVDEP. Table 3-5 shows the facilities that are within or close to 20 km of the

proposed project that may be included in the cumulative inventories for NO₂ and possibly PM_{2.5}. Figure 3-2 shows the locations of the candidate sources.

Table 3-5 Preliminary NO_x and PM_{2.5} Inventory Sources

Distances in km			2011 Emissions TPY		Modeling Candidate		Facility Name	State	County
East	North	Distance	PM25	NOx	PM25	NOx			
1.2	1.3	1.8	116.9	1089.5	x	x	Dupont Washington Works	WV	Wood
16.6	-1.0	16.6	7.2	5.3	-	-	Northwestern Landfill, Inc.	WV	Wood
11.3	-21.1	23.9	0.5	46.3	-	-	Rockport Compressor Station	WV	Wood
11.3	9.8	15.0	4.0	n/a	-	-	Marietta Industrial Enterprise	OH	Washington
10.4	7.2	12.7	0.2	n/a	-	-	Skyline Steel, LLC	OH	Washington
10.0	4.7	11.1	51.6	391.8	x	x	Orion Engineered Carbons LLC	OH	Washington
13.9	12.4	18.6	226.1	7.1	x	-	Eramet Marietta, inc.	OH	Washington
14.9	12.6	19.5	4.9	27.9	-	x	Solvay Specialty Polymers USA, L.L.C.	OH	Washington
14.6	12.7	19.3	1.4	1.0	-	-	Americas Styrenics, LLC	OH	Washington
4.0	2.5	4.7	108.8	560.4	x	x	KRATON Polymers U.S. LLC	OH	Washington

Figure 3-2 Locations of Preliminary NO_x and PM_{2.5} Inventory Sources



The Project will use the appropriate stack height listed for each emissions unit in the inventory. The Project will assume that all stack heights provided in the inventory are appropriate for use in a dispersion modeling analysis.

The Project proposes to reference the USEPA NO₂ modeling guidance to possibly reduce the number of facilities considered in the cumulative modeling analysis. This guidance emphasizes the importance of considering whether a background source is likely to create a significant concentration gradient in the vicinity of the source under consideration (i.e. the Project). The guidance also notes that a “significant concentration gradient” is a function of a number of factors that are evaluated on a case-by-case basis. These factors include but are not limited to the stack height, emission rate, and distance to the Project for the background sources, wind frequencies as illustrated by wind roses, terrain features, and location of the monitor used to determine background concentrations. The Project will develop information on these factors for the purpose of determining an appropriate background source inventory, and will work with WVDEP to finalize the inventory based on this analysis. The Project will document the justification for the background source inventories for NO₂ and possibly PM_{2.5}, including any exclusions, in the modeling report to WVDEP.

3.10 ***OZONE IMPACTS***

The 2010-2013 8-hour ozone design value for the Vienna, West Virginia ozone monitor (monitor 54-107-1002) is 68 ppb. The 8-hr ozone NAAQS is 75 ppb. The Project anticipates that the proposed project will result in VOC and NO_x increases that are greater than the respective SER. NO_x and VOC are precursors for tropospheric ozone formation. To assess whether a proposed project will have impacts with respect to ozone formation, it is useful to consider the regional emissions of ozone precursors. Table 3-6 presents the emissions of NO_x and VOC for Wood County, West Virginia, as well as the surrounding counties in West Virginia and Ohio from the 2011 NEI.

Table 3-6 Regional Ozone Precursor Emissions – 2011 NEI

Nox (tons/yr)							
County	Biogenic	Non Point	Non Road	On Road	Fires	Point	Total
Athens Co, OH	68	160	165	1567	10	676	2645
Meigs Co, OH	72	126	99	753	0	0	1049
Washington Co, OH	104	297	282	1949	0	10767	13399
Jackson Co, WV	73	1088	118	1214	3	151	2647
Pleasants Co, WV	21	713	37	115	0	6205	7090
Ritchie Co, WV	55	2619	65	182	0	219	3140
Wirt Co, WV	36	311	31	50	0	0	428
Wood Co, WV	59	1008	309	1694	0	1285	4356
Region Total	486	6322	1106	7523	14	19303	34755
VOC (tons/yr)							
	Biogenic	Non Point	Non Road	On Road	Fires	Point	Total
Athens Co, OH	5315	949	643	712	167	65	7850
Meigs Co, OH	4962	685	253	349	0	0	6248
Washington Co, OH	5864	1535	800	800	2	514	9515
Jackson Co, WV	7001	1907	387	338	37	158	9827
Pleasants Co, WV	2604	1232	90	53	5	201	4185
Ritchie Co, WV	6604	4267	144	91	2	198	11306
Wirt Co, WV	4609	703	81	23	5	19	5439
Wood Co, WV	4813	1308	929	817	6	401	8274
Region Total	41771	12585	3327	3181	224	1556	62645

The proposed project’s emissions of NO_x and VOC represent a small fraction of regional emissions of these compounds when compared to the historic data in the 2011 NEI. It is reasonable to assume that the relatively low emissions of these ozone precursors from the proposed project are unlikely to cause sufficient formation of additional ozone to endanger the ozone NAAQS.

To further illustrate that the proposed project’s impacts of NO_x in particular will be unlikely to cause significant formation of ozone, technical data relating to regional modeling for the Cross State Air Pollution Rule (CSAPR) have been reviewed. The technical data are available online at <http://www.epa.gov/crossstaterule/techinfo.html>.

Considering the prevailing winds the region (illustrated in Appendix D of this protocol), it can be stated that the majority of emissions that are expected to be culpable for ozone concentrations measured in Vienna would originate from either Ohio or West Virginia sources. Table 3-7 presents the emissions of NO_x from the CSAPR scenarios for OH and WV sources while Table 3-9 presents

ozone model results and historic ambient values for each case at the Vienna ozone monitor. These data were obtained from the spreadsheet “EmissionsSummaries.xlsx” and “CSAPR_Ozone and PM2.5_Design Values.xls”, available at the link above.

Table 3-7 CSAPR Emissions Cases

State	2005 Base Nox	2012 Base	2014 Base	2014 Remedy	2012 Base minus 2005 Base		2014 Base minus 2012 Base		2014 Remedy minus 2014 Base	
					Difference	Difference	Difference	Difference	Difference	Difference
Ohio	906,327	560,718	522,450	508,054	-345,609	-38.1%	-38,268	-6.8%	-14,396	-2.8%
West Virginia	308,655	172,143	166,094	155,245	-136,512	-44.2%	-6,049	-3.5%	-10,849	-6.5%

Table 3-8 CSAPR Modeled Values at the Vienna Ozone Monitor

Monitor ID	State	County	2003-2007 Maximum Ambient Values	2012 Base Case Maximum Values	2014 Base Case Maximum Values	2014 Remedy Maximum Values
541071002	West Virginia	Wood	82.0	73.8	71.0	69.7

Using the data summarized in Tables 3-7 and 3-8, it is possible to develop tons/ppb factors that illustrate how many tons reduction in NO_x were needed to affect a change in modeled values of ozone at the monitor. Table 3-9 summarizes these factors.

Table 3-9 Comparison of Modeled Emissions Reductions and Monitor Value Reductions

	Case	Statewide NO _x emissions reduction <i>tpy</i>	Monitor reduction <i>ppb</i>	tons/ppb
Ohio	2005 Base Case to 2012 Base	345,608.84	8.2	42,147.42
WV		136,512.21	8.2	16,647.83
Ohio	2012 Base Case to 2014 Base	38,267.81	2.8	13,667.07
WV		6,049.26	2.8	2,160.45
Ohio	2014 Base Case to 2014 Remedy	14,396.06	1.3	11,073.89
WV		10,848.81	1.3	8,345.24

The lowest tons/ppb factor for the various emissions reductions cases was for the West Virginia sources between the 2012 base case and the 2014 base case. This magnitude of NO_x emissions in this factor is significantly greater than the

emission rate of NO_x from the proposed project. Although this is a simplification of reality, where the actual emissions culpable will originate from Ohio and West Virginia combined (as well as other upwind states) and not all emissions from Ohio and West Virginia would be culpable, this demonstration does serve to illustrate the magnitude of emissions necessary to affect appreciable change in ozone values at the Vienna, WV ozone monitor. The Project believes that this demonstration supports the conclusion that emissions from the proposed project will not cause or contribute to a violation of the ozone NAAQS.

3.11 CLASS I IMPACTS

The proposed Project is located within 300 km of four (4) federally protected Class I areas. All of these Class I areas are located generally to the southeast of the Project. The Class I areas and distances from the Project site are as follows:

- Otter Creek Wilderness - 170 km, managed by the US Forest Service (USFS),
- Dolly Sods Wilderness - 190 km, managed by USFS
- Shenandoah National Park - 270 km, managed by the National Park Service (NPS)
- James River Face Wilderness - 271 km, managed by USFS

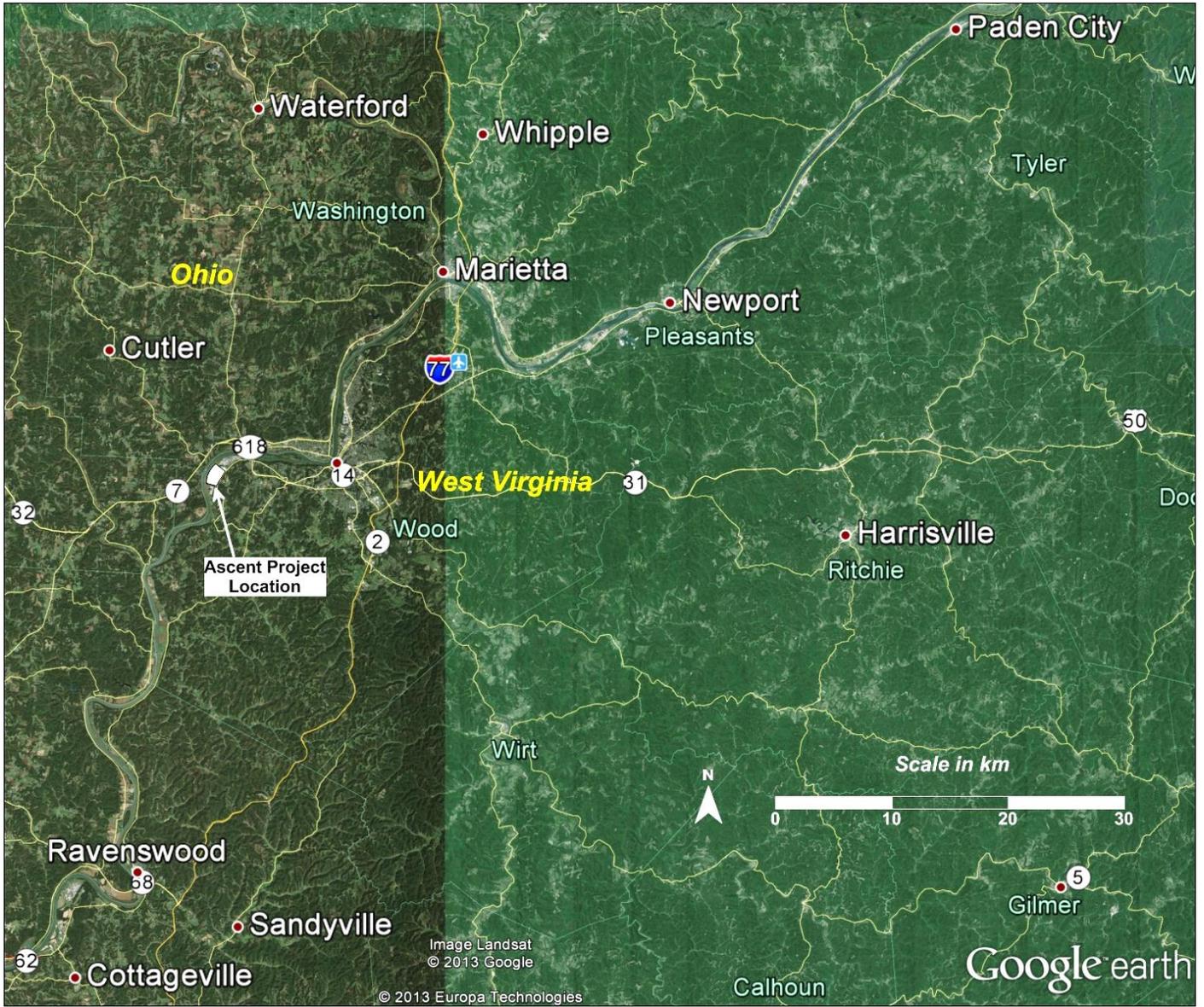
Based on ERM's past experience with WVDEP, ERM believes the Federal Land Managers responsible for the four (4) Class I areas will not be requesting any air quality modeling analysis in support of the permit application for the Project. Therefore, no Class I air quality modeling analyses will be performed as part of the permit application effort; however, notification of Project emissions will be provided to appropriate FLMs.

4.0 MODEL RESULTS PRESENTATION

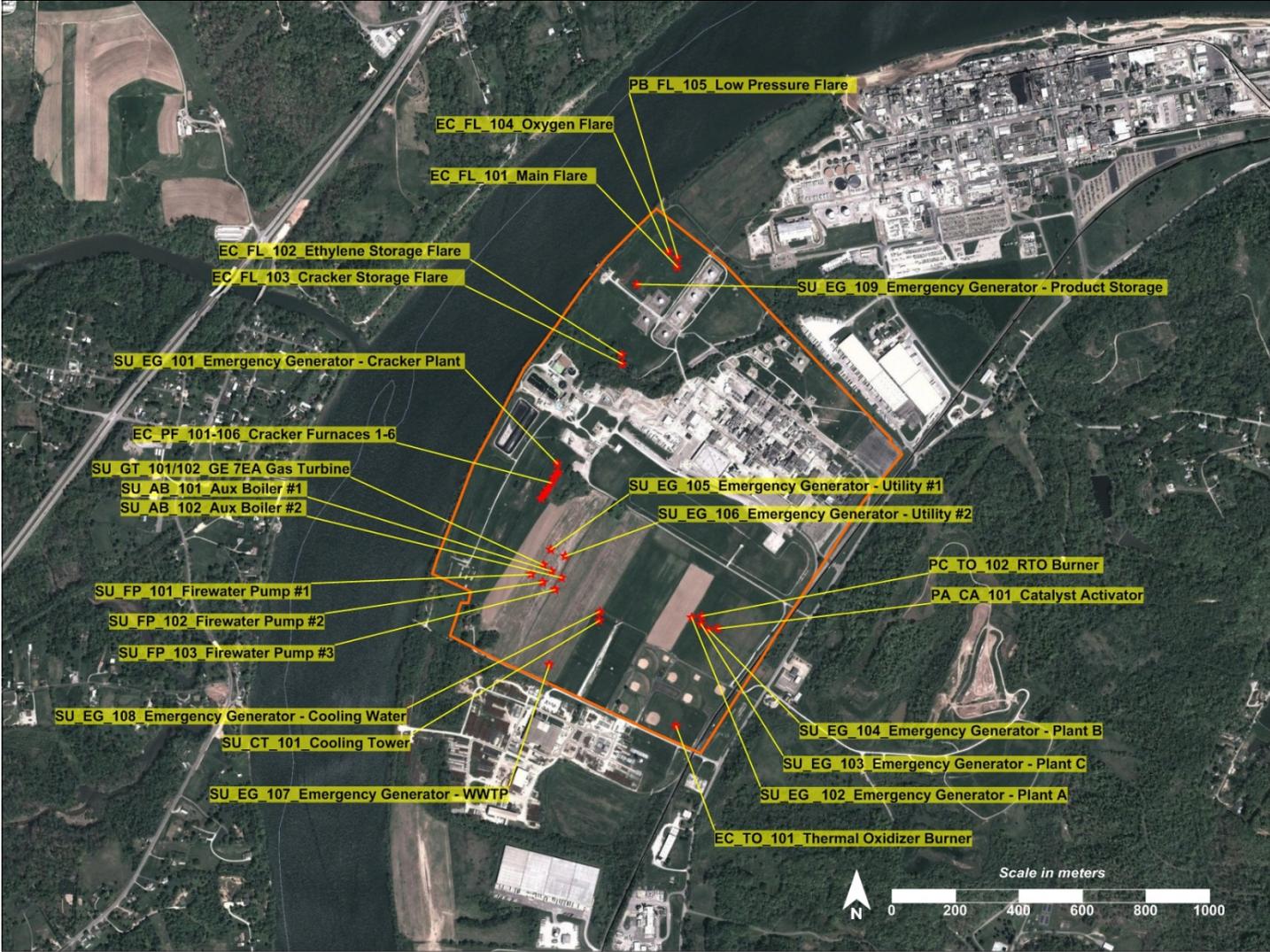
Four (4) criteria pollutants will be modeled, namely NO₂, PM_{2.5}, PM₁₀, and CO. Maximum ground level model design values will be identified for the appropriate averaging periods and compliance with SILs, and subsequently the NAAQS and PSD increments, as necessary. Results will be presented in tabular and graphic (contour isopleth) formats. Electronic modeling files will be provided with the report.

- U.S. Environmental Protection Agency. (USEPA 2011) USEPA memo entitled “Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO₂ National Ambient Air Quality Standard”, USEPA, Office of Air Quality Planning and Standards, Raleigh, NC. March 1, 2011.
- U.S. Environmental Protection Agency. (USEPA 2009) AERMOD Implementation Guide, AERMOD Implementation Workgroup. March 19, 2009.
- U.S. Environmental Protection Agency. (USEPA 2013) AERSURFACE User’s Guide, Office of Air Quality Planning and Standards, Raleigh, NC. January 2008, Revised 01/16/2013.
- U.S. Environmental Protection Agency. (USEPA 2013a) Draft Guidance for PM_{2.5} Permit Modeling, Office of Air Quality Planning and Standards, Raleigh, NC. March 4, 2013.
- West Virginia Department of Environmental Protection. (WVDEP 2005) 2005 Air Quality Annual Report
- West Virginia Department of Environmental Protection. (WVDEP 2008) 2008 Air Quality Annual Report
- West Virginia Department of Environmental Protection. (WVDEP 2012) Resignation Request and Maintenance Plan for the West Virginia portion of the Wheeling, WV-OH 1997 PM_{2.5} Nonattainment Area, March 2012
- Environ International Corporation. (ENVIRON 2008) Technical Support Document for the Association for Southeastern integrated planning (ASIP) Emissions and Air Quality Modeling to Support PM_{2.5} and 8-Hour ozone State Implementation Plans, March 24 2008
- West Virginia Department of Environmental Protection. (WVDEP2009) Resignation Request and Maintenance Plan for the West Virginia portion of the Wheeling, WV-OH 1997 PM_{2.5} Nonattainment Area - Appendix B, November 2009

Proposed Facility Location
Appendix A



Preliminary Project Plot Plan
Appendix B



Tier 3 NO₂ Modeling Protocol
Appendix C

Refined NO₂ Modeling Approach

The Guideline on Air Quality Models (GAQM, Appendix W of 40 CFR Part 51), with clarification from the US EPA March 01, 2011 memorandum² provides a tiered approach for modeling NO₂ from NO_x emissions with increasing levels of refinement:

- Tier 1: full conversion of NO_x to NO₂;
- Tier 2: use of 0.8 as a default ambient ratio for the 1-hour NO₂ standard (no further justification needed);
- Tier 3: application of the Ozone Limiting Method (OLM) or the Plume Volume Molar Ratio Method (PVMMR).

As part of the 1-hour NO₂ analysis for the proposed Project, ERM will first apply the Tier 2 refinement by multiplying the 1-hour modeled NO_x concentrations by 0.8. If further refinement of the modeling is necessary, the Tier 3 refinements will be evaluated for possible use. The following section describes the methodology ERM proposes should Tier 3 refinement be pursued.

Overview of Tier 3 Methods

Both the PVMMR and OLM options in AERMOD account for ambient conversion of NO to NO₂ in the presence of ozone based on ozone titration: the interaction of NO with ambient ozone (O₃) to form NO₂ and O₂. PVMMR and OLM both assume that all of O₃ measured at a representative ambient monitor will be available to oxidize NO to NO₂. The main distinction between the two methods is the approach taken to estimate the ambient concentrations of NO and O₃ for which the ozone titration mechanism is applied: OLM applies the mechanism to the modeled ground-level concentration of NO, while PVMMR applies the mechanism to the plume-average NO concentrations aloft.

In both PVMMR and OLM, the total NO₂ at a receptor is computed as the sum of the modeled concentration of initially emitted NO₂ plus the fraction initially emitted as NO that is converted to NO₂ due to O₃ titration. For the titration reaction to take place, O₃ is assumed to be well-mixed with the parcel

² "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO₂ National Ambient Air Quality Standard" From: Tyler Fox, Leader, Air Quality Modeling Group; To: Regional Air Division Directors. March 1, 2011.

of air containing concentrations of NO. The relative molar concentrations of ambient ozone and modeled NO in the parcel determines the fraction of NO that is assumed to be converted to NO₂ at a given receptor. The primary difference between PVMRM and OLM is how that parcel is defined. For OLM, the NO concentration in the parcel is the modeled NO concentration at a single receptor location. For PVMRM, the NO concentration in the parcel is computed from the plume cross-section at the downwind distance associated with the receptor of interest.

Two memoranda issued by USEPA's Office of Air Quality Planning and Standards (OAQPS) provide guidance on the use of PVMRM and OLM: the March 1st, 2011 memo described above and the original guidance published on June 29th, 2010³. According to these memoranda, PVMRM and OLM are non-regulatory default Tier 3 options within the AERMOD dispersion model that require justification and approval by the USEPA Regional Office on a case-by-case basis, pursuant to Sections 3.1.2.c, 3.2.2.a, and A.1.a(2) of Appendix W. Furthermore, the justification should be developed in accordance with 40 CFR Part 51, Appendix W (Section 3.2.2.e) which states that "an alternative refined model may be used provided that:

1. The model has received a scientific peer review;
2. The model can be demonstrated to be applicable to the problem on a theoretical basis;
3. The databases which are necessary to perform the analysis are available and adequate;
4. Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates; and,
5. A protocol on methods and procedures to be followed has been established."

These 5 requirements are addressed as follows:

Condition 1: The model has received a scientific peer review

PVMRM and OLM were developed over a decade ago and have been the subject of numerous peer-reviewed papers referenced in the USEPA memoranda.

ERM believes that both Tier 3 refinement methods have been subject to sufficient scientific peer review to satisfy this condition.

³ "Guidance Concerning the Implementation of the 1-hour NO₂ NAAQS for the Prevention of Significant Deterioration Program" From: Stephen D. Page, Director, Office of Air Quality Planning and Standards; To: Regional Air Division Directors. June 29, 2010.

Condition 2: The model can be demonstrated to be applicable to the problem on a theoretical basis

The USEPA memoranda state that “The issue of applicability to the problem on a theoretical basis is a case-by-case determination based on an assessment of the adequacy of the ozone titration mechanism utilized by these options to account for NO_x chemistry within the AERMOD model based on ‘the chemical environment into which the source's plume is to be emitted’”. ERM has reviewed the NO₂ data for the two nearest NO₂ monitors: Beaver Country, PA (AQS ID: 42-007-0014) and Washington County, PA (AQS ID: 41-125-0005), and the ozone data for the Wheeling, WV monitor (AQS ID: 54-069-0110), and based on the data there is a pattern of decreasing NO₂ and ozone concentrations. We believe that this pattern demonstrates that the “chemical environment into which the source’s plume is to be emitted” is consistent with the underlying principles used by PVMRM and OLM to simulate NO to NO₂ conversion, namely, that decreased ozone is associated with decreased conversion of NO to NO₂.

Condition 3: The databases which are necessary to perform the analysis are available and adequate

The necessary data for implementing PVMRM or OLM within AERMOD include hourly ozone data coincident with the meteorological data used to run the model and information on the in-stack NO₂/NO_x ratio. The proposed inputs are described fully in the next section of this appendix.

Condition 4: Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates

Several performance evaluations (ex. MACTEC, 2004 and MACTEC, 2005)^{4,5} have been performed that show that the Tier 3 refinements are not biased towards underestimates. Supplemental evaluations described in USEPA’s March 1, 2011 memorandum were performed to update the model used (AERMOD) and to evaluate one- hour concentrations. The memorandum stated that the supplemental evaluations “...lend further credence to the use of these Tier 3 options in AERMOD for estimating hourly NO₂ concentrations”. ERM believes that these evaluations and the more recent published evaluation (Hendrick et.al, 2013)⁶ satisfy this condition.

⁴ MACTEC, 2004. Sensitivity Analysis of PVMRM and OLM in AERMOD. Final Report, Alaska DEC Contract No. 18-8018-04. MACTEC Federal Programs, Inc., Research Triangle Park, NC.

⁵ MACTEC, 2005. Evaluation of Bias in AERMOD-PVMRM. Final Report, Alaska DEC Contract No. 18-9010-12. MACTEC Federal Programs, Inc., Research Triangle Park, NC.

⁶ Hendrick, E.M, Tino, V.R, Hanna, S.R, Hanrahan, P.L., and Egan, B.A., 2013. Evaluation of NO₂ predictions by the plume volume molar ratio method (PVMRM) and ozone limiting method (OLM) in

Condition 5: A protocol on methods and procedures to be followed has been established

The section below describes the approach proposed by ERM should the use of one of the Tier 3 requirements be pursued.

Proposed Modeling Inputs for Tier 3 Approach

Use of the Tier 3 refinements in AERMOD requires three additional inputs:

- Hourly ozone data that are concurrent with the meteorological data;
- An equilibrium nitric oxide (NO)/NO₂ ratio; and
- Identification of source specific in-stack ratios of NO₂/NO_x.

In the absence of source-specific in-stack data, US EPA provides a default in-stack NO₂/NO_x ratio of 0.5.

Initially, both methods take into account that some NO₂ is formed during the combustion process and emitted directly to the atmosphere. Therefore, to account for this initial component of NO₂, PVMRM and OLM as implemented in AERMOD use a specified in-stack ratio for each source in addition to the NO_x emission rate. The remaining fraction of NO_x emissions are assumed to be NO and available for conversion to NO₂. The PVMRM and OLM computations are performed on an hourly basis and therefore require representative ozone concentrations on an hourly basis for input to AERMOD. As ozone is required for the conversion of NO to NO₂ in the model, higher ozone concentrations for a given hour result in a larger fraction of the NO emitted being converted to NO₂.

Although PVMRM and OLM represent a refinement in estimating hourly NO₂ concentrations resulting from NO_x emissions from point sources, they retain the oversimplification that O₃ titration is the sole mechanism affecting ambient concentrations of NO₂. As such, if ambient O₃ concentrations exceed modeled parcel NO concentrations, then the method would indicate that 100% of the NO in the plume is converted to NO₂. In reality, measured hourly concentrations of NO_x are almost never entirely comprised only of NO₂. This is because there are many competing reactions in the atmosphere, including simple reactions where NO₂ absorbs solar radiation decomposing to NO + O, as well as complex photochemical reactions which ultimately form ozone. As such, to account for these competing reactions, PVMRM and OLM require an

“equilibrium ratio” be specified that sets an upper limit to the fraction of modeled NO_x that is in the form of NO₂. Should one of the Tier 3 refinements be adopted for this analysis, the US EPA default value 0.9 will be used.

In-Stack NO₂/NO_x Ratios:

ERM will research and provide any available data to justify in-stack ratios for project NO_x emissions, including the latest version of US EPA’s NO₂/NO_x ISR Database⁷. For any non-project sources included in the modeling as part of a cumulative analysis, the US EPA default value of 0.50, allowed without further justification per the March 1st, 2011 memo, will be used as a first cut but research will be conducted to justify alternative values if necessary.

Ozone Data:

The Tier 3 refinements for AERMOD require the use of hourly ozone data that is concurrent with the meteorological data, which as discussed in this protocol consists of five years from the Wood County airport 2008-2012. Hourly ozone data from the Vienna, WV monitor for those dates will be downloaded from the US EPA AQS Database (<http://www.epa.gov/ttn/airs/airsaqs/detaildata/downloadaqsddata.htm>) for use in the analysis.

⁷ http://www.epa.gov/ttn/scram/no2_isr_database.htm

Wind Roses from Wood County Airport
Appendix D

