LETTER ATTACHMENTS

Re: INHALATION RISK ASSESSMENT FOR PETROCHEMICALS COMPLEX SHELL CHEMICAL APPALACHIA LLC BEAVER COUNTY, PENNSYLVANIA

Prepared for:
Shell Chemical Appalachia LLC
910 Louisiana
Houston TX 77002

Prepared by:
RTP Environmental Associates
304A West Millbrook Road
Raleigh, North Carolina 27609

Attachments to letter from Shell Chemical Appalachia LLC to Pennsylvania Department of Environmental Protection, January 26, 2015

Shell Chemical LP
910 Louisiana St.
Houston, TX 77002

January 26, 2015

Mark Wayner
Program Manager
Pennsylvania Dept. of Environmental Protection
Bureau of Air Quality – Southwest Regional Office
400 Waterfront Drive
Pittsburgh, Pennsylvania 15222-4745

Re: Inhalation Risk Assessment for the Shell Chemical Appalachia LLC Petrochemicals Complex to be Located in Beaver County Pennsylvania

Dear Mr. Wayner

At the request of Pennsylvania Department of Environmental Protection (PaDEP), Shell Chemical Appalachia LLC (Shell) conducted an inhalation risk assessment for the proposed Shell Petrochemicals Complex to be constructed in Beaver County, Pennsylvania. This assessment was conducted in accordance with the Inhalation Risk Assessment Protocol submitted to and approved by PaDEP.[1,2]

As summarized in Table 1, the results of the assessment show that the levels of risk posed by both chronic and acute exposure to the emissions of compounds of potential concern (COPC) from the proposed project do not exceed PaDEP's inhalation risk assessment benchmarks.

Table 1. Summary of Inhalation Risk Assessment

Inhalation Risk	PaDEP Inhalation Risk Assessment Benchmark	Shell Inhalation Risk Assessment Result
Excess Lifetime Cancer Risk	1 in 100,000	8 in 1,000,000
Chronic Non Cancer Risk	HI<0.25	HI=0.07
Acute Non Cancer Risk	HQ<1	Highest HQ=0.21

The analysis evaluated chronic risks posed by the emissions from the proposed facility operating at maximum conditions as well as acute exposure scenarios posed by short term emissions.

[1]Protocol for the Inhalation Risk Assessment Petrochemicals Complex Shell Chemical Appalachia LLC Beaver County, Pennsylvania, January 6, 2015
[2]Email from A. Binder, PaDEP to P. May, RTP Environmental Assoc., January 12, 2015

Details of the analysis are presented in Attachments A through C. Attachment A contains the emissions information for the proposed project, including the identification of the COPCs and the emissions rate estimates used for the chronic and acute scenarios that are considered by the assessment. Attachment B provides a discussion of the dispersion modeling analysis and the resulting maximum one-hour and five-year annual average exposure concentrations used in the assessment. Attachment C provides the methodology for determining the inhalation risk posed by the emissions from the proposed facility and detailed results of the risk assessment.

Due to the confidential nature of the information provided, Shell is submitting a confidential version of this letter, which contains trade secret and confidential proprietary information as defined by Pennsylvania Right to Know. An additional copy of this letter with redacted confidential information is also provided.

Shell looks forward to working with the Department to facilitate the review of this assessment. If you have any questions, please do not hesitate to contact Shari Keller at (713) 241-1071 or by email at shari.keller@shell.com.

Sincerely,

Ate S. Visser
President
Shell Chemical Appalachia LLC

cc:
Shari Keller
Randy Armstrong
Pierre Espejo

ATTACHMENT A

EMISSION ESTIMATES FOR THE INHALATION RISK ASSESSMENT FOR PETROCHEMICALS COMPLEX SHELL CHEMICAL APPALACHIA LLC BEAVER COUNTY, PENNSYLVANIA

Prepared for:
Shell Chemical Appalachia LLC
910 Louisiana
Houston TX 77002

Prepared by:
RTP Environmental Associates
304A West Millbrook Road
Raleigh, North Carolina 27609

January 2015

Emission Estimates for Shell Petrochemicals Complex Inhalation Risk Assessment

1.0 General Discussion

The methodologies used to estimate emissions rates for the compounds of potential concern (COPC) are consistent with the methodologies presented in the April 30, 2014, Plan Approval Application submitted to the Pennsylvania Department of Environmental Protection (PaDEP) and the September 23, 2014, Technical Supplement. To identify the COPC from the project's combustion sources, EPA's compilation of Air Pollutant Emission Factors (i.e., AP-42) was used. The COPC emissions for the remaining points of emission were determined based on process knowledge. A summary of the identified COPCs is presented in Table 1.

A summary of the one-hour emission rate estimates used in the chronic and acute exposure analyses are presented in Table 2 and Table 3, respectively. The following subsections provide more specific discussion of the calculation methodologies used for each type of emissions unit. References to hazardous air pollutants (HAP) are for Plan Approval purposes and should be considered synonymous with COPC for this analysis.

1.1 Combustion Sources

As previously noted, COPC emission rates from the combustion sources (i.e., cracking furnaces, combustion turbines, emergency engines, flares, and incinerators) are based on the application of the appropriate AP-42 factor and the fuel firing rate of the unit. Emission rates for the combustion units are presented in Table 4 through Table 7.

1.2 Polyethylene Units

The COPCs emitted from the polyethylene manufacturing units are hexavalent chromium (CrVI) from the catalyst heaters and hexane from equipment leaks. Estimated hexane emission rates are provided in Section 1.7. Chromium emissions result from the catalyst activation process. To activate the catalyst, hot air produced via electrical heaters is passed through the catalyst heater where it contacts with the catalyst. After passing through the heater, the air exhausts through a stack to the atmosphere. Catalyst particulate entrained in the hot exhaust contains trace amounts of CrVI. The CrVI emissions rate estimate is based on the licensor information presented in Table 8.

1.3 Storage Tanks

Uncontrolled COPC emission rates from certain fixed roof atmospheric storage tanks are presented in Table 9. These emission rates are estimated using the methodology outlined in AP-42, Chapter 7, Section 1. Total VOC emissions are determined using EPA's TANKS 4.09d software. The Hazardous Air Pollutant (HAP) Speciation methodology (AP-42, Section 7.1.4) is then used to determine the COPC emission rate.

No routine emissions, other than fugitive emissions from equipment components, are estimated from pressurized storage tanks (*i.e.*, the C3+ storage spheres). These tanks are sealed and pressurized so working and breathing losses do not occur. Emissions from storage tanks with

vents routed to the flare headers are accounted for in the estimated emissions rates from the LP Thermal and Spent Caustic Vent Thermal Incinerators.

1.4 Process Cooling Water Tower

COPC emissions from the process cooling water tower are estimated by assuming 10 percent of the VOC emissions is hexane. The VOC emissions are based on the proposed VOC LAER limit and the design cooling water circulation rate. The process cooling water tower VOC emissions rate estimate is presented in Table 10.

1.5 Wastewater Treatment Plant

Uncontrolled emissions from the Wastewater Treatment Plant (WWTP) operations are estimated using EPA's WATER9 air emissions model. Controlled emissions are accounted for in the emissions rate estimates from the Spent Caustic Vent Thermal Incinerator. The WWTP emissions rate estimates are presented in Table 11.

1.6 Flares and Incinerators

COPC emissions from the flares and incinerators are based on a combination of the products of combustion and any COPC in the process gas that remains in the exhaust stream of the control device. Products of combustion are estimated using AP-42 emission factors for natural gas combustion as a surrogate for the combusted stream. Constituents in the controlled streams are estimated based on licensor information. The short term and annualized hourly emissions rates for the flares are presented in Table 12Table 12. Speciated Short Term and Annualized Hourly Flare Emission. The short term and annualized hourly emissions rates for the low pressure thermal incinerator and the spent caustic incinerator are presented in Table 13 and Table 14, respectively.

1.7 Fugitive Emissions from equipment leaks

EPA's 1995 Protocol for Equipment Leak Emission Estimates (EPA-453-R-95-017) is used to estimate emissions from equipment leaks for all components except connectors. Consistent with the approach used to estimate VOC emissions for the April 30, 2014, Plan Approval application, the average emission factor approach used for the synthetic organic chemical manufacturing industry (SOCMI) are used to estimate the fugitive emissions from the proposed facility. The 1995 Protocol does not provide for any adjustment in the emissions from connectors in light or heavy liquid service. To account for these service types, the factors provided by TCEQ in "Emissions Factors for Equipment Leak Fugitive Components (Addendum to RG-360A, Jan. 2008)" are used. To determine the emissions rate for an individual COPC, process knowledge of the chemical composition of the lines is applied to the EPA/TCEQ based VOC emissions rate. To account for the level of control resulting from the implementation of the proposed LDAR program, control efficiencies developed by the Texas Commission on Environmental Quality (TCEQ) are applied to the uncontrolled SOCMI emissions factors for the various equipment components types. A summary of the ethylene manufacturing fugitive emissions rates by process location is presented in Table 15. Table 16 provides a cross reference to the ethylene manufacturing fugitive locations. Table 17 and Table 18 provide the summary of the fugitive

emissions rates from areas located outside the boundary limits (OSBL) and a cross reference to the specific OSBL areas, respectively. A summary of the fugitive hexane emission rates from the polyethylene manufacturing units is presented in Table 19.

Table 1. Identified Compounds of Potential Concern[1]

1,3-Butadiene	Dichlorobenzene
2-Methylnaphthalene	Ethylbenzene
3-Methylchloranthrene	Ethylene Oxide
7,12-Dimethylbenz(a)anthracene	Fluoranthene
Acenaphthene	Fluorene
Acenaphthylene	Formaldehyde
Acetaldehyde	Hexane
Acrolein	Indeno(1,2,3-cd)pyrene
Anthracene	Lead
Arsenic	Manganese
Barium	Mercury
Benzene	Methanol
Benzo(a)anthracene	Molybdenum
Benzo(a)pyrene	Naphthalene
Benzo(b)fluoranthene	Nickel
Benzo(g,h,i)perylene	Pentane
Benzo(g,h,l)perylene	Phenanthrene
Benzo(k)fluoranthene	Phenol
Beryllium	Propane
Biphenyl	Propylene Oxide
Cadmium	Pyrene
Chromium VI	Selenium
Chromium III[2]	Styrene
Chrysene	Toluene
Cobalt	Vanadium
Copper	Xylenes
Dibenzo(a,h)anthracene	

[1]Compounds of Potential Concern were identified from EPA's Compilation of AP-42 Emission Factors for combustion of natural gas and from process knowledge.

[2]For purposes of this analysis, all chromium emissions were conservatively assumed to be in the form of Chromium VI.

Placeholder for 11 x 17 Table.

Table 2. Maximum Annual Average COPC E

Pollutant	One Cracking Furnace	Pe ency U ne	O Firev Pu En		
1,3-Butadiene					
2-Methylnaphthalene	7.54E-06				
3-Methylchloranthrene	5.65E-07				
7,12-Dimethylbenz(a)anthracene	5.02E-06				
Acenaphthene	5.65E-07	E-06	2.62E-07		
Acenaphthylene		E-06	5.16E-07		
Acetaldehyde		E-05	1.41E-06		
Acrolein		E-06	4.41E-07		
Anthracene	7.54E-07	E-07	6.88E-08		
Arsenic	6.28E-05				
Benzene	6.59E-04	E-04	4.34E-05	9.64E-03	
Benzo(a)anthracene	5.65E-07	E-07	3.48E-08		
Benzo(a)pyrene	3.77E-07	E-07	1.44E-08		
Benzo(b)fluoranthene	5.65E-07	E-07	6.21E-08		
Benzo(g,h,i)perylene	3.77E-07				
Benzo(g,h,l)perylene		E-07	3.11E-08		
Benzo(k)fluoranthene	5.65E-07	E-08	1.22E-08		
Beryllium	3.77E-06				
Biphenyl					
Cadmium	3.45E-04				
Chromium	4.40E-04	2.1			
Chrysene	5.65E-07	E-07	8.56E-08		
Cobalt	2.64E-05				
Dibenzo(a,h)anthracene	3.77E-07	E-07	1.94E-08		
Dichlorobenzene	3.77E-04				
Ethylbenzene					
Ethylene Oxide					
Fluoranthene	9.42E-07	E-06	2.25E-07		
Fluorene	8.79E-07	E-06	7.16E-07		
Formaldehyde	2.35E-02	E-05	4.41E-06		
Hexane	5.65E-01				0.070
Indeno(1,2,3-cd)pyrene	5.65E-07	E-07	2.32E-08		
Lead	1.57E-04				
Manganese	1.19E-04				
Mercury	8.16E-05				
Methanol					
Naphthalene	1.92E-04	E-05	7.27E-06		

Placeholder for 11 x 17 Table.

Pollutant	One Cracking Furnace	Pe[2] ency Une	One Firewat Pump Engine		
Nickel	6.59E-04				
PAH[2]					
Phenanthrene	5.34E-06	E-05	2.28E-06		
Phenol				7.50E-07	
Propylene Oxide					
Pyrene	1.57E-06	E-06	2.08E-07		
Selenium	7.54E-06				
Styrene					
Toluene	1.07E-03	E-04	1.57E-05		
Xylenes		E-05	1.08E-05		

[1]All emission rates are provided in lb/hr

[2] AP-42 factors for stationary combustion turbines are not avai cancer and non-cancer impact..

Placeholder for 11×17 Table.

Table 3. Maximum Hourly COPC Emission l

Pollutant	One Cracking Furnace	Per E... Uni...	...ne ...rgency ...gine		...ng ...r³
1,3-Butadiene					
2-Methylnaphthalene	7.54E-06				
3-Methylchloranthrene	5.65E-07				
7,12-Dimethylbenz(a)anthracene	5.02E-06				
Acenaphthene	5.65E-07	1.65E-04	2.29E-05		
Acenaphthylene		3.25E-04	4.52E-05		
Acetaldehyde		8.87E-04	1.23E-04		
Acrolein		2.77E-04	3.86E-05		
Anthracene	7.54E-07	4.33E-05	6.03E-06		
Arsenic	6.28E-05				
Benzene	6.59E-04	2.73E-02	3.80E-03	4.77E-02	
Benzo(a)anthracene	5.65E-07	2.19E-05	3.05E-06		
Benzo(a)pyrene	3.77E-07	9.04E-06	1.26E-06		
Benzo(b)fluoranthene	5.65E-07	3.91E-05	5.44E-06		
Benzo(g,h,i)perylene	3.77E-07				
Benzo(g,h,l)perylene		1.96E-05	2.72E-06		
Benzo(k)fluoranthene	5.65E-07	7.67E-06	1.07E-06		
Beryllium	3.77E-06				
Biphenyl					
Cadmium	3.45E-04				
Chromium	4.40E-04	2.94E			
Chrysene	5.65E-07	5.38E-05	7.50E-06		
Cobalt	2.64E-05				
Dibenzo(a,h)anthracene	3.77E-07	1.22E-05	1.70E-06		
Dichlorobenzene	3.77E-04				
Ethylbenzene					
Ethylene Oxide					
Fluoranthene	9.42E-07	1.42E-04	1.97E-05		
Fluorene	8.79E-07	4.50E-04	6.27E-05		
Formaldehyde	2.35E-02	2.78E-03	3.87E-04		
Hexane	5.65E-01				0.070
Indeno(1,2,3-cd)pyrene	5.65E-07	1.46E-05	2.03E-06		
Lead	1.57E-04				
Manganese	1.19E-04				
Mercury	8.16E-05				

Placeholder for 11x17 Table.

Pollutant	One Cracking Furnace	Per Emergency Engine			
Methanol					
Naphthalene	1.92E-04	4.58E-03	6.37E-04		
Nickel	6.59E-04				
PAH[2]					
Phenanthrene	5.34E-06	1.44E-03	2.00E-04		
Phenol				3.73E-06	
Propylene Oxide					
Pyrene	1.57E-06	1.31E-04	1.82E-05		
Selenium	7.54E-06				
Styrene					
Toluene	1.07E-03	9.89E-03	1.38E-03		
Xylenes		6.79E-03	9.46E-04		

[1]All emission rates are provided in lb/hr

[2] AP-42 factors for stationary combustion turbines are not availcancer and non-cancer impact..

Table 4. Speciated Emissions from Ethylene Cracking Furnaces

Emission Unit IDs =	*F-11101 - F17010*	*Ethylene Cracking Furnace HAP PTE*
Max CH4+NG Input =	320 (MMBtu/hr)	Based on 620 MMBtu/hr and 51.7% of heat in from CH4+NG.*
Annual Hours @ 100% Load =	8,760 hr/yr	Conservatively assumes full-time at 100% load.
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)	
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)	

Pollutant	EF (lb/MMSCF)	EF Source	EF (lb/MMBtu)	§112 HAP?	PTE 1 Cracking Furnace (lb/hr)	PTE 1 Cracking Furnace (T/yr)
2-Methylnaphthalene	2.40E-05	AP42; Table 1.4-3; 7/98.	2.35E-08	YES	7.54E-06	3.30E-05
3-Methylchloranthrene	<1.8E-06	AP42; Table 1.4-3; 7/98.	<1.76E-09	YES	<5.65E-07	<2.48E-06
7,12-Dimethylbenz(a)anthracene	<1.6E-05	AP42; Table 1.4-3; 7/98.	<1.57E-08	YES	<5.02E-06	<2.20E-05
Acenaphthene	<1.8E-06	AP42; Table 1.4-3; 7/98.	<1.76E-09	YES	<5.65E-07	<2.48E-06
Anthracene	<2.4E-06	AP42; Table 1.4-3; 7/98.	<2.35E-09	YES	<7.54E-07	<3.30E-06
Benzo(a)anthracene	<1.8E-06	AP42; Table 1.4-3; 7/98.	<1.76E-09	YES	<5.65E-07	<2.48E-06
Benzene	2.10E-03	AP42; Table 1.4-3; 7/98.	2.06E-06	YES	6.59E-04	2.89E-03
Benzo(a)pyrene	<1.2E-06	AP42; Table 1.4-3; 7/98.	<1.18E-09	YES	<3.77E-07	<1.65E-06
Benzo(b)fluoranthene	<1.8E-06	AP42; Table 1.4-3; 7/98.	<1.76E-09	YES	<5.65E-07	<2.48E-06
Benzo(g,h,i)perylene	<1.2E-06	AP42; Table 1.4-3; 7/98.	<1.18E-09	YES	<3.77E-07	<1.65E-06
Benzo(k)fluoranthene	<1.8E-06	AP42; Table 1.4-3; 7/98.	<1.76E-09	YES	<5.65E-07	<2.48E-06
Butane	2.10E+00	AP42; Table 1.4-3; 7/98.	2.06E-03	NO	6.59E-01	2.89E+00
Chrysene	<1.8E-06	AP42; Table 1.4-3; 7/98.	<1.76E-09	YES	<5.65E-07	<2.48E-06
Dibenzo(a,h)anthracene	<1.2E-06	AP42; Table 1.4-3; 7/98.	<1.18E-09	YES	<3.77E-07	<1.65E-06
Dichlorobenzene	1.20E-03	AP42; Table 1.4-3; 7/98.	1.18E-06	YES	3.77E-04	1.65E-03
Ethane	3.10E+00	AP42; Table 1.4-3; 7/98.	3.04E-03	NO	9.73E-01	4.26E+00
Fluoranthene	3.00E-06	AP42; Table 1.4-3; 7/98.	2.94E-09	YES	9.42E-07	4.13E-06
Fluorene	2.80E-06	AP42; Table 1.4-3; 7/98.	2.75E-09	YES	8.79E-07	3.85E-06
Formaldehyde	7.50E-02	AP42; Table 1.4-3; 7/98.	7.35E-05	YES	2.35E-02	1.03E-01
Hexane	1.80E+00	AP42; Table 1.4-3; 7/98.	1.76E-03	YES	5.65E-01	2.48E+00
Indeno(1,2,3-cd)pyrene	<1.8E-06	AP42; Table 1.4-3; 7/98.	<1.76E-09	YES	<5.65E-07	<2.48E-06
Naphthalene	6.10E-04	AP42; Table 1.4-3; 7/98.	5.98E-07	YES	1.92E-04	8.39E-04
Pentane	2.60E+00	AP42; Table 1.4-3; 7/98.	2.55E-03	NO	8.16E-01	3.58E+00
Phenanthrene	1.70E-05	AP42; Table 1.4-3; 7/98.	1.67E-08	YES	5.34E-06	2.34E-05
Propane	1.60E+00	AP42; Table 1.4-3; 7/98.	1.57E-03	NO	5.02E-01	2.20E+00
Pyrene	5.00E-06	AP42; Table 1.4-3; 7/98.	4.90E-09	YES	1.57E-06	6.88E-06

Emission Unit IDs =	F-11101 - F17010	Ethylene Cracking Furnace HAP PTE
Max CH4+NG Input =	320 (MMBtu/hr)	Based on 620 MMBtu/hr and 51.7% of heat in from CH4+NG.*
Annual Hours @ 100% Load =	8,760 hr/yr	Conservatively assumes full-time at 100% load.
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)	
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)	

Pollutant	EF (lb/MMSCF)	EF Source	EF (lb/MMBtu)	§112 HAP?	PTE 1 Cracking Furnace (lb/hr)	PTE 1 Cracking Furnace (T/yr)
Toluene	3.40E-03	AP42; Table 1.4-3; 7/98.	3.33E-06	YES	1.07E-03	4.68E-03
Arsenic	2.00E-04	AP42; Table 1.4-4; 7/98.	1.96E-07	YES	6.28E-05	2.75E-04
Barium	4.40E-03	AP42; Table 1.4-4; 7/98.	4.31E-06	NO	1.38E-03	6.05E-03
Beryllium	<1.2E-05	AP42; Table 1.4-4; 7/98.	<1.18E-08	YES	<3.77E-06	<1.65E-05
Cadmium	1.10E-03	AP42; Table 1.4-4; 7/98.	1.08E-06	YES	3.45E-04	1.51E-03
Chromium**	1.40E-03	AP42; Table 1.4-4; 7/98.	1.37E-06	YES	4.40E-04	1.93E-03
Cobalt	8.40E-05	AP42; Table 1.4-4; 7/98.	8.24E-08	YES	2.64E-05	1.16E-04
Copper	8.50E-04	AP42; Table 1.4-4; 7/98.	8.33E-07	NO	2.67E-04	1.17E-03
Lead	5.00E-04	AP-42; Table 1.4-4	4.90E-07	YES	1.57E-04	6.88E-04
Manganese	3.80E-04	AP42; Table 1.4-4; 7/98.	3.73E-07	YES	1.19E-04	5.23E-04
Mercury	2.60E-04	AP42; Table 1.4-4; 7/98.	2.55E-07	YES	8.16E-05	3.58E-04
Molybdenum	1.10E-03	AP42; Table 1.4-4; 7/98.	1.08E-06	NO	3.45E-04	1.51E-03
Nickel	2.10E-03	AP42; Table 1.4-4; 7/98.	2.06E-06	YES	6.59E-04	2.89E-03
Selenium	<2.4E-05	AP42; Table 1.4-4; 7/98.	<2.35E-08	YES	<7.54E-06	<3.30E-05
Vanadium	2.30E-03	AP42; Table 1.4-4; 7/98.	2.25E-06	NO	7.22E-04	3.16E-03
Zinc	2.90E-02	AP42; Table 1.4-4; 7/98.	2.84E-05	NO	9.11E-03	3.99E-02
Total §112 HAPs from 1 Cracking Furnace =					**<5.93E-01**	**<2.60E+00**
Total §112 HAPs from 7 Cracking Furnaces =					**<4.15E+00**	**<1.82E+01**

* No HAP emissions have been attributed to combustion of H2 in the cracking furnaces.
**All Chromium emitted from the ethylene cracking furnaces conservatively assumed to be hexavalent.

Table 5. Speciated Emissions from Combustion Turbines and Duct Burners

Emission Unit(s) ID =	***CT1/2/3***		***Combustion Turbine & Duct Burner HAP PTE****		
Max CH4+NG Input:	664 (MMBtu/hr)		Total heat input to turbines plus duct burners.*		
Annual Hours @ 100% Load:	8,760 hr/yr		Conservatively assumes full-time at 100% load.		
CO Oxidizer DRE**:	90 %				
Hourly Emissions:	(Max Heat Input - MMBtu/hr) x (EF - lb/MMBtu)				
Annual Emissions:	(Max Heat Input - MMBtu/hr) x (EF - lb/MMBtu) x (Annual Operating Hours) / (2,000 lb/T)				
Pollutant	**EF Source**	**Uncontrolled EF (lb/MMBtu)**	**§112 HAP?**	**Controlled PTE 1 CT/DB (lb/hr)**	**Controlled PTE 1 CT/DB (T/yr)**
1,3-Butadiene :	AP42; Table 3.1-3; 4/00.	<4.30E-07	YES	<2.86E-05	<1.25E-04
Acetaldehyde :	AP42; Table 3.1-3; 4/00.	4.00E-05	YES	2.66E-03	1.16E-02
Acrolein :	AP42; Table 3.1-3; 4/00.	6.40E-06	YES	4.25E-04	1.86E-03
Benzene :	AP42; Table 3.1-3; 4/00.	1.20E-05	YES	7.97E-04	3.49E-03
Ethylbenzene :	AP42; Table 3.1-3; 4/00.	3.20E-05	YES	2.12E-03	9.31E-03
Formaldehyde :	AP42; Table 3.1-3; 4/00.	7.10E-04	YES	4.71E-02	2.06E-01
Naphthalene :	AP42; Table 3.1-3; 4/00.	1.30E-06	YES	8.63E-05	3.78E-04
PAH :	AP42; Table 3.1-3; 4/00.	2.20E-06	YES	1.46E-04	6.40E-04
Propylene Oxide :	AP42; Table 3.1-3; 4/00.	<2.90E-05	YES	<1.93E-03	<8.43E-03
Toluene :	AP42; Table 3.1-3; 4/00.	1.30E-04	YES	8.63E-03	3.78E-02
Xylenes :	AP42; Table 3.1-3; 4/00.	6.40E-05	YES	4.25E-03	1.86E-02
Total §112 HAPs from 1 Cogen Unit =				**<6.82E-02**	**<2.99E-01**
Total §112 HAPs from 3 Cogen Units =				**<2.05E-01**	**<8.96E-01**

* HAP emissions from duct burners assumed to have the same profile as HAP emissions from the turbines.

** AP-42 factors adjusted for controlled emissions due to 90% DRE of CO Oxidizer. Ref. http://jmsec.com/Library/Brochures/jm_sec_data_gas_turbine_033012m.pdf

Table 6. Speciated Emissions from Emergency Generators

Emergency Generator Diesel ICE HAP PTE - EGEN1/2/3/4 (total for all engines)					
Pollutant	**EF (lb/MMBtu)**	**Source**	**§112 HAP?**	**Emissions Rate (lb/hr)**	**Emissions Rate (T/yr)**
Acetaldehyde	2.52E-05	AP42; Table 3.4-3; 10/96.	YES	3.55E-03	1.77E-04
Acrolein	7.88E-06	AP42; Table 3.4-3; 10/96.	YES	1.11E-03	5.55E-05
Benzene	7.76E-04	AP42; Table 3.4-3; 10/96.	YES	1.09E-01	5.46E-03
Formaldehyde	7.89E-05	AP42; Table 3.4-3; 10/96.	YES	1.11E-02	5.55E-04
Propylene	2.79E-03	AP42; Table 3.4-3; 10/96.	NO	3.93E-01	1.96E-02
Toluene	2.81E-04	AP42; Table 3.4-3; 10/96.	YES	3.96E-02	1.98E-03
Xylenes	1.93E-04	AP42; Table 3.4-3; 10/96.	YES	2.72E-02	1.36E-03
Naphthalene	1.30E-04	AP42; Table 3.4-4; 10/96.	YES	1.83E-02	9.15E-04
Acenaphthylene	9.23E-06	AP42; Table 3.4-4; 10/96.	YES	1.30E-03	6.50E-05
Acenaphthene	4.68E-06	AP42; Table 3.4-4; 10/96.	YES	6.59E-04	3.29E-05
Fluorene	1.28E-05	AP42; Table 3.4-4; 10/96.	YES	1.80E-03	9.01E-05
Phenanthrene	4.08E-05	AP42; Table 3.4-4; 10/96.	YES	5.74E-03	2.87E-04
Anthracene	1.23E-06	AP42; Table 3.4-4; 10/96.	YES	1.73E-04	8.66E-06
Fluoranthene	4.03E-06	AP42; Table 3.4-4; 10/96.	YES	5.67E-04	2.84E-05
Pyrene	3.71E-06	AP42; Table 3.4-4; 10/96.	YES	5.22E-04	2.61E-05
Benzo(a)anthracene	6.22E-07	AP42; Table 3.4-4; 10/96.	YES	8.76E-05	4.38E-06
Chrysene	1.53E-06	AP42; Table 3.4-4; 10/96.	YES	2.15E-04	1.08E-05
Benzo(b)fluoranthene	1.11E-06	AP42; Table 3.4-4; 10/96.	YES	1.56E-04	7.81E-06
Benzo(k)fluoranthene	<2.18E-07	AP42; Table 3.4-4; 10/96.	YES	<3.07E-05	<1.53E-06
Benzo(a)pyrene	<2.57E-07	AP42; Table 3.4-4; 10/96.	YES	<3.62E-05	<1.81E-06
Indeno(1,2,3-cd)pyrene	<4.14E-07	AP42; Table 3.4-4; 10/96.	YES	<5.83E-05	<2.91E-06
Dibenzo(a,h)anthracene	<3.46E-07	AP42; Table 3.4-4; 10/96.	YES	<4.87E-05	<2.44E-06
Benzo(g,h,I)perylene	<5.56E-07	AP42; Table 3.4-4; 10/96.	YES	<7.83E-05	<3.91E-06
Total PAH	<1.68E-04	AP42; Table 3.4-4; 10/96.	NO	<2.36E-02	<1.18E-03
			Total § 112 HAP =	<2.22E-01	<1.11E-02
Calculation Basis:	Hourly Emissions = EF x Max Heat In x No. of Engines				
	Annual Emissions = Hourly x 100 Hrs/yr / 2000.				

Table 7. Speciated Emissions from Fire Water Pump Engines

Fire Pump ICE HAP PTE - FWP1/2/3 (total for all engines)					
Pollutant	**EF (lb/MMBtu)**	**Source**	**§112 HAP?**	**Emissions Rate (lb/hr)**	**Emissions Rate (T/yr)**
Acetaldehyde	2.52E-05	AP42; Table 3.4-3; 10/96.	YES	3.70E-04	1.85E-05
Acrolein	7.88E-06	AP42; Table 3.4-3; 10/96.	YES	1.16E-04	5.79E-06
Benzene	7.76E-04	AP42; Table 3.4-3; 10/96.	YES	1.14E-02	5.70E-04
Formaldehyde	7.89E-05	AP42; Table 3.4-3; 10/96.	YES	1.16E-03	5.80E-05
Propylene	2.79E-03	AP42; Table 3.4-3; 10/96.	NO	4.10E-02	2.05E-03
Toluene	2.81E-04	AP42; Table 3.4-3; 10/96.	YES	4.13E-03	2.07E-04
Xylenes	1.93E-04	AP42; Table 3.4-3; 10/96.	YES	2.84E-03	1.42E-04
Naphthalene	1.30E-04	AP42; Table 3.4-4; 10/96.	YES	1.91E-03	9.56E-05
Acenaphthylene	9.23E-06	AP42; Table 3.4-4; 10/96.	YES	1.36E-04	6.78E-06
Acenaphthene	4.68E-06	AP42; Table 3.4-4; 10/96.	YES	6.88E-05	3.44E-06
Fluorene	1.28E-05	AP42; Table 3.4-4; 10/96.	YES	1.88E-04	9.41E-06
Phenanthrene	4.08E-05	AP42; Table 3.4-4; 10/96.	YES	6.00E-04	3.00E-05
Anthracene	1.23E-06	AP42; Table 3.4-4; 10/96.	YES	1.81E-05	9.04E-07
Fluoranthene	4.03E-06	AP42; Table 3.4-4; 10/96.	YES	5.92E-05	2.96E-06
Pyrene	3.71E-06	AP42; Table 3.4-4; 10/96.	YES	5.45E-05	2.73E-06
Benzo(a)anthracene	6.22E-07	AP42; Table 3.4-4; 10/96.	YES	9.14E-06	4.57E-07
Chrysene	1.53E-06	AP42; Table 3.4-4; 10/96.	YES	2.25E-05	1.12E-06
Benzo(b)fluoranthene	1.11E-06	AP42; Table 3.4-4; 10/96.	YES	1.63E-05	8.16E-07
Benzo(k)fluoranthene	<2.18E-07	AP42; Table 3.4-4; 10/96.	YES	3.20E-06	<1.60E-07
Benzo(a)pyrene	<2.57E-07	AP42; Table 3.4-4; 10/96.	YES	3.78E-06	<1.89E-07
Indeno(1,2,3-cd)pyrene	<4.14E-07	AP42; Table 3.4-4; 10/96.	YES	6.09E-06	<3.04E-07
Dibenzo(a,h)anthracene	<3.46E-07	AP42; Table 3.4-4; 10/96.	YES	5.09E-06	<2.54E-07
Benzo(g,h,I)perylene	<5.56E-07	AP42; Table 3.4-4; 10/96.	YES	8.17E-06	<4.09E-07
			Total § 112 HAP =	<2.31E-02	<1.16E-03
Calculation Basis:	Hourly Emissions = EF x Max Heat In x No. of Engines				
	Annual Emissions = Hourly x 100 Hrs/yr / 2000.				

Table 8. Particulate Chromium Emissions from Polyethylene Unit

Catalyst Activation Heater Cr VI Calculation

Parameter	Value	Unit
MW air	28.97	g/mol
Mol Volume 0C	22.4	m3/k mole
Mol Volume 20C	24.0	m3/k mole
Stack Diameter	0.33	ft
Constant	35.3145	ft3/m 3

Calculation

Process Step	Conc. (mg/Nm^3)	% CrVI	Mass Rate (kg/hr)	Temp. (^{O}C)	Vol. Flow Rate (Nm3/hr)	Actual Vol. Flow Rate (m3/hr)	Actual Vol. Flow Rate ft3/hr)	Vel. (ft/sec)	Short Term Max CrVI Rate (mg/hr)	Short Term Max CrVI Rate (lb/hr)	Duration (hr)	Occ /yr	Annualized lb/hr
Loading	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Heat Ramp Step	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Activation Step	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cooling Step	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Total (lb/hr)	2.9E-04	Total (lb/hr)	2.2E-04

Concentration is consistent with proposed LAER PM limit of 0.005 gr/dscf

Redacted information considered trade secret and/or confidential proprietary information as defined in the Pennsylvania Right to Know Law

Table 9. Speciated Emissions from Diesel Storage Tanks

Diesel Storage Tank Emissions Calculation				
	Pollutant			
Parameter	Biphenyl	Naphthalene	Toluene	Ethyl Benzene
Zli Wt. Fraction in liquid, lb/lb*	4.37E-04	7.53E-04	1.38E-03	1.29E-02
ML Mol Wt Fuel	188	188	188	188
Mi Mol Wt Component	154.21	128.17	92.14	106.17
Mv Mol Wt Vapor	130	130	130	130
xi Liquid Mol Fraction	5.33E-04	1.10E-03	2.81E-03	2.29E-02
P Vapor Pressure, psia	0.0002011	0.0034	1.04	0.19
Pi Partial Pressure	1.07E-07	3.78E-06	2.92E-03	4.43E-03
Pv Total Vapor Pressure of liquid	0.0049	0.0049	0.0049	0.0049
Yi Vapor Mol Fraction	2.19E-05	7.72E-04	5.96E-01	9.03E-01
Zvi Wt fraction in vapor, lb/lb	2.59E-05	7.61E-04	4.23E-01	7.38E-01
Lti lb/yr Diesel Locomotive	6.9E-06	2.0E-04	1.1E-01	2.0E-01
Lti lb/yr Emer Gen Diesel Total	1.07E-05	3.15E-04	1.75E-01	3.05E-01
Lti lb/yr Firewater Total	9.1E-07	2.7E-05	1.5E-02	2.6E-02
Diesel Locomotive, lb/hr	7.9E-10	2.3E-08	1.3E-05	2.2E-05
Emer Gen Diesel Total, lb/hr	1.2E-09	3.6E-08	2.0E-05	3.5E-05
Firewater Diesel Total, lb/hr	1.0E-10	3.0E-09	1.7E-06	2.9E-06

* Low sulfur diesel fuel constituents reference, J. Environ. Monit. , 2005, 7, pp. 983-988
Calculation is based on controlled VOC emissions per tank

Table 10. Process Cooling Tower Emissions

Emission Unit(s) ID =	PCT		Process Cooling Tower
Parameter	**Value**		**Source / Basis**
Calculation Inputs			
Number of Cells =	28		Design Specification
Cell Circulation Rate =	10,893	gal/min /cell	=(Cooling Water Rate)/(Number of Cells)
Annual Operating Hours =	8,760	hrs/yr	Maximum potential use.
Drift Loss Factor =	0.00050%	wt. %	Design specification. Basis for proposed BACT limit.
Cooling Water Rate =	305,000	gal/min	Maximum Water Flow Rate (gpm)
Cooling Water TDS =	2,400	ppmw	Annual average BACT/LAER proposal.
VOC Emissions Limit =	0.50	lb/MMg al	Proposed LAER limit.
OHAP Fraction of VOC =	10%	wt. %	ROM estimate; few HAP-containing streams in process.
Calculation Results			
Hourly VOC PTE [per cell] =	0.33	lb/hr	= (Cell Circulation Rate - gpm) x (60 min/hr) x (VOC Emissions Limit - lb/MMGal) / (1,000,000)
Annual VOC PTE [total] =	40.1	T/yr	= (Hourly VOC PTE [per cell]) x (Annual Operating Hours) / (2,000 lb/T) x (Number of Cells)
Annual HAP PTE [total] =	4.0	T/yr	= (OHAP Fraction of VOC) x (Annual VOC PTE [total])
PM10 Fraction of PM =	57.2%	wt. %	See particle size distribution calculation -->
PM2.5 Fraction of PM =	0.21%	wt. %	See particle size distribution calculation -->
Hourly PM PTE [per cell] =	0.1	lb/hr	= (Cell Circulation Rate) x (60 min/yr) x (8.34 lb/gal) x (Drift Loss Factor) x (Cooling Water TDS) / (1,000,000)
Annual PM PTE [total] =	8.0	tpy	= (Hourly PM PTE [per cell]) x (Annual Operating Hours) / (2,000 lb/T) x (Number of Cells)
Hourly PM10 PTE [per cell] =	0.037	lb/hr	= (PM10 Fraction of PM) x (Hourly PM PTE [per cell])
Annual PM10 PTE [total] =	4.6	tpy	= (PM10 Fraction of PM) x (Annual PM PTE [total])
Hourly PM2.5 PTE [per cell] =	0.00	lb/hr	= (PM2.5 Fraction of PM) x (Hourly PM PTE [per cell])
Annual PM2.5 PTE [total] =	0.0168	tpy	= (PM2.5 Fraction of PM) x (Annual PM PTE [total])

Table 11. WWTP Emissions

WWTP Equipment (W-1001) - Emissions Summary								
	Maximum Rate	Emission Factor	Short Term Max Emissions	Annualized Emissions			Calculation/ Estimation Method	Emission Factor Reference
Pollutant	MMG /day	lb/MMG	lb/hr	lb/hr	hrs/year	TPY		
VOC	N/A	N/A	0.048	0.010	8,760	4.22E-02	Emissions model	EPA WATER9
Benzene	N/A	N/A	0.048	0.010	8,760	4.22E-02	Emissions model	EPA WATER9
Phenol	N/A	N/A	3.7E-06	7.5E-07	8,760	3.29E-06	Emissions model	EPA WATER9
WWTP Equipment (W-1001) include: Biotreater Aeration Tank, two Secondary Clarifiers, Biosludge Holding Tank, Biosludge Dewatering Tank, Centrate Sump, Sand Filter, Sand Filter Backwash Receiver and Outfall. The Flow Equalization and Oil Removal Tanks (T-5307A/B) are vented to the Spent Caustic Vent Incinerator (A5401).								
Basis: Emissions were modeled under worst-case conditions of dry weather flow. Short term maximum emissions based on peak concentrations to the WWTP. Annualized emissions based on annual average concentrations.								
Example Calculations: 0.42 ton VOC/yr = (0.097 lb/hr) x (8,760 hrs/year) / (2,000 lb/ton)								

Table 12. Speciated Short Term and Annualized Hourly Flare Emission

Flare	MMBtu /hr*	
HP Ground Flares / Short-Term Max	2,687	Maximum expected short-term rates based on proposed vendor data associated with various potential scenarios (e.g., a cold start-up). Includes 1.0 MM Btu/hr of pilot gas at all times.
HP Ground Flares / Annual Average	91	Represents reasonably anticipated maintenance events, 1 start up and 1 shutdown, and 1.0 MMBtu/hr pilot gas
HP Elevated Flare / Normal Ops	52	Represents 1.0 MMBtu/hr of pilot gas and 1.0MT/hr of natural gas as sweep gas
MP Grnd. Flare / Normal Ops	2	Based on 1 start up and 1 shutdown with anticipated flaring of 225 MT of ethane/event and includes 1.0 MM Btu/hr pilot gas
MP Grnd Flare / Short-Term Max	100	Based on flaring 2.0 MT/hr of ethane, which is maximum anticipate rate from various SU/SD modes and includes 1.0 MMBtu/hr pilot gas.
Annual Hours @ 100% Load =	8,760 hr/yr	
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)	
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)	

Pollutant	EF (lb/ MMSCF)	EF Source (AP-42 7/98 Table #)	EF (lb/MMBtu)	§112 HAP?	HP Ground Flares Short Term Max (lb/hr)	HP Ground Flares Annual Average (tpy)	HP Elevated Flare Short Term Max (lb/hr)	HP Elevated Flare Annual Average (tpy)	MP Ground Flares Short Term Max (lb/hr)	MP Ground Flares Annual Ave. (tpy)
2-Methylnaphthalene	2.40E-05	1.4-3	2.35E-08	YES	6.32E-05	9.42E-06	1.22E-06	5.33E-06	2.35E-06	2.34E-07
3-Methylchloranthrene	<1.8E-06	1.4-3	<1.76E-09	YES	4.74E-06	7.06E-07	9.12E-08	4.00E-07	1.76E-07	1.75E-08
7,12-Dimethylbenz(a)anthracene	<1.6E-05	1.4-3	<1.57E-08	YES	4.21E-05	6.28E-06	8.11E-07	3.55E-06	1.56E-06	1.56E-07
Acenaphthene	<1.8E-06	1.4-3	<1.76E-09	YES	4.74E-06	7.06E-07	9.12E-08	4.00E-07	1.76E-07	1.75E-08
Anthracene	<2.4E-06	1.4-3	<2.35E-09	YES	6.32E-06	9.42E-07	1.22E-07	5.33E-07	2.35E-07	2.34E-08
Benzo(a)anthracene	<1.8E-06	1.4-3	<1.76E-09	YES	4.74E-06	7.06E-07	9.12E-08	4.00E-07	1.76E-07	1.75E-08
Benzene	2.10E-03	1.4-3	2.06E-06	YES	5.53E-03	8.24E-04	1.06E-04	4.66E-04	2.05E-04	2.05E-05
Benzo(a)pyrene	<1.2E-06	1.4-3	<1.18E-09	YES	3.16E-06	4.71E-07	6.08E-08	2.66E-07	1.17E-07	1.17E-08
Benzo(b)fluoranthene	<1.8E-06	1.4-3	<1.76E-09	YES	4.74E-06	7.06E-07	9.12E-08	4.00E-07	1.76E-07	1.75E-08
Benzo(g,h,i)perylene	<1.2E-06	1.4-3	<1.18E-09	YES	3.16E-06	4.71E-07	6.08E-08	2.66E-07	1.17E-07	1.17E-08
Benzo(k)fluoranthene	<1.8E-06	1.4-3	<1.76E-09	YES	4.74E-06	7.06E-07	9.12E-08	4.00E-07	1.76E-07	1.75E-08

Flare	MMBtu /hr*	
HP Ground Flares / Short-Term Max	2,687	Maximum expected short-term rates based on proposed vendor data associated with various potential scenarios (e.g., a cold start-up). Includes 1.0 MM Btu/hr of pilot gas at all times.
HP Ground Flares / Annual Average	91	Represents reasonably anticipated maintenance events, 1 start up and 1 shutdown, and 1.0 MMBtu/hr pilot gas
HP Elevated Flare / Normal Ops	52	Represents 1.0 MMBtu/hr of pilot gas and 1.0MT/hr of natural gas as sweep gas
MP Grnd. Flare / Normal Ops	2	Based on 1 start up and 1 shutdown with anticipated flaring of 225 MT of ethane/event and includes 1.0 MM Btu/hr pilot gas
MP Grnd Flare / Short-Term Max	100	Based on flaring 2.0 MT/hr of ethane, which is maximum anticipate rate from various SU/SD modes and includes 1.0 MMBtu/hr pilot gas.
Annual Hours @ 100% Load =	8,760 hr/yr	
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)	
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)	

Pollutant	EF (lb/ MMSCF)	EF Source (AP-42 7/98 Table #)	EF (lb/MMBtu)	§112 HAP?	HP Ground Flares Short Term Max (lb/hr)	HP Ground Flares Annual Average (tpy)	HP Elevated Flare Short Term Max (lb/hr)	HP Elevated Flare Annual Average (tpy)	MP Ground Flares Short Term Max (lb/hr)	MP Ground Flares Annual Ave. (tpy)
Butane	2.10E+00	1.4-3	2.06E-03	NO	5.53E+00	8.24E-01	1.06E-01	4.66E-01	2.05E-01	2.05E-02
Chrysene	<1.8E-06	1.4-3	<1.76E-09	YES	4.74E-06	7.06E-07	9.12E-08	4.00E-07	1.76E-07	1.75E-08
Dibenzo(a,h)anthracene	<1.2E-06	1.4-3	<1.18E-09	YES	3.16E-06	4.71E-07	6.08E-08	2.66E-07	1.17E-07	1.17E-08
Dichlorobenzene	1.20E-03	1.4-3	1.18E-06	YES	3.16E-03	4.71E-04	6.08E-05	2.66E-04	1.17E-04	1.17E-05
Ethane	3.10E+00	1.4-3	3.04E-03	NO	8.17E+00	1.22E+00	1.57E-01	6.88E-01	3.03E-01	3.02E-02
Fluoranthene	3.00E-06	1.4-3	2.94E-09	YES	7.90E-06	1.18E-06	1.52E-07	6.66E-07	2.93E-07	2.92E-08
Fluorene	2.80E-06	1.4-3	2.75E-09	YES	7.38E-06	1.10E-06	1.42E-07	6.22E-07	2.74E-07	2.73E-08
Formaldehyde	7.50E-02	1.4-3	7.35E-05	YES	1.98E-01	2.94E-02	3.80E-03	1.67E-02	7.34E-03	7.31E-04
Hexane	1.80E+00	1.4-3	1.76E-03	YES	4.74E+00	7.06E-01	9.12E-02	4.00E-01	1.76E-01	1.75E-02
Indeno(1,2,3-cd)pyrene	<1.8E-06	1.4-3	<1.76E-09	YES	4.74E-06	7.06E-07	9.12E-08	4.00E-07	1.76E-07	1.75E-08
Naphthalene	6.10E-04	1.4-3	5.98E-07	YES	1.61E-03	2.39E-04	3.09E-05	1.35E-04	5.97E-05	5.94E-06
Pentane	2.60E+00	1.4-3	2.55E-03	NO	6.85E+00	1.02E+00	1.32E-01	5.77E-01	2.54E-01	2.53E-02
Phenanthrene	1.70E-05	1.4-3	1.67E-08	YES	4.48E-05	6.67E-06	8.62E-07	3.77E-06	1.66E-06	1.66E-07

Flare	MMBtu /hr*	
HP Ground Flares / Short-Term Max	2,687	Maximum expected short-term rates based on proposed vendor data associated with various potential scenarios (e.g., a cold start-up). Includes 1.0 MM Btu/hr of pilot gas at all times.
HP Ground Flares / Annual Average	91	Represents reasonably anticipated maintenance events, 1 start up and 1 shutdown, and 1.0 MMBtu/hr pilot gas
HP Elevated Flare / Normal Ops	52	Represents 1.0 MMBtu/hr of pilot gas and 1.0MT/hr of natural gas as sweep gas
MP Grnd. Flare / Normal Ops	2	Based on 1 start up and 1 shutdown with anticipated flaring of 225 MT of ethane/event and includes 1.0 MM Btu/hr pilot gas
MP Grnd Flare / Short-Term Max	100	Based on flaring 2.0 MT/hr of ethane, which is maximum anticipate rate from various SU/SD modes and includes 1.0 MMBtu/hr pilot gas.
Annual Hours @ 100% Load =	8,760 hr/yr	
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)	
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)	

Pollutant	EF (lb/ MMSCF)	EF Source (AP-42 7/98 Table #)	EF (lb/MMBtu)	§112 HAP?	HP Ground Flares Short Term Max (lb/hr)	HP Ground Flares Annual Average (tpy)	HP Elevated Flare Short Term Max (lb/hr)	HP Elevated Flare Annual Average (tpy)	MP Ground Flares Short Term Max (lb/hr)	MP Ground Flares Annual Ave. (tpy)
Propane	1.60E+00	1.4-3	1.57E-03	NO	4.21E+00	6.28E-01	8.11E-02	3.55E-01	1.56E-01	1.56E-02
Pyrene	5.00E-06	1.4-3	4.90E-09	YES	1.32E-05	1.96E-06	2.53E-07	1.11E-06	4.89E-07	4.87E-08
Toluene	3.40E-03	1.4-3	3.33E-06	YES	8.96E-03	1.33E-03	1.72E-04	7.55E-04	3.33E-04	3.31E-05
Arsenic	2.00E-04	1.4-4	1.96E-07	YES	5.27E-04	7.85E-05	1.01E-05	4.44E-05	1.96E-05	1.95E-06
Barium	4.40E-03	1.4-4	4.31E-06	NO	1.16E-02	1.73E-03	2.23E-04	9.77E-04	4.30E-04	4.29E-05
Beryllium	<1.2E-05	1.4-4	<1.18E-08	YES	3.16E-05	4.71E-06	6.08E-07	2.66E-06	1.17E-06	1.17E-07
Cadmium	1.10E-03	1.4-4	1.08E-06	YES	2.90E-03	4.32E-04	5.58E-05	2.44E-04	1.08E-04	1.07E-05
Chromium	1.40E-03	1.4-4	1.37E-06	YES	3.69E-03	5.49E-04	7.10E-05	3.11E-04	1.37E-04	1.36E-05
Cobalt	8.40E-05	1.4-4	8.24E-08	YES	2.21E-04	3.30E-05	4.26E-06	1.87E-05	8.22E-06	8.18E-07
Copper	8.50E-04	1.4-4	8.33E-07	NO	2.24E-03	3.34E-04	4.31E-05	1.89E-04	8.31E-05	8.28E-06
Lead	5.00E-04	1.4-4	4.90E-07	YES	1.32E-03	1.96E-04	2.53E-05	1.11E-04	4.89E-05	4.87E-06
Manganese	3.80E-04	1.4-4	3.73E-07	YES	1.00E-03	1.49E-04	1.93E-05	8.44E-05	3.72E-05	3.70E-06
Mercury	2.60E-04	1.4-4	2.55E-07	YES	6.85E-04	1.02E-04	1.32E-05	5.77E-05	2.54E-05	2.53E-06
Molybdenum	1.10E-03	1.4-4	1.08E-06	NO	2.90E-03	4.32E-04	5.58E-05	2.44E-04	1.08E-04	1.07E-05

Flare	MMBtu /hr*	
HP Ground Flares / Short-Term Max	2,687	Maximum expected short-term rates based on proposed vendor data associated with various potential scenarios (e.g., a cold start-up). Includes 1.0 MM Btu/hr of pilot gas at all times.
HP Ground Flares / Annual Average	91	Represents reasonably anticipated maintenance events, 1 start up and 1 shutdown, and 1.0 MMBtu/hr pilot gas
HP Elevated Flare / Normal Ops	52	Represents 1.0 MMBtu/hr of pilot gas and 1.0MT/hr of natural gas as sweep gas
MP Grnd. Flare / Normal Ops	2	Based on 1 start up and 1 shutdown with anticipated flaring of 225 MT of ethane/event and includes 1.0 MM Btu/hr pilot gas
MP Grnd Flare / Short-Term Max	100	Based on flaring 2.0 MT/hr of ethane, which is maximum anticipate rate from various SU/SD modes and includes 1.0 MMBtu/hr pilot gas.

Annual Hours @ 100% Load =	8,760 hr/yr
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)

Pollutant	EF (lb/ MMSCF)	EF Source (AP-42 7/98 Table #)	EF (lb/MMBtu)	§112 HAP?	HP Ground Flares Short Term Max (lb/hr)	HP Ground Flares Annual Average (tpy)	HP Elevated Flare Short Term Max (lb/hr)	HP Elevated Flare Annual Average (tpy)	MP Ground Flares Short Term Max (lb/hr)	MP Ground Flares Annual Ave. (tpy)
Nickel	2.10E-03	1.4-4	2.06E-06	YES	5.53E-03	8.24E-04	1.06E-04	4.66E-04	2.05E-04	2.05E-05
Selenium	<2.4E-05	1.4-4	<2.35E-08	YES	6.32E-05	9.42E-06	1.22E-06	5.33E-06	2.35E-06	2.34E-07
Vanadium	2.30E-03	1.4-4	2.25E-06	NO	6.06E-03	9.03E-04	1.17E-04	5.11E-04	2.25E-04	2.24E-05
Zinc	2.90E-02	1.4-4	2.84E-05	NO	7.64E-02	1.14E-02	1.47E-03	6.44E-03	2.84E-03	2.82E-04
Total §112 HAPs					**<4.97E+00**	**<7.41E-01**	**<9.57E-02**	**<4.19E-01**	**<1.85E-01**	**<1.84E-02**

* Emissions from the combustion of process gases based on natural gas combustion emission factors and heat input values consistent with those presented in the April 2014 Plan Approval Application and September 2014 Technical Supplement.

Table 13. Speciated Low Pressure Thermal Incinerator Emissions

LPTI HAP EMISSIONS CALCULATIONS*										
Potential Heat Input (HHV)	140	MMBtu/hr Proposed design basis								
Max Short Term Heat Input (HHV)	250	MM Btu/hr based on 10tph capacity at 22,000 Btu/lb								
Annual Hours @ 100% Load =	8,760	hr/yr								
DRE =	99.9	%								
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)									
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)									
					Combustion Product		**Process Gas**		**Total**	
Pollutant	**EF (lb/MMSCF)**	**EF Source (AP-42 7/98 Table #)**	**EF (lb/MMBtu)**	**§112 HAP?**	**Short Term Max (lb/hr)**	**Annual Average (tpy)**	**Short Term Max (lb/hr)**	**Annual Ave. (tpy)**	**Short Term Max (lb/hr)**	**Annual Average (tpy)**
1,3-Butadiene	N/A			YES			3.34E-05	1.46E-04	3.34E-05	1.46E-04
2-Methylnaphthalene	2.40E-05	1.4-3	2.35E-08	YES	5.88E-06	1.44E-05			5.88E-06	1.44E-05
3-Methylchloranthrene	<1.8E-06	1.4-3	<1.76E-09	YES	4.41E-07	1.08E-06			4.41E-07	1.08E-06
7,12Dimethylbenz(a) anthracene	<1.6E-05	1.4-3	<1.57E-08	YES	3.92E-06	9.63E-06			3.92E-06	9.63E-06
Acenaphthene	<1.8E-06	1.4-3	<1.76E-09	YES	4.41E-07	1.08E-06			4.41E-07	1.08E-06
Anthracene	<2.4E-06	1.4-3	<2.35E-09	YES	5.88E-07	1.44E-06			5.88E-07	1.44E-06
Benzo(a)anthracene	<1.8E-06	1.4-3	<1.76E-09	YES	4.41E-07	1.08E-06			4.41E-07	1.08E-06
Benzene	2.10E-03	1.4-3	2.06E-06	YES	5.15E-04	1.26E-03	1.76E-03	7.71E-03	2.27E-03	8.97E-03
Benzo(a)pyrene	<1.2E-06	1.4-3	<1.18E-09	YES	2.94E-07	7.22E-07			2.94E-07	7.22E-07
Benzo(b)fluoranthene	<1.8E-06	1.4-3	<1.76E-09	YES	4.41E-07	1.08E-06			4.41E-07	1.08E-06
Benzo(g,h,i)perylene	<1.2E-06	1.4-3	<1.18E-09	YES	2.94E-07	7.22E-07			2.94E-07	7.22E-07
Benzo(k)fluoranthene	<1.8E-06	1.4-3	<1.76E-09	YES	4.41E-07	1.08E-06			4.41E-07	1.08E-06
Butane	2.10E+00	1.4-3	2.06E-03	NO	5.15E-01	1.26E+00			5.15E-01	1.26E+00
Chrysene	<1.8E-06	1.4-3	<1.76E-09	YES	4.41E-07	1.08E-06			4.41E-07	1.08E-06
Dibenzo(a,h)anthracene	<1.2E-06	1.4-3	<1.18E-09	YES	2.94E-07	7.22E-07			2.94E-07	7.22E-07

LPTI HAP EMISSIONS CALCULATIONS*										
Potential Heat Input (HHV)	140	MMBtu/hr Proposed design basis								
Max Short Term Heat Input (HHV)	250	MM Btu/hr based on 10tph capacity at 22,000 Btu/lb								
Annual Hours @ 100% Load =	8,760	hr/yr								
DRE =	99.9	%								
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)									
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)									
					Combustion Product		**Process Gas**		**Total**	
Pollutant	**EF (lb/MMSCF)**	**EF Source (AP-42 7/98 Table #)**	**EF (lb/MMBtu)**	**§112 HAP?**	**Short Term Max (lb/hr)**	**Annual Average (tpy)**	**Short Term Max (lb/hr)**	**Annual Ave. (tpy)**	**Short Term Max (lb/hr)**	**Annual Average (tpy)**
Dichlorobenzene	1.20E-03	1.4-3	1.18E-06	YES	2.94E-04	7.22E-04			2.94E-04	7.22E-04
Ethane	3.10E+00	1.4-3	3.04E-03	NO	7.60E-01	1.87E+00	2.78E-06	1.22E-05	7.60E-01	1.87E+00
Ethylbenzene	N/A			YES			7.72E-05	3.38E-04	7.72E-05	3.38E-04
Fluoranthene	3.00E-06	1.4-3	2.94E-09	YES	7.35E-07	1.80E-06			7.35E-07	1.80E-06
Fluorene	2.80E-06	1.4-3	2.75E-09	YES	6.86E-07	1.68E-06			6.86E-07	1.68E-06
Formaldehyde	7.50E-02	1.4-3	7.35E-05	YES	1.84E-02	4.51E-02			1.84E-02	4.51E-02
Hexane	1.80E+00	1.4-3	1.76E-03	YES	4.41E-01	1.08E+00			4.41E-01	1.08E+00
Indeno(1,2,3-cd)pyrene	<1.8E-06	1.4-3	<1.76E-09	YES	4.41E-07	1.08E-06			4.41E-07	1.08E-06
Naphthalene	6.10E-04	1.4-3	5.98E-07	YES	1.50E-04	3.67E-04	1.60E-03	7.02E-03	1.75E-03	7.39E-03
Pentane	2.60E+00	1.4-3	2.55E-03	NO	6.37E-01	1.56E+00			6.37E-01	1.56E+00
Phenanthrene	1.70E-05	1.4-3	1.67E-08	YES	4.17E-06	1.02E-05			4.17E-06	1.02E-05
Propane	1.60E+00	1.4-3	1.57E-03	NO	3.92E-01	9.63E-01			3.92E-01	9.63E-01
Pyrene	5.00E-06	1.4-3	4.90E-09	YES	1.23E-06	3.01E-06			1.23E-06	3.01E-06
Styrene	N/A			YES			4.39E-04	1.92E-03	4.39E-04	1.92E-03
Toluene	3.40E-03	1.4-3	3.33E-06	YES	8.33E-04	2.05E-03	9.10E-04	3.99E-03	1.74E-03	6.03E-03
Xylenes	N/A			YES			2.92E-05	1.28E-04	2.92E-05	1.28E-04
Arsenic	2.00E-04	1.4-4	1.96E-07	YES	4.90E-05	1.20E-04			4.90E-05	1.20E-04
Barium	4.40E-03	1.4-4	4.31E-06	NO	1.08E-03	2.65E-03			1.08E-03	2.65E-03

LPTI HAP EMISSIONS CALCULATIONS*										
Potential Heat Input (HHV)	140	MMBtu/hr Proposed design basis								
Max Short Term Heat Input (HHV)	250	MM Btu/hr based on 10tph capacity at 22,000 Btu/lb								
Annual Hours @ 100% Load =	8,760	hr/yr								
DRE =	99.9	%								
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)									
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)									
					Combustion Product		**Process Gas**		**Total**	
Pollutant	**EF (lb/MMSCF)**	**EF Source (AP-42 7/98 Table #)**	**EF (lb/MMBtu)**	**§112 HAP?**	**Short Term Max (lb/hr)**	**Annual Average (tpy)**	**Short Term Max (lb/hr)**	**Annual Ave. (tpy)**	**Short Term Max (lb/hr)**	**Annual Average (tpy)**
Beryllium	<1.2E-05	1.4-4	<1.18E-08	YES	2.94E-06	7.22E-06			2.94E-06	7.22E-06
Cadmium	1.10E-03	1.4-4	1.08E-06	YES	2.70E-04	6.62E-04			2.70E-04	6.62E-04
Chromium	1.40E-03	1.4-4	1.37E-06	YES	3.43E-04	8.42E-04			3.43E-04	8.42E-04
Cobalt	8.40E-05	1.4-4	8.24E-08	YES	2.06E-05	5.05E-05			2.06E-05	5.05E-05
Copper	8.50E-04	1.4-4	8.33E-07	NO	2.08E-04	5.11E-04			2.08E-04	5.11E-04
Lead	5.00E-04	1.4-4	4.90E-07	YES	1.23E-04	3.01E-04			1.23E-04	3.01E-04
Manganese	3.80E-04	1.4-4	3.73E-07	YES	9.31E-05	2.29E-04			9.31E-05	2.29E-04
Mercury	2.60E-04	1.4-4	2.55E-07	YES	6.37E-05	1.56E-04			6.37E-05	1.56E-04
Molybdenum	1.10E-03	1.4-4	1.08E-06	NO	2.70E-04	6.62E-04			2.70E-04	6.62E-04
Nickel	2.10E-03	1.4-4	2.06E-06	YES	5.15E-04	1.26E-03			5.15E-04	1.26E-03
Selenium	<2.4E-05	1.4-4	<2.35E-08	YES	5.88E-06	1.44E-05			5.88E-06	1.44E-05
Vanadium	2.30E-03	1.4-4	2.25E-06	NO	5.64E-04	1.38E-03			5.64E-04	1.38E-03
Zinc	2.90E-02	1.4-4	2.84E-05	NO	7.11E-03	1.74E-02			7.11E-03	1.74E-02
Total §112 HAPs					**<4.63E-01**	**<1.14E+00**	**<4.85E-03**	**<2.12E-02**	**<4.68E-01**	**<1.16E+00**

* Emissions from the combustion of process gases based on natural gas combustion emission factors and heat input values consistent with those presented in the April 2014 Plan Approval Application and September 2014 Technical Supplement.

Table 14. Speciated Spent Caustic Incinerator Emissions

SCTI HAP EMISSIONS CALCULATIONS*										
Potential Heat Input (HHV)	11	MMBtu/hr Proposed design basis								
Max Short Term Heat Input (HHV)	11	MM Btu/hr based on 10 tph capacity at 22,000 Btu/lb								
Annual Hours @ 100% Load =	8,760	hr/yr								
DRE =	99.0	%								
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)									
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)									
					Combustion Product		**Process Gas**		**Total**	
Pollutant	**EF (lb/MMSCF)**	**EF Source (AP-42 7/98 Table #)**	**EF (lb/MMBtu)**	**§112 HAP?**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**
1,3-Butadiene	N/A			YES			1.50E-02	1.50E-02	1.50E-02	1.50E-02
2-Methylnaphthalene	2.40E-05	1.4-3	2.35E-08	YES	2.52E-07	2.52E-07			2.52E-07	2.52E-07
3-Methylchloranthrene	<1.8E-06	1.4-3	<1.76E-09	YES	1.89E-08	1.89E-08			1.89E-08	1.89E-08
7,12 Dimethylbenz(a) anthracene	<1.6E-05	1.4-3	<1.57E-08	YES	1.68E-07	1.68E-07			1.68E-07	1.68E-07
Acenaphthene	<1.8E-06	1.4-3	<1.76E-09	YES	1.89E-08	1.89E-08			1.89E-08	1.89E-08
Anthracene	<2.4E-06	1.4-3	<2.35E-09	YES	2.52E-08	2.52E-08			2.52E-08	2.52E-08
Benzo(a)anthracene	<1.8E-06	1.4-3	<1.76E-09	YES	1.89E-08	1.89E-08			1.89E-08	1.89E-08
Benzene	2.10E-03	1.4-3	2.06E-06	YES	2.21E-05	2.21E-05	1.09E-01	1.09E-01	1.09E-01	1.09E-01
Benzo(a)pyrene	<1.2E-06	1.4-3	<1.18E-09	YES	1.26E-08	1.26E-08			1.26E-08	1.26E-08
Benzo(b)fluoranthene	<1.8E-06	1.4-3	<1.76E-09	YES	1.89E-08	1.89E-08			1.89E-08	1.89E-08
Benzo(g,h,i)perylene	<1.2E-06	1.4-3	<1.18E-09	YES	1.26E-08	1.26E-08			1.26E-08	1.26E-08
Benzo(k)fluoranthene	<1.8E-06	1.4-3	<1.76E-09	YES	1.89E-08	1.89E-08			1.89E-08	1.89E-08

SCTI HAP EMISSIONS CALCULATIONS*

Potential Heat Input (HHV)	11	MMBtu/hr Proposed design basis
Max Short Term Heat Input (HHV)	11	MM Btu/hr based on 10 tph capacity at 22,000 Btu/lb
Annual Hours @ 100% Load =	8,760	hr/yr
DRE =	99.0	%
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)	
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)	

					Combustion Product		Process Gas		Total	
Pollutant	**EF (lb/MMSCF)**	**EF Source (AP-42 7/98 Table #)**	**EF (lb/MMBtu)**	**§112 HAP?**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**
Butane	2.10E+00	1.4-3	2.06E-03	NO	2.21E-02	2.21E-02			2.21E-02	2.21E-02
Chrysene	<1.8E-06	1.4-3	<1.76E-09	YES	1.89E-08	1.89E-08			1.89E-08	1.89E-08
Dibenzo(a,h)anthracene	<1.2E-06	1.4-3	<1.18E-09	YES	1.26E-08	1.26E-08			1.26E-08	1.26E-08
Dichlorobenzene	1.20E-03	1.4-3	1.18E-06	YES	1.26E-05	1.26E-05			1.26E-05	1.26E-05
Ethane	3.10E+00	1.4-3	3.04E-03	NO	3.26E-02	3.26E-02			3.26E-02	3.26E-02
Ethylbenzene	N/A			YES						
Ethylene Oxide	N/A			YES						
Fluoranthene	3.00E-06	1.4-3	2.94E-09	YES	3.15E-08	3.15E-08			3.15E-08	3.15E-08
Fluorene	2.80E-06	1.4-3	2.75E-09	YES	2.94E-08	2.94E-08			2.94E-08	2.94E-08
Formaldehyde	7.50E-02	1.4-3	7.35E-05	YES	7.89E-04	7.89E-04			7.89E-04	7.89E-04
Hexane	1.80E+00	1.4-3	1.76E-03	YES	1.89E-02	1.89E-02			1.89E-02	1.89E-02
Indeno(1,2,3-cd)pyrene	<1.8E-06	1.4-3	<1.76E-09	YES	1.89E-08	1.89E-08			1.89E-08	1.89E-08
Naphthalene	6.10E-04	1.4-3	5.98E-07	YES	6.41E-06	6.41E-06			6.41E-06	6.41E-06

SCTI HAP EMISSIONS CALCULATIONS*

Potential Heat Input (HHV)	11	MMBtu/hr Proposed design basis
Max Short Term Heat Input (HHV)	11	MM Btu/hr based on 10 tph capacity at 22,000 Btu/lb
Annual Hours @ 100% Load =	8,760	hr/yr
DRE =	99.0	%
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)	
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)	

					Combustion Product		Process Gas		Total	
Pollutant	**EF (lb/MMSCF)**	**EF Source (AP-42 7/98 Table #)**	**EF (lb/MMBtu)**	**§112 HAP?**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**
Pentane	2.60E+00	1.4-3	2.55E-03	NO	2.73E-02	2.73E-02			2.73E-02	2.73E-02
Phenanthrene	1.70E-05	1.4-3	1.67E-08	YES	1.79E-07	1.79E-07			1.79E-07	1.79E-07
Propane	1.60E+00	1.4-3	1.57E-03	NO	1.68E-02	1.68E-02			1.68E-02	1.68E-02
Pyrene	5.00E-06	1.4-3	4.90E-09	YES	5.26E-08	5.26E-08			5.26E-08	5.26E-08
Styrene	N/A			YES						
Toluene	3.40E-03	1.4-3	3.33E-06	YES	3.58E-05	3.58E-05			3.58E-05	3.58E-05
Xylenes	N/A			YES						
Arsenic	2.00E-04	1.4-4	1.96E-07	YES	2.10E-06	2.10E-06			2.10E-06	2.10E-06
Barium	4.40E-03	1.4-4	4.31E-06	NO	4.63E-05	4.63E-05			4.63E-05	4.63E-05
Beryllium	<1.2E-05	1.4-4	<1.18E-08	YES	1.26E-07	1.26E-07			1.26E-07	1.26E-07
Cadmium	1.10E-03	1.4-4	1.08E-06	YES	1.16E-05	1.16E-05			1.16E-05	1.16E-05
Chromium	1.40E-03	1.4-4	1.37E-06	YES	1.47E-05	1.47E-05			1.47E-05	1.47E-05
Cobalt	8.40E-05	1.4-4	8.24E-08	YES	8.83E-07	8.83E-07			8.83E-07	8.83E-07

SCTI HAP EMISSIONS CALCULATIONS*

Potential Heat Input (HHV)	11	MMBtu/hr Proposed design basis
Max Short Term Heat Input (HHV)	11	MM Btu/hr based on 10 tph capacity at 22,000 Btu/lb
Annual Hours @ 100% Load =	8,760	hr/yr
DRE =	99.0	%
Hourly Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF)	
Annual Emissions =	(Max Heat Input - MMBtu/hr) x (1 SCF/1,020 Btu) x (EF - lb/MMSCF) x (Annual Operating Hours) / (2,000 lb/T)	

					Combustion Product		Process Gas		Total	
Pollutant	**EF (lb/MMSCF)**	**EF Source (AP-42 7/98 Table #)**	**EF (lb/MMBtu)**	**§112 HAP?**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**	**Short Term Max (lb/hr)**	**Annual Ave. (lb/hr)**
Copper	8.50E-04	1.4-4	8.33E-07	NO	8.94E-06	8.94E-06			8.94E-06	8.94E-06
Manganese	3.80E-04	1.4-4	3.73E-07	YES	4.00E-06	4.00E-06			4.00E-06	4.00E-06
Mercury	2.60E-04	1.4-4	2.55E-07	YES	2.73E-06	2.73E-06			2.73E-06	2.73E-06
Molybdenum	1.10E-03	1.4-4	1.08E-06	NO	1.16E-05	1.16E-05			1.16E-05	1.16E-05
Nickel	2.10E-03	1.4-4	2.06E-06	YES	2.21E-05	2.21E-05			2.21E-05	2.21E-05
Selenium	<2.4E-05	1.4-4	<2.35E-08	YES	2.52E-07	2.52E-07			2.52E-07	2.52E-07
Vanadium	2.30E-03	1.4-4	2.25E-06	NO	2.42E-05	2.42E-05			2.42E-05	2.42E-05
Zinc	2.90E-02	1.4-4	2.84E-05	NO	3.05E-04	3.05E-04			3.05E-04	3.05E-04
Total §112 HAPs					<1.99E-02	<1.99E-02	<1.24E-01	<1.24E-01	<1.44E-01	<1.44E-01

* Emissions from the combustion of process gases based on natural gas combustion emission factors and heat input values consistent with those presented in the April 2014 Plan Approval Application and September 2014 Technical Supplement.

Table 15. Speciated Equipment Leak Emissions Estimates

Ethylene Manufacturing Fugitives Area Designation	Equipment	Service	SOCMI Emission Factor (lb/hr/source)	LAER Control Efficiency (%)	Compound	Equip. Count	Composition (wt%)	Emissions (lb/hr)
1	Valves	Gas/Vapor	0.0132	97	1,3-Butadiene	442	1	0.002
1	Connectors	Gas/Vapor	0.0039	97	1,3-Butadiene	1908	1	0.002
2	Valves	Gas/Vapor	0.0132	97	1,3-Butadiene	160	1	0.001
2	Connectors	Gas/Vapor	0.0039	97	1,3-Butadiene	504	1	0.001
3	Valves	Gas/Vapor	0.0132	97	1,3-Butadiene	70	1	0.000
3	Valves	Light Liquid	0.0089	97	1,3-Butadiene	430	0.48	0.001
3	Valves	Light Liquid	0.0089	97	Benzene	430	25.31	0.029
3	Valves	Light Liquid	0.0089	97	Naphthalene	430	16	0.018
3	Valves	Light Liquid	0.0089	97	Toluene	430	13.09	0.015
3	Valves	Light Liquid	0.0089	97	Styrene	430	6.31	0.007
3	Valves	Light Liquid	0.0089	97	Xylenes	430	0.42	0.000
3	Valves	Light Liquid	0.0089	97	Ethylbenzene	430	1.11	0.001
3	Connectors	Gas/Vapor	0.0039	97	1,3-Butadiene	209	1	0.000
3	Connectors	Light Liquid	0.0005	97	1,3-Butadiene	1324	0.48	0.000
3	Connectors	Light Liquid	0.0005	97	Benzene	1324	25.31	0.005
3	Connectors	Light Liquid	0.0005	97	Naphthalene	1324	16	0.003
3	Connectors	Light Liquid	0.0005	97	Toluene	1324	13.09	0.003
3	Connectors	Light Liquid	0.0005	97	Styrene	1324	6.31	0.001
3	Connectors	Light Liquid	0.0005	97	Xylenes	1324	0.42	0.000
3	Connectors	Light Liquid	0.0005	97	Ethylbenzene	1324	1.11	0.000
4	Valves	Gas/Vapor	0.0132	97	1,3-Butadiene	187	1	0.001
4	Valves	Light Liquid	0.0089	97	1,3-Butadiene	171	0.48	0.000
4	Valves	Light Liquid	0.0089	97	Benzene	171	25.31	0.012
4	Valves	Light Liquid	0.0089	97	Naphthalene	171	16	0.007
4	Valves	Light Liquid	0.0089	97	Toluene	171	13.09	0.006

Ethylene Manufacturing Fugitives Area Designation	Equipment	Service	SOCMI Emission Factor (lb/hr/source)	LAER Control Efficiency (%)	Compound	Equip. Count	Composition (wt%)	Emissions (lb/hr)
4	Valves	Light Liquid	0.0089	97	Styrene	171	6.31	0.003
4	Valves	Light Liquid	0.0089	97	Xylenes	171	0.42	0.000
4	Valves	Light Liquid	0.0089	97	Ethylbenzene	171	1.11	0.001
4	Connectors	Gas/Vapor	0.0039	97	1,3-Butadiene	583	1	0.001
4	Connectors	Light Liquid	0.0005	97	1,3-Butadiene	400	0.48	0.000
4	Connectors	Light Liquid	0.0005	97	Benzene	400	25.31	0.002
4	Connectors	Light Liquid	0.0005	97	Naphthalene	400	16	0.001
4	Connectors	Light Liquid	0.0005	97	Toluene	400	13.09	0.001
4	Connectors	Light Liquid	0.0005	97	Styrene	400	6.31	0.000
4	Connectors	Light Liquid	0.0005	97	Xylenes	400	0.42	0.000
4	Connectors	Light Liquid	0.0005	97	Ethylbenzene	400	1.11	0.000
4	Pumps	Light Liquid	0.0439	93	Naphthalene	4	28	0.003
5	Valves	Gas/Vapor	0.0132	97	1,3-Butadiene	31	1	0.000
5	Valves	Light Liquid	0.0089	97	1,3-Butadiene	28	0.48	0.000
5	Valves	Light Liquid	0.0089	97	Benzene	28	25.31	0.002
5	Valves	Light Liquid	0.0089	97	Naphthalene	28	16	0.001
5	Valves	Light Liquid	0.0089	97	Toluene	28	13.09	0.001
5	Valves	Light Liquid	0.0089	97	Styrene	28	6.31	0.000
5	Valves	Light Liquid	0.0089	97	Xylenes	28	0.42	0.000
5	Valves	Light Liquid	0.0089	97	Ethylbenzene	28	1.11	0.000
5	Connectors	Gas/Vapor	0.0039	97	1,3-Butadiene	84	1	0.000
5	Connectors	Light Liquid	0.0005	97	1,3-Butadiene	61	0.48	0.000
5	Connectors	Light Liquid	0.0005	97	Benzene	61	25.31	0.000
5	Connectors	Light Liquid	0.0005	97	Naphthalene	61	16	0.000
5	Connectors	Light Liquid	0.0005	97	Toluene	61	13.09	0.000
5	Connectors	Light Liquid	0.0005	97	Styrene	61	6.31	0.000
5	Connectors	Light Liquid	0.0005	97	Xylenes	61	0.42	0.000
5	Connectors	Light Liquid	0.0005	97	Ethylbenzene	61	1.11	0.000

Ethylene Manufacturing Fugitives Area Designation	Equipment	Service	SOCMI Emission Factor (lb/hr/source)	LAER Control Efficiency (%)	Compound	Equip. Count	Composition (wt%)	Emissions (lb/hr)
6	Valves	Gas/Vapor	0.0132	97	1,3-Butadiene	67	0.48	0.000
6	Valves	Gas/Vapor	0.0132	97	Benzene	67	25.31	0.007
6	Valves	Gas/Vapor	0.0132	97	Naphthalene	67	16	0.004
6	Valves	Gas/Vapor	0.0132	97	Toluene	67	13.09	0.003
6	Valves	Gas/Vapor	0.0132	97	Styrene	67	6.31	0.002
6	Valves	Gas/Vapor	0.0132	97	Xylenes	67	0.42	0.000
6	Valves	Gas/Vapor	0.0132	97	Ethylbenzene	67	1.11	0.000
6	Valves	Light Liquid	0.0089	97	Benzene	163	0.02	0.000
6	Valves	Light Liquid	0.0089	97	Naphthalene	163	16.62	0.007
6	Valves	Light Liquid	0.0089	97	Toluene	163	0.01	0.000
6	Valves	Light Liquid	0.0089	97	Styrene	163	0.01	0.000
6	Connectors	Gas/Vapor	0.0039	97	1,3-Butadiene	180	0.48	0.000
6	Connectors	Gas/Vapor	0.0039	97	Benzene	180	25.31	0.005
6	Connectors	Gas/Vapor	0.0039	97	Naphthalene	180	16	0.003
6	Connectors	Gas/Vapor	0.0039	97	Toluene	180	13.09	0.003
6	Connectors	Gas/Vapor	0.0039	97	Styrene	180	6.31	0.001
6	Connectors	Gas/Vapor	0.0039	97	Xylenes	180	0.42	0.000
6	Connectors	Gas/Vapor	0.0039	97	Ethylbenzene	180	1.11	0.000
6	Connectors	Light Liquid	0.0005	97	Benzene	485	0.02	0.000
6	Connectors	Light Liquid	0.0005	97	Naphthalene	485	16.62	0.001
6	Connectors	Light Liquid	0.0005	97	Toluene	485	0.01	0.000
6	Connectors	Light Liquid	0.0005	97	Styrene	485	0.01	0.000
6	Pumps	Light Liquid	0.0439	93	Naphthalene	12	16.62	0.006
6	Pumps	Light Liquid	0.0439	93	Benzene	8	0.02	0.000
6	Pumps	Light Liquid	0.0439	93	Toluene	8	0.01	0.000
6	Pumps	Light Liquid	0.0439	93	Styrene	8	0.01	0.000
6	Pumps	Light Liquid	0.0439	93	1,3-Butadiene	4	0.48	0.000
6	Pumps	Light Liquid	0.0439	93	Benzene	4	25.31	0.003

Ethylene Manufacturing Fugitives Area Designation	Equipment	Service	SOCMI Emission Factor (lb/hr/source)	LAER Control Efficiency (%)	Compound	Equip. Count	Composition (wt%)	Emissions (lb/hr)
6	Pumps	Light Liquid	0.0439	93	Toluene	4	13.09	0.002
6	Pumps	Light Liquid	0.0439	93	Styrene	4	6.31	0.001
6	Pumps	Light Liquid	0.0439	93	Xylenes	4	0.42	0.000
6	Pumps	Light Liquid	0.0439	93	Ethylbenzene	4	1.11	0.000
7	Valves	Light Liquid	0.0089	97	1,3-Butadiene	174	31.8	0.015
7	Valves	Light Liquid	0.0089	97	Benzene	174	10.1	0.005
7	Connectors	Light Liquid	0.0005	97	1,3-Butadiene	553	31.8	0.003
7	Connectors	Light Liquid	0.0005	97	Benzene	553	10.1	0.001
8	Valves	Light Liquid	0.0089	97	Methanol	34	100	0.009
8	Connectors	Light Liquid	0.0005	97	Methanol	106	100	0.002
9	Valves	Light Liquid	0.0089	97	Methanol	102	100	0.027
9	Connectors	Light Liquid	0.0005	97	Methanol	304	100	0.005
9	Pumps	Light Liquid	0.0439	93	1,3-Butadiene	4	31.8	0.004
9	Pumps	Light Liquid	0.0439	93	Benzene	4	10.1	0.001
9	Pumps	Light Liquid	0.0439	93	Methanol	2	100	0.006
10	Valves	Light Liquid	0.0089	97	1,3-Butadiene	18	0.48	0.000
10	Valves	Light Liquid	0.0089	97	Benzene	18	25.31	0.001
10	Valves	Light Liquid	0.0089	97	Naphthalene	18	16	0.001
10	Valves	Light Liquid	0.0089	97	Toluene	18	13.09	0.001
10	Valves	Light Liquid	0.0089	97	Styrene	18	6.31	0.000
10	Valves	Light Liquid	0.0089	97	Xylenes	18	0.42	0.000
10	Valves	Light Liquid	0.0089	97	Ethylbenzene	18	1.11	0.000
10	Connectors	Light Liquid	0.0005	97	1,3-Butadiene	40	0.48	0.000
10	Connectors	Light Liquid	0.0005	97	Benzene	40	25.31	0.000
10	Connectors	Light Liquid	0.0005	97	Naphthalene	40	16	0.000
10	Connectors	Light Liquid	0.0005	97	Toluene	40	13.09	0.000
10	Connectors	Light Liquid	0.0005	97	Styrene	40	6.31	0.000
10	Connectors	Light Liquid	0.0005	97	Xylenes	40	0.42	0.000

Ethylene Manufacturing Fugitives Area Designation	Equipment	Service	SOCMI Emission Factor (lb/hr/source)	LAER Control Efficiency (%)	Compound	Equip. Count	Composition (wt%)	Emissions (lb/hr)
10	Connectors	Light Liquid	0.0005	97	Ethylbenzene	40	1.11	0.000
11	Pumps	Light Liquid	0.0439	93	1,3-Butadiene	2	0.48	0.000
11	Pumps	Light Liquid	0.0439	93	Benzene	2	25.31	0.002
11	Pumps	Light Liquid	0.0439	93	Naphthalene	2	16.62	0.001
11	Pumps	Light Liquid	0.0439	93	Toluene	2	13.09	0.001
11	Pumps	Light Liquid	0.0439	93	Styrene	2	6.31	0.000
11	Pumps	Light Liquid	0.0439	93	Xylenes	2	0.42	0.000
11	Pumps	Light Liquid	0.0439	93	Ethylbenzene	2	1.11	0.000

Table 16. Key Code for Ethylene Cracking Unit Fugitive Emission Locations

Ethane Cracking Fugitives Area Key Code	
Area Designation	**Area Description**
1	[redacted]
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

Redacted information considered trade secret and/or confidential proprietary information as defined in the Pennsylvania Right to Know Law

Table 17. Speciated OSBL Fugitive Emissions by Location

OSBL Fugitives Area Designation	Equipment	Service	SOCMI Emission Factor (lb/hr/source)	LAER Control Efficiency (%)	Compound	Equipment Count	Composition (wt %)	Emissions (lb/hr)
1	Valves	Gas /Vapor	0.0132	97	Benzene	2	25.31	2.00E-04
1	Valves	Gas /Vapor	0.0132	97	Naphthalene	2	16.62	1.32E-04
1	Valves	Gas /Vapor	0.0132	97	Toluene	2	13.09	1.04E-04
1	Valves	Gas /Vapor	0.0132	97	Styrene	2	6.31	5.00E-05
1	Valves	Gas /Vapor	0.0132	97	Ethylbenzene	2	1.11	8.79E-06
1	Valves	Gas /Vapor	0.0132	97	1,3-Butadiene	2	0.48	3.80E-06
1	Valves	Gas /Vapor	0.0132	97	Xylenes	2	0.42	3.33E-06
1	Valves	Light Liquid	0.0089	97	Benzene	86	25.31	5.81E-03
1	Valves	Light Liquid	0.0089	97	Naphthalene	86	16.62	3.82E-03
1	Valves	Light Liquid	0.0089	97	Toluene	86	13.09	3.01E-03
1	Valves	Light Liquid	0.0089	97	Styrene	86	6.31	1.45E-03
1	Valves	Light Liquid	0.0089	97	Ethylbenzene	86	1.11	2.55E-04
1	Valves	Light Liquid	0.0089	97	1,3-Butadiene	86	0.48	1.10E-04
1	Valves	Light Liquid	0.0089	97	Xylenes	86	0.42	9.64E-05
1	Connectors	Gas /Vapor	0.0039	97	Benzene	6	25.31	1.78E-04
1	Connectors	Gas /Vapor	0.0039	97	Naphthalene	6	16.62	1.17E-04
1	Connectors	Gas /Vapor	0.0039	97	Toluene	6	13.09	9.19E-05
1	Connectors	Gas /Vapor	0.0039	97	Styrene	6	6.31	4.43E-05
1	Connectors	Gas /Vapor	0.0039	97	Ethylbenzene	6	1.11	7.79E-06
1	Connectors	Gas /Vapor	0.0039	97	1,3-Butadiene	6	0.48	3.37E-06
1	Connectors	Gas /Vapor	0.0039	97	Xylenes	6	0.42	2.95E-06
1	Connectors	Light Liquid	0.0005	97	Benzene	294	25.31	1.12E-03
1	Connectors	Light Liquid	0.0005	97	Naphthalene	294	16.62	7.33E-04
1	Connectors	Light Liquid	0.0005	97	Toluene	294	13.09	5.77E-04
1	Connectors	Light Liquid	0.0005	97	Styrene	294	6.31	2.78E-04
1	Connectors	Light Liquid	0.0005	97	Ethylbenzene	294	1.11	4.90E-05

OSBL Fugitives Area Designation	Equipment	Service	SOCMI Emission Factor (lb/hr/source)	LAER Control Efficiency (%)	Compound	Equipment Count	Composition (wt %)	Emissions (lb/hr)
1	Connectors	Light Liquid	0.0005	97	1,3-Butadiene	294	0.48	2.12E-05
1	Connectors	Light Liquid	0.0005	97	Xylenes	294	0.42	1.85E-05
1	Pumps	Light Liquid	0.0439	93	Benzene	8	25.31	6.22E-03
1	Pumps	Light Liquid	0.0439	93	Naphthalene	8	16.62	4.09E-03
1	Pumps	Light Liquid	0.0439	93	Toluene	8	13.09	3.22E-03
1	Pumps	Light Liquid	0.0439	93	Styrene	8	6.31	1.55E-03
1	Pumps	Light Liquid	0.0439	93	Ethylbenzene	8	1.11	2.73E-04
1	Pumps	Light Liquid	0.0439	93	1,3-Butadiene	8	0.48	1.18E-04
1	Pumps	Light Liquid	0.0439	93	Xylenes	8	0.42	1.03E-04
2	Valves	Gas /Vapor	0.0132	97	1,3-Butadiene	3	31.8	3.78E-04
2	Valves	Gas /Vapor	0.0132	97	Benzene	3	10.1	1.20E-04
2	Valves	Light Liquid	0.0089	97	1,3-Butadiene	27	31.8	2.29E-03
2	Valves	Light Liquid	0.0089	97	Benzene	27	10.1	7.28E-04
2	Connectors	Gas /Vapor	0.0039	97	1,3-Butadiene	9	31.8	3.35E-04
2	Connectors	Gas /Vapor	0.0039	97	Benzene	9	10.1	1.06E-04
2	Connectors	Light Liquid	0.0005	97	1,3-Butadiene	81	31.8	3.86E-04
2	Connectors	Light Liquid	0.0005	97	Benzene	81	10.1	1.23E-04
2	Pumps	Light Liquid	0.0439	93	1,3-Butadiene	2	31.8	1.95E-03
2	Pumps	Light Liquid	0.0439	93	Benzene	2	10.1	6.21E-04
3	Valves	Light Liquid	0.0089	97	Benzene	20	0.138	7.37E-06
3	Valves	Light Liquid	0.0089	97	Xylenes	20	0.138	7.37E-06
3	Valves	Light Liquid	0.0089	97	Styrene	20	0.0753	4.02E-06
3	Valves	Light Liquid	0.0089	97	Biphenyl	20	0.0437	2.33E-06
3	Connectors	Light Liquid	0.0005	97	Benzene	84	0.138	1.74E-06
3	Connectors	Light Liquid	0.0005	97	Xylenes	84	0.138	1.74E-06
3	Connectors	Light Liquid	0.0005	97	Styrene	84	0.0753	9.49E-07
3	Connectors	Light Liquid	0.0005	97	Biphenyl	84	0.0437	5.51E-07
3	Pumps	Light Liquid	0.0439	93	Benzene	8	0.138	3.39E-05
3	Pumps	Light Liquid	0.0439	93	Xylenes	8	0.138	3.39E-05

OSBL Fugitives Area Designation	Equipment	Service	SOCMI Emission Factor (lb/hr/source)	LAER Control Efficiency (%)	Compound	Equipment Count	Composition (wt %)	Emissions (lb/hr)
3	Pumps	Light Liquid	0.0439	93	Styrene	8	0.0753	1.85E-05
3	Pumps	Light Liquid	0.0439	93	Biphenyl	8	0.0437	1.07E-05
4	Valves	Gas /Vapor	0.0132	97	1,3-Butadiene	32	31.8	4.03E-03
4	Valves	Gas /Vapor	0.0132	97	Benzene	32	10.1	1.28E-03
4	Valves	Light Liquid	0.0089	97	1,3-Butadiene	18	31.8	1.53E-03
4	Valves	Light Liquid	0.0089	97	Benzene	18	10.1	4.85E-04
4	Connectors	Gas /Vapor	0.0039	97	1,3-Butadiene	108	31.8	4.02E-03
4	Connectors	Gas /Vapor	0.0039	97	Benzene	108	10.1	1.28E-03
4	Connectors	Light Liquid	0.0005	97	1,3-Butadiene	54	31.8	2.58E-04
4	Connectors	Light Liquid	0.0005	97	Benzene	54	10.1	8.18E-05

Table 18. Key Code for OSBL Fugitives Emission Locations

OSBL Fugitives Area Key Code	
Area Designation	Area Description
1	[redacted]
2	[redacted]
3	[redacted]
4	[redacted]
Redacted information considered trade secret and/or confidential proprietary information as defined in the Pennsylvania Right to Know Law	

Table 19. COPC Fugitive Emissions from Polyethylene Manufacturing Units

Equipment	Service	SOCMI Average Emissions Factor lb/hr/src	LAER Control Efficiency %	Component Count	Hexane Composition[1] (wt %)	Hexane Emissions (lb/hr)	Hexane Emissions (tpy)
POLYETHYLENE UNITS 1 & 2							
Valves	Gas/Vapor	0.0132	97	8,568	5.7	0.19	0.85
	Light Liquid	0.0089	97	1,992	5.7	0.03	0.13
Relief Valves	Gas/Vapor	0.2293	97	180	5.7	0.071	0.31
Pumps	Light Liquid	0.0439	93	32	5.7	0.0056	0.02
Compressor Seals	Gas/Vapor	0.5027	95	8	5.7	0.011	0.05
Connectors/Flanges	Gas/Vapor	0.0039	97	23,990	5.7	0.160	0.70
	Light Liquid	0.0005	97	5,578	5.7	0.005	0.02
Subtotal of PE 1 & 2 Hexane Emissions (total for 2 units) =						**0.48**	**2.09**
POLYETHYLENE UNIT 3							
Valves	Gas/Vapor	0.0132	97	1,116	3.5	0.015	0.068
	Light Liquid	0.0089	97	10	43.4	0.001	0.005
	Light Liquid	0.0089	97	947	3.5	0.009	0.039
Relief Valves	Gas/Vapor	0.2293	97	50	3.5	0.012	0.053
Pumps	Light Liquid	0.0439	93	32	3.5	0.003	0.015
Compressor Seals	Gas/Vapor	0.5027	95	4	3.5	0.004	0.015
Agitators	Light Liquid	0.0439	93	3	3.5	0.00032	0.001
Connectors/Flanges	Gas/Vapor	0.0039	97	5,197	3.5	0.021	0.093
	Light Liquid	0.0005	97	2,090	3.5	0.001	0.005
	Heavy Liquid	0.00007	30	0	3.5	0.000	0.000
Subtotal of PE 3 Hexane Emissions =						**0.07**	**0.29**
Total Hexane Emissions =						**0.54**	**2.38**

[1] For PE 1 & 2, equipment counts were provided by the Licensor by area with a 20% increase in the valve and connector counts as a conservative estimate. All components assumed to be in service of a stream with 5.7% hexane. For PE 3, equipment counts were provided as total counts for the unit. Preliminary design information indicates the various hexane-containing streams range in content from 0.01% to 43.36%. The highest stream hexane composition of 43.46% applies to at most 10 valves per proposed design documentation. For the purposes of the fugitives emission rate estimate, it is assumed that the second highest stream composition of 3.5% applies to the remaining components.

ATTACHMENT B

DISPERSION MODELING ANALYSIS FOR THE INHALATION RISK ASSESSMENT FOR PETROCHEMICALS COMPLEX SHELL CHEMICAL APPALACHIA LLC BEAVER COUNTY, PENNSYLVANIA

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January 2015

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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 the proposed Shell Chemical Appalachia LLC Petrochemicals Complex to be constructed in Beaver County, Pennsylvania. The air quality dispersion modeling conforms with the modeling procedures outlined in the Environmental Protection Agency's Guideline on Air Quality Models[1] (Guideline) and associated EPA modeling policy and guidance.

[1]. Guidelines on Air Quality Models, (Revised). EPA-450/2-78-027R, Appendix W of 40 CFR Part 51, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. November 2005.

2.0 PROJECT DESCRIPTION

The proposed Shell facility will produce approximately 1,500,000 metric tons per year of ethylene and 1,600,000 metric tons per year of polyethylene. From an air emissions modeling perspective, the facility includes seven ethane cracking furnaces, a number of diesel engines to provide emergency power and power fire water pumps, flares, cooling towers, catalyst activation vents, fugitive emissions from equipment leaks and liquid storage tanks, and combustion turbines with heat recovery systems to provide steam and electric power to the facility and electric power for sale.

3.0 SITE DESCRIPTION

The Shell facility will occupy approximately 400 acres on the property previously owned by the Horsehead Corporation. The site is located adjacent to the Ohio River in the Borough of Monaca, 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 2 shows the specific facility location on a 7.5-minute U.S. Geological Survey (USGS) topographic map.

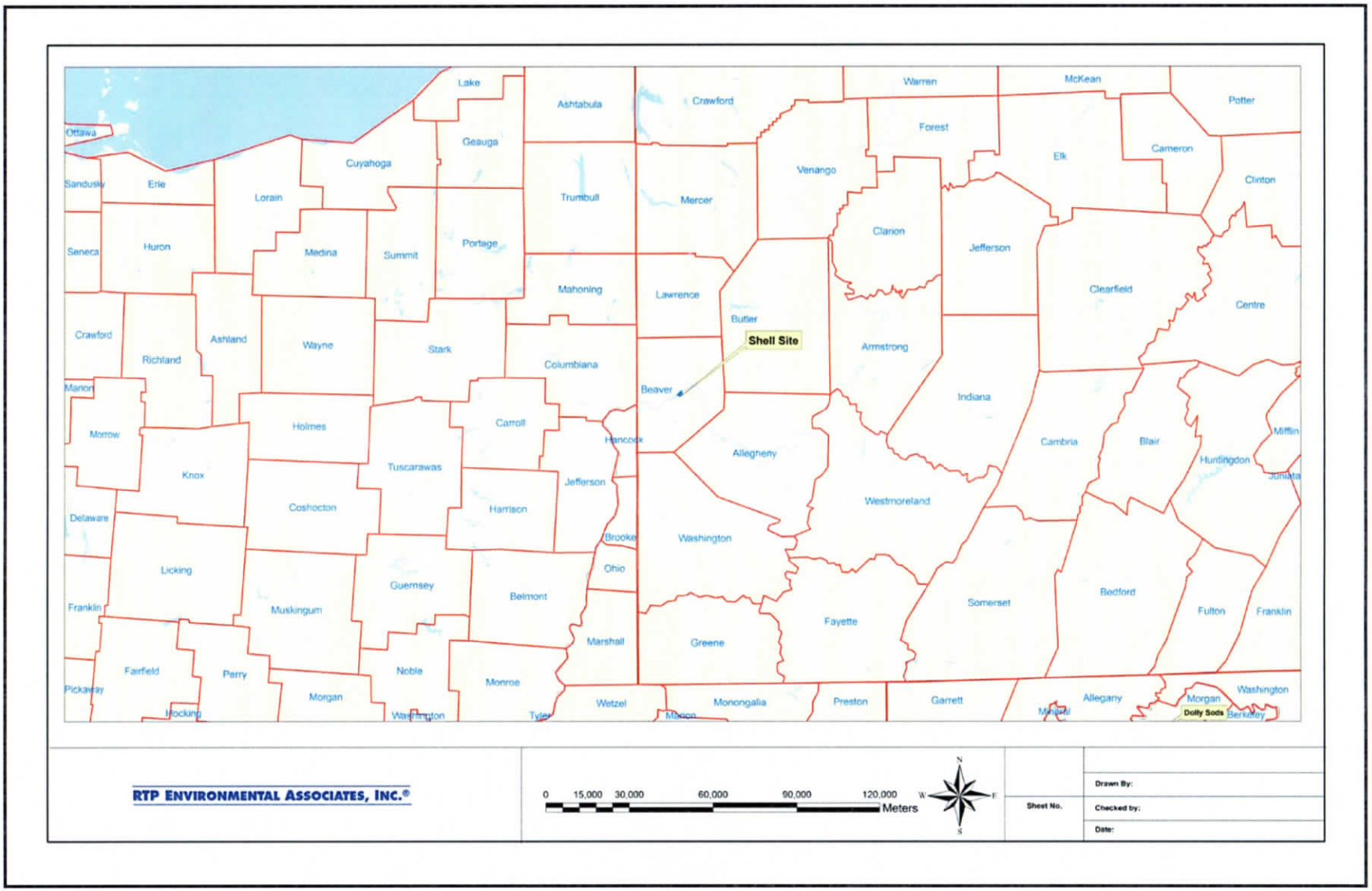

Figure 1. General Location of Shell Facility

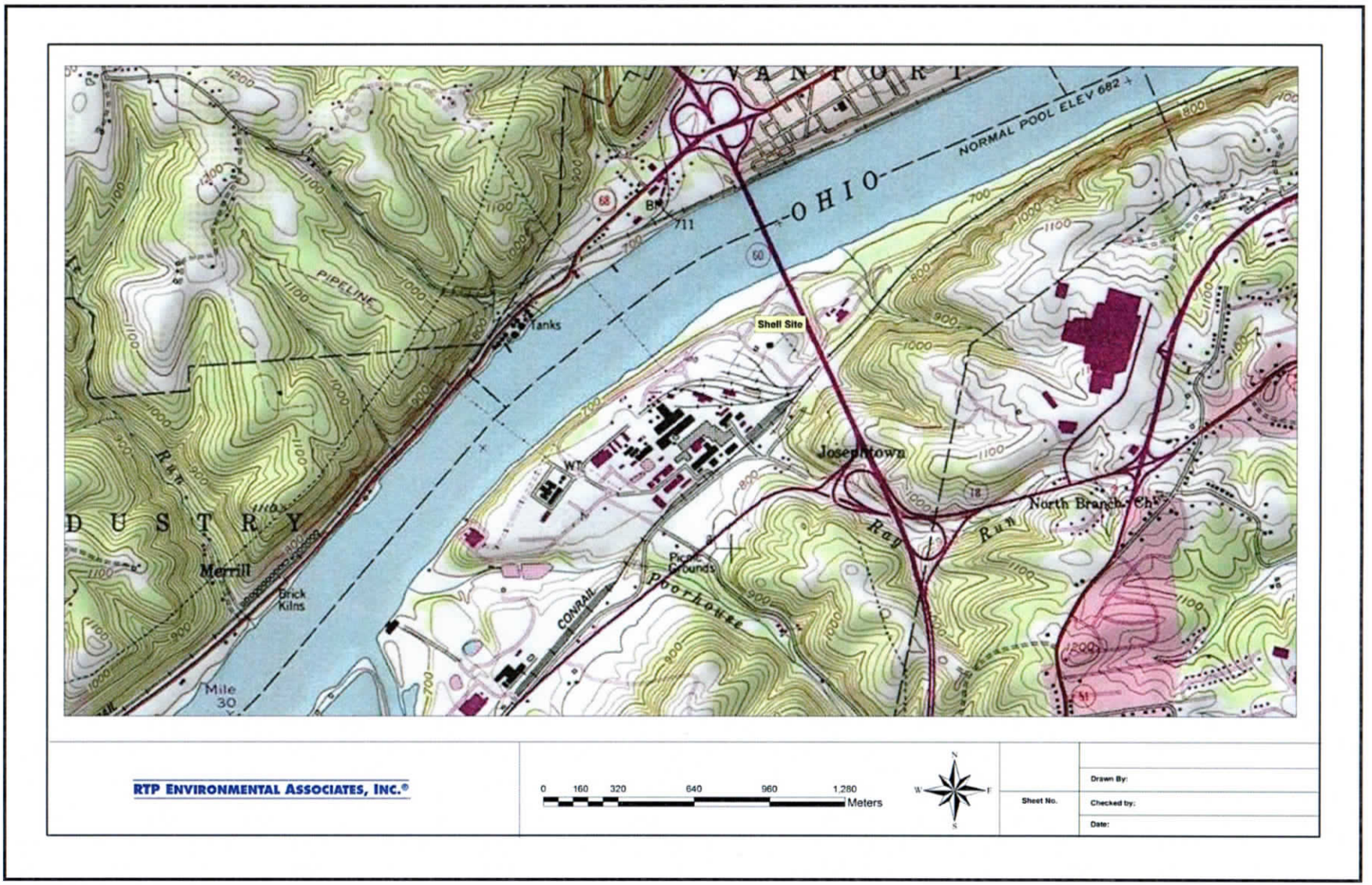

Figure 2. Specific Location of the Shell Facility

4.0 MODEL SELECTION AND MODEL INPUT

4.1 Model Selection

The latest version of the AMS/EPA Regulatory Model (AERMOD, Version 14134) was used to conduct the dispersion modeling analysis. AERMOD is a Gaussian plume dispersion model that is based on planetary boundary layer principals 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 the proposed Shell facility, 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 will be selected as recommended in the EPA Guideline on Air Quality Models.

Oris Solution's BEEST Graphical User Interface (GUI) was used to run AERMOD. The GUI uses an altered version of the AERMOD code to allow for flexibility in the file naming convention. The dispersion algorithms of AERMOD are not altered.

4.2 Model Control Options and Land Use

AERMOD was run in the regulatory default mode for all pollutants. The default rural dispersion coefficients in the model were used. This is supported by the Land Use Procedure consistent with subsection 7.2.3(c) of the Guideline and Section 5.1 of the

AERMOD Implementation Guide.

The USGS 2006 National Land Cover Data (NLCD) within 3km of the site were converted to Auer 1978 land use types, using recommendations from the DEP, and evaluated.[2] It was determined that the land use in the vicinity of the proposed Shell facility is predominantly rural (less than 15% of the area is classified as urban, Figure 3). 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 the proposed Shell site will 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 modeled emission rates for each source can be found in Table 2 of Attachment A. The location of each point source is shown in Figure 4.

Fugitive Emissions from Tanks and Equipment Leaks

Fugitive emissions from tanks and equipment leaks were modeled as volume sources. The emissions rate for a given COPC was determined by applying process area component speciation data to the VOC emissions 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 3-1 of the AERMOD User's Guide.

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[2]. Auer, Jr., A.H. "Correlation of Land Use and Cover with Meteorological Anomalies." Journal of Applied Meteorology, 17:636-643, 1978.

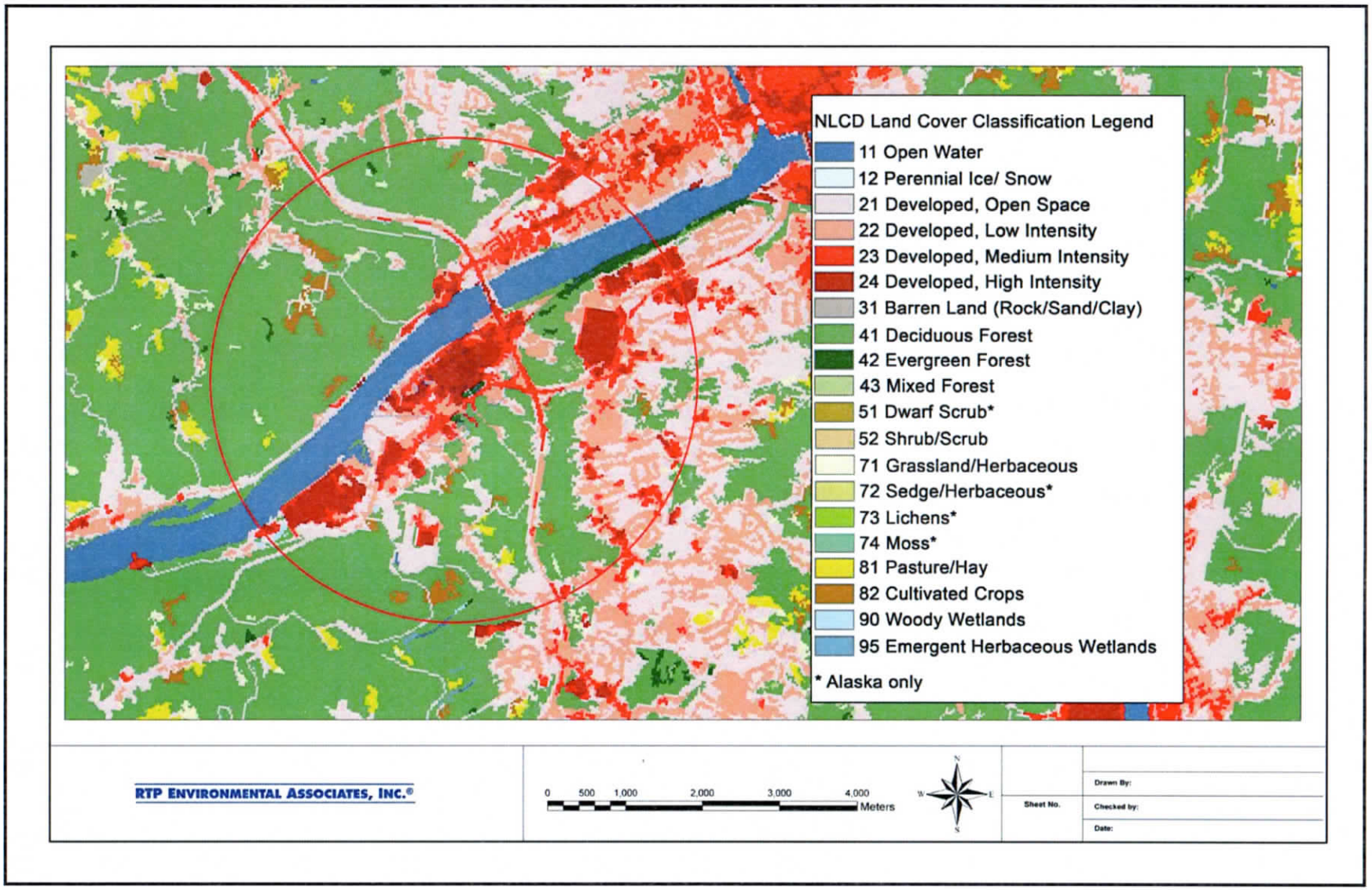


Figure 3. Land Use within Three Kilometers

Table 20. Point Source Input Parameters

Source ID	Source Description	Easting (X) (m)	Northing (Y) (m)	Base Elevation (ft)	Stack Height (ft)	Temperature (°F)	Exit Velocity (ft/sec)	Stack Diameter (ft)
EC#1	Ethane Cracking Furnace #1	555501.14	4502188.87	795.0	280.0	284.0	49.4	8.5
EC#2	Ethane Cracking Furnace #2	555511.76	4502175.45	795.0	280.0	284.0	49.4	8.5
EC#3	Ethane Cracking Furnace #3	555527.98	4502157.00	795.0	280.0	284.0	49.4	8.5
EC#4	Ethane Cracking Furnace #4	555538.60	4502143.59	795.0	280.0	284.0	49.4	8.5
EC#5	Ethane Cracking Furnace #5	555550.90	4502128.49	795.0	280.0	284.0	49.4	8.5
EC#6	Ethane Cracking Furnace #6	555563.76	4502115.07	795.0	280.0	284.0	49.4	8.5
EC#7	Ethane Cracking Furnace #7	555579.42	4502098.86	795.0	280.0	284.0	49.4	8.5
CT1	Combustion Turbine 1	555933.42	4502051.09	795.0	213.0	230.0	85.5	10.0
CT2	Combustion Turbine 2	555980.35	4502092.11	795.0	213.0	230.0	85.5	10.0
CT3	Combustion Turbine 3	556028.27	4502134.12	795.0	213.0	230.0	85.5	10.0
GFLARE1	Ground Flare 1	555442.56	4502003.30	785.0	206.9	1832.0	65.62	21.10
GFLARE2	Ground Flare 2	555391.59	4502079.77	785.0	206.9	1832.0	65.62	21.10
HPFLARE	HP Elevated Flare	555352.88	4501999.99	785.0	246.0	1832.0	65.62	4.14
INCIN	LP Incinerator	556444.09	4502531.19	795.0	250.0	1600.0	186.2	4.5
COI	Caustic Oxidizer	556057.92	4502629.58	795.0	200.0	1600.0	45.0	2.0
CAH1	Catalyst Heater 1	556072.59	4502416.74	795.0	150.0	392.0	35.0	1.3
CAH2	Catalyst Heater 2	556094.85	4502437.06	795.0	150.0	392.0	35.0	1.3
COOLTWR1	Cooling Tower 1	555787.85	4502476.91	795.0	70.0	71.0	20.0	45.0
COOLTWR2	Cooling Tower 2	555800.72	4502488.26	795.0	70.0	71.0	20.0	52.0
COOLTWR3	Cooling Tower 3	555813.21	4502499.24	795.0	70.0	71.0	20.0	52.0
COOLTWR4	Cooling Tower 4	555826.07	4502511.73	795.0	70.0	71.0	20.0	52.0
COOLTWR5	Cooling Tower 5	555838.94	4502521.57	795.0	70.0	71.0	20.0	52.0
COOLTWR6	Cooling Tower 6	555851.81	4502533.31	795.0	70.0	71.0	20.0	52.0
COOLTWR7	Cooling Tower 7	555864.67	4502544.66	795.0	70.0	71.0	20.0	52.0
COOLTWR8	Cooling Tower 8	555877.17	4502554.50	795.0	70.0	71.0	20.0	52.0
COOLTWR9	Cooling Tower 9	555890.79	4502566.61	795.0	70.0	71.0	20.0	52.0
COLTWR10	Cooling Tower 10	555903.28	4502577.97	795.0	70.0	71.0	20.0	52.0
COLTWR11	Cooling Tower 11	555915.38	4502588.57	795.0	70.0	71.0	20.0	52.0
COLTWR12	Cooling Tower 12	555928.63	4502599.92	795.0	70.0	71.0	20.0	52.0
COLTWR13	Cooling Tower 13	555941.78	4502611.02	795.0	70.0	71.0	20.0	52.0
COLTWR14	Cooling Tower 14	555955.12	4502622.26	795.0	70.0	71.0	20.0	52.0
COLTWR15	Cooling Tower 15	555967.54	4502633.32	795.0	70.0	71.0	20.0	52.0
COLTWR16	Cooling Tower 16	555980.48	4502644.70	795.0	70.0	71.0	20.0	52.0
FWP1	Fire Water Pump 1	556106.23	4501684.22	854.0	30.0	885.0	113.0	1.0
FWP2	Fire Water Pump 2	556113.57	4501691.56	854.0	30.0	885.0	113.0	1.0
FWP3	Fire Water Pump 3	556121.78	4501697.32	854.0	30.0	885.0	113.0	1.0
GEN1	Generator 1	555883.22	4502092.44	795.0	30.0	882.5	125.0	2.0
GEN2	Generator 2	555889.13	4502097.04	795.0	30.0	882.5	125.0	2.0
GEN3	Generator 3	555895.69	4502101.96	795.0	30.0	882.5	125.0	2.0
GEN4	Generator 4	555901.27	4502107.54	795.0	30.0	882.5	125.0	2.0

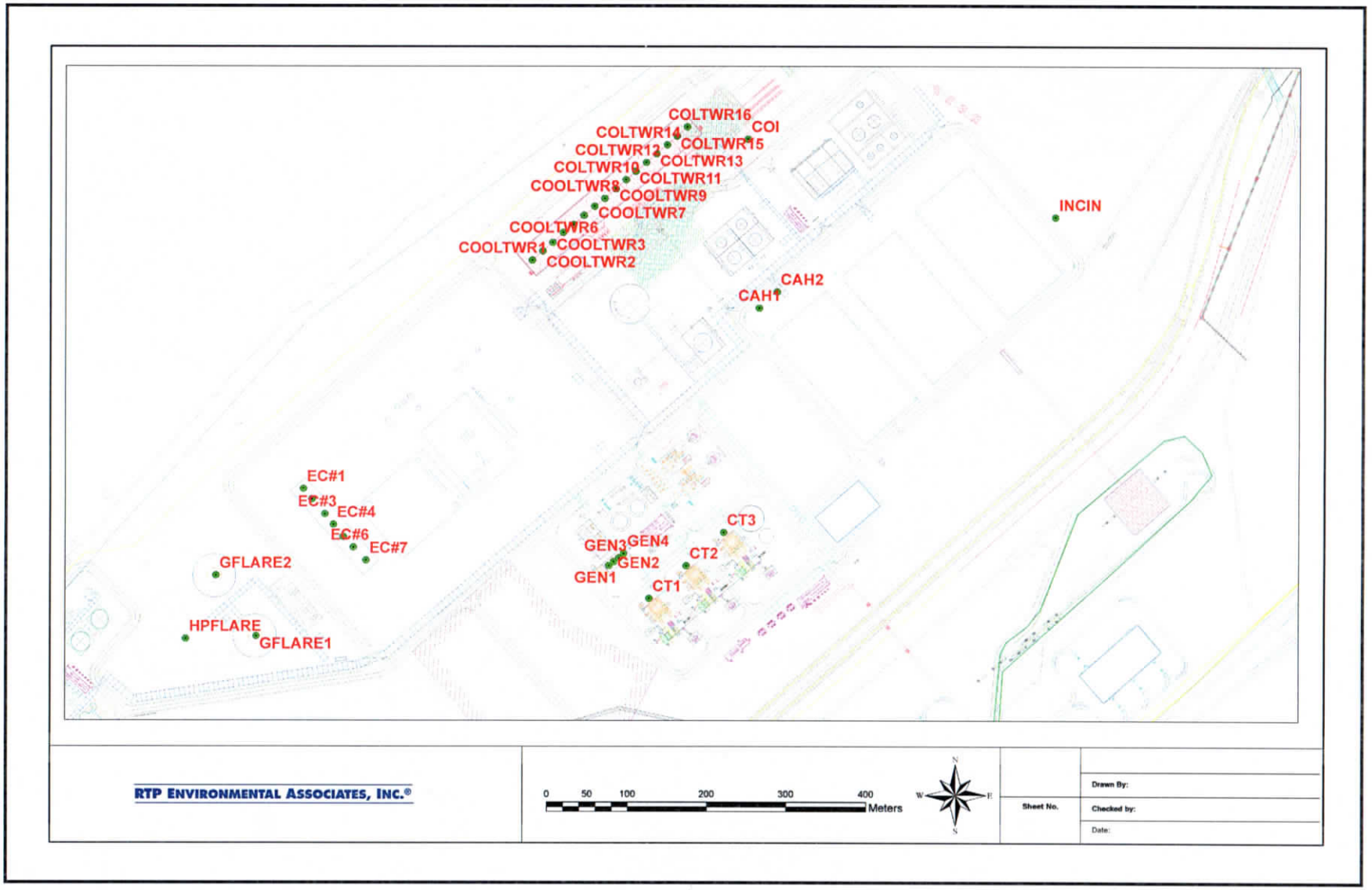


Figure 4. Modeled Point Source Locations

Flares

There will also be an elevated flare, ground flares and a multipoint ground flare. The elevated flare will only be operated during periods of malfunction. Only the emissions associated with the pilots were modeled for this flare. The ground flares will be used for startup or shutdown (i.e., non-emergency flaring) and to control other VOC emissions and were modeled using the SCREEN3 procedures developed by the EPA, as described by the Ohio EPA[3]. The effective stack height (H, in meters) was computed as a function of heat release rate according to the following equation, where Q is the heat release rate of the flare in MMBtu/hr:

$$H_{equivalent} = H_{actual} + 0.944(Q)^{0.478}$$

The effective flare diameter (d, in meters) was computed as a function of heat release rate according to the following equation, where Q is the heat release rate of the flare in MMBtu/hr:

$$d_{equivalent} = 0.1755(Q)^{0.5}$$

An exit temperature of 1273 K and velocity of 20 m/sec was assumed.

Multipoint Ground Flare

There will also be a multipoint ground flare surrounded by a 45 ft tall wind screen/fence at the facility. The multipoint ground flare was modeled as volume source. The release height was calculated as the effective stack height. The effective stack height was calculated as the top of the wind fence (45') plus the plume rise of the multipoint ground flare (calculated as a function of the flare heat release based upon the SCREEN3 proceedures described above). 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 3-1 of the AERMOD User's Guide.

The volume source parameter calculations can be found in Table 2. The modeled emission rates for each source can be found in Table 2 of Attachment A. The location

3. Engineering Guide #69, Air Dispersion Modeling Guidance. Ohio EPA, Division of Air Pollution Control, 2003.

of each modeled volume source is shown in Figure 5. All source locations were based upon a NAD83, UTM Zone 17 projection. Source elevations were determined from facility survey data, not from AERMAP.

Table 21. Shell Franklin Non-Road Volume Source Parameter Calculations

Model ID	Source Description	Source Dimensions					Initial Dispersion Coefficients		Reference
		Length (ft)	Width (ft)	Square Root of Area (ft)	Structure Height/Vertical Dimension (ft)	Release Height (ft)	Initial Horizontal Dimension σ_y (ft)	Initial Vertical Dimension σ_z (ft)	
PEBLD	PE Blending Silos	190.0	82.0	124.8	131.2	131.2	29.03	61.0	Note 1, 2, and 3
PERC	PE Rail Loading Silos	130.0	16.0	45.6	151.0	151.0	10.61	70.2	Note 1, 2, and 3
PETK	PE Truck Loading Silos	190.0	190.0	190.0	151.0	151.0	44.19	70.2	Note 1, 2, and 3
PEU1&2	LDPE Vents	190.0	90.0	130.8	131.2	131.2	30.41	61.0	Note 1, 2, and 3
PEU3	HDPE Vents	190.0	90.0	130.8	131.2	131.2	30.41	61.0	Note 1, 2, and 3
MPFLARE	Multi Point Ground Flare	250.0	150.0	193.6	45.0	58.86	45.03	16.91	Note 2, 4 and 5
ECFUG1	Ethane Cracking	600.0	200.0	346.4	82.0	41.0	80.56	38.14	Note 2, 6 and 7
ECFUG2	Fuel Gas and Regeneration System	300.0	300.0	300.0	82.0	41.0	69.77	38.14	Note 2, 6 and 7
ECFUG3	Wash Water System	300.0	300.0	300.0	82.0	41.0	69.77	38.14	Note 2, 6 and 7
ECFUG4	Cracked Gas Compression	425.0	425.0	425.0	82.0	41.0	98.84	38.14	Note 2, 6 and 7
ECFUG5	Caustic Wash	300.0	300.0	300.0	82.0	41.0	69.77	38.14	Note 2, 6 and 7
ECFUG6	Gas Redistillation	300.0	300.0	300.0	82.0	41.0	69.77	38.14	Note 2, 6 and 7
ECFUG7	C2/C3 Separation	300.0	300.0	300.0	82.0	41.0	69.77	38.14	Note 2, 6 and 7
ECFUG8	C2 Hydrogenation	300.0	300.0	300.0	82.0	41.0	69.77	38.14	Note 2, 6 and 7
ECFUG9	C1/C2 Separation	300.0	300.0	300.0	82.0	41.0	69.77	38.14	Note 2, 6 and 7
ECFUG10	Spent Caustic Treatment	300.0	300.0	300.0	82.0	41.0	69.77	38.14	Note 2, 6 and 7
ECFUG11	Flare Condensate	300.0	300.0	300.0	82.0	41.0	69.77	38.14	Note 2, 6 and 7
OSBLFUG1	Recovered Oil and Truck Loadout	300.0	300.0	300.0	30.0	15.0	69.77	13.95	Note 2, 6 and 7
OSBLFUG2	Rail for C3+	300.0	300.0	300.0	52.0	26.0	69.77	24.19	Note 2, 6 and 7
OSBLFUG3	Diesel Tanks	300.0	300.0	300.0	52.0	26.0	69.77	24.19	Note 2, 6 and 7
OSBLFUG4	C3+	300.0	300.0	300.0	52.0	26.0	69.77	24.19	Note 2, 6 and 7
WWTP	Waste Water Treatment Fugitives	225.0	225.0	225.0	30.0	15.0	52.33	13.95	Note 2, 6 and 7

Note 1: Release height equal to top of structure as process is aspirated and emissions will occur at the top of the structure.

Note 2: Sigma Y value calculated as the square root of the area, or average length of side, divided by 4.3 (Table 3-1 of AERMOD Manual for single volume source).

Note 3: Sigma Z values for elevated sources on or adjacent to a building calculated as the building height divided by 2.15 (Table 3-1 of AERMOD Manual for Elevated Source on or Adjacent to Building).

Note 4. Release height of ground flare calculated based upon Ohio EPA Guidance for deriving plume rise for a flare (0.944*(98)^0.478)*3.28). The modeled height was set to the height of the wind fence plus 1/2 of the total plume rise. The plume rise was calculated to be 27.7'. The heat release rate of flare is 98 MMBtu/hr.

Note 5. Sigma Z value for ground flare assumed equal to effective stack height (vertical dimension) divided by 4.3. Effective height calculated based upon Ohio EPA Guidance and heat release rate of 98 MMBtu/hr [45+((0.944*(98)^0.478)*3.28)].

Note 6: Sigma Z values for surface based source calculated as the vertical dimension of source divided by 2.15 (Table 3-1 of AERMOD Manual for Surface Based Source).

Note 7: Release height for surface based volume source calculated as 1/2 of the vertical dimension.

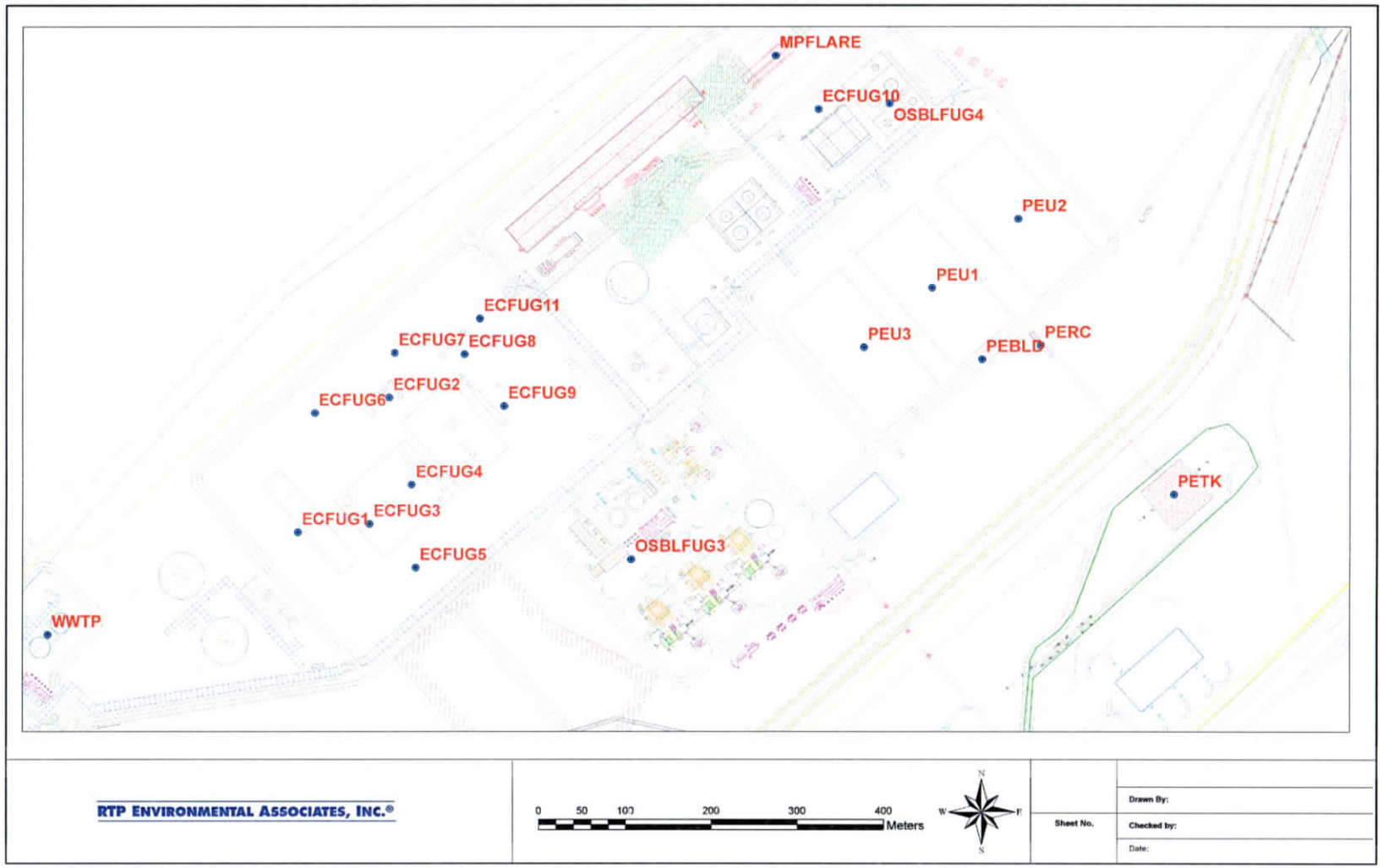


Figure 5. Modeled Volume Source Locations

Load/Operating Conditions

The combustion turbines may operate at a reduced load. Therefore, a range of load conditions was evaluated to identify the load condition which results in the worst-case impact for each averaging period of concern. Three load conditions were evaluated: 100%, 75%, and 50%. The emission rates and flow conditions associated with each load were modeled. The condition resulting in the worst-case impact was carried forward for the remainder of the analysis.

Good Engineering Practice Stack Height Analysis

A Good Engineering Practice (GEP) stack height evaluation was conducted to determine appropriate building dimensions to include in the model and to calculate the GEP formula stack height used to justify stack height credit for stacks to be constructed in excess of 65m. Procedures used were in accordance with those described in the EPA Guidelines for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations-Revised)[4]. 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. Building/structure locations will be determined from a facility plot plan. The structure 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. The proposed Shell facility plot plan is shown in Figure 6. A three dimensional rendering of the proposed facility is shown in Figure 7. All stacks were included in the AERMOD runs.

[4]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.

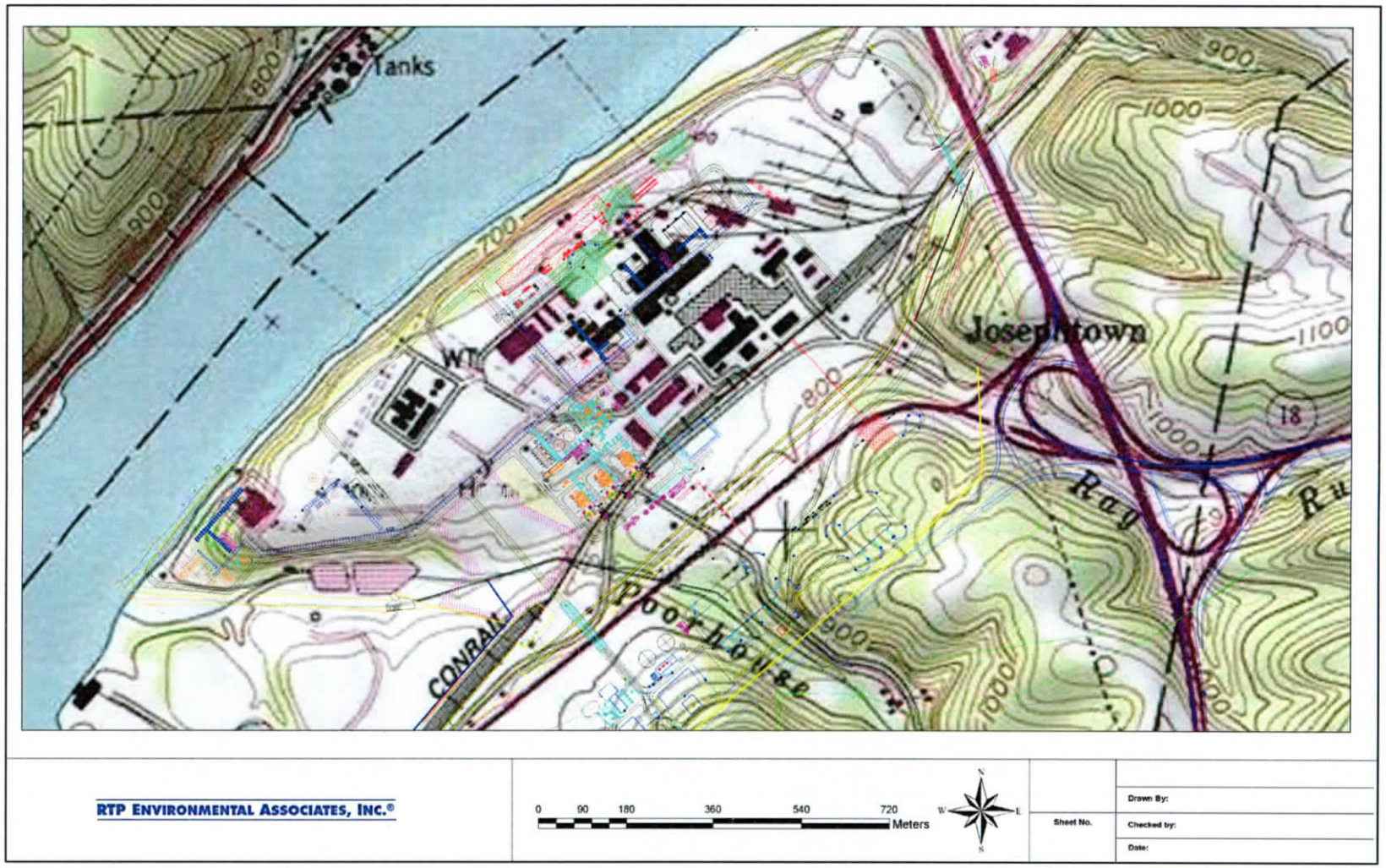


Figure 6. Proposed Shell Facility Plot Plan

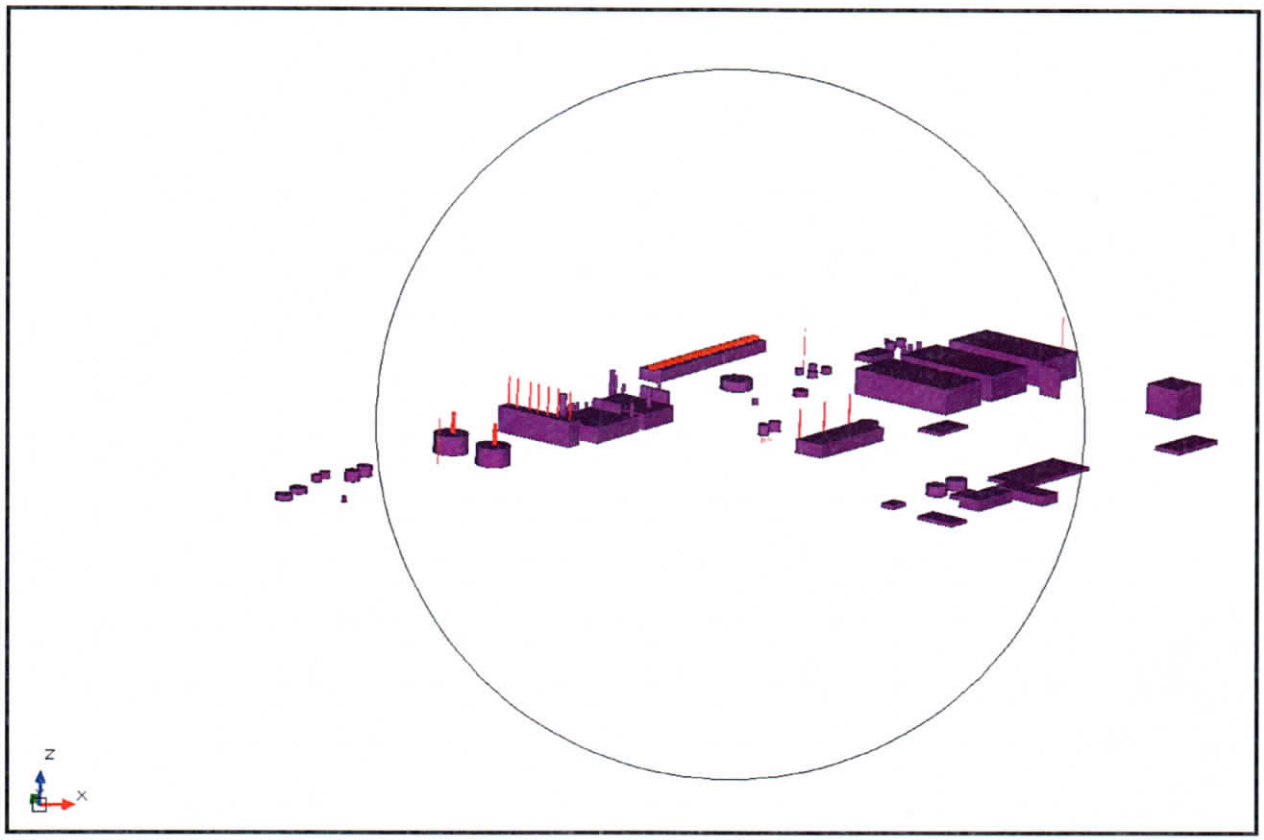


Figure 7. Proposed Shell Three Dimensional Plot Plan (View from SW)

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 as "ambient air" pursuant to 40 CFR 50.1(e). Ambient air is defined as that portion of the atmosphere, external to buildings, to which the general public has access. The receptor grid consisted of three Cartesian grids and receptors spaced at 25m intervals along the facility fenceline and the railroad that transects the facility. The first cartesian grid extended to approximately 1km from the fence in all directions. Receptors in this region were spaced at 50m intervals. The second grid extended to 3km. Receptor spacing in this region was 100m. The third grid extended to approximately 5km with a spacing of 500m. Receptors with flagpole elevations were also placed along the Highway 376 bridge (Vanport Bridge) east of the facility. The receptor grid was designed such that maximum facility impacts fall within the 50m spacing of receptors. The receptor grid spacing is presented in Table 3.

Table 22. Receptor Grid Spacing

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

The second grid was used for assessment of chronic impacts. This grid did not include receptors located on the Ohio River, facility property adjacent to the river, the Vanport 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.

The proposed Shell facility will be located in western Pennsylvania. Terrain within 10km 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 (11103). The elevation data will be obtained from the USGS 1 arc second National Elevation Data (NED) obtained from the USGS. Locations were based upon a NAD83, UTM Zone 17 projection. The receptor grids used in the acute and chronic assessments are shown in Figures 8 and 9, respectively.

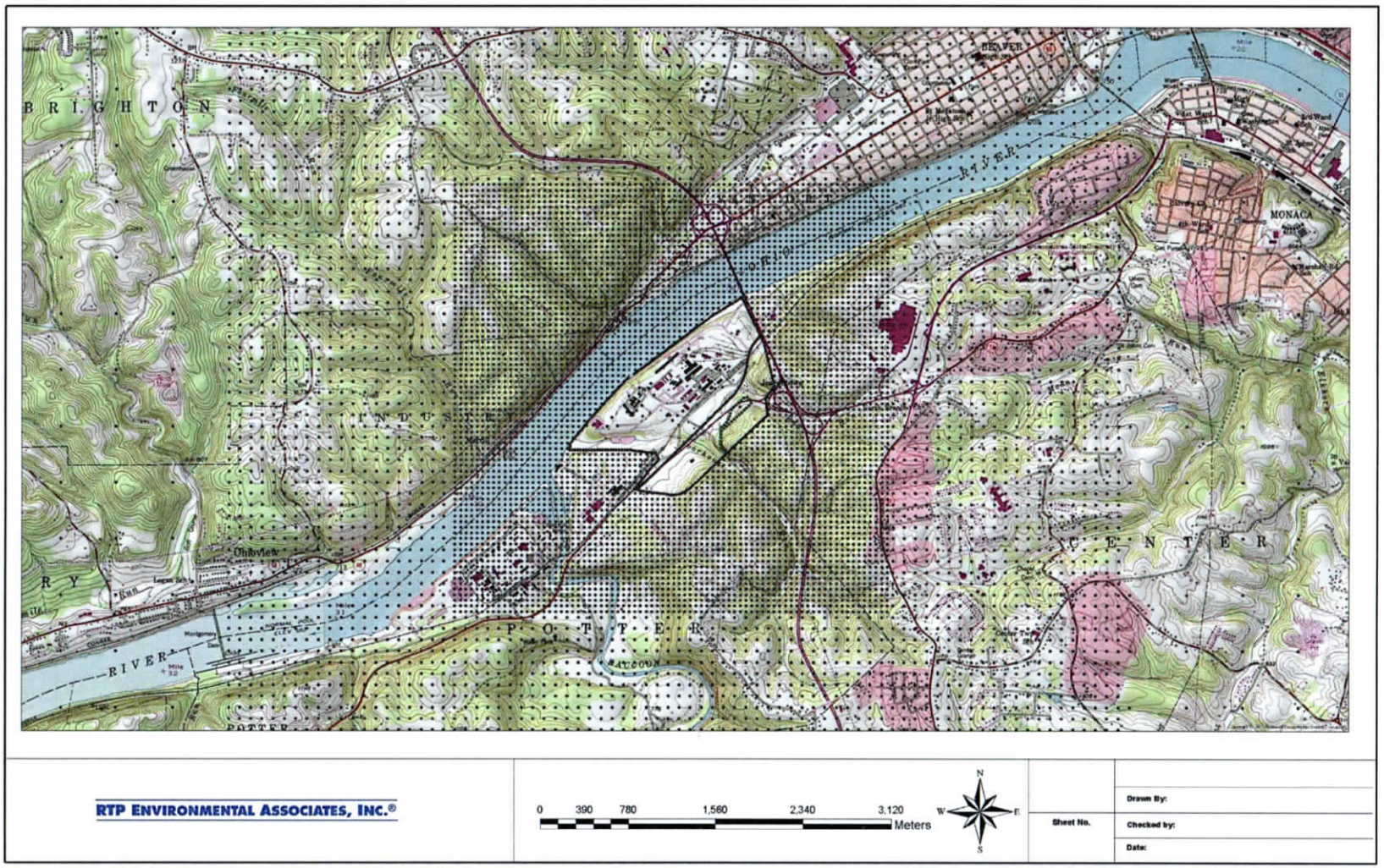


Figure 8. Shell Acute Analysis Receptor Grid

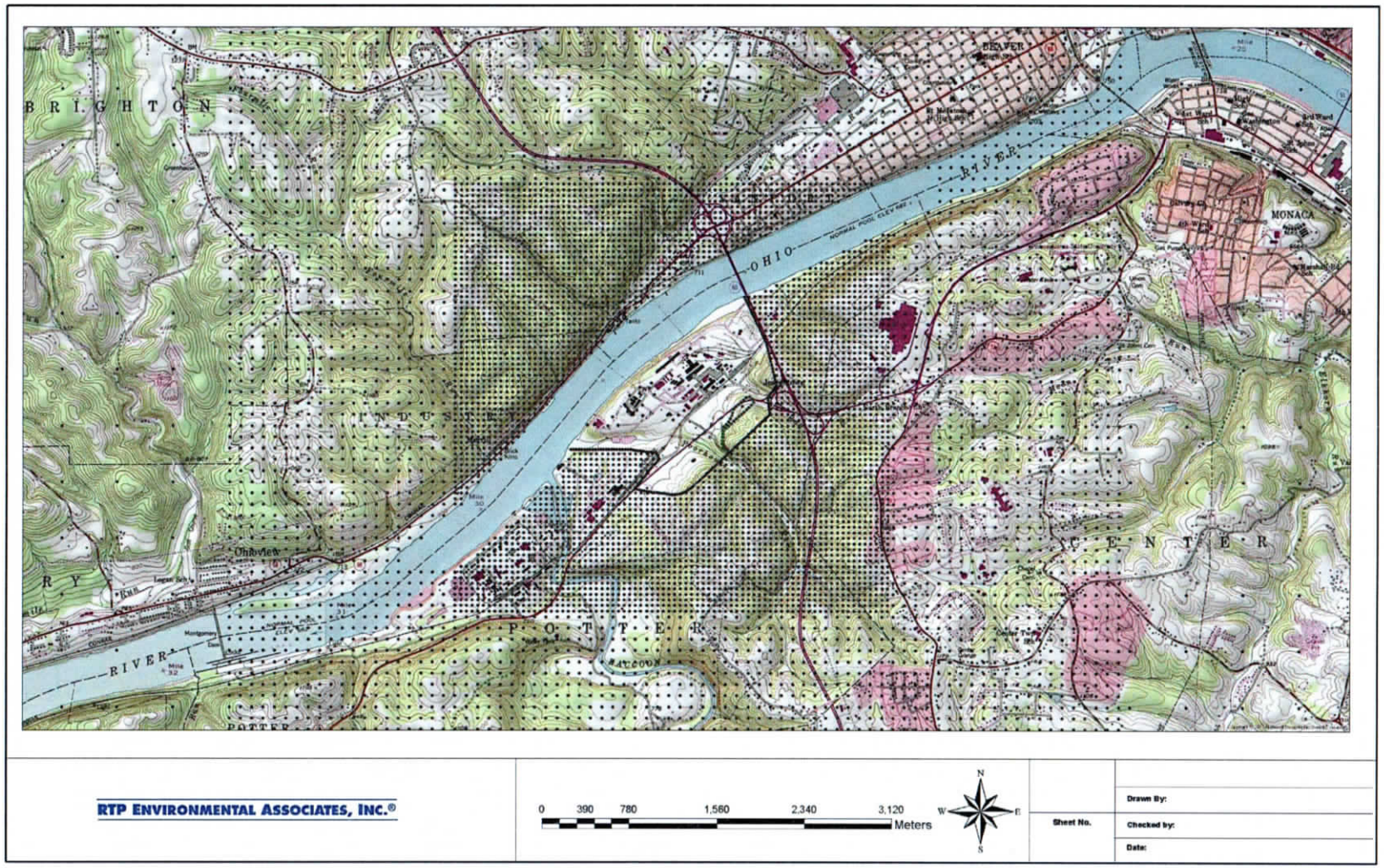


Figure 9. Shell Chronic Analysis Receptor Grid

4.5 Meteorological Data

Data Selection and Representativeness

The 2006-2010, 5-year sequential hourly surface meteorological data collected at the First Energy Beaver Valley Nuclear Generating Station (Beaver Valley) and secondary surface and upper air data from the Pittsburgh International Airport (KPIT, WBAN 94823) were used in the analysis. The First Energy surface data were collected as part of a continuous data collection program required by the U.S. Nuclear Regulatory Commission (NRC). For the reasons discussed below, RTP believes the meteorological data adequately represent atmospheric boundary layer conditions within the Shell analysis domain for AERMOD to properly characterize the transport and dispersion of the Shell emissions plumes. A profile base elevation of 228.6m was employed which corresponds to the base elevation of the Beaver Valley tower.

The First Energy station is located approximately 8km downstream of the proposed Shell site, also on the Ohio River. The Beaver Valley meteorological station and proposed Shell site also share a similar orientation in relation to the Ohio River. As can be seen in Figure 10, the river flows from the northeast to southwest relative to both the proposed Shell site and the Beaver Valley meteorological station. The topography is also similar at each location. The wind patterns are therefore likely similar at each location (see the wind rose Figure 11). Wind speed, direction and standard deviation of the horizontal wind direction are measured at three levels at the Beaver Valley station (10.7m, 45.7m, and 152.4m). Temperature is also measured at the 10.7m level. These three levels will provide adequate representation of plume behavior at the various release heights to be seen at the proposed Shell site.

The Pittsburgh International Airport is located approximately 21km southeast of the facility (Figure 12). Station pressure, cloud cover, and twice daily sounding data from

Figure 10. First Energy Meteorological Tower Location Relative to Shell

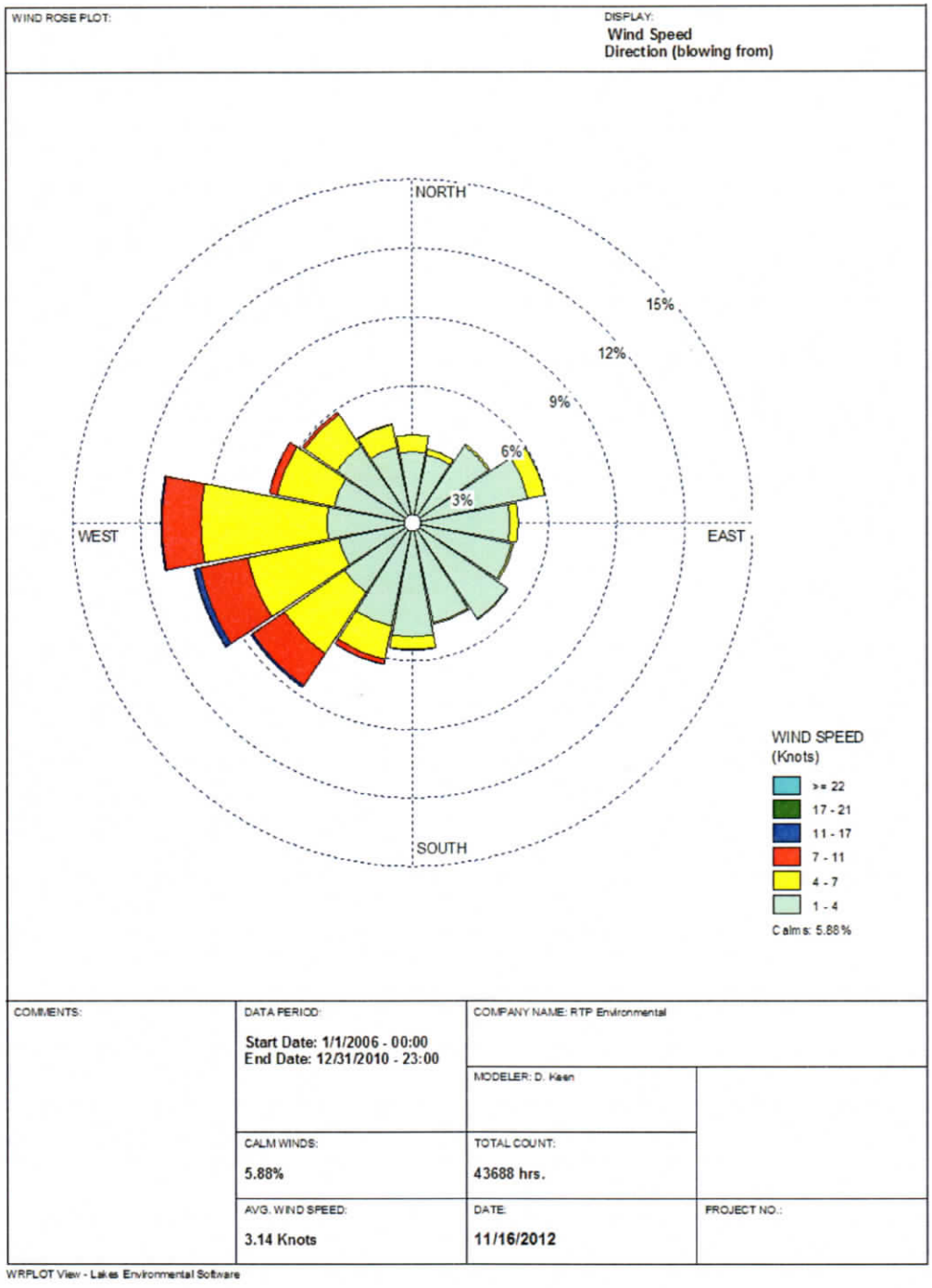


Figure 11. Beaver Valley Windrose 2006-2010

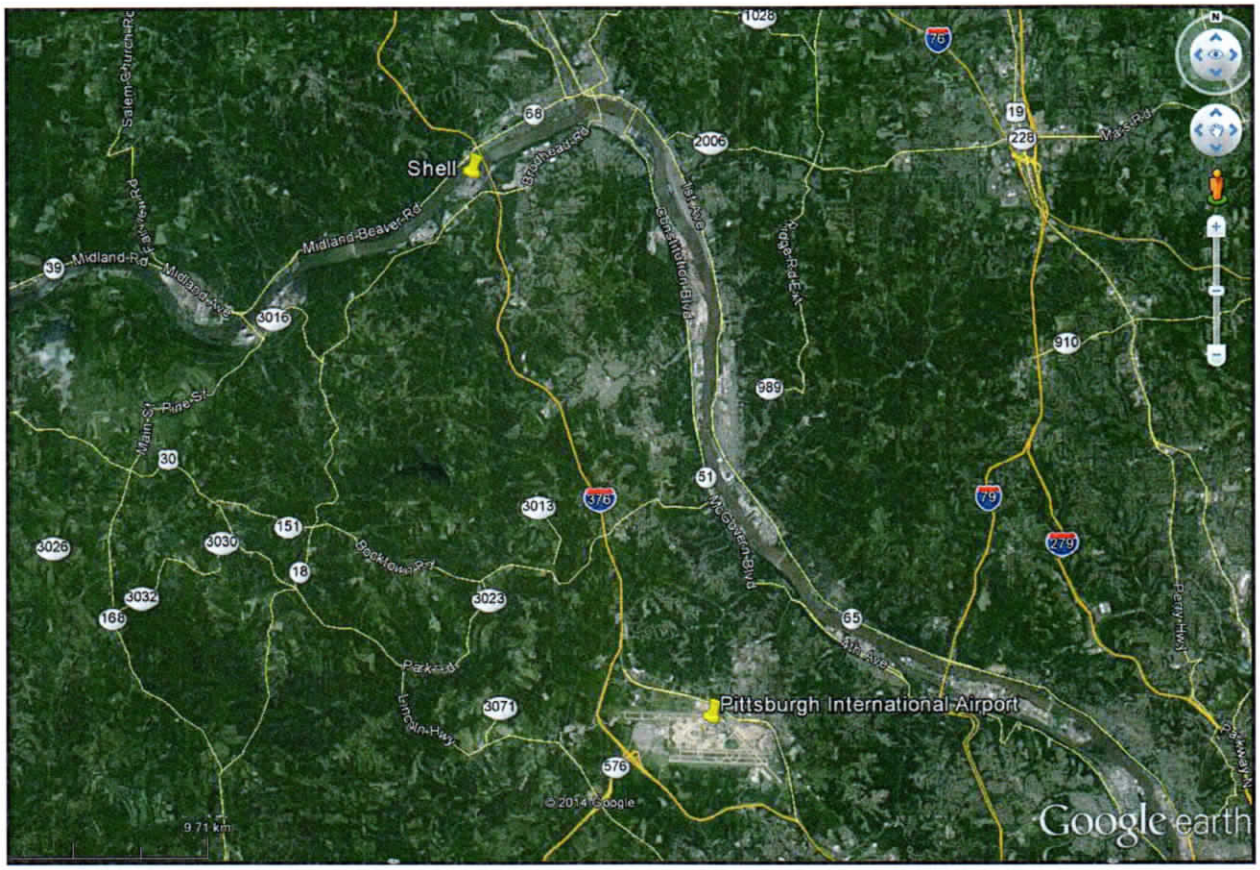


Figure 12. Pittsburgh International Airport Location Relative to Shell

Pittsburgh were used. These meteorological parameters are of synoptic scale and are adequately representative of the Beaver Valley area.

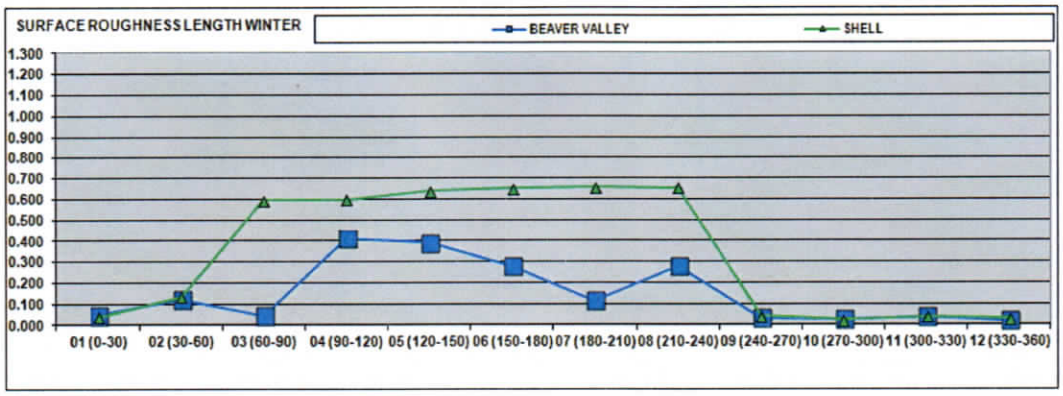
According to the EPA's AERMOD Implementation Guide[5], the surface characteristics should be similar for the meteorological station and the study site. RTP compared the surface characteristics at the First Energy station and the proposed site. The AERSURFACE program was run to determine the characteristics for comparison. The results of the surface roughness comparison, by season, are shown in Figure 13. As can be seen, the surface characterisitics values for the two sites, when compared on a seasonal and sector basis, are similar.

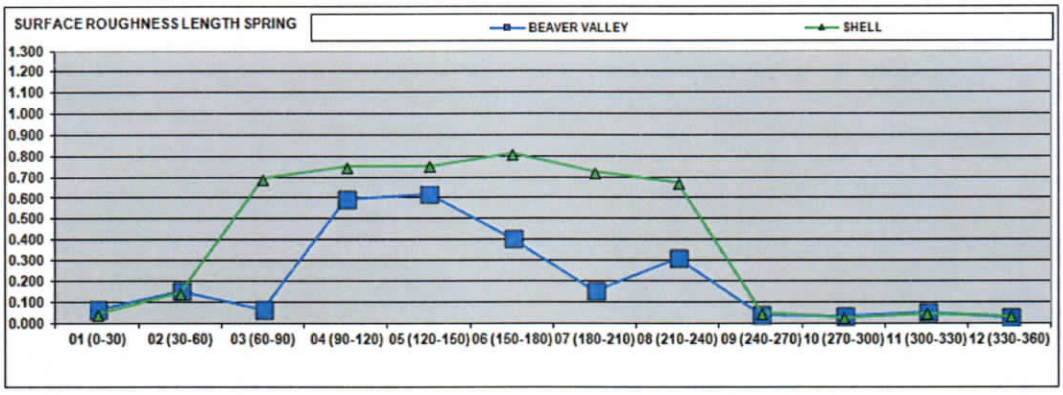
Data Processing

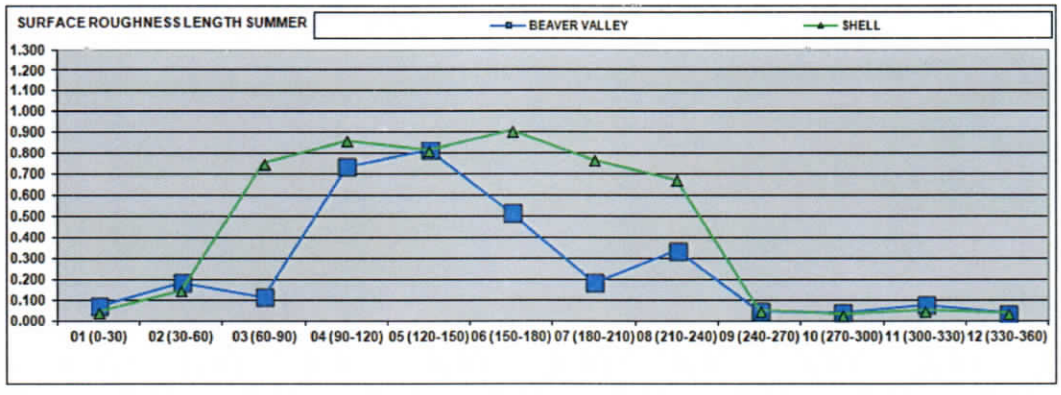
The meteorological data were provided to RTP Environmental by the DEP. The DEP processed the Beaver Valley surface data, Pittsburgh International Airport (KPIT) surface data and KPIT upper air data using the meteorological preprocessor AERMET (Ver. 14134). In AERMET Stage 1, KPIT surface meteorological data in the Integrated Surface Data (ISD) format were extracted. KPIT upper air meteorological data in the Forecast Systems Laboratory (FSL) 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 3, values of the surface characteristics (noon-time albedo, Bowen ratio, and surface roughness length) representative of the Beaver Valley surface meteorological site, were entered.

5AERMOD Implementation Guide, EPA, September 27, 2005.







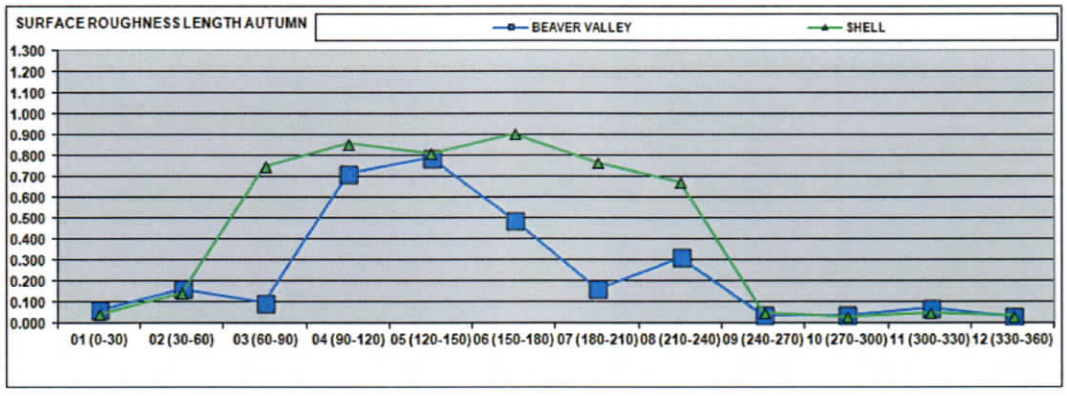


Figure 13. Meteorological Data Representativeness Analysis Results

These surface characteristics values were calculated by AERSURFACE 13016 using USGS National Land Cover Data (NLCD) for 1992. The following options were selected in AERSURFACE: default 1-km radius and default twelve 30-degree sectors for surface roughness length, seasonal temporal resolution, non-airport site 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 3 was then executed for each set of surface characteristics to produce six surface (.sfc) files. The final AERMET surface file was assembled by season, 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 Climatic Data Center (NCDC) Local Climatological Data from KPIT.

4.6 Output Options

The output options were specified to generate graph files of concentrations for each pollutant and averaging period. The chronic impacts for each pollutant were based upon the five year average. Acute impacts were calculated as the maximum 1-hour concentrations from the five years of meteorology.

5.0 RESULTS

5.1 Turbine Load Analysis Results

The results of the 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 remainder of the modeling analysis.

Table 23. Turbine Load Analysis Results

Averaging Period	Source Name	Modeled Concentration ($\mu g/m^3$)	Source Description
1-hr	**CT1_100**	**2.04**	**Turbine 1, 100% load**
	CT1_75	1.82	Turbine 1, 75% load
	CT1_45	1.09	Turbine 1, 45% load
	CT2_100	**2.06**	**Turbine 2, 100% load**
	CT2_75	1.74	Turbine 2, 75% load
	CT2_45	1.09	Turbine 2, 45% load
	CT3_100	**2.05**	**Turbine 3, 100% load**
	CT3_75	1.58	Turbine 3, 75% load
	CT3_45	1.06	Turbine 3, 45% load
Annual	**CT1_100**	**0.02**	**Turbine 1, 100% load**
	CT1_75	0.02	Turbine 1, 75% load
	CT1_45	0.01	Turbine 1, 45% load
	CT2_100	**0.02**	**Turbine 2, 100% load**
	CT2_75	0.02	Turbine 2, 75% load
	CT2_45	0.01	Turbine 2, 45% load
	CT3_100	**0.02**	**Turbine 3, 100% load**
	CT3_75	0.02	Turbine 3, 75% load
	CT3_45	0.01	Turbine 3, 45% load

5.2 Acute Pollutant Results

Table 5 presents the results of the acute COPC modeling. The maximum 1-hr impact from the five years of meteorology is presented for each pollutant. All model input and output files are provided on the attached CD.

5.3 Chronic Pollutant Results

To calculate the ambient concentrations used in the chronic cancer and non-cancer risks, a unit emission rate of 1 lb/hr was modeled for each source. An AERMOD concentration file (graph file) was generated containing the unit impacts by source and by receptor. The graph file, Shell Franklin HRA_5yrs_Unit.GRF is provided on the attached CD. The impacts resulting from the proposed project for each COPC were then calculated by multiplying the annual average hourly emission rate (in lb/hr) for each source by the modeled unit concentration for that source and receptor. To determine the total exposure concentration, the concentrations for all facility sources at each receptor for each COPC were then summed. An example of the calculation of the total concentration at each receptor for benzene is provided in the spreadsheet, benzene_annual_impact_xreceptor.xlsx, on the attached CD. A summary of the total concentration of all COPCs at each receptor is provided in the spreadsheet, COPC_annual_impact_xreceptor.xlsx on the attached CD.

Table 5. Acute Model Results - Maximum 1-hr Concentrations

COPC	Conc/Dep	East (X)	North (Y)	Elev	Hill	Flag	Time	Met File	Sources	Groups	Receptors
13BUTA	2.25367	556700	4502900	240.09	343.02	0	8110623	BEAVER_VALLEY_06-10.SFC	18	1	11016
2METHY	0.00014	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
3METHY	0.00001	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
712DIMET	0.00009	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
ACENAP	0.01197	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
ACENAPL	0.02359	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	7	1	11016
ACET	0.06436	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	10	1	11016
ACROL	0.0201	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	10	1	11016
ANTHRA	0.00314	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
AS	0.00114	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
BA	0.01422	555000	4502900	343.75	343.75	0	9120121	BEAVER_VALLEY_06-10.SFC	7	1	11016
BE	0.00007	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
BENSOAP	0.00066	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
BENZOAA	0.00159	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
BENZOB	0.00284	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
BENZOG	0.00001	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
BENZOG2	0.00142	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	7	1	11016
BENZOK	0.00056	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
BIPH	0.00138	556288.88	4502083.8	246.1	337.73	0	6090620	BEAVER_VALLEY_06-10.SFC	1	1	11016
BZ	16.78551	555122.4	4501969.2	210.5	353.88	0	10041405	BEAVER_VALLEY_06-10.SFC	35	1	11016
CD	0.0063	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
CHRYS	0.0039	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
CO	0.00048	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
CR	0.01026	557250	4503050	308.13	339.23	0	9051506	BEAVER_VALLEY_06-10.SFC	9	1	11016
CU	0.00275	555000	4502900	343.75	343.75	0	9120121	BEAVER_VALLEY_06-10.SFC	7	1	11016
DIBENZ	0.00089	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
DICHLB	0.00683	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
EB	0.20365	555100	4502000	207.93	355.27	0	7070304	BEAVER_VALLEY_06-10.SFC	12	1	11016
FL	0.03266	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
FLUOR	0.0103	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016

COPC	Conc/Dep	East (X)	North (Y)	Elev	Hill	Flag	Time	Met File	Sources	Groups	Receptors
FORM	0.42977	553300	4502200	360.14	360.14	0	8032922	BEAVER_VALLEY_06-10.SFC	23	1	11016
HEX	18.04259	556300	4504500	264.12	355.17	0	7080822	BEAVER_VALLEY_06-10.SFC	29	1	11016
HG	0.00148	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
IDENO	0.00106	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
MEOH	2.51428	555588.8	4502461.9	212.82	354.3	0	7110320	BEAVER_VALLEY_06-10.SFC	2	1	11016
MN	0.00217	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
MOLYB	0.00355	555000	4502900	343.75	343.75	0	9120121	BEAVER_VALLEY_06-10.SFC	7	1	11016
NAPTH	3.12448	555122.4	4501969.2	210.5	353.88	0	10041405	BEAVER_VALLEY_06-10.SFC	31	1	11016
NICKEL	0.01196	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
PAH	0.00087	554350	4502650	352.99	352.99	0	7072924	BEAVER_VALLEY_06-10.SFC	3	1	11016
PB	0.00285	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	12	1	11016
PENT	8.40833	555000	4502900	343.75	343.75	0	9120121	BEAVER_VALLEY_06-10.SFC	7	1	11016
PHEN	0.00116	555179.1	4502041	211.27	353.88	0	10101303	BEAVER_VALLEY_06-10.SFC	1	1	11016
PHENAN	0.10449	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
PROP	0.01148	554350	4502650	352.99	352.99	0	7072924	BEAVER_VALLEY_06-10.SFC	3	1	11016
PROPANE	5.17277	555000	4502900	343.75	343.75	0	9120121	BEAVER_VALLEY_06-10.SFC	7	1	11016
PYR	0.00951	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	20	1	11016
SEL	0.00014	556800	4502600	261.23	343.02	0	6041101	BEAVER_VALLEY_06-10.SFC	13	1	11016
STY	1.14084	555100	4502000	207.93	355.27	0	7070304	BEAVER_VALLEY_06-10.SFC	8	1	11016
TOL	2.36966	555100	4502000	207.93	355.27	0	8100720	BEAVER_VALLEY_06-10.SFC	31	1	11016
VAN	0.00744	555000	4502900	343.75	343.75	0	9120121	BEAVER_VALLEY_06-10.SFC	7	1	11016
XY	0.49281	556211.2	4501557.1	290.48	340.28	0	7031821	BEAVER_VALLEY_06-10.SFC	18	1	11016

ATTACHMENT C

INHALATION RISK ASSESSMENT FOR PETROCHEMICALS COMPLEX SHELL CHEMICAL APPALACHIA LLC BEAVER COUNTY, PENNSYLVANIA

Prepared for:
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January 2015

1.0 General Discussion

This inhalation risk assessment for the proposed Shell Chemical Appalachia LLC Petrochemicals Complex to be constructed in Beaver County, Pennsylvania evaluated the potential cancer and non-cancer inhalation risks from the compounds of potential concern (COPC) emitted from the proposed facility. The approach used to conduct the assessment is based on guidance provided by the Pennsylvania Department of Environmental Protection (PaDEP) as outlined in the approved Inhalation Risk Assessment Protocol.[1]

1.1 Chronic Cancer and Non-cancer Risks

Chronic cancer and non-cancer impacts were estimated for each COPC at approximately 10,000 habitable points on a receptor grid surrounding the proposed facility. As detailed in Attachment B, exposure concentrations at each receptor were determined by modeling a unit emissions rate (i.e., 1 lb/hr) from each emissions unit at the proposed facility. The resulting concentration was then scaled based on the estimated annual hourly average emission rate for each COPC from each emissions unit. As referenced in Attachment B, a summary of the total concentration of all COPCs at each receptor is provided in the spreadsheet, COPC_annual_impact_xreceptor.xlsx on the attached CD. For the chronic excess lifetime cancer risk (ELCR), the exposure concentration of each pollutant at each receptor was multiplied by the compound specific unit risk factor. The compound specific unit risk factors used in the ELCR calculation are presented in Table 1. The aggregate ELCR was then determined for each receptor by summing the individual COPC ELCR. (The ELCR for each COPC and the aggregate ELCR at each receptor is provided in the spreadsheet, COPC_ELCR_xreceptor.xlsx on the attached CD. As shown in Figure 1, the receptor with the highest ELCR is located southwest of the proposed facility's fence line. The ELCR at this receptor is 0.79 in 100,000 (i.e., 7.9E-6) which does not exceed PaDEP's inhalation risk management facility-wide target level of cancer risk of 1 in 100,000 (i.e., 1eE-5).

For the chronic non-cancer risk, the exposure concentration of each pollutant at each receptor was divided by the compound specific reference concentration (RfC) to determine the hazard quotient (HQ) for that COPC. The reference concentrations used for this analysis are presented in Table 1. The aggregate health index (HI) was determined for each receptor by summing the individual COPC HQ values. The HQ for each COPC and the aggregate HI at each receptor is provided in the spreadsheet, COPC_HQ_xreceptor.xlsx on the attached CD. As shown in Figure 1, the receptor with the highest HI is located southwest of the proposed facility's fence line. The facility HI at this receptor is 0.075, which does not exceed PaDEP's inhalation risk management facility-wide target level for non-cancer HI of 0.25.

1.2 Acute Non-cancer Risks

The acute health risks were determined for the one hour average exposure to each COPC at all points in the receptor grid. For each pollutant, the highest modeled exposure concentration was divided by compound-specific RfC values derived from short term exposure levels to determine the HQ for each

[1] Email from A. Binder, PaDEP to P. May, RTP Environmental Assoc., January 12, 2015

pollutant. The compound specific RfC values are presented in Table 1. Each HQ was then compared to the threshold of 1.0, the level at which no adverse effect would be expected from the exposure per PaDEP guidance. As presented in Table 2, no COPC has an HQ above 1. The pollutant with the highest HQ is benzene with an HQ of 0.2.

Table 1. Chronic and Acute Risk Factors for Inhalation Risk Assessment

Pollutant	Inhalation Unit Risk Factor (IUR) $(\mu g/m^3)^{-1}$	Reference [1]	Chronic Ref. Conc. RfC (mg/m^3)	Reference [1]	Acute Reference Conc. RfC (mg/m^3)	STEL	Ceiling	TLV	IDLH	Reference[1]
1,3-Butadiene	0.00003	EPA IRIS	0.002	EPA IRIS	0.275	11		4.4		CalEPA
2-Methylnaphthalene					3					
3-Methylchloranthrene	6.30E-03	CalEPA			0.074					
7,12Dimethylbenz(a) anthracene	7.10E-02	CalEPA								
Acenaphthene					3.6					
Acenaphthylene					10					
Acetaldehyde	0.0000022	EPA IRIS	0.009	EPA IRIS	4.5		45			PADEP
Acrolein			2.00E-05	EPA IRIS	0.025		0.25			CalEPA
Anthracene					0.27					NIOSH
Arsenic	0.0043	EPA IRIS	0.000015	CalEPA	0.0002		0.002			PADEP
Benzene	0.0000078	EPA IRIS	0.03	EPA IRIS	0.08	3.2				PADEP
Benzo(a)anthracene	0.00011	CalEPA			0.03			0.2		PADEP
Benzo(a)pyrene	0.0011	CalEPA	0		0.03			0.2		PADEP
Benzo(b)fluoranthene	0.00011	CalEPA	0		0					
Benzo(g,h,i)perylene					30					
Benzo(g,h,l)perylene										
Benzo(k)fluoranthene	1.10E-04	CalEPA			0.019					
Beryllium	0.0024	EPA IRIS	0.00002	EPA IRIS	0.00025					PADEP
Biphenyl					0.15			1		NIOSH
Cadmium	0.0018	EPA IRIS	0.00001	PaDEP	0.0003					PADEP
Chromium	0.012		0.0001		0.00075					PADEP
Chromium III					0.075			0.5		ACGIH
Chrysene	1.10E-05	CalEPA	0		0.03					PADEP
Cobalt	0.009	PPRTV	0.000006	PPRTV	0.003					PADEP
Dibenzo(a,h)anthracene	1.20E-03	CalEPA								
Dichlorobenzene	1.10E-05	CalEPA	0.8	EPA IRIS	16.875	675				CalEPA
Ethylbenzene	2.50E-06	CalEPA	1	EPA IRIS	3.25	130				CalEPA
Ethylene Oxide	8.80E-05	CalEPA	0.03	CalEPA	0.9		9			NIOSH

Pollutant	Inhalation Unit Risk Factor (IUR) ($\mu g/m^3$)$^{-1}$	Reference [1]	Chronic Ref. Conc. RfC (mg/m^3)	Reference [1]	Acute Reference Conc. RfC (mg/m^3)	STEL	Ceiling	TLV	IDLH	Reference[1]
Fluoranthene										
Fluorene	0		0		0					
Formaldehyde	0.000013	EPA IRIS	0.0098	ATSDR	0.0625					PADEP
Hexane	-		0.2	EPA IRIS	27			180		ACGIH
Indeno(1,2,3-cd)pyrene	1.10E-04	CalEPA								
Manganese	-		5.00E-05	EPA IRIS	0.075					PADEP
Mercury			0.0003	EPA IRIS	0.01					PADEP
Methanol			4	CalEPA	8.125	325				CalEPA
Naphthalene	0.000034	CalEPA	0.003	EPA IRIS	2					PADEP
Nickel	0.00048	PADEP	0.00009	ATSDR	0.00225					PADEP
PAH										
Phenanthrene										
Phenol			0.2	CalEPA	2.85					CalEPA
Propylene Oxide	3.70E-06	EPA IRIS	0.03	CalEPA	0.7125					CalEPA
Pyrene										NIOSH
Selenium	0		0.02	CalEPA	0.03					PADEP
Styrene			0.9	CalEPA	10.625	425				CalEPA/ NIOSH
Toluene	0		5	EPA IRIS	14					PADEP
Xylenes			0.1	EPA IRIS	16.275	651				ACGIH
Pentane					270			1800		CalEPA
Propane					270			1800		CalEPA
Barium			5.00E-04	HEAST	7.50E-02					PADEP
Copper					2.50E-03					PADEP
Molybdenum					0.45			3		CalEPA
Vanadium									35	NIOSH
Zinc										
Lead	1.20E-05	CalEPA	1.50E-04	NAAQS	7.50E-03					PaDEP

Pollutant	Inhalation Unit Risk Factor (IUR) $(\mu g/m^3)^{-1}$	Reference [1]	Chronic Ref. Conc. RfC (mg/m^3)	Reference [1]	Acute Reference Conc. RfC (mg/m^3)	STEL	Ceiling	TLV	IDLH	Reference[1]

[1]References:
PaDEP = Values provided by Pennsylvania Department of Environmental Protection
EPA IRIS = EPA Integrated Risk Information System
CalEPA = California Environmental Protection Agency
PPRTV = Provisional Peer-reviewed Toxicity Value
NIOSH = National Institute for Occupational Safety and Health
ACGIH = American Conference of Industrial Hygienists
ASTDR = Agency for Toxic Substances and Disease Registry
HEAST = Health Effects Assessment Summary Table
NAAQS = National Ambient Air Quality Standard

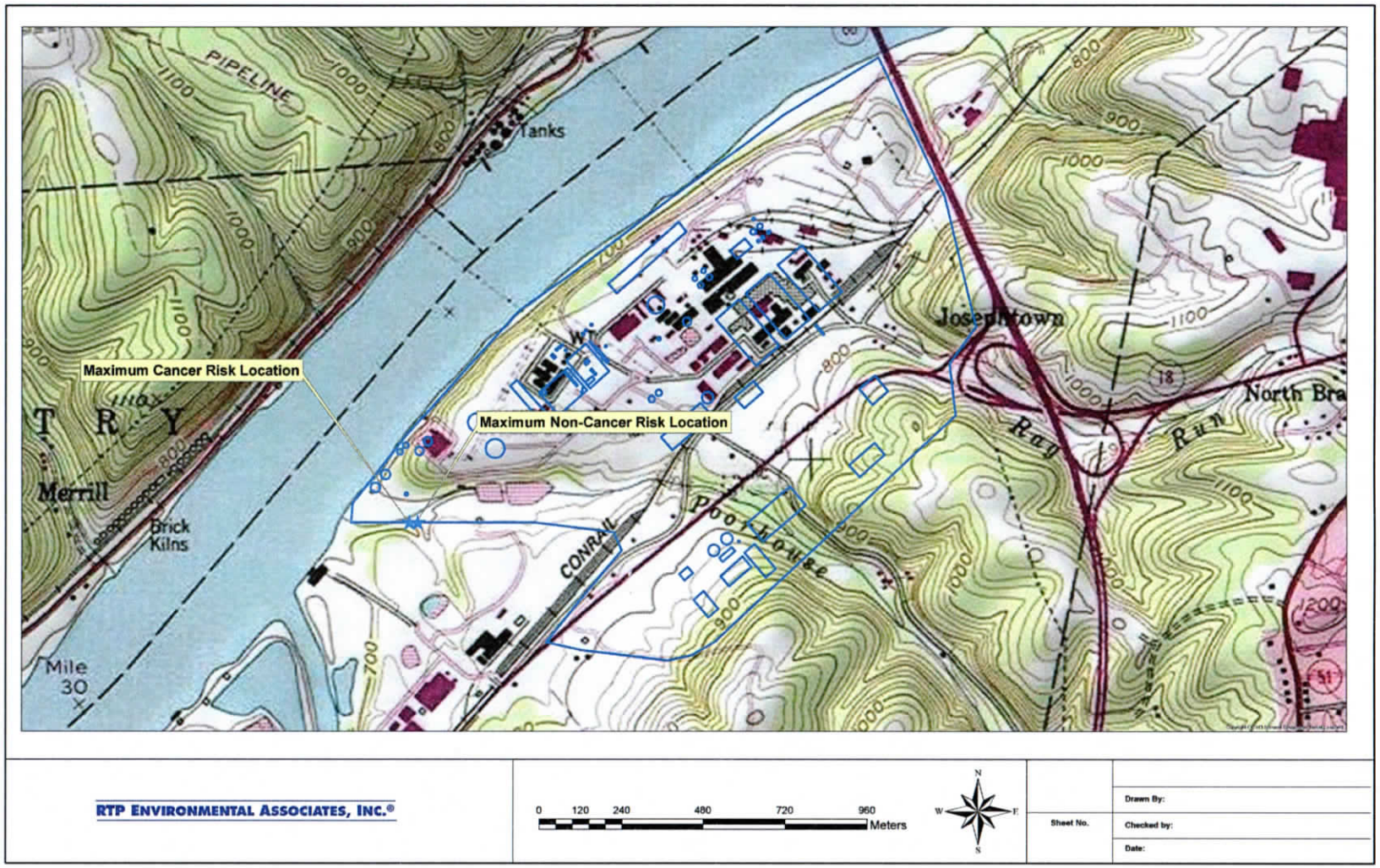

Figure 1. Location of Receptors with the Highest Chronic Cancer and Non-cancer Risks

Table 2. Risks from COPCs at Receptor with the Highest Aggregate Chronic Risk

Compound of Potential Concern	Excess Lifetime Cancer Risk	Chronic Non-cancer HQ
1,3-Butadiene	1.1E-06	1.9E-02
2-Methylnaphthalene	-	-
3-Methylchloranthrene	4.2E-11	-
7,12-Dimethylbenz(a)anthracene	4.3E-09	-
Acenaphthene		-
Acenaphthylene		-
Acetaldehyde	3.3E-11	1.7E-06
Acrolein	-	1.5E-04
Anthracene	-	-
Arsenic	3.2E-09	4.9E-05
Benzene	2.0E-06	8.7E-03
Benzo(a)anthracene	1.2E-11	-
Benzo(a)pyrene	5.2E-11	-
Benzo(b)fluoranthene	2.1E-11	-
Benzo(g,h,i)perylene	-	-
Benzo(g,h,l)perylene	-	-
Benzo(k)fluoranthene	4.8E-12	-
Beryllium	1.1E-10	2.2E-06
Biphenyl	-	-
Cadmium	7.4E-09	4.1E-04
Chromium[1]	3.0E-07	2.4E-04
Chrysene	2.9E-12	-
Cobalt	2.8E-09	5.2E-05
Dibenzo(a,h)anthracene	7.5E-11	-
Dichlorobenzene	4.9E-11	5.5E-09
Ethylbenzene	2.0E-08	7.8E-06
Ethylene Oxide	-	-
Fluoranthene	-	-
Fluorene	-	-
Formaldehyde	6.3E-09	4.9E-05
Hexane	-	1.6E-03
Indeno(1,2,3-cd)pyrene	8.4E-12	-
Manganese	-	2.8E-05
Mercury	-	3.2E-06
Methanol	-	8.5E-06
Naphthalene	4.3E-06	4.2E-02

Compound of Potential Concern	Excess Lifetime Cancer Risk	Chronic Non-cancer HQ
Nickel	3.8E-09	8.6E-05
PAH[2]	4.3E-08	-
Phenanthrene	-	-
Phenol	-	3.0E-08
Propylene Oxide	2.9E-11	2.6E-07
Pyrene	-	-
Selenium	-	4.4E-09
Styrene	-	4.8E-05
Toluene	-	1.8E-05
Xylenes	-	3.0E-05
Lead	2.2E-11	1.2E-05
Pentane	-	-
Propane	-	-
Barium	-	2.9E-05
Copper	-	-
Molybdenum	-	-
Vanadium	-	-
Total Risk at Receptor with Highest Risk=	**7.9E-06**	**7.3E-02**

[1]Emissions of chromium conservatively assumed to be in hexavalent form

[2]AP-42 factors for stationary combustion turbines are not available for individual PAH compounds. For this assessment, PAH emissions from CTs were conservatively assumed to be benzo(a)pyrene

- Denotes no available risk factor

Table 3. Acute Non Cancer Risk Assessment

Compound of Potential Concern	Modeled 1-hr Impact	Modeled 1-hr Impact	Acute Non-Cancer RfC[1]	HQ
	(µg/m3)	(mg/m3)	(mg/m3)	
1,3-Butadiene	2.30785	0.00230785	0.275	0.008195
2-Methylnaphthalene	0.00014	0.00000014	-	-
3-Methylchloranthrene	0.00001	0.00000001	-	-
7,12-Dimethylbenz(a)anthracene	0.00009	0.00000009	-	-
Acenaphthene	0.01197	0.00001197	-	-
Acenaphthylene	0.02359	0.00002359	-	-
Acetaldehyde	0.06436	0.00006436	4.5	1.43E-05
Acrolein	0.0201	0.0000201	0.025	0.000804
Anthracene	0.00314	0.00000314	0.03	0.000105
Arsenic	0.00114	0.00000114	0.0002	0.0057
Barium	0.01422	0.00001422	0.075	0.00019
Beryllium	0.00007	0.00000007	0.00025	0.00028
Benzo(a)pyrene	0.00066	0.00000066	0.03	0.000022
Benzo(a)anthracene	0.00159	0.00000159	0.03	0.000053
Benzo(b)fluoranthene	0.00284	0.00000284	-	-
Benzo(g,h,i)perylene	0.00001	0.00000001	-	-
Benzo(g,h,l)perylene	0.00142	0.00000142	-	-
Benzo(k)fluoranthene	0.00056	0.00000056	-	-
Biphenyl	0.00138	0.00000138	0.15	9.2E-06
Benzene	16.84422	0.01684422	0.08	0.209819
Cadmium	0.0063	0.0000063	0.0003	0.021
Chrysene	0.0039	0.0000039	0.03	0.00013
Cobalt	0.00048	0.00000048	0.003	0.00016
Chromium[2]	0.01026	0.00001026	0.00075	0.01368
Copper	0.00275	0.00000275	0.0025	0.0011
Dibenzo(a,h)anthracene	0.00089	0.00000089	-	-
Dichlorobenzene	0.00683	0.00000683	16.875	4.05E-07
Ethylbenzene	0.20395	0.00020395	3.25	6.27E-05
Fluoranthene	0.03266	0.00003266	-	-
Fluorene	0.0103	0.0000103	-	-
Formaldehyde	0.42977	0.00042977	0.0625	0.006876
Hexane	49.34828	0.04934828	27	0.001828
Mercury	0.00148	0.00000148	0.01	0.000148
Indeno(1,2,3-cd)pyrene	0.00106	0.00000106	-	-

Compound of Potential Concern	Modeled 1-hr Impact	Modeled 1-hr Impact	Acute Non-Cancer RfC[1]	HQ
Methanol	2.86786	0.00286786	8.125	0.000309
Manganese	0.00217	0.00000217	0.075	2.89E-05
Molybdenum	0.00355	0.00000355	0.45	7.89E-06
Naphthalene	3.30265	0.00330265	2	0.001562
Nickel	0.01196	0.00001196	0.00225	0.005316
PAH[3]	0.00087	0.00000087	0.019	4.58E-05
Lead	0.00285	0.00000285	0.0075	0.00038
Pentane	8.40833	0.00840833	270	3.11E-05
Phenol	0.00116	0.00000116	2.85	4.07E-07
Phenanthrene	0.10449	0.00010449	0.03	0.003483
Propane	5.17277	0.00517277	270	1.92E-05
Pyrene	0.00951	0.00000951	0.03	0.000317
Selenium	0.00014	0.00000014	0.03	4.67E-06
Styrene	1.14256	0.00114256	10.625	0.000107
Toluene	2.37996	0.00237996	14	0.000169
Vanadium	0.00744	0.00000744	1.75	4.25E-06
Xylenes	0.49281	0.00049281	16.275	3.03E-05

[1]Reference concentrations developed using short term exposure limits as per PaDEP guidance. Refer to Table 1 for more information.

[2]Emissions of chromium conservatively assumed to be in hexavalent form

[3]AP-42 factors for stationary combustion turbines are not available for individual PAH compounds. For this assessment, PAH emissions from CTs were conservatively assumed to be benzo(k)fluoranthene

- Denotes no available risk factor