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November 1, 2013

Mr. Ali Mirzaklhalili, Director
State of Delaware
Department of Natural Resources
and Environmental Control
Division of Air Quality
655 South Bay Road, Suite 5N
Dover, DE 19901

Re: Project No. 8718.CI (Duffield Associates)
Wolf 1 CHP
550 South College Avenue
Newark, New Castle County, Delaware

Dear Mr. Mirzaklhalili:

Duffield Associates, Inc. (Duffield Associates) respectfully submits this Air Quality Construction Permit Application package for the Combined Heat and Power Plant (CHP) that will be an integral component of the Wolf Technology Center 1 (Wolf 1) proposed for construction on the University of Delaware's Science, Technology and Advanced Research Campus (STAR Campus) in Newark, New Castle County, Delaware. This permit application package has been prepared in accordance with the State of Delaware, Department of Natural Resources and Environmental Control's (DNREC) Regulations Governing the Control of Air Pollution. This permit application addresses comments received from DNREC and Region III of the Environmental Protection Agency (EPA) regarding Duffield Associates' September 2013, "Air Quality Impact Analysis Modeling Protocol" as well as our draft permit application submission. The permit applicant is The Data Centers, LLC (TDC), who will own and operate the CHP in support of the attached data centers.

The CHP will be a state-of-the-art, energy efficient, source of uninterruptable power for the associated data center, which is the other significant component of Wolf 1. The CHP design incorporates primary cogeneration of electricity and steam with combined-cycle generation of electricity, using General Electric LM2500 DLE gas combustion turbines and Wartsila 18V50SG reciprocating gas engines as primary combustion equipment. Heat recovery steam generators (HRSGs) will make steam from the exhaust heat of the turbines and engines. The steam will be used to power condensing steam turbines and absorption chillers located in the CHP. Excess steam will be supplied to the University of Delaware for further reuse. Three electricity generators and one mechanical chiller unit will be powered by the four condensing steam turbines of the CHP. The plant is forecast to achieve an average annual energy efficiency of approximately 60%, in contrast to energy efficiencies of approximately 40% commonly achieved for combined-cycle power plants or to approximately 33% commonly achieved by simple cycle power plants. The CHP will operate solely using natural gas as a fuel source, and the facility will be equipped with advanced-combustion and post-combustion control technologies to control emissions to the atmosphere.

Duffield Associates' analysis concludes that the CHP will utilize Best Available Control Technology (BACT) for pollutants regulated under the Delaware Minor New Source Review program. Lowest Achievable Emission Rate (LAER) control technology will be implemented for nitrogen oxides (NO_x)

and volatile organic compounds (VOC) emissions, as required under the applicable Nonattainment New Source Review Rules. Cumulative emissions air dispersion modeling included in this application package are based on permitted emissions for other major sources of NO_x and PM_{10} located within 10 kilometers (km) of the CHP, as provided by DNREC. The results of Duffield Associates' analysis demonstrate that construction and operation of the proposed well-controlled CHP facility will not impact Delaware's air resources adversely.

TDC is pursuing acquisition of the requisite emission credits for NO_x and VOC emissions. Sufficient emission reduction credits are available in Delaware's emission reduction credit (ERC) bank and/or in combination with credits banked in the 16 upwind states cited by Regulation 1125. TDC will be able to obtain sufficient ERCs before requesting an operating permit.

In addition to the Construction Permit Application, enclosed are two checks made payable to DNREC in the amounts of $3,805.00 and $1,980.00. These checks represent DNREC's Construction Permit and Advertisement Fees, in accordance with the Construction Fee Schedule and Fee Calculator Program, a copy of which is also provided in the Application.

Should DNREC have any questions regarding this Construction Permit Application, please contact M. Richard Beringer, P.E. of Duffield Associates at (302) 239-6634 or via electronic mail at rberinger@duffnet.com.

Thank you in advance for the Department's timely administrative completeness and technical reviews of this Application.

Very truly yours,

DUFFIELD ASSOCIATES, INC.

Michael F. Panhuise, P.E.
Environmental Engineer

M. Richard Beringer, P.E., LEED AP
Senior Environmental Consultant

AJM/MFP/MRB:bac
WORD\8718CI.1113-PSD-ConstructionPermitApplication.RPT

Enclosures: Construction Permit Application Package for Wolf Technology Center 1
Construction Permit Fee Schedule and Fee Calculator
Checks (2)

cc: Mr. Michael Bednar – The Data Centers, LLC
Mr. Matthew Rendon – DNREC DAQ (electronic)
Mr. Mohammed Majeed – DNREC DAQ (electronic)
Ms. Tammy Henry – DNREC DAQ (electronic)

DUFFIELD ASSOCIATES

NONATTAINMENT NEW SOURCE REVIEW, MINOR NEW SOURCE REVIEW AND PREVENTION OF SIGNIFICANT DETERIORATION REVIEW AIR QUALITY CONSTRUCTION PERMIT APPLICATION COMBINED HEAT AND POWER PLANT FOR THE WOLF TECHNOLOGY CENTER 1

SCIENCE, TECHNOLOGY, AND ADVANCED RESEARCH CAMPUS NEWARK, DELAWARE

November 2013

Prepared for:

State of Delaware
Department of Natural Resources
and Environmental Control
Division of Air Quality
655 South Bay Road, Suite 5N
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On behalf of:

The Data Centers, LLC
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Prepared by:

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Project No. 8718.CI

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EXECUTIVE SUMMARY

This report presents the Nonattainment New Source Review, Minor New Source Review and Prevention of Significant Deterioration (PSD) assessment of air quality for the Combined Heat and Power Plant (CHP) that is an integral component of the proposed Wolf Technology Center 1 (Wolf 1) to be located within the University of Delaware's Science, Technology, and Advanced Research Campus (STAR Campus) in Newark, New Castle County, Delaware. The report is part of a construction permit application package for the Wolf 1 CHP equipment that will generate air emissions and the associated air pollution control equipment.

The CHP will be a natural gas-fired facility that will produce electricity using combined-cycle generation and produce thermal energy to support the data center (data storage facility), which is the other significant component of Wolf 1. Steam will be generated from heat produced in gas turbines and reciprocating engines using heat recovery steam generators (co-generation). This recovered energy source will power condensing steam turbines in combined-cycle that will: 1) drive electricity generators; 2) drive a chiller that will provide conditioned air to the data center; and 3) support absorption chillers that condition inlet air to the gas turbines when ambient air temperatures would otherwise reduce the efficiency of turbine combustion.

The CHP must operate in a manner that provides uninterruptable energy to the data center in the form of conditioned air and electricity, which means that multiple power producing units in the CHP must be operating at all times, in case one or two units must be shut down. The proposed combination of varied electrical generating units and the generating capacity of the CHP will ensure that uninterruptable power is provided to the data center. This fundamental requirement results in electricity and steam production in excess of the data center demand. To efficiently use the excess electricity and steam, The Data Centers, LLC (TDC) plans to provide electricity to the City of Newark (through the Delaware Municipal Electric Corporation (DEMEC)) and steam to the University of Delaware under the terms of power purchase agreements.

The proposed Wolf 1 CHP will be classified as a major stationary source subject to Nonattainment New Source Review requirements for nitrogen oxides (NO_x) and volatile organic compounds (VOCs). The project site is located within the Philadelphia-Wilmington-Atlantic City (PA-NJ-MD-DE) area for ozone. Currently, this area is designated by the State of Delaware as marginal attainment for 8-hour ozone, but maintains legacy "severe" non-attainment ozone area status from a Federal (and permitting) perspective. While the project site is also located in the Philadelphia–Wilmington (PA-NJ-DE) non-attainment area for particulate matter smaller than 2.5 micrometers in size ($PM_{2.5}$), the facility will be a minor source of $PM_{2.5}$ and is subject to the State of Delaware Minor New Source Review. The facility will also be a minor source of sulfur dioxide (SO_2) and hazardous air pollutants (HAPs) and these emissions are subject to State of Delaware Minor New Source Review. Emissions of greenhouse gases (GHG), sulfuric acid (H_2SO_4) mist and particulate matter smaller than 10 micrometers in size (PM_{10}) are subject to Prevention of Significant Deterioration (PSD) review.

The Wolf 1 CHP will use state-of-the-art control technology to limit air emissions incorporating Lowest Achievable Emission Rate (LAER) control technology as required for ozone precursor substances under the applicable Nonattainment New Source Review rules and Best Available Control Technology (BACT) for pollutants regulated under the PSD and State of Delaware Minor New Source Review requirements. Conservative air dispersion modeling procedures, approved by the State of Delaware, Department of Natural Resources and Environmental Control (DNREC) and Federal Environmental Protection Agency (EPA), have been used to demonstrate that the proposed facility, under forecast operating modes and worst-case meteorological conditions, would not result in adverse air quality impacts.

The assessment concludes that the proposed construction and subsequent operation of the Wolf 1 CHP will not cause or contribute to State of Delaware or National Ambient Air Quality Standards (NAAQS) being exceeded and will not cause PSD increments to be exceeded. In most cases, the Wolf 1 CHP impacts were below levels considered to be significant under PSD rules. In summary, the construction and operation of the proposed Wolf 1 CHP will not impact the State of Delaware's existing air quality resources adversely.

1.0 INTRODUCTION

The Data Centers, LLC (TDC) is proposing to develop, construct, and operate a self-sustaining data center complete with an electrical power production plant at the University of Delaware's Science, Technology, and Advanced Research (STAR) Campus in Newark, New Castle County, Delaware (see Figure 1). Preliminary site preparation activities, such as demolition of existing slabs, pavements and foundations, may start during November or December 2013, after obtaining soil erosion and sediment control plan approval from DNREC. Site grading is anticipated to start during February or March 2014 after obtaining required approvals and permits for earth disturbing and stormwater management activities. Purchase, delivery and installation of equipment that are the subject of this permit application will not begin until after DNREC-AQM has issued the permit-to construct.

The Wolf Technology Center 1 (Wolf 1) is a unique data management and storage center designed to serve multiple users in 288,000 square feet of secure environment with an uninterruptible source of power and cooling. TDC is planning to construct a Leadership in Energy and Environmental Design (LEED) certified sustainable campus that includes a state-of-the-art data center powered by an onsite Combined Heat and Power (CHP) facility. The CHP facility will provide required electricity and cooling heat for the data center facility and supporting buildings. This facility will provide a technologically advanced, secure environment servicing organizations that need to reliably manage and store vast amounts of data around the clock. TDC expects customers would be banks and other financial institutions, universities, insurance companies, telecommunications firms and public and private sector researchers.

CHP is an approved and recognized technology by the US Environmental Protection Agency (EPA) and the US Department of Energy (DOE) as providing reliable, efficient power, with minimized adverse environmental impact. TDC is a member of the EPA Combined Heat and Power Partnership (see Appendix H). Facilities such as hospitals and schools use CHP. However, this would be the first instance that a CHP has been used to provide dedicated uninterrupted power to a data center. Data centers traditionally are a drain on the utility grid that provides power to the facility. A provisional patent has been awarded to TDC for the concept embodied in the proposed facility and an application for a non-provisional patent is in development. The TDC managers have data center planning, engineering, construction management, corporate and outsourced information technology (IT) management, regulatory economics, environmental affairs, corporate planning, project finance, and financial engineering experience as well as close relationships with internationally renowned engineering and construction companies and state-of-the-art equipment and service suppliers. TDC plans to contract operation services for the Wolf 1 CHP once it is constructed to a firm with appropriate expertise. Veolla Energy, an energy partner of TDC, operates an award winning 170 MW similar facility, in Philadelphia, called the Grays Ferry Cogeneration Plant. This facility provides steam service to over 400 buildings including industry, hospitals, universities, hotels and residences.

The proposed CHP will be a natural gas-fired, cogeneration and combined-cycle facility that generates electricity and steam. The Wolf 1 CHP conceptual design and site layout is included as Figure 2. The Wolf 1 CHP aggregated combustion units (gas turbines and reciprocating engines) and steam turbines producing electricity will have a combined maximum nominal power capacity of approximately 279 MW, accounting for the capacity of the gas combustion turbine held in reserve. The planned operating electricity output of the CHP, based on six combustion turbines, three reciprocating gas engines and the three steam turbines will be approximately 181 MW. Approximately 131 MW of electricity is required to operate Wolf 1. Approximately 50 MW is anticipated to be supplied to the City of Newark (through DEMEC) under normal conditions.

The power demand of Wolf 1 is anticipated to peak during summer conditions at approximately 131.5 megawatts (MW) and drop to approximately 130.8 MW during the winter. This power demand can be met by the CHP through operation of:

- Four nominally 23 MW gas combustion turbines driving electricity generators;
- One nominally 18 MW reciprocating gas engine driving an electricity generator;
- Three nominally 20 MW condensing steam turbines driving electricity generators; and
- One condensing steam turbine driving a chiller unit.

This operating equipment configuration is termed “N”. However, this arrangement of equipment does not ensure reliable, uninterruptable power production, which is a requirement for data storage facilities such as Wolf 1.

To support reliable, uninterruptable power supply, six gas combustion turbines (two more than minimum required) and three reciprocating gas engines (two more than minimum required) must be operated, which is known in industry parlance as “N+2” operations. The minimum efficient operating loads of the additional power units are approximately 50% of the rated capacities. In this configuration, up to two operating (power production units) can fail and the required uninterruptable power demand of the data center can be met. A seventh gas combustion turbine would not be operated under normal operating conditions. As a further reliability measure, it would be held in reserve for use when one of the other power generating equipment is off-line for maintenance.

The “N+2” mode of operation described above would result in the production of approximately 41.2 MW of excess electrical power and approximately 46,000 pounds per hour (lb/hr) of excess steam during the summer. Excess steam during the winter would rise to approximately 450,000 lb/hr, due to the absence of chiller loads (both the steam driven chiller and turbine inlet chiller systems would not be operating). Excess electrical power during the winter would rise to approximately 42 MW, due to the reduced data center and CHP loads. To make efficient use of this excess power, TDC plans to provide the electricity to the City of Newark (through DEMEC) and the steam to the University of Delaware through power purchase agreements (PPA).

The Wolf 1 CHP will produce electricity using energy efficient combined-cycle technology. The installed combustion-based power generating equipment will consist of seven General Electric (GE) LM2500 DLE gas turbines and three Wartsila 18V50SG lean burn reciprocating gas engines. The combustion turbines and engines will drive electricity generators. Heat recovery steam generators (HRSG) connected to the exhaust systems of the combustion equipment will produce steam. The steam will be used in combined-cycle to power three condensing steam turbines that will drive electricity generators, a condensing steam turbine that will drive a chiller unit, and up to seven steam absorption inlet chillers to support efficient combustion in the gas turbines during the summer. The turbine driven chiller unit (not the inlet chillers) will supply conditioned air to the data center. The combination of varied electrical generating units and the planned generating capacity of the CHP will ensure that efficiently produced, uninterruptable power is provided to the data center.

Wolf 1 CHP will emit several regulated air pollutants: nitrogen oxides (NO_x); carbon monoxide (CO); particulate matter (PM), including PM less than or equal to 10 micrometers in aerodynamic diameter (PM_{10}) and PM less than or equal to 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$); volatile organic compounds (VOCs); sulfur dioxide (SO_2); sulfuric acid (H_2SO_4) mist; and greenhouse gases (GHGs). The facility will also potentially emit several hazardous air pollutants (HAPs), due to unavoidable incomplete combustion of natural gas. In addition, PM will be emitted from the cooling towers as water vapor drift losses. The cooling tower PM emissions are linked to the dissolved solids content of the water vapor. Finally, some ammonia, which will be used in the selective catalytic reduction (SCR) NO_x control process, will also be emitted. Estimated hourly and annual emissions are summarized in Sections 2.3 and 2.4 of this report. NO_x and VOC emissions have been addressed through the application of lowest achievable emission rate (LAER) technology. All other emissions have been addressed through application of best available control technology (BACT). Air dispersion modeling of NO_2 and PM_{10} emissions has indicated that the emissions will have an acceptable impact on air quality and will not adversely impact human health.

The project site is located within the Philadelphia-Wilmington-Atlantic City (PA-NJ-MD-DE) area for ozone. This area currently is designated by the State of Delaware as marginal attainment for 8-hour ozone, but maintains the legacy “severe” non-attainment ozone area status from a Federal (and permitting) perspective. The project site is also located in the Philadelphia–Wilmington (PA-NJ-DE) Area for $PM_{2.5}$. This area is considered non-attainment for $PM_{2.5}$. The project site location is in attainment or not listed for all other National Ambient Air Quality Standards (NAAQS).

The STAR Campus has many advantages for the proposed project. The project is a re-use of a former Chrysler Newark Assembly Plant site (a State of Delaware Certified Brownfield Site). The project will bring new “blue” and “white” collar jobs to an area that was impacted badly by the closure of the former Chrysler plant and the recent economic recession. Star Campus has ample room for the proposed development, is supported by existing infrastructure, is located close to outlets for the excess electricity and steam produced by necessity at the facility, and is zoned properly for the intended

use. Zoning information for the site has been included as Appendix I of this permit application, along with an opinion letter provided to the City of Newark by the City's Solicitor that was obtained from the City of Newark website. The proposed project site within STAR Campus currently is paved, has no significant wildlife habitat and no wetlands. The project site is not located in a Federal Emergency Management Agency (FEMA) identified 100-year flood plain.

In Chapter 7, Part 1125, Delaware Administrative Code [DE Admin. Code]), the Delaware Department of Natural Resources and Environmental Control (DNREC) has adopted the Federal Environmental Protection Agency (EPA) rules pertaining to Prevention of Significant Deterioration (PSD) as contained in Chapter 40, Part 52.21, Code of Federal Regulations (40 CFR 52.21). Section 3.0 of this report provides a detailed review of applicable PSD, NNSR, and other DNREC requirements for permitting of the Wolf 1 CHP.

This report is organized as follows:

Section	1.0	Provides an overview and a summary of the key regulatory determinations.
Section	2.0	Describes the proposed facility and associated air emissions.
Section	3.0	Describes Federal and State air quality standards and discusses applicability of PSD and other NSR requirements and procedures applicable to the proposed facility.
Section	4.0	Provides a summary of applicable state and federal emissions standards.
Section	5.0	Provides an analysis of control technologies, including Best Available Control Technology (BACT) for several pollutants subject to PSD review and Lowest Achievable Emissions Rate (LAER) for pollutants subject to NNSR.
Section	6.0	Presents the alternatives analyses required for NNSR.
Section	7.0	Describes the modeling approach for source impact analyses.
Section	8.0	Presents the results of source impact analyses.
Section	9.0	Summarizes analyses of additional impacts in the plant vicinity.
Section	10.0	Describes air emissions screening for Class I Areas.

Additional information is contained in the following Appendices:

Appendix A	Provides the requisite DNREC air quality construction permit application forms (AQM Forms).
Appendix B	Provides air pollutant emissions estimates and supporting information and calculations.

Appendix C	Includes a copy of the modeling protocol dated August 2013, which outlines Wolf 1 CHP's methodology in demonstrating compliance with the air quality impact analyses.
Appendix D	Contains the comments on the modeling protocol received from DNREC, EPA Region III, and the U.S. Fish & Wildlife Service (USFWS) and responses to those comments.
Appendix E	Contains the BACT/LAER tables.
Appendix F	Provides the Class II plume modeling input and output files on compact disc.
Appendix G	Contains the Material Safety Data Sheets (MSDSs) for natural gas and ammonia.
Appendix H	EPA Certificate of Partnership
Appendix I	City of Newark Zoning
Appendix J	The Economic Impact of the Proposed Data Center at the University of Delaware STAR Campus
Appendix K	Risk Assessment Calculations

1.1 ENERGY AND ENVIRONMENTAL EFFICIENCY

Efficient energy use and concepts form the founding ideal behind the proposed Wolf 1 CHP. Data centers have high energy demands and those energy demands must be met 100% of the time, with no interruptions, for data centers to function reliably. Conventionally, data centers have been supplied electrical energy from distribution grids, such as the PJM grid that serves the State of Delaware. Energy inputs to the PJM distribution grid come from many sources, such as wind farms, solar arrays, hydroelectric facilities, nuclear power plants, waste-to-energy power plants, biomass power plants, and conventional fossil fuel power plants. Per PJM, in 2012 more than 40% of the grid electricity was produced by coal-fired power plants, more than 30% was produced by nuclear plants, and approximately 15% was produced by gas-fired plants. Approximately 3% of the electricity was produced by renewable resource plants, such as hydroelectric plants, wind farms, and solar arrays.

The energy transformation in combustion-based processes occurs when carbon in the fuel source combines with oxygen to form CO_2, transforming the latent energy of the fuel to heat energy. Engines (internal combustion or external combustion) in the power plants convert heat energy to other forms of useful energy, such as electricity. Facilities can be designed to convert heat energy to useful energy in a single system known as simple cycle or through multiple systems known as a cogeneration and combined-cycle.

Simple cycle conversions of heat to mechanical and mechanical to electrical energy generally are less than 50% thermally efficient, and frequently are less than 33% thermally efficient. In other words, approximately 67% of the available heat energy is wasted and a large fraction of the air emissions produced by combustion yield no benefit. Simple cycle electricity power plants are typified by facilities that currently provide base load electricity to the PJM grid. Due to the plants being located remotely from points of energy use they cannot operate as combined heat and power plants, which results in a wasting of thermal energy. Another simple cycle example is a facility operated intermittently to produce electricity to meet peak grid demands ("peaker plants"). Simple cycle energy conversions can also be used to produce steam as a final product. The power plant that formerly supported the Chrysler Newark Assembly Plant at STAR Campus was a simple cycle plant that converted heat energy to steam. Under the circumstances described, the heat energy not transferred by the simple cycle process to electricity is released to the atmosphere, a body of water, or the ground providing no benefits.

When combustion heat energy from a <u>single</u> heat source is converted to <u>multiple forms</u> of useful energy, in multiple operating systems, the process is termed cogeneration or combined heat and power. Examples of cogeneration facilities are power plants located in cities like New York and Philadelphia, where heat energy is converted to electrical energy and steam, which is used to heat local buildings (distributed heating). The energy transfer efficiency of these facilities can be as high as 80%, but more commonly is about 50%. The examples cited point to a key aspect of combined heat and power facilities – they must be located close to the end use of the energy they provide. Heat energy (including steam) cannot be transported efficiency over large distances. Recognizing the significant energy and environmental conservation potential of CHP, the United States Department of Energy has set a goal of obtaining 20% of the power used in the United States from combined heat and power systems by 2030.

When combustion heat energy from a <u>single</u> heat source is converted to a <u>single useful form</u> of energy through <u>multiple operating systems</u>, the process is termed combined-cycle. Examples of combined-cycle facilities are electrical power plants that use two or more operating systems to generate electricity from a single heat source. Combined-cycle electrical power plants commonly can achieve thermal energy efficiencies of 40 to 50%. Most modern, base load, electricity power plants are being designed as combined-cycle plants.

The proposed Wolf 1 CHP facility is intended to blend the efficiency of cogeneration with the efficiency of combined-cycle operations. The thermal efficiency of the plant should be approximately 60% during summer and winter operating conditions. The proposed location of the facility on the STAR Campus is a key factor to the success of combined heat and power. Steam generated by the facility can be used on-site and can be distributed to the University of Delaware for use from that location through a dedicated pipeline. This steam production would

offset the production of steam at UD to meet the growing need for expansion of the UD power plant.

The remote location of grid-supplying power plants necessitates transmission of the electrical energy over power lines to points of use. The transmission of energy results in unproductive losses of electrical energy to heat due to resistance within the power lines. Further losses occur each time the electricity is transformed (voltage increased or decreased). This aspect of the current power grid system compounds the energy inefficiency of remote energy conversion and non-productive environmental emissions.

The transmission system is also vulnerable to disruption due to accidents and natural disasters. In the context of data centers, this disruption potential sets-off a chain of responses. Existing grid–connected data centers typically require at least dual power feeds that originate from operationally separate locations in the distribution grid. This solution combats the potential for a disruption of power in a portion of the grid, to result in a loss of power to a data center. However, dual feeds do not ensure uninterruptable power and do not address conditions of wide-spread power outages, like those that occurred during superstorm Sandy in 2012. In response, existing grid-connected data centers typically have massive battery back-up systems that can instantaneously maintain short-term electrical power to critical devices, while emergency power generation located on-site is activated and brought up to full production. Typically, the emergency power system is powered by diesel engines, and has sufficient capacity to meet the full-power demand of the data center for a longer term. These solutions to short-comings of using grid-based electricity often result in large areas of land dedicated to battery storage and emergency power generation, plus extensive capital investment in equipment that receives minimal use. The large diesel emergency generator engines typically are started and run once per month for approximately one hour as part of maintenance and reliability requirements. This practice results in the production of considerable air emissions with no useful benefit. Due to the emergency use limitation, these engines are not held to the same standards as other large sources of air emissions.

The Wolf 1 CHP and data center concept seeks to alter the above paradigm by eliminating the weakness of reliance on grid-based power, while expending limited capital and land on productive equipment.

The location of the CHP adjacent to the data center significantly shortens the distribution system required for energy delivery, thereby improving reliability. This feature also limits losses of energy to line resistance and voltage transformations, which improves the efficiency of the energy usage.

In the CHP, the initial conversion of latent fuel energy to heat energy occurs in an engine. Gas turbines, operating based on Brayton cycle thermodynamics, will be used to convert heat energy to mechanical energy. Reciprocating engines, operating based on Otto cycle thermodynamics, also will be used to convert heat energy to

mechanical energy. Both the Brayton cycle and the Otto cycle operations can only use a portion of the heat energy liberated by the combustion of fuel. The unused heat energy will be used to make steam in Heat Recovery Steam Generators (HRSGs) and the steam will be used to store the recovered heat energy for subsequent use. The coupling of mechanical energy conversion and heat energy storage is termed cogeneration. The stored heat energy will be converted to mechanical energy through steam turbines (or engines) operating in Rankine cycle thermodynamics. The coupling of multiple thermodynamic cycles to convert heat energy to mechanical energy is termed combined-cycle operation. The steam will also be used for thermal heating or other processes, based on heat transfer.

CO_2 is a product of combustion of fuel containing carbon, which is inherent in any power generation technology using fossil or renewable fuel. The basic theoretical combustion equation for natural gas, which is mostly methane (CH_4), is:

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$

CO_2 emissions are the product of the chemical reaction between the fuel and the oxygen in air, not a byproduct caused by imperfect combustion. Therefore, CO_2 emissions cannot be reduced by improving the combustion efficiency, and there is no technology available that can reduce CO_2 generation from the combustion of carbon-based fuels. In fact, improvements in combustion efficiency always increase the production of CO_2, while decreasing the production of unwanted byproducts. The only effective means to minimize the amount of CO_2 generated by a fuel-burning power plant is through high-efficiency use of the heat energy released by the chemical reaction, which leads to lower fuel consumption. Reduced fuel consumption results in reduced CO_2 emissions. Minimizing the amount of fuel required (in units of million British thermal units) to produce a given amount of power output (in units of kilowatt-hours) results in the least amount of CO_2 generated for required power.

Maximizing energy transfer efficiencies is the most effective means of obtaining useful energy from fuel combustion while minimizing CO_2 production. Combustion converts latent energy in fuel to heat energy. In an ideally efficient combustion process, all of the heat energy released could be transferred to other forms of useful energy (i.e., 100% efficient energy transfer). Ideal efficiency cannot be achieved with current technology. There are numerous losses of energy largely due to heat transfer and friction losses. However, the idea is to develop systems that approach ideal heat transfer as closely as possible.

1.2 SUMMARY OF REGULATORY MATTERS

Equipment that will produce air emissions at the proposed facility will include:

- Seven gas combustion turbine units coupled to individual HRSGs and electricity generators;

- Three reciprocating gas engine units coupled to individual HRSGs and electricity generators; and
- Two cooling towers.

The combustion units and associated HRSG units will be arranged in one-on-one configurations. The steam generated in the HRSGs will power three condensing steam turbines coupled to three electricity generators and another condensing steam turbine coupled to a chiller unit. Steam will also power absorptive chillers that will provide cooled inlet air to the combustion turbines during warm weather, thereby improving the combustion efficiency of the turbines. The combustion turbines will be GE LM2500 Dry Low Emissions (DLE) units. The reciprocating gas engines will be Wartsila 18V50SG lean burn units. The turbines and reciprocating engines will be fueled with "pipeline-quality natural gas" obtained from Eastern Shore Natural Gas Company, containing no more than 0.5 grains of total sulfur per 100 standard cubic feet (gr S/100 scf). This upper limit for total sulfur was used in the accompanying emissions estimates, which resulted in the calculation of conservatively high emissions values.

The Wolf 1 CHP potential to emit (PTE) emission estimates have been based on 8,760 hours of operation for each of the 7 combustion turbines, and a permit-limited operational restriction of 20,000 hours of combined operation for the three reciprocating engines. As such, the facility's PTE anticipated emissions are 73.96 tons per year (tpy) of NO_x, 72.36 tpy of carbon monoxide (CO); 97.56 tpy of total PM, including PM_{10} and $PM_{2.5}$; 10.34 tpy of sulfur dioxide (SO_2); and 67.83 tpy of volatile organic compounds (VOCs). No lead emissions are anticipated due to the use of natural gas as combustion fuel.

Currently, New Castle County is in attainment for all National Ambient Air Quality Standards (NAAQS) except ozone (O_3) and $PM_{2.5}$. Although New Castle County is currently designated as a "moderate" nonattainment area for the 8-hour ozone standard, the requirements applicable to the previous designation as a "severe" nonattainment area for the 1-hour ozone standard are still in force for permitting. NO_x and VOCs are ozone precursors. As such, the threshold for major source designation in New Castle County for VOC and NO_x is 25 tpy. The facility' PTE emissions exceed these thresholds. As such, the facility is classified as a major source for NO_x and VOCs. Due to this classification, a LAER analysis has been conducted for NO_x and VOCs emissions that will be emitted in excess of the 25-tpy nonattainment new source review (NNSR) thresholds. As required by Federal and Delaware regulations, emission reduction credits (ERCs) for NO_x and VOCs will be acquired at ratios of 1.3 ERCs to 1 ton of permitted emissions before operations commence at the proposed Wolf 1 CHP. Estimated $PM_{2.5}$ emissions do not exceed the NNSR threshold. As such, $PM_{2.5}$ emissions have been addressed in accordance with State of Delaware minor new source review (MNSR) requirements.

Regarding non-criteria pollutants potentially subject to PSD review, the Wolf 1 CHP is anticipated to emit approximately 8.63 tpy of H_2SO_4 mist. H_2SO_4 emissions

result from the oxidation of SO_2 in the non-selective oxidation catalyst units incorporated to treat CO and VOC emissions. The resultant H_2SO_4 mist emissions have been estimated conservatively by assuming that 50% of the sulfur in fuel is converted to sulfur trioxide (SO_3) by the oxidation catalyst and that all of the SO_3 is converted to H_2SO_4 mist. Similarly, approximately 78.03 tpy of ammonia introduced in the SCR systems will not be consumed in reactions with NO_x and will be emitted (ammonia slip).

Worst-case projections of hazardous air pollutants (HAPs) emissions were made for the Wolf 1 CHP. Incomplete combustion of natural gas will produce small amounts of organic HAPs. The Wolf 1 CHP will emit a maximum individual HAP at 6.70 tpy (acrolein), and approximately 18.36 tpy of total HAPS, based on emission factors provided by the manufacturer and US EPA AP-42. The estimated HAP emissions were compared to major source thresholds found in Section 112(a)(1) of the Clean Air Act (CAA). The major source thresholds for HAPs are 10 tpy for an individual HAP and 25 tpy for total HAPs. As such, the facility is a minor source of HAPs.

EPA's PSD and Title V GHG Tailoring Rule became effective on August 2, 2010. GHGs are defined as the following six pollutants: CO_2, methane, nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons, and perfluorocarbons. Carbon dioxide equivalent [CO_{2e}] is defined as the sum of the six GHG pollutants multiplied by their respective global warming potential (GWP) coefficients. Potential CO_{2e} emissions for the Wolf 1 CHP facility are estimated to be 950,836 tpy. (Note: For comparison to PSD applicability thresholds, CO_{2e} emissions are provided in units of short tons per year.) The potential CO_{2e} emissions exceed the PSD applicability threshold of 75,000 tpy outlined in the Tailoring Rule and are subject to GHG BACT review.

Based on the annual potential emissions, the facility will be a minor source of sulfur dioxide (SO_2) and hazardous air pollutants (HAPs), and these emissions are subject to State of Delaware Minor New Source Review requirements, including BACT analysis. Emissions of greenhouse gases (GHG), sulfuric acid (H_2SO_4) mist and particulate matter smaller than 10 micrometers in size (PM_{10}) are subject to Prevention of Significant Deterioration (PSD) review and BACT analysis. Section 3.0 of this report provides a more detailed description of GHG PSD applicability and requirements.

For **normal operation**, at least six of the combustion turbines and two of the reciprocating engines are anticipated to operate full-time at loads near the unit rated capacities to meet data center load requirements. Anticipated annual hours of operation and anticipated normal operating emissions are further described in Section 2.0 of this report.

1.3 ANALYSIS RESULTS

As presented in this report, the required air quality analyses resulted in the following conclusions:

- The use of good combustion practices and natural gas as a fuel is considered to be BACT for $PM/PM_{10}/PM_{2.5}$. The Wolf 1 CHP combustion units will use the latest available technologies applicable to gas turbines and reciprocating engines to maximize combustion efficiency and minimize $PM/PM_{10}/PM_{2.5}$ emissions rates;
- Installation of an oxidation catalyst system is considered LAER for VOC control of emissions from gas turbines and reciprocating engines. At operating conditions, the VOC emissions for the GE LM2500 DLE are a maximum 0.46 lb per hour and emissions from the Wartsila 18V50SG is a maximum 5.37 lb per hours;
- Low-NO_x combustion technology in combination with selective catalytic reduction (SCR) emission control systems are proposed as LAER for controlling NO_x emissions from the gas combustion turbines. At operating conditions, 1-hour average exhaust concentrations of NO_x are projected to be 2 ppmvd, corrected to 15% oxygen. Four-cycle, spark induced ignition lean burn combustion coupled with SCR emission controls are proposed as LAER for controlling NO_x emissions from the reciprocating gas engines. Under operating conditions, exhaust emissions of NO_x are projected to be a maximum of 0.132 lb per MWh;
- Use of the gas combustion turbines and reciprocating gas engines in energy efficient combined-cycle and cogeneration operations is proposed as BACT for GHG emissions. Combined-cycle operation produces the least GHG emissions per MWh of electricity produced by current combustion-based technologies. Cogeneration further maximizes use of thermal energy released by combustion, which in turn, ensures the least amount of GHG is emitted to meet thermal and electrical energy demands;
- The proposed emissions of air pollutants will be less than emissions from many existing combustion-based power generation facilities located in the mid-Atlantic. To the extent that electricity generated at the Wolf 1 CHP displaces electricity produced at other gas-fired plants that do not incorporate combined-cycle technology, emissions of air pollutants from regional power generation will decrease, and an improvement in the regional air quality will result. This benefit increases when the electricity produced at the Wolf 1 CHP displaces electricity production at power plants fueled by petroleum or coal and off-sets at other fossil fuel combustion facilities;
- The proposed CHP is projected to emit PM/PM_{10} at levels subject to PSD review, as they exceed PSD significant emissions rate (SER) levels. Per recent EPA guidelines, NO_2 emissions are also subject to PSD review. The facility air quality impact analysis has demonstrated that impacts will be below the PSD

monitoring de minimis levels for each of these pollutants. Therefore, the facility qualifies for an exemption from the PSD preconstruction ambient air monitoring requirements per 40 CFR 52.21(i)(8)(i);

- The PSD Class II air quality analysis demonstrated that pollutants emitted during the three potential operating conditions will be below the significant impact levels (SILs) for each pollutant and averaging time, with the exception of the 24-hour averaging period for PM_{10}. Modeling of emissions generated by the CHP has indicated that PM_{10} emissions would exceed the applicable PM_{10} 24-hour SIL for each of the three operating conditions modeled. Therefore, conservative, multisource, interactive assessments (cumulative modeling) of PM_{10} emissions was performed to demonstrate compliance with the applicable NAAQS;
- The PSD Class I air quality analysis demonstrated that impacts for the pollutants at Class I areas within 300 kilometers (km) of the facility site were below the initial Q/D ratio of 10. Based on this screening criterion, the facility air quality analysis is not anticipated to be detrimental to soils and vegetation and will not impair visibility at the Class I areas. Short-range modeling performed using AERMOD demonstrated Class I SILs were met at a distance of 50 km from the facility, less than the projected distances to the Class I areas; and
- The facility air pollutant emissions will be well controlled to levels consistent with BACT and LAER. As a result, operation of the Wolf 1 CHP will have minimal adverse impact to local and regional air quality.

2.0 DESCRIPTION OF PROPOSED FACILITY

2.1 FACILITY DESCRIPTION, LOCATION MAPS, AND PLOT PLAN

As discussed in Section 1.0, the proposed Wolf 1 CHP facility will be located in the University of Delaware's Science Technology and Advanced Research (STAR) Campus in Newark, Delaware. Figure 1 shows the site location within the State of Delaware, within the local area and within STAR Campus. Figure 2 shows the anticipated site layout plan. Beside the power generating equipment, the only other stationary source of air emissions at the facility will include the wet mechanical draft cooling towers. As part of the air emissions minimization design of the facility, TDC has obtained authorization to install an electric fire pump in lieu of the typically required diesel powered pump, due to the uninterruptable nature of electricity production and supply at the facility.

Major components of the Wolf 1 CHP will consist of:

- Seven combustion turbines with seven HRSG units and seven electricity generators;

- Three reciprocating gas engines with three HRSG units and three electricity generators;
- Three condensing steam turbines with three electricity generators;
- Two wet mechanical draft cooling towers;
- One steam driven chiller unit and one mechanical chiller unit;
- Seven steam absorption chillers for inlet air to the gas turbines;
- Ancillary equipment, including raw and demineralized water storage tanks; and
- Ammonia hydroxide (aqueous ammonia) storage and handling equipment.

The combustion turbines will be energy efficient GE LM2500 DLE units rated at 23.2 MW (winter) and 22.4 MW (summer). These units are equipped with dry-low NO_x burners to suppress NO_x formation. The combustion turbines will be equipped with inlet cooling, which is designed to lower the temperature of the turbine intake air during periods of higher ambient air temperatures (summer), thereby supporting combustion efficiency year-round. Six of the combustion turbines are anticipated to operate at close to 100% load under normal operating conditions. The seventh turbine is anticipated to operate intermittently, typically when one of the other turbines or an engine is shut down for maintenance or other reasons. No restrictions are proposed for operation of the gas combustion turbines at the facility and PTE emissions provided reflect fulltime operation of all seven gas combustion turbines.

The reciprocating gas engines will be 4-stroke, lean-burn energy efficient, Wartsila 18V50SG units rated at 18.8 MW. These engines are equipped with low NO_x systems that include a pre-combustion chamber, where a rich mixture of fuel is ignited by spark, which in turn ignites a lean fuel mixture in the main combustion chamber to ensure efficient fuel combustion and low generation of emissions. Two of the reciprocating gas engines are anticipated to operate at close to 100% load under normal operating conditions. The third engine is anticipated to operate intermittently. The reciprocating engines will be shut down periodically for maintenance. A restriction limiting combined total operating hours for the engines to 20,000 hours per year has been proposed and the PTE emissions provided in this application package reflect that limitation.

The HRSG units will produce steam using exhaust heat from the gas turbines and reciprocating gas engines. The steam will be used in three condensing steam turbines connected to generators to produce electricity, one steam turbine that will drive a chiller unit for the Data Center, and seven steam absorption chillers that will be used to cool inlet air for the combustion turbines during warm weather operations. Excess steam will also be exported to the University of Delaware for use on their campus. Each of the steam turbines coupled to electricity generators will be capable of generating up to 20 MW of electrical power.

Emissions control systems proposed for the facility include:

- Dry low-NO_x technology in gas combustion turbines;
- Lean burn technology in 4-stroke, reciprocating gas engines;
- SCR systems located in each of the HRSG. In an SCR system, NO_x-laden flue gas, which is created as a byproduct of combustion processes, is reduced to elemental nitrogen and water vapor through the injection of ammonia (NH_3) into the flue gas in front of a catalyst bed. The chemical primary reactions in the SCR are:

$$4NH_3 + 4NO + O_2 \rightarrow 4N_2 + 6\ H_2O$$

$$4NH_3 + 2NO_2 + O_2 \rightarrow 3N_2 + 6\ H_2O$$

- Oxidation catalyst units in the HRSGs and good combustion practices for control of CO and VOCs. In oxidation catalyst units, flue gas passes over a metal catalyst (typically platinum) to oxidize CO into CO_2. The chemical reaction is $CO + ½O_2 \rightarrow CO_2$. The chemical reactions for VOCs vary with the substance, but generally result in the formation of CO_2 and H_2O; and
- Exclusive use of pipeline-quality natural gas and efficient combustion practices to minimize $PM/PM_{10}/PM_{2.5}$ emissions, and formation of SO_2 and H_2SO_4.

Two mechanical draft cooling towers will be used to condense spent steam exiting the four steam turbines and inlet chillers. The cooling towers will be equipped with multi-pass drift eliminators designed to limit water vapor drift. Water captured by the drift eliminator will be directed to the cold water basin of the cooling towers. Since the cooling water contains total dissolved solids (TDS), the cooling tower drift results in PM emissions. As the cooling tower water is recycled, the TDS concentration of the water increases as the number of recirculation cycles increases and water is evaporated. However, the cooling tower cells will be equipped with high-efficiency drift eliminators (i.e., 99.999%) to reduce the drift loss to 0.0005%. The drift eliminators serve to reduce water loss in cooling (which reduces water use), reduces the TDS concentrating effect of water recirculation, and reduces PM emissions by lessening the amount of water vapor emissions and lessening the TDS concentration of the water vapor emissions. The water used in the cooling tower will be obtained from the potable water system supplied by United Water Delaware.

Figure 2 presents the proposed facility site plan showing major process equipment and structures, emissions points, and property boundaries. Primary access to the site will be via an entrance on the eastern side of the facility. The entrance will have a security gate to control site access, and the perimeter of the site will be fenced.

2.2 PROCESS DESCRIPTION AND PROCESS FLOW DIAGRAM

The proposed combined-cycle facility will consist of seven nominal 23.2 MW, GE LM2500 DLE gas combustion turbines and three nominal 18.8 MW, Wartsila 18V50SG 4-stroke, lean burn, reciprocating gas engines with spark induced ignition. Each of these combustion units will be connected to individual HRSGs and electricity generators. Steam produced in the HRSGs will power three nominal 20 MW steam turbines connected to electrical generators. Figure 3 presents a process flow diagram for the proposed facility.

Gas combustion turbines and reciprocating gas engines are heat engines that convert latent fuel energy into work using compressed hot gas as the working medium. These devices deliver mechanical output by means of a rotating shaft that is used to drive electricity generators, thereby converting a portion of the engine's mechanical output to electrical energy. To maintain combustion turbine efficiency during warm weather, inlet ambient air will be cooled using chillers (one per turbine unit). Both types of combustion units will be equipped with low NO_x emission technology. In essence, this technology consists of a pre-combustion chamber where a rich mixture of fuel is ignited and then fed into the main combustion chambers where it ignites a lean fuel mixture. This technology improves combustion efficiency and reduces combustion temperatures, which in turn, reduces NO_x emissions.

The hot exhaust gases from the combustion units flow to the HRSGs for the production of steam. Within the HRSG units, the exhaust gases will be combined with aqueous ammonia and pass through a SCR and separate catalytic oxidizer. The SCR unit will transform most of the exhaust NO_x to elemental nitrogen and water vapor. Some unreacted ammonia will pass through SCR and remain entrained in the exhaust gasses, a process known as ammonia slip. The ammonia slip rate will not exceed 7 ppmvd corrected to 15% oxygen content on a three hour average. The catalytic oxidizers will transform CO and VOCs principally into CO_2 and water vapor. After passing through the HRSGs, exhaust gasses will flow through flues or stacks and be discharged to the atmosphere. Each gas turbine HRSG will have a dedicated stack and discharge at approximately 165 feet above ground level. Each reciprocating gas engine HRSG will have a dedicated flue within a common stack. The discharge point for the flues will be approximately 165 feet above ground level.

Steam generated in the HSRGs will be used within the Wolf 1 CHP. Additionally, surplus/excess steam will be exported to the University of Delaware for their use. Steam-based energy use within the Wolf 1 CHP will be based on condensing steam turbines and steam absorption chillers. The steam turbines will drive three electricity generators and one chiller unit. That chiller unit will provide conditioned air to the data center. The absorption chillers will cool inlet air for the gas turbines. Spent steam from the turbines will flow to condensing units (steam to water heat exchangers). Steam condensate, with the exception of blow-down, will be circulated back to the HRSG units. Blow-down water will be discharged to the

existing public sanitary sewer system, which has adequate capacity to handle the proposed discharge. Cooling water for the condensing units will be circulated to cooling towers to exhaust residual heat. Water vapor generated by the cooling tower processes will be mostly (all but 0.0005%) captured by drift eliminators, condensed and returned to the cooling tower cold water basin for recirculation. Water vapor that escapes the drift eliminators will discharge to the atmosphere. This water vapor will contain dissolved solids, which have been addressed as particulate emissions in this report.

The operation of the SCR will require an onsite aqueous ammonia storage tank.

2.3 HOURLY EMISSIONS RATES AND STACK PARAMETERS

Table 2-1 below provides maximum hourly criteria and non-criteria pollutant emissions rates for each gas combustion turbine and each reciprocating gas engine at 100% loads and winter operating conditions, as well as for the cooling towers. Winter operating conditions use a higher heat input and, therefore, increased emissions.

Table 2-1. Maximum Hourly Pollutant Emission Rates per unit (Winter Conditions)

	Pollutant								
Source	**NO_x (lbs/hr)**	**CO (lbs/hr)**	**VOC (lbs/hr)**	**PM (lbs/hr)**	**SO_2 (lbs/hr)**	**H_2SO_4 (lbs/hr)**	**Ammonia (lbs/hr)**	**HAPs (lbs/hr)**	**Formaldehyde (lbs/hr)**
GE LM2500 DLE Combustion Turbines	1.6	0.61	0.46	1.5	0.31	0.234	2.11	0.023	0.016
Wartsila 18V50SG Reciprocating Gas Engines	2.48	5.37	5.37	1.38	0.08	0.147	1.3	1.77	0.250
Cooling Tower 1	-	-	-	0.14	-	-	-	-	-
Cooling Tower 2	-	-	-	0.65	-	-	-	-	-

Criteria pollutant emission rates were obtained from manufacturer provided performance information for the power generating equipment, where available, or from government sources for emissions estimating, including EPA's AP-42, "Compilation of Air Pollutant Emission Factors." Performance criteria for the air pollution control devices (SCR and oxidation catalysts) were obtained based on a BACT/LAER analysis discussed in Section 5.0 of this document. Appendix B includes emission tables documenting equipment performance information and emission estimates.

Table 2-2 provides the stack parameters used in the air dispersion modeling.

Table 2-2.a Stack Parameters at Full Capacity Operations
(7 turbines @ 100% load, and 3 engines @ 100% load)

Inputs	Combustion Turbines/ HRSG	Reciprocating Gas Engines/ HRSG	Steam Turbine Cooling Tower (CT1)	Chiller Tower (CT2)
Temperature (°F)	345	345	98	98
Stack Height (ft)	165	165	45	45
Stack Inside Diameter (ft)	8.0	5.0	26.0	38.0
Stack Exit Velocity (ft/sec)	60.6	70.0	28.3	30.0
Stack Exit Flow Rate (ft^3/min)	182,898	82,465	901,720	2,044,018

Table 2-2.b Stack Parameters at Normal Operating Conditions
(6 turbines @ 100% load, and 2 engines @ 100% load)

Inputs	Combustion Turbines/ HRSG	Reciprocating Gas Engines/ HRSG	Steam Turbine Cooling Tower (CT1)	Chiller Tower (CT2)
Temperature (°F)	345	345	98	98
Stack Height (ft)	165	165	45	45
Stack Inside Diameter (ft)	8.0	5.0	26.0	38.0
Stack Exit Velocity (ft/sec)	60.6	70.0	28.3	30.0
Stack Exit Flow Rate (ft^3/min)	182,898	82,465	901,720	2,044,018

Table 2-2.c Stack Parameters at Minimum Operating Conditions
(4 turbines @ 100% load, 2 turbines @ 50% load, and 2 engines @ 50% load)

Inputs	Combustion Turbines/ HRSG (100%)	Combustion Turbines/ HRSG (50%)	Reciprocating Gas Engines/ HRSG (50%)	Steam Turbine Cooling Tower (CT1)	Chiller Tower (CT2)
Temperature (°F)	345	345	345	98	98
Stack Height (ft)	165	165	165	45	45
Stack Inside Diameter (ft)	8.0	8.0	5.0	26.0	38.0
Stack Exit Velocity (ft/sec)	60.6	53.9	33.0	28.3	30.0
Stack Exit Flow Rate (ft^3/min)	182,898	162,474	38,913	901,720	2,044,018

As with all combustion processes, firing of natural gas in the gas combustion turbines and reciprocating gas engines will result in minor amounts of incomplete combustion products. Some of these compounds are classified as HAPs. Emissions of HAPs were estimated and compared with the 112(g) thresholds. Table B-4 of Appendix B presents details on emissions of each species of HAP. These estimates were based on manufacturer provided emissions factors, where available, and emission factors taken from AP-42, Section 3.1, dated April 2000, for combustion turbines; and AP-42, Section 3.2, dated July 2000, for the reciprocating gas engines. Individual and total annual estimated HAPs emissions were less than the 112(g) thresholds (i.e., total HAP less than 25 tpy and individual HAP less than 10 tpy).

Total dissolved solids (TDS) contained in cooling water drift droplets (liquid water entrained in the cooling tower exhaust air stream) are considered PM emissions. Table 2-3 provides PM emissions from the cooling towers. Conservatively, PM was assumed to be equivalent to both PM_{10} and $PM_{2.5}$. As documented in Appendix B, the combined estimated PM emissions rate from the wet mechanical draft cooling towers is 0.79 lb/hr. Assuming continuous operation, the maximum potential annual emissions of $PM/PM_{10}/PM_{2.5}$ would be 3.46 tpy.

Table 2-3. PM Emissions from Cooling Towers

	Steam Turbine Cooling Tower (CT1)	**Chiller Tower (CT2)**
Recirculating Water Flow Rate (gpm)	37,500	170,010
$PM/PM_{10}/PM_{2.5}$ emissions (lbs/hr) *[with drift eliminator]*	0.14	0.65
	0.79	

2.4 ANNUAL POTENTIAL EMISSIONS

Annual potential emissions from the Wolf 1 CHP are based on 8,760 hours per year (hr/yr) of operation for seven gas combustion turbines and approximately 6,666 hr/yr of operation for three reciprocating gas engines. Annual potential emissions for this scenario are referred to as “full bore-PTE” and estimate potential emissions are summarized below in Table 2-4 as well as in Table B-1A in Appendix B.

Table 2-4. Full Bore PTE Annualized Emissions Rates (tpy)

Pollutant	Combustion Turbine/HRSG (7 Units)	Reciprocating Gas Engine/ HRSG (3 units)	Cooling Towers (2 units)	Facility Totals
NO_x	49.2	24.76	-	73.96
CO	18.7	53.65	-	72.36
VOC	14.2	53.65	-	67.83
SO_2	9.5	0.81	-	10.34
H_2SO_4	7.2	1.47	-	8.63
GHG (as CO_{2e})	Facility-wide			950,836
Ammonia	64.8	13.26	-	78.03
$PM/PM_{10}/PM_{2.5}$	44.6	49.52	3.5	97.56
HAPs	0.7	17.7	-	18.36

For anticipated **normal operating** conditions, annual emissions from the Wolf 1 CHP are based on 8,760 hours per year (hr/yr) of operation for **six** of the seven gas combustion turbines and for **two** of the three reciprocating gas engines, operating at 100% load. This operating scenario is applicable after both Phase 1 and Phase 2 construction of the data center and CHP has occurred and the data centers are fully operational. The seventh gas turbine and third reciprocating engine are anticipated to operate intermittently and primarily when maintenance is being performed on another turbine or engine unit.

When the demand for electricity is reduced, combinations of turbines and engines may operate at a reduced load, but will always be operated in a manner that satisfies the N+2 operating requirements for uninterruptable power for the data center. The combustion turbine manufacturer guarantees emission concentrations from 50%-100% of the operating load. Aside from periods of startup or shutdown, the combustion turbines will not be operated at less than 50% load. The reciprocating engines produce the highest pound per hour emissions at 100% operating load. Reduced loads for the reciprocating engines produce fewer emissions.

Anticipated emissions under anticipated normal operating conditions are summarized in Appendix B, Table B-1B and below in Table 2-5 Normal Operating Annual Emission Rates (tpy).

Table 2-5. Normal Operating Annual Emissions Rates (tpy)

Pollutant	Combustion Turbine/HRSG (6 Units)	Reciprocating Gas Engine/ HRSG (2 units)	Cooling Towers (2 units)	Facility Totals
NO_x	42.2	21.69	-	63.87
CO	9.6	47.00	-	56.62
VOC	12.2	47.00	-	59.16
SO_2	8.2	0.71	-	8.88
H_2SO_4	6.1	1.28	-	7.42
GHG (as CO_{2e})	Facility-wide			818,804
Ammonia	55.5	11.62	-	67.13
$PM/PM_{10}/PM_{2.5}$	38.2	43.38	3.5	85.05
HAPs	0.6	12.85	-	13.44

2.5 ESTIMATES OF EQUIPMENT SHUTDOWNS AND STARTUPS

Based on information provided by the gas turbine manufacturer, GE, the first scheduled maintenance requiring shutdown of a gas combustion turbine will occur at 4,000 hours with an outage time of approximately 100 hours. To be conservative, the minimal reduction in operating time due to maintenance of the gas combustion turbines has not been accounted in the yearly emissions or hours of operation. Based on the maintenance schedule, each turbine is anticipated to operate under start-up conditions at most three times per year (three maintenance events), yielding 18 total start-ups. The seventh turbine in the group is anticipated to have more frequent (13 events estimated) start-ups, since it will be used to provide power when the other turbines and the engines are sequentially shut down for maintenance. Start-up emission concentrations for NO_x and CO will be higher during turbine start-ups since the add-on controls (discussed later in this report) will not be operating at their optimum efficiency. GE has indicated that start-up time for the turbines is approximately 10 minutes. The increased emissions of NO_x and CO from the gas combustion turbines during the start-up period are discussed below.

N+2 operating requirements for the CHP means six turbines will be producing power at all times. The seventh turbine primarily will operate only when one of the other turbines or a reciprocating gas engine is shutdown intentionally for maintenance or shutdown due to malfunction. As such, the seventh turbine will have more startups and shutdowns than the other six turbines. Startups that occur within 2 to 6 hours of shutdown would be considered “warm starts,” where temperatures within the HRSG (including the oxidation catalyst and selective catalytic reduction (SCR) pollution control units) rapidly reach normal operating conditions and emissions reach operating levels. However, for purposes of this analysis, few warm starts are anticipated to occur. “Cold starts”, where the HSRG and air pollution control units

will need time to heat before being able to treat emissions, likely will be the typical condition. Therefore, startup emissions are based on "cold start" conditions.

To provide a conservative estimate of down time, Duffield Associates assumed that turbine shutdowns last 100 hours rather than 24 hours, for maintenance, and therefore these restarts would be "cold". Balancing equipment maintenance cycles with N+2 operating conditions and anticipated power output requirements, yielded an estimated 31 total shutdowns per year for the seven turbines. According to GE, the proposed combustion turbines will reach 100% loading within 10 minutes from a cold start. Estimated emissions during the 10 minute startup are quoted at 1.7 pounds of NO_x and 1.4 pounds of CO.

Based on our understanding of SCR systems for combustion turbines, the emissions controls will not reach full operating temperature until approximately 30 minutes after startup. Assuming startup emission estimates for the first ten minutes plus emissions without controls for the next twenty minutes, yields NO_x emissions of approximately 9.3 pounds and CO emissions of approximately 6.0 pounds per turbine startup event. Startup emission calculations are shown in Appendix B.

At 30 minutes per startup times 31 starts per year, startup conditions are anticipated to exist for a total time of 930 minutes or 15.5 hours per year out of an estimated combined operating time of 53,436 hours. Therefore, turbine startup conditions are anticipated to occur during approximately 0.03% of the total annual runtime of the turbines. Currently unforeseen operating conditions or mechanical issues may necessitate additional shutdowns of individual turbines. To illustrate the truly minor nature of turbine startup emission conditions, the turbines could be shut down and restarted up to 107 times during the year without the startup period contributing more than 0.1% of total operating time for the turbines. Startup conditions for the turbines will be an intermittent operating circumstance.

Operations planning forecasts that two of the three reciprocating gas engines will be operated, when not shut down for maintenance or to stagger maintenance timing. The manufacturer estimates that each engine will need to be shut down for an average of 15 days per year over a 12 year time period, if the engines are operated more than 8,000 hours per year (which is more than the anticipated average amount of operating hours per engine). Each year, maintenance shutdown durations likely will vary between a total of 8 days and 26 days, reflecting the extent of required maintenance. The following estimate of startups and shutdowns is based on the 15 average days of maintenance and an estimated duration of three days (72 hours) per maintenance event, which yields an estimated five shutdowns and startups per year per engine for maintenance. Under these assumptions, all restarts would be considered "cold" starts, where the APC units would need time to heat before being able to treat emissions. According to Wartsila, the reciprocating gas engines will reach 100% loading operation within 30 minutes of a cold start and produce an estimated 17.4 pounds of NO_x and 16.5 pounds of CO during that 30 minute period. Based on an analysis similar to the one prepared for the turbines, TDC anticipates a

maximum of 20 startups per year for the combined three reciprocating gas engines and a permit-limited restriction of a total of 20,000 operating hours combined from the three engines. At 30 minutes per startup, the time period when reciprocating gas engines would be operating under startup conditions amounts to an estimated 10 hours (600 minutes) per year when reciprocating gas engines would be operating in startup mode. This time equates to less than 0.05% of the total yearly operation. The engines could be restarted up to 40 times per year before the startup operating conditions amounted to more than 0.1% of total operating time. Startup conditions for the reciprocating gas engines will be an intermittent operating circumstance.

Manufacturer's experience with HRSG maintenance is that their availability/reliability is approximately 95-98% of the time. Additional startups/shutdowns would not result from maintenance requirement for the HRSGs. HRSG maintenance is anticipated to occur during periods when the associated gas combustion turbine or reciprocating gas engine is being maintained.

Startup and shutdown emissions from both the combustion turbines and reciprocating gas engines are shown below.

Table 2-6. Cold Start Emissions per Event

Pollutant	**Cold Start Emissions (lb/event)**	**Minimum Number of Events**	**Cold Start Emissions (tpy)**
GE LM2500 (30 minute start-up)			
NO_x	9.3	31	0.144
CO	6.0	31	0.093
Wartsila 18V50SG (30 minute start-up)			
NO_x	17.4	20	0.174
CO	16.5	20	0.165
VOC as CH_4 equivalent	11.0	20	0.110
PM_{10}	2.9	20	0.029
$PM_{2.5}$	2.9	20	0.029

Note: Emissions @ ref 15% O_2

Table 2-7. Shutdown Emissions per Event

Pollutant	**Emissions per Shutdown (lb/event)**	**Minimum Number of Events**	**Shutdown Emissions (tpy)**
GE LM2500 (8 minute shutdown)			
NO_x	1.6	31	0.0248
CO	2.1	31	0.0325
Wartsila 18V50SG (1 minute shutdown)			
NO_x	0.352	20	0.003
CO	0.22	20	0.002
VOC as CH_4 equivalent	0.132	20	0.001
PM_{10}	0.154	20	0.001

Note: Emissions @ ref 15% O_2

3.0 NEW SOURCE REVIEW REQUIREMENTS

3.1 NATIONAL AND STATE AAQS

As a result of the CAA, EPA has enacted primary and secondary NAAQS for six air pollutants (40 CFR 50). Primary NAAQS are intended to protect the public health with an adequate margin of safety, and secondary NAAQS are intended to protect the public welfare from any known or anticipated adverse effects associated with the presence of pollutants in the ambient air. Delaware has also adopted ambient air quality standards (AAQS) (7 DE Admin. Code 1103). Table 3-1 presents the current national and Delaware AAQS.

Areas of the country where pollutant concentrations exceed AAQS are designated as nonattainment areas and new sources to be located in or near these areas may be subject to more stringent air permitting requirements. The Wolf 1 CHP site is located in New Castle County, which presently is designated in 40 CFR 81.308 as better than national standards for total suspended particulates (TSPs) and SO_2, unclassifiable/attainment for CO, unclassifiable or better than national standards for NO_2, and nonattainment for 8-hour ozone, 1-hour ozone, and $PM_{2.5}$. New Castle County is not designated for PM_{10} and lead.

Delaware also has a 3-hour AAQS for hydrocarbons, exclusive of methane, of 160 micrograms per cubic meter ($\mu g/m^3$) not to be exceeded more than once per year. This concentration is measured over a 3-hour period from 6 to 9 a.m. local time. In addition, Delaware has an AAQS for hydrogen sulfide of 0.06 part per million (ppm) not to be exceeded over any consecutive 3-minute period and 0.03 ppm not to be exceeded over any 1-hour period.

Table 3-1. National and Delaware Ambient Air Quality Standards
([µg/m^3] unless otherwise stated)

Pollutant	Averaging Periods	National Standards		Delaware Standards µg/m^3
		Primary	Secondary	
SO_2	1-hour *	196		
	3-hour †		1,300	1,300
	24-hour †	365		365
Suspended PM	24-hour †			260
	Annual ‡			75
PM_{10}	24-hour §	150	150	150
	Annual ¥	50	50	50
$PM_{2.5}$	24-hour #	35	35	65 **
	Annual ††	15	15	15
CO	1-hour †	40,000		40,000
	8-hour †	10,000		10,000
Ozone (ppmv)	1-hour ‡‡			0.12
	8-hour §§	0.08	0.08	0.08
NO_2	1-hour	188 ¥¥	188	
	Annual ##	100	100	100
Lead				1.5**
	Rolling 3-month average	0.15	0.15	

Note: ppmv = part per million by volume.

* Standard based on 3-year average of the 99th percentile of the annual distribution of 1-hour daily maximum SO_2 concentrations.
† Not to be exceeded more than once per calendar year.
‡ Geometric mean.
§ The standards are attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m^3, as determined in accordance with 40 CFR 50 Appendix K, is equal to or less than one.
¥ The standards are attained when the expected annual arithmetic mean concentration, as determined in accordance with 40 CFR 50 Appendix K, is less than or equal to 50 µg/m^3.
98th percentile concentration, as determined in accordance with 40 CFR 50 Appendix N.
** Delaware has not yet incorporated 24-hour $PM_{2.5}$ or rolling 3-month average lead NAAQS into their regulations.
††Arithmetic mean concentration, as determined in accordance with 40 CFR 50 Appendix N.
‡‡Standard attained when the expected number of calendar days per calendar year with maximum hourly average concentrations above the standard is equal to or less than 1, as determined by 40 CFR 50, Appendix H.
§§Standard attained when the average of the annual 4th highest daily maximum 8-hour average concentrations over a 3-year period are less than or equal to the standard, as determined by 40 CFR 50, Appendix I.
¥¥Standard based on 3-year average of the 98th percentile of the annual distribution of 1-hour daily maximum NO_2 concentrations.
##Arithmetic mean.

Sources: 40 CFR 50.
DNREC

3.2 NONATTAINMENT NSR APPLICABILITY

The Wolf 1 CHP site is located in New Castle County, which presently is designated as a nonattainment area for the 8-hour ozone standard and $PM_{2.5}$. Ozone concentrations are elevated in the summer months when the more intense sunlight interacts with NO_x and VOCs to form photochemical oxidants, including ozone.

Nonattainment pollutants which exceed major source thresholds in a nonattainment area are subject to NNSR requirements as defined in 7 DE Admin. Code 1125 Section 2.0. Table 3-2 presents projected annual facility emissions for TDC and major source thresholds. Due to the projected annual facility NO_x and VOC emissions exceeding the major stationary source thresholds of 25 tpy in an ozone nonattainment area, the Wolf 1 CHP facility will be subject to NNSR requirements for NO_x and VOCs.

Table 3-2. NSR Major Source Thresholds

Pollutant	Estimated PTE Annual Emissions (tpy)	Major Source Threshold (tpy)
NOx	**73.96**	**25**
CO	72.36	100
VOC	**67.83**	**25**
SO_2	10.34	100
PM Total	97.56	100
PM_{10}	97.56	100
$PM_{2.5}$	97.56	100
HAPs (Individual / Aggregate)	0.7 / 17.7	10/25
H_2SO_4	8.63	100
Greenhouse Gases (GHG) in CO2e*	**950,836**	**100,000**

Values that exceed Major Source Thresholds are shown in bold font

The Wolf 1 CHP will **not** be subject to NNSR requirements for $PM_{2.5}$ since the projected emissions do not exceed the major source threshold of 100 tpy as shown in Table 3-2. $PM_{2.5}$ is addressed in accordance with State of Delaware Minor New Source Review requirements (see section 3.5)

General NNSR requirements for NO_x are enumerated in 7 DE Admin. Code 1125 Section 2.0, Emissions Offset Provisions. In summary, the special requirements applicable to this project are as follows:

- Each other major facility in Delaware "owned or operated by the applicant, or any entity controlling, controlled by, or under common control with the

applicant," must be in compliance with applicable emissions limitations and standards or have a federally enforceable plan for compliance;

- Emissions sources will comply with LAER;
- Facility potential NO_x and VOC emissions must be offset with emissions reductions at a ratio of 1.3 to 1 to provide a positive net air quality benefit. Such NO_x and VOC emissions reduction credits (ERCs) must be procured prior to facility startup; and
- An analysis must be conducted of "alternative sites, sizes, production processes, and environmental control techniques;" the alternatives analysis must demonstrate that the "benefits of the proposed source significantly outweigh the environmental and social costs imposed as a result of its location, construction, or modification."

The proposed facility will not be able to commence operation until the required NO_x and VOC offsets (ERCs) are procured. Based on the facility's potential NO_x emissions of 73.96 tons and applying the 1.3-to-1 ratio, Wolf 1 CHP will need to secure up to 96.15 tons of NO_x offsets. Based on the facility's potential VOC emissions of 67.83 tons and applying the 1.3-to-1 ratio, Wolf 1 CHP will need to secure up to 88.18 tons of VOC offsets. Offsets generally are acceptable if obtained within the same nonattainment area as the new or modified emissions unit. In accordance with 7 DE Admin. Code 1125 Section 2.5.6, offsets may also be obtained from any area with an equal or higher nonattainment classification than the area in which the emissions unit is located, provided the emissions from the other area have been demonstrated to contribute to a violation in the area in which the new emissions unit is located. Wolf 1 CHP will obtain the required, properly certified, credits or equivalent emission offsets in accordance with 7 DE Admin Code 1125.

3.3 PSD NSR APPLICABILITY

Facilities with potential emissions that exceed the major source thresholds in Table 3-2 are considered major stationary sources and are subject to PSD requirements as defined in 7 DE Admin. Code 1125 Section 3.0. Pollutants which are considered "significant" are subject to PSD review. "Significant" pollutants are those pollutants that exceed the PSD significant emission rates (SERs) listed in 7 DE Admin. Code 1125 Section 3.0. Table 3-3 presents projected facility emissions and SER levels to identify significant pollutants subject to PSD review. Effective July 1, 2011, GHG became subject to PSD requirements at a facility that is a new stationary source that will have the potential to emit 100,000 tpy or more CO_{2e}.

Table 3-3. PSD SER Comparison

Pollutant	Estimated PTE Annual Emissions (tpy)	Significant Emission Rate (SER) (tpy)	Prevention of Significant Deterioration (PSD)
NOx*	**73.96**	**25**	**No***
CO	72.36	100	No
VOC*	**67.83**	**25**	**No***
SO_2	10.34	40	No
PM Total	**97.56**	**25**	**Yes**
PM_{10}	**97.56**	**15**	**Yes**
$PM_{2.5}$*	**97.56**	**10**	**No***
HAPs (Individual / Aggregate)	0.7 / 17.7	no SER	N/A
H_2SO_4	**8.63**	**7**	**Yes**
Greenhouse Gases (GHG)	**950,836**	**100,000**	**Yes**

Values that exceed Major Source Thresholds are shown in bold font

*Note: These pollutants exceed the SER. However, since New Castle County is nonattainment for these pollutants, PSD does not apply.

NO_x, VOC, PM/PM_{10}/$PM_{2.5}$, H_2SO_4 mist, and GHG are each projected to exceed the applicable PSD SER level. New Castle County is located in a nonattainment zone for NO_x, VOC, and $PM_{2.5}$. As such, PSD regulations do not apply to these pollutants. PM/PM_{10}, H_2SO_4, and GHG are subject to the PSD NSR requirements as defined in 7 DE Admin. Code 1125 Section 3.0. Information included in Appendix B of this application provides detailed facility emissions rate estimates.

3.4 PSD REQUIREMENTS

3.4.1 CONTROL TECHNOLOGY REVIEW

An analysis of BACT is required for each pollutant proposed to be emitted in amounts equal to or greater than the PSD SER levels. BACT is defined as: "an emissions limitation, including a visible emissions standard, based on the maximum degree of reduction of each pollutant emitted which the Administrator, on a case by case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable…. through application of production processes or available methods, systems and techniques (including fuel cleaning or treatment or innovative fuel combustion techniques) for control of each such pollutant."

BACT determinations are made on a case-by-case basis as part of the NSR process and apply to each pollutant that exceeds the PSD SER thresholds shown in Table 3-3. Emissions units that emit or increase emissions of the

applicable pollutants involved in a major modification or a new major source must undergo BACT analysis. Because each applicable pollutant must be analyzed, particular emissions units may undergo BACT analysis for more than one pollutant.

BACT is defined in terms of a numerical emissions limit. This numerical emissions limit can be based on the application of air pollution control equipment; specific production processes, methods, systems, or techniques; fuel cleaning; or combustion techniques. BACT limitations may not exceed applicable federal NSPS, national emissions standard for hazardous air pollutants (NESHAPs), or other emissions limitation established by state regulations.

BACT analyses must be conducted using the following five step top-down approach:

1. Available control technology alternatives are identified based on knowledge of the particular industry of the applicant, control technology vendors, technical journals and reports, and previous control technology permitting decisions for other identical or similar sources.

2. The identified available control technologies are evaluated for technical feasibility. If a control technology has been installed and operated successfully on the type of source under review, it is considered demonstrated and technically feasible. An undemonstrated control technology may be considered technically feasible if it is available and applicable. A control technology is considered available if it can be obtained commercially (i.e., the technology has reached the licensing and commercial sales phase of development). An available control technology is applicable if it can reasonably be installed and operated on the source type under consideration. Undemonstrated available control technologies that are determined to be technically infeasible, based on physical, chemical, and engineering principals, are eliminated from further consideration.

3. The technically feasible technology alternatives are rank-ordered by stringency into a control technology hierarchy.

4. The hierarchy is evaluated starting with the top or most stringent alternative to determine economic, environmental, and energy impacts and assesses the feasibility or appropriateness of each alternative as BACT, based on site- specific factors. If the top control alternative is accepted as BACT from an economic and energy standpoint, evaluation of energy and economic impacts of the other alternative technologies is not required since the only reason for conducting these assessments is to document the rationale for rejecting a more stringent alternative

technology as BACT. Instead, the applicant proceeds to evaluate the top case control technology for impacts of unregulated air pollutants or impacts in other media (i.e., collateral environmental impacts). If there are no issues regarding collateral environmental impacts, the BACT analysis is complete, and the top case control technology alternative is proposed as BACT. If the top control alternative is not applicable due to adverse energy, environmental, or economic impacts, it is rejected as BACT, and the next most stringent control alternative is considered.

5. This evaluation process continues until an applicable control alternative is determined to be both technologically and economically feasible, thereby defining the emissions level corresponding to BACT for the evaluated pollutant.

Chapter B of EPA's Draft New Source Review Manual, dated October 1990 describes in detail this five-step procedure for conducting a BACT analysis.

3.4.2 AMBIENT AIR QUALITY MONITORING

In accordance with the PSD requirements of 7 DE Admin. Code 1125 Section 3.0, an application for a PSD permit must contain, for each pollutant subject to review, an analysis of ambient air quality data in the area affected by the proposed major stationary source or major modification. The affected pollutants are those that the new or modified source would potentially emit in significant amounts (i.e., those that exceed the PSD SER thresholds shown in Table 3-3).

Preconstruction ambient air monitoring for a period of up to 1 year is generally required. Existing data from the vicinity of the proposed source may be used if the data meet certain quality assurance requirements; otherwise, additional data may need to be gathered. Guidance in designing a PSD monitoring network is provided by EPA's Ambient Monitoring Guidelines for Prevention of Significant Deterioration (1987a).

7 DE Admin. Code 1125 Section 3.0 provides an exemption that excludes or limits the pollutants for which an air quality monitoring analysis is conducted. This exemption states that a proposed facility will be exempt from the preconstruction ambient air monitoring requirements with respect to a particular pollutant if the emissions increase of the pollution from the new source would cause, in any area, air quality impacts less than the PSD *de minimis* ambient impact levels presented in Table 3-4. In addition, an exemption may be granted if the air quality impacts due to existing sources in the area of concern are less than the PSD *de minimis* ambient impact levels.

Section 8.2 discusses the applicability of the PSD preconstruction ambient monitoring requirements to the proposed Wolf 1 CHP facility.

Table 3-4. PSD *De Minimis* Levels

Pollutant	**Averaging Time**	***De Minimis* Level (μg/m^3)**
NO_2	Annual	14
SO_2	24-Hour	13
CO	8-Hour	575
PM_{10}	24-Hour	10
Lead	Quarterly	0.1
Fluorides	24-Hour	0.25
Total Reduced Sulfur	1-Hour	10
H_2S	1-Hour	0.2
Reduced Sulfur Compounds	1-Hour	10

3.4.3 AMBIENT IMPACT ANALYSIS

An air quality or source impact analysis must be performed for a proposed major stationary source subject to PSD for each pollutant for which the increase in emissions exceeds the SERs (see Table 3-3) with the exception of GHG and H_2SO_4 mist. There currently are no AAQS for GHG or H_2SO_4 mist. Therefore, an ambient air quality impact analysis under PSD rules is not required for those pollutants. The PSD regulations specifically require the use of applicable EPA atmospheric dispersion models in determining conservative estimates of predicted ground level ambient air quality concentrations. Guidance for the use and application of dispersion models is presented in the EPA Guideline on Air Quality Models (GAQM) as published in Appendix W to 40 CFR 51. Full source impact analysis of criteria pollutants is not required typically when modeling results indicate that the net addition of criteria pollutants from new or modified sources are below the applicable PSD significant impact levels (SILs) presented in Table 3-5.

Table 3-5. PSD SILs

Pollutant	**Averaging Time**	**Significant Impact Level (μg/m^3)**
NO_2	Annual	1
	1-Hour	7.5
SO_2	Annual	1
	24-Hour	5
	3-Hour	25
	1-Hour	7.8
CO	8-Hour	500
	1-Hour	2,000
PM_{10}	Annual	1
	24-Hour	5
PM2.5	Annual	0.3
	24-Hour	1.2
Lead	Quarterly	0.03

Ozone is one pollutant for which a source impact analysis typically is not required. Ozone is formed in the atmosphere on hot, sunny, summer days as a result of complex photochemical reactions. Models for ozone generally are applied to entire urban areas.

Various lengths of record for meteorological data can be used for impact analyses. A 5-year period can be used with corresponding evaluation of the highest of the second- highest (HSH) short-term concentrations for comparison to AAQS or PSD increments. The term highest, second-highest refers to the highest of the second-highest concentrations at all receptors (i.e., the highest concentration at each receptor is discarded). The second-highest concentration is significant because short-term PSD increments specify the standard should not be exceeded at any location more than once per year. If less than 5 years of meteorological data are used, the highest concentration at each receptor must be used.

In promulgating the 1977 CAA Amendments, Congress specified that certain increases above an air quality baseline concentration level for SO_2 and total suspended particulates (TSP) would constitute significant deterioration of air quality. The magnitude of the increment that cannot be exceeded depends on the classification of the area in which a new source (or modification) will have an impact. Three classifications were designated based on criteria established in the 1977 CAA Amendments. Initially, Congress promulgated areas as Class I (international parks, national wilderness areas, and memorial parks larger than 2,024 hectares [5,000 acres], and national parks larger than 2,428 hectares [6,000 acres]) or Class II (all other areas not designated as Class I). No Class III areas, which would be allowed greater deterioration than Class II areas, were designated. However, the states were given the authority to redesignate any Class II area to Class III status, provided certain requirements were met. EPA then promulgated, as regulations, the requirements for classifications and area designations.

On October 17, 1988, EPA promulgated PSD increments for NO_2. The effective date of the new regulation was October 17, 1989. However, the baseline date for NO_2 increment consumption was set at February 8, 1988. New major sources or modifications constructed after that date will consume NO_2 increments.

On June 3, 1993, EPA promulgated PSD increments for PM_{10}. The effective date of the new regulation was June 3, 1994. The increments for PM_{10} replaced the original PM increments that were based on TSP. Baseline dates and areas previously established for the original TSP increments remained in effect for the new PM_{10} increments. Revised NAAQS for PM, which include revised NAAQS for PM_{10} and $PM_{2.5}$, became effective on October 17, 2006. PSD increments, SILs and

significant monitoring concentration levels for $PM_{2.5}$ PSD requirements became finalized effective December 20, 2010 (Federal Register, Volume 75, No. 202, October 20, 2010). Table 3-6 presents current PSD allowable increments. Section 8.2 discusses the applicability of the PSD allowable increments requirements to the proposed Wolf 1 CHP facility.

Table 3-6. PSD Allowable Increments

Pollutant	**Averaging Time**	**PSD Allowable Increment (μg/m^3)**		
		Class I	Class II	Class III
PM_{10}	Annual arithmetic mean	4	17	34
	24-Hour maximum*	8	30	60
$PM_{2.5}$	Annual arithmetic mean	1	4	8
	24-Hour maximum*	2	9	18
SO_2	Annual arithmetic mean	2	20	40
	24-Hour maximum*	5	91	182
	3-Hour maximum*	25	512	700
NO_2	Annual arithmetic mean	2.5	25	50

*Maximum concentration not to be exceeded more than once per year at any one location.

Sources: 40 CFR 52.21.

The term "baseline concentration" evolved from Federal and state PSD regulations and denotes a concentration level corresponding to a specified baseline date and certain additional baseline sources. By definition in the PSD regulations, as amended, baseline concentration means the ambient concentration level that exists in the baseline area at the time of the applicable minor source baseline date. A baseline concentration is determined for each pollutant for which a baseline date is established based on:

- The actual emissions representative of sources in existence on the applicable minor source baseline date.
- The allowable emissions of major stationary sources that commenced construction before the major source baseline date but were not in operation by the applicable minor source baseline date.

The following will not be included in the baseline concentration and will affect the applicable maximum allowable increase(s) (i.e., allowed increment consumption):

- Actual emissions from any major stationary source on which construction commenced after the major source baseline date.

- Actual emissions increases and decreases at any stationary source occurring after the minor source baseline date.

Determination of the baseline concentration is not necessary to determine the amount of PSD increment consumed. Instead, increment consumption calculations need only reflect the ambient pollutant concentration change attributable to emissions sources that affect an increment. Major source baseline date means January 6, 1975, for PM (TSP/PM_{10}) and SO_2 and February 8, 1988, for NO_2. Minor source baseline date means the earliest date after the trigger date on which the first complete application was submitted by a major stationary source or major modification subject to the requirements of 40 CFR 52.21. The trigger dates are August 7, 1977, for PM (TSP/PM_{10}) and SO_2 and February 8, 1988, for NO_2.

In this report, Sections 7.0 (Air Quality Impact Analysis Methodology) and 8.0 (PSD Class II Air Quality Impact Analysis Results) provide the ambient impact analyses for the Wolf 1 CHP facility.

3.4.4 ADDITIONAL IMPACT ANALYSES

PSD regulations require additional impact analyses for three topics: associated growth, soils and vegetation impact, and visibility impairment. The level of analysis for each area should be commensurate with the scope of the project. A more extensive analysis would be conducted for projects having large emissions increases than those that will cause a small increase in emissions.

The growth analysis generally includes:

- A projection of the associated industrial, commercial, and residential growth that will occur in the area;
- An estimate of the air pollution emissions generated by the permanent associated growth; and
- An air quality analysis based on the associated growth emissions estimates and the emissions expected to be generated directly by the new source or modification.

The soils and vegetation analysis typically is conducted by comparing projected ambient concentrations for the pollutants of concern with applicable susceptibility data from the air pollution literature. For most types of soils and vegetation, ambient air concentrations of criteria pollutants below the NAAQS will not result in harmful effects. Sensitive vegetation and emissions of toxic air pollutants could necessitate a more extensive assessment of potential adverse effects on soils and vegetation.

The visibility impairment analysis pertains particularly to Class I area impacts and other areas where good visibility is of special concern. A quantitative estimate of visibility impairment is conducted, if warranted by the scope of the project. Section 9.0 of this report provides the additional impact analyses for the Wolf 1 CHP facility.

3.5 DELAWARE MINOR NEW SOURCE REVIEW PROGRAM

Delaware regulates non-major sources under their minor new source review program contained in 7 DE Admin. Code 1125 Section 4.0 *Minor New Source Review*. This regulation applies to new stationary sources with the potential to emit 5 tpy or more of NO_x, VOC, sulfur oxides, $PM_{2.5}$, and aggregate HAPs.

Therefore, pollutants that are identified as not subject to PSD or NNSR, may be subject to Minor New Source Review, if emissions exceed the MNSR thresholds. Table 3-7 lists the pollutants that were exempt from PSD and NNSR. Based on the estimated emissions, SO_2, $PM_{2.5}$ and HAPs are subject to MNSR.

Table 3-7. New Source Review Permitting Track

Pollutant	Estimated Annual Emissions (tpy)	PSD	NNSR	MNSR
NO_x	73.96		X	
CO	72.36	< SER		N/A
VOC	67.83		X	
SO_2	10.34			X
PM Total	97.56	X		
PM_{10}	97.56	X		
$PM_{2.5}$	97.56			X
HAPs (Individual/Aggregate)	0.7 / 17.7			X
H_2SO_4	8.63	X		
Greenhouse Gases (GHG) CO_{2e}	950,836	X		

MNSR includes installing and operating emissions control technology that limits emissions to the atmosphere by meeting the BACT, LAER, or control technologies approved either in advance by DNREC or on a case-by case basis. NO_x and VOCs are subject to NNSR and Wolf 1 CHP will be required to install the most stringent control technology equivalent to LAER for these pollutants. SO_2, $PM_{2.5}$, and HAPs from the Wolf 1 CHP exceed the 5-tpy threshold, and the facility will be subject to the Delaware MNSR program. Section 5.0 of this report provides the BACT assessment for those substances.

3.6 DELAWARE CO_2 BUDGET TRADING PROGRAM

The Wolf 1 CHP is not subject to 7 DE Admin. Code 1147 (Delaware's component of the CO_2 Budget Trading Program). None of the proposed power units will serve an electricity generator with a nameplate capacity equal to or greater than 25 MW_e.

4.0 STATE AND FEDERAL EMISSIONS STANDARDS

4.1 NEW SOURCE PERFORMANCE STANDARDS

Section 111 of the CAA, Standards of Performance of New Stationary Sources, requires EPA to establish Federal emissions standards for source categories that cause or contribute significantly to air pollution. These standards are intended to promote use of the best air pollution control technologies, taking into account the cost of such technology and any other non-air quality, health, and environmental impact and energy requirements. These standards apply to sources that have been constructed or modified since the proposal of the standard. Since December 23, 1971, EPA has promulgated more than 75 standards. NSPS are codified in 40 CFR 60. NSPS regulations are also addressed in 7 DE Admin. Code 1120.

The Wolf 1 CHP facility's air emissions sources include seven dry, low NO_x, gas combustion turbines with HRSGs to support combined cycle operation, three lean-burn, spark-ignition, reciprocating gas engines with HRSGs to support combined cycle operation, and two cooling towers. The following subsections discuss those NSPS that potentially are applicable to the Wolf 1 CHP facility emission sources.

4.1.1 NSPS SUBPART KKKK—STATIONARY GAS COMBUSTION TURBINES

40 CFR 60 Subpart KKKK establishes emissions limits for natural gas combustion turbine units that commenced construction after February 18, 2005, and have a heat input at peak load equal greater than 50 MMBtu per hour HHV but less than or equal to 850 MMBtu per hour HHV. The gas turbines proposed for the Wolf 1 CHP will be in this category and will be subject to the requirements of Subpart KKKK.

NSPS Subpart KKKK specifies emissions limitations, monitoring, reporting, and record- keeping requirements for NO_x and SO_2. Applicable NSPS Subpart KKKK emissions standards for each of the proposed gas combustion turbine units are summarized as follows:

NO_x – 25 ppmvd at 15% O2
SO_2 – 0.90 lb/MWh gross energy output or
0.060 lb/MMBtu of heat input sulfur content for the fuel.

The proposed dry low NO_x, gas-fired combustion turbine units have NO_x emission rates well below the NSPS Subpart KKKK emissions standard and the fuel supplied by Eastern Shore has a sulfur content that is less than the Subpart KKKK fuel requirement, based on monthly records provided by two of the three gas suppliers to Eastern Shore (Williams Transo and Texas

Eastern). Eastern Shore will be the gas utility supplying the proposed Wolf 1 CHP.

4.1.2 NSPS SUBPART JJJJ - STATIONARY SPARK IGNITION INTERNAL COMBUSTION ENGINES

40 CFR 60 Subpart JJJJ establishes emissions limits for spark ignited, reciprocating gas engine units rated at 500 Hp or more that commence construction after July 1, 2010. The Wolf 1 CHP facility reciprocating gas engines will be subject to the requirements of Subpart JJJJ.

NSPS Subpart JJJJ specifies emissions limitations, monitoring, reporting, and record-keeping requirements for NO_x, CO, and VOC. Applicable NSPS Subpart JJJJ emissions standards for each of the reciprocating gas engine units are summarized as follows:

NO_x – 82 ppmvd at 15% O_2
CO – 270 ppmvd at 15% O_2
VOC – 60 ppmvd at 15% O_2

Including emissions control technology, the Wolf 1 CHP facility's lean-burn, spark ignition, four stroke reciprocating natural gas-fired engine units will have emissions well below the NSPS Subpart JJJJ emissions standards. In accordance with Section 60.4243 of Subpart JJJJ, the non-certified engines and control device will be operated and maintained according to the manufacturer's emission-related written instructions. The operator of the Wolf 1 CHP will keep records of conducted maintenance to demonstrate compliance. TDC will comply with all applicable requirements of NSPS Subpart JJJJ, including arranging for an initial performance test within 1 year of engine start up and conducting subsequent performance testing after every 8,760 hours of engine operation or 3 years, whichever occurs first.

4.2 NATIONAL EMISSIONS STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAPS)

The provisions of the CAA that address the control of HAP emissions, or air toxics, are found in Section 112. Section 112 of the CAA includes provisions for the promulgation of NESHAPs, or maximum achievable control technology (MACT) standards, as well as several related programs to enhance and support the NESHAPs program. Section 112 requires EPA publish and regularly update (at least every 8 years) a list of the categories and subcategories of major and area sources that emit HAPs. The Section 112(c) list of source categories initially was published in the Federal Register on July 16, 1992, and has been revised periodically thereafter. EPA must promulgate regulations establishing emissions standards (NESHAPs) for each category or subcategory of major sources and area sources of HAPs that are listed pursuant to Section 112(c). The standards must require the maximum degree

of emissions reduction that EPA determines to be achievable by each particular source category. Different criteria for MACT apply for new and existing sources. Less stringent standards, known as generally available control technology standards, are allowed at the EPA Administrator's discretion for area sources.

In general, the 40 CFR 63 NESHAPs are only applicable to major HAP sources (i.e., facilities that have potential emissions of an individual HAP of 10 tpy or more, and potential emissions of total HAPs of 25 tpy or more). The Wolf 1 CHP facility has potential HAP emissions rates below these thresholds and, therefore, is a minor, or area, source of HAPs.

4.2.1 COMBUSTION TURBINE NESHAP

NESHAPs emitted from combustion turbines are established in 40 CFR 63 Subpart YYYY. This regulation establishes national emission limitations and operating limitations for HAPs emitted from combustion turbines located at major sources. Since the Wolf 1 CHP is a minor, or area source, of HAPs, this regulation is not applicable. The LM2500 DLE combustion turbines will meet the NSPS required under 40 CFR 60 Subpart KKKK and discussed in Section 4.1.1 of this application.

4.2.2 RECIPROCATING INTERNAL COMBUSTION ENGINE NESHAP

NESHAPs emitted from stationary reciprocating internal combustion engines (RICE) are established in 40 CFR 63 Subpart ZZZZ. Also known as RICE NESHAP, this regulation establishes national emission limitations and operating limitations for HAPs emitted from stationary reciprocating internal combustion engines located at major and area sources. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations and operating limitations.

Based on the facility's HAP potential to emit, which includes emissions from both the RICE and combustion turbines, the facility will qualify as a minor or "area source." According to Section 63.6590(c), new engines at area sources comply with RICE NESHAP by complying with the requirements of 40 CFR 60 Subpart JJJJ. Subpart JJJJ is the New Source Performance Standard (NSPS) for spark ignited reciprocating internal combustion engines.

The Wolf 1 CHP will comply with the RICE NESHAP and referenced NSPS through applicable emissions standards and maintenance requirements outlined in 40 CFR 60 Subpart JJJJ previously discussed in Section 4.1.2 of this application.

4.3 PROGRAM (CAA TITLE IV)

The Wolf 1 CHP is not an affected unit subject to the requirements of the Acid Rain Program. 40 CFR 72.6(b)(4)(ii) offers the following exemption from the requirements of the Acid Rain Program:

> "(b) The following types of units are not affected units subject to the requirements of the Acid Rain Program. (4) A cogeneration facility which: (ii) For units which commenced construction after November 15, 1990, supplies equal to or less than one-third its potential electrical output capacity or equal to or less than 219,000 MWe-hrs actual electric output on an annual basis to any utility power distribution system for sale (on a gross basis)."

The Wolf 1 CHP has an electricity generation capacity of approximately 279 MW. If operated at that capacity for a year (8,760 hours), it would produce 2,444,040 MWe-hrs. TDC anticipates providing approximately 50 MW of power to the City of Newark through DMEC, a power distribution utility. If they provide an average of 50 MW of power over the course of a year, 438,000 MWe-hrs would be provided, which is approximately 17.90% of the Wolf 1 CHP capacity. Within the "equal to or less than one third of its potential capacity" provision of the Acid Rain Program exemption, the Wolf 1 CHP could provide up to 806,533 MWe-hrs to DMEC annually.

4.4 DELAWARE EMISSIONS STANDARDS

Delaware's air quality regulations are contained in Title 7, Natural Resources and Environmental Control, DE Admin. Code. The following is a brief description of the Delaware emissions regulations that are relevant to the Wolf 1 CHP:

- 7 DE Admin. Code 1104, *Particulate Emissions from Fuel-Burning Equipment* – Section 1104.2.0 limits PM from fuel-burning equipment to no more than 0.3 lb/MMBtu determined as the maximum 2-hour average. Due to the use of natural gas as the sole fuel source, the maximum PM emissions will be approximately 0.0066 lb/MMBtu for the combustion turbines and 0.0099 lb/MMBtu for the reciprocating gas turbines. Therefore, the Wolf 1 CHP will meet the requirements of this rule;
- 7 DE Admin. Code 1105, *Particulate Emissions from Industrial Process Operations* – Section 1105.2.0 limits the potential PM emissions of cooling towers to 0.2 grains per standard cubic foot. Wolf 1 CHP's PM emissions will be less than 0.00001 grains per standard cubic foot. Section 1105.7.0 states that the concentration of potentially hazardous PM should be listed. Only negligible amounts of such substances (e.g., silica) are expected to be emitted from the cooling towers. Therefore, the Wolf 1 CHP will meet the requirements of this rule;

- 7 DE Admin. Code 1108, *Sulfur Dioxide Emissions from Fuel Burning Equipment* – Section 1108.2.2 and 2.3 specify maximum allowable sulfur contents for fuels prior to July 2016 and after July 2016, respectively. For natural gas, the specified sulfur content does not change. The maximum sulfur content is 1.0% by weight. Compliance with this requirement rests with TDC and Eastern Shore, the fuel vendor (supplier) for the Wolf 1 CHP. SO_2 Emissions from Fuel Burning Equipment— Section 1108.2.2 states that no person shall purchase or use fuel containing sulfur greater than 0.3% by weight. The sulfur content of the fuels used by Wolf 1 CHP will be well below the emissions limit of this rule. The natural gas will have a maximum sulfur content of 0.5 grains or less per 100 standard cubic feet (i.e., less than or equal to 0.0015% sulfur by weight) and will be demonstrated by periodic testing of the gas supplies;
- 7 DE Admin. Code 1112, *Control of NO_x Emissions* – Section 1112.3.2.2 addresses Reasonably Available Control Technology (RACT) for fuel burning equipment. In Section 1112.3.2.2.1, low NO_x burner technology is identified as RACT. Per section 1112.3.4, the reciprocating engines will have pre-ignition chamber technology where a rich mixture of fuel will be ignited by spark. The ignited rich mixture will flow into the combustion chamber where it will ignite a compressed lean fuel mixture. A similar two stage rich/lean combustion process (Dry Low NO_x system) will be used in the combustion turbines in compliance with the requirement for low NO_x burner technology. In accordance with Section 1112.3.2.4.3, the combustion turbines and reciprocating engines will have a Continuous Emissions Monitoring System (CEMS). Therefore, the Wolf 1 CHP will meet the requirements of this rule;
- 7 DE Admin. Code 1114, *Visible Emissions*—Section 1114.2.1 states that no more than 20% opacity for 3 minutes in 1 hour or 15 minutes in 24 hours shall occur. Wolf 1 CHP will comply with this rule;
- 7 DE Admin. Code 1116, *Sources Having an Interstate Air Pollution Potential* – Section 1116.3.2 states that "all new sources of air contaminants, whose emissions are carried into a neighboring state, shall control their emissions to such an extent as to not substantially affect the ambient air quality of the receptor state." Wolf 1 CHP's emissions will comply with this regulation;
- 7 DE Admin. Code 1119, *Control of Odorous Air Contaminants* – Section 1119.2.0 states that "no person shall cause or allow the emissions of an odorous air contaminant such as to cause a condition of air pollution." Wolf 1 CHP will comply with this rule. This is a Delaware enforceable requirement only; and
- 7 DE Admin. Code 1144, *Control of Stationary Generator Emissions* – Section 1.2.1.1 states that this regulation is <u>not</u> applicable to new generators covered by a permit which imposes a NO_x emission limitation established to meet BACT or LAER. Wolf 1 CHP will incorporate LAER for NO_x emissions, which will control emissions to more stringent requirements than those outlined in 7 DE Admin. Code 1144.

5.0 CONTROL TECHNOLOGY ANALYSES

The proposed Wolf 1 CHP is subject to review with respect to the following control technology requirements:

- LAER for NO_x and VOCs. New Castle County is classified as nonattainment for ozone and $PM_{2.5}$. NO_x and VOCs are ozone precursors. The potential facility emissions of these substances exceed the applicable NNSR thresholds;
- BACT for PM_{10} and H_2SO_4, which exceeds the PSD significant emissions rate thresholds specified in 40 CFR 52.21(b)(23). New Castle County is classified as being in attainment or not listed for those pollutants;
- BACT for complying with minor new source review requirements of 7 DE Admin. Code 1125 for pollutants, including SO_2 and HAPs, that have potential to be emitted at rates equal to or greater than 5 tpy; and
- BACT for GHG emissions if the total facility CO_{2e} potential emissions exceed 75,000 tpy and the facility is subject to PSD review for a regulated non-GHG pollutant or if the total facility CO_{2e} potential emissions exceed 100,000 tpy (per the "Tailoring Rule").

BACT and LAER requirements apply to each air emissions source at the facility that emits that particular pollutant. These analyses are discussed in the following subsections.

5.1 LOWEST ACHIEVABLE EMISSIONS RATE (LAER)

5.1.1 POLLUTANT APPLICABILITY

New Castle County retains the legacy designation of severe ozone nonattainment for the 1-hour ozone standard. Due to the projected annual facility NO_x and VOC emissions exceeding the major stationary source thresholds of 25 tpy in a severe ozone nonattainment area, as defined in 7 DE Admin. Code 1125 Section 2.0, the Wolf 1 CHP facility will be subject to NNSR requirements for NO_x and VOCs and a LAER analysis is required for these substances.

New Castle County is designated as nonattainment for $PM_{2.5}$. The projected annual emissions of $PM_{2.5}$ from the Wolf 1 CHP do not exceed 100 tpy. Therefore, a LAER assessment for $PM_{2.5}$ is not required, but a BACT analysis is applicable due to the MNSR requirement.

5.1.2 METHODOLOGY

LAER is defined in 7 DE Admin. Code 1101 Section 2.0, as: "The more stringent rate of emissions based on the following:

(i) The most stringent emissions limitation which is contained in the implementation plan of any State for such class or category of source, unless the owner or operator of the proposed source demonstrates that such limitations are not achievable; or

(ii) The most stringent emissions limitation which is achieved in practice by such class or category of source.

In no event shall the application of this term permit a proposed new or modified facility to emit any pollutant in excess of the amount allowable under the new source standards of performance."

Sources of information that were used to identify the potential LAER alternatives include:

- EPA's Reasonably Available Control Technology (RACT)/BACT/LAER Clearinghouse [RBLC] database;
- Vendor information; and
- Experience with similar projects.

The following LAER analysis for NO_x and VOCs describes the available control technologies and discusses the most stringent emissions limitations that have been achieved in practice. The LAER assessment is discussed separately per stationary source beginning with the gas combustion turbines followed by reciprocating gas engines.

5.1.3 GAS COMBUSTION TURBINE EMISSIONS

Gas combustion turbines emit criteria pollutants including NO_x, CO, VOCs, and lesser amounts of PM, and SO_x as a byproduct of combustion or as a direct result of incomplete combustion. This LAER assessment is limited to the emissions of NO_x and VOCs.

NO_x emissions from gas combustion turbines consist of two components: oxidation of atmospheric nitrogen in combustion air (thermal NO_x and prompt NO_x) and conversion of chemically bound fuel nitrogen (FBN or fuel NO_x). Essentially all NO_x emissions originate as nitric oxide (NO). NO generated by combustion processes subsequently are further oxidized in the atmosphere to the more stable NO_2 molecule.

Thermal NO_x results from the oxidation of atmospheric nitrogen under high temperature combustion conditions. The amount of thermal NO_x formed is primarily a function of combustion temperature and residence time, air/fuel ratio, and, to a lesser extent, combustion pressure. Thermal NO_x increases

exponentially with increases in temperature and linearly with increases in residence time as described by the Zeldovich mechanism.

Prompt NO_x is formed near the combustion flame front from the oxidation of intermediate combustion products. Prompt NO_x comprises a small portion of total NO_x in conventional near-stoichiometric combustors, but increases under fuel-lean conditions. Therefore, prompt NO_x is an important consideration with respect to low-NO_x combustors that use lean fuel mixtures. Prompt NO_x levels may also become significant with ultra-low- NO_x burners.

Fuel NO_x arises from the oxidation of non-elemental nitrogen contained in the fuel. The conversion of FBN to NO_x depends on the bound nitrogen content of the fuel. In contrast to thermal NO_x, fuel NO_x formation does not vary appreciably with combustion variables such as temperature or residence time. Presently, there are no combustion processes or fuel treatment technologies available to control fuel NO_x emissions. For this reason, the regulations typically contain an allowance for FBN directly or inherently (i.e., part of the emissions limit). Typically, natural gas contains a negligible amount of FBN. As such, fuel NO_x typically does not contribute significantly to total NO_x emissions from gas-fired turbines.

In general, VOC emissions from combustion turbines inherently are very low and largely dependent on the fuel source. Factors affecting VOC emissions include firing temperatures, residence time in the combustion zone, and combustion chamber mixing characteristics. VOC emissions generally are produced at the lowest rate when combustion turbines are operating at full load and combustion temperatures are high. Conversely, emissions of VOC generally increase during turbine partial load conditions, when combustion temperatures are lower.

Emissions of NO_x and VOC can be inversely related (i.e., decreasing NO_x emissions will result in an increase in VOC emissions). Accordingly, combustion turbine vendors have had to consider the competing factors involved in NO_x and VOC formation to develop units that achieve acceptable emissions levels for both pollutants. For instance, decreased combustion zone temperature due to the injection of water or steam for NO_x control leads to increases in VOC emissions. An increase in combustion zone residence time and improved mixing of fuel and combustion air will increase oxidation rates and cause a decrease in VOC emissions rates, but can produce more NO_x emissions.

The LAER assessment below begins with a discussion of applicable combustion turbine control technologies for NO_x, followed by a discussion of applicable control technologies for VOCs.

5.1.3.1 Potential Control Technologies - NO_x

Available technologies for controlling NO_x emissions from combustion turbines include combustion process modifications and post-combustion exhaust gas treatment systems. A listing of available technologies for each of these categories follows:

Combustion Process Modifications:

- Water or steam injection and standard combustor design;
- Water or steam injection and advanced combustor design;
- Dry low-NO_x combustor design; and
- Catalytic combustion controls.

Post-Combustion Exhaust Gas Treatment Systems:

- Selective non-catalytic reduction (SNCR);
- Non-selective catalytic reduction (NSCR);
- Selective Catalytic Reduction (SCR); and
- SCONOx™.

A description of each of the listed control technologies is provided in the following subsections.

Water or Steam Injection and Standard Combustor Design

Injection of water or steam into the primary combustion zone of a combustion turbine reduces the formation of thermal NO_x by decreasing the peak combustion temperature. Water injection decreases the peak flame temperature by diluting the combustion gas stream and acting as a heat sink by absorbing heat necessary to vaporize the water (latent heat of vaporization) and raise the vaporized water temperature to the combustion temperature. High purity water must be employed to prevent turbine corrosion and deposition of solids on the turbine blades. Steam injection employs the same mechanisms to reduce the peak flame temperature with the exclusion of heat absorbed due to vaporization since the heat of vaporization has been added to the steam prior to injection. Accordingly, a greater amount of steam, on a mass basis, is required to achieve a specified level of NO_x reduction in comparison to water injection. Typical injection rates range from 0.3 to 1.0 and 0.5 to 2.0 pounds of water and steam,

respectively, per pound of fuel. Water or steam injection will not reduce the formation of fuel NO_x.

The maximum amount of steam or water that can be injected depends on the combustor design. Excessive rates of injection will cause flame instability, combustor dynamic pressure oscillations, thermal stress (cold-spots), and increased emissions of CO and VOCs, due to combustion inefficiency. Accordingly, the efficiency of steam or water injection to reduce NO_x emissions also depends on turbine combustor design. For a given turbine design, the maximum water to fuel ratio (and maximum NO_x reduction) will occur up to the point where cold-spots and flame instability adversely affect safe, efficient, and reliable operation of the turbine. The use of water or steam injection and standard turbine combustor design generally can achieve NO_x exhaust concentrations of 42 ppmvd for gas-firing.

Water or Steam Injection and Advanced Combustor Design

Water or steam injection functions in the same manner for advanced combustor designs as described previously for standard combustors. However, advanced combustors are designed to generate lower levels of NO_x and tolerate greater amounts of water or steam injection. The use of water or steam injection and advanced turbine combustor design typically can achieve NO_x exhaust concentrations of 25 ppmvd for gas-firing.

Dry Low-NO_x Combustor Design

Dry low-NO_x combustors are designed to premix turbine fuel and air prior to combustion in the primary zone. The use of a premix burner results in a homogeneous air/fuel mixture without an identifiable flame front. This allows a lower flame temperature in the combustion zone, causing a decrease in thermal NO_x emissions.

Currently, premix burners are limited in application to natural gas and loads above approximately 35 to 50% of baseline due to flame stability considerations.

In addition to lean premixed combustion, dry low-NO_x combustors typically incorporate lean combustion and reduced combustor residence time to reduce the rate of NO_x formation. Dilution air is added to the combustion chamber which leans the fuel mixture and cools the hot combustor gases rapidly to temperatures below those needed for NO_x formation. Reduced residence time combustors

add dilution air sooner than do standard combustors. The amount of thermal NO_x is reduced because the combustion gases are at a high temperature for a short period of time.

Current dry low-NO_x combustor technology typically can achieve NO_x exhaust concentrations of approximately 9 ppmvd or less using natural gas fuel, depending on the combustion turbine vendor.

Catalytic Combustion Controls (XONON™)

Another technology that is potentially capable of reducing gas turbine NO_x emissions to less than 3.5 ppmvd is catalytic combustion. Catalytica, Inc. was the first entity to commercially develop catalytic combustion controls for certain (mostly smaller) turbine engines and markets this system under the name XONON™. In October 2006, this technology was sold to Kawasaki Heavy Industries Ltd. It is not commercially available for larger combustion turbines. Therefore, catalytic combustion does not represent an available control option for the proposed GE LM2500 DLE combustion turbines.

Selective Non-Catalytic Reduction

The SNCR process involves the gas phase reaction, in the absence of a catalyst, of NO_x in the exhaust gas stream with injected ammonia or urea to yield nitrogen and water vapor. The two commercial applications of SNCR include the Electric Power Research Institute's NOxOUT™ and Exxon's Thermal DeNOx™ processes. The two processes are similar in that either ammonia (Thermal DeNOx™) or urea (NOxOUT™) is injected into the hot exhaust gas stream at a location specifically chosen to achieve the optimum reaction temperature and residence time. Simplified chemical reactions for the Thermal DeNOx™ process are as follows:

Reaction (1): $4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$

Reaction (2): $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

The NOxOUT™ process is similar with the exception that urea is used in place of ammonia. The critical design parameter for both SNCR processes is the reaction temperature. At temperatures below 1,600 degrees Fahrenheit (°F), rates for both reactions decrease allowing unreacted ammonia to exit with the exhaust stream. Temperatures between 1,600 and 2,000°F will favor

reaction (1), resulting in a reduction in NO_x emissions. Reaction (2) will dominate at temperatures above approximately 2,000°F, causing an increase in NO_x emissions. Due to reaction temperature considerations, the SNCR injection system must be located at a point in the exhaust duct where temperatures are consistently between 1,600 and 2,000°F.

Non-Selective Catalytic Reduction

The NSCR process uses a platinum/rhodium catalyst to reduce NO_x to nitrogen and water vapor under fuel-rich (less than 3% oxygen [O_2]) conditions. NSCR technology has only been applied to automobiles and stationary reciprocating engines.

Selective Catalytic Reduction

In contrast to SNCR, SCR reduces NO_x emissions by reacting ammonia with exhaust gas NO_x to yield nitrogen and water vapor in the presence of a catalyst. Ammonia is injected upstream of the catalyst bed where the following primary reactions take place:

Reaction (3): $4NH_3 + 4NO + O_2 \rightarrow 4N_2 + 6H_2O$

Reaction (4): $4NH_3 + 2NO_2 + O_2 \rightarrow 3N_2 + 6H_2O$

The catalyst serves to lower the activation energy of these reactions, which allows the NO_x conversions to take place at a lower temperature than the exhaust gas. The optimum temperatures can range from 350°F to 1,100°F, but typically is designed to occur between 600°F and 750°F, depending on the catalyst. Typical SCR catalysts include metal oxides (titanium oxide and vanadium), noble metals (combinations of platinum and rhodium), zeolite (alumino-silicates), and ceramics. Water vapor and elemental nitrogen are released to the atmosphere as part of the exhaust stream.

Factors affecting SCR performance include space velocity (volume per hour of flue gas divided by the volume of the catalyst bed), ammonia/NO_x molar ratio, and catalyst bed temperature. Space velocity is a function of catalyst bed depth. Decreasing the space velocity (increasing catalyst bed depth) will improve NO_x removal efficiency by increasing residence time, but will also cause an increase in catalyst bed pressure drop. The reaction of NO_x with ammonia theoretically requires a 1:1 molar ratio. Ammonia/NO_x molar ratios greater than 1:1 are necessary to achieve high NO_x removal efficiencies, due to imperfect mixing and other reaction

limitations. Typically, ammonia/NO_x molar ratios are maintained at 1:1 or lower to prevent excessive unreacted ammonia (ammonia slip) emissions. As was the case for SNCR, reaction temperature is critical for proper SCR operation. Below the minimum temperature, reduction reactions (3) and (4) will not proceed. At temperatures exceeding the optimal range, oxidation of ammonia will take place resulting in an increase in NO_x emissions. NO_x removal efficiencies for SCR systems typically range from 80 to 90%.

SCR catalyst can be subject to deactivation by a number of mechanisms. Loss of catalyst activity can occur from thermal degradation, if the catalyst is exposed to excessive temperatures over a prolonged period of time. Catalyst deactivation can also occur due to chemical poisoning. Principal poisons include arsenic, sulfur, potassium, sodium, and calcium. Another consideration with the application of SCR technology is the possibility of "fouling" (i.e., formation of sticky ammonium sulfates and plugging the catalyst bed surfaces over time). This condition is caused by the use of high sulfur fuels and is especially problematic for combined-cycle operations using HRSGs.

EMx™ (SCONOx™)

EMx™ (formerly referred to as SCONOx™) is a multi-pollutant reduction catalytic control system offered by EmeraChem. EMx™ is a complex technology that is designed to reduce NOx, VOC, and CO simultaneously through a series of oxidation/absorption catalytic reactions.

The EMx™ system employs a single catalyst to oxidize CO to CO_2 and NO to NO_2, simultaneously. NO_2 formed by the oxidation of NO is absorbed subsequently onto the catalyst surface through the use of a potassium carbonate absorber coating. The EMx™ oxidation/absorption cycle reactions are:

Reaction (5): $CO + \frac{1}{2} O_2 \rightarrow CO_2$

Reaction (6): $NO + \frac{1}{2} O_2 \rightarrow NO_2$

Reaction (7): $2NO_2 + K_2CO_3 \rightarrow CO_2 + KNO_2 + KNO_3$

CO_2 produced by reactions (5) and (7) is released to the atmosphere as part of the exhaust stream. Due to absorption of NO_2 on the catalyst coating, the catalyst must be regenerated periodically. Following regeneration, the EMx™ catalyst has a fresh coating of potassium carbonate, allowing the

oxidation/absorption cycle to begin again. Since the regeneration cycle must take place in an oxygen-free environment, the section of catalyst undergoing regeneration is isolated from the exhaust gas stream using a set of louvers.

The EMx™ operates at a temperature range of 300 to 700°F and, therefore, must be installed in the appropriate temperature section of a HRSG. For installations below 450°F, the EMx™ system uses an inert gas generator for the production of hydrogen and CO_2. For installations above 450°F, the EMx™ catalyst is regenerated by introducing a small quantity of natural gas with a carrier gas, such as steam, over a steam reforming catalyst and then to the EMx™ catalyst. The reforming catalyst initiates the conversion of methane to hydrogen, and the conversion is completed over the EMx™ catalyst. Water vapor (from the steam) and CO_2 would be released to the atmosphere during regeneration.

Consumable materials needed for the operation of the EMx™ control system include ambient air, natural gas, water, steam, and electricity. The primary consumable is natural gas used for regeneration gas production. Steam is used as the carrier/dilution gas for the regeneration gas. Electricity is required to operate the computer control system, control valves, and louver actuators.

Commercial experience to date with the EMx™ control system is based upon several small combined-cycle power plants located in California. Representative of these small power plants is a GE LM2500 turbine, owned by Sunlaw Energy Corporation, equipped with water injection to control NO_x emissions to approximately 25 ppmvd. The low temperature SCONOx™ control system (i.e., located downstream of the HRSG where the exhaust gas temperature is between 300 and 400°F) was retrofitted to the Sunlaw Energy facility in December 1996 and has achieved a NO_x exhaust concentration of 3.5 ppmv, resulting in an approximate 85% NO_x removal efficiency. This facility is no longer operating due to market factors. A high-temperature application of EMx™ (i.e., control system located within the HRSG at an exhaust gas temperature between 600 and 700°F) has been in service since June 1999 on a small, 5-MW solar combustion turbine located at the Genetics Institute in Massachusetts. Although considered commercially available for natural gas-fired combustion turbines, there currently are no known combined-cycle units of similar scale to those proposed for the Wolf 1 CHP that have demonstrated successful application of the EMx™ control technology.

5.1.3.2 Technical Feasibility

Water/steam injection and standard combustor design, water/steam injection and advanced combustor, and dry low-NO_x combustor design would be feasible combustion process modifications for the project combustion turbines. The GE LM2500 DLE is equipped with dry low-NO_x burner technology for natural gas firing. By definition, this technology is feasible.

Of the post-combustion exhaust gas treatment technologies, SNCR is not feasible because the temperature required for this technology (between 1,600 and 2,000°F) exceeds that which will be found in the combustion turbine gas streams (less than 1,500°F). NSCR was also determined to be technically infeasible because the process must take place in a fuel-rich (less than 3% oxygen) environment. The oxygen content of the proposed combustion turbine exhaust gases is in excess of 12%.

SCR units have been used successfully in combined-cycle gas turbine and HRSG applications. Therefore, it is technically feasible for use in the proposed Wolf 1 CHP. The proposed GE LM2500 DLE combustion turbines will be fueled by pipeline-quality natural gas, which has inherently low metal and sulfur contents. Therefore, catalyst poisoning is unlikely to occur. Ammonia slip can be limited to 7 ppmvd (3-hour average) under all operating conditions. To ensure optimal performance of the catalyst, NO_x emissions can be monitored, periodic ammonia slip testing can be performed, ammonia inventory can be maintained, ammonia flow rate monitoring can be implemented, and periodic physical inspections of the catalyst bed can be done through the placement of “coupons” in the bed that can be visually checked and analyzed to assess catalyst life.

EMx™ is desirable in that it, unlike SCR, does not require ammonia. This technology appears to provide a rate of NO_x removal that is similar to the rate achievable using SCR. However, as discussed previously, there are many complex technical issues associated with this technology and there are few operating examples to view for treatment reliability and effectiveness, when compared to SCR technology. The installation of EMx™ technology would likely result in an increase in the back pressure in the exhaust system amounting to twice that of an SCR system, which might reduce the operating efficiency of the gas turbines and HRSG. The EMx™ technology will consume additional resources to support the regeneration process, adding to both capital and operating costs.

5.1.3.3 Proposed NO_x LAER Emissions Limit for Combustion Turbines

To determine the most stringent NO_x emissions limit for the combustion sources, the EPA's RBLC database was queried for combined-cycle gas combustion turbines rated at less than 25 MW. BACT and LAER determinations were obtained for units combusting pipeline-quality natural gas for the past 10 years and are summarized in Appendix E, Table E-1. As shown, the lowest NO_x emissions limits are in the range of 2 to 2.5 ppmvd at 15% oxygen for natural gas-fired combustion turbines, depending on the manufacturer and operating case. The typical control system used to achieve these emissions limits includes dry low-NO_x combustors and SCR units.

The proposed NO_x LAER emissions rate for the Wolf 1 CHP gas turbines is 2 ppmvd at 15% oxygen, based on a 1-hour average for base load operating cases. These proposed NO_x LAER emissions rates are consistent with the results of previous LAER and BACT determinations. Table 5-1 provides a summary of the proposed NO_x LAER emissions limit for all operating cases. The proposed control system to achieve these emissions limits is dry low-NO_x combustors and SCR. In all operating cases, ammonia slip will be limited to 7 ppm (3-hour average) at 15% oxygen.

NO_x emissions limits will be monitored by continuous emissions monitoring systems (CEMs) to document ongoing compliance with the proposed NO_x emissions limit of 2 ppmvd or 1.6 lb/hr. In addition, the operating temperature at the SCR units will be periodically recorded to document proper operating temperatures are being achieved, and recorded more frequently during start-up to demonstrate the duration of start-up conditions. Initial compliance testing of NOx emissions will be conducted using test Method 7.

Table 5-1 Proposed NO_X LAER Emissions Limits

Emissions Source	Proposed NO_x LAER Emissions Limit (1-hour average)	
Gas Combustion Turbines	2 ppmvd*	1.6 lb/hr†

*Corrected to 15% oxygen
†Maximum hourly emissions rate, excluding startup and shutdown emissions.

5.1.3.4 Potential Control Technologies - VOCs

There are two known available technologies for controlling VOC from gas turbines: combustion process design and oxidation catalyst.

Combustion Process Design

Combustion process controls involve combustion chamber designs and operation practices that improve the oxidation process and minimize incomplete combustion. Due to the high combustion efficiency of gas combustion turbines, approximately 99%, VOC emissions inherently are low. Additionally, burner control technologies, such as the Dry Low-NO_x system proposed for control of NO_x formation, also promote complete combustion through use of a well-designed combustion sequence. Complete combustion reduces VOC formation or pass-through of VOCs contained in natural gas.

Oxidation Catalyst

Noble metal (commonly platinum or palladium) oxidation catalysts are used to promote oxidation of VOC to CO_2 and water at temperatures lower than would be necessary for oxidation without a catalyst. The design operating temperature range for oxidation catalysts is between 650 and 1,150°F.

Removal efficiency of VOC oxidation processes vary with inlet temperature. Removal efficiency increases with increasing temperature up to a temperature of approximately 1,100°F, with significant VOC oxidation occurring at temperatures above roughly 900°F. Inlet temperature must be maintained below 1,350 to 1,400°F to prevent thermal aging of the catalyst, which will reduce catalyst activity and pollutant removal efficiencies. Removal efficiency also increases with increased gas residence time, which is a function of catalyst bed depth. Increasing bed depth will increase removal efficiencies, but will also cause an increase in pressure drop across the catalyst bed.

VOC removal efficiency will vary with the species of hydrocarbon. In general, unsaturated hydrocarbons such as ethylene are more reactive with oxidation catalysts than saturated species such as ethane. A typical VOC control efficiency using oxidation catalyst is in the range of 30 to 50%.

Oxidation catalysts are susceptible to deactivation due to impurities present in the exhaust gas stream. Arsenic, iron, sodium, phosphorous, and silica (typically present in fuel oil) will all act as catalyst poisons causing a reduction in catalyst activity and pollutant removal efficiencies. Oxidation catalysts are also non-selective and will oxidize other compounds in addition to VOC. The non-selectivity of oxidation catalysts is important in assessing applicability to exhaust streams containing sulfur compounds. Sulfur compounds that have been oxidized to SO_2 in the combustion process will be further oxidized by the catalyst to SO_3. Higher SO_3 concentrations increase the potential for formation of ammonia salt particles and H_2SO_4 mist. These substances may condense and adhere to the ductwork and stack, resulting in corrosion and increased maintenance. Due to the oxidation of sulfur compounds and excessive formation of H_2SO_4 mist emissions, oxidation catalysts are not considered appropriate for combustion devices fired with fuels containing appreciable amounts of sulfur. The exclusive use of low-sulfur pipeline quality natural gas is proposed for the Wolf 1 CHP project.

5.1.3.5 Technical Feasibility

Both combustion process design and oxidation catalysts are considered technically feasible for the Wolf 1 CHP facility's combustion turbines. The application of both technologies represents the top level of control and, therefore, LAER for the control of VOCs.

5.1.3.6 Proposed VOC LAER Emissions Limit for Combustion Turbines

To determine the most stringent VOC emissions limit for the combustion turbines, the EPA's RBLC database was queried for combined cycle combustion turbines with capacities less than 25 MW firing natural gas. BACT and LAER determinations were obtained for the past 10 years and are summarized in Appendix E, Table E-2. As shown, the lowest VOC emissions limits are for natural gas-fired, combined-cycle, combustion turbines operating with good combustion practices and an attached oxidation catalyst. LAER emission rates for turbines operating with a similar exhaust flow rate are listed as 2 ppmvd (assumed to be based on 15% O_2) and 2.9 lb/hr. Another listed turbine of similar size posed a VOC emission rate of 0.6 lb/hr, but neither the technology used nor the basis of determination were listed in the database.

The proposed VOC LAER emissions limit for the Wolf 1 CHP gas combustion turbines is 0.46 lb/hr for all operating cases when firing natural gas (see Table 5-2). This proposed VOC LAER emissions limit is consistent with typical emissions limits for a GE LM2500 DLE combustion turbines operating with good combustion practices and equipped with an oxidation catalyst unit to treat the exhaust stream. Compliance will be demonstrated through initial emissions testing as well as periodic (every 5 years) emissions monitoring using Method 25/204 or an appropriate method approved by DNREC. Ongoing compliance of VOC emission limits will be demonstrated through good combustion practices, which will include monitoring and recording temperatures at the catalytic oxidizer units periodically during each day and more frequently during periods of start-up to demonstrate temperatures are appropriate for proper operation of the catalytic oxidizer and demonstrate the duration of start-up conditions. TDC plans to inspect the catalyst on a periodic basis and to place "coupons" in the catalyst bed to assess and ensure its functionality and performance. These proposed VOC LAER emissions rates are consistent with the results of previous LAER and BACT determinations.

Table 5-2 Proposed VOC LAER Emissions Limit

Emissions Source	Proposed VOC LAER Emissions Limit
Gas Combustion Turbines	0.46 lb/hr†

†Maximum hourly emissions rate, excluding startup and shutdown emissions.

5.1.4 RECIPROCATING GAS ENGINE EMISSIONS

This LAER assessment is limited to the emissions of NO_x and VOCs.

The reciprocating gas engines proposed for the facility are categorized as 4-stroke, lean burn, with spark ignition. The primary emission pollutants of reciprocating engines include NO_x, CO, and VOCs. Production of other emission pollutants such as oxides of sulfur (SO_x) and PM primarily is dependent on the fuel used. For instance, the sulfur content of the fuel determines emissions of sulfur compounds, primarily SO_2. As a result, SO_x and PM emissions from reciprocating gas-fired engines are low when compared to engines fired by other fuels, such as petroleum distillates.

NO_x emissions are usually the primary subject for reciprocating natural gas engines. NO_x emissions are essentially a mixture of NO and NO_2. As discussed in Section 5.1.3 above for gas turbines, there are three mechanisms that form NO_x: thermal NO_x, prompt NO_x, and fuel-bound NO_x. The predominant NO_x formation mechanism in reciprocating gas engines is thermal NO_x. Early reactions of nitrogen molecules in the combustion air and hydrocarbon radicals from the fuel can form prompt NO_x. Fuel-bound NO_x forms when the fuel contains nitrogen as part of the hydrocarbon structure. Natural gas has negligible chemically bound nitrogen. Therefore, fuel-bound NO_x is not a significant component of total NO_x formed by reciprocating gas engines.

Volatile hydrocarbons or VOCs, include a wide range of organic compounds, some of which are also hazardous air pollutants. VOCs from reciprocating gas engines are emitted when some portion of the fuel remains unburned or partially burned (oxidized).

The LAER assessment below begins with a discussion of applicable reciprocating gas engine control technologies for NO_x, followed by discussion of technologies available for controlling VOCs.

5.1.4.1 Potential Control Technologies – NO_x

Similar to combustion turbines, available technologies for controlling NO_x emissions from RGEs/HRSGs include combustion process modifications and post-combustion exhaust gas treatment systems. A listing of available technologies for each of these categories follows:

<u>Combustion Process Modifications</u>:

- Rich Burn;
- Lean Burn; and
- Clean Burn.

<u>Post-Combustion Exhaust Gas Treatment Systems</u>:

- Non-Selective Catalytic Reduction (NSCR);
- Selective Catalytic Reduction (SCR);
- Catalytic Absorption; and
- Lean-NO_x Catalysts.

A description of each of the listed control technologies is provided in the following subsections.

Rich Burn

Rich burn engines have a lower air-to-fuel ratio that limits the oxygen availability in the cylinder and results in lower NO_x emissions. This technology has a limitation of producing more CO and hydrocarbon emissions. This method also requires the installation of an automatic air to fuel ratio controller.

Lean Burn

Lean burn technology increases the air to fuel ratio resulting in decreased NO_x emissions due to lower combustion temperatures in the combustion chamber. Extra air is added to the combustion chamber, which dilutes the combustion gas, thus lowering peak flame temperature and thermal NO_x formation. This technology generally is coupled with use of a turbocharger that increases combustion air to the engine. Lean burn technology can increase VOC and CO emissions, if air-to-fuel ratios become too high to support complete combustion or result in temperatures becoming too low in the combustion chamber.

Clean Burn

Clean Burn or low emission combustion (LEC) is combustion of a very fuel lean mixture. The fuel mixture acts as a heat sink, lowering cylinder temperatures and reducing NO_x formation. Turbochargers and after coolers are added to provide the additional, cooled combustion air, which services to maintain the rated power output of the engine.

Non-Selective Catalytic Reduction (NSCR)

This post-combustion technology uses three-way catalysts to promote reduction of NO_x to nitrogen and water. The exhaust passes over a catalyst, such as a noble metal (platinum, rhodium or palladium) to non-selectively transform NO_x, CO and VOCs to N_2, CO_2 and H_2O. NSCR is only applicable to rich burn engines.

Selective Catalytic Reduction (SCR)

SCR is based on a catalyzed reduction of NO_x in combination with injected ammonia or urea solution. This technology is only applicable to lean burn engines (i.e., engines with greater than about 1% exhaust oxygen, since oxygen is a reagent in the selective reduction reaction). A drawback to SCR use is unreacted ammonia (slip) and monitors are necessary to provide correct

control of ammonia injection rates to minimize slip. The SCR reduction chemistry was discussed previously in the LAER NO_x section for combustion turbines.

Catalytic Adsorption

Catalytic Adsorption includes the use of a single catalyst and hydrogen regeneration to remove carbon monoxide and nitrogen oxides. A precious metal oxidation catalyst simultaneously oxidizes CO to CO_2 and NO to NO_2.

Lean-NO_x Catalyst

A lean NO_x catalyst uses a reducing agent (diesel fuel) to facilitate catalytic conversions. Hydrocarbons in diesel fuel act as a reducing agent to facilitate the conversion of NO_x to nitrogen and water vapor.

5.1.4.2 Technical Feasibility

All of the listed technologies have been implemented and are commercially available. As such they are feasible technologies for consideration.

5.1.4.3 Proposed NO_x LAER Emissions Limit for Reciprocating Gas Engines

To determine the most stringent NO_x emissions limit for the reciprocating gas engines, the EPA's RBLC database was queried for internal combustion engines greater than 500 horsepower (hp) firing natural gas. BACT and LAER determinations were obtained for the past 10 years and are summarized in Appendix E, Table E-3. No reciprocating gas engines of comparable output (approximately 25,000 hp) were listed in the database and no LAER determination was posted. A 2003 BACT determination for one of the two largest engines listed in the database (4,730 hp), described the emission control technology as "Clean Burn" and provided a NO_x emission rate of 2.07 lb/MWh. Another large engine (4,735 hp) was listed as a case-by-case determination in 2005 and no technology was described. The listed NO_x emission rate for that engine was 2.95 lb/MWh. BACT determinations in 2004 for two relatively small engines listed lean burn as the technology used and provided a NO_x emission rate of 2.36 lb/MWh for both engines. A 2011 BACT determination for a small (550 kW) engine listed the technology as SCR and the NO_x emission rate as 0.62 lb/MWh. Other BACT determinations listed

the applied technologies as turbochargers, intercoolers and good combustion practices. The NO_x emission rates for these engines were larger than the rates cited above.

The database listings suggest that a combination of combustion control technologies and post-combustion technologies would yield LAER. The lowest listed NO_x emission rate, 0.62 lb/MWh, was associated with use of SCR for post-combustion treatment. Lean burn technology apparently yielded the lowest NO_x emission rate of combustion technologies at 2.36 lb/MWh. However, the applicability of that rate to a much larger engine is not known. Wartsila, the manufacturer of the engines proposed for use in the Wolf 1 CHP, has indicated that their engine uses lean burn technology and can achieve a NO_x emission rate of 3.3 lb/MWh at full (100%) loading. Discussions with SCR equipment providers and Wartsila indicate that post-combustion treatment of the exhaust could lower the NO_x emission rate to 0.132 lb/MWh at full loading, which is a lower rate of emissions than the BACT rates found in the RBLC database. Based on this analysis, a rate of 0.132 lb/MWh is LAER for a natural gas-fired reciprocating engine.

The proposed NO_x LAER emissions limit for the Wolf 1 CHP reciprocating gas engines is 0.132 lb/MWh [5 ppmvd (1-hour average)] for all operating cases, excluding periods of startup and shutdown (see Table 5-3). This proposed NO_x LAER emissions limit is consistent with controlled emissions rates provided by Wartsila for an 18V50SG reciprocating engine with add-on emission controls, such as the proposed SCR units. Compliance will be demonstrated through good combustion practices and continuous emissions monitoring. In addition, the operating temperature at the SCR units will be periodically recorded to document proper operating temperatures are being achieved, and recorded more frequently during start-up to demonstrate the duration of start-up conditions. This proposed NO_x LAER emissions rate is an improvement over emission rates listed as BACT in the RBLC database.

NO_x emissions limits will be monitored by continuous emissions monitoring systems (CEMs) to document ongoing compliance with the proposed NO_x emissions limit of 5 ppmvd or 0.132 lb/MWh. Further, compliance will be demonstrated through initial emissions testing as well as testing every 3 years or after 8,760 hours of engine operation, whichever occurs first, using Method 7 or an equivalent method approved by DNREC/EPA.

Table 5-3 Proposed NO_X LAER Emissions Limit

Emissions Source	Proposed NO_x LAER Emissions Limit (1-hour average)	
Reciprocating Gas Engines	5 ppmvd*	0.132 lb/MWh†

*Corrected to 15% oxygen
†Maximum hourly emissions rate, excluding startup and shutdown emissions.

5.1.4.4 Potential Control Technologies – VOCs

Parallel to gas combustion turbines, available technologies for controlling VOC emissions from reciprocating gas engines include combustion process modifications to promote complete combustion of fuel and post-combustion exhaust gas treatment systems. Lean burn technologies that incorporate use of pre-combustion chamber and spark induced ignition tend to promote complete fuel combustion in the main combustion chamber, as long as good combustion practices, such as maintenance and tuning are implemented. Oxidation catalysts can be used to reduce post-combustion emissions of CO and VOC in the same manner described in Section 5.1.3.4 for combustion turbines. For effective reduction of CO and VOC, the flue gas must be lean to promote the conversion of CO to CO_2 and hydrocarbon VOCs to H_2O and CO_2.

5.1.4.5 Technical Feasibility

Both combustion process design and oxidation catalysts are considered technically feasible for controlling reciprocating gas engine VOC emissions. The application of lean burn technology and oxidation catalysts represents the top level of control. Therefore, these technologies are expected to produce LAER for the reciprocating gas engines.

5.1.4.6 Proposed VOC LAER Emissions Limit for the Reciprocating Gas Engines

To determine the most stringent VOC emissions limit for the reciprocating gas engines, the EPA's RBLC database was queried for internal combustion engines greater than 500 horsepower (hp) firing natural gas. BACT and LAER determinations were obtained for the past 10 years and are summarized in Appendix E, Table E-4. No LAER determinations were listed in the database. All of

the engines listed in the RBLC database had smaller output ratings than the proposed Wartsila 18V50SG engines (25,000 hp). As such, the technologies presented in the database may not be applicable to engines in the large output class.

A 2009 BACT determination for a much smaller engine (875 hp) indicated that a "catalytic converter" was specified. The BACT emissions for that engine were 2.7 lb/hr, which translates to 4.135 lb/MWh. Several 2005 case-by-case determinations were listed, but had no technology descriptions were provided. These engines ranged in output between 440 hp and 3,105 hp. Listed emission rates varied with the listed output, ranging from 0.48 lb/hr (1.462 lb/MWh) for the 440 hp engine to 10.94 lb/hr (4.721 lb/MWH) for the 3,105 hp engine, but the variability of the emission rates was not linked in a one to one ratio to the rated output. A 2005 BACT determination for a 4,735 hp engine listed as incorporating an oxidation catalyst for exhaust treatment had a listed VOC emission rate of 7.1 lb/hr (2.009 lb/MWh). This engine had the largest rated output of the database entries. Two other small engines were listed as using oxidation catalysts for exhaust treatment to achieve VOC emission rates of 0.886 lb/MWh, per 2004 BACT analyses. As such, minimal definitive information was derived from the RBLC database that was useful for determination of LAER VOC emissions from reciprocating gas engines.

However, the database review suggests that LAER likely would be linked to a combined use of technology supporting complete combustion and post-combustion treatment by oxidation catalyst units. Wartsila indicates that the 18V50SG engine has a VOC emission rate of 1.39 lb/MWh at 100% load. That rate is less than the rates listed for BACT determinations in the RBLC database. Wartsila further indicates that when emissions are controlled through use of an oxidation catalyst, a VOC emission rate of 0.286 lb/MWh can be achieved at 100% loading. This emission rate is less than the emission rates listed in in the RBLC database as BACT. Based on the preceding analysis, a VOC emission rate of 0.286 lb/MWh is proposed as LAER for the Wolf 1 CHP reciprocating gas engines (see Table 5-4).

This proposed VOC LAER emissions limit is consistent with the information provided by Wartsila for an 18V50SG reciprocating engine with add-on emission controls. Compliance will be demonstrated through initial emissions testing as well as testing every 3 years or after 8,760 hours of engine operation, whichever occurs first, using Method 25/204 or an equivalent method

approved by DNREC/EPA. Ongoing compliance of VOC emission limits will be demonstrated through good combustion practices, which will include monitoring and recording temperatures at the catalytic oxidizer units periodically during each day and more frequently during periods of start-up to demonstrate temperatures are appropriate for proper operation of the catalytic oxidizer and demonstrate the duration of start-up conditions. TDC plans to inspect the catalyst on a periodic basis and to place "coupons" in the catalyst bed to assess and ensure its functionality and performance. These proposed VOC LAER emissions rates are consistent with the results of previous LAER and BACT determinations.

Table 5-4. Proposed VOC LAER Emissions Limit

Emissions Source	Proposed VOC LAER Emissions Limit (1-hour average)	
Reciprocating Gas Engines	26 ppmvd*	0.286 lb/MWh†

* Corrected to 15% Oxygen
† Maximum hourly emissions, excluding periods of startup and shutdown

5.2 BEST AVAILABLE CONTROL TECHNOLOGY

5.2.1 POLLUTANT APPLICABILITY

Pursuant to 40 CFR 52.21(j)(2), an analysis of BACT is required for each pollutant that will be emitted by the proposed project in amounts equal to or greater than the PSD significant emissions rates (SER). In addition, BACT is also required for facilities in Delaware when potential emissions exceed 5 tpy in accordance with 7 DE Admin. Code 1125. The proposed Wolf 1 CHP project has the potential to emit H_2SO_4, and PM_{10} in amounts that exceed the PSD SER. Potential NO_x and VOC emissions have been addressed through the LAER analysis summarized in Section 5.1. LAER emissions limitations for NO_x and VOC are required to be at least as stringent as those determined through BACT analysis. A separate BACT analysis for NO_x and VOC is not necessary (i.e., the LAER control technology analyses also serves as the BACT analyses for NO_x and VOC). Therefore, H_2SO_4 and $PM/PM_{10}/PM_{2.5}$, are addressed in this section of the report through BACT analysis. SO_2 potential emissions will exceed 5 tpy. As a result, controls for those substances also are subject to an assessment of BACT. Lastly, the proposed Wolf 1 CHP project has the potential to emit GHG emissions (calculated as CO_{2e}) in amounts greater than 100,000 tpy. Therefore, GHG emissions will be subject to an assessment of BACT.

5.2.2 METHODOLOGY

BACT is defined in 7 DE Admin. Code 1125 Section 1.9, as:

> "…an emissions limitation (including a visible emissions standard) based on the maximum degree of reduction for each pollutant subject to regulation under CAA which would be emitted from any proposed major stationary source or major modification which the Department, on a case-by-case basis, takes into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant. In no event shall application of best available control technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 7 DE Admin. Code 1120 and 1121. If the Department determines that technological or economic limitations on the application of measurement methodology to a particular emissions unit would make the imposition of an emissions standard infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of best available control technology. Such standard shall, to the degree possible, set forth the emissions reduction achievable by implementation of such design, equipment, work practice or operation, and shall provide for compliance by means which achieve equivalent results."

BACT analyses were performed in accordance with the EPA top-down method as previously described in Section 3.4.1. The first step in the top-down BACT procedure is the identification of available control technologies. Alternatives considered included process designs and operating practices that reduce the formation of emissions, post-process exhaust controls that reduce emissions after they are formed, and combinations of these two control categories. Like the LAER analyses, sources of information used to identify control alternatives include:

- EPA's RBLC database;
- Vendor information; and
- Experience from similar projects.

Following the identification of available control technologies, the next step in the analysis is to determine which technologies may be infeasible technically. Technical feasibility was evaluated using the criteria contained in Chapter B of the draft EPA NSR Workshop Manual (EPA, 1990). The third step in the top-down BACT process is the ranking of the remaining technically feasible control technologies from high to low in order of control effectiveness.

An assessment of energy, environmental, and economic impacts is then performed. The economic analysis employed the procedures found in the Office of Air Quality Planning and Standards Control Cost Manual (EPA, 1996). The fifth and final step is the selection of a BACT emissions limitation or a design, equipment, work practice, operational standard, or combination thereof corresponding to the most stringent, technically feasible control technology that was not eliminated based on adverse energy, environmental, or economic grounds.

If the most stringent or top control technology is selected, an assessment of energy and economic impacts is not required. In this case, a review of collateral environmental impacts is conducted to determine if selection of a less stringent alternative control technology is warranted. If there are no issues regarding collateral environmental impacts, the top control technology is proposed as BACT, and the BACT analysis is concluded.

Sections 5.2.3 through 5.2.7 provide control technology analyses using the five-step top- down BACT method for $PM/PM_{10}/PM_{2.5}$, SO_2, H_2SO_4, and GHG emissions, respectively.

5.2.3 BACT ANALYSIS FOR $PM/PM_{10}/PM_{2.5}$ FROM GAS COMBUSTION TURBINES AND RECIPROCATING GAS ENGINES

Emissions of $PM/PM_{10}/PM_{2.5}$ from the proposed project will occur due to the combustion of natural gas in the turbines and the reciprocating engines. The choice of exclusively using pipeline quality natural gas ensures that the least amount of particulate matter will be produced by combustion. Combustion of any other fuel would result in the emission of more particulate matter to the atmosphere. The relative absence of suspended solids is the primary reason for the low emission of particulates from natural gas combustion. The second most significant reason is that natural gas combustion products are gases that, with the exception of water vapor, generally do not condense into liquids or solids at common atmospheric temperatures.

A query and review of the EPA's RBLC database for BACT and LAER determinations for the past 10 years pertaining to PM control from natural gas-fired combustion turbines and reciprocating gas engines yielded no control practices or equipment that could be added to natural gas-fired turbines with rated capacities less than 25 MW or reciprocating gas engines with rated capacities greater than 500 hp, to lower particulate matter emissions, other than the implementation of good combustion practices. The results of the query are provided in Appendix E, Tables E-5 and E-6. Good combustion practices, such as equipment maintenance and combustion equipment tune-ups, help to insure that the least amount of particulate matter is emitted. The conclusion to be drawn from this assessment is that

the use of pipeline quality natural gas as a fuel and the implementation of good combustion practices is BACT for particulate matter emitted by combustion equipment, as summarized in Table 5-5 below. No further analysis is required for this topic. Compliance with PM emission limits will be demonstrated through good combustion practices, initial stack testing, and periodic (5 year) stack testing using Method 201/202.

Table 5-5
Proposed PM/PM10/PM$_{2.5}$ BACT Emissions Limits for Gas Combustion Turbines and Reciprocating Gas Engines

Emissions Source	Proposed PM/PM10/PM2.5 BACT Emissions Limit	
Gas Combustion Turbines	Exclusive use of pipeline-quality natural gas and good combustion practices	1.5 lb/hr
Reciprocating Gas Engines	Exclusive use of pipeline-quality natural gas and good combustion practices	0.264 lb/MWh

5.2.4 BACT ANALYSIS FOR PM/PM$_{10}$/PM$_{2.5}$ FROM COOLING TOWERS

Operation of the cooling towers will also be a source of PM emissions. PM/PM$_{10}$/PM$_{2.5}$ emissions from operation of the cooling towers will be particles formed by crystallization of the dissolved solids carried in water droplets discharged to the atmosphere. The water droplets evaporate causing the dissolved solids to coalesce and become particulate matter. The size of the particulates directly reflects the dissolved solid content of the water at the time of droplet formation. Large concentrations of dissolved solids tend to produce larger particulates after evaporation of the water, whereas small concentrations of dissolved solids tend to produce smaller particulates.

5.2.4.1 Potential Control Technologies for Cooling Tower PM

High efficiency drift eliminators are a potential control technology for PM/PM$_{10}$/PM$_{2.5}$ emissions from cooling towers. High efficiency drift eliminators control PM/PM$_{10}$/PM$_{2.5}$ emissions by capturing water droplets from the cooling tower exhaust using inertial separation principles and returning the captured water to the water basin for the cooling tower. A high efficiency drift eliminator can provide a drift rate (water loss rate) of 0.0005% of the total recirculating cooling water rate.

5.2.4.2 Technical Feasibility for Cooling Tower PM Control

A query and review of the EPA's RBLC database for BACT and LAER determinations for the past 10 years pertaining to PM control from cooling towers indicates that drift eliminators have been used for applications similar to those proposed for the Wolf 1 CHP. The results of the query are provided in Appendix E, Table E-7. Drift eliminators are by definition feasible technology.

5.2.4.3 Proposed PM/PM10/PM2.5 BACT Emissions Limit for Cooling Towers

The only control system to control $PM/PM_{10}/PM_{2.5}$ emissions from wet mechanical draft cooling tower is high efficiency drift eliminators. Wolf 1 CHP proposes to use high efficiency drift eliminators with a drift rate of 0.0005% as $PM/PM_{10}/PM_{2.5}$ BACT for the cooling towers. Based on the anticipated dissolved solids content of the cooling water following five cycles of concentration, the $PM/PM_{10}/PM_{2.5}$ emission rate would be 0.79 lb/hr.

A summary of the proposed $PM/PM_{10}/PM_{2.5}$ BACT emissions limit for cooling towers is provided in Table 5-6. Compliance with PM emission limits will be demonstrated through good combustion practices, initial stack testing, and periodic (5 year) stack testing using Method 201/202.

Table 5-6.
Proposed $PM/PM_{10}/PM_{2.5}$ BACT Emissions Limit for Cooling Towers

Emissions Source	Proposed PM/PM10/PM2.5 BACT Emissions Limit (1-hour average)	
Cooling Towers	0.0005% drift rate†	0.79 lb/hr†

†Maximum hourly emissions

5.2.5 BACT ANALYSIS FOR SO_2

Emissions of SO_2 from the proposed project will occur due to the combustion of natural gas in the gas combustion turbines and reciprocating gas engines. SO_2 emissions resulting from the combustion of natural gas will be low due to the inherently low sulfur content of the fuel. The turbines and reciprocating engines will be fueled with "pipeline-quality natural gas"

obtained from Eastern Shore Natural Gas Company, containing no more than 0.5 grains of total sulfur per 100 standard cubic feet (gr S/100 scf) [1].

In accordance with 40 CFR 75 Appendix D, The Data Center will be responsible for documenting annual (or more frequent) sulfur content testing performed by Eastern Shore's natural gas suppliers including Williams Energy (Transco), Spectra Energy (Texas Eastern), and NiSource (Columbia) to demonstrate that the natural gas does not exceed 0.5 gr S/100 scf.

5.2.5.1 Potential Control Technologies

Control is accomplished by limiting the fuel to pipeline quality natural gas. There are no post-combustion control systems, such as scrubbers or duct sorbent injection, for SO_2 emissions that have been applied to natural gas-fired combustion turbines or reciprocating engines.

There are no post-combustion control systems that are technically feasible to control SO_2 emissions from natural gas-fired combustion turbines or reciprocating engines.

5.2.5.2 Technical Feasibility

Limiting the fuel to pipeline quality natural gas is feasible. To limit the potential for disruption of gas supply to the CHP, two gas service lines will be extended to the facility, each connected to separate transcontinental pipelines.

5.2.5.3 Proposed SO_2 BACT Emissions Limit for Gas Combustion Turbines and Reciprocating Gas Engines

SO_2 emissions from natural gas-fired combustion turbines and reciprocating engines are dependent on the sulfur content of the fuel. The sulfur content of pipeline-quality natural gas can vary slightly depending on the area of the country and the natural gas supplier. As summarized in Table 5-7, Wolf 1 CHP proposes the exclusive use of pipeline-quality natural gas as the sole fuel in the gas combustion turbines and reciprocating gas engines as BACT for SO_2. Compliance will be demonstrated through initial emissions testing. Ongoing compliance of SO_2 emission limits will be demonstrated through good combustion practices and annual sulfur content testing and documentation.

[1] Pipeline-quality natural gas is defined by 40 CFR 72.2 as containing 0.5 grains or less of total sulfur per 100 standard cubic feet. One year of natural gas sulfur content data was obtained from two of Eastern Shore's suppliers confirming natural gas sulfur content less than 0.5 gr/100scf. The sulfur content data has been included in Appendix B.

Table 5-7 Proposed SO_2 BACT Control Technologies and Emission Limits

Emissions Source	Proposed SO_2 BACT Emissions Limit	
Gas Combustion Turbines	Exclusive use of pipeline-quality natural gas	1.86 lb/hr
Reciprocating Gas Engines	Exclusive use of pipeline-quality natural gas	0.24 lb/hr

5.2.6 BACT ANALYSIS FOR H_2SO_4

Emissions of H_2SO_4 from the proposed project potentially will occur due to the use of oxidation catalyst to treat VOC and CO emissions. H_2SO_4 emissions could result from oxidation of SO_2 to SO_3 through the catalyst and subsequent reaction of SO_2 with water vapor (H_2O) to form H_2SO_4. The emission rate of H_2SO_4 will be low due to the low sulfur content of the natural gas fuel supply, which limits the formation of SO_2 and subsequent formation of H_2SO_4.

5.2.6.1 Potential Control Technologies

Control is accomplished by limiting the fuel to pipeline quality natural gas. There are no post-combustion control systems, such as scrubbers or duct sorbent injection, for H_2SO_4 emissions that have been applied to natural gas-fired combustion turbines or reciprocating engines.

5.2.6.2 Technical Feasibility

Limiting the fuel to pipeline quality natural gas is feasible. To limit the potential for disruption of gas supply to the CHP, two service lines will be extended to the facility, each connected to separate transcontinental pipelines.

There are no post-combustion control systems that are technically feasible to control H_2SO_4 emissions from gas combustion turbines or reciprocating gas engines.

5.2.6.3 Proposed H_2SO_4 BACT Emissions Limit for Gas Combustion Turbines and Reciprocating Gas Engines

As summarized in Table 5-8, Wolf 1 CHP proposes the exclusive use of pipeline-quality natural gas as the sole fuel in the gas combustion turbines and reciprocating gas engines as BACT for H_2SO_4. Compliance will be demonstrated through initial emissions testing.

Ongoing compliance of H_2SO_4 emission limits will be demonstrated through good combustion practices as well as periodic (every 5 years) emissions monitoring using Method 8 or a DNREC/EPA approved equivalent at the time of testing.

Table 5-8 Proposed H_2SO_4 BACT Control Technologies and Emission Limits

Emissions Source	Proposed H_2SO_4 BACT Emissions Limit	
Gas Combustion Turbines	Exclusive use of pipeline-quality natural gas	1.4 lb/hr
Reciprocating Gas Engines	Exclusive use of pipeline-quality natural gas	0.44 lb/hr

5.2.7 BACT FOR GHGs

Since Wolf 1 CHP will be a new major stationary source for a NSR pollutant other than GHG and will have CO_{2e} emissions greater than 75,000 tpy, Wolf 1 CHP is subject to PSD review for GHG including a BACT analysis. CO_{2e} emissions are defined as the sum of the mass emissions of each individual GHG adjusted for the respective global warming potential (GWP) of the substance using Table A-1 of the Greenhouse Gas Reporting Program (40 CFR 98, Subpart A). The anticipated GHG that will be emitted by combustion units in the Wolf 1 CHP are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

Sulfur hexafluoride (SF_6) is another GHG that may be emitted from the facility. Unlike the other GHG, SF_6 is not a product of combustion. Sulfur hexafluoride is used as a gaseous dielectric medium (insulator) in pressurized high voltage electrical switches. Emissions to the atmosphere of SF_6 would be associated with possible leaks from this electrical equipment.

In March 2011, EPA published an updated version of the guidance document entitled PSD and Title V Permitting Guidance for Greenhouse Gases (EPA, 2011). This guidance document, which was originally published in November 2010, provides guidance on performing BACT analyses for GHG emissions. EPA's guidance affirms that a BACT analysis for GHG emissions must be conducted using the same five-step, top-down approach used for other NSR pollutants. Per EPA's guidance, the GHG BACT analyses should lead to implementing energy efficiency measures, in most cases.

Carbon dioxide is a product of complete combustion of fuel containing carbon. Complete combustion is the objective in any power generation

technology using fossil fuel. The basic theoretical combustion equation for methane (CH_4) is:

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$

Carbon dioxide emissions are the product of the chemical reaction between the fuel and the oxygen, not a byproduct caused by imperfect combustion. Therefore, CO_2 emissions cannot be reduced by improving the combustion efficiency, and there is no technology available that can reduce CO_2 generation during combustion of carbon-based fuels without reducing combustion efficiency and producing other unwanted products, like carbon monoxide (CO). In fact, improvements in combustion efficiency always increase the production of CO_2, while decreasing the production of unwanted byproducts. The only effective means to minimize the amount of CO_2 generated by a fuel-burning power plant is through high-efficiency use of the heat energy released by the combustion reaction, which leads to lower fuel consumption. The reduced fuel consumption is the source of the reduced CO_2 emissions. Minimizing the amount of fuel required (in units of British thermal units) to produce a given amount of power output (in units of kilowatt-hours) results in the least amount of CO_2 generated per output power produced.

For natural gas-fired combustion units, methane emissions result from incomplete combustion of the fuel and can be reduced, but not eliminated, by improved combustion efficiency. Methane is a more potent GHG than carbon dioxide. As such, improvements in combustion efficiency do improve GHG emissions by converting more methane to the less potent GHG carbon dioxide.

The other GHG anticipated to be emitted by the combustion units is nitrous oxide (N_2O). Nitrous oxide is a byproduct of combustion that is formed in the combustion chamber. Natural gas combustion tends to produce less nitrous oxide than combustion of most other fuels due to the low nitrogen content of natural gas. As discussed in Section 5.1.3, most of the nitrogen oxide compounds, including nitrous oxide, are formed by the reaction of atmospheric nitrogen and oxygen as thermal NO_x and prompt NO_x in the elevated temperature of the combustion chamber. Unfortunately, combustion temperature controls that reduce NO and NO_2 formation tend to increase N_2O formation and vice versa. By example, the dry low NO_x and lean burn technologies that are being applied to the turbines and reciprocating engines to reduce NO and NO_2 emissions by lowering combustion temperatures will increase the amount of N_2O produced.

5.2.7.1 Potential Control Technologies

Technologies that formed the basis of an applicable NSPS must be considered in the BACT analysis, since a BACT emissions limit cannot be less stringent than an applicable NSPS emissions limit. The reciprocating gas engines are subject to the NSPS for Stationary Spark Ignition Internal Combustion Engines, 40 CFR 60, Subpart JJJJ. The gas combustion turbines are subject to the NSPS for Stationary Combustion Turbines, 40 CFR 60, Subpart KKKK.

Available control technologies or techniques that have a practical application to the control of GHG emissions include:

- Use of low emission fuels;
- Use of energy efficient equipment;
- Incorporation of energy efficient processes;
- Incorporation of add-on controls; and
- Good operating practices.

Low Emission Fuels

Of the fossil fuels available for combustion processes, natural gas produces the fewest number of GHG substances and the least concentrations of those substances. Use of natural gas as a fuel instead of other carbon-based fossil fuels (coal or petroleum) reduces GHG production for a given amount of power production.

Energy Efficient Equipment

Use of energy efficient equipment reduces the amount of fuel consumed, which results in lower GHG emissions for the amount of power produced. Energy efficiency takes many forms. Those of principle interest in the case of the Wolf 1 CHP include:

- High efficiency combustion equipment; and
- High energy efficiency of equipment using the energy provided by the CHP.

Energy efficiency in the CHP equipment includes such items as completeness of combustion, maximization of heat energy transfer to mechanical energy, maximization of mechanical energy transfer to electrical energy, reduction of friction losses and reduction of heat losses. In the data center, energy efficiency is focused on the

electrical and thermal efficiency of electronic equipment and building systems.

Energy Efficient Processes

Like the use of energy efficient equipment, employment of energy efficient processes lowers fuel consumption and results in lower emissions of GHG. Processes such as combined heat and power and combined-cycle operations of energy conversions are examples of energy efficient processes.

Add-on Controls

Add-on controls for addressing GHG emissions take several forms and are dependent (specific) to the substances being controlled. There are no known controls that can be applied to destroy CO_2 emissions. Technological control of CO_2 emissions are based on capture and either reuse or sequestration of that substance. These technologies are progressing from theoretical to pilot testing. Sequestration technologies appear to be dependent on geologic and geographic conditions, as they rely on the presence of geologic formations capable of storing and retaining CO_2 or large deep bodies of water that can retain CO_2 in dissolved form, under pressure. CO_2 is a useful gas in several industries. Capture and direct reuse of CO_2 from combustion sources is a promising technology for control of GHG if it displaces other technologies that form or liberate CO_2 from other sources (i.e., result in an overall minimization of release to the atmosphere). If capture and direct reuse replaces CO_2 technology that obtains CO_2 from the atmosphere, it would not result in a direct reduction of atmospheric CO_2 concentrations. Such a process likely would improve the energy efficiency of the CO_2 capture process due to the higher concentration of CO_2 in exhaust streams than in the atmosphere. The logical outcome of lower energy usage is a reduction of fuel consumption, which would result in a reduction of CO_2 emissions at a power source.

Technologies are being developed to destroy methane through the use of oxidation catalysts, based on a review of patent descriptions. The product of methane oxidation would be the same as for combustion, CO_2 and H_2O, at a ratio on one part CH_4 to 2 parts CO_2. Methane is 27 times more potent than CO_2 as a GHG. The trade-off of lower methane emissions for higher CO_2 emissions, assuming 100% removal efficiency, would be a 2,700% reduction of GHG effect for the environment.

Like CO_2, no add-on control technologies apparently exist for destroying N_2O. Most reaction-based technologies would result in the formation of NO or NO_2.

Good Operating Practices

Good operating practices for combustion equipment include monitoring the efficiency of combustion and equipment operation to support identification of performance deterioration. Maintenance and tuning can then be scheduled and accomplished to re-establish high efficiency. Similarly, other heat transfer equipment can be monitored and maintained to retain high thermal efficiency throughout heat transfers in the HRSG, steam turbine, chiller, heat exchanger and cooling tower units. Good operating practice for processes includes inspection of equipment for indications of insulation breaches and open valves or leaks in steam lines. Noted breaches, open valves or leaks can be repaired (or closed) to maintain the heat retention of the process system. Similarly, switchgear can be inspected for leaks of SF_6 and action can be taken to reduce loss of SF_6 to the atmosphere.

5.2.7.2 Technical Feasibility

It is technically feasible to operate the proposed CHP solely using natural gas and this technology has been adopted. CHP is an energy efficient technology. It is technically feasible to operate a CHP facility in an even more energy efficient manner by combining cogeneration of heat and electricity with combined-cycle production of electricity. It is technically feasible to use energy efficient combustion equipment. The proposed GE LM2500 DLE gas combustion turbines and Wartsila 18V50SG reciprocating gas engines are very efficient combustion devices within the rated capacity classes for these types of engines. TDC will install inlet air chiller units to maintain combustion efficiency during conditions when warm ambient air temperatures exist.

The anticipated winter heat input rate of the gas turbines at 100% load is 220.3 MMBtu/hour based on the lower heating value (LHV) of natural gas (946 MMBtu/scf). 220.3 MMBtu is equivalent to 64.564 MW. At that heat flow rate, the turbines are anticipated to generate 23.241 MW of electric power per hour. The heat recovered from exhaust gases are anticipated to generate superheated steam at a rate of 68,053.88 pounds per hour, at 765.4 pounds per square inch absolute (psia) and 879.6 ^{o}F. Multiplying the enthalpy of the steam by the steam production rate yields the power of superheated steam, 28.840 MW. The

combined power output of the turbine and HRSG therefore is 52.081 MW. Dividing the total output power by the heat input rate (52.081 MW/64.564 MW x 100) yields a power conversion efficiency of approximately 81%. Using a similar calculation, the summer power conversion efficiency is estimated to be 82%. Similar calculations performed on the same basis for the reciprocating engines and attached HRSG yielded estimated power conversion efficiencies of approximately 66.5% for both summer and winter. During operation of the CHP, the proposed efficiency condition will be maintained through good operating practices.

Current operational planning indicates that the CHP plant should achieve a heat rate of 5,710 British thermal units per kilowatt-hour (Btu/kWh). This heat rate is appropriate for the proposed combinations of equipment and power produced, based on the higher heat value (HHV) of natural gas. This heat rate is equivalent to a net CHP plant efficiency of 59.8%. The net heat rate reflects the production of electricity and steam in the CHP during summer operating conditions and assumes electricity is supplied to the power grid and steam is supplied to the University of Delaware. A lower net heat rate (i.e., more efficient power production) is anticipated to be achieved during winter operating conditions.

The applicant has proposed to pursue LEED accreditation for the data center and other supporting buildings. A guiding principle of LEED is energy efficiency. The data centers and supporting buildings will demonstrate energy efficiency in excess of current international building code requirements in pursuit of LEED accreditation. These energy efficiency measures in combination will minimize GHG emissions.

TDC is exploring incorporating a CO_2 capture and reuse technology. If that technology proves feasible for reducing CO_2 emissions, TDC will submit a separate construction permit application to DNREC before proceeding with application of the technology. This BACT analysis does not rely on the facility using CO_2 capture and reuse. This paragraph is provided for informational purposes only.

Carbon dioxide sequestration is not feasible at the proposed facility location. Neither geologic conditions nor large bodies of deep water are present.

The add-on oxidation catalyst system for CO and VOC control may have some capability to also oxidize CH_4 to CO_2.

Good operating practices are feasible to implement.

5.2.7.3 Proposed GHG BACT Emission Limits

Analysis has determined that BACT for GHG emissions consists of maintaining a high-efficiency plant design inherent to this type of gas-fired power plant. The GHG efficiency of the combined gas combustion turbines and attached HRSG units is estimated to be 470.6 pounds of CO_{2e} per MWh of energy produced. The GHG efficiency of the combined reciprocating gas engines and attached HRSG units is estimated to be 785.6 pounds of CO_{2e} per MWh of energy produced.

These numerical GHG BACT emissions limits are based on the exclusive use of pipeline-quality natural gas. Compliance with these numerical GHG BACT emissions limits will be demonstrated by measuring and recording the total heat input for each combustion sources expressed in million British thermal units per year and using that value to generate estimated annual GHG emissions from the unit. CO_2 emissions will be calculated using the methodology for calculating CO_2 emissions under the ARP in accordance with 40CFR75, Equation G-4, as described in the following:

$$W_{CO2} = \frac{(F_c \text{ x } H_f \text{ x } U_f \text{ x MW } CO_2)}{(2{,}000)}$$

Where:

W_{CO2} = CO_2 emitted from combustion, tons/hr

MW CO_2 = Molecular weight of carbon dioxide, 44.0 lb/lb-mole

F_c = Carbon based F-factor, 1040 scf/MMBtu for natural gas, according to the procedures in Section 3.3.5 of Appendix E to 40CFR75 for other gaseous fuels

H_f = Hourly heat input in MMBtu, as calculated using the procedures in section 5 of Appendix E

U_f = 1/385 scf CO_2/lb-mole at 14.7 psia and 68 °F

Methane and nitrous oxide emissions will be calculated using emissions factors as defined in the Mandatory Greenhouse Gas Reporting Rule, Table C-2. CO_2e emissions will then be calculated using each GHG pollutant's respective global warming

potential as defined in the Mandatory Greenhouse Gas Reporting Rule, Table A-1. Example CO_2e emissions calculations are provided in Appendix B.

Annualized steam production and electricity production values for individual turbines/HRSG combinations and engine/HRSG combinations will be developed from operating records. Those records will be used to calculate an annualized energy production per unit. That value will be divided into the annual GHG value for the unit to generate a pound of CO_{2e} value per energy produced (in MWh).

5.2.8 BACT DURING STARTUP AND SHUTDOWN

BACT must be met at all times including during periods of startup and shutdown. Pollutants subject to BACT analysis and review must address BACT emissions limits not only during normal operation, but also during startup and shutdown.

NO_x and CO emissions are expected to have higher hourly emissions rates during periods of startup. This is due, in general, to the following two factors. One factor is that these pollutants are the products of incomplete combustion and complete combustion will not occur during periods of startup. The other factor is that NO_x and CO emissions are controlled by SCR and oxidation catalyst, respectively. When gas combustion turbine and reciprocating gas engine exhaust gas temperatures cannot heat the catalysts to the minimum activation temperature, such as during a cold startup, the SCR control system will not permit the flow of ammonia into the exhaust gas stream. Therefore, the SCR system will not function to reduce NO_x emissions. Below the minimum catalyst temperature, the oxidation catalyst will not function at peak efficiency to lower CO emissions.

Other pollutants, such as $PM/PM_{10}/PM_{2.5}$, SO_2, H_2SO_4, and VOCs, have lower emissions during startup and shutdown as these emissions are directly proportional to the amount of fuel flow. Since fuel flow is lower during startup as compared to normal operation, emissions of these pollutants will be lower when compared to normal operating conditions. Therefore, the BACT emissions limits proposed for these pollutants will be valid during periods of normal operation as well as startups and shutdowns.

The proposed BACT emissions limits for NO_x and CO during startup and shutdown are provided in Table 5-9 and Table 5-10, respectively:

Table 5-9. Proposed BACT Emissions Limits during Cold Startup

Status	Cold Start	
Equipment	**Emissions (lb./event)**	**Duration (minutes)**
Gas Turbines		
NO_x	9.3	30
CO	6.0	30
Reciprocating Engines		
NO_x	17.4	30
CO	16.5	30

Table 5-10. Proposed BACT Emissions Limits during Shutdown

Status	Shutdown	
Equipment	**Emissions (lb./event)**	**Duration (minutes)**
Gas Turbines		
NO_x	1.6	8
CO	2.1	8
Reciprocating Engines		
NO_x	0.35	1
CO	0.22	1

To demonstrate compliance with the proposed BACT limitations during startup and shutdown, The Data Center will document the date, time, and length of each event, as well as the temperature at which the SCR begins or ceases operation.

5.2.9 BACT SUMMARY

Table 5-11 provides a summary of BACT control technologies proposed for the Wolf 1 CHP project.

Table 5-11. Summary of BACT Control Technologies

Equipment	Pollutant	Control Technology
A. Combustion Turbines and Reciprocating Gas Engines		
	VOC	Efficient combustion
		Oxidation catalyst
	PM/PM10/PM2.5	Exclusive use of pipeline-quality natural gas as primary fuel
	SO2	Exclusive use of pipeline-quality natural gas as primary fuel
	H2SO4	Exclusive use of pipeline-quality natural gas as primary fuel
	GHG	Annual CO_{2e} emissions limit expressed in pounds per MWh
B. Cooling Tower		
	PM/PM10/PM2.5	High-efficiency drift eliminators

5.3 SUMMARY OF PROPOSED EMISSIONS LIMITATIONS AND DEMONSTRATION OF COMPLIANCE

Wolf 1 CHP will comply with the LAER and BACT emissions limitations described above, as well as emissions limitations for other regulated pollutants as summarized below in Table 5-12. Initial and periodic stack testing in conjunction with continuous emissions monitoring systems (CEMs) and documentation of daily operating conditions will be used to demonstrate compliance with the anticipated permit conditions.

Wolf 1 CHP will perform initial stack testing, using the reference methods listed below from 40 CFR Part 60, or an approved equivalent, to demonstrate compliance with the emission factors and facility-wide emissions.

Table 5-12. Summary of Emissions Compliance

Pollutant	Emission Point Source	Emissions Limit	Stack Test Method*	Initial Stack Testing	CEMS	Periodic Monitoring
NOx	CT	2 ppmvd or 1.6 lb/hour	Method 7	X	X	
	RGE	5 ppmvd or 0.132 lb/MWh		X	X	
CO	CT	0.61 lb/hr	Method 10 / 20	X	X	
	RGE	0.286 lb/MWh		X	X	
VOCs	CT	0.46 lb/hr	Method 25 / 204	X		X
	RGE	26 ppmvd or 0.286 lb/MWh		X		X
PM/PM10/PM2.5	CT	1.5 lb/hr	Method 201 / 202	X		X
	RGE	0.264 lb/MWh		X		X
	Cooling Towers	0.79 lb/hr		X		X
CO2	CT	750,500 tons/year	Method 3A	X		
	RGE	200,295 tons/year		X		
Sulfuric Acid (H2SO4)	CT	1.4 lb/hr	Method 8	X		X
	RGE	0.44 lb/hr		X		X
Ammonia (NH3)	CT	7 ppmvd	Department Approved	X		X
	RGE	7 ppmvd		X		X
	RGE	0.250 lb/hr		X		X

Notes:
* = TDC will use either the aforementioned Stack Test Method or a DNREC/EPA method approved at the time of testing
CT = Combustion turbine
RGE = Reciprocating gas engine

To comply with the permit restrictions, TDC will perform the aforementioned testing and record operating data including the following:

- Date, time, hours of operation, and loading for each combustion unit;
- Quantity of fuel combusted (heat input) for each combustion unit and generating rate on an hourly basis;
- Date and duration of each startup and shutdown;
- Temperatures at the SCR and catalytic oxidizer units to document proper operating temperatures are being maintained and to document the duration of unit start-up conditions;
- Maintenance log for each combustion and emissions control unit; and
- Monthly sulfur content of the natural gas from various suppliers.

6.0 PROJECT ALTERNATIVES ANALYSIS

In accordance with 7 DE Admin. Code 1125 Section 2.4.4, the application for a construction permit shall include "an analysis of alternative sites, sizes, production processes, and environmental control techniques for the proposed source which demonstrates that benefits of the proposed source significantly outweigh the environmental and social costs imposed as a result of its location, construction, or modification." The following subsections provide the analyses to satisfy this regulatory requirement.

This section is not intended to address specific control of pollutants. Section 5.0 provides a detailed discussion of the air emissions control system alternatives considered as part of the New Source Review.

6.1 SITE AND DESIGN ALTERNATIVES

This section highlights TDC's efforts to minimize or mitigate environmental impacts associated with the selected site and the equipment selected for the Wolf 1 CHP and Data Center facility. The entire facility development effort, from inception, has been driven by TDC's energy and environmental stewardship as exhibited by their pursuit of US Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) certification for the project. This section presents some of the considerations included in TDC's decision to locate their facility at the STAR Campus, in the City of Newark, New Castle County, Delaware.

The concept of uninterruptable power has become industry standard for electronic data storage to assure reliable client access to stored data. This uninterruptible power requirement cannot be met through even multiple connections to a power supply grid alone. For instance, a failure of a transmission line, blackout or brownout in the grid would cause failure of a data storage center. At other data storage facilities, typified by those existing in New Castle County, Delaware, the goal of uninterruptible electrical power has been attempted through a combination of purchased, dual feed electricity from the regional supply grid, installation of large capacity emergency generating equipment capable of meeting the electricity demand of the data storage facility, and installation of large battery systems sized to instantaneously handle data center electrical loads in the event of grid power failure for a short period of time, while the emergency generator units are brought up to full power production. This typical system necessitates large investments in equipment that is seldom used (stranded assets) and results in: inefficient use of land, production of air emissions with no net benefit from emergency generator engine testing, and less than desirable energy efficiency, in part due to transmission system energy losses associated with obtaining large amounts of electricity from remote locations. Such a system does not result in the generation of fewer air emissions in the region - it merely trans locates emission generation from the location where the electricity is used.

The proposed Wolf Technology Center 1 eliminates the negative aspects of typical uninterruptable power systems. The CHP generates the base power, including electricity and thermal, required to support the Data Center. It meets the uninterruptable power requirement by insuring that enough power generating equipment is operating so that, in the event any two primary power units fail, the remaining operating equipment could support the Data Center power load. Satisfaction of this requirement necessitates the production of more electricity than is demanded by the data center. This excess electricity will be supplied to the City of Newark for use, under routine operating conditions.

The number of power production units necessary to assure uninterruptable power is defined as N+2+1, where N is the number of power production units (by type) required to power the facility (produce base load), +2 is the number of additional power production units that are required to assure operational requirements are met if base load units fail, and +1 is the number of additional production units that are available for use when units are non-operational for maintenance. This requirement results in a strong preference for multiple, moderate capacity, power production units as opposed to fewer, large power units. In a system designed to provide uninterruptable power, multiple moderate capacity units result in a more efficient matching of power production to demand and less generation of excess electricity, resulting in fewer air emissions than would be the case if fewer, large capacity power production units were used.

The requirement for uninterruptable power also factors into the selection of the types of electrical power generating equipment for the facility. A combination of natural gas-fired turbines, reciprocating engines, and condensing steam turbines has been selected to produce electricity. Gas turbines have been selected as the principle power producing machines. Gas turbines are very efficient at converting fuel combustion heat to power and produce fewer criteria pollutants emissions per unit of heat compared to other combustion technologies when operated near full power capacity. The design of the CHP is based on the turbines operating at full power capacity. However, since gas turbines respond poorly to changing power demand, reciprocating engines were selected to meet varying loads. Reciprocating engines produce more criteria pollutants per unit of heat and require more maintenance than gas turbines, but produce power more efficiently under varying loads. The use of condensing steam turbines improves the overall thermal efficiency of the CHP, and through that improved efficiency, contributes to reducing air emissions per unit of power produced over simply cycle power generation facilities.

TDC selected natural gas over other fossil fuels (primarily petroleum and coal) to power the CHP due to the inherently lower air emissions that result from utilizing natural gas. Additionally, natural gas use requires less storage and handling space on site than would be necessary for use of other fossil fuels, which contributes to efficient land use.

To maximize energy efficiency, and in turn reduce the amount of air emissions being produced for electrical power generation, heat exiting from the primary combustion units (gas turbines and reciprocating engines) will be used to generate steam (cogeneration). The steam will be used to power steam turbines in combined-cycle operation and absorption inlet air chillers. Three steam turbines in the Wolf 1 CHP will drive electrical generators to produce electrical power. A steam turbine will also drive a chiller that provides cooling for the data center. The combination of design features will make the proposed CHP thermally energy efficient. In addition, surplus steam will be exported to the University of Delaware for use thereby offsetting a portion of their need to generate steam to meet thermal loads.

The excess electricity generated by the CHP will be supplied to the City of Newark's power system under a power purchase agreement (PPA), replacing a portion of the current importation of electrical power from the regional PJM (Pennsylvania-Jersey-Maryland) power grid. The transmission of the Wolf 1 CHP electricity is more efficient than PJM-supplied electricity transmission due to the close proximity of the power plant to the end users (the data center and the City of Newark), which reduces line losses associated with long distance power transmission. To the extent that the CHP-supplied electricity offsets "UPWIND" PJM electricity generated by simple cycle plants or plants fired by a coal or petroleum, fewer air emissions will be released during the production of the electricity. These aspects of the proposed system will benefit regional air quality by ensuring a more efficient transfer of electricity to end users, ultimately resulting in the production of less electricity, and fewer emissions to the region.

The benefits of lower emissions due to electricity production in the proposed CHP are magnified when compared to the emissions that would otherwise be produced to supply power to the data center and the City of Newark from sources within the PJM grid. Under normal operating conditions, the data center and CHP will consume approximately 131 MWh of electrical energy. That value coupled with the estimated 50 MWh of average electrical energy provided to the City of Newark yields a total electricity demand of 181 MWh. Table 6-1 provides a summary of the emissions that are anticipated for the Wolf 1 CHP providing that energy and compares them to the emissions that would otherwise be produced within the PJM grid to satisfy the 181 MWh energy demand.

Table 6-1. PJM Emissions Averted by the Wolf 1 CHP Electricity Production

Emission Type	Wolf Technology Center 1 CHP Emissions			Averted PJM Emissions			Emission Reductions		Reduction
	Emission Rate	Emissions at 181 MW		Average PJM Emission Rate	Average Emissions at 181 MW		Daily	Annually	
	(lbs/MWh)	(lbs/day)	(tons/year)	(lbs/MWh)	(lbs/day)	(tons/year)	(lbs/day)	(tons/year)	
SO_2	0.0112	48.72	8.891	2.3	9,991	1,823	9,942	1,815	100%
NO_x	0.0806	349.9	63.86	1.0	4,344	793	3,994	729	92%
CO_2	1,024	4,450,320	812,183	1,090	4,734,960	864,130	284,640	51,947	6%

Table notes:

Estimated CHP Emission Rates:

SO_2 = 2.03 lbs/hr / 181 MW = 0.0112 lbs/MWh
NO_x = 14.58 lbs/hr / 181 MW = 0.0806 lbs/MWh
CO_2 = 185,430 lbs/hr / 181 MW = 1,024 lbs/MWh

Wolf 1 CHP emissions were calculated conservatively based on maximized use of gas turbines and gas engines and minimized use of steam turbines to generate 181 MW of electricity. Actual emissions should be less due to maximized use of steam turbines and minimized use of gas-fired equipment.

Daily Energy Production = 24 hrs * 181 MW = 4,344 MWh
Annual Energy Production = 365 days * 4,344 MWh/day = 1,585,560 MWh

PJM emissions as published on the PJM website table titled, " PJM Market – Average Power Generation Emissions Pounds per MWh of Electricity Produced," dated 2013. Values presented represent calendar year 2012 emissions within PJM. Average values account for fossil fuel electric, wind electric, hydroelectric, solar electric and nuclear electric power sources supplying power to the PJM grid. In 2012, approximately 41% of the power supply was derived from coal-fired plants, approximately 33% was derived from nuclear plants, and approximately 20% was derived from gas-fired plants.

6.1.1 SELECTED SITE

TDC sought to redevelop a previously developed property rather than construct at a "greenfield" location. TDC's selection of the STAR Campus location was first and foremost based on the criteria it satisfied:

- The STAR Campus is a former industrial site, properly zoned for the proposed use, with an adequate amount of previously developed land available for siting the Wolf Technology Center 1; and

- STAR Campus is located in a mature, urbanized environment that has adequate public and private infrastructure to support most needs that will be imposed by the proposed facility. The location, and the entities present in the neighboring community, will support efficient use of the electrical and steam energy that will be produced by the proposed facility, which serves to conserve natural resources and realize that maximum benefits are derived from the air emissions produced.

STAR Campus is located within the City of Newark and close to a major user of electrical power and steam, the University of Delaware. The site is located in a portion of Delaware where there is little local production of base load electricity. (Bloom Energy and Delmarva Power have installed approximately 3 MW of electricity generation at the Brookside electrical substation.) This circumstance will support the efficient use of the energy released from the combustion of fossil fuel and serve to not only minimize the production of air emissions associated with local energy use, but also will offset the upwind production of electricity using technologies/processes that produce significant air quality impacting emissions. Electricity generated in excess of the immediate demand of the Wolf Technology Center 1 will be transmitted to the City of Newark for distribution to City residents and businesses, offsetting the need to import electricity from more remote locations. Steam in excess of the demands within the Wolf Technology Center 1 will be transmitted to the University of Delaware for use in their distribution system, partially offsetting the need to generate that quantity of steam in the University's central power plant to meet their demand. The overall thermal efficiency of the proposed CHP combined-cycle and cogeneration operation is anticipated to be approximately 60%, due in part to the site location selected. A more remotely located site for the CHP would not support this level of efficiency and would likely result in the wasting of heat generated by fossil fuel combustion, as commonly occurs in most existing electricity generating stations in the region. For instance, a site location that did not offer an outlet for steam would likely limit the energy efficiency of the plant to approximately 40%, a typical efficiency rating for a modern combined-cycle power plant. Few other locations in Delaware or neighboring states would support this efficiency benefit. Among the many benefits of higher energy

efficiency is the corresponding reduction of air emissions generated for the same amount of power produced.

The STAR Campus location offered an additional benefit. The property is a DNREC Certified Brownfield and the project will bring jobs back into a location where many prior jobs of similar character have been lost. The proposed facility will generate approximately 370 fulltime equivalent jobs and 90 indirect jobs in a community that lost thousands of direct and indirect jobs with the closure of the former Chrysler Newark Assembly Plant during December 2008 and other nearby industrial and distribution facilities over the last decade. No other available location could provide a similar benefit.

The proposed site location should serve to minimize air emissions associated with future employee commuting. Bus and commuter rail service are available at STAR Campus. Few other locations in the State of Delaware could offer the combination of sufficient available land appropriate zoning and commuter rail service. The Delaware Department of Transportation (DelDOT), in conjunction with area commuter rail systems (DART, SEPTA and MART), is planning an expansion of existing commuter rail service and constructing a new railroad station adjacent to the STAR Campus. Future employees and clients of the proposed Wolf Technology Center 1 will be able to utilize that commuter rail service, which will suppress the generation of air emissions from commuting vehicles. Commuting distances from existing residential areas are short enough to support a portion of the future work force walking or biking to work. STAR Campus is bounded by two state highways (DE Route 896 and DE Routes 2 and 4) and is located close to a major interstate highway (I-95). The state highways in the vicinity of the proposed project location previously handled the commuter traffic associated with the large number of employees at the former Chrysler Newark Assembly Plant. The vehicle loading associated with the fewer employees of the proposed Wolf Technology Center 1 will not burden the existing highway infrastructure and is not anticipated to lead to congestion and impactful air emissions from idling vehicles.

The STAR Campus is located along the Northeast Corridor Railroad which provides freight service as well as the previously mentioned passenger service. The freight aspect of operations will facilitate the energy efficient delivery of large equipment and construction materials to the project site.

Water service is provided to the site by an existing utility system operated by United Water Delaware. That water system previously provided water to meet the demands of the Chrysler Newark Assembly Plant prior to closure of that facility. The water supply system has adequate capacity to supply the demand of the proposed Wolf 1 CHP and that demand is not a new burden for the utility. For water efficiency, in addition to LEED focused conservation the Wolf 1 CHP will incorporate closed-cycle steam

production and closed-cycle cooling water systems. Steam condensate is collected and reused in steam production and cooling water is reused by circulating it through cooling towers. Both systems serve to minimize the water demand of power production and in turn, lessen the demand on the potable water system. The data center is anticipated to use gray water (rain water and chiller condensate) for flushing water closets and urinals and to irrigate landscape, which also lessens the demand on the potable water delivery system.

Wastewater service is provided by a public sewage collection system. A trunk sanitary sewer interceptor sewer is located along the southern side of the site, which has the capacity to convey the projected wastewater load from the Wolf Technology Center 1, which is anticipated to include condensate blow-down, cooling tower blow-down and sanitary wastewater. That sanitary sewer interceptor previously conveyed the industrial wastewater load of the Former Chrysler Newark Assembly Plant. The anticipated wastewater load from the Wolf Technology Center 1 will not be a new or expanded burden on the existing municipal sewerage system.

The site currently is paved (nearly 100% impervious surface cover) and construction of the proposed Wolf Technology Center 1 offers the opportunity to reduce the quantity and improve the quality of storm water runoff from the property. Currently, there is no management of storm water quantity or quality. There are no wetlands on site and there is no wildlife habitat on site. Therefore, adaptively reusing the property for the Wolf Technology Center 1 will not impact wetlands or impact local wildlife through habitat destruction.

The site does not have natural gas service with sufficient capacity for the demand of the Wolf 1 CHP. TDC is in discussions with Eastern Shore Gas to secure delivery of an adequate, dual feed, gas supply. The dual feed will necessitate construction of high pressure/high volume gas mains from transmission pipelines located near Hockessin, Delaware and Elkton, Maryland.

6.1.2 DESIGN ALTERNATIVES

Alternative technologies and designs were considered by TDC for the Wolf 1 CHP equipment and are discussed in the following:

- Alternative generation technologies; and
- Air emissions control system alternatives.

The process of selecting natural gas as the fuel was a relatively straightforward choice – there is no fossil fuel that produces fewer emissions or waste products and the current supply of natural gas is abundant. Natural

gas use is more energy efficient than other fossil fuels when considered holistically, which serves to conserve natural resources and lead to the production of energy at the least amount of air pollution feasible for the energy produced. According to Federal Department of Energy reports, less energy is required to extract, refine and transport natural gas than for oil or coal. The choice to couple cogeneration and combined-cycle technology with the natural gas-fired combustion equipment selected for the Wolf 1 CHP is also straightforward. The fuel and power technologies selected offer the following advantages over other fuels and technologies:

- Higher efficiency of electrical generation (as represented by heat rate in terms of Btu/kWh);
- Lower environmental impacts with regard to air emissions from use, fuel production (exploration, extraction and refining), and transport;
- Lower operation and maintenance costs; and
- Less acreage needed for plant footprint.

The facility's design will minimize pollution in a number of ways which will result in lower environmental impacts when compared to alternate power generating technologies. The facility will be cleaner and more efficient than many of the existing fossil fuel-fired electrical power generating plants in the ozone transport region. Therefore, the regional power generation that the Wolf 1 CHP displaces from other plants consuming coal, petroleum products or natural gas, which generally utilize single-cycle technology, or older combustion or emission control equipment, will provide local air quality improvements as well as general regional improvements. The high efficiency of the facility will also prevent pollution by requiring the combustion of less fuel per unit of energy produced. Construction of the facility will enable management of storm water quantity and storm water treatment to improve the quality of runoff in comparison to existing site conditions.

Specific systems within the facility have been conceived and designed to minimize pollution. Primary examples include:

- The use of natural gas as the sole fuel source for power generation, which will result in fewer air emissions, less solid waste generation and lower dust emissions than with the use of coal or petroleum;
- The selection of gas turbines and reciprocating engines that incorporate advanced low-NO_x combustion technology in the primary mode of operation to reduce emissions of NO_x, while improving the efficiency of combustion, which reduces the production of CO, VOC and PM at the same time;
- The incorporation of cogeneration and combined-cycle power generation that results in more efficient energy extraction per unit of fossil fuel

burned, which lowers the quantity of pollutants emitted per unit of electricity and thermal energy produced;

- The use of an SCR system to control the emissions of NO_x from the combustion units;
- The use of an oxidation catalyst to control the emissions of CO and VOC from the combustion units; and
- Incorporation of storm water quantity and quality management.

In summary, the design alternatives selected, which utilize advanced technology and pipeline quality natural gas, along with LAER and BACT emission controls, contribute to minimization of the WOLF 1 CHP impact on the environment and make it compatible with the STAR Campus location site in the City of Newark. These decisions will make the Wolf 1 CHP cleaner and more efficient than most other existing or planned fossil fuel-fired power plants in Delaware or in the ozone transport region. The proposed Wolf Technology Center 1 will be an asset for the community as it will achieve positive economic benefits, makes use of existing developed land and infrastructure, support resource conservation through efficient use of energy in exchange for minimized emissions to the atmosphere, which, through the purchase of emission credits and offsetting power production at other regional facilities, will result in a net local improvement in air quality.

6.2 BENEFIT-COST ANALYSIS

Construction and operation of the Wolf 1 CHP facility will result in economic and social effects. This subsection describes the socioeconomic benefits and costs. TDC engaged Econsult Solutions, Inc. (Econsult) to prepare an assessment of economic conditions that would stem from construction of the proposed Wolf Technology Center 1, including the CHP. A copy of Econsult's report titled, "The Economic Impact of the Proposed Data Center at the University of Delaware STAR Campus," dated October 29, 2013, is provided in Appendix J and is the source of the economic benefits highlighted in this subsection. Additional benefits are forecast in Econsult's report.

6.2.1 PROJECT BENEFITS

A primary benefit to the region will be the introduction of a new forward looking economic development project that will create hundreds of good sustainable jobs, an even greater number of construction jobs and construction spending as well as significant investment in regional gas infrastructure and fiber optics while also providing a clean, and reliable energy power source and improvement of regional air quality. These project benefits are further discussed in the following paragraphs.

The near term construction impacts on local employment opportunities will

be significant. This project will likely be the largest construction project that Delaware has seen in many years. Phase I alone is anticipated to cost $1.45 billion for construction and equipment expenditures, of which approximately $607 million is projected to occur in Delaware, including approximately $567 million in New Castle County. Construction employment, likely to last approximately 3 years, will be a positive socio-economic benefit to the region and locality. TDC estimates that approximately 1,000 construction jobs (over the life of construction) will be generated as a direct result of the proposed project. Additional, indirect employment in the local area will occur primarily in retail and wholesale trade, business services, health services, and dining establishments. In addition, the local purchase of construction materials will have a significant beneficial impact to area supply companies.

Duffield Associates anticipates that New Castle County companies and residents, will receive a majority of the construction wages. Another local economic benefit from construction will be the use of local subcontractors and vendors to provide labor and goods.

Once fully operational after completion of both Phase I and Phase II construction, the Wolf 1 CHP and Data Center is anticipated to directly employ 640 employees and generate nearly $38 million in annual wages and salaries. The project is forecast to stimulate 320 indirect and induced jobs, generating approximately $15 million in additional wages and salaries per annum. These jobs most likely will be filled by people who reside in Newark, New Castle County; and nearby areas of Cecil County, Maryland; and Chester County, Pennsylvania – the same area economically impacted by the closure of the Chrysler Newark Assembly Plant. The “ripple effect” of good paying jobs is well documented and will occur as a result of the Wolf Technology Center 1 project.

Construction of the facility will also generate significant public revenues through corporate and individual income taxes. Current forecasts prepared for TDC project that the State of Delaware would receive over $20 million from taxes over the three year construction period, including nearly $8 million in income taxes, nearly $14 million in gross receipts and $7.7 million in business tax revenue for Phase I alone. Construction of Phase I of the data center is also anticipated to generate nearly $5.6 million in on-time fees for state and local governments, including $4.7 million to the City of Newark. Purchased services for wastewater conveyance and treatment will restore a portion of the City of Newark’s revenue that was lost as a result of the closure of the former Chrysler Plant. Similarly, revenues to United Water Delaware, lost when Chrysler closed, will be restored. This restored revenue will aid with system maintenance expenses.

6.2.2 PROJECT SOCIO-ECONOMIC COSTS

No significant traffic problems are expected during the construction period. Much of the heavy equipment and materials for the Wolf Technology Center 1 is anticipated to arrive at the site by railroad, rather than by over the road transport. The road network around the proposed construction was developed to handle the employee traffic of the former Chrysler Newark Assembly Plant. The number of people traveling to or from the site during construction or when the facility becomes operational will be significantly less than the number of employees that formerly traveled daily to and from the site when the vehicle assembly plant was operational. Simultaneous construction of the adjoining Bloom Energy manufacturing plant and the College of Health Sciences building on STAR Campus has not resulted in noticeable traffic congestion. Construction of both of those currently ongoing projects is anticipated to be substantially complete before construction starts at the Wolf Technology Center 1.

Nearby neighborhoods adjacent to the site may experience minimal impacts during construction of the Wolf Technology Center 1. These impacts might include intermittent temporary construction noise and visual impacts. Noise levels during construction and from plant operations will be controlled to ensure compliance with applicable City of Newark noise standards. The facility design is intended to minimize long-term aesthetic impacts through the incorporation of architectural features and site screening. The proposed screening techniques should render most daily operational activities at the site invisible to nearby residents, with the possible exception of visible water vapor emanating from the cooling towers during specific atmospheric conditions. The site is located in an area that currently experiences transportation noise from Christina Parkway (Delaware Routes 2 and 4) and the Northeast Corridor railroad, one of the most active railroads in the United States, serving Amtrak, SEPTA and Norfolk Southern, currently. In addition to through train noise, Norfolk Southern operates a rail car switching yard adjacent to the site.

Rental properties and hotels will benefit during construction and long-term operation, to provide construction workforce temporary residence for construction workers, vendors, and transient employees. Construction of the proposed facility will have a beneficial impact on housing market by improving employment and stemming foreclosures that have resulted from the economic downturn of the local economy. Similarly, no negative impacts are expected on local restaurants and lodging/hotel properties.

Construction and post-construction impacts related to public services and facilities such as police, fire, and medical services and water, wastewater, and solid waste disposal (related to housing) are not expected to be significant. Those services were provided to the larger employment base of the former Chrysler Newark Assembly Plant.

Following construction, benefits associated with the operation of the facility are anticipated to be significant. Projections prepared for TDC forecast that following completion of Phase I the State of Delaware should receive approximately $4.5 million in annual state taxes from the Wolf Technology Center 1 operations. Similarly, the City of Newark should receive approximately $1.5 million and Christina School District should receive approximately $4.2 million annually. Construction of Phase II likely will result in an additional $0.3 million to the City of Newark and $0.9 million to Christina School District. Adverse impacts associated with facility operations are expected to be marginal and localized. The following summarizes some of these potential minor impacts.

The improved employment condition anticipated to occur as a result of the Wolf Technology Center 1 should help support real estate values in the local community. While the number of permanent employees is not anticipated to generate a large demand for new housing construction, employment at the facility likely will improve demand for local resale housing, which in turn, should serve to stabilize or increase the value of local residential real estate.

Adverse impacts to aesthetic quality of the area will be minimal. While the Wolf Technology Center 1 project will be visible from the surrounding area, the appearance of the facility is intended to blend with the other entities being built at STAR Campus, such as the Bloom Energy factory. The proposed site is not located near national or state parks or designated scenic views. Screening devices (berms and vegetation) are planned for installation along the railroad tracks to the north of the facility. These features should reduce the visible presence of the facility for the closest residents, who are located to the north of the existing railroad. Motorists driving along Christina Parkway, the closest road, may briefly view (in passing the facility) portions of the Wolf Technology Center 1 buildings, but that view will not be incongruous with the new Bloom Energy factory that is being constructed between the proposed facility and Christina Parkway or the prior Chrysler Newark Assembly Plant. Existing woodlands on the DelDOT property to the west of proposed site location should contribute to the screening of the facility from drivers traveling on Christina Parkway. The site is approximately one mile west of South College Avenue (DE Route 896) and should be unobtrusive to drivers traveling along that road.

Operation of the proposed Wolf Technology Center 1 will not affect essential services or facilities negatively. While the facility will rely on local police and fire protection, the facility will be equipped with Fire Marshall approved fire protection systems, and the site will be secured with controlled, fenced access and manned around the clock.

In summary, the Wolf Technology Center 1 will directly employ an estimated 640 employees and is anticipated to create or induce another 320

indirect jobs. Most of these future workers should be drawn from the existing population of the area. Employment at the facility, or created in support of the facility, should not affect provision of services, schools, or degrade traffic along local roadways materially. Such services previously were adequate to handle the much larger employment and infrastructure of the former Chrysler Newark Assembly Plant. In the unlikely event of medical emergency, existing local medical facilities are available and previously were adequate to support the need for such services at the former Chrysler Newark Assembly Plant.

Further, the Wolf Technology Center 1 facility is a Brownfield Redevelopment project of an abandoned heavy industrial site including large antiquated electrical substations, a wastewater treatment plant and a massive assembly plant, a very large painting facility, and a regional parts warehouse. The Wolf Technology Center 1 project is an adaptive reuse of this former heavy industrial site and is following recommended land use practices including seeking LEED Certification. Further, the project is not anticipated to displace residents, adversely impact property values, or place an unmanageable burden on public infrastructure. The site will also not displace visually impact or otherwise impair scenic, recreational, or ecologically sensitive lands.

7.0 AIR QUALITY IMPACT ANALYSIS METHODOLOGY

7.1 GENERAL APPROACH

As previously noted in Subsection 3.1, the Wolf 1 CHP facility site is located in an area designated as attainment or unclassifiable for criteria pollutants except ozone and $PM_{2.5}$. All areas of Delaware are designated as PSD Class II areas. PSD Class I areas located within 300 km of the Wolf 1 CHP include Brigantine National Wilderness Area (NWA) in New Jersey and Shenandoah National Park (NP) in Virginia. This section focuses on the methodology used to determine project air quality impacts with respect to the PSD Class II increments and NAAQS.

The approach to assessing air quality impacts for a new or modified emissions source generally begins by determining the impacts of only the proposed facility. If facility impacts are below the PSD SILs, no further analysis is required. The PSD Class II SILs were presented previously in Table 3-5. If the impacts of a proposed facility are found to exceed a particular PSD SIL, an additional cumulative analysis considering other existing sources and background pollutant concentrations is required for that pollutant and averaging time.

The approach used to analyze the potential impacts from the facility, as described in detail in the following subsections, was developed in accordance with accepted practice. Guidance contained in EPA manuals and user's guides was followed. In addition, an air dispersion modeling protocol was submitted to DNREC on August 13, 2013, for review and comment, followed by subsequent discussions of specific modeling options and scenarios. The air quality impact analyses conducted for the facility incorporate comments and suggestions received from DNREC, EPA and United States Fish and Wildlife Service (USFWS) regarding the modeling protocol. Appendix C contains the modeling protocol, and Appendix D contains responses to the comments regarding the modeling protocol received from DNREC, EPA, and USFWS. The relevant agency comments have been incorporated into air quality analyses and the modeling approach described in this section for assessing the impacts of the Wolf 1 CHP facility emissions.

7.2 POLLUTANTS EVALUATED

Table 3-2 previously presented the estimated potential annual emissions rates for the facility. As shown in that table, potential emissions of NO_x, VOCs, H_2SO_4, and PM/ PM_{10}/$PM_{2.5}$ and GHGs, are each projected to exceed the applicable PSD SER threshold. Potential emissions from the facility are below the applicable PSD SER levels for the other PSD-regulated pollutants. Accordingly, the facility is subject to the PSD NSR air quality impact analysis. As Table 3-2 indicates, NO_x and VOCs are regulated under NNSR, while $PM_{2.5}$ is regulated under MNSR. Although projected facility GHG and H_2SO_4 emissions will exceed the PSD applicability threshold, an air quality impact analysis is not required, due to the absence of an

EPA established NAAQS for those pollutants. Therefore, PM_{10} and NO_2 will be the only pollutants modeled as part of the PSD NSR air quality impact analysis.

7.3 MODEL SELECTION AND USE

For this air quality analysis, the current version of the American Meteorological Society (AMS)/EPA regulatory model (AERMOD) modeling system (Version 11103 – April 13, 2011), together with 5 years of hour-by-hour National Weather Service meteorology, was used to obtain predictions of both short-term periods (i.e., periods equal to or less than 24 hours) and annual average air quality impacts. In the November 9, 2005, Federal Register, EPA approved the use of AERMOD as a GAQM Appendix A preferred model, effective December 9, 2005. Lakes Environmental's AERMOD View user interface program was used to facilitate the use of AERMOD software.

The highest heat rate input to the facility combustion equipment has been predicted to occur during the winter and would result in the largest discharge of emissions to the atmosphere. Therefore, annual and hourly emission rates used for modeling were based on winter operating conditions. Modeled scenarios included:

- Operations based on the projected minimum power output of CHP, which conceivably would occur only when the CHP and data center are operating under "island" conditions. That condition would occur when the power grid could not accept electrical power from the CHP such as when the power grid is disrupted by weather events. This scenario is based on four gas combustion turbines operating at 100% load, two gas combustion turbines operating at 50% load, and two reciprocating gas engines operating at 50% load. The combination of equipment cited would provide sufficient power to run the CHP and data center and conforms to N+2 operating requirements. This scenario assessed emissions impacts associated with lowest expected exhaust temperatures and exhaust velocities;
- Operations based on projected "normal" operating conditions, where the CHP would be supplying power to the data center, exporting steam to the University of Delaware and supplying approximately 50 MW of electricity to the City of Newark through the distribution grid. This scenario is based on six combustion gas turbines operating at 100% load and two reciprocating gas engines operating near 100% load. This scenario should assess typical operating conditions; and
- Operations based on all of the combustion equipment running at 100% loads (i.e., seven gas combustion turbines and three reciprocating gas engines at 100% load). This scenario is not anticipated to represent standard operating conditions. However, it does provide an assessment of emission impacts associated with operating the available CHP combustion equipment at the maximum rated capacity.

7.4 MODEL OPTIONS

Procedures applicable to the AERMOD modeling system specified in the latest version of the User's Guide for the AMS/EPA Regulatory Model—AERMOD (September 2004) and EPA's November 9, 2005, revisions to the GAQM were followed. Also guidance from the EPA AERMOD Implementation Guide (September 27, 2005, and October 19, 2007) was applied.

The facility will be located in an area of New Castle County that includes a mix of residential, commercial and industrial land use. Per guidance provided by DNREC and USEPA, the AERMOD option to model rural conditions was selected, based on the land use percentages calculated for the surrounding area within 3 km of the site location.

7.5 NO_2 AMBIENT IMPACT ANALYSIS

On January 22, 2010, the EPA announced a new 1-hour average NO_2 NAAQS. The 1-hour NO_2 NAAQS was set at 100 ppb for the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour concentrations. This 1-hour NO_2 NAAQS became effective April 12, 2010.

A memorandum issued by the EPA on March 1, 2011 titled, "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard" described modeling parameters for assessing compliance with the new NO_2 NAAQS. Based upon this memorandum the following conditions/parameters were used:

- Ambient air quality modeling was conducted using the current version of AERMOD;
- NO_2 impact was estimated using the Tier 2 ratio of 0.80 as the ratio of NO_2/NO, which is a conservative assumption since at stack exit conditions, NO typically comprises 90% or more of total NO_x;
- For each receptor, the daily 1-hour maximum NO_2 concentrations was averaged over the 5-year modeling period; and
- The predicted averages were compared to the EPA recommended interim SIL of 7.5 $\mu g/m^3$.

The maximum modeled concentrations of NO_2 were below the applicable SILs; therefore, cumulative modeling for NO_2 was not performed.

7.6 TERRAIN CONSIDERATION

The GAQM defines: "flat terrain" as terrain equal to the elevation of the stack base, "simple terrain" as terrain lower than the height of the stack top, and "complex terrain" as terrain exceeding the height of the stack being modeled. The

project site elevation is approximately 90 feet above mean sea level (ft-msl). The combustion equipment exhaust stacks will each have a height of approximately 140 feet above ground level (ft-agl) and the cooling towers will have discharge heights of approximately 45 ft-agl. Accordingly, terrain elevations above approximately 200 ft-msl (for the combustion equipment stacks) and 135 ft-msl for the cooling towers discharges would be classified as complex terrain.

U.S. Geological Survey (USGS) National Elevation Dataset (NED) terrain data was examined for terrain features within the expected Wolf 1 CHP impact area (see Figure 4). As shown in Figure 4, the general topography in the area surrounding Wolf 1 CHP was found to rise to the north of the site. A number of local high points were found to the south of Wolf 1 CHP, one of which (Iron Hill) approaches approximately 310 feet above sea level. Based on this examination, terrain in the vicinity of the Wolf 1 CHP site was classified as complex terrain, and AERMOD was run accordingly.

7.7 BUILDING WAKE EFFECTS

The CAA Amendments require that stack height not exceed the limit established by good engineering practice (GEP) as a means of achieving compliance with NAAQS. On July 8, 1985, EPA promulgated final stack height regulations (40 CFR 51). GEP stack heights for the facility emissions sources will comply with EPA promulgated final stack height regulations (40 CFR 51). GEP stack height is defined as the highest of 65 meters, or a height established by applying the formula:

$$Hg = H + 1.5\ L$$

where:

Hg = GEP stack height.
H = height of the structure or nearby structure.
L = lesser dimension (height or projected width) of the nearby structure.

Nearby is defined as a distance up to five times the lesser of the height or width dimension of a structure or terrain feature, but not greater than 800 meters. GEP stack height regulations require that stack height used in modeling for determining compliance with NAAQS and PSD increments not exceed the GEP stack height. Guidelines for determining GEP stack height have been issued by EPA (1985).

The anticipated maximum building height at the proposed facility is approximately 75 ft-agl, which is the lesser of the structure descriptive dimension. Application of the above formula yielded a stack height of 188 ft-agl. The stack height proposed for the combustion equipment stacks, 165 ft-agl, is less than the GEP stack height of 188 feet or the maximum allowable stack height of 65 meters (213 feet).

Since the stack heights for the facility emissions sources will comply with the EPA promulgated final stack height regulations, the proposed facility stack heights were

used in the modeling analyses. According to EPA, stacks with heights lower than GEP stack height could potentially result in higher downwind concentrations of criteria pollutants, due to building downwash effects. Therefore, the use of a less than GEP stack height in air dispersion modeling should yield a conservative assessment of atmospheric concentrations of those pollutants at receptor locations. AERMOD evaluates the effects of building downwash based on the PRIME building downwash algorithms. For the ambient impact analysis, the complex downwash analysis implemented by AERMOD was performed using the current version of EPA's BPIP for PRIME (BPIPPRM) (Version 04274 [September 30, 2004]). The EPA BPIP program was used to determine the area of influence for each building, whether a particular stack is subject to building downwash, the area of influence for directionally dependent building downwash, and finally to generate the specific building dimension data required by the model. BPIP output consists of an array of 36 direction-specific (10 to 360 degrees) building heights, lengths, widths, and along-flow and across-flow distances for each stack suitable for use as input to AERMOD.

Figure 7 shows a three-dimensional view of facility buildings/structures evaluated for wake effects. The building/structure dimensions were determined from the concept-level design drawings for the facility. A DXF file of the design drawings was prepared and imported to AEMROD for use during modeling. The DXF file is included in Appendix F.

7.8 RECEPTOR GRIDS

The latest version of AERMAP, the terrain pre-processor for AERMOD, was utilized to provide a terrain elevation for each receptor used in modeling. NED 1/3 arc second data was not available for the entire modeling area. Therefore, NED 1 arc second terrain data was used to determine facility and receptor elevations.

A receptor grid was prepared to identify those points at which the ambient air quality was modeled. Ambient air is identified by the EPA as "that portion of the atmosphere, external to buildings, to which the general public has access." Therefore, the nearest locations of general public access were determined to be at and beyond the Wolf 1 CHP facility fence line. The ambient air receptor grid was prepared with the following constraints, which are illustrated in Figure 5:

- Fence Line Receptors – Receptors placed at 25 meter intervals along the Wolf 1 CHP facility fence line;
- Close Receptors – Receptors placed at 50-meter intervals on the x and y axes starting at the fence line and extending outward to a minimum of 1 km;
- Medium Receptors – Receptors placed at 100-meter intervals on the x and y axes starting at approximately 1 km and extending outward to a minimum of 5 km; and

- Far Receptors – Receptors placed at 1,000-meter intervals on the x and y axes starting at approximately 5 km and extending outward to a minimum of 10 km.

This receptor grid spacing was chosen to ensure a high density of modeling points in areas closest to the points of discharge, where substance dispersion has had less time and distance to provide dilution of discharged substance concentrations.

Figure 5 provides a graphical representation of the ambient air receptor grid.

7.9 METEOROLOGICAL DATA

AERMET is the meteorological preprocessor for AERMOD. AERMET uses a collection of inputs including weather observations, land use inputs from the AERSURFACE preprocessor, and wind inputs from the AERMINUTE preprocessor to produce a meteorological input for AERMOD. The latest version of AERMET (Version 12345) was utilized to develop the meteorological inputs for AERMOD.

AERMET requires input data regarding upper air soundings and hourly surface weather data. Upper air soundings data is collected at a limited number of locations throughout the country. The nearest upper air data stations include Aberdeen Phillips Field Station in Aberdeen, Maryland, and Wallops Flight Facility on Wallops Island, Virginia. Under close inspection during modeling, Duffield Associates determined that the upper air data from Aberdeen Phillips Field Station was missing more than 10% of the data. At this level of missing data, the modeling results would not be considered valid. In order to obtain valid modeling results, upper air data from Wallops Flight Facility was used. Data were obtained for the 5-year period from January 1, 2008 to December 31, 2012 from http://www.esrl.noaa.gov/raobs/.

Hourly surface data is available at a greater number of locations compared to upper air data including New Castle Airport (NCA), Aberdeen Phillips Field Station, Philadelphia International Airport, Dover Air Force Base, and Millville Municipal Airport. The closest location to the proposed Wolf 1 CHP facility is NCA, and hourly surface data is available at NCA consistently from January 1, 1973, to the present day. Data were obtained for the 5-year period from January 1, 2008 to December 31, 2012, from ftp://ftp.ncdc.noaa.gov/pub/data/noaa.

AERMINUTE is an AERMET preprocessor that factors in wind speed and direction to complement the reported surface weather data. AERMINUTE uses 1-minute automated surface observing station (ASOS) data. The latest version of AERMINUTE was used (Version 11325) to supplement AERMET. Nearby 1-minute ASOS locations include NCA, Sussex County Airport, and Millville Municipal Airport. NCA is the closest location to the proposed Wolf 1 CHP facility, and 1-minute ASOS data is available for NCA from January 2000 to the date of this report. Data were obtained for the 5-year period from January 1, 2008 to December 31, 2012, from ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin/.

AERMET requires information on surface roughness length, albedo, and Bowen ratio to determine the effect of surface conditions on weather patterns. AERSURFACE was developed to calculate surface roughness length, albedo, and Bowen ratio from information on land cover for input to AERMET. The latest version of AERSURFACE was used (Version 13016). National Land Cover Database's (NLCD's) land cover data from 1992 was used in AERSURFACE. The land cover was obtained for NCA according to GAQM guidance, which recommends that land cover data be collected for the site where weather information is collected. As shown in Figure 6, the land cover at NCA has not varied significantly since 1992. Therefore, the 1992 land use data is still applicable.

7.10 MODELED EMISSIONS INVENTORY

7.10.1 ON-PROPERTY SOURCES

Emissions sources in the air quality impact analysis include the proposed facility combustion units, cooling towers, and chiller towers.

There are three different Wolf 1 CHP operating scenarios considered in the air quality impact analysis. The modeled emission rates associated with those operating conditions have been summarized in Appendix B. The stack parameters for each operating scenario have been summarized in Tables 2-2.a through 2-2.c. The modeled emissions rates and discharge parameters for the cooling towers also have been summarized in 2-2.a through 2-2.c. The impacts for NO_2, and PM_{10} were assessed using these parameters and emission rates.

In their March 2011 guidance memorandum for 1-hour NO_2 air quality compliance demonstrations, EPA indicates emissions sources that operate intermittently do not need to be included in the modeled emissions inventory. Similarly, startup/shutdown emissions are also addressed in the memorandum and can be omitted if they can be considered an intermittent source. As summarized in Section 2.5 of this report, individual combustion units in the Wolf 1 CHP will be shut down or restarted as necessary to perform maintenance, and to meet varying power demands. However, the turbines could be shut down and restarted 107 times per year before cold start-up conditions would amount to 0.1% of annual operating time and the engines could be similarly cycled 40 times per year before cold startup conditions would amount to 0.1% of annual operating time. Both of these shutdown/startup frequencies far exceed the anticipated number of events that would occur for maintenance or load matching. The cold startup mode is not considered a continuous operating mode or to occur frequently enough to impact daily emission rates, but could disproportionally impact daily 1-hour maximum values if included in air dispersion modeling. Therefore, the emissions associated with cold startups were not modeled.

7.10.2 OFF-PROPERTY SOURCES

Initial modeling results for all three operating conditions indicated a need to perform cumulative modeling for PM_{10}, where ambient air quality monitoring concentrations and emissions from other, off-property sources of PM_{10} are taken into consideration. After consultation with DNREC, Duffield Associates contacted the Pennsylvania Department of Environmental Protection (PADEP), the Maryland Department of Environmental Protection (MDE), and DNREC-AQM for a list of major sources of PM_{10} within10 km of the Wolf 1 CHP facility. PADEP indicated that there are no such facilities in Pennsylvania within that radius. MDE and DNREC-AQM provided a list of multiple facilities which met those criteria. After further consultation with DNREC, the list of Maryland and Delaware facilities were narrowed to those listed in Table 7-2.

Table 7-2. Off-Site Sources

Facility Name	State	UTM Coordinates (meters)	Source Type
Christiana Care	Delaware	442,574.00, 4,393,411.00	Point Source
DuPont Stine-Haskell	Delaware	432,571.00, 4,390,658.00	Point Source
FMC Biopolymers	Delaware	437,831.00, 4,393,171.00	Area Source
Rohm & Haas	Delaware	440,945.00, 4,389,169.00	Point Source
University of Delaware	Delaware	435,612.00, 4,392,665.00	Point Source
W.L. Gore – Cherry Hill Plant	Maryland	426,422.00, 4,391,429.00	Point Source

DNREC-AQM provided permitted emission rates and stack parameters for the Delaware facilities, while MDE provided actual annual emission rates and the facility location but not stack parameters. Delaware facilities with multiple stack parameters were averaged, while stack parameters for the Maryland facility were estimated using similar facility data. The emission rates of the off-site sources are listed in Table 7-3 and stack parameters are provided in Table 7-4. Due to the number and variations of stacks at FMC Biopolymers, that site was modeled as an area source.

Table 7-3. Off-Site Sources Emission Rates

Facility Name	NO_x Emissions (lb/hr)	PM_{10} Emissions (lb/hr)
Christiana Care	3.42	0.027
DuPont Stine-Haskell	2.16	0.12
FMC Biopolymers	7.10	5.37
Rohm & Haas	0.76	0.089
University of Delaware	4.29	0.073
W.L. Gore – Cherry Hill Plant	2.86	0.24

Table 7-4. Off-Site Sources Stack Parameters

Facility Name	Stack Height (feet)	Stack Diameter (feet)	Exhaust Temperature (°F)	Exhaust Velocity (ft/s)
Christiana Care	142	9.0	480	2.1
DuPont Stine-Haskell	60	2.5	490	57.0
FMC Biopolymers	50*	1443.5**	N/A	N/A
Rohm & Haas	45	2.0	500	40.1
University of Delaware	70	6.0	600	60.0
W.L. Gore – Cherry Hill Plant	60	5.0	500	50.0

*FMC Biopolymers was modeled as an area source with a release height of 50 feet
**FMC Biopolymers was modeled as an area source with a release area of 1,443.5 feet by 1,443.5 feet

8.0 PSD CLASS II AIR QUALITY IMPACT ANALYSIS RESULTS

8.1 AIR QUALITY IMPACT ANALYSIS RESULTS

The AERMOD dispersion model was used to assess the impacts for each of the three operating cases for each pollutant and averaging period subject to PSD review (i.e., NO_2 and PM_{10}). Each of the three operating cases was assessed for a 5-year meteorological data period (2008 through 2012). The specific emissions rates, stack exit exhaust temperature, and exhaust gas velocity appropriate for each operating case was modeled.

The following four separate pollutants/averaging periods were analyzed:

- PM_{10} annual averaging period.
- PM_{10} 24-hour averaging period.
- NO_2 annual averaging period.
- NO_2 1-hour averaging period.

The two PM_{10} averaging periods were combined in the same AERMOD input file as were the two NO_2 averaging periods. As noted below, some operating conditions exceeded the applicable SILs, and additional cumulative source modeling was required to show compliance with the NAAQS.

8.2 MAXIMUM FACILITY IMPACTS

This section discusses the modeling performed to compare the predicted impacts of the Wolf 1 CHP sources to the SILs, de minimis levels, and allowable increase levels. Tables 8-1 through 8-3 summarize the maximum AERMOD results for each pollutant and averaging period for the three operating cases.

Table 8-1. Normal Operating Conditions Assessment Summary of Maximum Predicted Concentrations

Pollutant	Averaging Period	Predicted Maximum Concentration ($\mu g/m^3$)	SIL ($\mu g/m^3$)	*de minimis* ($\mu g/m^3$)	Allowable Increase ($\mu g/m^3$)
PM_{10}	Annual	0.57	1.0	---	17
	24-Hour	5.73	5.0	10	25
NO_2	Annual*	0.30	1.0	14	25
	1-Hour*	4.68	7.5	---	---

*Tier 2 values assuming an 80% conversion rate of NO_x to NO_2

Under projected normal operating conditions, the maximum 24-hour PM_{10} concentration is predicted to exceed the SIL value. None of the PM_{10} or NO_2 concentrations are predicted to exceed *de minimis* or allowable increase levels.

Table 8-2. Full Capacity Output Assessment
Summary of Maximum Predicted Concentrations

Pollutant	Averaging Period	Predicted Maximum Concentration (µg/m^3)	SIL (µg/m^3)	*de minimis* (µg/m^3)	Allowable Increase (µg/m^3)
PM_{10}	Annual	0.79	1.0	---	17
	24-Hour	8.45	5.0	10	25
NO_2	Annual*	0.39	1.0	14	25
	1-Hour*	5.94	7.5	---	---

*Tier 2 values assuming an 80% conversion rate of NO_x to NO_2

Under projected full capacity operating conditions, the maximum 24-hour PM_{10} concentration is predicted to exceed the SIL value. None of the PM_{10} or NO_2 concentrations are predicted to exceed *de minimis* or allowable increase levels.

Table 8-3. Minimum Output (Island Mode) Assessment
Summary of Maximum Predicted Concentrations

Pollutant	Averaging Period	Predicted Maximum Concentration (µg/m^3)	SIL (µg/m^3)	*de minimis* (µg/m^3)	Allowable Increase (µg/m^3)
PM_{10}	Annual	0.73	1.0	-	17
	24-Hour	7.40	5.0	10	25
NO_2	Annual*	0.31	1.0	14	25
	1-Hour*	4.73	7.5	-	-

*Tier 2 values assuming an 80% conversion rate of NO_x to NO_2

Under projected minimum output (during island mode) the maximum 24-hour PM_{10} concentration is predicted to exceed the SIL value. None of the PM_{10} or NO_2 concentrations are predicted to exceed *de minimis* or allowable increase levels.

Cumulative modeling was performed for the 24-hour PM_{10} averaging time, which exceeded the SIL for each of the three operating cases.

8.2.1 PM_{10} RESULTS

Table 8-4 presents the maximum annual PM_{10} concentrations for the three operating conditions averaged across the five years of meteorological data and presents a summary with a comparison to the PSD SIL value. The distance to the maximum concentration from the center of the Wolf 1 CHP facility is also provided.

Table 8-4. Maximum Annual PM_{10} Concentrations

Operating Condition	Max Concentration (µg/m^3)	Location (UTM)	Distance (meters)	PSD SIL (µg/m^3)	Above SIL?
Normal	0.57	434421.73, 4390410.07	2336.83	1.0	No
Full Capacity	0.79	434421.73, 4390410.07	2336.83	1.0	No
Island Mode	0.73	434421.73, 4390410.07	2336.83	1.0	No

Table 8-5 presents the maximum 24-hour PM_{10} concentrations for the three operating conditions across the five years of meteorological data and presents a summary with a comparison to the PSD SIL value. The distance to the maximum concentration from the center of the Wolf 1 CHP facility is also provided.

Table 8-5. Maximum 24-Hour PM_{10} Concentrations

Operating Condition	Max Concentration (µg/m^3)	Location (UTM)	Distance (meters)	Date (M/D/Y)	PSD SIL (µg/m^3)	Above SIL?
Normal	5.73	433971.13, 4390552.64	2776.65	11/12/09	5.0	Yes
Full Capacity	8.45	433971.13, 4390552.64	2776.65	11/12/09	5.0	Yes
Island Mode	7.40	433971.13, 4390552.64	2776.65	11/12/09	5.0	Yes

As a result of these findings, cumulative modeling was performed for PM_{10} emissions during a 24-hour averaging time under the three operating conditions.

8.2.2 NO_2 RESULTS

Table 8-6 presents the maximum annual NO_2 concentrations for the three operating conditions averaged across the five years of meteorological data and presents a summary with a comparison to the PSD SIL value. The distance to the maximum concentration from the center of the Wolf 1 CHP facility is also provided.

Table 8-6. Maximum Annual NO_2 Concentrations

Operating Condition	Tier	Max Concentration (µg/m^3)	Location (UTM)	Distance (meters)	PSD SIL (µg/m^3)	Above SIL?
Normal	Tier 1*	0.37	434471.13, 4390352.64	2294.48	1.0	No
	Tier 2**	0.30				No
Full Capacity	Tier 1*	0.49	434421.13, 4390402.64	2338.20	1.0	No
	Tier 2**	0.39				No
Island Mode	Tier 1*	0.39	434421.13, 4390402.64	2338.20	1.0	No
	Tier 2**	0.31				No

*Tier 1 values assume a 100% conversion rate of NO_x to NO_2
**Tier 2 values assume an 80% conversion rate of NO_x to NO_2

Table 8-7 presents the maximum 1-hour NO_2 concentrations for the three operating conditions averaged across the five years of meteorological data and presents a summary with a comparison to the PSD SIL. The distance to the maximum concentration from the center of the Wolf 1 CHP facility is also provided.

Table 8-7. Maximum 1-Hour NO_2 Concentrations

Operating Condition	Tier	Max Concentration (µg/m^3)	Location (UTM)	Distance (meters)	PSD SIL (µg/m^3)	Above SIL?
Normal	Tier 1*	5.85	434171.13, 4390852.64	2582.68	7.5	No
	Tier 2**	4.68				No
Full Capacity	Tier 1*	7.42	434171.13, 4390852.64	2582.68	7.5	No
	Tier 2**	5.94				No
Island Mode	Tier 1*	5.91	434121.13, 4390852.64	2582.68	7.5	No
	Tier 2**	4.73				No

*Tier 1 values assume a 100% conversion rate of NO_x to NO_2
**Tier 2 values assume an 80% conversion rate of NO_x to NO_2

As a result of these findings, cumulative modeling was not performed for NO_2 emissions under the three operating conditions.

8.3 CUMULATIVE MODELING RESULTS

Due to modeling results indicating that the maximum air concentrations associated with the Wolf 1 CHP emissions are projected to exceed the 24-hour PM_{10} PSD SIL, cumulative modeling including other sources was performed to demonstrate compliance with the NAAQS. Discussions with DNREC and MDE identified a list of facilities that are major emitters of NO_X and PM_{10} within 10 kilometers of the proposed Wolf 1 CHP. Cumulative modeling focused on the fence line receptor and close receptor grid area since the predicted concentrations exceeding the PSD SIL occurred within that area. The results of the modeling are discussed in the following subsection.

8.3.1 CUMULATIVE MODELING FOR THE 24-HOUR PM_{10} NAAQS

Tables 8-8, 8-9, and 8-10 show the results of the PM_{10} cumulative modeling for the normal, full capacity, and island mode operating cases. The values shown in the tables are the highest daily PM_{10} concentrations predicted to occur at a fence line receptor or close receptor over the 5 year modeling period for each operating condition. The contribution from the Wolf 1 CHP facility and off site facilities has been listed separately from the background for comparison. Since PM_{10} background concentration measurements are not available for Delaware, background concentrations were obtained from the Philadelphia area at East Lycoming Street. This metropolitan location provides a conservative estimate of background PM_{10} concentrations near Wolf 1 CHP. The total concentrations have been compared to the NAAQS to identify values in excess of that standard.

Table 8-8. Cumulative Modeling of 24-Hour PM_{10} Assessment at Normal Capacity

Concentration from Wolf 1 and Off-Site Sources (µg/m^3)	Concentration from Background (µg/m^3)	Total Concentration (µg/m^3)	Location (UTM)	NAAQS (µg/m^3)	Exceeds NAAQS?
12.60	67	79.60	435471.13, 4391702.64	150	No

Table 8-9. Cumulative Modeling of 24-Hour PM_{10} Assessment at Full Capacity

Concentration from Wolf 1 and Off-Site Sources (µg/m^3)	Concentration from Background (µg/m^3)	Total Concentration (µg/m^3)	Location (UTM)	NAAQS (µg/m^3)	Exceeds NAAQS?
12.62	67	79.62	435471.13, 4391702.64	150	No

Table 8-10. Cumulative Modeling of 24-Hour PM_{10} Assessment for Island Mode

Concentration from Wolf 1 and Off-Site Sources (µg/m^3)	Concentration from Background (µg/m^3)	Total Concentration (µg/m^3)	Location (UTM)	NAAQS (µg/m^3)	Exceeds NAAQS?
12.60	67	79.60	435471.13, 4391702.64	150	No

The maximum concentrations are below the NAAQS of 150 µg/m^3.

8.4 ADDITIONAL AIR QUALITY ANALYSES

Wolf 1 CHP is expected to emit approximately 18.36 tpy of total HAPs. Of those 18.36 tpy of total HAPs, approximately 17.71 tpy are expected to be from acetaldehyde, acrolein, formaldehyde, and methanol. Two of those compounds, acetaldehyde and formaldehyde, are known carcinogens. In order to assess the cancer risk posed by predicted emissions of acetaldehyde and formaldehyde, AERMOD and the EPA's Risk Assessment Information System (RAIS) model were used to conduct a risk assessment. The other two compounds, acrolein and methanol, may pose a non-carcinogenic risk depending upon their concentrations. In order to assess the risk posed by these two pollutants, AERMOD and National Institute for Occupational Safety and Health (NIOSH) threshold limit value – time weighted averages (TLV-TWAs) were used to conduct a risk assessment.

In addition to HAPs, approximately 78.03 tpy of ammonia emissions from Wolf 1 CHP are also expected. Since ammonia does not have a NAAQS, it is not included in the Class II analysis. Ammonia is not considered a carcinogen, but may pose a non-carcinogenic risk depending upon its concentration. In order to assess the risk posed by ammonia, AERMOD and the NIOSH TLV-TWAs were used to conduct a risk assessment.

8.4.1 CANCER RISK ASSESSMENT

Modeling was performed in AERMOD using the concentrations and stack parameters from the predicted full capacity operating condition identified during the Class II analysis. During the Class II analysis, the full capacity operating condition generated the highest predicted concentrations of the modeled pollutants. Therefore, that operating mode was used in this instance as a conservative measure. The results of the modeling predicted maximum 1-hour, maximum 24-hour, and annual averaging time concentrations over the 5 year modeling period for the selected carcinogens. The applicable modeling files are included in Appendix F. The maximum predicted 1-hour concentrations were processed in RAIS for a residential ambient air exposure scenario. The RAIS output file is included in Appendix K. Since the 1-hour concentration is the maximum predicted concentration expected to occur for 1 hour within 50 kilometers of Wolf 1 CHP over a five year period, it is a conservative estimate of the continuous residential exposure concentration. Based upon the exposure scenario (resident) and exposure pathway (inhalation), the RAIS output predicts a cumulative cancer risk to be 5.00×10^{-6}. The cumulative cancer risk of acetaldehyde and formaldehyde at 5.00×10^{-6} is less than the acceptable limit of 1.00×10^{-5}; therefore, it does not pose an unacceptable cancer risk.

8.4.2 NON-CARCINOGENIC RISK ASSESSMENT

Modeling was performed in AERMOD using the concentrations and stack parameters from the predicted full capacity operating condition identified during the Class II analysis. During the Class II analysis, the full capacity operating condition generated the highest predicted concentrations of the modeled pollutants. Therefore, that operating mode was used in this instance as a conservative measure. The results of the modeling predicted maximum 1-hour, maximum 24-hour, and annual averaging time concentrations over the 5 year modeling period for the selected substances. The applicable modeling files are included in Appendix F. The maximum predicted 1-hour concentrations were converted to 8-hour concentrations by multiplying by 0.7. The applicable NIOSH 8-hour TLV-TWA, published in the NIOSH Pocket Guide (September 2005), were then divided by the maximum predicted 8-hour concentrations. These calculations are provided in Appendix K. Of the three calculated hazard quotients, the smallest (the value posing the most risk) was 192 for acrolein. This finding means that the maximum predicted 8-hour concentrations are at least 192 times less than the applicable 8-hour TLV-TWA. DNREC-AQM generally requires that calculated hazard quotients be greater than 100. Based upon these calculations, acrolein, methanol, and ammonia pose an acceptable non-carcinogenic risk.

8.5 CONCLUSIONS

Comprehensive and conservative air quality dispersion modeling using AERMOD demonstrates that the maximum predicted ambient air quality impacts due to operation of the Wolf 1 CHP in three operating conditions, under worst-case meteorological conditions, will:

- Have an insignificant ambient air quality impact. Maximum predicted air concentrations of PM_{10} and NO_2 are less than the PSD SILs for all pollutants and averaging times, except for the PM_{10} 24-hour averaging time concentration for the three operating capacities. Further assessment through cumulative modeling of these cases indicates that the proposed Wolf 1 CHP facility will not cause or contribute to PM_{10} 24-hour averaging time air concentrations in excess of corresponding NAAQS for any of the three operating cases;
- Be below the PSD preconstruction ambient monitoring *de minimis* levels for all pollutants;
- Not exceed PSD allowable increase increments; and
- Not pose an unacceptable cancer or non-carcinogenic risk based upon the risk assessments performed.

9.0 ADDITIONAL IMPACT ANALYSIS

Per Section 3.13.1 of DE Admin. Code 1125, "The owner or operator shall provide an analysis of the impairment to visibility, soils and vegetation that would occur as a result of the source or modification and general commercial, residential, industrial and other growth associated with the source or modification. The owner or operator need not provide an analysis of the impact on vegetation having no significant commercial or recreational value." Similarly, Section 3.12.2 of the same regulations requires the owner or operator shall provide an analysis of the air quality impact projected for the area as a result of general commercial, residential, industrial and other growth associated with the source or modification. The following sections provide that analysis.

9.1 GROWTH IMPACT ANALYSIS

The proposed Wolf 1 CHP and associated data storage facility is proposed to be constructed on the former Chrysler Newark Assembly Plant, which ceased operations during December 2008. The former Newark Assembly Plant was a major source of air emissions, primarily NO_x and VOCs in its final configuration, and employed thousands of people in up to three work shifts. As such, the proposed project represents "regrowth" rather than new growth. Many of the future employees of the facility are anticipated to come from the existing population of the City of Newark and nearby communities in New Castle County, Delaware, Cecil County, Maryland, and Chester County, Pennsylvania. The site location is urbanized, appropriately zoned for the proposed use, and will make use of existing public infrastructure that formerly supported the vehicle assembly plant operations. The proposed facility will produce fewer air emissions than the prior vehicle assembly plant. Given the existing degree of urbanization in the vicinity of the site, no appreciable additional population or services related growth is anticipated to result from construction of the proposed Wolf Technology Center 1, but the project is anticipated to replace some of the employment and area-wide property values that were lost when the former Chrysler Newark Assembly Plant closed.

Local air quality impacts associated with construction of the Wolf Technology Center 1 will be minor and temporary. While not readily quantifiable, the temporary increase in air emissions from construction equipment emissions, vehicle-miles traveled in the area by construction vehicles, material delivery vehicles and construction worker vehicles are anticipated to be insignificant in comparison to vehicle emissions associated with the adjoining railroad freight traffic, traffic on the adjoining State highways (Delaware Routes 2, 4 and 896) and nearby Interstate Highway 95.

The Wolf Technology Center 1 is forecast to employ approximately 640 employees and stimulate creation of approximately 320 indirect jobs, when operational. Most full-time, part-time and contracted workers at the facility are anticipated to come from proximate locations (within a 10 mile radius of the site) and essentially partially replace the commuting work force formerly employed at the vehicle assembly plant. A 10 mile radius of the site includes: the densely populated

portion of New Castle County, Delaware located to the north of the Chesapeake and Delaware Canal; the densely populated western portion of Cecil County, Maryland; and a portion of Chester County, Pennsylvania. The 2012 U.S. Census Bureau estimated populations for New Castle County, Delaware, Cecil County, Maryland and Chester County, Pennsylvania, respectively as 546,076, 101,696 and 506,575, respectively. The workforce needed to operate the proposed plant, represents a small fraction of the population already present in the immediate area. Therefore, while some small increase in area vehicle-miles traveled could occur, the air quality implications for the locality will be minimal.

9.2 IMPACTS ON SOILS, VEGETATION, AND WILDLIFE

Certain air pollutants in acute concentrations or chronic exposures can impact soils, vegetation, or wildlife resources. For instance, SO_2 and NO_x emissions can combine with atmospheric moisture and form acids. Those acids can contribute to soil and surface water acidification. The Wolf 1 CHP equipment will combust pipeline-quality natural gas and employ state-of-the-art equipment and emissions controls to reduce the formation of NOx and SO_2. Detrimental effects on soils, vegetation, and wildlife will be insignificant, based on the projected emissions rates and minimal potential air quality impacts. The emissions of those substances will be well within the limits established thorough Federal regulations that were intended to guard against environmental degradation. The emissions of these substances for the facility will be substantially less than those from the former power plant and manufacturing related emitting sources such as the paint shop and wastewater treatment plant that was located on STAR Campus and supported the former Chrysler Newark Assembly Plant.

Possibly the greatest potential impact to wildlife, as a whole, is degradation of the composition, structure, and habitat that can result from facility construction. The proposed facility will not result in a direct loss of trees or wildlife habitat. In fact, construction of the facility will result in significant increase of trees, plants, and other vegetation on the site. The site currently is almost 100% covered by pavements that are remnants of the former site usage.

Releases of pollutants can affect wildlife through inhalation, exposure through skin, or ingestion. However, based on low emissions levels from this facility, natural dispersion of emissions, and mobility of wildlife, no direct impacts to regional wildlife resources are expected.

Most impacts to wildlife due to emissions from fuel combustion are indirect. For instance, increased acidification to soils and water due to high levels of SO_2 affects amphibians through skin absorption, as well as impacting breeding success, particularly those that breed in vernal pools and acidified ponds. However, the facility's low emissions of pollutants known to stress vegetation will result in impacts below known thresholds of injury. To the extent that energy produced by facility displaces energy production at existing facilities that produce significantly

larger amounts of such emissions, the CHP emissions should reduce impacts to sensitive vegetation in the region. Therefore, no adverse impacts to wildlife due to operation of the facility are predicted.

Given the apparent lack of particularly sensitive soils or vegetation in the site area, air pollutant impacts well below the NAAQS should cause no adverse effects on soils or vegetation. At the national level, the primary AAQS have been established to protect the public health, while the secondary AAQS have been established to protect the public welfare, property, vegetation, and other ecological systems from any known or anticipated detrimental effects. Ambient concentrations of the criteria pollutants at levels below the NAAQS would not be expected to harm most types of soils, vegetation or wildlife. Predicted maximum substance concentrations in air that would result from operation of the proposed facility are well below the NAAQS (Table 3-1). Therefore, no adverse effects are expected.

In summary, based on the types of soils, vegetation, and wildlife onsite and in the vicinity, as well as the minimal emissions levels associated with plant operation, no impacts to soils, vegetation, or wildlife in the Wolf 1 CHP facility site vicinity are anticipated.

9.3 VISIBILITY IMPAIRMENT POTENTIAL

No visibility impairment at the local level is expected due to the types and quantities of emissions projected from the facility sources. The opacity of exhausts from the facility will be low and typically at or approaching zero, principally due to the low concentrations of particulates and the virtual absence of sulfur oxides associated with natural gas combustion. The contribution of emissions of VOC to potential haze formation in the area will be minimal given the low VOC emissions rate from the Wolf 1 CHP.

Wet mechanical draft cooling towers transfer heat from facility processes to the atmosphere through the evaporation and dispersion of cooling water. Depending on the meteorological conditions, warm, moist air leaving a tower may become cooled to the point of saturation, causing the water to condense forming a visible plume. Based on the size of the cooling towers and the frequency of occurrence the magnitude of a visible plume is expected to be small, and not significantly noticeable beyond the Wolf 1 site.

Aesthetically, the site was previously dominated by a large industrial facility. The site is separated from the closest residential community by the Northeast Corridor Railroad and a rail car switch/storage yard. The site design for Wolf 1 includes visual screening devices (topography, berms and vegetation) to minimize the aesthetic impact of the facility on residents located to the north of the railroad. The facility is set-back a distance of approximately 500 feet from the closest highways (Delaware Routes 2 and 4 (Christina Parkway)] and is partially screened from view by existing woodlands and the Bloom Energy manufacturing facility that is also being constructed on STAR Campus. The proposed facility should not adversely affect aesthetic or visual qualities in the area.

9.4 NOISE IMPACTS

The Wolf 1 CHP will be designed with noise reduction controls including, but not limited to, mufflers and sound proofing enclosures. In addition, exterior noise attenuating walls and landscaping will be considered to further reduce noise at and beyond the Property boundary, if determined to be necessary. The noise levels will not exceed the allowable noise levels outlined in Section 20-A6 of the City of Newark Municipal Code. Since the Wolf 1 Property is located adjacent to residential neighborhood (i.e., the "receiving land use"), the residence district noise levels will be applicable.

9.5 ODOR IMPACTS

Duffield Associates evaluated the potential for odor impacts as a result of ammonia slip from the SCR control units. SCR controls will be incorporated into the 10 proposed HRSG units on the Property. The maximum allowable ammonia slip will be limited to 7 ppmvd, or an equivalent of approximately 2.11 lb/hr for the combustion turbines and approximately 1.33 lb/hr for the reciprocating gas engines. AERMOD was used to model maximum projected 1-hour, 24-hour, and annual averaging time ambient air concentrations. The weather data and receptor grid previously prepared for the Class I and Class II Ambient Air Impact Analyses were used for this modeling scenario.

The maximum projected 1-hour averaging time concentration was 6.61 µg/m3 (9.44 ppb). This conservative value is less than the odor threshold for ammonia of 3.5 mg/m^3 (5 ppm) as published by Agency for Toxic Substances and Disease Registry (ATSDR). As such, the anticipated ammonia emissions will not exceed the detectable ammonia odor threshold.

10.0 PSD CLASS I AREA IMPACT ANALYSIS RESULTS

Under the CAA, the Federal Land Managers (FLMs) and the federal official with direct responsibility for management of Federal Class I parks and wilderness areas (i.e., park superintendent, refuge manager, forest supervisor) have affirmative responsibility to protect the air quality-related values (AQRVs) (including visibility) of such lands and consider whether a proposed major emitting facility will have an adverse impact on such values. The FLMs' decision regarding whether there is an adverse impact is then conveyed to the permitting authority (usually a state agency) for consideration in its determinations regarding the permit. The permitting authority's determinations generally consider a wide range of factors, including the potential impact of the new source or major modification on the AQRVs of Class I areas, if applicable.

This section provides the results of the air quality assessment at two PSD Class I areas: the Shenandoah National Park (NP) and Brigantine National Wildlife Area (NWA) as shown in Figure 8. Section 8.0 previously addressed facility air quality impacts in the vicinity of the site.

Shenandoah NP and Brigantine NWA are located within 300 km of the facility site. The PSD Class I area nearest to the site is the Brigantine NWA located approximately 113 km north- west of the site. The Shenandoah NP is located approximately 225 km west of the site at its closet point. The Class I impact analyses addresses these two PSD Class I areas.

10.1 INITIAL SCREENING ANALYSIS

For new sources that will be located at a distance of 50 km or greater from a Class I area, the Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase 1 Report (revised 2010) guidance on initial screening criteria recommends using the ratio of potential project emissions rates divided by the project's distance from a Class I area (i.e., Q/D or 10D Rule) to determine whether an assessment of Class I area AQRVs is necessary. Potential project emissions (i.e., Q) include SO_2, NO_2, PM_{10}, and H_2SO_4 mist annual emissions in tons per year (tpy), based on 24-hour maximum allowable emissions. The distance (i.e., D) is the distance in kilometers from the Class I area. For cases in which the source is located more than 50 km and has a calculated Q/D ratio of 10 or less, the FLMs will consider the source to have negligible impacts with respect to Class I AQRVs and would not request further Class I AQRV impact analyses for such sources.

A Q/D ratio was calculated for the Wolf 1 CHP using the potential emissions of the facility (based on 8,760 hours of operation at the maximum load, which is representative of the 24-hour maximum allowable emissions as required by the FLM screening guidance) and the nearest distance to each of the two Class I areas located within 300 km of the Wolf 1 CHP project site. Table 10-1 summarizes the facility's NO_2, SO_2, H_2SO_4 mist, and PM potential annual emissions (tpy), the distance to each Class I area (km), and the calculated Q/D ratio for each Class I area.

Table 10-1. PSD Class I Area Initial Screen Analysis

Subject	NOx	SO_2	H_2SO_4	PM	Total Annual Emissions (Q)
TDC Full Bore PTE emissions	73.96 tpy	10.34 tpy	8.63 tpy	97.56 tpy	190.49 tpy
Class I Entity	Brigantine National Wildlife Refuge			Shenandoah National Park	
Distance from TDC (D)	97		km	212	km
Q/D screening ratio	1.96 Ton/yr-km			0.90 Ton/yr-km	

The calculated Q/D ratios are below the FLM threshold of 10; therefore, further Class I AQRV analyses are not required in accordance with the FLAG guidance. The United States Fish and Wildlife Service indicated in their response to the modeling protocol that "based on the emissions and distance from the Brigantine Wildness [area], the USFWS anticipates that modeling would not show any significant additional impacts to the AQRV at the Class I area."

10.2 GENERAL APPROACH

Generally, Class I area impact assessments are conducted using the CALPUFF dispersion model because steady state dispersion models like AERMOD are not suitable for predicting air quality at distances greater than 50 km. CALPUFF is used to predict air quality at receptors located at Class I areas which may be up to 300 km from a proposed emissions source. Due to the low total expected emissions from TDC however, AERMOD was used to predict air quality at a distance of 50 km from TDC. These results were compared to the Class I SILs.

10.3 MODEL SELECTION AND USE

AERMOD was used to model predicted air quality impact at receptors located at a 50 km radius from the proposed TDC site. The same weather data used for the Class II impact analysis was used for this Class I impact analysis. This Class I impact analysis was conducted for two operating cases, the full capacity operating case and the island mode operating case. The sources, stack parameters, and emission rates used in the Class II impact analysis for those cases were also used for the applicable Class I impact analysis operating cases.

10.4 MODEL RESULTS

The modeling results for the full capacity operating case are provided in Table 10-2. The modeling results for the island mode operating case are provided in Table 10-3. Neither the predicted PM_{10} annual averaging time nor predicted 24 hour averaging time concentrations exceed the applicable Class I SILs for either operating case. The predicted NO_x annual averaging time concentrations for both operating cases do not exceed the applicable Class I SIL either. Based upon these results at 50 km, no Class I SILs are anticipated to be exceeded at Shenandoah NP and Brigantine NWA.

Table 10-2. Class I Impact Analysis Modeling Results for Full Capacity Operating Case

Parameter	PM10 Annual	PM10 24 Hour	NOx Annual
Maximum Predicted Concentration (µg/m^3)	0.0042	0.15	0.0029
Location (UTM Coordinates)	467014.71, 4352878.74	429853.97, 4440423.95	467014.71, 4352878.74
PSD Class I SIL (µg/m^3)	0.2	0.3	0.1
SIL Exceeded?	No	No	No

Table 10-3. Class I Impact Analysis Modeling Results For Island Mode Operating Case

Parameter	PM10 Annual	PM10 24 Hour	NOx Annual
Maximum Predicted Concentration (µg/m^3)	0.0031	0.10	0.0021
Location (UTM Coordinates)	467668.29, 4353456.98	462171.41, 4432066.10	467668.29, 4353456.98
PSD Class I SIL (µg/m^3)	0.2	0.3	0.1
SIL Exceeded?	No	No	No

FIGURES

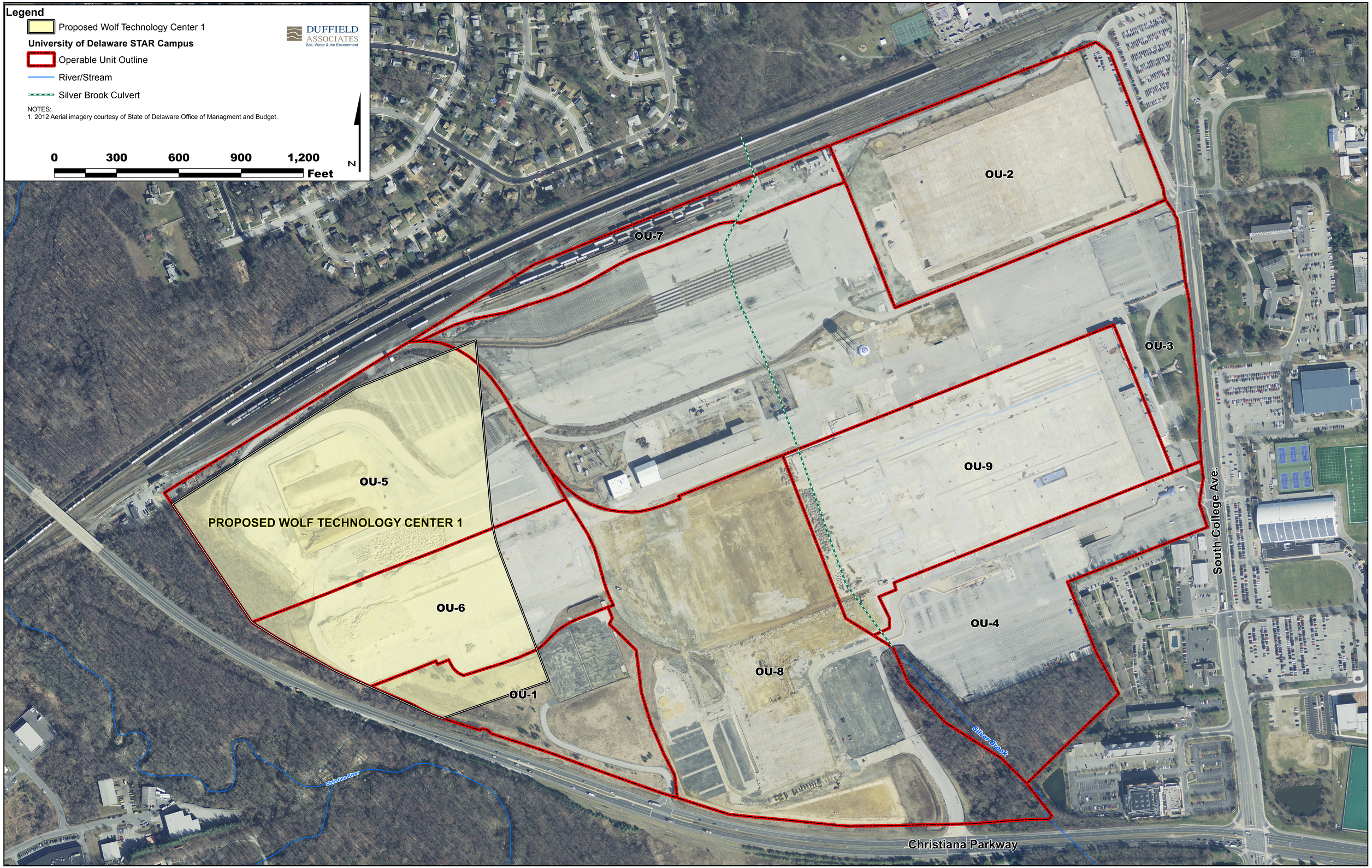
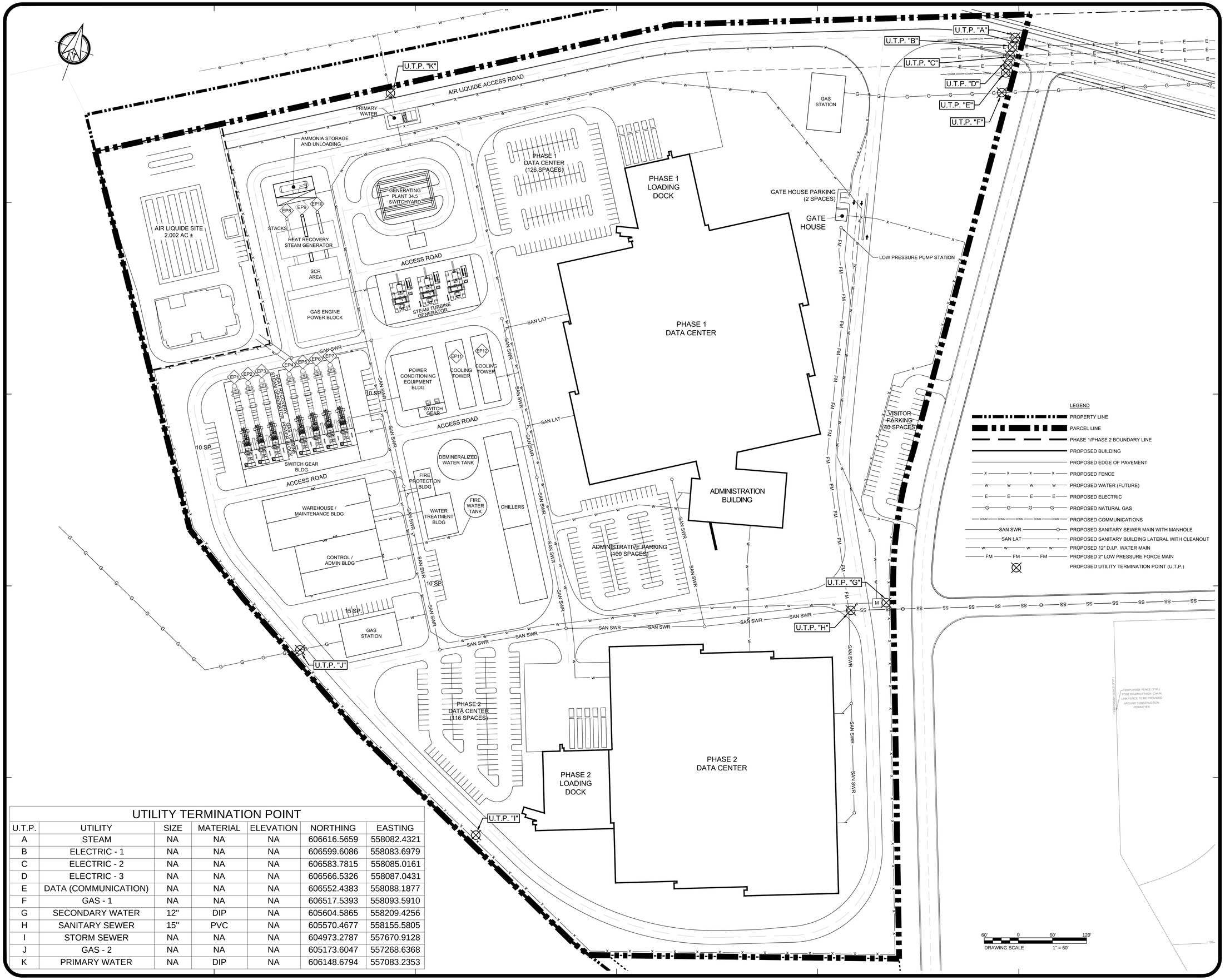

Legend
Proposed Wolf Technology Center 1
University of Delaware STAR Campus
Operable Unit Outline
River/Stream
Silver Brook Culvert
NOTES:
1. 2012 Aerial imagery courtesy of State of Delaware Office of Managment and Budget.
DUFFIELD ASSOCIATES
Soil, Water & the Environment
0
300
600
900
1,200
Feet
N
OU-2
OU-7
OU-3
OU-9
OU-5
PROPOSED WOLF TECHNOLOGY CENTER 1
OU-6
OU-4
OU-8
OU-1
Silver Brook
Christina River
South College Ave.
Christiana Parkway

Figure 1



UTILITY TERMINATION POINT

U.T.P.	UTILITY	SIZE	MATERIAL	ELEVATION	NORTHING	EASTING
A	STEAM	NA	NA	NA	606616.5659	558082.4321
B	ELECTRIC - 1	NA	NA	NA	606599.6086	558083.6979
C	ELECTRIC - 2	NA	NA	NA	606583.7815	558085.0161
D	ELECTRIC - 3	NA	NA	NA	606566.5326	558087.0431
E	DATA (COMMUNICATION)	NA	NA	NA	606552.4383	558088.1877
F	GAS - 1	NA	NA	NA	606517.5393	558093.5910
G	SECONDARY WATER	12"	DIP	NA	605604.5865	558209.4256
H	SANITARY SEWER	15"	PVC	NA	605570.4677	558155.5805
I	STORM SEWER	NA	NA	NA	604973.2787	557670.9128
J	GAS - 2	NA	NA	NA	605173.6047	557268.6368
K	PRIMARY WATER	NA	DIP	NA	606148.6794	557083.2353

DUFFIELD ASSOCIATES
5400 LIMESTONE ROAD
WILMINGTON, DE 19808-1232
TEL: (302)239-6634
FAX: (302)239-8485
OFFICES IN DELAWARE, MARYLAND, PENNSYLVANIA AND NEW JERSEY
E-MAIL: DUFFIELD@DUFFNET.COM

CHECKED BY:
DESIGNED BY: VJM
DRAWN BY: EJP/JJL
FILE NAME: F18UCSITE PLAN.dwg

No.	REVISION	CHKD BY DATE
-		

OWNER:

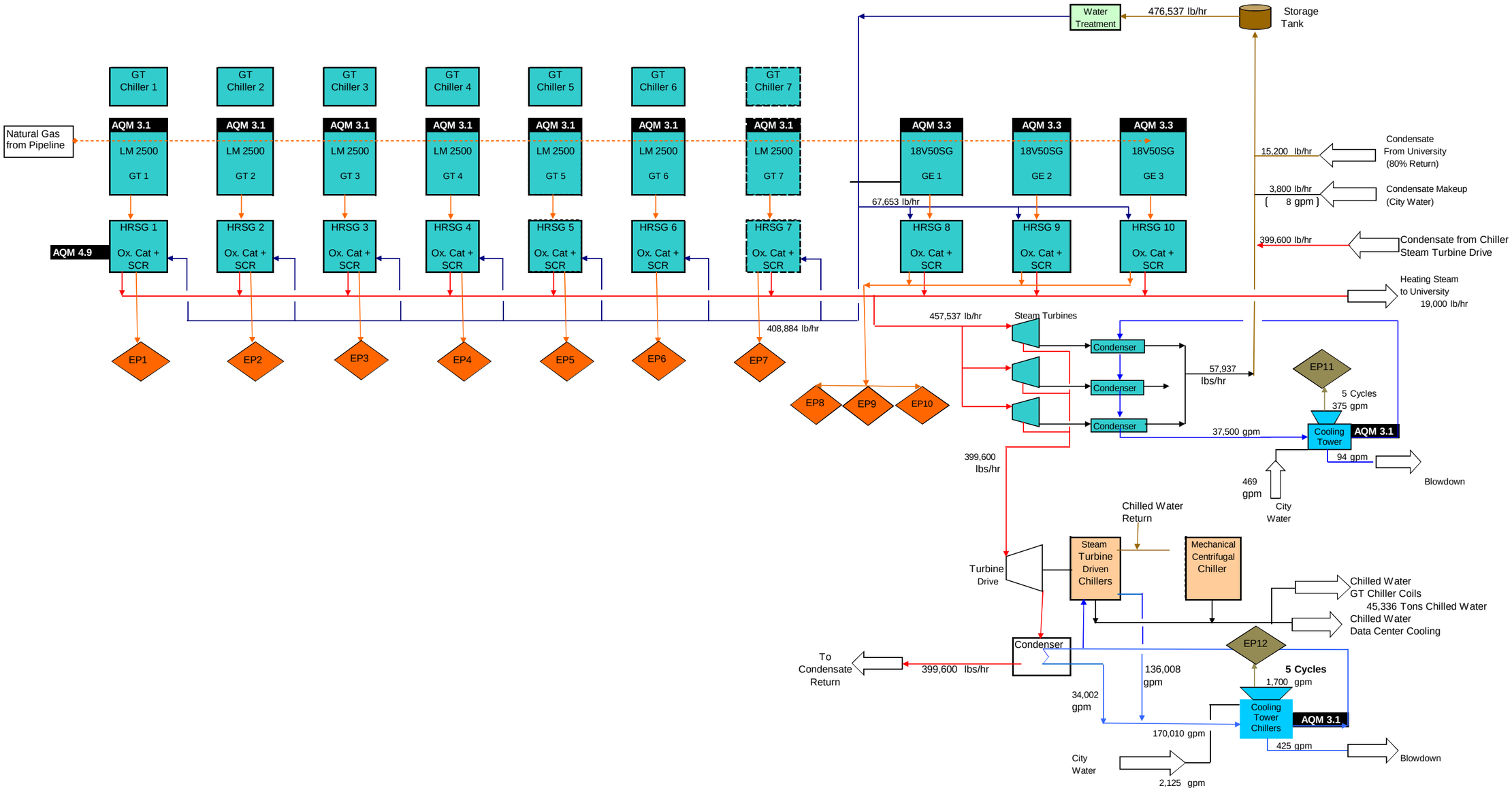
Figure 2

SITE PLAN/UTILITY PLAN

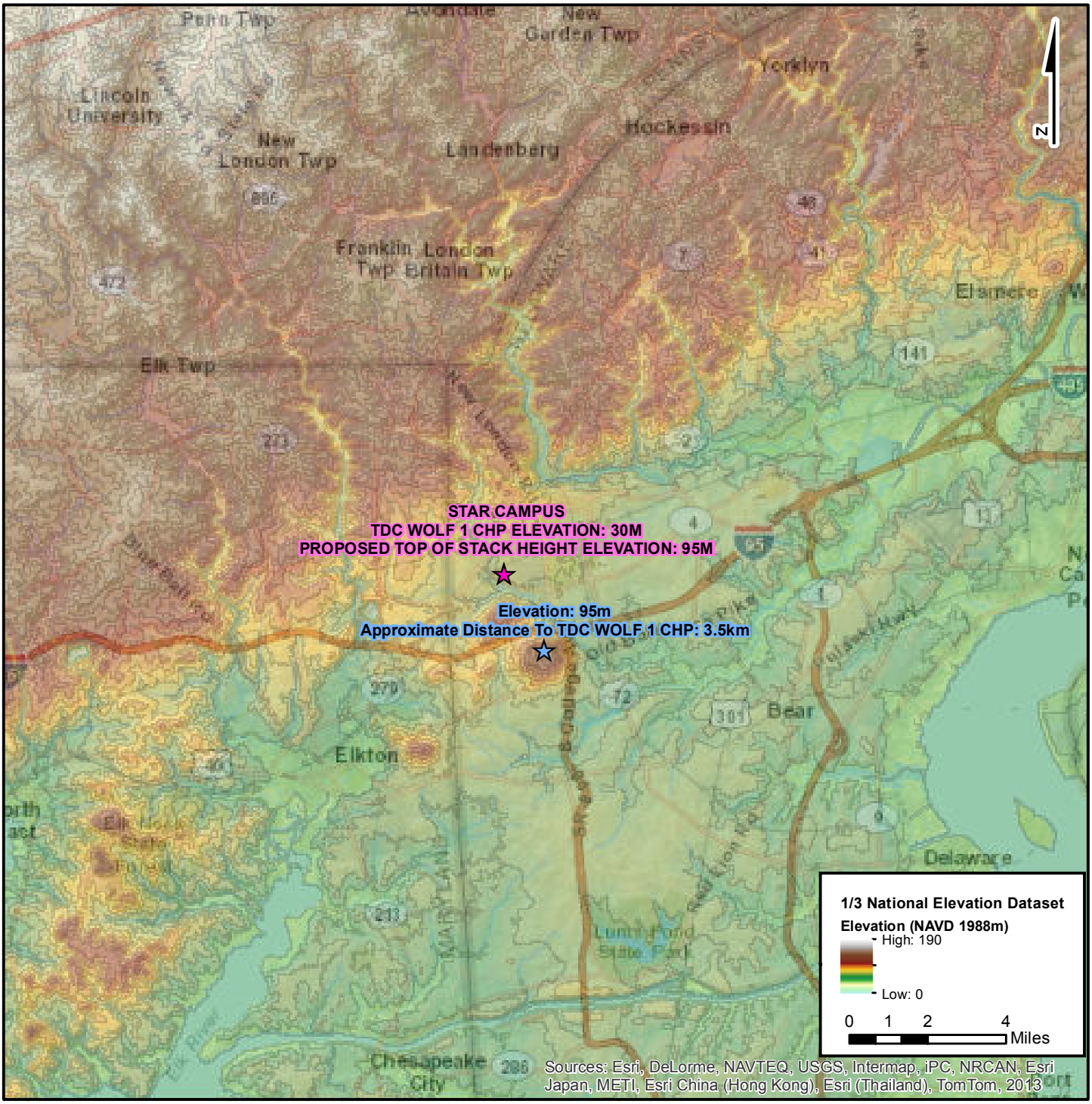
UD STAR CAMPUS DATA CENTER

CITY OF NEWARK ~ NEW CASTLE COUNTY ~ DELAWARE

DATE: 06 SEPTEMBER 2013
SCALE: 1" = 60'
PROJECT NO. 8718.CI
SHEET: 1 OF 1



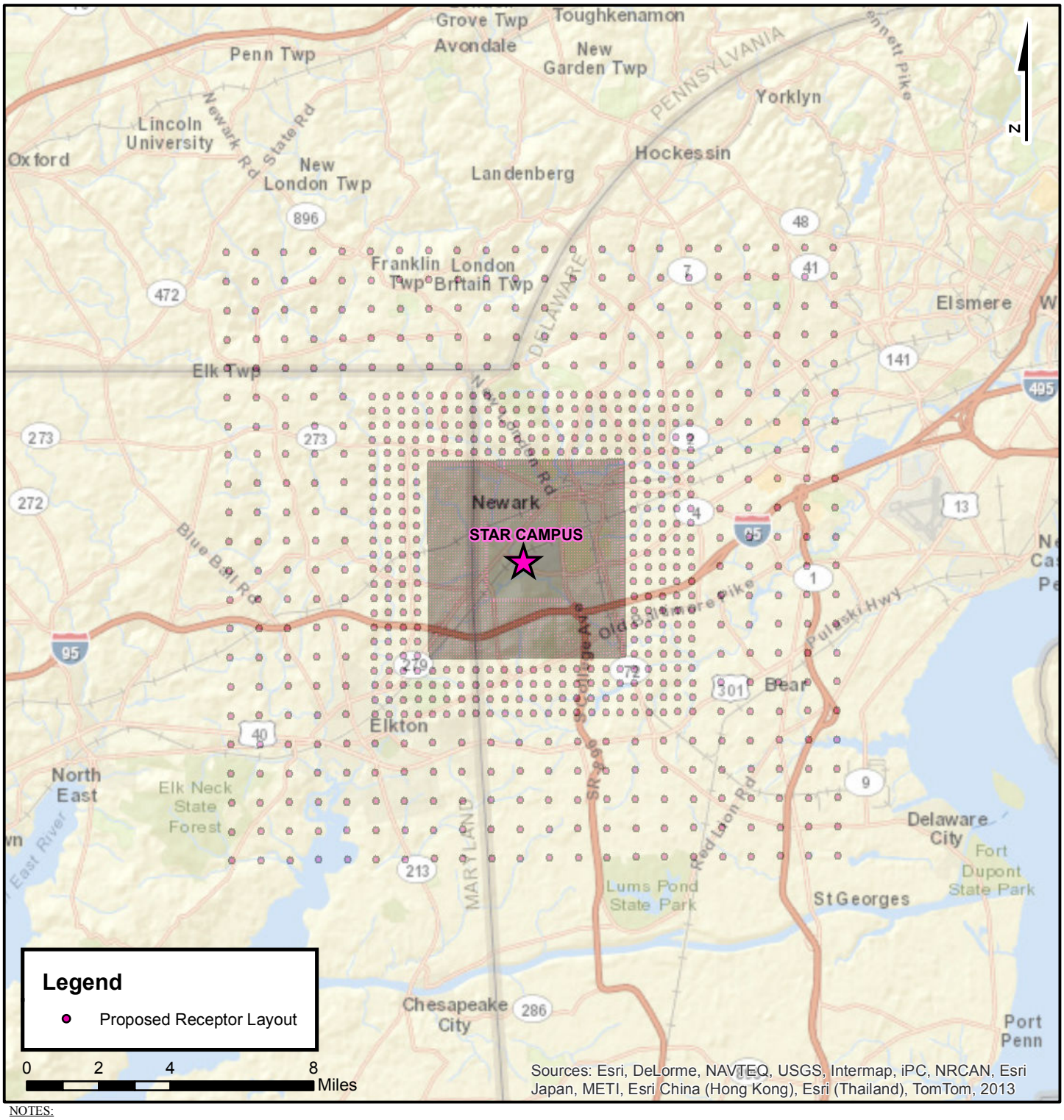
Drawing Release Record					Project No.:	Process Flow Diagram for Combined Heat & Power Plant Wolf Technology Center 1 Summer Extreme Ambient, N + 2 Running Basic Cycle Schematic	Ambient Conditions Site Elevation: 125.0 ft AMSL Dry Bulb Temperature: 98.4 °F Relative Humidity: 50.0 %	Sargent & Lundy LLC	FIGURE 3
Rev.	Date	Prepared By	Reviewed By	Approved By					
0	9-Jul-2013	M. Rosen			13119-000				
1	August 1,2013	J. Smith							
2	28-Aug-13	M. Panhuise (Duffield)							



NOTES:

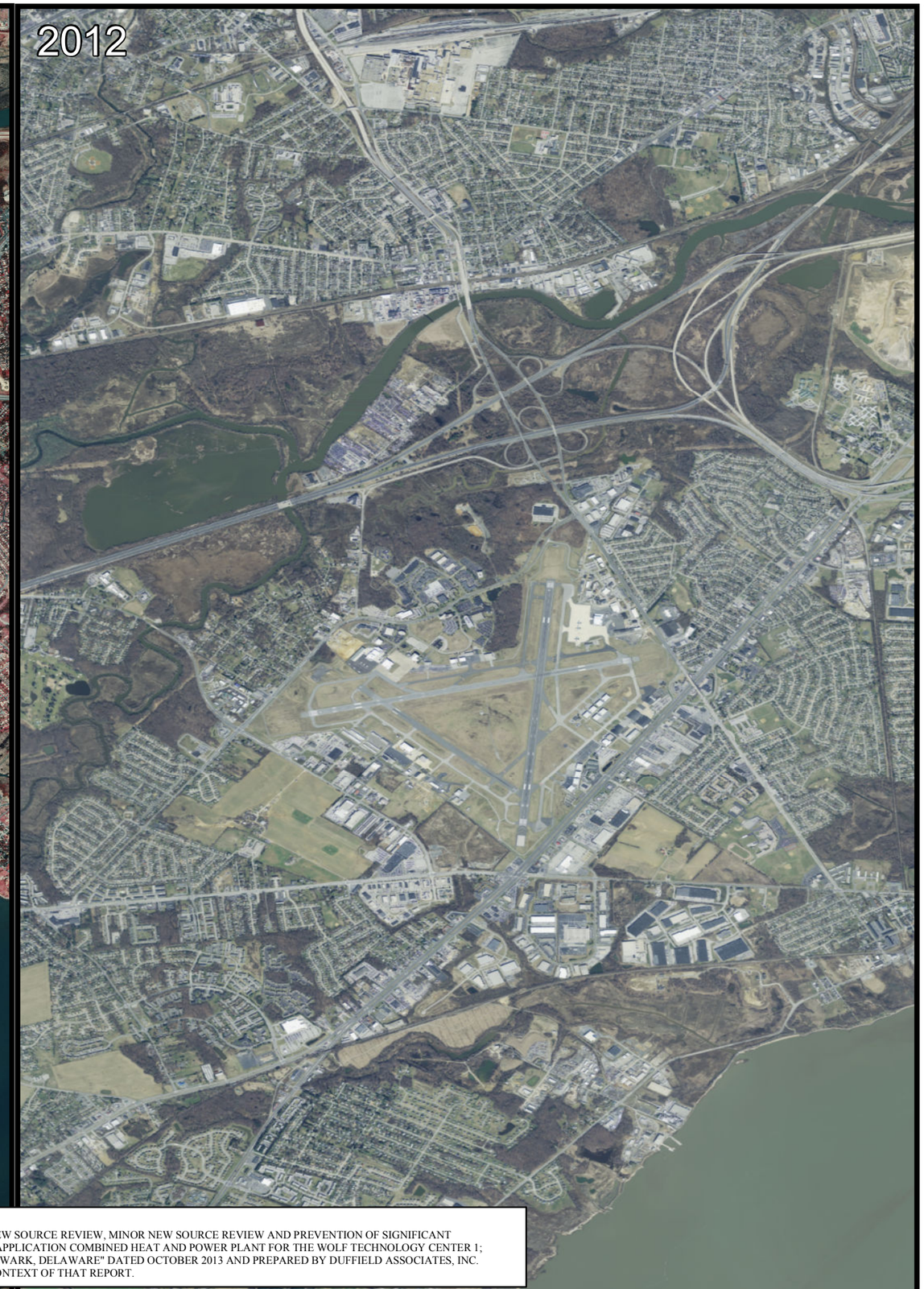
1. THIS SKETCH IS PART OF A REPORT TITLED "NONATTAINMENT NEW SOURCE REVIEW, MINOR NEW SOURCE REVIEW AND PREVENTION OF SIGNIFICANTDETERIORATION REVIEW AIR QUALITY CONSTRUCTION PERMIT APPLICATION COMBINED HEAT AND POWER PLANT FOR THE WOLF TECHNOLOGY CENTER 1," DATED NOVEMBER 2013 AND PREPARED BY DUFFIELD ASSOCIATES, INC. AND AS SUCH, THIS SKETCH SHOULD ONLY BE VIEWED IN THE CONTEXT OF THAT REPORT
2. 1/3 NATIONAL ELEVATION DATASET OBTAINED FROM THE USGS SEAMLESS SERVER WEB MAPPING SERVICE

DATE: SEPTEMBER 2013	REGIONAL TERRAIN MAP	DESIGNED BY: MFP	DUFFIELD ASSOCIATES
SCALE: 1 in = 4 miles	**TDC WOLF 1 CHP**	DRAWN BY: MPN	5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485
PROJECT NO. 9718.CI	**AIR MODELING PROTOCOL**	CHECKED BY: MFP	OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY
SHEET: FIGURE 4	NEWARK~NEW CASTLE COUNTY~DELAWARE	FILE: 8718CI_TerrainMap.MXD	EMAIL: DUFFIELD@DUFFNET.COM



NOTES:
THIS SKETCH IS PART OF A REPORT TITLED "NONATTAINMENT NEW SOURCE REVIEW, MINOR NEW SOURCE REVIEW AND PREVENTION OF SIGNIFICANT DETERIORATION REVIEW AIR QUALITY CONSTRUCTION PERMIT APPLICATION COMBINED HEAT AND POWER PLANT FOR THE WOLF TECHNOLOGY CENTER 1; SCIENCE, TECHNOLOGY, AND ADVANCED RESEARCH CAMPUS NEWARK, DELAWARE" DATED OCTOBER 2013 AND PREPARED BY DUFFIELD ASSOCIATES, INC. AND AS SUCH, THIS SKETCH SHOULD ONLY BE VIEWED IN THE CONTEXT OF THAT REPORT.

DATE: JULY 2013	AMBIENT AIR RECEPTOR GRID	DESIGNED BY: MFP	DUFFIELD ASSOCIATES
SCALE: 1 in = 4 miles	**WOLF 1 CHP**	DRAWN BY: MPN	5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485
PROJECT NO. 8718.CI		CHECKED BY: MFP	OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY
SHEET: FIGURE 5	NEWARK~NEW CASTLE COUNTY~DELAWARE	FILE: 8718CI_ReceptorMap.mxd	EMAIL: DUFFIELD@DUFFNET.COM



NOTES:
THIS SKETCH IS PART OF A REPORT TITLED "NONATTAINMENT NEW SOURCE REVIEW, MINOR NEW SOURCE REVIEW AND PREVENTION OF SIGNIFICANT DETERIORATION REVIEW AIR QUALITY CONSTRUCTION PERMIT APPLICATION COMBINED HEAT AND POWER PLANT FOR THE WOLF TECHNOLOGY CENTER 1; SCIENCE, TECHNOLOGY, AND ADVANCED RESEARCH CAMPUS NEWARK, DELAWARE" DATED OCTOBER 2013 AND PREPARED BY DUFFIELD ASSOCIATES, INC. AND AS SUCH, THIS SKETCH SHOULD ONLY BE VIEWED IN THE CONTEXT OF THAT REPORT.

DUFFIELD ASSOCIATES
Soil, Water & the Environment

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TEL. (302)239-6634
FAX (302)239-8485

OFFICES IN DELAWARE, MARYLAND, PENNSYLVANIA, AND NEW JERSEY

E-MAIL: DUFFIELD@DUFFNET.COM

BASEMAP:
DELAWARE DEMAC

DRAWN BY:
MPN

CHECKED BY:
MFP

FILE:
8718CI_LANDUSECOVER.MXD

LAND USE COVER

WOLF 1 CHP

AIR MODELING PROTOCOL

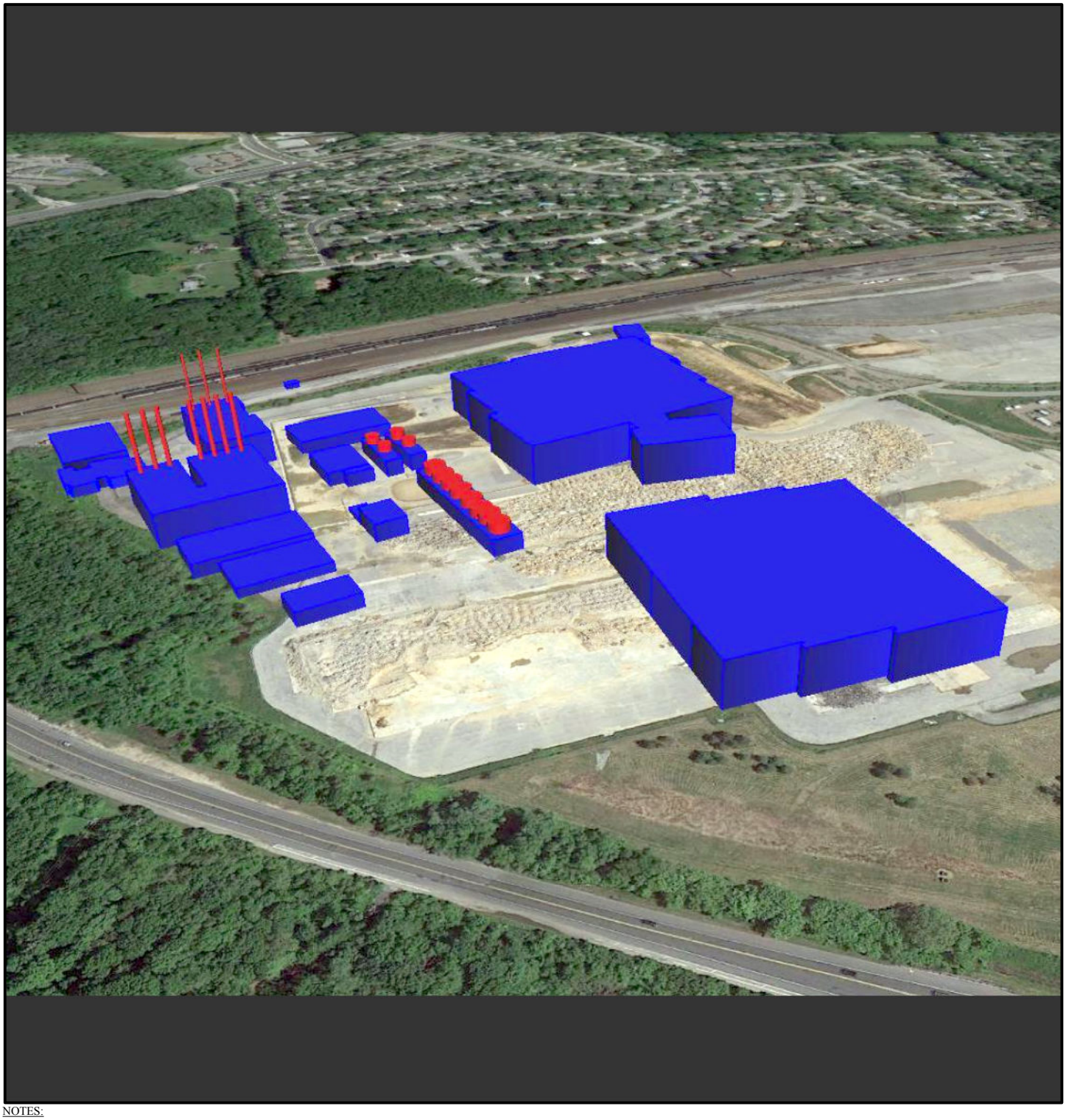
NEWARK-NEW CASTLE COUNTY-DELAWARE

DATE:
SEPTEMBER 2013

SCALE:
1 in = 1 miles

PROJECT NO.
8718.CL

SHEET:
FIGURE 6



NOTES:
THIS SKETCH IS PART OF A REPORT TITLED "NONATTAINMENT NEW SOURCE REVIEW, MINOR NEW SOURCE REVIEW AND PREVENTION OF SIGNIFICANT DETERIORATION REVIEW AIR QUALITY CONSTRUCTION PERMIT APPLICATION COMBINED HEAT AND POWER PLANT FOR THE WOLF TECHNOLOGY CENTER 1; SCIENCE, TECHNOLOGY, AND ADVANCED RESEARCH CAMPUS NEWARK, DELAWARE" DATED OCTOBER 2013 AND PREPARED BY DUFFIELD ASSOCIATES, INC. AND AS SUCH, THIS SKETCH SHOULD ONLY BE VIEWED IN THE CONTEXT OF THAT REPORT.

DATE: NOVEMBER 2013	THREE-DIMENSIONAL VIEW OF MAJOR BUILDINGS/STRUCTURES	DESIGNED BY: MFP	DUFFIELD ASSOCIATES
SCALE:	**WOLF 1 CHP**	DRAWN BY: MPN	5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485
PROJECT NO. 8718.CI		CHECKED BY: MFP	OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY
SHEET: FIGURE 7	NEWARK~NEW CASTLE COUNTY~DELAWARE	FILE: FigureX_8718CI_3DMajorBuilding Sketch.mxd	EMAIL: DUFFIELD@DUFFNET.COM

NOTES:
THIS SKETCH IS PART OF A REPORT TITLED "THE DATA CENTERS, LLC - WOLF 1 CHP AIR QUALITY IMPACT ANALYSIS MODELING PROTOCOL," DATED SEPTEMBER 2013 AND PREPARED BY DUFFIELD ASSOCIATES, INC. AND AS SUCH, THIS SKETCH SHOULD ONLY BE VIEWED IN THE CONTEXT OF THAT REPORT.

DATE: SEPTEMBER 2013	CLASS 1 AREAS	DESIGNED BY: MFP	DUFFIELD ASSOCIATES
SCALE: 1 in = 74 miles	**TDC WOLF 1 CHP**	DRAWN BY: MPN	5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485
PROJECT NO. 8718.CI	**AIR MODELING PROTOCOL**	CHECKED BY: MFP	OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY
SHEET: FIGURE 8	NEWARK~NEW CASTLE COUNTY~DELAWARE	FILE: 8718CI_Class1Areas.MXD	EMAIL: DUFFIELD@DUFFNET.COM

APPENDIX A

AQM FORMS

Administrative Information

If you are using this form electronically, press F1 at any time for help
All Application Forms Should Be Mailed To:
Air Quality Management
Blue Hen Corporate Center
655 S. Bay Road, Suite 5 N
Dover, DE 19901

All Checks Should Be Made Payable To:
State of Delaware

For Department Use Only

Date Received Stamp | Assigned Permit Number

Company and Site Information

1.	Company Name: **The Data Centers, LLC**
2.	Company Mailing Address: **1554 Paoli Pike Suite 325** City: **West Chester** State: **PA** Zip Code: **19380**
3.	Site Name: **Wolf 1 CHP Data Center**
4.	Site Mailing Address: **550 South College Avenue c/o The Data Centers, LLC** *(if different from above)* City: **Newark** State: **DE** Zip Code: **19710**
5.	Physical Location of Site: **550 South College Avenue** *(if different from above)* City: **Newark** State: **DE** Zip Code: **19710**
6.	Air Quality Management Facility ID Number: **N/A**
7.	Site NAICS Code): **221112, 518210** *(list all that apply*
8.	Site SIC Code: : **4911, 7374** *(list all that apply)*
9.	Site Location Coordinates: **lat 39.663417 lon -75.767191**
10.	Is the Facility New or Existing? ☒ NEW ☐ EXISTING
If the Facility is an Existing Facility, Complete the Rest of Question 10. If Not, Proceed to Question 11.	
10.1.	Does the Facility Have Active Air Permits? ☐ YES ☐ NO

Company and Site Information

11. Is this Application For a New Source or Modification of an Existing Source?
☒ New Source
☐ Modification of Existing Source
☐ Other (Specify):

If the application is for the modification of an existing source, complete the rest of Question 11. If not, proceed to Question 12.

11.1. Does the Source Have an Active Air Permit? ☐ YES ☐ NO

If the source has an active air permit, complete the rest of Question 11. If not, proceed to Question 12.

11.2. Permit Number of Existing Source:

12. Status of Source Being Applied For: ☐ Natural Minor Source ☐ Synthetic Minor Source ☒ Major Source

13. Facility Status: ☐ Natural Minor Facility ☐ Synthetic Minor Facility ☒ Major Facility

If the source is a Major Source, complete the rest of Question 13. If not, proceed to Question 14.

13.1. Responsible Official Name: **Cole Bauer**

13.2. Responsible Official Title: **Vice President - Site Engineering**

Contact Information

14. Name of Owner or Facility Manager: **Cole Bauer**

15. Title of Owner or Facility Manager: **Vice President - Site Engineering**

16. Permit Contact Name: **Cole Bauer**

17. Permit Contact Title: **Vice President - Site Engineering**

18. Permit Contact Telephone Number: **610-675-6230**

19. Permit Contact Fax Number: **610-672-9675**

20. Permit Contact E-Mail Address: **cole.bauer@thedatacenters.com**

Proposed Operating Schedule

21. Proposed Operating Schedule: **24** hours/day **7** days/week **52** weeks/year

21.1. Is There Any Additional Information Regarding the Operating Schedule? ☒ YES ☐ NO

If YES, complete the rest of Question 21. If NO, proceed to Question 22.

21.2. Describe the Additional Information: **Some of the facility equipment will be operating at all times and producing air emissions as there will always be a demand imposed by the data ceneter for the energy produced. Some of the operating equipment will be operated in response to the varying portion of energy demands. Each unit of equipment will be shutdown at separate times during a year so that maintenance can be performed.**

Coastal Zone Information

22. Is the Facility Located in the Coastal Zone? ☐ YES ☒ NO

If the facility is located in the Coastal Zone complete the rest of Question 22. If not, proceed to Question 23.

22.1. Is a Coastal Zone Permit Required for Construction or Operation of the Source Being Applied for? ☐ YES ☐ NO

Attach a copy of the Coastal Zone Determination if it has not been previously submitted

If a Coastal Zone Permit is required complete the rest of Question 22. If not, proceed to Question 23.

22.2. Has a Coastal Zone Permit Been Issued? ☐ YES ☐ NO

Attach a copy of the Coastal Zone Permit if it has not been previously submitted

Local Zoning Information

23. Parcel Zoning: **City of Newark, 18STC - SCIENCE & TECHNOLOGY CAMPUS**

Attach Proof of Local Zoning if it has not been previously submitted

Application Information

24. Is the Appropriate Application Fee Attached? ☒ YES ☐ NO

25. Is the Advertising Fee Attached? ☒ YES ☐ NO

Attach the appropriate fees. Note that your Application will not be considered complete if the appropriate fees are not included.

26. Is a Cover Letter Describing the Process Attached? ☒ YES ☐ NO

Attach a brief cover letter describing your Application.

If the Facility is a New Facility complete Question 27. If not, proceed to Question 28.

27. Is a Copy of the Applicant Background Information Questionnaire on Record at the Department? ☐ YES ☒ NO

If NO, complete the rest of Question 27. If YES, process to Question 28.

27.1 Is a Copy of the Applicant Background Information Questionnaire Attached? ☒ YES ☐ NO

Attach a copy of the Applicant Background Information Questionnaire if applicable.

28. Check Which Application Forms are Attached:

☒ AQM-1	☐ AQM-3.4	☐ AQM-3.9	☐ AQM-3.14	☐ AQM-4.4	☒ AQM-4.9	☒ AQM-6
☒ AQM-2	☐ AQM-3.5	☐ AQM-3.10	☐ AQM-3.15	☐ AQM-4.5	☐ AQM-4.10	
☒ AQM-3.1	☐ AQM-3.6	☐ AQM-3.11	☐ AQM-4.1	☐ AQM-4.6	☐ AQM-4.11	
☐ AQM-3.2	☐ AQM-3.7	☐ AQM-3.12	☐ AQM-4.2	☐ AQM-4.7	☐ AQM-4.12	
☒ AQM-3.3	☐ AQM-3.8	☐ AQM-3.13	☐ AQM-4.3	☐ AQM-4.8	☒ AQM-5	

Application Information

29. Check Which Documents are Attached:

- ☐ Coastal Zone Determination
- ☐ Coastal Zone Permit
- ☒ Proof of Local Zoning
- ☒ Application Fee
- ☒ Advertising Fee
- ☐ Applicant Background Information Questionnaire
- ☐ Claim of Confidentiality
- ☒ Manufacturer Specification(s)
- ☒ Material Safety Data Sheets (MSDSs)
- ☒ Supporting Calculations
- ☒ Descriptive Cover Letter
- ☒ Other (Specify): **Facility Diagram**

Confidentiality Information

30. Do You Consider Any of the Information Submitted With this Application Confidential? ☒ YES ☐ NO Only the Environment Permit Application Background Statement

If a Claim of Confidentiality is made it MUST meet the requirements of Section 6 of DNREC's Freedom of Information ("FOIA") Regulation at the time the Application is submitted.

Signature Block

I, the undersigned, hereby certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all of its attachments as to the truth, accuracy, and completeness of this information. I certify based on information and belief formed after reasonable inquiry, the statements and information in this document are true, accurate, and complete. By signing this form, I certify that I have not changed, altered, or deleted any portions of this application. I acknowledge that I cannot commence construction, alteration, modification or initiate operation until I receive written approval (i.e. permit, registration, or exemption letter) from the Department. I acknowledge that I may be required to perform testing of the equipment to receive construction or operation approval, and that if I do not receive approval to construct or operate that I may appeal the decision.

Cole Bauer
Owner or Authorized Agent

10/30/13
Date

Cole Bauer
Signature of Owner or Authorized Agent

All Application Forms Should Be Mailed To:
Air Quality Management
Blue Hen Corporate Center
655 S. Bay Road, Suite 5 N
Dover, Delaware 19901

All Checks Should Be Made Payable To:
State of Delaware

Process Flow Diagram

Sketch the Process Flow Diagram for the equipment or process being applied for. Include each emission unit and control device (even existing emission units that will not be modified by this application). You may identify each emission unit with a simple shape. Label each emission unit and control device with a unique identifier. Show the relationship between each emission unit and/or control device by drawing arrows between them to indicate the flow of air pollutants. List which application forms are included for each emission unit or control device below the shape representing each emission unit or control device . See http://www.delaware.gov/reg2/default.htm for example Process Flow Diagrams for common processes. If you already have a Process Flow Diagram for the equipment or process being applied for, you may attach it to the application instead of using this form.

See attached sketch titled, “Process Flow Diagram for Combined Heat and Power Plant, Wolf Technology Center 1, Summer Extreme Ambient, N+2 Running, Basic Cycle Schematic”

Generic Process Equipment Application

If you are using this form electronically, press F1 at any time for help

General Information

1.	Facility Name: **Wolf Technology Center 1**
2.	Equipment ID Number: **Chiller Tower and Steam Turbine Cooling Tower**
3.	Provide a brief description of Equipment or Process: **Two cooling towers will be used. Steam Turbine Cooling Tower is for cooling water from the steam condensers (Steam Turbine Tower). Chiller Tower is associated with condensers from the steam driven chiller unit.**
4.	Manufacturer: **TBD**
5.	Model: **TBD**
6.	Serial Number: **TBD**

Raw Material Information

7. Raw Materials Used in Process

If there are more than four Raw Materials used, attach additional copies of this page as needed.

	Raw Material Used	CAS Number	Usage Rate (include units)	MSDS Attached?
7.1.	**United Water (makeup water)**	**7732-18-5**	**2,594 gpm**	☐ YES ☒ NO
7.2.				☐ YES ☐ NO
7.3.				☐ YES ☐ NO
7.4.				☐ YES ☐ NO

Attach a copy of all calculations made to support the data in the table above.
Attach a Material Safety Data Sheet (MSDS) for each Raw Material used.

Products Produced Information

8. Products Produced

If there are more than four Products Produced, attach additional copies of this page as needed.

	Product Produced	CAS Number	Production Rate (include units)	MSDS Attached?
8.1.	**N/A**			☐ YES ☐ NO
8.2.				☐ YES ☐ NO
8.3.				☐ YES ☐ NO
8.4.				☐ YES ☐ NO

Attach a copy of all calculations made to support the data in the table above.
Attach a Material Safety Data Sheet (MSDS) for each Product Produced.

Byproducts Generated Information

9. Byproducts Generated

If there are more than four Byproducts Generated, attach additional copies of this page as needed.

	Byproduct Generated	CAS Number	Generation Rate (include units)	MSDS Attached?
9.1.				☐ YES ☐ NO
9.2.				☐ YES ☐ NO
9.3.				☐ YES ☐ NO
9.4.				☐ YES ☐ NO

Attach a copy of all calculations made to support the data in the table above.
Attach a Material Safety Data Sheet (MSDS) for each Byproduct Generated.

General Information

10. Manufacturer's Rated Capacity or Maximum Throughput of Equipment or Process:
Recirculation Rate:
Steam Turbine Cooling Tower = 37,500 gallons per minute
Chiller Tower = 170,010 gallons per minute
Combined recirculating rate = 207,510 gallons per minute

11. Describe Important Manufacturer Specifications and/or Operating Parameters for Equipment or Process: **Not Available**

Attach the Manufacturer's Specification Sheet(s) for the equipment or process.

Control Device Information

12. Is an Air Pollution Control Device Used? ☒ YES ☐ NO

If an Air Pollution Control Device is used, complete the rest of Question 12. If not, proceed to Question 13.

12.1. Is Knockout Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.11 and attach it to this application.

12.2. Is a Settling Chamber Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.10 and attach it to this application.

12.3. Is an Inertial or Cyclone Collector Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.5 and attach it to this application.

12.4. Is a Fabric Collector or Baghouse Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.6 and attach it to this application.

12.5. Is a Venturi Scrubber Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.8 and attach it to this application.

12.6. Is an Electrostatic Precipitator Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.7 and attach it to this application.

Control Device Information

12.7. Is Adsorption Equipment Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.2 and attach it to this application.

12.8. Is a Scrubber Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.4 and attach it to this application.

12.9. Is an Incinerator, Afterburner or Oxidizer Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.1 and attach it to this application.

12.10. Is a Flare Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.3 and attach it to this application.

12.11. Is Any Other Control Device Used? ☒ YES ☐ NO

If YES, attach a copy of the control device Manufacturer's Specification Sheet(s).

If any other control device is used, complete the rest of Question 12. If not, proceed to Question 13.

12.12. Describe Control Device: **High efficiency drift eliminators on both cooling towers**

12.13. Pollutants Controlled: ☐ VOCs ☐ HAPs ☒ PM ☒ PM_{10} ☒ $PM_{2.5}$ ☐ NO_X ☐ SO_X ☐ Metals
☐ Other (Specify):

12.14. Control Device Manufacturer: **TBD**

12.15. Control Device Model: **TBD**

12.16. Control Device Serial Number: **TBD**

12.17. Control Device Design Capacity: **N/A**

12.18. Control Device Removal or Destruction Efficiency: **approximately 99.9995 or greater**

Stack Information

13. How Does the Process Equipment Vent:
(check all that apply)
☒ Directly to the Atmosphere
☐ Through a Control Device Covered by Forms AQM-4.1 through 4.12
☐ Through Another Control Device Described on This Form

If any of the process equipment vents directly to the atmosphere or through another control device described on this form, proceed to Question 14. If the process equipment vents through a control device, provide the stack parameters on the control device form and proceed to Question 18.

14. Number of Air Contaminant Emission Points: **2**

If there are more than three Emission Points, attach additional copies of this page as needed.

For the first Emission Point

15. Emission Point Name: **EP11 - Steam Turbine Cooling Tower**

15.1. Stack Height Above Grade: **45 feet**

15.2. Stack Exit Diameter: **26 feet**
(Provide Stack Dimensions If Rectangular Stack)

15.3. Is a Stack Cap Present? ☐ YES ☒ NO

15.4. Stack Configuration: ☒ Vertical ☐ Horizontal ☐ Downward-Venting

Stack Information
(check all that apply) ☐ Other (Specify):
15.5. Stack Exit Gas Temperature: **98 °F**
15.6. Stack Exit Gas Flow Rate: **1699 ACFM**
15.7. Distance to Nearest Property Line: **~480 feet**
15.8. Describe Nearest Obstruction: **Chillers**
15.9. Height of Nearest Obstruction: **45 feet**
15.10. Distance to Nearest Obstruction: **20 feet**
15.11. Are Stack Sampling Ports Provided? ☐ YES ☒ NO
For the second Emission Point. If there is no second Emission Point, proceed to Question 18.
16. Emission Point Name: **EP12 - Chiller Tower**
16.1. Stack Height Above Grade: **45 feet**
16.2. Stack Exit Diameter: **38 feet** *(Provide Stack Dimensions If Rectangular Stack)*
16.3. Is a Stack Cap Present? ☐ YES ☒ NO
16.4. Stack Configuration: ☒ Vertical ☐ Horizontal ☐ Downward-Venting *(check all that apply)* ☐ Other (Specify):
16.5. Stack Exit Gas Temperature: **98 °F**
16.6. Stack Exit Gas Flow Rate: **1803 ACFM**
16.7. Distance to Nearest Property Line: **~480 feet**
16.8. Describe Nearest Obstruction: **Chillers**
16.9. Height of Nearest Obstruction: **45 feet**
16.10. Distance to Nearest Obstruction: **20 feet**
16.11. Are Stack Sampling Ports Provided? ☐ YES ☒ NO
For the third Emission Point. If there is no third Emission Point, proceed to Question 18.
17. Emission Point Name:
17.1. Stack Height Above Grade: **feet**
17.2. Stack Exit Diameter: **feet** *(Provide Stack Dimensions If Rectangular Stack)*
17.3. Is a Stack Cap Present? ☐ YES ☐ NO
17.4. Stack Configuration: ☐ Vertical ☐ Horizontal ☐ Downward-Venting *(check all that apply)* ☐ Other (Specify):
17.5. Stack Exit Gas Temperature: **°F**
17.6. Stack Exit Gas Flow Rate: **ACFM**
17.7. Distance to Nearest Property Line: **feet**
17.8. Describe Nearest Obstruction:
17.9. Height of Nearest Obstruction: **feet**

Stack Information

17.10. Distance to Nearest Obstruction:	**feet**
17.11. Are Stack Sampling Ports Provided?	☐ YES ☐ NO

Monitoring Information

18. Will Emissions Data be Recorded by a Continuous Emission Monitoring System?	☐ YES ☒ NO
If Yes, attach a copy of the Continuous Emission Monitoring System Manufacturer's Specification Sheets	
If YES, complete the rest of Question 18. If NO, proceed to Question 19.	
18.1. Pollutants Monitored:	☐ VOCs ☐ HAPs ☐ PM ☐ PM_{10} ☐ $PM_{2.5}$ ☐ NO_X ☐ SO_X ☐ Metals ☐ Other (Specify):
18.2. Describe the Continuous Emission Monitoring System:	
18.3. Manufacturer:	
18.4. Model:	
18.5. Serial Number:	
18.6. Will Multiple Emission Units Be Monitored at the Same Point?	☐ YES ☐ NO
If YES, complete the rest of Question 18. If NO, proceed to Question 19.	
18.7. Emission Units Monitored:	
18.8. Will More Than One Emission Unit be Emitting From the Combined Point At Any Time?	☐ YES ☐ NO
If YES, complete the rest of Question 18. If NO, proceed to Question 19.	
18.9. Emission Units Emitting Simultaneously:	

Monitoring and Alarm Information

19. Are There Any Alarms You Would Like the Department to Consider When Drafting the Permit?	☐ YES ☒ NO
If YES, complete the rest of Question 19. If NO, proceed to Question 20.	
19.1. Describe the System Alarm(s):	
If there are more than five alarms, attach additional copies of this page as needed.	

	Operating Parameter Monitored	Describe Alarm Trigger	Monitoring Device or Alarm Type	Does the Alarm Initiate an Automated Response?
19.1.1.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
19.1.2.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:

Monitoring and Alarm Information

19.1.3.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
19.1.4.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
19.1.5.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:

Emissions Information

20. Do You Plan to Take Any Emission Limitations to Avoid Major Source Status, Minor New Source Review, MACT, NSPS, etc.? ☐ YES ☒ NO

If YES, complete the rest of Question 20. If NO, proceed to Question 21.

20.1. Describe Any Proposed Emission Limitations:

Operating Information

21. Do You Plan to Take Any Operating Limitations to Avoid Major Source Status, Minor New Source Review, MACT, NSPS, etc.? ☐ YES ☒ NO

If YES, complete the rest of Question 21. If NO, proceed to Question 22.

21.1. Describe Any Proposed Operating Limitations:

Additional Information

22. Is There Any Additional Information Pertinent to this Application? ☐ YES ☒ NO

If YES, complete the rest of Question 22.

22.1. Describe:

Generic Process Equipment Application

If you are using this form electronically, press F1 at any time for help

General Information

1.	Facility Name: **Wolf Technology Center 1**
2.	Equipment ID Number: **CT-1 through CT-7**
3.	Provide a brief description of Equipment or Process: **The facility will include seven natural gas fired combustion turbines with heat recovery steam generators (HRSGs) in combined cycle with three steam turbines.**
4.	Manufacturer: **General Electric**
5.	Model: **LM 2500 DLE**
6.	Serial Number: **TBD**

Raw Material Information

7. Raw Materials Used in Process

If there are more than four Raw Materials used, attach additional copies of this page as needed.

Raw Material Used	CAS Number	Usage Rate (include units)	MSDS Attached?
7.1. **Natural Gas**	**see MSDS**	**varies (see emission calcs)**	☒ YES ☐ NO
7.2.			☐ YES ☐ NO
7.3.			☐ YES ☐ NO
7.4.			☐ YES ☐ NO

Attach a copy of all calculations made to support the data in the table above.
Attach a Material Safety Data Sheet (MSDS) for each Raw Material used.

Products Produced Information

8. Products Produced

If there are more than four Products Produced, attach additional copies of this page as needed.

Product Produced	CAS Number	Production Rate (include units)	MSDS Attached?
8.1.			☐ YES ☐ NO
8.2.			☐ YES ☐ NO
8.3.			☐ YES ☐ NO
8.4.			☐ YES ☐ NO

Attach a copy of all calculations made to support the data in the table above.
Attach a Material Safety Data Sheet (MSDS) for each Product Produced.

Byproducts Generated Information

9. Byproducts Generated

If there are more than four Byproducts Generated, attach additional copies of this page as needed.

	Byproduct Generated	CAS Number	Generation Rate (include units)	MSDS Attached?
9.1.	**N/A**			☐ YES ☐ NO
9.2.				☐ YES ☐ NO
9.3.				☐ YES ☐ NO
9.4.				☐ YES ☐ NO

Attach a copy of all calculations made to support the data in the table above.
Attach a Material Safety Data Sheet (MSDS) for each Byproduct Generated.

General Information

10. Manufacturer's Rated Capacity or Maximum Throughput of Equipment or Process: **Natural gas-fired with maximum (Winter) usage rate of 220.3 mmBtu/hr.**

11. Describe Important Manufacturer Specifications and/or Operating Parameters for Equipment or Process: **N/A**

Attach the Manufacturer's Specification Sheet(s) for the equipment or process.

Control Device Information

12. Is an Air Pollution Control Device Used? ☒ YES ☐ NO

If an Air Pollution Control Device is used, complete the rest of Question 12. If not, proceed to Question 13.

12.1. Is Knockout Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.11 and attach it to this application.

12.2. Is a Settling Chamber Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.10 and attach it to this application.

12.3. Is an Inertial or Cyclone Collector Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.5 and attach it to this application.

12.4. Is a Fabric Collector or Baghouse Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.6 and attach it to this application.

12.5. Is a Venturi Scrubber Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.8 and attach it to this application.

12.6. Is an Electrostatic Precipitator Used? ☐ YES ☒ NO

If YES, complete Form AQM-4.7 and attach it to this application.

Control Device Information

12.7. Is Adsorption Equipment Used?	☐ YES ☒ NO
If YES, complete Form AQM-4.2 and attach it to this application.	
12.8. Is a Scrubber Used?	☐ YES ☒ NO
If YES, complete Form AQM-4.4 and attach it to this application.	
12.9. Is an Incinerator, Afterburner or Oxidizer Used?	☐ YES ☒ NO
If YES, complete Form AQM-4.1 and attach it to this application.	
12.10. Is a Flare Used?	☐ YES ☒ NO
If YES, complete Form AQM-4.3 and attach it to this application.	
12.11. Is Any Other Control Device Used?	☒ YES ☐ NO
If YES, attach a copy of the control device Manufacturer's Specification Sheet(s).	
If any other control device is used, complete the rest of Question 12. If not, proceed to Question 13.	
12.12. Describe Control Device: **Dry Low NOx combustors, Selective Catalytic Reduction (SCR) for NOx removal, and Oxidation Catalyst for VOC and CO removal**	
12.13. Pollutants Controlled: ☒ VOCs ☒ HAPs ☐ PM ☐ PM_{10} ☐ $PM_{2.5}$ ☒ NO_X ☐ SO_X ☐ Metals ☒ Other (Specify): **CO**	
12.14. Control Device Manufacturer: **TBD**	
12.15. Control Device Model: **TBD**	
12.16. Control Device Serial Number: **TBD**	
12.17. Control Device Design Capacity: **TBD**	
12.18. Control Device Removal or Destruction Efficiency: **specified per LAER and BACT requirements (see emission calculations)**	

Stack Information

13. How Does the Process Equipment Vent: *(check all that apply)*	☐ Directly to the Atmosphere ☒ Through a Control Device Covered by Forms AQM-4.1 through 4.12 ☒ Through Another Control Device Described on This Form
If any of the process equipment vents directly to the atmosphere or through another control device described on this form, proceed to Question 14. If the process equipment vents through a control device, provide the stack parameters on the control device form and proceed to Question 18.	
14. Number of Air Contaminant Emission Points: **7**	
If there are more than three Emission Points, attach additional copies of this page as needed.	
For the first Emission Point	
15. Emission Point Name: **EP 1 through EP 7 (identical with exception of lat/long)**	
15.1. Stack Height Above Grade: **165 feet**	
15.2. Stack Exit Diameter: **8 feet** *(Provide Stack Dimensions If Rectangular Stack)*	
15.3. Is a Stack Cap Present?	☐ YES ☒ NO

Stack Information
15.4. Stack Configuration: ☒ Vertical ☐ Horizontal ☐ Downward-Venting *(check all that apply)* ☐ Other (Specify):
15.5. Stack Exit Gas Temperature: **345 °F**
15.6. Stack Exit Gas Flow Rate: **182,898.0 ACFM**
15.7. Distance to Nearest Property Line: **130 feet**
15.8. Describe Nearest Obstruction: **Data Center**
15.9. Height of Nearest Obstruction: **75 feet**
15.10. Distance to Nearest Obstruction: **430 feet**
15.11. Are Stack Sampling Ports Provided? ☒ YES ☐ NO
For the second Emission Point. If there is no second Emission Point, proceed to Question 18.
16. Emission Point Name:
16.1. Stack Height Above Grade: **feet**
16.2. Stack Exit Diameter: **feet** *(Provide Stack Dimensions If Rectangular Stack)*
16.3. Is a Stack Cap Present? ☐ YES ☐ NO
16.4. Stack Configuration: ☐ Vertical ☐ Horizontal ☐ Downward-Venting *(check all that apply)* ☐ Other (Specify):
16.5. Stack Exit Gas Temperature: **°F**
16.6. Stack Exit Gas Flow Rate: **ACFM**
16.7. Distance to Nearest Property Line: **feet**
16.8. Describe Nearest Obstruction:
16.9. Height of Nearest Obstruction: **feet**
16.10. Distance to Nearest Obstruction: **feet**
16.11. Are Stack Sampling Ports Provided? ☐ YES ☐ NO
For the third Emission Point. If there is no third Emission Point, proceed to Question 18.
17. Emission Point Name:
17.1. Stack Height Above Grade: **feet**
17.2. Stack Exit Diameter: **feet** *(Provide Stack Dimensions If Rectangular Stack)*
17.3. Is a Stack Cap Present? ☐ YES ☐ NO
17.4. Stack Configuration: ☐ Vertical ☐ Horizontal ☐ Downward-Venting *(check all that apply)* ☐ Other (Specify):
17.5. Stack Exit Gas Temperature: **°F**
17.6. Stack Exit Gas Flow Rate: **ACFM**
17.7. Distance to Nearest Property Line: **feet**
17.8. Describe Nearest Obstruction:
17.9. Height of Nearest Obstruction: **feet**

Stack Information

17.10. Distance to Nearest Obstruction:	**feet**
17.11. Are Stack Sampling Ports Provided?	☐ YES ☐ NO

Monitoring Information

18. Will Emissions Data be Recorded by a Continuous Emission Monitoring System?	☒ YES ☐ NO
If Yes, attach a copy of the Continuous Emission Monitoring System Manufacturer's Specification Sheets	
If YES, complete the rest of Question 18. If NO, proceed to Question 19.	
18.1. Pollutants Monitored:	☐ VOCs ☐ HAPs ☐ PM ☐ PM_{10} ☐ $PM_{2.5}$ ☒ NO_X ☐ SO_X ☐ Metals ☒ Other (Specify): **CO**
18.2. Describe the Continuous Emission Monitoring System:	**See Form AQM 4.9**
18.3. Manufacturer:	**TBD**
18.4. Model:	**TBD**
18.5. Serial Number:	**TBD**
18.6. Will Multiple Emission Units Be Monitored at the Same Point?	☐ YES ☒ NO
If YES, complete the rest of Question 18. If NO, proceed to Question 19.	
18.7. Emission Units Monitored:	
18.8. Will More Than One Emission Unit be Emitting From the Combined Point At Any Time?	☐ YES ☐ NO
If YES, complete the rest of Question 18. If NO, proceed to Question 19.	
18.9. Emission Units Emitting Simultaneously:	

Monitoring and Alarm Information

19. Are There Any Alarms You Would Like the Department to Consider When Drafting the Permit?	☒ YES ☐ NO
If YES, complete the rest of Question 19. If NO, proceed to Question 20.	
19.1. Describe the System Alarm(s):	
If there are more than five alarms, attach additional copies of this page as needed.	

	Operating Parameter Monitored	Describe Alarm Trigger	Monitoring Device or Alarm Type	Does the Alarm Initiate an Automated Response?
19.1.1.	**NOx**	**CEM data**	☒ Visual ☒ Auditory ☒ Automatic (Remote Monitoring) ☐ Other	☐ NO ☒ YES Describe: **Facility operators will take corrective action**
19.1.2.	**CO**	**CEM data**	☒ Visual ☒ Auditory ☒ Automatic (Remote Monitoring) ☐ Other	☐ NO ☒ YES Describe: **Facility operators will take corrective action**

Monitoring and Alarm Information

19.1.3.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
19.1.4.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
19.1.5.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:

Emissions Information

20. Do You Plan to Take Any Emission Limitations to Avoid Major Source Status, Minor New Source Review, MACT, NSPS, etc.? ☐ YES ☒ NO

If YES, complete the rest of Question 20. If NO, proceed to Question 21.

20.1. Describe Any Proposed Emission Limitations:

Operating Information

21. Do You Plan to Take Any Operating Limitations to Avoid Major Source Status, Minor New Source Review, MACT, NSPS, etc.? ☐ YES ☒ NO

If YES, complete the rest of Question 21. If NO, proceed to Question 22.

21.1. Describe Any Proposed Operating Limitations:

Additional Information

22. Is There Any Additional Information Pertinent to this Application? ☐ YES ☒ NO

If YES, complete the rest of Question 22.

22.1. Describe:

Generator/Engine Application

If you are using this form electronically, press F1 at any time for help

General Information	
1.	Facility Name: **Wolf Technology Center 1**
2.	Equipment ID: **RGE 1 / RGE 2 / RGE 3**
3.	Manufacturer: **Wartsila**
4.	Model: **18V50SG**
5.	Serial Number: **TBD**
6.	Rated Heat Input: **138.3** MMBTU/hour
7.	Maximum Power Output: **18,759 kilowatt**
8.	Date of Manufacture: **TBD**
9.	Installation Date: **TBD**
10.	Is the Equipment Being Applied For a Generator or an Engine? ☐ Generator ☒ Engine
If the equipment is a Generator, complete the rest of Question 10. If not, proceed to Question 11.	
10.1.	Is the Generator Existing or New? ☐ Existing ☐ New
10.2.	Will the Generator Be Classified as an Emergency Generator or a Distributed Generator? ☐ Emergency ☐ Distributed
10.3.	Has an Initial Notification Pursuant to 7 **DE Admin. Code** 1144 Been Submitted for this Generator? ☐ YES ☐ NO
If NO, include a copy of the Initial Notification with this application.	
10.4.	Have the Emissions From the Generator Been Certified to Meet the Currently Applicable US EPA Non-Road Emission Standards? ☐ YES ☐ NO
If YES, attach a copy of the Manufacturer's Certification. If NO, attach copies of any/all of the following: any maintenance or operating requirements/instructions provided by the generator manufacturer; the type, or a description, of any emission control equipment use; and/or emissions test data for the generator (such as a manufacturer's technical data sheet), any supporting documentation for any emission control equipment used, any supporting calculations, any quality control or assurance information, and any other information needed to demonstrate compliance with the requirements. Proceed to Question 11.	
11.	Primary Fuel: ☒ Natural Gas ☐ Diesel ☐ Propane ☐ Biodiesel ☐ Other (specify):
11.1.	Maximum Annual Primary Fuel Consumption: **867 (per RGE) MMCF**
11.2.	Heat Content of Primary Fuel: **1,027 BTU/CF**
11.3.	Maximum Firing Rate: **0.13 (per RGE) MMCF/hr**
11.4.	Percent Sulfur of Primary Fuel: **0.0015** %
11.5.	Percent Ash of Primary Fuel: **0.0** %

General Information

12. Secondary Fuel: ☐ Natural Gas ☐ Diesel ☐ Propane ☐ Biodiesel ☐ Other (specify):

12.1. Maximum Annual Secondary Fuel Consumption: **MMCF**

12.2. Heat Content of Secondary Fuel: **BTU/CF**

12.3. Maximum Firing Rate: **MMCF/hr**

12.4. Percent Sulfur of Secondary Fuel: %

12.5. Percent Ash of Secondary Fuel: %

Stack Information

13. How Does the Process Equipment Vent:
(check all that apply)
☐ Directly to the Atmosphere
☒ Through a Control Device Covered by Forms AQM-4.1 through 4.12

If any of the process equipment vents directly to the atmosphere proceed to Question 14. If the process equipment vents through a control device, provide the stack parameters on the control device form and proceed to Question 15.

14. Emission Point Name: **EP-8 (3 RGE flues exit one HRSG Stack)**

14.1. Stack Height Above Grade: **140 feet**

14.2. Stack Exit Diameter: **5 feet**
(Provide Stack Dimensions If Rectangular Stack)

14.3. Is a Stack Cap Present? ☐ YES ☒ NO

14.4. Stack Configuration: ☒ Vertical ☐ Horizontal ☐ Downward-Venting
(check all that apply) ☐ Other (Specify):

14.5. Stack Exit Gas Temperature: **345 °F**

14.6. Stack Exit Gas Flow Rate: **82,465 ACFM**

14.7. Distance to Nearest Property Line: **~190 ft**

14.8. Describe Nearest Obstruction: **Data Center**

14.9. Height of Nearest Obstruction: **75 ft**

14.10. Distance to Nearest Obstruction: **420 ft**

14.11. Are Stack Sampling Ports Provided? ☒ YES ☐ NO

Monitoring Information

15. Will Emissions Data be Recorded by a Continuous Emission Monitoring System? ☒ YES ☐ NO

If Yes, Attach a Copy of the Continuous Emission Monitoring System Manufacturer's Specification Sheets

If YES, complete the rest of Question 15. If NO, proceed to Question 16.

Monitoring Information
15.1. Pollutants Monitored: ☐ VOCs ☐ HAPs ☐ PM ☐ PM_{10} ☐ $PM_{2.5}$ ☒ NO_X ☐ SO_X ☐ Metals ☒ Other (Specify): **CO**
15.2. Describe the Continuous Emission Monitoring System: **See Form 4.9**
15.3. Manufacturer: **TBD**
15.4. Model: **TBD**
15.5. Serial Number: **TBD**
15.6. Will Multiple Emission Units Be Monitored at the Same Point? ☐ YES ☒ NO
If YES, complete the rest of Question 15. If NO, proceed to Question 16.
15.7. Emission Units Monitored:
15.8. Will More Than One Emission Unit be Emitting From the Combined Point At Any Time? ☐ YES ☐ NO
If YES, complete the rest of Question 15. If NO, proceed to Question 16.
15.9. Emission Units Emitting Simultaneously:

Visible Emissions Monitoring Information
For Primary Fuel
16. Proposed Technique Used to Monitor Visible Emissions: ☐ Opacity Monitor (COM) ☐ Manual (Method 9) ☐ Manual (Method 22) ☐ Other (Describe):
If an Opacity Monitor (COM) is used, complete the rest of Question 16. If not, proceed to Question 17.
16.1. Describe the Continuous Opacity Monitoring System:
16.2. Manufacturer:
16.3. Model:
16.4. Serial Number:
17. Proposed Frequency of Opacity Monitoring:
For Secondary Fuel. If no Secondary Fuel is used, proceed to Question 20.
18. Proposed Technique Used to Monitor Visible Emissions: ☐ Opacity Monitor (COMs) ☐ Manual (Method 9) ☐ Manual (Method 22) ☐ Other (Describe):
If an Opacity Monitor (COMs) is used, complete the rest of Question 18. If not, proceed to Question 19.
18.1. Describe the Continuous Opacity Monitoring System:
18.2. Manufacturer:
18.3. Model:

Visible Emissions Monitoring Information

18.4. Serial Number:

19. Proposed Frequency of Opacity Monitoring:

Monitoring and Alarm Information

20. Are There Any Alarms You Would Like the Department to Consider When Drafting the Permit? ☒ YES ☐ NO

If YES, complete the rest of Question 20. If NO, proceed to Question 21.

20.1. Describe the System Alarm(s):

If there are more than five alarms, attach additional copies of this page as needed.

	Operating Parameter Monitored	Describe Alarm Trigger	Monitoring Device or Alarm Type	Does the Alarm Initiate an Automated Response?
20.1.1.	**NOx**	**CEM data**	☒ Visual ☒ Auditory ☒ Automatic (Remote Monitoring) ☐ Other	☐ NO ☒ YES Describe: **Facility operators will take corrective action**
20.1.2.	**CO**	**CEM data**	☒ Visual ☒ Auditory ☒ Automatic (Remote Monitoring) ☐ Other	☐ NO ☒ YES Describe: **Facility operators will take corrective action**
20.1.3.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
20.1.4.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
20.1.5.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:

Emissions Information

21. Do You Plan to Take Any Emission Limitations to Avoid Major Source Status, Minor New Source Review, MACT, NSPS, etc.? ☐ YES ☒ NO

If YES, complete the rest of Question 21. If NO, proceed to Question 22.

Emissions Information

21.1. Describe Any Proposed Emission Limitations:

Operating Information

22. Do You Plan to Take Any Operating Limitations to Avoid Major Source Status, Minor New Source Review, MACT, NSPS, etc.? ☒ YES ☐ NO

If YES, complete the rest of Question 22. If NO, proceed to Question 23.

22.1. Describe Any Proposed Operating Limitations: **The three engines will be limited to a combined operating limit of 20,000 hours per year or an equivalent of approximately 6,666 hours/year-engine.**

Additional Information

23. Is There Any Additional Information Pertinent to this Application? ☒ YES ☐ NO

If YES, complete the rest of Question 23.

23.1. Describe:

1,027 BTU / CF is the average of four months of natural gas heating values for the Eastern Shore Parkersburg station where TDC will obtain their natural gas [Upper heating value of 1035 BTU/CF and lowest heating value was 1020 BTU/CF].

Rated Heat Input = 138.3 mmBtu/hr is highest heat input rate (occurs during winter conditions)

133.55 mmBTU/hr = average of winter and summer heat inputs (138.3+128.8)/2=133.55mmBTU/hr

Max annual primary fuel consumption = 133.55 mmBTU/hr x 6,666.6 hr/yr x 10^6 BTU/mm BTU x 1CF/1,027BTU x 1MCF/10^6 CF= 1,116 MCF/yr (per engine)

6,666.6 hours / year = Permit limited operation of 20,000 hours per year / 3 engines = 6,666.6 hrs / engine-yr

Max firing rate = 133.55mmBTU/hr x 10^6BTU/1mmBTUx1cf/1027BTUx1mmCF/10^6CF=0.13 mmCF/hr (per engine)

Selective Catalytic Reduction (SCR), Selective Non-Catalytic Reduction (SNCR), Non-Selective Catalytic Reduction (NSCR), and Ammonia Injection Application

If you are using this form electronically, press F1 at any time for help

General Information

1. Facility Name: **Wolf Technology Center 1**
2. Equipment ID Number: **OX1 through OX10**
3. Manufacturer: **TBD**
4. Model: **TBD**
5. Serial Number: **TBD**
6. Type:
   - ☒ Selective Catalytic Reduction
   - ☐ Selective Non-Catalytic Reduction
   - ☐ Non-Selective Catalytic Reduction
   - ☒ Ammonia Injection

Attach the Manufacturer's Specification Sheet.

Contaminant Information

7. Concentration of Each Contaminant in the Waste Gas and Removal Efficiency

If more than five Contaminants are present, attach additional copies of this page as needed.

	Contaminant	CAS Number	Concentration in Waste Gas	Removal Efficiency
7.1.	**NOx (Natural Gas)**	**NA**	**2.0 (1-hr average) ppm**	**92** %
7.2.	**CO**	**NA**	**1.25 ppm**	**95** %
7.3.			**% by Weight**	%
7.4.			**% by Weight**	%
7.5.			**% by Weight**	%

Gas Stream Information

8. Maximum Inlet Volumetric Gas Flow Rate: **182,898 acfm** at **993 °F**
9. Maximum Outlet Volumetric Gas Flow Rate: **182,898 acfm** at **993 °F**
10. Pressure Drop: **<1 inches water**

Operational Information

11. Design Operating Temperature: 600 to 750 **°F**

Operational Information

12.	Ammonia/Urea Slip: **7 (3-hr average)** ppm
13.	Method of Determining Slip: ☐ Continuous Emissions Monitor ☒ Stack Test ☒ Manufacturer's Specifications ☐ Other (Specify):
14.	Describe the Operating Conditions that are Monitored to Determine the Reducing Agent Injection Rate: **The SCR will include controls and alarms to provide adequate ammonia flow to control amount of ammonia injected into the flue gas**
15.	Describe the Process Controls for Proper Mixing of the Reducing Agent in the Gas Stream: **Aqueous ammonia will be stored in a tank onsite. The ammonia will be injected into the HRSG where NOx is reduced to N and water.**
16.	Operating Temperature Range for Catalyst: From **TBD °F** To **TBD °F**
17.	Describe the Oxidation Catalyst Used: **TBD**
18.	Design Service Life of Catalyst: **typically > 5 years**
19.	Describe Reducing Agent Used: **aqueous ammonia**
20.	Expected Usage Rate of Reducing Agent: **TBD**
21.	Expected Concentration of Reducing Agent: **TBD**
Attach justification for the Expected Usage Rate and Concentration of the Reducing Agent.	
22.	Describe How Spent Catalyst is Treated or Disposed of: **Spent catalyst will be removed and replaced by the vendor. The vendor will be responsible for proper disposal.**
If SNCR is used complete Question 23. If not, proceed to Question 24.	
23.	Describe How Frequently the System is Optimized:

Stack Information

24.	Emission Point Name: **EP 1 through EP 10**
24.1.	Stack Height Above Grade: **165 feet**
24.2.	Stack Exit Diameter: **8 feet** *(Provide Stack Dimensions If Rectangular Stack)*
24.3.	Is a Stack Cap Present? ☐ YES ☒ NO
24.4.	Stack Configuration: ☒ Vertical ☐ Horizontal ☐ Downward-Venting *(check all that apply)* ☐ Other (Specify):
24.5.	Stack Exit Gas Temperature: **345 °F**
24.6.	Stack Exit Gas Flow Rate: **182,898 ACFM**
24.7.	Distance to Nearest Property Line: **130 feet**
24.8.	Describe Nearest Obstruction: **Data Center**
24.9.	Height of Nearest Obstruction: **75 feet**
24.10.	Distance to Nearest Obstruction: **430 feet**

Stack Information

24.11. Are Stack Sampling Ports Provided? ☒ YES ☐ NO

Monitoring and Alarm Information

25. Are There Any Alarms You Would Like the Department to Consider When Drafting the Permit? ☒ YES ☐ NO

If YES, complete the rest of Question 25. If NO, proceed to Question 26.

25.1. Describe the System Alarm(s):

If there are more than five alarms, attach additional copies of this page as needed.

	Operating Parameter Monitored	Describe Alarm Trigger	Monitoring Device or Alarm Type	Does the Alarm Initiate an Automated Response?
25.1.1.	**NOx**	**CEM data**	☒ Visual ☒ Auditory ☒ Automatic (Remote Monitoring) ☐ Other	☐ NO ☒ YES Describe: **Facility operators will take corrective action**
25.1.2.	**CO**	**CEM data**	☒ Visual ☒ Auditory ☒ Automatic (Remote Monitoring) ☐ Other	☐ NO ☒ YES Describe: **Facility operators will take corrective action**
25.1.3.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
25.1.4.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
25.1.5.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:

Additional Information

26. Is There Any Additional Information Pertinent to this Application? ☐ YES ☒ NO

If YES, complete the rest of Question 26.

26.1. Describe: **Stack information provided pertains to EP1 through EP7. Stack information for EP8 through EP10: Diameter - 5 feet, temp - 345, velocity - 70 fps, flow rate - 82,465 cfm, Dist. to property line 190 feet, nearest obstruction - 420 feet (Data Center @ 75 ft high).**

Selective Catalytic Reduction (SCR), Selective Non-Catalytic Reduction (SNCR), Non-Selective Catalytic Reduction (NSCR), and Ammonia Injection Application

If you are using this form electronically, press F1 at any time for help

General Information

1. Facility Name: **Wolf Technology Center 1**
2. Equipment ID Number: **SCR1 through SCR10**
3. Manufacturer: **TBD**
4. Model: **TBD**
5. Serial Number: **TBD**
6. Type:
   - ☒ Selective Catalytic Reduction
   - ☐ Selective Non-Catalytic Reduction
   - ☐ Non-Selective Catalytic Reduction
   - ☒ Ammonia Injection

Attach the Manufacturer's Specification Sheet.

Contaminant Information

7. Concentration of Each Contaminant in the Waste Gas and Removal Efficiency

If more than five Contaminants are present, attach additional copies of this page as needed.

	Contaminant	CAS Number	Concentration in Waste Gas	Removal Efficiency
7.1.	**NOx (Natural Gas)**	**NA**	**2.0 (1-hr average) ppm**	**92** %
7.2.			**% by Weight**	%
7.3.			**% by Weight**	%
7.4.			**% by Weight**	%
7.5.			**% by Weight**	%

Gas Stream Information

8. Maximum Inlet Volumetric Gas Flow Rate: **182,898 acfm** at **993 °F**
9. Maximum Outlet Volumetric Gas Flow Rate: **182,898 acfm** at **993 °F**
10. Pressure Drop: **<1 inches water**

Operational Information

11. Design Operating Temperature: 600 to 750 **°F**

Operational Information

12.	Ammonia/Urea Slip: **7 (3-hr average)** ppm
13.	Method of Determining Slip: ☐ Continuous Emissions Monitor ☒ Stack Test ☒ Manufacturer's Specifications ☐ Other (Specify):
14.	Describe the Operating Conditions that are Monitored to Determine the Reducing Agent Injection Rate: **The SCR will include controls and alarms to provide adequate ammonia flow to control amount of ammonia injected into the flue gas**
15.	Describe the Process Controls for Proper Mixing of the Reducing Agent in the Gas Stream: **Aqueous ammonia will be stored in a tank onsite. The ammonia will be injected into the HRSG where NOx is reduced to N and water.**
16.	Operating Temperature Range for Catalyst: From **TBD °F** To **TBD °F**
17.	Describe the Oxidation Catalyst Used: **TBD**
18.	Design Service Life of Catalyst: **typically > 5 years**
19.	Describe Reducing Agent Used: **aqueous ammonia**
20.	Expected Usage Rate of Reducing Agent: **TBD**
21.	Expected Concentration of Reducing Agent: **TBD**
Attach justification for the Expected Usage Rate and Concentration of the Reducing Agent.	
22.	Describe How Spent Catalyst is Treated or Disposed of: **Spent catalyst will be removed and replaced by the vendor. The vendor will be responsible for proper disposal.**
If SNCR is used complete Question 23. If not, proceed to Question 24.	
23.	Describe How Frequently the System is Optimized:

Stack Information

24.	Emission Point Name: **EP 1 through EP 10**
24.1.	Stack Height Above Grade: **165 feet**
24.2.	Stack Exit Diameter: **8 feet** *(Provide Stack Dimensions If Rectangular Stack)*
24.3.	Is a Stack Cap Present? ☐ YES ☒ NO
24.4.	Stack Configuration: ☒ Vertical ☐ Horizontal ☐ Downward-Venting *(check all that apply)* ☐ Other (Specify):
24.5.	Stack Exit Gas Temperature: **345 °F**
24.6.	Stack Exit Gas Flow Rate: **182,898 ACFM**
24.7.	Distance to Nearest Property Line: **130 feet**
24.8.	Describe Nearest Obstruction: **Data Center**
24.9.	Height of Nearest Obstruction: **75 feet**
24.10.	Distance to Nearest Obstruction: **430 feet**

Stack Information

24.11. Are Stack Sampling Ports Provided? ☒ YES ☐ NO

Monitoring and Alarm Information

25. Are There Any Alarms You Would Like the Department to Consider When Drafting the Permit? ☒ YES ☐ NO

If YES, complete the rest of Question 25. If NO, proceed to Question 26.

25.1. Describe the System Alarm(s):

If there are more than five alarms, attach additional copies of this page as needed.

	Operating Parameter Monitored	Describe Alarm Trigger	Monitoring Device or Alarm Type	Does the Alarm Initiate an Automated Response?
25.1.1.	**NOx**	**CEM data**	☒ Visual ☒ Auditory ☒ Automatic (Remote Monitoring) ☐ Other	☐ NO ☒ YES Describe: **Facility operators will take corrective action**
25.1.2.	**CO**	**CEM data**	☒ Visual ☒ Auditory ☒ Automatic (Remote Monitoring) ☐ Other	☐ NO ☒ YES Describe: **Facility operators will take corrective action**
25.1.3.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
25.1.4.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:
25.1.5.			☐ Visual ☐ Auditory ☐ Automatic (Remote Monitoring) ☐ Other	☐ NO ☐ YES Describe:

Additional Information

26. Is There Any Additional Information Pertinent to this Application? ☐ YES ☒ NO

If YES, complete the rest of Question 26.

26.1. Describe: **Stack information provided pertains to EP1 through EP7. Stack information for EP8 through EP10: Diameter - 5 feet, temp - 345, velocity - 70 fps, flow rate - 82,465 cfm, Dist. to property line 190 feet, nearest obstruction - 420 feet (Data Center @ 75 ft high).**

Emissions Information Application

If you are using this form electronically, press F1 at any time for help

Process Information	
1.	Number of Individual Pieces of Process Equipment in Process: **The facility includes 12 pieces of air pollution emitting equipment including 7 CTs/HRSGs, 3 RGE/HRSGs, and two cooling towers**
2.	Number of Individual Control Devices in Process: **Each combustion turbine includes dry low NOx combustion (7), each HRSG includes catalytic oxidation and SCR units (8), and drift eliminators on cooling towers (2)**

Emissions Information for First Emission Point/Stack

3. Emission Point Name: **refer to Emission tables for emissions estimates**

4. Equipment ID Number for all Process Equipment and Control Devices Venting Through Emission Point/Stack:

5. Pollutant Emissions

If more than 18 pollutants are emitted at this Emission Point/Stack, attach additional copies of this page as needed.

	Pollutant Name (Specify VOCs and HAPs Individually in 5.10 through 5.18)	CAS Number (Not required for 5.1 through 5.9)	Maximum Uncontrolled Emission Rate at Design Capacity	Maximum Controlled Emission Rate at Design Capacity	Annual Potential to Emit (PTE)	Expected Annual Emissions
5.1.	Particulate Matter (PM)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.2.	PM_{10}		**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.3.	$PM_{2.5}$		**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.4.	Sulfur Oxides (SO_X)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.5.	Nitrogen Oxides (NO_X)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.6.	Carbon Monoxide (CO)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.7.	Lead		**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.8.	Total Volatile Organic Compounds (VOCs)		**lbs/hour**	**lbs/hour**	tons/year	tons/year

Emissions Information for First Emission Point/Stack

5.9.	Total Hazardous Air Pollutants (HAPs)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.10.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.11.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.12.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.13.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.14.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.15.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.16.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.17			**lbs/hour**	**lbs/hour**	tons/year	tons/year
5.18.			**lbs/hour**	**lbs/hour**	tons/year	tons/year

6. Provide Any Additional Information Necessary to Understanding the Emission Rates Provided Above:

Attach the Basis of Determination or Calculations for each Emission Rate provided above.

Emissions Information for Second Emission Point/Stack

7. Emission Point Name:

8. Equipment ID Number for all Process Equipment and Control Devices Venting Through Emission Point/Stack:

9. Pollutant Emissions

If more than 18 pollutants are emitted at this Emission Point/Stack, attach additional copies of this page as needed.

Pollutant Name (Specify VOCs and HAPs Individually in 9.10 through 9.18)	CAS Number (Not required for 9.1 through 9.9)	Maximum Uncontrolled Emission Rate at Design Capacity	Maximum Controlled Emission Rate at Design Capacity	Annual Potential to Emit (PTE)	Expected Annual Emissions

Emissions Information for Second Emission Point/Stack

9.1.	Particulate Matter (PM)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.2.	PM_{10}		**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.3.	$PM_{2.5}$		**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.4.	Sulfur Oxides (SO_X)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.5.	Nitrogen Oxides (NO_X)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.6.	Carbon Monoxide (CO)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.7.	Lead		**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.8.	Total Volatile Organic Compounds (VOCs)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.9.	Total Hazardous Air Pollutants (HAPs)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.10.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.11.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.12.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.13.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.14.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.15.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.16.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.17			**lbs/hour**	**lbs/hour**	tons/year	tons/year
9.18.			**lbs/hour**	**lbs/hour**	tons/year	tons/year

10. Provide Any Additional Information Necessary to Understanding the Emission Rates Provided Above:

Attach the Basis of Determination or Calculations for each Emission Rate provided above.

Emissions Information for Third Emission Point/Stack

11. Emission Point Name:

12. Equipment ID Number for all Process Equipment and Control Devices Venting Through Emission Point/Stack:

13. Pollutant Emissions

If more than 18 pollutants are emitted at this Emission Point/Stack, attach additional copies of this page as needed.

	Pollutant Name (Specify VOCs and HAPs Individually in 13.10 through 13.18)	CAS Number (Not required for 13.1 through 13.9)	Maximum Uncontrolled Emission Rate at Design Capacity	Maximum Controlled Emission Rate at Design Capacity	Annual Potential to Emit (PTE)	Expected Annual Emissions
13.1.	Particulate Matter (PM)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.2.	PM_{10}		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.3.	$PM_{2.5}$		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.4.	Sulfur Oxides (SO_X)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.5.	Nitrogen Oxides (NO_X)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.6.	Carbon Monoxide (CO)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.7.	Lead		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.8.	Total Volatile Organic Compounds (VOCs)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.9.	Total Hazardous Air Pollutants (HAPs)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.10.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.11.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.12.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.13.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.14.			**lbs/hour**	**lbs/hour**	tons/year	tons/year

Emissions Information for Third Emission Point/Stack					
13.15.		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.16.		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.17		**lbs/hour**	**lbs/hour**	tons/year	tons/year
13.18.		**lbs/hour**	**lbs/hour**	tons/year	tons/year
14. Provide Any Additional Information Necessary to Understanding the Emission Rates Provided Above:					
Attach the Basis of Determination or Calculations for each Emission Rate provided above.					

Emissions Information for Fourth Emission Point/Stack					
15. Emission Point Name:					
16. Equipment ID Number for all Process Equipment and Control Devices Venting Through Emission Point/Stack:					
17. Pollutant Emissions					
If more than 18 pollutants are emitted at this Emission Point/Stack, attach additional copies of this page as needed.					
Pollutant Name (Specify VOCs and HAPs Individually in 17.10 through 17.18)	CAS Number (Not required for 17.1 through 17.9)	Maximum Uncontrolled Emission Rate at Design Capacity	Maximum Controlled Emission Rate at Design Capacity	Annual Potential to Emit (PTE)	Expected Annual Emissions
17.1. Particulate Matter (PM)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.2. PM_{10}		**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.3. $PM_{2.5}$		**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.4. Sulfur Oxides (SO_X)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.5. Nitrogen Oxides (NO_X)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.6. Carbon Monoxide (CO)		**lbs/hour**	**lbs/hour**	tons/year	tons/year

Emissions Information for Fourth Emission Point/Stack

17.7.	Volatile Organic Compounds (VOCs)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.8.	Lead		**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.9.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.10.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.11.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.12.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.13.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.14.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.15.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.16.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.17			**lbs/hour**	**lbs/hour**	tons/year	tons/year
17.18.			**lbs/hour**	**lbs/hour**	tons/year	tons/year

18. Provide Any Additional Information Necessary to Understanding the Emission Rates Provided Above:

Attach the Basis of Determination or Calculations for each Emission Rate provided above.

If there are more than four Emission Points/Stacks, attach additional copies of this form as needed.

Overall Process Emissions

19. Pollutant Emissions

If more than 18 pollutants are emitted from this Process, attach additional copies of this page as needed.

Pollutant Name (Specify VOCs and HAPs Individually in 19.10 through 19.18)	CAS Number (Not required for 19.1 through 19.9)	Maximum Uncontrolled Emission Rate at Design Capacity	Maximum Controlled Emission Rate at Design Capacity	Annual Potential to Emit (PTE)	Expected Annual Emissions

Overall Process Emissions

19.1.	Particulate Matter (PM)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.2.	PM_{10}		**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.3.	$PM_{2.5}$		**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.4.	Sulfur Oxides (SO_X)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.5.	Nitrogen Oxides (NO_X)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.6.	Carbon Monoxide (CO)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.7.	Lead		**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.8.	Total Volatile Organic Compounds (VOCs)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.9.	Total Hazardous Air Pollutants (HAPs)		**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.10.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.11.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.12.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.13.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.14.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.15.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.16.			**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.17			**lbs/hour**	**lbs/hour**	tons/year	tons/year
19.18.			**lbs/hour**	**lbs/hour**	tons/year	tons/year

20. Provide Any Additional Information Necessary to Understanding the Emission Rates Provided Above:

Attach the Basis of Determination or Calculations for each Emission Rate provided above.

Minor New Source Review Information

21. Does the Process Have the Potential to Emit More Than Five Tons Per Year of Any Pollutant? ☒ YES ☐ NO

22. Is the Source New or Existing? ☒ NEW ☐ EXISTING
See Question 11 of AQM-1

If the Process has the Potential to Emit more than five tons per year of any pollutant, and is a New Source, a Control Technology Analysis pursuant to Regulation No. 1125 Section 4 must be conducted and attached to this application.

Additional Information

23. Is There Any Additional Information Pertinent to this Application? ☒ YES ☐ NO

If YES, complete the rest of Question 23.

23.1. Describe: **Emissions calculations include in Appendix B of application report.**

Air Emissions Modeling Application

This form is optional. Applications will be considered complete without this form. Completing this form may expedite processing of your permit.

If you are using this form electronically, press F1 at any time for help. For additional help conducting air emissions modeling see the air contaminant equipment registration form booklet sections V and VI available at:
http://www.awm.delaware.gov/AQM/Pages/AirContaminantEquipmentRegistration.aspx.

General Information

1. Identification of Equipment/Process Being Modeled: **Wolf Technology Center 1**

2. Modeling Tool Used: ☒ SCREEN3 ☐ ISC3 ☐ AERSCREEN ☒ AERMOD ☐ Other (Specify): Refer to Nonattainment New Source Review, Minor New Source Review and Prevention of Significant Deterioration Review Air Quality Construction Permit Application, Combined Heat and Power Plant for the Wolf Technology Center 1 report for modeling output

Modeling Information

3. Modeling Information

If there are more than 20 Contaminants, attach additional copies of this page as needed

Contaminant Name	Maximum Controlled Emission Rate at Design Capacity	Short Term Emission Rate	Threshold Limit Value (TLV)	TLV Source	Maximum Downwind Concentration (MDC) (8-Hour Average)	TLV:MDC Ratio
3.1.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.2.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.3.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.4.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.5.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.6.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.7.	lbs/day	grams/second	mg/m^3		mg/m^3	

Modeling Information

3.8.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.9.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.10.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.11.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.12.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.13.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.14.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.15.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.16.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.17.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.18.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.19.	lbs/day	grams/second	mg/m^3		mg/m^3	
3.20.	lbs/day	grams/second	mg/m^3		mg/m^3	

NOTE: If the TLV:MDC Ratio is less than 100 for any of the Contaminants listed above, the equipment may not be eligible for approval. Contact the Department immediately to discuss the situation.

Attach copies of all modeling analyses conducted.

Additional Information

4. Is There Any Additional Information Pertinent to this Application? ☒ YES ☐ NO

If YES, complete the rest of Question 4.

Additional Information

4.1. Describe: **See Section 8 of permit application. AERMOD was utilized for criteria pollutants.**

APPENDIX B

EMISSION CALCULATIONS / SUPPORTING DOCUMENTS AND TABLES:

Table B-1A Facility Wide Emissions – Full Bore PTE
Table B-1B Facility Wide Emissions – Normal Operating
Table B-1C Facility Wide Emissions – Island Mode
Table B-2 Combustion Turbine Emissions Calculations
Table B-3 Reciprocating Gas Engine Emissions Calculations
Table B-4 Hazardous Air Pollutant (HAPs) Emissions

Table B-1A: Facility Wide Emissions - FULL BORE PTE
Wolf 1 CHP Data Center
Newark, Delaware

Facility Yearly Estimated Actual Emissions - Full Bore PTE

Emitting Units	LM2500 DLE CT	18V50SG RGE	Cooling Towers	Facility Total	
Number of Units	**7**	**3**	**2**		
Pollutant	(tons/year)	(tons/year)	(tons/year)	(tons/year)	
NO_x	49.2	24.76	-	73.96	
CO	18.7	53.65	-	72.36	
VOC	14.2	53.65	-	67.83	
SO_2	9.5	0.81	-	10.34	
PM_{10}	44.6	49.52	3.46	97.56	
$PM_{2.5}$	44.6	49.52	3.46	97.56	
PM_{Total}	44.6	49.52	3.46	97.56	
H_2SO_4	7.2	1.47	-	8.63	
Ammonia	64.8	13.26	-	78.03	
HAPs	0.7	17.7	-	18.36	
Greenhouse Gas Emissions (CO_{2e})				*GWP factor*	CO_{2e} (tons)
CO_2	742,984	200,139	-	1	943,122
CH_4	58.1	3.04	-	21	1,284
N_2O	20.3	0.30	-	310	6,376
SF6*	0.00225			23,900	54
Total Greenhouse Gas Emissions (CO_{2e})				-	950,836

Notes:
1. Full Bore PTE emissions based on 7 turbines operating at 100% loading for 8,760 hours per year per turbineyear which does not take into account downtime for maintenance. Annual downtime for maintenance is anticipated to be minimal.
2. Full Bore PTE emissions for reciprocating gas engines are based on combined operations of 20,000 hours per or approximately 6,666 hours per engine. A permit restriction will be enforced.

SF6 Emissions		
Insulated Circuit Breaker SF6 capacity	75	lbs
Estimated Number of Breakers at the Facility (CHP)	12	
Estimated Annual Loss Rate	0.5	% by weight
Estimated Annual SF6 mass emission rate	0.00225	tons / year

Facility Hourly Estimated Actual Emissions

Emitting Units	LM2500 DLE CT	18V50SG RGE	Cooling Towers	Facility Total
Number of Units	7	3	2	
Pollutant	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
NO_x	11.23	7.43	-	18.66
CO	4.27	16.10	-	20.37
VOC	3.24	16.10	-	19.33
SO_2	2.17	0.24	-	2.42
PM_{10}	10.18	14.86	0.79	25.82
$PM_{2.5}$	10.18	14.86	0.79	25.82
PM_{Total}	10.18	14.86	0.79	25.82
H_2SO_4	1.63	0.44	-	2.07
Ammonia	14.79	3.98	-	18.77
HAPs	0.023	1.767	-	1.79
Greenhouse Gases (CO_{2e})				
CO_2	169,631	60,048	-	229,679
CH_4	13.26	0.91	-	14.17
N_2O	4.63	0.09	-	4.72

Q/D calculation for Class I areas			
Total NO_X	73.96	tpy	
SO_2	10.34	tpy	
H_2SO_4	8.63	tpy	
PM_{total}	97.56	tpy	
Q totals	190.48	tpy	**Q/D**
Distance to Brigantine (D)	97	km	**1.964**
Distance to Shenandoah (D)	212	km	**0.899**

This table is part of Duffield Associates Inc.'s November 2013, "Air Quality Construction Permit Application for the Wolf Technology Center 1" and should only be viewed in the context of that report.

Table B-1B: Facility Wide Emissions - NORMAL OPERATING
Wolf 1 CHP Data Center
Newark, Delaware

Facility Yearly Estimated Actual Emissions - Normal Operating

Emitting Units	LM2500 DLE CT	LM2500 DLE CT	18V50SG RGE	Cooling Towers	Facility Total	
Number of Units	**6**	**0**	**2**	**2**		
Pollutant	(tons/year)	(tons/year)	(tons/year)	(tons/year)	(tons/year)	
NO_x	42.2	0.0	21.69	-	63.87	
CO	9.6	0.0	47.00	-	56.62	
VOC	12.2	0.0	47.00	-	59.16	
SO_2	8.2	0.0	0.71	-	8.88	
PM_{10}	38.2	0.0	43.38	3.46	85.05	
$PM_{2.5}$	38.2	0.0	43.38	3.46	85.05	
PM_{Total}	38.2	0.0	43.38	3.46	85.05	
H_2SO_4	6.1	0.0	1.28	-	7.42	
Ammonia	55.5	0.0	11.62	-	67.13	
HAPs	0.6	0.0	12.85	-	13.44	
Greenhouse Gas Emissions (CO_{2e})					*GWP factor*	CO_{2e} (tons)
CO_2	636,843	0	175,339	-	1	812,182
CH_4	49.8	0.0	2.67	-	21	1,102
N_2O	17.4	0.0	0.27	-	310	5,467
SF6*	0.00225				23,900	54
Total Greenhouse Gas Emissions (CO_{2e})					-	818,804

Notes:
1. Normal operating emissions for reciprocating gas engines are based on operations of 2 engines at 100% rated capacity for 8,760 hours per year.
2. Normal operating emissions for gas combustion turbines are based on operations of 6 engines at rated capacity for 8,760 hours per year, which does not take into account downtime for maintenance. Annual downtime for turbine maintenance is anticipated to be minimal.

SF6 Emissions		
Insulated Circuit Breaker SF6 capacity	75	lbs
Estimated Number of Breakers at the Facility (CHP)	12	
Estimated Annual Loss Rate	0.5	% by weight
Estimated Annual SF6 mass emission rate	0.00225	tons / year

Facility Hourly Estimated Actual Emissions - Normal Operating

Emitting Units	LM2500 DLE CT	LM2500 DLE CT	18V50SG RGE	Cooling Towers	Facility Total
Number of Units	6	0	2	2	
Pollutant	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
NO_x	9.63	0.00	4.95	-	14.58
CO	2.20	0.00	10.73	-	12.93
VOC	2.78	0.00	10.73	-	13.51
SO_2	1.86	0.00	0.16	-	2.03
PM_{10}	8.72	0.00	9.90	0.79	19.42
$PM_{2.5}$	8.72	0.00	9.90	0.79	19.42
PM_{Total}	8.72	0.00	9.90	0.79	19.42
H_2SO_4	1.40	0.00	0.29	-	1.69
Ammonia	12.67	0.00	2.65	-	15.33
HAPs	0.023	0.000	0.998	-	1.02
Greenhouse Gases (CO_{2e})					
CO_2	145,398	0	40,032	-	185,430
CH_4	11.37	0.00	0.61	-	11.98
N_2O	3.97	0.00	0.06	-	4.03

Q/D calculation for Class I areas			
Total NO_X	63.87	tpy	
SO_2	8.88	tpy	
H_2SO_4	7.42	tpy	
PM_{total}	85.05	tpy	
Q totals	165.22	tpy	**Q/D**
Distance to Brigantine (D)	97	km	**1.703**
Distance to Shenandoah (D)	212	km	**0.779**

This table is part of Duffield Associates Inc.'s November 2013, "Air Quality Construction Permit Application for the Wolf Technology Center 1" and should only be viewed in the context of that report.

Table B-1C: Facility Wide Emissions - ISLAND MODE
Wolf 1 CHP Data Center
Newark, Delaware

Facility Yearly Estimated Actual Emissions - Island Mode

Emitting Units	LM2500 DLE CT	LM2500 DLE CT	18V50SG RGE	Cooling Towers	Facility Total	
Number of Units	**4**	**2**	**2**	**2**		
Pollutant	(tons/year)	(tons/year)	(tons/year)	(tons/year)	(tons/year)	
NO_x	28.1	12.5	15.26	-	43.38	
CO	6.4	2.9	40.07	-	46.48	
VOC	8.1	3.6	40.07	-	48.17	
SO_2	5.4	2.4	0.36	-	5.80	
PM_{10}	25.5	11.3	38.16	3.46	67.09	
$PM_{2.5}$	25.5	11.3	38.16	3.46	67.09	
PM_{Total}	25.5	11.3	38.16	3.46	67.09	
H_2SO_4	4.1	1.8	0.64	-	4.73	
Ammonia	37.0	16.4	5.81	-	42.82	
HAPs	0.6	0.6	12.85	-	13.44	
Greenhouse Gas Emissions (CO_{2e})					*GWP factor*	CO_{2e} (tons)
CO_2	424,562	188,577	101,693	-	1	526,255
CH_4	33.2	14.7	1.33	-	21	725
N_2O	11.6	5.1	0.13	-	310	3,631
SF6*	0.00225				23,900	54
Total Greenhouse Gas Emissions (CO_{2e})					-	530,664

Notes:
1. Island Mode potential emissions for gas combustion turbines are based on operating 4 CTs at 100% capacity, two CTs at 50% capacity, and two reciprocating engines at 50% capacity.

SF6 Emissions		
Insulated Circuit Breaker SF6 capacity	75	lbs
Estimated Number of Breakers at the Facility (CHP)	12	
Estimated Annual Loss Rate	0.5	% by weight
Estimated Annual SF6 mass emission rate	0.00225	tons / year

Facility Hourly Estimated Actual Emissions - Island Mode

Emitting Units	LM2500 DLE CT	LM2500 DLE CT	18V50SG RGE	Cooling Towers	Facility Total
Number of Units	4	2	2	2	
Pollutant	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
NO_x	6.42	2.85	3.48	-	12.76
CO	1.47	0.65	9.15	-	11.26
VOC	1.85	0.82	9.15	-	11.82
SO_2	1.24	0.55	0.08	-	1.88
PM_{10}	5.82	2.58	8.71	0.79	17.90
$PM_{2.5}$	5.82	2.58	8.71	0.79	17.90
PM_{Total}	5.82	2.58	8.71	0.79	17.90
H_2SO_4	0.93	0.41	0.15	-	1.50
Ammonia	8.45	3.75	1.33	-	13.53
HAPs	0.023	0.023	0.998	-	1.04
Greenhouse Gases (CO_{2e})					
CO_2	96,932	43,054	0.30	-	139,986
CH_4	7.58	3.37	0.03	-	10.97
N_2O	2.64	1.17	0.00	-	3.82

Q/D calculation for Class I areas			
Total NO_X	43.38	tpy	
SO_2	5.80	tpy	
H_2SO_4	4.73	tpy	
PM_{total}	67.09	tpy	
Q totals	121.00	tpy	**Q/D**
Distance to Brigantine (D)	97	km	**1.247**
Distance to Shenandoah (D)	212	km	**0.571**

This table is part of Duffield Associates Inc.'s November 2013, "Air Quality Construction Permit Application for the Wolf Technology Center 1" and should only be viewed in the context of that report.

Table B-2: Combustion Turbine Emissions Calculations
Wolf 1 CHP Data Center
Newark, Delaware

Unit Type		Gas Combustion Turbine @ 100% Loading		Gas Combustion Turbine @ 50% Loading	
Equipment Model		LM2500 DLE			
Manufacturer		GE			
Rated Capacity		23.2	MW	11.6	MW
Exhaust Flow per CT	*Summer*	489,421	lb/hr	372,194	lb/hr
	Winter	556,863	lb/hr	444,095	lb/hr
Heat Input Rate per CT, H_{in} LHV = 946 BTU/scf	*Summer*	213.1	MMBtu/hr (LHV)	162.2	MMBtu/hr (LHV)
	Winter	**220.3**	MMBtu/hr (LHV)	**195.7**	MMBtu/hr (LHV)
Exhaust Flow Rate per CT, Q	*Summer*	109,583	dscfm	141,006	dscfm
	Winter	113,286	dscfm	168,201	dscfm

Unit Emissions		
Pollutant	***LM2500 DLE***	
	GE CT @ 50% load and greater	
	Emission Factor	Units
NOx[+]	2.0	ppmv d
	0.0073	lb/MMBTU
CO[+]	1.25	ppmv d
	0.0028	lb/MMBTU
VOC[++]	0.0021	lb/MMBTU
SO_2[++]	0.00141	lb/MMBTU
PM_{10}[++]	0.0066	lb/MMBTU
$PM_{2.5}$[++]	0.0066	lb/MMBTU
PM_{Total}[++]	0.0066	lb/MMBTU
H_2SO_4[1]	0.0011	lb/MMBTU
Ammonia[*]	7	ppmv d
	0.0096	lb/MMBTU
Green House Gases		
CO_2[++]	110	lb/MMBTU
CH_4[++]	0.0086	lb/MMBTU
N_2O++	0.003	lb/MMBTU
Calculated Hourly Emissions Potential to Emit - PER UNIT		
NO_x	1.6	lb/hr
CO	0.61	lb/hr
VOC	0.46	lb/hr
SO_2	0.31	lb/hr
PM_{10}	1.45	lb/hr
$PM_{2.5}$	1.5	lb/hr
PM_{Total}	1.5	lb/hr
H_2SO_4	0.234	lb/hr
Ammonia	2.11	lb/hr
Green House Gases		
CO_2	24,233	lb/hr
CH_4	1.9	lb/hr
N_2O	0.7	lb/hr
Gross Annual Potential to Emit - PER UNIT		
NO_x	7.0	tons/year
CO	2.7	tons/year
VOC	2.0	tons/year
SO_2	1.4	tons/year
PM_{10}	6.4	tons/year
$PM_{2.5}$	6.4	tons/year
PM_{Total}	6.4	tons/year
H_2SO_4	1.0	tons/year
Ammonia	9.3	tons/year
Green House Gases		
CO_2	106,141	tons/year
CH_4	8.3	tons/year
N_2O	2.9	tons/year

Emission Factor Source:

[1] H_2SO_4 calculated assuming a conservative estimate of 0.5 grains of Sulfur per 100 standard cubic foot (scf); natural gas heating value of 1027BTU/scf; 50% of Sul becomes SO_3 and 100% of SO_3 becomes H_2SO_4.

[*] Emission factor based on BACT/LAER assessment

[+] Emission Factors obtained via the manufacturer

[++] Emission Factors obtained via Table 3.1-2A of the EPA AP-42, Compilation of Air Pollutant Emission Factors Document Table.

Sulfur content of Natural Gas = 0.5 grains / 100 scf or approximately 0.0015%

This table is part of Duffield Associates Inc.'s November 2013, "Air Quality Construction Permit Application for the Wolf Technology Center 1" and should only be viewed in the context of that report.

Table B-3: Reciprocating Gas Engine Emission Calculations
Wolf 1 CHP Data Center
Newark, Delaware

Unit Type		Reciprocating Gas Engine		Reciprocating Gas Engine	
Equipment Model		18V50SG			
Manufacturer		Wartsila			
Rated Capacity		18.759	MW	9.9	MW
Exhaust Flow per RGE	*Summer*	236,511	lb/hr	-	lb/hr
	Winter	251,590	lb/hr	-	lb/hr
Heat Input Rate per CT, H_{in} LHV = 946 BTU/scf	*Summer*	128.8	MMBtu/hr (LHV)	-	MMBtu/hr (LHV)
	Winter	**138.3**	MMBtu/hr (LHV)	**69.2**	MMBtu/hr (LHV)
Exhaust Flow Rate per RGE, Q	*Summer*	66,233	dscfm	-	dscfm
	Winter	71,119	dscfm	35,559	dscfm

Unit Emissions		
Pollutant	***18V50SG***	
	Wartsila @ 100% load	
	Emission Factor	Units
NO_x[+]	0.132	lb/MWh
CO[+]	0.286	lb/MWh
VOC[+]	0.286	lb/MWh
SO_2[++]	0.000588	lb/MMBTU
PM_{10}[+]	0.264	lb/MWh
$PM_{2.5}$[+]	0.264	lb/MWh
PM_{Total}[+]	0.264	lb/MWh
H_2SO_4[1]	0.0011	lb/MMBTU
Ammonia[*]	7	ppmv d
	0.0096	lb/MMBtu
Green House Gases		
CO_2[+]	1,067	lb/MWh
CH_4[§]	0.001	kg/MMBTU
N_2O[§]	0.0001	kg/MMBTU
Calculated Hourly Emissions Potential to Emit - PER UNIT		
NO_x	2.48	lb/hr
CO	5.37	lb/hr
VOC	5.4	lb/hr
SO_2	0.08	lb/hr
PM_{10}	4.95	lb/hr
$PM_{2.5}$	4.95	lb/hr
PM_{Total}	4.95	lb/hr
H_2SO_4	0.147	lb/hr
Ammonia	1.3	lb/hr
Green House Gases		
CO_2	20,016	lb/hr
CH4[§]	0.304	lb/hr
N_2O[§]	0.030	lb/hr
Gross Annual Potential to Emit - PER UNIT		
NO_x	10.8	tons/year
CO	23.5	tons/year
VOC	23.5	tons/year
SO_2	0.36	tons/year
PM_{10}	21.7	tons/year
$PM_{2.5}$	21.7	tons/year
PM_{Total}	21.7	tons/year
H_2SO_4	0.6	tons/year
Ammonia	5.8	tons/year
Green House Gases		
CO_2	87,669	tons/year
CH_4	1.3	tons/year
N_2O	0.133	tons/year

Emission Factor Source:

[1] H_2SO_4 calculated assuming a conservative estimate of 0.5 grains of Sulfur per 100 standard cubic foot (scf); natural gas heating value of 1027BTU/scf; 50% of Sulfur becomes SO_3 and 100% of SO_3 becomes H_2SO_4.

[*] Emission factor based on BACT/LAER assessment

[+] Emission Factors obtained via the manufacturer specifications

[++] Emission Factors obtained via Table 3.2-2 of the EPA AP-42 (7/2000)

[§] Emission Factor obtained from Table C-2 to Subpart C of Part 98 - Default CH4 and N2O Emission Factors for Various Types of Fuel - of the United States

This table is part of Duffield Associates Inc.'s November 2013, "Air Quality Construction Permit Application for the Wolf Technology Center 1" and should only be viewed in the context of that report.

Table B-4: Hazardous Air Pollutant (HAPs) Emissions - FULL BORE PTE
Wolf 1 CHP Data Center
Newark, Delaware

			LM 2500 DLE=	7	Wartsila 18V50SG =	3
Parameter	Units	Per Combustion Turbine	CT combined annual hours	Per Reciprocating Engine	RGE combined annual hours
Maximum heat input (HHV):	MMBtu/hr	220.3	61,320	138.3	20,000
Maximum annual hours:	hr/yr	8,760		6,667	

Pollutant	CT Gas-Fired Emission Factor * (lb/MMBtu)	4-Stroke Lean-Burn Reciprocating Engines Emission Factor ‡ (lb/MMBtu)	CT Gas-Fired Emissions (lb/hr)	RGE Emissions (lb/hr)	Maximum Uncontrolled CT and RGE [TOTAL] (tpy)	Maximum Controlled CT and RGE [TOTAL]+ (tpy)	Maximum Controlled CT Emissions (lb/hr)	Maximum Controlled RGE Emissions (lb/hr)
1,1,2,2-Tetrachloroethane		4.00E-05		0.006	0.055	0.006	0.0E+00	5.5E-04
1,1,2-Trichloroethane		3.18E-05		0.004	0.044	0.004	0.0E+00	4.4E-04
1,3-Butadiene	4.3E-07	2.67E-04	9.47E-05	0.037	0.372	0.037	9.5E-06	3.7E-03
1,3-Dichloropropene		2.64E-05		0.004	0.037	0.004	0.0E+00	3.7E-04
2-Methylnaphthalene		3.32E-05		0.005	0.046	0.005	0.0E+00	4.6E-04
2,2,4-Trimethylpentane		2.50E-04		0.035	0.346	0.035	0.0E+00	3.5E-03
Acenaphthene		1.25E-06		0.000	0.002	0.000	0.0E+00	1.7E-05
Acenaphthylene		5.53E-06		0.001	0.008	0.001	0.0E+00	7.6E-05
Acetaldehyde^	4.0E-05	Manufacturer provided	8.81E-03	0.530	n/a	5.327	8.8E-04	5.3E-01
Acrolein^	6.4E-06	Manufacturer provided	1.41E-03	0.670	n/a	**6.704**	1.4E-04	6.7E-01
Benzene	1.2E-05	4.40E-04	2.64E-03	0.061	0.690	0.069	2.6E-04	6.1E-03
Benzo(b)fluoranthene		1.66E-07		0.000	0.000	0.000	0.0E+00	2.3E-06
Benzo(e)pyrene		4.15E-07		0.000	0.001	0.000	0.0E+00	5.7E-06
Benzo(g,h,i)perylene		4.14E-07		0.000	0.001	0.000	0.0E+00	5.7E-06
Biphenyl		2.12E-04		0.029	0.293	0.029	0.0E+00	2.9E-03
Carbon Tetrachloride		3.67E-05		0.005	0.051	0.005	0.0E+00	5.1E-04
Chlorobenzene		3.04E-05		0.004	0.042	0.004	0.0E+00	4.2E-04
Chloroform		2.85E-05		0.004	0.039	0.004	0.0E+00	3.9E-04
Chyrsene		6.93E-07		0.000	0.001	0.000	0.0E+00	9.6E-06
Ethylbenzene	3.2E-05	3.97E-05	7.05E-03	0.005	0.271	0.027	7.0E-04	5.5E-04
Ethylene Dibromide		4.43E-05		0.006	0.061	0.006	0.0E+00	6.1E-04
Fluoranthene		1.11E-06		0.000	0.002	0.000	0.0E+00	1.5E-05
Fluorene		5.67E-06		0.001	0.008	0.001	0.0E+00	7.8E-05
Formaldehyde^	7.1E-04	Manufacturer provided	1.56E-01	0.250	n/a	2.980	1.6E-02	2.5E-01
Methanol^		Manufacturer provided		0.270	n/a	2.700	0.0E+00	2.7E-01
Methylene Chloride		2.00E-05		0.003	0.028	0.003	0.0E+00	2.8E-04
n-Hexane		1.11E-03		0.154	1.535	0.154	0.0E+00	1.5E-02
Naphthalene	1.3E-06	7.44E-05	2.86E-04	0.010	0.112	0.011	2.9E-05	1.0E-03
PAHs	2.2E-06	2.69E-05	4.85E-04	0.004	0.052	0.005	4.8E-05	3.7E-04
Phenanthrene		1.04E-05		0.001	0.014	0.001	0.0E+00	1.4E-04
Phenol		2.40E-05		0.003	0.033	0.003	0.0E+00	3.3E-04
Propylene Oxide	2.9E-05		6.39E-03		0.196	0.020	6.4E-04	0.0E+00
Pyrene		1.36E-06		0.000	0.002	0.000	0.0E+00	1.9E-05
Styrene		2.36E-05		0.003	0.033	0.003	0.0E+00	3.3E-04
Tetrachloroethane		2.48E-06		0.000	0.003	0.000	0.0E+00	3.4E-05
Toluene	1.3E-04	4.08E-04	2.86E-02	0.056	1.442	0.144	2.9E-03	5.6E-03
Vinyl Chloride		1.49E-05		0.002	0.021	0.002	0.0E+00	2.1E-04
Xylene	6.4E-05	1.84E-04	1.41E-02	0.025	0.687	0.069	1.4E-03	2.5E-03
				Max. individual HAP		**6.704**	**0.023**	**1.767**
				Total HAPs		**18.36**		

Emission Factor Source:

* EPA AP-42, Table 3.1-3, (4/2000)

‡ EPA AP-42, Table 3.2-2, (7/2000)

\+ Controlled emissions account for 90% reduction of HAPs due to the use of an oxidation catalyst of the exhaust.

^ Wartsila provided lb/hr emissions estimates for several HAPs including acetaldehyde, acrolein, formaldehyde, and methanol

This table is part of Duffield Associates Inc.'s November 2013, "Air Quality Construction Permit Application for the Wolf Technology Center 1" and should only be viewed in the context of that report.

Typical Emissions After Catalyst for Spark Gas Engines

Engine Load	100%	75%	50%	Units
NOx	0.06	0.07	0.08	g/kWh
CO	0.13	0.15	0.21	g/kWh
VOC	0.13	0.16	0.21	g/kWh
PM10 total	0.12	0.13	0.20	g/kWh
CO2	485	502	533	g/kWh
NOx	0.000132	0.000154	0.000176	lb/kWh
CO	0.000286	0.00033	0.000462	lb/kWh
VOC	0.000286	0.000352	0.000462	lb/kWh
PM10 total	0.000264	0.000286	0.00044	lb/kWh
CO2	1.067	1.1044	1.1726	lb/kWh
NOx	5	5	5	ppm-v, dry at 15% O2
CO	15	17	23	ppm-v, dry at 15% O2
VOC	26	32	41	ppm-v, dry at 15% O2
PM10 total	18	18	27	mg/m3, dry, NTP at 15% O2

Indicative Uncontrolled Emissions for Spark Gas Engines

Engine Load	100%	75%	50%	Units
NOx	1.5	1.54	0.67	g/kWh
CO	2.07	n/a	n/a	g/kWh
VOC	0.632	0.713	1.096	g/kWh
PM10 total	0.12	0.13	0.20	g/kWh
CO2	448	461	483	g/kWh
NOx	0.0033	0.003388	0.001474	lb/kWh
CO	0.004554	n/a	n/a	lb/kWh
VOC	0.0013904	0.0015686	0.0024112	lb/kWh
PM10 total	0.000264	0.000286	0.00044	lb/kWh
CO2	0.9856	1.0142	1.0626	lb/kWh
NOx	110	110	40	ppm-v, dry at 15% O2
CO	250	n/a	n/a	ppm-v, dry at 15% O2
VOC	133	146	213	ppm-v, dry at 15% O2
PM10 total	18	18	27	mg/m3, dry, NTP at 15% O2

Wartsila Engine Performance

Data for Sargent & Lundy. Information is not guaranteed. Performance is based on gas with Methane Number minimum of 80.

18V50SG on gas fuel (Engine does not have duel fuel capability)

Elevation: 125 ft AMSL

	Inlet air temp F	Relative Humidity %	Gross Output kWe	Gross Heat Rate BTU/kWh, LHV	Exhaust Gas Flow lb/h	Exhaust Gas Temp F
Summer	98	50	17221	7478	236511	714
ISO and Below	59	60	18759	7375	251590	707

Summer Exhaust Constituents		
N2	72.70%	by volume
O2	10.90%	by volume
H2O	11.00%	by volume
CO2	4.37%	by volume
Ar	0.87%	by volume

ISO and Below Exhaust Constituents		
N2	73.90%	by volume
O2	10.20%	by volume
H2O	10.00%	by volume
CO2	4.87%	by volume
Ar	0.88%	by volume

WARTSILA

Startup and Shutdown Emissions for 18V50SG

This document provides engineering estimates on the start-up emissions for one Wärtsilä® 18V50SG engine equipped with an efficient emission control system. The system includes a selective catalytic reduction system and an oxidation catalyst.

The figures are best estimates only and shall under no circumstances be considered guarantee data. The fast start-up of the engines results in transients in emissions, temperatures and flows which make accurate measurement and prediction of emissions virtually impossible. The flue gas emission estimates herein are based on emission measurement for steady conditions at different loads together with limited measurements performed during start-up. The emission control performance in a start situation is based on supplier estimates and data. The data assumes that the engines will reach full load in ten minutes.

The start-up emissions are estimated for two different conditions: cold catalyst start and warm catalyst start. A cold catalyst start is defined as a start where the emission control system is cold. A warm catalyst start is defined as a start where the temperature of the emission control system is minimum 270 °C at the time of the start. Typically this condition is fulfilled if the engine is started within 2 to 6 hours after the engine was stopped.

For cold start conditions, the engine will reach steady state conditions and the emission control system will typically reach its full abatement efficiency within 30 minutes from the start. For warm start conditions, the engine will reach steady state conditions and the emission control system will typically reach its full abatement efficiency within 15 minutes from the start. The estimated cumulative flue gas emissions expressed as kg per a start period (30 min) of one (1) Wärtsilä® 18V50SG engine are given in the table below for warm and cold start-up.

Component	Cold catalyst start emissions [kg per 30 min start]	Warm catalyst start emissions [kg per start 15 min]
NOx as NO_2	7.9	2.8
CO	7.5	1.2
VOC as CH_4 equivalent	5.0	1.7
PM_{10} (total)	1.3	0.8
$PM_{2.5}$ (total)	1.3	0.8

Shutdown data based on 1 minute shutdown

Component	1 min shut down [kg]
NOx as NO_2	0.16
CO	0.10
VOC as CH_4 equivalent	0.06
PM_{10} (total)	0.07

WARTSILA provided HAPs E. Fs

Michael Panhuise

From: Chris.Whitney@wartsila.com
Sent: Tuesday, October 22, 2013 2:03 PM
To: Michael Panhuise
Subject: RE: Wartsila HAPs emissions

Michael,

Following received from my colleague who is much more of an emissions person than I. Methane and Ethane are not included in the VOC's.

Rgds,
Chris Whitney

For a 3x18V50SG plant, based on conservative numbers, the following would be the HAP emissions rates, per engine after the oxidation catalyst:

Formaldehyde – 0.25 pound per hour per engine
Methanol – 0.27 #/hr per engine
Acrolein – 0.67 #/hr per engine
Acetaldehyde – 0.53 lb/hr per engine

These would keep the plant under the 10 tons for each HAP and 25 tons for total HAPs, based on 8760 run hours per year.

The values above are reported as each compound, not reported as methane or propane.

If there are other constraints that need to be taken into account with the 10T/25T, please let me know. I can work with Technology to see where we would have room to improve if needed.

From: Michael Panhuise [mailto:mpanhuise@duffnet.com]
Sent: Tuesday, October 22, 2013 10:06 AM
To: Whitney, Chris
Subject: RE: Wartsila HAPs emissions

Right now they are considering (3) 18V50SGs @ ~18.8 MW each = 56 MW

From: Chris.Whitney@wartsila.com [mailto:Chris.Whitney@wartsila.com]
Sent: Tuesday, October 22, 2013 10:01 AM
To: Michael Panhuise
Subject: RE: Wartsila HAPs emissions

How many MW of recips?

From: Michael Panhuise [mailto:mpanhuise@duffnet.com]
Sent: Tuesday, October 22, 2013 9:40 AM
To: Whitney, Chris
Subject: RE: Wartsila HAPs emissions

Hi Chris,

Wartsila 18V50SG Estimated Availability

Year	2,000 HRS/YEAR Estimated Downtime HRS	Estimated Downtime Days	Estimated Availability	4,000 HRS/YEAR Estimated Downtime HRS	Estimated Downtime Days	Estimated Availability	6,000 HRS/YEAR Estimated Downtime HRS	Estimated Downtime Days	Estimated Availability	8,000 HRS/YEAR Estimated Downtime HRS	Estimated Downtime Days	Estimated Availability
1	33	1	99.6%	94	4	98.9%	131	5	98.5%	193	8	97.8%
2	61	3	99.3%	99	4	98.9%	201	8	97.7%	249	10	97.2%
3	37	2	99.6%	139	6	98.4%	256	11	97.1%	443	18	94.9%
4	62	3	99.3%	110	5	98.7%	143	6	98.4%	205	9	97.7%
5	28	1	99.7%	249	10	97.2%	538	22	93.9%	566	24	93.5%
6	105	4	98.8%	195	8	97.8%	119	5	98.6%	324	14	96.3%
7	28	1	99.7%	114	5	98.7%	295	12	96.6%	431	18	95.1%
8	81	3	99.1%	91	4	99.0%	369	15	95.8%	229	10	97.4%
9	188	8	97.9%	476	20	94.6%	195	8	97.8%	617	26	93.0%
10	61	3	99.3%	90	4	99.0%	124	5	98.6%	180	8	97.9%
11	61	3	99.3%	90	4	99.0%	588	25	93.3%	229	10	97.4%
12	166	7	98.1%	234	10	97.3%	118	5	98.6%	611	25	93.0%
13	28	1	99.7%	89	4	99.0%	201	8	97.7%		AVERAGE	95.9%
14	86	4	99.0%	342	14	96.1%	411	17	95.3%			
15	29	1	99.7%	342	14	96.1%	290	12	96.7%			
16	62	3	99.3%	134	6	98.5%		AVERAGE	97.0%			
17	28	1	99.7%	249	10	97.2%						
18	447	19	94.9%	96	4	98.9%						
19	28	1	99.7%	90	4	99.0%						
20	62	3	99.3%	527	22	94.0%						
21	29	1	99.7%	89	4	99.0%						
22	61	3	99.3%	91	4	99.0%						
23	34	1	99.6%	139	6	98.4%						
24	201	8	97.7%	90	4	99.0%						
25	28	2	99.4%	381	16	95.6%						
		AVERAGE	99.1%		AVERAGE	97.9%						

GE Power & Water

Aeroderivative Gas Turbines

LM2500® Gas Turbines for Offshore Applications

fact sheet

Technology

The LM2500 gas turbine 538 package is designed to provide the quality and durability that the oil and gas industry expects from power generating equipment. Its compact configuration provides valuable benefits aboard floating or fixed offshore production facilities.

- Baseload power capabilities ranging from 23 to 33 MWe
- High reliability
- Ease of maintenance

Experience

Just as the LM2500 aeroderivative gas turbine maintains a high degree of commonality with its flight-tested forerunners, the marine gas turbine package has thousands of hours aboard class-certified commercial marine vessels. As the prime mover, the LM2500+ and LM2500+G4 is a flagship product that has:

- Over 10 million engine operating hours
- More than 1,300 industrial units in operation
- End-users: FPSOs, semi-submersibles, SPARS, TLP, fixed platforms, LNG carriers

Innovation

As a leading packager of gas turbines, GE's Aeroderivative Gas Turbines business continues to apply customer feedback into our products in many ways.

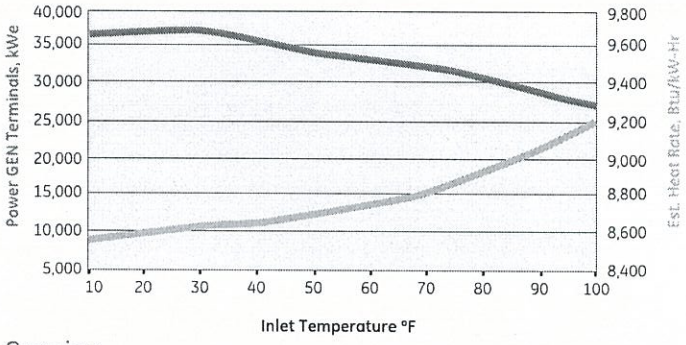
- Compact package design for reduced weight and space
- Smart electronics to enable uninterrupted turbine operation
- Package materials and designs for reliable installation in harsh environments
- Severe pitch and roll characteristics
- ABS, DNV, and Lloyd's Register certifications

ISO Performance on Natural Gas

	LM2500	LM2500+	LM2500+G4
Power Output (kWe)	23,300	30,700	33,400
Heat Rate LHV (Btu/kWe-Hr)	9,315	8,835	8,755
Efficiency (%)	36.6	38.6	39.0
Exhaust Flow (lbs/sec)	153	192	202
Exhaust Temperature (F)	992	959	976
Power Turbine Speed (rpm)	3,600	3,600	3,600
No. of Compressor Stages	16	17	17
No. of Turbine Stages	6	6	6

ISO, natural gas, no inlet/exhaust losses, 98% efficient generation

LM2500+ 60 Hz Output and Heat Rate



Service

GE is the world's largest aeroderivative service provider, with a global network of field service offices and fully equipped depots. A wide range of products and services are offered for LM2500 and LM2500+ operators, including:

- Level IV depot repair and overhaul capability in Houston, Texas and Rheden, The Netherlands
- Conversions, Modifications, and Upgrades (CM&Us) designed to enhance the efficiency, power output, and reliability of the LM2500 family
- Wide variety of contractual or long-term service agreements

This comprehensive product offering, combined with GE's commitment to reduced depot and outage turn times, results in substantial life-cycle cost savings for the facility owner/operator.

For more information, contact your GE representative or visit www.ge-aero.com.

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GEA17272D (10/2012)

GE Energy

Performance By: **Jeff Cobb**
Project Info: **Confidential**

Engine: **LM2500 PJ DLE**
Deck Info: **GE166B - 7qd.scp**
Generator: **BDAX 193ER 60Hz, 13.8kV, 0.85PF (10799)**
Fuel: **Gas Fuel #10-1, 19000 Btu/lb,LHV**

Date: **05/22/2013**
Time: **1:07:02 PM**
Version: **3.9.5**

Case #	**Not Used**	**Not Used**	**Not Used**	**Not Used**	**104**	**105**	**106**	**107**
Ambient Conditions								
Dry Bulb, °F	98.0	59.0	32.0	5.0	98.0	59.0	32.0	5.0
Wet Bulb, °F	81.5	51.5	27.0	3.1	81.5	51.5	27.0	3.1
RH, %	50.0	60.0	50.0	50.0	50.0	60.0	50.0	50.0
Altitude, ft	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
Ambient Pressure, psia	14.630	14.630	14.630	14.630	14.630	14.630	14.630	14.630
Engine Inlet								
Comp Inlet Temp, °F	98.0	59.0	32.0	5.0	50.0	50.0	32.0	5.0
RH, %	50.0	60.0	50.0	50.0	95.0	83.3	50.0	50.0
Conditioning	NONE	NONE	NONE	NONE	CHILL	CHILL	NONE	NONE
Tons(Chilling) or kBtu/hr(Heating)	0	0	0	0	1156	100	0	0
Pressure Losses								
Inlet Loss, inH20	4.00	4.00	4.00	4.00	5.00	5.00	5.00	5.00
Exhaust Loss, inH20	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Partload %	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
kW, Gen Terms	19230	21960	23329	23869	22396	22388	23241	23776
Est. Btu/kW-hr, LHV	**9809**	**9523**	**9465**	**9411**	**9514**	**9512**	**9477**	**9422**
Fuel Flow								
MMBtu/hr, LHV	188.6	209.1	220.8	224.6	213.1	213.0	220.3	224.0
lb/hr	9927	11006	11622	11822	11215	11208	11593	11791
NOx Control	**DLE**	**DLE**	**DLE**	**DLE**	**DLE**	**DLE**	**DLE**	**DLE**
Control Parameters								
HP Speed, RPM	9438	9454	9557	9512	9483	9475	9556	9512
PT Speed, RPM	3600	3600	3600	3600	3600	3600	3600	3600
PS3 - CDP, psia	235.9	258.4	269.8	276.7	261.8	261.8	269.1	276.0
T3CRF - CDT, °F	869.68	845.90	828.95	790.75	839.27	839.37	828.86	790.73
T48IN, °R	1970	1970	1970	1928	1970	1970	1970	1928
T48IN, °F	1510	1510	1510	1468	1510	1510	1510	1468
Exhaust Parameters								
Temperature, °F	1022.4	996.0	984.6	945.2	992.9	992.7	985.2	945.7
lb/sec	136.0	148.8	155.1	160.4	150.6	150.6	154.7	160.0
lb/hr	489421	535519	558268	577409	542109	542230	556863	575968
Energy, Btu/s- Ref 0 °R	52069	55305	56977	57107	55910	55873	56861	56986
Cp, Btu/lb-R	0.2800	0.2760	0.2747	0.2728	0.2762	0.2760	0.2747	0.2728
Emissions (ESTIMATED, NOT FOR GUARANTEE)								
NOx ppmvd Ref 15% O2	25	25	25	25	25	25	25	25
NOx as NO2, lb/hr	19	21	22	23	22	22	22	23
CO ppmvd Ref 15% O2	25	25	25	25	25	25	25	25
CO, lb/hr	11.59	12.85	13.57	13.80	13.10	13.09	13.54	13.76
CO2, lb/hr	28589.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HC ppmvd Ref 15% O2	15	15	15	15	15	15	15	15
HC, lb/hr	3.97	4.41	4.65	4.73	4.49	4.49	4.64	4.72
SOX as SO2, lb/hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

GE Energy

Performance By: **Jeff Cobb**
Project Info: **Confidential**

Engine: **LM2500 PJ DLE**
Deck Info: **GE166B - 7qd.scp**
Generator: **BDAX 193ER 60Hz, 13.8kV, 0.85PF (10799)**
Fuel: **Gas Fuel #10-1, 19000 Btu/lb,LHV**

Date: **05/22/2013**
Time: **1:07:02 PM**
Version: **3.9.5**

Case #	Not Used	Not Used	Not Used	Not Used	104	105	106	107
Exh Wght % Wet (NOT FOR USE IN ENVIRONMENTAL PERMITS)								
AR	1.2377	1.2536	1.2588	1.2609	1.2523	1.2534	1.2588	1.2609
N2	72.7483	73.6825	73.9929	74.1114	73.6077	73.6746	73.9929	74.1116
O2	15.1283	15.3195	15.3210	15.4785	15.2490	15.2755	15.3210	15.4798
CO2	5.1264	5.1944	5.2610	5.1751	5.2281	5.2239	5.2610	5.1743
H20	5.7535	4.5441	4.1603	3.9682	4.6569	4.5666	4.1603	3.9676
SO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
HC	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
NOX	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
Exh Mole % Dry (NOT FOR USE IN ENVIRONMENTAL PERMITS)								
AR	0.9630	0.9630	0.9632	0.9627	0.9632	0.9632	0.9632	0.9627
N2	80.7146	80.7157	80.7392	80.6897	80.7363	80.7315	80.7392	80.6893
O2	14.6951	14.6923	14.6364	14.7541	14.6433	14.6546	14.6364	14.7553
CO2	3.6205	3.6221	3.6542	3.5867	3.6502	3.6438	3.6542	3.5860
H20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO	0.0026	0.0026	0.0027	0.0026	0.0026	0.0026	0.0027	0.0026
HC	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
NOX	0.0026	0.0026	0.0027	0.0026	0.0027	0.0026	0.0027	0.0026
Exh Mole % Wet (NOT FOR USE IN ENVIRONMENTAL PERMITS)								
AR	0.8760	0.8938	0.8997	0.9021	0.8923	0.8936	0.8997	0.9021
N2	73.4259	74.9166	75.4154	75.6099	74.7953	74.9030	75.4154	75.6103
O2	13.3681	13.6367	13.6713	13.8253	13.5658	13.5966	13.6713	13.8265
CO2	3.2936	3.3619	3.4133	3.3609	3.3816	3.3807	3.4133	3.3603
H20	9.0302	7.1846	6.5938	6.2955	7.3585	7.2196	6.5939	6.2945
SO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO	0.0024	0.0024	0.0025	0.0024	0.0025	0.0025	0.0025	0.0024
HC	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015
NOX	0.0024	0.0024	0.0025	0.0024	0.0025	0.0025	0.0025	0.0024

Aero Energy Fuel Number	**10-1 (GEDEF)**	
	Volume %	**Weight %**
Hydrogen	0.0000	0.0000
Methane	84.5000	71.8447
Ethane	5.5800	8.8924
Ethylene	0.0000	0.0000
Propane	2.0500	4.7909
Propylene	0.0000	0.0000
Butane	0.7800	2.4027
Butylene	0.0000	0.0000
Butadiene	0.0000	0.0000
Pentane	0.1800	0.6883
Cyclopentane	0.0000	0.0000
Hexane	0.1700	0.7764
Heptane	0.0000	0.0000
Carbon Monoxide	0.0000	0.0000
Carbon Dioxide	0.6700	1.5628
Nitrogen	5.9300	8.8044
Water Vapor	0.0000	0.0000
Oxygen	0.1400	0.2374
Hydrogen Sulfide	0.0000	0.0000
Ammonia	0.0000	0.0000

Btu/lb, LHV	19000
Btu/scf, LHV	946.0
Btu/scf, HHV	1047.0
Btu/lb, HHV	20996
Fuel Temp, °F	77.0
NOx Scalar	0.998
Specific Gravity	0.65

GE Energy

Performance By: **Jeff Cobb**
Project Info: **Confidential**

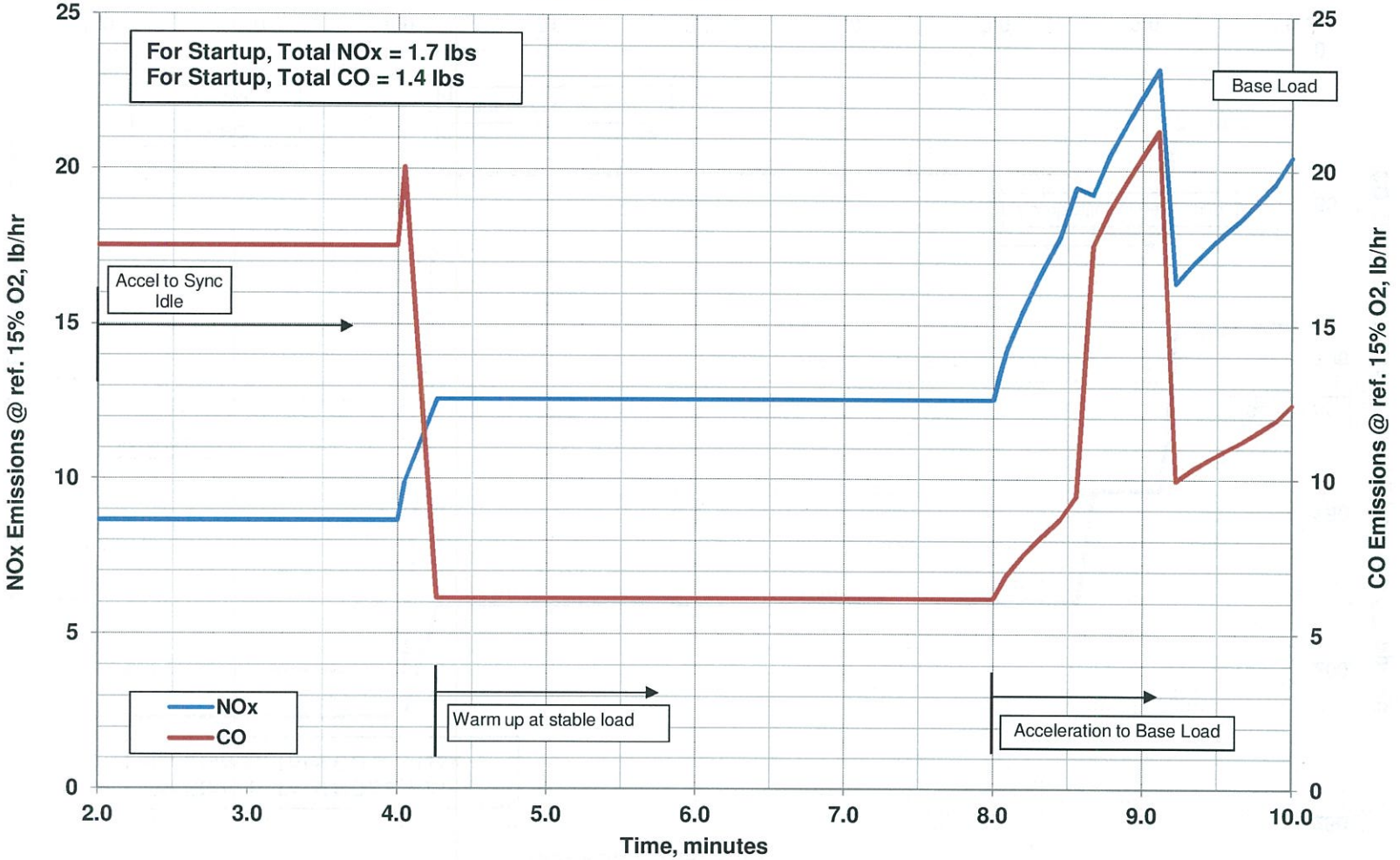
Engine: **LM2500 PJ DLE**
Deck Info: **GE166B - 7qd.scp**
Generator: **BDAX 193ER 60Hz, 13.8kV, 0.85PF (10799)**
Fuel: **Gas Fuel #10-1, 19000 Btu/lb,LHV**

Date: **05/22/2013**
Time: **1:07:02 PM**
Version: **3.9.5**

Case #	**Not Used**	**Not Used**	**Not Used**	**Not Used**	**104**	**105**	**106**	**107**
Wobbe	50.657	50.657	50.657	50.657	50.657	50.657	50.657	50.657
Engine Exhaust								
Exhaust Avg. Mol. Wt., Wet Basis	28.3	28.5	28.6	28.6	28.5	28.5	28.6	28.6
Inlet Flow Wet, pps	134.3	146.9	153.1	158.4	148.7	148.7	152.7	158.0
Inlet Flow Dry, pps	131.7	146.0	152.8	158.3	147.6	147.8	152.4	157.9
Shaft HP	26517	30229	32093	32830	30822	30812	31973	32702
Generator Information								
Capacity kW	34430	41594	45763	49143	34430	41594	45763	49143
Efficiency	0.9725	0.9742	0.9748	0.9750	0.9744	0.9744	0.9748	0.9750
Inlet Temp, °F	98.0	59.0	32.0	5.0	98.0	59.0	32.0	5.0
Gear Box Loss, HP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Burner Mode	ABC	ABC	ABC	ABC	ABC	ABC	ABC	ABC
8th Stage Bleed								
Flow, pps	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pressure, psia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Temperature, °R	0	0	0	0	0	0	0	0
CDP Bleed								
Flow, pps	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pressure, psia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Est. Gas Pressure at Baseplate, p	**305.8**	**338.5**	**356.0**	**360.1**	**344.0**	**343.9**	**355.1**	**359.1**
WAR36 - Combustor Water to Air R	0.0196	0.0064	0.0019	0.0006	0.0073	0.0064	0.0019	0.0006
WFA - Fuel Flow, A Ring	3836.99	4195.31	4388.84	4606.73	4263.50	4260.43	4377.94	4595.30
WFB - Fuel Flow, B Ring	4648.48	5188.47	5501.57	5318.77	5289.45	5287.20	5487.40	5303.32
WFC - Fuel Flow, C Ring	1441.78	1622.63	1731.49	1896.85	1661.91	1660.52	1727.37	1892.20
T25INF - HPC Inlet Temp(Control Value), °F								
T25 - HPC Actual Inlet Temp, °F								
WAR3	0.0063							
CardPack	**7qd**	**7qd**	**7qd**	**7qd**	**7qd**	**7qd**	**7qd**	**7qd**
Exhaust CardPack								
NSI	**0**	**0**	**0**	**302**	**0**	**0**	**0**	**302**
NSI	**0**	**0**	**0**	**2301**	**0**	**0**	**0**	**2301**
NSI	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

GE Energy

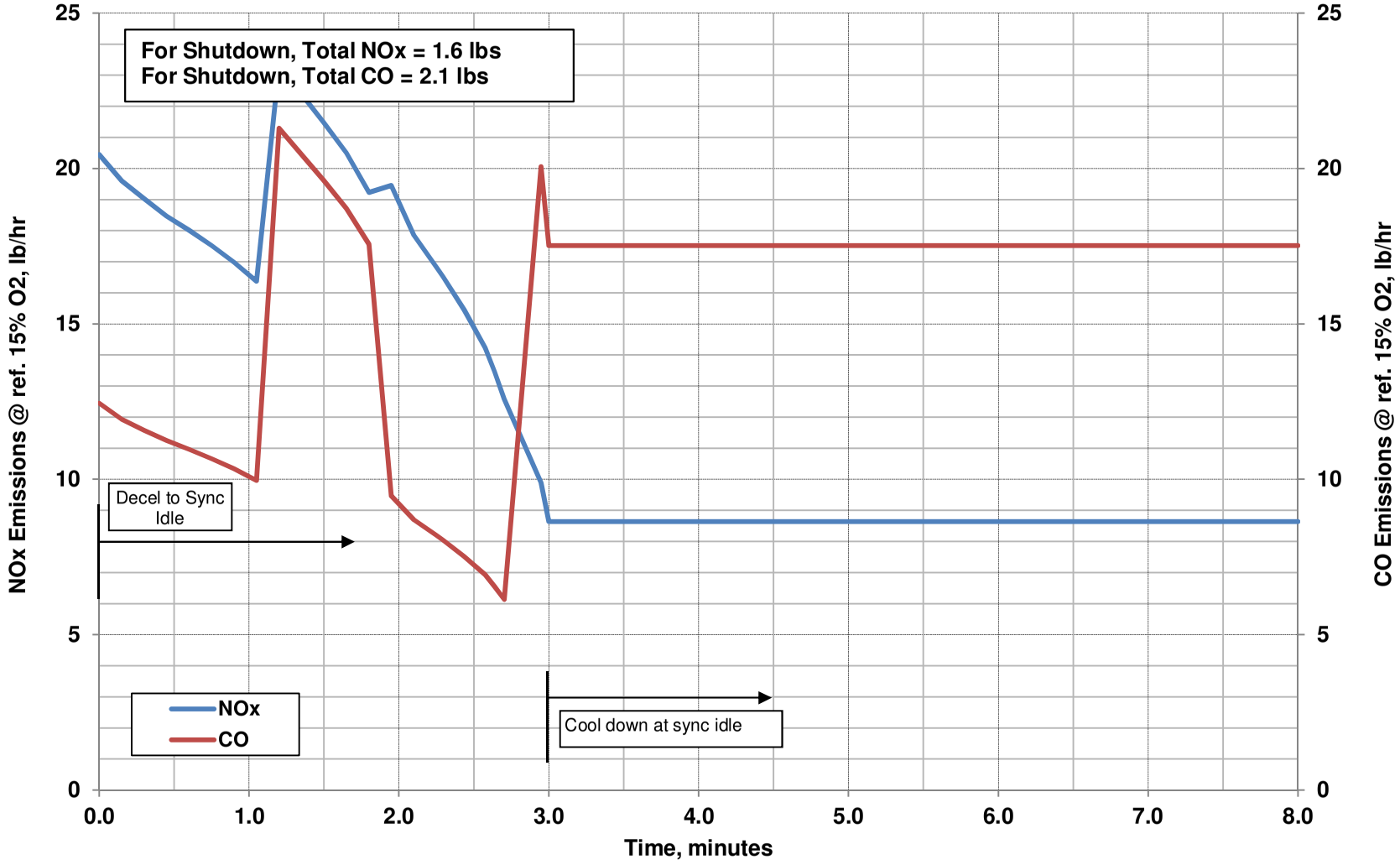
Estimated NOx and CO Emissions During 10 minute Startup
LM2500 PJ, DLE
NOT FOR GUARANTEE



Acceleration to base load is based on LM2X 10 minute startup, 59.0°F, RH of 60.0% with 5.0 inH2O, 12.0 inH2O at 754.0ft. MSL,
Fuel: Gas Fuel #900-3422, LHV 20648 Btu/lb, BDAX 7-193ERH 60Hz, 13.8kV, 0.85PF

GE Energy

Estimated NOx and CO Emissions During 8 minute Shutdown
LM2500 PJ, DLE
NOT FOR GUARANTEE



Deceleration is based on LM2X 8 minute shutdown, 59.0°F, RH of 60.0% with 5.0 inH2O, 12.0 inH2O at 754.0ft. MSL, Fuel: Gas Fuel # 900-3422, LHV 20648 Btu/lb, BDAX 7-193ERH 60Hz, 13.8kV, 0.85PF

Typical GE LM GTG Service Intervals

Interval	Scheduled Maintenance Action	Outage Duration
4,000 hours (every 4K h)	Borescope Inspection (includes cool-down time)	12 hours
25,000 hours	Hot Section Interval* 1) On-Site Hot Section Replacement (Combustor, & HPT)	4 days[(a)]
50,000 hours	Depot Maintenance[(b)] 1) Major Hot Section Overhaul (Combustor, HPT) 2) Power Turbine Overhaul	4 days[(a)]
75,000 hours	Hot Section Interval[(b)] 1) On-Site Hot Section Replacement (Combustor, HPT)	4 days[(a)]
100,000 hours	Depot Maintenance[(b)] 1) Major Hot Section Overhaul (Combustor, HPT) 2) Power Turbine Overhaul	4 days[(a)]

(a) Rotable module installed during maintenance period
(b) Lease/spare "supercore" and Power Turbine modules are installed during maintenance period. For depot maintenance, outage duration is 60 days if no spare/lease module(s) are used.
(c) Roller and ball bearings are replaced at 50,000 hours; hydrodynamic bearings are inspected.

DUFFIELD ASSOCIATES, INC.
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PROJECT NO. _____ NAME _____
RE _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

LM2500 CT

NO_x emission calculations:

need to meet 2.0 ppmvd @ 15% O_2

$$\frac{lb}{mmBTU} = \frac{2.0\,ppmvd \times \left(\frac{21-0}{21-15}\right) \times 46\frac{lb\,NO_x}{mole} \times \left(\frac{8710\,dscf/mmBTU}{385\,scf/mole}\right)}{10^6}$$

F_d ; MW ; V_m ; % O_2 correction

$$= 0.0073\,\frac{lb\,NO_x}{mmBTU}$$

CO emissions:

manufacturer emissions 25 ppm without controls
oxidation catalyst removal efficiency 95%

$$25\,ppm - (25 \times .95) = 1.25\,ppmvd$$

$$\frac{lb}{mmBTU} = \frac{1.25\,ppmvd \times \left(\frac{21-0}{21-15}\right) \times \frac{28\,lb\,CO}{mole\,CO} \times \left(\frac{8710\,dscf/mmBTU}{385\,scf/mole}\right)}{10^6}$$

$$= 0.0028\,\frac{lb\,CO}{mmBTU}$$

DELUXE FOR BUSINESS 1-800-888-6327 Ref. No: G 355806471

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PROJECT NO. _____ NAME _____
RE _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

LM2500 CT

$VOC_S = 0.0021 \frac{lb\ VOC}{mmBTU}$

AP-42 Table 3.1-2A

SO_2 = AP-42 Table 3.1-2A

$0.94 \times S$ ← sulfur content of fuel = .0015%

$0.94 \times 0.0015 = 0.00141 \frac{lb\ SO_2}{mmBTU}$

$PM_{10/2.5/Total}$ =
AP-42 Table 3.1-2A

PM_{total} E.F. of 6.6×10^{-3} lb/mmBTU was used for $PM_{10}/PM_{2.5}$ + PM_{total}

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PROJECT NO. _____ NAME _____
RE _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
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LM2500 CT

H_2SO_4 - Sulfuric Acid Emissions

$$\frac{0.5\ gr\ S}{100\ scf} \times \frac{1\ lb}{7000\ gr} \times \frac{1\ scf}{1027\ BTU} \times \frac{10^6\ BTU}{1\ MMBTU} = 0.000695\ \frac{lb\ S}{MMBTU}$$

$$.000695\ \frac{lb\ S}{MMBTU} \times \frac{98.079\ lb\ H_2SO_4}{32.065\ lb\ S} \times 0.5 = .0011\ \frac{lb\ H_2SO_4}{MMBTU}$$

transfer rate
(assumes 50% S becomes SO_3
and 100% SO_3 becomes H_2SO_4)

Ammonia (NH_3) - need to have ammonia slip no greater than 7ppmvd

$$\frac{lb\ NH_3}{MMBTU} = \frac{7\ ppmvd \times \underbrace{\left(\frac{21-0}{21-15}\right)}_{\%\ O_2\ correction} \times \frac{17.31\ lb\ NH_3}{mole} \times \left(\frac{8710\ dscf/MMBTU}{385\ scf/mole}\right)}{10^6}$$

$$= .0096\ \frac{lb\ NH_3}{MMBTU}$$

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PROJECT NO. _____ NAME _____
RE _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

CO_2 emissions: AP-42 Table 3.1-2A

$$110 \frac{lb\ CO_2}{MMBTU}$$

CH_4 emissions:

AP-42 Table 3.1-2A

methane $= .0086 \frac{lb\ CH_4}{MMBTU}$

N_2O emissions:

AP-42 Table 3.1-2A

$N_2O = 0.003 \frac{lb\ N_2O}{MMBTU}$

DELUXE FOR BUSINESS 1-800-888-6327 Ref. No: G 355806471

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PROJECT NO. _____ NAME _____
RE _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

LM2500 STARTUP EMISSIONS

NO_x emissions per GE first 10 minutes = 1.7 lbs

NO_x emission max per GE 20 minutes (no controls) = 23.0 $\frac{lbs}{hr}$

$$23.0 \frac{lbs}{hr} \times \frac{1 hr}{60 min} \times 20 minutes = 7.6 lbs\ NO_x$$

$$+ 1.7 lbs\ NO_x$$

$$9.3 lbs\ NO_x / startup$$

CO emissions per GE first 10 minutes = 1.4 lbs

CO emission max per GE 20 minutes (no controls) = 13.8 $\frac{lbs}{hr}$

$$13.8 \frac{lbs}{hr} \times \frac{1 hr}{60 min} \times 20 minutes = 4.6 lbs\ CO$$

$$+ 1.4 lbs\ CO$$

$$6.0 lbs\ CO / startup$$

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PROJECT NO. _____ NAME _____
RE _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

WARTSILA 18V50SG
See "Typical Emissions After Catalyst for Spark Gas Engines"

NO_x emissions:

@ 100% load $0.000132 \frac{lb}{kWh} \times 18759\ kW = 2.47 \frac{lb}{hr}\ NO_x$

@ 50% load $0.000176 \frac{lb}{kWh} \times 9379.50\ kW = 1.65 \frac{lb}{hr}\ NO_x$

CO emissions:

@ 100% load $0.000286 \frac{lb}{kWh} \times 18759\ kW = 5.37 \frac{lb}{hr}\ CO$

VOC emissions:

@ 100% load $0.000286 \frac{lb}{kWh} \times 18759\ kW = 5.37 \frac{lb}{hr}\ VOC$

@ 50% load $0.000462 \frac{lb}{kWh} \times 9379.50\ kW = 4.33 \frac{lb}{hr}\ VOC$

CO_2 emissions:

@ 100% load $1.067 \frac{lb}{kWh} \times 18759 = 20{,}015 \frac{lb}{hr}\ CO_2$

DELUXE FOR BUSINESS 1-800-888-6327 Ref. No: G 355806-171

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PROJECT NO. _____ NAME _____
RE _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

WARTSILA 18V50SG

$PM_{total} / PM_{10} / PM_{2.5}$ emissions

$$0.000264 \frac{lb}{kwh} \times 18759\ kW = 4.95 \frac{lb}{hr}$$

SO_2 emissions:

AP-42 Table 3.2-2 $= 5.88 \times 10^{-4} \frac{lb}{MMBTU}$

H_2SO_4 emissions:

transfer rate

$$0.000695 \frac{lb\ S}{MMBTU} \times \frac{98.079\ lb\ H_2SO_4}{32.065\ lb\ S} \times 0.5 = 0.0011 \frac{lb\ H_2SO_4}{MMBTU}$$

[Assumes 50% S in gas becomes SO_3 and 100% $SO_3 \rightarrow H_2SO_4$]

Ammonia (NH_3) ammonia slip < 7ppmvd

see Ammonia calculation for LM2500CT

DELUXE FOR BUSINESS 1-800-888-6327 Ref. No: G 355806171

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PROJECT NO. _____ NAME _____
RE _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

EXAMPLE
CO_{2e} emissions

LM2500 CT/
WARTSILA
18V50SG

$$110 \frac{lb\ CO_2}{MMBTU} \times 220.3 \frac{MMBTU}{hr} = 24{,}233 \frac{lb\ CO_2}{hr}$$

$$0.0086 \frac{lb\ CH_4}{MMBTU} \times 220.3 \frac{MMBTU}{hr} = 1.9 \frac{lb}{hr}\ CH_4$$

$$0.003 \frac{lb\ N_2O}{MMBTU} \times 220.3 \frac{MMBTU}{hr} = 0.66 \frac{lb\ N_2O}{hr}$$

$$24{,}233 \frac{lb}{hr}\ CO_2 \times \frac{8760\ hr}{yr} \times \frac{1\ ton}{2000\ lb} = 106{,}141 \frac{tons}{yr}\ CO_2 \text{ per Turbine}$$

$$1.9 \frac{lb}{hr}\ CH_4 \times \frac{8760}{2000} = 8.3 \frac{tons}{yr}\ CH_4 \text{ per Turbine}$$

$$0.66 \frac{lb}{hr}\ N_2O \times \frac{8760}{2000} = 2.9 \frac{ton}{yr}\ N_2O \text{ per Turbine}$$

$$106{,}141 \frac{ton\ CO_2}{yr\text{-turbine}} \times 7 \text{ turbines} \times \text{GWP factor} \begin{pmatrix} 1 \text{ for } CO_2 \\ 21 \text{ for } CH_4 \\ 310 \text{ for } N_2O \end{pmatrix} = 742{,}987 \text{ tons } CO_{2e}$$

$$8.3 \frac{ton\ CH_4}{yr\text{-turbine}} \times 7 \text{ turbines} \times 21 = 1{,}220 \text{ tons } CO_{2e}$$

$$2.9 \frac{ton\ N_2O}{yr\text{-turbine}} \times 7 \text{ turbines} \times 310 = 6{,}293 \text{ tons } CO_{2e}$$

$$750{,}500 \frac{tons\ CO_{2e}}{yr}$$

DELUXE FOR BUSINESS 1-800-888-6327 Ref. No: G 355806-171

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PROJECT NO. _____ NAME _____
RE _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

CO_{2e} emissions (continued)

$1{,}067 \frac{lb}{mwh} \times 18.8 mwe = 20{,}016 \frac{lbs}{hr}$ CO_2 per RGE

$0.001 \frac{kg\ CH_4}{mmBTU} \times 138.3 \frac{mmBTU}{hr} \times \frac{2.2 lbs}{1 kg} = 0.304 \frac{lb\ CH_4}{hr}$ per RGE

$0.0001 \frac{kg\ N_2O}{mmBTU} \times 138.3 \frac{mmBTU}{hr} \times \frac{2.2 lbs}{1 kg} = 0.030 \frac{lb\ N_2O}{hr}$ per RGE

GWP

$20{,}016 \frac{lb}{hr} CO_2 \times \frac{1 ton}{2000 lb} \times 6{,}666 \frac{hr}{yr} \times 1 = 66{,}713$ tons CO_{2e}
$\times 3$ RGE
$= 200{,}139$ tons CO_{2e}

$0.304 \frac{lb}{hr} CH_4 \times \frac{1 ton}{2000 lb} \times 6{,}666 \frac{hr}{yr} \times 21 = 21.3$ tons CO_{2e}
$\times 3$ RGE
$= 63.9$ tons CO_{2e}

$0.030 \frac{lb\ N_2O}{hr} \times \frac{1 ton}{2000 lb} \times 6{,}666 \frac{hr}{yr} \times 310 = 31.0$ tons CO_{2e}
$\times 3$ RGE
$= 93$ tons CO_{2e}

$200{,}295 \frac{tons\ CO_{2e}}{yr}$

742,987
1,220
6,293
200,139
63.9
93
} tons CO_{2e}

~ 950,795 tpy CO_{2e} rounding => 950,836 tpy CO_{2e}

DELUXE FOR BUSINESS 1-800-888-6327 Ref. No: G 355806-171

DUFFIELD ASSOCIATES, INC.
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Phone (302) 239-6634 Fax (302) 239-8485

PROJECT NO. 8718CI NAME MFP
RE TDC AIR PERMIT
SHEET NO. 1 OF 2
CALCULATED BY MFP DATE 8-30-13
CHECKED BY _____ DATE _____

PM emissions from Cooling Towers

(1) Chiller Tower
# of cells = 5
Recirculating water flow rate = 170,010 gpm
Drift loss rate = 0.0005%
TDS = 310 ppmw ← per United Water Delaware

$PM_{emissions}$ = 310 ppm × 5 cycles of concentrations = 1550 ppm TDS

eqn for TDS of makeup water from AP-42 Ch. 13-4 wet cooling towers

$$PM_{emissions} = 170{,}010 \frac{gal}{min} \times \frac{.0005\%}{100} \times \frac{8.345\,lb}{gal} \times \frac{1550\,ppmw}{10^6} \times \frac{60\,min}{hr}$$

= 0.65 lb/hr TDS Chiller Tower

per cell ⇒ $0.65 \frac{lb\ TDS}{hr\text{-}cooling\ Tower} \times \frac{1\ tower}{8\ cells} = 0.08 \frac{lb}{hr}$ TDS (per cell)

$$0.08 \frac{lb}{hr\text{-}cell} \times 8\ cells \times \frac{8760\,hr}{yr} \times \frac{1\,ton}{2000\,lb} = 2.8\ tpy$$

Reorder From NEBS CUSTOM printing service 1-800-888-6327 NEBS, Inc. Groton, MA 01471 www.nebs.com Ref. No: G 355806471

DUFFIELD ASSOCIATES, INC.
Consultants in the Geosciences
5400 Limestone Road
WILMINGTON, DELAWARE 19808
Phone (302) 239-6634 Fax (302) 239-8485

PROJECT NO. 8718CI NAME MFP
RE TQC Air Permit
SHEET NO. 2 OF 2
CALCULATED BY MFP DATE
CHECKED BY DATE

PM emissions from Cooling Towers

(2) Steam Turbine Cooling Tower
4 cells = 4
Recirculating water flow rate = 37,500 gpm
Drift loss rate = 0.0005%
TDS = 310 ppmw × 5 cycles of concentration = 1550 ppm TDS

$$PM_{emissions} = 37{,}500\,gpm \times \frac{.0005\%}{100} \times \frac{8.345\,lb}{gal} \times \frac{1550\,ppm}{10^6} \times \frac{60\,min}{hr}$$

$$= 0.14\,\frac{lb}{hr}\ TDS \text{ Steam Turbine Cooling Tower}$$

$$\text{per cell} \Rightarrow 0.14\,\frac{lb\ TDS}{hr\text{-cooling Tower}} \times \frac{1\ tower}{4\ cells} = 0.036\,\frac{lb}{hr}\ TDS\ (\text{per cell})$$

$$.036\,\frac{lb\ TDS}{hr\text{-cell}} \times 4\,cells \times \frac{8760\,hr}{yr} \times \frac{1\,ton}{2000\,lbs} = 0.64\ tpy$$

Total Cooling Tower lb/hr = 0.65
+ 0.14
0.79 lb/hr

$$0.79\,\frac{lb}{hr} \times \frac{8760\,hr}{yr} \times \frac{1\,ton}{2000\,lbs} = 3.46\ tpy$$

Reorder From NEBS CUSTOM printing service 1-800-888-6327 NEBS, Inc. Groton, MA 01471 www.nebs.com Ref. No: G 355806471

PM emissions from cooling tower

Primary Standards

Directly related to the safety of drinking water.

Distribution Disinfection Residuals	MRDL	MRDLG	Result	Range of Results	Violation	Likely Source
UWDE Distribution System chlorine residual (ppm)	4	4	1.6	1.1 - 1.6	No	Water additive used to control microbes
UW Bethel Distribution System chlorine residual (ppm)	4	4	1.8	0.6 - 1.8	No	Water additive used to control microbes

Entry Point Disinfection Residual	Minimum Disinfection Residual	Lowest Result	Range of Results	Violation	Likely Source
Chlorine ppm	0.3	0.25	0.25 - 3.5	No*	Water additive to control microbes

*Chlorine residual <0.3 ppm for less than 4 hours; therefore, there is no violation.

Disinfection Byproducts*	MCL	MCLG	Result	Range of Results	Violation	Likely Source
UW Bethel						
Total Trihalomethanes (ppb)	80	NA	53	20 - 112	No	Byproduct of chlorination
Haloacetic Acids (ppb)	60	NA	33	11 - 74	No	Byproduct of chlorination
UWDE						
Total Trihalomethanes (ppb)	80	NA	34	13 - 105	No	Byproduct of chlorination
Haloacetic Acids (ppb)	60	NA	22	12 - 79	No	Byproduct of chlorination

* See Disinfection Byproducts Health Effects section for more information.

	MCL	MCLG	% Removal Required	% Removal Achieved	Violation	Likely Source
Total Organic Carbon (ppm)	TT	NA	0 - 45	37 - 57	No	Naturally occurring

Disinfection Byproducts Health Effects

Some people who drink water containing trihalomethanes in excess of the MCL over many years may experience problems with their liver, kidneys, or central nervous systems, and may have an increased risk of getting cancer.

Some people who drink water containing haloacetic acids in excess of the MCL over many years may have an increased risk of getting cancer.

Non-Regulated and Secondary Substances (UWDE)

Substance	MCL/ Guideline*	Average Result	Range of Results	Likely Source
Alkalinity ppm	NA	66	43 - 90	Erosion of natural deposits
Bromochloroacetic acid (ppb)	NA	3.5	ND - 5.6	Byproduct of chlorination
Chloride ppm	250	66	43 - 128	Erosion of natural deposits
Manganese ppb	50	10	ND - 19	Erosion of natural deposits
pH units	6.5 - 8.5	7.3	6.7 - 7.6	Erosion of natural deposits
Sodium ppm	NA	31	30 - 32	Erosion of natural deposits
Sulfate ppm	250	27	16 - 38	Erosion of natural deposits
Total dissolved solids ppm	500	255	210 - 310	Erosion of natural deposits
Total hardness ppm	NA	120	52 - 236	Erosion of natural deposits

United Water makeup water TDS concentration

*MCL compliance with Secondary Standards per ODW is based on monitoring period average for each substance for UWDE Entry Points. PA DEP does not apply MCLs to Secondary Standards, but provides guidelines for these parameters.

The US EPA finalized a new regulation in 2006 called the Stage 2 Disinfectants-Disinfection Byproducts Rule (Stage 2). This rule requires our public water systems to perform additional sampling throughout our distribution systems for total trihalomethanes and haloacetic acids. This sampling is known as the Initial Distribution System Evaluation or IDSE. The monitoring period for this IDSE took place in 2007 and 2008. The results of this study were used to determine new compliance sampling locations for the Stage 2 Rule. The range of results of the samples collected in 2008 for our systems are shown below.

UWDE IDSE
Total Trihalomethanes (ppb): 5 - 123
Haloacetic Acids (ppb): 10 - 64

Bethel IDSE
Total Trihalomethanes (ppb): 17 - 75
Haloacetic Acids (ppb): 33 - 60

★ June 2013 United Water Water Quality Report ★

Eastern Shore Gas Quality - Williams Transco

Month	Sample Date	Unodorized Grains/100scf	Odorized Grains/100scf
Aug-13	8/8/2013	0.134	0.389
Jul-13	7/6/2013	0.147	0.374
Jun-13	6/6/2013	0.15	0.387
May-13	5/17/2013	0.149	0.398
Apr-13	4/2/2013	0.158	0.388
Mar-13	3/3/2013	0.148	0.366
Feb-13	2/3/2013	0.145	0.354
Jan-13	1/6/2013	0.143	0.373
Dec-12	12/19/2012	0.134	0.372
Nov-12	11/13/2012	0.142	0.362
Oct-12	10/5/2012	0.134	0.355
Sep-12	9/24/2012	0.122	0.36

40CFR72.2 Acid Rain Program - "Definitions"

Pipeline natural gas means a naturally occurring fluid mixture of hydrocarbons (e.g., methane, ethane, or propane) produced in geological formations beneath the Earth's surface that maintains a gaseous state at standard atmospheric temperature and pressure under ordinary conditions, and which is provided by a supplier through a pipeline. Pipeline natural gas contains 0.5 grains or less of total sulfur per 100 standard cubic feet. Additionally, pipeline natural gas must either be composed of at least 70 percent methane by volume or have a gross calorific value between 950 and 1100 Btu per standard cubic foot.

Texas Eastern Sulfur Content - Perulack Station, Central Pennsylvania

PostingTimestamp	DeviceId	DeviceNam	DataTimestamp	TOTAL SUL	Total SULFUR (gr/100scf)
2/20/2013	78017	Perulack	2/20/2013	4.484	0.280425266
2/21/2013	78017	Perulack	2/21/2013	5.041	0.315259537
2/22/2013	78017	Perulack	2/22/2013	5.331	0.333395872
2/23/2013	78017	Perulack	2/23/2013	5.691	0.355909944
2/24/2013	78017	Perulack	2/24/2013	5.144	0.321701063
2/25/2013	78017	Perulack	2/25/2013	5.206	0.325578487
2/26/2013	78017	Perulack	2/26/2013	5.063	0.316635397
2/27/2013	78017	Perulack	2/27/2013	5.415	0.338649156
2/28/2013	78017	Perulack	2/28/2013	4.925	0.308005003
3/1/2013	78017	Perulack	3/1/2013	4.41	0.275797373
3/2/2013	78017	Perulack	3/2/2013	4.888	0.305691057
3/3/2013	78017	Perulack	3/3/2013	3.874	0.242276423
3/4/2013	78017	Perulack	3/4/2013	6.487	0.405691057
3/5/2013	78017	Perulack	3/5/2013	5.737	0.358786742
3/6/2013	78017	Perulack	3/6/2013	4.921	0.307754847
3/7/2013	78017	Perulack	3/7/2013	4.969	0.310756723
3/8/2013	78017	Perulack	3/8/2013	5.232	0.327204503
3/9/2013	78017	Perulack	3/9/2013	5.306	0.331832395
3/10/2013	78017	Perulack	3/10/2013	5.746	0.359349593
3/11/2013	78017	Perulack	3/11/2013	5.192	0.324702939
3/12/2013	78017	Perulack	3/12/2013	5.508	0.344465291
3/13/2013	78017	Perulack	3/13/2013	3.726	0.233020638
3/14/2013	78017	Perulack	3/14/2013	4.996	0.312445278
3/15/2013	78017	Perulack	3/15/2013	6.257	0.391307067
3/16/2013	78017	Perulack	3/16/2013	5.005	0.31300813
3/17/2013	78017	Perulack	3/17/2013	5.707	0.356910569
3/18/2013	78017	Perulack	3/18/2013	5.777	0.361288305
3/19/2013	78017	Perulack	3/19/2013	6.673	0.417323327
3/20/2013	78017	Perulack	3/20/2013	5.627	0.351907442
3/21/2013	78017	Perulack	3/21/2013	5.527	0.345653533
3/22/2013	78017	Perulack	3/22/2013	5.427	0.339399625
3/23/2013	78017	Perulack	3/23/2013	5.775	0.361163227
3/24/2013	78017	Perulack	3/24/2013	4.554	0.284803002
3/25/2013	78017	Perulack	3/25/2013	4.965	0.310506567
3/26/2013	78017	Perulack	3/26/2013	5.207	0.325641026
3/27/2013	78017	Perulack	3/27/2013	5.02	0.313946216
3/28/2013	78017	Perulack	3/28/2013	5.066	0.316823014
3/29/2013	78017	Perulack	3/29/2013	5.051	0.315884928
3/30/2013	78017	Perulack	3/30/2013	5.219	0.326391495
3/31/2013	78017	Perulack	3/31/2013	5.118	0.320075047
4/1/2013	78017	Perulack	4/1/2013	5.109	0.319512195
4/2/2013	78017	Perulack	4/2/2013	4.131	0.258348968
4/3/2013	78017	Perulack	4/3/2013	5.139	0.321388368
4/4/2013	78017	Perulack	4/4/2013	5.794	0.36235147
4/5/2013	78017	Perulack	4/5/2013	5.315	0.332395247
4/6/2013	78017	Perulack	4/6/2013	5.431	0.339649781
4/7/2013	78017	Perulack	4/7/2013	5.173	0.323514697
4/8/2013	78017	Perulack	4/8/2013	5.91	0.369606004
4/9/2013	78017	Perulack	4/9/2013	5.698	0.356347717
4/10/2013	78017	Perulack	4/10/2013	5.928	0.370731707
4/11/2013	78017	Perulack	4/11/2013	7.385	0.461851157
4/12/2013	78017	Perulack	4/12/2013	7.385	0.461851157
4/13/2013	78017	Perulack	4/13/2013	4.752	0.297185741
4/14/2013	78017	Perulack	4/14/2013	4.459	0.278861789
4/15/2013	78017	Perulack	4/15/2013	4.664	0.291682301
4/16/2013	78017	Perulack	4/16/2013	5.856	0.366228893
4/17/2013	78017	Perulack	4/17/2013	5.011	0.313383365
4/18/2013	78017	Perulack	4/18/2013	5.023	0.314133834
4/19/2013	78017	Perulack	4/19/2013	4.706	0.294308943
4/20/2013	78017	Perulack	4/20/2013	5.151	0.322138837
4/21/2013	78017	Perulack	4/21/2013	5.222	0.326579112
4/22/2013	78017	Perulack	4/22/2013	4.902	0.306566604
4/23/2013	78017	Perulack	4/23/2013	4.724	0.295434647
4/24/2013	78017	Perulack	4/24/2013	4.526	0.283051907
4/25/2013	78017	Perulack	4/25/2013	5.368	0.335709819
4/26/2013	78017	Perulack	4/26/2013	5.078	0.317573483
4/27/2013	78017	Perulack	4/27/2013	4.883	0.305378361
4/28/2013	78017	Perulack	4/28/2013	4.706	0.294308943
4/29/2013	78017	Perulack	4/29/2013		
4/30/2013	78017	Perulack	4/30/2013	4.914	0.307317073
5/1/2013	78017	Perulack	5/1/2013	5.165	0.323014384
5/2/2013	78017	Perulack	5/2/2013	5.609	0.350781739
5/3/2013	78017	Perulack	5/3/2013	5.224	0.32670419
5/4/2013	78017	Perulack	5/4/2013	5.773	0.361038149
5/5/2013	78017	Perulack	5/5/2013	5.188	0.324452783
5/6/2013	78017	Perulack	5/6/2013	5.062	0.316572858
5/7/2013	78017	Perulack	5/7/2013	5.245	0.328017511
5/8/2013	78017	Perulack	5/8/2013	4.778	0.298811757
5/9/2013	78017	Perulack	5/9/2013	4.979	0.311382114
5/10/2013	78017	Perulack	5/10/2013	5.019	0.313883677
5/11/2013	78017	Perulack	5/11/2013	4.666	0.29180738
5/12/2013	78017	Perulack	5/12/2013	4.916	0.307442151
5/13/2013	78017	Perulack	5/13/2013	5.225	0.326766729
5/14/2013	78017	Perulack	5/14/2013	6.016	0.376235147
5/15/2013	78017	Perulack	5/15/2013	4.757	0.297498437
5/16/2013	78017	Perulack	5/16/2013	3.578	0.223764853
5/17/2013	78017	Perulack	5/17/2013	5.121	0.320262664
5/18/2013	78017	Perulack	5/18/2013	5.244	0.327954972
5/19/2013	78017	Perulack	5/19/2013	4.941	0.309005629
5/20/2013	78017	Perulack	5/20/2013	5.744	0.359224515
5/21/2013	78017	Perulack	5/21/2013	4.872	0.304690432
5/22/2013	78017	Perulack	5/22/2013	5.388	0.3369606
5/23/2013	78017	Perulack	5/23/2013	5.968	0.373233271
5/24/2013	78017	Perulack	5/24/2013	4.804	0.300437774
5/25/2013	78017	Perulack	5/25/2013	5.411	0.338398999
5/26/2013	78017	Perulack	5/26/2013	4.635	0.289868668
5/27/2013	78017	Perulack	5/27/2013	4.987	0.311882427
5/28/2013	78017	Perulack	5/28/2013	4.822	0.301563477
5/29/2013	78017	Perulack	5/29/2013	5.646	0.353095685
5/30/2013	78017	Perulack	5/30/2013	10.599	0.662851782
5/31/2013	78017	Perulack	5/31/2013	5.054	0.316072545
6/1/2013	78017	Perulack	6/1/2013	3.702	0.2315197
6/2/2013	78017	Perulack	6/2/2013	5.011	0.313383365
6/3/2013	78017	Perulack	6/3/2013	4.19	0.262038774
6/4/2013	78017	Perulack	6/4/2013	4.568	0.285678549
6/5/2013	78017	Perulack	6/5/2013	1.408	0.088055034
6/6/2013	78017	Perulack	6/6/2013	3.745	0.234208881
6/7/2013	78017	Perulack	6/7/2013	4.059	0.253846154
6/8/2013	78017	Perulack	6/8/2013	4.608	0.288180113
6/9/2013	78017	Perulack	6/9/2013	5.119	0.320137586
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6/11/2013	78017	Perulack	6/11/2013	4.386	0.274296435
6/12/2013	78017	Perulack	6/12/2013	4.418	0.276297686
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6/14/2013	78017	Perulack	6/14/2013	4.219	0.263852408
6/15/2013	78017	Perulack	6/15/2013	4.68	0.292682927
6/16/2013	78017	Perulack	6/16/2013	4.305	0.269230769
6/17/2013	78017	Perulack	6/17/2013	6.107	0.381926204
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6/22/2013	78017	Perulack	6/22/2013	4.47	0.279549719
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6/24/2013	78017	Perulack	6/24/2013	5.274	0.329831144
6/25/2013	78017	Perulack	6/25/2013	3.69	0.230769231
6/26/2013	78017	Perulack	6/26/2013	4.626	0.289305816
6/27/2013	78017	Perulack	6/27/2013	4.265	0.266729206
6/28/2013	78017	Perulack	6/28/2013	4.216	0.26366479
6/29/2013	78017	Perulack	6/29/2013	4.235	0.264853033
6/30/2013	78017	Perulack	6/30/2013	6.477	0.405065666
7/1/2013	78017	Perulack	7/1/2013	5.026	0.314321451
7/2/2013	78017	Perulack	7/2/2013	5.006	0.313070669
7/3/2013	78017	Perulack	7/3/2013	4.769	0.298248906
7/4/2013	78017	Perulack	7/4/2013	4.116	0.257410882
7/5/2013	78017	Perulack	7/5/2013	4.567	0.28561601
7/6/2013	78017	Perulack	7/6/2013	5.263	0.329143215
7/7/2013	78017	Perulack	7/7/2013	5.213	0.32601626
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7/9/2013	78017	Perulack	7/9/2013	5.213	0.32601626
7/10/2013	78017	Perulack	7/10/2013	5.213	0.32601626
7/11/2013	78017	Perulack	7/11/2013	5.213	0.32601626
7/12/2013	78017	Perulack	7/12/2013	5.213	0.32601626
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7/16/2013	78017	Perulack	7/16/2013	5.213	0.32601626
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7/31/2013	78017	Perulack	7/31/2013	5.213	0.32601626
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8/2/2013	78017	Perulack	8/2/2013	5.213	0.32601626
8/3/2013	78017	Perulack	8/3/2013	5.213	0.32601626
8/4/2013	78017	Perulack	8/4/2013	5.213	0.32601626
8/5/2013	78017	Perulack	8/5/2013	5.213	0.32601626
8/6/2013	78017	Perulack	8/6/2013	5.213	0.32601626
8/7/2013	78017	Perulack	8/7/2013	5.213	0.32601626
8/8/2013	78017	Perulack	8/8/2013	5.213	0.32601626
8/9/2013	78017	Perulack	8/9/2013	5.213	0.32601626
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8/29/2013	78017	Perulack	8/29/2013	5.213	0.32601626
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8/31/2013	78017	Perulack	8/31/2013	5.213	0.32601626
9/1/2013	78017	Perulack	9/1/2013	5.213	0.32601626
9/2/2013	78017	Perulack	9/2/2013	5.213	0.32601626
9/3/2013	78017	Perulack	9/3/2013	5.213	0.32601626
9/4/2013	78017	Perulack	9/4/2013	5.213	0.32601626
9/5/2013	78017	Perulack	9/5/2013	5.213	0.32601626
9/6/2013	78017	Perulack	9/6/2013	5.213	0.32601626
9/7/2013	78017	Perulack	9/7/2013	5.213	0.32601626
9/8/2013	78017	Perulack	9/8/2013	5.213	0.32601626
9/9/2013	78017	Perulack	9/9/2013	5.213	0.32601626
9/10/2013	78017	Perulack	9/10/2013	5.213	0.32601626
9/11/2013	78017	Perulack	9/11/2013	4.259	0.266353971
9/12/2013	78017	Perulack	9/12/2013	4.638	0.290056285
9/13/2013	78017	Perulack	9/13/2013	6.144	0.38424015
9/14/2013	78017	Perulack	9/14/2013	5.095	0.318636648
9/15/2013	78017	Perulack	9/15/2013	5.75	0.35959975
9/16/2013	78017	Perulack	9/16/2013	4.59	0.287054409
9/17/2013	78017	Perulack	9/17/2013	5.075	0.317385866
9/18/2013	78017	Perulack	9/18/2013	4.78	0.298936836
9/19/2013	78017	Perulack	9/19/2013	5.101	0.319011882
9/20/2013	78017	Perulack	9/20/2013	5.286	0.330581614
9/21/2013	78017	Perulack	9/21/2013	4.748	0.296935585
9/22/2013	78017	Perulack	9/22/2013	4.652	0.290931832
9/23/2013	78017	Perulack	9/23/2013	4.552	0.284677924
9/24/2013	78017	Perulack	9/24/2013	2.768	0.173108193
9/25/2013	78017	Perulack	9/25/2013	3.952	0.247154472
9/26/2013	78017	Perulack	9/26/2013	5.259	0.328893058
9/27/2013	78017	Perulack	9/27/2013	5.169	0.32326454
9/28/2013	78017	Perulack	9/28/2013	4.905	0.306754221
9/29/2013	78017	Perulack	9/29/2013	5.243	0.327892433
9/30/2013	78017	Perulack	9/30/2013	5.291	0.330894309
10/1/2013	78017	Perulack	10/1/2013	5.436	0.339962477
10/2/2013	78017	Perulack	10/2/2013	5.05	0.315822389
10/3/2013	78017	Perulack	10/3/2013	4.838	0.302564103
10/4/2013	78017	Perulack	10/4/2013	5.828	0.364477799
10/5/2013	78017	Perulack	10/5/2013	3.858	0.241275797
10/6/2013	78017	Perulack	10/6/2013	5.444	0.340462789
10/7/2013	78017	Perulack	10/7/2013	4.485	0.280487805
10/8/2013	78017	Perulack	10/8/2013	5.438	0.340087555
10/9/2013	78017	Perulack	10/9/2013	4.841	0.30275172
10/10/2013	78017	Perulack	10/10/2013	5.127	0.320637899
10/11/2013	78017	Perulack	10/11/2013	4.714	0.294809256
10/12/2013	78017	Perulack	10/12/2013	4.409	0.275734834
10/13/2013	78017	Perulack	10/13/2013	4.905	0.306754221
10/14/2013	78017	Perulack	10/14/2013	4.79	0.299562226
10/15/2013	78017	Perulack	10/15/2013	4.704	0.294183865
10/16/2013	78017	Perulack	10/16/2013	5.278	0.330081301
10/17/2013	78017	Perulack	10/17/2013	5.265	0.329268293
10/18/2013	78017	Perulack	10/18/2013	4.927	0.308130081
10/19/2013	78017	Perulack	10/19/2013	5.83	0.364602877
10/20/2013	78017	Perulack	10/20/2013	4.587	0.286866792
10/21/2013	78017	Perulack	10/21/2013	5.49	0.343339587
10/22/2013	78017	Perulack	10/22/2013	5.451	0.340900563

AVERAGE SULFUR CONTENT (gr/100scf)=	0.319

APPENDIX C

MODELING PROTOCOL

DUFFIELD ASSOCIATES

5400 Limestone Road
Wilmington, DE 19808
Phone: 302.239.6634
Fax: 302.239.8485
duffnet.com

August 13, 2013

Mr. Mohammed Majeed
State of Delaware
Department of Natural Resources
and Environmental Control
Division of Air Quality
715 Grantham Lane
New Castle, DE 19720

Re: Project No. 8718.CI (Duffield Associates)
The Data Centers, LLC – Wolf 1 CHP
Air Quality Impact Analysis Modeling Protocol
550 South College Avenue
Newark, Delaware

Dear Mr. Majeed:

Duffield Associates, Inc. respectfully submits this Air Quality Impact Analysis Modeling Protocol for the proposed Wolf Technology Center 1 Combined Heat and Power Plant (Wolf 1 CHP) to be located at the University of Delaware's Science, Technology and Advanced Research Campus (STAR Campus) in Newark, Delaware. This Air Quality Impact Analysis Modeling Protocol describes our anticipated modeling approach for the project, which will be subject to a Prevention of Significant Deterioration (PSD) review.

Should DNREC have any questions regarding this Air Quality Impact Analysis Modeling Protocol, please feel free to contact us at (302) 239-6634.

Thank you in advance for the Department's timely review of this document.

Very truly yours,

DUFFIELD ASSOCIATES, INC.

Anthony J. McGuire, E.I.
Environmental Engineer

Michael F. Panhuise, P.E.
Environmental Engineer

AJM/MFP:bac
WORD\8718CI.0813-MODELING PROTOCOL.RPT

cc: Mr. Matthew Rendon – DNREC DAQ (electronic)

DUFFIELD ASSOCIATES

AIR QUALITY IMPACT ANALYSIS
MODELING PROTOCOL

WOLF TECHNOLOGY CENTER 1
COMBINED HEAT AND POWER PLANT

SCIENCE, TECHNOLOGY, AND ADVANCED RESEARCH CAMPUS
(STAR CAMPUS)
NEWARK, DELAWARE

August 2013

Prepared for:

State of Delaware
Department of Natural Resources
and Environmental Control
Division of Air Quality
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Project No. 8718.CI

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1.0 INTRODUCTION

The Data Centers, LLC (TDC) is proposing to develop, construct, and operate a self-sustaining data center complete with an electrical power production plant at the University of Delaware's Science, Technology, and Advanced Research (STAR) Campus in Newark, New Castle County, Delaware (see Figure 1). The proposed generating station, to be called the Wolf Technology Center 1 Combined Heat and Power Plant (Wolf 1 CHP) will be a natural gas-fired, combined-cycle and co-generation facility that generates electricity and steam, which primarily powers an associated data storage facility, but also will provide electricity to the City of Newark and steam to the University of Delaware. The power plant will have a total electrical power production capacity of approximately 230 megawatts (MW). Steam will be generated through heat recovery units located along the exhaust systems of the natural gas fired combustion turbines (CT) and reciprocating gas engines (RGE). Steam will power the additional turbines that in turn will: (1) drive electricity generators (combined-cycle) and mechanical chillers located in the CHP; and (2) be exported to the University of Delaware for use in heating buildings (co-generation). The CHP will also use natural gas solid oxide fuel cells to generate electricity. The combination of varied electrical generating units and the generating capacity of the CHP will ensure that uninterruptable power is provided to the data storage facility. The conceptual CHP design and site layout is included as Figure 2.

The project site is located within the Philadelphia-Wilmington-Atlantic City (PA-NJ-MD-DE) area for ozone and the Philadelphia–Wilmington (PA-NJ-DE) Area for $PM_{2.5}$. This area is currently designated by the State of Delaware as marginal attainment for 8-hour ozone, but maintains its legacy "severe" non-attainment ozone area status from a Federal (and permitting) perspective. This area is also non-attainment for $PM_{2.5}$. The area is in attainment or not listed for all other National Ambient Air Quality Standards (NAAQS).

Wolf 1 CHP will emit several regulated air pollutants, most notably nitrogen oxides (NO_x); carbon monoxide (CO); particulate matter (PM), including PM less than or equal to 10 microns in aerodynamic diameter (PM_{10}) and PM less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$); volatile organic compounds (VOCs); sulfur dioxide (SO_2); sulfuric acid (H_2SO_4) mist; and greenhouse gases (GHGs). The facility will also potentially emit several hazardous air pollutants (HAPs), such as formaldehyde. In addition, PM will be emitted from the cooling tower as water vapor drift losses, which contain dissolved solids. Finally, some ammonia, which will be used in the selective catalytic reduction (SCR) NO_x control process will also be emitted.

Based on our initial emission estimates, we have identified that this project will be subject to a Prevention of Significant Deterioration (PSD) review. For projects subject to PSD review, the Delaware Department of Natural Resources and Environmental Control (DNREC) recommends the submittal of an air quality impact analysis modeling protocol prior to the start of regulatory modeling. Accordingly, Duffield Associates, Inc. (Duffield Associates), prepared this air quality impact analysis modeling protocol for the Wolf 1 CHP facility for review and comment by DNREC and other regulatory agencies including the U.S. Environmental Protection Agency (EPA) and U.S. Fish and Wildlife Service.

2.0 APPLICABLE REGULATIONS

DNREC has adopted Federal EPA regulations pertaining to New Source Review (NSR) which includes a PSD analysis for attainment pollutants and Nonattainment New Source Review (NNSR) for nonattainment pollutants (i.e., NOx and VOCs – potential ozone precursors, as well as $PM_{2.5}$). DNREC's New Source Review regulations are contained in the Delaware Administrative Code (DE Admin. Code) Chapter 7, Part 1125 *Preconstruction Review*.

According to DE Admin. Code 1125, nonattainment pollutants which are emitted at rates that exceed major source thresholds are regulated by Section 2.0 *Emission Offset Provisions.* Attainment pollutants which are emitted by major sources and exceed the significant emission rates (SERs) are regulated by DE Admin. Code 1125 Section 3.0 *Prevention of Significant Deterioration of Air Quality*. Pollutants that are not subject to Sections 2.0 or 3.0 of DE Admin. Code 1125 may be subject to Section 4.0 *Minor New Source Review*. The **requirements** of each Section (i.e., Emission Offsets, PSD, and MNSR) are outlined below. The **applicability** of each section is discussed in the Applicability Determination section of this modeling protocol.

Section 2.0 – Emission Offset Provisions –

Facilities are required to:

- Install Lowest Achievable Emission Rate (LAER) controls;
- Satisfy emission reductions (offsets)(i.e., obtain Emission Reduction Credits [ERCs]);
- Include analysis of alternative sites, sizes, production processes and environmental control techniques; and
- Demonstrate that the project will not adversely impact Class I areas.

Section 3.0 – Prevention of Significant Deterioration of Air Quality –

Facilities are required to:

- Apply Best Available Control Technology (BACT);
- Conduct an ambient air quality analysis for each pollutant that it will emit by modeling the impact from emissions. Pollutants that do not have a designated NAAQS are not subject to modeling (e.g., $H_2SO_4$and GHGs).
    - If modeling of select pollutants (from the source alone) exceed Significant Impact Level (SIL) concentrations, an additional cumulative impact analysis is required. This cumulative impact analysis incorporates emissions from surrounding sources and background concentrations of select pollutants in addition to emissions from the project.
- Include an additional impact analysis to evaluate impairment to visibility, soils and vegetation that would occur as a result of the source. The additional impact analysis will also include an evaluation of the effect of the general commercial, residential, industrial growth associated with the new source.

- Demonstrate that emissions will not adversely impact Class I areas.

Section 4.0 – Minor New Source Review –

Facilities are required to:

- Install LAER controls, BACT controls, or emission control technology approved in advance by DNREC for the source being constructed.

3.0 APPLICABILITY DETERMINATION

STEP 1: To identify which pollutants require evaluation under their respective DE Admin. Code 1125 New Source Review Sections (i.e., Section 2.0, 3.0, or 4.0), Duffield Associates first estimated the annual maximum potential to emit from the Wolf 1 CHP. Table 1 below includes the approximate potential emissions for the facility on an annual basis in tons per year (tpy).

Table 1. Potential Annual Wolf 1 CHP Emissions

Pollutant	Estimated PTE Annual Emissions (tpy)
NOx	93.15
VOCs	108.52
CO	106.18
SO_2	24.39
PM Total	68.57
PM_{10}	68.57
$PM_{2.5}$	68.57
HAPs (Individual/Aggregate)	8.50 / 12.0
H_2SO_4	20.80
Greenhouse Gases (GHG) in CO2e	1,107,288

Note: These emission totals are subject to change

STEP 2: To determine applicability to the New Source Review – Prevention of Significant Deterioration (PSD) requirements, Duffield Associates compared the projected emissions to State of Delaware Major Source Thresholds for New Castle County (see Table 2). Based on the estimated annual emissions of NOx, VOCs, CO, and GHG, the facility is considered a Major Stationary Source, potentially subject to PSD requirements. Furthermore, based on the estimated GHG emissions and the EPA's "Tailoring Rule," the facility is considered a major source, and all nonattainment pollutants are, therefore, subject to Step 3 and comparison to the Significant Emission Rates (SERs).

Table 2. New Source Review (NSR) Major Source Pollutants

Pollutant	Estimated PTE Annual Emissions (tpy)	Major Source Threshold (tpy)
NOx	**93.15**	**25**
VOC	**108.52**	**25**
CO	**106.18**	**100**
SO_2	24.39	100
PM Total	68.57	100
PM_{10}	68.57	100
$PM_{2.5}$	68.57	100
HAPs (Individual / Aggregate)	8.50 / 12.0	10 / 25
H_2SO_4	20.80	100
Greenhouse Gases (GHG) in CO2e	**1,107,288**	**100,000**

Step 3: To identify which individual pollutants are emitted at such rates that would deem them "significant," Duffield Associates compared the facility's estimated annual emissions to the PSD Significant Emission Rates (SERs). Table 3 below identifies the pollutants that will be emitted in excess of the SERs including: NOx, VOC, CO, PM total, PM_{10}, and $PM_{2.5}$. As such, these pollutants would be subject to PSD requirements. However, since New Castle County is non-attainment for ozone and $PM_{2.5}$, PSD requirements are not applicable to NOx, VOCs, and $PM_{2.5}$.

Table 3. Prevention of Significant Deterioration SER Comparison

Pollutant	Estimated PTE Annual Emissions (tpy)	Significant Emission Rate (SER) (tpy)	Prevention of Significant Deterioration (PSD)
NOx*	**93.15**	**25**	**No***
VOC*	**108.52**	**25**	**No***
CO	**106.18**	**100**	**Yes**
SO_2	24.39	40	No
PM Total	**68.57**	**25**	**Yes**
PM_{10}	**68.57**	**15**	**Yes**
$PM_{2.5}$*	**68.57**	**10**	**No***
HAPs (Individual / Aggregate)	8.50 / 12.0	no SER	N/A
H_2SO_4	**20.80**	**7**	**Yes**
Greenhouse Gases (GHG)	**1,107,288**	**100,000**	**Yes**

*Note: These pollutants exceed the SER, however, since New Castle County is nonattainment for these pollutants, PSD does not apply.

Step 4: Since New Castle County is currently designated as non-attainment for ozone and $PM_{2.5}$, Duffield Associates compared the emissions of NOx and VOCs (ozone precursors) as well as $PM_{2.5}$ to the Major Source Thresholds to determine whether these pollutants would be subject to the more stringent Nonattainment New Source Review requirements. Table 4 below identifies that NOx and VOCs are subject to NNSR. However, since estimated $PM_{2.5}$ emissions do not exceed the Major Source Threshold of 100 tpy, this pollutant is not subject to NNSR.

Table 4. Non-Attainment New Source Review (NNSR) Applicability

Pollutant	Estimated PTE Annual Emissions (tpy)	Major Source Threshold (tpy)	Non-Attainment New Source Review (NNSR)
NOx	**93.15**	**25**	**Yes**
VOC	**108.52**	**25**	**Yes**
$PM_{2.5}$	68.57	100	No

Step 5: Pollutants that are identified as not subject to NSR PSD or NNSR, may be subject to the DE Admin. Code 1125 Section 3.0 *Minor New Source Review* if they exceed the MNSR review threshold. Table 5 lists the pollutants which were exempt from PSD and NNSR. Based on the estimated emissions of SO_2, HAPs, and $PM_{2.5}$ exceeding 5 tpy, these pollutants are, therefore, subject to MNSR.

Table 5. Minor New Source Review Applicability

Pollutant	Estimated PTE Annual Emissions (tpy)	Minor New Source Review Threshold (tpy)	Minor New Source Review (MNSR)
SO_2	**24.39**	**5**	**Yes**
HAPs	**8.50/12.0**	**5**	**Yes**
$PM_{2.5}$	**68.57**	**5**	**Yes**

In summary, Table 6 below includes the regulatory requirements applicable to each specific pollutant for the Wolf 1 CHP facility.

Table 6. Regulatory Permitting Track

Pollutant	Estimated PTE Annual Emissions (tpy)	PSD	NNSR	MNSR
NOx	93.15		X	
VOC	108.52		X	
CO	106.18	X		
SO_2	24.39			X
PM Total	68.57	X		
PM_{10}	68.57	X		
$PM_{2.5}$	68.57			X
HAPs (Aggregate)	8.50 / 12.0			X
H_2SO_4	20.80	X*		
Greenhouse Gases (GHG)	1,107,288	X*		

Note: * No PSD modeling is required for these pollutants since no NAAQS exists for H_2SO_4 and GHGs.

4.0 MODELING EMISSIONS INVENTORY

4.1 ***ON-PROPERTY SOURCES***

The Wolf 1 CHP facility dispersion modeling inventory will begin with modeling of emissions limited to on-site sources including CTs, RGEs, solid oxide fuel cells, and cooling tower. Based on the PSD applicability determination (see Table 6), Duffield Associates anticipates that only CO, PM total, PM_{10}, and NO_2 will be modeled for assessing Class II impacts.

The portion of the PSD analysis submitted to DNREC regarding the ambient air quality impact analysis will include summary tables of emissions rates and operating parameters for each Wolf 1 CHP emissions source. The CTs, RGEs, fuel cells and cooling tower are expected to operate at or near 100 percent load 100 percent of the time except for periods of startup or shut down for maintenance. Based upon preliminary operating configurations, start-ups, shutdowns, and malfunctions are anticipated to account for less than 5 percent of the hours per year. At this frequency, those situations can be dismissed as intermittent sources. Emission rates used for annual average impacts will be based on the projected worst-case operating mode for non-intermittent sources.

4.2 ***OFF-PROPERTY SOURCES***

If pollutants from the Wolf 1 CHP facility are shown to exceed a SIL, cumulative modeling will be conducted. Cumulative modeling will require emissions inventory information from DNREC, and adjacent state regulatory agencies if necessary, for background concentrations and emissions sources located in the significant impact area (to be determined through modeling).

5.0 MODEL PROPOSED AND MODELING TECHNIQUES

5.1 MODEL PROPOSED

For the Wolf 1 CHP facility air quality impact analysis, the current version of the EPA-approved American Meteorological Society (AMS)/EPA Regulatory Model (AERMOD) modeling system (Version 12345), together with five years set of hour-by-hour meteorological data, will be used to obtain emissions impact predictions. The EPA's Guideline on Air Quality Models (GAQM), which is codified in 40 CFR Part 51 Appendix W, will be used along with the EPA provided user guides for AERMOD and its associated preprocessor, and the EPA's AERMOD Implementation Guide. Based on the guidance in these documents, AERMOD will be run using the default parameters. AERMOD will also be run using the URBANOPT keyword to account for the heat island effect caused by the urban location of Wolf 1 CHP.

5.2 NO_2 AMBIENT IMPACT ANALYSIS

On January 22, 2010, the EPA announced a new 1-hour average NO_2 NAAQS. The 1-hour NO_2 NAAQS was set at 100 ppb for the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour concentrations. This 1-hour NO_2 NAAQS became effective April 12, 2010.

A memorandum issued by the EPA on March 1, 2011 titled "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard" described modeling parameters to follow for assessing compliance with the new NO_2 NAAQS. Based upon this memorandum the following conditions/parameters will be followed:

- Ambient air quality modeling will be conducted using the current version of AERMOD;
- NO_2 impact will be estimated using the Tier 2 ratio of 0.80 as the ratio of NO_2/NO. If choices during the final design phase lead to a situation where the Tier 3 ratio of 0.50 for NO_2/NO is justified, the Tier 3 ratio will be used, and the justification will be provided in the PSD analysis;
- For each receptor, the daily 1-hour maximum NO_2 concentrations will be averaged over the 5-year modeling period;
- The predicted averages will be compared to the EPA recommended interim SIL of 7.5 $\mu g/m^3$; and
- If the predicted averages exceed the SIL, cumulative NO_2 modeling will be performed using nearby NO_x sources identified by DNREC along with background data from an appropriate monitoring station. The predicted concentrations in excess of the NAAQS, beginning with the highest, 8th highest (H8H) 1-hour NO_2 concentration over the 5-year modeling period will be assessed to determine if Wolf 1 CHP contributes significantly.

6.0 TERRAIN AND RECEPTOR CONSIDERATION

The GAQM defines simple terrain as terrain at a lower elevation than the height of the stack top and complex terrain as terrain exceeding the height of the stack being modeled. The elevation of the Wolf 1 CHP facility is approximately 30 meters (98 feet) above sea level. The proposed stacks are anticipated to have a maximum height of approximately 65 meters (213 feet), based on Good Engineering Practice (GEP) stack height. Stack heights may be less than this value, but are assumed to be 65 meters for the purposes of this modeling protocol. Accordingly, terrain elevations greater than approximately 95 meters (311 feet) above sea level would be classified as complex terrain, and would require that AERMOD be run for complex terrain.

U.S. Geological Survey (USGS) National Elevation Dataset (NED) terrain data was examined for terrain features within the expected Wolf 1 CHP impact area (see Figure 3). As shown in Figure 3, the general topography in the area surrounding Wolf 1 CHP rises to the north. Additionally, there are a number of local high points south of Wolf 1 CHP, one of which approaches approximately 95 meters above sea level (Iron Hill). Based on this examination, terrain in the vicinity of the Wolf 1 CHP site is classified as complex terrain, and AERMOD will be run accordingly.

AERMAP, the terrain pre-processor for AERMOD, will be utilized to provide a terrain elevation for each receptor used in modeling. The latest version of AERMAP will be utilized (Version 11103). As of April 13, 2013, USGS NED data is no longer available in a digital format consistent with use for AERMAP. The NED data will be obtained from the National Land Cover Database's (NLCD's) Multi-Resolution Land Characteristics Consortium (MRLC) map located at http://www.mrlc.gov/viewerjs/. Duffield Associates understands that AERMAP cannot model terrain nodes which exceed a 10 percent slope line from the receptor. Appropriate NED files will be utilized to include these types of terrain nodes, if appropriate.

A receptor grid was prepared to identify those points at which the ambient air quality will be modeled. Ambient air is identified by the EPA as "that portion of the atmosphere, external to buildings, to which the general public has access." Therefore, the nearest locations of general public access will be at and beyond the Wolf 1 CHP facility fence line. The ambient air receptor grid was prepared with the following constraints, which are illustrated in Figure 4:

- Fence Line Receptors – Receptors will be placed at 25 meter intervals on the Wolf 1 CHP facility fence line;
- Close Receptors – Receptors will be placed at 50-meter intervals on the x and y axes starting at the fence line and extending to a minimum of 1 kilometer (km);
- Medium Receptors – Receptors will be placed at 100-meter intervals on the x and y axes starting at approximately 1 km and extending to a minimum of 5 km; and
- Far Receptors – Receptors will be placed at 1,000-meter intervals on the x and y axes starting at approximately 5 km and extending to a minimum of 10 km.

This receptor grid will be prepared for input into AERMAP along with the receptor heights. The receptor grids used for the ambient impact analysis will be refined following preliminary modeling, as necessary, to ensure that appropriate spacing is used in those areas with the highest ambient impacts for each pollutant and averaging period.

7.0 BUILDING WAKE EFFECTS

Buildings within a close proximity to a stack can produce a downwash effect caused by turbulent air movement around downwind buildings. This turbulent air movement can potentially cause air pollutants to disperse to the ground surface faster than normally modeled, and therefore, increase surface concentrations unexpectedly. To account for potential building downwash effects at TDC, the latest edition of BPIPPRM will be implemented. BPIPPRM relies upon user supplied information of emissions data, building locations, and building dimensions to generate an input file for AERMOD. Although site design is currently in the preliminary phase, Duffield Associates anticipates that the final proposed building locations and dimensions will be available at the time of the construction permit application submission (PSD report). This information, along with the emissions data, will be input in BPIPPRM to account for potential downwash effects in the final AERMOD modeling.

8.0 METEOROLOGICAL DATA

AERMET is the meteorological preprocessor for AERMOD. AERMET uses a collection of inputs including weather observations, land use inputs from the AERSURFACE preprocessor, and wind inputs from the AERMINUTE preprocessor to produce a meteorological input for AERMOD. The latest version of AERMET (Version 12345) will be utilized to develop the meteorological inputs for AERMOD.

AERMET requires input data regarding upper air soundings and hourly surface weather data. Upper air soundings data is collected at a limited number of locations throughout the country. The nearest upper air data stations include Aberdeen Phillips Field Station in Aberdeen, Maryland, and Wallops Flight Facility in Wallops Island, Virginia. Aberdeen is the closest location to the proposed Wolf 1 CHP facility, and upper air soundings data is available at that site from January 1, 2000, to the present day. Data will be collected for the 5-year period from January 1, 2008 to December 31, 2012 from http://www.esrl.noaa.gov/raobs/.

Hourly surface data is available at a greater number of locations compared to upper air data including New Castle Airport (NCA), Aberdeen Phillips Field Station, Philadelphia International Airport, Dover Air Force Base, and Millville Municipal Airport. The closest location to the proposed Wolf 1 CHP facility is NCA, and hourly surface data is available at NCA consistently from January 1, 1973, to the present day. Data will be collected for the 5-year period from January 1, 2008 to December 31, 2012, from ftp://ftp.ncdc.noaa.gov/pub/data/noaa.

AERMINUTE is an AERMET preprocessor that factors in wind speed and direction to compliment the reported surface weather data. AERMINUTE uses 1-minute automated surface observing station (ASOS) data. The latest version of AERMINUTE will be used (Version 11325). Nearby 1-minute ASOS locations include NCA, Sussex County Airport, and Millville Municipal Airport. NCA is the closest location to the proposed Wolf 1 CHP facility, and 1-minute ASOS data is available for NCA from January 2000 to the present day. Data will be collected for the 5-year period from January 1, 2008 to December 31, 2012, from ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin/.

AERMET requires information on surface roughness length, albedo, and Bowen ratio to determine the effect of surface conditions on weather patterns. AERSURFACE was developed to calculate surface roughness length, albedo, and Bowen ratio from information on land cover for input to AERMET. The latest version of AERSURFACE will be used (Version 13016). The AERSURFACE land cover input data will be collected from NLCD's MRLC for the year 1992 at the NCA from http://www.mrlc.gov/viewerjs/. The land cover will be collected from NCA according to GAQM guidance which recommends that land cover data be collected for the site where weather information is collected. As shown in Figure 5, the land cover use at NCA has not varied significantly since 1992, therefore, the 1992 land use data is still applicable.

9.0 CLASS I AREA ANALYSES

According to Section 2.0 and Section 3.0 of DE Admin. Code 1125, Emission Offset Provisions and PSD analysis requires that new major source facilities demonstrate that potential air quality impacts will not adversely impact Class I areas. Class I areas were identified by the Clean Air Act Amendments of 1977 as national parks greater than 6,000 acres and national wilderness areas greater than 5,000 at the time of the amendments in 1977. A map of Class I areas within a 300 km radius of TDC is provided in Figure 6. Two Class I areas are located within this radius including: Brigantine National Wildlife Refuge, located approximately 113 km from TDC; and Shenandoah National Park, located approximately 225 km from TDC.

The Federal Land Managers' Air Quality-Related Values Workgroup Phase I Report provides an initial screening method for determining if air dispersion modeling must be performed for the Class I areas. The screening method relies upon dividing the total annual emissions (Q, in tons per year) of pollutants including SO_2, NO_x, PM_{10}, and H_2SO_4 by the distance from the facility to the Class I area (D, in kilometers). If the resulting quotient (Q/D) is less than 10, then additional air dispersion modeling is not required. Table 7 below includes the results of the screening method for each applicable pollutant and Class I area.

As indicated in Table 7, no quotient is greater than ten. Based upon these results, air dispersion modeling will not be performed for a Class I area analysis.

Table 7. PSD Class I Area Initial Screen Analysis

	NOx	SO_2	H_2SO_4	PM10	Total Annual Emissions (Q)
	Tons per year				
TDC potential emissions	93.15	24.39	20.80	68.57	206.91

	Brigantine National Wildlife Refuge	Shenandoah National Park
	km	
Distance from TDC (D)	113	225
	Ton/yr-km	
Q/D screening ratio	1.8	0.92

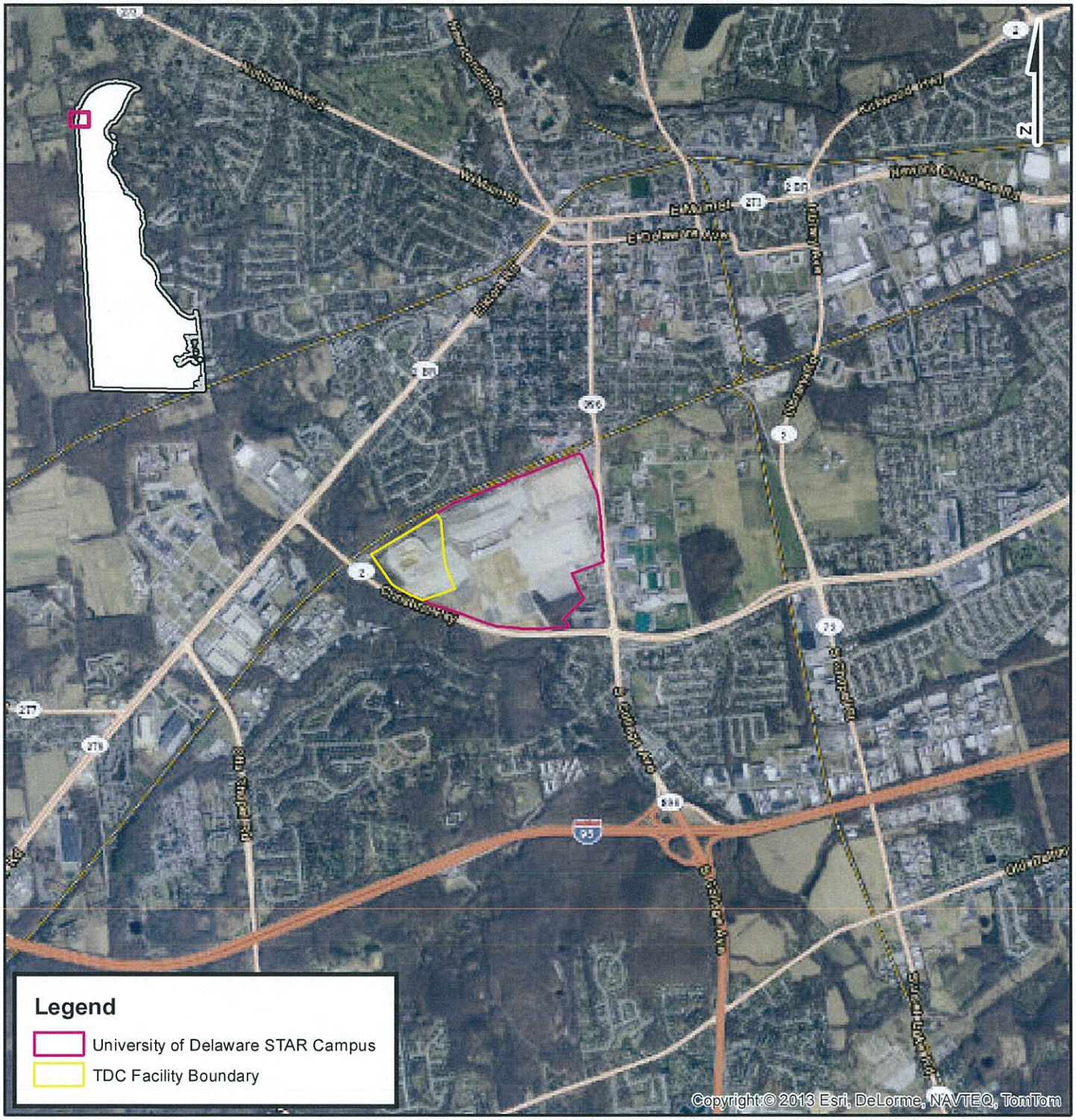
10.0 MODEL RESULTS

The purpose of conducting the Wolf 1 CHP facility ambient impact analysis is to show compliance with PSD regulations. In order to meet the requirements of those regulations, Duffield Associates must demonstrate through air quality modeling that the emission from the Wolf 1 CHP facility will not exceed PSD increments or NAAQS for a Class II area. Duffield Associates has already shown in this modeling protocol that a Class I area analysis is not appropriate for this facility and location.

Refined modeling results obtained from the AERMOD modeling system will be summarized in tabular format. The PSD ambient air quality monitoring results will be compared to the *de minimis* values, SIL values, and maximum allowable increases. If the SIL value is exceeded for an applicable pollutant, a "cumulative" ambient air quality analysis will be conducted. The modeled increase in ambient air pollutant concentrations will be added to background concentrations and other off-site stationary source emissions information to be provided by DNREC. This calculated cumulative ambient air concentration will be compared to appropriate NAAQS.

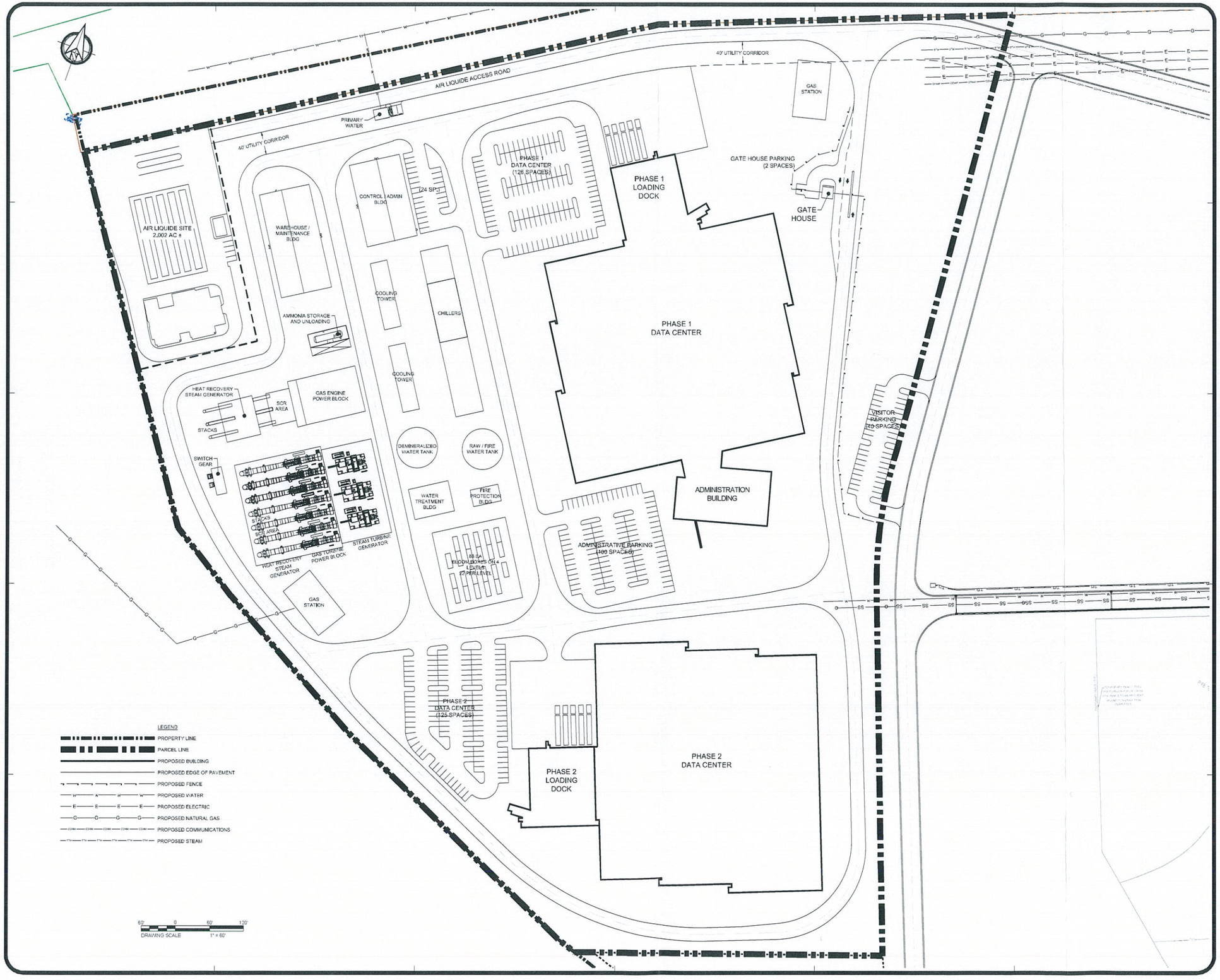
The PSD report will include documentation of the data files and input files used for the air quality impact analysis modeling, along with digital copies of the files.

FIGURES



NOTES:
THIS SKETCH IS PART OF A REPORT TITLED "WOLF 1 CHP AIR QUALITY IMPACT ANALYSIS MODELING PROTOCOL," DATED SEPTEMBER 2013 AND PREPARED BY DUFFIELD ASSOCIATES, INC. AND AS SUCH, THIS SKETCH SHOULD ONLY BE VIEWED IN THE CONTEXT OF THAT REPORT.

DATE: JULY 2013	SITE LOCATION SKETCH	DESIGNED BY: MFP	DUFFIELD ASSOCIATES
SCALE: 1 in = 4,000 feet	**WOLF 1 CHP**	DRAWN BY: MPN	5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485
PROJECT NO. 8718.CI		CHECKED BY: MFP	OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY
SHEET: FIGURE 1	NEWARK~NEW CASTLE COUNTY~DELAWARE	FILE: 8718CI_SiteLocationSketch.mxd	EMAIL: DUFFIELD@DUFFNET.COM



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No.	REVISION	DATE	BY

DESIGNED BY: WDH
DRAWN BY: DP/JH
CHECKED BY:
FILE NAME: PH-MSTR-PLAN

OWNER:

SITE PLAN

UD STAR CAMPUS

CITY OF NEWARK ~ NEW CASTLE COUNTY ~ DELAWARE

DATE: 07 AUGUST 2013
SCALE: [redacted]
PROJECT NO. 8718.CI
SHEET: FIGURE 2

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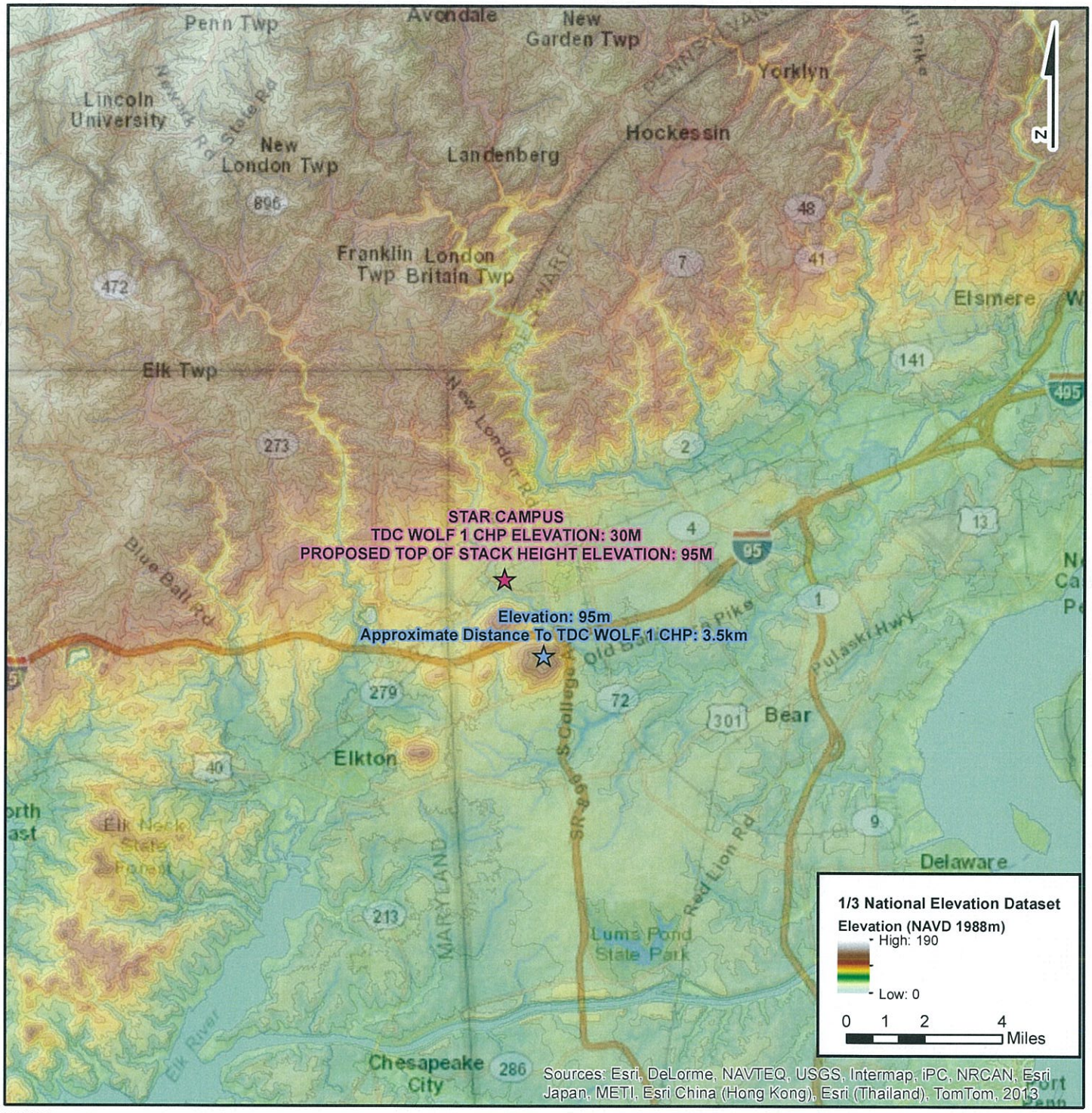
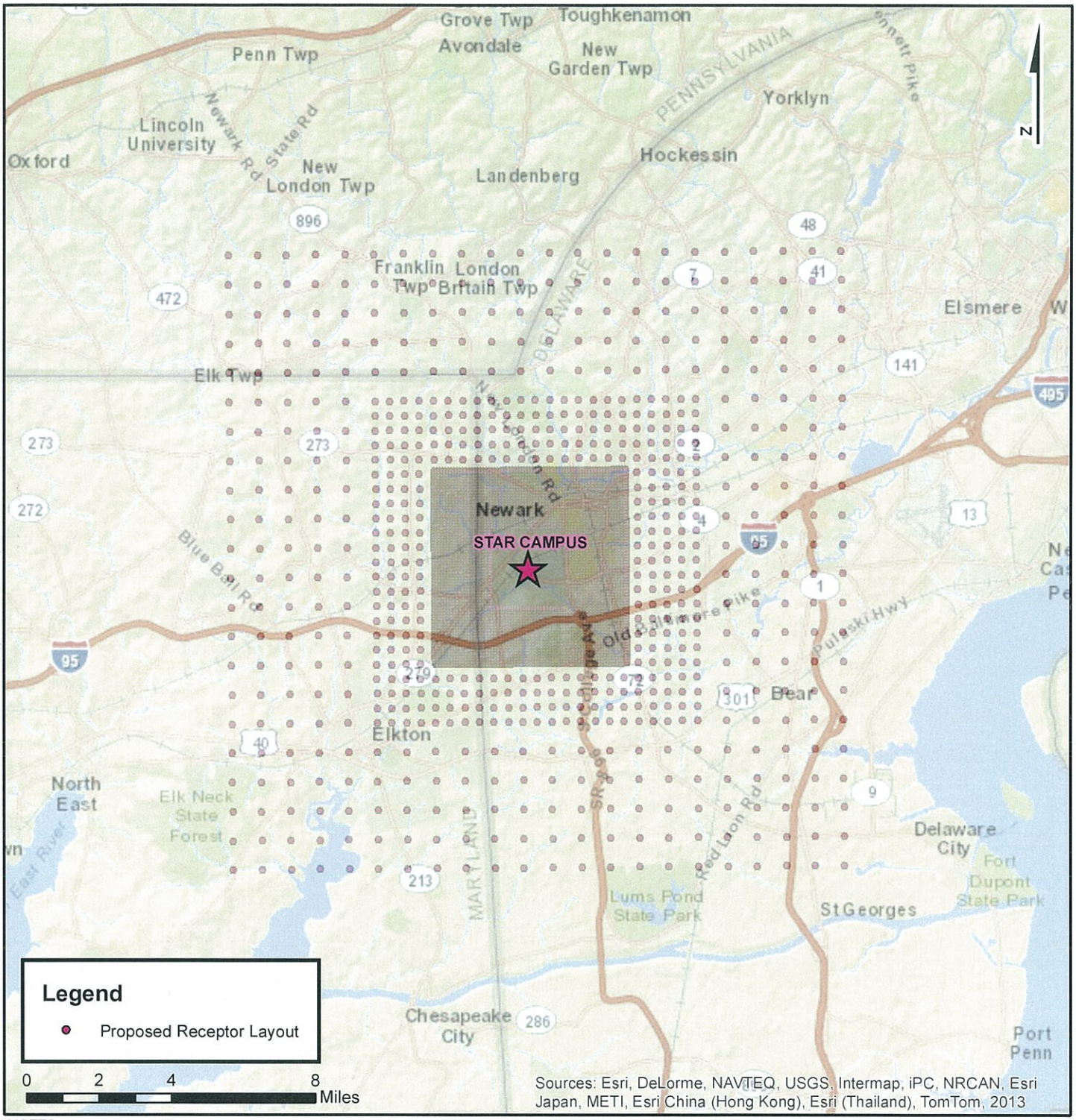


NOTES:

1. THIS SKETCH IS PART OF A REPORT TITLED "THE DATA CENTERS, LLC - WOLF 1 CHP AIR QUALITY IMPACT ANALYSIS MODELING PROTOCOL," DATED SEPTEMBER 2013 AND PREPARED BY DUFFIELD ASSOCIATES, INC. AND AS SUCH, THIS SKETCH SHOULD ONLY BE VIEWED IN THE CONTEXT OF THAT REPORT
2. 1/3 NATIONAL ELEVATION DATASET OBTAINED FROM THE USGS SEAMLESS SERVER WEB MAPPING SERVICE

DATE: SEPTEMBER 2013	REGIONAL TERRAIN MAP	DESIGNED BY: MFP	DUFFIELD ASSOCIATES
SCALE: 1 in = 4 miles	**TDC WOLF 1 CHP**	DRAWN BY: MPN	5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485
PROJECT NO. 9718.CI	**AIR MODELING PROTOCOL**	CHECKED BY: MFP	OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY
SHEET: FIGURE 3	NEWARK~NEW CASTLE COUNTY~DELAWARE	FILE: 8718CI_TerrainMap.MXD	EMAIL: DUFFIELD@DUFFNET.COM



NOTES:
THIS SKETCH IS PART OF A REPORT TITLED "THE DATA CENTERS, LLC - WOLF 1 CHP AIR QUALITY IMPACT ANALYSIS MODELING PROTOCOL," DATED SEPTEMBER 2013 AND PREPARED BY DUFFIELD ASSOCIATES, INC. AND AS SUCH, THIS SKETCH SHOULD ONLY BE VIEWED IN THE CONTEXT OF THAT REPORT.

DATE: JULY 2013	AMBIENT AIR RECEPTOR GRID	DESIGNED BY: MFP	DUFFIELD ASSOCIATES
SCALE: 1 in = 4 miles	**WOLF 1 CHP**	DRAWN BY: MPN	5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485
PROJECT NO. 8718.CI	**AIR MODELING PROTOCOL**	CHECKED BY: MFP	OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY
SHEET: FIGURE 4	NEWARK~NEW CASTLE COUNTY~DELAWARE	FILE: 8718CI_ReceptorMap.mxd	EMAIL: DUFFIELD@DUFFNET.COM

NOTES:
THIS SKETCH IS PART OF A REPORT TITLED "THE DATA CENTERS, LLC - WOLF 1 CHP AIR QUALITY IMPACT ANALYSIS MODELING PROTOCOL," DATED SEPTEMBER 2013 AND PREPARED BY DUFFIELD ASSOCIATES, INC. AND AS SUCH, THIS SKETCH SHOULD ONLY BE VIEWED IN THE CONTEXT OF THAT REPORT.

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Soil, Water & the Environment

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OFFICES IN DELAWARE, MARYLAND, PENNSYLVANIA, AND NEW JERSEY

E-MAIL: DUFFIELD@DUFFNET.COM

BASEMAP:
DELAWARE DEMAC

DRAWN BY:
MPN

CHECKED BY:
MFP

FILE:
8718CI_LANDUSECOVER.MXD

LAND USE COVER

WOLF 1 CHP

AIR MODELING PROTOCOL

NEWARK-NEW CASTLE COUNTY-DELAWARE

DATE:
SEPTEMBER 2013

SCALE:
1 in = 1 miles

PROJECT NO.
8718.CL

SHEET:
FIGURE 5

NOTES:
THIS SKETCH IS PART OF A REPORT TITLED "THE DATA CENTERS, LLC - WOLF 1 CHP AIR QUALITY IMPACT ANALYSIS MODELING PROTOCOL," DATED SEPTEMBER 2013 AND PREPARED BY DUFFIELD ASSOCIATES, INC. AND AS SUCH, THIS SKETCH SHOULD ONLY BE VIEWED IN THE CONTEXT OF THAT REPORT.

DATE: SEPTEMBER 2013	CLASS 1 AREAS	DESIGNED BY: MFP	DUFFIELD ASSOCIATES
SCALE: 1 in = 74 miles	**TDC WOLF 1 CHP**	DRAWN BY: MPN	5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485
PROJECT NO. 8718.CI	**AIR MODELING PROTOCOL**	CHECKED BY: MFP	OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY
SHEET: FIGURE 6	NEWARK~NEW CASTLE COUNTY~DELAWARE	FILE: 8718CI_Class1Areas.MXD	EMAIL: DUFFIELD@DUFFNET.COM

APPENDIX D

MODELING PROTOCOL COMMENTS

DUFFIELD ASSOCIATES

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duffnet.com

November 1, 2013

Mr. Mohammed Majeed
State of Delaware
Department of Natural Resources
and Environmental Control
Division of Air Quality
715 Grantham Lane
New Castle, DE 19720

Re: Project No. 8718.CI (Duffield Associates)
The Data Centers, LLC – Wolf 1 CHP
Comment Response Letter
Air Quality Impact Analysis Modeling Protocol
550 South College Avenue
Newark, Delaware

Dear Mr. Majeed:

Duffield Associates, Inc. (Duffield Associates or DAI) reviewed the comments provided by the State of Delaware, Department of Natural Resources and Environmental Control (DNREC), the Environmental Protection Agency's (EPA) Region III, and the United States Fish & Wild Life Service (USFWS) regarding the *Air Quality Impact Analysis Modeling Protocol*, dated August 2013, for the proposed Wolf 1 CHP Data Center project in Newark, Delaware. Duffield Associates has prepared this correspondence to specifically address each comment that was provided. Our responses, in part, reflect discussions with DNREC and EPA Region III that occurred subsequent to Duffield Associates' receipt of the written comments.

I. DNREC Comments –

DNREC: *Remodeling: Based on our communications, the Wolf 1 CHP is still in preliminary design phase, and the emissions provided in the modeling protocol are estimates. Once the design is finalized, it is likely that the stack parameters, emissions, and the building locations and dimensions change. Such changes are likely to affect modeled impacts considerably. Therefore, when the CHP project is fully designed, DNREC would like to see remodeling with the final emissions estimates, stack parameters, and building locations and dimensions, and also compliance demonstration of the NAAQS.*

Response: The permit application submitted to DNREC reflects the current site design. As discussed, stack heights and locations, as well as building dimensions and locations are subject to change pending final design. We do not anticipate that total emissions will significantly change during the design process. Should operations, stack heights, building locations or building dimensions change

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significantly, Duffield Associates will discuss these changes with DNREC and revise the modeling analysis, if requested.

DNREC: *Turbine Load Analysis: Depending upon the demand, the turbines may run at different loads, which could impact the emissions and stack flows. DNREC would like to see that the CHP complies with the NAAQS for different load conditions.*

Response: As requested by DNREC in our conference call on September 9, 2013, the permit application includes modeling emissions of the combustion turbines and reciprocating gas engines at three different load conditions associated with low, medium, and high loading conditions, roughly corresponding to: "island mode," where the CHP will be providing power to the data centers with no export of energy; "normal operating," where the CHP will be powering the data center, exporting steam and exporting 50 MW of electrical power to the City of Newark; and full load, where the CHP will be operating at capacity. Although the composition and concentration of substances emitted are not anticipated to change significantly when the CHP is operating at these loads, dispersion of those substances in the atmosphere may be affected by in the varying stack gas velocities and exhaust temperatures. As such, Duffield Associates concurs that dispersion modeling of those operating conditions is warranted to assess potential impacts. These three different loading conditions were modeled and discussed in Section 8 of the permit application.

DNREC: *Startup and Shut Down Operations: See the comment from EPA Region III Office. The SCR controls are not likely to work during the startup and shut down operations, thus causing the emissions to be higher compared to those during the normal operations. DNREC would like to see the emissions from "intermittent sources" included and the modeling analyses performed for these operations as well.*

Response: Duffield Associates concurs that these add-on emission control units will not reduce exhaust emissions during startup events at the same rates that they would at normal operating temperatures.

Startup and shutdown estimated emissions and frequency of events is discussed in Section 2.5 of the permit application. Based on the hours of operation that the plant is projected to have units operating in startup/shutdown mode, Duffield Associates considers these emissions to be <u>intermittent sources that do not warrant air dispersion modeling</u>.

DNREC: *Backup Fuels: See the comment from EPA Region III Office.*

Response: The only fuel source proposed is natural gas.

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DNREC: *HAPs: The protocol lists formaldehyde as one of the potential HAPs that is likely to be emitted. DNREC would like to see a demonstration that the risk posed by the HAPs is minimal.*

Response: An analysis of the risk posed by HAPs was performed and is discussed in Section 8.4 of the permit application.

II. EPA Region III Comments:

EPA: *Section 4.1: Appropriate restrictions on the number of start-up and shutdown cycles the facility will conduct should be included to ensure these emissions would be considered intermittent sources in accordance with EPA's March 1, 2011 memo entitled "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2, National Ambient Air Quality Standard" (see treatment of intermittent sources section).*

Response: Duffield Associates has included a permit restriction on the number of startups and shutdowns per year for the CTs and RGEs, to classify these emissions as intermittent sources and forego emissions modeling during these periods.

EPA: *Please ensure all sources are accounted for in the modeling analysis and that correct primary and backup fuel types are included in the emission inventory.*

Response: All sources at the proposed facility will be included in the modeling analysis. The only fuel source includes a dual feed of natural gas. No backup fuel types (e.g., diesel) will be used at the facility.

EPA: *Section 5.1: Using the urban option in AERMOD needs proper justification. See Section 7.2.3 of the Guideline on Air Quality Models for further discussion regarding rural and urban setting for AERMOD.*

Response: Following our discussions, Duffield Associates re-evaluated land-use cover using 2007 GIS data. Based on our findings, the facility is in fact within a "rural" setting. Approximately 70% of the land-use was designated as rural-type land uses, as opposed to approximately 30% designated as urban land-uses. AERMOD was operated under the rural settings.

EPA: *Section 5.2: An alternative model request under section 3.2.2 of the Guideline on Air Quality Models will be necessary to use a Tier 3 screening analysis for NO_2. The facility should consider collecting in-stack NO_2/NO_x ratios for EPA's ISR database (http://www.epa.gov/ttn/scram/no2_isr_database.htm). Please ensure that EPA's interim 1-hour NO_2 SIL has been adopted for use by the Delaware Department of Natural Resources and Environmental Control.*

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Response: Tier 3 screening analysis was not required to demonstrate compliance for NO_2 emissions.

EPA: *Section 6: Please ensure that the model receptor grid will capture the maximum modeled concentration in accordance with section 7.2.2 of the Guideline on Air Quality Models.*

Response: The receptor grid input into the model was based on our experience and refined using the initial screening output, in accordance with section 7.2.2 of the Guideline on Air Quality Models. In general, the highest concentrations were identified at receptors within the near field concentrated receptor layout (within 1 km of the facility).

EPA: *Section 8: Meteorological data used in the air modeling analysis should be representative of the source. Information regarding representative meteorological data can be found in a number of sources including section 8.3 of the Guideline on Air Quality Models, section 3.1 of EPA's Meteorological Monitoring Guidance for Regulatory Modeling Applications and section 3.1.1 of EPA's AERMOD Implementation Guide.*

The applicant should also consider surface characteristics in its determination of representativeness. EPA is also concerned that the applicant's selection of upper air from Aberdeen Proving Grounds may not be representative of the emission source; it may be overly influenced by maritime air.

Response: During initial modeling, Duffield Associates identified that the upper air data from the Aberdeen Proving Ground was missing in excess of 10% of the data, whereas the Wallops Flight Facility had sufficient upper air information for the model. This station may be affected by maritime air. However, it is more representative of the conditions likely to be encountered at the facility than data acquired from an air station in Pittsburgh, PA (over 230 miles away). The proposed facility is located at the northern end of the Delmarva Peninsula, approximately 15 miles inland of the Delaware River and Chesapeake Bay. The location is less than 100 miles inland from the Atlantic Ocean, making it likely that the atmosphere above the facility is also subject to maritime air.

EPA: *Section 9: The protocol addresses Class I AQRVs but should also address Class I increments.*

Response: The PSD Class I Area Impact Analysis was performed and summarized in Section 10 of the permit application. Section 10 includes an analysis of both AQRVs and Class I increments using applicable calculations and modeling.

EPA: *Section 10: In some instances a source may be required to conduct a cumulative modeling analysis if its emissions exceed established SILs. This would generally*

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occur if the area in which a source will be located is close to a NAAQS of PSD Increment limit.

Response: Duffield Associates performed cumulative modeling for NO_2 and PM_{10} as discussed in Section 7.10.2 of the permit application.

III. <u>US Fish and Wildlife Service Comments:</u>

USFWS: *Based on the emissions and the distance from the Brigantine Wilderness (as provided in the attached documentation), the Fish and Wildlife Service anticipates that modeling would not show any significant additional impacts to air quality related values (AQRV) at the Class I area. Therefore, we are not requesting that a Class I analysis be included in the permit application. Please note that we are specifically addressing the need for a Class I analysis for the Brigantine Wilderness.*

Should the emissions or the nature of the project change, please contact me so that we might re-evaluate the proposed project.

Response: Duffield Associates will reassess the need for Class I modeling should emissions from the facility change significantly.

Should DNREC have any questions, comments, or concerns regarding this correspondence, please feel free to contact us at (302) 239-6634.

Very truly yours,

DUFFIELD ASSOCIATES, INC.

Anthony J. McGuire, E.I.
Environmental Engineer

Michael F. Panhuise, P.E.
Environmental Engineer

AJM/MFP:bac
WORD\8718CI.1113 Modeling Comment Response.COR

APPENDIX E

RBLC BACT/LAER TABLES

Table E-1: RBLC NOx Summary for Combined Cycle Combustion Turbines <25 MW, Natural Gas Fired

POLLUTANT	RBLCID	Facility Name	Permit Issuance Dates	Permit Update Date	Process Description	THROUGHPUT	THROUGHPUT_UNIT	Control System Description	Emission Limit	Emission Limit Unit	Basis
Nitrogen Oxides (NOx)	*NJ-0079	WOODBRIDGE ENERGY CENTER	7/25/2012	4/4/2013	Combined Cycle Combustion Turbine w/o duct burner	40297.6	mmcubic ft per year	DLN combustion system with SCR on each of the two combustion turbines and use of only natural gas as fuel.	2	PPMVD	LAER
Nitrogen Oxides (NOx)	TX-0552	WOLF HOLLOW POWER PLANT NO. 2	3/3/2010	5/18/2010	Natural gas-fired turbines	600	MW	Dry low NOx combustors plus selective catalytic reduction	2	PPMVD	BACT-PSD
Nitrogen Oxides (NOx)	WI-0227	PORT WASHINGTON GENERATING STATION	10/13/2004	8/31/2006	COMBINED CYCLE COMBUSTION TURBINES (4 W/ DUCT BURNER, HRSG)	2096	MMBTU/H	NATURAL GAS, DRY LOW NOX BURNERS, SELECTIVE CATALYTIC REDUCTION (SCR)	3	PPM @15% O2	BACT-PSD
Nitrogen Oxides (NOx)	TX-0551	PANDA SHERMAN POWER STATION	2/3/2010	5/17/2010	Natural Gas-fired Turbines	600	MW	Dry low NOx combustors and Selective Catalytic Reduction	9	PPMVD	BACT-PSD
Nitrogen Oxides (NOx)	*PA-0289	GEISINGER MED CTR/DANVILLE	6/18/2010	5/30/2013	COMBINED HEAT AND POWER COMBUSTION TURBINE	55.62	MMBTU/HR	SoLoNOx combustor	15	PPM @15% O2	OTHER CASE-BY-CASE
Nitrogen Oxides (NOx)	WY-0067	ECHO SPRINGS GAS PLANT	4/1/2009	4/16/2009	TURBINES S35-S36	12555	HP	SOLONOX	15	PPMV	BACT-PSD
Nitrogen Oxides (NOx)	WY-0067	ECHO SPRINGS GAS PLANT	4/1/2009	4/16/2009	TURBINE S37	16162	HP	GOOD COMBUSTION PRACTICES	15	PPMV	BACT-PSD
Nitrogen Oxides (NOx)	*NJ-0079	WOODBRIDGE ENERGY CENTER	7/25/2012	4/4/2013	Combined Cycle Combustion Turbine with Duct Burner	40297.6	mmcubic ft per year	Low NOx burners and Selective Catalytic Reduction System	19.8	LB/H	LAER
Nitrogen Oxides (NOx)	AK-0066	ENDICOTT PRODUCTION FACILITY, LIBERTY DEVELOPMENT PROJECT	6/15/2009	8/6/2009	EU ID 10A, TURBINE	7.5	KW	DRY LOW NOX COMBUSTORS (DLN)	25	PPMV AT 15% O2	BACT-PSD
Nitrogen Oxides (NOx)	FL-0313	AUBURNDALE CITRUS FACILITY	6/12/2008	9/30/2010	COGEN SYSTEM TURBINE NO. 1 W/EXISTING DUCT BURNER #1	62.7	MMBTU/H	DRY LOW NOX BURNERS	25	PPMVD	BACT-PSD
Nitrogen Oxides (NOx)	FL-0313	AUBURNDALE CITRUS FACILITY	6/12/2008	9/30/2010	COGEN SYSTEM TURBINE #2 W/EXISTING DUCT BURNER #2	62.7	MMBTU/H	DRY LOW NOX BURNERS	25	PPMVD	BACT-PSD
Nitrogen Oxides (NOx)	FL-0314	LEESBURG CITRUS FACILITY	6/2/2008	1/26/2010	COGEN SYSTEM TURBINE & EXISTING STEAM GENERATOR	62.7	MMBTU/H	DRY LOW NOX BURNER	25	PPMVD	BACT-PSD
Nitrogen Oxides (NOx)	WY-0067	ECHO SPRINGS GAS PLANT	4/1/2009	4/16/2009	TURBINE S34	3856	HP	SOLONOX	25	PPMV	BACT-PSD
Nitrogen Oxides (NOx)	*SD-0005	DEER CREEK STATION	6/29/2010	10/14/2011	Combustion turbine/heat recovery steam generator	300	Megawatts	Selective catalytic reduction	25.8	POUNDS PER HOUR	BACT-PSD
Nitrogen Oxides (NOx)	TX-0498	SIGNAL HILLS WICHITA FALLS POWER LP	5/8/2006	8/17/2010	TURBINES (3)	20	MW		52	LB/H	BACT-PSD

Table E-2: RBLC VOC Summary for Combined Cycle Combustion Turbines <25 MW, Natural Gas Fired

POLLUTANT	RBLCID	Facility Name	Permit Issuance Dates	Permit Update Date	Process Description	THROUGHPUT	THROUGHPUT_UNIT	Control System Description	Emission Limit	Emission Limit Unit	Basis
Volatile Organic Compounds (VOC)	*NJ-0079	WOODBRIDGE ENERGY CENTER	7/25/2012	4/4/2013	Combined Cycle Combustion Turbine with Duct Burner	40297.6	mmcubic ft per year	oxidation Catalyst and Good Combustion Practices and use of Clean fuel (Natural gas)	2	PPMVD	LAER
Volatile Organic Compounds (VOC)	*NJ-0079	WOODBRIDGE ENERGY CENTER	7/25/2012	4/4/2013	Combined Cycle Combustion Turbine w/o duct burner	40297.6	mmcubic ft per year	Oxidation catalyst and good combustion practices, use of natural gas a clean burning fuel	2.9	LB/H	LAER
Volatile Organic Compounds (VOC)	*PA-0289	GEISINGER MED CTR/DANVILLE	6/18/2010	5/30/2013	COMBINED HEAT AND POWER COMBUSTION TURBINE	55.62	MMBTU/HR		0.6	POUND PER HR	OTHER CASE-BY-CASE
Volatile Organic Compounds (VOC)	TX-0498	SIGNAL HILLS WICHITA FALLS POWER LP	5/8/2006	8/17/2010	TURBINES (3)	20	MW		0.87	LB/H	BACT-PSD
Volatile Organic Compounds (VOC)	TX-0551	PANDA SHERMAN POWER STATION	2/3/2010	5/17/2010	Natural Gas-fired Turbines	600	MW	Good combustion practices	1	PPMVD	BACT-PSD
Volatile Organic Compounds (VOC)	TX-0552	WOLF HOLLOW POWER PLANT NO. 2	3/3/2010	5/18/2010	Natural gas-fired turbines	600	MW	Good combustion practices	4	PPMVD	BACT-PSD
Volatile Organic Compounds (VOC)	WI-0227	PORT WASHINGTON GENERATING STATION	10/13/2004	8/31/2006	COMBINED CYCLE COMBUSTION TURBINES (4 W/ DUCT BURNER, HRSG)	2096	MMBTU/H	NATURAL GAS, GOOD COMBUSTION PRACTICES, OXIDATION CATALYST	1.2	PPMDV @15% O2	BACT-PSD
Volatile Organic Compounds (VOC)	WY-0067	ECHO SPRINGS GAS PLANT	4/1/2009	4/16/2009	TURBINES S35-S36	12555	HP	GOOD COMBUSTION PRACTICES	25	PPMV	BACT-PSD
Volatile Organic Compounds (VOC)	WY-0067	ECHO SPRINGS GAS PLANT	4/1/2009	4/16/2009	TURBINE S37	16162	HP	GOOD COMBUSTION PRACTICES	25	PPV	BACT-PSD
Volatile Organic Compounds (VOC)	WY-0067	ECHO SPRINGS GAS PLANT	4/1/2009	4/16/2009	TURBINE S34	3856	HP	GOOD COMBUSTION PRACTICES	50	PPMV	BACT-PSD

POLLUTANT	RBLCID	Facility Name	Permit Issuance Dates	Permit Update Date	Process Description	THROUGHPUT	THROUGHPUT_UNIT	Control System Description	Emission Limit	Emission Limit Unit	Standardized Emission Limit (lb/MWh)	Basis
Nitrogen Oxides (NOx)	AK-0066	ENDICOTT PRODUCTION FACILITY, LIBERTY DEVELOPMENT PROJECT	6/15/2009	8/6/2009	EU IDS 49 - 56, DRILLING MAIN ENGINES	2889	BHP	TURBOCHARGERS AND AFTERCOOLERS (GOOD COMBUSTION PRACTICES)	1	G/HP-H	2.95	BACT-PSD
Nitrogen Oxides (NOx)	AK-0066	ENDICOTT PRODUCTION FACILITY, LIBERTY DEVELOPMENT PROJECT	6/15/2009	8/6/2009	EU ID 58, CAMP ENGINE 3	1041	HP	GOOD COMBUSTION PRACTICES	4.7	G/HP-H	13.88	BACT-PSD
Nitrogen Oxides (NOx)	*CA-1192	AVENAL ENERGY PROJECT	6/21/2011	4/29/2013	EMERGENCY IC ENGINE	550	KW	SCR, OPERATIONAL LIMIT OF 50 HRS/YR	0.21	G/HP-H	0.62	BACT-PSD
Nitrogen Oxides (NOx)	*CA-1192	AVENAL ENERGY PROJECT	6/21/2011	4/29/2013	EMERGENCY FIREWATER PUMP ENGINE	288	HP	EQUIPPED W/ A TURBOCHARGER AND AN INTERCOOLER/AFTERCOOLER	3.4	G/HP-H	10.04	BACT-PSD
Nitrogen Oxides (NOx)	CO-0058	CHEYENNE STATION	6/12/2004	8/15/2006	FREP ENGINE	13	MMBTU/H	LEAN BURN COMBUSTION TECHNOLOGY	0.8	G/B-HP-H	2.36	BACT-PSD
Nitrogen Oxides (NOx)	CO-0058	CHEYENNE STATION	6/12/2004	8/15/2006	CPP ENGINE	16.47	MMBTU/H	LEAN BURN TECHNOLOGY	0.8	G/B-HP-H	2.36	BACT-PSD
Nitrogen Oxides (NOx)	IA-0077	STATION 204	6/8/2005	12/23/2005	NATURAL GAS-FIRED INTERNAL COMBUSTION ENGINE	4735	HP		10.44	LB/H	2.95	Other Case-by-Case
Nitrogen Oxides (NOx)	LA-0232	STERLINGTON COMPRESSOR STATION	6/24/2008	8/17/2009	COMPRESSOR ENGINE NO. 1	32.2	MMBTU/H	GOOD COMBUSTION PRACTICES	7.31	LB/H		BACT-PSD
Nitrogen Oxides (NOx)	LA-0257	SABINE PASS LNG TERMINAL	12/6/2011	5/11/2012	Generator Engines (2)	2012	hp	Comply with 40 CFR 60 Subpart JJJJ	9.76	LB/H	6.50	BACT-PSD
Nitrogen Oxides (NOx)	MI-0390	WHITE PIGEON COMPRESSOR STATION - PLANT #3	11/24/2008	5/17/2010	COMPRESSOR ENGINE	0			0.5	G/B-HP-H	1.48	BACT-PSD
Nitrogen Oxides (NOx)	MS-0056	SOUTHERN NATURAL GAS CO. - ENTERPRISE COMPRESSOR	8/26/2003	10/10/2003	IC ENGINE, COMPRESSOR ENGINE, NATURAL GAS(2)	4730	HP	USE OF LOW EMISSION (OR CLEAN BURN) TECHNOLOGY	7.3	LB/H	2.07	BACT-PSD
Nitrogen Oxides (NOx)	NJ-0073	TRIGEN	3/8/2008	8/12/2008	DUAL FUEL ENGINES (2)	90.08	%	THE TWO(2) DUAL FUEL ENGINES ARE EQUIPPED WITH ‘‘ CLEAN BURN TECHNOLOGY‘‘. THIS CONTROL DEVICE MINIMIZES THE EFFECT OF COMBUSTION TEMPERATURE ON NOX FORMATION BY DILLUTING THE COMBUSTION CHAMBER WITH EXCESS AIR.	2.3	G/B-HP-H	6.79	RACT
Nitrogen Oxides (NOx)	NJ-0073	TRIGEN	3/8/2008	8/12/2008	DUAL FUEL ENGINES ON 100 % DISTILLATE FUEL OIL	1	MMGAL/YR		12	G/B-HP-H	35.45	RACT
Nitrogen Oxides (NOx)	OK-0109	MOORELAND CRYOGENIC PLT	1/21/2005	4/18/2005	INTERNAL COMBUSTION ENGINE, (1)	2200	hp	LEAN BURN CONVERSION	2	G/B-HP-H	5.91	BACT-PSD
Nitrogen Oxides (NOx)	OK-0109	MOORELAND CRYOGENIC PLT	1/21/2005	4/18/2005	INTERNAL COMBUSTION ENGINE, (3)	842	hp	CATALYTIC CONVERTERS	5.57	LB/H	8.86	BACT-PSD
Nitrogen Oxides (NOx)	OK-0114	WETUMKA GAS PROCESSING PLT	3/24/2006	5/10/2007	THREE 110-HP WHITE 8GTL COMPRESSOR ENGINES			TURBO CHARGED AF/IR CONTROLS; MAINTAIN AIR MANIFOLD INLET TEMPERATURE OF APPROXIMATELY 130 DEGREES F; CONTROLS ADDED TO OTHER SOURCES AT SITE	207.12	T/YR		BACT-PSD
Nitrogen Oxides (NOx)	OK-0114	WETUMKA GAS PROCESSING PLT	3/24/2006	5/10/2007	1- 1650-HP MEP 10GT COMPRESSOR ENGINE AND 1- 2750-HP MEP 10GT COMPRESSOR ENGINES			CLEAN BURN DESIGN	146.05	T/YR		BACT-PSD
Nitrogen Oxides (NOx)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(2) INGERSOLL-RAND ENGINES, #IR-SVG-8, EPN4&5	440	HP	NONE INDICATED	18.41	LB/H	56.07	BACT-PSD
Nitrogen Oxides (NOx)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(2) INGERSOLL-RAND ENGINES, #IR-SVG-8, EPN10A&B	1330	HP	NONE INDICATED	59.31	LB/H	59.76	BACT-PSD
Nitrogen Oxides (NOx)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(3) COOPER-BESSEMER ENGINES, #GMVH-12C2, EPN21-23	3105	HP	NONE INDICATED	21.89	LB/H	9.45	BACT-PSD
Nitrogen Oxides (NOx)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	COOPER-BESSEMER ENGINE, #GMVH-12, EPN1	2400	HP	NONE INDICATED	44.4	LB/H	24.79	BACT-PSD
Nitrogen Oxides (NOx)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(2) CLARK ENGINE, #TLAB-6, EPN2&3	2000	HP EACH	NONE INDICATED	84.58	LB/H	56.67	BACT-PSD
Nitrogen Oxides (NOx)	TX-0501	TEXSTAR GAS PROCESS FACILITY	7/11/2006	4/28/2009	TREATED GAS COMPRESSOR ENGINE STACK WITH CATALYTIC CONVERTER WAUKESHA L-7042GSI	875	HP		5.79	LB/H	8.87	BACT-PSD
Nitrogen Oxides (NOx)	WV-0019	LOST RIVER COMPRESSOR STATION	2/19/2003	8/7/2003	COMPRESSOR ENGINE, NATURAL GAS	4640	HP	‘‘CLEAN BURN‘‘ TECHNOLOGY OF LEAN-BURN ENGINES	39	T/YR		BACT-PSD
Nitrogen Oxides (NOx)	WV-0020	COLUMBIA GAS TRANSMISSIONS LOST RIVER	2/14/2003	6/28/2004	IC ENGINE, NATURAL GAS, # 10	4640	HP		20.5	LB/H	8.87	BACT-PSD

Table E-4: RBLC VOC Summary for Internal Combustion Engines > 500 HP

POLLUTANT	RBLCID	Facility Name	Permit Issuance Dates	Permit Update Date	Process Description	THROUGHPUT	THROUGHPUT_UNIT	Control System Description	Emission Limit	Emission Limit Unit	Standardized Emissions Limit (lb/MWh)	Basis
Volatile Organic Compounds (VOC)	CO-0058	CHEYENNE STATION	6/12/2004	8/15/2006	FREP ENGINE	13	MMBTU/H	OXIDATION CATALYST	0.3	G/B-HP-H	0.886	BACT-PSD
Volatile Organic Compounds (VOC)	CO-0058	CHEYENNE STATION	6/12/2004	8/15/2006	CPP ENGINE	16.47	MMBTU/H	OXIDATION CATATLYST	0.3	G/B-HP-H	0.886	BACT-PSD
Volatile Organic Compounds (VOC)	IA-0077	STATION 204	6/8/2005	12/23/2005	NATURAL GAS-FIRED INTERNAL COMBUSTION ENGINE	4735	HP	OXIDATIVE CATALYST	7.1	LB/H	2.009	BACT-PSD
Volatile Organic Compounds (VOC)	LA-0232	STERLINGTON COMPRESSOR STATION	6/24/2008	8/17/2009	COMPRESSOR ENGINE NO. 1	32.2	MMBTU/H	CATALYTIC OXIDATION AND GOOD COMBUSTION PRACTICES	1.84	LB/H		BACT-PSD
Volatile Organic Compounds (VOC)	LA-0257	SABINE PASS LNG TERMINAL	12/6/2011	5/11/2012	Generator Engines (2)	2012	hp	Comply with 40 CFR 60 Subpart JJJJ	4.43	LB/H	2.950	BACT-PSD
Volatile Organic Compounds (VOC)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(2) INGERSOLL-RAND ENGINES, #IR-SVG-8, EPN4&5	440	HP	NONE INDICATED	0.48	LB/H	1.462	Other Case-by-Case
Volatile Organic Compounds (VOC)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(2) INGERSOLL-RAND ENGINES, #IR-SVG-8, EPN10A&B	1330	HP	NONE INDICATED	1.76	LB/H	1.773	Other Case-by-Case
Volatile Organic Compounds (VOC)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(3) COOPER-BESSEMER ENGINES, #GMVH-12C2, EPN21-23	3105	HP	NONE INDICATED	10.94	LB/H	4.721	Other Case-by-Case
Volatile Organic Compounds (VOC)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	COOPER-BESSEMER ENGINE, #GMVH-12, EPN1	2400	HP	NONE INDICATED	6.35	LB/H	3.545	Other Case-by-Case
Volatile Organic Compounds (VOC)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(2) CLARK ENGINE, #TLAB-6, EPN2&3	2000	HP EACH	NONE INDICATED	1.32	LB/H	0.884	Other Case-by-Case
Volatile Organic Compounds (VOC)	TX-0501	TEXSTAR GAS PROCESS FACILITY	7/11/2006	4/28/2009	TREATED GAS COMPRESSOR ENGINE STACK WITH CATALYTIC CONVERTER WAUKESHA L-7042GSI	875	HP		2.7	LB/H	4.135	BACT-PSD
Volatile Organic Compounds (VOC)	WV-0020	COLUMBIA GAS TRANSMISSIONS LOST RIVER	2/14/2003	6/28/2004	IC ENGINE, NATURAL GAS, # 10	4640	HP		0.7	G/B-HP-H	2.068	BACT-PSD

Table E-5: RBLC PM Summary for Combined Cycle Combustion Turbines <25 MW, Natural Gas Fired

POLLUTANT	RBLCID	Facility Name	Permit Issuance Dates	Permit Update Date	Process Description	THROUGHPUT	THROUGHPUT_UNIT	Control System Description	Emission Limit	Emission Limit Unit	Basis
Particulate matter, filterable (FPM)	*NJ-0079	WOODBRIDGE ENERGY CENTER	7/25/2012	4/4/2013	Combined Cycle Combustion Turbine with Duct Burner	40297.6	mmcubic ft per year	Good Combustion Practices and use of Natural gas,a clean burning fuel.	8.2	LB/H	OTHER CASE-BY-CASE
Particulate matter, filterable < 10 µ (FPM10)	*NJ-0079	WOODBRIDGE ENERGY CENTER	7/25/2012	4/4/2013	Combined Cycle Combustion Turbine with Duct Burner	40297.6	mmcubic ft per year	Good Combustion Practices and use of Natural gas,a clean burning fuel.	19.1	LB/HR	
Particulate matter, filterable < 2.5 µ (FPM2.5)	*NJ-0079	WOODBRIDGE ENERGY CENTER	7/25/2012	4/4/2013	Combined Cycle Combustion Turbine with Duct Burner	40297.6	mmcubic ft per year	Good Combustion Practices and use of Natural gas,a clean burning fuel.	19.1	LB/H	OTHER CASE-BY-CASE
Particulate matter, filterable (FPM)	*NJ-0079	WOODBRIDGE ENERGY CENTER	7/25/2012	4/4/2013	Combined Cycle Combustion Turbine w/o duct burner	40297.6	mmcubic ft per year	use of natural gas only which is a clean burning fuel	4.8	LB/H	OTHER CASE-BY-CASE
Particulate matter, filterable < 10 µ (FPM10)	*NJ-0079	WOODBRIDGE ENERGY CENTER	7/25/2012	4/4/2013	Combined Cycle Combustion Turbine w/o duct burner	40297.6	mmcubic ft per year	Use of Natural gas,a clean burning fuel.	12.1	LB/H	OTHER CASE-BY-CASE
Particulate matter, filterable < 2.5 µ (FPM2.5)	*NJ-0079	WOODBRIDGE ENERGY CENTER	7/25/2012	4/4/2013	Combined Cycle Combustion Turbine w/o duct burner	40297.6	mmcubic ft per year	use of natural gas only which is a clean burning fuel	12.1	LB/H	OTHER CASE-BY-CASE
Particulate matter, total < 10 µ (TPM10)	*SD-0005	DEER CREEK STATION	6/29/2010	10/14/2011	Combustion turbine/heat recovery steam generator	300	Megawatts	Good Combustion	23.2	POUNDS PER HOUR	BACT-PSD
Particulate Matter (PM)	TX-0498	SIGNAL HILLS WICHITA FALLS POWER LP	5/8/2006	8/17/2010	TURBINES (3)	20	MW		1.04	LB/H	BACT-PSD
Particulate matter, filterable < 10 µ (FPM10)	WI-0227	PORT WASHINGTON GENERATING STATION	10/13/2004	8/31/2006	COMBINED CYCLE COMBUSTION TURBINES (4 W/ DUCT BURNER, HRSG)	2096	MMBTU/H	NATURAL GAS; GOOD COMBUSTION PRACTICES	33	LB/H	BACT-PSD

Table E-6: RBLC PM Summary for Internal Combustion Engines > 500 HP, Natural Gas Fired

POLLUTANT	RBLCID	Facility Name	Permit Issuance Dates	Permit Update Date	Process Description	THROUGHPUT	THROUGHPUT_UNIT	Control System Description	Emission Limit	Emission Limit Unit	Standardized Emissions Limit (lb/MWh)	Basis
Particulate matter, filterable < 10 µ (FPM10)	IA-0077	STATION 204	6/8/2005	12/23/2005	NATURAL GAS-FIRED INTERNAL COMBUSTION ENGINE	4735	HP		0.36	LB/H	0.10188	Other Case-by-Case
Particulate matter, total (TPM)	LA-0257	SABINE PASS LNG TERMINAL	12/6/2011	5/11/2012	Generator Engines (2)	2012	hp	fueled by natural gas	0.75	LB/H	0.49950	BACT-PSD
Particulate matter, filterable < 10 µ (FPM10)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(2) INGERSOLL-RAND ENGINES, #IR-SVG-8, EPN4&5	440	HP	NONE INDICATED	0.01	LB/H	0.03045	Other Case-by-Case
Particulate matter, filterable < 10 µ (FPM10)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(2) INGERSOLL-RAND ENGINES, #IR-SVG-8, EPN10A&B	1330	HP	NONE INDICATED	0.12	LB/H	0.12090	Other Case-by-Case
Particulate matter, filterable < 10 µ (FPM10)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(3) COOPER-BESSEMER ENGINES, #GMVH-12C2, EPN21-23	3105	HP	NONE INDICATED	1.09	LB/H	0.47040	Other Case-by-Case
Particulate matter, filterable < 10 µ (FPM10)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	COOPER-BESSEMER ENGINE, #GMVH-12, EPN1	2400	HP	NONE INDICATED	0.62	LB/H	0.34617	Other Case-by-Case
Particulate matter, filterable < 10 µ (FPM10)	TX-0364	SALT CREEK GAS PLANT	1/31/2003	1/4/2005	(2) CLARK ENGINE, #TLAB-6, EPN2&3	2000	HP EACH	NONE INDICATED	0.53	LB/H	0.35510	Other Case-by-Case
Particulate matter, filterable < 10 µ (FPM10)	WV-0020	COLUMBIA GAS TRANSMISSIONS LOST RIVER	2/14/2003	6/28/2004	IC ENGINE, NATURAL GAS, # 10	4640	HP		0.12	G/B-HP-H	0.03466	BACT-PSD

Table E-7 - RBLC PM/PM10/PM2.5 Summary for Fossil Fuel Power Plants with Cooling Towers (NAICS Code 221112 and Process Code 99.009)

RBLCID	FACILITY_NAME	FACILITY_STATE	NAICS_CODE	DATE_DETERMINATION_LAST_UPDATED	PROCESS_NAME	PROCCESS_TYPE	POLLUTANT	CONTROL_METHOD_DESCRIPTION	EMISSION_LIMIT_1	EMISSION_LIMIT_1_UNIT	CASE-BY-CASE_BASIS
AR-0074	PLUM POINT ENERGY	AR	221112	3/2/2004	COOLING TOWER , SN-03	99.009	Particulate matter, filterable < 10 µ (FPM10)	MIST ELIMINATORS	0.8	LB/H	N/A
AZ-0049	LA PAZ GENERATING FACILITY	AZ	221112	7/24/2007	MECHANICAL DRAFT COOLING TOWERS FOR GE TURBINES	99.009	Particulate matter, filterable < 10 µ (FPM10)	DRIFT ELIMINATORS	0.0005	% BY VOL	BACT-PSD
AZ-0049	LA PAZ GENERATING FACILITY	AZ	221112	7/24/2007	MECHANICAL DRAFT COOLING TOWERS FOR SIEMENS TURBINES	99.009	Particulate matter, filterable < 10 µ (FPM10)	DRIFT ELIMINATORS	0.0005	% BY VOL	BACT-PSD
CO-0057	COMANCHE STATION	CO	221112	8/24/2006	COOLING TOWER	99.009	Particulate Matter (PM)	DRIFT ELIMINATORS TO ACHIEVE 0.0005 % DRIFT OR LESS.	0		BACT-PSD
CO-0057	COMANCHE STATION	CO	221112	8/24/2006	COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)	DRIFT ELIMINATORS TO ACHIEVE 0.0005% DRIFT OR LESS	0		BACT-PSD
FL-0299	CRYSTAL RIVER POWER PLANT	FL	221112	12/15/2008	COOLING TOWERS	99.009	Particulate Matter (PM)		0.0005	PERCENT	BACT-PSD
FL-0304	CANE ISLAND POWER PARK	FL	221112	4/20/2009	AN EIGHT-CELL MECHANICAL COOLING TOWER	99.009	Particulate matter, total < 10 µ (TPM10)		0		BACT-PSD
IA-0067	WALTER SCOTT JR. ENERGY CENTER	IA	221112	12/3/2010	COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)	MIST ELIMINATOR	1050	MG/L	BACT-PSD
IA-0067	WALTER SCOTT JR. ENERGY CENTER	IA	221112	12/3/2010	COOLING TOWER	99.009	Particulate Matter (PM)	MIST ELIMINATORS	1050	MG/L	BACT-PSD
IA-0067	WALTER SCOTT JR. ENERGY CENTER	IA	221112	12/3/2010	COOLING TOWER	99.009	Visible Emissions (VE)	MIST ELIMINATOR	0	% OPACITY	BACT-PSD
ID-0018	LANGLEY GULCH POWER PLANT	ID	221112	10/5/2010	COOLING TOWER	99.009	Particulate Matter (PM)	DRIFT ELIMINATORS, GOOD OPERATING PRACTICES	0		BACT-PSD
*IN-0158	ST. JOSEPH ENEGRY CENTER, LLC	IN	221112	8/15/2013	TWO (2) COOLING TOWERS	99.009	Particulate matter, filterable (FPM)	DRIFT ELIMINATOR	0.0005	% DRIFT LOSS	BACT-PSD
*IN-0158	ST. JOSEPH ENEGRY CENTER, LLC	IN	221112	8/15/2013	TWO (2) COOLING TOWERS	99.009	Particulate matter, filterable < 10 µ (FPM10)	DRIFT ELIMINATOR	0.0005	% DRIFT LOSS	BACT-PSD
*IN-0158	ST. JOSEPH ENEGRY CENTER, LLC	IN	221112	8/15/2013	TWO (2) COOLING TOWERS	99.009	Particulate matter, filterable < 2.5 µ (FPM2.5)	DRIFT ELIMINATOR	0.0005	% DRIFT LOSS	BACT-PSD
LA-0136	PLAQUEMINE COGENERATION FACILITY	LA	221112	4/28/2009	COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)	GOOD OPERATING PRACTICES	1.4	LB/H	BACT-PSD
LA-0191	MICHOUD ELECTRIC GENERATING PLANT	LA	221112	6/2/2006	COOLING TOWERS (2)	99.009	Particulate matter, filterable < 10 µ (FPM10)	DRIFT ELIMINATORS AND GOOD OPERATING PRACTICES	0.052	LB/H	BACT-PSD
LA-0192	CRESCENT CITY POWER	LA	221112	4/8/2008	MAIN COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)	MARLEY EXCEL DRIFT ELIMINATORS	2.61	LB/H	BACT-PSD
LA-0192	CRESCENT CITY POWER	LA	221112	4/8/2008	CHILLER COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)		1.75	LB/H	BACT-PSD
LA-0221	LITTLE GYPSY GENERATING PLANT	LA	221112	3/3/2009	COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)	DRIFT ELIMINATOR WITH A 99.999% CONTROL EFFICIENCY	0.05	LB/H	BACT-PSD
LA-0224	ARSENAL HILL POWER PLANT	LA	221112	5/18/2012	COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)	USE OF MIST ELIMINATORS	1.4	LB/H	BACT-PSD
LA-0254	NINEMILE POINT ELECTRIC GENERATING PLANT	LA	221112	12/12/2011	CHILLER COOLING TOWER (CHILL CT)	99.009	Particulate matter, total < 10 µ (TPM10)	HIGH EFFICIENCY MIST ELIMINATOR	0.001	PERCENT DRIFT	BACT-PSD
LA-0254	NINEMILE POINT ELECTRIC GENERATING PLANT	LA	221112	12/12/2011	CHILLER COOLING TOWER (CHILL CT)	99.009	Particulate matter, total < 2.5 µ (TPM2.5)	HIGH EFFICIENCY MIST ELIMINATOR	0.001	PERCENT DRIFT	BACT-PSD
LA-0254	NINEMILE POINT ELECTRIC GENERATING PLANT	LA	221112	12/12/2011	UNIT 6 COOLING TOWER	99.009	Particulate matter, total < 10 µ (TPM10)	HIGH EFFICIENCY MIST ELIMINATOR	0.0005	PERCENT DRIFT	BACT-PSD
LA-0254	NINEMILE POINT ELECTRIC GENERATING PLANT	LA	221112	12/12/2011	UNIT 6 COOLING TOWER	99.009	Particulate matter, total < 2.5 µ (TPM2.5)	HIGH EFFICIENCY MIST ELIMINATOR	0.0005	PERCENT DRIFT	BACT-PSD
*MI-0400	WOLVERINE POWER	MI	221112	5/9/2013	Cooling Tower (EUCOOLINGTWR)	99.009	Particulate matter, filterable (FPM)	Drift eliminators	0.0005	%	BACT-PSD
ND-0024	SPIRITWOOD STATION	ND	221112	3/27/2008	COOLING TOWER	99.009	Particulate matter, filterable (FPM)	DRIFT ELIMINATOR	0.0005	% COOLING WATER FLOW	BACT-PSD
NE-0031	OPPD - NEBRASKA CITY STATION	NE	221112	8/30/2006	COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)		0.001	LB/H	BACT-PSD
NV-0036	TS POWER PLANT	NV	221112	8/31/2006	COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)	DRIFT ELIMINATORS	0.0005	PERCENT DRIFT	BACT-PSD
OH-0252	DUKE ENERGY HANGING ROCK ENERGY FACILITY	OH	221112	10/18/2013	COOLING TOWER, (2) 10 CELL MECHANICAL DRAFT	99.009	Particulate matter, filterable < 10 µ (FPM10)	DRIFT ELIMINATORS	2.6	LB/H	BACT-PSD
OH-0254	DUKE ENERGY WASHINGTON COUNTY LLC	OH	221112	7/5/2005	COOLING TOWER	99.009	Particulate Matter (PM)		2.08	LB/H	BACT-PSD
OK-0090	DUKE ENERGY STEPHENS, LLC STEPHENS ENERGY	OK	221112	10/10/2003	COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)	DRIFT ELIMINATORS	1.2	LB/H	BACT-PSD
OR-0041	WANAPA ENERGY CENTER	OR	221112	8/18/2008	COOLING TOWER	99.009	Particulate Matter (PM)	INSTALLATION OF HIGH EFFICIENCY 0.0005% DRIFT ELIMINATORS. LIMIT TOTAL DISSOLVED SOLIDS IN THE WATER TO LESS THAN 3,532 PPMW.	3532	PPMW	BACT-PSD
SC-0104	SANTEE COOPER CROSS GENERATING STATION	SC	221112	8/31/2006	COOLING TOWERS (2)	99.009	Particulate Matter (PM)		1.86	LB/H	Other Case-by-Case
TX-0551	PANDA SHERMAN POWER STATION	TX	221112	5/17/2010	Cooling tower	99.009	Particulate matter, total (TPM)	Drift eliminators	0.0005	% DRIFT	BACT-PSD
TX-0552	WOLF HOLLOW POWER PLANT NO. 2	TX	221112	5/18/2010	Cooling tower	99.009	Particulate matter, total (TPM)	Drift eliminators	0.0005	% DRIFT	BACT-PSD
*VA-0319	GATEWAY COGENERATION 1, LLC - SMART WATER PROJECT	VA	221112	5/2/2013	COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)	Use of drift eliminators to a drift rate of 0.001% of the circulating water flow and a total dissolved solids content of the cooling water of no more than 1200 mg/l.	0.1	LB/H	BACT-PSD
*VA-0319	GATEWAY COGENERATION 1, LLC - SMART WATER PROJECT	VA	221112	5/2/2013	COOLING TOWER	99.009	Particulate matter, total < 2.5 µ (TPM2.5)	Use of drift eliminators to a drift rate of 0.001% of the circulating water flow and a total dissolved solids content of the cooling water of no more than 1200 mg/l.	0.1	LB/H	BACT-PSD
WA-0328	BP CHERRY POINT COGENERATION PROJECT	WA	221112	8/14/2007	COOLING TOWER	99.009	Particulate Matter (PM)	INSTALLATION OF DRIFT ELIMINATORS WITH DRIFT LOSS OF LESS THAN 0.001% OF THE RECIRCULATING WATER FLOW RATE.	0		BACT-PSD
WA-0329	DARRINGTON ENERGY COGENERATION POWER PLANT	WA	221112	7/5/2006	COOLING TOWER	99.009	Particulate Matter (PM)	INSTALLATION OF DRIFT ELIMINATORS WITH DRIFT LOSS OF LESS THAN 0.001% OF THE RECIRCULATING WATER FLOW RATE.	0		BACT-PSD
WV-0023	MAIDSVILLE	WV	221112	2/3/2009	COOLING TOWER	99.009	Particulate Matter (PM)	REDUNDANT BAFFLE AND MESH DEMISTER SYSTEM	0.9	LB/H	BACT-PSD
WV-0023	MAIDSVILLE	WV	221112	2/3/2009	COOLING TOWER	99.009	Particulate matter, filterable < 10 µ (FPM10)	REDUNDANT BAFFLE AND MESH DEMISTER SYSTEM	0.9	LB/H	BACT-PSD
WV-0024	WESTERN GREENBRIER CO-GENERATION, LLC	WV	221112	9/15/2006	COOLING TOWER	99.009	Particulate Matter (PM)	DRIFT ELIMINATORS @ 0.0005% DRIFT RATE	0.79	LB/H	BACT-PSD

APPENDIX F

MODELING INPUT/OUTPUT FILES (CD-ROM)

APPENDIX G

MSDS FOR NATURAL GAS AND AMMONIA

SAFETY DATA SHEET

1. Identification

Product identifier **Natural Gas**

Other means of identification Not available.

Synonyms Methane, Natural Gas Sweet, Fuel Gas, Petroleum Gas, Methyl Hydride

Recommended use Fuel.

Recommended restrictions None known.

Manufacturer / Importer / Supplier / Distributor information

Company name Williams, Inc.

Address One Williams Center
Tulsa, OK 74172
US

Telephone 800-688-7507

E-mail enterpriseehs@williams.com

Emergency phone number 888-677-2370

2. Hazard(s) identification

Physical hazards	Flammable gases	Category 1
	Gases under pressure	Compressed gas

Health hazards Not classified.

OSHA hazard(s) Simple asphyxiant

Label elements

Hazard symbol

Signal word Danger

Hazard statement Extremely flammable gas. Contains gas under pressure; may explode if heated. May displace oxygen and cause rapid suffocation.

Precautionary statement

Prevention Keep away from heat/sparks/open flames/hot surfaces. - No smoking.

Response Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.

Storage Protect from sunlight. Store in a well-ventilated place.

Disposal Dispose of contents/container in accordance with local/regional/national/international regulations.

Hazard(s) not otherwise classified (HNOC) Not classified.

3. Composition/information on ingredients

Substance

Hazardous components

Chemical name	Common name and synonyms	CAS number	%
Natural gas		8006-14-2	100

Composition comments All concentrations are in percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

4. First-aid measures

Inhalation Move injured person into fresh air and keep person calm under observation. If breathing is difficult, give oxygen. Get medical attention if any discomfort continues.

Skin contact Frostbite: Do not remove clothes, but flush with copious amounts of lukewarm water. Call an ambulance and continue to flush during transportation to hospital.

Eye contact Immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.

Ingestion	This material is a gas under normal atmospheric conditions and ingestion is unlikely.
Most important symptoms/effects, acute and delayed	Narcosis. Behavioral changes. Decrease in motor functions.
Indication of immediate medical attention and special treatment needed	Treat symptomatically.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Extinguish with foam, carbon dioxide, dry powder or water fog.
Unsuitable extinguishing media	None.
Specific hazards arising from the chemical	Extremely flammable gas. Closed containers can burst violently when heated, due to excess pressure build-up. Gas may travel considerable distance to a source of ignition and flash back. Gases may form explosive mixtures with air. Fire or high temperatures create: Carbon monoxide. Carbon oxides. Sulfur oxides.
Special protective equipment and precautions for firefighters	Selection of respiratory protection for firefighting: follow the general fire precautions indicated in the workplace. Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with full face-piece operated in positive pressure mode. Use approved gas detectors in confined spaces.
Fire-fighting equipment/instructions	Evacuate area. Move container from fire area if it can be done without risk. Stay away from ends of tanks. If a leak or spill has not ignited, use water spray to disperse the vapors and to protect men attempting to stop a leak. Cool equipment exposed to flames with water, if it can be done without risk. Close the valve if no risk is involved. Do not extinguish a leaking gas fire unless leak can be stopped. If leak cannot be stopped and no danger to surrounding area allow the fire to burn out. Fight fire from a protected location. Prevent buildup of vapors or gases to explosive concentrations.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Extremely flammable. Spillages of liquid product will create a fire hazard and may form an explosive atmosphere. Keep all sources of ignition and hot metal surfaces away from spill/release if safe to do so. The use of explosion-proof electrical equipment is recommended. Beware of accumulation in low areas or contained areas, where explosive concentrations may occur. Prevent from entering drains or any places where accumulation may occur. Ventilate well and allow to evaporate. Stay upwind. Avoid inhalation and contact with skin and eyes. For large spillages notify persons down wind of the spill/release, isolate immediate hazard area and keep unauthorized personnel out. Wear appropriate personal protective equipment (See Section 8).
Methods and materials for containment and cleaning up	In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.
Environmental precautions	Stop leak if possible without any risk. Water may be useful in minimizing or dispersing vapors. If spill occurs on water notify appropriate authorities in accordance with all applicable regulations.

7. Handling and storage

Precautions for safe handling	Keep away from sources of ignition - No smoking. Take precautionary measures against static discharges. Observe good industrial hygiene practices. Wear appropriate personal protective equipment (See Section 8). Contents under pressure. Gas can accumulate in confined spaces and limit oxygen available for breathing. Use only with adequate ventilation. Use non-sparking hand tools and explosion-proof electrical equipment. The product can accumulate electrostatic charges, which may cause an electrical spark (ignition source). Ground container and transfer equipment to eliminate static electric sparks. Before entering storage tanks and commencing any operation in a confined area, check the atmosphere for oxygen content, hydrogen sulfide (H2S) and flammability. Cold burns may occur during filling operations. Containers and delivery lines may become cold enough to present cold burn hazard. The use hydrocarbon fuel in an area without adequate ventilation may result in hazardous levels of incomplete combustion products (e.g. carbon monoxide, oxides of sulfur and nitrogen, benzene and other hydrocarbons) and/or dangerously low oxygen levels.

Conditions for safe storage, including any incompatibilities

Keep container(s) tightly closed and properly labeled. Use and store this material in cool, dry, well-ventilated areas away from heat, direct sunlight, hot metal surfaces, and all sources of ignition. Store only in approved containers. Post areas "No Smoking or Open Flame." Store away from incompatible materials. Protect against physical damage. Outdoor or detached storage is preferred. Indoor storage should meet OSHA standards and appropriate fire codes.

Empty containers may contain flammable product residues. Do not pressurize, cut, weld, braze, solder, drill, grind or expose empty containers to heat, flame, sparks, static electricity, or other sources of ignition; they may explode and cause injury or death.

8. Exposure controls/personal protection

Occupational exposure limits

US. ACGIH Threshold Limit Values

Components	Type	Value
Natural gas (CAS 8006-14-2)	TWA	1000 ppm

Biological limit values No biological exposure limits noted for the ingredient(s).

Exposure guidelines No exposure standards allocated.

Appropriate engineering controls Provide shower facilities near the work place. In confined spaces, make sure the area is well-ventilated and sufficient oxygen (19.5%) exists before entry. Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Use explosion-proof equipment.

Individual protection measures, such as personal protective equipment

Eye/face protection Wear approved safety glasses as a good hygiene practice.

Skin protection

Hand protection Wear suitable gloves as a good hygiene practice.

Other Wear suitable protective clothing.

Respiratory protection A NIOSH approved, self-containing breathing apparatus (SCBA) or equivalent operated in a pressure demand or other positive pressure mode should be used in situations of oxygen deficiency (oxygen content less than 19.5 percent), unknown exposure concentrations, or situations that are immediately dangerous to life or health (IDLH). A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever work place conditions warrant a respirator's use.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Appearance Colorless gas.

Physical state Gas Compressed.

Form Gas.

Color Colorless.

Odor Odorless to slight, sweet.

Odor threshold Not available.

pH Not applicable.

Melting point/freezing point Not available.

Initial boiling point and boiling range -259.6 °F (-162 °C)

Flash point -304.6 °F (-187 °C)

Evaporation rate Not available.

Flammability (solid, gas) Extremely flammable gas.

Upper/lower flammability or explosive limits

Flammability limit - lower (%) 5 %

Flammability limit - upper (%) 15 %

Explosive limit - lower (%) Not available.

Explosive limit - upper (%) Not available.

Vapor pressure	40 mm Hg (77°F/25°C)
Vapor density	0.55 Approximate.
Relative density	Not available.
Solubility(ies)	Slightly soluble in water.
Partition coefficient (n-octanol/water)	1.81
Auto-ignition temperature	> 550.4 °F (> 288 °C)
Decomposition temperature	Not available.
Viscosity	Not available.
Other information	
Percent volatile	100

10. Stability and reactivity

Reactivity	The product is non-reactive under normal conditions of use, storage and transport.
Chemical stability	Stable under normal temperature conditions and recommended use.
Possibility of hazardous reactions	Polymerization will not occur.
Conditions to avoid	Heat, sparks, flames, elevated temperatures. Do not pressurize, cut, weld, braze, solder, drill, grind or expose empty containers to heat, flame, sparks, static electricity, or other sources of ignition; they may explode and cause injury or death.
Incompatible materials	Oxidizing agents.
Hazardous decomposition products	Carbon oxides. Sulfur oxides.

11. Toxicological information

Information on likely routes of exposure

Ingestion	This material is a gas under normal atmospheric conditions and ingestion is unlikely.
Inhalation	High concentrations: Suffocation (asphyxiant) hazard - if allowed to accumulate to concentrations that reduce oxygen below safe breathing levels. In high concentrations, vapors are narcotic and may cause headache, fatigue, dizziness and nausea.
Skin contact	Contact with liquefied gas can cause damage (frostbite) due to rapid evaporative cooling.
Eye contact	Contact with liquefied gas can cause damage (frostbite) due to rapid evaporative cooling.
Symptoms related to the physical, chemical and toxicological characteristics	Exposure to rapidly expanding gas or vaporizing liquid may cause frostbite ("cold burn"). Contact with evaporating liquid may cause frostbite or freezing of skin. Symptoms of overexposure can include shortness of breath, drowsiness, headaches, confusion, decreased coordination, visual disturbances and vomiting, and are reversible if exposure is stopped. Continued exposure can lead to hypoxia (inadequate oxygen), rapid breathing, cyanosis (bluish discoloration of skin), numbness of the extremities, unconsciousness and death.

Information on toxicological effects

Acute toxicity	Suffocation (asphyxiant) hazard - if allowed to accumulate to concentrations that reduce oxygen below safe breathing levels. Exposure to rapidly expanding gas or vaporizing liquid may cause frostbite ("cold burn").

Product	Species	Test Results
Natural gas (CAS 8006-14-2)		
Acute		
Oral		
LD50	Rat	> 5 g/kg

Skin corrosion/irritation	Not classified.
Serious eye damage/eye irritation	Not classified.
Respiratory sensitization	Not classified.
Skin sensitization	Not a skin sensitizer.
Germ cell mutagenicity	Not classified.
Carcinogenicity	Not classified.
Reproductive toxicity	Not classified.
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Not classified.

Aspiration hazard	Not applicable.
Chronic effects	Prolonged exposure may cause chronic effects.

12. Ecological information

Ecotoxicity	Not expected to be harmful to aquatic organisms.
Persistence and degradability	The hydrocarbons in this material are expected to be inherently biodegradable. In practice, hydrocarbon gases are not likely to remain in solution long enough for biodegradation to be a significant loss process. Hydrogen sulfide, if present in refinery gas streams, will be oxidized in water and insoluble sulfides precipitated from water when metallic radicals are present.
Bioaccumulative potential	The product is not expected to bioaccumulate.

Partition coefficient n-octanol / water (log Kow)

Natural gas	1.81

Mobility in soil	Not relevant, due to the form of the product.
Mobility in general	The product is a volatile substance, which may spread in the atmosphere.
Other adverse effects	The product is a volatile organic compound which has a photochemical ozone creation potential.

13. Disposal considerations

Disposal instructions	This material is a gas and would not typically be managed as a waste.
Local disposal regulations	Disposal recommendations are based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.
Hazardous waste code	D001
Waste from residues / unused products	Dispose of in accordance with local regulations.
Contaminated packaging	Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

UN number	UN1971
UN proper shipping name	Natural gas, compressed
Transport hazard class(es)	2.1
Subsidary class(es)	Not available.
Packing group	Not available.
Special precautions for user	Not available.
Labels required	2.1
Packaging exceptions	306
Packaging non bulk	302
Packaging bulk	302

IATA

UN number	UN1971
UN proper shipping name	Natural gas, compressed
Transport hazard class(es)	2.1
Subsidary class(es)	-
Packaging group	Not available.
Environmental hazards	No
Labels required	2.1
ERG Code	10L
Special precautions for user	Not available.

IMDG

UN number	UN1971
UN proper shipping name	NATURAL GAS, COMPRESSED
Transport hazard class(es)	2.1
Subsidary class(es)	-
Packaging group	Not available.
Environmental hazards	
Marine pollutant	No
Labels required	2,1
EmS	F-D, S-U
Special precautions for user	Not available.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	No information available.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not on regulatory list.

CERCLA Hazardous Substance List (40 CFR 302.4)

Natural gas (CAS 8006-14-2) LISTED

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard - Yes
Delayed Hazard - No
Fire Hazard - Yes
Pressure Hazard - Yes
Reactivity Hazard - No

SARA 302 Extremely hazardous substance No

SARA 311/312 Hazardous chemical Yes

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

Drug Enforcement Administration (DEA). List 2, Essential Chemicals (21 CFR 1310.02(b) and 1310.04(f)(2) and Chemical Code Number

Not listed.

Drug Enforcement Administration (DEA). List 1 & 2 Exempt Chemical Mixtures (21 CFR 1310.12(c))

Not regulated.

DEA Exempt Chemical Mixtures Code Number

Not regulated.

Food and Drug Administration (FDA) Not regulated.

US state regulations This product does not contain a chemical known to the State of California to cause cancer, birth defects or other reproductive harm.

US. Massachusetts RTK - Substance List

Natural gas (CAS 8006-14-2)

US. New Jersey Worker and Community Right-to-Know Act

Not regulated.

US. Pennsylvania RTK - Hazardous Substances

Natural gas (CAS 8006-14-2)

US. Rhode Island RTK

Not regulated.

US. California Proposition 65

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

Not listed.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No

Country(s) or region	Inventory name	On inventory (yes/no)*
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	No
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s)

16. Other information, including date of preparation or last version

Issue date	11-08-2012
Revision date	-
Version #	01
Further information	Not available.
References	Registry of Toxic Effects of Chemical Substances (RTECS)
Disclaimer	This information is provided without warranty. The information is believed to be correct. This information should be used to make an independent determination of the methods to safeguard workers and the environment.

TANNER INDUSTRIES, INC.
1-800-643-6226
www.tannerind.com

AQUA AMMONIA: MSDS (Material Safety Data Sheet)

Tanner Industries, Inc. divisions: National Ammonia, Northeastern Ammonia, Hamler Industries, Bower Ammonia & Chemical
735 Davisville Road, Third Floor, Southampton, PA 18966; 215-322-1238

Corporate emergency telephone number: 800-643-6226
Chemtrec: 800-424-9300

Overview:

:: Description
:: Statement of Health Hazard
:: General Physical Data
:: Emergency Treatment
:: Fire and Explosion
:: Hazard Data
:: Chemical Reactivity
:: Spill or Leak Procedures
:: Special Protection and Procedures
:: Special Precautions
:: Labeling and Shipping
:: Solution-Specific Physical Data
:: Other Regulatory Requirements
:: Disclaimer

Description

Chemical Name: Ammonium Hydroxide Solutions (10% to 30%)
CAS Registry No: 1336-21-6
Synonyms: Aqua Ammonia
Chemical Family: Inorganic nitrogen compounds
Formula: NH_4OH ($NH_3 + H_2O$)
Molecular Weight: 35.05 (NH_4OH)
Composition: Solutions: Anhydrous Ammonia (10% to 30%); Water (90% to 70%); Density: 16° Baumé to 26° Baumé
Ammonia, Anhydrous: CAS # 7664-41-7; Water: CAS# 7732-18-5

Statement of Health Hazard

Hazard Description

Ammonia is an irritant and corrosive to the skin, eyes, respiratory tract and mucous membranes. May cause severe chemical burns to the eyes, lungs and skin. Skin and respiratory related diseases could be aggravated by exposure.

• Not recognized by OSHA as a carcinogen
• Not listed in the National Toxicology Program
• Not listed as a carcinogen by the International Agency for Research on Cancer

Exposure Limits for Ammonia: Vapor

OSHA	50 ppm	35 mg / m^3 PEL	8 hour TWA
NIOSH	35 ppm	27 mg / m^3 STEL	15 minutes
	25 ppm	18 mg / m^3 REL	10 hour TWA
	300 ppm	IDLH	
ACGIH	25 ppm	18 mg / m^3 TLV	8 hour TWA
	35 ppm	27 mg / m^3 STEL	15 minutes

Toxicity: LD 50 (ammonia) (Oral / Rat) 350 mg / kg

General Physical Data

Appearance and Odor: Colorless liquid with a pungent odor
Solubility in Water: Miscible
Specific Gravity of Vapor (air = 1): 0.596 at 32°F
Weight (per gallon): 7.46 pounds to 7.71 pounds
Evaporation Rate (water = 1): Similar
pH: 13+

To see Solution-Specific Physical Data (Page 2) download the Aqua Ammonia manual (pdf)

Emergency Treatment

Effects of Overexposure
Eye: Tearing, edema or blindness may occur. Vapors cause irritation. Effects of direct contact may range from irritation and lacrimation to severe injury and blindness.
Skin: Irritation, corrosive burns, blister formation may result. Contact with liquid may produce caustic burns.
Inhalation: Acute exposure to vapor may result in severe irritation of the respiratory tract, bronchospasm, edema or respiratory arrest.
Ingestion: May cause corrosion to the esophagus and stomach with perforation and peritonitis. ***Extreme exposure may result in death from spasm, inflammation or edema.***

Emergency Aid

Remove patient to uncontaminated area
Eye: Immediately flush with copious amounts of tepid water for a minimum of 20 minutes. Eyelids should be held apart and away from eyeball for thorough rinsing.
Skin: Immediately flush with copious amounts of tepid water for a minimum of 20 minutes while removing contaminated clothing, jewelry and shoes. Do not rub or apply topical, occlusive compounds, such as ointments, certain creams, etc., on affected area.
Inhalation: Immediately remove to fresh air. If not breathing, administer artificial respiration. If trained to do so, administer supplemental oxygen, if required.
Ingestion: If conscious, give large amounts of water to drink. May drink orange juice, citrus juice or diluted vinegar (1:4) to counteract ammonia. If unconscious, do not give anything by mouth. **DO NOT INDUCE VOMITING!**

SEEK IMMEDIATE MEDICAL HELP FOR ALL EXPOSURES!

Note to Physician
Respiratory injury may appear as a delayed phenomenon. Pulmonary edema may follow chemical bronchitis. Supportive treatment with necessary ventilation actions, including oxygen, may warrant consideration.

Fire and Explosion Hazard Data

Flashpoint: None
Flammable Limits in Air: LEL/UEL 16% to 25% (listed in the *NIOSH Pocket Guide to Chemical Hazards* 15% to 28%)
Extinguishing Media: Dry Chemical, CO_2, water spray or alcohol-resistant foam if gas flow cannot be stopped

Auto Ignition Temperature: 1,204°F (If catalyzed), 1,570°F (If un-catalyzed)

Special Fire-Fighting Procedures
Must wear protective clothing and a positive pressure SCBA. Stop source if possible. If a portable container (such as a drum, Intermediate Bulk Container [IBC] or trailer) can be moved from the fire area without risk to the individual, do so to prevent the pressure relief valve from discharging or the container from failing. Fight fires using dry chemical, carbon dioxide, water spray or alcohol-resistant foam. Cool fire exposed containers with water spray. Stay upwind when containers are threatened. Use water spray to knock down vapor and dilute.

Unusual Fire and Explosion Hazards
• When heated, product will give off ammonia vapor, which is a strong irritant to the eye, skin and respiratory tract.
• Outdoors, ammonia is not generally a fire hazard. Indoors, in confined areas, ammonia vapors may be a fire hazard, especially if oil and other combustible materials are present. Combustion may form toxic nitrogen oxides.
• If relief valves are inoperative, heat-exposed storage containers may become explosion hazards due to over pressurization.

Chemical Reactivity
Stability
Stable at room temperature. Ammonium Hydroxide will react exothermically with acids. Will not polymerize. Ammonia vapors are released when heated.

Conditions to Avoid
• Avoid Ammonium Hydroxide contact with chemicals such as mercury, chlorine, iodine, bromine, silver oxide or hypochlorites; they can form explosive compounds.
• Avoid Ammonium Hydroxide contact with chlorine, which forms a chloramine gas, which is a primary skin irritant and sensitizer.
• Ammonium Hydroxide has a corrosive reaction with galvanized surfaces, copper, brass, bronze, aluminum alloys, mercury, gold and silver.

Hazardous Decomposition Products
Ammonia will be liberated if heated. Hydrogen will be released on heating ammonia above 450°C (842°F).

Spill or Leak Procedures
Steps to be Taken
Stop source of leak if possible, provided it can be done in a safe manner. Leave the area of a spill by moving laterally and upwind. Isolate the affected area. Non-responders should evacuate the area, or shelter in place. Only properly trained and equipped persons should respond to an ammonium hydroxide release. Wear eye, hand and respiratory protection and protective clothing; see PROTECIVE EQUIPMENT. Stay upwind and use water spray downwind of container to absorb the evolved gas. Contain spill and runoff from entering drains, sewers, and water systems by utilizing methods such as diking, containment, and absorption.

Waste Disposal
Listed as hazardous substance under CWA (40 CFR 116.4 and 40 CFR 117.3). Reportable Quantity 1,000 pounds (as NH_4OH). Classified as hazardous waste under RCRA (40 CFR 261.22 Corrosive #D002). Comply with all regulations. Suitably diluted product may be utilized as fertilizer on agricultural land. Keep spill from entering streams, lakes, or any water systems.

Special Protection and Procedures
Respiratory Protection

Respiratory protection approved by NIOSH/MSHA for ammonia must be used when applicable safety and health exposure limits are exceeded. For escape in emergencies, MSHA / NIOSH approved respiratory protection that consists of a full-face gas mask and canisters approved for ammonia is required. Refer to 29 CFR 1910.134 and ANSI: Z88.2 for requirements and selection. A positive pressure SCBA is required for entry into ammonia atmospheres at or above 300 ppm (IDLH).

Eye Protection
Chemical splash goggles should be worn when handling ammonium hydroxide (aqua ammonia). A face shield can be worn over chemical splash goggles as additional protection. Do not wear contact lenses when handling ammonium hydroxide.

Ventilation
Local exhaust should be sufficient to keep ammonia vapor to 25 ppm or less.

Protective Equipment
• At a minimum, splash proof, chemical safety goggles, ammonium hydroxide resistant gloves (such as rubber), and ammonium hydroxide-impervious clothing should be worn to prevent contact during normal loading, unloading and transfer operations and handling small spills. Face shield and boots can be worn as additional protection.
• Respiratory protection approved by NIOSH/MSHA for ammonia must be used when applicable safety and health exposure limits are exceeded. For a hazardous material release response, Level A and/or Level B ensemble including positive-pressure SCBA should be used. A positive pressure SCBA is required for entry into ammonia atmospheres at or above 300 ppm (IDLH). Refer to 29 CFR 1910.132 through 1910.138 for personal protective equipment requirements.

Special Precautions

Storage and Handling
Only trained persons should handle ammonium hydroxide. Store in cool, dry and well-ventilated areas, with containers tightly closed. Keep out of direct sunlight and away from heat sources. Do not use any non-ferrous metals such as copper, brass, bronze, aluminum, tin, zinc or galvanized metals. Protect containers from physical damage. Closed storage tanks should be provided with safety relief valves and vacuum breakers as necessary.

Work-Place Protective Equipment
Protective equipment should be stored near, but outside of ammonium hydroxide area. Water for first aid, such as an eyewash station and safety shower should be kept available in the immediate vicinity.

Disposal
See WASTE DISPOSAL. Classified as RCRA Hazardous Waste due to corrosivity with designation D002, if disposed of in original form.

Labeling and Shipping

Hazard Class: 8 [Corrosive Material]
Proper Shipping Description: Ammonia Solutions, 8, UN2672, PG III, RQ
Placard: Corrosive
Identification No: UN 2672
National Fire Protection Assoc. Hazardous Rating and Hazardous Materials Identification System Labels:

Ammonium Hydroxide
HEALTH = 3
FLAMMABILITY = 1
REACTIVITY = 0
PERSONAL PROTECTION = H

Solution-Specific Physical Data

	20.5° Baumé	25° Baumé	26° Baumé
Ammonia Percentage	18.5% to 19.5%	26.5% to 27.5%	29.4% to 30.0%
Water Percentage	81.5% to 80.5%	73.5% to 72.5%	70.6% to 70.0%
Specific Gravity (water = 1)	0.9309 to 0.9278 at 60°F	0.9060 to 0.9030 at 60°F	0.8974 to 0.8957 at 60°F
Boiling Point	124°F at 14.7 psia	88°F at 14.7 psia	84.9°F at 14.7 psia
Vapor Pressure	3.9 psia at 60°F	6.9 psia at 60°F	9.1 psia at 60°F
Approximate Freezing Point	-32°F	-89°F	-110°F

Other Regulatory Requirements

Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), Section 103, any environmental release of this chemical equal to or over the reportable quantity of 1,000 pounds (as NH_4OH) must be reported promptly to the National Response Center, Washington, D.C. (1-800-424-8802).

The material is subject to the reporting requirements of Section 304, Section 312 and Section 313, Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 and 40 CFR 372. Under Section 313, as of June 30, 1995, this material is reportable with the following qualifications: 10% of total aqueous ammonia is reportable as Ammonia (CAS #: 7664-41-7) under this listing.

Toxic Substances Control Act (TSCA): This material and its components are listed in the TSCA Inventory.

EPA Hazard Categories - Immediate: Yes; Delayed: No; Fire: No; Sudden Release: No; Reactive: No.

Clean Air Act – Section 112(r): Material is listed under EPA's Risk Management Program (RMP), 40 CFR Part 68 at concentrations greater than 20% and storage/process amounts greater than the Threshold Quantity (TQ) of 20,000 pounds of contained Ammonia (CAS #: 7664-41-7).

Disclaimer

The information, data, and recommendations in this material safety data sheet relate only to the specific material designated herein and do not relate to use in combination with any other material or in any process. The information, data, and recommendations set forth herein are believed by us to be accurate. We make no warranties, either expressed or implied, with respect thereto and assume no liability in connection with any use of such information, data, and recommendations.

Revision: February 2006 Prepared By: JRP

APPENDIX H

EPA CERTIFICATE OF PARTNERSHIP

Certificate of Partnership

Presented to

The Data Centers, LLC

by the United States Environmental Protection Agency Combined Heat and Power Partnership in recognition of efforts to improve the environmental performance of the United States energy supply system by supporting combined heat and power.

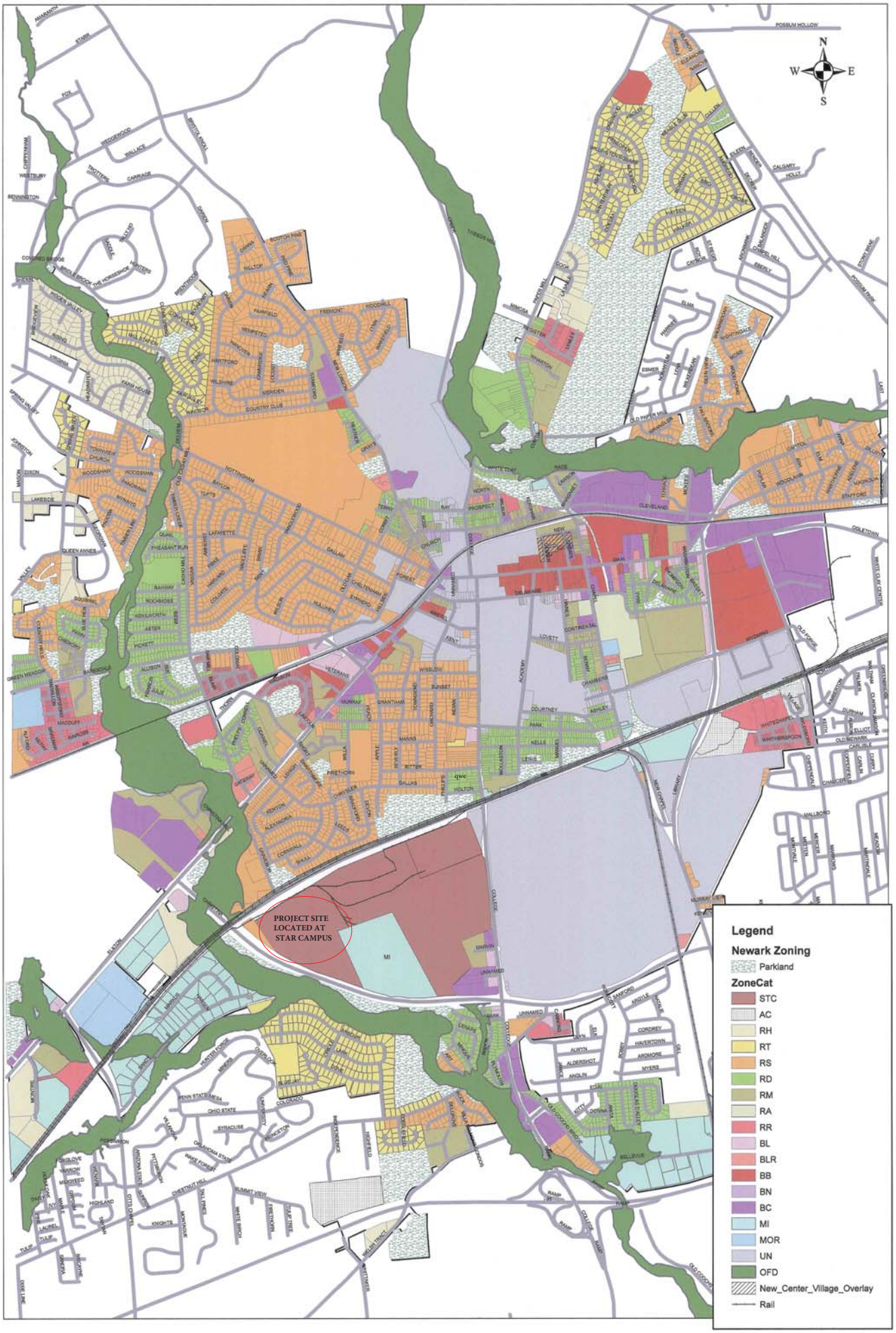
Susan Wickwire, Chief, Energy Supply and Industry Branch
Climate Protection Partnerships Division
United States Environmental Protection Agency

CHP
EPA COMBINED HEAT AND POWER PARTNERSHIP

APPENDIX I

CITY OF NEWARK ZONING

Official City of Newark Zoning Map



Updated: June 11, 2013

0 0.1 0.2 0.4 Miles

CONNOLLY
GALLAGHER LLP

MEMORANDUM

To: Carol Houck, City Manager
Bruce Herron, Esq., City Solicitor

Privileged & Confidential

From: Max B. Walton, Esq., Special Counsel

CC: Mayor and Council

Date: September 9, 2013

RE: Proposal by Data Center LLC

Question Presented

Is a power plant a permitted accessory use for a 900,000 square foot data center in the City of Newark's ("City") Science and Technology Campus ("STC") zoning district?[1]

Short Answer

Whether a power plant is an accessory use for a 900,000 square foot data center is largely a question of fact – and all of the facts regarding the power plant and the data center as a whole are unknown at this time because no application has been submitted to the City. Based upon our initial understandings and assumptions regarding the proposed data center and power plant, and assuming the assumptions discussed below are correct, the proposed power plant would likely be deemed as a permitted accessory use for the data center by a reviewing court.

Assumptions And Documents Reviewed

For purposes of this memorandum, our examination of documents has been limited to the examination of executed or conformed counterparts, or copies otherwise proved to our satisfaction, of the following:

---

[1] In this memorandum, we only address whether the proposed power plant is a permitted accessory use under the City of Newark Code. We do not express any view on whether the data center and associated power plant complies with other Federal, State or local laws, regulations, or ordinances. We further assume that the data center buildings, exclusive of the proposed power plant, total 900,000 square feet.

(a) EPA CHP Report: The Role of Distributed Generation and Combined Heat and Power (CHP) Systems in Data Centers (August, 2007);

(b) EPA CHP Report: Combined Heat and Power; Energy Savings and Energy Reliability for Data Centers (October, 2008);

(c) ICF International Report: Opportunities for Combined Heat and Power in Data Centers; Table 20: CHP Installations in Data Centers and Communications Facilities (March, 2009);

(d) The Data Centers, LLC Article: The Perfect Complement: Data Center + CHP Plant; Going off the Grid: Delaware Data Center Will Generate Its Own Power (2012);

(e) Memo to Bruce Herron, City Solicitor, from Maureen Feeney Roser re: Science and Technology Campus District Zoning Interpretation (July 24, 2012);

(f) Information Week Article: Modern Manhattan Data Center's Secret: Gas Turbines (October 9, 2012);

(g) ASME Article: Taking Data Centers Off the Grid (December 2012);

(h) Documents from the City of Newark: Delaware Municipal Electric Corporation Letter; E-mails from Carol Houck; The Data Centers, LLC Project Summary (2013);

(i) The New York Times Article: Landlords Double as Energy Brokers (May 13, 2013);

(j) Information Week Article: EBay's Secret Data Center Efficiency Weapon: Fuel Cells (June 24, 2013);

(k) E-mails from Carol Houck, City of Newark (July 8, 2013);

(l) Memo to Mayor and Council, City of Newark from Bruce C. Herron re: STAR Campus – Data Storage Facility and Electric Generator (July 10, 2013);

(m) Delawareonline Article: Newark Airs Concerns Over Planned Data Center at Chrysler Site (July 22, 2013);

(n) Community Information Session Presentation Site Drawing: The Data Center (TDC) Proposed Project for the UD Star Campus;

(o) Wolf Technology Center Power Point Presentation; and

(p) Certain Confidential and/or Privileged Documents Received from the City.

For purposes of this memorandum, with the exception of the items listed in footnote 12, we have not reviewed any documents other than the documents listed in paragraphs (a) through

(p) above and applicable statutes and case law. In particular, we have not reviewed any document (other than the documents listed in paragraphs (a) through (p) above) that is referred to in or incorporated by reference into any document reviewed by us. We have assumed that there exists no provision in any document that we have not reviewed that is inconsistent with the conclusions stated herein. We have conducted a very limited independent factual investigation of our own (limited to footnote 12 below) and have relied primarily upon the foregoing documents, the statements and information set forth therein and/or provided by the City and the additional matters recited or assumed herein, all of which we have assumed to be true, complete and accurate in all material respects. Because there has been no formal application submitted to the City, we assume (without verifying) certain facts relating to the size, type, and uses of the power plant at the proposed data center obtained from publicly available sources.

With respect to all documents examined by us, we have assumed that (i) all signatures on documents examined by us are genuine, (ii) all documents submitted to us as originals are authentic, and (iii) all documents submitted to us as copies conform with the originals of those documents. Our conclusions are rendered only with respect to Delaware laws, rules, regulations and orders thereunder that are currently in effect and based upon the limited information known regarding the proposed use. If additional factual information comes to light contrary to the facts presently assumed and understood, a change in facts or circumstances may alter the conclusions stated herein.

Statement Of Currently Known Facts

Following the University of Delaware's acquisition of the former Chrysler site, in 2011, the City adopted the new STC zoning district and applied the new zoning district to the site. This site is now known as the University of Delaware's Science, Technology, and Advanced Research Campus ("STAR Campus").

The University is in the process of developing and leasing the site for various educational and other uses. The present issue relates to the University of Delaware's lease of a 43-acre parcel on the STAR Campus to Data Center, LLC for the construction and operation of a 900,000 square foot data center ("Data Center"). The proposed Data Center will provide huge banks for computer storage for various companies and will provide a number of other jobs and amenities for the City.[2] We are advised that the Data Center will utilize certain new technology which will make the center attractive to customers.

We understand that the Data Center will require enormous amounts of power for its operation – and power interruptions cannot occur.[3] According to an article formerly on the Data

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[2] At a September 3, 2013 public presentation at the George Wilson building, the owners represented that the Data Center buildings will contain primarily computers, electronic equipment, servers, switches, and routers.

[3] According to the U.S. Environmental Protection Agency Combined Heat and Power Partnership, in a publication entitled *The Role of Distributed Generated and Combined Heat and Power (CHP) Systems in Data Centers* (August 2007), "[a] continuous supply of premium power

Center LLC's website, the Data Center "will use more electrical power than the City of Newark."[4] To meet this demand for power required by the Data Center, the owners have proposed to construct a 248 megawatt power plant at the site to ensure a constant supply of power. While no plans for the plant have been submitted to the City, published reports state that the proposed power plant "consists of a proprietary configuration of natural gas turbines, steam turbines and gas engines, with two independent natural gas supply lines on site to provide the reliability to deliver uninterrupted, fault tolerant power to the data center." At a public presentation on September 3, 2013, the Data Center owners stated that the power producing facility will contain seven gas turbines and three engines – and power will be generated via natural gas and steam.[5]

Based on representations of the owner, the proposed power plant will supply 100% of the power for the Data Center, including redundancy power (e.g. backup power). It is anticipated that approximately 20% of the total power generated[6] (the backup power) will be sold back to the City (through the Delaware Municipal Electric Corporation ("DEMEC")), and a substation will be constructed to handle the supply of excess power. A crude and very preliminary drawing illustrates that the proposed power plant will occupy approximately 1/3 of the area of the lot covered by both phases of the data center buildings.

Questions have been raised whether the construction of a power plant for the Data Center is permitted in the STC district. While the Data Center itself is a permitted use in the district (*see* Newark City Code § 32-23.1(a)(5)), the STC district does not expressly permit (or prohibit) power plants and/or power generating facilities like the power plant proposed to support the Data Center. The STC district, however, permits "[a]ccessory uses and accessory buildings." Newark City Code § 32-23.1(a)(13). Thus, even though power plants are not permitted uses in the STC district, if the power plant qualifies as an accessory use to the Data Center, the power plant is a permitted use.

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is essential to all data centers to avoid equipment downtime . . . . the cost of being offline, even for a short period, can run well into the millions of dollars." *Id.* at p. 4. The report notes that losses for power outages or lapses in power quality can range as high as $30 million per minute for data center operations during peak periods. *Id.* at 10.

[4] According to a *New York Times* article, a similar data center operated by Quality Technology Services uses roughly the amount of electric needed to power 15,000 homes.

[5] City officials have confirmed that the City is not equipped to supply the power necessary for the proposed Data Center's needs.

[6] It is unclear at this time exactly how much redundancy power will be sold back to the electrical grid – as the documents provided contain varying percentages. In a power point presentation, the Data Center represents that 112 MW will be used for critical load, 88 MW will be used for cooling, lighting, etc., and 48 MW will be used for redundancy (approximately 24%).

Discussion

A. Standard Of Review

To determine whether the proposed power plant is an accessory use, we interpret the meaning of the City's zoning ordinance and apply well-settled canons of statutory construction.

"The primary goal of statutory construction is to 'ascertain and give effect to the intent of the legislature.'" *Acadia Brandywine Town Center, LLC v. New Castle County,* 879 A.2d 923, 927 (Del. 2005) (citing *Director of Revenue v. CNA Holdings, Inc.,* 818 A.2d 953, 957 (Del. 2003)). Intent is determined by the plain language of the statute, and absent ambiguity, "there is no room for judicial interpretation and 'the plain meaning of the statutory language controls.'" *PHL Variable Ins. Co. v. Price Dawe 2006 Ins. Trust*, 28 A.3d 1059, 1070 (Del. 2011); *Chase Alexa, LLC v. Kent County Levy Court*, 991 A.2d 1148, 1152 (Del. 2009) (same).[7]

The statute is only "ambiguous if it is susceptible of two reasonable interpretations." *PHL Variable Insurance Co.,* 28 A.3d at 1070. In the context of land regulations, "if there are two reasonable interpretations of the statute, the interpretation that favors the landowner controls." *Chase Alexa LLC*, 991 A.2d at 1152. The Delaware Supreme Court has made clear that if there is "any doubt as to the correct interpretation [of a zoning statute], that doubt must be resolved in favor of the landowner." *Dewey Beach Ent., Inc. v. Board of Adjustment of the Town of Dewey Beach*, 1 A.3d 305, 310 (Del. 2010). A statute will also be construed in a manner as to avoid an absurd result. *Doroshow, Pasquale, Krawitz & Bhaya v. Nanticoke Mem. Hosp., Inc.,* 36 A.3d 336, 343 (Del. 2012) (quoting *Moore v. Wilm. Hous. Auth.*, 619 A.2d 1166, 1173 (Del. 1993) ("We read statutes by giving language its reasonable and suitable meaning while avoiding 'patent absurdity.'")).

B. The Accessory Use Provisions In The Newark City Code

An accessory use of land is by definition one that is not expressly permitted by the zoning ordinance itself. 101A C.J.S. *Zoning and Land Planning* § 144 (2013). As such, "[e]ach accessory use case must be decided on its own particular facts." *Wiggin v. Mummert*, 1992 WL 113455, at *5 (Del. Ch.); 101A C.J.S. *Zoning and Land Planning* § 144 (2013) ("whether a particular use of property qualifies as an accessory use is ordinarily a question of fact . . ."). Consequently, an accessory use for one property may not qualify as an accessory use for another. Thus, we apply the plain meaning of the statute to the facts at hand to determine whether the proposed power plant is an accessory use to the Data Center pursuant to Newark City Code § 32-23.1(a)(13).

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[7] Statutory definitions are also important. It is well settled that "where a zoning ordinance has expressly defined the meaning of the term . . . the stated definition is controlling." *Hayward v. Gaston*, 542 A.2d 760, 768 (Del. 1988). If the term is not defined, a Court is required to "look to the commonly accepted meaning of the term." *Dahl v. State*, 926 A.2d 1077, 1083 (Del. 2007); *Gow v. Director of Revenue,* 556 A.2d 190, 193 (Del. 1989) ("The general rule is that where a statutory term is not defined by the statute, the rules of construction require that the term be given its ordinary meaning.").

An accessory use is defined by the Newark City Code as "[a] use customarily incidental and subordinate to the principal use or building and located on the same lot with such principal use or building." Newark City Code § 32-4(a)(2).[8] Because the proposed power plant will be constructed on the same lot as the Data Center, to be a permitted accessory use, the proposed power plant use must be "customarily incidental and subordinate" to be permitted in the STC district.

1. The Meaning Of Customarily Incidental And Subordinate

"[C]ustomarily" as that phrase is used in the context of accessory uses means "a recognized mode of activity in the field, although it need not be the more prevalent one." 101A C.J.S. *Zoning and Land Planning* § 144 (2013). To determine whether a proposed use is "customary," Delaware courts review the proposed use on a statewide basis, but there is no "absolute requirement that an accessory use be common in the area and universally considered unobjectionable." *The Commissioners of Bellefonte v. Coppola*, 453 A.2d 457, 461 (Del. 1982). However, under the "customary" prong of the accessory use test, Delaware Courts have closely scrutinized "whether the proposed use is commonly, habitually and by long practice been established as reasonably associated with the primary use." *McKinney v. Kent County Board of Adjustment*, 1995 WL 109032, at *4 (Del. Super. Ct.), *aff'd*, 673 A.2d 1199, 1204 (Del. 1996). Courts have required that a "significant percentage of like principal uses in the area have accessory uses of the nature and extent in question," or that the use is a "recognized mode of activity in the field." 2 Rathkopf's *The Law of Zoning And Planning* § 33:3 (4th ed. 2013). Even if the use is "incident to only a small percentage of similar principal use[s], it may nevertheless be found to be 'customary.'" *Id.* To decide whether a use is customary, Courts are not required to limit inquiry to a mere mathematical count. 101A C.J.S. *Zoning and Land Planning* § 144 (2013).

To be incidental[9] and subordinate,[10] the accessory use "must have a reasonable relationship or connection with the primary use." *Wiggin*, 1992 WL 113455, at *5; 101A C.J.S. *Zoning and Land Planning* § 144 (2013) (same); *Drummey v. Town of Falmouth Zoning Board of Appeals*, 2013 WL 3205142, at *11 (Mass. App.) (same).[11] Stated differently, the accessory

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[8] The Delaware Supreme Court has held that this language, stated differently, means that "the accessory use must be one habitually associated with and subordinate to the functioning" of the principal use. *Di's Inc. v. McKinney,* 673 A.2d 1199, 1204 (Del. 1996); *see also Application of Emmett S. Hickman Co.*, 108 A.2d 667, 671 (Del. 1954).

[9] Incidental is defined as "[d]epending upon or pertaining to something else as primary; something necessary, appertaining to or depending upon another which is termed the principal; something incidental to the main purpose." Henry C. Black, *Black's Law Dictionary*, 388 (5th Abr. ed. 1983).

[10] Subordinate means submissive to or falling under the control of the primary use. *Stone Mill Properties, L.P. v. Board of Adjustment of New Castle County*, 1992 WL 91164, at *3 (Del. Super. Ct.); http://www.merriam-webster.com/dictionary/subordinate.

[11] Various definitions of "incidental and subordinate" have been proffered to the City by members of the public in the record provided for this review of the Data Center. Even though the proffered definitions conflict with the judicial interpretation of the meaning of incidental and

use may not be the principal use of the property. 101A C.J.S. *Zoning and Land Planning* § 144 (2013). It must be dependent upon or pertain to the principal use of the land. *Id.*; *Drummey*, 2013 WL 3205142, at *11.

Because a determination of whether a proposed accessory use is permissible is a largely fact based inquiry, the phrase "customarily incidental" should be interpreted by invoking an objective reasonable person standard, with consideration of how frequently the proposed use is found in association with the primary use, the applicant's particular circumstances, the zoning ordinance and the indications therein as to the governing body's intent regarding the intensity of land use appropriate to the particular district, as well as the surrounding land conditions and any other relevant information, including general experience and common understanding to reach a conclusion whether a reasonable person could consider the use in question to be customarily incidental. *Northampton Area School Dis.* v. *Zoning and Hearing Bd. of the Tp. of Lehigh,* 64 A.3d 1152, 1156 (Pa. Cmmw. 2013) (quoting *Hess v. Warwick Tp. Zoning Hearing Bd.*, 977 A.2d 1216, 1244 (Pa. Cmmw. 2009)).

2. The Power Plant Qualifies As An Accessory Use To The Data Center

Based upon the plain meaning of the "accessory use" definition in the Newark City Code, and based upon the facts presently assumed, the proposed power plant likely qualifies as a permitted accessory use. As noted by the publications reviewed, having a reliable power source is mission critical for a Data Center operation. *See supra* n. 3. As such, numerous Data Centers across the country have individual power plants to handle the need for the massive amounts of power – demonstrating that the use of power plants in connection with Data Centers is a common and customary practice in the field.[12] 2 Rathkopf's *The Law of Zoning And Planning* § 33:3 (4th ed. 2013). While not all data centers have power plants, based upon the facts currently known, a power plant is a use that is customarily a component of a Data Center and therefore likely qualifies as a customary use under the Newark City Code's definition of "accessory use."[13]

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subordinate, these definitions at best create an ambiguity in the meaning. If ambiguity in the language is present, that ambiguity in the zoning ordinance must be construed in favor of the free use of land. *Dewey Beach Ent., Inc.,* 1 A.3d at 310.

[12] We are advised (but have not verified) that all large scale data centers have some form of backup power generation capacity. Online research has revealed that data centers in Burlingame, CA, Concord, CA, Fresno, CA, La Jolla, CA, San Dimas, CA, San Ramon, CA, Sunnyvale, CA, Warner Robbins, GA, Bozeman, MT, Omaha, NE, Basking Ridge, NJ, Neptune, NJ, Garden City, NY, Ontario, CA, Pomona, CA, Newington, CT, Cheyenne, WO, Salt Lake City, UT, and New York, New York are associated with power generating facilities. We note that the owners have represented that this will be the first "off the grid" Data Center. While the lack of a connection to the grid is unique, the pertinent question is whether power generating facilities (such as power plants) are reasonably associated with the primary data center use and are a recognized mode of activity in the field of large scale data centers.

[13] In *Commissioners of Bellefonte*, 453 A.2d at 461, the Delaware Supreme Court held that the "use" in question should be reviewed in a statewide context. *See also Sawers v. New Castle County Board of Adjustment*, 1988 WL 25370, at *6 (Del. Super. Ct.). Both cases relate to whether certain proposed home based occupations (golf club repair business and a conversion of

The power plant, as represented, also appears to be incidental and subordinate to the Data Center use. As presented, power plant will not be the primary use of the property – the principal use of the property will be the storage of data at the Data Center. The power plant will be smaller and apparently will occupy approximately 1/3 of the space required for the 900,000 square foot Data Center based upon the preliminary drawings provided. The power plant has a reasonable connection to the primary use (the Data Center) because approximately 80% of the power generated by the power plant will be used by the Data Center operation.[14] We note that the owner's representation at the public meeting stating that less than 30% of its revenue will be generated from the sale of redundancy power makes it a closer call on whether the proposed power plant is subordinate to the Data Center. However, on balance, the power plant use likely remains submissive to and falls under the control of the primary use because a sizeable majority of the power generated will be used and consumed by the power needs of the Data Center, thereby creating a reasonable relationship and connection to the primary use.[15]

Thus, under the plain language of the "accessory use" definition in the Newark City Code as applied to the facts currently known, and under the applicable case law, the power plant likely qualifies as an accessory use for the Data Center.[16]

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a barn into storage space) constitute an accessory use. Because, to our knowledge, there are few data centers of this type located in Delaware, we believe that the Delaware Supreme Court would not confine its review of customarily incidental uses to uses existing in the State. Instead, we believe that the Court would likely look at the use of power plants for data centers in the industry as a whole.

[14] We understand that the Data Center buildings will be built in two phases. Based upon representations made at the September 3, 2013 informational meeting, we understand that the power plant will initially be sized to provide power for phase 1 of the project, and will be expanded at a later time to add additional power generating capacity for phase 2. It was also represented that phase 1 will take 2-3 years to complete, and phase 2 will be complete in 5-6 years. If the power plant is initially built to fully service both phases, and the future construction of phase 2 of the Data Center were substantially delayed, the conclusions stated herein might change because a power plant of that size might not be subordinate to the Data Center use. For this memorandum, we assume that both phases of the Data Center will be timely built and that approximately 80% of the power generated will be used for the Data Center's own use.

[15] If the Data Center went out of business, the power plant could not thereafter become a stand alone use as an electric producer without a zoning change. Indeed, when an accessory use attains such magnitude as to no longer be incidental to the principal use, it loses its status as an accessory use. 2 Rathkopf's *The Law of Zoning And Planning* § 33:3 (4th ed. 2013). In addition, if the facts and circumstances change and it is shown that the Data Center is not the primary use of the property (and the selling of power is the primary use), the power plant would be prohibited in the STC district.

[16] Some have argued that if the power plant for the Data Center is subordinate or incidental to the Data Center, a landfill built for the use of the Data Center might also qualify as an accessory use. To qualify as an accessory use, the use must be dependent upon the principal use of the property – and the Data Center's operation would not be dependent on a landfill. *See McKinney*, 1995 WL 109032, at *4 (holding that a shopping center is not an accessory use to a

3. Other Courts Have Reached The Same Conclusion

In a similar case, the District of Columbia Court of Appeals in the case of *Citizens Coalition v. District of Columbia Bd. of Zoning Adjustment*, 619 A.2d 940 (D.C. App. 1993) held that a power plant constituted a permissible accessory use. In *Citizens Coalition,* Georgetown University sought to build a fifty-six megawatt co-generator on its campus. *Id.* at 942. The power generated by the facility would be sold, pursuant to a power purchase agreement, to the Potomac Electric Power Company ("PEPCO"), and the power plant was to be constructed and operated by Dominion Energy, Inc. ("Dominion"). *Id.* The Board of Zoning Appeals granted a special exception for the power plant, and held that the cogeneration facility constituted an accessory use of the University. *Id.* at 944.

On appeal, the principal issue was whether the power plant constituted an accessory use, which is defined under the applicable code as "a use customarily incidental and subordinate to the principal use, and located on the same lot with the principal use." *Id.* at 947. Even though the electric generated by the power plant would not be used directly by the University and surplus energy would be sold, the Court held that:

> . . . the accessory use, i.e. the proposed facility, is attendant and reasonably related to the principal use which is the function and operation of a University as it contributes to the health and well being of its students and the Hospital patients and personnel.

Id. at 954.

The Court went on to hold that the construction of the co-generation facility to serve the University's utility needs was incidental and subordinate to the University's operations and thereby constituted a permitted accessory use. *Id.* There, as here, under the applicable facts, a power generating facility qualified as a permitted accessory use under the zoning code.

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mobile home park); *Wiggin*, 1992 WL 113455, at *5 (holding that towing and storage of vehicles that are beyond repair have no reasonable relationship or connection to the operation of a service station). The Data Center use is dependent on large amounts of power – power that the City is unable to generate at this time under its current generation capacity.

4. A Different Conclusion Would Likely Yield A Result Contrary To Legislative Intent

The "golden rule of statutory interpretation . . . is that unreasonableness of the result produced by one among possible interpretations . . . is reason for rejecting that interpretation in favor of another which would produce a reasonable result." *Delaware Bay Surgical Services P.C. v. Swier*, 900 A.2d 646, 652 (Del. 2006). Consequently, an interpretation of the statutory provisions contrary to legislative intent must be rejected. *Id.*

In the STC district, data centers are a permitted use. Newark City Code § 32-23.1(a)(5) (permitting technologically dependent or computer based facilities that are dedicated to the processing of data or the analysis of information). Consequently, the presumed legislative intent is to allow the proposed Data Center in this district. We are advised that the City cannot (at this time) supply the power necessary for the operation of the Data Center on this particular site. It would be an absurd result indeed if the City Council permitted data centers but at the same time forbid the power generation required for the permitted data center use. By expressly permitting accessory uses in this district, the City Council presumably foresaw that accessory uses (like a power plant) might be needed for a data center type use in this district. Because a contrary interpretation of the accessory use provision in the code would effectively foreclose a large Data Center use, the reasonable interpretation of the accessory use definition is to allow the power plant as an accessory use for the Data Center.[17] A different interpretation under the assumed facts presented would be contrary to the presumed legislative intent and should be rejected.

Conclusion

Based on and subject to the foregoing, the qualifications and analysis set forth above, and to the further qualification that there is no definitive Delaware judicial authority confirming the correctness of the analysis, it is our conclusion that, in connection with the question of whether a power plant constitutes an accessory use in the STC district for the proposed Data Center, a Delaware Court exercising jurisdiction, in a properly briefed, argued and presented case and exercising reasonable judgment and discretion after full consideration of all relevant factors, would conclude that the power plant for the Data Center is a permitted accessory use.

While we believe that our views set forth herein are supported by sound analysis of existing law, we found no Delaware reported cases containing all the material facts and circumstances applicable to the proposed power plant for the Data Center. In rendering our views herein, we have thus relied on cases discussing certain of the facts and circumstances that are present in the factual situation presented and on cases discussing accessory uses more generally. We also note that the Court of Chancery has broad equitable powers which may allow for equitable or injunctive relief or other remedies. Consequently, the view set forth herein is not a guarantee of outcome or result. The foregoing memorandum is expressly subject to there being no material fact that has not been communicated to us, and that all the foregoing facts have been

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[17] "Incidental uses have always been authorized where they are customary and do no violence to the plain intent of the statute or ordinance." *Application of Emmett S. Hickman Co.*, 108 A.2d at 670.

accurately represented to us as represented herein and on which we have relied as the source of our information and assumptions.

We express no view as to the law of any jurisdiction other than Delaware, and we express no view as to any issue not expressly addressed herein, including, without limitation, any issue regarding: (1) whether the power plant is separately permitted pursuant to Newark City Code § 32-23.1(a)(10); (2) whether the City of Newark's zoning authority applies to this project; or (3) whether the power plant may be a permitted use under other applicable law. This memorandum is limited to the effect of the present state of the laws of the State of Delaware and the City of Newark, insofar as they relate to the issues specifically addressed herein. In providing this memorandum, we assume no obligation to revise or supplement this memorandum should the applicable facts, the present law (or the interpretation thereof) be changed.

This memorandum is furnished to the City solely for the City's benefit. This memorandum may not be used, quoted from, or relied upon by any other person or entity (including lenders or financial institutions) without our prior written consent, except that the views in the memorandum may be used by the City in conjunction with applications or other matters relating to the Data Center.

NEWARK DELAWARE
Committed to Service Excellence

PLANNING AND DEVELOPMENT DEPARTMENT
CITY OF NEWARK
220 South Main Street • Newark, Delaware 19711

(302) 366-7030 • Fax (302) 366-7160 • www.cityofnewarkde.us

November 1, 2013

By Electronic Mail

Mr. Rick Beringer, PE
Duffield Associates
5400 Limestone Road
Wilmington, DE 19808

Re: City of Newark's Response At A Request for Zoning Verification Application No. 8718 (The Data Center LLC- Wolf I CHP)

Dear Mr. Beringer:

On behalf of the City of Newark ("Newark" or "City"), I write in conjunction with The Data Center LLC's ("Data Center") request for a zoning verification for a gas fired power plant at the former Chrysler site, now known as the STAR Campus. The property is located in the City's Science and Technology Campus zoning district ("STC"). Power plants are not a permitted use in the STC zoning district. However, a power plant might qualify as a permitted accessory use in the district, so long as the power plant is customarily incidental and subordinate to the primary use – e.g. a data center. *See* Newark City Code § 32-23.1(a)(13).[1]

Please be advised that, at this time, Newark is unable to provide a zoning verification that the proposed power plant (for which the air permit is sought) is a permitted use in the STC zoning district. The City has not received any finalized plans, applications, or specifications regarding the project. Without specifications and concrete proposals from the owners, the City cannot determine whether the power plant qualifies as a permitted accessory use.

To date, Newark has received conflicting and inconsistent statements from individuals representing the Data Center regarding the scope and/or intended uses for the power plant and the project as a whole. For example, in a September 3, 2013 public presentation at the George Wilson Community Center in Newark, representatives of the Data Center stated that the power plant would be designed to produce 248MW of power, of which 200MW would be used by the

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[1] An accessory use is defined by the Newark City Code as "[a] use customarily incidental and subordinate to the principal use or building and located on the same lot with such principal use or building." Newark City Code § 32-4(a)(2),

proposed data center, with the remaining 48MW of power being sold back to the Delaware Municipal Electric Corporation ("DEMEC"). Data Center representatives also stated that up to 30% of the total power generated by the power plant would be sold back as excess. Prior to the September meeting, however, the Data Center represented to City officials that only 10% of the excess power would be sold and the remaining power produced would be used by its customers.

Just yesterday, the City (for the first time) received a copy of the Data Center's request for a grant from the Delaware Economic Development Office ("DEDO") dated April, 2013. Statements in the DEDO application appear to demonstrate the power plant may not be accessory to the primary use. Rather, the DEDO application states that "the power plant *runs independently of the data center* so it's [sic] economic viability is only tied to the cost of natural gas (NG) and the national grid energy costs." (emphasis supplied). If the power plant runs "independently" from the data center, the proposed power plant may not qualify as an accessory use in the STC zoning district.

The recently received DEDO application also states that the owners/lessors will apply for a 100MW interconnection to the PJM grid, and that they intend to sell up to 90MW of the excess power to Newark. This appears to be contrary to the representations made at the September 3, 2013 public meeting. Although there are a number of conflicting statements in the air permit application, it appears that the owners/lessors are seeking an air permit for generation of 279 MW of power. At least as of September 3, 2013, the Data Center advised the City (and the public) that only 248MW of power would be generated. These are just a few examples of what appears to be unsettled proposals regarding the proposed power plant and the data center project as a whole.

To reiterate, the proposed power plant only qualifies as a permitted use in the STC zoning district if it is "customarily incidental and subordinate to the principal use." Newark City Code § 32-4(a)(2); Newark City Code § 32-23.1(a)(13). Without having formal plans and a concrete proposal from the owners/lessors about the proposed data center and the power plant, the City is unable to determine whether the proposed power plant is a permitted use in the STC zoning district. Based upon statements made by the president and CEO of the Data Center at a presentation to the University of Delaware faculty on October 15, 2013, plans will not be formalized until late March or early April 2014. Unless and until the owners/lessors submit formalized and concrete plans to the City for the intended uses at the site, and can demonstrate compliance with applicable City zoning laws, the City cannot provide a zoning verification for the air permit application. We look forward to receiving the necessary information to resolve this matter in the near future.

If you have any questions, please feel free to contact me.

Sincerely,

Maureen Feeney Roser
Director of Planning and Development

Cc: Carol Houck, City Manager (by electronic mail)
Bruce Herron, Esq., City Solicitor (by electronic mail)
Paul Foster, PE, DNREC (by electronic mail)
Michael Bednar, The Data Centers, LLC (electronic mail)

APPENDIX J

THE ECONOMIC IMPACT OF THE PROPOSED DATA CENTER AT THE UNIVERSITY OF DELAWARE STAR CAMPUS

THE ECONOMIC IMPACT OF THE PROPOSED DATA CENTER AT THE UNIVERSITY OF DELAWARE STAR CAMPUS

OCTOBER 29, 2013

FINAL REPORT SUBMITTED TO:

The Data Centers, LLC
1554 Paoli Pike, Suite 325
West Chester, PA 19380

FINAL REPORT SUBMITTED BY:

Econsult Solutions, Inc.
1435 Walnut Street
Philadelphia, PA 19102

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Executive Summary

Data Centers, LLC is proposing the construction of a data center and combined heat and power (CHP) facility on the STAR campus of the University in Delaware in Newark. The facility will combine a state-of-the-art data center with a self-contained power source. In addition to generating significant fiscal and economic impacts, it offers a tangible sign that Delaware is making the transition into the digital economy.

The construction and operation of the proposed data center and CHP facility will generate significant fiscal benefits to the state and local community...

- Delaware will collect over **$20 million** in taxes over the three year construction period, including nearly $8 million in income taxes, nearly $4.4 million in gross receipts and $7.7 million in business tax revenue for Phase I alone.
- The construction of the data center and CHP facility will also generate nearly **$5.6 million** in one-time fees for state and local governments, including **$4.7 million** to the City of Newark from Phase I alone.
- The annual operations will generate nearly **$4.5 million** in new state taxes every year, including $1.6 million in income tax revenue, $1.5 million in gross receipts, and $1.3 million in business tax revenue from Phase I.
- The project will also generate over **$6.6 million** in annual property tax revenues from Phase I alone, including **$4.2 million** to the Christina School District and **$1.5 million** to the City of Newark.
- The additional $300 million in development associated with Phase II has the potential to generate **$1.4 million** in new property tax revenue per annum, including nearly **$0.9 million** to the Christina School District and **$0.3 million** to the City of Newark.
- Phases I and II are estimated to generate close to a total of **$8.0 million** in property tax revenue annually, including nearly **$5.1 million** to the Christina School District and **$1.8 million** to the City of Newark.

The data center will also generate significant stimulative impacts in the local and state economies through the construction of the facility…

- Phase I of the project will result in 640,000 square feet of new construction and over **$1.45 billion** in upfront construction and equipment expenditures, of which nearly **$607 million** will occur in Delaware, including **$567 million** in New Castle County.

- Within Delaware, the direct construction spending of Phase I is estimated to generate about **$1 billion** in total output, nearly **8,400 total jobs** and over **$478 million** in wages and salaries.
- New Castle County will be responsible for **$935 million** of the total output of Phase I construction, **7,300 total jobs**, and nearly **$453 million** of the wages and salaries.

…and through the annual operations of the data center and CHP facility.

- The annual operation of the facility (excluding Phase II) will require annual expenditures for tenant equipment, labor, supplies, and maintenance of both buildings as well as the servers and computer equipment. This will result in about **$47 million** of annual spending, over **90%** of which will be directly sourced from within the state of Delaware.
- The combined facility (excluding Phase II) is estimated to directly employ 640 employees and generate over **$38 million** in annual wages and salaries. The average wage of the full time employees working at the data center will be over **$65,000** and the average annual wage of employees working at the CHP facility will be nearly **$60,000.**
- The $47 million in direct expenditures of the Phase I combined facility and 640 direct employees are expected to generate nearly **$90 million** in total output and support for about **320 indirect** and induced jobs and about **$15 million** in additional wages and salaries per annum.

Box ES-1: Project Highlights

- **$1.45 billion** in Phase I upfront construction and equipment expenditures.
  - **$607 million** in total construction spending in Delaware.
- **$20 million** in state taxes generated during the Phase I construction period.
- **$5.6 million** in one-time fees for state and local governments from Phase I.
  - **$4.7 million** in one-time fees for the City of Newark**.**
- **$4.5 million** in state taxes from annual operations from the Phase I facility.
- **$6.6 million** in local property taxes annually, including **$4.2 million** to the Christina School District and **$1.5 million** to the City of Newark from Phase I alone.
- **$1 billion** in total output from Phase I, nearly **8,400 total jobs** and over **$478 million** in wages and salaries generated during the Phase I construction period in Delaware.
- The combined Phase I facility alone will directly employ **640 employees** and generate nearly **$39 million** in annual wages and salaries.
- The average annual wage of the full time employees working at the data center will be over **$65,000** and the average annual wage of employees working at the CHP facility will be nearly **$60,000.**
- **$90 million** in total output and support for **320 indirect and induced jobs** and **$15 million** in additional wages and salaries generated from the **$47 million** in annual operating expenditures from the Phase I facility.
- An estimated **$7.9 million** in property tax revenue annually from both Phases I and II, including nearly **$5.1 million** to the Christina School District and **$1.8 million** to the City of Newark.

1.0 INTRODUCTION

1.1 PROJECT SUMMARY

The Data Centers, LLC is proposing the construction of a data center and combined heat and power (CHP) facility on the STAR campus of the University of Delaware in Newark, Delaware. This facility will have a reliable and self-sustained power source with a state-of-the-art data center. Located between two of the largest data hubs in the country (Washington, DC and New York City, New York), this data center intends to serve both public and private entities with their data processing needs.

1.2 ECONOMIC IMPACT METHODOLOGY

To determine the scale and composition of economic impacts associated with the construction and operation of a data center, an economic impact model was constructed that utilized multiplier data from the Minnesota IMPLAN Group's IMPLAN software to estimate the composition and scale of expenditures, employment, and labor income resulting from the direct expenditures associated with the construction and operation of the data center. This model estimated two forms of spillover impacts resulting from these direct expenditures:

1. Indirect expenditures are generated as local vendors increase production in response to the initial expenditures. New expenditures on inputs and services (e.g. equipment, materials, professional services) cause suppliers of those inputs and services to ramp up production, and to acquire additional inputs and services from their suppliers, who themselves will do the same. The sum of these economic activities is known as the indirect expenditures, and they support additional employment and labor income beyond the employment and labor income supported by the direct expenditures.

2. Induced expenditures are generated as employees spend their labor income within the local economy. New expenditures on people (i.e. salaries) provide those people with additional spending power. Some of that spending power is exercised within the region, supporting local providers of various goods and services (e.g. food, entertainment, lodging, transportation). The sum of these economic activities is known as the induced expenditures, and they also support additional employment and labor income beyond the employment and labor income supported by the direct expenditures.

Direct, indirect, and induced expenditures support a certain scale and composition of employment and labor income, which can also be estimated using IMPLAN. For the

purposes of this report, the units of geography for which estimates were made were the State of Delaware, and New Castle County.[1]

1.3 REPORT OVERVIEW

This report describes the economic and fiscal impacts of the proposed data center and CHP station. Economic impacts are generated from two sources: the upfront capital expenditures associated with the proposed data center and CHP station (Section 2), and the ongoing operations of the proposed data center and CHP station (Section 3). These temporary and permanent increases in economic activity in turn generate tax revenue for the State of Delaware, New Castle County, City of Newark, and Christina School District (Section 4).

[1] See Appendix A for additional detail on Econsult Solutions, Inc.'s economic and fiscal impact model methodology.

2.0 ECONOMIC IMPACT OF UPFRONT CAPITAL EXPENDITURES

2.1 OVERVIEW

The capital costs associated with building this data center in Newark requires significant upfront capital costs, considering the size and breadth of the data center. The facility will be "off-grid" and derive power from its own, separate CHP energy hub. The phase I construction project consists of over 510,000 square feet of data center space, 50,000 square feet of administrative space, and a 75,000 square feet CHP facility. The upfront costs include the construction of the facility, data center building, as well as the cooling system and the administration building. Total upfront expenditures in phase I are expected to be close to $1.45 billion, with over $800 million in construction and $620 million in tenant equipment purchases.[2][3] Of these expenditures, a significant portion is anticipated to be sourced directly from within the State of Delaware and New Castle County.[4]

2.2 SUMMARY OF MODELABLE UPFRONT CAPITAL EXPENDITURES

Since a portion of the manufacturing work associated with the capital expenditures of the data center and CHP facility occurs outside of the State of Delaware (eg: manufacturing of the turbines), that portion is excluded for modeling purposes. What is included are the various wholesale and retail margins, as well as transportation costs included in the value of the product manufactured outside of the State. Based on data provided by The Data Centers, LLC and estimates from National Income and Product Accounts data on retail, wholesale, and transportation margins, about 60 percent of the total capital expenditures for the data center and CHP facility are estimated to be sourced within in the State. Nineteen percent of the upfront equipment purchases are considered to take place within the State and are therefore modelable. Within New Castle County, about 59 percent of the data center and CHP facility upfront capital expenditures and 14 percent of upfront equipment purchases are estimated to occur, and are used for modeling purposes (see Table 2.1).

[2] Tenant purchases account for server hardware and software purchases in each of the data center's twelve pods.
[3] These expenditures do not include the projected $350 million dollar expansion of the data center in phase II. Including both phases, total construction costs will be about $1.1 billion.
[4] New Castle County is the most populous County in Delaware and accounting for 71 percent of its economy and 59 percent of the population, which implies that a larger portion of the construction spending in the State will likely occur in New Castle County and Newark specifically.

Table 2.1 – Summary of Total and Modelable Phase I Upfront Capital Expenditures Associated with the Proposed Data Center

Construction Expenditures	Project Expenditures ($M)	State-Level Spending	Modelable Expenditures[5] ($M)	County-Level Spending	Modelable Expenditures[6] ($M)
CHP Construction (BoP)	$55.34	100%	$55.34	100%	$55.34
CHP Construction (Equipment)	$178.36	46%	$82.78	43%	$76.37
Data Center Construction	$125.35	100%	$125.35	100%	$125.35
Data Center Cooling System	$100.00	44%	$44.12	40%	$40.25
Admin Building Construction	$22.50	100%	$22.50	100%	$22.50
Design & Construction Admin	$24.00	75%	$18.00	75%	$18.00
Development Expenses	$15.00	100%	$15.00	100%	$15.00
Land Acquisition Fee	$3.10	0%	$0.00	0%	$0.00
UD Common Areas (Roads, etc.)	$7.00	100%	$7.00	100%	$7.00
Owner's Oversight (Includes OE)	$14.45	100%	$14.45	100%	$14.45
Attorney's Fees Project	$1.50	100%	$1.50	100%	$1.50
Project Representative (PM)	$4.90	100%	$4.90	100%	$4.90
Real Estate Tax	$0.00	0%	$0.00	0%	$0.00
Environmental Abatement & Tax	$0.00	0%	$0.00	0%	$0.00
Insurance, Bonds and Warranties	$2.41	0%	$0.00	0%	$0.00
Development Fee	$35.60	100%	$35.60	100%	$35.60
Investors' Expenses	$1.50	100%	$1.50	100%	$1.50
Power Conditioning + Buildings	$45.87	100%	$45.87	100%	$45.87
Contingency Fund	$48.15	0%	$0.00	0%	$0.00
Transaction Fee	$10.15	0%	$0.00	0%	$0.00
Steam Pipeline	$10.00	46%	$4.57	44%	$4.38
Gas Pipeline, Fiber Optics, Transmission Line	$27.25	46%	$12.44	44%	$11.92
Interest During Construction	$20.53	0%	$0.00	0%	$0.00

[5] It was assumed that none of the manufacturing of components associated with the construction or upfront equipment will occur within the State of Delaware. Only the margins on retail, wholesale, and transportation were included. Additionally, it was assumed that 75% of design and construction administration expenditures will occur within the State of Delaware.

[6] It was assumed that none of the manufacturing of components associated with construction or upfront equipment will occur within New Castle County. Only the margins on retail, 75% of the wholesale margin, and 50% of the transportation margin were included. Additionally, it was assumed that 75% of design and construction administration will occur within New Castle County.

Commitment Fees	$8.61	0%	$0.00	0%	$0.00
Debt Establishment Fees	$18.44	0%	$0.00	0%	$0.00
Initial DSRAc Funding	$12.79	0%	$0.00	0%	$0.00
Reserve Funding	$19.00	0%	$0.00	0%	$0.00
Total Construction Expenditures ($M)	$811.8		$490.9		$479.9
Server Hardware	$280.8	18.6%	$52.2	14.0%	$39.2
Server Software	$343.2	18.6%	$63.6	14.0%	$47.9
Total Upfront Equipment Expenditures	$624.0		$116.1		$87.0
Total Expenditures ($M)	$1,435.8		$607.0		$567.0

Source: Data Centers, LLC (2013), Econsult Solutions (2013)

2.3 ECONOMIC IMPACT OF UPFRONT CAPITAL EXPENDITURES

Multiplying these modelable capital expenditures ($607 million and $567 million for the State and County, respectively) by the corresponding IMPLAN multiplier categories generates total output, jobs, and labor income impacts. Within the State, direct spending is estimated to generate about $1 billion in total output, supporting 8,400 jobs, and $478 million in labor income. Of these impacts, about $390 million in output, 3,100 jobs, and $143 million in labor income are considered to be indirect and induced impacts (see Table 2.2). Within New Castle County, direct spending is estimated to generate about $935 million in total output, supporting 7,300 jobs representing $453 million in labor income. The indirect and induced will represent about $370 million in output, about 2,800 jobs, and $143 million in labor income (see Table 2.3).

Table 2.2 – One-Time Economic Impacts to the State of Delaware from Phase I Upfront Construction of the Data Center and CHP Facility, Including Tenant Equipment Purchases

Impact Type	Employment	Labor Income ($M)	Value Added ($M)	Output ($M)
Direct Effect	4,770	$283.0	$351.3	$490.9
Indirect Effect	1,509	$105.8	$174.5	$247.6
Induced Effect	2,094	$89.3	$160.5	$258.1
Total Effect	8,373	$478.1	$686.4	$996.6

Source: Data Centers, LLC (2013, Minnesota IMPLAN Group (2012), Econsult Solutions (2013)

Table 2.3 – One-Time Economic Impacts on New Castle County from Phase I Upfront Construction of the Data Center and CHP Facility, Including Tenant Equipment Purchases

Impact Type	Employment	Labor Income ($M)	Value Added ($M)	Output ($M)
Direct Effect	3,954	$257.2	$314.7	$480.0
Indirect Effect	1,438	$109.0	$176.4	$216.6
Induced Effect	1,891	$87.6	$152.1	$238.9
Total Effect	7,283	$453.8	$643.2	$935.5

Source: Data Centers, LLC (2013, Minnesota IMPLAN Group (2012), Econsult Solutions (2013)

2.4 INDUSTRY DISTRIBUTION OF UPFRONT CAPITAL EXPENDITURES AND JOBS[7]

While the wholesale and construction industries will benefit the most from upfront capital expenditures of the Data Center, other industries will gain as well. The IMPLAN model estimates that within the State, about 83 percent of the one-time expenditure impact will be in industries besides wholesale trade businesses and about 84 percent of the temporary employment impact will be in industries besides construction of new nonresidential commercial and healthcare structures (see Table 2.3 and Table 2.4).

Table 2.3 – Industry Distribution of the One-Time Expenditure Impact of Phase I Upfront Construction and Equipment Purchases Associated with The Data Center in the State of Delaware

Description	Expenditures	% of Total Expenditures
Wholesale trade businesses	$162.3	16.3%
Construction of new nonresidential commercial and health care structures	$147.9	14.8%
Retail Stores - Electronics and appliances	$62.0	6.2%
Management of companies and enterprises	$60.1	6.0%
Construction of new nonresidential manufacturing structures	$55.3	5.6%
Other Industries	$509.0	51.1%

[7] Here, the "expenditures" column refers to the "output" column in Table 2.2.

Source: Data Centers, LLC (2013, Minnesota IMPLAN Group (2012), Econsult Solutions (2013)

Table 2.4 – Industry Distribution of the One-Time Employment Impact of Phase I Upfront Construction and Equipment Purchases Associated with The Data Center in the State of Delaware

Description	Employment	% of Total Employment
Construction of new nonresidential commercial and health care structures	1,339	16.0%
Retail Stores - Electronics and appliances	823	9.8%
Wholesale trade businesses	769	9.2%
Construction of new nonresidential manufacturing structures	525	6.3%
Air conditioning, refrigeration, and warm air heating equipment manufacturing	449	5.4%
Other Industries	4,468	53.4%

Source: Data Centers, LLC (2013, Minnesota IMPLAN Group (2012), Econsult Solutions (2013)

Within New Castle County about 84 percent of the one-time expenditure impact and about 83 percent of the temporary employment impact will be in industries besides construction of new nonresidential commercial and healthcare structures (see Table 2.5 and Table 2.6).

Table 2.5 – Industry Distribution of the One-Time Expenditure Impact of Phase I Upfront Construction and Equipment Purchases Associated with The Data Center in New Castle County

Description	Expenditures	% of Total Expenditures
Construction of new nonresidential commercial and health care structures	$147.8	15.8%
Wholesale trade businesses	$126.3	13.5%
Retail Stores - Electronics and appliances	$62.0	6.6%
Management of companies and enterprises	$60.4	6.5%
Construction of new nonresidential manufacturing structures	$55.3	5.9%
Other Industries	$483.6	51.7%

Source: Data Centers, LLC (2013, Minnesota IMPLAN Group (2012), Econsult Solutions (2013)

Table 2.6 – Industry Distribution of the One-Time Employment Impact of Phase I Upfront Construction and Equipment Purchases Associated with The Data Center in New Castle County

Description	Employment	% of Total Employment
Construction of new nonresidential commercial and health care structures	1,206	16.6%
Retail Stores - Electronics and appliances	803	11.0%
Wholesale trade businesses	722	9.9%
Construction of new nonresidential manufacturing structures	468	6.4%
Retail Stores - Building material and garden supply	414	5.7%
Other Industries	3,670	50.4%

Source: Data Centers, LLC (2013, Minnesota IMPLAN Group (2012), Econsult Solutions (2013)

3.0 ECONOMIC IMPACT OF ONGOING OPERATIONS

3.1 OVERVIEW

Once the data center and CHP facility and its surface facilities have been completed, the data center will require significant ongoing expenditures for tenant equipment, labor, supplies, and equipment maintenance of both components of the facility. These ongoing expenditures will represent significant economic impacts to the State of Delaware and New Castle County.

3.2 SUMMARY OF MODELABLE ONGOING OPERATIONS EXPENDITURES

Total costs, modelable and unmodelable, are expected to be $49 million annually. Of these expenditures, over 90% (or $47 million) is anticipated to be sourced directly from within the State of Delaware and New Castle County. (See Table 3.1)

Table 3.1 – Summary of Total and Modelable Ongoing Operating Expenditures Associated with the Proposed Data Center and CHP Facility

	Total Expenditures ($M)	State-Level Spending	Modelable ($M)	County-Level Spending	Modelable ($M)
Data Center and Tenant Operations					
Cleaning	$0.44	100%	$0.44	100%	$0.44
HVAC Repairs + Maintenance	$0.82	100%	$0.82	100%	$0.82
Electrical Repairs + Maintenance	$0.29	89%	$0.26	89%	$0.26
Elevator Repairs + Maintenance	$0.04	47%	$0.02	47%	$0.02
Plumbing Repairs + Maintenance	$0.02	61%	$0.01	61%	$0.01
General Building Repairs + Maintenance	$0.18	46%	$0.08	46%	$0.08
Landscaping	$0.17	100%	$0.17	100%	$0.17
Security	$0.07	100%	$0.07	100%	$0.07
Fire and Life Safety	$0.04	100%	$0.04	100%	$0.04
Utilities	$1.06	100%	$1.06	100%	$1.06
General Administrative Expenses	$0.54	99%	$0.54	99%	$0.54
Salaries + Payroll	$31.39	100%	$31.39	100%	$31.39
Total Data Center and Tenant Operations Expenditures	$35.1		$34.9		$34.9
CHP Facility Operations					
Training, Travel & General Expenses	$0.03	100%	$0.03	100%	$0.03
Office Equipment & Furnishings	$0.02	47%	$0.01	47%	$0.01
Office Supplies & Expenses	$0.02	47%	$0.01	47%	$0.01
Maintenance Equipment & Tools	$0.04	30%	$0.01	30%	$0.01
Facility Spares & Major Maintenance	$6.14	100%	$6.14	100%	$6.14
Consumables	$0.12	100%	$0.12	100%	$0.12
Facility Vehicles	$0.01	21%	$0.00	21%	$0.00
Outside Services	$0.09	100%	$0.09	100%	$0.09
Equipment Rental	$0.02	100%	$0.02	100%	$0.02
Buildings & Grounds	$0.07	100%	$0.07	100%	$0.07
Utilities (Communications)	$0.04	100%	$0.04	100%	$0.04
Insurance	$0.02	100%	$0.02	100%	$0.02
Staffing	$0.01	100%	$0.01	100%	$0.01
Facility Labor	$5.12	100%	$5.12	100%	$5.12
Facility Program Development	$0.00	0%	$0.00	0%	$0.00
Contingency Costs	$1.00	0%	$0.00	0%	$0.00

Management Fees	$0.38	0%	$0.00	0%	$0.00
Lease Engine Program Membership	$0.58	100%	$0.58	100%	$0.58
CHP Facility Operations	$13.7		$12.3		$12.3
Data Center and Tenant Operations	$35.1		$34.9		$34.9
Total Operating Expenditures	$48.8		$47.2		$47.2

Source: Data Centers, LLC (2013), Econsult Solutions (2013)

3.3 ECONOMIC IMPACT OF ONGOING OPERATING EXPENDITURES

Considering only modelable expenditures, annual operations of the Data Center and CHP facility will have a significant economic impact within the State and County. The $47 million in direct expenditures and 640 direct employees are expected to generate about $90 million in total output, supporting about 320 indirect and induced jobs, and $15 million in labor income in the State and County (see Table 3.2).

Table 3.2 – Annual Economic Impact of Ongoing Operating Expenditures Associated with the Proposed Data Center and CHP Facility, Including Tenant Operations

Impact Type	Employment	Labor Income ($M)	Value Added ($M)	Output ($M)
Direct Effect	640	$38.5	$52.5	$47.2
Indirect Effect	91	$4.8	$7.8	$13.3
Induced Effect	233	$9.9	$17.8	$28.7
Total Effect	964	$53.3	$78.1	$89.2

Source: Data Centers, LLC (2013), Econsult Solutions (2013)

3.4 INDUSTRY DISTRIBUTION OF ECONOMIC IMPACT OF ONGOING OPERATING EXPENDITURES

While the data processing and web services industry will benefit the most from ongoing expenditures of the Data Center, other industries will gain as well. It is estimated that within the State, about 71 percent of the one-time expenditure impact and about 46 percent of the employment impact will be in industries besides data processing and web services (see Table 3.3 and Table 3.4).

Table 3.3 – Industry Distribution of the Expenditure Impact of Ongoing Operations Expenditures Associated with The Data Center

Description	Expenditures	% of Total Expenditures
Data processing, hosting, ISP, web search portals and related services	$25.7	28.7%
Maintenance and repair construction of nonresidential structures	$7.9	8.8%
Electric power generation, transmission, and distribution	$4.8	5.4%
Funds, trusts, and other financial vehicles	$4.7	5.3%
Imputed rental activity for owner-occupied dwellings	$3.9	4.4%
Other Industries	$42.4	47.4%

Source: Data Centers, LLC (2013, Minnesota IMPLAN Group (2012), Econsult Solutions (2013)

Table 3.4 – Industry Distribution of the Employment Impact of Ongoing Operations Expenditures Associated with The Data Center

Description	Employment	% of Total Employment
Data processing, hosting, ISP, web search portals and related services	517	53.6%
Electric power generation, transmission, and distribution	73	7.7%
Food services and drinking places	35	3.6%
Business support services	29	3.0%
Services to buildings and dwellings	24	2.5%
Other Industries	286	29.7%

Source: Data Centers, LLC (2013, Minnesota IMPLAN Group (2012), Econsult Solutions (2013)

4.0 FISCAL IMPACT OF UPFRONT CAPITAL EXPENDITURES AND ONGOING OPERATIONS

4.1 OVERVIEW

The upfront and ongoing economic impacts generated by the proposed data center in turn create temporary and permanent increases in various State and Local tax bases, thus producing additional tax revenues for the State of Delaware, New Castle County, Christina School District and City of Newark. This section describes the tax revenue gains to the State and Local Governments from upfront capital expenditures and from the data center's ongoing operating expenditures.

4.2 TOTAL FISCAL IMPACT FROM UPFRONT CONSTRUCTION

As a result of upfront construction expenditures, the State of Delaware collects income, gross receipts, and business tax from activity generated by direct, indirect, and induced spending. It is estimated that the State will collect about $20 million in new taxes as a result of the construction of the facility (see Table 4.1). Additionally, the construction of the data center and the CHP facility will generate revenues for the City of Newark, and various State entities through permits and fees. Of the estimated $5.6 million in permits and fees, about $4.7 million will go to the City of Newark (see Table 4.2).

Table 4.1 – Fiscal Impacts to the State of Delaware from Phase I Upfront Capital Expenditures Associated with the Proposed Data Center and CHP Facility

Construction	Taxes (3 year Aggregate)	Annualized Taxes over 3 Years
Income Tax Revenues ($M)	$7.98	$2.66
Gross Receipts ($M)	$4.35	$1.45
Business Tax Revenues ($M)[8]	$7.69	$2.56
Total Tax Revenues ($M)	$20.02	$6.67

Source: Data Centers, LLC (2013), Econsult Solutions (2013)

[8] Business taxes include franchise taxes, corporate income tax, limited partnership & LLC taxes, and corporate fees. Franchise and corporate taxes represent about 75% of the business tax collections.

Table 4.2 – Fiscal Impact of Permits and Fees Associated with the Phase I Upfront Construction of the Proposed Data Center and CHP Facility

Entity[9]	Amount
DELDOT ($M)	$0.10
DNREC ($M)	$0.28
City of Newark	$4.71
University of Delaware ($M)	$0.36
Norfolk Southern Rail Road ($M)	$0.06
AMTRAK ($M)	$0.04
Total ($M)	$5.56

Source: Data Centers, LLC (2013), Econsult Solutions (2013)

4.3 TOTAL FISCAL IMPACT FROM ONGOING OPERATIONS

Ongoing operations of the data center and CHP facility, including tenant operations will generate annual tax revenues for the State in the form of income, gross receipts, and business taxes from direct expenditures and spillover indirect and induced activity. It is estimated that the State will collect about $4 million in new taxes each year as a result (see Table 4.3).

Table 4.3 – Annual Fiscal Impacts to the State of Delaware from Ongoing Operating Expenditures Associated with the Proposed Data Center, Including Tenant Operations

Operations	Annual Taxes
Income Tax Revenues ($M)	$1.57
Gross Receipts ($M)	$1.54
Business Tax Revenues ($M)[10]	$1.34
Total Tax Revenues ($M)	$4.45

Source: Data Centers, LLC (2013), Econsult Solutions (2013)

[9] Pernits and fee payments to DELDOT (Delaware Department of Transportation) and DNREC (Delaware Department of Natural Resources and Resource Control) represent transfers to the State of Delaware.
[10] Business taxes include franchise taxes, corporate income tax, limited partnership & LLC taxes, and corporate fees. Franchise and corporate taxes represent about 75% of the business tax collections.

In addition, the building will be subject to property tax once construction is completed and will have a fiscal impact on New Castle County, the Christina School District and Newark City. Based on millage rates and an expected assessment of $210.4 million (in 1983 dollars), we estimate that the fiscal impact from property taxes for Phase I of the project to be over $6.6 million annually, with nearly 70% ($4.2 million) going to the Christina School District alone (see Table 4.4).[11]

Phase II of the project will result in an additional investment of $300 million. Assuming that the ratio of total project costs to assessed value is the same for Phase I and Phase II, we estimate that Phase II will result in an additional $44 million in assessed value. This will generate an additional $1.4 million in total property taxes, including an additional $0.9 million for the Christina School District.[12]

Together Phases I and II could generate a total of $7.9 million in property taxes, including nearly $5.1 million for the Christina School District.

Table 4.4 – Annual Fiscal Impacts to New Castle County, the City of Newark, and Christina School District from Property Taxes Associated with The Data Center and CHP Facility

Property Taxes	Rate (per $100)	Annual Taxes Phase I	Annual Taxes Phase II	Total Annual Taxes
New Castle County	$0.2436	$0.5	$0.1	$0.6
City of Newark	$0.6961	$1.5	$0.3	$1.8
School District (Christina)	$1.9970	$4.2	$0.9	$5.1
Crossing Guard (Christina)	$0.0267	$0.1	$0.0	$0.1
New Castle County Vo-Tech	$0.1500	$0.3	$0.1	$0.4
Total Taxes ($M)		$6.6	$1.4	$7.9

Source: Data Centers, LLC (2013), Econsult Solutions (2013)

[11] See Appendix B for additional detail on the calculation of the assessed value of the Data Center and CHP facility.
[12] See Appendix B for additional detail on the calculation of the assessed value for Phase II.

APPENDIX A – ECONOMIC AND FISCAL IMPACT MODEL METHODOLOGY

A.1 History

The theory behind input-output modeling stretches as far back as the mid 17th century, when Sir William Petty described the interconnectedness of "production, distribution, and wealth disposal." While Perry can be credited with noticing links between economies, input-output modeling did not begin to take true form until the mid 18th century, when French physician François Quesnay created the Tableau Économique. His work detailed how a landowner spends his earnings on goods from farms and merchants, who in turn spend their money on a host of goods and services. Over the course of the century, an algebraic framework was added by Achille-Nicholas Isnard. Robert Torrens and Léon Walras refined the model by establishing the connections between profits and production.

The modern input-output system can be attributed to Wassily Leontief. In his thesis, "The Economy as a Circular Flow" (1928), he outlined the economy as an integrated system of linear equations relating inputs and outputs. This framework soon gained popularity, and became a widely accepted analytical tool. In 1936, Leontief produced the first input-output analysis of the US. Leontief's work became the US Department of Commerce's Bureau of Economic Analysis's (BEA) standard benchmark for US production in the 1950's. Leontief received a Nobel Prize for his work in 1973.

In 1976 the USDA Forest Service became required to submit five year management plans to the federal government concerning the socio-economic effects of resource use. Through extensive surveying, the impacts of each industry could be determined at local levels. This directly resulted in the creation of IMPLAN software for measuring economic impacts. By the late 1980's the University of Minnesota began to offer the software to a wider audience. Seeing the need to update economic databases and improve the existing software, the Minnesota IMPLAN Group (MIG) was formed in 1993. Using a similar methodology to the USDA Forest Service, MIG was able to provide a user-friendly input-output modeling software to a wider range of users with frequent database updates.

A.2 Application

The use and application of multipliers are fairly basic and intuitive. Multipliers, in their most basic form, are the result of an algebraic analysis expressing how two inputs are interconnected in the production of an output. The result of the equation generates a multiplier that is broken down into direct, indirect, and induced effects. In a generalized example: if the multiplier for good "X" to good "Y" is 3, then the direct of good "X" on "Y" is

1, with indirect and induced effects of 2. Essentially, every unit of good “X” supports 2 units of good “Y”.

When implemented on a large complex scale, such as that of the US economy or any subsection of it, multiplier effects across industries can be complicated. However, the same general concept comes into play. Each industry has largely different and varied inputs into other industries. The quantity of the output is largely decided by the scale and efficiency of the industries involved. As a result, the sum of those inputs equates to an output product plus a value added/component. By arranging these inputs and outputs by industry in a matrix, and performing some algebra to find the Leontief inverse matrix, each industry’s effect on final demand can be estimated. Additionally, the direct, indirect, and induced effects can also be determined. Direct effects include direct purchases for production, indirect effects include expenses during production, and induced effects concern the expenditures of employees directly involved with production. Using building construction as an example, the direct effects would include materials, brick, steel, and mortar, the indirect effects would involve the steel fabrication, concrete mixing, and the induced effects would consider the construction workers purchases from their wages. While impacts vary in size, each industry has rippling effects throughout the economy. By using an input-output model, these effects can be more accurately quantified and explained.

IMPLAN is one of several popular choices for regional input-output modeling. Each system has its own nuances in establishing proper location coefficients. IMPLAN uses a location quotient to determine its regional purchase coefficient (RPC). This represents the proportion of demand for a good that is filled locally; this assessment helps determine the multiplier for the localized region. Additionally, IMPLAN also accounts for inter-institutional transfers (eg. firms to households, households to the government, etc…) through its social account matrix (SAM) multipliers. IMPLAN takes the multipliers and divides them into 440 industry categories in accordance to the North American Industrial Classification System (NAICS) codes. A comprehensive breakdown of a region’s multipliers by industry can be shown.

Despite the usefulness of input-output modeling, there are some shortcomings to the system. Notably, input-output models ignore economies of scale. Input-output models assume that costs and inputs remain proportionate through different levels of production. Further, multipliers are not generally updated on a timely basis; most multipliers are prone to be outdated with the current economy. If the multipliers are sourced from a year of a recession economy, the multipliers may not accurately represent the flows from an economic boom period. Additionally, the multipliers may not capture sudden legal or technological changes which may improve or decrease efficiency in the production process. Regardless, I-O models still serve as the standard in the estimation of local and regional impacts.

A.3 Economic Impact Model

The methodology and input-output model used in this economic impact analysis are considered standard for estimating such expenditure impacts, and the results are typically recognized as reasonable and plausible effects, based on the assumptions (including data) used to generate the impacts. In general, one can say that any economic activity can be described in terms of the total output generated from every dollar of direct expenditures. If an industry in a given region sells $1 million of its goods, there is a direct infusion of $1 million into the region. These are referred to as *direct expenditures*.

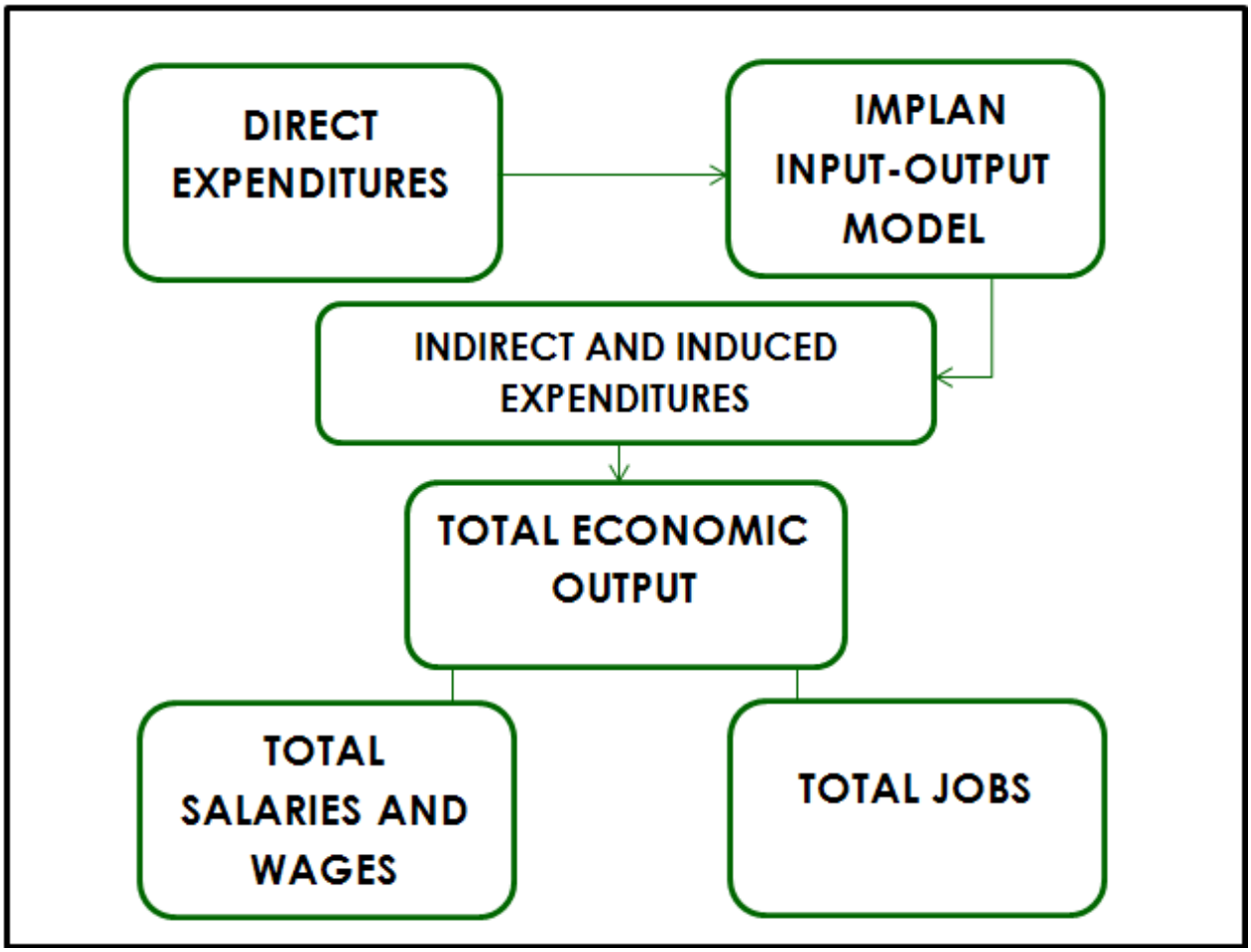
However, the economic impact on the region does not stop with that initial direct expenditure. Regional suppliers to that industry have also been called upon to increase their production to meet the needs of the industry to produce the $1 million in goods sold. Further, suppliers of these same suppliers must also increase production to meet their increased needs as well. These are referred to as *indirect expenditures*. In addition, these direct and indirect expenditures require workers, and these workers must be paid for their labor. These wages and salaries will, in turn, be spent in part on goods and services produced locally, engendering another round of impacts. These are referred to as *induced expenditures*.

Direct expenditures are fed into a model constructed by Econsult Solutions and based on IMPLAN data. The model then produces a calculation of the total expenditure effect on the regional economy. This total effect includes the initial direct expenditure effect, as well as the ripple effects described, the indirect and induced expenditure effects.

Part of the total expenditure effect is actually the increase in total wages and salaries (usually referred to as labor income), which the model can separate from the expenditure estimates. Direct payroll estimates are fed into the “household’ industry of the input-output model. Impacts of this industry are estimated using the personal consumption expenditure breakdown of the national input-output table and are adjusted to account for regional consumption spending and leakages from personal taxes and savings. The direct, indirect, and induced labor income represent a component of the total economic impact attributable to wages and salaries. Finally, the model calculates the total expenditures affecting the various industries and translates this estimate into an estimate of the total labor (or jobs) required to produce this output.

In short, the input-output model estimates the total economic activity in a region that can be attributed to the direct demand for the goods or services of various industries. This type of approach is used to estimate the total economic activity attributable to the expenditures associated with various types of spending in the region (see Figure A.1 and Table A.1).

Figure A.1 – Flowchart of Input-Output Methodology for Estimating Economic Impact



Source: Econsult Solutions, Inc. (2013)

Table A.1 – Glossary of Terms for Input-Output Models

Multiplier Effect – the notion that initial outlays have a ripple effect on a local economy, to the extent that direct expenditures lead to indirect and induced expenditures.

Economic Impacts – total output, employment, labor income, and value added generated.

Fiscal Impacts – local and/or state tax revenues generated.

Direct Expenditures – initial outlays usually associated with the project or activity being modeled; examples: one-time upfront construction and related expenditures associated with a new or renovated facility, annual expenditures associated with ongoing facility maintenance and/or operating activity.

Direct Employment – the full time equivalent jobs associated with the direct expenditures.

Direct Labor Income – the salaries and wages earned by employees, contractors, and proprietors as part of the direct expenditures.

Indirect Expenditures – indirect and induced outlays resulting from the direct expenditures; examples: vendors increasing production to meet new demand associated with the direct expenditures, workers spending direct labor income on various purchases within the local economy.

Indirect Employment – the full time equivalent jobs associated with the indirect expenditures.

Indirect Labor Income – the salaries and wages earned by employees, contractors, and proprietors as part of the indirect expenditures.

Total Output – the sum total of direct expenditures and indirect expenditures.

Total Employment – the sum total of direct employment and indirect employment.

Total Labor Income – the sum total of direct labor income and indirect labor income.

Value Added – the difference between the output and the cost of the intermediate inputs (cost of goods and services used in production). Value added is the addition to GDP made by producers.

Source: Econsult Corporation (2009)

A.4 Fiscal Impact Model

The IMPLAN model provides estimates of the economic impact of a new project or program on the regional economy. It does provide only a rough estimate of the combined fiscal impact of the increased economic activity on state and local governments. Consequently, Econsult has constructed a model that takes the output from the IMPLAN model and generates detailed estimates of the increases in state and local tax collections that arise from the new project. Those revenues are in fact a part of the total economic impact of a new project that is often ignored in conventional economic impact analyses.

The IMPLAN model provides estimates of direct, indirect, and induced expenditures, labor income, and employment within the defined region. The Econsult fiscal impact model combines the IMPLAN output with the relevant tax types and tax bases associated with the jurisdiction or jurisdictions for which fiscal impact is being modeled. Specifically, the estimated labor income supported by the direct, indirect, and induced expenditures generated by the model are used to apportion the net increase in the relevant tax bases and therefore in those tax revenue categories. The resulting estimates represent the projected tax revenue gains to the jurisdiction or jurisdictions as a result of the increased business activity and its attendant indirect and induced effects.

A.5 Sources

Miller, Ronald E., and Peter D. Blair.*Input-output Analysis Foundations and Extensions*. Cambridge, UK: Cambridge UP, 2009. Print.

Lahr, Michael. “Input-Output Analysis: Technical Description and Application.” Rutgers University Edward J. Bloustein School of Planning and Public Policy

“Researching IMPLAN Data.” Minnesota IMPLAN Group LLC, 2012.

APPENDIX B – ADDITIONAL DETAIL ON THE CALCULATION OF ASSESSED VALUE FOR THE DATA CENTER AND CHP FACILITY

New Castle County assessed values are based on 100 percent of the July 1, 1983 fair market value. To estimate the fair market value for property tax purposes, we used the hard construction costs and excluded the expenses associated with the CHP plant equipment ($178.36 million), the computer servers and associated software ($280.8 and $343.2 million, respectively), as well as the expenses related to financing the construction of the building. This resulted in total eligible expenditures of $491.9 million (see Table B.1). This figure was then converted to 1983 dollars using the consumer price index. This resulted in an assessed value of $210.4 million to which we applied the various property tax rates of the school district, Newark City, and New Castle County (See Table B.2).

Table B.1 – Conversion of Phase I Construction Expenditures to Market Value for Tax Purposes

Construction Expenditures	Project Expenditures
CHP Construction (BoP)	$55.3
Data Center Construction	$125.4
Data Center Cooling System	$100.00
Admin Building Construction	$22.5
Design & Construction Admin	$24.0
Development Expenses	$15.0
Land Acquisition Fee	$3.1
UD Common Areas (Roads, etc.)	$7.0
Owner's Oversight (Includes OE)	$14.5
Attorney's Fees Project	$1.5
Project Representative (PM)	$4.9
Development Fee	$35.6
Power Conditioning + Buildings	$45.9
Steam Pipeline	$10.0
Gas Pipeline, Fiber Optics, Transmission Line	$27.2
Total Market Value for Tax Purposes	$491.9

Source: Data Centers, LLC (2013), Econsult Solutions (2013)

Table B.2 – Phase I Assessed Value Calculations

Phase I Assessed Value	
Estimated Market Value	$491.9
1983 Adjustment Factor	0.43
Phase I Assessed Value	$210.4

Source: Econsult Solutions (2013)

Similarly detailed costs estimates were not available for Phase II of the project. To estimate the market value of Phase II we assumed that the ratio of total project costs to market value was the same as for Phase I (See Table B.3). We then used this ratio to estimate the potential market value for Phase II based on the total estimated project costs for Phase II. This figure was then converted to 1983 dollars using the consumer price index. Based on a total Phase II project cost of $300 million this will result in a potential assessed value of approximately $44 million to which we applied the various property tax rates of the school district, Newark City, and New Castle County (see Table B.4). Phases I and II in all show an estimated assed value of $254.4 million (see Table B.5).

Table B.3 – Phase I Total Project Cost to Market Value Ratio

	Value
Phase I Total Project Costs	$1,435.8
Phase I Market Value	$491.9
Ratio of Phase I Costs to Market Value	0.34

Source: Data Centers, LLC (2013), Econsult Solutions (2013)

Table B.4 – Phase II Total Project Cost to Market Value Ratio

Phase II Assessed Value	Value
Phase II Estimated Costs	$300.0
Ratio of Phase I Costs to Market Value	0.34
Phase II Market Value	$102.78
1983 Adjustment Factor	0.43
Phase II Assessed Value	$44.0

Source: Data Centers, LLC (2013), Econsult Solutions (2013)

Table B.5 – Total Assessed Property Value

Total Assessed Value	Value
Phase I Assessed Value	$210.4
Phase II Assessed Value	$44.0
Total Assessed Value	$254.4

Source: Econsult Solutions (2013)

APPENDIX K

RISK ASSESSMENT CALCULATIONS

Resident Equation Inputs for Ambient Air

Variable	Value
TR (target cancer risk) unitless	1.0E-6
ED_r (exposure duration - resident) year	30
THQ (target hazard quotient) unitless	1
LT (lifetime - resident) year	70
EF_r (exposure frequency) day/year	350
ET_r (exposure time) hour/day	24
ED_{0-2} (exposure duration first phase) year	2
ED_{2-6} (exposure duration second phase) year	4
ED_{6-16} (exposure duration third phase) year	10
ED_{16-30} (exposure duration fourth phase) year	14

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Resident RISK for Ambient Air

Chemical	Mutagen?	VOC?	Concentration (ug/m^3)	Inhalation Ambient Air Noncarcinogenic CDI	Inhalation Ambient Air Carcinogenic CDI	Inhalation Ambient Air HQ	Inhalation Ambient Air Risk
Acetaldehyde	No	Yes	1.46141	1.40E-03	6.01E-01	1.56E-01	1.32E-06
Formaldehyde	No	No	0.68934	6.61E-04	2.83E-01	6.73E-02	3.68E-06
**Total Risk/HI*			-	-	-	*2.23E-01*	*5.00E-06*

Output generated 01NOV2013:11:47:55

Risk Assessment Calculations
for Non-Carcinogenic Risk

Pollutant	Total Emission Rate lb/hr	TLV-TWA values (8-hr day) (mg/m3)	AERMOD Predicted Concentrations (from Screen) ug/m^3 (1 hr)	mg/m^3 (8 hr)	ug/m^3 (24 hr)	ug/m^3 (annual)	TLV/MDC (8 hr values)
Acrolein	2.01	0.25	1.84744	0.0013	0.79	0.18	**193**
Methanol	0.81	260	0.74449	0.0005	0.32	0.07	**498,903**
Ammonia	18.77	18	6.60823	0.0046	2.84	0.66	**3,891**

Notes:
1. lb/hr = pounds per hour
2. Total Emission Rate is the combined emission rate from the combustion turbines and reciprocating engines
3. TLV-TWA = threshold limit value - time weighted average
4. TLV-TWA from 2005 NIOSH Pocket Guide to Chemical Hazards
5. AERMOD Predicted Concentrations are based upon AERMOD output for full capacity operations. The applicable input and output files can be found in Appendix F.
6. ug/m3 = micrograms per cubic meter
7. mg/m3 = milligrams per cubic meter
8. 1 hour ug/m3 were converted to 8 hour mg/m3 by multiplying by 0.7 and then dividing by 1000 as described in the text.

This table is part of Duffield Associates, Inc.'s November 2013, "Air Quality Construction Permit Application for the Wolf Technology Center 1" and should only be viewed in the context of that report.