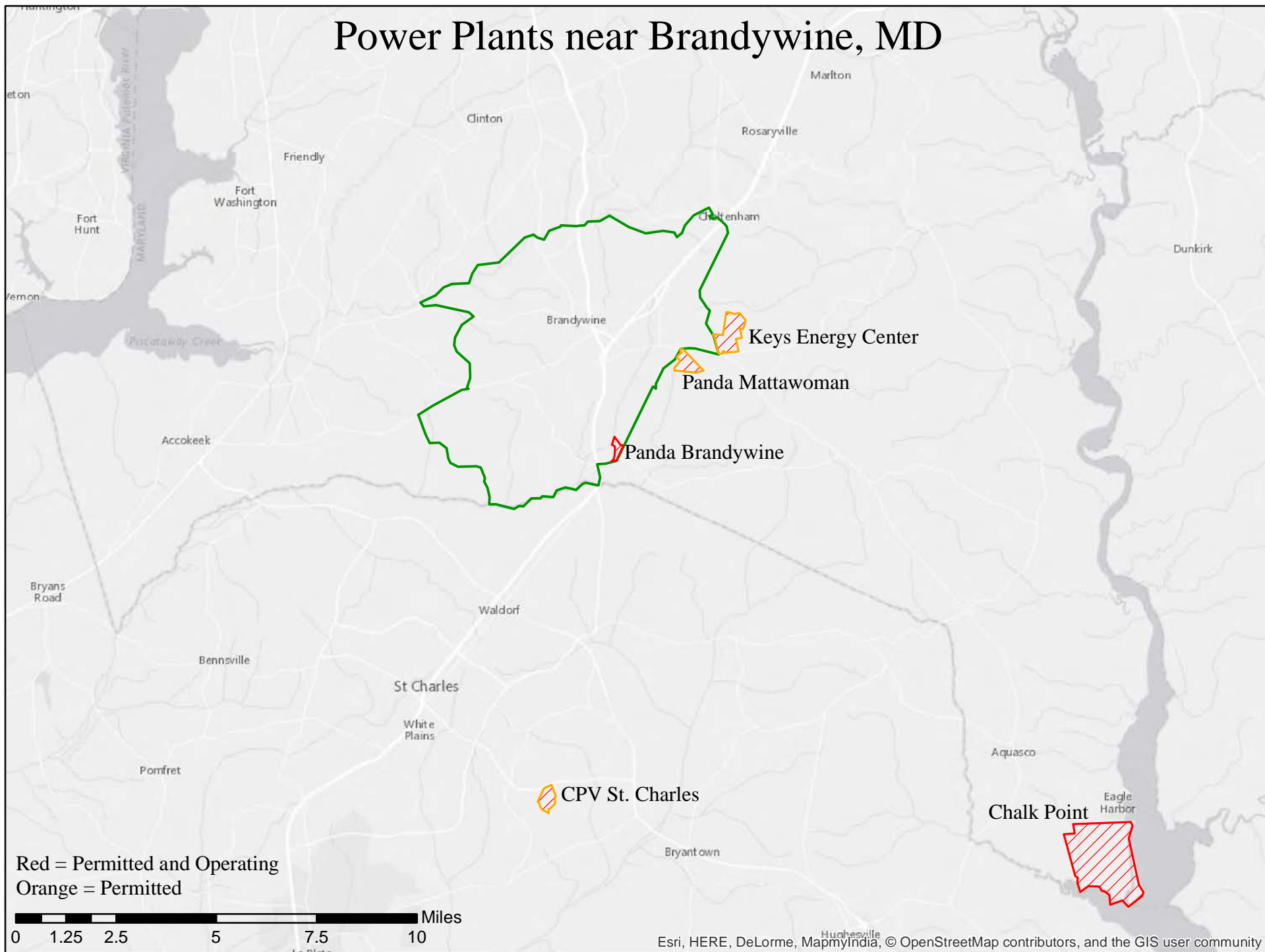


EXHIBIT LIST

- Ex. 1 Map of Power Plants near Brandywine, MD**
- Ex. 2 Map of Power Plants in Close Proximity to Schools in Brandywine, MD**
- Ex. 3 Map of Large Fossil-Fuel Power Plants in Maryland**
- Ex. 4 Map of Distribution of Black Population and Power Plants in Maryland**
- Ex. 5 Proposed Order, PSC Case No. 9330**
- Ex. 6 CPCN Conditions**
- Ex. 7 Reagan National Wind Rose**
- Ex. 8 Petitioners' Memorandum in Support of Petition for Judicial Review**
- Ex. 9 PPRP Fact Book**
- Ex. 10 Soil Safe Permit and Webpage**
- Ex. 11 Emission Reduction Credits Frequently Asked Questions**
- Ex. 12 Prince George's County Planning Department Correspondence (excerpts)**
- Ex. 13 Autism Spectrum Disorder and Particulate Matter Air Pollution before, during, and after Pregnancy (Ranaan Raz, et al., March 2015)**
- Ex. 14 PJM List of Withdrawn Deactivation Requests**
- Ex. 15 The Effect of Power Plants on Local Housing Values and Rents: Evidence From Restricted Census Microdata (Lucas W. Davis, June 2008)**

Exhibit 1

Power Plants near Brandywine, MD



Red = Permitted and Operating
Orange = Permitted

0 1.25 2.5 5 7.5 10 Miles

Exhibit 2

Power Plants in Close Proximity to Schools in Brandywine, MD

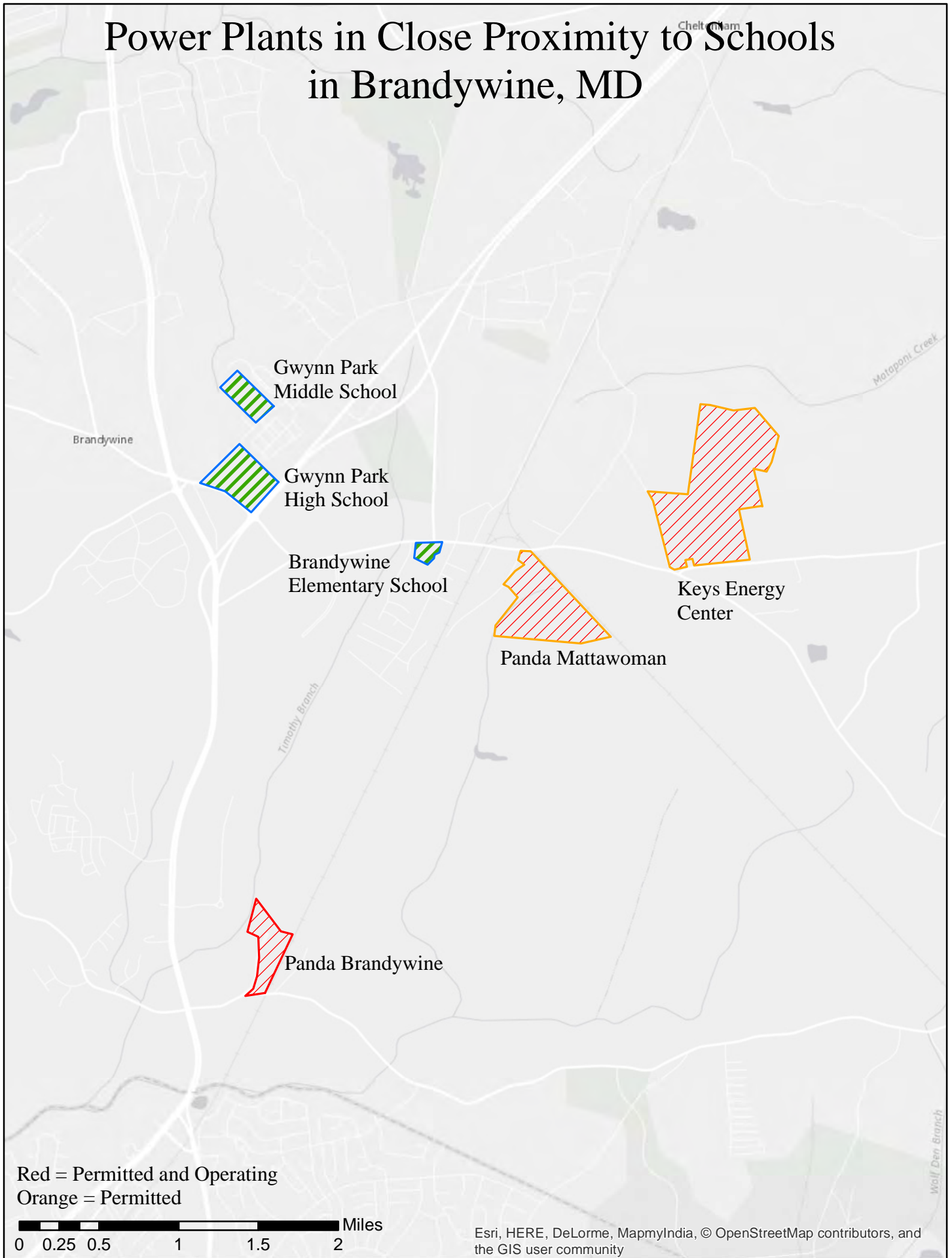


Exhibit 3

Large Fossil-Fuel Power Plants in Maryland (>200 MW)

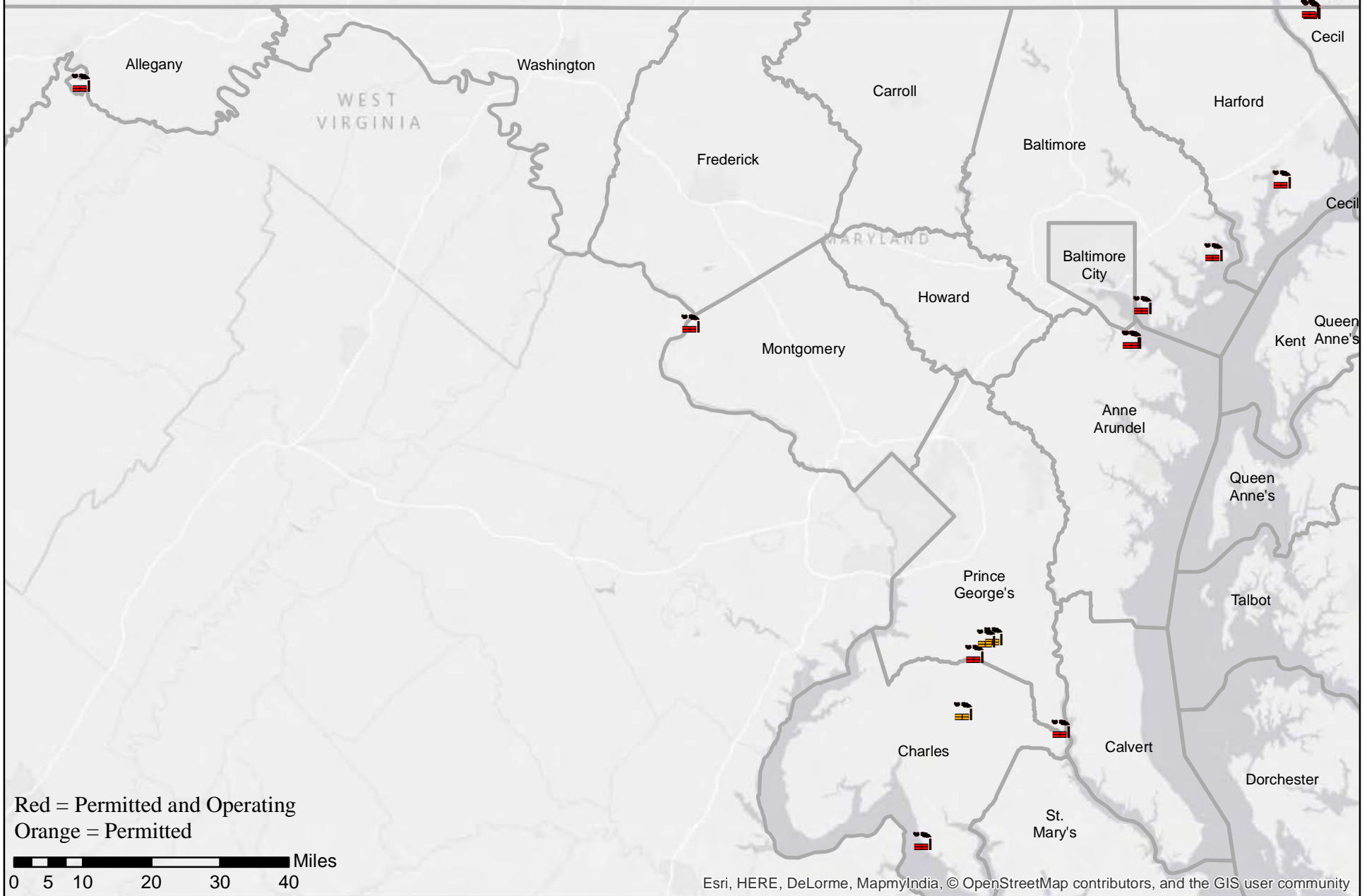


Exhibit 4

Distribution of Black Population and Power Plants in Maryland

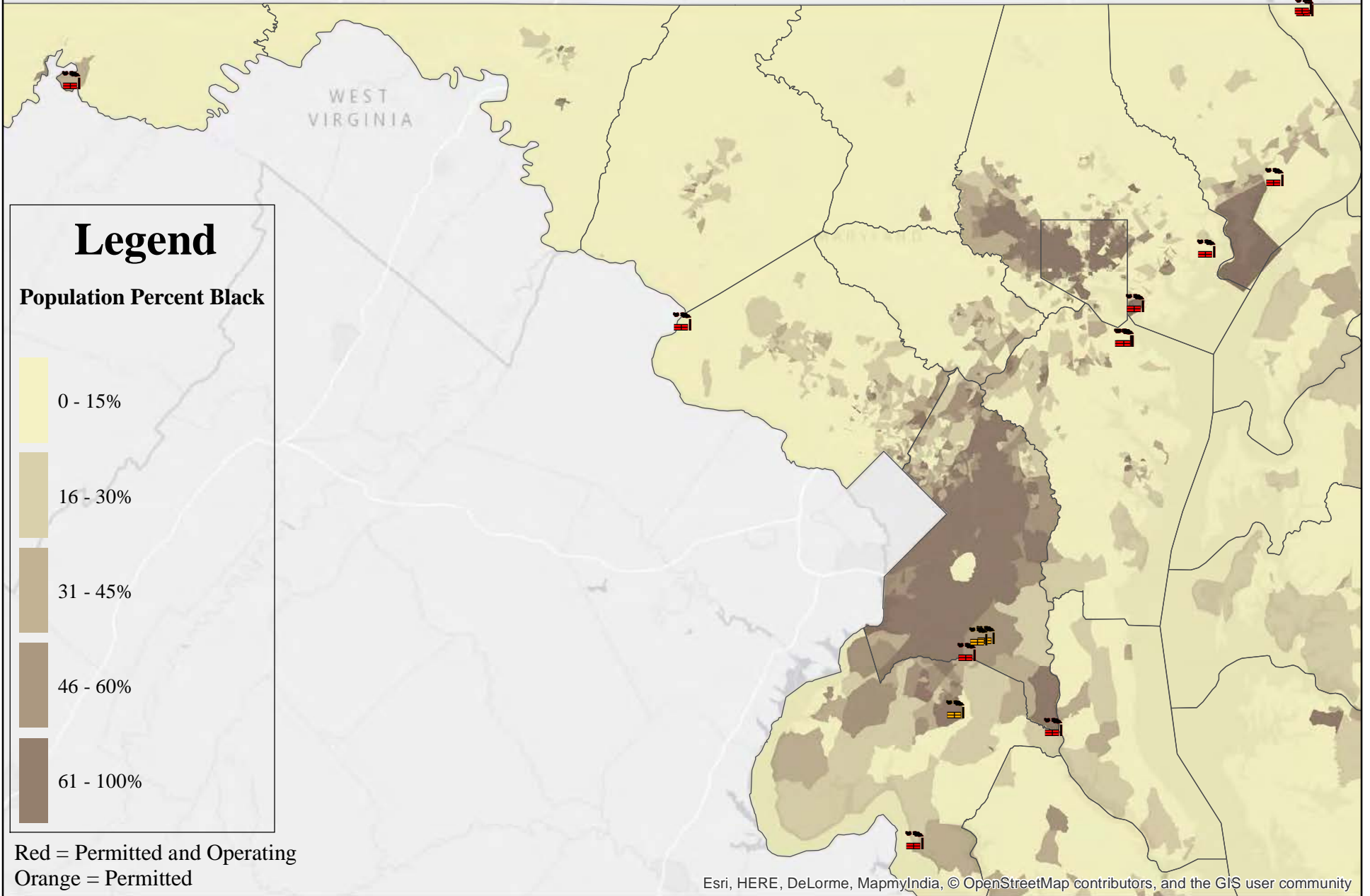


Exhibit 5

ORDER NO. 87243

IN THE MATTER OF THE APPLICATION * BEFORE THE
OF MATTAWOMAN ENERGY, LLC FOR A PUBLIC SERVICE COMMISSION
CERTIFICATE OF PUBLIC CONVENIENCE * OF MARYLAND
AND NECESSITY TO CONSTRUCT A *
NOMINALLY RATED 859 MW GENERATING *
FACILITY IN PRINCE GEORGE'S COUNTY, *
MARYLAND. * CASE NO. 9330
*
Issued: October 13, 2015

PROPOSED ORDER OF PUBLIC UTILITY LAW JUDGE

Appearances:

Suedeem G. Kelly, Esquire, J. Porter Wiseman, Esquire,
and Kenneth G. Hurwitz, Esquire, for Mattawoman Energy,
LLC.

Paula M. Carmody, Esquire, and Theresa V. Czarski,
Esquire, for the Maryland Office of People's Counsel.

Brent A. Bolea, Esquire, and Steven M. Talson, Esquire,
for the Maryland Department of Natural Resources, Power
Plant Research Program.

Michael L. Casillo, Esquire, Cara M. Johnson, Esquire,
and Frank W. Miller, Esquire, for the United States Air
Force - Joint Base Andrews.

Jennifer J. Grace, Esquire, for the Staff of the Public
Service Commission of Maryland.

**Background and Description of Requested Certificate of Public
Convenience and Necessity**

This case was instituted upon a filing by Mattawoman
Energy, LLC ("Mattawoman") requesting the issuance of a Certificate
of Public Convenience and Necessity ("CPCN") to allow it to
construct a nominally rated 859 megawatt ("MW") combined-cycle

combustion turbine electric generating facility in Prince George's County, Maryland ("the Project"). Changes to the Project now have the specifications including a 990 MW generating facility, a substation, a lead line, a water pipeline, and a gas pipeline, part of which is in Charles County, Maryland.

The site is on an 88 acre property that is 12.1 miles from Washington, D.C. It is in an area zoned by the County for industrial use and sits just south of a Super Fund site as designated by the Environmental Protection Agency ("EPA").

Procedural History

Mattawoman filed, on July 19, 2013, an application for a CPCN to construct a nominally rated 859 MW electric generating station in Prince George's County, Maryland. By letter dated July 22, 2013, the Commission delegated this proceeding to the Public Utility Law Judge Division to conduct the proceedings. A pre-hearing conference was held on August 23, 2013.

Appearances in the case were entered by the Staff of the Public Service Commission ("Staff"); the Maryland Office of People's Counsel ("OPC"); and the Maryland Department of Natural Resources, Power Plant Research Program ("PPRP"). A petition to intervene was granted to the United States Air Force - Joint Base Andrews ("JBA").

On September 10, 2013, Mattawoman filed its Environmental Review Document ("ERD") along with the direct testimony of Steven Tessem, Senior Vice President for Business

Development for Panda Power Funds, the parent company of Mattawoman; Thomas W. Davis, Principal Engineer and Vice President of Environmental Consulting & Technology, Inc. ("ECT"); Paul Scheuren, Principal of Impact DataSource, LLC; Darren Stowe, Principal Planner and Environmental Consultant of ECT; David Hessler, Acoustic Engineer of Hessler Associates, Inc.; Lisa D. (Ricker) Walker, Staff Scientist and Senior Ecologist of ECT; and David Nelson, President of Street Traffic Studies, Ltd.

On January 15, 2014, supplemental direct testimony was filed by Mattawoman's witnesses Tessem, Walker, and Stowe. Additional supplemental testimony was filed, on June 30, 2014, by Mattawoman's witnesses Tessem and Walker along with a substitute ERD.

Mattawoman then made, on January 30, 2015, a third filing of supplemental direct testimony of its witnesses Tessem, Davis, Hessler, Walker, Stowe, and Nelson; Jennifer C. Leonard, a Registered Landscape Architect and Project Manager employed by Dewberry Consultants, LLC; and along with the panel testimony and supporting attachments of Vilma Brueggmeyer, a Senior Principal Engineer and former Vice President at Environmental & Technology, Inc.; Bradley Scott Pekas, Senior Professional Engineer at TriHydro; and Marianne Horinko, President of The Horinko Group. An errata to this testimony was filed on March 4, 2015, to correct mis-statements contained in that filing.

Mattawoman made a fourth filing of supplemental direct testimony of a panel of its witnesses, Walker and Leonard, on

April 16, 2015. On the same date its witness Stowe filed a Substation Supplemental ERD.

On July 2, 2015, Mattawoman filed its June 2015 Ecological Survey and Comprehensive Project Impact Summary.

On July 10, 2015, Staff filed the direct testimony and exhibits of Ralph DeGeeter, the Commission's Generation and Transmission Engineer.

On July 10, 2015, PPRP filed the direct testimony of Frederick S. Kelly, Program Manager; William V. Paul, Chief of the Combustion and Metallurgical Division of the Air and Radiation Management Administration, Maryland Department of the Environment; Mark DiPrinzo, a partner and Senior Air Quality Professional at Environmental Resources Management, Inc. ("ERM"); Thomas S. Wickstrom, a Senior Air Quality Professional at ERM; John W. Grace, Chief of the Resources Protection and Appropriation Division of the Maryland Department of the Environment, Water Management Division; Robert W. Keating, a Geologist at ERM; Kristine B. Sillett, an Environmental Scientist and the National Environmental Policy Act Coordinator at Versar, Inc; Peter D. Hall, President of Metametrics, Inc.; and Diane Mountain, Senior Project Manager at ERM. It also filed its Initial Recommended Licensing Conditions.

Mattawoman then filed, on July 10, 2015, an Agreement of Stipulation and Settlement between Mattawoman and Joint Base Andrews. Then, on July 16, 2015, the State Agencies filed Revised Recommended Licensing Conditions, and, on August 20, 2015, PPRP filed the EPA Region Three's comments in review of the air condi-

tions contained in the Initial Licensing Conditions and supporting documents for the CPCN, followed by its reply comments on September 16, 2015.

An extensive volume of public comments were also filed during the pendency of this case.

Legal Standards

This application has been filed pursuant to Sections 7-207 and 7-208 of the Public Utilities Article ("PUA"). Pursuant to Section 7-207(e) of the PUA, the Commission shall take action on an application for a CPCN only after due consideration of the following factors:

- 1) the recommendation of the governing body of each county or municipal corporation in which any portion of the construction of the generating station or overhead transmission line is proposed to be located; and
- (2) the effect of the generating station or overhead transmission line on:
 - (i) the stability and reliability of the electric system;
 - (ii) economics;
 - (iii) esthetics;
 - (iv) historic sites;
 - (v) aviation safety as determined by the Maryland Aviation Administration and the administrator of the Federal Aviation Administration;
 - (vi) when applicable, air and water pollution; and

(vii) the availability and means for the required timely disposal of wastes produced by any generating station.

Under Section 7-208, the Commission shall include in the CPCN it issues the requirements of the federal and state environmental laws and standards that are identified by the Department of the Environment, and the methods and conditions that the Commission determines are appropriate to comply with those environmental laws and standards.¹

Public Comments

A large number of individuals and groups offered public comment in this case. Three evening hearings for public comment were held, two in Prince George's County and one in Charles County, where a portion of the gas pipeline is proposed to be located. The time period for public comment was extended on two occasions to allow for a complete opportunity to be available to those who wished to comment.

Public comment was voluminous and strident. Those who spoke in favor emphasized the economic benefits. They spoke of the construction and permanent jobs for local residents. These were stated to be well paying union jobs. Those same people spoke about the need for clean gas-generated electricity to replace the dirty coal production which is now in service. Those same people were

¹ In addition, the Commission may not adopt any method, or condition under these provisions that the Department of the Environment determines is inconsistent with federal and state environmental laws and standards. Section 7-208(f).

confident that this plant would not damage the environment as it would meet all applicable standards. The local elected representatives were either in favor of or silent about this Project within this hearing process (with the exception of the State Senator for this district, who was opposed).

The vast majority of the speakers at the public comment hearings and of the written comments were opposed to the granting of a CPCN.

Those opposed were individuals and groups which mostly were concerned with the environmental harm that the plant would cause. These concerns covered the entire environmental spectrum. Issues were raised as to noise pollution; traffic congestion; water use; dewatering and the negative impacts on nearby streams; air pollution; viewsapes; gas issues, including fracking, pipeline safety, and gas quality safety; propane storage; injury to local flora and fauna; and social equity issues. The social issues raised stated that this geographic area was targeted due to its minority population and economic demographics, and the area is also being targeted and overburdened by the concentration of power plants within a small local area. This concentration of plants was stated to be intentionally discriminatory, and the cumulative effects of the cluster of power plants were not properly considered.

On September 17, 2015, a group of residents and organizations filed a petition to intervene in order to offer expert testimony on these issues, but the petition was denied due

to its late filing and prejudicial impacts on the hearing process. The filings by that group were included in the record as public comment.

Discussion and Findings

This request for a CPCN is for the final form of the amended request filed by Mattawoman. The current form has been amended since its initial filing so that it meets and complies with the requests of the other parties and with all applicable laws and regulations.

The scope of a CPCN case, as with all proceedings before the Public Service Commission, are limited to those areas and powers assigned to it by the Legislature. Issues and matters that do not fall under those limits cannot be part of this case. As stated above in the "Legal Standards" section, which stated the legal considerations in a CPCN case, each area of consideration will be analyzed, based upon the evidence in this case, and a determination will be made as to whether the facts in the record comply with those legal requirements. If all the requirements are met that will allow the plant to operate in compliance with the law, and if it is in the public convenience and necessity, a CPCN will be granted. If the applicant fails to meet any of the requirements, the CPCN request will be denied.

A waiver of the two-year notice requirement was granted in this case, and the governing bodies of the two counties involved (Prince George's and Charles) did not choose to jointly sit with

this Public Utility Law Judge at the public hearings that were held.

All of the parties filed extensive and greatly detailed expert testimony that addressed collectively all of the statutory requirements.

As noted above, a petition to intervene filed on October 16, 2013, by JBA was granted.

On July 10, 2015, an Agreement of Stipulation and Settlement ("Settlement") between Mattawoman and JBA was filed. The Settlement addressed the significant impacts that the Project has on the functions and facilities at JBA. No party objected to the Settlement which contained licensing conditions to be added as conditions to any CPCN to be granted.

On July 16, 2015, PPRP filed the final version of its Revised Recommended Licensing Conditions.

Staff also included in its testimony proposed licensing conditions that it wants incorporated into the CPCN, if it is granted.

Mattawoman has accepted all of the licensing conditions proposed by the parties in this case.

There were, however, no recommendations provided by the local or county governing units, so no consideration can be given to their wishes when deciding this case.

I find that several of the issues raised in the public comments need to be analyzed, even though they are not solely determinative of the final outcome of this case.

Some public comments alleged that notice to the citizens of Brandywine was ineffective as it was placed in newspapers, which are not read by the public. This may be true, but the notice requirements contained in the statute require notice in newspapers as a means to notify the public. This process depends on people reading newspapers, which may not be as effective a notice mechanism as it was in the past when newspapers were the main source of dissemination of information. While this is an issue that needs attention by the Legislature and the Commission, I find that Mattawoman met and exceeded the legal notice requirements for the issuance of a CPCN.

An allegation was made in public comments that the Brandywine area was targeted for new projects by power plant companies due to its racial and economic demographics. I find that there is no evidence of any improper motive or conduct by Mattawoman in its choice of a location for the Project. It is very hard to find locations in Maryland which have the infrastructure needed to support a power plant that does not have other areas of legal restrictions which makes those locations unsuitable. It is unfortunate for Brandywine that it is a suitable and legally available area for proposed power plant projects. If a proposed plant to be sited in Brandywine meets all legal requirements (at all governmental levels), the fact that other plants are located nearby is not a legal restriction to another one being built. This is true even though the negative impacts of a plant fall most severely

upon Brandywine while the benefits are distributed across a much larger geographic area.

Another allegation in the comments questioned the bias of the expert testimony. I find from my analysis of the expert testimony from Mattawoman that it clearly supports its position. This is to be expected as the applicant gets to choose its experts. The testimony from the Staff and PPRP does not suffer from this same orientation. I find that the testimony from the Staff and PPRP is not tainted with any bias, and I therefore give it the consideration appropriate for its weight and probativeness. The governmental structures in place are there to protect and serve the citizens of Maryland, and the professionals at PPRP and the Commission do not take lightly the burdens upon them or the trust placed upon them in the performance of their duties.

I find that the evidence proves that the Project will enhance the stability and reliability of the electric system. It will add needed capacity in a constrained area and will help speed up the decommissioning of older, dirtier, and less reliable generating stations.

I find that there are both short-term and long-term economic benefits to the Project. The short-term benefits are the construction jobs, construction materials bought, and the influx of workers shopping in the area during construction. The long-term benefits include the permanent jobs created, the local taxes paid, and the increased stability of reliable power to run the businesses and infrastructure of our modern technological society.

I find that the site of the Project is zoned for industrial use by Prince George's County, and this Project is designed to have a small visual impact on the area and limited levels of noise addition to the environment. The aesthetic impacts are minor in nature as compared to other like-sized industrial facilities. I find that no historic sites are impacted by this Project, and all aviation safety issues are resolved.

The issues of air and water pollution are areas of concern to the public in Brandywine and its vicinity. I find that the licensing conditions which are to be made a part of any CPCN are very detailed and quite extensive in nature. These comprehensive conditions ensure that the Project can be constructed and function within all applicable air and water laws and regulations. If the state experts were not convinced that this was the case, they would have testified to that effect and would have opposed the Project's construction. I place my trust in their experience in this area to make my findings on this aspect of the analysis herein.

This same consideration applies to the question of disposal of waste produced by this Project and the water usage issues. I find that the licensing conditions and the design of the Project cover the legal requirements of these issues, and I find that these requirements are not a road block to the issuance of a CPCN.

This Project will also have a positive impact on the future needs for electric service in Maryland by adding capacity with the production of electricity within a constrained area.

I therefore find that the CPCN requested, inclusive of all of the licensing conditions proposed by the parties in this case and accepted by Mattawoman, is in the public convenience and necessity. The conditions included, which are attached hereto and made a part hereof, are those contained in the Settlement between Mattawoman and JBA; the proposed conditions contained in the testimony of Staff witness DeGeeter; and the Revised Recommended Licensing Conditions filed by PPRP.

IT IS, THEREFORE, this 13th day of October, in the year Two Thousand Fifteen,

ORDERED: (1) That the application for a Certificate of Public Convenience and Necessity to construct a 990 MW generating facility in Prince George's County, Maryland is hereby granted to Mattawoman Energy, LLC in accordance with the findings and decisions rendered herein.

(2) That all of the proposed conditions of the parties accepted by Mattawoman Energy, LLC are incorporated herein and accepted as licensing conditions of the Certificate of Public Convenience and Necessity in accordance with the findings of this Proposed Order.

(3) This Proposed Order will become a final order of the Commission on November 13, 2015, unless before that date an appeal is noted with the Commission by any party to this

proceeding as provided in Section 3-113(d)(2) of the Public Utilities Article, or the Commission modifies or reverses the Proposed Order or initiates further proceedings in this matter as provided in Section 3-114(c)(2) of the Public Utilities Article.

Dennis H. Sober
Public Utility Law Judge
Public Service Commission of Maryland

Exhibit 6



STATE OF MARYLAND

July 10, 2015

W. Kevin Hughes, Chairman
Public Service Commission
6 St. Paul Center
Baltimore, Maryland 21202

Re: Case No. 9330, In the Matter of the Application of Mattawoman Energy, LLC for a Certificate of Public Convenience and Necessity to Construct a Nominally Rated 859 MW Generating Facility in Prince George's County, Maryland

Dear Chairman Hughes:

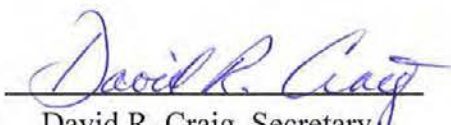
In accordance with Section 3-306(b) of the Natural Resources Article and the process described in Section 7-207 and 7-208 of the Public Utility Companies Article, we are enclosing our preliminary recommendation in Case Number 9330 on behalf of the Departments of Natural Resources, Environment, Agriculture, Transportation, Business and Economic Development, and Planning and the Maryland Energy Administration. Our recommendation and proposed conditions relate to the application for a Certificate of Public Convenience and Necessity (CPCN) by Mattawoman Energy, LLC (Mattawoman) to construct an 859 megawatt natural gas-fired generating facility in Prince George's County, Maryland, which was subsequently increased to a 990 MW rating.

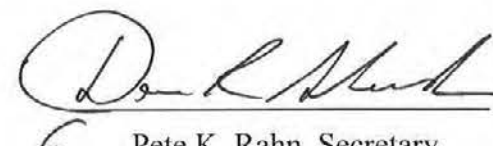
Based on our review of the application and associated environmental information available to date, we have concluded that the site is suitable and that the 990 MW power plant can be constructed and operated in accordance with all applicable environmental regulations provided that the attached recommendations are incorporated as conditions to the CPCN. Our preliminary evaluation of the environmental impacts associated with the proposed facility is summarized in the document titled "Environmental Review of the Proposed Mattawoman Energy Center Project," which has been supplied as an exhibit in this proceeding. At the conclusion of the hearing process and close of the record these conditions will be final. Should these recommendations need to be modified, we will provide our final recommendation and conditions for the project.


Sincerely,



Joseph Bartenfelder, Secretary
Department of Agriculture

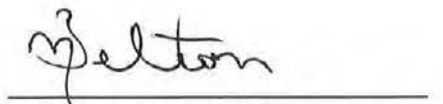

R. Michael Gill, Secretary
Department of Business and
Economic Development


David R. Craig, Secretary
Department of Planning


Pete K. Rahn, Secretary
Department of Transportation


A. Leigh Williams, Esq., Director
Maryland Energy Administration


Ben Grumbles, Secretary
Department of the Environment


Mark J. Belton, Secretary
Department of Natural Resources

Initial Recommended Licensing Conditions
PSC Case No. 9330
Mattawoman Energy, LLC

A. CPCN GENERAL REQUIREMENTS

A-1 Except as otherwise provided for in the following provisions, the application for the Certificate of Public Convenience and Necessity (CPCN) is considered to be part of this CPCN for the Mattawoman Energy Center (Mattawoman Project). In the application, estimates of dimensions, volumes, emission rates, operating rates, feed rates and hours of operation are not deemed to constitute enforceable numeric limits except to the extent that they are necessary to make a determination of applicable regulations. Construction and operation of the Mattawoman Project shall be undertaken in accordance with the following:

- CPCN application of July 19, 2013;
- CPCN application supplement of January 30, 2015;
- CPCN application supplement of April 16, 2015; and
- Mattawoman responses to data requests filed by PPRP as part of its Environmental Review Document, and those filed by the applicant Mattawoman Energy.

If there are any inconsistencies between any of the prior applications or supplements, the conditions in this CPCN shall take precedence. If CPCN conditions incorporate federal or state laws through paraphrased language, where there is any inconsistency between the paraphrased language and the actual state or federal laws being paraphrased, the applicable federal or state laws shall take precedence.

A-2 All provisions of this CPCN that apply to Mattawoman shall apply to all subsequent owners and/or operators of the facility. In the event of any change in control or ownership, Mattawoman shall notify the succeeding owner/operator of the existence of the requirements of this CPCN by letter and shall send a copy of that letter to the Maryland Public Service Commission (PSC) and the Maryland Department of the Environment (MDE).

A-3 If any provision of this CPCN shall be held invalid for any reason, the remaining provisions shall remain in full force and effect and such invalid provision shall be considered severed and deleted from this CPCN.

A-4 Representatives of the Maryland PSC shall be afforded access to the Mattawoman Energy Center at any reasonable time to conduct inspections and evaluations necessary to assure compliance with the CPCN. Mattawoman shall provide such assistance as reasonably may be necessary to conduct such inspections and evaluations by representatives of the PSC effectively and safely.

A-5 Representatives of the Maryland Department of the Environment (MDE) and the Prince George's County Health Department shall be afforded access to the Mattawoman Project facility at any reasonable time to conduct inspections and evaluations necessary to assure compliance with the CPCN requirements. Mattawoman shall provide such assistance as reasonably may be necessary to conduct such inspections and evaluations effectively and safely, which may include but need not be limited to the following:

- a) Inspecting construction authorized under this CPCN;
- b) Sampling any materials stored or processed on site, or any waste or discharge into the environment;
- c) Inspecting any monitoring or recording equipment required by this CPCN or applicable regulations;
- d) Having access to or copying any records required to be kept by Mattawoman pursuant to this CPCN or applicable regulations;
- e) Obtaining any photographic documentation and evidence; and
- f) Determining compliance with the conditions and regulations specified in the CPCN.

B. AIR QUALITY REQUIREMENTS

I. GENERAL

B-I-1 The Maryland Department of the Environment – Air and Radiation Management Administration (MDE-ARMA) shall have concurrent jurisdiction with the PSC to enforce the air quality conditions of the CPCN.

B-I-2 The CPCN serves as the Prevention of Significant Deterioration (PSD) approval, Nonattainment New Source Review (NA-NSR) approval, and air quality construction permit for the Mattawoman Project and does not constitute the permit to construct or approvals until such time as Mattawoman has provided documentation demonstrating that nitrogen oxides (NO_x) emission offsets totaling at least 287 tons and volatile organic compound (VOC) emission offsets totaling at least 187 tons have been obtained and approved by the MDE and are federally enforceable.

B-I-3 For air permitting purposes, the Mattawoman Project shall be defined as the following equipment:

- a) Two Siemens II-class (SGT-8000H Version 1.4 - Optimized) combustion turbines (CTs) each with a nominal generating capacity of 286 megawatts (MW), fueled exclusively on pipeline quality natural gas, equipped with low-NO_x combustors;
- b) Two heat recovery steam generators (HRSGs) each rated at 687.3 million British Thermal Units per hour (MMBtu/hr), fueled exclusively on pipeline quality

natural gas, equipped with duct firing capabilities (duct burners will employ low-NO_x burners), and including a selective catalytic reduction system (SCR) and an oxidation catalyst system (CT/HRSG1 and CT/HRSG2);

- c) One auxiliary boiler, rated at 42 MMBtu/hr and equipped with dry ultra-low NO_x burners (ULNB) (AUXB1);
- d) One 1,490-horsepower (hp) diesel-fired emergency generator (EG1);
- e) One 305-horsepower (hp) diesel-fired emergency fire water pump engine (FP1);
- f) One 13.8 MMBtu/hr natural gas fired fuel gas heater (FG1);
- g) One 12-cell wet mechanical draft cooling tower (CTW1);
- h) Circuit breakers that contain sulfur hexafluoride (SF₆) (CB1);
- i) Natural gas pipeline components, including valves, connectors, flanges, pump seals, and pressure relief valves within the facility boundary (FUG1).

B-I-4 In accordance with COMAR 26.11.02.04B, the air quality provisions expire if, as determined by MDE-ARMA:

- a) Substantial construction or modification is not commenced within 18 months after the date of issuance of the CPCN final order;
- b) Construction or modification is substantially discontinued for a period of 18 months after the construction or modification has commenced; or
- c) Construction is not completed within a reasonable period after the date of issuance of the CPCN final order.

B-I-5 **Permits, Approvals and Registrations** - At least 60 days prior to the anticipated date of start-up of the Mattawoman Energy Center, Mattawoman shall submit to MDE-ARMA an application for a State permit to operate [COMAR 26.11.02.14D].

B-I-6 **Permits, Approvals and Registrations** - Mattawoman shall submit a complete Part 70 (Title V Operating Permit) application to MDE-ARMA no later than 12 months after the date the Mattawoman Project commences operations [COMAR 26.11.03.02B(4)].

B-I-7 All records and logs required by this CPCN shall be maintained at the facility for at least 5 years (unless otherwise noted) after the completion of the calendar year in which they were collected. These data shall be readily available for inspection by representatives of MDE-ARMA.

II. DEFINITIONS

- B-II-1 "Commence" as applied to the construction of the Project means that the owner or operator either has:
- a) Begun, or caused to begin, a continuous program of actual on-site construction of the source, to be completed within a reasonable time; or
 - b) Entered into binding agreements or contractual obligations, which cannot be canceled or modified without substantial loss to the owner or operator, to undertake a program of actual on-site construction of the source to be completed within a reasonable time.
- B-II-2 "Excess emissions" means an emission rate which exceeds any applicable emission standard unless the emission rate is in compliance with an approved plan for compliance, departmental order, consent order, or condition of a permit.
- B-II-3 "Malfunction" is defined as any sudden, infrequent, and not reasonably preventable failure of air pollution control equipment, process equipment, or a process that operates in an abnormal or unusual manner. Failures that are caused in part by poor maintenance or careless operation are not malfunctions.
- B-II-4 "Startup" as it relates to the CTs is defined as the period of time from initiation of combustion firing with the intent to startup until the unit reaches the targeted steady state operating condition which could take up to 1 hour in duration.
- B-II-5 "Cold Startup" is defined as a startup event prior to which the CT has not been operating for at least 64 hours or when the steam turbine rotor temperature is less than or equal to 485 °F.
- B-II-6 "Warm Startup" is defined as a startup event prior to which the CT has not been operating for at least 16 hours but no more than 64 hours, or when the steam turbine rotor temperature is between 485 °F and 675 °F.
- B-II-7 "Hot Startup" is defined as a startup event prior to which the CT has been operating within the last 16 hours or when the steam turbine rotor temperature is greater than 675 °F.
- B-II-8 "Shutdown" as it relates to the CTs is defined as the period of time from which the turbine output is lowered with the intent to shut down, beginning at the point at which the load drops below 40%.

III. FACILITY-WIDE CONDITIONS

- B-III-1 The Mattawoman Project is subject to all applicable federally enforceable State air quality requirements including, but not limited to, the following regulations:

- a) **Testing and Monitoring** - Requires Mattawoman to follow test methods described in COMAR 26.11.01.04C to determine compliance. MDE-ARMA may require Mattawoman to install, use, and maintain monitoring equipment or employ other methods as specified by MDE-ARMA to determine the quantity or quality, or both, of emissions discharged into the atmosphere and to maintain records and make reports on these emissions to MDE-ARMA in a manner and on a schedule approved by MDE-ARMA or the control officer; [COMAR 26.11.01.04]
- b) **Emission Statements** - Requires Mattawoman to submit a certified, facility-wide emission statement to MDE-ARMA by April 1 of each year; [COMAR 26.11.01.05-1]
- c) **Malfunctions and Other Temporary Increases of Emissions** - Requires Mattawoman to report the onset and the termination of the occurrence of excess emissions, expected to last or actually lasting for one hour or more to MDE-ARMA by telephone. Telephone reports shall include all information required by COMAR 26.11.01.07C(2); [COMAR 26.11.01.07]
- d) **Particulate Matter From Confined Sources** - Prohibits Mattawoman from causing or permitting particulate matter to be discharged from any installation constructed on or after January 17, 1972 in excess of 0.03 gr/SCFD (68.7 mg/dscm); [COMAR 26.11.06.03B(2)(a)]
- e) **Particulate Matter From Unconfined Sources** - Prohibits Mattawoman from causing or permitting emissions from an unconfined source without taking reasonable precautions to prevent particulate matter from becoming airborne. These reasonable precautions shall include, when appropriate as determined by MDE-ARMA, the installation and use of hoods, fans, and dust collectors to enclose, capture, and vent emissions. In making this determination, MDE-ARMA shall consider technological feasibility, practicality, economic impact, and the environmental consequences of the decision; [COMAR 26.11.06.03C]
- f) **Particulate Matter from Materials Handling and Construction** - Prohibits Mattawoman from causing or permitting any material to be handled, transported, or stored, or a building, its appurtenances, or a road to be used, constructed, altered, repaired, or demolished without taking reasonable precautions to prevent particulate matter from becoming airborne; [COMAR 26.11.06.03D]
- g) **Control of NSPS Sources** - Prohibits Mattawoman from constructing, modifying, or operating, or causing to be constructed, modified, or operated, a New Source Performance Standard (NSPS) source as defined in COMAR 26.11.01.01B(23), which results or will result in violation of the provisions of 40 CFR §60, as amended; [COMAR 26.11.06.12]
- h) **Control of PSD Sources** - Prohibits Mattawoman from constructing, modifying, or operating, or causing to be constructed, modified, or operated, a Prevention of

Significant Deterioration (PSD) source as defined in COMAR 26.11.01.01B(37), which results or will result in violation of the provisions of 40 CFR §52.21, as amended, except that the reviewing authority is MDE-ARMA instead of the U.S. EPA Administrator unless otherwise specified in 40 CFR §52.1116, and the applicable procedures are those set forth in COMAR 26.11.02. [COMAR 26.11.06.14]

i) **Nonattainment Provisions for Major New Sources and Major Modifications - General Conditions**

(i) Prohibits Mattawoman from commencing construction or modification of any proposed emissions unit without first obtaining all permits and approvals required;

(ii) Requires Mattawoman to certify that all existing major stationary sources owned or operated by Mattawoman, or any entity controlling, controlled by, or under common control with Mattawoman, in the State are in compliance with all applicable emission limitations or are in compliance with an approved federally enforceable plan for compliance;

(iii) The offset ratio for VOC and NO_x shall equal or exceed 1.3 to 1 for sources of VOC or NO_x in Prince George's County;

(iv) Requires Mattawoman to comply with all other applicable requirements of COMAR 26.11.17.03A and COMAR 26.11.17.03B(1-7). [COMAR 26.11.17.03]

j) **Cross-State Air Pollution Rule (CSAPR) - Mattawoman shall comply with all applicable requirements of the Cross-State Air Pollution Rule (CSAPR) [40 CFR §97 Subparts AAAAA, BBBBB, and CCCCC]**

B-III-2 The Mattawoman Project is subject to all applicable State-only air quality requirements including, but not limited to, the following regulations:

a) **Fee Schedule** – Requires Mattawoman to pay annual Title V operating permit fees; [COMAR 26.11.02.19A]

b) **Nuisance** – Prohibits Mattawoman from operating or maintaining the facility in such a manner that a nuisance or air pollution is created; [COMAR 26.11.06.08]

c) **Odors** – Prohibits Mattawoman from causing or permitting the discharge into the atmosphere of gases, vapors, or odors beyond the property line in such a manner that a nuisance or air pollution is created; [COMAR 26.11.06.09]

d) **Emission Certification** – Requires Mattawoman to certify the actual emissions of regulated air pollutants from all installations at the plant or facility. Certification shall be on a form obtained from MDE-ARMA and shall be submitted to MDE-ARMA not later than April 1 of the year following the year for which certification is required. An emission certification submitted pursuant to this section and

which contains all information required by COMAR 26.11.01.05-1 for NO_x and VOC, satisfies the requirements of COMAR 26.11.01.05-1; [COMAR 26.11.02.19D]

- e) **Maryland CO₂ Budget Trading Program** – Mattawoman shall comply with all applicable requirements of the Maryland CO₂ Budget Trading Program. [COMAR 26.09]

B-III-3 Emissions for all sources identified as part of the Mattawoman Project, including emissions during periods of startup and shutdown, shall be limited to the following, in tons per year, in any consecutive 12-month rolling period:

Pollutant	Facility-wide Emission Limit (tons per year)
Particulate Matter (PM) – Filterable	82.9
Particulate Matter less than 10 microns (PM10) – Filterable and Condensable	149.8
Particulate Matter less than 2.5 microns (PM2.5) – Filterable and Condensable	146.8
Sulfur Dioxide (SO ₂)	19.6
Nitrogen Oxides (NO _x)	220.7
Carbon Monoxide (CO)	558.4
Volatile Organic Compounds (VOCs)	144.1
Sulfuric Acid Mist (SAM)	11.2
Greenhouse Gas (GHG) as Carbon Dioxide Equivalent (CO ₂ e)	3,738,364

Compliance Demonstration

Testing and Monitoring Requirements

Recordkeeping and Reporting Requirements

B-III-4 Mattawoman shall submit a quarterly report to MDE-ARMA to be postmarked by the 30th day of the month following the end of each calendar quarter that includes the following information:

- a) Lists instances of deviations from permit requirements;
- b) Summarizes separately the date, time, and duration of each startup, shutdown, or malfunction that occurred for each combustion turbine during the prior quarterly period. The report shall include total monthly and consecutive rolling 12-month hours of startup, shutdown, and malfunction for each source;
- c) Summarizes the downtime or malfunction of all required continuous emissions monitoring systems (CEMS). The report shall include the date and time of each

period during which the CEMS was inoperative and the nature of the monitoring system repairs or adjustments completed;

- d) Summarizes the monthly and consecutive rolling 12-month fuel usage and operating hours for each CT and duct burner and auxiliary boiler;
- e) Summarizes the monthly and consecutive rolling 12-month total emissions (in tons per month and tons per year) of PM, PM10, PM2.5, SO₂, sulfuric acid mist, NO_x, CO, VOCs, ammonia slip, and GHGs (as CO₂e) for all Mattawoman Project sources facility-wide.

B-III-5 Mattawoman shall furnish written notification to MDE-ARMA and EPA for sources subject to an NSPS of the following events: [40 CFR §60.7(a)]

- a) The date construction commenced within 30 days after such date;
- b) The actual startup date within 15 days after such date; and
- c) The anticipated date of compliance stack testing at least 30 days prior to such date.

B-III-6 Mattawoman shall furnish written notification to MDE-ARMA and EPA, where required, of the actual startup date of a source within 15 days after such date, for sources subject to a National Emission Standard for Hazardous Air Pollutants (NESHAP) [40 CFR §63.9(b)(4) and (b(5))].

B-III-7 Mattawoman shall provide MDE-ARMA with the manufacturer, make, and model, vendor specifications, or other details requested by MDE-ARMA upon selection of auxiliary sources (auxiliary boiler, fuel gas heater, emergency generator, and fire water pump engine) no later than 15 days prior to startup.

IV. COMBUSTION TURBINES AND HEAT RECOVERY STEAM GENERATORS (HRSGs)

Emission Unit Number(s): CT/HRSG1, CT/HRSG2

Two Siemens H-Class Series (SGT-8000H Version 1.4 - Optimized) combustion turbines (CTs) and heat recovery steam generators (HRSGs) with duct burners, fueled exclusively on pipeline quality natural gas, equipped with dry low-NO_x (DLN1) combustors, SCR_s, and oxidation catalysts.

Applicable Requirements

B-IV-1 Only pipeline quality natural gas shall be used as fuel in the combustion turbines and duct burners.

B-IV-2 The CTs/HRSGs are subject to all applicable federally enforceable State air quality requirements including, but not limited to, the following regulations:

- a) **Continuous Emission Monitoring Requirements** - Requires Mattawoman to operate all continuous emission monitors (CEMS) under the requirements of COMAR 26.11.01.11. This requirement is applicable to the NO_x, O₂, CO₂, and CO CEMS that are planned to be installed at each CT/HRSG exhaust stack; [COMAR 26.11.01.11]
- b) **Visible Emissions** - Except as provided in COMAR 26.11.09.05A(3), prohibits Mattawoman from causing or permitting the discharge of emissions from any fuel burning equipment, other than water in an uncombined form, which is visible to human observers; [COMAR 26.11.06.01, COMAR 26.11.09.05A(2)]
- c) **Control of NO_x Emissions for Major Stationary Sources** - Requires Mattawoman to meet an hourly average NO_x emission rate of not more than 42 parts per million (ppm) for the combustion turbine with a capacity factor of greater than 15%, when burning process gas or meet applicable Prevention of Significant Deterioration limits, whichever is more restrictive; [COMAR 26.11.09.08G(2)]
- d) **Control of NO_x Emissions for Major Stationary Sources, Reporting Requirements** - Requires Mattawoman when using a CEMS to demonstrate compliance with the NO_x emission standards in COMAR 26.11.09.08 to submit quarterly emission reports to MDE-ARMA on or before the thirtieth day of the month following the end of each calendar quarter. [COMAR 26.11.09.08K]

B-IV-3 The CTs/HRSGs are subject to 40 CFR §60 Subpart KKKK - Standards of Performance for Stationary Combustion Turbines; 40 CFR §60.4300, et seq., which contain various requirements for emission limitations, monitoring, testing, recordkeeping, and reporting for NO_x and SO₂, specified in Table B-1 and the following additional requirements:

- a) **Monitoring of Operations** – Mattawoman shall install, calibrate, maintain, and operate a continuous NO_x emissions monitoring system as described in 40 CFR §60, Appendix B and the Quality Assurance Procedures under 40 CFR §60, Appendix F, 40 CFR §60.4335(b) and §60.4345; [40 CFR §60.4340(a)-(b)]
- b) **Excess Emissions** – Mattawoman shall follow the calculation procedures set forth in 40 CFR §60.4350 for purposes of identifying excess emissions. [40 CFR §60.4350]

B-IV-4 The CTs/HRSGs are subject to all applicable provisions of the Acid Rain program under 40 CFR §72, including, but not limited to:

- a) Subpart A §72.30(b)(2)(i) requires Mattawoman to submit an application for an Acid Rain Permit for the CT/HRSG units;
- b) Subpart A §72.9(b)(1) requires Mattawoman, to the extent applicable, to comply with monitoring requirements in 40 CFR §75;

- c) Subpart A §72.9(c) requires Mattawoman to hold allowances in the source's compliance account not less than the total annual emissions of SO₂ for the previous year and comply with applicable Acid Rain limits for SO₂;
- d) Subpart A §72.9(e) requires Mattawoman to submit a proposed offset plan if emission limitations are exceeded; and
- e) Subpart A §72.9(f) requires Mattawoman, unless otherwise provided, to retain required documents for a period of 5 years from the date that the document was created. Documents may include, but are not limited to, certificates of representation, emissions monitoring information, copies of reports, compliance certifications, and other documentation pertaining to the Acid Rain program.

Operational and Emission Limits

- B-IV-5 **Best Available Control Technology (BACT)** – Emissions of NO_x, CO, PM, PM10, PM2.5, SAM, and GIIG from the CTs and duct burners shall meet the BACT limits in Table B-1 through the use of efficient design of the CTs with dry low NO_x combustors, heat recovery stream generators (HRSGs) and duct burners designed to operate based on manufacturer's specifications, use of pipeline quality natural gas fuel only, operation of an oxidation catalyst, operation of an SCR system, and application of good combustion practices.
- B-IV-6 **Lowest Achievable Emission Rate (LAER)** - Emissions of NO_x and VOC from the CTs and duct burners shall meet the LAER limits in Table B-1 through the use of efficient design of the CTs with dry low NO_x combustors, heat recovery stream generators (HRSGs) and duct burners designed to operate based on manufacturer's specifications, use of pipeline quality natural gas fuel only, operation of an oxidation catalyst, operation of an SCR system, and application of good combustion practices.
- B-IV-7 Mattawoman shall limit emissions of ammonia resulting from un-reacted ammonia (ammonia slip) from each of the SCRs to be installed on the CTs/HRSGs as specified in Table B-1.
- B-IV-8 **Best Available Control Technology (BACT) and Lowest Achievable Emission Rate (LAER)** - Mattawoman shall comply with emission limitations during facility startup and shutdown events specified in Table B-1. These emissions shall be included in demonstrating compliance with the facility-wide emissions (Condition B-III-3) limits, on a consecutive 12-month rolling basis.

Compliance Demonstration

Testing and Monitoring Requirements

- B-IV-9 At least 30 days prior to conducting any compliance stack test, Mattawoman shall submit a test protocol to MDE-ARMA for review and approval.

- a) Compliance stack testing shall be conducted in accordance with MDE-ARMA Technical Memorandum (TM) 91-01, "Test Methods and Equipment Specifications for Stationary Sources" (January 1991), as amended by Supplement 3 (October 1 1997), 40 CFR §60, or subsequent test protocols approved by MDE-ARMA; and
- b) Test ports shall be located in accordance with TM 91-01 (January 1991), or subsequent or alternative measures approved by MDE-ARMA.

B-IV-10 Initial compliance performance testing of each CT/HRSC shall be conducted within 180 days after initial startup to quantify pollutant emissions and demonstrate compliance with the emission limits specified in the CPCN for the following pollutants: VOC, PM, PM10, PM2.5, SO₂, SAM, and ammonia. Testing shall be conducted while the CTs are operating at 90% or higher capacity and duct burners operating at a maximum capacity depending on the ambient temperature at the time of the test. Subsequent stack tests shall be conducted annually for PM, PM10, PM2.5, VOC, SAM, and SO₂ (unless fuel sulfur content is determined through fuel sampling in lieu of stack testing in accordance with 40 CFR §60.4415 as noted in Table B-1), and at least once every five years for ammonia. After three continuous years of conducting annual stack tests, the permittee may request MDE-ARMA to reduce the frequency of the stack tests.

Initial and continuous compliance with the emission limits specified in the CPCN for compliance with NO_x, CO, and CO₂ shall be demonstrated by installing and operating certified CEMS. The CEMS shall comply with applicable performance specifications in 40 CFR Part §60 Appendix B, Quality Assurance Procedures in 40 CFR Part §60 Appendix F, and applicable requirements in 40 CFR §75.

B-IV-11 Unless otherwise approved by MDE-ARMA, Mattawoman shall install on each CT/HRSG a CO₂ CEMS or calibrated in-line fuel flow-meter as specified under 40 CFR §75.10(3) to measure CO₂ emissions associated with the production of electricity. Emissions of CO₂ from the CTs and duct burners are to be monitored and recorded hourly utilizing a data handling acquisition system (DHAS) installed, calibrated, and maintained in accordance with 40 CFR §75. [40 CFR 75.10(3)]

B-IV-12 Mattawoman shall install a fuel flow meter and continuously monitor the fuel flow for each CT and duct burner. The total fuel usage per month shall be recorded.

B-IV-13 Methane (CH₄) and nitrous oxide (N₂O) emissions from the CTs/HRSGs shall be calculated in accordance with the methodology and emission factors noted in 40 CFR 98, Subpart D. On a monthly basis, fuel consumption, coupled with the appropriate emission factors and global warming potentials (25 for CH₄ and 298 for N₂O), shall be used to calculate the CH₄ and N₂O emissions on a CO₂e basis. These emission rates, summed with the monthly CO₂ emissions based on CEMS, shall be used to establish GHG emissions from the CTs on a CO₂e basis.

B-IV-14 The combustion turbines and associated duct burners and heat recovery steam generators are subject to all applicable monitoring provisions of the Acid Rain program under 40 CFR §75, including, but not limited to:

- a) Subpart A §75.4(b) which generally requires Mattawoman, in accordance with 40 CFR §75.20, to ensure that all applicable monitoring systems for SO₂, NO_x, CO₂, and volumetric flow required under 40 CFR §75 are installed and all certification tests completed no later than the earlier of 90 unit operating days or 180 calendar days after the date the unit commences commercial operations;
- b) Subpart B §75.10 which generally requires Mattawoman to measure, as applicable, opacity, SO₂, NO_x, and CO₂ emissions; to ensure that continuous emission monitoring systems (CEMS) required by 40 CFR §75 meet the equipment, installation, and performance specifications in 40 CFR §75; and to maintain the CEMS according to the quality assurance and quality control procedures in this part;
- c) Subpart F §75.53(a) which generally requires Mattawoman to prepare a monitoring plan with sufficient information on applicable continuous opacity or emissions monitoring systems to demonstrate that all SO₂, NO_x, CO₂ emissions and opacity, as required, are monitored and reported;
- d) Subpart F §75.57(a) which requires Mattawoman to keep a file for each affected unit of all measurements, data, reports, and other information required by 40 CFR §75 in a form suitable for inspection for at least three years from the date of each record;
- e) Subpart F §75.57(b)-(f) which require Mattawoman to record various operations, emissions, and other information, as specified; and
- f) Subpart G §75.60(a) and (b) which generally require Mattawoman to comply with all reporting requirements, with all signatory requirements of 40 CFR §72.21 of this chapter for all submissions, and with all required certifications and reports.

B-IV-15 Initial compliance with the visible emission limitation in COMAR 26.11.09.05A(2) shall be demonstrated using EPA Method 9 within 180 days of startup of the CT/HRSGs [COMAR 26.11.09.05A(2 and 5)] as specified in Table B-1.

Recordkeeping and Reporting Requirements

B-IV-16 Final results of each compliance stack test shall be submitted to MDE-ARMA within 60 days after completion of the test. [COMAR 26.11.01.05B and C]

B-IV-17 Unless otherwise approved by MDE-ARMA, Mattawoman shall submit electronic quarterly reports from the DHAS to the EPA Clean Air Markets Division System as specified in 40 CFR §75.64. [40 CFR §75.64]

- B-IV-18 Mattawoman shall submit a Quarterly CEMS Summary Reports as required by COMAR 26.11.01.11E(2)(c), as well as CEMS System Downtime Reports as required by COMAR 26.11.01.11E(1). [COMAR 26.11.01.11E]
- B-IV-19 Mattawoman shall submit reports of excess emissions and monitor downtime associated with the CTs/HRSGs, in accordance with 40 CFR §60.7(c). Excess emissions as defined in 40 CFR §60.4380 (NO_x) and 40 CFR §60.4385 (SO₂) must be reported for all periods of unit operation, including startup, shutdown, and malfunction. [40 CFR §60.4375]
- B-IV-20 Mattawoman shall maintain annual fuel use records on site for not less than three years, and make these records available to MDE-ARMA upon request. [COMAR 26.11.09.08K]
- B-IV-21 Mattawoman shall submit a quarterly report to MDE-ARMA to be postmarked by the 30th day of the month following the end of each calendar quarter that includes the following information:
- a) All instances of deviations from permit requirements for the CTs and HRSG units including duct burners;
 - b) The date, time, type (e.g., "Cold", "Warm", or "Hot" as defined in Conditions B-II-5 through B-II-7), and duration of each startup, shutdown, or malfunction that occurred for each CT/HRSG during the prior period. The report shall include total monthly and consecutive rolling 12-month hours of startup, shutdown, or malfunction for each source. The report shall also include the total NO_x, CO, VOC, SO₂, SAM, PM, PM10, PM2.5, and CO_{2e} emissions emitted by both CTs/HRSGs for each startup and shutdown event;
 - c) The downtime or malfunction of any CEMS equipment. The report shall include the date and time of each period during which the CEMS was inoperative and the nature of the monitoring system repairs or adjustments completed;
 - d) The monthly and consecutive rolling 12-month total fuel use and hours of operation for each CT and duct burner;
 - e) The monthly (in tons per month) and consecutive rolling 12-month (tons per year) total emissions of PM, PM10, PM2.5, NO_x, CO, VOCs, SAM, ammonia slip, SO₂, and CO_{2e} separately for the CT/HRSG1 and CT/HRSG2, Auxiliary Boiler, and for total emissions of those pollutants facility-wide;
- B-IV-22 If Mattawoman elects to demonstrate compliance with the SO₂ emissions limit in 40 CFR §60.4330 using methods described in §60.4415(a) as described in Table B-1, submit periodic representative fuel sampling records.

V. AUXILIARY BOILER

Emission Unit Number(s): AUXB1

One auxiliary boiler with Ultra Low NO_x Burner (ULNB)

Applicable Requirements

B-V-1 The auxiliary boiler is subject to all applicable federally enforceable State air quality requirements including, but not limited to, the following regulations:

- a) **Fuel Burning Equipment with a Rated Heat Input of Less than 100 MMBTU/hr** – Mattawoman is subject to the following requirements:
 - (i) Requires Mattawoman to perform a combustion analysis at least once each year and optimize combustion based on this analysis; [COMAR 26.11.09.08(E)(2)]
 - (ii) Requires Mattawoman to train auxiliary boiler operators at least once every three years on combustion analysis through a training program sponsored by MDE-ARMA, the EPA, or equipment vendors. [COMAR 26.11.09.08(E)(4)]
- b) **Control of NO_x Emissions for Major Stationary Sources** - Requires Mattawoman to comply with all applicable provisions of COMAR 26.11.09.08. Mattawoman shall demonstrate compliance with the emission limits of COMAR 26.11.09.08 by complying with the applicable BACT and LAER emission limits;
- c) **Visible Emissions** – Prohibits Mattawoman from discharging emissions from the auxiliary boiler, other than water in an uncombined form, which are visible to human observers. [COMAR 26.11.09.05A(2)]

B-V-2 The auxiliary boiler is subject to the applicable requirements of NSPS 40 CFR §60 Subpart Dc - Standards of Performance for Industrial-Commercial-Institutional Generating Units, which contain various requirements for recordkeeping and reporting.

Operational and Emission Limits

B-V-3 The auxiliary boiler shall be fueled exclusively on pipeline quality natural gas.

B-V-4 **Best Available Control Technology (BACT)** - The auxiliary boiler shall be designed to meet the following BACT limits, through the use of efficient boiler design, exclusive use of pipeline quality natural gas, the use of ultra-low NO_x burners, and application of good combustion practices:

- a) Emissions of NO_x shall not exceed 0.01 lb/MMBtu on a 3-hour block average basis;

- b) Emissions of CO shall not exceed 0.037 lb/MMBtu on a 3-hour block average basis;
- c) Emissions of PM shall not exceed 0.0019 lb/MMBtu on a 3-hour block average basis;
- d) Emissions of PM10 and PM2.5 shall each not exceed 0.0075 lb/MMBtu on a 3-hour block average basis;
- e) Emissions of sulfuric acid mist shall not exceed 0.004 lb/MMBtu on a 3-hour block average basis; and
- f) GHG emissions shall be totaled with all other sources facility-wide to comply with the limits established in B-III-3.

B-V-5 Lowest Achievable Emission Rate (LAER) – Emissions from the auxiliary boiler shall meet the following LAER limits, through the use of efficient boiler design, exclusive use of pipeline quality natural gas, the use of ultra-low NO_x burners, use of pipeline quality natural gas and good combustion practices:

- a) Emissions of NO_x shall not exceed 0.01 lb/MMBtu on a 3-hour block average basis; and
- b) Emissions of VOC shall not exceed 0.003 lb/MMBtu on a 3-hour block average basis.

B-V-6 Visible Emissions – Visible emissions, other than water in an uncombined form, that are visible to human observers shall not be discharged from the auxiliary boiler except as specified during load changing, soot blowing, startup, adjustment, or occasional cleaning of control equipment. [COMAR 26.11.09.05A(2 and 3)]

Compliance Demonstration

Testing and Monitoring Requirements

B-V-7 Compliance with the BACT and LAER emission limitations shall be demonstrated as follows:

- a) Mattawoman shall obtain vendor guarantees to demonstrate compliance with the BACT and LAER emission limits;
- b) Emissions of NO_x, VOC, CO, SAM, PM, and PM10/PM2.5 shall be calculated using fuel measurements and vendor guaranteed emission rates;
- c) Mattawoman shall conduct an annual combustion analysis and tune-up on the auxiliary boiler;

- d) Methane (CH₄) and nitrous oxide (N₂O) emissions from the auxiliary boiler shall be calculated in accordance with the methodology and emission factors noted in 40 CFR §98, Subpart C. On a monthly basis, fuel consumption, coupled with the appropriate emission factors and global warming potentials (25 for CH₄ and 298 for N₂O), shall be used to calculate the CH₄ and N₂O emissions on a CO₂e basis. These emission rates, summed with the monthly CO₂ emissions based on 40 CFR 98, Subpart C or other methods approved by MDE-ARMA, shall be used to calculate GIIG emissions from the auxiliary boiler on a CO₂e basis.

B-V-8 Initial compliance with the visible emission limitation in COMAR 26.11.09.05A(2) shall be demonstrated using the following:

- a) Mattawoman shall conduct EPA Method 9 testing within 180 days of startup of the boiler; [COMAR 26.11.09.05A(2 and 5)]
- b) Visible observation shall be conducted in accordance with EPA Reference Method 22 at least once each calendar quarter to verify that there are no visible emissions during operation. If the auxiliary boiler is not operated in a quarter, Mattawoman shall document this and no visible emission observation is required during that quarter. If visible emissions are observed, Mattawoman shall inspect the combustion control system, perform necessary adjustments and/or repairs within 48 hours, and document in writing the results of inspection, adjustments and/or repairs. After 48 hours, if the required adjustments and/or repairs have not eliminated the visible emissions, Mattawoman shall perform EPA Reference Method 9 observations once daily for at least one hour until corrective actions have eliminated the visible emissions. [COMAR 26.11.02.02(II)]

B-V-9 Mattawoman shall install and operate a fuel flow meter on the auxiliary boiler to continuously monitor the fuel flow. The fuel usage shall be recorded at least on a monthly basis.

B-V-10 All monitoring devices required to demonstrate continuous compliance shall be installed, calibrated, and maintained according to manufacturer's specifications.

Notification Requirements

B-V-11 Mattawoman shall furnish written notification to MDE-ARMA and EPA of the following events related to the auxiliary boiler: [40 CFR §60.7(a)]

- a) The date construction commenced within 30 days after such date; and
- b) The actual startup date within 15 days after such date.

Recordkeeping and Reporting Requirements

B-V-12 Mattawoman shall maintain records of natural gas fuel usage at the auxiliary boiler on a monthly basis. [40 CFR §60.48c(g)(1)-(3)]

- B-V-13 The results of the combustion tune-up required for the auxiliary boiler shall be provided to MDE-ARMA within 45 days of its completion.
- B-V-14 Mattawoman shall comply with the following applicable requirements for the auxiliary boiler: [COMAR 26.11.09.08(E)]
- a) Submit to MDE-ARMA an identification of the auxiliary boiler and the rated heat input capacity of this source;
 - b) Maintain the results of the combustion analysis at the site for at least two years and make this data available to MDE-ARMA and the EPA upon request;
 - c) Prepare and maintain a record of training program attendance for each operator at the site, and make these records available to MDE-ARMA upon request.
- B-V-15 Mattawoman shall maintain annual fuel use records on site for not less than three years, and make these records available to MDE-ARMA upon request. [COMAR 26.11.09.08K]
- B-V-16 Mattawoman shall maintain records of any maintenance performed on the auxiliary boiler for two years from the date of the record. (40 CFR §60.48c(i))

VI. FUEL GAS HEATER

Emission Unit Number(s): FG1

One fuel gas heater

Applicable Requirements

- B-VI-1 The fuel gas heater is subject to all applicable federally enforceable State air quality requirements including, but not limited to, the following regulations:
- a) **Fuel Burning Equipment with a Rated Heat Input of Less than 100 MMBTU/hr** – Mattawoman is subject to the following requirements:
 - (i) Mattawoman is required to perform a combustion analysis at least once each year and optimize combustion based on this analysis; [COMAR 26.11.09.08(E)(2)]
 - (ii) Requires Mattawoman to train fuel gas heater operators at least once every three years on combustion analysis through a training program sponsored by MDE-ARMA, the EPA, or equipment vendors. [COMAR 26.11.09.08(E)(4)]
 - b) **Control of NO_x Emissions for Major Stationary Sources** - Mattawoman shall comply with all applicable provisions of COMAR 26.11.09.08.

- c) **Visible Emissions** – Prohibits Mattawoman from discharging emissions from the fuel gas heater, other than water in an uncombined form, which are visible to human observers. [COMAR 26.11.09.05A(2)]

Operational and Emission Limits

B-VI-2 The fuel gas heater shall be fueled exclusively on pipeline quality natural gas at all times.

B-VI-3 **Best Available Control Technology (BACT)** – The fuel gas heater shall meet the following BACT limits, through the use of efficient design of the heater, exclusive use of pipeline quality natural gas, and application of good combustion practices:

- a) Emissions of NO_x shall not exceed 0.035 lb/MMBtu on a 3-hour block average basis;
- b) Emissions of CO shall not exceed 0.021 lb/MMBtu on a 3-hour block average basis;
- c) Emissions of PM₁₀ and PM_{2.5} shall each not exceed 0.0075 lb/MMBtu on a 3-hour average basis;
- d) Emissions of PM shall not exceed 0.0019 lb/MMBtu on a 3-hour block average basis;
- e) Emissions of SAM shall not exceed 0.004 lb/MMBtu on a 3-hour block average basis; and
- f) GHG emissions shall be totaled with all other sources facility-wide to comply with the limits established in B-III-3.

B-VI-4 **Lowest Achievable Emission Rate (LAER)** – Emissions from the fuel gas heater shall meet the following LAER limits, through the use of pipeline quality natural gas and good combustion practices:

- a) Emissions of NO_x shall not exceed 0.035 lb/MMBtu on a 3-hour block average basis; and
- b) Emissions of VOC shall not exceed 0.0054 lb/MMBtu on a 3-hour block average basis.

B-VI-5 **Visible Emissions** – Visible emissions, other than water in an uncombined form, that are visible to human observers shall not be discharged from the fuel gas heater except as specified during load changing, soot blowing, startup, adjustment, or occasional cleaning of control equipment. [COMAR 26.11.09.05A(3)]

Compliance Demonstration

Testing and Monitoring Requirements

B-VI-6 Compliance with the BACT and LAER emission limitations shall be demonstrated as follows:

- a) Mattawoman shall obtain vendor guarantees to demonstrate compliance with the BACT and LAER emission limits;
- b) Emissions of NO_x, VOC, CO, SAM, PM and PM10/PM2.5 shall be calculated using fuel measurements and vendor guaranteed emission rates. Monthly emissions (tons per month) shall be used to calculate 12-month rolling period emissions (tons per year);
- c) Mattawoman shall conduct an annual combustion analysis on the fuel gas heater;
- d) CH₄ and N₂O emissions from the fuel gas heater shall be calculated in accordance with the methodology and emission factors noted in 40 CFR §98, Subpart C. On a monthly basis, fuel consumption, coupled with the appropriate emission factors and global warming potentials (25 for CH₄ and 298 for N₂O), shall be used to calculate the CH₄ and N₂O emissions on a CO₂e basis. These emission rates, summed with the monthly CO₂ emissions based on 40 CFR §98, Subpart C or other methods approved by MDE-ARMA shall be used to establish GIIG emissions from the fuel gas heater on a CO₂e basis.

B-VI-7 Initial compliance with the visible emission limitation in COMAR 26.11.09.05E shall be demonstrated using the following:

- a) Mattawoman shall conduct EPA Method 9 testing within 180 days of startup of the fuel gas heater; [COMAR 26.11.09.05A(2 and 5)]
- b) Visible observation shall be conducted in accordance with EPA Reference Method 22 at least once each calendar quarter to verify that there are no visible emissions during operation. If the fuel gas heater is not operated in a quarter, Mattawoman shall document this and no visible emission observation is required during that quarter. If visible emissions are observed, Mattawoman shall inspect the combustion control system, perform necessary adjustments and/or repairs within 48 hours, and document in writing the results of inspection, adjustments and/or repairs. After 48 hours, if the required adjustments and/or repairs have not eliminated the visible emissions, Mattawoman shall perform EPA Reference Method 9 observations once daily for at least one hour until corrective actions have eliminated the visible emissions. [COMAR 26.11.02.02(II)]

B-VI-8 Mattawoman shall install a fuel flow meter on the fuel gas heater to continuously monitor the fuel flow. The fuel usage shall be recorded at least on a monthly basis.

B-VI-9 All monitoring devices required to demonstrate continuous compliance shall be installed, calibrated, and maintained according to manufacturer's specifications.

Recordkeeping and Reporting Requirements

B-VI-10 The results of the combustion tune-up required for the fuel gas heater shall be provided to MDE-ARMA within 45 days of its completion.

B-VI-11 Mattawoman shall comply with the following applicable requirements for the fuel gas heater: [COMAR 26.11.09.08(E)]

- a) Submit to MDE-ARMA an identification of the fuel gas heater, the rated heat input capacity of this source, guaranteed emission limits, and the type of fuel burned in this source;
- b) Maintain the results of the combustion analysis at the site for at least two years and make this data available to MDE-ARMA and the EPA upon request;
- c) Prepare and maintain a record of training program attendance for each operator at the site, and make these records available to MDE-ARMA upon request.

B-VI-12 Mattawoman shall maintain annual fuel use records on site for not less than three years, and make these records available to MDE-ARMA upon request. [COMAR 26.11.09.08K].

VII. DIESEL-FIRED EMERGENCY ENGINES

Emission Unit Number(s):

EG1 1,490-hp emergency generator

FP1 305-hp fire water pump engine

Applicable Requirements

B-VII-1 The emergency generator and fire water pump engine are each subject to all applicable federally enforceable State air quality requirements including, but not limited to, the following regulations:

- a) **Visible Emissions During Idle Mode** - Prohibits Mattawoman from causing or permitting the discharge of emissions from any internal combustion engine, operating at idle, greater than 10 percent opacity; [COMAR 26.11.09.05E(2)]
- b) **Visible Emissions During Operating Mode** - Prohibits Mattawoman from causing or permitting the discharge of emissions from any internal combustion engine, operating at other than idle conditions, greater than 40 percent opacity; [COMAR 26.11.09.05E(3)]

- c) **Exceptions to Visible Emissions Standards for Internal Combustion Engines:**
 - (i) Standards do not apply for a period of two consecutive minutes after a period of idling of 15 consecutive minutes for the purpose of clearing the exhaust system; [COMAR 26.11.09.05E(4)(a)]
 - (ii) Standards do not apply to emissions resulting directly from cold engine start-up and warm-up for the following maximum periods:
 - (1) Engines that are idled continuously when not in service: 30 minutes;
 - (2) All other engines: 15 minutes; [COMAR 26.11.09.05E(4)(b)]
 - (iii) COMAR 26.11.09.05E(2) and (3) do not apply while maintenance, repair, or testing is being performed by qualified mechanics; [COMAR 26.11.09.05E(4)(c)]
- d) **Control of Sulfur Oxides From Fuel Burning Equipment - Prohibits** Mattawoman from burning, selling, or making available for sale distillate fuel oils with a sulfur content of greater than 0.3 percent; [COMAR 26.11.09.07A(2)(c)]
- e) **Control of NO_x Emissions for Major Stationary Sources - Fuel Burning Equipment with a Requirements for Fuel-Burning Equipment with a Capacity Factor of 15 Percent or Less -** Requires Mattawoman to comply with the requirements of COMAR 26.11.09.08G, including providing certification of the capacity factor of the equipment to MDE-ARMA in writing, conducting an annual combustion analysis for each installation if the equipment operates more than 500 hours during a calendar year, and attending operator training programs sponsored by MDE-ARMA, EPA, or equipment vendors every three years; [COMAR 26.11.09.08G]
- f) **Control of NO_x Emissions for Major Stationary Sources - Requires** Mattawoman, for all fuel burning equipment with a capacity factor (as defined in 40 CFR §72.2) of 15 percent or less, to comply with the following requirements:
 - (i) Provide certification of the capacity factor of the equipment to MDE in writing; and
 - (ii) Require each operator of an installation to attend operator training programs on combustion optimization that are sponsored by MDE-ARMA, the EPA, or equipment vendors, at least once every three years. [COMAR 26.11.09.08G(1)]

B-VII-2 The emergency generator is subject to all applicable State-only air quality requirements including, but not limited to, the following regulations and operational limitations:

- a) **Distributed Generation - Emergency Generators and Load Shaving Units NO_x Requirements** - Prohibits Mattawoman from operation of the emergency

generator, except for emergencies, testing, and maintenance purposes; [COMAR 26.11.36.03A(1)]

- b) **Distributed Generation - Emergency Generators and Load Shaving Units NO_x Requirements** – Prohibits Mattawoman from the operation of the emergency generator for testing or maintenance purposes between 12:01 a.m. and 2:00 p.m. on any day on which MDE-ARMA forecasts that the air quality will be code orange, code red, or code purple unless the engine fails a test and engine maintenance and a re-test are necessary. [COMAR 26.11.36.03A(5)]

Operational and Emission Limits

B-VII-3 The emergency generator and the fire water pump engine are subject to NSPS 40 CFR §60, Subpart III, Standards of Performance for Stationary Compression Ignition Internal Combustion Engines. Mattawoman shall meet the monitoring, compliance, testing, notification, reporting, and recordkeeping requirements of 40 CFR §60.4200 to 40 CFR §60.4219 and related applicable provisions of 40 CFR §60.7 and 40 CFR §60.8. The diesel fuel combusted in the emergency generator and the fire water pump engine shall meet the requirements of 40 CFR §60.4207.

Mattawoman shall meet the following emission limits for the emergency generator and the fire water pump engine:

- a) Under 40 CFR §60.4202 and 40 CFR §89.112, Table 1, emissions from the 1,490-hp emergency generator shall not exceed 6.4 g/kW-hour (4.8 g/hp-hr) combined non-methane hydrocarbons (NMHC) and NO_x, 3.5 g/kW-hour (2.6 g/hp-hr) CO, and 0.20 g/kW-hour (0.15 g/hp-hr) PM filterable.
- b) Under 40 CFR §60 Subpart III, Table 4, emissions from the 305-hp fire pump engine shall not exceed 4.0 g/kW-hour (3.0 g/hp-hr) combined NMHC and NO_x, 3.5 g/kW-hour (2.6 g/hp-hr) CO, and 0.20 g/kW-hour (0.15 g/hp-hr) PM filterable.

B-VII-4 The emergency generator and fire water pump engine are subject to the following requirements under 40 CFR Part 60 Subpart III:

- a) Mattawoman shall purchase an engine certified to the emission standards in 40 CFR §60.4204(b) or 40 CFR §60.4205(b) or (c), as applicable, for the same model year and maximum (or in the case of fire pumps, NFPA nameplate) engine power. The engine must be installed and configured according to the manufacturer's emission-related specifications; [40 CFR §60.4211(c)]
- b) Mattawoman shall operate and maintain the emergency generator and fire water pump engine according to the manufacturer's written instructions or procedures developed by the owner or operator that are approved by the engine manufacturer, over the entire life of the engine; [40 CFR §60.4206]

- c) The emergency generator and fire water pump may be operated for the purpose of maintenance checks and readiness testing limited to 100 hours per year, provided that those tests are recommended by Federal, State, or local government, the manufacturer, the vendor, or the insurance company associated with the engine; [40 CFR §60.4211(f)]
- d) There are no restrictions on hours of operation on the use of emergency generators and fire water pump engines in emergency situations;
- e) Mattawoman shall install and operate a non-resettable hour meter prior to startup of the engine. [40 CFR §60.4209(a)]

B-VII-5 The emergency generator and the fire water pump engine are subject to 40 CFR §63 Subpart ZZZZ - National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines. The emergency generator and the fire water pump engine shall comply with all the applicable requirements of NSPS Subpart IIII under 40 CFR §63.6590(c)(1).

B-VII-6 The emergency generator and fire water pump engine shall be fueled with ultra-low sulfur diesel (ULSD) fuel only with a sulfur content not to exceed 15 parts per million by weight (ppmw) of sulfur.

B-VII-7 Best Available Control Technology (BACT)

- a) The 1,490-hp diesel emergency generator shall be designed to meet the following BACT emission limits below through the exclusive use of ultra-low sulfur diesel fuel and good combustion practices:
 - (i) NO_x+NMHC, CO, and PM emissions shall not exceed the applicable NSPS Subpart IIII emission limitations;
 - (ii) PM10/PM2.5 (filterable and condensable) emissions shall not exceed 0.17 g/hp-hour;
 - (iii) SAM emissions shall not exceed 0.007 g/hp-hr on a 3-hour block average basis;
 - (iv) GHG emissions shall be totaled with all other sources facility-wide to comply with the limits established in B-III-3.
- b) The 305-hp fire water pump engine shall be designed to meet the following BACT limits below through the exclusive use of ULSD fuel and good combustion practices:
 - (i) NO_x+NMHC, CO, and PM emissions shall not exceed the applicable NSPS Subpart IIII emission limitations;
 - (ii) SAM emissions shall not exceed 0.007 g/hp-hr on a 3-hour block average basis;

(iii) PM10/PM2.5 (filterable and condensable) emissions shall not exceed 0.17 g/hp-hour; and

(iv) GHG emissions shall be totaled with all other sources facility-wide to comply with the limits established in B-III-3.

B-VII-8 Lowest Achievable Emission Rate (LAER)

The emergency generator and fire water pump engine shall be designed to meet the applicable emission limits in NSPS Subpart IIII for NO_x+NMHC through the use of ULSD fuel and good combustion practices at all times.

Compliance Determination

Testing and Monitoring Requirements

B-VII-9 Compliance with the BACT and LAER emission limitations shall be demonstrated as follows:

- a) Emissions of NO_x+NMHC, CO, PM, PM10, and PM2.5 shall be calculated using vendor guaranteed emission rates to calculate 12-month rolling emissions;
- b) Emissions of SAM shall be calculated using AP-42 emission factors or other emission factors approved by MDE and used to calculate 12-month rolling emissions;
- c) CH₄ and N₂O emissions from the emergency generator and fire water pump engine shall be calculated in accordance with the methodology and emission factors noted in 40 CFR §98, Subpart C. On a monthly basis, fuel consumption, coupled with the appropriate emission factors and global warming potentials (25 for CH₄ and 298 for N₂O), shall be used to calculate the CH₄ and N₂O emissions on a CO₂e basis. These emission rates, summed with the monthly CO₂ emissions based on 40 CFR §98, Subpart C or other methods approved by MDE-ARMA shall be used to establish GHG emissions from the emergency generator and fire water pump engine on a CO₂e basis.

B-VII-10 Mattawoman shall install and operate a non-resettable operating hour meter or the equivalent on the emergency generator and fire water pump engine to indicate the elapsed operating time.

Notification Requirements

B-VII-11 Mattawoman shall furnish written notification to MDE-ARMA and EPA of the following events related to the installation of the emergency generator and fire water pump engine: [40 CFR §60.7(a)]

- a) The date construction commenced within 30 days after such date; and

- b) The actual startup date within 15 days after such date.

Recordkeeping and Reporting Requirements

- B-VII-12 Mattawoman shall maintain records onsite of the hours of operation of the emergency generator and fire water pump, including date, time, and duration and an explanation of reasons for operation of each engine.
- B-VII-13 Mattawoman shall comply with all applicable reporting and recordkeeping requirements for the emergency generator and the fire water pump engine specified in 40 CFR §60.4214.
- B-VII-14 Mattawoman shall maintain fuel supplier certifications for each fuel delivery that documents the sulfur content of the ultra-low sulfur diesel (ULSD) is 15 ppm sulfur by weight or less. Fuel supplier certification shall include the following information:
 - a) The name of the oil supplier;
 - b) The sulfur content of the oil;
 - c) The method used to determine the sulfur content of the oil. ASTM D129-00, D2622-98, D4294-02, D1266-98, D5453-00, or D1552-01 may be used; and
 - d) A statement that the sampling was performed according to either the single tank composite sampling procedure or the all-levels sampling procedure in ASTM D4057-88, "Standard Practice for Manual Sampling of Petroleum and Petroleum Products" and that no additions have been made to the supplier's tank since sampling. [40 CFR §60.17]
- B-VII-15 Mattawoman shall comply with the following recordkeeping and reporting requirements for the emergency generator and fire water pump engine: [COMAR 26.11.09.08(G)]
 - a) Provide certification of the capacity factor of the equipment to MDE-ARMA in writing as part of the April 1 certification report;
 - b) Maintain the results of the combustion analyses (if applicable) at the site for at least two years and make this data available to MDE-ARMA and the EPA upon request;
 - c) Maintain records of training program attendance for each operator at the site, and make these records available to MDE-ARMA upon request.
- B-VII-16 Mattawoman shall maintain annual fuel use records for the emergency generator and fire water pump engine on site for not less than three years, and make these records available to MDE-ARMA upon request. [COMAR 26.11.09.08K]

VIII. COOLING TOWER

Emission Unit Number(s): CTW1

Wet Mechanical Draft Cooling Tower

Applicable Requirements

B-VIII-1 Best Available Control Technology (BACT)

- a) The cooling tower shall be designed with high efficiency drift eliminators to achieve a drift loss not to exceed 0.0005% of recirculating water flow;
- b) A written maintenance procedure shall be established prior to start-up of the Mattawoman Project that states how often and what procedures will be used to ensure the integrity of the drift eliminators. The maintenance procedure shall be maintained on-site and a copy provided to MDE-ARMA upon request.

IX. EQUIPMENT LEAKS

Emission Unit Number(s): FUG1

Natural gas pipeline components, including valves, connectors, flanges, pump seals and pressure relief valves within the facility boundary

Applicable Requirements

- B-IX-1 **Best Available Control Technology (BACT)** - GHG BACT for the natural gas pipeline components associated with the pipeline shall be the implementation of an audible, visual, and olfactory (AVO) Program Plan on site for review upon request by MDE-ARMA. In accordance with the AVO Program Plan, the AVO inspections shall be documented, leaks identified from the AVO assessment shall be repaired within five days of discovery, repairs documented, and associated repair records maintained.
- B-IX-2 **Lowest Achievable Emission Rate (LAER)** - VOC LAER for the natural gas pipeline components associated with the pipeline shall be the implementation of an AVO Program Plan on site for review upon request by MDE-ARMA. In accordance with the AVO Program Plan, the AVO inspections shall be documented, leaks identified from the AVO assessment shall be repaired within five days of discovery, repairs documented, and associated repair records maintained.
- B-IX-3 GHG emissions shall be totaled with all other sources facility-wide to comply with the limits established in B-III-3. The GHG emissions from the natural gas pipeline components shall be calculated as follows:
- a) The GHG emissions from the natural gas pipeline components shall be based on EPA AP-42 emission factors, methodology described in 40 CFR Part 98 Subpart W, or other MDE-approved emission factors.

- b) The total GHG emissions from the natural gas pipeline components shall be presented on a CO₂e basis.

Compliance Determination

Recordkeeping and Reporting Requirements

- B-IX-4 Mattawoman shall maintain all records of monitoring and repair associated with the natural gas pipeline components at the Facility for at least 5 years after the completion of the calendar year in which they were collected. These data shall be readily available for inspection by representatives of MDE-ARMA.

X. CIRCUIT BREAKERS

Emission Unit Number(s): CB1

Circuit breakers containing SF₆

Applicable Requirements

- B-X-1 **Best Available Control Technology.** GHG BACT for the circuit breakers shall be installation of state-of-the-art circuit breakers that are designed to meet ANSI C37.013 or equivalent to detect and minimize SF₆ leaks. Leaks detected shall be repaired within five days of discovery, repairs documented, and associated repair records maintained.
- B-X-2 GHG emissions shall be totaled with all other sources facility-wide to comply with the limits established in B-III-3. The GHG (SF₆) emissions from the circuit breakers shall be calculated using a manufacturer provided leak rate, the methodology in 40 CFR Part 98, Subpart DD and assuming 8,760 hours per year of operation.

Compliance Determination

Recordkeeping and Reporting Requirements

- B-X-3 Mattawoman shall maintain all records of monitoring and repair associated with the circuit breakers at the Facility for at least five years after the completion of the calendar year in which they were collected. These data shall be readily available for inspection by representatives of MDE-ARMA.

XI. NOTIFICATION REQUIREMENTS

- B-XI-1 All air quality notifications and reports required by this CPCN shall be submitted to:
Administrator, Compliance Program
Air and Radiation Management Administration
1800 Washington Boulevard
Baltimore, Maryland 21230

B-XI-2 All notifications and reports required by 40 CFR §60 Subpart KKKK, Subpart IIII, Subpart Dc, and 40 CFR §63 Subpart ZZZZ shall be submitted to:

Director, Air Protection Division
U.S. EPA - Region 3
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
Ammonia	5 ppmvd at 15% O ₂	COMAR 26.11.02.02H	Average of three test runs (for stack tests)	Initial stack test using EPA Method CTM-027 or equivalent method approved by MDE-ARMA	Performance stack tests at least once every five years using EPA Method CTM-027 or equivalent method approved by MDE-ARMA
CO	2.0 ppmvd at 15% O ₂ with and without duct firing, except during periods of startup and shutdown	BACT	3-hour block average	Install a certified CO CEMS per Condition B-IV-10 and in accordance with 40 CFR 60 Appendix B and F -or- Initial and annual performance test using EPA Method 10 or equivalent method approved by MDE- ARMA	Emissions shall be continuously monitored via CO CEMS. [COMAR 26.11.01.11]. Mattawoman shall calculate monthly emissions from the CTs/HRSGs, based on emissions measured using the CEMS to demonstrate compliance with the project-wide emissions limit in Condition B-III-3.

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
CO During Startup/ Shutdown	1,772 lb/event (cold startup); 1,461 lb/event (warm startup); 1,216 lb/event (hot startup); 156 lb/event (shutdown) Limits are for each CT	BACT	N/A	None required	Emissions shall be continuously monitored via CO CEMS. [COMAR 26.11.01.11] Mattawoman shall calculate monthly emissions from the CTs/HRSGs, based on emissions measured using the CEMS to demonstrate compliance with the project-wide emissions limit in Condition B-III-3.

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
GHG (as CO ₂ e)	865 lb CO ₂ /MW-hr (gross) with and without duct firing at all times	BACT	12-month rolling average	Install a certified CO ₂ CEMS per Condition B-IV-10 and in accordance with 40 CFR 60 Appendix B and F -or- Initial and annual performance test using EPA Method 3A or equivalent method approved by MDE-ARMA	Monitor CO ₂ emissions from each CTs/HRSGs using a certified CO ₂ CEMS. The total generation (MW) shall be monitored to calculate the emission rate of CO ₂ (lb/MW-hr), determined each month by summing the CO ₂ e emissions for all hours in which power is being generated to the grid during the previous 12 months and dividing that value by the sum of the electrical energy output over that same period.

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
Heat Rate	Operating Standard: 6,793 Btu/kWh (net) at all times when the CTs/HRSGs are operating (LHV)	BACT	N/A	Initial compliance with the heat rate limitation shall be demonstrated using ASME PTC 46 test method.	Annual thermal efficiency test conducted according to ASME PTC- 46, or another methodology approved by MDE-ARMA, and compare results to design thermal efficiency value. An exceedance of the heat rate operating standard triggers a requirement for Mattawoman to submit a maintenance plan to MDE-ARMA which specifies the actions Mattawoman plans to take in order to achieve the heat rate limit. The plan shall include a timeframe within which the heat rate limit will be met not to exceed 60 days unless agreed to by MDE- ARMA.

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
NO _x	15 ppmvd at 15% O ₂ or 54 ng/J (0.43 lb/MWh) of useful output at all times	NSPS Subpart K K K K K [40 CFR §60.4320]	30-day rolling	Install a certified NO _x CEMS per Condition B-IV- 10 and in accordance with 40 CFR 60 Appendix B and F	Emissions shall be continuously monitored via NO _x CEMS. [40 CFR §60.4340(a)-(b)]
NO _x	42 ppm at 15% O ₂	COMAR 26.11.09.08G(2)	3-hour block average	Install a certified NO _x CEMS per Condition B-IV- 10 and in accordance with 40 CFR 60 Appendix B and F	Emissions shall be continuously monitored via NO _x CEMS.
NO _x	2.0 ppmvd at 15% O ₂ with and without duct firing, except during periods of startup and shutdown	BACT and LAER	3-hour block average	Install a certified NO _x CEMS per Condition B-IV- 10 and in accordance with 40 CFR 60 Appendix B and F	Emissions shall be continuously monitored via NO _x CEMS. [40 CFR §60.4340(a)-(b)]. Mattawoman shall calculate monthly emissions from the CTs/HRSGs, based on emissions measured using the CEMS to demonstrate compliance with the project-wide emissions limit in Condition B-III-3.

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
NO _x During Startup/ Shutdown	153 lb/event (cold startup); 132 lb/event (warm startup); 105 lb/event (hot startup); 23 lb/event (shutdown) Limits are for each CT	BACT and LAER	N/A	None required	Emissions shall be continuously monitored via NO _x CEMS. Mattawoman shall calculate monthly emissions from the CTs/HRSGs, based on emissions measured using the CEMS to demonstrate compliance with the project-wide emissions limit in Condition B-III-3.
PM (filterable)	8.9 lb/hr without duct firing and 13.9 lb/hr with duct firing at all times	BACT	3-hour block average	Initial and annual performance test using EPA Method 5 or equivalent method approved by MDE- ARMA	Mattawoman shall calculate monthly emissions from the CTs/HRSGs, based on fuel throughput rate to the CTs/HRSGs and emission factors developed during annual stack tests to demonstrate compliance with the project-wide emissions limit in Condition B-III-3.

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
PM10/PM2.5 (filterable and condensable)	17.9 lb/hr without duct firing and 27.7 lb/hr with duct firing, at all times	BACT	Average of three stack test runs	Initial and annual performance test using EPA Methods 201A/202 or equivalent method approved by MDE- ARMA	Mattawoman shall calculate monthly emissions from the CTs/HRSGs, based on fuel throughput rate to the CTs/HRSGs and emission factors developed during annual stack tests to demonstrate compliance with the project-wide emissions limit in Condition B-III-3.
SAM	4.6 lb/hr without duct firing and 5.6 lb/hr with duct firing, except during periods of startup and shutdown	BACT	3-hour block average	Initial and annual performance test using EPA Method 8 or equivalent method approved by MDE-ARMA	Mattawoman shall calculate monthly emissions from the CTs/HRSGs, based on fuel throughput rate to the CTs/HRSGs and emission factors developed during annual stack tests to demonstrate compliance with the project-wide emissions limit in Condition B-III-3.

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
SO ₂	Mattawoman shall not burn any fuel with total potential sulfur emissions in excess of 26 ng/J (0.060 lb/MMBtu) heat input	NSPS [40 CFR §60.4330]	At all times	Initial and annual performance tests per 40 CFR §60.4415	N/A (if Mattawoman elects to demonstrate compliance with the emission limits by performing stack tests) or If Mattawoman elects to comply with the minimum fuel sulfur content limit under 40 CFR§60.4330, Mattawoman must monitor the total sulfur content of the fuel using the methods described in 40 CFR §60.4415 at a frequency described in 40 CFR §60.4370. [40 CFR §60.4360]

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
Visible Emissions	No visible emissions	COMAR 26.11.09.05A(2)	At all times, except as provided in COMAR 26.11.09.05A(3)	Initial Method 9 for 1 hour within 180 days of initial startup [COMAR 26.11.09.05A(2) and (5)]	Visible observation in accordance with EPA Reference Method 22 at least once each calendar quarter to verify that there are no visible emissions during operation. If visible emissions are observed Mattawoman shall inspect combustion control system, perform necessary adjustments and/or repairs within 48 hours, and document in writing the results of inspection, adjustments and/or repairs. After 48 hours, if the required adjustments and/or repairs have not eliminated the visible emissions, Mattawoman shall perform Method 9 observations once daily for at least one hour until corrective actions have eliminated the visible emissions. [COMAR 26.11.02.02(H)]

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
VOC	1.0 ppmvd at 15% O ₂ , without duct firing and 1.9 ppmvd at 15% O ₂ with duct firing, except during periods of startup and shutdown	LAER	3-hour block average	Initial and annual performance test using EPA Method 18/25A or equivalent method approved by MDE-ARMA	CO CEMS data shall be used as a surrogate for VOC emissions. A correlation shall be developed between CO and VOC emissions based on an initial stack test. The emission correlation shall be verified annually by stack test or a new correlation established. Monthly emissions during normal operation shall be calculated using the VOC emission rates and monthly fuel throughput rates to the CTs/HRSGs.

Table B-1 – Emissions Standards for CTs/HRSGs

Pollutant/ Operation	Emission Limit or Operating Standard	Underlying Requirement	Averaging Period	Performance Test	Continuous Compliance Demonstration Method
VOC	301 lb/event (cold startup); 258 lb/event (warm startup); 207 lb/event (hot startup); 63 lb/event (shutdown) Limits are for each CT	LAER	N/A	N/A	The VOC emissions factors during startup and shutdown provided by the vendor and number and type of startup and shutdown events shall be used to calculate the monthly VOC emissions during startup and shutdown events. The monthly emissions shall be used to demonstrate compliance with the project-wide VOC emissions limit in Condition B-III-3.

C. CONSTRUCTION DEWATERING

- C-1. This CPCN authorizes Mattawoman Energy, LLC to appropriate and use waters of the State. The appropriation will be tracked under MDE Water Management Administration (WMA) permit number XXXXX. The water appropriation will be subject to the following conditions:
- a) Allocation—The water withdrawal granted by this appropriation is limited to:
A daily average of 60,000 gallons on a yearly basis, and
A daily average of 275,000 gallons for the month of maximum use.
 - b) Use—The water is to be used for construction dewatering.
 - c) Source—The water shall be withdrawn from excavations completed in the Upland Deposits.
 - d) Location—The point(s) of withdrawal shall be located at the site of the Mattawoman Energy, LLC facility, Brandywine Road, Brandywine, Prince George's County, Maryland.
- C-2. Right of Entry—Mattawoman shall allow authorized representatives of MDE WMA and the PSC staff access to the facility to conduct inspections and evaluations necessary to assure compliance with the conditions of this appropriation. Mattawoman shall provide such assistance as may be necessary to effectively and safely conduct such inspections and evaluations.
- C-3. Permit Review—Mattawoman may be queried every three years (triennial review) regarding water withdrawal under the terms and conditions of this appropriation. Failure to return the triennial review query will result in suspension or revocation of this appropriation.
- C-4. Appropriation Duration and Renewal—The appropriation will expire in three (3) years from the effective date of the issuance of the CPCN. In order to renew the appropriation, Mattawoman shall file a renewal application with MDE WMA no later than 45 days prior to expiration. In the event that the construction schedule is extended, and groundwater dewatering will continue to be needed to support construction, a one-year renewal of the appropriation shall be granted only if Mattawoman provides written documentation to MDE WMA within six months of the expiration date demonstrating that the construction schedule will be extended and dewatering for construction activities will continue to be needed.
- C-5. Appropriation Suspension or Revocation—MDE WMA may suspend or revoke this appropriation upon violation of the conditions of this appropriation, or upon violation of any regulation promulgated pursuant to Title 5 of the Environment Article, Annotated Code of Maryland (2007 replacement volume) as amended.
- C-6. Change of Operations—Mattawoman shall report to MDE WMA any anticipated change in appropriation, which may result in a new or different use, quantity, source, or place of use of water, by submission of a new application.

- C-7. Additional Permit Conditions—MDE WMA may at any time (including triennial review or when a change application is submitted) revise any condition of this appropriation or add additional conditions concerning the character, amount, means and manner of the appropriation or use, which may be necessary to properly protect, control and manage the water resources of the State. Condition revisions and additions will be accompanied by issuance of a revised appropriation.
- C-8. Drought Period Emergency Restrictions—If MDE WMA determines that a drought period or emergency exists, Mattawoman may be required under MDE WMA direction to stop or reduce water use. Any cessation or reduction of water use must continue for the duration of the drought period or emergency, or until MDE WMA directs Mattawoman that water use under standard appropriation conditions may be resumed.
- C-9. Non-Transferable—This appropriation is only transferable to a new owner if the new owner acquires prior authorization to continue this appropriation by filing a new application with MDE WMA. Authorization will be accomplished by issuance of a new appropriation by MDE WMA.
- C-10. Flow Measurement—Mattawoman shall measure all water used under this appropriation by a method which shall be approved by MDE WMA.
- C-11. Withdrawal Reports—Mattawoman shall submit to MDE WMA, semi-annually (July-December, no later than January 31 and January-June, no later than July 31), pumping records. These records shall show the total quantity of water withdrawn each month under this appropriation.
- C-12. Initiation of Withdrawal—Mattawoman shall notify MDE WMA by certified mail when the withdrawals for the uses specified in this appropriation have been initiated. This appropriation shall expire if withdrawal is not commenced within two years after the effective date of the appropriation except upon written request to MDE WMA prior to the expiration of the two year period. The time limit may be extended for good cause at the discretion of MDE WMA.
- C-13. Water Level and Quality Monitoring—Mattawoman shall monitor water levels in monitoring wells during construction dewatering, and if the results of the monitoring indicate a potential for off-site drawdown impacts to occur in connection with Mattawoman's construction dewatering, then the implementation of mitigation measures shall be required. Mattawoman shall conduct the following actions within the specified timeframes to ensure that any potential drawdown impacts are mitigated.
- a) Install two new monitoring wells into the Upland Deposits, one well designated MW-8 to be located on the northern boundary of the property at Brandywine Road north of existing well MW-6, and the second well to be designated as MW-9 to be located on the western boundary of the property but north of the unnamed tributary to Mattawoman Creek. The two monitoring wells need to be installed 270 days in advance of the initiation of construction dewatering withdrawals. The top of casing elevations for the two new monitoring wells and the existing seven monitoring wells need to be surveyed to the nearest one-hundredth of a foot to the national geodetic vertical datum.

- b) Conduct baseline water level monitoring of the two new monitoring wells and the existing seven monitoring wells at the Mattawoman property, and the four monitoring wells on the Brandywine DRMO National Priorities List (NPL) Site and CSX properties to determine groundwater flow directions and gradients. The baseline monitoring needs to include at least two synoptic water level monitoring events conducted at least one month apart, and include the nine monitoring wells on the Mattawoman property, wells DP-1 and DP-55 on the Brandywine DRMO NPL Site property (subject to access granted), and wells DP-35 and DP-37 on CSX property (subject to access granted). The baseline water level monitoring also needs to include the collection of continuous water level measurements in wells MW-6, MW-7, MW-8 and MW-9 using transducers for a period of at least two weeks.
- c) Conduct baseline groundwater quality monitoring in three existing monitoring wells completed in the area where dewatering will occur (MW-1, MW-3 and MW-5). Analyze the groundwater samples for U.S. Environmental Protection Agency Target Compound List (TCL) Volatile Organic Compounds and Semi-Volatile Organic Compounds, and Target Analyte List Metals. Describe how extracted groundwater will be managed during the duration of the dewatering, including but not limited to: 1) obtaining any necessary permits or approvals for discharge of the extracted groundwater; 2) mitigating any groundwater quality impacts identified by the baseline groundwater quality monitoring; 3) containing and characterizing the quality of the extracted groundwater during the duration of dewatering prior to discharge; and 4) mitigating any water quality impacts identified by the analysis of the water quality samples during the dewatering prior to discharge.
- d) No later than 180 days in advance of the initiation of construction dewatering withdrawals, Mattawoman shall provide a proposed Water Level Monitoring and Mitigation Plan (Plan) of study to the Brandywine DRMO NPL Site Tier 1 Project Review Team consisting of EPA, MDE, and JBA project managers (Tier 1 Review Team), as well as MDE Water Management Administration (MDE WMA) and MDE Land Management Administration (MDE LMA), for review. The Plan shall describe the approach for water level monitoring, triggers for mitigation, and proposed mitigation. The Plan shall include the results of the baseline water level and groundwater quality monitoring, a determination of the ground water flow direction and gradients, and the results of the continuous water level recording. The Plan shall include: 1) the proposed locations, frequency and duration of water level monitoring, including the use of continuous water level monitoring using transducers; 2) a description of the proposed threshold criteria that, if triggered, will require implementation of mitigation measures; 3) frequency and content of reporting for the Water Level Monitoring and Mitigation Plan; and 4) a description of the proposed mitigation measures to be implemented. Proposed mitigation measures will include at a minimum modifying pumping of groundwater to reduce drawdown impacts and recharging recovered groundwater. If recharging recovered groundwater is proposed, identify the necessary approvals, if any, to be obtained from the MDE Underground Injection Control (UIC) Program in accordance with MDE UIC

Program requirements. After consulting with Mattawoman, JBA, MDE WMA and MDE LMA, the EPA and MDE members of the Project Review Team shall determine whether the proposed Water Level Monitoring and Mitigation Plan is acceptable.

- e) Implement the Water Level Monitoring and Mitigation Plan concurrent with the initiation of construction dewatering withdrawals.
- f) If the EPA and MDE members of the Tier 1 Review Team determine that construction dewatering by Mattawoman has adversely impacted groundwater remediation at or associated with the Brandywine DRMO NPL Site, Mattawoman must implement additional mitigation within 30 days of the determination, and demonstrate satisfactory mitigation of the impact to the EPA and MDE members of the Tier 1 Review Team. Any proposed additional mitigation measures need to be reviewed and approved by the EPA and MDE members of Tier 1 Review Team. If additional mitigation implemented by Mattawoman is determined by the EPA and MDE Tier 1 Review Team to be ineffective, Mattawoman will be responsible for paying JBA for any and all additional costs and penalties paid or incurred by the United States Air Force in undertaking actions to address the impacts; provided, however, that, as a prerequisite to the obligation to make such payment, JBA will first provide to Mattawoman invoices or other documents demonstrating that such additional remediation costs and/or penalties were paid or incurred and the basis for JBA's belief that such costs and/or penalties were directly attributable to Mattawoman's construction dewatering activities.

C-14. Construction Dewatering for Pipeline Installation – Prior to constructing the gas and reclaimed water pipelines, Mattawoman shall conduct an analysis to determine whether construction dewatering will be required to install the gas and reclaimed water pipelines, and if construction dewatering is necessary, whether the amount or duration of construction dewatering will exceed the amount and duration threshold limits listed in COMAR 26.17.06.03.B(3). Mattawoman shall submit this analysis to MDE WMA for review and approval, and shall provide a copy to PPRP. If the analysis shows that construction dewatering will exceed the thresholds referenced above, Mattawoman shall promptly file a request with the PSC for an amendment to the CPCN that authorizes groundwater appropriations for the gas and/or reclaimed water pipelines. Mattawoman shall provide a copy of this request to MDE WMA and PPRP. Information supporting the request must include, but not be limited to the following: (1) the estimated length of pipeline to be installed beneath the water table, (2) the estimated depth that excavations will extend below the water table, (3) the duration those excavations below the water table will remain open, and (4) a request for a water appropriation on the form provided by MDE WMA indicating the anticipated average daily appropriation on an annual basis and the average daily appropriation during the month of maximum use. Mattawoman may propose to MDE WMA construction of a segment of a pipeline, if Mattawoman demonstrates to MDE WMA's satisfaction that no construction dewatering will be required, or that construction dewatering will not trigger the thresholds referenced above, for the segment of the pipeline at issue.

D. COOLING WATER SUPPLY

- D-1. At the point where Mattawoman accepts control of the reclaimed water at Piscataway Wastewater Treatment Plant (WWTP), Mattawoman shall ensure that a detectable free chlorine residual exists before the reclaimed water enters the pipeline to the power plant site. Once the water reaches the power plant site, Mattawoman shall have the ability to add chlorine, if necessary, to re-establish a detectable level of free chlorine in the reclaimed water at the following points:
- a) Where the reclaimed water enters any on-site water storage structures; and
 - b) Where the reclaimed water enters the circulating cooling water system.
- D-2. At no time shall Mattawoman accept reclaimed water from the WWTP that exceeds 5 Nephelometric Turbidity Units (NTU). Any water that exceeds 5 NTU shall be prevented from entering the pipeline conveying reclaimed water to the Mattawoman Energy Center facility site.
- D-3. No later than 60 days prior to construction of the water conveyance and on-site treatment and storage facilities, Mattawoman shall provide to PPRP and the PSC final design documentation, including, but not limited to, drawings, materials and equipment specifications related to the disinfection system, water quality monitoring systems, and water storage. The scope of this submittal shall be sufficient to demonstrate that Mattawoman will have in place the means to adequately disinfect water prior to its use in the circulating cooling tower system.
- D-4. Mattawoman shall develop a detailed sampling and analysis plan to demonstrate compliance with the above conditions. The procedures shall be submitted to the PSC and PPRP for review and approval no later than 90 days prior to the start of commercial operation.
- D-5. Where Mattawoman uses reclaimed water in place of potable water, Mattawoman shall adhere to specifications outlined by the American Water Works Association in "Guidelines for Distribution of Nonpotable Water" and OSHA regulations 1926.51b to prevent inadvertent and inappropriate use of the reclaimed water.
- D-6. If there are substantive modifications to the May 2014 agreement between Mattawoman and Washington Suburban Sanitary Commission, Mattawoman shall provide the PSC and PPRP with a copy of the revised agreement.
- D-7. Mattawoman shall maintain a log to document off-site shipments of filter cake solids from the zero liquid discharge system. At a minimum, the log shall identify the date of shipment, amount of solids (by weight or by volume), name of third-party transporter, and ultimate disposal location. Mattawoman shall provide copies of the shipment logs to MDE upon request.

E. TERRESTRIAL AND AQUATIC ECOLOGY

- E-1. Construction and operation of the Mattawoman Energy Center, including the power

generating facility, natural gas pipeline, reclaimed water pipeline, generator lead line and substation, shall be undertaken in accordance with this certificate and shall comply with all applicable local, State, and federal regulations, including but not limited to the following:

- a) Nontidal Wetlands – COMAR 26.23.01 applies to activities conducted in nontidal wetlands.
 - b) Waterway Construction – COMAR 26.17.04 applies to regulations governing construction activities in nontidal waters and floodplains.
 - c) Water Quality and Water Pollution Control – COMAR 26.08.01 through COMAR 26.08.04 apply to discharges to surface water and maintenance of surface water quality.
 - d) Erosion and Sediment Control – COMAR 26.17.01 applies to the preparation, submittal, review, approval, and enforcement of erosion and sediment control plans.
 - e) Forest Conservation – Maryland's Forest Conservation Act, Md. Code, Section 5-1601 et seq. of the Natural Resources Article and Maryland's Forest Conservation regulations, COMAR 08.19.01 through 08.19.06, implement Maryland's forest conservation, reforestation, and afforestation requirements, and apply to the development of forest stand delineations and the preparation of forest conservation plans.
 - f) Scenic and Wild River - Maryland's Scenic and Wild River Act, MD. Code, Section 8-401 et seq. of the Natural Resources Article.
 - g) Vegetation Management - COMAR 20.50.12.09 applies to vegetation management requirements that are necessary and appropriate to maintain safety and electric system reliability.
- E-2. Mattawoman shall provide PPRP and the PSC with the following as-built details: engineering and construction plans of the power plant, substation and all linear facilities associated with the project that were included with the CPCN application and approval, specifically the reclaimed water pipeline, the natural gas pipeline, and generator lead line, including the right-of-way (ROW) width, length, and total acreage of each such ROW. Where the above-listed as-built details are identical to those submitted with the CPCN application, Mattawoman should provide a statement to this effect and not resubmit the information.
- E-3. Mattawoman shall provide engineering and construction plans for all new access roads and those modifications to existing access roads for which a construction drawing is required for permitting, as well as the final plans for roadway reclamation following construction of the Project, if any. All impacts to wetlands, wetland buffers, waterways or 100-year floodplains that may result from site access, including runoff from roads, must be quantified and included in the wetlands, waterways and floodplains permit applications submitted to MDE.

- E-4. Mattawoman shall advise the FSC and PPRP that copies of contract specifications for clearing, construction, rehabilitation of the rights-of-way for the linear facilities are available within thirty (30) days of preparation, and prior to the beginning of construction. Contract specifications for any clearing of the ROWs for the linear facilities shall delineate sensitive habitats that are to be avoided and clearly specify state park boundaries and the work that is authorized on park lands. Contracts shall also indicate that tree roots and stumps shall be left in place, except where such roots and stumps interfere with pipeline trenches, access roads, or other physical components of the linear facilities. Additionally, contract provisions will indicate that cleared trees will be cut and windrowed along the edge of the ROW, outside of wetland areas to create wildlife habitat, where acceptable to the property owner; otherwise, trees will be cut and removed or chipped. These provisions shall also specify that brush may be shredded or chipped and distributed only on the cleared ROW, outside of regulated areas to the maximum extent practicable as a ground cover to stabilize the soil surface, but the depth shall not exceed 4 to 6 inches in upland areas. If the placement of wood chips in regulated areas is unavoidable, Mattawoman shall consult with MDE to determine the appropriate application of a wood chip and topsoil mixture during stabilization activities to ensure that wetland vegetation is established.
- E-5. All impacts (temporary or permanent) to the following resources shall be assessed, and where possible quantified by Mattawoman and shown in the wetlands, waterways and floodplains permit applications submitted to MDE, with copies provided to PPRP for its review, prior to any construction activities:
- a) Streams and their 100-year floodplains;
 - b) Nontidal wetlands and their regulated buffers, including but not limited to all Wetlands of Special State Concern (WSSC) and their 100-ft regulatory buffers. Impacts to nontidal waters and floodplains shall follow Maryland guidelines for Waterway Construction, Section 4.0;
 - c) The water quality and "natural values" of the Wicomico/Zekiah Scenic River system that are protected by Maryland's Scenic and Wild Rivers Act and the Wicomico Scenic River Management Plan, including impacts to the River mainstem and all tributaries thereof.
- E-6. Any impact to wetlands, including vernal pools within or abutting the Project ROW shall be mitigated if required by Maryland Nontidal Wetlands laws and regulations. Mattawoman shall consult with MDE to identify sensitive wetlands in the ROW, including but not limited to nontidal WSSC, and to develop plans to manage the wetlands in the ROW to encourage growth of sustainable populations of native herbaceous plant species through approved treatments.
- a) No disturbance whatsoever shall occur to WSSC or their 100-foot buffers, as determined by MDE and the Maryland Department of Natural Resources (DNR). To avoid all vegetation removal or disturbance, Horizontal Directional Drilling (HDD) shall be used, with approval from MDE, to place pipelines below any area where construction would disturb WSSC located near or within the project ROW. Specifically, in regards to the crossing of all wetlands and/or waterways within

Cedarville State Forest, Mattawoman shall use HDD, subject to MDE approval. HDD shall also be used, if feasible, in all areas of "new ROW," which are undisturbed areas of the proposed ROW that are outside the boundaries of existing utility rights-of-way, including the Mattawoman Creek crossing and forested wetland habitat parallel to Jordan Swamp. In areas where HDD is not used, permanent ROW widths shall not exceed 25 feet, subject to MDE approval. Prior to the start of construction, geotechnical investigations, construction plans, and contingency plans must be provided to MDE for approval, and to PPRP for review, for each HDD crossing location. All cuttings returned from the HDD borings shall be transported to and disposed of at an approved waste disposal facility or location permitted to accept that type of material, without leaving waste material at the drilling site, on access roads, or on highways.

- b) Prior to construction, Mattawoman shall submit a Hydrostatic Testing and Discharge Plan to DNR-Project Review Division for evaluation. Information should include, but is not limited to: source water, whether water is chlorinated or un-chlorinated, and discharge points/velocity of discharge. If the water is chlorinated, Mattawoman must provide de-chlorination procedures.
- c) Construction activities for linear facilities in wetlands shall occur, if possible, during seasonally dry periods and shall be minimized, with the total disturbed area during construction limited to a width no greater than 40 ft, with the exception of Wetland 2 (60 ft), Wetland 6 (90 ft) and Wetland 31 (75 ft) as identified in Mattawoman's SERD dated Jan 2015, Figure 3-4. To reduce soil compression and elevation changes, matting shall be used for all access roads, staging areas, or construction work areas that must be located in wetlands areas. To the maximum extent practicable, soil removed during trenching activities through wetlands shall be stockpiled in nearby upland areas and used to refill the trench when the pipe is in place. Temporary hydrological barriers or diversion mechanisms shall be removed and soil consistency, density, and elevation in these wetlands areas shall be restored to pre-construction conditions as soon as possible after pipe placement.
- d) All construction activities for those portions of the linear facilities that transect the mapped watersheds of Mattawoman Creek or Zekiah Swamp shall comply with "Best Management Practices for Nontidal Wetlands of Special State Concern" as stipulated in COMAR 26.23.06.03, including enhanced best management practices in the vicinity of very sensitive nontidal wetlands sites. These practices and techniques will include use of adequately sized temporary sediment traps, as needed, as well as super silt fencing and other specialized techniques such as double silt fences and redundant stormwater runoff controls specifically needed for limiting the quantity of sediment entering these wetlands during the construction process.
- e) All clearing of forest from wetlands areas that will be retained as herbaceous wetlands shall be mitigated by restoration of an equal or greater amount of forested wetland - as approved by MDE. Any wetland area that is completely drained or destroyed shall be mitigated according to the provisions of the Nontidal Wetlands Act and as approved by MDE.

- f) Mattawoman shall provide a plan to MDE for approval, and PPRP for review, for conversion of cleared forested wetlands areas to herbaceous wetlands containing sustainable populations of native species similar to those found in existing herbaceous wetlands in the watershed. This plan shall include monitoring and treatment of the wetlands as necessary, for a period of 5 years, to ensure the desired result and to prevent a takeover by invasive species. Mattawoman shall provide for third-party monitoring in these areas if deemed necessary by MDE. Condition and monitoring reports for each wetland area shall be provided annually to MDE and PPRP.

E-7. With the exception of those specific stream locations within the permanent 25-ft wide natural gas pipeline ROW that will be trenched, construction crossings of all streams and drainage channels on the Mattawoman site, on access roads, or in the linear facilities ROWs shall be bridged or culverted to minimize disturbance to the streams during construction and maintenance.

- a) Mattawoman shall employ enhanced best management practices for all construction in or near streams and drainage channels, such as double silt fences and redundant stormwater runoff controls, construction of earth dikes in appropriate locations, sediment traps, use of super silt fences, stabilizing disturbed areas as quickly as possible, use of sandbag dikes in streams and along pond edges where necessary, and the use of timber mats or other temporary bridge systems for crossing over streams where practicable, and converting silt traps to permanent features as soon as practicable.
- b) All stream bottoms and banks that are trenched during construction shall be restored to their original contours and soil composition as soon as practicable, stabilized, and monitored for a period of 5 years to verify recovery and address as necessary any erosion, scouring, or other deterioration. Condition and monitoring reports for each trenched stream area shall be provided annually to MDE and PPRP.
- c) Stream banks that are disturbed or cleared of vegetation for construction of the linear facilities shall be stabilized as soon as practicable. Upon completion of construction, these areas shall be restored to pre-construction contours and planted to create a vegetated buffer, not less than 25 feet in width as measured from the top of the stream bank or the mapped 100-year floodplain boundary, whichever is greater. The plantings shall use native species of low-growing trees, shrubs, forbs, and grasses which, in conjunction with natural regeneration, shall produce a sustainable vegetation community that provides wildlife habitat as well as shades the stream and protects it from runoff and bank erosion. This buffer shall be designated as a no-mow zone, in which integrated vegetation management (IVM) approaches will be used to establish and maintain a vegetation canopy of the maximum height and density that is consistent with the topography and the safety of the linear facility, but in no case less than 10 inches in height for underground facilities or 3 feet in height for overhead facilities. At any location where these current transmission ROW stream BMPs are incompatible with any existing binding agreement between the State and any collocated utility, Mattawoman may substitute appropriate procedures from the

utility's vegetation management plan, if both MDE and PPRP agree to the substitution.

- E-8. Mattawoman shall minimize construction disturbance to any rare, threatened, endangered, or disturbance-sensitive species that may be present in or adjacent to the ROW, including the use of fencing, restricting construction during breeding seasons, and implementing a third-party environmental monitoring program during construction activities.
- a) Prior to construction, Mattawoman shall perform rare, threatened, and endangered species surveys for the interconnection substation parcel and submit results to DNR Wildlife and Heritage Service (WHS), PPRP and MDE. Mattawoman shall also perform additional surveys for the spring blooming sedge, *Carex buxbaumii* (State Threatened), in early June 2015 as specified by WHS.
 - b) Construction activities that would cause disturbance or disruption to Forest Interior Dwelling Species (FIDS) of birds in designated areas adjacent to the ROW, raptor nests in or adjacent to the ROW, or ground-dwelling birds within the ROW shall be avoided to the maximum extent practicable during the breeding seasons for these species. This includes limits on disturbance of forest habitat during April 1-August 31, the breeding season for most FIDS. Seasonal restriction may be expanded to February-August if certain early nesting FIDS (e.g., Barred Owl) are present.
 - c) The reclaimed water and natural gas pipelines, generator lead line and substation for the Project will cross streams that are upstream of Tier II stream segments of Mattawoman Creek, Piscataway Creek, Jordan Swamp, and Zekiah Swamp Run. Two fish species, the State threatened "Flier" (*Centrarchus macropterus*) and the State rare "Swamp Darter" (*Etheostoma fusiforme*), are known to occur in the Upper Zekiah Swamp Watershed. Construction crews shall take all necessary precautions during work to avoid potential downstream impacts to these species, where applicable. Surface disturbance and vegetation removal shall be avoided or minimized in this sensitive watershed, in conjunction with MDE permit requirements. A Use I Time of Year (TOY) restriction from March 1 to June 15 for in-stream work applies to this project, including HDD unless exempted by MDE. The Piscataway watershed contains two State-threatened fish species: the American Brook Lamprey (*Lampetra appendix*) and Comely Shiner (*Notropis amoenus*). Mattawoman shall coordinate with DNR Fisheries prior to construction, and take all necessary precautions during stream disturbance to avoid impacts to these species. Surface disturbance and vegetation removal shall be avoided or minimized at stream crossings in these sensitive watersheds, in conjunction with MDE permit requirements.
 - d) Mattawoman shall avoid construction during critical reproductive periods of plants and animals of the wetlands ecosystem and adhere to all designated TOY restrictions, unless otherwise agreed to by DNR WHS and, if necessary, authorized by the relevant permitting authority.

- E-9. Mattawoman shall notify and consult with DNR WIIS to determine appropriate actions if additional rare, threatened, or endangered species are encountered during planning, construction, or maintenance of this facility.
- E-10. Mattawoman shall minimize tree clearing to the maximum extent practicable. The total acreage of trees removed for construction of the power plant and its associated linear facilities and substation shall be mitigated in the amount determined by DNR Forest Service according to the FCA specifications. This mitigation shall be accomplished by planting native trees in a restoration location or location(s) that will be entered into a conservation easement, or by the purchase of credits from an approved forest conservation bank preferably within the same watershed in which the loss was incurred. Prior to conducting any tree removal activities, Mattawoman shall file a Forest Stand Delineation and a Forest Conservation Plan with the DNR Forest Service, at least sixty (60) days prior to construction within these areas. Mattawoman shall notify the Forest Service and PPRP of any route changes that require modification to these Plans and allow an additional 30 days for review prior to construction. All restored areas shall be monitored for at least 5 years to ensure survival of plantings, and annually restocked to the planned density to compensate for seedling mortality. Annual monitoring reports, including the number of dead trees replaced with new plantings, along with statistical estimates of live stem density, average stem diameter, average height, biomass, and a professional assessment of the general condition of the trees shall be provided to the Forest Service and PPRP.
- E-11. Mattawoman shall employ erosion and sediment control best management practices (BMPs) presented in the MDE document titled 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control, and as otherwise may be approved or required by Prince George's County or Charles County. All portions of the power plant site or the ROWs for the associated linear facilities that are disturbed during construction shall be stabilized as soon as practicable after the cessation of construction activities within that portion of the site or ROW, followed by seed application, except in actively cultivated lands, in accordance with the above cited document. In no instance shall non-native species be seeded or otherwise planted in these areas. In wetlands and wetland buffers, seed application shall consist of the following species: annual ryegrass (*Lolium multiflorum*), millet (*Setaria italica*), barley (*Hordeum spp.*), oats (*Uniola spp.*), and/or rye (*Secale cereale*). Other non-persistent vegetation may be acceptable, but must be approved by the MDE Water Management Administration. Kentucky 31 fescue shall not be used in wetlands or buffers.
- E-12. To conserve natural resources and preserve environmental quality, Mattawoman shall manage vegetation in permanent ROWs of the natural gas pipeline and for the generator lead line by employing the measures specified in paragraphs (a) through (e) below. Methods used for mechanical, manual, or chemical treatments shall be consistent with those specified in the following: Best Management Practices: Integrated Vegetation Management on Electric Utility Rights-of-Way (R. Miller, International Society of Arboriculture, 2007). This condition shall apply to all portions of Mattawoman's permanent ROWs for the natural gas pipeline and the generator lead line that are not currently subject to CPCN vegetation management conditions under a prior CPCN issued to another utility with collocated facilities. In those portions of the ROWs where

any of the requirements below conflict with existing CPCNs, the approved vegetation management plan for those collocated facilities may be substituted, provided that the plan does not conflict with current environmental laws or regulations. Thereafter, any future modifications of the collocated utility's CPCN vegetation management conditions, or vegetation management conditions imposed by new CPCNs issued for collocated facilities in the ROW, shall also govern the maintenance of those portions of Mattawoman's ROW for which such substitution was made.

- a) In any part of the ROW that bisects designated DNR Green Infrastructure, forested Maryland state parkland, or other forested parcels, and which is not under active cultivation, Mattawoman shall maintain the ROW such that it supports a low-growing plant community dominated by grasses, herbs, and forbs. Where the depth of the pipe or duct bank allows woody vegetation to grow (e.g., areas above HDD areas), the natural vegetation shall not be cut, treated with herbicides, or otherwise disturbed.

Detailed vegetation management plans, as described in Condition E-12(e) below, shall be prepared for the 7 areas of the ROW identified by PPRP as particularly environmentally sensitive, specifically described as:

- i. Area E - Mattawoman Site, which contains a tributary of a Tier II segment of Mattawoman Creek, Green Infrastructure and FIDS habitat.
- ii. Area F - Mattawoman Creek headwaters crossing by the natural gas pipeline, upstream of the Tier II segment. The area also contains a Green Infrastructure Hub, FIDS habitat, as well as a Sensitive Species Project Review Area (SSPRA).
- iii. Area G (Cedarville State Forest) - Multiple stream crossings in PEPCO/SMECO ROW, in Cedarville State Forest at the Prince George's/Charles County Line, near Bee Oak Road.
- iv. Area H (Cedarville State Forest) - Multiple stream crossings in PEPCO/SMECO ROW, in Cedarville State Forest, near St. Peter's Church Road, Havensbrook Drive and Holly Spring Road.
- v. Area I - wetlands in the new ROW adjacent to Jordan Swamp.
- vi. Area J - PEPCO 500 kV ROW and tributary of Mataponi Creek crossing by the generator lead line.
- vii. Area K - Generator lead line substation site in forested area adjacent to PEPCO's 230-kV transmission line and upstream of Tier II segment of Piscataway Creek.

These plans shall be submitted to PPRP for review and comment at least 30 days prior to the start of construction. Any access tracks through these areas that require mowing shall follow mowing conditions noted in Condition E-12(b) below. The ROW shall be maintained as such while the ROW is in use by Mattawoman and its successors or assignees.

- b) Subject to landowner consent and local grass height ordinances, Mattawoman shall not mow areas within the ROW maintained as grasses and forbs during the breeding season for ground nesting birds from May through August of each year. If mowing is necessary outside of the May through August breeding season, mowing shall be to a height of no less than 10 inches, with the exception of areas under special management for invasive species control.
- c) Subject to applicable law and landowner requirements, herbicide applications employed for IVM purposes shall be performed in accordance with industry best practices and incorporated into the plans to accomplish the desired habitat, as described in Condition E-12(a) above.
- d) Wetlands within the permanent ROWs for the reclaimed water pipeline, natural gas pipeline, and generator lead line rights-of way shall not be mowed, and there shall be an additional 100-ft-wide no-mow zone established within the permanent ROW adjacent to all wetlands and streams. In these areas, manual methods or IVM protocols may be employed to remove incompatible vegetation, while maintaining a sustainable vegetation community of maximum height and density. If Mattawoman requires a mowed access track through any stream or wetland buffer, all mowing shall be restricted as described in Condition E-12(b) above.
- c) Detailed vegetation management plans shall include a map with permanent access roads, pipe and transmission centerline positions and depths, wetlands and streams and the buffers around them, areas of mowed, maintained but not mowed, and not to be disturbed vegetation, with the extant vegetation clearly indicated. The plan will describe the appearance/functionality of the vegetation in the ROW after construction, the proposed long-term appearance/functionality, and what prescribed vegetation management shall be implemented in each zone or area.

E-13. Any tree clearing and disposal activities shall be conducted in accordance with the Revised Quarantine Order of the Secretary of Agriculture, State of Maryland, to prevent the spread of Emerald Ash Borer in this state (Plant Protection Order #11-02 dated July 21, 2011).

E-14. Mattawoman shall formulate contingency plans to address inadvertent releases of drilling fluid that occur in areas where HDD operations are used and comply with the following:

- a) The contingency plans shall identify any sensitive resources in the vicinity of the HDD locations that would require protection from the effects of a frac-out.
- b) The plans shall be submitted to PPRP, DNR, and MDE prior to construction of the project and drilling shall not commence until the contingency plans are approved.
- c) Mattawoman shall have all necessary equipment and personnel on site during drilling operations to ensure that these plans can be implemented expeditiously.

- d) During construction, Mattawoman shall record all release events and report them within 24 hours of occurrence to PPRP, the PSC, and all agencies that have issued permits for the construction. Reports shall include the location, volume, and duration of the release, the action(s) taken to stop the release, the containment procedures used to minimize the effects of the release, and the initial assessment of the clean-up or restoration actions that shall be required to repair any natural resources damages resulting from the release.

E-15. Natural gas pipeline construction in Cedarville State Forest shall not begin until Mattawoman has obtained an easement agreement with the State of Maryland/DNR that has been approved by the Board of Public Works (BPW) and DNR's Attorney General (AG). All Conditions of Approval for the easement as determined by DNR shall be implemented by Mattawoman during project construction, operation, and management.

E-16. Mattawoman shall evaluate the following construction design options:

- a) Constructing the natural gas pipeline under the CSX railroad track north of Mattawoman Creek at a 45 degree angle to the tracks, directly adjacent to the PEPCO ROW, minimizing forest habitat clearing.
- b) Placing the proposed 230-kV generator lead line underground where it crosses the ROW for PEPCO's Burches Hill to Chalk Point 500-kV transmission line and tributary of Mataponi Creek.

If Mattawoman determines that it is not practicable to achieve these preferred construction design options, Mattawoman shall provide documentation to the PSC and PPRP demonstrating why they are not feasible.

E-17. Mattawoman shall minimize tree clearing in areas of project construction where alternative means of construction and operation are feasible, or implement additional tree planting mitigation:

- a) Along the eastern side of the generator lead line ROW, north of the DRMO Site to the existing PEPCO 500-kV transmission line, the ROW would accommodate the generator lead line and a 69-kV distribution line operated by SMECO for a distance of approximately one-half mile. If the conductors for SMECO's 69-kV circuit are placed on the western arms of the new 69-kV double circuit poles, no trees would have to be removed more than 20 feet east of the center line of the poles. The ROW may be cleared to its full width of 109 ft when SMECO constructs the second 69-kV circuit.
- b) In the vicinity of Mattawoman Creek and Jordan Swamp, installation of the natural gas pipeline will create a newly cleared ROW through contiguous forest and forested wetlands. If Mattawoman's permanent and temporary construction easements in these areas are reduced to 25' and 50', respectively, the amount of forest clearing will be minimized.

The additional mitigation shall consist of planting areas at a 2:1 ratio to areas permanently cleared that are in excess of minimized tree clearing requirements. This

mitigation shall be separate of other forest mitigation requirements, but does not apply to forested wetlands that are already mitigated by 2:1 replacement. Mitigation shall be accomplished by planting native trees at a density of at least 200 trees per acre, in a restoration location or location(s), preferably within the same watershed, that will be entered into a conservation easement, or permanently protected by other similar means. All restored areas shall be monitored for at least 5 years to ensure survival of plantings, and annually restocked to the planned density to compensate for seedling mortality. Annual monitoring reports, including the number of dead trees replaced with new plantings, along with statistical estimates of live stem density, average stem diameter, average height, biomass, and a professional assessment of the general condition of the trees shall be provided to DNR.

F. STORMWATER MANAGEMENT/EROSION AND SEDIMENT CONTROL

F-1. Stormwater management plans for all aspects of this project shall use best management practices (BMPs) that include:

- a) Groundwater infiltration and channel volume protection;
- b) Grading to encourage overland flow;
- c) Slope minimization to decrease flow velocities and reduce erosion;
- d) Conveyance of runoff via a closed storm water sewer system discharging into an engineered stormwater management facility consistent with the latest MDE and Prince George's County guidelines when overland flow is not desirable;
- e) Encourage water conveyance through the aggregate to facilitate infiltration by using overlay material for the switchyard;
- f) Utilize a storm water drain collection system;
- g) Utilize vegetation filters and physical structures, including outfall pipes, to control release rates from an engineered stormwater management facility consistent with MDE's latest guidelines.

F-2. The CPCN is not an authorization to discharge stormwater or wastewater to waters of the State. If required by MDE, Mattawoman shall obtain a discharge permit from MDE under the National Pollutant Discharge Elimination System (NPDES) for the Mattawoman Energy Center.

F-3. Mattawoman shall ensure that the solid cake by-product from the zero liquid discharge system is stored in a manner that prevents contact with precipitation and minimizes any potentially contaminated runoff.

G. FUEL AND HAZARDOUS MATERIALS

G-1. Mattawoman shall ensure that, prior to commencement of construction near Air Force property and/or within the Brandywine DRMO NPL Site Land Use Control area (LUC), soil and/or groundwater testing will be conducted to properly evaluate whether special

protections should be required in the vicinity of known areas of contamination prior to the excavation of these sites.

- a) Should any soil containing petroleum contamination (COMAR 26.10.13) and/or hazardous substances (COMAR 26.14.02) exceeding the current EPA regional screening levels (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm) for residential soil be excavated during construction, Mattawoman shall properly dispose of the impacted soil at a licensed solid waste facility in accordance with local and State solid and hazardous waste laws, regulations and guidance.
- b) Any groundwater generated during construction activities in the areas of contamination shall be contained and tested. If the water is determined to contain petroleum contamination and/or hazardous substances (COMAR 26.14.02) exceeding the current EPA regional screening levels (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm), procedures shall be developed and implemented to ensure contaminated groundwater is either treated or disposed of in accordance with all applicable local, State, and federal laws, regulations and guidance.
- c) Mattawoman shall adhere to appropriate Occupational Safety and Health Administration (OSHA, 29 CFR 1910) and Maryland OSHA (MOSHA, COMAR 09.12.20) regulations and procedures to ensure worker protection.
- d) Mattawoman shall prepare a plan to collect groundwater quality samples in selected monitoring wells prior to construction near the Brandywine DRMO NPL Site property. The plan shall specify the location and number of wells that will be sampled both prior to construction to establish a baseline and after construction to determine if construction had any impact on the groundwater quality. The plan shall also include the proposed analyses of the samples. The plan shall be submitted to the Brandywine DRMO NPL Site Tier 1 Project Review Team consisting of EPA, MDE, and JBA project managers (Tier 1 Review Team) for review. The EPA and MDE members of the Tier 1 Review Team shall determine whether the proposed plan is acceptable.
- e) If the EPA and MDE members of the Tier 1 Review Team determine that Mattawoman's construction activities have adversely impacted groundwater remediation at the Brandywine DRMO NPL Site, Mattawoman must implement additional mitigation within 30 days of the determination, and demonstrate satisfactory mitigation of the impact to the EPA and MDE members of the Tier 1 Review Team. Any proposed additional mitigation measures need to be reviewed and approved by the EPA and MDE members of the Tier 1 Review Team. If this additional mitigation implemented by Mattawoman is determined by the EPA and MDE members of the Tier 1 Review Team to be ineffective, Mattawoman will be responsible for paying JBA for additional costs and penalties paid or incurred by the United States Air Force in undertaking actions to address the impacts; provided, however, that, as a prerequisite to the obligation to make such payment, JBA will first provide to Mattawoman invoices

or other documents demonstrating that such additional remediation costs and/or penalties were paid or incurred and the basis for JBA's belief that such costs and/or penalties were directly attributable to Mattawoman's construction activities.

- G-2. Mattawoman shall provide secondary containment for each of the on-site diesel storage tanks. All piping associated with the diesel storage tanks shall either be above ground or shall have secondary containment. Electric equipment that contains dielectric or fuel oil located in the substation and switchyards shall have secondary containment.
- G-3. Mattawoman shall prepare a Spill Prevention, Control and Countermeasures (SPCC) Plan, and have the plan reviewed and certified by a Professional Engineer in the State of Maryland as specified in 40 CFR 112.3. The SPCC Plan shall address on-site storage of diesel fuel and any other aboveground storage of petroleum products or potentially hazardous liquids.

H. NOISE LEVELS

- II-1. Mattawoman shall monitor noise levels at the boundaries of the Mattawoman Energy Center site, after the facility is operational, to verify results of the predictive analysis presented in the Mattawoman CPCN Application. The scope of work for the noise monitoring shall be provided to PPRP and the PSC for review and approval within one year after the effective date of this CPCN. Measurements shall be taken while the facility is in full operation, to represent maximum noise emissions. Mattawoman shall provide results within six (6) months after the facility begins commercial operation.
- H-2. The facility shall operate in compliance with all applicable noise regulations. If the post-construction noise monitoring indicates that the facility is not operating in compliance with those standards, Mattawoman shall work with PPRP and the PSC to incorporate appropriate noise mitigation to ensure regulatory compliance.

I. TRAFFIC

- I-1. Prior to the start of construction, Mattawoman's general contractor shall submit for review a facility construction plan to the Maryland State Highway Administration (SHA). The SHA reserves the right to require temporary improvements at any of the intersections within the study area in order to reduce impacts to traffic operations and maintain safety. For the purpose of this condition, the study area will be defined as the intersections of MD 381 @ Cherry Tree Crossing, MD 381 @ Missouri Avenue, MD 381 @ US 301, MD 381 @ MD 5, MD 381 @ Site Access, and all connecting road segments within. All roadway improvements must be completed prior to on-site manpower exceeding 300 craft and non-manual workers, and shall be required to meet all American Association of State Highway and Transportation Officials (AASHTO) and SHA policies, design criteria, standards and practices for pedestrian and bicycle mobility. Any proposed improvements must be accompanied by a detailed concept schematic/ drawings noting existing and proposed roadway and traffic conditions. An access permit shall be required for all construction work within the SHA ROW. Information on the administrative process and technical requirements for obtaining the appropriate

SHIA access permit can be found in the Maryland State Highway Access Manual, January 2004 at <http://www.roads.maryland.gov/index.aspx?PageId=393>.

- I-2. Mattawoman shall comply with all permit requirements for transport of oversize or overweight loads on State highways and Prince George's County roads, and to obtain appropriate approvals, as necessary.
- I-3. Mattawoman shall obtain appropriate utility permits from the Prince George's County Department of Public Works, Charles County, and the Maryland State Highway Administration to construct the reclaimed water, potable water, sanitary sewer and natural gas pipelines.
- I-4. Prior to construction of the reclaimed water pipeline, natural gas pipeline and generator lead line, Mattawoman shall submit to the SHA a Maintenance of Traffic plan that details work zone impact management strategies on State highways that will be affected by the Project. The plan must be submitted and deemed approved by the SHA prior to the issuance of an access permit for construction within the right-of-way.

J. LAND USE AND VISUAL QUALITY

- J-1. Mattawoman shall design the facility in substantial conformity with the Site Plan drawings reviewed by the Prince George's County Planning Department.
- J-2. Mattawoman shall develop a lighting distribution plan to mitigate intrusive night lighting and avoid undue glare onto adjoining properties. Mattawoman shall submit the plan to PPRP, Joint Base Andrews and the PSC for review and approval prior to operation of the facility.
- J-3. Mattawoman shall establish a landscape buffer along Brandywine Road to provide screening for nearby residential lots and motorists. Enhancements should be in substantial conformance with buffering requirements defined in Section 4.6(c)(2)(A)(ii) of the Prince George's County Landscape Manual.
- J-4. Prior to construction of the generator lead line, Mattawoman shall certify to PPRP and the PSC that it has obtained approval from the Maryland Agricultural Land Preservation Foundation (MALPF) Board of Trustees for an Overlay Easement through Cheltenham Property LLC that is perpetually protected under a Deed of Easement with the Maryland Department of Agriculture as referenced in File No. 16-06-03.

K. PUBLIC SAFETY

- K-1. Prior to construction, Mattawoman shall contact the Prince George's County Fire and Emergency Medical Services Department and the Brandywine Volunteer Fire Department to address site safety and EMS coverage, establish timely response options and facilitate emergency vehicle access throughout the site in case of an accident or injury. Where existing emergency response capabilities are determined to be inadequate, Mattawoman shall assist these organizations through contributions, training and/or general support.

L. CULTURAL RESOURCES

- L-1. In the event that relics of unforeseen archeological sites are revealed and identified during construction of the power plant and associated linear facilities, Mattawoman shall consult with the MHT to develop and implement a plan for avoidance and protection, data recovery, or destruction without recovery of such relics or sites, subject to MHT's written approval.
- L-2. Prior to construction, Mattawoman shall consult with the MHT to determine whether additional cultural resource investigations will be required for the proposed substation site. To the extent that subsequent archeological investigations determine that cultural resources would be adversely affected by the Project, the resolution of all adverse effects will require the negotiation and execution of a Memorandum of Agreement (MOA) between the MHT, Mattawoman and other involved parties stipulating the agreed-upon mitigation measures that will be implemented by Mattawoman prior to construction. This consultation process shall include Prince George's County.

M. LINEAR FACILITIES

- M-1. Mattawoman shall immediately notify the PSC and PPRP if it becomes aware of any significant changes in the routing, permitting, or construction of the natural gas pipeline, reclaimed water pipeline or generator lead line and interconnection substation. If necessary, the PSC may determine, in consultation with State agencies, whether the change constitutes a modification of this CPCN.
- M-2. Mattawoman shall notify the PSC and PPRP if it becomes aware that Dominion Cove Point LNG, L.P. will not be able to meet the expected delivery date to supply natural gas to the Mattawoman Energy Center Project prior to the facility in-service date of May 1, 2018, and provide updated information on the natural gas supply plan.
- M-3. Mattawoman shall submit to the PSC and to PPRP a status report on the permitting and construction of the natural gas pipeline, the reclaimed water pipeline and the generator lead line, within six (6) months after the effective date of this CPCN and every 6 months thereafter until the facilities are permitted and constructed.
- M-4. Prior to construction of the generator lead line and relocation of the SMECO 69-kV distribution line, Mattawoman shall certify to PPRP and the PSC that it has been granted an easement (s) from the Air Force for portions of the generator lead line that cross Air Force land that allow all contemplated activities associated with the generator lead line.

N. GENERAL AND MISCELLANEOUS PROVISIONS

- N-1. Informational copies of the required reports regarding change of ownership, air quality requirements, water supply and process cooling, cultural resources, visual quality, noise studies and linear facilities as described in the Licensing Conditions of Case 9330 (A-2, B-I-2, B-III-5, B-III-6, B-III-7, D-3, D-4, D-6, E-2, E-4, E-5, E-6a, E-6f, E-7b, E-8a, E-10, E-12a, E-14b, E-14d, E-16, H-1, J-2, J-4, M-1, M-2, M-3, M-4) shall be sent to the Power Plant Research Program at:

Director
Power Plant Assessment Division

Department of Natural Resources
Tawes State Office Bldg., B-3
580 Taylor Avenue
Annapolis, Maryland 21401
e-mail: pprp.dnr@maryland.gov

Exhibit 7

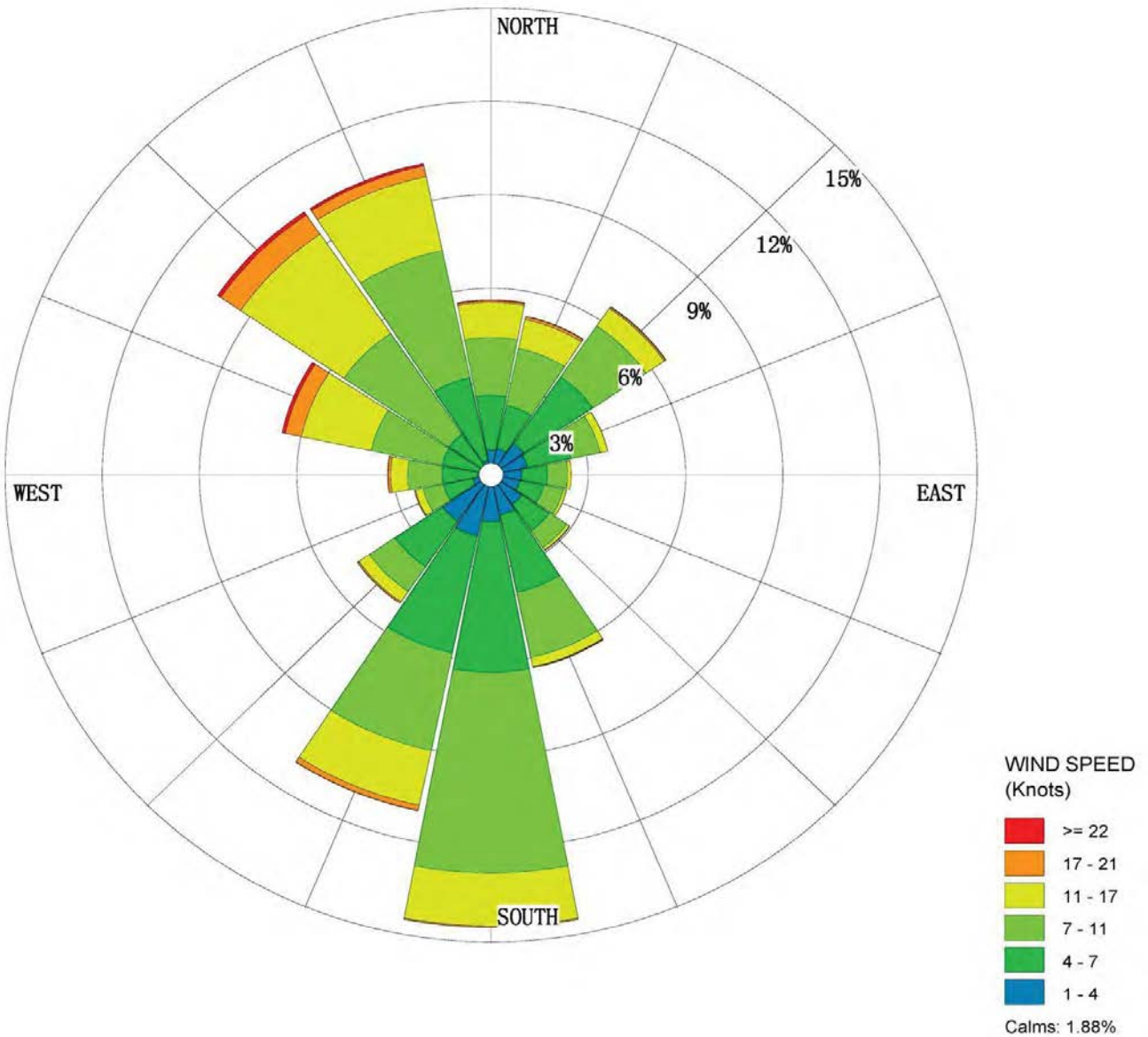


FIGURE 2.2-1.

5-YEAR WIND ROSE FOR WASHINGTON REAGAN NATIONAL AIRPORT (2007 THROUGH 2011)

Source: ECT, 2014.



Exhibit 8

LAW OFFICE OF
G. MACY NELSON, LLC

G. MACY NELSON
DAVID S. LYNCH

SUITE 803
401 WASHINGTON AVENUE
TOWSON, MARYLAND 21204
www.gmacynelson.com

TELEPHONE: (410) 296-8166
FACSIMILE: (410) 825-0670

March 10, 2016

Hand-Delivered

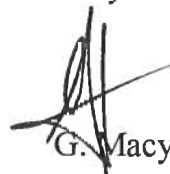
Civil Clerk
Circuit Court for Baltimore City
Courthouse East
111 N. Calvert Street
Baltimore, Maryland 21202

**RE: *In the Matter of John T. Bradley, et al. FOR JUDICIAL
REVIEW OF THE DECISION OF: THE PUBLIC
SERVICE COMMISSION OF MARYLAND***
Case No.: 24-C-15-006839

Dear Clerk:

Enclosed is Petitioners' Memorandum in Support of Petition for Judicial Review for filing in the above-captioned case.

Very truly yours,


G. Macy Nelson

GMN:ldr

Enclosure

cc: Suedeen G. Kelly, Esquire
J. Porter Wiseman, Esquire
Kenneth G. Hurwitz, Esquire
Jennifer J. Grace, Esquire
Theresa V. Czarski, Esquire
Brent A. Bolea, Esquire
Sondra S. McLemore, Esquire
Frank W. Miller, Esquire
Michael L. Casillo, Esquire
Cara M. Johnson, Esquire

PETITION OF:	*	IN THE
JOHN T. BRADLEY, et al.	*	CIRCUIT COURT
FOR JUDICIAL REVIEW	*	FOR
OF THE DECISION OF THE:	*	BALTIMORE CITY
PUBLIC SERVICE COMMISSION	*	
OF MARYLAND	*	
IN THE CASE OF:	*	Case No.:24-C-15-006830
IN THE MATTER OF THE	*	
APPLICATION OF MATTAWOMAN	*	
ENERGY, LLC FOR A CERTIFICATE	*	
OF PUBLIC CONVENIENCE AND	*	
NECESSITY TO CONSTRUCT A	*	
NOMINALLY RATED 859 MW	*	
GENERATING FACILITY IN PRINCE	*	
GEORGE'S COUNTY, MARYLAND	*	
PSC CASE NO. 9330; ORDER NO. 87234		

* * * * *

PETITIONERS' MEMORANDUM IN
SUPPORT OF PETITION FOR JUDICIAL REVIEW

Petitioners, John T. and Leslie Bradley, Joyce and William Dowling, Ginger A. and Michael R. Fluharty, Joanne Flynn. Heather McKee, Earthreports, Inc., Greater Baden Aquasco Citizens Association, and Mattawoman Watershed Society, Inc. (collectively, "Citizen-Protestants"), by their attorneys, G. Macy Nelson, David S. Lynch, and the Law Office of G. Macy Nelson, LLC, pursuant to

Maryland Rule 7-207, hereby submit this memorandum in support of their Petition for Judicial Review.

STATEMENT OF THE CASE

This case arises out of an approval by the Public Service Commission of Maryland (“Commission”) of Mattawoman Energy, LLC’s (“Mattawoman”) request for the issuance of a Certificate of Public Convenience and Necessity (“CPCN”) to allow it to construct a nominally rated 859 megawatt (“MW”) combined-cycle combustion turbine electric generating facility in Brandywine, Prince George’s County, Maryland. The Commission delegated Mattawoman’s request to the Public Utility Law Judge Division to conduct the proceedings. Citizen-Protestants John T. Bradley, Joanne Flynn, and Mattawoman Watershed Society were interested persons to the proceeding.

After a series of public hearings, the Public Utility Law Judge (“Law Judge”) issued a Proposed Order of Public Utility Law Judge (“Proposed Order”), subject to certain conditions, approving Mattawoman’s request for a CPCN. No party to the proceeding noted an appeal to the Commission and the Proposed Order became a Final Order of the Commission. Thereafter, Citizens petitioned for judicial review.

QUESTIONS PRESENTED

1. Whether the Commission's Order adequately articulates the basis of the Commission's decision at a level sufficient for judicial review of the legality of the decision.
2. Whether the Law Judge erred when he denied Citizen-Protestants' Joint Petition to Intervene?

SUMMARY OF THE LAW

Section 7-207 of the Maryland Code (1998, Repl. Vol. 2010), Public Utility Companies Article ("PUA") governs the Commission's review of an application for a CPCN. Section 7-207 provides, in pertinent part:

(e) The Commission shall take final action on an application for a certificate of public convenience and necessity only after due consideration of:

(1) the recommendation of the governing body of each county or municipal corporation in which any portion of the construction of the generating station, overhead transmission line, or qualified generator lead line is proposed to be located; and

(2) the effect of the generating station, overhead transmission line, or qualified generator lead line on:

(i) the stability and reliability of the electric system;

(ii) economics;

(iii) esthetics;

(iv) historic sites;

(v) aviation safety as determined by the Maryland Aviation Administration and the administrator of the Federal Aviation Administration;

(vi) when applicable, air and water pollution; and

(vii) the availability of means for the required timely disposal of wastes produced by any generating station.

Id.

PUA, section 3-106 governs intervention in Commission proceedings:

Application to intervene

(a) If a person timely files, the person may apply to intervene in a proceeding before the Commission.

Decision by Commission

(b) The Commission shall grant leave to intervene unless the Commission concludes that:

(1) the parties to the proceeding adequately represent the interest of the person seeking to intervene; or

(2) the issues that the person seeks to raise are irrelevant or immaterial.

Id.

STATEMENT OF FACTS

On July 19, 2013, Mattawoman filed an application with the Commission for a CPCN to construct a nominally rated 859 MW, natural gas-fired, electric power generating facility on approximately 88-acres of land located at 14175 Brandywine Road in the town of Brandywine, Prince George's County, Maryland

("Subject Property"). (Mattawoman Application, p. 4). The Subject Property is located 1.5 miles east of U.S. Highway 301 on Old Brandywine Road. *Id.* at 11. The proposed Mattawoman power plant would be one of four power plants that either exist or are proposed for the Brandywine area. (Transcript ("Tr"), July 21, 2015, pp. 112-13).

Following Mattawoman's application, the Commission assigned the case to the Public Utility Law Judge Division. Staff of the Public Service Commission ("Staff"), Maryland Office of People's Counsel ("OPC"), and the Maryland Department of Natural Resources, Power Plant Research Program ("PPRP") entered their appearances in the case. On November 13, 2013, the Law Judge granted a petition to intervene filed by the Joint Base Andrews, United States Air Force. (Proposed Order, p. 2).

Thereafter, Mattawoman filed its Environmental Review Document along with direct testimony on various issues related to its application. Staff and PPRP also filed direct testimony. On July 10, 2015, Mattawoman filed an Agreement of Stipulation and Settlement between Mattawoman and Joint Base Andrews. On July 16, 2015, the PPRP filed Revised Licensing Conditions. These conditions include, but are not limited to, regulations related to CPCN general requirements, air quality, construction dewatering, cooling water supply, terrestrial and aquatic ecology, noise levels, and traffic.

The Law Judge held a public comment hearing on July 21, 2015 at the Brandywine Volunteer Fire Department. At that hearing, numerous citizens and environmental organizations testified in opposition to Mattawoman's application for reasons related to traffic, environmental justice, general environmental harm, and air quality.

Citizen-Protestant John Bradley opposed the Mattawoman application and testified about the impact of the proposed Mattawoman power plant on traffic in his community:

I enjoy shopping at a new shopping center in Brandywine. The Brandywine Crossing Shopping Center has a Target and a Safeway and a Costco. I need to plan my trip to get to that shopping center.

In fact, I can't drive to Waldorf any more, and my guess is that most people in this room, if they live in the area, also cannot get to Waldorf.

It's not the shopping center's fault, but the lights on Route 301 and the traffic is an absolute disaster. Absolute disaster.

(Applause)

So my point is that the Keys Power Plant is going to take several years to build. My guess is Mattawoman is going to take several years to build.

As I understand it, for the Mattawoman Plant there was some analysis to potentially put one little light in Brandywine right across from the antique store there, I forget the name of the road, Zoy (phonetic) Avenue, I forget. And that that was mixed.

I am fearful that there will be hundreds of construction vehicles for the Keys Energy Plant and hundreds of construction vehicles and cars of union jobs, et cetera, for the Mattawoman Plant on top of the hundreds of trucks dumping fly ash on the road to my house. That stinks.

I would love it if you guys at the Commission can re-evaluate the transportation and re-assess the value of traffic lights in this area that I don't have to cut through ever winding roads filled with potholes, that's another issue.

So I don't have to time getting to the shopping centers or even Brandywine itself. I now find myself shopping in Marlton or farther away places coming through neighborhoods.

Last point on transportation, this fire station is scheduled to move a little bit farther away, i.e., the high school. And I do believe that we will have a traffic disaster in Brandywine here with all the construction vehicles.

So not only am I concerned about my commute to work. I'm also concerned about the amount of time it's going to take for the fire engine trucks or ambulances, et cetera, to come from the high school on Brandywine Road and North Keys Road with all of this junk going around.

(Tr. July 21, 2015, pp. 75-77).

Frederick Tutman, on behalf of Citizen-Protestant Patuxent Riverkeeper, opposed Mattawoman's application for a CPCN and testified about how the proposed Mattawoman power plant violated principles of environmental justice:

I think it's rather terrible that one could consider siting a power plant in a rural area without further addressing the questions of cumulative impact on the surrounding communities.

Whether it's the part of the process, or whether it's legally compulsory, or I would say certainly it's morally and ethically

compulsory to look at the full impact and not just those that are convenient or expedient.

You know, I'm very aware that it's not unusual for these sorts of cities to shift the burden on its citizens, but we have some obligation to disprove the feasibility of the applicant's plan. And it makes much more sense, right, if the applicant bears the burden to prove that feasibility and to prove those impacts are not onerous.

We know certainly statistically, EPA statistics in particular, as has been said earlier, there is an Environmental Justice trend nationally, not just in to put these onerous protests.

And when I talk about Environmental Justice, I realize most people immediately think of communities of color. But **we're also talking about have and have nots, as in those who have four power plants in their neighborhood and those do not.** There's a heck of a difference between those two extremes.

So there's no way factually, logically, or reasonably that you can suggest that the multiple industrial power facilities put in a relatively small portion, basically the same zip code in urbanizing counties. We'll at least have some change to the quality of life and the quality of the environment for people in those host communities.

The problem is, you know, the applicants obviously are representing investors and they look for affordable spaces and maybe they look for zoning or maybe they look for infrastructure hookups, but Environmental Justice is really not something that is typically compulsory in these processes.

In this case, you know, it's not a federal process. We understand that as well. It's a state process. And it is a troubled process that's one that actually does leave out certain areas of analysis.

Things that it just doesn't look at it doesn't make it germane, and that's again, very, very troublesome. Anyway, there's a lot

of momentum. You know this as well as I, behind these proposals.

It's like citizens who want to push back, find themselves as though they're standing in front of a speeding train trying to hold their hand up. And by the time the train runs over them, someone notices they were hit, is about the time someone wonders gee, I wonder what they were holding their hand up about.

So with that kind of momentum, it's a very lopsided process and obviously, if we're going to get any traction, the citizens who have our concerns considered, not just recorded, but actually reviewed and considered, then it will probably have to be in a much different form.

But anyway, you know, I've been coming to these things for some time, quite a long time, and watching folks officiate over processing. Although impartiality may be a liability, right. You really need advocacy on behalf of the quality of life of these citizens.

So I'm uncomfortable with the only forum being afforded us is one that is pre-determined generally to expedite or facilitate the approval of these applications. That's really tough. So in the simplest of terms, I'm asking you to look honestly and closely at whether we're creating a sacrifice zone here, not just with one unwanted facility, but multiple unwanted facilities.

I know you're supposed to look at them in isolation but it's really not sensible to look at these as discreetly separate applications when there's a cumulative effect. And I understand that there are people in the loop, there always are, who want these plants built regardless of the possible impacts, for any number of possible reasons.

But the citizens here have at least the equitable right to know precisely what those impacts are. That disclosure really hasn't been made.

What will be taken from us that can never be put back. What is being done here that cannot be mitigated, and how do these applications again, cumulatively affect our air, our water, and our environmental quality of life. Any process that can't find this question to be relevant to this process is probably a very broken one. But I'd love it if you'd prove me wrong. I encourage you to try and prove me wrong. Thank you.

Id. at 104-110 (emphasis supplied).

Dr. Henry S. Cole, a former Senior Scientist with the United States Environmental Protection Agency's Office of Air Quality Planning and Standards, testified in opposition to Mattawoman's application. He testified that the cumulative impact of nitrogen emissions from the proposed Mattawoman power plant and other nearby power plants will dramatically impair the air quality and environment of the nearby residential communities and he advocated for the Commission to properly evaluate the significant air quality impacts:

...This community has raised innumerable questions and has not had a proper opportunity to get involved with expertise of its own.

Frankly, if you have to look at the Public Service Commission, it looks to most people like a rubber stamp agency. That must not be the case here. We're talking about a density of power plants in this area that is absolutely unprecedented.

We're talking about major emissions of oxides of nitrogen. **And let me add, that this county is part of a non-attainment region for ozone. The air quality is already unacceptable.** I'm sure that the Public Service Commission understands that. And it might think twice and thrice about locating four power plants in

this area, actually it's five. If we consider, no, I'll name them. Chalk Point is not immediately in this area, but it certainly affects the air quality. Then we have the North Keys Plant. Supposedly it's approved, although I understand there's a permit for the wetlands that needs, something has to happen with that.

Then we have the proposed Panda Mattawoman Plant right in this area. Then we have the North Keys Plant, less than a mile away from here. And over in Charles County we have the Charles Center, Charles County Energy Center.

* * *

So we have this cluster of power plants, some already pumping emissions into the air. Some under construction such as the one in Waldorf which is only 8 miles away from the Mattawoman Plant. And these plants are aligned. I have a map that I've given you which shows that these plants with the exception of Chalk Point, are aligned in a basically a south, southwest to north northeast transect.

What does that mean? It means that when the wind is from the south southwest, to south, to southwest, it comes to a greater or lesser extent and will overlap. In other words, you have the cumulative impact of all of these power plants affecting the air quality in the region.

Now I understand that some modeling has been done. Frankly, I have not had the time to examine those in detail but I can tell you that when it comes to air quality modeling, the devil is in the details, number one; and number two, I can tell you that the consulting firms that do that modeling know exactly where their bread is buttered.

And it's not from the community. They know where their bread is buttered and there's only one right answer to that modeling. That's why you need independent expertise.

And I can tell you that what I've seen so far is that these questions have not been examined to the extent that they need to be examined.

It's not enough, it's not enough to convince the Public Service Commission. You need to convince this community that we're breathing the air here. There's another issue that needs to be addressed.

These power plants leave what's called the rural tier of Prince George's County. That is supposed to be protected because of its tremendous natural resource potential. That's the watershed for the Chesapeake Bay. It's the watershed for the Patuxent River.

When you pump hundreds and hundreds of tons of oxides of nitrogen into the atmosphere, that forms nitrates. That is the positive in the Chesapeake Bay and in the watershed. It's one of the leading power plants, is one of the leading causes of nitrate deposition in the Chesapeake Bay.

* * *

I'll say a little bit more about ozone formation. This is a non-attainment area for ozone, meaning that the air quality here exceeds the national ambient air quality standards for ozone.

That means that the air is not healthy. When you pump in hundreds of tons of oxides of nitrogen, those are precursors for further chemical smog and for ground level ozone. We need to be as a non-attainment zone, reducing the emission of oxides of nitrogen, not increasing them.

Now there's another reason I think we need to delay. You said, and I'm not sure that EPA has yet made its comments on the analysis. I believe Region 3 will be reviewing it. They need an opportunity to look at that. So for all of these reasons, you need to extend the comment period. You need to extend the hearing committee.

This community as person after person has testified, has not had an adequate opportunity to weigh in on very complicated technical issues, on issues that will affect the quality of life and the public health of the people in this area.

So I hope you'll take my requests seriously. You need -- you clearly have not convinced the public here. You need to hold more hearings, more evidentiary hearings to address the many issues you've heard about tonight.

And I can tell you that if you approve that, the fifth power plant in this small area, you will be hearing about it for many years to come. Thank you.

Id. at 110-18 (emphasis supplied).

On August 21, 2015, a group of citizens, including Citizen-Protestants John T. Bradley and Joanne Flynn, filed a Joint Petition to Intervene. Citizen-Protestant Mattawoman Watershed Society, Inc. was also a petitioner. The Joint Petition requested the right to submit written rebuttal expert testimony on the air quality and related environmental and social justice impacts. The Law Judge held a hearing on the Petition to Intervene and on September 25, 2015, issued a ruling denying the Petition to Intervene. The Law Judge wrote: "I find that the Joint Petition to Intervene of the Citizens is not timely, improper under the rules, contrary to the procedural schedule, and not in the best interest of the administration of justice. The Petition is therefore denied." (Law Judge Ruling, p. 5).

On October 13, 2015, the Law Judge issued a Proposed Order approving Mattawoman's application for a CPCN. Before addressing the PUA, section 7-207 criteria, the Law Judge dismissed the environmental and social justice concerns raised by citizens at the public hearing. He wrote:

An allegation was made in public comments that the Brandywine area was targeted for new projects by power plant companies due to its racial and economic demographics. I find that there is no evidence of any improper motive or conduct by Mattawoman in its choice of a location for the Project. It is very hard to find locations in Maryland which have the infrastructure needed to support a power plant that does not have other areas of legal restrictions which makes those locations unsuitable. It is unfortunate for Brandywine that it is a suitable and legally available area for proposed power plant projects. If a proposed plant to be sited in Brandywine meets all legal requirements (at all governmental levels), the fact that other plants are located nearby is not a legal restriction to another one being built. This is true even though the negative impacts of a plant fall most severely upon Brandywine while the benefits are distributed across a much larger geographic area.

(Proposed Order, p. 10).

With respect to the PUA, section 7-207(e)(2)(vi), the Law Judge wrote:

The issues of air and water pollution are areas of concern to the public in Brandywine and its vicinity. I find that the licensing conditions which are to be made part of any CPCN are very detailed and quite extensive in nature. These comprehensive conditions ensure that the Project can be constructed and function within all applicable air and water laws and regulations. **If the state experts were not convinced that this was the case, they would have testified to that effect and would have opposed the Project's construction. I place my trust in their experience in this area to make my findings on this aspect of the analysis herein.**

Law Judge Decision, p. 12 (emphasis supplied). Immediately following this finding, the Law Judge made the following finding regarding section 7-207(e)(2)(vi):

This same consideration applies to the question of disposal of waste produced by this Project and the water usage issues. I find that the licensing conditions and the design of the Project cover the legal requirements of these issues, and I find that these requirements are not a road block to the issuance of a CPCN.

(Proposed Order, p. 12).

No formal party to the proceeding noted an appeal to the Commission, and the Commission adopted the Law Judge's Proposed Order on November 13, 2015. Thereafter, pursuant to PUA, section 3-202(a), Citizen-Protestants noted a timely petition for judicial review.

STANDARD OF REVIEW

Section 3-203 of the PUA sets forth the standard for judicial review of a decision of the Commission:

Every final decision, order, or regulation of the Commission is prima facie correct and shall be affirmed unless clearly shown to be:

- (1) unconstitutional;
- (2) outside the statutory authority or jurisdiction of the Commission;
- (3) made on unlawful procedure;

- (4) arbitrary or capricious;
- (5) affected by other error of law; or
- (6) if the subject of review is an order entered in a contested proceeding after a hearing, unsupported by substantial evidence on the record considered as a whole.

Id.

A court reviews the Commission's decisions "as consistent with the standard of review applicable to all administrative agencies." *Columbia Gas of Md., Inc. v. Pub. Serv. Comm'n of Md.*, 224 Md. App. 575, 580 (2015) (citing *Office of People's Counsel v. Md. Pub. Serv. Comm'n*, 355 Md. 1, 15 (1999)). On judicial review, a court may generally not uphold a decision by an agency "unless it is sustainable on the agency's findings and for the reasons stated by the agency." *Balt. Gas & Elect. Co. v. Pub. Serv. Comm'n*, 75 Md. App. 87, 97 (1988) (quoting *United Steelworkers of America AFL-CIO, Local 2610 v. Bethlehem Steel Corp.*, 298 Md. 665, 679 (1984)). The Commission's written findings "must at least be sufficiently detailed to apprise the parties as to the basis for the agency's decision." *Id.* at 97. "It is not enough for an agency to make only ultimate findings." *Id.* at 98 (quoting B. Schwartz, *Administrative Law*, § 140 (1976)); see also *Bucktail, LLC v. County Council of Talbot County*, 352 Md. 530, 553 (1999) ("[f]indings of fact must be meaningful and cannot simply repeat statutory criteria, broad conclusory statements, or boilerplate resolutions."). "The

agency's decision must be precise and clear enough to allow for meaningful appellate review. If the agency fails to meet this basic requirement, the decision is considered arbitrary and the case must be remanded for the purpose of correcting the deficiency." *Mortimer v. Howard Research & Dev. Corp.*, 83 Md. App. 432, 441-42 (1990).

ARGUMENT

I. THE COMMISSION FAILED TO ADEQUATELY ARTICULATE THE BASIS OF ITS DECISION AT A LEVEL SUFFICIENT FOR JUDICIAL REVIEW OF THE LEGALITY OF ITS DECISION.

By statute, the Commission may only take final action on an application for a CPCN after consideration of specific impacts, including the effect of the proposed power generating station on: "air and water pollution" and "the availability of means for the required timely disposal of wastes produced by any generating station." PUA, § 7-207(e)(2)(vi) and (vii). In approving Mattawoman's application in this case, the Commission's decision was arbitrary and capricious because it failed to adequately articulate findings of fact regarding the effect of the generating station on air and water pollution and the availability of timely disposal of waste generated by the proposed generating station.

Maryland's jurisprudence on the question of what constitutes adequate articulation of findings of fact in an agency decision is well established. An agency's "[f]indings of fact must be meaningful and cannot simply repeat

statutory criteria, broad conclusory statements, or boilerplate resolutions.” *Bucktail v. Talbot County*, 352 Md. 530, 553 (1999). The basis of the decision must appear within the four corners of the decision. *Mortimer*, 83 Md. App. at 446 (declining to speculate on which facts in the record the planning board might have adopted). Maryland’s jurisprudence prohibits a reviewing court from searching the record to find evidence to support an agency action. *See, e.g., United Steelworkers of Am. v. Bethlehem Steel Corp.*, 298 Md. 665, 679-80 (1984). *Cf. E. Outdoor Adver. Co. v. Mayor of Baltimore*, 128 Md. App. 494, 517-18 (1999) (stating that courts reviewing agency records may not “*read* the record ...[and] *guess* at the conclusions drawn.”) (emphasis in original).

In this case, the Law Judge did not adhere to these principles when he recommended approval of Mattawoman’s CPCN application. With respect to air and water pollution, he found:

The issues of air and water pollution are areas of concern to the public in Brandywine and its vicinity. I find that the licensing conditions which are to be made part of any CPCN are very detailed and quite extensive in nature. These comprehensive conditions ensure that the Project can be constructed and function within all applicable air and water laws and regulations. **If the state experts were not convinced that this was the case, they would have testified to that effect and would have opposed the Project’s construction. I place my trust in their experience in this area to make my findings on this aspect of the analysis herein.**

(Proposed Order, p. 12) (emphasis supplied). He then wrote:

This same consideration applies to the question of disposal of waste produced by this Project and the water usage issues. I find that the licensing conditions and the design of the Project cover the legal requirements of these issues, and I find that these requirements are not a road block to the issuance of a CPCN.

Id. From the four corners of the Law Judge decision, which was adopted by the Commission, it is impossible to determine the basis of the decision on air quality and waste disposal. From the Proposed Order, this Court can only conclude that the Commission based its approval of the CPCN on lack of expert testimony from the State opposing the construction of Mattawoman's proposed power plant. Nowhere does the Law Judge articulate what record evidence he relies upon to make his decision regarding air quality and water quality. The Law Judge made no independent factual finding regarding air and water pollution. Rather, he rejected the public's well-reasoned objections based on air quality on the grounds that if they had had merit the State would have sided with the public. This finding is not meaningful. It requires this Court to guess at the conclusions drawn. This Court should vacate the Law Judge's decision because the Law Judge did not articulate what the Law Judge decided and why.

Moreover, even if this Court interprets the Law Judge's reference to the licensing conditions and lack of testimony from "State experts" as the basis of the Law Judge's decision regarding air quality and waste disposal, the Law Judge failed to adopt those conditions and testimony as part of his decision. In an

administrative zoning appeal, the Court of Special Appeals has instructed that “there is nothing inherently improper if the decision that the Council adopted, i.e., the ZHE’s decision, in turn adopts and incorporates reports and recommendations of other public offices – so long as the adopted findings and conclusions within each of those reports are sufficiently articulated, clear, and specific.” *Colao v. County Council of Prince George’s County*, 109 Md. App. 431, 460-61 (1996); see also *Md.-Nat’l Capital Park & Planning Comm’n v. Greater Baden-Aquasco Citizens Assoc.*, 412 Md. 73, 82 n.9 (2009) (“We note that the Planning Board did not simply incorporate by reference the Technical Staff’s Report. It included large portions of the report in the Resolution and added additional findings of fact and conclusions. The Board’s adoption of a substantial portion of a Staff Report does not give rise, in and of its mere adoption, to an adverse inference that the Board abdicated its task to exercise independent judgment.). Here, unlike the administrative decision maker in *Greater Baden-Aquasco*, the Law Judge never adopted the licensing conditions or any other record evidence as part of his findings on the issues of air quality and waste disposal. Indeed, he did not adopt any report or recommendation from any party to the case on the issue of air quality and waste disposal. It is irrelevant whether the licensing conditions contain sufficiently articulated, clear, and specific findings and conclusions regarding air quality and waste disposal (Citizen-Protestants maintain they do not), because the

Law Judge failed to adopt, incorporate by reference, or even reproduce those elements of the record. The Court is bound by the four corners of the decision, and nowhere in the Proposed Order does the Law Judge articulate or give meaningful consideration to the issues of air quality and waste disposal, consideration of which is statutorily mandated.

For these reasons, the Commission's decision, which adopted the Law Judge's Proposed Order, does not articulate clear and specific findings such that it allows this Court to engage in a meaningful review. Citizen-Protestants respectfully urge this Court to remand this case to the Commission for a decision consistent with this Court's Order.

II. THE LAW JUDGE ERRED WHEN HE DENIED CITIZEN-PROTESTANTS PETITION TO INTERVENE.

In *Clipper Windpower v. Sprenger*, 399 Md. 539, 562 (2007), the Court of Appeals explained that a petition to intervene in a Commission proceeding under PUA, section 3-106 would be timely if filed "prior to the close of the proceedings." Here, Citizen-Protestants moved to intervene on August 21, 2015, well before the close of the proceedings. PUA, section 3-106 requires the Commission to allow the applicant to intervene, "unless the Commission concludes that: (1) the parties to the proceeding adequately represent the interest of the person seeking to intervene; or (2) the issues that the person seeks to raise are irrelevant or immaterial." *Id.*, § 3-106(b). Here, the Law Judge found that:

“Citizens raised several areas of concern....All of these issues could have been addressed during the hearing process. Testimony, cross-examination, and evidence could have been presented, **the results of which may have had an impact on the final result of the hearing process.**” (Law Judge Decision, p. 4) (emphasis supplied). If the Law Judge found that the concerns raised by the Citizen-Protestants may have had an impact on the final result of the hearing process, then there can be no question that Citizens met the test set forth in PUA, 3-106(b). The issues Citizen-Protestants sought to raise were not immaterial. Citizen-Protestants satisfied the requirements of PUA, 3-106, and filed a timely Petition to Intervene prior to the conclusion of the case. The Law Judge erred when he denied Citizen-Protestants an opportunity to intervene and introduce expert testimony regarding environmental and social justice concerns, “which may have had an impact on the final result” of the case. For these reasons, Citizen-Protestants respectfully request that this Court reverse the Law Judge’s decision, remand this case to the Commission, and allow Citizen-Protestants to intervene.

CONCLUSION

For all of the reasons stated above, Citizen-Protestants respectfully urge this Court to remand this case to the Commission.

Respectfully submitted,



G. Macy Nelson, Esquire
David S. Lynch, Esquire
Law Office of G. Macy Nelson, LLC
Suite 803
401 Washington Avenue
Towson, Maryland 21204
(410) 296-8166
Attorneys for Petitioners

CERTIFICATE OF SERVICE

I HEREBY CERTIFY, that on this 10th day of March, 2016 a copy of the foregoing Petitioners' Memorandum in Support of Petition for Judicial Review was mailed first-class, postage pre-paid to:

Sudeen G. Kelly, Esquire
J. Porter Wiseman, Esquire
Akin Gump Strauss Hauer & Feld LLP
1333 New Hampshire Avenue, NW
Washington, DC 20036-1564

Kenneth G. Hurwitz, Esquire
Law Office of Kenneth G. Hurwitz
1100 17th Street, NW, Suite 901
Washington, DC 20036-4646

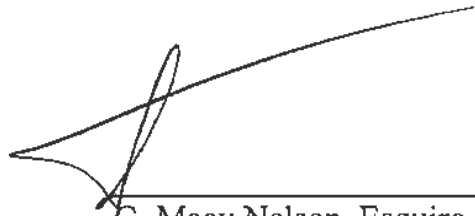
Jennifer J. Grace, Esquire
Assistant Staff Counsel
Maryland Public Service Commission
William Donald Schaeffer Tower
6 St. Paul Street
Baltimore, Maryland 21202-6806

Theresa V. Czarski, Esquire
Deputy People's Counsel
William Donald Schaeffer Tower
6 St. Paul Street, Suite 2102
Baltimore, Maryland 21202-6806

Brent A. Bolea, Esquire
Sondra S. McLemore, Esquire
Assistant Attorneys General
Maryland Energy Administration
60 West Street, Suite 300
Annapolis, Maryland 21401

Frank W. Miller, Esquire
General Attorney
1500 W. Perimeter Road, Suite 5770
Andrews AFB, Maryland 20762

Michael L. Casillo, Esquire
Cara M. Johnson, Esquire
Environmental Litigation Attorneys
AFLOA/JACE
1500 W. Perimeter Road, Suite 1500
Andrews AFB, Maryland 20762



G. Macy Nelson, Esquire

Exhibit 9

A Publication of the Maryland
Power Plant Research Program

PPRP

Electricity in **MARYLAND**

FACT BOOK

2014



MARTIN O'MALLEY, GOVERNOR
ANTHONY G. BROWN, LT. GOVERNOR

“The Maryland Department of Natural Resources (DNR) seeks to preserve, protect, and enhance the living resources of the state. Working in partnership with the citizens of Maryland, this worthwhile goal will become a reality. This publication provides information that will increase your understanding of how DNR strives to reach that goal through its many diverse programs.”

Joseph P. Gill, Secretary
Maryland Department of Natural Resources

This document is available in alternative format upon request from a qualified individual with a disability.

The facilities and services of the Maryland Department of Natural Resources are available to all without regard to race, color, religion, sex, sexual orientation, age, national origin, or physical or mental disability.

Table of Contents



Maryland’s Power Industry..... 1

Introduction 1
Electricity Sales in Maryland 4
Generation, Transmission, and Distribution..... 7
Maryland’s CPCN Process for Generation..... 8



Generation..... 8

Generation Resources in Maryland 9
Distributed Generation 14
PJM Capacity Market..... 15



Transmission 16



Distribution..... 19

Maryland’s Efforts to Improve Grid Resiliency 21



Renewable Energy and Energy Efficiency... 22

Solar 23
Wind 24
Offshore Wind Energy 24
Energy Efficiency and Demand Response..... 26
Policy..... 28



Environmental Considerations 28

References for Additional Information..... 31

Maryland Agencies and Related Publications..... 31



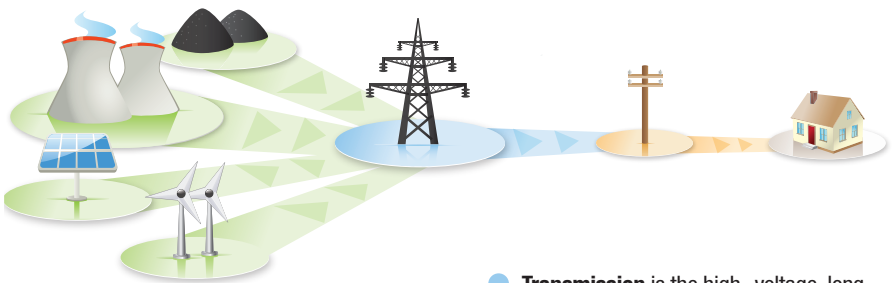
Maryland's Power Industry

Introduction

Maryland's electricity industry is functionally separated into three lines of business: generation and supply, transmission, and distribution (see Figure 1). While customers are billed for each of these three separate functions, most only receive one consolidated electric bill. The generation and supply of electricity is not regulated in Maryland, and prices are set by competitive wholesale and retail electricity markets. The distribution of electricity is a regulated monopoly function of local utilities and is therefore subject to price and quality-of-service regulation by the Maryland Public Service Commission (PSC). The high-voltage bulk electric transmission system is also a monopoly function and is regulated by the Federal Energy Regulatory Commission (FERC).

Retail competition for power supply provides Maryland consumers with an opportunity to choose their own electricity suppliers. For more information about electric choice, visit the Maryland PSC website (<http://webapp.psc.state.md.us>).

Figure 1. *Maryland's Electricity Market*



- **Generation** companies produce power to be sold in the wholesale marketplace. Generation of electricity is a competitive industry in Maryland (i.e., is not subject to price regulation). Retail power supply to end-use customers is also competitive, allowing consumers to choose their own supplier.

- **Transmission** is the high-voltage, long-distance movement of power, while **distribution** is the low-voltage, local delivery of power.

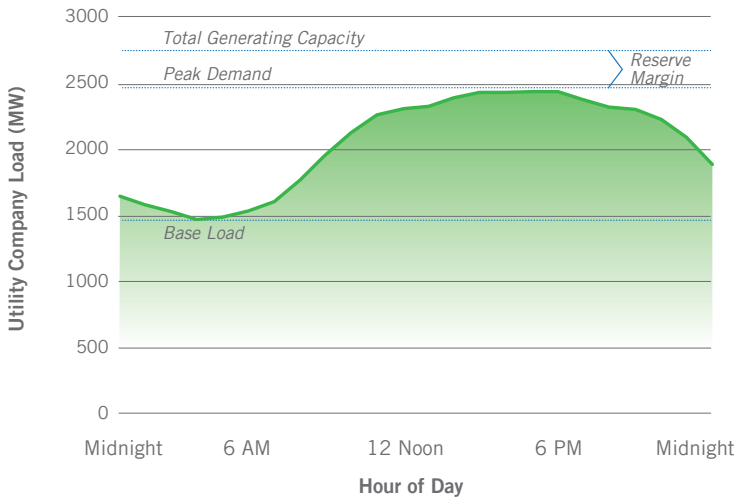
- **Transmission** and **distribution** of electricity continue to be provided by local utilities within their various franchised service territories.

Note on Terminology: The **generating capacity** of a power plant is the maximum amount of power it can instantaneously supply to the grid and is measured in megawatts (MW). **Electricity generation** is the amount of power supplied through time (energy) and is measured in megawatt-hours (MWh).

Maryland is part of PJM Interconnection (PJM), a regional transmission organization (RTO) that is responsible for balancing electricity demand and supply across the Mid-Atlantic region.¹ PJM administers the markets for energy, capacity, and ancillary services, but it does not direct the construction of new generation capacity. As conditions change throughout the day, PJM tells generators when to send electricity out into the grid based on the electricity prices bid by the generators. The power plants that are the least expensive to run operate almost continuously in order to meet the minimum level of electricity that is demanded by a system, which is typically overnight. These plants are considered “base-load” generators. These base-load plants have traditionally been coal and nuclear; however, natural gas has become increasingly more predominant. While base-load generators are expensive to construct, they are relatively inexpensive to operate, and they perform more efficiently and cost effectively when running at a constant level. The typical level of demand that must be met by these base-load plants can be seen in the low-electricity demand hours of Figure 2.

When consumers demand more electricity, the power plants with the ability to quickly send electricity out onto the grid to meet peak demand are put into operation. Peaking power typically comes from smaller fossil fuel units. These units can be more expensive to operate, but they are relatively inexpensive to construct and can start up and shut down quickly. Intermediate or mid-merit plants—which can fill the gap between peak load and base load generators—have become more prevalent in recent years. Intermediate plants typically provide most or all of their energy during the day when energy demand increases, and

Figure 2. Typical Load Profile



¹For more information on regional transmission organizations, see the Transmission Section on page 16; for more information on PJM specifically, see the PJM Interconnection callout box on page 3.

they can either turn off or cycle to a low minimum run level at night so they can match the diurnal demand patterns. Although some coal plants can provide this capability, it is typically natural gas, oil, or hydropower plants that act as mid-merit plants.

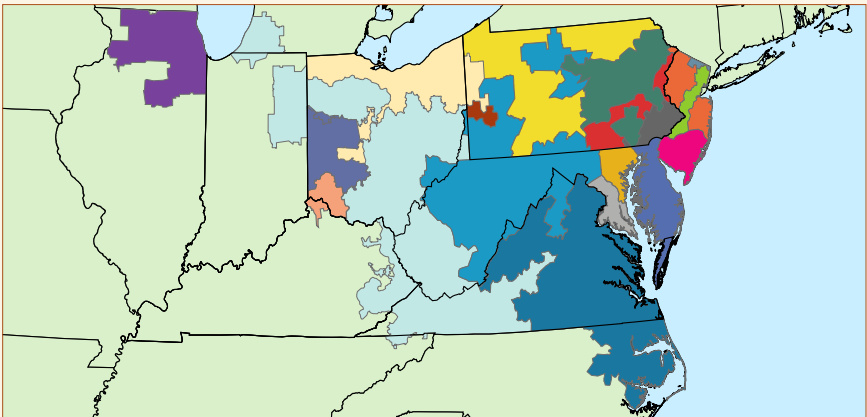
Another resource that PJM can utilize to meet peak demand is demand response (DR), which is achieved when customers voluntarily shut down some of their electricity-using systems, thereby reducing demand for electricity at that time (curtailment). In PJM, thousands of customers participating in DR programs are aggregated by curtailment service providers to create significant savings during times of peak demand. Alternately, customers can use distributed generation (DG) and use small, local generators to switch some local electricity use to those generators.

Retail end-use customers—including residential, commercial, and industrial customers—may purchase electricity from licensed competitive suppliers (i.e., non-utility electricity suppliers) participating in Maryland’s retail electricity market. If a customer does not (or cannot) choose a competitive supplier, then that customer will be served by the regulated electric distribution company under a tariff rate, which differs among the various customer classes. A residential or small commercial customer would be placed on the utility’s Standard Offer Service rate. A larger customer, such as an industrial establishment, would be placed on a different rate, in which the price of energy varies hourly based on the zonal wholesale market for electricity.

PJM Interconnection

PJM Interconnection, which serves Maryland and several nearby states, is one of eight regional transmission organizations and independent system operations with territory covering the United States. It is the largest regional transmission organization, serving more than 61 million people.

PJM Transmission Zones



Source: Transmission Zone, pjm.com/documents/%7E/media/about-pjm/pjm-zones.ashx.

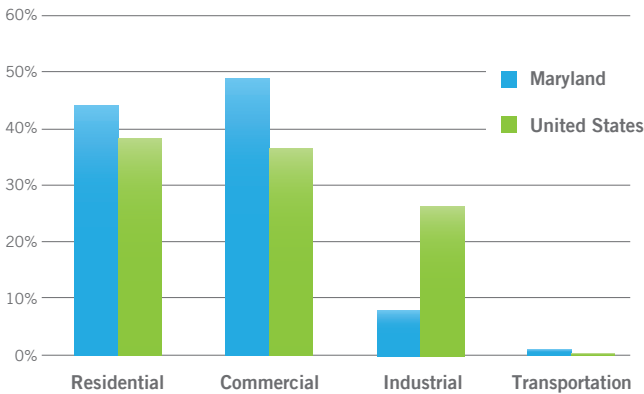
Electricity Sales in Maryland

At the beginning of 2009, only 2.8% of residential customers were being served by competitive suppliers (i.e., non-utility electricity suppliers), but by June 2014, 25% of residential customers had signed with competitive suppliers. By comparison, 34% of small commercial and industrial (C&I) customers were receiving competitive supply, while the majority of medium-to-large C&I customers were already purchasing electricity from competitive suppliers. About 60% of medium C&I customers and 87% of large C&I customers had signed with competitive suppliers by June 2014.

In 2013, Maryland's electricity users consumed approximately 62 million megawatt-hours (MWh) of electricity. Figure 3 shows the percentage of state retail electric sales by customer class. As shown in the figure, Maryland has a larger percentage of sales to residential and commercial customers than the Untitled States as a whole. Recent reductions in electricity consumption in Maryland have been outpacing those in the United States across all sectors.²

In 2013, electricity supply (i.e., generation) accounted for approximately 62% of electricity costs for Maryland's residential customers, 68% for commercial customers, and 71% for industrial customers. Transmission costs represented approximately 5% of the state's total costs for all customer classes. The remaining costs component (33% for residential, 27% for commercial, and 24% for industrial) was related to distribution charges. Figures 4 and 5 and Table 1 provide data on electricity rates in Maryland and the PJM region. Figure 5 shows that Potomac Edison, which serves customers in Western Maryland, has lower electricity prices as compared to the rest of the State's utilities. This price differential is mainly due to congestion between the western region of PJM, where abundant low-cost generation is located, and PJM's Mid-Atlantic region, where the large load centers are located.

Figure 3. Distribution of Retail Electricity Sales in Maryland and the United States, 2013



Source: U.S. Energy Information Administration.

² Maryland Power Plant Research Project, Cumulative Environmental Impact Report-17.

Maryland Electricity Imports

Although the exact percentage varies slightly from year to year, Maryland imported about 40% of its electricity supply in the past two years. Maryland's decreased level of in-state generation in recent years, relative to the earlier parts of the decade, can be partially attributed to record low prices for natural gas which have made imported electricity generated from gas more competitive than in-state generation from coal. As discussed in the generation section, Maryland's share of generation capacity from natural gas is relatively small compared to the rest of the United States.

Electricity (thousand MWh)

	Retail Sales (Consumption)	Sales + T&D Losses	Generation	Net Imports	Percentage of Sales Imported
2000	60,620	65,470	51,145	14,325	22%
2005	68,365	73,834	52,662	21,172	29%
2007	65,391	70,622	50,198	20,424	29%
2008	63,326	68,392	47,361	21,031	31%
2009	62,589	67,596	43,775	23,821	35%
2010	65,489	70,728	43,613	27,115	38%
2011	63,581	68,667	41,913	26,754	39%
2012	61,814	66,759	37,810	28,949	43%

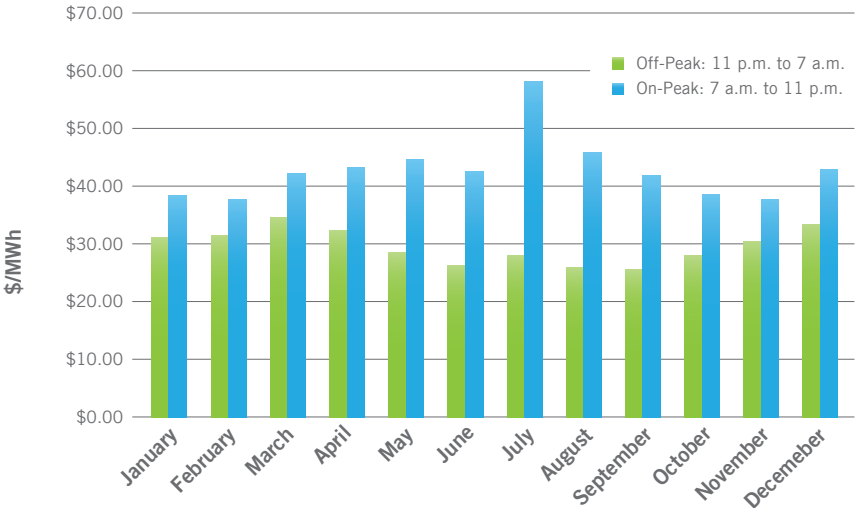
Source: U.S. Energy Information Administration.

Table 1. Typical Prices for Electric Service, 2013

	Residential	Commercial	Industrial
Typical usage billed (kWh/month)	1,000	10,000	50,000
Average per-kWh cost in Maryland (cents/kWh)	13.3	11.1	10.7
Average per-kWh cost in the Mid-Atlantic (cents/kWh)	15.5	13.8	8.6
Average per-kWh cost in the U.S. (cents/kWh)	12.4	10.5	6.9

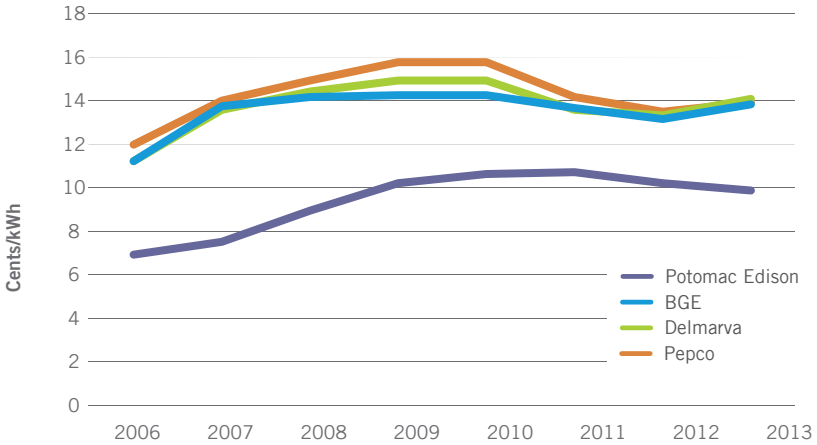
Source: Edison Electric Institute, Typical Bills and Average Rates Report.

Figure 4. PJM Representative Peak and Off-Peak Wholesale Power Prices, 2013



Source: Calculated from 2011 PJM hourly day-ahead locational marginal prices (LMPs) and hourly load data.

Figure 5. Maryland Summer Electric Rates for Residential Standard Offer Service Customers



Note: Includes generation, transmission, and distribution charges.

Source: Edison Electric Institute, Typical Bills and Average Rates Report.

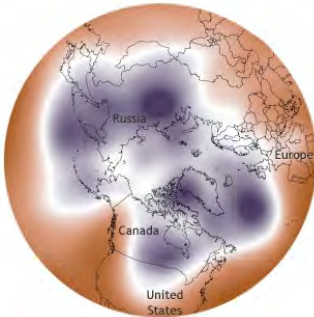
Generation, Transmission, and Distribution

Currently in Maryland, 45 power plants with generation capacities greater than 2 megawatts (MW) are interconnected to the regional transmission grid. In aggregate, Maryland power plants represent more than 13,400 MW of operational capacity. The largest portion of Maryland's generating capacity comes from fossil fuels, with the remainder attributed to nuclear and renewables. In Maryland, there are more than 2,000 miles of transmission lines operating at voltages between 115 kilovolts and 500 kilovolts. There are 13 electric distribution utilities in Maryland serving about 2.5 million customer accounts. About 90% of these customer accounts are served by Maryland's four investor-owned utilities.

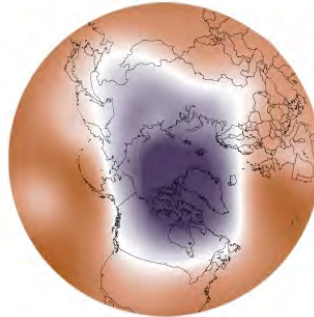
Electricity Price Spikes during the January 2014 Polar Vortex

The polar vortex is a high altitude low-pressure system that hovers over the Arctic during winter (see figure below). From January 6–8, 2014, a polar vortex weather event brought prolonged, deep cold temperatures to the entire PJM region. System operators had to contend with record-high electricity use and significantly higher than normal generator outages. Because of heating needs, PJM demand for electricity set a new winter peak record of 141,846 MW the evening of January 7, but during the peak demand hour, 22% of generation capacity—including coal, gas, and nuclear—was out of service. Although power supplies were maintained without interruption, electricity prices increased significantly due to the generation shortage. On January 7, 2014, wholesale electricity prices in PJM exceeded \$1,800 per MWh. This price was set by emergency DR offers, which meant that DR participants responded to calls for emergency energy and high prices to voluntarily curtail their use of electricity in exchange for curtailment payments. Due to the extreme weather during January 2014, the average wholesale electricity price in PJM was more than \$110/MWh that month. By comparison, the average wholesale electricity price in PJM during January 2013 was only about \$35/MWh—approximately one-third of the January 2014 average.

January 2014 polar vortex configuration



Typical polar vortex



Source: National Oceanic and Atmospheric Administration.



Generation

In states with restructured markets, such as Maryland, electricity is generated by power companies that are separate from the entities responsible for transporting and delivering the resource to end-use customers. In order for a power company to construct or modify a generating facility (or transmission line) in Maryland, it must receive a Certificate of Public Convenience and Necessity (CPCN) from the PSC prior to the start of construction.

Maryland's CPCN Process for Generation

An approved CPCN constitutes permission to construct the facility and incorporates several, but not all, additional permits required prior to construction (such as air quality and water appropriation). Applications for a CPCN are reviewed before a Public Utility Law Judge in a formal adjudicatory process that includes written and oral testimony, cross examination, and the opportunity for full public participation. Parties to a CPCN licensing case include the applicant, PSC Staff, the Office of People's Counsel (acting on behalf of the Maryland ratepayers), and interveners such as Power Plant Research Program (PPRP) (acting on behalf of the Department of Natural Resources (DNR) and six other State agencies). Other groups, such as federal agencies and private environmental organizations, as well as individuals, also have a right to participate as interveners in these hearings. The broad authority of the PSC allows for the comprehensive review of all pertinent issues and was designed in 1971 to be a "one-stop shop" for power plant licensing. In recent years, PPRP has been involved in numerous CPCN cases representing several thousand megawatts of potential generating capacity at existing facilities and green field sites (see Table 2).

Table 2. Recent CPCNs for Generation in Maryland

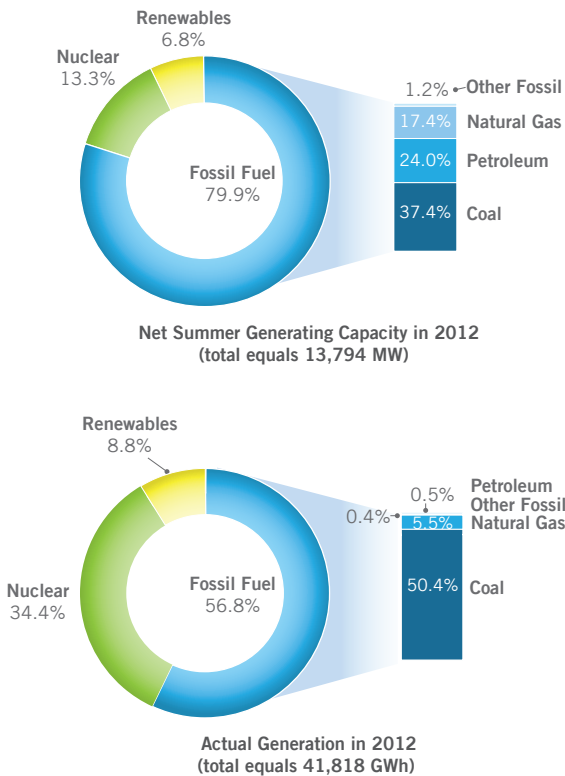
Facility Name	Proposed Size (MW)	CPCN Status	PSC Case Number*
Church Hill Solar	6	granted	9314
Cove Point Natural Gas	130	granted	9318
CPV St. Charles Natural Gas	725	granted	9280
Keys Energy Center Natural Gas	755	granted	9297
Maryland Solar	20	granted	9272
Mattawoman Energy Center Natural Gas	859	pending	9330
Old Dominion Natural Gas	1,000	granted	9327
OneEnergy Cambridge Solar	4.2	pending	9348
Perryman Natural Gas	120	granted	9136
Rockfish Solar	10	pending	9351

* More information regarding each application can be found by using the PSC's case search tool on its website <http://webapp.psc.state.md.us>.

Generation Resources in Maryland

The largest new generation project recently issued a CPCN in the state is a 1,000 MW natural gas power plant that Old Dominion Electric Cooperative (ODEC) is building in Cecil County. In April 2013, ODEC asked the PSC for expedited approval of a CPCN for the project so that it could bid into PJM's May 2014 capacity auction (see page 15 for a description of PJM's capacity market). The project, which is called the Wildcat Point power plant, was approved by the PSC in March 2014, began construction in late 2014, and is expected to be online by June 2017.

Figure 6. Power Plant Capacity (MW) and Generation (GWh) in Maryland by Fuel Category

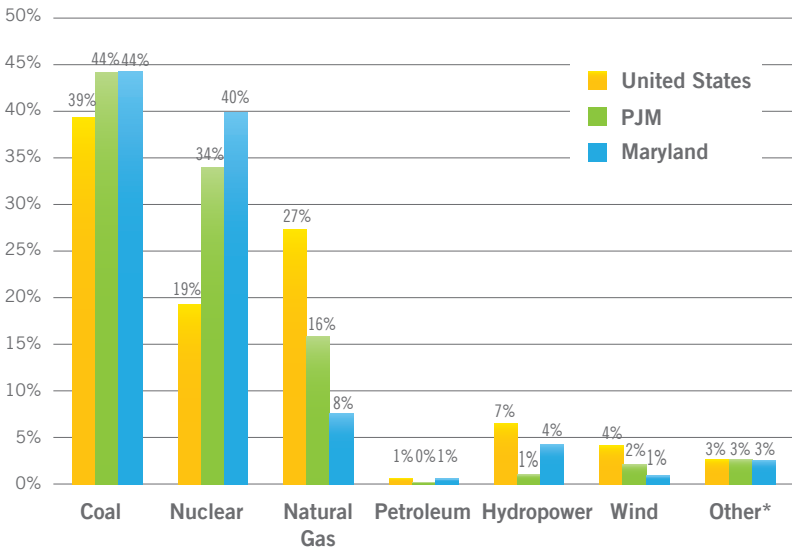


Source: U.S. Energy Information Administration.

Coal is the primary fuel used to generate electricity in Maryland, with nuclear power being the second-largest generation source. Maryland’s coal-fired power plants typically supply about half of the state’s annual electricity generation, while power from the state’s only nuclear plant—the dual-unit Calvert Cliffs facility—typically supplies about one-third of annual generation. Much of the remaining generation is supplied by natural-gas-fueled plants, hydropower plants, and other renewable resources (see Figure 6).

Several major pipelines from the Gulf Coast region supply natural gas to Maryland markets. As shown in Figure 7, Maryland generates a larger portion of its electricity from coal and nuclear fuel than the United States as a whole, while natural gas is used to a larger extent by power plants in other areas of the country compared to Maryland. This is expected to change in the coming years as older coal-fired generators are retired and new natural gas-fired generators, such as the ODEC plant discussed above, come online. Maryland has less renewable generation than the United States as a whole due to the geographic nature of the State. The heartland of the United States has much better wind resources than Maryland, and there are limited opportunities to utilize hydroelectric resources in Maryland.

Figure 7. Electric Generation by Fuel Type for the United States, the PJM Region, and Maryland, 2013



*"Other" includes both fossil and renewable fuels, including: solar, blast furnace gas, biomass, methane, tired derived fuels, and other fuels not otherwise explicitly represented in the figure.

Source: U.S. Energy Information Administration.

Note: Totals may not add up to 100% due to independent rounding.

Table 3. Operational Generating Capacity in Maryland (>2 MW)

Owner	Plant Name	Fuel Type	Nameplate Capacity (MW)
Independent Power Producers			
AES Enterprise	Warrior Run	Coal	229
BP Piney & Deep Creek, LLC	Deep Creek	Hydroelectric	20
Calpine Corporation	Crisfield	Oil	10
Eastern Landfill Gas	Eastern Landfill	Landfill Gas	3
	Calvert Cliffs	Nuclear	1,829
	Conowingo	Hydroelectric	572
	Criterion Wind Park	Wind	70
	Gould Street	Natural Gas	104
	Mount Saint Mary's	Solar	16
	Notch Cliff	Natural Gas	144
	Perryman	Oil/Natural Gas	404
	Philadelphia Road	Oil	83
	Riverside	Oil/Natural Gas	244
Exelon Generation	Westport	Natural Gas	121
	Hagerstown	Solar	20
First Solar, Inc.	Hagerstown	Solar	20
INGENCO	Newland Park Landfill	Landfill Gas	3
Montgomery County	Resource Recovery Facility (RRF)	Waste	68
Northeast Maryland Waste Disposal Authority	Gude & Oaks Landfills	Landfill Gas	3
	Chalk Point	Coal/Oil/ Natural Gas	2,563
	Dickerson	Coal/Oil/ Natural Gas	930
NRG Energy	FedEx Field Solar Facility	Solar	2
	Morgantown	Coal/Oil	1,548
	Vienna	Oil	183
Panda Energy	Brandywine	Natural Gas	289
Pepco Energy Services	National Institutes of Health	Natural Gas	23
Prince George's County	Brown Station Road	Landfill Gas	6

Owner	Plant Name	Fuel Type	Nameplate Capacity (MW)
Gestamp Wind	Roth Rock Wind Facility	Wind	50
	Brandon Shores	Coal	1,273
Raven Power Holdings, LLC	C.P. Crane	Coal/Oil	399
	H.A. Wagner	Coal/Natural Gas/Oil	976
Suez Energy North America	Millennium Hawkins Point	Oil/Natural Gas	11
	University of Maryland – College Park	Oil/Natural Gas	27
SunEdison	University of Maryland - Eastern Shore	Solar	2
Wheelabrator Technologies	Wheelabrator Incinerator (formerly BRESCO)	Waste	65
Publicly Owned Electric Companies			
Town of Berlin	Town of Berlin	Oil	9
Easton Utilities	Easton	Oil/Biodiesel	69
Old Dominion Electric Cooperative	Rock Springs	Natural Gas	770
Southern Maryland Electric Cooperative (SMECO)	SMECO Solar	Solar	5
	Chalk Point Turbine	Natural Gas	84
Self-Generators			
American Sugar Refining Co.	Domino Sugar	Oil/Natural Gas	18
Hilco Industrial	Sparrows Point	Natural Gas/Blast Furnace Gas	120
Maryland Department of Public Safety and Corrections	Eastern Correctional Institution (ECI) Cogeneration Facility	Wood	4
New Page	Luke Mill	Coal	65
Solo Cup	Solo Cup – Owings Mills	Natural Gas	11

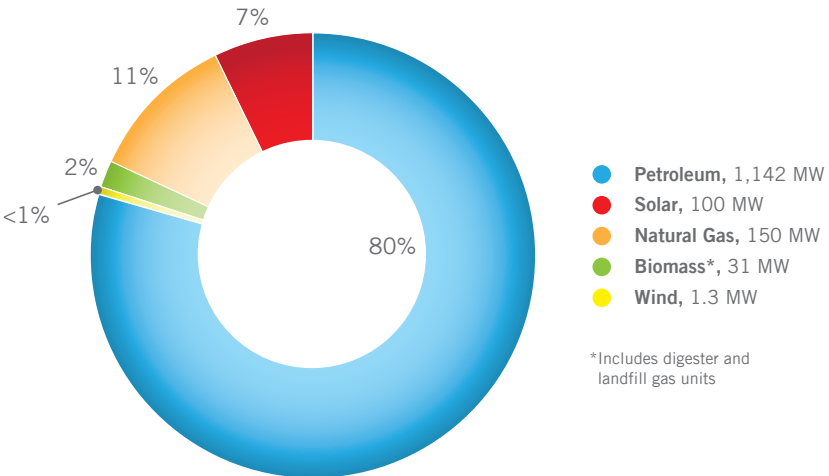
Source: Maryland Power Plant Research Project, *Cumulative Environmental Impact Report-17*.

Distributed Generation

It is difficult to accurately estimate the total amount of DG in Maryland, as the majority of DG units are diesel-fired, emergency back-up generators. However, an increasing share of this capacity comes from solar energy, which is predominantly grid-tied for the purposes of net metering and generating solar renewable energy credits (SRECs) for sale or trade. Net metering is a billing mechanism that allows DG owners to be credited for excess electricity that is added to the grid. In other words, under a net metering arrangement, a DG customer's electric meter can run backwards when the DG system is generating more electricity than the customer is consuming. SRECs are used to comply with Maryland's Renewable Energy Portfolio Standard (RPS), which is described on page 22.

Onsite generators with capacity less than 1,500 kilowatts (kW) are not required to apply for a CPCN through the PSC. Certain generators, including most solar DG, that have a capacity of 1,500 kW to 70 MW are eligible to seek a CPCN exemption. As of the end of 2013, a total of about 1,575 MW of generation capacity had been granted CPCN exemptions in Maryland, including 61.8 MW of solar capacity and 190 MW of onshore wind power. Under net-metering arrangements, 100 MW of solar DG and 1.3 MW of small wind facilities had been installed in Maryland by mid-2013 (see Figure 9).

Figure 9. *Distributed Generation Capacity in Maryland, 2013*



Source: Maryland Power Plant Research Project, Cumulative Environmental Impact Report-17.

PJM Capacity Market

PJM operates a forward capacity market, in which an auction is conducted three years in advance of the need for generation capacity, where load serving entities (LSEs, for example, Baltimore Gas and Electric) purchase supply-side and demand-side capacity resources.³ Each LSE is required to have available its share of the PJM system peak plus a reserve margin of an additional (approximately) 15% of peak load. This means that the system as a whole must always have more generation capacity available than what is expected to be required to meet peak loads so that extra electricity generation can be brought into use if needed, e.g., in the event of an unplanned outage of one or more large generating plants or extreme weather conditions.

The current PJM capacity market is based on PJM's Reliability Pricing Model (RPM), implemented in 2007 as a means to provide power plant developers with price signals to influence decisions on whether (and where) to construct new power plants and to provide owners of existing generation with price signals to influence decisions on whether to retire existing plants. The RPM is an approach developed by PJM and used to provide a market price for capacity that is aligned with PJM's assessment of the cost of new entry, i.e., the level of revenue that a power plant developer would require in order to make the decision to develop peaking resources economically feasible. The approach also recognizes and accommodates higher capacity prices when PJM is capacity short and lower prices when excess capacity exists.

The RPM establishes capacity prices that are determined through an auction three years in advance of the need for generation capacity resources. The most recent auction, which occurred in May 2014 for the 2017/2018 delivery year (i.e., June 1, 2017 through May 31, 2018), cleared 167,004 MW of unforced capacity in the PJM region.

Fundamentally, capacity market prices are determined through the intersection of a demand curve and a supply curve (i.e., the equilibrium market clearing price):

The Demand Curve—the downward sloping demand curve, referred to by PJM as the Variable Resource Requirement (VRR), is developed for the PJM region and also for the locational delivery areas (LDAs). This curve is plotted on a graph with dollars per MW-day on the vertical axis and MW of capacity (or percentage of reliability requirement) on the horizontal axis.

The Supply Curve—the supply curve is obtained by PJM through the capacity bids offered by the capacity owners. Eligible capacity includes existing and new capacity, demand-side resources (e.g., load response), and qualified transmission upgrades. The capacity offers from the auction are stacked (lowest cost to highest cost), resulting in an upward sloping supply curve. The auction clearing price is determined by the intersection of the VRR and the supply curve (the auction bids).

³ An LSE is any entity that (a) serves end-users located in PJM, and (b) is granted the authority or has an obligation pursuant to state or local law, regulation, or franchise to sell electric energy to end-users located in PJM.



Transmission

The transmission grid conveys electricity over a system of high-voltage electric lines that extend between electric generators and distribution companies. Proper coordination and planning of the transmission system is critical to maintaining electric reliability and providing adequate power supplies at reasonable prices. The map in Figure 10 illustrates the extent of Maryland’s existing transmission network. FERC regulates the transmission of electricity, natural gas, and oil in the United States. In regard to the electricity industry, FERC is responsible for regulating the transmission system and wholesale sales of electricity, ensuring the reliability of high-voltage transmission systems, and monitoring and investigating the energy markets. For more information, visit FERC’s website (www.ferc.gov).

Under Maryland regulations, an electric company that is planning to construct a transmission line greater than 69 kilovolts (kV) in Maryland must receive a CPCN from the PSC prior to the start of construction. The PSC considers impacts on Maryland’s resources (e.g., land use impacts) and requires a thorough environmental and socioeconomic impact evaluation as part of the CPCN approval process for transmission projects in Maryland. Table 4 summarizes the recent projects for which CPCN permits have been obtained.

Table 4. Recent CPCNs for Transmission in Maryland

Line Name	Developer/ Owner	Size (kV)	Approximate Length in MD (miles)	Affected MD Counties
Monocacy-Ringgold-Carroll Modification	Potomac Edison	230	13	Washington, Frederick, Carroll
Northwest-Deer Park	BGE	115	3	Baltimore, Carroll
Conastone-Graceton	BGE	230	2	Harford
Church-DE/MD State Line	Delmarva	138	11	Queen Anne’s
Bagley-Graceton	BGE	230	14	Harford
Church-Wye Mill	Delmarva	138	26	Queen Anne’s
Cecil to MD/DE State Line	Delmarva	138	2	Cecil
Northeast Transmission System	BGE	230	21	Harford, Baltimore
Mt. Storm to Doubs	Potomac Edison	500	3	Frederick
Burtonsville to Takoma	Pepco	230	10	Montgomery

Source: Maryland Power Plant Research Program, *Cumulative Environmental Impact Report-17*.

Regional transmission organizations are responsible for operating and controlling transmission assets, providing equal-access wholesale transmission services, and administering the wholesale electricity and ancillary services market within a geographic region. Independent system operators (ISOs) perform similar functions; however, in contrast to RTOs, they have not sought formal RTO status from FERC, or they do not meet one of FERC’s characteristic or functional RTO criteria. The concept and regulatory construct governing these organizations was created by FERC as a mechanism to facilitate the many transactions that take place when states, like Maryland, introduce competitive electricity supply.

PJM is the FERC-regulated RTO that dispatches and coordinates the flow of bulk power across the District of Columbia and all or parts of the following 13 states: Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. PJM routinely examines proposed transmission projects to determine if they are economically justified and would produce an overall system benefit. Authorized transmission upgrades to improve system reliability could potentially alleviate congestion costs in Maryland. PJM’s 2013 Regional Transmission Expansion Plan authorized 10 transmission upgrades for Maryland and the District of Columbia, with each costing more than \$5 million. Together, the upgrades cost approximately \$179.2 million. Also, Edison Electric Institute highlighted six ongoing transmission upgrades within Maryland totaling approximately \$469 million. According to the Public Service Commission of Maryland’s *Ten-Year Plan (2014-2023) of Electric Companies in Maryland*, there are 45 identified transmission enhancement accounting for more than 239 miles of upgrades.

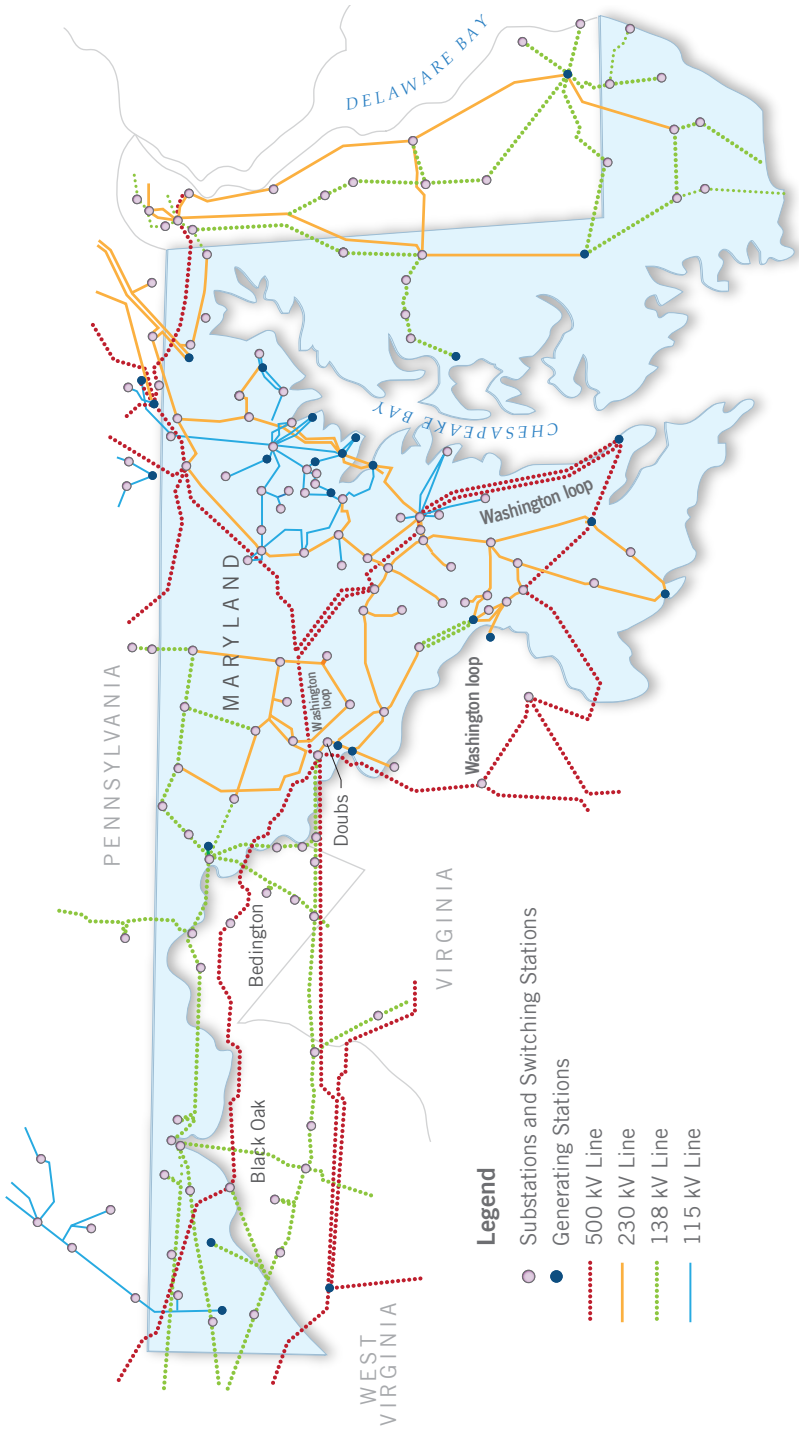
PJM zones are organized according to the service territories of the distribution utilities. To establish energy prices, PJM uses a uniform price auction based on locational marginal prices (LMPs), which vary across PJM zones and time of day. Electricity generators bid the amount of energy they would like to sell at a particular time and price. In the wholesale electricity market, LMPs vary because of physical system limitations, congestion, and loss factors. Table 5 shows the average annual LMPs for 2013.

Table 5. Average Annual LMPs, 2013

Maryland	\$43.59	Pennsylvania	\$39.15
Delaware	\$41.01	Washington D.C.	\$43.27
Ohio	\$36.34	West Virginia	\$36.19

Source: U.S. Energy Information Administration.

Figure 10. Transmission Lines in Maryland





Distribution

Distribution is the process by which electricity is physically delivered to end users. The Maryland PSC regulates and recognizes electric companies' monopoly franchise function to deliver electricity to all customers within their respective service areas. As part of the monopoly franchise arrangement, distribution companies are subject to price and other regulations by the PSC.

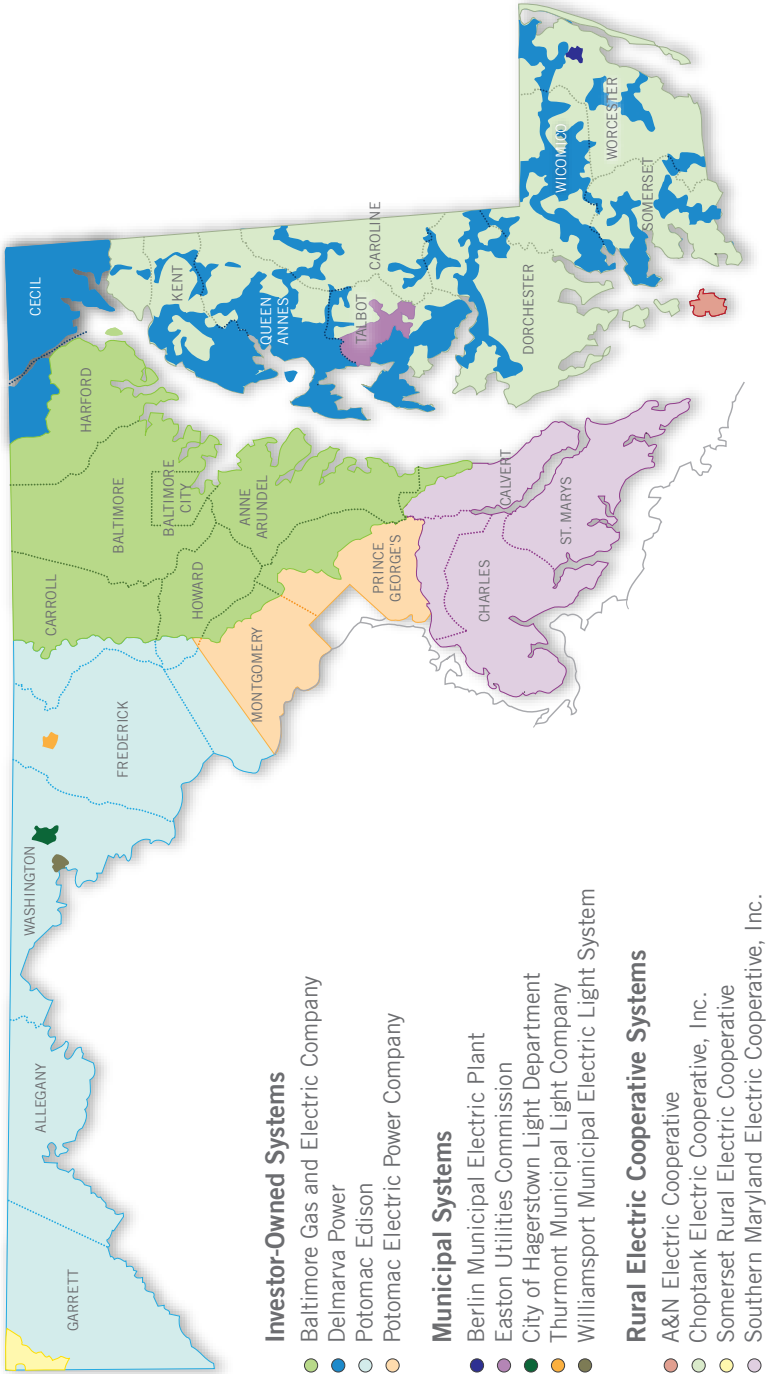
There are 13 electric distribution utilities in the State of Maryland (see Figure 11) that serve about 2.5 million electricity customer accounts. Of these, four are investor-owned systems, five are municipal systems, and four are electric cooperatives. As shown in Table 6, about 90% of Maryland's electric service is provided by the four investor-owned utilities. The remaining customers are served by municipal systems and rural electric cooperatives.

Table 6. *Maryland Electric Distribution Companies*

Company	Approximate Number of Maryland Customers
Investor-Owned Systems	90.3%
Baltimore Gas and Electric Company	1,240,300
Delmarva Power	199,400
Potomac Edison	252,800
Potomac Electric Power Company	531,200
Municipal Systems	1.4%
Berlin Municipal Electric Plant	2,400
Easton Utilities Commission	10,500
City of Hagerstown Light Department	17,400
Thurmont Municipal Light Company	2,800
Williamsport Municipal Electric Light System	1,000
Rural Electric Cooperative Systems	8.3%
A&N Electric Cooperative	300
Choptank Electric Cooperative	52,000
Somerset Rural Electric Cooperative	800
Southern Maryland Electric Cooperative	151,700
Total	2,462,700

Source: Maryland Power Plant Research Program, *Cumulative Environmental Impact Report-17*.

Figure 11. Maryland Electric Distribution Service Territories



Microgrids and Resiliency in Maryland

On June 23, 2014, the Maryland Energy Administration released the *Resiliency through Microgrids Task Force Report*, charting a path forward for microgrid deployment in Maryland. The report is the result of roundtable meetings with representatives from Maryland's government agencies, sister states, project developers, utilities, and non-profit think tanks, as well as ratepayer advocates, regulatory lawyers, and university and law school professors. As defined by the Task Force, a "microgrid" is a collection of interconnected loads, generation assets, and advanced control equipment installed across a defined geographic area that is capable of disconnecting from the macrogrid (i.e., the utility scale electric distribution system) and operating independently. The Task Force focused on microgrids serving the public good, termed "public purpose microgrids", and recommended that Maryland pursue the development of public purpose microgrids for uninterrupted electric service to critical community assets such as community centers, commercial hubs, and emergency service complexes. The Task Force also recommended that Maryland create a Grid Transformation Program to help facilitate its recommendations, and that Maryland launch three new grant programs for public purpose microgrid projects, advanced controls, and energy storage.

Maryland's Efforts to Improve Grid Resiliency

Following several incidents of storms and outages in Maryland during 2010 and 2011, the PSC initiated Rulemaking 43 to consider revisions to state regulations in regard to electric company reliability and service quality standards. On April 17, 2012, regulations were adopted to include new requirements and stricter standards. Examples include service interruption standards that require utilities to restore service within a defined amount of time; downed wire standards that require utilities to respond within 4 hours of notification by a fire department, police department, or 911 emergency dispatcher at least 90% of the time; a communications standard that requires utilities to answer calls within a certain amount of time; vegetation management standards that aim to keep power lines clear of potential falling hazards; and a requirement for periodic equipment inspections.

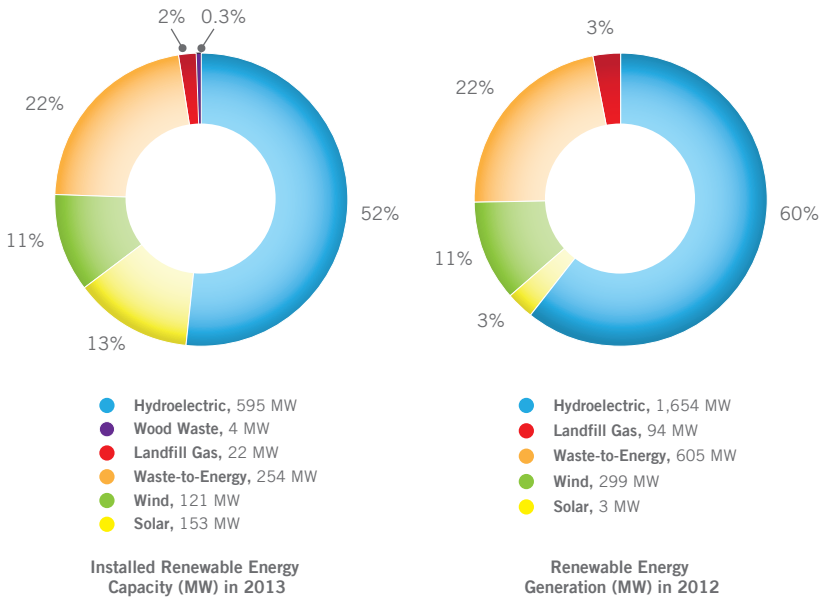
Shortly after the 2012 derecho, Maryland issued a comprehensive report, *Grid Resiliency Task Force: Weathering the Storm*, and published interactive maps of both the Pepco and BGE service territories. The maps display those areas that experienced outages after major storms from 2010–2012. In addition, the report details a list of specific technology, infrastructure, regulatory, and process recommendations to improve the resiliency of Maryland's electric distribution grid.



Renewable Energy and Energy Efficiency

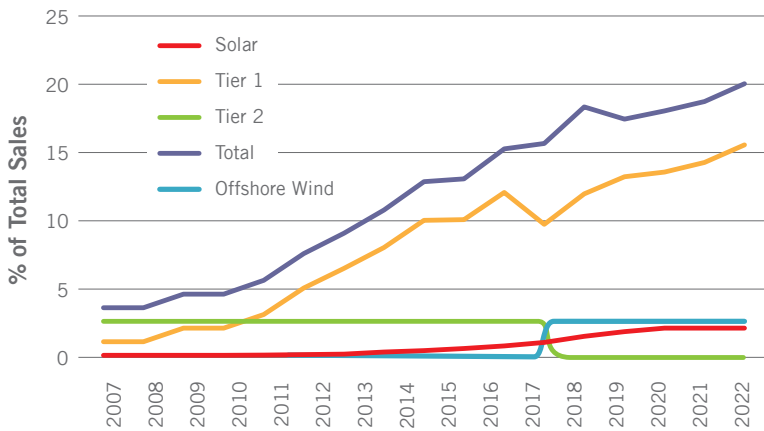
There are four main types of renewable energy resources in use in Maryland: wind, biomass, solar, and hydropower. Approximately 1,150 MW of generation capacity in Maryland comes from these resources, with hydroelectric accounting for the largest share (see Figure 12). In 2004, Maryland's State Legislature established the Maryland Renewable Energy Portfolio Standard (RPS), which requires electricity suppliers to obtain an increasing percentage of their power from renewable energy sources (see Figure 13). The RPS has been amended numerous times over the past decade; the most recent significant legislation affecting the RPS was passed in 2013 to include a carve-out specifically for offshore wind energy. For more information about Maryland's renewable resources, as well as their eligibility for inclusion in the RPS, follow the Program Activities link on the Maryland Power Plant Research Program website (www.pprp.info).

Figure 12. Renewable Energy in Maryland



Source: Maryland Power Plant Research Project, *Cumulative Environmental Impact Report-17*.

Figure 13. Maryland RPS Requirements



Source: Maryland Offshore Wind Energy Act of 2013; Maryland House Bill 226; 2013.

Notes: The Tier 1 line represents the remaining portion of the Tier 1 requirement after netting out the solar and offshore wind carve-outs. The offshore wind carve-out does not come into effect until 2017, coinciding with the time that the Tier 2 requirement declines to zero.

Solar

Maryland has several policies in place that encourage the deployment of solar energy systems. One such policy is the state’s RPS, which calls for 20% renewable energy by 2022, with 2% coming from solar energy sources by 2020. Solar systems must be connected to the distribution grid in Maryland to be eligible. Load-serving entities can self-generate solar power, purchase SRECs, or pay the solar alternative compliance payment of up to \$400 per MWh (declining through time)—providing a financial incentive to homeowners, businesses, and independent developers to install solar renewable energy systems.

As of late 2013, there were more than 5,400 in-state solar projects representing more than 150 MW of generating capacity in the state. While most of the facilities are smaller than 10 kW, at least seven systems larger than 1 MW have come online. Maryland’s solar RPS resources generated 82,610 MWh of renewable electricity in 2012. Based on expected electricity consumption in 2020, about 1,150 MW of solar capacity is required to be operational in Maryland to meet the 2020 solar requirement, meaning that Maryland’s solar generation must grow by about 30% per year.

Wind

Wind power is one of the most affordable, scalable, and deployable renewable energy sources in the region. There are seven land-based wind turbine projects under development in the State of Maryland—each in various stages of permitting, construction, and operation. The Backbone Mountain ridge line in Garrett County already supports two utility-scale wind facilities: the 70 MW Criterion Wind Park and the 50 MW Roth Rock Wind Energy Farm. Their combined power capacity of 120 MW is estimated to represent less than 10% of Maryland’s onshore wind resource potential. The five other projects—representing about 420 MW of wind-power capacity—are currently in the planning and development stages. For more information about renewable wind energy, visit MEA’s website (<http://energy.maryland.gov>).

Offshore Wind Energy

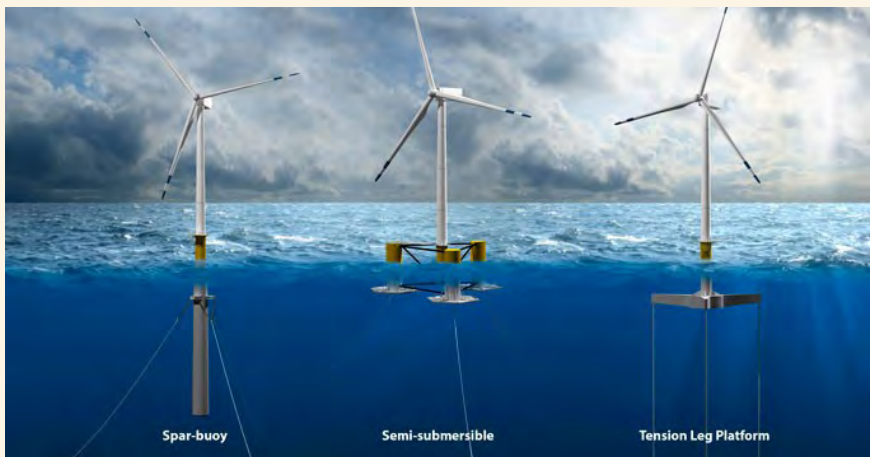
According to the National Renewable Energy Laboratory (NREL), the United States may have a usable offshore wind resource capacity of more than 4,000 GW, with approximately 480 GW to 570 GW of that potential in the Mid-Atlantic region. NREL estimates that Maryland alone has an unrestricted offshore wind power capacity in excess of 25 GW. A report prepared by the University of Delaware suggests that after accounting for possible conflict areas, Maryland’s wind resource potential is likely closer to 13 GW.

The Maryland Offshore Wind Energy Act of 2013 (the Offshore Wind Act) creates a mechanism to incentivize the development of up to 500 MW of offshore wind capacity, at least 10 nautical miles off of Maryland’s coast. The Offshore Wind Act creates a “carve-out” for energy derived from offshore wind within the state RPS. The carve-out requires that a portion of state electricity sales must come from offshore wind power facilities beginning in 2017 and for every following year. The amount of offshore energy required each year is set by the PSC, is based on the projected annual creation of “offshore wind renewable energy credits” by qualified offshore wind projects, and may not exceed 2.5% of total retail sales. The Offshore Wind Act establishes an application and review process for the PSC for proposed offshore wind projects and limits rate impacts to both residential and nonresidential electric customers. The electric bills of residential customers are limited to a \$1.50 per month increase, while commercial customers are limited to a 1.5% increase.

Under the Energy Policy Act of 2005, the U.S. Department of the Interior’s Bureau of Ocean Energy Management (BOEM) is the lead federal agency responsible for issuing leases in federal waters (greater than 3 nautical miles from shore) for ocean energy technologies. BOEM held a lease sale (i.e., a competitive auction) on August 19, 2014, for the Wind Energy Area (WEA) identified off Maryland’s coast. The WEA shown in Figure 14 covers approximately 80,000 acres and is located about 10 nautical miles off the coast of Ocean City, Maryland. BOEM auctioned the Maryland WEA as two leases—referred to as the North Lease Area (32,737 acres) and the South Lease Area (46,970 acres).

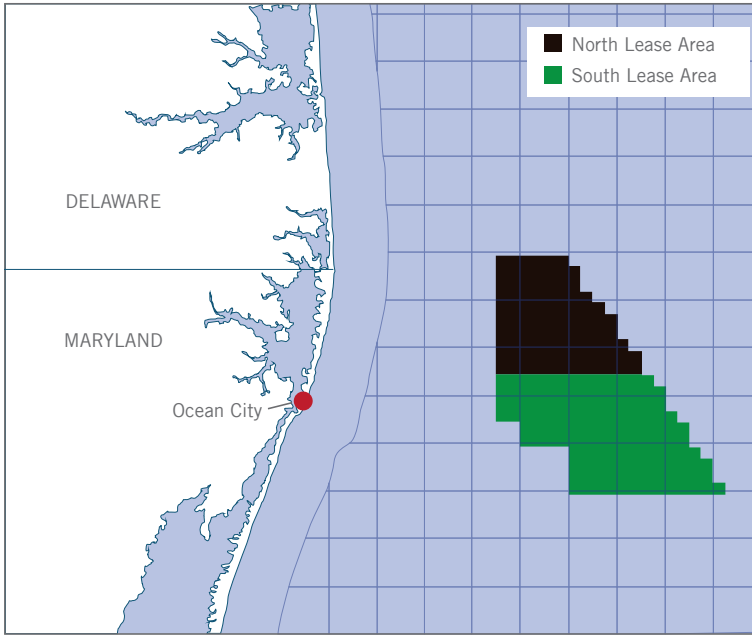
Engineering Concepts for Offshore Wind Turbines

Manufacturers are currently working to develop large wind turbines capable of generating significantly more electricity than traditional onshore wind turbines. Modern land-based, commercial-scale wind turbines typically have a rated capacity between 1.5 MW and 3 MW, but offshore turbines are projected to be in the 10 MW–20 MW range. Support structure designs for large offshore wind turbines are still in the research and development stage and continue to evolve over time. Offshore turbines have historically been installed primarily in relatively shallow water (up to 30 meter [~100 ft] depth) on a mono-pile structure that is essentially an extension of the tower. Other concepts that are more appropriate for deeper water depths include fixed-bottom, space-frame structures (such as jackets and tripods); floating platforms (such as spar-buoys and semi-submersibles); and tension-leg platforms.



Source: Josh Bauer and National Renewable Energy Laboratory.

Figure 14. Map of the Maryland Wind Energy Area



Source: U.S. Department of the Interior, Bureau of Ocean Energy Management.

Energy Efficiency and Demand Response

Reductions in energy usage by Maryland electricity consumers can come from energy efficiency, conservation, or demand response. Energy efficiency means using less energy to accomplish the same work. Conservation means making conscious changes in behavior in order to use less energy (or other resources). Demand response means reducing the demand for electricity when prices are high by using efficiency, conservation, or alternative sources of electricity.

In July 2007, the state introduced EmPOWER Maryland, which aims to cut Maryland's per capita energy consumption and peak demand by 15% by 2015. By the end of 2013, the EmPOWER Maryland utilities' portfolio of energy efficiency, conservation, and direct-load control programs have resulted in energy savings of 61% of the 2015 EmPOWER Maryland goal, while peak-demand reductions accounted for 73% of the 2015 EmPOWER Maryland goal. Overall, these programs have achieved 1,538 MW in reported peak-demand reductions and more than 3.3 million MWh in reported energy savings.

Plug-In Electric Vehicles in Maryland

Over the next couple of decades it is expected that increasing electrification of the transportation sector in the form of plug-in electric vehicles (PEVs) will have a significant effect on the electricity system. As discussed in *Maryland Power Plants and the Environment* (CEIR-17), integrating PEV charging into the electric grid comes with both costs and benefits. For more information related to the impact of PEVs on the electric grid, please visit: <http://pprp.info/ceir17/HTML/Chapter5-5-4.html>.

As the EmPOWER Maryland legislation did not set goals beyond 2015, the state is actively coordinating with various utility, environmental, and industry stakeholders to plan for the next phase of EmPOWER Maryland. In September 2014, the state's utilities submitted plans to the Maryland PSC for achieving EmPOWER Maryland targets for the next three years.

Demand response allows end-use customers to reduce their energy consumption during periods of high demand (and high prices). Voluntary usage reductions can come from customers of all sizes. Large industrial customers may choose to shift some high-energy-intensity processes to lower-cost hours. Small residential consumers can cycle air conditioning and electric water heaters. When aggregated across thousands of customers, these residential energy-use reductions can create significant savings during times of peak demand. For more information, visit the MEA website (<http://energy.maryland.gov/>).

Avoided Energy Costs in Maryland

In April 2014, PPRP and MEA released *Avoided Energy Costs in Maryland*, a report that provides a set of estimates of the avoided costs associated with electric energy efficiency and conservation in Maryland implemented through the state's EmPOWER Maryland initiative. The report provides a common framework and methodology that can be used to estimate the value of future energy efficiency and conservation measures in Maryland. The avoidable cost components analyzed in the report include electric energy, electric capacity, renewable energy, transmission and distribution, demand reduction induced price effects, natural gas, other fuels, and water and wastewater.



Environmental Considerations

Policy

There are several state and federal policies with which Maryland must comply in order to help reduce the environmental impacts of the state's electricity sector.

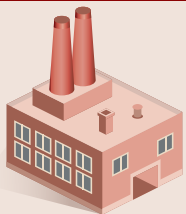

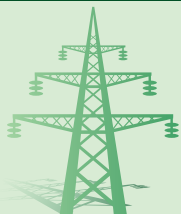
State and federal regulations continue to be developed to address air quality. The Maryland Healthy Air Act of 2006 required 15 coal-fired generating units at seven power plants in Maryland to make substantial reductions in the emission of nitrogen oxides (NO_x), sulfur dioxide (SO₂), and mercury (Hg). In September 2014, Maryland proposed regulations to reduce emissions of NO_x from coal-fired powers further, under the Reasonably Achievable Control Technology (RACT) program. In addition, the Maryland Legislature passed the Greenhouse Gas Emissions Reductions Act of 2009, committing the state to reduce greenhouse gas emissions by 25% below 2006 levels by 2020. To achieve this goal, the state is an active member of the Regional Greenhouse Gas Initiative, a market-based system for reducing carbon dioxide (CO₂) emissions from power plants. Maryland has also committed to other regional initiatives, such as the Low-Carbon Fuel Standard and the implementation of greenhouse gas reporting and control technology regulations.

At the federal level, the U.S. Environmental Protection Agency (EPA) has promulgated numerous regulations targeted at reducing emissions from fossil-fuel-fired power plants. Among the more important federal regulatory initiatives are the Clean Air Interstate Rule (CAIR) which—like the Maryland Healthy Air Act—regulates NO_x and SO₂ emissions, and the Mercury and Air Toxics Standards (MATS), which is targeted at reducing hazardous air pollutant emissions from power plants. In June 2014, the EPA proposed the Clean Power Plan, which calls for a 30% reduction in carbon emissions from 2005 levels by 2030. The proposal provides state-by-state interim CO₂ reduction goals to be achieved by 2030 with the option of achieving interim goals by 2020. In addition to these regulations targeted at reducing emissions, the EPA has proposed stringent revisions to the National Ambient Air Quality Standards (NAAQS) for ozone, which will require further reductions in NO_x and volatile organic compound (VOC) emissions from power plant and other major air emission sources in the state.

Also in 2014, EPA finalized new standards under the Clean Water Act to minimize fish mortality from water withdrawals for cooling at power plants. Under this new rule, existing facilities are required to use additional water withdrawal methods and technologies that reduce fish mortality, and new units at these facilities are required to use technology with withdrawal rates equivalent to closed-loop cooling towers.

Figure 15 illustrates some of the most significant effects associated with nuclear, fossil-fuel-fired, and hydroelectric generation—the technologies that provide the great majority of Maryland's electricity supply. For more information about these topics, as well as the potential impacts from other generating technologies (e.g., wind power), access the Maryland Power Plants and the Environment report (Cumulative Environmental Impact Report-17) on the Power Plant Research Program's website (www.pprp.info).

Figure 15. Environmental Impacts of Energy-Generating Technologies

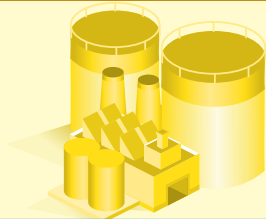
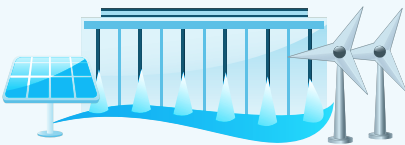
INPUTS	<p>WATER - Surface and ground water withdrawals may reduce the amount available for other users.</p> <p>Large volume withdrawals of surface water for cooling can affect small fish or other aquatic organisms drawn into cooling systems.</p>	<p>FUEL - Potential impacts to water and land can result from oil and gas drilling, mining for coal and uranium, as well as accidental spills and releases.</p>	<p>LAND USE - The operation of transmission facilities requires no fuel or water, but can consume and/or alter significant land areas.</p>
	<p>FOSSIL FUEL PLANT</p> 	<p>NUCLEAR PLANT</p> 	<p>TRANSMISSION</p> 
OUTPUTS/EFFECTS	<p>AIR EMISSIONS</p> <ul style="list-style-type: none"> • Nitrogen oxides (NO_x) • Sulfur dioxide (SO₂) • Mercury • Greenhouse gases • Particulate matter <p>SOLID BY-PRODUCTS</p> <ul style="list-style-type: none"> • Ash • Scrubber sludge <p>WATER DISCHARGES</p> <p>Any generating facility with steam turbines likely utilizes water for cooling purposes.</p> <p>Discharges from once-through cooling systems can create thermal plumes (warm areas) in receiving water bodies. Power plant discharges can also carry small amounts of chlorine or other chemicals used to control biofouling in cooling systems.</p>	<p>RADIOLOGICAL WASTE</p> <ul style="list-style-type: none"> • High-level waste (spent fuel): Spent nuclear fuel is stored onsite under stringent Nuclear Regulatory Commission guidelines. • Low-level waste: Solid waste that is contaminated with radiation is trucked offsite for disposal at a licensed radioactive waste-handling site. 	<p>Transmission line construction can have significant effects on plants and animals:</p> <ul style="list-style-type: none"> • Alteration of wildlife habitat • Forest fragmentation, especially as it affects bird species • Disturbance associated with construction that crosses wetlands or streams.

LAND USE - The operation of some renewable energy facilities requires no fuel or water, but can consume and/or alter significant land areas.

FUEL - Burning waste or biofuel to generate electricity can help reduce the volume of waste going to landfills and conserve other fuel resources.

HYDROELECTRIC, WIND & SOLAR

WASTE/BIOFUEL PLANT



Renewable energy facilities can affect plants and animals and their habitats

- Alteration of habitat from impounded rivers
- Loss of wildlife habitat from facility installation
- Direct impacts to fish, birds, and bats

WATER DISCHARGES

(from hydroelectric facilities)

Releases from hydroelectric reservoirs can make temperature and dissolved gas levels unsafe for native aquatic species.

- Similar air emissions to those produced from fossil fuel combustion
- Ash (if solid waste is burned)

WATER DISCHARGES

Any generating facility with steam turbines likely utilizes water for cooling purposes.

Discharges from once-through cooling systems can create thermal plumes (warm areas) in receiving water bodies. Power plant discharges can also carry small amounts of chlorine or other chemicals used to control biofouling in cooling systems.

References for Additional Information

Maryland Agencies and Related Publications

Power Plant Research Program (PPRP)– <http://www.pprp.info/>

Maryland Power Plants and the Environment (CEIR 17th Edition) – December 2014

Provides information on the effects of power generation on Maryland's natural resources.

Avoided Energy Costs in Maryland – April 2014

An assessment of the costs avoided through energy efficiency and conservation measures in Maryland.

Long-Term Electricity Report for Maryland: Reference Case Update – May 2013

Update to the 2011 comprehensive assessment of approaches to meet Maryland's long-term electricity needs, examining sustainable energy challenges and assessing electric energy and peak demand requirements

Maryland Energy Administration (MEA)– <http://energy.maryland.gov/>

MEA promotes affordable, reliable, and clean energy. MEA's programs and policies help lower energy bills, fuel the creation of green collar jobs, address environmental and climate impacts, and promote energy independence. Visit MEA's website to learn more about Maryland's goals and energy use — and to find out what you can do to make smart energy choices.

Maryland Department of the Environment (MDE)– <http://www.mde.state.md.us/>

Maryland's Greenhouse Gas Reduction Act Plan – October 2013

Plan to achieve the 25% reduction in greenhouse gasses, as required by the Maryland Greenhouse Gas Emissions Reduction Act, while also creating jobs and improving Maryland's economy.

Maryland Public Service Commission (PSC) – <http://www.psc.state.md.us/>

Ten-Year Plan (2014 – 2023) of Electric Companies in Maryland – August 2014

Includes a compilation of information pertaining to the long-range plans of Maryland's electric companies.

The EmPOWER Maryland Standard Report of 2014 – March 2014

Contains a summary of energy efficiency/conservation and demand response program achievements; progress on advanced meter infrastructure initiatives; and information on forthcoming milestones.

RPS Report to the General Assembly 2014 – January 2014

Highlights data from Maryland electricity suppliers' 2012 compliance reports and relevant data such as the renewable facilities certified by the State of Maryland.

The Power Plant Research Program (PPRP) was established in 1971 to ensure that Maryland could meet its demands for electric power at a reasonable cost while protecting the state's valuable natural resources.

This Fact Book has been prepared by PPRP as a service to electricity users in Maryland. It is intended to provide current information on power generation in the state for the use of state agencies, industrial and residential electricity consumers, and the interested public.

PPRP coordinates the state's comprehensive review of new power plants and associated facilities as part of the state and federal licensing process. The Program also conducts a range of research and monitoring projects on existing and proposed power plants. PPRP biennially produces a Cumulative Environmental Impact Report (CEIR), which provides information on the effects of power generation on the state's natural resources. A bibliography listing the general and site-specific reports that PPRP has produced since the early 1970s is also available.

For more information, or to request a copy of the CEIR, bibliography, or other reports, contact PPRP at (410) 260-8660 or visit its website at

www.pprp.info.



Prepared by the Maryland Department of Natural
Resources Power Plant Research Program

Tawes State Office Building, B-3
580 Taylor Avenue
Annapolis, Maryland 21401-2397
Toll Free in Maryland: 1-877-620-8DNR, ext. 8660
Outside Maryland: 1-410-260-8660
TTY users call via the Maryland Relay
www.pprp.info



Exhibit 10



MARYLAND DEPARTMENT OF THE ENVIRONMENT

Oil Control Program, Suite 620, 1800 Washington Boulevard • Baltimore MD 21230

410-537-3442 • 410-537-3092 (fax)

1-800-633-6101

Martin O'Malley
Governor

Shari T. Wilson
Secretary

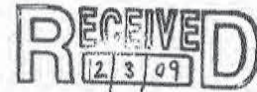
Anthony G. Brown
Lieutenant Governor

Robert M. Summers, Ph.D.
Deputy Secretary

NOV 30 2009

CERTIFIED MAIL

Mr. Milt Morris
Soil Safe, Inc.
6700 Alexander Bell Drive, Suite 300
Columbia MD 21046



Dear Mr. Morris:

Enclosed is the validated Oil Operations Permit No. 2010-OPS-14480 for your facility. Please review the conditions of this permit and become thoroughly familiar with its requirements. This permit is considered to be an enforceable document on its effective date.

If you have any questions, please contact Mr. Thomas Yoo of the Permits Section at (410) 537-3403.

Sincerely,

Horacio Tablada, Director
Land Management Administration

HT:ty

Enclosures

cc: Mr. Herbert Meade



OIL OPERATIONS PERMIT

Oil Operations Permit Number	2010-OPS-14480
Effective Date	NOV 30 2009
Expiration Date	NOV 30 2014

Pursuant to the provisions of Title 4 of the Environment Article, Annotated Code of Maryland and regulations promulgated thereunder, the Department of the Environment, hereinafter referred to as the "Department," hereby authorizes:

Soil Safe, Inc.
6700 Alexander Bell Drive, Suite 300
Columbia, Maryland 21046

to operate an oil-contaminated soil facility:

Located at:
Mattawoman Drive
Brandywine, Prince George's County
Maryland

to treat and store oil-contaminated soils in accordance with the special and general conditions imposed by this permit. **This permit does not authorize the storage or treatment of soils contaminated with any other material, except oil.**

This Oil Operations Permit is issued in addition to, and not in substitution of, the requirements of other permits or authorizations granted for this facility.

**REPORT ANY OIL SPILL OR DISCHARGE OF OIL IMMEDIATELY
TO THE DEPARTMENT OF THE ENVIRONMENT**

1-866-633-4686
(24 Hours)

AND THE APPROPRIATE FEDERAL AUTHORITY



[Home](#)

[About Us](#)

[Services](#)

[Facilities](#)

[Forms & Downloads](#)

[Contact Us](#)



Facility Information

SSI-Metro12

- [Sampling / Analysis Requirements](#)
- [Material Characterization Report](#)
- [Operating Permits](#)
- [Soil Safe Credit Application](#) (PDF)

SSI-Logan

- [Sampling / Analysis Requirements](#)
- [Material Characterization Report](#)
- [Operating Permit](#) (PDF)
- [Soil Safe Credit Application](#) (PDF)

SSI-Brandywine

- [Sampling / Analysis Requirements](#)
- [Material Characterization Report](#)
- [Operating Permit](#) (PDF)
- [Soil Safe Credit Application](#) (PDF)

SSI-Adelanto

- [Sampling / Analysis Requirements](#)
- [Soil Data and Certification Sheet](#)
- [Operating Permits](#)
- [Soil Safe Credit Application](#) (PDF)

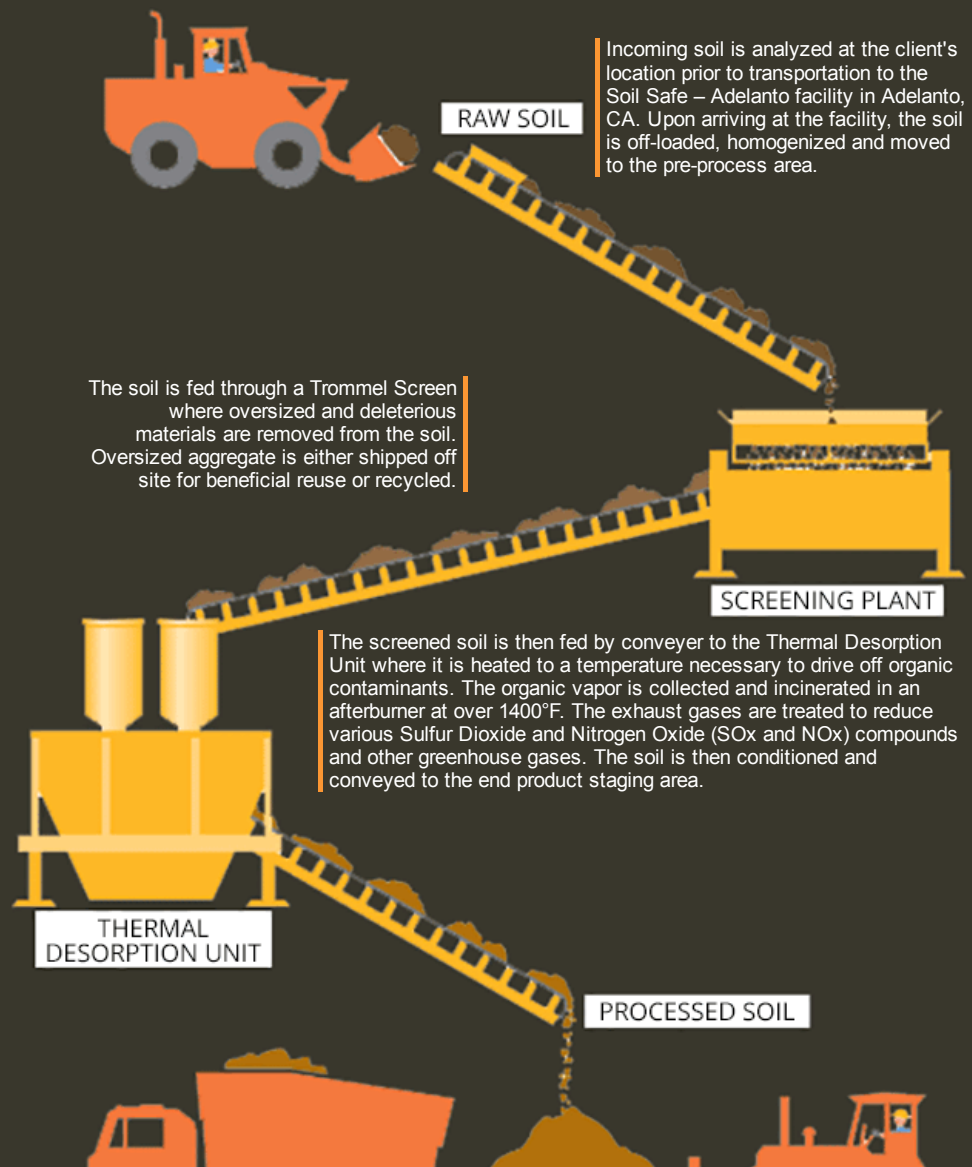
Miscellaneous

- [Industry Resources](#)
- [Career Opportunities](#)
- [Contact Us](#)

REQUEST A QUOTE

THERMAL DESORPTION

[Home](#) > [Services](#) > Thermal Desorption



Incoming soil is analyzed at the client's location prior to transportation to the Soil Safe – Adelanto facility in Adelanto, CA. Upon arriving at the facility, the soil is off-loaded, homogenized and moved to the pre-process area.

The soil is fed through a Trommel Screen where oversized and deleterious materials are removed from the soil. Oversized aggregate is either shipped off site for beneficial reuse or recycled.

The screened soil is then fed by conveyor to the Thermal Desorption Unit where it is heated to a temperature necessary to drive off organic contaminants. The organic vapor is collected and incinerated in an afterburner at over 1400°F. The exhaust gases are treated to reduce various Sulfur Dioxide and Nitrogen Oxide (SO_x and NO_x) compounds and other greenhouse gases. The soil is then conditioned and conveyed to the end product staging area.

Exhibit 11

Emission Reduction Credits Frequently Asked Questions

1. What are Emission Reduction Credits (ERCs)?

A major new source or a major modification at an existing major source planned in a nonattainment area must obtain emission offsets as a condition for approval. These offsets must (1) offset the emissions increase from the new source or modification and (2) provide a net air quality benefit.

2. How are ERCs created?

An ERC may be created by:

- (1) Controlling emissions below the emission levels required by applicable State and federal requirements and the State Implementation Plan through a federally enforceable permit limit;
- (2) Curtailing operations and reducing emissions through a federally enforceable permit condition; or
- (3) Permanently discontinuing the operation of one or more emission units at a source.

Creditable emission reductions that qualify as ERCs must be permanent, quantifiable and federally enforceable. In addition, the shutdown or curtailment is creditable only if it occurred on or after January 1, 2003, and if the reduction was not necessary to meet any other State or federal requirement.

3. What Information Must be Submitted to the Department to Certify ERCs?

- (a) A description of the equipment or process that resulted in a reduction in actual emissions, including any air pollution control devices serving that equipment or process;
- (b) The actual emissions occurring when the equipment or process operated in compliance with all applicable requirements during the selected 24-month period;
- (c) Identification of all regulations or other requirements that apply to the equipment or process and a demonstration of compliance with those requirements.

4. How are ERCs Certified?

Information on emissions reduction submitted by the person who owns or operates the emissions units creating the ERCs shall be verified by the Department based on review of information in the Department's files including the source's emission certification reports, stack tests, inspection reports, and other information relating to emissions and compliance with applicable requirements.

5. When must ERCs be obtained?

Possession of the ERCs are not required before a permit is issued. However, the Permittee must either purchase the ERCs outright or own the option to buy the ERCs prior to the commencement of construction. If the option to buy is in effect, it must be exercised prior to the commencement of operation of the affected unit(s). Further, documentation regarding the status of the ERC requirement must be submitted to MDE before commencing construction.

6. Do ERCs expire?

ERCs expire as follows:

- (a) For emission units discontinuing operation before January 1, 2002, the ERCs expire January 1, 2012;
- (b) For emission units discontinuing operation on or after January 1, 2002, the ERCs expire January 1, 2012, or 10 years after the discontinued operation, whichever is later.

An exception to (a) and (b) above is that ERCs do not expire if the ERCs are committed to a new or modified emissions unit through a permit to construct that has an enforceable contract to transfer the ERCs to the owner or operator of a new or modified emissions unit.

7. Can ERCs be transferred?

An ERC may be transferred to the control of another person after it is certified and becomes federally enforceable.

8. Can ERCs from Another State be Used in Maryland?

A source located in Maryland may use an ERC created by a source located in another State if:

- (a) The emission reduction is certified by the state in which it is created;
- (b) The conditions of the transfer are enforceable by the other state and the EPA;
- and
- (c) All of the requirements of COMAR 26.11.17 are met.

Example: Can ERCs generated in the Philadelphia nonattainment area be used for a project in Maryland?

Currently, the Philadelphia area is classified as marginal ozone nonattainment. Maryland is classified as marginal ozone nonattainment except for the Baltimore region which consists of the following counties: Anne Arundel, Baltimore, Carroll, Harford and Howard along with Baltimore City. The Baltimore area is classified as a moderate ozone nonattainment area.

Philadelphia ERCs can be used in all areas of Maryland except for the Baltimore nonattainment area.

Exhibit 12



Prince George's County Planning Department
Countywide Planning Division

14741 Governor Oden Bowie Drive
Upper Marlboro, Maryland 20772
TTY: (301) 952-4366
www.mncppc.org/pgco

301-952-3650

MEMORANDUM

TO: Prince George's County Planning Board

VIA: Fern Piret, Planning Director *J.P.*
Derick Berlage, Chief, Countywide Planning Division

FROM: Christine A. Osei, Planner Coordinator, Countywide Planning Division *CAO*

SUBJECT: MR-1317F Staff Report – Mattawoman Energy, LLC in Brandywine

BACKGROUND

The Land Use Article §20-301 through 305 of the Maryland Annotated Code requires the Planning Board to review public construction projects for all federal, state, county and municipal governments, and publicly and privately owned utilities through the Mandatory Referral Review Process.

PROJECT SUMMARY

The development application is for the construction of a natural gas fired electric generating facility on a former sand and gravel site located at 14175 Brandywine Road on a 88.9-acre site (Council District 9) in Prince George's County. In addition, the applicant proposes to construct a 20-inch wastewater line along Accokeek Road that will connect to the existing Piscataway Waste Water Treatment Plant. This wastewater line will be used as the non-potable service water supply for the project. The 2013 *Approved Subregion 6 Master Plan and Sectional Map Amendment* retained this property in the I-2 Zone where an electric generating plant is a permitted use. In addition, this plan reclassified the property from the Rural Tier to the Developing Tier.

RECOMMENDATIONS

Staff requests Planning Board approval to transmit staff recommendations as follows:

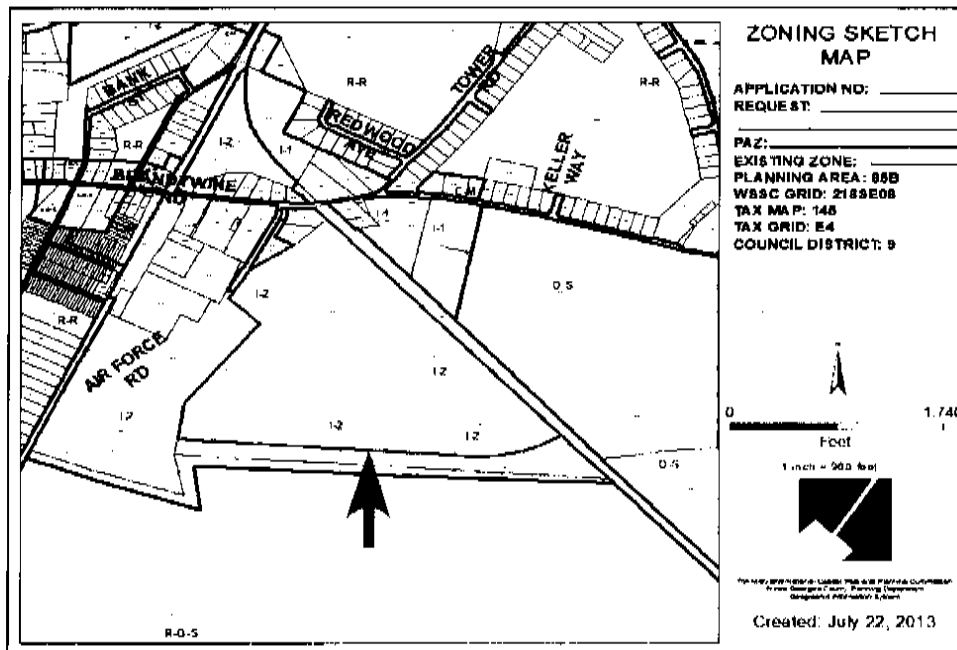
- Applicant should coordinate traffic controls and intersection modifications illustrated in the transportation study (pages 31 and 32) with State Highway Administration.
- The proposed landscape plan should be revised to screen the entire electricity plant from all existing adjacent and planned uses along Brandywine Road and Tower Road.
- Applicant should minimize impacts on Historic Sites and Resources when planning the construction of the proposed 20-inch wastewater line along Accokeek Road: McKendree Methodist Church Site and Cemetery (HR 85-020), and Asbury Methodist Episcopal Church and Cemetery (84-014).
- Applicant should seek Mandatory Referral Review input prior to the construction of the proposed natural gas and wastewater lines.

- Applicant should coordinate proposed construction schedule with Keys Energy Center to minimize construction traffic impacts on existing Brandywine Road and other streets.
- The proposed guard house operation should be moved further into the site to minimize traffic impacts at the project entrance at Brandywine Road (MD 381).
- Applicant should work with WSSC to address on-site pumping and low-pressure sewer issues that are to be addressed prior to water and sewer connections to the site. WSSC stated that “The proposed development will most likely require the relief of segments of downstream sewer as part of the development activities to address water pressure issues. Comments provided by WSSC indicate that further investigation will occur upon submittal of a Phase I Hydraulic Planning Analysis to WSSC for review. Drainage will be to the Mattawoman trunk sewer and wastewater treatment plant, owned and maintained by Charles County. Interceptor Capacity: Deficient.”
- Applicant should provide written documentation from Joint Base Andrews staff that the cooling tower will not pose a hazard to air navigation.

PROJECT LOCATION

The proposed electricity generating facility site is located at 14175 Brandywine Road (MD 381), west of its intersection with Tower Road. It is bounded on the north by Brandywine Road, on the south by a United States military installation (Globecom Radio Receiving Station), on the east by the CSX rail line, and on the west by a vehicle salvage yard in the I-2 Zone. In 2001 staff reviewed two preliminary applications for this site: 4-00006 and 4-00043 for a Brandywine Recycling Facility, also referred to as Brandywine Sand and Gravel. The documents provided by the applicant indicate that the entire 88.9 acre-site will be used for the proposed electric plant.

MAP 1: Location of Proposed Mattwoman Energy Site

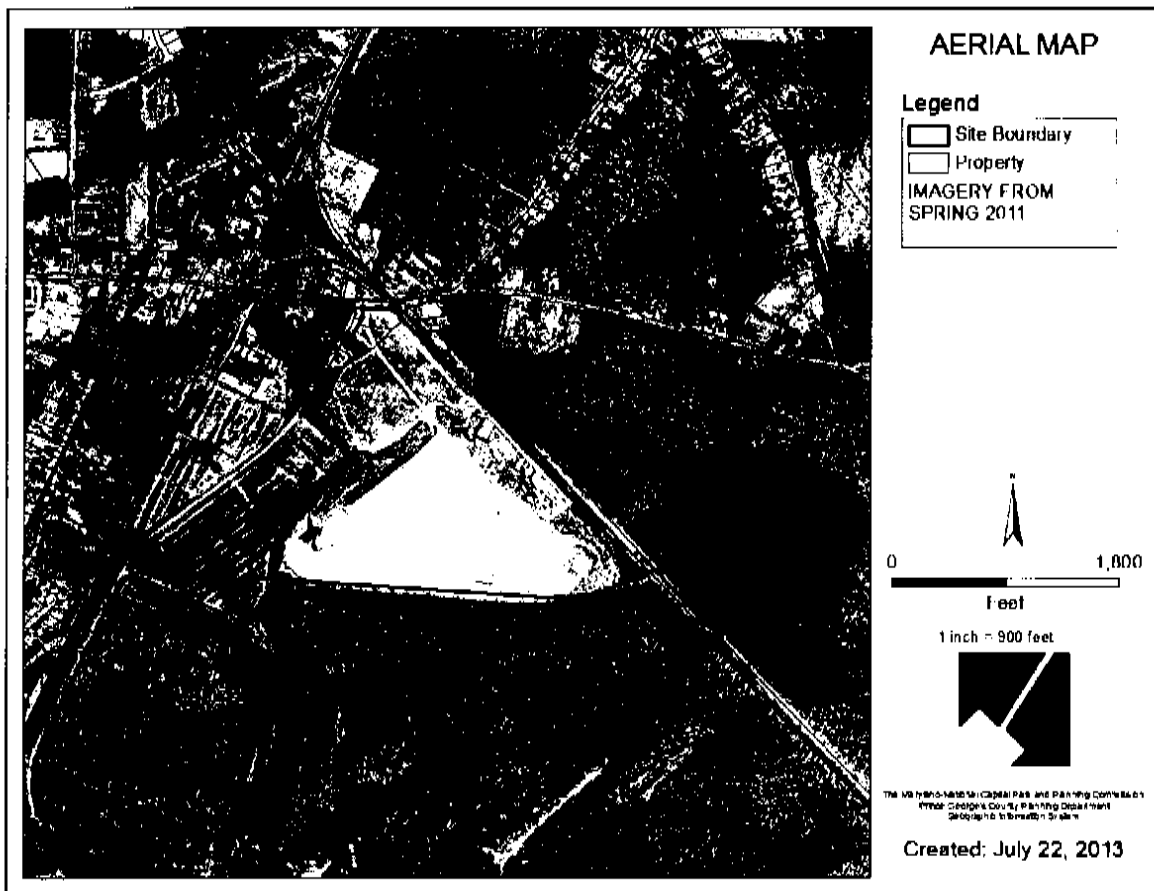


PROJECT DESCRIPTION

Mattawoman Energy, LLC is proposing to construct and operate a nominal 859-megawatt (MW), natural gas-fired, two-in-one, combined-cycle electric generating facility configured with two combustion turbines, two heat recovery steam generators, with supplemental duct firing, and one steam turbine in a multi-shaft arrangement. It is an outdoor electricity plant with no structural walls enclosing the combustion turbines and generator. The two heat recovery steam generators will include a selective catalytic reduction system and oxidation catalyst system. The proposed facility is planned to use a multi-cell wet cooling tower for heat rejection. (See aerial view of project site below.)

Linear Utility Connections: The proposed development will be served by outside gas, electricity and water – potable and non-potable. The facility will be fueled by natural gas originating from Dominion Cove, an existing gas pipeline located approximately 9 miles from the site. In addition, the applicant proposes to construct a 20-inch wastewater line along Accokeek Road that will connect to the existing Piscataway Waste Water Treatment Plant (WWTP) sewer line. The treated effluent will be used as the cooling water for the project. The operation of the proposed facility will not generate any discharge or industrial wastewater to the site, or ground water because of the use of a zero liquid discharge system. The facility will connect to an existing 230-kilovolt (kV) Potomac Electric Power Company (PEPCO) overhead transmission line located approximately one-half mile to the west of the site. The project site is within Water and Sewer Category 6. The applicant will need approval from the WSSC to change the existing water and sewer category prior to connecting to potable public water and sewer system.

MAP 2: Aerial View of Project Site



PROJECT SCHEDULE, CONSTRUCTION AND STAFFING

Construction of the power plant from site preparation and grading to commercial operation is expected to take approximately 28 months, with a construction labor force of 175 to 645 employees, depending on the stage of the project. Information provided by the applicant indicates that a large number of workers are expected to be employed at the site, totaling 645 employees during the peak construction phase of the project. The traffic study undertaken by the applicant also indicates that the construction workforce will be high within the first 15 months and then steadily decline over the final nine months. The project is expected to employ on average 175 – 200 construction workers for two years and four months. There will be 66 full-time employees once the plant is operational.

**[The following pages contain
The Maryland-National Capital Park and Planning Commission
staff comments on the above project description]**

ANALYSIS OF PROJECT IMPACT AREAS

The Maryland-National Capital Park and Planning Commission, Prince George's County Planning Department reviewed the Mattawoman Energy, LLC Electricity Plant proposal and provided the following comments:

1. ENVIRONMENTAL ASSESSMENT

The proposed development may have adverse impacts on environmental resources, including but not limited to air quality, noise, geology and soils, water resources, and biological resources. Staff expects these impacts to be reviewed and appropriately managed by the federal and state agencies having regulatory jurisdiction over the project. The following commentary is based on a review of the information provided by the applicant through the Mandatory Referral Review Process:

- Soils/Geology: No long-term impacts on soils are anticipated; however, it is unknown if there will be any oil tanks for back-up generators for operational uses. These oil tanks, if required, should be placed above ground and not buried.
- Ground and Surface Waters: A review of the site layout included in the applicant's submittal package indicates that no wetland fills or stream impacts will be necessary to construct the power plant facility. There will be wooded wetland clearing for a high tower power line access. This clearing is considered an impact because the wetland type will be changed from forested wetlands to a scrub-shrub or emergent wetland system. This impact usually requires mitigation approval from the permitting section of the Maryland Department of the Environment.
- Linear Utility Facilities to the Project Site: Installation of these facilities may impact off-site streams and wetlands, as it will be necessary to connect them to off-site sources, which will result in the crossing of several stream systems. Currently, the alignment for the non-potable water will follow the existing road right-of-way with a section going through an open wooded area.
- Special Roadways: The project site is along Historic Brandywine Road, a County designated Scenic and Historic Road. Scenic and Historic Roads contain natural and cultural resources that should be preserved and protected to the fullest extent possible. Since this area along Brandywine Road is not vegetated, a landscape buffer should be established to meet the required scenic and historic buffer specifications. The Prince George's County's Landscape Manual generally requires a minimum 40-foot-wide buffer when development is proposed on sites that have frontage on special roadways. The buffer is required to contain at least 160 plant units (all native species) per 80-linear feet of frontage. The site in its current condition shows no vegetative buffers along Brandywine Road.
- The applicant should establish a minimum 40-foot-wide wooded buffer along the Historic Brandywine Road.

2. TRANSPORTATION ASSESSMENT

The proposed Mattawoman Energy, LLC project is consistent with the area and functional master plans that govern transportation. Based on staff findings, traffic impacts in the existing neighborhoods will be minimal once the project has completed the construction phase. Impacts during construction could be more significant. The applicant is directed to coordinate all intersection modifications to address peak construction traffic issues with State Highway Administration (SHA). The traffic study provided by the applicant does not offer any recommendations or discussions on adjusting work shifts during the construction phase. Several other concepts are outlined at the end of the study. They are noted and discussed below:

A temporary traffic signal at MD 381 and Missouri Avenue should be considered to alleviate traffic conditions during the construction phase.

Discussion: Revised analysis procedures in the guidelines indicate that this intersection will operate acceptably during the construction and post-construction phases. Consider discussions with the Maryland State Highway Administration during the access permit process as a means of handling construction phase traffic in the area.

A temporary traffic signal at MD 381 and the site access, or possibly police staffing should be considered to alleviate traffic conditions during the construction phase.

Discussion: Revised analysis procedures in the Guidelines actually indicate that this intersection will operate acceptably during the construction and post-construction phases. Consider discussions with the Maryland State Highway Administration during the access permit process as a means of handling construction phase traffic in the area.

Location of the guard house near the site entrance to control access to the site: Guard house operations should be moved further into the site to prevent potential queuing onto MD 381.

Discussion: The issue should be addressed in discussions with the Maryland State Highway Administration during the access permit process as a means of handling construction phase traffic in the area.

The relevant master plans are the 2013 *Approved Subregion 6 Master Plan and Sectional Map Amendment* and the 2010 *Approved Countywide Master Plan of Transportation*. MD 381 is a designated rural collector road with an 80-foot future right-of-way. The non-vehicular element of the master plan also includes shared use bike routes along MD 381.

3. HISTORIC PRESERVATION/ARCHEOLOGY

The subject property is located in the vicinity of the Brandywine-Early Family National Register Historic District, which includes the William H. Early Store (85A-032-11), the William B. Early House (85A-032-10), the William W. Early House (85A-009), the Marian Early Bean House (85A-032-28), and the Charles S. Early, Jr. House (85A-029). There are five Prince George's County Historic Sites and one historic resource, located within one mile of the subject property: William B. Early House (85A-032-10), William H. Early Store (85A-032-11), Old Bank of Brandywine (85A-032-30), Marian Early Bean House (85A-032-28), William W. Early House (85A-032-09), and Chapel of the Incarnation (85A-032-27). The William W. Early House and Chapel of the Incarnation are also listed individually in the National Register of Historic Places. All of these historic resources are located to the northwest of the subject property. There are 17 archeological sites within one mile of the proposed Mattawoman Energy Project. These sites represent the prehistoric occupation of the Brandywine area, as well as its historic occupation from the 1700s to the present. There are no identified archeological resources in any of the proposed areas of construction. This proposal will not impact any known archeological resources.

The Southern Maryland Railroad, recorded as archeological site 18PR606, is adjacent to the subject property on the northeast. The original line was constructed in the 1870s and operated until 1965. The proposed power plant will not impact the rail line. The Maryland Historical Trust (MHT) reviewed the proposed Mattawoman Energy Project in February and April 2013. MHT determined that the proposed project will have no adverse effect on historic properties.

- Visual impacts from the proposed electricity plant on existing uses.
- Potential impacts on existing military installation and operations at Joint Base Andrews.
- Possible truck traffic conflicts along Historic Brandywine Road could pose major challenges for commuters during the construction of the two proposed electric plants, if construction schedules are not managed properly.
- Potable water connections to the project site need to be coordinated with WSSC/other approval agencies.
- The proposed guard house is too close to the intersection of Brandywine Road and the main entrance of the project site.

STAFF RECOMMENDATIONS

- Applicant should coordinate traffic controls and intersection modifications illustrated in the transportation study (pages 31 and 32) with State Highway Administration.
- The proposed landscape plan should be revised to screen the entire electricity plant from all existing adjacent and planned uses along Brandywine Road and Tower Road.
- Applicant should minimize impacts on Historic Sites and Resources when planning the construction of the proposed 20-inch wastewater line along Accokeek Road: McKendree Methodist Church Site and Cemetery (HR 85-020), and Asbury Methodist Episcopal Church and Cemetery (84-014).
- Applicant should seek Mandatory Referral Review input prior to the construction of the proposed natural gas and wastewater lines.
- Applicant should coordinate proposed construction schedule with Keys Energy Center to minimize construction traffic impacts on the existing Brandywine Road and other streets.
- The proposed guard house operations should be moved further into the site to minimize traffic impacts at the project entrance at Brandywine Road (MD 381).
- Applicant should work with WSSC to address on-site pumping and low- pressure sewer issues that are to be addressed prior to water and sewer connections to the site. WSSC stated that “The proposed development will most likely require the relief of segments of downstream sewer as part of the development activities to address water pressure issues. Comments provided by WSSC indicate that further investigation will occur upon submittal of a Phase I Hydraulic Planning Analysis to WSSC for review. Drainage will be to the Mattawoman trunk sewer and wastewater treatment plant, owned and maintained by Charles County. Interceptor Capacity: Deficient.”
- Applicant should provide written documentation from Joint Base Andrews staff that the cooling tower will not pose a hazard to air navigation.

Attachments

Vegetation:

According to the information provided, woodland clearing is proposed in conjunction with the proposed high tower transmission lines access to the power plant. The trees will be removed and the stumps left in places in this clearing area. A review of the remaining site shows that the proposed development will be located in the existing open, grassed areas of the site.

The proposed project is for a public utility that is expected to operate under an a Certificate of Public Convenience and Necessity issued under the Natural Resources Article 5-1603(f), which could exempt the project from the requirements of the Maryland Forest Conservation Act administered by the Department of Natural Resources (DNR). The DNR may require that the project submit a revised tree conservation plan to the local government (Prince George's County) because the site currently has an approved Type II Tree Conservation Plan (TCPII-142-00).

Noise:

Short-term increases in noise would result from the use of construction equipment. For construction activities, the State's maximum allowable noise level is 90 dBA for all receiving land uses in the vicinity of the site. The project's expected sound level during the day at all four residential design point locations will range from 44 dBA to 51 dBA. These levels are based on noise measurements from the similar existing natural gas power plant (owned by PANDA Mattawoman LP) to the proposed project. According to the noise report, this facility should produce a "bland hum during the night time and early morning hours, particularly at times when there is a lull in the local traffic or when no other significant noise events are occurring." Noise mitigation of noise walls located around the facilities CT generators and exhaust diffusers are proposed with the development. The initial start-up process for the plant is estimated to have levels ranging from 59 dBA to 67 dBA near the residential design points. These levels are above the plant target limit of 55 dBA and slightly above State standard of 65 dBA level during the day. This start-up process is anticipated during the early mornings if necessary. Proposed night time levels will be below the required State standard of 55 dBA, but these levels may be exceeded during the early morning hours with the intermittent start-up process. The noise report list a series of options to lesser the facility noise during this process to bring the noise levels to the expected steady state of operations.

Air Quality:

The Clean Air Act, as amended, gives the Environmental Protection Agency (EPA) responsibility to establish the primary and secondary National Ambient Air Quality Standards (NAAQS) that set acceptable concentration levels for six criteria pollutants; Particulate Matter (measured as particulate matter and fine particulate matter, sulfur dioxide, carbon monoxide, nitrogen oxides, ozone, and lead. While each state has the authority to adopt standards stricter than those established under the federal program, Maryland accepts the federal standards.

Federal regulations designate Air Quality Control Regions (AQCRs) in violation of the NAAQS as nonattainment areas. Federal regulations designate AQCRs with levels below the NAAQS as attainment areas. According to the severity of the pollution problem, ozone nonattainment areas can be categorized as marginal, moderate, serious, severe or extreme.

Prince George's County, and the proposed Mattawoman Energy, LLC facility is within the National Capital Interstate Air Quality Control Region (AQCR 47). AQCR 47 is in the ozone transport region that includes 12 states and the District of Columbia. The Environmental Planning Section (EPS) has designated Prince George's County as follows: Moderate nonattainment for the 1997 8-hour ozone (O₃); nonattainment for the 1997 fine particulate matter (PM 2.5); and attainment for all other criteria pollutants.



THE MARYLAND-NATIONAL CAPITAL PARK AND PLANNING COMMISSION

Prince George's County Planning Department
Countywide Planning Division, Transportation Planning Section

(301) 952-3680
www.mncppc.org

August 19, 2013

MEMORANDUM

TO: Christine Osei, Special Projects Section, Countywide Planning Division

FROM: Tom Masog, Transportation Planning Section, Countywide Planning Division

SUBJECT: Mandatory Referral, Mattawoman Energy

The Transportation Planning Section has reviewed the referral noted above. The referral involves the construction of a gas-fired electric generating facility. The overall subject property consists of approximately 90.54 acres of land in the I-2 Zone. The property is located south of the intersection of MD 381 and Tower Road, and south of the Conrail railroad right-of-way. The plan proposes the generation facility within an area that encompasses about one-half of the site.

Review Comments

A justification statement with all needed backup materials, including a site plan and a traffic study, has been forwarded for review. Regarding the review of the traffic study for the subject site, the following comments are offered for consideration:

- The traffic study is dated April 2013. The study bases the analysis on turning movement counts conducted during February 2013. For the purpose of conducting a mandatory review, and without the requirement of making a finding of transportation adequacy, the traffic study is deemed to be acceptable for the scope of this review.
- The study is done in general conformance to the 2012 "Transportation Review Guidelines, Part 1," otherwise termed the Guidelines. The staff's review of the study finds little issue with the general means of conducting the study.
- The scope of the traffic study is consistent with general scoping procedures used by the Prince George's County Planning Department. The study establishes four critical intersections for review, along with a fifth intersection which is the future site access:
 1. MD 5/Brandywine Road (signalized)
 2. US 301/MD 381 (signalized)
 3. MD 381/Missouri Avenue (unsignalized)
 4. MD 381/Cherry Tree Crossing Road (unsignalized)
 5. MD 381/site access (unsignalized/future)

- Under existing traffic, the following conditions are noted:

EXISTING TRAFFIC CONDITIONS				
Intersection	Critical Lane Volume (CLV) (AM & PM)		Level of Service (LOS, AM & PM)	
	MD 5/Brandywine Road	1,463	1,389	E
US 301/MD 381	1,320	1,007	D	B
MD 381/Missouri Avenue	11.4*	20.4*	--	--
MD 381/Cherry Tree Crossing Road	13.5*	11.3*	--	--
MD 381/site access	future		--	--

*In analyzing unsignalized intersections, average vehicle delay for each approach is reported in seconds of vehicle delay. It is noted that the Planning Board's standards require the reporting of delay for each movement within the intersection. According to the Guidelines, delay exceeding 50.0 seconds in any movement indicates inadequate traffic operations. Values shown as "+999" suggest that the parameters are beyond the normal range of the procedure, and should be interpreted as a severe inadequacy.

- The traffic study identifies five approved but unbuilt developments in the study area. It also applies a five-year growth rate of 1.0 percent per year as a means of accounting for through traffic. The growth rate is acceptable and can be used, and the approved but unbuilt development in the immediate area has been taken into account.

Notwithstanding the above statements, it is noted that several developments to the south of the study area, but within the Brandywine Road Club area, have been consistently factored into analyses in this area. The inclusion of these developments is not deemed to alter the overall conclusions of the study, and has not been required of this applicant.

- Under background traffic, the following conditions are noted by staff:

BACKGROUND TRAFFIC CONDITIONS				
Intersection	Critical Lane Volume (CLV) (AM & PM)		Level of Service (LOS, AM & PM)	
	MD 5/Brandywine Road	1,835	1,591	F
US 301/MD 381	1,804	1,461	F	E
MD 381/Missouri Avenue	11.9*	24.7*	--	--
MD 381/Cherry Tree Crossing Road	13.5*	11.6*	--	--
MD 381/site access	future		--	--

*In analyzing unsignalized intersections, average vehicle delay for each approach is reported in seconds of vehicle delay. It is noted that the Planning Board's standards require the reporting of delay for each movement within the intersection. According to the Guidelines, delay exceeding 50.0 seconds in any movement indicates inadequate traffic operations. Values shown as "+999" suggest that the parameters are beyond the normal range of the procedure, and should be interpreted as a severe inadequacy.

- The analysis for the site includes an analysis of the impact during peak construction, when a large number of workers are expected to be employed at the site, and during post-construction, when the facility will assume regular operations and a relatively few number of workers will be employed at the site.

- The peak construction scenario is based upon a maximum of 645 workers on the site. The traffic study indicates that the construction workforce will slowly grow over the initial 15 months of construction, operate at a peak for approximately six months, and then steadily decline over the final nine months. Trip generation is based upon industrial trip generation data in *Trip Generation* (Institute of Transportation Engineers), with a number of assumptions regarding peak hour arrivals. Using this methodology, the following trip generation summary for the peak construction scenario is provided:

Trip Generation Summary, Keys Energy, Peak Construction								
Land Use	Use Quantity	Metric	AM Peak Hour			PM Peak Hour		
			In	Out	Tot	In	Out	Tot
Trips			338	84	422	84	338	422

The assumptions made in determining these numbers are reasonable. Nonetheless, the trip generation noted above is a peak level for a construction phase that is temporary. We might seek greater reliability in trip generation if such a level of trip generation were planned to be sustained indefinitely.

- The full build (post-construction) scenario is based upon 66 permanent workers on the site on a daily basis plus low intensity truck activity. Because this is a gas-fired plant, an extension of a natural gas pipeline will be used to deliver the primary resources to the plant. Trip generation is based upon data in *Trip Generation* (Institute of Transportation Engineers) for the General Light Industrial use (Land Use Code 110). While an argument could be made for the use of rates for Manufacturing (Land Use Code 140), the numbers used show a slightly higher trip generation and therefore represent a worst-case scenario for the use. Using this methodology, the following trip generation summary for the full build scenario is provided:

Trip Generation Summary, Keys Energy, Permanent Full Build (Post-Construction)								
Land Use	Use Quantity	Metric	AM Peak Hour			PM Peak Hour		
			In	Out	Tot	In	Out	Tot
Trips			11	2	13	3	10	13

- A trip distribution to and from the site is used in the traffic study. The distribution used is heavily oriented toward MD 5 (30 percent) and US 301 (20 percent north and 35 percent south). While the distribution is acceptable for the full-build scenario, the peak construction scenario should have used a distribution oriented more heavily toward the Capital Beltway given the temporary nature of the workforce. This change would not, however, have resulted in a change to the overall recommendations.

- With the trip generation and distribution noted above, the following conditions for each scenario are noted:

TOTAL TRAFFIC CONDITIONS, PEAK CONSTRUCTION (TEMPORARY)				
Intersection	Critical Lane Volume (CLV) (AM & PM)		Level of Service (LOS, AM & PM)	
	MD 5/Brandywine Road	1,901	1,636	F
US 301/MD 381	1,860	1,595	F	E
MD 381/Missouri Avenue				
Maximum Vehicle Delay (in seconds)	14.5*	108.7*	Pass	Fail
Maximum Minor Street Approach Volume	N/A	61*		Pass
MD 381/Cherry Tree Crossing Road				
Maximum Vehicle Delay (in seconds)	16.0*	15.8*	Pass	Pass
MD 381/site access				
Maximum Vehicle Delay (in seconds)	18.4*	82.6*	Pass	Fail
Maximum Minor Street Approach Volume	N/A	338*		Fail
Critical Lane Volume	N/A	1,023*		Pass

*In analyzing two-way stop-controlled intersections, a three-step procedure is employed in which the greatest average delay in seconds for any movement within the intersection, the maximum approach volume on a minor approach, and the critical lane volume is computed and compared to the approved standards. According to the Guidelines, all three tests must fail in order to require a signal warrant study.

TOTAL TRAFFIC CONDITIONS, FULL BUILD (PERMANENT)				
Intersection	Critical Lane Volume (CLV) (AM & PM)		Level of Service (LOS, AM & PM)	
	MD 5/Brandywine Road	1,807	1,466	F
US 301/MD 381	1,836	1,591	F	E
MD 381/Missouri Avenue				
Maximum Vehicle Delay (in seconds)	12.2*	26.1*	Pass	Pass
MD 381/Cherry Tree Crossing Road				
Maximum Vehicle Delay (in seconds)	13.5*	11.6*	Pass	Pass
MD 381/site access				
Maximum Vehicle Delay (in seconds)	9.6*	13.6*	Pass	Pass

*In analyzing two-way stop-controlled intersections, a three-step procedure is employed in which the greatest average delay in seconds for any movement within the intersection, the maximum approach volume on a minor approach, and the critical lane volume is computed and compared to the approved standards. According to the Guidelines, all three tests must fail in order to require a signal warrant study.

- Operational issues are noted at both signalized intersections in the study area. With regard to this issue, it is noted that the greatest impacts occur during the peak construction phase, which is a temporary situation. Under the permanent full build scenario, a maximum of 13 trips during the peak hour would affect these intersections, and the Planning Board's Guidelines would not have even required study of these intersections given the size of the impact. The traffic study offers some useful ideas, such as adjusting the beginning and end of shifts and the scheduling of major

truck deliveries, to ease the impact of construction-related traffic. Otherwise, no improvements at the MD 5/Brandywine Road and the US 301/MD 381 intersections should be required of this applicant.

- The traffic study does not, in a formal way, offer recommendations. Aside from the discussion adjusting work shifts during the construction phase, several other concepts are discussed at the end of the study. These are noted below and discussed briefly:

It is suggested that a temporary traffic signal at MD 381 and Missouri Avenue be considered to alleviate traffic conditions during the construction phase.

Discussion: Revised analysis procedures in the Guidelines actually indicate that this intersection will operate acceptably during the construction and post-construction phases. Nonetheless, this may be considered in discussions with the Maryland State Highway Administration during the access permit process as a means of handling construction phase traffic in the area.

It is suggested that a temporary traffic signal at MD 381 and the site access, or possibly police staffing, be considered to alleviate traffic conditions during the construction phase.

Discussion: Revised analysis procedures in the Guidelines actually indicate that this intersection will operate acceptably during the construction and post-construction phases. Nonetheless, this may be considered in discussions with the Maryland State Highway Administration during the access permit process as a means of handling construction phase traffic in the area.

Given that the plans include a guard house near the site entrance to control access to the site, guard house operations should be moved further into the site to prevent potential queuing onto MD 381.

Discussion: This is a very real issue, and should be addressed in discussions with the Maryland State Highway Administration during the access permit process as a means of handling construction phase traffic in the area.

- The relevant master plans are the 2013 *Approved Subregion 5 Master Plan and Sectional Map Amendment* and the 2009 *Approved Countywide Master Plan of Transportation*. MD 381 is a designated rural collector facility within an 80-foot future right-of-way. The submitted plan shows no structures within the current or future rights-of-way, and any future widening could be accomplished with little or no impact on the site.
- The non-vehicular element of the master plan includes a shared use bike route along MD 381. This would be accomplished with signage; therefore, the recommendation would have minimal impact upon the site.

Conclusion

The Transportation Planning Section has reviewed the referral, and determines that the proposal for Mattawoman Energy is consistent with the area and functional master plans that govern transportation. Based on findings given in this memorandum and information provided in the master plan document, it is determined that traffic impacts in the neighborhood will be minimal once the project has completed the construction phase. Impacts during construction will be more significant. More coordination must occur regarding the recommendations in the traffic study, however. In that regard, it is advised that the Planning Board recommend the following:

1. It is recommended that the Maryland State Highway Administration review this proposal, and make recommendations regarding traffic control and intersection modifications, as described on

pages 31 and 32 of the traffic study and summarized herein, to alleviate the impact of construction phase traffic on nearby roadways.

Exhibit 13

Autism Spectrum Disorder and Particulate Matter Air Pollution before, during, and after Pregnancy: A Nested Case–Control Analysis within the Nurses' Health Study II Cohort

Raanan Raz,¹ Andrea L. Roberts,² Kristen Lyall,^{3,4} Jaime E. Hart,^{1,5} Allan C. Just,¹ Francine Laden,^{1,5,6} and Marc G. Weisskopf^{1,6}

¹Department of Environmental Health, ²Department of Social and Behavioral Sciences, and ³Department of Nutrition, Harvard T.H. Chan School of Public Health, Boston, Massachusetts, USA; ⁴Department of Public Health Sciences, University of California, Davis, Davis, California, USA; ⁵Channing Division of Network Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA; ⁶Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, Massachusetts, USA

BACKGROUND: Autism spectrum disorder (ASD) is a developmental disorder with increasing prevalence worldwide, yet has unclear etiology.

OBJECTIVE: We explored the association between maternal exposure to particulate matter (PM) air pollution and odds of ASD in her child.

METHODS: We conducted a nested case–control study of participants in the Nurses' Health Study II (NHS II), a prospective cohort of 116,430 U.S. female nurses recruited in 1989, followed by biennial mailed questionnaires. Subjects were NHS II participants' children born 1990–2002 with ASD ($n = 245$), and children without ASD ($n = 1,522$) randomly selected using frequency matching for birth years. Diagnosis of ASD was based on maternal report, which was validated against the Autism Diagnostic Interview–Revised in a subset. Monthly averages of PM with diameters $\leq 2.5 \mu\text{m}$ (PM_{2.5}) and 2.5–10 μm (PM_{10–2.5}) were predicted from a spatiotemporal model for the continental United States and linked to residential addresses.

RESULTS: PM_{2.5} exposure during pregnancy was associated with increased odds of ASD, with an adjusted odds ratio (OR) for ASD per interquartile range (IQR) higher PM_{2.5} (4.42 $\mu\text{g}/\text{m}^3$) of 1.57 (95% CI: 1.22, 2.03) among women with the same address before and after pregnancy (160 cases, 986 controls). Associations with PM_{2.5} exposure 9 months before or after the pregnancy were weaker in independent models and null when all three time periods were included, whereas the association with the 9 months of pregnancy remained (OR = 1.63; 95% CI: 1.08, 2.47). The association between ASD and PM_{2.5} was stronger for exposure during the third trimester (OR = 1.42 per IQR increase in PM_{2.5}; 95% CI: 1.09, 1.86) than during the first two trimesters (ORs = 1.06 and 1.00) when mutually adjusted. There was little association between PM_{10–2.5} and ASD.

CONCLUSIONS: Higher maternal exposure to PM_{2.5} during pregnancy, particularly the third trimester, was associated with greater odds of a child having ASD.

CITATION: Raz R, Roberts AL, Lyall K, Hart JE, Just AC, Laden F, Weisskopf MG. 2015. Autism spectrum disorder and particulate matter air pollution before, during, and after pregnancy: a nested case–control analysis within the Nurses' Health Study II cohort. *Environ Health Perspect* 123:264–270; <http://dx.doi.org/10.1289/ehp.1408133>

Introduction

Autism spectrum disorder (ASD) is a developmental disorder with increasing reported prevalence worldwide (French et al. 2013). Although genetics plays a strong role in ASD, evidence suggests that environmental exposures, particularly *in utero* or during early life, also affect ASD risk (Grønberg et al. 2013; Hallmayer et al. 2011; Quak et al. 2013). However, no specific environmental toxicant has been consistently associated with increased risk of ASD.

Air pollution contains various toxicants that have been found to be associated with neurotoxicity and adverse effects on the fetus *in utero* (Crump et al. 1998; Grandjean and Landrigan 2006; Rice and Barone 2000; Rodier 1995; Stillerman et al. 2008). Airborne particles are covered with various contaminants, and have been found to penetrate the subcellular environment and induce oxidative stress and mitochondrial damage *in vitro* (Li et al. 2003; MohanKumar et al. 2008). In

rodents, these particles also have been found to stimulate inflammatory cytokine release systemically and in the brain, and alter the neonatal immune system (Hertz-Picciotto et al. 2005, 2008; MohanKumar et al. 2008)—processes that have been implicated in ASD (Depino 2013; Napoli et al. 2013).

Several studies have explored associations of air pollution with ASD, using the U.S. Environmental Protection Agency (EPA) hazardous air pollutant models, distance to freeway, or local models for specific pollutants. These studies suggest increased odds of having a child with ASD with higher exposures to diesel particulate matter (PM) (Roberts et al. 2013; Windham et al. 2006), several metals (Roberts et al. 2013; Windham et al. 2006), criteria pollutants (Becerra et al. 2013; Volk et al. 2013), and some organic materials as well as closer proximity to a freeway (Volk et al. 2011).

Our goal was to explore the association between ASD and exposure to PM during defined time periods before, during, and

after pregnancy, within the Nurses' Health Study II (NHS II), a large, well-defined cohort with detailed residential history. This nested case–control study includes participants from across the continental United States, and exposure was linked to monthly data on two size fractions of PM.

Methods

Participants. The study population included offspring of participants in NHS II, a prospective cohort of 116,430 U.S. female nurses 25–43 years of age when recruited in 1989, followed biennially (Solomon et al. 1997). NHS II participants originally were recruited from 14 states in all regions of the continental United States, but they now reside in all 50 states. The study was approved by the Partners Health Care Institutional Review Board and complied with all applicable U.S. regulations; return of completed questionnaires constituted consent to participate.

In 2005, NHS II participants were asked whether any of their children had been diagnosed with autism, Asperger's syndrome, or "other autism spectrum," and 839 women replied affirmatively. In 2007, we initiated a pilot follow-up study, shortly followed by a full-scale follow-up as described previously (Lyall et al. 2012). The follow-up questionnaire included questions about the pregnancy and birth, child's sex, and diagnosis. NHS II protocol allows re-contacting only the nurses who responded to the most recent

Address correspondence to R. Raz, Harvard T.H. Chan School of Public Health, 401 Park Dr., Landmark Center, P.O. Box 15697, Boston, MA 02215 USA. Telephone: (617) 735-5554. E-mail: rraz@hsph.harvard.edu

We acknowledge M. Power, M.-A. Kioumourtzoglou, and R. Seals for discussions that enhanced this study.

The study was supported by a postdoctoral fellowship to R.R. from the Environment and Health Fund (EHF, Israel); National Institutes of Health grants P30 ES000002, R01 ES017017, and UM1 CA176726; U.S. Department of Defense grant W81XWH-08-1-0499; and Autism Speaks Foundation grant 1788.

The authors declare they have no actual or potential competing financial interests.

Received: 15 January 2014; Accepted: 10 December 2014; Advance Publication: 18 December 2014; Final Publication: 1 March 2015.

biennial questionnaire. Thus, this follow-up was attempted with the 756 mothers of ASD cases for whom this was the case. Mothers who reported having more than one child with ASD were directed to report about the youngest one. Controls were selected from among parous women not reporting a child with ASD in 2005. For each case mother, controls were randomly selected from among those women who gave birth to a child in a matching birth year, to yield a total of 3,000 controls. Six hundred thirty-six (84%) mothers of cases and 2,747 (92%) mothers of controls responded; 164 women (including 51 case mothers) declined to participate.

For the current study, only children whose estimated conception month was June 1989 or later were included because nurses' addresses before this month were unknown. Of the 265 children reported to have an ASD diagnosis who met this criterion we excluded 4 for whom ASD was not confirmed by the mother on the follow-up questionnaire, and another 2 with genetic syndromes associated with ASD ($n = 1$ Down syndrome; $n = 1$ Rett syndrome). The remaining 259 children were classified as ASD cases. There were 1,640 control children who met the conception month criterion. We further excluded participants missing PM data because their addresses could not be geocoded (8 cases and 30 controls), controls who were reported to have ASD on the 2009 questionnaire ($n = 9$), and children missing data on birth month (6 cases and 79 controls). The final study sample included 245 cases and 1,522 controls born 1990 through 2002. The average (\pm SD) year of diagnosis of the ASD cases was 1999 ± 3.3 . None of these children were reported to have been adopted. Of 188 ASD cases with data on ASD in siblings, 7.4% were reported to have a sibling with ASD. Analyses excluding those 7.4% were similar to analyses including all children and are therefore not reported.

Case validation. ASD diagnosis was validated by telephone administration of the Autism Diagnostic Interview–Revised (ADI-R) (Lord et al. 1994) in a subsample of 50 cases randomly selected from mothers who indicated on our follow-up questionnaire willingness to be contacted (81% of all case mothers). In this sample, 43 children (86%) met full ADI-R criteria for autistic disorder [which is stricter than the broader “autism spectrum disorder” of the current DSM-V (*Diagnostic and Statistical Manual of Mental Disorders, 5th Edition*) criteria, or other autism spectrum disorders including PDD-NOS (pervasive developmental disorder not otherwise specified) or Asperger syndrome of DSM-IV criteria], defined by meeting cutoff scores in all three domains (social interaction, communication and

language, restricted and repetitive behaviors) and having onset by 3 years of age. The remaining individuals met the onset criterion and communication domain cutoff and missed the autistic disorder cutoff by one point in one domain ($n = 5$; 10%), or met cutoffs in one or two domains only ($n = 2$; 4%), thus indicating presence of ASD traits [for further details on scoring of ADI-R, see Lord et al. (1994)]. In addition, Social Responsiveness Scale (SRS) scores (Constantino et al. 2000), obtained for approximately 90% of eligible cases, also indicated accuracy of case ascertainment. Although it is not a clinical diagnostic instrument, the SRS is a widely used measure of social functioning and autistic traits, and has been shown to have excellent validity as compared to ADI-R and ADOS (Autism Diagnostic Observation Schedule) (Constantino et al. 2003). Among our ASD cases, 93% met the SRS cutoff for ASD. In contrast, 93% of controls completing the same measure fell within the normative range. Therefore, both ADI-R and SRS scores support reliable ASD case ascertainment in our population. For all analyses only the maternal reports were used for determination of ASD status.

Exposure assessment. Residential locations of the nurses were determined from the mailing addresses used for the biennial NHS II questionnaire. Monthly ambient exposure predictions of airborne particulate matter with an aerodynamic diameter $\leq 10 \mu\text{m}$ (PM_{10}) and $\leq 2.5 \mu\text{m}$ ($\text{PM}_{2.5}$) were generated from nationwide expansions of previously validated spatiotemporal models (Yanosky et al. 2008, 2009, 2014). The models use monthly average PM_{10} and/or $\text{PM}_{2.5}$ data from the U.S. EPA's Air Quality System (<http://www.epa.gov/ttn/airs/airsaqs/>), a nationwide network of continuous and filter-based monitors, as well as monitoring data from various other sources. The models also incorporated information on several geospatial predictors including distance to road, population density, point sources (e.g., power-generating utilities, waste combustors), elevation, and meteorology. All data were used in generalized additive statistical models (Yanosky et al. 2008) with smoothing terms of space and time to create separate PM prediction surfaces for each month. Because monitoring data on $\text{PM}_{2.5}$ are limited before 1999, $\text{PM}_{2.5}$ in the period before 1999 was modeled using data on PM_{10} and visibility data at airports (Yanosky et al. 2009, 2014). $\text{PM}_{10-2.5}$ predictions were calculated as the difference between monthly PM_{10} and $\text{PM}_{2.5}$ predictions. These models provide estimates for any geolocation in the conterminous United States by monthly intervals. The models also have been shown

to have low bias and high precision: The normalized mean bias factor for $\text{PM}_{2.5}$ is -1.6% , and the absolute value of the prediction errors is 1.61. For $\text{PM}_{2.5-10}$ these values are -3.2% and 4.18, respectively (Yanosky et al. 2014).

For each child, we estimated exposures to $\text{PM}_{2.5}$ and $\text{PM}_{10-2.5}$ before, during, and after pregnancy by averaging monthly concentrations for the mother's residential address during the relevant months. The months of pregnancy were determined from the child's birth month and gestational age at birth, as reported by the mother. Exposures to PM during each pregnancy trimester were calculated similarly.

Covariates. The following covariates, all associated with autism in previous studies, were included in multivariable models: child's birth year, birth month, and sex, maternal age at birth, paternal age at birth, and median census tract income in the birth year. Among these variables, only census tract income (1.5%) and paternal age (10.6%) had missing data. We used the missing indicator method for missing data. We conducted sensitivity analyses to evaluate the influence of adjusting for gestational factors (premature birth, birth weight, gestational diabetes, preeclampsia), smoking during pregnancy, state, marital status, median census house value, paternal education, and maternal grandparents' education. All covariate data except for census variables were from maternal self-report.

Statistical analyses. Logistic regression models were used to estimate odds ratios (OR) and 95% confidence intervals (CI) of ASD by PM exposures modeled both using PM quartiles and as continuous variables, in separate models. Exposures to different PM size fractions were examined in separate models, and also together in a single model.

For nurses who moved residence between two questionnaires straddling pregnancy, we did not know the exact date of moving. Therefore, we conducted separate analyses for exposures assigned assuming the nurse was at the earlier address during the whole intervening period (prepregnancy address) or at the later address during the whole period (postpregnancy address). In addition, to reduce misclassification of exposure, we conducted analyses that were limited to those mothers for whom the pre- and postpregnancy addresses were identical [160 cases (65%) and 986 controls (65%), referred to here as “nonmovers”].

To examine temporal specificity of any associations between PM and ASD, we considered the association with $\text{PM}_{2.5}$ exposure during the 9 months before pregnancy, the pregnancy period, and the 9 months after birth. These examinations were restricted to nonmovers with complete

Table 1. Study population characteristics by ASD status, Nurses' Health Study II.

Characteristic	Cases (n = 245)	Controls (n = 1,522)
Male sex [n (%)]	209 (85)	793 (52)
Year of birth [median (IQR)]	1993 (5)	1993 (5)
Maternal age at birth (years) (mean ± SD)	34.0 ± 4.0	33.7 ± 3.7
Paternal age at birth (years) (mean ± SD)	36.8 ± 5.3	36.3 ± 4.9
Median census income (\$1,000) [median (IQR)]	63 (26)	61 (27)
Median census house value (\$1,000) [median (IQR)]	144 (108)	136 (98)
Birth weight (lbs) (mean ± SD)	7.1 ± 1.5	7.2 ± 1.3
Husband's/partner's education [n (%)]		
High school	33 (13)	208 (14)
2-year college	45 (18)	218 (14)
4-year college	79 (32)	537 (35)
Graduate school	74 (30)	501 (33)
Missing	14 (6)	58 (4)
Marital status [n (%)]		
Married	186 (76)	1,159 (76)
Never married	51 (21)	269 (18)
Other	8 (3)	94 (6)
Premature birth [n (%)]		
Yes	44 (18)	227 (15)
No	142 (58)	1,137 (75)
Missing	59 (24)	158 (10)
Gestational diabetes [n (%)]		
Yes	17 (7)	87 (6)
No	189 (77)	1,222 (80)
Missing	39 (16)	213 (14)
Preeclampsia [n (%)]		
Yes	13 (5)	43 (3)
No	193 (79)	1,266 (83)
Missing	39 (16)	213 (14)
Smoking during pregnancy [n (%)]		
Yes	22 (9)	50 (3)
No	160 (65)	1,099 (72)
Missing	63 (26)	373 (25)

IQR, Interquartile range.

Table 2. Control population characteristics by pregnancy PM_{2.5} quartile, Nurses' Health Study II (n = 1,522 controls).

Characteristic	Quartile [$\mu\text{g}/\text{m}^3$ (range)]			
	1st (5.24–12.3)	2nd (12.4–14.5)	3rd (14.6–16.7)	4th (16.7–30.8)
n	397	376	375	374
Male sex (n (%))	208 (52)	203 (54)	192 (51)	190 (51)
Year of birth [median (IQR)]	1995 (5)	1994 (4)	1993 (4)	1992 (3)
Maternal age at birth (years) (mean ± SD)	34.3 ± 3.8	34.0 ± 3.8	33.5 ± 3.6	32.7 ± 3.6
Paternal age at birth (years) (mean ± SD)	37.4 ± 5.1	36.5 ± 4.9	36.1 ± 5.0	35.2 ± 4.5
Median census income (\$1,000) [median (IQR)]	62 (31)	64 (28)	61 (26)	58 (24)
Median census house value (\$1,000) [median (IQR)]	137 (107)	144 (104)	135 (96)	128 (82)
Birth weight (lbs) (mean ± SD)	7.2 ± 1.3	7.2 ± 1.2	7.1 ± 1.3	7.2 ± 1.3
Premature birth (n (%))				
Yes	56 (14)	57 (15)	52 (14)	62 (17)
No	298 (75)	282 (75)	275 (73)	282 (75)
Missing	43 (11)	36 (10)	48 (13)	30 (8)
Gestational diabetes (n (%))				
Yes	18 (5)	27 (7)	21 (6)	21 (6)
No	314 (79)	303 (81)	299 (80)	306 (82)
Missing	65 (16)	46 (12)	55 (15)	47 (13)
Preeclampsia (n (%))				
Yes	12 (3)	9 (2)	8 (2)	14 (4)
No	320 (81)	321 (85)	312 (83)	313 (84)
Missing	65 (16)	46 (12)	55 (15)	47 (13)
Smoking during pregnancy (n (%))				
Yes	17 (4)	17 (4)	21 (5)	17 (4)
No	323 (73)	313 (71)	308 (70)	315 (71)
Missing	102 (23)	112 (25)	112 (25)	110 (25)

IQR, interquartile range.

data for all exposure periods, and each time period was considered independently, and then also in a single model that included all three time periods simultaneously. Because of differences in ASD rates by sex and prior suggestions that air pollution effects may be specific to boys, we *a priori* decided to also examine associations stratified by sex of the child. For simplicity, we did this only among the children whose mothers did not move during pregnancy. We used SAS version 9.3 (SAS Institute Inc., Cary, NC) for data extraction, and R version 3.0.1 (<http://www.r-project.org/foundation/>) for Linux-gnu for analyses. All analyses were conducted at the 0.05 alpha level.

Results

ASD cases were more likely to be male, to have been exposed to maternal preeclampsia or maternal smoking during gestation, and to be missing data on premature birth compared with controls (Table 1). The median (25th–75th percentile) year of birth for cases and controls was the same: 1993 (1991–1996). As expected given time trends in air pollution, control children born in earlier years were more likely to be in higher PM_{2.5} quartiles. Census income and parental age also decreased slightly, but generally steadily by exposure, whereas there was little clear pattern of difference by exposure for other variables (Table 2).

The average (\pm SD) levels of PM_{2.5} and PM_{10–2.5} during pregnancy were 14.6 \pm 3.3 and 9.9 \pm 4.9 $\mu\text{g}/\text{m}^3$, respectively. Although PM_{10–2.5} did not show a clear and consistent association with ASD, PM_{2.5} was associated with ASD regardless of the address used for the PM estimation (Figure 1). Among nonmovers, for whom misclassification of exposure because of an address change is reduced, the OR was 2.06 (95% CI: 1.17, 3.63) in the 4th quartile, compared with the 1st quartile. The results were also similar when analysis was limited to nonmovers and used continuous PM estimates, with an OR of 1.57 (95% CI: 1.22, 2.03) per interquartile range (IQR) increase in PM_{2.5} (4.42 $\mu\text{g}/\text{m}^3$), and little association with PM_{10–2.5} [OR = 1.07 per PM_{10–2.5} IQR (5.15 $\mu\text{g}/\text{m}^3$); 95% CI: 0.89, 1.28]. When PM_{2.5} and PM_{10–2.5} were in the same model together, the difference between the two was greater: OR = 1.61 per PM_{2.5} IQR (95% CI: 1.22, 2.12); OR = 0.96 per PM_{10–2.5} IQR (95% CI: 0.79, 1.17). The association with PM_{2.5} among nonmovers was slightly stronger for boys (OR = 1.73; 95% CI: 1.29, 2.31) than for girls (OR = 1.12; 95% CI: 0.59, 2.12), but there were only 23 nonmover girls with ASD (137 nonmover boys), and the interaction *p*-value was 0.17.

When estimating the association with PM_{2.5} exposure during the 9 months before pregnancy, the pregnancy period, and the 9 months after birth, all restricted to nonmovers with exposure estimates for all three exposure periods, the associations with exposures before or after the pregnancy were lower compared with the association with exposure during pregnancy (Table 3). The partial correlation of PM_{2.5} during pregnancy with PM_{2.5} during the 9 months before or after pregnancy was 0.85 and 0.83, respectively. When we included all three PM_{2.5} exposure periods together in a mutually adjusted model, ASD was significantly associated only with exposure during the pregnancy period (Table 3). This pattern did not change after further restriction to women who did not move during the whole period from 9 months before conception to 9 months after birth (data not shown).

When examining trimester-specific associations in nonmovers, exposure to PM_{2.5} was associated with ASD in all three trimesters, but PM_{10-2.5} was not associated with ASD in any of the trimesters (Figure 2). The highest association with PM_{2.5} was seen in the third trimester (OR = 1.49 per PM_{2.5} IQR; 95% CI: 1.20, 1.85) (Figure 2). In a model with all trimesters mutually adjusted, the only statistically significant association was seen

with PM_{2.5} in the third trimester (OR = 1.42; 95% CI: 1.09, 1.86), whereas exposure during the first and second did not show associations (OR = 1.06; 95% CI: 0.83, 1.35, and OR = 1.00; 95% CI: 0.78, 1.30, respectively). When third-trimester PM_{2.5} and PM_{10-2.5} were in the same model together, the difference between the two was greater: OR = 1.50 per PM_{2.5} IQR (95% CI: 1.19, 1.89); OR = 0.89 per PM_{10-2.5} IQR (95% CI: 0.81, 1.19).

ORs and CIs were comparable in separate analyses excluding premature births, or participants missing data on census tract income, or paternal age (data not shown). Adjusting for PM_{10-2.5} also resulted in comparable estimates for PM_{2.5} (data not shown). Results were also similar in models adjusted for (each in a separate model): gestational variables (premature birth, birth weight, gestational diabetes, preeclampsia), smoking during pregnancy, census tract house value, state, marital status of the nurse, or husband's/partner's education or maternal grandparents' education (data not shown). In addition, models limited to either mothers with white race/ethnicity (95% of the nurses) or children who had a full-term pregnancy (i.e., excluding premature births and those with missing data on this variable) showed comparable estimates (data not shown).

Discussion

In our nested case-control study of nurses from across the continental United States, ambient PM_{2.5} concentrations during pregnancy were significantly associated with having a child diagnosed with ASD. Importantly, the association we found appeared specific to PM_{2.5} during pregnancy; PM_{2.5} exposure before or after pregnancy showed weaker associations with ASD, and PM_{10-2.5} during pregnancy showed little association with ASD. In a model mutually adjusted for all three exposure periods, only the pregnancy period was associated with ASD. The change in the ORs with mutual adjustment did not appear to be an artifact of collinearity because the precision of the mutually adjusted model was not substantially lower than the single exposure model (e.g., CI widths for an IQR change in PM_{2.5} during pregnancy of 2.3 vs. 1.7, respectively). The 95% CIs were not notably larger in this analysis, suggesting that collinearity was not a significant problem. Moreover, during pregnancy we found the association to be specifically with the third-trimester exposure in models that included exposure in all trimesters together. The specificity of the association to the prenatal period is in line with several other lines of evidence that suggest a prenatal origin of ASD, including data on differences in brain cytoarchitecture in brains of children with ASD (McFadden and Minshew 2013; Stoner et al. 2014) and associations between maternal exposure to teratogens during pregnancy and ASD (Rodier 1995). Our results also suggest an association predominantly in boys, but this finding should be interpreted with caution, given the small number of girls with ASD in our sample.

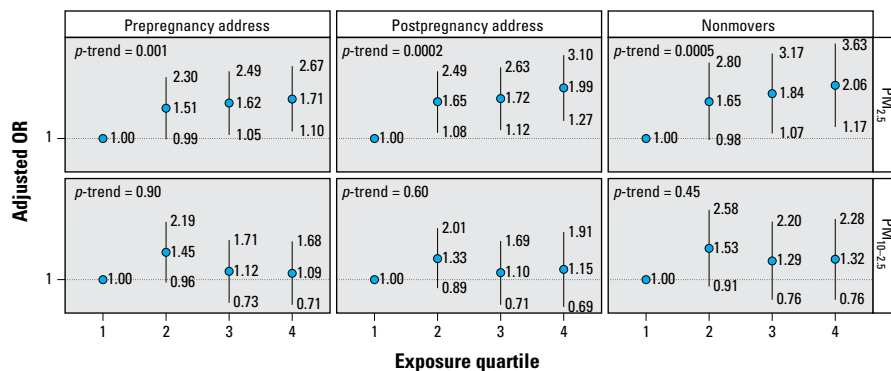


Figure 1. ORs (95% CIs) for ASD by quartile of PM exposure. ORs are adjusted for child sex, year of birth, month of birth, maternal age at birth, paternal age at birth, and census income. There were 245 cases and 1,522 controls in analyses using pre- and postpregnancy addresses. Prepregnancy address is the last known residential address before conception. Postpregnancy address is the first known residential address after birth. Nonmovers are those participants for whom prepregnancy and postpregnancy addresses were the same [cases = 160 (65%), controls = 986 (65%)]. *p*-Trend, *p*-values from models of exposures as continuous variables. The number of cases (including movers) by quartiles from low to high: 45, 66, 66, 68; controls: 397, 376, 375, 374. PM_{2.5} quartile ranges (μg/m³): 5.24–12.3, 12.4–14.5, 14.6–16.7, 16.7–30.8; PM_{10-2.5} quartile ranges (μg/m³): 1.9–6.7, 6.8–8.9, 9–11.9, 12–49.4.

Table 3. ORs (95% CI) for ASD per IQR increase in PM_{2.5} levels in different time periods, nonmovers only.^a

Exposure period	OR (95% CI) per 4.40 μg/m ³ PM _{2.5}		
	Unadjusted	Adjusted ^b	Mutually adjusted ^c
9 months before conception	1.20 (0.98, 1.47)	1.32 (1.04, 1.69)	0.83 (0.58, 1.19)
Whole pregnancy	1.37 (1.09, 1.71)	1.50 (1.16, 1.94)	1.63 (1.08, 2.47)
9 months after birth	1.19 (0.96, 1.49)	1.29 (1.00, 1.67)	0.96 (0.65, 1.40)

^aRestricted to nonmovers who also have data on all exposure periods (158 cases, 977 controls). ^bAdjusted for child sex, year of birth, month of birth, maternal age at birth, paternal age at birth, census income. ^cMutually adjusted for other two exposure periods, as well as all other covariates listed above.

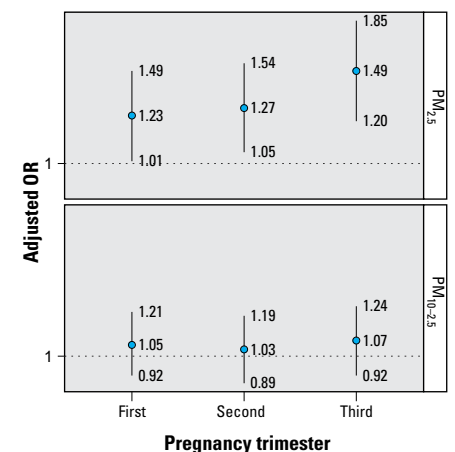


Figure 2. ORs for ASD with exposure to particulate matter during pregnancy trimesters. ORs are adjusted for child sex, year of birth, month of birth, maternal age at birth, paternal age at birth, and census income. The analyses are limited to nonmovers only (i.e., those for whom prepregnancy and postpregnancy addresses were the same). Cases, *n* = 160, controls *n* = 986.

These results generally agree with previous studies. A report from the CHildhood Autism Risks from Genetics and the Environment (CHARGE) study among 304 ASD cases and 259 controls, in several areas in California, used residential address history reported by parents to calculate distance to roads as a proxy for traffic-related air pollution exposure and found increased risk for ASD among women who lived in proximity to a freeway (Volk et al. 2011). Further analysis of the CHARGE study group in a subset of 279 cases and 245 controls using data from the U.S. EPA Air Quality System suggested positive associations of ASD with traffic-related air pollution during pregnancy, and specifically with PM_{2.5} (Volk et al. 2013). ASD was also associated with pregnancy exposure to PM₁₀, and—in contrast to our results—the association with traffic-related air pollution exposure during the first year of life was higher than that found for the exposure during pregnancy. In the CHARGE study, associations were also seen with exposures in the year after birth that were about as strong as exposures during pregnancy. Our findings suggested a weaker association with postpregnancy exposure that was essentially null in models that included exposure during all time periods. In the CHARGE study, however, the pregnancy and postpregnancy exposure periods were not included together in the same regression model.

Another study, from Los Angeles (LA) County, used birth certificate address and ASD cases identified from the Department of Developmental Services in California (Becerra et al. 2013). Using exposure data from the nearest monitoring stations and from a land use regression model (Su et al. 2009), they found a positive association between PM_{2.5} exposure and autism (OR per 4.68 µg/m³ PM_{2.5} = 1.15; 95% CI: 1.06, 1.24 in a model of exposure over the entire pregnancy and also adjusted for ozone levels). There was not a consistent association with PM₁₀. The LA study included many more ASD cases than any of the other studies, so the effect estimate could represent a more stable estimate of the true effects of PM. Alternatively, differences in the composition of PM in the LA area could result in smaller effects. Other differences in study design could also have led to smaller effect sizes in the LA study. The case definition was a primary diagnosis of autistic disorder, the most severe among ASD diagnoses, and the association with PM could be preferentially with milder forms of ASD. Slightly more measurement error from using a nearest monitor exposure assignment approach or addresses from the birth certificate could have biased results toward the null. Smaller associations in that study could also have occurred if there was

under-ascertainment of cases among children of more highly exposed mothers. Lower socioeconomic status has been associated with under-ascertainment in ASD registries such as that used in the LA study (Kalkbrenner et al. 2012). Although estimates were not much different when the sample was stratified by education level, if residual socioeconomic differences were associated with PM_{2.5} exposures (lower socioeconomic status with higher PM_{2.5}) this could lead to bias toward the null because the controls included all birth certificates in the region. The importance of the environment in the development of ASD was recently implicated in a comparison of concordance rates between monozygotic and dizygotic twins that found that the shared environment accounted for 58% (95% CI: 30, 80%) of the broader autism phenotype (Hallmayer et al. 2011). In line with these findings, a comparison of sibling ASD recurrence risk in a different population revealed a much higher rate of ASD recurrence in half-siblings with the same mother (2.4; 95% CI: 1.4, 4.1) compared with half-siblings with the same father (1.5; 95% CI: 0.7, 3.4) (Grønborg et al. 2013). This finding may be attributed either to maternal factors affecting the *in utero* environment or to common mitochondrial DNA.

Exposure to high levels of environmental toxicants during pregnancy might interfere with normal *in utero* processes of brain development, such as neurogenesis, cell proliferation, cell differentiation, and apoptosis (Rice and Barone 2000; Rodier 1995). PM_{2.5} and especially ultrafine particles (< 0.1 µm in diameter) were shown to penetrate the subcellular environment and to induce strong oxidative stress and mitochondrial damage *in vitro* (Li et al. 2003). These effects were associated with the organic carbon and polycyclic aromatic hydrocarbon contents of the particles (Li et al. 2003). *In vivo* studies in rodents have also shown that PM_{2.5} activates the stress axis, involves microglial activation, and causes production of pro-inflammatory cytokines in the brain (MohanKumar et al. 2008). In one study, increased mitochondrial DNA damage, possibly caused by reactive oxygen species, was found to be more common in 67 children with ASD than in 46 typically developing children (Napoli et al. 2013).

PM_{2.5} may alter the development of the neonatal immune system. In a study of 1,397 children in the Czech Republic, gestational exposures to PM_{2.5} and polycyclic aromatic hydrocarbons were associated with reduction in T cells and an increase in B lymphocytes in neonatal cord blood (Hertz-Picciotto et al. 2005). Early activation of the immune system and neuroinflammation have been found to be associated with ASD in humans (Atladóttir et al. 2010; Careaga et al. 2013; Depino

2013; Gadad et al. 2013; Libbey et al. 2005; Patterson 2011) and in animal models of autism (Gadad et al. 2013; Libbey et al. 2005; Patterson 2011), and this has been proposed as a possible mechanism by which environmental toxicants could increase the risk of ASD (Hertz-Picciotto et al. 2008). Furthermore, a recent transcriptomic comparison of post-mortem brain tissues of individuals with ASD (*n* = 19) and controls (*n* = 17) taken from the Autism Tissue Project, the Harvard Brain Bank, and the MRC London Brain Bank for Neurodegenerative Disease, revealed involvement of genes related to synaptic and neuronal signaling dysfunction, and also microglial and immune dysregulation (Voineagu et al. 2011). The implicated genes related to synaptic and neuronal signaling dysfunction, compared with those related to immune changes, had more overlap with genes identified in genome-wide association studies (Voineagu et al. 2011). This suggests that expression of immune-related genes in ASD may be driven more by environmental influences than underlying genetic differences.

These processes that could affect neurodevelopment are general in nature, so the question still would remain why there is an association specifically with ASD. However, the ASD phenotype is quite heterogeneous, and ASD can share features with other neurodevelopmental disorders (e.g., intellectual disability). There is some suggestion that exposures to components of air pollution can also affect neurodevelopment more generally (Perera et al. 2009; Suglia et al. 2008). Determining the range of phenotypic profiles associated with maternal PM exposure during pregnancy would be of interest in future studies. Another interesting direction for future research would be to determine whether the association between PM and ASD is different among children who have one or more siblings with ASD.

A limitation of our study is that we did not have the exact dates on which mothers changed addresses. Thirty-five percent of the nurses (both cases and controls) changed their residential address between the last questionnaire before pregnancy and the first questionnaire after delivery. However, we found statistically significant associations with pregnancy PM when the exposure for movers was based either on pre- or postpregnancy address. When we reduced exposure misclassification by analyzing the smaller sample of nonmovers, the association between ASD and PM_{2.5} was stronger. We also did not have information on how much time the nurses actually spent at their residential addresses, nor did we have information about their work addresses. Error from this source, however, would not affect the estimates of PM at the residential address and so would not create an association with

residential PM levels where an association with PM exposure did not exist. Information was also unavailable on indoor air pollution exposures and sources. In addition, ASD diagnoses in the study were based on parental reporting. As medically trained professionals, however, nurse mothers' reporting of ASD is likely to be reliable, a supposition supported by our validation study using the ADI-R.

Strengths of our study include the wide geographic distribution of the nurses and the nesting within a well-defined cohort, which reduces the likelihood of selection bias. In addition, the specificity of our findings for the pregnancy period places important limitations on possible residual confounding. Specifically, any factor that is not differentially related to PM during pregnancy versus before or after pregnancy is very unlikely to confound our results. Thus, for example, although population density, a choice to take folate supplements during pregnancy, or a host of other potential confounders (Gray et al. 2013; Kalkbrenner et al. 2012) may be related to PM_{2.5} exposure, they would be expected to be equally related to PM_{2.5} exposure before or after pregnancy as during it. But no association with them were seen in mutually adjusted models. In this way, PM_{2.5} exposure before and after pregnancy (because no association is seen with them in mutually adjusted models) acts as a negative control (Flanders et al. 2011; Lipsitch et al. 2010) and rules out confounding by many—even unmeasured—potential confounders. We cannot, however, rule out another pollutant that co-varies with PM_{2.5}. Nor can we determine whether there is a particular component of PM_{2.5} that is responsible for the associations we found. PM_{2.5}, however, is a complex mixture that may be correlated with other air pollution constituents. In the present study we did not have high temporal and spatial resolution data on other air pollution constituents or on specific PM_{2.5} components to determine whether a specific component is associated with autism.

Conclusions

Our findings support the possibility of an effect of maternal exposure to air pollution during pregnancy, and especially during the third trimester, on the development of ASD in her child. The results suggest that air pollution is a modifiable risk factor for autism, and reduced exposure during pregnancy could lead to lower incidence of ASD and reduce the substantial, increasing economic burden of ASD on families and on society (Croen et al. 2006; Leslie and Martin 2007; Mandell et al. 2006; Raz et al. 2013; Shimabukuro et al. 2008). Understanding the biological mechanism that may underlie the association by which PM exposure and ASD could provide important insight to ASD pathogenesis.

REFERENCES

- Atladóttir HO, Thorsen P, Østergaard L, Schendel DE, Lemcke S, Abdallah M, et al. 2010. Maternal infection requiring hospitalization during pregnancy and autism spectrum disorders. *J Autism Dev Disord* 40:1423–1430; doi:10.1007/s10803-010-1006-y.
- Becerra TA, Wilhelm M, Olsen J, Cockburn M, Ritz B. 2013. Ambient Air Pollution and Autism in Los Angeles County, California. *Environ Health Perspect* 121:380–386; doi:10.1289/ehp.1205827.
- Careaga M, Hansen RL, Hertz-Piccolto I, Van de Water J, Ashwood P. 2013. Increased anti-phospholipid antibodies in autism spectrum disorders. *Mediators Inflamm* 2013:935608; doi:10.1155/2013/935608.
- Constantino JN, Davis SA, Todd RD, Schindler MK, Gross MM, Brophy SL, et al. 2003. Validation of a brief quantitative measure of autistic traits: comparison of the social responsiveness scale with the autism diagnostic interview-revised. *J Autism Dev Disord* 33:427–433.
- Constantino JN, Przybeck T, Friesen D, Todd RD. 2000. Reciprocal social behavior in children with and without pervasive developmental disorders. *J Dev Behav Pediatr* 21:2–11.
- Croen LA, Najjar DV, Ray GT, Lotspeich L, Bernal P. 2006. A comparison of health care utilization and costs of children with and without autism spectrum disorders in a large group-model health plan. *Pediatrics* 118:e1203–e1211; doi:10.1542/peds.2006-0127.
- Crump KS, Kjellström T, Shipp AM, Silvers A, Stewart A. 1998. Influence of prenatal mercury exposure upon scholastic and psychological test performance: benchmark analysis of a New Zealand cohort. *Risk Anal* 18:701–713.
- Depino AM. 2013. Peripheral and central inflammation in autism spectrum disorders. *Mol Cell Neurosci* 53:69–76; doi:10.1016/j.mcn.2012.10.003.
- Flanders WD, Klein M, Darrow LA, Strickland MJ, Sarnat SE, Sarnat JA, et al. 2011. A method for detection of residual confounding in time-series and other observational studies. *Epidemiology* 22:59–67; doi:10.1097/EDE.0b013e3181fdcbabe.
- French LR, Bertone A, Hyde KL, Fombonne E. 2013. Epidemiology of autism spectrum disorders. In: *The Neuroscience of Autism Spectrum Disorders* (Buxbaum JD, Hof PR, eds). New York:Academic Press, 3–24.
- Gadad BS, Hewitson L, Young KA, German DC. 2013. Neuropathology and animal models of autism: genetic and environmental factors. *Autism Res Treat* 2013:731935; doi:10.1155/2013/731935.
- Grandjean P, Landrigan PJ. 2006. Developmental neurotoxicity of industrial chemicals. *Lancet* 368:2167–78; doi:10.1016/S0140-6736(06)96665-7.
- Gray SC, Edwards SE, Miranda ML. 2013. Race, socioeconomic status, and air pollution exposure in North Carolina. *Env Res* 126:152–8; doi:10.1016/j.envres.2013.06.005.
- Grønberg TK, Schendel DE, Parner ET. 2013. Recurrence of autism spectrum disorders in full- and half-siblings and trends over time: a population-based cohort study. *JAMA Pediatr* 167:947–953; doi:10.1001/jamapediatrics.2013.2259.
- Hallmayer J, Cleveland S, Torres A, Phillips J, Cohen B, Torigoe T, et al. 2011. Genetic heritability and shared environmental factors among twin pairs with autism. *Arch Gen Psychiatry* 68:1095–1102; doi:10.1001/archgenpsychiatry.2011.76.
- Hertz-Piccolto I, Herr CEW, Yap PS, Dostál M, Shumway RH, Ashwood P, et al. 2005. Air pollution and lymphocyte phenotype proportions in cord blood. *Environ Health Perspect* 113:1391–1398; doi:10.1289/ehp.7610.
- Hertz-Piccolto I, Park HY, Dostal M, Kocan A, Trnovec T, Sram R. 2008. Prenatal exposures to persistent and non-persistent organic compounds and effects on immune system development. *Basic Clin Pharmacol Toxicol* 102:146–154; doi:10.1111/j.1742-7843.2007.00190.x.
- Kalkbrenner AE, Braun JM, Durkin MS, Maenner MJ, Cunniff C, Lee L, et al. 2012. Maternal smoking during pregnancy and the prevalence of autism spectrum disorders, using data from the autism and developmental disabilities monitoring network. *Environ Health Perspect* 120:1042–1048; doi:10.1289/ehp.1104556.
- Leslie DL, Martin A. 2007. Health care expenditures associated with autism spectrum disorders. *Arch Pediatr Adolesc Med* 161:350–355; doi:10.1001/archpedi.161.4.350.
- Li N, Sioutas C, Cho A, Schmitz D, Misra C, Sempf J, et al. 2003. Ultrafine particulate pollutants induce oxidative stress and mitochondrial damage. *Environ Health Perspect* 111:455–460; doi:10.1289/ehp.6000.
- Libbey JE, Sweeten TL, McMahon WM, Fujinami RS. 2005. Autistic disorder and viral infections. *J Neurovirol* 11:1–10; doi:10.1080/1355028059000553.
- Lipsitch M, Tchetgen Tchetgen E, Cohen T. 2010. Negative controls: a tool for detecting confounding and bias in observational studies. *Epidemiology* 21:383–8; doi:10.1097/EDE.0b013e3181d61eeb.
- Lord C, Rutter M, Couteur A. 1994. Autism Diagnostic Interview-Revised: a revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *J Autism Dev Disord* 24:659–685.
- Lyall C, Pauls DL, Spiegelman D, Santangelo SL, Ascherio A. 2012. Fertility therapies, infertility and autism spectrum disorders in the Nurses' Health Study II. *Paediatr Perinat Epidemiol* 26:361–372; doi:10.1111/j.1365-3016.2012.01294.x.
- Mandell DS, Cao J, Ittenbach R, Pinto-Martin J. 2006. Medicaid expenditures for children with autistic spectrum disorders: 1994 to 1999. *J Autism Dev Disord* 36:475–485; doi:10.1007/s10803-006-0088-z.
- McFadden K, Minshew NJ. 2013. Evidence for dysregulation of axonal growth and guidance in the etiology of ASD. *Front Hum Neurosci* 7:671; doi:10.3389/fnhum.2013.00671.
- MohanKumar SMJ, Campbell A, Block M, Veronesi B. 2008. Particulate matter, oxidative stress and neurotoxicity. *Neurotoxicology* 29:479–488; doi:10.1016/j.neuro.2007.12.004.
- Napoli E, Wong S, Giulivi C. 2013. Evidence of reactive oxygen species-mediated damage to mitochondrial DNA in children with typical autism. *Mol Autism* 4:2; doi:10.1186/2040-2392-4-2.
- Patterson PH. 2011. Maternal infection and immune involvement in autism. *Trends Mol Med* 17:389–394; doi:10.1016/j.molmed.2011.03.001.
- Perera FP, Li Z, Whyatt R, Hoepner L, Wang S, Camann D, et al. 2009. Prenatal airborne polycyclic aromatic hydrocarbon exposure and child IQ at age 5 years. *Pediatrics* 124:e195–e202; doi:10.1542/peds.2008-3506.
- Quaak I, Brouns M, Van de Bor M. 2013. The dynamics of autism spectrum disorders: how neurotoxic compounds and neurotransmitters interact. *Int J Environ Res Public Health* 10:3384–3408; doi:10.3390/ijerph10083384.
- Raz R, Lerner-Geva L, Leon O, Chodick G, Gabib LV. 2013. A survey of out-of-pocket expenditures for children with autism spectrum disorder in Israel. *J Autism Dev Disord* 43(10):2295–2302; doi:10.1007/s10803-013-1782-2.
- Rice D, Barone S Jr. 2000. Critical periods of

- vulnerability for the developing nervous system: evidence from humans and animal models. *Environ Health Perspect* 108:511–533.
- Roberts AL, Kristen L, Hart JE, Laden F, Just AC, Bobb JF, et al. 2013. Perinatal air pollutant exposures and autism spectrum disorder in the children of Nurses' Health Study II participants. *Environ Health Perspect* 121:978–984; doi:10.1289/ehp.1206187.
- Rodier PM. 1995. Developing brain as a target of toxicity. *Environ Health Perspect* 103(suppl 6):73–76.
- Shimabukuro TT, Grosse SD, Rice C. 2008. Medical expenditures for children with an autism spectrum disorder in a privately insured population. *J Autism Dev Disord* 38:546–552; doi:10.1007/s10803-007-0424-y.
- Solomon CG, Willett WC, Carey VJ, Rich-Edwards J, Hunter DJ, Colditz GA, et al. 1997. A prospective study of pregravid determinants of gestational diabetes mellitus. *JAMA* 278:1078–1083.
- Stillerman KP, Mattison DR, Giudice LC, Woodruff TJ. 2008. Environmental exposures and adverse pregnancy outcomes: a review of the science. *Reprod Sci* 15:631–650; doi:10.1177/1933719108322436.
- Stoner R, Chow ML, Boyle MP, Sunkin SM, Mouton PR, Roy S, et al. 2014. Patches of disorganization in the neocortex of children with autism. *N Engl J Med* 370:1209–1219; doi:10.1056/NEJMoa1307491.
- Su JG, Jerrett M, Beckerman B, Wilhelm M, Ghosh JK, Ritz B. 2009. Predicting traffic-related air pollution in Los Angeles using a distance decay regression selection strategy. *Environ Res* 109:657–670; doi:10.1016/j.envres.2009.06.001.
- Suglia SF, Gryparis A, Wright RO, Schwartz J, Wright RJ. 2008. Association of black carbon with cognition among children in a prospective birth cohort study. *Am J Epidemiol* 167:280–286; doi:10.1093/aje/kwm308.
- Voineagu I, Wang X, Johnston P, Lowe JK, Tian Y, Horvath S. 2011. Transcriptomic analysis of autistic brain reveals convergent molecular pathology. *Nature* 474:380–384; doi:10.1038/nature10110.
- Volk HE, Hertz-Picciotto I, Delwiche L, Lurmann F, McConnell R. 2011. Residential proximity to freeways and autism in the CHARGE study. *Environ Health Perspect* 119:873–877; doi:10.1289/ehp.1002835.
- Volk HE, Lurmann F, Penfold B, Hertz-Picciotto I, McConnell R. 2013. Traffic-related air pollution, particulate matter, and autism. *JAMA Psychiatry* 70:71–77; doi:10.1001/jamapsychiatry.2013.266.
- Windham GC, Zhang L, Gunier R, Croen LA, Grether JK. 2006. Autism spectrum disorders in relation to distribution of hazardous air pollutants in the San Francisco Bay Area. *Environ Health Perspect* 114:1438–1444; doi:10.1289/ehp.9120.
- Yanosky JD, Paciorek CJ, Laden F, Hart JE, Puett RC, Liao D, et al. 2014. Spatio-temporal modeling of particulate air pollution in the conterminous United States using geographic and meteorological predictors. *Environ Health* 13:63; doi:10.1186/1476-069X-13-63.
- Yanosky JD, Paciorek CJ, Schwartz J, Laden F, Puett R, Suh HH. 2008. Spatio-temporal modeling of chronic PM₁₀ exposure for the Nurses' Health Study. *Atmos Env* (1994) 42:4047–4062; doi:10.1016/j.atmosenv.2008.01.044.
- Yanosky JD, Paciorek CJ, Suh HH. 2009. Predicting chronic fine and coarse particulate exposures using spatiotemporal models for the Northeastern and Midwestern United States. *Environ Health Perspect* 117:522–529; doi:10.1289/ehp.11692.

Exhibit 14

WITHDRAWN DEACTIVATIONS
(as of March 1, 2016)

Unit	Capacity	Trans. Zone	Age (Years)	Critical Owner Request	Requested Deactivation Date	Actual Deactivation Date	PJM Reliability Status ¹	Comments
Branney CT	20	ME	31	Black Start Unit operational until at least 12/05	2/12/2004	Withdrawn	Reliability Issue - Blackstart	Rolling two-year commitment to provide black start service
Blossum CT	19	FN	32	Black Start Unit operational until at least 12/05	2/12/2004	Withdrawn	Reliability Issue - Blackstart	Rolling two-year commitment to provide black start service
Old Orchard 1&2	40	JC	31	Black Start Unit operational until at least 12/05	2/12/2004	Withdrawn	Reliability Issue - Blackstart	Rolling two-year commitment to provide black start service
Gilbert 1&4 CTs	50	JC	33	Black Start Unit operational until at least 12/05	2/12/2004	Withdrawn	Reliability Issue - Blackstart	Rolling two-year commitment to provide black start service
Gilbert 2 & 3 CTs	48	JC	33	Withdrawn	Withdrawn	No Reliability Issues	Deactivation notice withdrawn 4/25/2004	
Old Cayuga 2, 4, & 8	120	JT	33	Withdrawn	Withdrawn	No Reliability Issues	Deactivation notice withdrawn 4/25/2004	
Warner 1-4 CTs	212	JC	32	Withdrawn	Withdrawn	No Reliability Issues	Deactivation notice withdrawn 4/25/2004	
Hudson 2	608	PS	38	10/2/2006	12/31/2006	Withdrawn	Reliability Issue Identified	Deactivation notice withdrawn 12/31/2006
B.L. Enginet 1	120	JE	41	9/21/2004	12/15/2007	Withdrawn	Reliability Issue Identified	Deactivation notice withdrawn 12/15/2007
B.L. Enginet 2	155	JE	39	9/21/2004	12/15/2007	Withdrawn	Reliability Issue Identified	Deactivation notice withdrawn 12/15/2007
B.L. Enginet 3	155	JE	39	9/21/2004	12/15/2007	Withdrawn	Reliability Issue Identified	Deactivation notice withdrawn 12/15/2007
B.L. Enginet C&D (C&D)	8	JE	42	9/21/2004	12/15/2007	Withdrawn	Reliability Issue Identified	Deactivation notice withdrawn 12/15/2007
BT GT 1 & BT1 (C&D Tractor)	3	ME	17	9/19/2006	1/11/2008	Withdrawn	No Reliability Issues	Deactivation notice withdrawn 4/24/2007
Burton Island GCC	244	MD	31	12/2/2005	1/11/2008	Withdrawn	Reliability Issue Identified	Deactivation notice withdrawn 1/15/2007
Prime Energy (Mechan)	47	PS	18	8/19/2005	10/31/2005	Withdrawn	Deactivated 1/9/2006 Reactivated for 8/1/2006	Queue R66 (11/2/2007) Offered and cleared in RPM auction for 2007/2008.
Parlin	114	JC	15	2/28/2006	5/31/2006	Withdrawn	Deactivated 4/10/2006 Reactivated for 8/1/2006	Queue S25 (4/9/2007) Offered and cleared in RPM auction for 2006/2007.
Howard M. Dean (Unpaired Unit 1)	17	JE	45	2/24/2006	5/31/2006	Withdrawn	Deactivated 9/1/2006 Reactivated for 8/1/2006	Queue S43 (5/15/2007) Offered and cleared in RPM auction for 2006/2007.
David Foster	101	BTPE	51	11/4/2003	1/14/2003	Withdrawn	Deactivated 12/10/03 Reactivated for 4/1/2004	Queue S27 (7/26/2007)
Seawater 1	104	PS	55	8/9/2004	1/27/2004	Withdrawn	Reliability Issue Identified	Seawater Units 1-4 were offered and cleared in time for delivery and began the process for what they were required for reliability. A new deactivation notice was submitted after the auction.
Seawater 2	118	PS	55	8/9/2004	1/27/2004	Withdrawn	Reliability Issue Identified	Seawater Units 1-4 were offered and cleared in time for delivery and began the process for what they were required for reliability. A new deactivation notice was submitted after the auction.
Seawater 3	107	PS	54	8/9/2004	1/27/2004	Withdrawn	Reliability Issue Identified	Seawater Units 1-4 were offered and cleared in time for delivery and began the process for what they were required for reliability. A new deactivation notice was submitted after the auction.
Seawater 4	124	PS	53	8/9/2004	1/27/2004	Withdrawn	Reliability Issue Identified	Seawater Units 1-4 were offered and cleared in time for delivery and began the process for what they were required for reliability. A new deactivation notice was submitted after the auction.
Seawater 5	550	PS	5	1/15/2006	8/1/2011	Withdrawn	Reliability Issue Identified	Deactivation notice withdrawn 8/2/2006
Warner 3 CT	97	FN	31	2/12/2004	10/17/2003	Withdrawn	Deactivated 10/4/2004 Reactivated for 4/1/2011	Deactivated 10/4/2004. Reactivated 4/1/2011 (48141)
Big Sandy 1	280	AEP	50	3/22/2012	8/1/2015	Withdrawn	Reliability Analysis complete. Impacts identified and expected to be resolved by May 2015.	Deactivation notice withdrawn on 3/8/13.
Peak Lake 2 (see comment text)	95	ATN	43	3/30/2012	4/16/2015	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by May 2015.	Deactivation notice withdrawn on 4/9/13. Aaron Lake 2 submitted a new deactivation notice on 12/1/2015.
Aaron Lake 3	660	ATN	42	3/30/2012	4/16/2015	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by May 2015.	Deactivation notice withdrawn on 4/9/13.
New Castle 3	93	ATN	59	3/22/2012	4/16/2015	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by June 2015. This generator can be allowed to deactivate as scheduled.	Deactivation notice withdrawn on 4/9/13.
New Castle 4	93	ATN	53	3/22/2012	4/16/2015	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by June 2015. This generator can be allowed to deactivate as scheduled.	Deactivation notice withdrawn on 4/9/13.
New Castle 5	140	ATN	47	3/22/2012	4/16/2015	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by June 2015. This generator can be allowed to deactivate as scheduled.	Deactivation notice withdrawn on 4/9/13.
New Castle Desals A and B	5.4	ATN	43	3/22/2012	4/16/2015	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by June 2015. This generator can be allowed to deactivate as scheduled.	Deactivation notice withdrawn on 4/9/13.
Gilbert 8	90	ATN	35	1/24/2013	4/1/2015	Withdrawn	Reliability analysis complete. Impacts identified and expected to be resolved by May 2015.	Deactivation notice withdrawn on 3/8/13.
Seawater 1-5 (see comment text)	104	PS&G	43	3/21/2012	8/1/2015	Withdrawn	Reliability Analysis complete. No impacts associated with PJSC consolidating re-use of Capacity Rights for a new deactivation event.	PJSC sent in clarifying notice that they did not intend to withdraw this deactivation notice but instead just intended to change the deactivation date to November 1, 2017. Thus the unit now shows up on the Future Deactivation profile and this withdrawal notice is not in effect.
Seawater 2-5 (see comment text)	118	PS&G	43	3/21/2012	8/1/2015	Withdrawn	Reliability Analysis complete. No impacts associated with PJSC consolidating re-use of Capacity Rights for a new deactivation event.	PJSC sent in clarifying notice that they did not intend to withdraw this deactivation notice but instead just intended to change the deactivation date to November 1, 2017. Thus the unit now shows up on the Future Deactivation profile and this withdrawal notice is not in effect.
Seawater 3-5 (see comment text)	107	PS&G	42	3/21/2012	8/1/2015	Withdrawn	Reliability Analysis complete. No impacts associated with PJSC consolidating re-use of Capacity Rights for a new deactivation event.	PJSC sent in clarifying notice that they did not intend to withdraw this deactivation notice but instead just intended to change the deactivation date to November 1, 2017. Thus the unit now shows up on the Future Deactivation profile and this withdrawal notice is not in effect.
Seawater 4-5 (see comment text)	124	PS&G	40	3/21/2012	8/1/2015	Withdrawn	Reliability Analysis complete. No impacts associated with PJSC consolidating re-use of Capacity Rights for a new deactivation event.	PJSC sent in clarifying notice that they did not intend to withdraw this deactivation notice but instead just intended to change the deactivation date to November 1, 2017. Thus the unit now shows up on the Future Deactivation profile and this withdrawal notice is not in effect.
Chalk Point 1	337	PEPCO	49	11/20/2013 5/2/2014 4/30/2015	5/31/2017 5/31/2018 5/31/2019	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by June 2015. This generator can be allowed to deactivate as scheduled.	Reliability system complete. Impacts identified - upgrades scheduled to be completed by 2/1/2016. On 10/19/14 PJSC received an updated deactivation notice with a new deactivation date of 10/1/15. The reliability analysis complete. Impacts identified and will not complete until 2015. Impacts expected to be resolved by June 2015. This generator can be allowed to deactivate as scheduled. Deactivation notice withdrawn on 2/2/2016.
Chalk Point 2	341	PEPCO	48	11/20/2013 5/2/2014 4/30/2015	5/31/2017 5/31/2018 5/31/2019	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by June 2015. This generator can be allowed to deactivate as scheduled.	Reliability system complete. Impacts identified - upgrades scheduled to be completed by 2/1/2016. On 10/19/14 PJSC received an updated deactivation notice with a new deactivation date of 10/1/15. The reliability analysis complete. Impacts identified and will not complete until 2015. Impacts expected to be resolved by June 2015. This generator can be allowed to deactivate as scheduled. Deactivation notice withdrawn on 2/2/2016.
Dickerson 1	182	PEPCO	54	4/30/2015	5/31/2019	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by June 2015. This generator can be allowed to deactivate as scheduled.	Reliability system complete. Impacts identified - upgrades scheduled to be completed by 2/1/2016. On 10/19/14 PJSC received an updated deactivation notice with a new deactivation date of 10/1/15. The reliability analysis complete. Impacts identified and will not complete until 2015. Impacts expected to be resolved by June 2015. This generator can be allowed to deactivate as scheduled. Deactivation notice withdrawn on 2/2/2016.
Dickerson 2	194	PEPCO	52	4/30/2015	5/31/2019	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by June 2015. This generator can be allowed to deactivate as scheduled.	Reliability system complete. Impacts identified - upgrades scheduled to be completed by 2/1/2016. On 10/19/14 PJSC received an updated deactivation notice with a new deactivation date of 10/1/15. The reliability analysis complete. Impacts identified and will not complete until 2015. Impacts expected to be resolved by June 2015. This generator can be allowed to deactivate as scheduled. Deactivation notice withdrawn on 2/2/2016.
Dickerson 3	182	PEPCO	51	4/30/2015	5/31/2019	Withdrawn	Reliability Analysis complete - impacts identified - upgrades scheduled to be completed by June 2015. This generator can be allowed to deactivate as scheduled.	Reliability system complete. Impacts identified - upgrades scheduled to be completed by 2/1/2016. On 10/19/14 PJSC received an updated deactivation notice with a new deactivation date of 10/1/15. The reliability analysis complete. Impacts identified and will not complete until 2015. Impacts expected to be resolved by June 2015. This generator can be allowed to deactivate as scheduled. Deactivation notice withdrawn on 2/2/2016.

Total Withdrawn: 6275.5

Exhibit 15



CEEPR

Center for Energy and Environmental Policy Research

**The Effect Of Power Plants On Local Housing Values And
Rents: Evidence From Restricted Census Microdata**

by
Lucas W. Davis

08-009

June 2008

**A Joint Center of the Department of Economics,
MIT Energy Initiative, and Sloan School of Management**

The Effect of Power Plants on Local Housing Values and Rents: Evidence from Restricted Census Microdata

Lucas W. Davis*
University of Michigan

June 18, 2008

Abstract

Current trends in electricity consumption imply that hundreds of new fossil-fuel power plants will be built in the United States over the next several decades. Power plant siting has become increasingly contentious, in part because power plants are a source of numerous negative local externalities including elevated levels of air pollution, haze, noise and traffic. Policymakers attempt to take these local disamenities into account when siting facilities, but little reliable evidence is available about their quantitative importance. This paper examines neighborhoods in the United States where power plants were opened during the 1990s using household-level data from a restricted version of the U.S. decennial census. Compared to neighborhoods farther away, housing values and rents decreased by 3-5% between 1990 and 2000 in neighborhoods near sites. Estimates of household marginal willingness-to-pay to avoid power plants are reported separately for natural gas and other types of plants, large plants and small plants, base load plants and peaker plants, and upwind and downwind households.

Key Words: Power Plants, Siting, Local Air Quality, Housing Markets

JEL: D62, D63, H23, Q51

*Department of Economics, University of Michigan, 611 Tappan Street, Ann Arbor, MI 48109, USA. I am grateful to Soren Anderson, Matias Busso, Dallas Burtraw, Meredith Fowle, Matt Kahn, Ian Lange, Matt White and seminar participants at the University of California Energy Institute, Wharton, Resources for the Future, the Harris School of Public Policy, the University of Michigan and Stanford for helpful comments. The research in this paper was conducted while the author was a Special Sworn Status researcher of the U.S. Census Bureau at the Michigan Census Research Data Center with generous guidance from Clint Carter, Maggie Levenstein, Arnold Reznick and Stan Sedo. Research results and conclusions expressed are those of the author and do not necessarily reflect the views of the Census Bureau. This paper has been screened to insure that no confidential data are revealed.

1 Introduction

Electricity consumption in the United States is forecast to increase by 41% between 2005 and 2030, according to baseline estimates from the U.S. Department of Energy.¹ Despite recent increased attention to renewable energy sources, the share of electricity production in the United States from fossil-fuel power plants is forecast to increase during this period from 71% to 74%. This will require a 47% increase in electricity generation from fossil fuel plants, necessitating a substantial investment in new plants over the next several decades. This investment has already begun, with 319 new fossil-fuel generators scheduled to be opened between 2008 and 2011.²

Power plant siting in the United States has become increasingly contentious, in part because power plants are a source of numerous negative local externalities including elevated levels of air pollution, haze, noise and traffic. In most states these factors are taken into account during the siting approval process, but this is typically done qualitatively. As siting decisions become more and more difficult, there are large potential social gains from incorporating formal cost-benefit analysis into this process. One of the limiting factors has been the lack of reliable estimates in the literature for household valuation of the local disamenities from power plants.

This paper examines neighborhoods in the United States where power plants were opened during the 1990s. Compared to neighborhoods farther away, the evidence shows that housing values and rents decreased by 3-5% between 1990 and 2000 in neighborhoods near plant sites. Estimates of household marginal willingness-to-pay (MWTP) to avoid power plants are reported separately for natural gas and other types of plants, large plants and small plants, base load plants and peaker plants, and upwind and downwind households. The evidence implies an average housing market capitalization within two miles of a plant of \$14.5 million, with large variation in capitalization across sites depending on the size of the affected population.

This study is germane to an extensive literature that uses hedonic methods to make inference about household preferences for local public goods. This literature has shown that estimates of household MWTP can be inferred for a variety of environmental local public goods including air quality (Chay and Greenstone, 2005; Bayer, Keohane and Timmins, 2006) and water quality (Leggett and Bockstael, 2000). There is also a literature that examines housing values in neighborhoods near hazardous waste sites (Gayer, Hamilton and Viscusi, 2000; Greenstone and Gallagher, 2008), waste incinerators (Kiel and McClain, 1995), nuclear power plants (Nelson, 1981; Gamble

¹U.S. Department of Energy (2007a), p. 82.

²U.S. Department of Energy (2007b), Table 2.5.

and Downing, 1982), fossil fuel plants (Blomquist, 1974), and other sites.

In practice hedonic price functions have proven difficult to estimate because neighborhood amenities are not distributed randomly across locations. For example, power plants tend to be located in industrial areas near rail lines or waterways. Because locations with power plants differ from other locations and neighborhood characteristics are imperfectly measured it is difficult to disentangle the causal impact of power plants on housing values. This omitted variables problem is compounded by an important sorting issue. Households move to locations endowed with amenities that match their preferences. When households near the amenity of interest are not representative of the population at large it becomes difficult to interpret observed price differentials.

This paper addresses these empirical difficulties in several ways. First, the analysis focuses on changes over time, exploiting power plant openings to control for unobserved neighborhood characteristics. Second, the empirical strategy relies on highly-localized comparisons across neighborhoods to control for omitted variables that vary over time. In the main specification, homes located within two miles of power plant sites are compared to homes located two to five miles from sites. In addition, results are presented from a specification in which MWTP to avoid living near a power plant site varies flexibly with distance. In all cases, the estimates are derived from comparisons both across time and across locations. This difference-in-difference approach for addressing concerns about omitted variables and sorting is not without its limitations, as discussed in the paper, but it offers distinct advantages over a cross-sectional approach.

A key feature of this study is that it uses restricted census microdata. These data, which must be accessed at a census research data center under authorization from the Census Bureau, include all of the demographic and housing characteristics available in public-use versions of the decennial census. In addition, whereas in public-use microdata households are identified at the PUMA (a census region with an average of approximately 100,000 individuals), these restricted microdata identify households at the census block (approximately 100 individuals). This precision is important for the analysis because of the highly-localized nature of these externalities. In addition, the large (1 in 6) national sample ensures broad geographic coverage, even in the non-urban areas where many power plants were opened during this period.

The format of the paper is as follows. Section 2 provides background about the local impact of power plants and describes how plants are sited. Sections 3 and 4 describe the data and empirical strategy. Section 5 presents estimates of MWTP for a variety of alternative specifications and section 6 presents concluding remarks.

2 Background

2.1 The Local Impact of Power Plants

In 2005, power plants in the United States emitted 2,500 million metric tons of carbon dioxide, 10 million metric tons of sulfur dioxide and 4 million metric tons of nitrogen oxides.³ Most of the social costs from these emissions are borne far away from plants. Carbon dioxide is associated with climate change and sulfur dioxide is associated with acid rain. These externalities do not disproportionately affect households who live near power plants. Studies using regional atmospheric models (e.g., Levy and Spengler, 2002, Levy, et al., 2002, Mauzerall, et al., 2005, and Muller and Mendelsohn, 2007) tend to find that concentration patterns for these pollutants are centered over the source of emissions, but with substantial health impacts over a large geographic range. For example, Levy and Spengler (2002) find that exposure to health risks from sulfur dioxide and nitrogen oxides decrease approximately linearly between 0 and 500 kilometers from the source of emissions at two power plants in Massachusetts. They find that because of population concentrations, more than half of the social costs from emissions are borne 100 kilometers or more from the source.⁴

Power plants also emit low levels of uranium, thorium, and other radioactive elements as well as mercury, and other heavy metals. These toxic pollutants have been associated with serious health problems including cognitive impairment, mental retardation, autism and blindness.⁵ Although emitted in far smaller quantities than the criteria pollutants described above, these emissions have potentially a larger impact on local communities because large airborne particles typically settle out from the air relatively close to their emission source.⁶ For example, U.S. EPA (1997) reviews the evidence on mercury transport, reporting evidence from environmental monitoring studies that suggest that measured mercury levels are higher around stationary industrial and combustion sources known to emit mercury.

In addition to local air quality there are additional local externalities from power plants. First, sulfur dioxide and nitrogen dioxide from power plants are two of the principal components of low-hanging haze or smog. Second, power plants and transmission infrastructure may be local eyesores. Third, power plants can be noisy. This is particularly the case for natural gas plants. Fourth,

³U.S. Department of Energy (2007), Table 5.1.

⁴In a related paper, Kahn (2007) examines the proximity between power plants and population centers. Kahn finds that census tracts within 2.5 miles of the 100 dirtiest power plants in the U.S. have slower population growth than other tracts, consistent with a national migration pattern toward the South and West where electricity tends to be produced using newer, cleaner plants.

⁵U.S. Department of Health and Human Services (2007).

⁶U.S. Environmental Protection Agency (2004), p. 6.

power plants cause increased traffic. This is particularly the case for coal plants because whereas natural gas is delivered to the plant by pipeline, coal typically arrives by train, truck, or barge. Power plants in the United States use over one billion tons of coal annually (over 650,000 tons per generator).⁷ These deliveries require thousands of trips at all hours of the day along with the associated noise, traffic, and local air impact. In addition, coal transport is a major source of airborne particulates.

Another local externality from power plants is fossil fuel residue. When fossil fuels are burned they leave a residue that consists of the noncombustible portion of the fuel as well as residues from dust-collecting systems, sulfur dioxide scrubbers and other emissions abatement equipment. Coal power plants produce 120 million tons of residue annually, according to National Research Council (2006), including fly ash, bottom ash, boiler slag, and flue gas desulfurization sludge.⁸ These residues consist mostly of silicon, aluminum, and iron, but also contain lead, cadmium, arsenic, selenium, mercury. Many plants landfill these residues on site. If managed improperly, particles can be picked up by wind and transported locally. There is also risk that residuals can enter drinking water supplies and be dangerous for health.

Local disamenity effects could be obscured by indirect impacts on housing values through employment effects. According the U.S. Bureau of Labor Statistics (2008), in 2006 there were 35,000 power plant operators in the United States. Employment from power plants increases demand for local housing, causing a positive (and offsetting) effect on housing values. Similarly, disamenity effects could be obscured by indirect impacts on housing values through reduced property taxes.⁹ It is important to note, however, that increased employment and property tax revenues typically affect both the households in the immediate vicinity of the plant and households living farther away in the same town. The empirical strategy used in this paper is to compare changes in housing values near sites where power plants were opened with changes in housing values in neighborhoods farther

⁷U.S. Department of Energy (2007), Table ES1. As a point of reference, a train car can hold approximately 100 tons of coal. Therefore, the average 4-generator power plant will use over 70 train cars of coal per day.

⁸U.S. EPA (2008) reports that 60% of this residue end up in landfills and 40% is used beneficially, for example, in concrete.

⁹This discussion is germane to an extensive literature in public economics that examines the efficiency implications of competition between jurisdictions in tax levels and environmental standards. See, for example, Epple and Zelenitz (1981) and Oates and Schwab (1988). Anecdotal evidence suggests that property tax payments from power plants are large. For example, an energy company in Maryland with four power plants recently paid \$33 million for its 2004 taxes (“Mirant to Resume its Tax Payments to Three Maryland Counties.” *Washington Post*, August 31, 2004) and a new plant, also in Maryland, is expected to pay \$2 million annually in property tax (“Natural Gas-Fired Utility Planned in Charles County.” *Washington Post*, July 26, 2007). In some cases the revenue from power plants makes up a substantial portion of total local revenues (“Two Power Plants Win a Lawsuit, and Property Taxes Rise Drastically in Several Towns.” *New York Times*, January 23, 2007).

away. Because the comparison group is drawn from the same local area, this approach attempts to control for these employment and tax effects.

2.2 How Are Power Plant Locations Determined?

In light of the local disamenities from power plants, it would seem to be welfare-maximizing to site power plants in areas with extremely low population density. However, in siting power plants there is a tradeoff between local disamenities and transmission costs. In 2006, electric utilities reported spending \$837,000 for each new generator in interconnection costs (i.e. the costs incurred for the direct, physical interconnection of generators including distribution lines and transformers).¹⁰ According to Hirst and Kirby (2002), the typical cost of a large capacity (435 kilovolt) transmission line is \$800,000 per mile. Perhaps more importantly, plants must receive right-of-way from all property owners along the transmission route and many property owners are resistant to allowing utilities to build transmission lines.¹¹ Transmission lines impose visual disamenities and other negative externalities on nearby households. Finally, there are direct line losses from transmission, particularly with low-voltage lines.

These tradeoffs are evaluated at the state and local level by siting authorities according to state and local regulations. For example, in California, all new energy generating facilities 50 megawatts or larger must be approved by the California Energy Commission (CEC). Developers submit an application that describes the plant and proposed location in detail. CEC staff reviews the application considering the possible impact of the plant on air quality, traffic, noise, visual disamenities, and many other factors. When necessary, the CEC staff consults with other agencies and reviews relevant federal, state, and local laws. Finally, the staff makes a recommendation to the full Commission at a hearing that is open to the public. During the 1990s in California no projects were rejected, though some applications were withdrawn prior to the completion of the review.

The process in California is generally representative of the application process in other states. The California State Auditor (2001) reviewed procedures in Oregon, Minnesota, Connecticut, Florida and Texas and found that these states follow a procedure similar to California in which

¹⁰U.S. Department of Energy (2007), Table 2.12.

¹¹Recent federal legislation has increased the scope for federal intervention in the siting of transmission lines. The Energy Policy Act of 2005, H.R. 6, Section 1221 authorizes the Federal Energy Regulatory Commission (FERC) to overrule local and state governments in the siting of interstate electric transmission lines and related facilities. In particular, holders of FERC-approved permits may acquire right-of-way along “national interest electric transmission corridors” by the exercise of eminent domain. As of April 2008, FERC has held discussions about several proposed interstate transmission lines, but no formal requests for federal intervention have been made.

developers submit an application which is submitted to agency review and public hearing before a decision is made. Edison Electric Institute (2004) provides a state-by-state description of siting regulations for all 50 states with contact information for relevant siting authorities. Most states follow the procedure in California, with an application that often includes an environmental impact statement, followed by public hearings and a final decision made by a state regulatory agency. In most states, the regulatory agency is a state public service commission or state utility commission, though in some states the primary siting agency is the state environmental agency (e.g. Alaska, Florida, Louisiana, Maine, Minnesota, Montana). Often siting applications must be approved by multiple state governmental agencies and in these cases state environmental agencies are usually one of the related agencies. In most states, approval is required for all power plants, though some states do not require approval for plants smaller than 10 megawatts (Kentucky, Texas), 25 megawatts (Iowa, Oregon), 50 megawatts (Ohio), 75 megawatts (Florida) or 100 megawatts (Arizona, Massachusetts, Wisconsin). Finally, a small number of states (Arkansas, Georgia, Illinois, Kansas, Pennsylvania, Tennessee) do not have a state-wide application process and power plant siting is determined locally.¹²

Thus, in siting power plants policymakers face a difficult tradeoff between transmission costs, local disamenities, and other factors. Although local policymakers typically take local disamenities into account when approving siting proposals, in the past this has been done qualitatively. As siting decisions continue to get more and more difficult, there are large potential social gains from incorporating the tools of cost-benefit analysis into this process. One of the limiting factors has been the lack of reliable estimates in the literature for household valuation of local disamenities. The estimates in this paper provide a benchmark for formally incorporating local disamenities.

3 Data

This paper uses household-level microdata from the decennial census combined with detailed information on power plant openings from the U.S. Department of Energy and the U.S. Environmental Protection Agency (EPA).

¹²See also Vajjhala and Fischbeck (2007) that documents differences in regulatory procedures, environmental factors, and public opposition across states in siting procedures.

3.1 Power Plant Characteristics

Power plant characteristics come from the EPA “Emissions and Generation Resource Integrated Database (eGrid)” for 2006, version 2.1. This database is a comprehensive inventory of the generation and environmental attributes of power plants in the United States. Much of the information in eGrid, including plant opening years, come from the U.S. Department of Energy “Annual Electric Generator Report” compiled from responses to the EIA-860, a form completed annually by all electric-generating plants. In addition, eGrid includes plant identification information, geographic coordinates, number of generators, primary fuel, plant nameplate capacity, plant annual net generation, and whether or not the plant is a cogeneration facility.

The sample of plants used in the analysis includes all fossil fuel plants that began operation between 1991 and 1999, between the 1990 census and the 2000 census.¹³ The analysis focuses on plant openings rather than announcements about plant openings because information about plant announcements is not available. Announcements typically precede openings by several years because plants construction typically takes at least 2 years. In an effort to assess these timing issues, results throughout are presented for both housing values and rents. Whereas housing values reflect the present discounted value of all future amenities associated with a particular location, rents reflect amenities at a particular point in time. In addition, results are presented from an alternative specification in which the sample is restricted to include plants that opened during the late 1990s.

Plants smaller than 100 megawatts are excluded because they tend to be built simultaneously with existing or expanding facilities such as industrial plants. Because the objective of the study is to disentangle the disamenities imposed by power plants from other locational amenities it makes sense to concentrate on these large plants, that tend overwhelmingly to be independent facilities. In addition, the geographic coordinates for these smaller plants are considerably more difficult to verify. As described below, larger plants can be seen on aerial photos, substantially increasing the reliability of the geographic coding.

The sample is restricted to plants in new locations. Existing facilities that increase the number of generators on site and plants that change their primary energy source (e.g. switch from coal to natural gas) are excluded. Changes in capacity and emissions levels may indeed affect the local

¹³No large (>100 MW) non-cogeneration plants were closed during the 1990s. In constructing these data there initially appeared to be a small number of plant closings. However, upon further inspection, these turned out to be temporary closures.

desirability of power plants, but including these changes in the analysis would make the results difficult to interpret. Moreover, these changes often occur simultaneously with other changes at the plant, further complicating the interpretation of results. Similarly, cogeneration plants (i.e. plants that produce both electricity and heat, typically in the form of steam) are excluded because they tend to be constructed simultaneously with industrial plants, large commercial buildings, and other facilities.

The database includes 982 non-cogeneration fossil-fuel plants larger than 100 megawatts. Of these, 60 were opened between 1991 and 1999 including 52 natural gas plants, six coal plants and two oil plants. Although the 1990s was a slow period of power plant construction compared to previous decades, this still represents a large sample of facilities compared to most hedonic studies, and a considerable improvement over Blomquist (1974) which examines a single power plant. Figure 1 provides a map indicating the locations of the plants. All geographic coordinates were verified using aerial photos from Google Maps.¹⁴

3.2 Demographic and Housing Characteristics

The demographic and housing characteristics used in the analysis come from restricted census microdata from the 1990 and 2000 decennial census. Demographic characteristics include household income, household size, family structure, educational attainment and race. Housing characteristics include type of home, age of home, number of bedrooms, acreage, and the number of units in the building, as well as reported housing value for homeowners and reported monthly rent for renters.¹⁵

These restricted data are accessed at a census research data center after having a project approved by the Census Bureau. The primary advantage of these data is their geographic detail. Whereas public-use microdata identify households at the PUMA, these restricted microdata identify households at the census block, the smallest geographic unit used by the Census Bureau. These

¹⁴For 53 of the 60 plants high resolution photos were available and the geographic coordinates of the facility could be confirmed visually up to the nearest 1/1000 of a degree (about 10 feet). For the remaining plants high resolution photos were not available and the EPA's coordinates could not be confirmed definitively. Still, the low resolution photos suggest that the coordinates are highly accurate. In many cases, despite the low resolution it was possible to visually discern the power plant. In other cases, the coordinates corresponded to locations along a river or other body of water, locations where power plants tend to be sited.

¹⁵It would have been valuable to expand the analysis to include data from the 1980 census. The Census Bureau, however, completely redesigned census geography with the 1990 Census, making it difficult to make comparisons between the 1980 and 1990 census. Moreover, it was not until 1990 that the entire U.S. was divided into census blocks. In 1980, census blocks had been created for all incorporated places with a population greater than 10,000. These places included approximately 70% of the nation's population and 7% of its land area. Furthermore, there are serious concerns about the reliability of the 1980 census block coding. By the Census Bureau's own admission, the geographic coding in 1980 was replete with errors, omissions, and inconsistencies, particularly with regard to census blocks and block groups. See U.S. Census Bureau (1994), page 11-8.

data offer more detailed geographic detail even than is available in summary files 1 and 3, the most detailed publicly-available tabulations for the 1990 and 2000 census. Although basic neighborhood characteristics about population, age and race from the short-form survey are available at the block level for both 1990 and 2000, the more detailed information from the long-form survey including housing values, rents, and housing characteristics are available only at the block group level for 2000. The neighborhood impact from power plants is highly localized so this geographic detail is critical.

In addition to the increased geographic detail, microdata make it possible to control for housing unit-specific covariates, increasing the precision of the estimates. Still, it is important not to overstate the benefits of using microdata as opposed to the publicly-available tabulations. Although microdata would allow one, for example, to examine how changes in housing prices and rents vary across homes with different characteristics, this is not the focus here. Nor are these microdata being used to examine how MWTP varies across households with different observable characteristics as in Bayer, Ferreira, and McMillan (2007).

The last important advantage of using restricted data is the broad geographic coverage. Restricted data provide information for the full sample of households that filled out the long-form survey. In 1990 and 2000, this includes 1 in 6 households in the United States compared to the 5% sample available with public-use microdata. Moreover, the stratified sampling used by the Census Bureau ensures that even places with small populations are represented proportionally in the sample.¹⁶

The measures of housing values and rents in the census data are self-reported. With any self-reported information one may be concerned about whether or not households are able to answer accurately. Housing values are self-reported in response to a question that prompts respondents to report how much they think their home would sell for if it were for sale. Particularly for owners

¹⁶In the 1990 census, 1 in 2 households were surveyed in places with population under 2,500 compared to 1 in 8 households elsewhere. In the 2000 census, 1 in 2 households were surveyed in places with fewer than 800 units, 1 in 4 households in places with fewer than 1200 units, 1 in 6 in places with fewer than 2000 units, and 1 in 8 elsewhere. An alternative to using census data would be to use the American Housing Survey. The advantage of the AHS is that it includes more detailed housing characteristics than the decennial census. However, the AHS does not have the geographical coverage or sample size available in the census. Most of the facilities examined in this study are not within the 47 metropolitan areas covered by the AHS. Also, during this period the AHS interviews approximately 55,000 households every other year, not enough households to be able to have broad coverage in the areas under consideration. Another alternative would be to use commercially available sales data. For example, DataQuick maintains an extensive database of housing sales based on public records from over 800 localities in 46 states including over 87 million total transactions. The advantage of sales data is that they are available at a high frequency. Sales data, however, are not a representative sample like the census data and typically rental prices are not available.

who purchased their homes many years ago, this may be difficult for some households to answer. In contrast, rent is presumably not subject to the same degree of misreporting as housing values because of the saliency of rent payments. Another potential problem with housing values is that they are reported for 20 different categories.¹⁷ In the empirical analysis housing value is treated as a continuous variable using the midpoint of the range. Again, rental rates are less problematic. In 1990 rent was categorical, but the number of categories was larger (26 categories), and in 2000 rent was a write-in response.

4 Empirical Strategy

4.1 The Omitted Variables Problem

In equilibrium, the price of housing near undesirable local facilities must be lower than the price of housing in other neighborhoods in order to attract households to these neighborhoods. In this paper, these equalizing differences are recovered by estimating a hedonic price function. Following Rosen (1974), the coefficients of the hedonic price function are interpreted as household MWTP for an incremental change in that attribute. In estimating this hedonic price function several econometric challenges must be addressed. Perhaps most importantly, there are unobserved differences between neighborhoods with power plants and neighborhoods without power plants. Siting decisions are likely to be correlated with local neighborhood and housing characteristics which are imperfectly observed. If these unobserved factors are also correlated with housing values then estimates of the hedonic price function will be biased.

Several different approaches have been used in recent hedonic studies to address this omitted variables problem. Chay and Greenstone (2005) measure the effect of air pollution on housing values using an instrumental variables approach exploiting variation in county-level air pollution induced by the Clean Air Act. Bayer, Keohane, and Timmins (2006) measure the effect of air pollution on housing values instrumenting for county-level particulate matter concentrations using distant emissions. Greenstone and Gallagher (2008) examine the effect of Superfund clean-ups using a regression discontinuity design, comparing housing values near clean-ups to housing values near sites that narrowly missed being cleaned up according the EPA's selection rule. These papers all rely on plausibly exogenous variation in amenities to identify the effect of amenities on housing

¹⁷In 1990 the highest category for housing values begins at \$500,000 and in 2000 the highest category begins at \$1,000,000. This change in categories is unlikely to influence the results, however, because only a tiny fraction of homes in the sample are in this highest category.

prices.

Another group of papers in this literature addresses the omitted variables problem by comparing before and after a change in amenities or before and after a change in information about amenities. For example, Kohlhase (1991) examines housing values before and after EPA announcements that a toxic waste site has been listed on the Superfund list. Kiel and McClain (1995) study the effect of a new garbage incinerator on housing values in Massachusetts. Gayer, Hamilton and Viscusi (2000) examine housing values near Superfund sites after information about the sites is released. These studies control for time-invariant neighborhood characteristics by focusing on changes in housing values over time. In some cases, a second location which did not experience the changes in amenities is used as a comparison group. For example, Davis (2004) examines housing prices in a county in Nevada before and after a cancer cluster, compared to changes in housing prices in a nearby county. Although this difference-in-differences approach offers advantages over a conventional cross-sectional analysis, it is not a panacea as is discussed below.

This paper addresses the omitted variables problem using this difference-in-differences approach. The study compares housing values and rents before and after plant openings to control for the unobserved characteristics of affected neighborhoods. In addition, the empirical strategy relies on highly localized comparisons across neighborhoods to control for time effects. In particular, homes far away from the site act as a comparison group for homes in the immediate vicinity. In the main specification, homes located within two miles of a power plant site are compared to homes located between two and five miles away.

4.2 The Baseline Specification

Equation (1) describes the hedonic price function estimated in the paper,

$$\begin{aligned} \logprice_{jt} = & \alpha_1 x_{jt} + \alpha_2 1(\text{within two miles})_j * 1(\text{year 2000})_t + \\ & \alpha_3 1(\text{year 2000})_t * \text{power plant site indicators}_j + \\ & \text{census block fixed effects}_j + \epsilon_{jt}. \end{aligned} \tag{1}$$

where j indexes individual houses and t indexes time. Equation (1) is estimated separately for home owners and renters. For home owners, the dependent variable, \logprice , is the reported housing value (in logs). For renters, the dependent variable is the reported monthly rent (in logs). There are two time periods, 1990 and 2000.

Census block fixed effects are used to control for unobserved factors that are consistent over time. Although geographic boundaries changed for many census blocks between 1990 and 2000, the census bureau provides files that describe the relationship between 1990 and 2000 census blocks. These files were used to create geographic identifiers linking 1990 and 2000. For expositional simplicity these units will be referred to as census blocks and in cases where there is a one-to-one matching between census blocks in 1990 and 2000, these units are indeed census blocks. In cases where the relationship is one-to-many, many-to-one, or many-to-many, geographic identifiers correspond to the smallest consistent geographic unit across the two surveys.

The sample includes homes located within five miles of the nearest power plant site. The indicator variable $1(\textit{within two miles})$ indicates homes within two miles of the nearest power plant site. The restricted census microdata make it possible to highly accurately assign distances to homes based on the distance between the plant site and the census block centroid.¹⁸ Two miles is selected as the cutoff in the baseline specification because it is a large enough area to include the households most affected by local disamenities. Section 5.1 presents results from an alternative specification that allows MWTP to vary flexibly with distance to the plant.

The coefficient of interest, α_2 , is household MWTP to avoid living within two miles of an operating power plant. This is the difference-in-difference estimate, the effect of power plants on housing prices, controlling for time and distance effects. The specification includes a variety of control variables. Housing characteristics are denoted x_{jt} and include age of the home and indicator variables for the number of bedrooms, number of units in the building, and whether or not the home has complete plumbing, one or more acres, and ten or more acres. The census block fixed effects control for unobserved neighborhood characteristics that do not change over time. For example, the census block fixed effects allow for the area in the immediate vicinity of the plant site to be different from the neighborhoods farther away, even prior to plant openings. In addition, the specification controls flexibly for time trends. In particular, the variable $1(\textit{year 2000})$ is interacted with indicator variables for each power plant site allowing the area around each power plant to have a different and unrestricted time trend between 1990 and 2000. This flexibility is important, for example, because of differential time trends by state and region. Finally, the estimating equation

¹⁸There is some precedent in this literature for constructing neighborhoods using circles. In related work, Banzhaf and Walsh (2008) create half-mile circles by aggregating up from census block and block group level tabulations, finding evidence in high-toxic areas of out-migration of Whites and in-migration of Hispanics. Saha and Mohai (2005) create 1 mile radius circles around 23 hazardous waste facilities in Michigan and then use block group tabulations for 1980 and 1990 to infer the population and demographic characteristics within the radius. With their area weighting approach, population characteristics within each circle are assumed to be an area-weighted average of the block groups that intersect the circle.

includes ϵ_{jt} , an idiosyncratic component.

The strategy of examining plant openings makes it possible to control for time-invariant neighborhood characteristics and the estimates of α_2 will be consistent even if the 5-mile-radius “neighborhoods” are not perfectly homogenous. Least squares estimation of equation (1) is consistent if the interaction of $1(\textit{year 2000})$ and $1(\textit{within two miles})$ is exogenous conditional on housing characteristics, $1(\textit{year 2000})$ interacted with power plant indicators, and census block fixed effects,

$$\begin{aligned}
 E[\epsilon_{jt} | x_{jt}, 1(\textit{within two miles})_j * 1(\textit{year 2000})_t, \\
 1(\textit{year 2000})_t * \textit{power plant site indicators}_j, \\
 \textit{census block fixed effects}_j] = 0.
 \end{aligned}
 \tag{2}$$

The primary source of potential correlation between ϵ_{jt} and the interaction term is highly-localized differential time trends in housing prices and rents that are correlated with plant location decisions. For example, if power plants tend to be opened in locations that are in decline relative to the comparison neighborhoods, this would lead to estimates of MWTP that are biased away from zero. Still, it is worth emphasizing that the specification allows for separate time trends for each power plant site, thus controlling for regional, state, and local trends in housing values and rents. In addition, the advantage of using a comparison group that is close in physical proximity to the neighborhoods in the immediate vicinity of plants is that many factors that explain local housing market trends (e.g. changes in labor markets) are therefore controlled for.

The variance matrix is estimated taking into account that there are unobserved factors that cause prices to be correlated within power plant sites. An important advantage of the distance-based approach is that within the five mile radii considered in the analysis many factors such as school quality, local property taxes, and other factors are likely to be similar. However, even within these relatively small areas, and even after controlling for housing characteristics there are unobserved factors such as highly-localized geographical features and neighborhood amenities that cause nearby housing values to be correlated. Under this correlation, parameter estimates are still unbiased and consistent but the variance matrix must be corrected. Clustering by plant site allows each site to have a different and unrestricted covariance structure, but assumes that errors are uncorrelated across sites.

An alternative empirical strategy would be to compare neighborhoods near power plant sites

to neighborhoods near sites where plants opened before 1990 or after 2000.¹⁹ Since the process by which plants are sited is not believed to have changed substantially during this period, these neighborhoods might have similar characteristics and trends compared to neighborhoods where plants opened during the 1990s. This approach is unlikely to provide a credible counterfactual, however, because plant openings before 1990 and after 2000 have direct effects on changes in housing values and rents between 1990 and 2000. Neighborhoods where plants opened before 1990 are not a credible comparison group because power plants permanently alter trends in housing values and rents by affecting neighborhood composition and subsequent decisions about whether or not to open additional industrial facilities. Also, plant utilization and other operating characteristics of existing plants change over time, affecting the desirability of local neighborhoods. Neighborhoods where plants opened after 2000 are not a credible comparison group because of anticipation effects. As discussed in the following section, plant openings require several years of planning. As a result, housing values in 2000 will already reflect expectations about future plant construction. In addition, neighborhoods where plants opened before 1990 or after 2000 come from different local markets. An advantage of the distance-based counterfactual is that the comparison group is in close geographic proximity making it possible to control for unobserved community-specific shocks.²⁰

The approach used in the paper for estimating MWTP ignores mobility costs and general equilibrium effects. See Bayer, Keohane, and Timmins (2006) for a recent study that uses a discrete choice model to incorporate mobility costs into a neighborhood choice framework. Bayer, Keohane, and Timmins find estimates of MWTP for air quality that are three times larger than the estimates of MWTP they find when they estimate a conventional hedonic model using these same data. Discrete choice models have also been used to distinguish between partial equilibrium and general equilibrium effects. Sieg, Smith, Banzhaf, and Walsh (2005), for example, adopt a general equilibrium framework to measure the effect of air quality on housing values. This general equilibrium approach is particularly important for their application because air quality affects a large proportion of households. Relatively few households live near power plants so partial

¹⁹This strategy has been used effectively in other contexts. For example, Busso and Kline (2008) use empowerment zones awarded in 1999 and 2001 as a point of comparison for empowerment zones awarded in 1994.

²⁰Furthermore, an alternative counterfactual using neighborhoods where plants opened before 1990 or after 2000 only makes sense if one believes that trends for a particular type of neighborhood are constant over time. Plant openings are endogenously determined at a particular point in time. Therefore, the fact that a plant was opened in one location in the 1980s and another in a location in the 1990s suggests that these locations are not identical. Moreover, even if these neighborhoods have similar characteristics and trends at the time of openings, this does not imply that the neighborhoods will follow similar trends during the 1990s. Because of this concern and the other considerations raised in this section, it does not make sense to perform a false experiment with neighborhoods with plants that opened before 1990 or after 2000.

equilibrium effects are likely to provide a reasonable approximation to general equilibrium effects.

4.3 Examining Where Power Plants Were Opened During the 1990s

This section examines the neighborhoods where power plants were opened during the 1990s. Household demographic and housing characteristics are examined in 1990, before the plants were opened, comparing households living near plant sites with households living farther away. These descriptive statistics are valuable because they provide information about the siting process for plants and because they provide evidence on the validity of these farther away neighborhoods as a comparison group.

Table 1 reports mean household demographic and housing characteristics in 1990 for households living within two miles of plant sites, households living between two and five miles of plant sites, and households in the entire United States. The table also reports p -values from tests of equal means. The table indicates that neighborhoods within two miles of the plant sites are different, both from the neighborhoods two to five miles from the sites and from the United States as a whole. For example, household income in the neighborhoods within two miles is lower than household income in the other two groups and the differences are highly statistically significant. Within two miles households tend to have more children and household heads are less likely to have finished high school. In addition, the proportion of households for which the household head is Black or Hispanic in the neighborhoods within two miles is higher than the proportion in the two to five mile neighborhoods or in the United States as a whole. This is consistent with evidence from a substantial environmental justice literature (see, e.g., Been 1994, Oakes, Anderton and Anderson 1996, Been and Gupta 1997, Helfand 1999, and Saha and Mohai 2005). Compared to the United States as a whole, the null hypothesis of equal means is rejected in all 20 cases. Compared to the two to five mile neighborhoods, equal means are rejected at the 1% level in 16 out of 20 cases. In part, these rejections reflect the large sample size. However, even when alternative critical values are adopted following Leamer (1978) that account for sample size the null of equal means continues to be rejected in most cases.

Despite these differences the two to five mile group is still a valuable comparison group because of its geographic proximity to the within two mile group. Many of the factors that explain local housing market trends (e.g. changes in labor markets) are likely to be similar within these relatively small geographic areas. As discussed in section 4.2, the estimates of MWTP will be unbiased as long as, controlling for observables and census block fixed effects, the trends in housing prices are

the same in the two to five mile neighborhoods as they would have been in the zero to two mile neighborhoods.

Column (4) reports covariate means weighted by propensity scores. The idea of propensity score weighting is to reweight the observations in the two to five mile group to balance the covariate means with the zero to two mile group, increasing the weight assigned to households that are similar to households in the immediate vicinity of plants. First, census block averages are created for all covariates. Second, propensity scores are estimated using a logit regression with *1(within two miles)* as the dependent variable and independent variables including all variables in table 1 except for housing values and rents. Cubics are used for all variables that are not proportions (household income, household size, number of children, and number of individuals over 65). Estimated coefficients and standard errors from the propensity score logit regression are reported in Table A1. Third, following Rosenbaum (1987) the propensity scores from this regression are used to reweight the observations in the two to five mile group by the relative odds, $\frac{p(x_{jt})}{1-p(x_{jt})}$, where $p(x_{jt})$ is the propensity score (i.e. the conditional probability of being in the zero to two mile group given covariates).²¹

The propensity score weighting substantially balances covariate means across the within two mile and two to five mile groups. Means for all covariates are similar in magnitude and the null hypothesis of equal means can be rejected at the 1% significance level in only two out of 20 cases. The reweighting specification reduces the potential scope for functional form misspecification in the estimating equation to bias the results. In addition, this reweighting helps address potential concerns about differential time trends. The results presented in the following section allow the area around each power plant site to have a different time trend. If, in addition, there are highly-localized trends within these neighborhoods that lead the within two mile group to have a different time trend from the two to five mile group, this is addressed in the propensity score weighting specification to the extent that these differential trends are explained by observables. For example, if trends in housing values and rents vary across census blocks with different levels of household income, the propensity score weighting specification controls for this by balancing average household income across the two groups.

²¹The following section reports results from estimating equation (1) using these weights. The standard errors reported for this specification do not account for the variance component due to estimation of the propensity scores. The coefficients in the logit regression are precisely estimated, however, so the magnitude of the potential bias is small. See Pagan (1984) and Murphy and Topel (1985) for discussion of inference in models with generated regressors.

5 Results

5.1 Estimates of MWTP to Avoid Living Near a Power Plant

Table 2 presents least squares estimates of the hedonic price function, equation (1). For all specifications the table reports the coefficient and standard error corresponding to the interaction between $1(\textit{within two miles})$ and $1(\textit{year 2000})$. All specifications include housing characteristics and power plant specific time trends. In column (1), the estimated household MWTP associated with living within two miles of an operating power plant is $-.030$, or 3.0% of housing values. Results for rents are similar, providing an important test of the robustness of the results. When the dependent variable is monthly rent in logs, column (4), the estimated MWTP is $-.044$. Columns (2) and (5) report results from a specification with census block fixed effects. Results are similar in this richer specification, with estimates of MWTP equal to $-.023$ for housing values and $-.055$ for rents. Columns (3) and (6) report results from the propensity score weighting specification. Results are similar to the results from the two previous specifications. Overall, point estimates for household MWTP to avoid living near a fossil-fuel power plant range from 2.3 – 3.0% for housing values and from 4.4 – 5.5% for rents.

Figures 2 and 3 describe the gradient of housing values and rents with respect to distance to the nearest power plant site. These figures were constructed using the census block fixed effects specification described in table 2, columns (2) and (5). For each figure fifty separate regressions were performed. In place of the interaction term $1(\textit{within two miles}) * 1(\textit{year 2000})$, each regression included an interaction term of $1(\textit{year 2000})$ with an indicator variable corresponding to a different 1-mile wide distance from the plant. For example, the point estimates for one mile in figures 2 and 3 correspond to the coefficient and standard error corresponding to the interaction $1(\textit{between .5 and 1.5 miles}) * 1(\textit{year 2000})$. Thus, the specification allows MWTP to avoid living near an active power plant to vary flexibly by distance to the plant. The figure was constructed using all homes located within ten miles of the nearest plant, making it possible to evaluate the validity of the two to five mile group as a comparison group.

The results in figures 2 and 3 are consistent with the results reported in table 2. For housing values, point estimates for MWTP are negative and between $-.03$ and $-.04$ between zero miles and two miles, then increasing gradually to zero between three and four miles from the nearest plant site. For rents, there is a negative and statistically significant impact within two miles, increasing to zero beyond two miles. These results suggest that minor changes in the definitions of the treatment

and comparison groups would not meaningfully change the results presented in table 2.

Figures 2 and 3 also address possible concerns about contamination of the comparison group. Even in the absence of a significant direct effect, property values and rents in the two to five mile neighborhood might have been affected indirectly by household mobility. Suppose power plants cause household to move out of neighborhoods in the immediate vicinity of the plant, but labor market and other considerations make it undesirable for these households to move far away. Increased demand for housing in the two to five mile neighborhood would cause the cost of housing to increase, potentially biasing the estimates of MWTP away from zero. Based on the evidence in figures 2 and 3, this does not appear to be the case. The estimated coefficients between two miles and ten miles are close to zero and not statistically significant for both housing values and rents, suggesting that contamination of the comparison group is not driving the results.

It is valuable to compare the estimated coefficients in this section with estimates of MWTP from previous studies. Chay and Greenstone (2005) find that the elasticity of housing values with respect to particulates concentrations ranges from $-.20$ to $-.35$ so that, for example, the 11 – 12% reduction in TSPs they observe in non-attainment counties is associated with a 2 – 3.5% increase in housing values. Bayer, Keohane, and Timmins (2006) find somewhat larger elasticities, $-.34$ to $-.42$, using a discrete-continuous approach that accounts for mobility costs. Greenstone and Gallagher (2008) find smaller point estimates, $-.008$ to $.018$, for homes within a 2-mile radius of hazardous waste clean-ups.

There are on average, 2900 housing units within two miles of each power plant site.²² The mean housing value from table 1 implies that the average total value of the housing stock within two miles of a plant site is \$483 million in year 2008 dollars. Multiplying this by the estimate of MWTP from column (3) yields an average housing market capitalization within two miles of a plant of \$14.5 million. As a point of comparison, recall that the typical cost of a large capacity (435 kilovolt) transmission line is \$800,000 per mile.²³ In some cases, moving a plant one or two miles in one direction or another would substantially reduce the size of the affected nearby population. In other cases, plants are in highly-populated areas and it would require many mile of additional transmission (and siting of transmission lines) in order to reduce the size of the affected nearby population. As described in section 2.2, policymakers must take many different factors into account

²²Table A2 in the appendix reports housing units per square mile near plant openings for various distances. See Greenstone and Gallagher (2008) for a discussion of the response of housing supply to changes in environmental amenities.

²³Hirst and Kirby (2002).

when deciding whether or not to approve power plant proposals including local disamenities and transmission costs. These estimates of the social cost of local disamenities provide a benchmark for formally incorporating local disamenities into the cost-benefit analysis.

This measure understates the total value of local disamenities because it reflects residential property, but not industrial, commercial, or undeveloped property. While some industrial uses may not be substantially impacted by power plant proximity, commercial property, and perhaps more importantly, undeveloped property, will certainly be affected. When making policies that affect power plant siting, policymakers should consider the costs imposed to all agents. In addition, this measure of the average housing market capitalization per plant obscures the fact that there are large differences across plants in the implied market capitalization. Some power plants that opened during the 1990s are located in almost completely uninhabited areas whereas other plants were opened in highly-populated areas. The results imply that the distribution of market capitalization across sites is right skewed with a small number of sites responsible for a large amount of total market capitalization. This is not, in itself, evidence that these plants would not pass a cost-benefit test because plant siting depends on many factors. However, it does illustrate that there can be large differences in the social cost of disamenities across sites.

5.2 Alternative Specifications Using Subsets of Plants

Table 3 reports least squares estimates of MWTP for 20 separate regressions, each using a particular subset of power plant sites or households. For each regression the table reports the estimated coefficient and standard error corresponding to the interaction $1(\text{within two miles}) * 1(\text{year 2000})$. All specifications are weighted by propensity scores and include housing characteristics, census block fixed effects, and separate time trends for each power plant site as in table 2, columns (3) and (6).

First, the table reports estimates separately for plants that use natural gas and plants that use coal. During the 1990s there was a pronounced shift in plant construction away from coal toward natural gas and this specification is relevant for evaluating the welfare consequences of this change. At current prices there is a substantial cost advantage for coal.²⁴ However, coal plants tend to emit higher levels of pollutants and have other differential impacts on local communities, and it is important to consider these differences when making policy which affects this tradeoff.

²⁴In 2005, the average cost for coal-based electricity generation was \$1.54 per million Btu compared to \$6.44 for fuel oil and \$8.21 for natural gas. See U.S. Department of Energy (2007), Table 4.5.

The estimates for both types of plants are similar in magnitude to the baseline MWTP estimates reported in table 2 and the estimates provide no evidence that MWTP differs by plant type. It is difficult to draw definitive conclusions, however, because the standard errors for coal plants are large, reflecting the fact that there were relatively few coal plants opened during the 1990s.

Second, the table reports estimates of MWTP separately for plants that opened during 1991-1995 and plants that opened between 1996 and 1999. This alternative specification addresses possible concerns about timing. Whereas information about plant openings during the early 1990s was likely available in 1990, openings in the late 1990s are unlikely to have been capitalized into housing values in 1990. For both housing values and rents the point estimates are larger for plants opened later in the decade, consistent with these anticipation effects.

Third, the table reports estimates of MWTP separately by plant capacity. Large capacity plants are those for which the nameplate capacity exceeds 275 megawatts, the median nameplate capacity in the dataset. The results are consistent with large capacity plants having a larger associated MWTP, though the differences are not statistically significant. Point estimates for large capacity plants are 5.5% for housing values and 5.3% for rents, compared to 1.2% and 3.8% for small capacity plants.

Fourth, the table reports estimates separately by plant utilization. High utilization plants are those for which the capacity factor exceeds .15, the median capacity factor in the dataset, where capacity factor is the ratio of plant net generation to nameplate capacity. Again the results are consistent with what would be expected with high utilization plants associated with larger disamenities. For example, for rents, the estimated coefficient for high utilization plants is $-.045$ compared to a point estimate near zero for low utilization plants.

Fifth, the table reports estimates separately for upwind and downwind households.²⁵ The sample was divided into two subsets based on prevailing wind direction. Downwind households were defined as homes for which the bearing between the power plant and the home was within 45 degrees of the prevailing wind direction. The results are similar for the two subsets, providing no evidence of a disproportionate impact on homes downwind of plants. These findings are consistent with the description of plants in section 2.1, that emphasizes that local externalities from power plants include not only air quality effects, but also traffic, visual disamenities, and other disamenities that affect households both upwind and downwind.

²⁵Prevailing wind direction comes from the U.S. Department of Commerce (1998) for 321 locations in the United States summarizing over 60 years of data from weather stations. The prevailing wind direction for each plant site is determined using the closest available weather station.

There are undoubtedly additional alternative specifications that would be valuable to examine. One alternative, for example, would be to estimate and report MWTP separately by plant. However, this specification does not meet Census disclosure requirements which prevent reporting coefficients based on a small number of households.²⁶

In addition to describing MWTP for different potentially important subsets, these alternative specifications also serve as an important test of the robustness of the full sample results in the previous section. Although it is impossible to rule out the possibility that differential highly-localized time trends are influencing the results, the robustness of the results across multiple specifications is reassuring. In order to explain the results with differential time trends, not only would one need differential decreases in neighborhoods in the immediate vicinity of where plants open, but these trends would need to hold for both housing values and rents, and hold for the different subsamples. To explain the results by plant capacity, for example, one would need stronger differential time trends for neighborhoods near large capacity plants.

The results from these alternative specifications also assuage concerns about the results being driven by broader changes in siting patterns. In particular, one could imagine highly-localized changes in the political climate that would make it easier to site power plants and other types of undesirable industrial facilities at the same time. Similarly, one might be concerned that power plant siting might affect subsequent decisions about where to site other types of industrial facilities, leading to a cluster of nearby facilities. Under these scenarios, the estimates of MWTP would be biased away from zero because they would reflect the disamenities from multiple facilities. Again, although it is impossible to rule out these possibilities, the fact that the estimates of MWTP respond somewhat predictably across plant type lends support to the idea that these estimates are capturing the impact of power plants, rather than the impact of other facilities that are correlated with power plant openings.

6 Conclusion

Electricity consumption in the United States is forecast to continue to increase over the next several decades. Although wind, solar, and other alternative sources of electricity production receive a great deal of attention from policymakers, the low cost of fossil-fuel electricity generation all but

²⁶Another potentially valuable specification would be to compare plants with different types of nitrogen oxides or sulfur dioxide control devices. However, relatively few plants that opened during the 1990s have selective catalytic reduction or scrubbers. In addition, the plants with control devices tend to be large capacity plants, making it difficult to disentangle the effect of these control devices from the effect of plant size.

guarantees that it will play a central role in meeting this growing demand. At the same time, siting of power plants has become more difficult than ever, in large part because the need for new facilities is most severe in places with large and growing populations. Policymakers face difficult, often politically contentious decisions about where to site plants balancing many different factors. Although local amenities are typically one of the important factors considered in this process, the lack of reliable empirical evidence about the magnitude of these costs has prevented the use of cost-benefit analysis.

This paper is the first large-scale effort to assess the value of local disamenities from power plants. Focusing on neighborhoods in the immediate vicinity of plants, the empirical analysis exploits plant openings to mitigate concerns about omitted variables and sorting. An integral feature of the analysis is the use of restricted census microdata. Although not without its limitations, these data provide a level of geographic detail and sample size that is not available anywhere else. The results provide a rich description of the impact of power plants on housing markets. Relative to neighborhoods farther away, housing values and rents decrease by 3 – 5% when plants open, implying an average housing market capitalization within two miles of a plant of \$14.5 million. Estimates of MWTP respond predictably across a variety of alternative specifications. For example, MWTP is larger for large capacity plants and for plants opened late in the decade. These estimates provide a benchmark for formally incorporating local disamenities into decisions about where plants are sited.

References

- [1] Bayer, Patrick, Fernando Ferreira, and Robert McMillan. "A Unified Framework for Measuring Preferences for Schools and Neighborhoods." *Journal of Political Economy*, 2007, 115(4): 588-638.
- [2] Bayer, Patrick, Nathaniel Keohane, and Christopher Timmins. "Migration and Hedonic Valuation: The Case of Air Quality." working paper, 2006.
- [3] Banzhauf, H. Spencer, Randall P. Walsh. "Do People Vote with their Feet?: An Empirical Test of Environmental Gentrification." *American Economic Review*, forthcoming, 2008.
- [4] Blomquist, Glenn. "The Effect of Electric Utility Power Plant Location on Area Property Value." *Land Economics*, 1974, 50(1): 97-100.
- [5] Busso, Matias and Patrick Kline. "Do Local Economic Development Programs Work? Evidence from the Federal Empowerment Zone Program." working paper, 2008.
- [6] California Energy Commission. "Rules of Practice and Procedure – Power Plant Site Certification Regulations." April 2007, CEC-140-2007-003.
- [7] California State Auditor. "California Energy Commission: Although External Factors Have Caused Delays in Its Approval of Sites, Its Application Process is Reasonable." August 2001, 2001-118.
- [8] Chay, Kenneth Y. and Michael Greenstone. "Does Air Quality Matter? Evidence from the Housing Market." *Journal of Political Economy*, 2005, 113(2), 376-424.
- [9] Davis, Lucas W. "The Effect of Health Risk on Housing Values: Evidence from a Cancer Cluster." *American Economic Review*, 2004, 94(5), 1693-1704.
- [10] Edison Electric Institute. "State Generation and Transmission Siting Directory: Agencies, Contacts, and Regulations." Washington, D.C., 2004.
- [11] Epple, Dennis and Allan Zelenitz. "The Implications of Competition Among Jurisdictions: Does Tiebout Need Politics?" *Journal of Political Economy*, 1981, 89(6), 1197-1217.
- [12] Gamble, H.B. and R.H. Downing. "Effects of Nuclear Power Plants on Residential Property Values." *Journal of Regional Science*, 1982, 22(4): 457-478.
- [13] Gayer, Ted, James T. Hamilton and W. Kip Viscusi. "Private Values of Risk Tradeoffs at Superfund Sites: Housing Market Evidence on Learning About Risk." *Review of Economics and Statistics*, 2000, 82(3), 439-451.
- [14] Greenstone, Michael and Justin Gallagher. "Does Hazardous Waste Matter? Evidence from the Housing Market and the Superfund Program." *Quarterly Journal of Economics*, forthcoming, 2008.
- [15] Hirst, Eric and Brenan Kirby. "Transmission Planning and the Need for New Capacity." U.S. Department of Energy, 2002, Washington, DC.
- [16] Kahn, Matthew E. "Population Change Near Polluting Power Plants: Implications for the Social Cost of Power Generation." working paper, 2007.
- [17] Kiel, K. and K. McClain. "House Prices during Siting Decision Stages: The Case of an Incinerator from Rumor through Operation." *Journal of Environmental Economics and Management*, 1995, 28, 241-255.
- [18] Kohlhase, Janet E. "The Impact of Toxic Waste Sites on Housing Values." *Journal of Urban Economics*, 1991, 30, 1-26.
- [19] Leggett, Christopher G. and Nancy E. Bockstael. "Evidence of the Effects of Water Quality on Residential Land Prices." *Journal of Environmental Economics and Management*, 2000, 39(2), 121-144.
- [20] Mauzerall, Denise L., Babar Sultan, Namsoug Kim and David F. Bradford. "NOx Emissions from Large Point Sources: Variability in Ozone Production, Resulting Health Damages and Economic Costs." *Atmospheric Environment*, 2005, 39: 2851-2866.

- [21] Muller, Nicholas Z. and Robert Mendelsohn. "Efficient Pollution Regulations: Getting the Prices Right." 2007, working paper, Middlebury College and Yale University.
- [22] Leamer, Edward E. *Specification Searches: Ad hoc Inference with Nonexperimental Data*, New York: Wiley-Interscience, 1978.
- [23] Levy, Jonathan I., John D. Spengler, Dennis Hlinka, David Sullivan, and Dennis Moon. "Using CALPUFF to Evaluate the Impacts of Power Plant Emissions in Illinois: Model Sensitivity and Implications." *Atmospheric Environment*, 2002, 36: 1063-1075.
- [24] Levy, Jonathan I. and John D. Spengler. "Modeling the Benefits of Power Plant Emission Controls in Massachusetts." *Air and Waste Management*, 2002, 52: 5-18.
- [25] Murphy, Kevin M. and Robert H. Topel. "Estimation and Inference in Two-Step Econometric Models." *Journal of Business and Economic Statistics*, 1985, 3(4), 370-379.
- [26] National Research Council. "Managing Coal Combustion in Mines." National Academies Press, Washington D.C., 2006.
- [27] Nelson, Jon P. "Three Mile Island and Residential Property Values: Empirical Analysis and Policy Implications." *Land Economics*, 1981, 57(3), 363-372.
- [28] Oates, Wallace E. and Robert M. Schwab. "Economic competition among jurisdictions: efficiency enhancing or distortion inducing?" *Journal of Public Economics*, 1988, 35(3), 333-354.
- [29] Pagan, Adrian. "Econometric Issues in the Analysis of Regressions with Generated Regressors." *International Economic Review*, 1984, 25(1), 221-232.
- [30] Rosen, Sherwin. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy*, 1974, 82, 34-55.
- [31] Rosenbaum, Paul. Model-Based Direct Adjustment. *Journal of the American Statistical Association*, 1987, 82(398), 387-394.
- [32] Saha, Robin and Paul Mohai. "Historical Context and Hazardous Waste Facility Siting: Understanding Temporal Patterns in Michigan." *Social Problems*, 2005, 52(4): 618-648.
- [33] Sieg, Holger, V. Kerry Smith, H. Spencer Banzhaf and Randy Walsh. "Estimating the General Equilibrium Benefits of Large Changes in Spatially Delineated Public Goods." *International Economic Review*, 2004, 45(4), 1047-1077.
- [34] U.S. Census Bureau. "Geographic Areas Reference Manual." November 1994.
- [35] U.S. Department of Commerce, National Oceanic and Atmospheric Administration. "National Climatic Data Center: Climatic Wind Data for the United States." November 1998.
- [36] U.S. Bureau of Labor Statistics, U.S. Department of Labor. "Occupational Outlook Handbook, 2008-09 Edition, Power Plant Operators, Distributors, and Dispatchers." 2008.
- [37] U.S. Department of Energy. "Electric Power Annual 1994." July 1995, DOE/EIA-0348.
- [38] U.S. Department of Energy. "Annual Energy Outlook 2007." February 2007 (2007a), DOE/EIA-0383.
- [39] U.S. Department of Energy. "Electric Power Annual 2006." November 2007 (2007b), DOE/EIA-0348.
- [40] U.S. Department of Health and Human Services. "ToxFAQs." 2007.
- [41] U.S. Environmental Protection Agency. "The Particle Pollution Report: Current Understanding of Air Quality and Emissions through 2003." December 2004, EPA 454-R-04-002.
- [42] U.S. Environmental Protection Agency. "Waste and Materials-Flow Benchmark Sector Report: Beneficial Use of Secondary Materials - Coal Combustion Products." February 2008.
- [43] U.S. Environmental Protection Agency. "Mercury Study Report to Congress, Volume III: Fate and Transport of Mercury in the Environment." December 1997, EPA 452-R-97-005.
- [44] Vajjhala, Shalini P. and Paul S. Fischbeck. "Quantifying siting difficulty: A case study of U.S. transmission line siting." *Energy Policy*, 2007, 35: 650-671.

Figure 2: Distance Gradient for Housing Values

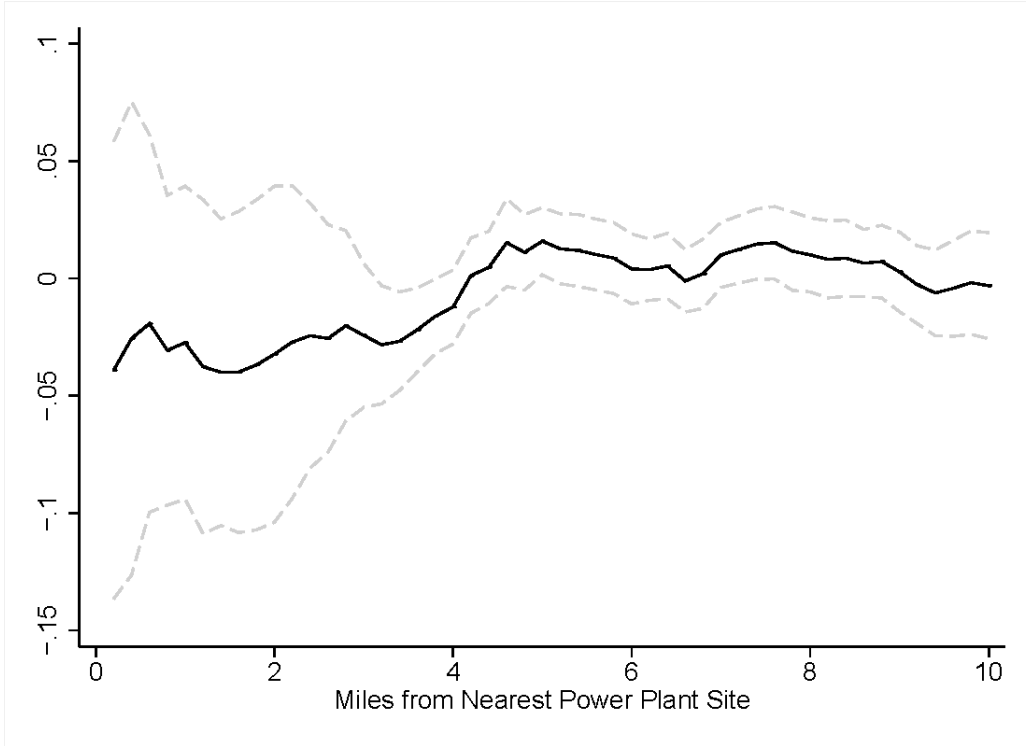


Figure 3: Distance Gradient for Rents

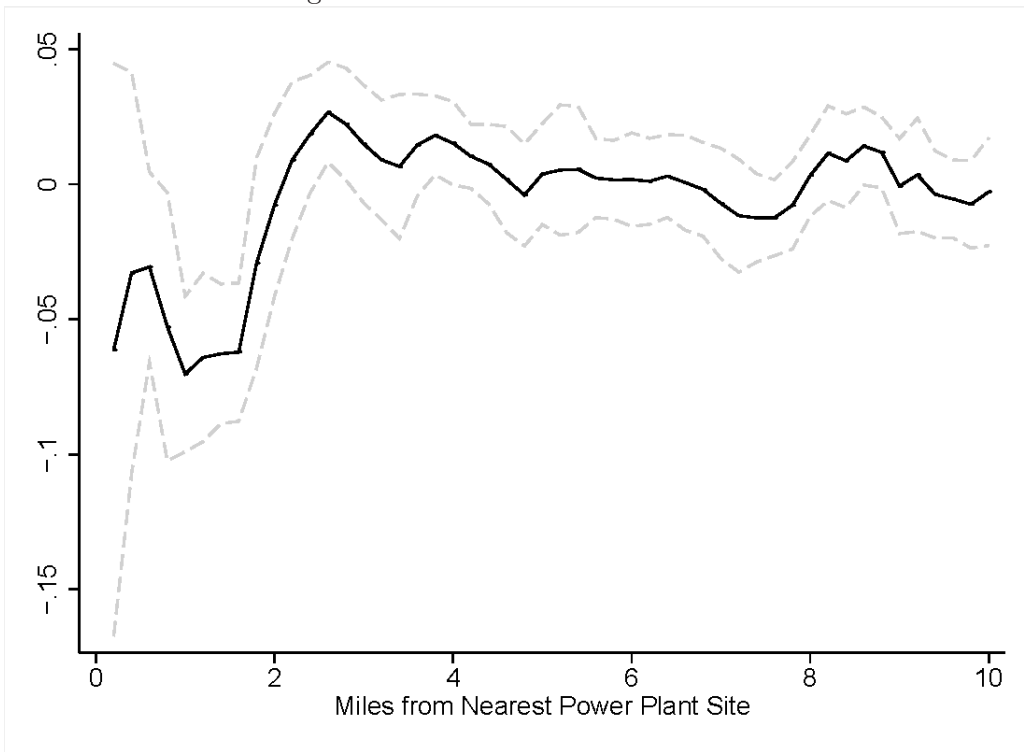


Table 1. Comparison of Covariate Means by Distance to Nearest Power Plant Site, 1990

	(1)	(2)	(3)	(4)			
	0-2 miles	2-5 miles	Entire U.S.	2-5 miles weighted	<i>p</i> -value (1) vs (2)	<i>p</i> -value (1) vs (3)	<i>p</i> -value (1) vs (4)
Household Demographics							
Household Income (1000s)	30.2	34.2	32.5	30.2	.00	.00	.85
Household Size (persons)	2.57	2.49	2.35	2.58	.00	.00	.70
Number of Individuals Under 18 Per Household	.71	.63	.60	.71	.00	.00	.81
Number of Individuals Over 65 Per Household	.27	.31	.29	.27	.00	.00	.93
Proportion Household Head Completed High School	.71	.75	.77	.71	.00	.00	.83
Proportion Household Head Completed College	.25	.24	.31	.25	.01	.00	.92
Proportion Household Head Black	.11	.07	.08	.11	.00	.00	.02
Proportion Household Head Hispanic	.21	.12	.18	.21	.00	.00	.95
Housing Characteristics							
House Value (1000s)	100.1	104.3	98.7	100.8	.00	.00	.40
Monthly Rent	478.9	461.5	470.0	443.1	.00	.00	.00
Proportion Occupied	.88	.92	.87	.88	.00	.00	.88
Proportion Owner Occupied	.52	.60	.59	.53	.00	.00	.02
Proportion 0-2 Bedrooms	.50	.45	.44	.50	.00	.00	.26
Proportion 3-4 Bedrooms	.47	.53	.52	.47	.00	.00	.24
Proportion Built Last 5 Years	.09	.09	.11	.09	.03	.00	.98
Proportion Built Last 10 Years	.16	.16	.20	.16	.32	.00	.70
Proportion Complete Plumbing	.97	.99	.98	.97	.00	.00	.04
Proportion One or More Acres	.08	.08	.14	.09	.72	.00	.18
Proportion Ten or More Acres	.03	.02	.07	.03	.00	.00	.16
Proportion Multi-Unit	.41	.30	.24	.39	.00	.00	.00

Note: Columns (1)-(4) report the means of the variables listed in the row headings for the group listed at the top of the column. Columns (1) and (2) describe household demographics and housing characteristics within two and between two and five miles of one of sixty 100 megawatt power plants opened in the United States during the 1990s. In column (4) observations are weighted using propensity scores. The remaining columns report *p*-values from tests that the means in the two subsamples are equal.

Table 2. The Effect of Power Plants on Housing Values and Rents
Difference-in-Differences Estimates

	Housing Values			Rents		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>1(within two miles) * 1(year 2000)</i>	-.030 (.040)	-.023 (.033)	-.030 (.027)	-.044 (.013)	-.055 (.016)	-.049 (.016)
Housing Characteristics	yes	yes	yes	yes	yes	yes
Power Plant Indicators x <i>1(within two miles)</i>	yes	-	-	yes	-	-
Power Plant Indicators x <i>1(year 2000)</i>	yes	yes	yes	yes	yes	yes
Census Block Fixed Effects	no	yes	yes	no	yes	yes
Propensity Score Weighting	no	no	yes	no	no	yes
Number of Observations	170,821	170,821	170,821	87,690	87,690	87,690
Number of Census Blocks	27,848	27,848	27,848	17,765	17,765	17,765
R^2	.62	.35	.34	.31	.18	.16

Note: The dependent variable in columns (1)-(3) is housing value in logs and the dependent variable in columns (4)-(6) is monthly rent in logs. The sample includes homes located within five miles of one of sixty 100 megawatt power plants opened in the United States during the 1990s. The variable *1(within two miles)* indicates homes located within two miles of the nearest power plant site. The variable *1(year 2000)* is an indicator for observations from the 2000 census. Standard errors clustered by power plant site are shown in parentheses. In columns (1),(2),(4) and (5) observations are weighted using sampling weights. In columns (3) and (6) observations in the comparison group are weighted using propensity scores.

Table 3. The Effect of Power Plants on Housing Values and Rents
Difference-in-Differences Estimates, Alternative Specifications

	Housing Values		Rents	
By Primary Fuel:				
Natural Gas Plants	-.033	(.029)	-.050	(.016)
Coal Plants	-.027	(.050)	-.069	(.050)
By Year Plant Opened:				
1991-1995	-.010	(.019)	-.039	(.020)
1996-1999	-.053	(.060)	-.069	(.016)
By Plant Capacity:				
Large Capacity Plants	-.055	(.063)	-.053	(.014)
Small Capacity Plants	-.012	(.015)	-.038	(.045)
By Plant Utilization:				
Base Load Plants	-.035	(.053)	-.045	(.013)
Peaker Plants	-.024	(.016)	-.005	(.038)
By Prevailing Wind Direction:				
Homes Downwind of Plant	-.033	(.034)	-.043	(.034)
Homes Upwind of Plant	-.036	(.028)	-.052	(.016)

Note: This table reports estimated coefficients and standard errors corresponding to $1(\text{within two miles}) * 1(\text{year } 2000)$ for 20 separate regressions. All specifications are weighted using propensity scores and include housing characteristics, power plant indicators $\times 1(\text{year } 2000)$, and census block fixed effects as in table 2, columns (3) and (6). The sample includes homes located within five miles of one of sixty 100 megawatt power plants opened in the United States during the 1990s, divided into two subsets as indicated in the row headings. Large capacity plants are those for which the nameplate capacity exceeds 275 megawatts, the median nameplate capacity in the dataset. High utilization plants are those for which the capacity factor exceeds .15, the median capacity factor in the dataset, where capacity factor is the ratio of plant net generation to nameplate capacity. Standard errors clustered by power plant site are shown in parentheses.

Table A1. Propensity Score Logit Regression

Household Income (100,000s)	-0.092	(.083)
Household Income Squared	-.012	(.035)
Household Income Cubed	.001	(.002)
Household Size	.246	(.022)
Household Size Squared	-.010	(.002)
Household Size Cubed (1000s)	.088	(.023)
Number of Individuals Under 18	.122	(.060)
Number of Individuals Under 18 Squared	.009	(.046)
Number of Individuals Under 18 Cubed	-.025	(.010)
Number of Individuals Over 65	.298	(.106)
Number of Individuals Over 65 Squared	-.696	(.186)
Number of Individuals Over 65 Cubed	.226	(.077)
Proportion Household Head Completed High School	-.236	(.040)
Proportion Household Head Completed College	-.208	(.050)
Proportion Household Head Black	.693	(.039)
Proportion Household Head Hispanic	1.40	(.050)
Proportion Occupied	-.988	(.092)
Proportion Owner Occupied	.713	(.043)
Proportion 0-2 Bedrooms	-.932	(.086)
Proportion 3-4 Bedrooms	-1.03	(.083)
Proportion Built Last 5 Years	-.030	(.076)
Proportion Built Last 10 Years	-.164	(.054)
Proportion Complete Plumbing	-1.65	(.102)
Proportion One or More Acres	.300	(.047)
Proportion Ten or More Acres	.878	(.072)
Proportion Multi-Unit	1.11	(.035)
Constant	.296	(.161)

Note: This table reports estimated coefficients and standard errors from a logit regression used to weight observations in the propensity score weighting specifications. The unit of observation is the census block and the sample includes all census blocks in the 1990 census located within five miles of one of sixty 100 megawatt power plants opened in the United States during the 1990s. The dependent variable is $1(\text{within two miles})$, an indicator variable for census blocks located within two miles of the nearest power plant site. Covariates are averaged across all households within each census block using sampling weights.

Table A2. Changes in the Number of Housing Units Near Plant Openings

	Housing Units Per Square Mile		Change
	1990	2000	
Less Than 1 Mile	133.4	171.2	28.3%
1-2 Miles	211.4	248.4	17.5%
2-3 Miles	215.0	263.4	22.5%
3-4 Miles	199.8	251.4	25.8%
4-5 Miles	214.7	270.5	26.0%
Entire United States (excluding Alaska)	34.4	39.0	13.4%

Note: The sample includes homes located within five miles of one of sixty 100 megawatt power plants opened in the United States during the 1990s. Observations are weighted using sampling weights.