Consumers Energy
Count on Us

A CMS Energy Company

William A. Schoenlein
Manager
Hydro and Renewable Generation

June 28, 2017

Kimberly D. Bose, Secretary
Nathaniel J. Davis, Sr., Deputy Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

FERC PROJECT NO. 2680 -108
LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
FINAL APPLICATION FOR NEW LICENSE

Dear Ms. Bose,

In accordance with 18 CFR § 5.16(c), Consumers Energy Company and DTE Electric Company (collectively, "Licensees") respectively submit the Final License Application (FLA) for the Ludington Pumped Storage Hydroelectric Project (Project) with the Federal Energy Regulatory Commission (FERC). The FLA is being filed in accordance with the Integrated Licensing Process (ILP) and consists of technical exhibits and an environmental assessment (Exhibit E, Section 4.4). Portions of the Exhibit F – General Design Drawings are being filed as Critical Energy Infrastructure Information (CEII) and only filed with the Commission. Additionally the Historic Properties Management Plan (HPMP), which contains sensitive archaeological site location information, is included with the Final Application as a non-public document.

The Project is located on the east shore of Lake Michigan in Mason and Ottawa Counties, Michigan. The Project's powerhouse and reservoir are located in Pere Marquette and Summit Townships (Mason County). A small satellite recreation area is located in Port Sheldon Township (Ottawa County), 70 miles south of the powerhouse and reservoir. The Pre-Application Document (PAD) and Notice of Intent (NOI) were filed on January 20, 2014. Studies were completed in 2015 and 2016, with final study reports filed with FERC on December 2, 2015 (Fisheries Phase I and II reports), March 4, 2016 (Wildlife, Botanical, Historic and Archaeological final reports), May 20, 2016 (Recreation final report) and December 1, 2016 (Fisheries Phase III report and second year cormorant count results). A Draft License Application was filed on January 30, 2017. Commission comments on the DLA were issued on March 29, 2017.

The Licensees are providing a copy of the FLA to relevant resource agencies, tribes, non-governmental organizations, and other potential interested parties included in the attached mailing list. Hard copies of the public portions of the filing will be available at:

1) Consumers Energy Company, Cadillac Service Center, 330 Chestnut Street, Cadillac, Michigan 49601
2) DTE Electric, 1 Energy Plaza, Detroit, MI 48226
3) Mason County District Library in Ludington, Michigan.

A copy will also be available on the Consumers LPSP's relicensing webpage: https://www.consumersenergy.com/ludingtonrelicensing.

The Final License Application for the Ludington Pumped Storage Project consists of the following documents:

Initial Statement
Exhibit A – Project Description
Exhibit B – Project Operation and Resource Utilization
Exhibit C – Construction History and Proposed Construction Schedule
Exhibit D – Statement of Costs and Financing
Exhibit E – Environmental Report
Exhibit F – General Design Drawings and Supporting Design Report (CEII)
Exhibit G – Project Map
Exhibit H – Description of Project Management and Need for Project Power

In addition to the Exhibits listed above, the FLA also includes a correspondence log and copies of the correspondence of the consultation that occurred during the development of the application.

When the FLA is filed, an application for a Water Quality Certificate and a request for a Coastal Zone Management Act review for consistency were provided to the Michigan Department of Environmental Quality. Additionally, the Licensees have requested concurrence from the U.S. Fish and Wildlife Service that relicensing the Ludington Project will have no adverse effect on Threatened and Endangered Species that have been identified as possibly being in the vicinity of the project. Documentation of these requests will be provided in a separate filing with the Commission.

With this filing, the Licensees are also requesting that FERC issue a 50 year license to the Project. The Licensees have identified substantial Protection, Mitigation and Enhancements (PMEs) that support a large investment in the protection and enhancement of natural resources in the Project area that also support this request for a longer license.

Please contact James Roush or David McIntosh if you have any questions regarding the FLA.

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Respectfully submitted on behalf of Licensees,

/s/ William A Schoenlein
William A Schoenlein

Copy to: Mailing List (attached)

CC: Shana Wiseman (FERC)

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CONSUMERS ENERGY COMPANY
JACKSON, MICHIGAN

DTE ELECTRIC COMPANY
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APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

Submitted by:

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Prepared by:

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June 2017

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BEFORE THE
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Consumers Energy Company	**)**	**Project No. 2680**
and DTE Electric Company	**)**	**Ludington Pumped Storage Project**
	)	

APPLICATION FOR NEW LICENSE
FOR MAJOR WATER POWER PROJECT – EXISTING DAM

INITIAL STATEMENT

1. Consumers Energy Company and DTE Electric Company (hereinafter the “Applicants” or “Licensees”) apply to the Federal Energy Regulatory Commission (hereinafter “FERC” or “Commission”) for a New License for the Ludington Pumped Storage Hydroelectric Project (“Project”), an existing licensed major project, as described in the attached exhibits. The Project is licensed as Project No. 2680. The current license for the Project was issued by order dated July 30, 1969. The license is for a period effective July 1, 1969 with a termination date of June 30, 2019. The Applicants are the only entities that have or intend to obtain and will maintain any proprietary rights or interest to construct, operate, or maintain the Project.

2. The location of the Project is:

State:	Michigan
County:	Mason
	Ottawa (satellite recreation facility only)
Township or nearby Towns:	Ludington
	Port Sheldon (satellite recreation facility only)
Stream or other body of water:	Lake Michigan

3. The exact name, business address, and telephone number of the Applicant is:

Consumers Energy Company	DTE Electric Company
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Jackson, MI 49201	Detroit, MI 48226
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The exact name and address of each person authorized to act as agent for the Applicant in this application are:

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4. The Applicants are:

Consumers Energy Company and DTE Electric Company, Licensees for the water power project designated as Project No. 2680 in the records of the Federal Energy Regulatory Commission. Licensees are not claiming preference under section 7(a) of the Federal Power Act, 16 U.S.C. §796.

5. (i) The statutory or regulatory requirements of the State of Michigan, in which the project is located, which would, assuming jurisdiction and applicability, affect the project as proposed with respect to bed and banks and the appropriation, diversion, and use of water for power purposes, and with respect to the right to engage in the business of developing, transmitting, and distributing power and in any other business necessary to accomplish the purposes of the license under the Federal Power Act are:

a. 1994 Public Act 451, Michigan, Natural Resources and Environmental Protection Act, as amended (NREPA)
b. Michigan Public Service Commission (MPSC) pursuant to various statutes, including 1909 Public Act 106, 1909 PA 300, 1919 PA 419 and 1939 PA 3. Article VII, Section 29 of the Michigan Constitution

(ii) The steps which the Applicant has taken or plans to take, to comply with each of the laws cited above are:

The Licensees have complied with all applicable Michigan statutes and regulations with respect to bed and banks and to the appropriation, diversion and use of water for power purposes for the Project.

With regard to construction of the Project, such compliance was established as part of the Licensees' application for the original Project license.

State regulation of dams is currently done pursuant to Part 307 and Part 315 of the NREPA, which exempts federally licensed dams such as the Project dam. (See MCL 324.31506(2)(a).)

The Licensees' have also complied with all applicable Michigan statutes and regulations with respect to the right to engage in the business of developing, transmitting and distributing power and in any other business necessary to accomplish the purposes of a license under the Federal Power Act. In connection with their retail electric businesses, Licensees are regulated by the Michigan Public Service Commission (MPSC) pursuant to various statutes, including 1909 Public Act 106,1909 PA 300,1919 PA 419 and 1939 PA 3. Consumers Energy has franchises in the Township of Port Sheldon, the Charter Township of Pere Marquette, and the Township of Summit in compliance with Article VII, Section 29 of the Michigan Constitution. Consumers Energy complies with the consent requirements contained in Article VII, Section 29 of the Michigan Constitution by having in place an annual permit with the Michigan Department of Transportation, the County of Mason, and the County of Ottawa. Consumers Energy monitors its compliance with MPSC requirements and seeks MPSC authorizations where appropriate. The Licensees monitor their various consents and franchises and seeks extensions or renewals before they expire, and seek consents or franchises as required.

6. The Ludington Pumped Storage Hydroelectric Project is owned in its entirety by Consumers Energy Company and DTE Electric Company. There are no federally owned or operated facilities associated with this application. The addresses of the owners are:

Consumers Energy Company One Energy Plaza Jackson, MI 49201 (800) 477-5050	DTE Electric Company One Energy Plaza Detroit, MI 48226 (800) 477-4747

Additional Information Required by 18 CFR 5.18(a)

1. **Identify every person, citizen, association of citizens, domestic corporation, municipality, or state that has or intends to obtain and will maintain any proprietary right necessary to construct, operate or maintain the project**.

Licensees have and will maintain all proprietary rights necessary to construct, operate or maintain the project.

2. **Identify (providing names and mailing addresses)**

(i) Every county in which any part of the project, and any Federal facilities that would be used by the project would be located*:*

The Project is located within Mason County and Ottawa County (satellite recreational facility only).

Mason County
304 E. Ludington Ave.
Ludington, MI 49431

Ottawa County
12220 Fillmore St. #310
West Olive, MI 49460

There are no Federal facilities used by the Project.

(ii) Every city, town, or similar local political subdivision: (A) In which any part of the project and any Federal facility that would be used by the project would be located, or (B) that has a population of 5,000 or more people and is located within 15 miles of the project dam:

The Project facilities are located in the city of Ludington, Mason County, and towns of Summit and Pere Marquette. A satellite recreation area is located in the town of Port Sheldon, and Ottawa County. The following political subdivisions have a population of 5,000 or more, and are located within 15 miles of the Project facilities:

The Project is located in the Pere Marquette Township, Summit Township and Port Sheldon Township.

Pere Marquette Charter Township
1699 Pere Marquette Highway
Ludington, MI 49431

Township of Summit
4560 W. Anthony Road
Ludington, MI 49431

Port Sheldon Township
16201 Port Sheldon Street
West Olive, MI 49460

The following political subdivisions with populations of 5,000 or more and are within 15 miles of the Project:

Powerhouse and Impoundment: City of Ludington (pop. 8,076);

City of Ludington
400 S. Harrison
Ludington, MI 49431

Port Sheldon Recreation Area: Allendale Township (pop. 20,708); Blendon Township (pop. 5,772); City of Grand Haven (pop. 10,412); Grand Haven Township (pop. 15,178); City of Holland (pop. 33,051); Holland Township (pop. 35,636); Park Township (pop. 17,802); Robinson Township (pop. 6,084); Spring Lake Township (pop. 11,977); City of Zeeland (pop. 5,504); and Laketown Township (pop. 5,505).

Allendale Township
6676 Lake Michigan Drive
PO Box 539
Allendale, MI 49401-0539 4

Blendon Township
7161 72nd Avenue
Hudsonville, MI 49426

City of Grand Haven
519 Washington Avenue
Grand Haven, MI 49417

Grand Haven Township
13300 168th Street
Grand Haven, MI 49417

City of Holland
270 South River Avenue
Holland, MI 49423

Holland Township
353 North 120th Avenue
PO Box 8127
Holland, MI 49422-8127

Park Township
52 152nd Avenue
Holland, MI 49424

Robinson Township
12010 120th Avenue
Grand Haven, MI 49417

Spring Lake Township
106 South Buchanan
Spring Lake, MI 49456

City of Zeeland
21 South Elm Street
Zeeland, MI 49464-1783

Laketown Township
4338 Beeline Road
Holland, MI 49423

(iii) Every irrigation district, drainage district or similar special purpose political subdivision: (A) in which any part of the project and any Federal facilities that would be used by the project, would be located; or (B) that owns, operates, maintains or uses any project facilities that would be used by the project:

Mason County Drain Commissioner
102 East Fifth Street
Scottville, MI 49454

(iv) Every other political subdivision in the general area of the project that there is reason to believe would be likely to be interested in, or affected by, the application:

There are no other political districts or subdivisions that are likely to be interested in or affected by the application.

(v) All Indian tribes that may be affected by the project:

There are no Native American tribes that are directly affected by the Project. The following Native American tribes may have some level of interest in the area surrounding the Project and have been included in the distribution list for the Project:

Bay Mills Indian Community
12140 W. Lakeshore Drive
Brimley, MI 49715

Burt Lake Band of Ottawa and Chippewa Indians
6461 Brutus Road
Brutus, MI 49716

Grand River Band of Ottawa
PO Box 2937
Grand Rapids, MI 49501

Grand Traverse Band of Ottawa and Chippewa Indians
2605 N. West Bay Shore Drive
Peshawbestown, MI 49682

Keweenaw Bay Indian Community
107 Beartown Road
Baraga, MI 49908

Lac Vieux Desert Band of Lake Superior Chippewa Indians
P.O. Box 249
E23857 Poplar Circle
Choate Road
Watersmeet, MI 49969

Little River Band of Ottawa Indians
375 River Street
Manistee, MI 49660

Little Traverse Bay Bands of Odawa Indians
7500 Odawa Circle
Harbor Springs, MI 49740

Match-e-be-nash-she-wish Band of Potawatomi Indians of Michigan
PO Box 218
Dorr, MI 49323

Nottawaseppi Huron Band of Potawatomi
2221 One Half Mile Road
Fulton, MI 49025

Ottawa Tribe of Oklahoma
P.O. Box 110
Miami, OK 74355

Pokagon Band of Potawatomi Indians
P.O. Box 180
Dowagiac, MI 49047

Red Lake Band of Chippewa Indians of Minnesota
P.O. Box 550
Red Lake, MN 56671

Saginaw Chippewa Indian Tribe of Michigan
7070 East Broadway Road
Mt. Pleasant, MI 48858

Sault Ste. Marie Tribe of Chippewa Indians of Michigan
523 Ashmun Street
Sault Ste. Marie, MI 49783

Saginaw Chippewa Indian Tribe of Michigan
7070 East Broadway Road
Mt. Pleasant, MI 48858

Wyandotte Tribe of Oklahoma
64700 E. Highway 60
Wyandotte, OK 74370

3.(i) For a license other than a license under section 15 of the Federal Power Act) state that **the Applicant has made, either at the time of or before filing the application, a good faith effort to give notification by certified mail of the filing of this application to:**

A. Every property owner of record of any interest in the property within the bounds of the project, or in the case of the project without a specific boundary, each such owner of property which would underlie or be adjacent to any project works including any impoundments; and

Property within the Project boundary is owned by the Licensees. No additional property owners of record own property within the Project boundary.

B. The entities identified in paragraph (a)(2) of 18 CFR §5.18, as well as any other Federal, state, municipal or other local government agencies that there is reason to believe would likely be interested in or affected by such application.

A Certificate of Service is attached to the transmittal letter for this Application for New License. [To be provided in the Final Application]

In accordance with Section 5.18 of the Commission's regulations, the following Exhibits are attached to and made a part of this application:

Exhibit A – Project Description

Exhibit B – Project Operation and Resource Utilization

Exhibit C – Construction History and Proposed Construction Schedule

Exhibit D – Statement of Costs and Financing

Exhibit E – Environmental Report

Exhibit F – General Design Drawings and Supporting Design Report (CEII filed under separate cover)

Exhibit G – Project Map

Exhibit H – Description of Project Management and Need for Project Power

This Application for New License for the Ludington Pumped Storage Project, FERC No. 2680 is executed in the State of Michigan, County of Wayne, by Matthew T. Paul, Vice President – Plant Operations, who, being duly sworn, deposes and says that the contents of this application are true to the best of his knowledge or belief and that he is authorized to execute this application on behalf of DTE Electric Company. The undersigned has signed this application this 28th day of June, 2017.

DTE Electric Energy

By ____________________
Matthew T. Paul
Vice President – Plant Operations

VERIFICATION

Subscribed and sworn to before me, a Notary Public of the State of Michigan this day of 28th June, 2017.

Karyn B. Kazyaka
____
(Notary Public)

(My Commission Expires 7/21/2017)/seal

KARYN B. KAZYAKA
Notary Public, State of Michigan
County of Macomb
My Commission Expires Jul. 21, 2017
Acting in the County of Wayne

SUBSCRIPTION

This Application for New License for the Ludington Pumped Storage Project, FERC No. 2680 is executed in the State of Michigan, County of Ottawa, by John Broschak, Consumers Energy Vice President Generation Operations, who, being duly sworn, deposes and says that the contents of this application are true to the best of his knowledge or belief and that he is authorized to execute this application on behalf of Consumers Energy Company. The undersigned has signed this application this 26th day of June, 2017.

Consumers Energy Company

By John Broschak
John Broschak
Vice President Generation Operations

VERIFICATION

Subscribed and sworn to before me, a Notary Public of the State of Michigan this day of 26 June, 2017.

Sara Ann Hankins
(Notary Public)

(My Commission Expires 5/13/2023)/seal

Sara Ann Hankins
Notary Public of Michigan
Wexford County
Expires 05/13/2023
Acting in the County of Ottawa

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT A
PROJECT DESCRIPTION

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT A
PROJECT DESCRIPTION

1.0 INTRODUCTION

The Ludington Pumped Storage Hydroelectric Project (Project) is an existing hydroelectric project owned by Consumers Energy and DTE Electric companies (Licensees) and is operated by Consumers Energy. The Project is located on the east shore of Lake Michigan near the City of Ludington in Summit and Pere Marquette Townships in Mason County, Michigan (Table A-1-1). In addition to the Project facilities located in Mason County, a satellite recreational facility is located 70 miles to the south in Port Sheldon Township in Ottawa County, Michigan. A map of the Project and facilities is included in this application as Exhibit G. The Project generating facilities described in Exhibit A reflect the pump-turbine/motor-generator ratings after the upgrades have been completed in 2019.[1] The License Application reflects the Project after upgrades are completed, unless otherwise noted.

[1] In an order issued on May 7, 2012, FERC amended the original license to allow a maintenance upgrade of the six units. In 2012, Licensees initiated construction at the site to support replacement of the six original pump-turbine runners motor-generator stators pursuant to the 2012 license amendment. The new pump-turbine runners are to be manufactured by Toshiba. Following completion, the units are expected to have a combined authorized installed capacity of 1,785 MW.

Table A-1-1: Description of Facilities

GENERAL INFORMATION	
Owners	Consumers Energy and DTE Electric
FERC Project Number	2680
County	Mason and Ottawa
Nearest Townships	Pere Marquette, Summit and City of Ludington (Mason County) Port Sheldon (Ottawa County)
LUDINGTON PUMPED STORAGE PROJECT	
General	
Waterbody	Upper Reservoir – manmade water storage constructed for the Project Lower reservoir – Lake Michigan The Project is not connected to a river.
Upper Reservoir Gross Storage	82,300 acre-feet (or approximately 26.8 billion gallons of water) at the maximum water surface elevation of 942 feet NGVD 29.
Upper Reservoir Usable Volume	54,000 acre-feet (approximately 17.5 billion gallons of water) with a maximum drawdown of 67 feet to the minimum water surface elevation of 875 feet NGVD 29.
Upper Reservoir Maximum Drawdown Rate	approximately 10 feet per hour with all six upgraded units generating
Upper Reservoir Surface Elevation change, normal operation	+ or – 1.5 foot per hour per upgraded operating unit.
Upper Reservoir Length	5.7 miles
Upper Reservoir Surface Area at Normal Full Pond	842 acres at elevation 942 ft. NGVD 29
Lower Reservoir	Lake Michigan
Lower reservoir Surface Area	22,300 square miles
Lower Reservoir mean depth	279 feet
Total Nominal Hydraulic Capacity	71,445 cfs (at time of FLA filing) 76,290 cfs after all upgrades are complete.
Structures	
Upper Reservoir	Earthen embankment with Hydraulic Asphaltic Concrete and clay linings construction
Total Perimeter Length	5.7 miles

Intake and Penstock for Powerhouse	A concrete intake structure located in the upper reservoir provides a separate inlet for each unit. Six approximately 1,300-foot long steel penstocks connect the intake structure to the powerhouse. Each penstock varies in diameter from 28.5 feet at the intake to 24 feet at the powerhouse; penstocks are encased in concrete as they pass through the embankment. Penstocks are supported on concrete saddles and buried in fill sand as they emerge from the downstream toe of the embankment and descend to the east side of the powerhouse.
Powerhouse	One concrete powerhouse with six bays, one for each pump-turbine/motor-generator unit. Approximately 85% of the powerhouse structure is below Lake Michigan water level.
Reversible Pump-Turbine/Motor-Generator Units	6
Units 1 – 6 (post-upgrade)	Toshiba Pump-Turbine with a rated capacity of 311 MW at 12,715 cfs. Motor-Generator with a rated installed capacity of 297.5 MW
Transmission Facilities	Motor-Generator leads, nine step-up transformers at the plant and three parallel, approximately 1,800-foot-long, 345-kV transmission tie lines, extending from the transformers on the powerhouse roof to the Ludington switchyard. The switchyard and the 345 kV transmission lines exiting from the switchyard are not included in the Project license.
Breakwater and Jetties	The breakwater is located approximately 2,700 feet from shore into Lake Michigan and is approximately 1,700 feet long. Each of the two jetties extend approximately 1,600 feet into Lake Michigan.

2.0 PROJECT STRUCTURES

2.1 Existing Structures

The Project facilities consist of upper and lower reservoirs, an intake structure in the upper reservoir, a powerhouse on the lower reservoir, and associated buildings and structures. The satellite recreational facility consists of a boardwalk, fishing areas, and parking. Design drawings are included in Exhibit F and are treated as CEII by the FERC.

2.1.1 Reservoirs

The lower reservoir is Lake Michigan. Lake Michigan has a surface area of approximately 22,300 square miles, a mean depth of 279 feet and a water level that is presently approximately 581 feet NGVD 29 (http://www.epa.gov/glnpo/factsheet.html). The upper reservoir is a man-made water storage structure with a perimeter of approximately 5.7 miles in length. The elevation of the top of the 842-acre upper reservoir is 950 feet NGVD 29 and the water level at full pool is at 942 feet NGVD 29. The upper reservoir is enclosed by an approximately 5.7-mile long hydraulic asphaltic concrete lined earth embankment with an average height of 108 feet and a maximum height of 170 feet.

2.1.2 Upper Reservoir Intake Structure and Penstocks

A concrete intake structure located in the upper reservoir provides a separate inlet for each pump-turbine/motor-generator unit. Six 1,300-foot long steel penstocks connect the intake structure to the powerhouse. Each penstock varies in diameter from 28.5 feet at the intake to 24 feet at the powerhouse. The penstocks are encased in concrete as they pass through the upper reservoir earthen embankment. They are supported on concrete saddles and buried in fill sand as they emerge from the downstream toe of the embankment and descend to the east side of the powerhouse.

2.1.3 Powerhouse

The concrete powerhouse consists of six bays which house the six pump-turbine/motor-generator units. Approximately 85% of the powerhouse structure is below Lake Michigan water level. The building has four main floors. The three main transformer banks (two units per transformer bank), station power transformers, gantry crane, heating and ventilation units, and the motor-generator collector rings are located on the first floor or roof of the powerhouse.

The second floor (also considered the operating floor) contains the motor-generator circuit breakers (connects the motor-generators to the main transformer banks), 4,160 volt switchgear, hydraulic governors, main control room, machine shop and other miscellaneous equipment. The next two floors have auxiliary cooling water equipment, air compressors, air and oil storage facilities, and other miscellaneous equipment.

2.1.4 Jetties and Breakwater

Because the powerhouse is located on Lake Michigan's shoreline, the Licensees constructed two jetties and a breakwater to protect the powerhouse against waves. Each jetty extends approximately 1,600 feet into Lake Michigan. The breakwater is approximately 1,700 feet long and is approximately 2,700 feet from shore. The design crest elevation of the jetties and breakwall is approximately 590 feet NGVD 29.

2.1.5 Seasonal Barrier Net

The Licensees install a barrier net seasonally to reduce fish entrainment and mortality during the pumping operation of the Project[2], and file annual barrier net reports. The seasonal barrier net is approximately 12,850 feet in length and consists of a total of 62 individual net panels. The 62 panel barrier net is comprised of 51 panels that are 200 feet long, two panels that are 175 feet long, two panels that are 100 feet long, and seven panels that are 300 feet long. The barrier net is anchored in place in Lake Michigan using a series of permanent bottom anchor piles generally spaced approximately 100 feet apart. An anchor chain is attached from each anchor pile to the barrier net panel's lead line at each of the permanent bottom anchors, distributing the stress from the anchor points to the rest of the barrier net panels.

The seasonal barrier net's main mesh panels are constructed of a synthetic, twisted knotted netting fabricated from Spectra 900 or Dyneema SK65 material. (The seasonal barrier net is further described in Exhibit E, Section 4.3.3.2.) All barrier net panels (except panels 1 and 62) have a bottom skirt of nylon net, coated with an abrasive resistant material. The bottom skirt is attached to the main net bottom border line. All barrier net panels (except panels 1 and 62) also have a top skirt fabricated of enhanced ultra-violet resistant polyethylene net that is attached to the top border line of the main net. (Net panels 1 and 62 do not have top and bottom skirts as they are wholly located on land when the net is deployed.) Main net float lines are attached to

[2] In accord with an Order issued on September 30, 1988 by the FERC Director, Division of Project Compliance and Administration; subsequent directives from FERC; and the January 23, 1996 Order Approving the Offer of Settlement, since 1989 the Licensees have annually installed a seasonal (April 15 – October 15) barrier net around the Project jetties and breakwater to minimize fish losses at the Project due to entrainment mortality. Additional details about the technical design and specifications of the barrier net can be found in the "2012 Annual Report of Barrier Net Operation" (Consumers Energy and Detroit Edison 2012), filed with FERC on December 18, 2012 [Accession Number 20121218-5029], and in the report "Ludington Pump Storage Plant Fish Protection Impact Evaluation, Potential Impacts to Barrier Net and Fisheries" (Alden 2011), which is included in the turbine upgrade amendment application filed on December 16, 2011 [Accession 20111216-5047]. It should be noted that the majority of the barrier net is deployed outside of the project boundary. The lake bottom anchor piles are allowed through MDEQ bottomlands Permit (12-53-0018-P).

the top border line of each main net panel. Float lines are also attached to the outer edge of each panel's top skirt.

The barrier net is installed by April 15 and removed beginning no sooner than October 15 each year. During the period the net is installed, it is inspected and maintained in place. Weather permitting, daily inspections are made four days per week (Monday through Thursday with Friday as a backup weather day). Daily visual inspections are made of the main net float line and top skirt along the entire net and a weekly underwater inspection is made of the main net lead line along the bottom of the entire barrier net as weather permits. Maintenance includes net repairs by the diving crew as identified by inspection and net cleaning between May 1 and September 30. Net cleaning is focused on removing debris (algae, zebra mussels, etc.) from the barrier net panels and is completed by three divers that work off of a jack-up barge using high pressure washers. After the net is removed in late October/early November, the net is cleaned and each of the 62 individual barrier net panels are inspected to identify any damage in need of repair or whether a barrier net panel has sufficient damage to warrant replacement rather than repair. Net panels are repaired over the winter months (December through February) or are replaced as necessary prior to reinstallation the following year.

2.1.6 Other appurtenant facilities

Other appurtenant facilities associated with the Project include:

- Service/office building,
- Guardhouse at Plant entrance,
- Maintenance/storage buildings,
- Barrier net fish lab,
- Divers Office/Crew Trailer,
- Construction office/shop complex, and
- Reservoir overlook building.

Project facilities are shown on Figure A-2.1.6-1 and A-2.1.6-2.

Figure A-2.1.6-1: Project Facilities

Figure A-1.1.6-2: Project Facilities at Port Sheldon

2.1.7 Port Sheldon Recreational Facility

In addition to the Project facilities located in Mason County, a satellite recreational facility is located 70 miles to the south in Port Sheldon Township, Ottawa County. This facility includes a parking area, a 4,600-foot long boardwalk, and Lake Michigan fishing access along the boardwalk. The Project boundaries for this facility are limited to the footprint of the parking area and boardwalk (Figure A-2.1.6-2).

3.0 IMPOUNDMENT DATA

3.1 Surface Area and Elevation, and Storage Capacity

The upper reservoir has a gross storage capacity of 82,300 acre-feet (or approximately 26.8 billion gallons of water) at the maximum water surface elevation of 942 feet NGVD 29. The usable volume is 54,000 acre-feet (approximately 17.5 billion gallons of water) with a maximum drawdown of 67 feet to the minimum water surface elevation of 875 feet NGVD 29. The maximum upper reservoir drawdown rate will be approximately 10 feet per hour with all six upgraded units generating. During normal operation, the upper reservoir water surface elevation rises or falls approximately 1.5 or 1.7 foot per hour for each operating unit at full and minimum pond, respectively.

4.0 TURBINES AND GENERATORS

4.1 Existing Turbines and Generators

The original installed capacity of the Project was 1,872 MW, supplied by six reversible pump-turbine motor-generator units designed and manufactured by Hitachi Ltd. of Tokyo, Japan. Each unit was nominally rated at 270 MW with a maximum rating of 312 MW. A 1981 license amendment order (16 FERC ¶ 62,596) revised the authorized installed capacity of the Project from 1,872 MW to 1,657.5 MW.[3] The order also revised the Project description to state that the nameplate rating for each of the six units was 276.25 MW.

On May 7, 2012, FERC approved a license amendment for a maintenance upgrade replacing the pump-turbine runners and motor-generator stators. This maintenance upgrade also increases the installed capacity of the Project. In 2013, Licensees initiated construction at the site pursuant to the 2012 license amendment. The new pump-turbine runners are manufactured by Toshiba. Following completion, the units are expected to have a combined authorized installed capacity of 1,785 MW. The nominal rating of each unit would be upgraded to 297.5 MW. Upgrade of the first unit began in November 2013, with upgrade of the final unit scheduled to be complete by the third quarter of 2019. Table A-4.1-1 lists the installed capacity based on the unit maintenance replacements completed at the time of filing. Table A-4.1-2 lists the installed electrical capacity and hydraulic capacity for the upgraded Project. After completion of the upgrades in 2019, the total installed and new license capacity will be 295.7 MW per unit or 1,785 MW for the Project.

The original hydraulic capacity data for the existing generating units on file with the Commission is the 1969 Hitachi Stepped-Up Performance of Pump-Turbine for Turbine Operation-Curves, which were developed during the design stage of the Ludington Pumped Storage Project. The 1969 Hitachi performance curves indicate that at a net mean head of 320 feet, the hydraulic capacity for each unit at the best gate setting (maximum efficiency point) would be 11,100 cfs. The upgraded Project unit performance curves (epfl prototype model hill curve), best efficiency point at 320 feet net head, were filed with FERC in December 2011 as Figure 1-2 of the amendment application.

[3] Unless otherwise noted, and consistent with FERC's definition at 18 C.F.R. §11.1(i), the generating and hydraulic capacities provided correspond to best gate opening and average head or "mid pond." (Since the level of the lower reservoir, Lake Michigan, does not vary due to operation, average head occurs when the upper reservoir is at mid pond level or 908.5 feet NGVD 29.)

Table A-4.1-1: Ludington Unit Nameplate Capacities[4]

Unit No.	Turbine (MW)[5]	Generator (MW)[6]	Hydraulic Capacity (cfs)[4]
1	276.25	276.25	11,100
2	311	297.5	12,715
3	276.25	276.25	11,100
4	311	297.5	12,715
5	311	297.5	12,715
6	276.25	276.25	11,100

The power-generating enhancements for the Project adds 127.5 MW of installed capacity and increases the Project's total hydraulic capacity at the best efficiency point and a mid-range net head by 9,690 cubic feet per second (cfs). This represents a 14.5-percent increase over the installed hydraulic capacity of 66,600 cfs. (Table A-4.1-2)

Table A-4.1-2: Nameplate and Hydraulic Capacities for the New Pump-Turbines[4]

Unit No.	Turbine (MW)	Generator (MW)[6]	Hydraulic Capacity (cfs)[5]	Scheduled Completion Date
1	311	297.5	12,715	3rd quarter 2019
2	311	297.5	12,715	Complete
3	311	297.5	12,715	4th quarter 2018
4	311	297.5	12,715	Complete
5	311	297.5	12,715	Complete
6	311	297.5	12,715	2nd quarter 2018

[4] These turbine and generator ratings, and hydraulic capacity have been updated to the new values for unit upgrades completed at the time of filing.
[5] Consistent with FERC's definition at 18 C.F.R. §11.1(i), the hydraulic capacities provided in this Application correspond to best gate opening. To date, the hydraulic capacity that corresponds to the installed capacity of the Project has not been formally established in any license exhibits or orders. As described in Section 4 of this Exhibit A, the Licensees, upon the recommendation of Commission staff, have provided the hydraulic capacity at the best efficiency point for a mid-range net head predicted on the original turbine manufacturer's performance curve.
[6] Generator capacity is based on 60 °C and a Power Factor = 0.85

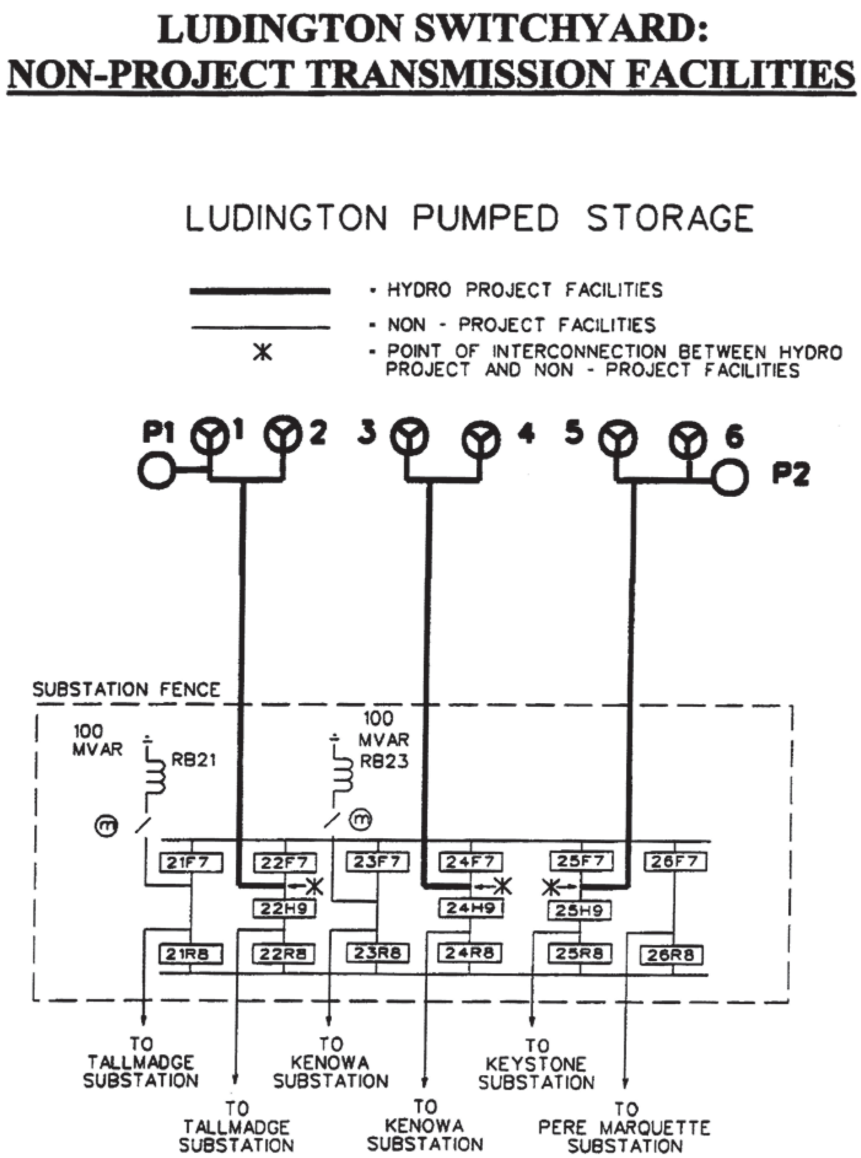
4.2 Proposed Turbines and Generators

After completion of the current turbine upgrades discussed in Section 4.1, no additional upgrades to turbines or generators are currently planned.

5.0 TRANSMISSION LINES

Transmission-related equipment included in the Project are the generator leads, the nine step-up transformers at the powerhouse and the three parallel, 1,800-foot-long, 345-kV transmission tie lines extending from the powerhouse to the Ludington switchyard. The switchyard and the 345 kV transmission lines exiting from the switchyard along with the electric transmission line right of way are not included in the Project license. (Commission Order dated February 2, 2001, 94 FERC ¶ 62,122, approved limiting the transmission system interconnection to the lines between the transformers and the Ludington switchyard). (Figure A-5-1)

Figure A-5-1: Single Line Diagram, Non Project Transmission Facilitie



6.0 ADDITIONAL EQUIPMENT

There is no additional equipment associated with the Project.

7.0 LANDS OF THE UNITED STATES

The Project is not located on lands of the United States.

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT B
PROJECT OPERATION AND RESOURCE UTILIZATION

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT B
PROJECT OPERATION AND RESOURCE UTILIZATION

1.0 PROJECT OPERATION

As a hydroelectric pumped storage facility, the Ludington Pumped Storage Project's (Project) operations differ both in purpose and nature from that of a conventional riverine hydroelectric facility. As a pumped storage facility, the Project generally supplies energy to the electric transmission grid daily to meet electric system peak demand, provides capacity support to the electric grid, and assists with grid reliability. The Project uses two water storage reservoirs of differing elevation, pumping water from the lower reservoir (Lake Michigan) to the upper reservoir (a separate man-made reservoir constructed for the Project), generally during off-peak times when energy loads and associated prices are relatively low. The water is then stored in the upper reservoir until electric system load demands are relatively high, at which time water is released from the upper reservoir down to hydroelectric turbines, where the water is used to generate electricity before being discharged back into the lower reservoir. Pumped storage provides an effective, large-scale way to store off-peak energy until needed to respond to high load demands.

The Project's upper reservoir has no contributory drainage area (i.e. there is no geographical area which provides run-off other than the inside slope of the reservoir itself). Consequently, the Project is unaffected by the low, normal or flood flows of any stream. Similarly, the Project does not affect the flows of any stream. The release of water from the upper reservoir to the lower reservoir has no influence upon the water level of the lower reservoir because of the relative size of the reservoirs. That is, Lake Michigan contains so much more water than the Project's upper reservoir that even if the upper reservoir was fully drained into Lake Michigan, the Lake's water level would not measurably change.

In an order issued on May 7, 2012, FERC amended the original license to allow a maintenance upgrade of the Project's six units. In 2012, Licensees initiated construction at the site to support replacement of the six original pump-turbine runners motor-generator stators pursuant to the 2012 license amendment. Following completion of the maintenance upgrade, the Project is expected to have a combined authorized installed capacity of 1,785 MW. This exhibit reflects the operation of the upgraded units.

1.1 Operating Mode

The Project is typically operated to generate electricity to meet peak electric system demand. The Project generally begins each week on Monday morning with the upper reservoir at or near full pool (i.e., water elevation of 942 feet NGVD 29). Generation usually occurs during the day with the upper reservoir replenished at night during pumping to meet the next day's forecast load. Generation and pumping operations throughout the course of the week generally result in the upper reservoir being at or near minimum pool (i.e., water elevation of 875 feet NGVD 29) by late Friday evening. The upper reservoir water level is then brought to full pool over the weekend to be ready for the start of the next week's operating cycle. Following completion of the ongoing unit overhauls/upgrades, the Project can generate at maximum capacity for approximately 7 hours, starting with a full upper reservoir. Refilling the upper reservoir requires approximately 10 hours of pumping at maximum capacity. The Licensees have no plans to change the current peaking operation of the Project.

1.2 Future Operations

The Licensees are not proposing any changes to current Project operations as part of the relicensing process.

1.3 Annual Plant Capacity Factor

The average annual plant capacity factor is a measure of the installed capacity utilized to produce energy on an annual basis. The plant capacity factor is determined using the following equation:

$$\frac{\text{Average Annual Output}}{\text{Licensed Capacity x 8,760 hours/year}} = \text{Average Annual Plant Capacity Factor}$$

The Project currently has a gross average annual energy production of approximately 2,357,066 megawatt-hours (MWh) per year, and an annual plant capacity factor of approximately 17 percent based on its current Federal Energy Regulatory Commission (FERC) authorized capacity of 1678.75 megawatt (MW)[1]. Table B-1.4-1 provides annual generation (October 1 to September 30) from October 1, 1999 through September 30, 2016.

1.4 Summary of Project Generation Records

The table below provides the actual annual power generated and actual power used for pumping in megawatt-hours (MWh) (data is taken from the annual statement of generation filed with the

[1] The installed capacity is a calculated average over the past 16 years, which includes upgraded unit capacities in 2015 and 2016. The long term average installed capacity used to calculate the capacity factor is 1659 MW.

Commission in October of each year). The Project is not located on a river, and the Licensees do not monitor water flow using methods similar to riverine projects. Water flow records are not available for the Project.

Table B-1.4-1: Annual Generation and Pumping

Report Period	Generation MWh	Pumping MWh
10/01/99 to 9/30/00	2,651,280	3,619,670
10/01/00 to 9/30/01	3,059,100	4,207,920
10/01/01 to 9/30/02	2,557,950	3,511,940
10/01/02 to 9/30/03	2,554,210	3,515,880
10/01/03 to 9/30/04	2,760,150	3,812,100
10/01/04 to 9/30/05	2,791,982	3,853,860
10/01/05 to 9/30/06	2,692,340	3,734,550
10/01/06 to 9/30/07	2,721,810	3,756,761
10/01/07 to 9/30/08	2,592,090	3,556,899
10/01/08 to 9/30/09	2,097,010	2,903,254
10/01/09 to 9/30/10	2,388,160	3,329,523
10/01/10 to 9/30/11	2,531,390	3,498,846
10/01/11 to 9/30/12	1,876,290	2,618,310
10/1/12 to 9/30/13	2,066,880	2,883,841
10/1/13 to 9/30/14	1,837,718	2,561,993
10/1/14 to 9/30/15	1,196,335	1,683,775
10/1/15 to 9/30/16	1,695,422	2,348,742
Average MWh	2,357,066	3,258,698

The lower values in the three years from 10/1/2013 to 9/30/2016 reflect the start of the major unit overhauls and upgrades, as well as other unit/plant related outages. Unit 2 was upgraded between 11/11/2013 and 3/12/2015; Unit 4 between 3/17/2015 and 5/25/2016; and Unit 5 upgrade began on 4/26/2016 and was completed on 4/26/2017 (a bearing failure resulted in Unit 5 being taken out of service on 6/9/2015). The upgrade for Unit No. 6 was initiated on March 27, 2017 and is scheduled to be completed in the 2nd quarter of 2018.

1.5 Project Operation During Adverse, Mean, and High Water Years

The Project is a pumped storage project that uses a self-contained man-made upper reservoir and Lake Michigan as its lower reservoir. As such, operation during adverse, mean and high water years does not change. Due to its large size, Lake Michigan is not as severely impacted by changes in water availability when compared to a conventional riverine hydroelectric project for which streamflow is impacted by variations in water year (adverse, mean and high flows). During the period of time when Lake Michigan was at its lowest elevation, operation of the Project was largely unchanged and had no impact on Lake levels.

2.0 DEPENDABLE CAPACITY AND AVERAGE ANNUAL ENERGY PRODUCTION

2.1 Project Hydrology

2.1.1 Flow Duration Curves

The Project is not located on a river, therefore there is no flow duration curve for the Project. Minimum, mean and maximum recorded flows do not apply to this Project.

2.2 Dependable Capacity

The Project generates electricity to meet peak electrical demand according to the operations description in Section 1.0, above. Within this operating mode, dependable capacity during the generation cycle is based on the authorized installed capacity of the Project, or 1,785 MW[2], and corresponds to mid-pond operation at the best gate opening.

2.3 Area-Capacity and Rule Curve

Appendix B -1 contains the characteristic curves for the project.

2.4 Estimated Hydraulic Capacity

The turbines have an authorized hydraulic capacity of 12,715 cfs per unit, for a combined maximum hydraulic capacity of 76,290 cfs at mid-pond level with best gate setting. After upgrade, Unit 4 performance was tested. Based on the test plot of turbine efficiency and discharge versus output at a net head of 353 ft., minimum flow for one unit would be 9,700 cfs (producing 250 MW) and maximum flow would be 15,000 cfs per unit, with a maximum plant output of 90,000 cfs.[3]

The plant capacity curve shows the maximum generation at 942 ft. as 2,292 MW (382 MW/unit), the net demonstrated capacity.

2.5 Tailwater Rating Curve

The normal tailwater elevation at the Project is 580.0 feet NGVD 29, and represents the elevation of Lake Michigan that is used in the calculation of the authorized installed and

[2] The installed capacity represents the total authorized installed capacity after completion of the FERC approved unit maintenance upgrades.
[3] The conditions for the testing were different than the flow associated with the authorized capacity of the project, 12,715 cfs as stated in this application. Testing indicates the range of flows for which the unit(s) can operate.

hydraulic capacities for the Project at a net mean head of 320 feet after accounting for 8.5 feet of penstock losses.

The openings between the breakwater and jetties are sufficiently large that the water level of Lake Michigan within such structures will not measurably differ from the water level of Lake Michigan outside. The relative size of' the upper reservoir compared to Lake Michigan preclude the Project's operation having any discernable effect upon Lake Michigan. For these reasons, no tailwater rating curve is submitted with this exhibit.

2.6 Powerplant Capability vs. Head

At the mid-pond level of 908.5 feet NGVD 29 with a Lake Michigan level of 572 feet (used for unit design), the Project has a gross head of 336.5 feet and a total rated generating capacity of 1,785 MW. Appendix B-2 contains the plant capability curve for the Project.

3.0 UTILIZATION OF PROJECT POWER

The Licensees are public utilities in Michigan and are regulated by the Michigan Public Service Commission regarding rates, construction projects and expenses. Both Licensees serve end use customers in the state of Michigan.

The Project generates renewable power for the state of Michigan and the regional power pool administered by Midcontinent Independent System Operator, Inc. (MISO), the non-profit independent transmission system operator for the Midwest and portions of the South. Currently, the Project's output is sold on the open market through bidding into the MISO. MISO administers all significant aspects of the Midwest power market.

4.0 PLANS FOR FUTURE DEVELOPMENT

The Licensees are in the process of completing unit upgrades that were approved by FERC on May 7, 2012. These unit upgrades involve turbine-pump runner replacement and generator-motor-stator replacement including new windings, with the final unit upgrade scheduled for completion in August 2019. With the filing of this license application, upgrades for three of the six units will have been completed. The Project's unit upgrade schedule is presented in Exhibit A, Table A-4.1-2.

The Licensees have no other plans for upgrades during the upcoming license period.

APPENDIX B-1

AREA CAPACITY RULE CURVE

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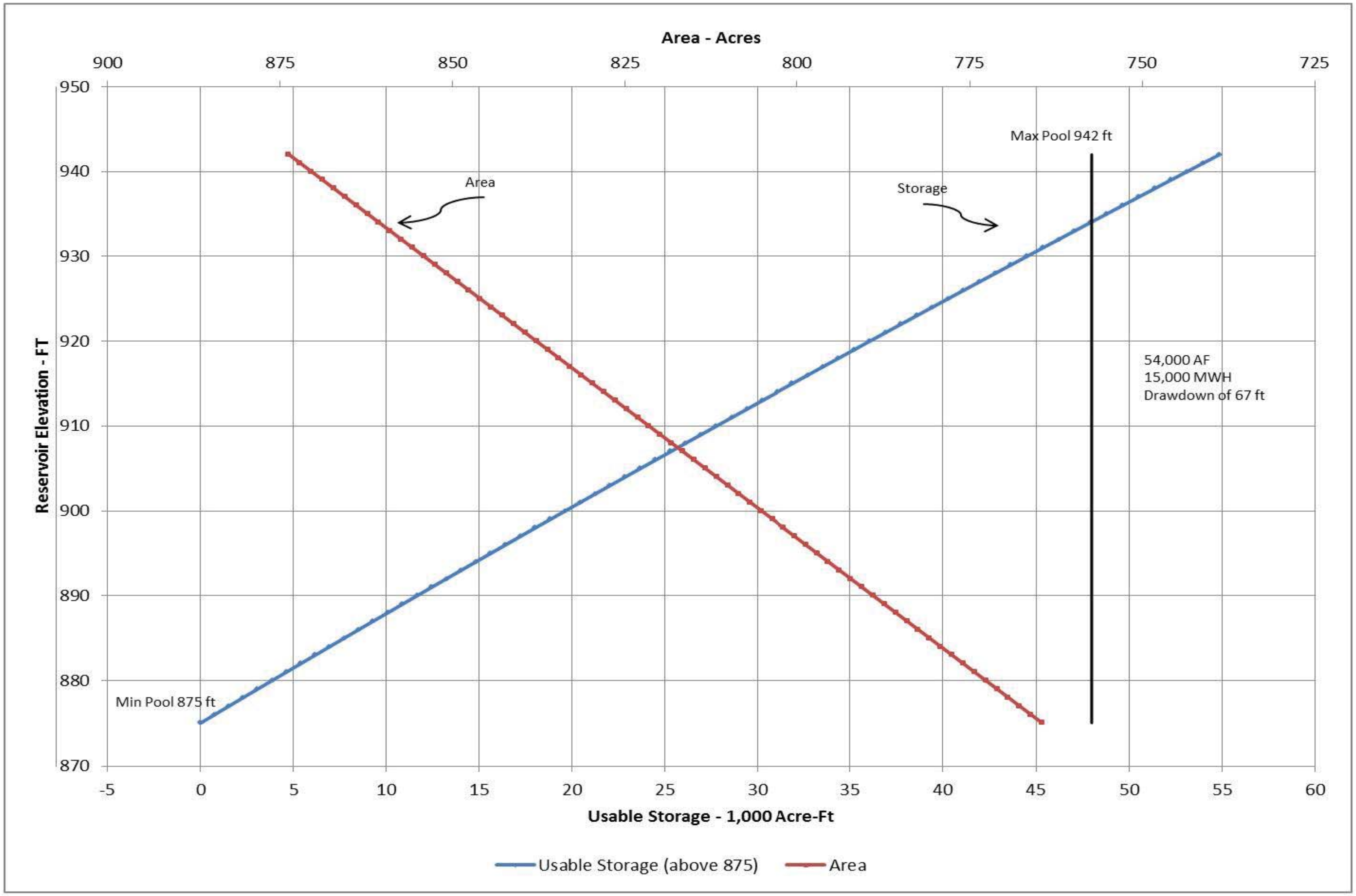
Area - Acres
900
875
850
825
800
775
750
725
950
940
930
920
910
900
890
880
870
Reservoir Elevation - FT
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
Usable Storage - 1,000 Acre-Ft
Max Pool 942 ft
Area
Storage
54,000 AF
15,000 MWH
Drawdown of 67 ft
Min Pool 875 ft
Usable Storage (above 875)
Area

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APPENDIX B-2

POWERPLANT CAPABILITY VERSUS HEAD CURVE

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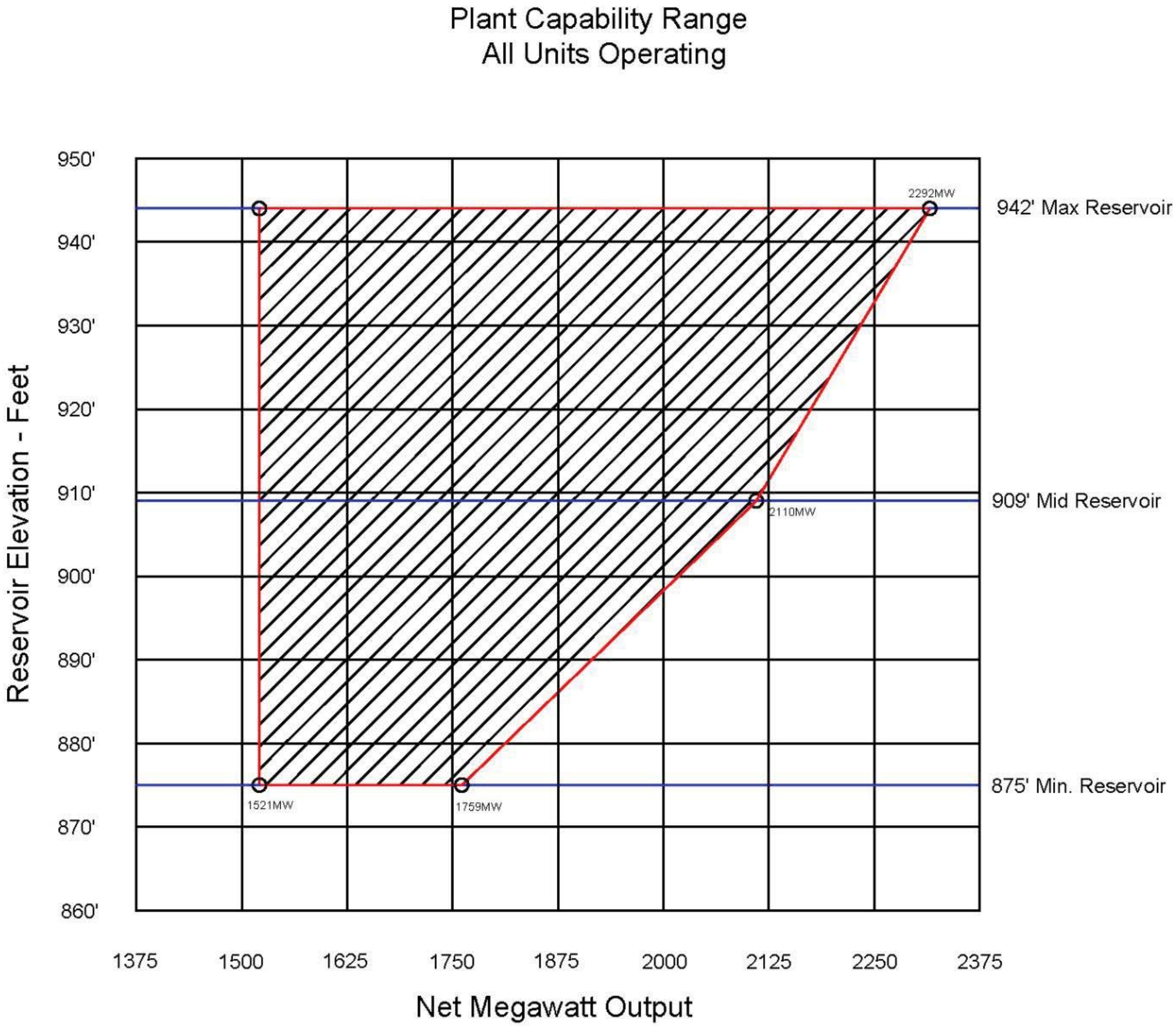
Plant Capability Range
All Units Operating
Reservoir Elevation - Feet
950'
940'
930'
920'
910'
900'
890'
880'
870'
860'
2292MW
942' Max Reservoir
2110MW
909' Mid Reservoir
1521MW
1759MW
875' Min. Reservoir
1375
1500
1625
1750
1875
2000
2125
2250
2375
Net Megawatt Output

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT C
CONSTRUCTION HISTORY
AND PROPOSED CONSTRUCTION SCHEDULE

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT C
CONSTRUCTION HISTORY
AND PROPOSED CONSTRUCTION SCHEDULE

1.0 CONSTRUCTION HISTORY

1.1 Original Construction

The Ludington Project is located on approximately 1,700 acres along the Lake Michigan shoreline, approximately 4 miles south of the City of Ludington, Michigan. On June 30, 1969, FERC issued a license to construct, operate and maintain the Project. The Project was constructed between 1969 and 1973, with commercial operation of the first unit on January 17, 1973, and the last unit September 28, 1973. The Licensees constructed: (1) an upper storage reservoir with a storage capacity of 28,300 acre-feet at a minimum elevation of 875 feet and 81,300 acre-feet at a maximum elevation of 942 feet; (2) six steel penstocks approximately 1,300-foot-long and 28- to 24-foot (tapered) in diameter; and (3) an outdoor-type powerhouse located adjacent to Lake Michigan, containing six pump-turbine/motor-generator units with an authorized installed capacity of 2,210,000 horsepower (1,657.5 megawatts (MW)). The lower reservoir is Lake Michigan.

In 1995, the Licensees entered into two settlement agreements – a FERC Settlement Agreement and a separate State Settlement Agreement. Both Agreements were with the State of Michigan and Michigan Department of Natural Resources (DNR); the U.S. Department of the Interior, on behalf of the U.S. Fish and Wildlife Service (USFWS) and as Trustee for Indian tribes, bands, or communities with reserved treaty rights in the Michigan waters of Lake Michigan; the Michigan United Conservation Clubs; the National Wildlife Federation; the Grand Traverse Band of Ottawa and Chippewa Indians; the Little River Band of Ottawa Indians; and the Little Traverse Bay Bands of Odawa Indians.

- The FERC Settlement Agreement, which was filed with the Commission on February 28, 1995 and accepted by the Commission in an Order dated January 23, 1996, provided for, in part, mitigation of fish mortality at the Ludington Pumped Storage Project through the seasonal installation of a 2.5- mile-long barrier net around the

Project's intake on Lake Michigan and a monitoring program to track the barrier net effectiveness.

- A separate State Settlement Agreement, covering non-FERC matters, was executed and was filed with the FERC for informational purposes along with the FERC Settlement Agreement.

In addition, both settlement agreements called for the creation of a Scientific Advisory Team (SAT) composed of representatives of the parties to the settlement to oversee elements of the settlement agreements.

1.2 Modification or Additions to the Existing Project

Since the issuance of the first license for the Project, the Licensees have completed several major modifications and additions to the Project, which are summarized below.

- Unit Upgrades. As part of the Project's overall maintenance program, the Licensees submitted a non-capacity amendment of the Project license in December 2011. In this amendment, the Licensees proposed to perform a maintenance upgrade on each of the six units, consisting of replacement of the pump-turbine runners combined with rewinding the associated motor/generators. The existing units have a combined licensed, authorized installed capacity of 1,657.5 MW. Following completion of the proposed maintenance upgrades, the units are expected to have a combined authorized installed capacity of 1,785 MW. Additional information was provided by the Licensees in January 30, February 8, and March 5, 2012 submittals to FERC. FERC issued an amendment authorizing the upgrades on May 7, 2012. The unit maintenance overhaul and upgrades started in 2013 and are being completed during the relicensing process with the last unit upgrade scheduled for completion in August, 2019. (A schedule of upgrades is provided in Exhibit A, Table A-4.1-2.) Units are available for operation once the overhaul and upgrade has been completed. The Project's hydraulic capacity will also increase by approximately 14.5 percent from 66,600 cfs to 76,290 cfs, and the pumping discharge rate would increase by approximately 22.2 percent.

  Additional upgrades and modifications made to the Project during the current unit overhauls/upgrades include:

  - Replacing a single 360 ton gantry crane with two 410 ton capacity gantry cranes
  - Adding two new construction buildings (north and south fabrication shops)
  - Extending the gantry crane rails to the north fabrication shop
  - Rebuilding existing boat dock to accommodate barge delivery of new pump-turbine runners
  - Rebuilding the plant entrance with an upgraded security building, which consists of one exit and two entry lanes to enhance site security

  - Modifying the spiral case stay vanes by adding extensions to each stay vane
  - Refurbishing and modifying the wicket gate servomotors and operating ring linkages
  - Refurbishing and reinsulating the rotor field poles
  - Installing new thrust bearings and high pressure oil pump systems
  - Installing new pump-turbine runners
  - Fabricating, on-site, and installing new generator-motor stators
  - Refurbishing and rewinding starting motor stators and rotors for Units 1 and 6
  - Installing new Motor-Generator circuit breakers
  - Installing new static exciters and voltage regulators
  - Installing the new generator step up transformer banks

- Seasonal Barrier Net construction. In accordance with a FERC Order issued on September 30, 1988, the Licensees constructed a 2.5-mile long barrier net and, since April 1989, have annually installed, inspected, cleaned, repaired, monitored for biological effectiveness, removed and stored the net. The Seasonal Barrier Net is installed annually from April 15 through October 15 around the Project jetties and break wall to minimize fish entrainment losses at the Project. Net design, endurance, and performance improved dramatically over the early years with the addition of top and bottom skirt netting, optimizing net floatation, lead line, anchor pilings, and stronger net mesh materials. The current cost to replace all 62 panels that make up the 2.5-mile long barrier net would be approximately $2.1 million dollars (2016 dollars). Over the past ten years, an average of 11 barrier net replacement panels have been purchased annually at an average cost of approximately $300,000 dollars. The annual cost for the required spring installation; spring/summer/fall inspection, cleaning and maintenance; fall removal; spring/summer/fall effectiveness monitoring; and over winter net panel repairs amounts to an expenditure of approximately $3.285 million dollars (2016 dollars). (These costs are provided in Exhibit D, Table D-4.6-2)

2.0 PROJECT SCHEDULE OF NEW DEVELOPMENT

The Licensee does not propose any new development (e.g., additional generating units) at the Project.

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT D
STATEMENT OF COSTS AND FINANCING

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT D
STATEMENT OF COSTS AND FINANCING

1.0 ORIGINAL COST OF EXISTING UNLICENSED FACILITIES

This section is not applicable to the Ludington Pumped Storage Hydroelectric Project (Project) because Consumers Energy and DTE Electric (Licensees) are not applying for an initial (original) license.

2.0 ESTIMATED AMOUNT PAYABLE UPON TAKEOVER PURSUANT TO SECTION 14 OF THE FEDERAL POWER ACT

Under Section 14(a) of the Federal Power Act (FPA), the Federal government may take over any project licensed by the Federal Energy Regulatory Commission (FERC) upon the expiration of the current license. FERC may also issue a new license in accordance with Section 15(a) of the FPA. If such a takeover were to occur upon expiration of the current license, the Licensees would have to be reimbursed for the net investment, not to exceed fair value, of the property taken, plus severance damages. To date, no agency or interested party has recommended a federal takeover of the Project pursuant to Section 14 of the FPA.

2.1 Fair Value

The fair value of the Project is dependent on prevailing power values and license conditions, both of which are currently subject to change. The best approximation of fair value would likely be the cost to construct and operate a comparable power generating facility. Because of the high capital costs involved with constructing new facilities that could provide for generation and storage, the fair value would be considerably higher than the net investment amount. If a takeover were to be proposed, the Licensee would calculate fair value based on then-current conditions.

2.2 Net Investment

The net book investment for the Project is approximately the appreciated/depreciated value of the project facilities and land. The value provided herein is $303,035,821 as of December 31, 2016. Table D-2.2-1 shows appreciated plant value, accumulated depreciation, and net investment, under the Commission's Uniform System of Accounts.

Table D-2.2-1: Data used to determine the net investment

FERC	Production Plant	Plant Value (as of 12/31/16) ($)	Accumulated Depreciation ($)	Net Investment (Plant value – Accumulated Depreciation) ($)
330	Land and Water Rights			
	Consumers	2,290,346	0	2,290,346
	DTEE	3,190,436	0	3,190,436
331	Structures and Improvements			
	Consumers	30,187,573	19,220,612	10,966,961

FERC	Production Plant	Plant Value (as of 12/31/16) ($)	Accumulated Depreciation ($)	Net Investment (Plant value – Accumulated Depreciation) ($)
	DTEE	32,742,229	21,618,739	11,123,490
332	Reservoirs, Dams and Waterways			
	Consumers	99,560,276	100,337,512	(777,236)
	DTEE	116,893,226	119,180,065	(2,286,839)
333	Waterwheels, Turbines and Generators			
	Consumers	120,970,998	16,461,026	104,509,972
	DTEE	153,524,948	27,403,413	126,121,535
334	Accessory Electrical Equipment			
	Consumers	27,123,601	9,828,318	17,295,283
	DTEE	17,284,468	4,175,013	13,109,455
335	Misc. Power Plant Equipment			
	Consumers	8,468,201	2,680,010	5,788,191
	DTEE	9,264,945	2,826,207	6,438,738
336	Roads, Railroads and Bridges			
	Consumers	1,544,624	1,670,976	(126,352)
	DTEE	1,862,785	1,970,494	(107,709)
391	Computer Equipment			
	Consumers	786,64	18,066	60,598
	DTEE			
Totals				
	Consumers	290,224,436	150,216,521	140,007,761
	DTEE	334,763,037	171,735,323	163,027,714
302	Relicensing Costs			
	Consumers	4,154	3,808	346
	DTEE	0	0	0

FERC	Production Plant	Plant Value (as of 12/31/16) ($)	Accumulated Depreciation ($)	Net Investment (Plant value – Accumulated Depreciation) ($)
Total including Relicense Costs				
	Consumers	290,228,435	150,220,329	140,008,107
	DTEE	334,763,037	171,735,323	163,027,714
	Project Total	624,991,472	321,955,652	303,035,821

2.3 Severance Damages

Severance damages are determined either by the cost of replacing (retiring) equipment that is "dependent for its usefulness upon the continuance of the License" (Section 14, Federal Power Act), or the cost of obtaining an amount of power equivalent to that generated by the Project from the least expensive alternative source, plus the capital cost of constructing any facilities that would be needed to transmit the power to the grid, minus the cost savings that would be realized from not operating the Project. As discussed above, these values would need to be calculated based on power values and license conditions at the time of project takeover.

3.0 ESTIMATED COST OF NEW DEVELOPMENT

3.1 Land and Water Rights

The Licensee is not proposing to expand land or water rights as a consequence of this license application.

3.2 Cost of New Facilities

The Licensee is not proposing any capacity-related developments at the Project during the new license term. Unit maintenance upgrades completed through 12/31/2016 have been included in the current value of the Project.

The anticipated capital cost for the additional maintenance upgrades is $ 264,000,000. These upgrades will be completed by 2019. Additional capital costs projected for 2017 through 2021 that are not related to the maintenance upgrade total $76,300,000 and include the following annual cost estimates in Table D-3.2-1.

Table D-3.2-1: Annual Projected Capital Costs for 2017 to 2021

Year	Unit Maintenance Upgrades ($ Million)	Additional Projected Capital costs, 2017 – 2021 ($ Million)	Total Capital Costs by Year ($ Million)
2017	104	18.3	122.3
2018	78	20.3	98.3
2019	51	16.1	67.1
2020	31	5.9	36.9
2021		15.7	15.7

4.0 ESTIMATED AVERAGE ANNUAL COST OF THE PROJECT

This section describes the annual costs of the Project as proposed. The estimated average cost of the total Project will be approximately $20,715,617 per year, based on an 8-year period of analysis. This estimate includes costs[1] associated with existing and projected project operations and maintenance, ongoing costs of installing, maintaining, repairing and storing the seasonal barrier net, and local property and real estate taxes. Income taxes, depreciation, and costs of financing are excluded from this estimate.

4.1 Capital Costs

As Licensee, Consumers uses a rate of 8.58 percent and DTEE uses a 7.98 percent rate to approximate average cost of capital. These rates are approved by the Michigan Public Service Commission. Actual capital costs are based on a combination of funding mechanisms that includes stock issues, debt issues, revolving credit lines, and cash from operations.

4.2 Taxes

Property taxes for 2016 are expected to be approximately $7,945,529. Property taxes in Michigan are paid directly to the local community(s) hosting the Project. For the Ludington Project, these property taxes are paid to Mason County and PMCT. Income taxes for the Project are incorporated into costs of the Licensee's consolidated business and are not separated out for the Project.

4.3 Depreciation and Amortization

The annualized composite rate of depreciation for the Project is 3.42% for Consumers and 3.22% for DTEE based on plant balances as of 12/31/2016.

4.4 Operation and Maintenance Expenses

The estimated 2017 annual operation and maintenance expense for the Project will be approximately $18,500,000. The pumping costs reflect MISO rates for energy used at the time pumping occurs. For 2016, the average cost of pumping was $22.01/MWH (based on day ahead and real time pumping costs, and weighted by the amount of pumping).

4.5 Costs to Develop the License Application

The approximate cost to prepare the application for a new license for the Project is $1.9 Million (which is included in the above cost of net investment).

[1] Including major maintenance costs.

4.6 Costs of Proposed Environmental Measures

The Licensee is proposing the following major environmental measures in this application:

- Develop and implement an historic properties management plan to provide for management of historic properties during the term of a new license;
- Develop and implement a recreation management plan;
- Continue the barrier net program which includes net deployment (deploying the net, maintaining the net while deployed, recovering the net, storing and repairing the net prior to deployment the following year), and continued net effectiveness testing.
- Continue to complete technology surveys to determine whether barrier net improvements or other fish protection technologies should be reviewed in detail.
- Continue to provide funding to the GLFT to support ongoing fishery programs to address critical Great Lakes fisheries health issues, both chronic and emerging, habitat, education, and access, particularly in Lake Michigan.

Table D-4.6-1: Summary of PME costs

Proposed Environmental Measure	Initial cost	Annual costs	Notes
Historic Properties Management Plan	$25,000	$20,000	$10,000 each for preparation of National Registry of Historic Places nomination forms estimated at $10,000 and an estimated $10,000 to provide protection of the two potentially eligible sites
Recreation Plan	$20,000	$40,000	$30,000 to Mason County for maintenance and $10,000 to maintain Port Sheldon
Barrier Net Program		$3,285,000	The details are provided below.
Periodic study of fish protection technology		$6,000	$30,000 every 5 years
Annual payments to GLFT		$2,722,148	Based on 2016 payment to GLFT; the annual payment would be adjusted by a

Proposed Environmental Measure	Initial cost	Annual costs	Notes
			scalar that is a composite of: (25%) CE increase in electric rates from the base case year of 1994, (25%) DTEE increase in electric rates from the base case year of 1994, and (50%) the cumulative implicit GNP deflator from 1994 through the year preceding the adjustment annual increases.
TOTAL	$45,000	$6,097,148	

The Barrier Net Program has seasonal cost components which are detailed in Table D-4.6-2. These costs are based on the 2016 annual cost for the required spring installation; spring/summer/fall inspection, cleaning and maintenance; fall removal; spring/summer/fall effectiveness monitoring; and over winter net panel repairs. The total 2016 expenditure for the barrier net was about $3.285 million dollars (2016 dollars).

Table D-4.6-2: Barrier Net Program details and annual cost

Barrier net program detailed items	Annual cost (2016 $)
Spring Installation	$979,000
Spring/Summer/Fall Inspection Cleaning and Maintenance	$697,000
Fall Removal	$769,000
Over Winter Repairs	$360,000
Effectiveness Monitoring	$180,000
Replacement net panels	$300,000
Total	$3,285,000

Over the past ten years, an average of 11 barrier net replacement panels have been purchased annually at an average cost of about $300,000 dollars. 2016 cost was $244,000.

5.0 ESTIMATED ANNUAL VALUE OF PROJECT POWER

Power generated by the project is sold through Midcontinent Independent System Operator (MISO), and power used to pump water off peak is also purchased from MISO at prevailing market rates. The Licensees estimate total annual energy production of about 2,658,200 megawatt-hours[2], which will be sold at the prevailing market rates. The average market clearing price for energy can be estimated based on the MISO website.

For 2016, the value of the Project power was $42.48/MWH, based on actual generation and MISO market rates.

[2] The energy generation is calculated for the Project using upgraded unit capacity of 297.5 MW and using the current capacity factor (17%).

6.0 SOURCES AND EXTENT OF FINANCING

The Licensees' current financing needs are generated from internal funds. Financing of major enhancements will likely be made through rates, earnings retention, equity contributions and/or loans made by the corporate parents.

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR WATER POWER PROJECT

EXHIBIT E
ENVIRONMENTAL REPORT

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LIST OF ACRONYMS

ACHP	Advisory Council on Historic Preservation
ADCPs	Acoustic Doppler Current Profilers
ANOVA	Analysis of Variance
APE	Area of Potential Effects
BIA	United States Department of the Interior, Bureau of Indian Affairs
C	Celsius
CCRG	Commonwealth Cultural Resources Group
CDM	cormorant damage management
CEII	Critical Energy Infrastructure Information
CFR	Code of Federal Regulations
cfs	cubic feet per second
Consumers	Consumers Energy
CZMA	Coastal Zone Management Act (federal)
DCCO	Double-crested cormorants
DDT	dichlorodiphenyltrichloroethane
DLA	Draft License Application
DO	dissolved oxygen
DTEE	DTE Electric
EAP	Emergency Action Plan
EP	Ephemeroptera, Plecoptera
EPT	Ephemeroptera, Plecoptera, Trichoptera
ESA	Endangered Species Act
F	Fahrenheit
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
GLFT	Great Lakes Fisheries Trust
GLSC	Great Lakes Science Center
HBN	Hilsenhoff's Biotic Index
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HPMP	Historic Properties Management Plan
IFC	Instream Flow Council
IGLD	International Great Lakes Datum
ILP	Integrated Licensing Process
ISR	Initial Study Report
kW	Kilowatt
Licensees	Consumers Energy and DTE Electric
LPS	Ludington Pumped Storage
MDOT	Michigan Department of Transportation
mg/l	milligrams per liter
Michigan DEQ	Michigan Department of Environmental Quality
Michigan DNR	Michigan Department of Natural Resources

Michigan SHPO	Michigan State Historic Preservation Officer
MISIN	Midwest Invasive Species Information Network
MISO	Midcontinent Independent Operating System
MW	Megawatt
MWh	megawatt hours
NEPA	National Environmental Policy Act
NREPA	Natural Resources and Environmental Protection Act, P.A. 451 of 1994
NGO	non-governmental organization
NHPA	National Historic Preservation Act
NMFS	United States Department of Commerce National Marine Fisheries Service
No.	Number
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPS	United States Department of the Interior National Park Service
NRHP	National Register of Historic Places
NRPA	Natural Resources Protection Act
NTU	Nephelometric Turbidity
PAD	Pre-Application Document
PEM	palustrine emergent wetland
PFO	palustrine forested wetland
PHABSIM	Physical Habitat Simulation
PMCT	Pere Marquette Charter Township
PME	protection, mitigation, and enhancement
POE	Panel of Experts
Project	Ludington Pumped Storage Hydroelectric Project
PSP	Proposed Study Plan
REA	Ready for Environmental Analysis
RM	river mile
RMP	Recreation Facilities Management Plan
ROA	Retail Open Access
RPS	Renewable Portfolio Standards
RSP	Revised Study Plan
RTE	Rare, Threatened, and Endangered
SAT	Scientific Advisory Team
SCORP	Michigan State Comprehensive Outdoor Recreation Plan
SD1	Scoping Document 1
SPD	Study Plan Determination
Study Plan	FERC-approved Study Plan
SWEC	Stone & Webster Engineering Corporation
UPEJ	Upper Penstock Encasement Joint
U.S.	United States
USACE	United States Army Corps of Engineers

USEPA	United States Environmental Protection Agency
USFWS	United States Department of the Interior Fish and Wildlife Service
USGS	United States Geological Survey
USR	Updated Study Report
WNS	white-nose syndrome
WSELs	Water surface elevations
WQC	Water Quality Certification

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT

EXHIBIT E
ENVIRONMENTAL REPORT

1.0 INTRODUCTION

Consumers Energy and DTE Electric (Licensees) are using the Federal Energy Regulatory Commission's (FERC) Integrated Licensing Process (ILP) for the relicensing of the Ludington Pumped Storage Hydroelectric Project (Project). Pursuant to the process and schedule requirements of the ILP (18 CFR Part 5), the Licensees are filing a Final License Application (FLA) with FERC. The FLA is being provided to interested parties including participating federal and state agencies, tribes, non-governmental organizations (NGOs), local governments, and the public for comment.

The Ludington Pumped Storage Project (Project) is located along the Lake Michigan shoreline, in the townships of Pere Marquette and Summit in Mason County, Michigan and in Port Sheldon in Ottawa County, Michigan[1]. (See Figure E-1.1-1) The Ottawa County portion is limited to a 1.8 acre satellite recreation site (established as part of the Settlement Agreement discussed below).

The Project consists of an 842-acre upper reservoir within a man-made embankment and uses Lake Michigan as the lower reservoir. The upper reservoir holds 28,300 acre-feet at a minimum elevation of 875 feet NGVD and 82,300 acre-feet at a maximum elevation of 942 feet NGVD. The usable volume is 54,000 acre-feet with a maximum drawdown of 67 feet. There are six (6) penstocks each of which is approximately 1,300 feet long. There is a 2,715-foot long tailrace area in the lower reservoir area (Lake Michigan). The powerhouse is protected from wave action by two parallel, 1,600-foot long jetties and an outer 1,700-foot long breakwater. A 12,850-foot long barrier net that extends from the lake bottom to the surface is installed seasonally from

[1]Pigeon Lake North Pier, a recreation site associated with the Project, is located in Port Sheldon, Ottawa County, approximately 70 miles south of the pump storage facility. This is the only portion of the Project in Ottawa County and consists of approximately 1.8 acres. This recreation site was developed as part of FERC's January 23, 1996 order approving a settlement agreement and provides amenities including a parking lot, boardwalk and Lake Michigan fishing access. The site is open from spring through fall. While the land associated with this recreation site is not contiguous with the Project boundary, the recreation site is discussed in Section 5 under recreation (5.8) and aesthetics (5.9).

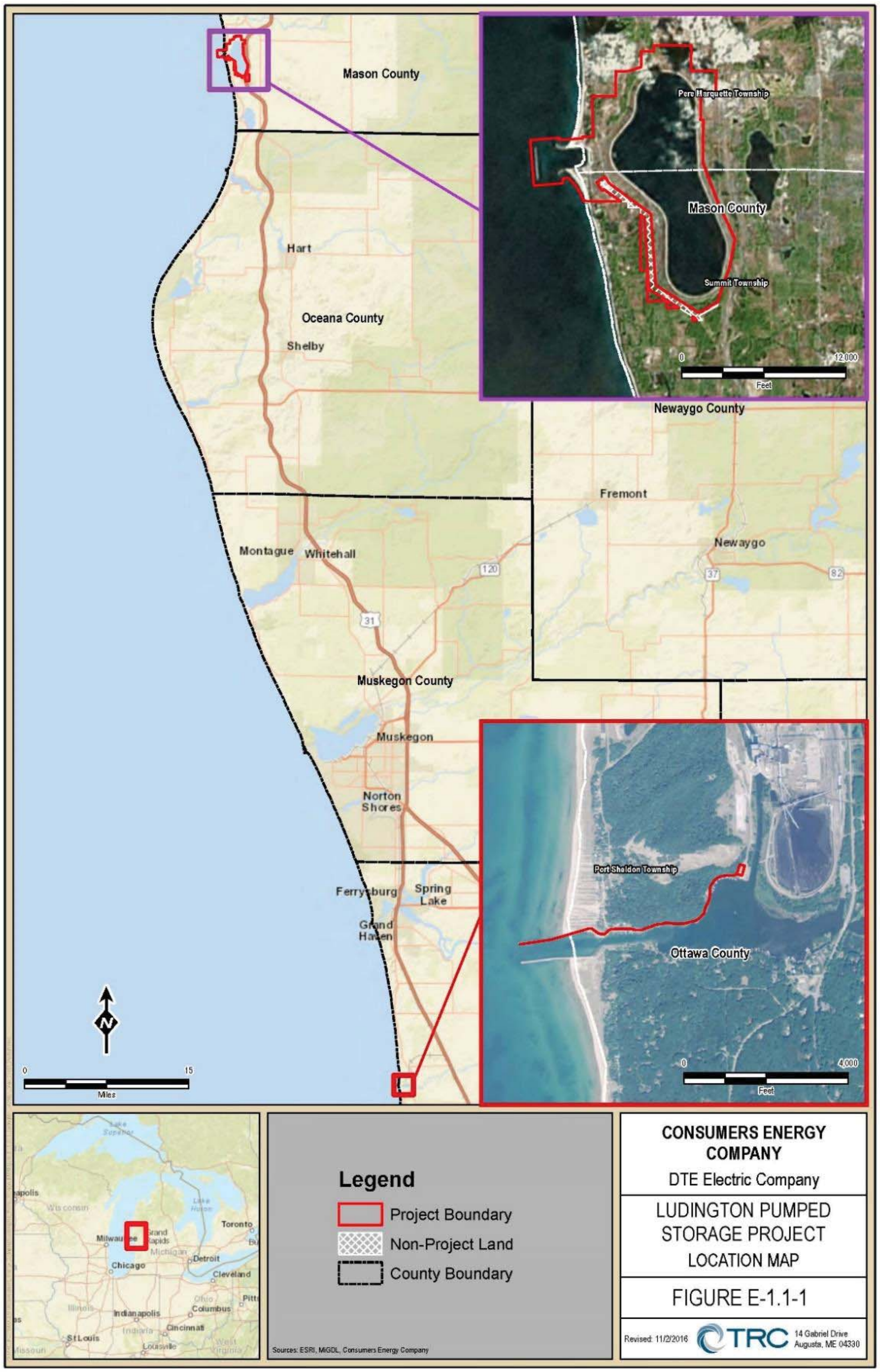
approximately mid-April to mid-October outside of the tailrace structures to prevent fish from approaching the units during pumping. Consistent with License Article 26, the Coast Guard approved navigation lighting for the Project in 1973 and subsequently approved the lighted navigational and warning buoys which are secured around the outer perimeter of the seasonal barrier net in 1988

There are six (6) generating units with a total authorized installed capacity of 1,785 MW[2] with an average annual generation of 2,357,066 MWh from 1999-2016.[3] The Project is operated to provide power during peak electrical demand periods which typically occurs during daytime hours. The upper reservoir is partially refilled at night and completely refilled on the weekends by pumping water from Lake Michigan.

[2] On May 7, 2012, FERC issued an Order Amending License to upgrade and overhaul all six pump-turbine/motor generating units at the Project, one unit at a time over the years 2013 through 2019. The proposed overhaul will increase the authorized installed capacity of the Project from 1,657.5 MW to 1,785 MW. The license application reflects the increased installed capacity.

[3] The average annual energy generation represents generation reported through October 2016.

Figure E-1.1-1: Ludington Pumped Storage Project Location



1.1 Purpose of Exhibit E

The purpose of the Exhibit E, as defined in 18 Code of Federal Regulations (CFR) § 5.18, is to describe the following: 1) the existing and proposed project facilities, including project lands and waters; 2) the existing and proposed project operation and maintenance, to include measures for protection, mitigation and enhancement (PME) with respect to each resource affected by the Project proposal; and 3) the continuing impacts of existing Project operations and maintenance on resources, including direct, indirect, and cumulative impacts based on information generated during the relicensing studies.

The environmental analysis in this Exhibit E (Section 4.4) presents the assessment of effects associated with existing and proposed Project operations and facilities and the expected benefits of proposed PME measures. This analysis is based in large part on the results of studies conducted by the Licensees under the FERC approved Study Plan (Study Plan). In consultation with participating agencies, Tribes and the public, the Licensees developed study plans, which were filed with and approved by FERC. A Proposed Study Plan (PSP) was filed with FERC on January 21, 2014. A Revised Study Plan (RSP) was filed with FERC on November 3, 2014 that contained modifications intended to address written comments provided by stakeholders, as well as study scope changes resulting from comments and discussions that occurred during the winter and spring of 2013. The Study Plan was approved with specific revisions by FERC in its Study Plan Determination (SPD) issued on December 2, 2014. Initial Study Reports (ISR) were filed with FERC on December 2, 2015 and March 4, 2016. The Updated Study Report (USR) was filed with FERC on December 1, 2016.

The results of the first and second year studies have been incorporated into the associated analysis of resources in this Exhibit E. The resource analyses contained in this Exhibit E will provide the foundation for FERC's National Environmental Policy Act (NEPA) analysis. In organizing this Exhibit E, the Licensees relied on FERC's Scoping Document 1 (SD1) for the Project (FERC 2014), FERC's requirements for Exhibit E of the License Application (18 CFR § 5.18[b]), and FERC's guidance document, Preparing Environmental Documents: Guideline for Applicants, Contractors, and Staff (FERC 2008b).

1.2 Consultation

Consultation with federal and state agencies, Tribes, NGOs and other interested parties was initiated in January, 2014, with the issuance of the Notice of Intent (NOI) and Pre-Application Document (PAD). Stakeholders are included in Table E-1.2-1.

Table E-1.2-1: List of Consulted Parties

Federal Agencies	
ACHP	Advisory Council on Historic Preservation
USACE	U.S. Army Corps of Engineers
BIA	U.S. Department of the Interior Bureau of Indian Affairs
FERC	Federal Energy Regulatory Commission
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	U.S. Department of the Interior National Park Service
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Department of the Interior Fish and Wildlife Service
USGS	U.S. Geological Survey
State Agencies	
Michigan DNR	Michigan Department of Natural Resources
Michigan DEQ	Michigan Department of Environmental Quality
	Michigan Office of the Governor/Attorney General
Michigan SHPO	Michigan State Historic Preservation Officer
Michigan SHDA	Michigan State Housing Development Authority
	Michigan State University Department of Fisheries and Wildlife
Tribes	
	Bad River Band of Lake Superior Tribe of Chippewa Indians
	Bay Mills Indian Community
	Burt Lake Band of Ottawa and Chippewa Indians
	Grand River Band of Ottawa
	Grand Traverse Band of Ottawa & Chippewa Indians (MI)
	Hannahville Indian Community of MI
	Keweenaw Bay Indian Community
	Lac Vieux Desert Band of Lake Superior Chippewa Indians (MI)
	Little River Band of Ottawa Indians
	Little Traverse Bay Band of Odawa Indians
	Match-E-Be-Nash-She-Wish Band of Pottawatomi Indians
	Nottawaseppi Huron Band of Potawatomi
	Ottawa Tribe of Oklahoma
	Pokagon Band of Potawatomi Indians of Michigan
	Red Lake Band of Chippewa Indians of Minnesota
	Saginaw Chippewa Indian Tribe of MI
	Sault Ste. Marie Tribe of Chippewa Indians of Michigan
	Wyandotte Tribe of Oklahoma

Local Governments	
Allegan	Allegan County
Allendale	Allendale Township
Blendon	Blendon Township
Pere Marquette	Charter Township of Pere Marquette
Grand Haven	City of Grand Haven
Holland	City of Holland
Ludington	City of Ludington
Zeeland	City of Zeeland
Grand Haven	Grand Haven Township
Holland	Holland Township
Laketown	Laketown Township
Marquette	Marquette County Board of Commissioners
Mason	Mason County
Ottawa	Ottawa County
Park	Park Township
Port Sheldon	Port Sheldon Township
Robinson	Robinson Township
Spring Lake	Spring Lake Township
Summit	Summit Township
Non-governmental Organizations	
ACA	American Canoe Association
AW	American Whitewater
	Anglers of Au Sable
FFF	Federation of Fly Fishers
HRC	Hydropower Reform Coalition
MHRC	Michigan Hydro Relicensing Coalition
MUCC	Michigan United Conservation Clubs
	Mountain Beach Association
NWF	National Wildlife Federation
	University of Michigan – School of Natural Resources and Environment
TU	Trout Unlimited

The NOI and PAD for the Project were issued to stakeholders and filed with FERC on January 21, 2014. FERC subsequently issued SD1 on March 20, 2014. In SD1, the Commission identified the following potential resource issues to be evaluated during the environmental analysis of the proposed relicensing pursuant to the National Environmental Policy Act (NEPA):

- Aquatic Resources
  - Effects of accidental spills of oil, grease, lubricants, etc., on water quality.
  - Effects of project operation on water quality, particularly on dissolved oxygen, water temperature, and turbidity, in Lake Michigan.
  - Effects of fish entrainment associated with pumping operations on fish populations, including state-listed species (i.e., lake herring and lake sturgeon) in Lake Michigan.

- Terrestrial Resources
  - Effects of continued project operation, including reservoir fluctuations, on riparian, littoral, and wetland habitats and associated wildlife.
  - Effects of continued project operation, including maintenance activities (e.g., road maintenance, transmission line maintenance, and rights-of-way vegetation management), on wildlife habitat and associated wildlife.
  - Effects of continued project operation and maintenance on the introduction, establishment, and spread of invasive plant species in the project area.
  - Effects of continued project operation and maintenance on Michigan state species of special concern, including the bald eagle, marsh wren, eastern box turtle, and ginseng.

- Threatened and Endangered Species
  - Effects of continued project operation and maintenance on the federally endangered Indiana bat, piping plover, karner blue butterfly, and the federally threatened pitcher's thistle.

- Recreation and Land Use Resources
  - Adequacy of existing recreational facilities in the project boundary to meet current and future recreational demand.

- Cultural Resources
  - Effects of the proposed action and alternatives on properties included in, or eligible for inclusion in, the National Register of Historic Places.

A public scoping meeting was held by FERC on April 17, 2014, and a site visit was held by FERC on July 30 - 31, 2014. The Licensees filed a PSP for the Project with FERC on October 3, 2014. The Licensees filed a RSP with FERC on November 3, 2014. The RSP was approved, with specific revisions, by FERC in its SPD issued on December 1, 2014. Appendix E-1 provides a summary of consultation correspondence over the course of the relicensing process to date.

The Licensees completed the five studies required according to the Commission's SPD (Table E-1.2-2) in 2015 and 2016. In addition, the Licensees conducted a Year 2 cormorant count in the fall of 2016.

Table E-1.2-2: List of Relicensing Studies Completed for Relicensing

Study	Report Filing Date
Fish and Aquatic Resources Evaluation Phase I and II Phase III	December 2, 2015 December 1, 2016
Wildlife and RTE Reconnaissance Surveys	March 4, 2016
Botanical, and RTE Reconnaissance Surveys	March 4, 2016
Recreation Inventory and Recreation Use Assessment	May 20, 2016
Cultural Resources Survey, including Archaeological and Historic Structures Surveys	March 4, 2016

The Licensees filed first year study results with FERC on December 2, 2015 and March 4, 2016 in ISRs and shared with stakeholders at ISR Meetings held in person on December 8, 2015 and a teleconference on March 17, 2016. The USR, with additional study results from the second year of studies was filed with FERC on December 1, 2016. The USR public review meeting was conducted by teleconference on December 16, 2016.

1.3 Response to Draft License Application Comments

Comments during the drafting process have been addressed and taken into consideration in drafting the license application. A summary of comments received and the License's response to those comments is included in the Final License Application (Appendix E-5).

1.4 REA Notice

Once FERC has determined that the Ludington Project's Final License Application meets all filing requirements, any deficiencies with the application have been resolved, and no additional information is required, FERC will issue the notice of acceptance and Ready for Environmental Analysis (REA).

The acceptance/REA notice solicits comments, protests, and interventions- along with recommendations, preliminary terms and conditions, and preliminary fishway prescriptions- including all supporting documentation. Comments, protests, and interventions must be filed within 60 days of notice. The Licensees will then have 45 days to respond to submitted comments (105 days from the REA notice). When the application is accepted, FERC provides public notice in the Federal Register, local newspapers, and directly to resource agencies and Indian tribes. In its notice, FERC invites protests and interventions and requests the final fish and wildlife recommendations, prescriptions, mandatory conditions, and comments from the appropriate resource agencies and Indian Tribes.

2.0 STATUTORY AND REGULATORY REQUIREMENTS

2.1 Section 401 of the Clean Water Act

Pursuant to Section 401 of the 1972 Amendments to the Federal Water Pollution Control Act, Public Law 92-500, the Licensees are required to apply for a Section 401 Water Quality Certification (WQC) from the Michigan Department of Environmental Quality (DEQ).

As part of the ILP, the Licensees consulted with the Michigan DEQ throughout the relicensing process. The Licensees will file an Application for WQC with Michigan DEQ for this relicensing in June, 2017, closely following filing of the Final License Application. A date-stamped copy of the application to Michigan DEQ will be filed with the FERC once it has been submitted to the Michigan DEQ.

2.2 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) (16 U.S.C. § 1536) requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. As part of the ILP, the Licensees consulted with the U.S. Department of the Interior Fish and Wildlife Service (USFWS) throughout the relicensing process to assess potential Project effects on federally listed threatened and endangered species in the Project area. There are no federally listed species known to occur within the Project boundary. Rare, threatened and endangered species are discussed in Section 4.3.7 of this Exhibit E.

2.3 Magnuson-Stevens Fishery Conservation and Management Act

In 1996 the U.S. Congress recognized the increasing pressure on marine resources in the country and addressed these issues in its reauthorization of the Magnuson Fishery Conservation and Management Act, now known as the Magnuson-Stevens Act (16 U.S.C. § 1801 et seq.). This Act required the eight Regional Fishery Management Councils, in collaboration with NOAA Fisheries, to give heightened consideration to Essential Fish Habitat (EFH) in resource management decisions. Congress defined EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity." The designation and conservation of EFH seeks to minimize adverse effects on habitat caused by fishing and non-fishing activities.

Before a Federal agency proceeds with an activity that may adversely affect a designated EFH (e.g., relicensing of a hydro project), the agency must: 1) consult with NOAA Fisheries and, if requested, the appropriate Council for the recommended measures to conserve EFH and 2) reply within thirty days of receiving EFH recommendations. The agency response must include proposed measures to avoid or minimize adverse impacts on the habitat, or alternatively an explanation if the agency cannot adhere to the recommendation from NOAA Fisheries.

There are no EFH designations in Lake Michigan, and this Act does not apply to the Project.

2.4 Coastal Zone Management Act

Under section 307 (c)(3)(A) of the Coastal Zone Management Act (CZMA) (16 U.S.C. § 1456), FERC cannot issue a license for a project within or affecting a states' coastal zone unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

The Ludington Pumped Storage Project (Project) is located along the Lake Michigan shoreline, in the townships of Pere Marquette and Summit in Mason County, Michigan and in Port Sheldon in Ottawa County, Michigan[4]. The Ottawa County portion is limited to a 1.8 acre satellite recreation site (established as part of the Settlement Agreement discussed below). The Licensees will submit a letter in June 2017 to the Michigan DEQ requesting a consistency determination for the Project, and file this letter and subsequent determination with FERC.

2.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, (16 U.S.C. § 470s) requires FERC to take into account the effect of its undertakings on historic properties. In this case the undertaking includes the issuance of a federal license for the continued operation of the Project. Section 106 of the NHPA is implemented through the Advisory Council on Historic Preservation (Council regulations "Protection of Historic Properties" (36 CFR Part 800)). For hydropower licensing actions, FERC typically completes Section 106 by entering into a Programmatic Agreement or Memorandum of Agreement with the licensee, the Advisory Council on Historic Preservation (ACHP), and the state and tribal historic preservation offices. FERC typically requires the licensee to develop and implement a Historic Properties Management Plan (HPMP) as a license condition. Through an approved HPMP, FERC can require consideration and management of effects on historic properties for the license term; thus, meeting the requirements of Section 106 for its undertakings.

[4] Pigeon Lake North Pier, a recreation site associated with the Project, is located in Port Sheldon, Ottawa County, approximately 70 miles south of the pump storage facility. This is the only portion of the Project in Ottawa County and consists of approximately 1.8 acres. This recreation site was developed as part of FERC's January 23, 1996 order approving a settlement agreement and provides amenities including a parking lot, boardwalk and Lake Michigan fishing access. The site is open from spring through fall. While the land associated with this recreation site is not contiguous with the Project boundary, the recreation site is discussed in Section 5 under recreation (5.8) and aesthetics (5.9).

The Licensees have consulted with the Michigan State Historic Preservation Officer (SHPO) and the Tribes that may have an interest in the Project, as appropriate, on archaeological and historic architectural surveys of the Project area. In March of 2013 the Licensees reached out to the eighteen Native American Tribes that were found to have some association with the Ludington Project. These tribes were also provided copies of the filings for the Initial Consultation Package, Proposed Study Plan, Revised Study Plan, Initial Year Study Reports (this included the public version of the Phase I Historic and Archaeological Study report) and the Second Year Study Reports. No expression of interest in participating in review of the cultural resource studies or comments were received from the tribes with the exception of the Saginaw Chippewa Indian Tribe of Michigan. The Saginaw Tribe was also provided the non-public version of the Historic-Archaeological Study Report and the Historic Properties Management Plan when these reports were provided to the Commission and the SHPO.

A draft HPMP was submitted to the SHPO and the Saginaw Tribe for comment on March 6, 2017 and a final HPMP will be filed with the FLA. The SHPO accepted the report without comment or modification. No comments were received from the Saginaw Tribe prior to filing the FLA. The HPMP will contain specific steps to be taken by the Licensees to protect and preserve the historic properties identified at the Project over the term of the new license. With the implementation of the approved HPMP, the continued operation of the Project as proposed by the Licensees will have no adverse impacts on cultural resources at the Project.

2.6 Wild and Scenic Rivers and Wilderness Acts

The National Wild and Scenic Rivers System was created by Congress in 1968 (Public Law 90-542; 16 U.S.C. § 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. Rivers are classified as wild, scenic, or recreational.

The Wilderness Act of 1964 [Public Law 88-577 (16 U.S.C. 1131-1136)] was enacted to establish a National Wilderness Preservation System for the permanent good of the whole people, and for other purposes.

There are no nationally designated wild and scenic rivers or wilderness areas within the Project boundary or in the vicinity of the Project.

3.0 PROPOSED ACTION AND ALTERNATIVES

FERC issued the original license for the Project by order dated July 30, 1969. The license was for a 50-year term effective from July 1, 1969 and terminating June 30, 2019. The proposed action consists of the issuance of a new FERC license to Consumers Energy and DTE Electric for the continued operation and maintenance of the Project with appropriate Project Mitigation and Enhancement (PME) measures.

3.1 No Action Alternative

The no action alternative means that the Project would continue to operate as authorized by the current license. Existing facilities would remain in place and existing PME measures would continue, but there would be no additional protection or enhancement of resources. If the Project were to operate as in the past, the Licensees would continue to produce energy in the present manner and the environmental effects of its operation would remain unchanged. Any ongoing effects of the Project would continue. The no action alternative represents the baseline Project energy production and environmental conditions for comparison with other alternatives.

3.1.1 Existing Project Facilities

The Project consists of an 842-acre upper reservoir within a man-made embankment and uses Lake Michigan as the lower reservoir. The upper reservoir holds 28,300 acre-feet at a minimum elevation of 875 feet NGVD 29 and 82,300 acre-feet at a maximum elevation of 942 feet NGVD 29. The usable volume is 54,000 acre-feet with a maximum drawdown of 67 feet. There are six (6) penstocks each of which is approximately 1,300 feet long. There is a 2,715-foot long tailrace area in the lower reservoir (Lake Michigan). The powerhouse is protected from wave action by two parallel, 1,600-foot long jetties and an outer 1,700-foot long breakwater. A 12,850-foot long barrier net that extends from the lake bottom to the surface is installed seasonally from approximately mid-April to mid-October outside of the tailrace structures to prevent fish from approaching the units during pumping. Consistent with current License Article 26, the Coast Guard approved navigation lighting for the Project in 1973 and subsequently approved the lighted navigational and warning buoys which are secured around the outer perimeter of the seasonal barrier net in 1988.

There are six (6) generating units with a total authorized installed capacity of 1,785 MW[5] with an average annual generation of 2,357,066 MWh from 1999-2016. The Project is operated to

[5] On May 7, 2012, FERC issued an Order Amending License to upgrade and overhaul all six pump-turbine/motor generating units at the Project, one unit at a time over the years 2013 through 2019. The proposed overhaul will increase the authorized installed capacity of the Project from the original 1,657.5 MW to 1,785 MW.

provide power during peak electrical demand periods which typically occurs during daytime hours. The upper reservoir is partially refilled at night and completely filled over the weekend by pumping from Lake Michigan.

Table E-3.1-1 summarizes existing Project information and facilities.

Table E-3.1-1: Ludington Pumped Storage Project Specifications

GENERAL INFORMATION	
Owners	Consumers Energy and DTE Electric
FERC Project Number	2680
County	Mason and Ottawa
Nearest Townships	Pere Marquette, Summit and City of Ludington (Mason County) Port Sheldon (Ottawa County)
LUDINGTON PUMPED STORAGE PROJECT	
General	
Waterbody	Upper Reservoir – manmade water storage constructed for the Project Lower reservoir – Lake Michigan The Project is not connected to a river.
Upper Reservoir Gross Storage	82,300 acre-feet (or approximately 26.8 billion gallons of water) at the maximum water surface elevation of 942 feet NGVD 29.
Upper Reservoir Usable Volume	54,000 acre-feet (approximately 17.5 billion gallons of water) with a maximum drawdown of 67 feet to the minimum water surface elevation of 875 feet NGVD 29.
Upper Reservoir Maximum Drawdown Rate	approximately 10 feet per hour with all six upgraded units generating
Upper Reservoir Surface Elevation change, normal operation	+ or – 1.5 foot per hour per upgraded operating unit.
Upper Reservoir Length	5.7 miles
Upper Reservoir Surface Area at Normal Full Pond	842 acres at elevation 942 feet NGVD 29
Lower Reservoir	Lake Michigan
Lower reservoir Surface Area	22,300 square miles
Lower Reservoir mean depth	279 feet
Total Nominal Hydraulic Capacity	71,445 cfs (at time of FLA filing) 76,290 cfs after all upgrades are complete.

Structures	
Upper Reservoir	Earthen embankment with Hydraulic Asphaltic Concrete and clay linings construction
Total Upper Reservoir Perimeter Length	5.7 miles
Intake and Penstock for Powerhouse	A concrete intake structure located in the upper reservoir provides a separate inlet for each unit. Six approximately 1,300-foot long steel penstocks connect the intake structure to the powerhouse. Each penstock varies in diameter from 28.5 feet at the intake to 24 feet at the powerhouse; penstocks are encased in concrete as they pass through the embankment. Penstocks are supported on concrete saddles and buried in fill sand as they emerge from the downstream toe of the embankment and descend to the east side of the powerhouse.
Powerhouse	One concrete powerhouse with six bays, one for each pump-turbine/motor-generator unit. Approximately 85% of the powerhouse structure is below Lake Michigan water level.
Reversible Pump-Turbine/Motor-Generator Units	6
Units 1 – 6 (post-upgrade)	Toshiba Pump-Turbine with a rated capacity of 311 MW at 12,715 cfs. Motor-Generator with a rated installed capacity of 297.5MW
Transmission Facilities	Motor-Generator leads, nine step-up transformers at the plant and nine parallel, approximately 1,800-foot-long, 345-kV transmission tie lines, extending from the transformers on the powerhouse roof to the Ludington switchyard. The switchyard and the 345 kV transmission lines exiting from the switchyard are not included in the Project license.
Breakwater and Jetties	The breakwater is located approximately 2,700 feet from shore into Lake Michigan and is approximately 1,700 feet long. Each of the two jetties extend approximately 1,600 feet into Lake Michigan.

3.1.2 Existing Project Boundary

The upper reservoir, powerhouse and the majority of associated Project lands are located entirely within Pere Marquette and Summit Townships in Mason County. Also, a satellite Project recreation site is located in Port Sheldon Township in Ottawa County, approximately 70 miles south of the upper reservoir.

The Project boundary at the upper reservoir contains approximately 1,670 acres, which includes the 842-acre upper reservoir. The Project boundary is a series of traverse lines that encompass the upper reservoir, powerhouse, recreation and other Project facilities, and the tailrace area in Lake Michigan (See Figure E-3.1.2-1). A switchyard and transmission lines south of the powerhouse are not included in the Project.

The Licensees submitted an application dated May 29, 2013 to FERC to remove approximately 35.2 acres of land from the original Project boundary, as the land is not needed for Project purposes. This application was approved by FERC on October 28, 2013. The Licensees submitted a second application dated November 12, 2013 to FERC to remove 95 acres of land located near the southeast corner of the upper reservoir from the original Project boundary. The land has not been used since construction for Project operational purposes. The application was approved by FERC on May 13, 2014.

The Pigeon Lake North Pier recreation site's boundary contains approximately 1.8 acres that includes a 30-vehicle parking lot and a 4,600-foot boardwalk/pathway along the Pigeon River and is denoted by traverse lines around the parking area and offsets from an established centerline along the boardwalk/pathway (See Figure E-3.1.2-2).

Figure E-3.1.2-1: Project Boundary Map

Figure E-3.1.2-2: Port Sheldon Recreation Facility Boundary Map

3.1.3 Project Safety

The Project complies with FERC's Emergency Action Plan (EAP) requirements. The current EAP is dated November 1, 2016. The EAP is reviewed and updated annually, and contains a five-year periodic update requirement. The most recent functional exercise was performed in March, 2013. The next table top exercise is scheduled for 2017, followed by a functional exercise in 2018. The Licensees have a Dam Safety Surveillance and Monitoring Plan per FERC regulations, containing various monitoring/inspection requirements. A Surveillance Monitoring Committee meets every other month to review the monitoring/inspection results. FERC conducts annual on-site inspections of the Project and Licensees also hire an independent consultant (approved by FERC) to perform the Part 12 Safety Inspection once every five years.

3.1.4 Existing Project Operations

As a hydroelectric pumped storage facility, the Project's operations differ both in purpose and nature from that of a conventional riverine hydroelectric facility. Most pumped storage projects assist with grid reliability. Such facilities use two reservoirs of differing elevation, pumping water from the lower reservoir to the upper reservoir, generally during off-peak times when electric demand is relatively low. The water is then stored in the upper reservoir until electric demand is relatively high, at which time water is released from the upper reservoir down to hydroelectric turbines, where the water is used to generate electricity before being discharged back into the lower reservoir. Pumped storage provides an effective, large-scale way to store energy until needed to respond to high load demands.

The upper reservoir has no contributory drainage area (i.e. there is no geographical area which provides run-off other than the reservoir itself). Consequently, the Project is unaffected by the low, normal or flood flows of any stream. Similarly, the Project does not affect the flows of any stream. The release of water from the upper reservoir to the lower reservoir has no influence upon the water level of the lower reservoir because of the relative size of the reservoirs. That is, Lake Michigan contains so much more water than the Project's upper reservoir that even if the upper reservoir was fully drained into Lake Michigan, the Lake's water level would not measurably change.

The Project is typically operated to generate electricity to meet peak electric system demand. The Project generally begins each week on Monday morning with the upper reservoir at or near full pool (i.e., water elevation of 942 feet NGVD 29). Generation usually occurs during the day with the upper reservoir replenished at night during pumping to meet the next day's forecast load. Generation and pumping operations throughout the course of the week generally result in the upper reservoir being at or near minimum pool (i.e., water elevation of 875 feet NGVD 29) by late Friday evening. The upper reservoir water level is then brought to full pool over the weekend to be ready for the start of the next week's operating cycle. Following completion of the ongoing unit overhauls/upgrades, the Project can generate at maximum capacity for approximately 7 hours, starting with a full upper reservoir. Refilling the upper reservoir requires approximately 10 hours of pumping at maximum capacity. The Licensees have no plans to change the current peaking operation of the Project.

The Project does not presently have a WQC, but does maintain compliance with Michigan water quality standards (see Section 4.3.2, Water Resources).

3.1.5 Existing Environmental Measures

The Licensees currently provide the following PME measures for recreational and aquatic resources:

- A Barrier Net is installed from April through October each year in order to reduce fish entrainment.
- Six recreation facilities are open and available to the public.

3.2 Alternatives Considered but Eliminated from Detailed Study

3.2.1 Federal Government Takeover of the Project

No party has suggested that federal takeover of the Project would be appropriate and no federal agency has expressed an interest in operating the Project. Thus, the federal takeover of the Project is not a reasonable alternative.

3.2.2 Issuance of Non-Power License

Since the Project was constructed as a hydroelectric pumped storage project, with a constructed upper reservoir, a non-power license is not a reasonable alternative to a new operating license with appropriate PME measures.

3.2.3 Project Decommissioning

No party has suggested Project decommissioning would be appropriate and there is no basis for recommending it. The Project provides a viable, safe, and clean source of power to the region. If the Project were decommissioned, its contribution to energy generation, energy storage and grid stabilization would be irreplaceable. Thus, Project decommissioning is not a reasonable alternative to relicensing the Project with appropriate PME measures.

3.3 Proposed Action

3.3.1 Proposed Project Facilities

The Licensees are proposing no modifications to the existing Ludington Project powerhouse, upper reservoir or related facilities. The pump-turbine/motor-generator equipment is being upgraded under a prior license amendment, and the upgrades are scheduled to be complete in early 2020, after a new license would be issued. (No electric transmission facilities, including the right of way, are included in the Project license.) The existing dam, powerhouse, generating, and appurtenant facilities are all well maintained, and in good working order, and no changes are required or proposed to these facilities that are outside normal maintenance practices or ongoing FERC safety requirements.

3.3.2 Proposed Project Boundary

The Licensees are not proposing to modify the Project boundary as part of the licensing process. The Project boundary is identified in Figures E-3.1.2-1 and E-3.1.2-2.

3.3.3 Proposed Project Operations

The Project will continue to operate as a hydroelectric pumped storage project, as described in Exhibit B and above in Section 3.1.4. Generation and Pumping hours are dictated by MISO request. The Project is located on Lake Michigan, using this lake as the lower reservoir, and uses a man-made upper reservoir. The Project is not located on a river. As one of the Great Lakes, Lake Michigan is a large body of water for which daily flow fluctuations from the plant are quickly absorbed into the lake. The Project does not have minimum flow requirements, reservoir water level limitations or other requirements that would impact other non-developmental resources. As such an Operations Compliance Management Plan is not required for the project. Periodically, the Licensees may be required to modify Project operations, including flows and impoundment levels in order to maintain or repair the Project, consistent with FERC requirements. However, any such planned changes in Project operation would be conducted in accordance with FERC's requirements for notification and consultation, consistent with the new Project license.

3.3.4 Proposed Environmental Measures

The Licensees are proposing the following PME measures for the protection of important resources.

- Develop a recreation facilities management plan (RMP) to provide for installation or modification, as applicable, and management of recreational facilities at the Project. (A draft Recreation Management Plan was provided to Pere Marquette Township, Mason County and the Michigan Department of Natural Resources on May 5, 2017.)

- Develop an HPMP to provide for management of historic properties throughout the term of the license. (A proposed HPMP was provided to the State Historic Preservation Office and the SaginawChippewa Tribe of Indians on March 6, 2017.)
- Install a seasonal barrier net and monitor the net effectiveness using the same program as is currently in place.

4.0 ENVIRONMENTAL ANALYSIS

4.1 General Description of the Basin

4.1.1 Overview

The Ludington Pumped Storage Project (Project) is located along the east shore of Lake Michigan, near Ludington, Michigan in the Lake Michigan basin, and a satellite recreation site is located in Port Sheldon Township, Michigan. The Project uses Lake Michigan as its lower reservoir while the upper reservoir is a man-made reservoir constructed solely for Project operations. There are no rivers, streams or other means of in-flow to the Project other than direct precipitation and the water that is pumped from Lake Michigan.

4.1.2 Hydrology

The Project is a hydroelectric pumped storage project utilizing water from Lake Michigan with a constructed upper reservoir. There is no applicable hydrology information.

4.1.3 Topography

The Project is located on the eastern shoreline of Lake Michigan, near Ludington, Michigan. Topography in the Project area ranges from less than 600 feet NGVD along the shore of Lake Michigan to over 950 feet along the upper reservoir; natural topography in the Project vicinity ranges from less than 600 feet above sea level to approximately 850 feet above sea level (USGS 2016). The Project Area is characterized by rolling hills and dunes generated by lake-driven winds (Kost 2007).

4.1.4 Climate

The Project region experiences a moderate climate with well-defined seasons. The mean monthly maximum air temperature in the region ranges from 29.8 °F (-1.22 °C) in January to 80.0 °F (26.67 °C) in July, while the mean monthly minimum temperatures range from 17.1 °F (-8.3 °C) in January to 59.8 °F (15.47 °C) in July. Overall monthly average temperatures are approximately 23.5 °F (-4.72 °C) in January and 69.9 °F (21.06 °C) in July. The average annual snowfall total for Ludington is 66.8 inches and the annual average total precipitation (rainfall) is 16.65 inches. (NOAA.gov 2014).

The State of Michigan is taking a proactive approach to climate change. On October 6, 2008, Public Act 295 was signed into law. The Act, known as The Clean, Renewable and Efficient Energy Act, established a Renewable Energy Standard in the State of Michigan. The Renewable Energy Standard requires Michigan electric providers to achieve a retail supply portfolio that includes at least ten percent renewable energy by 2015. In addition, Governor Jennifer Granholm established the Michigan Climate Action Council (MCAC) in 2007. A MCAC Climate Action Plan was published in 2009 (Michigan DEQ, 2009), also referencing Public Act 295. MCAC recommends the State of Michigan take a strong leadership role in promoting efficient, effective policies to address climate change at the national, regional, and state levels.

The report cites increased renewable energy generation in Michigan driven by renewable portfolio standards (RPS) as one mechanism for reducing greenhouse gas emissions. Wind, solar and distributed renewable energy resources are a focus of the RPS. Pumped storage projects, such as the Ludington Project, play a key role in storing energy generated by intermittent renewable resources, such as wind, that generate during periods of low electrical demand. This energy is stored for use during periods of peak demand, thus improving the value and ability to dispatch these renewable resources.

4.1.5 Land and Water Uses

4.1.5.1 Major land uses

Major land uses in the Project vicinity include industrial/commercial, agricultural and residential. The land adjacent to the Project is primarily wooded and agricultural with some residential use primarily along the Lake Michigan shoreline. More concentrated residential and industrial/commercial land uses are found in the communities close to the Project, including the City of Ludington.

4.1.5.2 Major water uses

Since the Project's watershed is associated with Lake Michigan, and not a river or stream, the major water uses are associated with use of Lake Michigan near the Project. Major water uses of Lake Michigan include recreational, industrial, and commercial uses. The Lake has a long history of providing an area to pursue many forms of water-based recreation (e.g. fishing, boating, and swimming) and, as such, the area is a popular tourist destination. The City of Ludington is also the homeport of the *SS Badger,* a coal-fired car ferry with daily service in the summer from Ludington to Manitowoc, Wisconsin. None of these water uses are associated with or impacted by operation of the Project.

The Project uses Lake Michigan water for power generation. A typical generation cycle consists of pumping water from Lake Michigan to the Project's upper reservoir through six reversible pump-turbines in pump mode. This pumping occurs during times of low electricity demand, which normally occurs at night and on the weekends. During periods of high electricity demand, the water is released from the upper reservoir through the six reversible pump-turbines for power generation. After passing through the pump-turbines, this water flows back into the Lake. In short, the cycle consists of passing water back and forth between Lake Michigan and the upper reservoir. Consumptive use does not occur at any point. This water is stored in the upper reservoir only for a relatively short time period. Based on a total impoundment volume of 82,300 acre-feet and an average weekly pumping rate of 200,000 acre-feet the weekly turnover rate is approximately 2.4.

4.1.6 References

Kost, M.A., D.A. Albert, J.G. Cohen, B.S. Slaughter, R.K. Schillo, C.R. Weber, and K.A. Chapman. 2007. Natural Communities of Michigan: Classification and Description. Michigan Natural Features Inventory, Report No. 2007-21, Lansing, MI.

Michigan DEQ, 2009. Michigan Climate Action Council Climate Action Plan. 125 pp, available online: http://www.michigan.gov/documents/deq/deq-miclimateactionplan-part1_276563_7.pdf.

NOAA. 2014. Climate Normals 198102010 compared with 1971-200. Muskegon. Available online: http://www.crh.noaa.gov/grr/climate/

U.S. Geological Survey (USGS). 2016. National Water Information System: Mapper. Available online: http://maps.waterdata.usgs.gov/mapper/index.html

4.2 Cumulative Effects

According to the Council on Environmental Quality's regulations for implementing NEPA (40 CFR 1508.7), an action may cause cumulative effects if its effects overlap in space and/or time with the effects of other past, present and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

4.2.1 Resources that could be Cumulatively Affected

The scope of the environmental analysis defines the physical limits or boundaries of the Proposed Action's effects on resources. The scope of the effects analysis for this Project was defined in FERC's Scoping Document 1 (SD1) dated March 22, 2014.

In SD1, FERC stated that it had not identified any resources that could be cumulatively affected by the proposed continued operation and maintenance of the Ludington Project. As a result of the analysis, no cumulatively affected resources were identified.

4.2.2 Geographic Scope

The geographic scope of analysis for cumulatively affected resources is defined by the physical limits or boundaries of: (1) the proposed action's effect on the resources, and (2) contributing effects from other activities in the vicinity of the Ludington Project. Because the proposed action can affect resources differently, the geographic scope for each resource may vary.

The geographic scope of the analysis is confined to the Project Boundary.

4.2.3 Temporal Scope

The temporal scope of analysis for cumulatively affected resources includes a discussion of the past, present, and reasonably foreseeable future actions and their effects on affected resources. Based on the potential term of a new license for the Project, the temporal scope looks 30-50 years into the future, concentrating on the effect to the resources from reasonably foreseeable future actions. The historical discussion is, by necessity, limited to the amount of available information for each resource.

4.3 Proposed Action and Action Alternatives

In this section, we discuss the effects of the project alternatives on environmental resources. For each resource, we first describe the affected environment, which is the existing condition and baseline against which we measure effects. We then discuss and analyze the specific cumulative and site-specific environmental issues. We will be analyzing the effects of continued operation of the Project on all resources identified in the PAD. Those resources that would be affected, or about which comments have been received, are addressed in detail in this EA; these resources were also identified in SD1. Based on this, we have determined that Fish and Aquatic, Terrestrial, Threatened and Endangered, Recreation and Land, and Cultural Resources may be affected by the proposed action and action alternatives. We have not identified any substantive issues related to the other relicensing-related issues.

For the Proposed Action, with special focus on the resources identified in SD1, for which studies were completed. These resources are:

- Fish and Aquatic Resources
- Terrestrial Resources
- Threatened and Endangered Resources
- Recreation and Land Resources
- Cultural Resources

4.3.1 Geology and Soils

4.3.1.1 Affected Environment

The Project area is located in the Michigan Basin, which is an elliptical, intracratonic basin situated against the southern margin of the Canadian Shield. The Michigan Basin covers all of Michigan's Lower Peninsula and the eastern half of the Upper Peninsula. Strata from the Middle Cambrian through Upper Pennsylvanian Periods are well represented throughout the subsurface throughout the Basin (Gillespie et al, 2008).

Existing Geological Features

There are limited outcrops throughout the Basin, especially at the margins near the Great Lakes. Most of the rocks of the Michigan Basin are buried beneath thick deposits of Pleistocene glacial drift (Gillespie et al, 2008) (and include some description of the area in Michigan along Lake Michigan that describes the general geology of the area). Final shaping of the general area occurred during the latter stages of the Wisconsin glaciation. The high ground on which the Project's upper reservoir is located is a terminal moraine. Terminal moraines are linear masses of glacial drift that accumulate at the glacier front when it is in equilibrium for a relatively long period of time.

Moraines are composed largely of till and beds of outwash. Till is described as a subglacial deposit which is heterogeneous in composition and includes clay, silt, sand, gravel and boulders. Till deposits are characterized by irregularities and discontinuities in extent and thickness. Outwash includes all types of waterlaid sediments deposited by meltwater streams at the glacial front. Outwash generally is interbedded with the till and may occur in sizable beds.

Other Pleistocene deposits of till underlie the site to a depth of approximately 800 feet where bedrock composed of Mississippian Coldwater formation shale has been encountered. Underlying the Coldwater Formation are Mississippian and Devonian age shales. Devonian limestones of the Traverse City Group, occurring at a depth of approximately 950 feet, initiate a thick sequence of limestones and dolomite with minor amounts of anhydrite and salt to approximately a depth of 2,100 feet. Devonian Filer sandstone occurs at or near the base of the Detroit River Group, a thick sequence of impervious dolomite, anhydrite and salt. The filer Sandstone, at a depth of approximately 2,850 to 3,100 feet, is approximately 100 feet thick beneath the Project's upper reservoir area and reaches a maximum thickness of approximately 140 feet just off-shore of the city of Ludington. Table E-4.3.1-1 provides a generalized stratigraphic column of the Project area and summarizes the elevations at which the more conspicuous maker beds were encountered when drilling brine wells in the area.

Table E-4.3.1-1: Brine Field Stratigraphy

Geologic Time Unit	Name of Rock Unit	Lithologic Description	Elevation in Feet (Top of Formation)						
			Well No. 5	Well No. 17	Well No. 18	Well No. 20	Well No. 30	Well No. 33	Well No. 34
Pleistocene		Glacial Till	+785	+805	+901	+760	+714	+682	+703
Mississippian	Coldwater Formation	Shale – Some Dolomite	+85	+90	+71	+64	+99	---	+103
Mississippian-Devonian	Antrium Formation	Shale	-675	---	-660	---	-715	---	-675
Devonian	Traverse Group	Dolomite, Limestone and Anhydrite	-925	-900	-870	-1005	-951	---	-960
Devonian	Dundee Formation	Limestone	-1500	-1505	-1500	-1485	-1501	---	-1565
Devonian	Detroit River Group	Dolomite, Anhdrite and Salt	-1520	-1618	-1565	-1654	-1551	---	-1565
Devonian	Filer Sandstone	Sandstone	-2088	-2104	-2101	-2075	-2078	-2129	-2142
Silurian	Bass Island Formation	Dolomite, Shale and Anhydrite	-2188	-2209	-2206	-2205	-2211	-2225	-2211

Soils

Deposits observed at the Project site include four main till units with interbedded and overlaying outwash deposits.

The oldest till (Till A) is a gray to grayish brown clayey till with occasional cobbles and boulders. This till lies below the level of Lake Michigan at approximately elevation 580 in the penstock area, with a maximum known thickness of 170 feet. This till is overlain by discontinuous layers of clean, fine- to medium-grain outwash sands with lenses of silty sands.

Overlying Till A and the discontinuous layers of outwash sands is a gray to grayish brown clayey to silty clay till (Till B). The upper surface of this till layer is generally located at approximately elevation 650 to 700; however, it has been observed as high as elevation 750. The thickness of this till varies up to 50 feet. This till contains very little coarse-grained material and is less pervious than the overlying material which is an outwash deposit of fine to medium sand. Most of the springs and seeps along the Lake Michigan shoreline occur at the top of this till stratum where it exists as an outcrop.

Overlying Till B and the outwash sands is Till C, which is a red to grayish-brown silty clay till. The upper surface of this till is generally located between elevation 670 and 750. It is highly irregular in pattern and not continuous. This till varies in thickness to 75 feet but is commonly found in multiple lenses 5 to 10 feet thick. Till C is overlain by a rather thick irregular outwash deposit of sand and gravelly sand.

Till D overlying Till C and the thick outwash deposit, is a red clayey till which grades to a sandy gravelly till at its contact with the underlying outwash sand. Overlying this till and exposed at the site surface is a one- to two-foot thick deposit of outwash and gravels.

4.3.1.2 Environmental Analysis

4.3.1.3 Proposed Environmental Measures

The Licensees are proposing to continue to operate and maintain the Project under the existing regime. Thus continued Project operation is not anticipated to have any direct or indirect adverse effects on geologic resources and soils. For this reason, no measures directly aimed at enhancing area geologic resources and soils are proposed.

4.3.1.4 Cumulative Effects

In SD1, no potential cumulative effects to geology and soil resources were identified as a potential concern at the Project. The Licensee’s proposal to continue to operate and maintain the Project under fundamentally the same existing operating regime is not expected to result in cumulative impacts to geological and soil resources.

The Licensee’s proposal to continue to operate and maintain the Ludington Project under the existing operating regime is not expected to result in cumulative impacts to geologic resources and soil.

4.3.1.5 Unavoidable Adverse Impacts

Unavoidable adverse impacts are those effects that may still occur after implementation of PME measures. Operation of the Project has no significant adverse effect on geological resources and soil. No unavoidable adverse impacts to geological resources and soil are expected to occur as a result of the continued operation of the Ludington Project.

4.3.1.6 References

Consumers Power Company and The Detroit Edison Company. Application for Original License. 1968.

Harding-Lawson Associates. 1980. Geophysical Investigation Ludington Pumped Storage Reservoir Ludington, Michigan.

General Analytics, Inc. 1968. Evaluation of Subsidence Caused By Brine Extraction Consumers Power Company Ludington Pumped Storage Project. April 1968.

Federal Energy Regulatory Commission, Chicago Regional Office. 2009 Dam Safety Inspection Report. Page 14.

Robb Gillespie, William B. Harrison III, and G. Michael Grammer; Geology of Michigan and the Great Lakes Michigan Geological Repository for Research and Education Western Michigan University, 2008.

4.3.2 Water Resources

4.3.2.1 Affected Environment

Overview

As identified in SD1 in Aquatic Resources, FERC listed concerns about the effects of project operation on water quality, specifically, dissolved oxygen (DO), water temperature, and turbidity. These parameters were studied with data presented in the PAD, and are discussed in this section. The Great Lakes Environmental Center (GLEC) Report on the Ludington Pumped Storage Hydroelectric Project 2013 Water Quality Data Collection is included in Appendix 4.

Additionally, SD1 lists effects of accidental spills of oil, grease, and lubricants on water quality. Since these substances are routinely used for various applications throughout the Project, the Licensees have procedures on the use of these materials to prevent such spills, and maintain spill kits at the Project.

The Project utilizes water pumped from Lake Michigan via penstocks into an upper reservoir from which it is released through the same penstocks back down to Lake Michigan to generate power during peak electricity demand periods. The Project is not located on a stream or river.

The upper reservoir is a man-made body of water with a surface area of 842 acres and a mean depth of 98 feet (the depth ranges from approximately 97 feet in the south end to approximately 112 feet in the north end when at full pool elevation of 942 feet NGVD 29). The embankment forming the perimeter of the upper reservoir does not allow for inflow or outflow from the reservoir other than through Project facilities.

The lower reservoir is Lake Michigan, which has a direct watershed area of approximately 45,600 square miles (http://www.epa.gov/glnpo/factsheet.html).

Because the Project is not located on a river, or stream, and does not create an impoundment with a watershed other than the surface of the upper reservoir itself, there are no gauging stations associated with the Project, and therefore flow duration curves are not applicable.

Water Quantity, Storage, and Use

The Project operates as a hydroelectric pumped storage project which generally pumps water from Lake Michigan to the Project's upper reservoir during off peak hours for use to generate electricity generally during peak electrical demand periods. There is no minimum flow requirement.

Project use of water is for generation only. The Licensees' water use is not for consumption, irrigation, municipal water supply, industrial purposes or to supply domestic water. The Licensees do not propose to change the Project's water use for generation during a new license.

The Project currently holds a National Pollution Discharge Elimination (NPDES) permit that covers eight monitored outfalls. These reflect non-contact cooling water discharges for each unit (outfalls 1-6), the oil/water separator discharge (outfall 7), and the dewatering sump pump discharge (outfall 8). Outfall 1-6 and 8 (the dewatering sump pump discharge is used to drain draft tubes for periodic outage work) are free of pollutant loads with monitoring consisting of daily visual observations and reporting of daily flow. Similar monitoring is required for outfall 7 with the addition of a monthly grab sample collected for oil and grease analysis.

Outfall 9 consists of uncontaminated groundwater drainage from the Upper Reservoir slopes and non-regulated storm water from the penstock upper encasement area. A piping system also connected to outfall 9 is associated with draining storm water from the Upper Penstock Encasement Joint (UPEJ). However the drains from the UPEJ have been closed due to the discovery of Polychlorinated biphenyls (PCB's) in the grout of that area in 1999. The UPEJ was remediated and storm water continues to be collected, tested for PCB's and properly disposed of offsite, in accordance with Part I Sections (A)(5 and 7) of the NPDES permit. The Project remains in compliance with the conditions of the NPDES permit.

Reservoir Bathymetry

The upper reservoir is a man-made body of water, approximately 5.7 miles in circumference. The water level elevation with a full upper reservoir is 942 feet NGVD. At this elevation the reservoir contains approximately 82,300 acre-feet of water, with a surface area of 842 acres. The reservoir has a mean depth of 98 feet (the depth ranges from approximately 97 feet in the south end to approximately 112 feet in the north end at full pool).

The upper reservoir was built by constructing an earthen dike primarily from local materials. There are three main sections of the dike: the downstream slope (exterior), the upstream slope (interior) and a central "chimney drain" section. The downstream slope of the dike is composed of random fill. The "chimney drain" is composed of course sand. The upstream slope is largely composed of fine sand and is topped with calcareous silt sand. The interior surface (i.e. water side) of the dike is lined with two layers of asphalt paving sandwiching a rock drainage course. The reservoir bottom is lined with clay, center thickness ranges from 3 to 5 feet with a thickness of 8 to 10 feet adjacent to the dike where it overlaps the bottom of the asphalt lining. Adjacent to the intake structure, the reservoir bottom is lined with riprap to protect the clay liner from scour due to the strong currents during pumping.

The lower reservoir is Lake Michigan, which has a surface area of 22,400 square miles. The Project boundary includes approximately 3,050 feet of Lake Michigan shoreline (Figure E-3.1.2-1). The long-term (1918-2012) average Lake Michigan water surface elevation as measured at Harbor Beach, MI is 578.8 feet (IGLD 85). During the period from 1973 (commencement of Project operations) until 1999, Lake Michigan elevations were consistently above the long-term average (Gronewold et al, 2013). Water levels were consistently below average beginning in 1999 and extending through January, 2013, when a record low level of 576.1 feet (IGLD 85) was established. However, from January, 2013 through mid-2015, Lake Michigan water levels rose by more than four feet, taking them well-above elevation 580 feet (IGLD 85) and the long-term average noted above. (USACE, 2016.) Wet weather during 2016 kept the water elevation above 580 feet (IGLD 85) in the summer of 2016, and summer elevations in 2017 are expected to be slightly above 2016 elevations. (Holland Sentinel, 2017.)

Water Quality

The Clean Water Act (CWA) was implemented after the current license for the Project was issued. Therefore, no CWA Section 401 Water Quality Certificate (WQC) has been issued for the Project.

That said, current Federal and State standards are in place that could apply to the Project discharge into Lake Michigan. CWA Section 401 provides the federal water quality standards applicable to the Project. Further, Water Quality Guidance for the Great Lakes System (Guidance) is provided in 40 CFR Part 130 as required by Section 118(c)(2) of the Clean Water Act, 33 USC § 1268(c)(2). The Guidance identifies minimum water quality standards, anti-degradation policies, and implementation procedures for the Great Lakes System to protect human health, aquatic life, and wildlife.

The Michigan Department of Environmental Quality (Michigan DEQ) implements the requirements of the CWA on behalf of the federal government. A 401 WQC issued by the Michigan DEQ would provide the conditions applicable to the Project for compliance with the Michigan Water Quality Standards.

Additionally, Lake Michigan water quality standards for applicable parameters as provided in Michigan Act 451 Part 4 are:

- Dissolved Oxygen (DO):
  - Rule 64 - DO in Great Lakes equal or greater than 7 mg/L
- Water Temperature:
  - The Great Lakes and connecting waters shall not receive a heat load which would warm the receiving water at the edge of the mixing zone more than 3 Fahrenheit degrees above the existing natural water temperature.
  - The Great Lakes and connecting waters shall not receive a heat load which would warm the receiving water at the edge of the mixing zone to temperatures in degrees Fahrenheit higher than the monthly maximum temperatures in Table E-4.3.2-1.

Table E-4.3.2-1: Monthly Maximum Allowable Lake Michigan Water Temperatures Applicable North of a Line due West from the City of Pentwater, MI

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
40 °F (4.4 °C)	40 °F (4.4 °C)	40 °F (4.4 °C)	50 °F (10 °C)	55 °F (12.8 °C)	70 °F (21.1 °C)	75 °F (23.9 °C)	75 °F (23.9 °C)	75 °F (23.9 °C)	65 °F (18.3 °C)	60 °F (15.6 °C)	45 °F (7.2 °C)

Note: Temperature requirements use Fahrenheit but Celsius equivalents are provided.

Existing Water Quality Data

Physical and chemical water quality studies were conducted at the Project during 1972 (prior to filling the upper reservoir) through 1974 (after filling the upper reservoir and the start of Project operation). Detailed information collected between 1972 and 1974 was presented in the PAD.

In order to supplement existing information with recent data, a water quality study was conducted during the summer and early fall of 2013, and results included in the PAD. To the extent practical, the study duplicated the efforts of Liston et al, 1976. The location of water quality sampling points from the historic and 2013 studies in Lake Michigan are listed in Table E-4.3.2-2 and depicted in Figures E-4.3.2-1 (Lake Michigan) and E-4.3.2-2 (Upper Reservoir).

Table E-4.3.2-2: Lake Michigan Sampling Locations (Liston et al, 1976)

Station	Location	Depth
1 (Control Area)	3 miles S of breakwater	12 m (39.4 feet)
2	1 mile SSE of south jetty	6 m (19.7 feet)
3	0.5 miles S of breakwater	14 m (45.9 feet)
4	1.5 miles W of breakwater	24 m (78.7 feet)
5	0.5 miles NNW of breakwater	12 m (39.4 feet)
6	1 mile N of north jetty	6 m (19.7 feet)

Figure E-4.3.2-1: Depiction of Lake Michigan Sampling Locations Utilized During Monitoring from 1972-1974 and 2013. (GLEC, 2014)

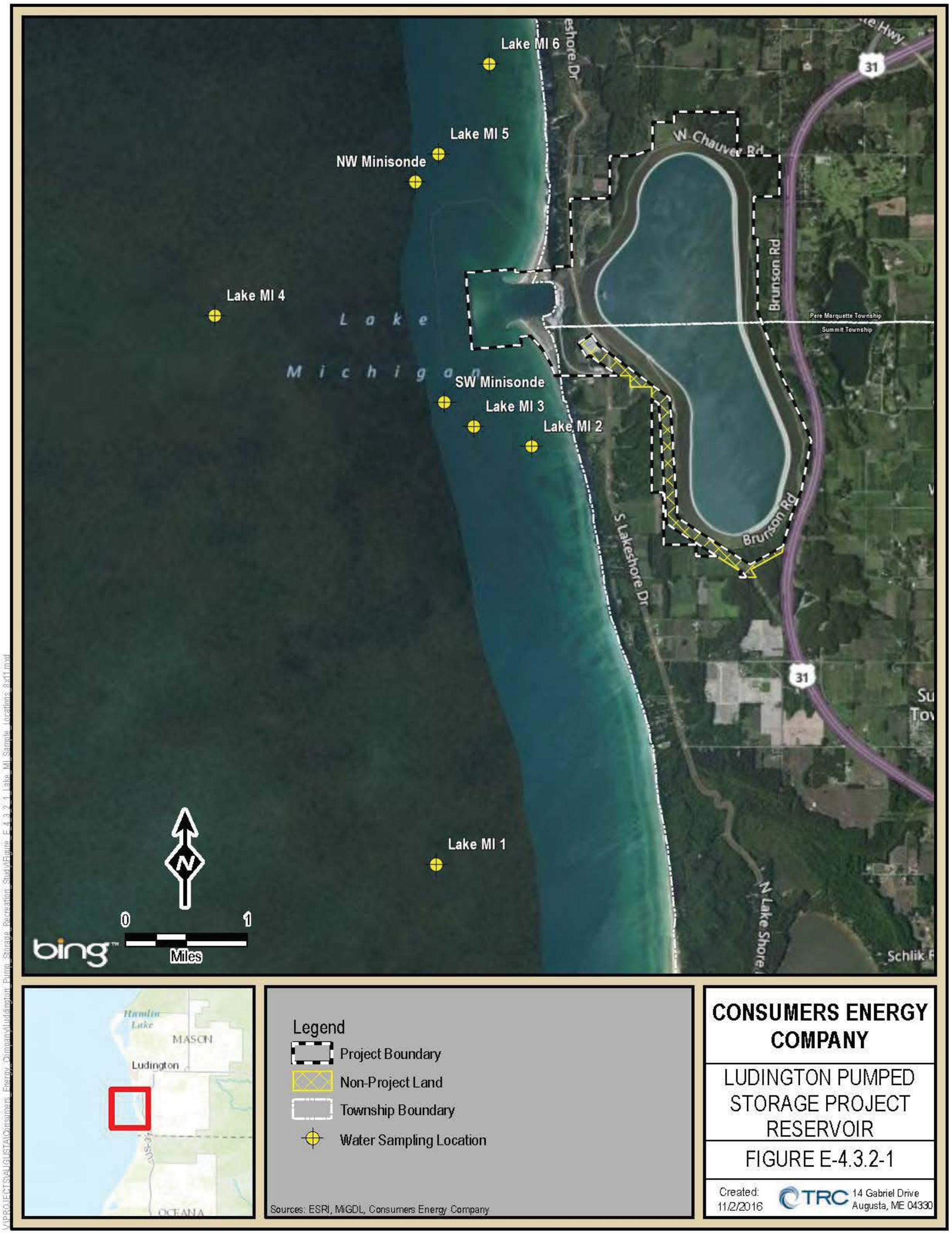
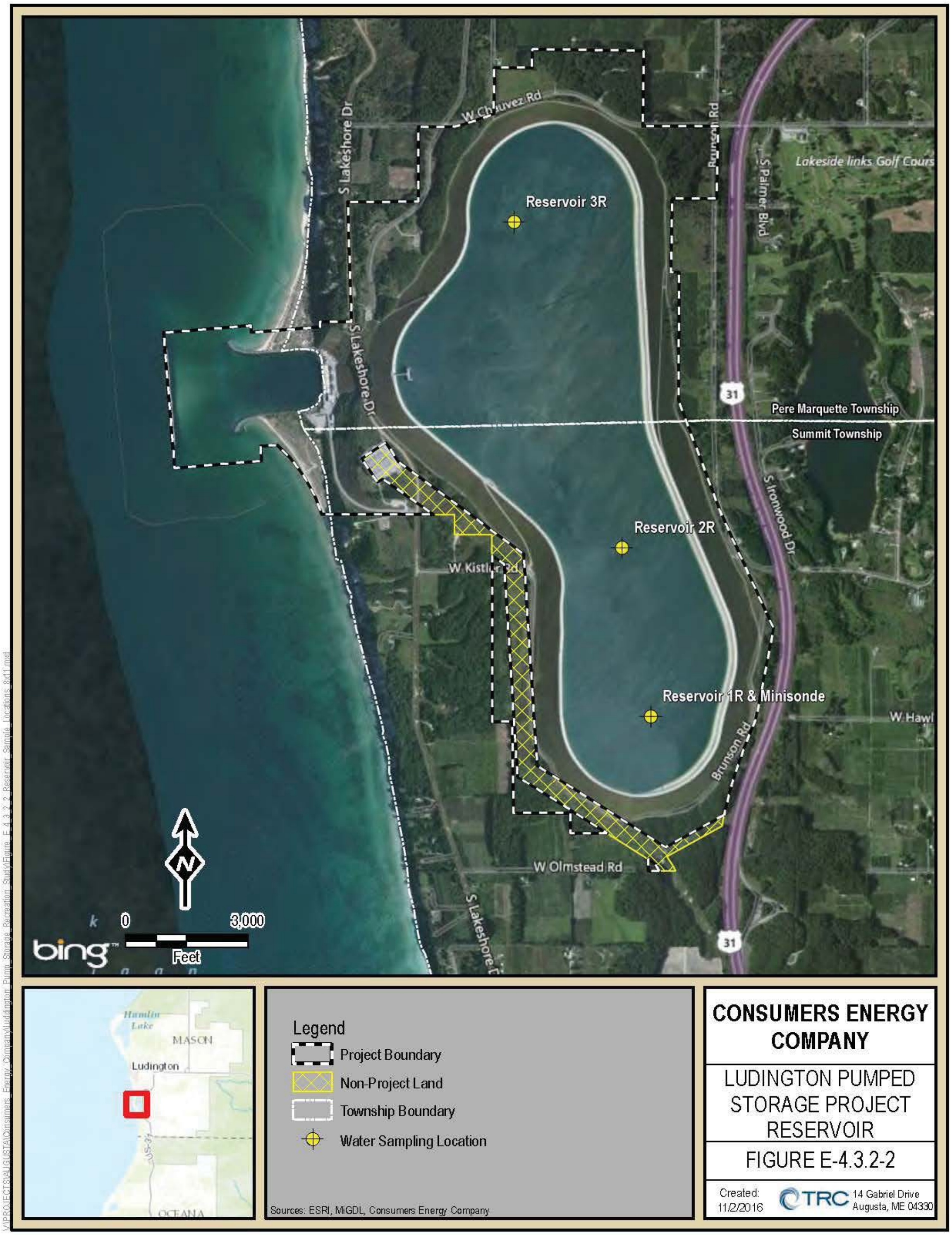


Figure E-4.3.2-2: Upper Reservoir Sampling Locations Utilized During 1972-1974 and 2013. (GLEC, 2014)



Water Quality Data 2013

As provided below, 2013 study results were comparable to the historic data (GLEC, 2014). Specifically, water quality parameters measured met water quality standards and plant impacts on water quality were not documented by either the historic or 2013 studies.

Profile Data

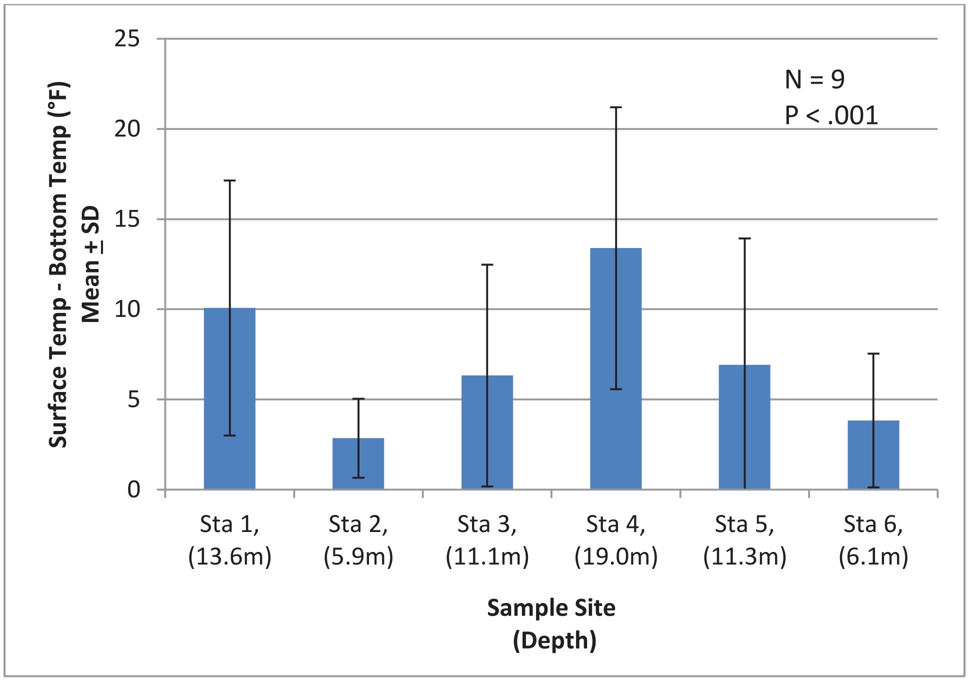
Water temperature and DO profiles were collected twice per month from June 20th to October 11th. Six Lake Michigan locations and three upper reservoir locations are consistent with those monitored by Liston et al (Figures 4.3.2-1 and 4.3.2-2) with the exception that some 2013 study depths measured differently. Station 1 measured deeper (approx. 13.6 m) while stations 3 and 5 measured shallower (approx. 11 m) and station 4 measured shallower (approx. 19 m). Profile data were collected at 3.3 feet (1 m) increments from the surface to the bottom at each site.

The data were evaluated to determine if temperature stratification occurred. Stratification was defined as a 1.8 °F (1°C) or greater temperature change within a 3.3 feet (1 m) interval (Wetzel, 1983). Data shows that the upper reservoir rarely thermally stratifies. Site 1R in the upper reservoir showed stratification once over the study period (on July 15, 2013) while sites 2R and 3R did not stratify. More instances of thermal stratification were observed in the Lake Michigan sites:

- Lake Michigan sites 1 and 4 showed stratification in seven out of nine visits
- Lake Michigan site 5 showed stratification in five out of nine visits
- Lake Michigan sites 2 and 3 showed stratification in four out of nine visits
- Lake Michigan site 6 showed stratification in three out of nine visits

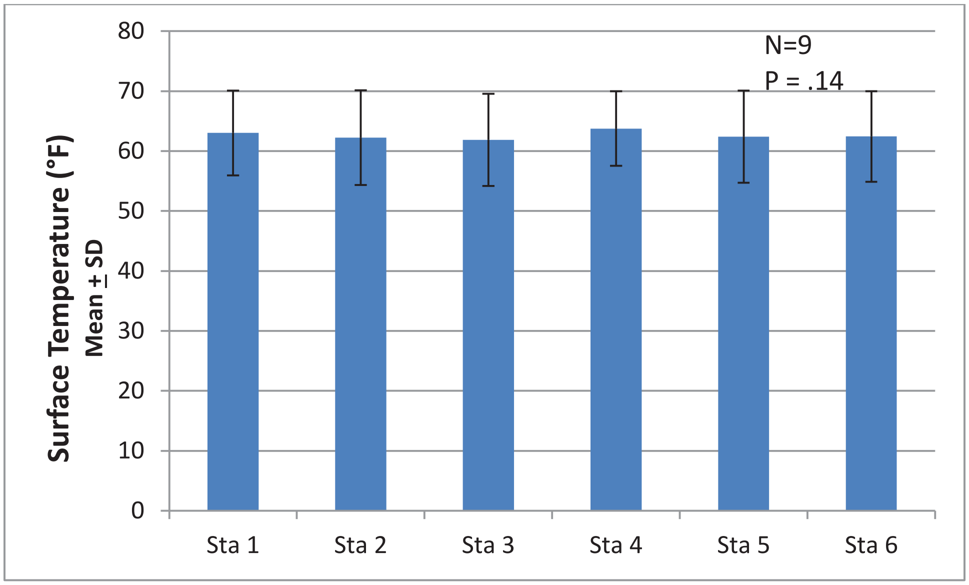
In addition, an analysis of variance (ANOVA) of the differences between top and bottom temperatures revealed that the means were significantly different among the sites (Figure 4.3.2-3), consistent with the stratification frequencies.

Figure E-4.3.2-3: 2013 Water Quality Study – Mean Difference Between Surface and Bottom Temperatures at Each Lake Michigan Sampling Station



Sites 2 and 6 are the two most shallow of the Lake Michigan sites so wave action is likely responsible for more mixing of the water and consequently a more homogeneous water temperature was observed at these locations. Lake Michigan sites 1 and 4 showed stratification most often over the course of the study period probably because these are the two deepest sites that were monitored and are less impacted by wave action when compared to the nearshore sample locations. Additionally, these two sites are the furthest away from the plant outlet and consequently less likely to be influenced by water released from the upper reservoir (Figure 4.3.2-1). Sites 5 and 3 are approximately the same depth and are the two sample sites located closest to the discharge from the powerhouse when generating (Figure 4.3.2-1). While stratification at these sites is more likely to be influenced by water released from the upper reservoir than it is at sites 1, 2, 4 and 6, the pattern of differences among sites appears to be more associated with water depth. An ANOVA of the surface temperatures showed no significant differences among the sites (Figure 4.3.2-4). Mean surface to bottom DO differences exhibited the same pattern as temperature (i.e., associated with depth) but were not significantly different (P=.10). Mean differences did not exceed 1mg/L with a maximum observed difference of 3.03mg/l at the Control Site 1 on July 15th. Mean surface DO measurements were also not significantly different (P=0.71).

Figure E-4.3.2-4: 2013 Water Quality Study – Mean Surface Temperatures at Each Lake Michigan Sampling Station



Average DO and average water temperature were calculated for each site by date on days during which a profile was taken by averaging all the profile data points to obtain a single temperature and DO value for that date (see Table E-4.3.2-3). For all nine study sites, average water temperature increased from June 20 to August 29 and then began to decline from August 29 to October 11. Average DO showed a general decline over the study period for all sites June values generally being in the 11-12 ppm range and October values being in the 8-9 ppm range.

Over the study period, DO ranged from 8.2 to 11.7 ppm in the upper reservoir and from 8.2 to 12.8 ppm in Lake Michigan. Mean DO values over the study period were slightly lower in the upper reservoir (9.5 ppm) than in Lake Michigan (9.8 ppm). Water temperature ranged from 51.8 to 70.9 °F (11.01 to 21.62 °C) in the upper reservoir and from 41.4 to 73.0 °F (5.20 to 22.80 °C) in Lake Michigan.

Table E-4.3.2-3: Summary of Average Dissolved Oxygen (ppm), Water Temperature (°F), and Turbidity (NTU) for each site using data obtained during profile measurements

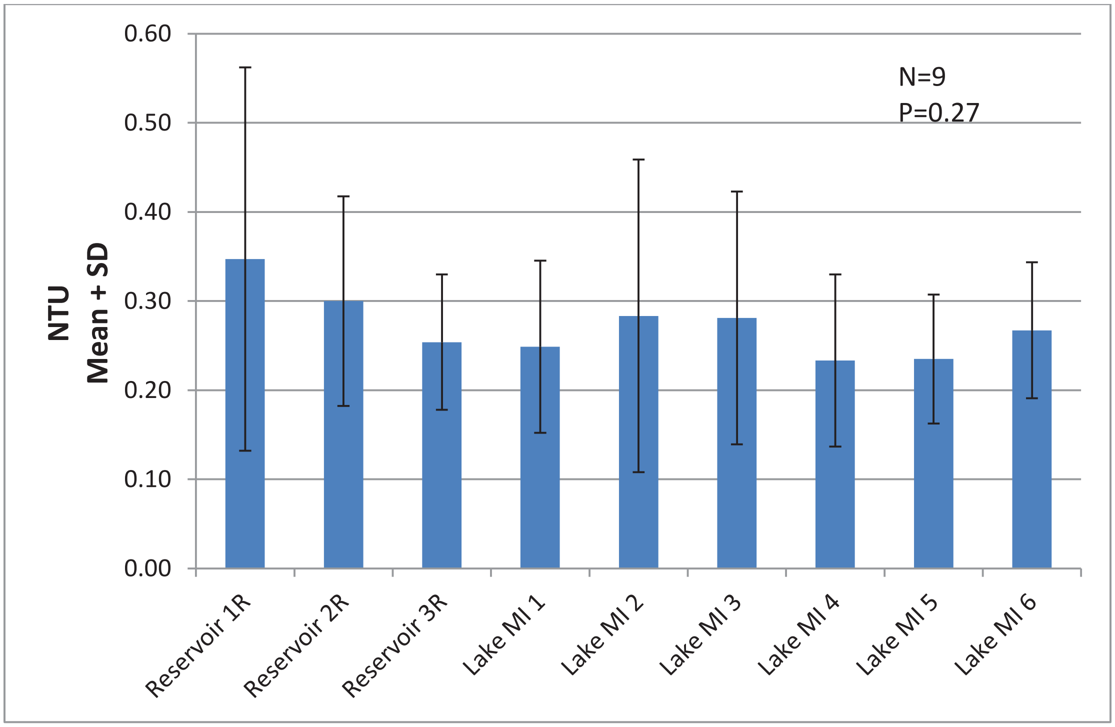
	Station 1R				Station 2R				Station 3R		
	Avg DO	Avg Temp	Avg Turbidity		Avg DO	Avg Temp	Avg Turbidity		Avg DO	Avg Temp	Avg Turbidity
6/21/2013	11.3	52.5	0.3	**6/21/2013**	11.3	52.6	0.2	**6/21/2013**	11.3	52.8	0.2
7/1/2013	10.0	57.5	0.5	**7/1/2013**	10.0	57.4	0.4	**7/1/2013**	10.0	56.6	0.2
7/15/2013	10.2	63.9	0.1	**7/15/2013**	10.3	63.9	0.4	**7/15/2013**	10.3	63.3	0.3
7/30/2013	8.7	59.3	0.3	**7/30/2013**	8.6	59.6	0.4	**7/30/2013**	8.9	59.2	0.4
8/13/2013	9.0	63.8	0.3	**8/13/2013**	9.0	63.5	0.3	**8/13/2013**	9.0	62.9	0.2
8/29/2013	8.5	70.0	0.6	**8/29/2013**	8.7	70.0	0.3	**8/29/2013**	8.6	70.0	0.2
9/11/2013	9.2	61.6	0.3	**9/11/2013**	9.1	62.2	0.2	**9/11/2013**	9.0	62.3	0.3
9/25/2013	9.2	58.6	0.2	**9/25/2013**	9.2	58.6	0.2	**9/25/2013**	9.1	58.6	0.2
10/11/2013	8.7	61.6	0.6	**10/11/2013**	8.6	61.6	0.2	**10/11/2013**	8.6	61.6	0.2
	Lake Michigan Station 1				**Lake Michigan Station 2**				**Lake Michigan Station 3**		
	Avg DO	**Avg Temp**	**Avg Turbidity**		**Avg DO**	**Avg Temp**	**Avg Turbidity**		**Avg DO**	**Avg Temp**	**Avg Turbidity**
6/20/2013	12.0	49.7	0.2	**6/20/2013**	12.0	53.7	0.2	**6/20/2013**	11.9	52.2	0.4
7/1/2013	11.4	45.5	0.2	**7/1/2013**	11.2	44.5	0.2	**7/1/2013**	11.6	45.3	0.2
7/15/2013	11.0	60.8	0.3	**7/15/2013**	9.9	68.0	0.2	**7/15/2013**	10.7	62.4	0.4
7/30/2013	9.4	57.5	0.3	**7/30/2013**	9.3	58.5	0.7	**7/30/2013**	9.4	57.4	0.4
8/12/2013	9.0	62.1	0.2	**8/12/2013**	8.5	66.3	0.2	**8/12/2013**	8.8	62.9	0.3
8/29/2013	9.1	68.3	0.3	**8/29/2013**	8.8	70.9	0.2	**8/29/2013**	8.8	70.1	0.3
9/11/2013	9.0	64.5	0.2	**9/11/2013**	8.8	64.7	0.3	**9/11/2013**	8.9	64.8	0.2
9/25/2013	9.3	58.8	0.3	**9/25/2013**	9.6	57.5	0.3	**9/25/2013**	9.5	58.1	0.2
10/11/2013	9.0	61.9	0.2	**10/11/2013**	9.0	61.4	0.3	**10/11/2013**	9.0	61.5	0.3
	Lake Michigan Station 4				**Lake Michigan Station 5**				**Lake Michigan Station 6**		
	Avg DO	**Avg Temp**	**Avg Turbidity**		**Avg DO**	**Avg Temp**	**Avg Turbidity**		**Avg DO**	**Avg Temp**	**Avg Turbidity**
6/20/2013	12.2	48.2	0.1	**6/20/2013**	11.9	50.5	0.2	**6/20/2013**	11.4	52.9	0.2
7/1/2013	11.3	48.7	0.3	**7/1/2013**	11.3	47.8	0.3	**7/1/2013**	11.9	45.4	0.2
7/15/2013	11.2	57.1	0.4	**7/15/2013**	10.9	60.1	0.3	**7/15/2013**	10.2	66.4	0.4
7/30/2013	10.0	51.6	0.3	**7/30/2013**	10.3	51.1	0.3	**7/30/2013**	9.8	55.2	0.3
8/12/2013	8.9	61.4	0.2	**8/12/2013**	8.6	65.8	0.2	**8/12/2013**	8.4	67.0	0.2
8/29/2013	9.5	66.0	0.4	**8/29/2013**	8.7	70.0	0.3	**8/29/2013**	8.8	70.6	0.4
9/11/2013	9.0	64.4	0.2	**9/11/2013**	8.9	64.6	0.2	**9/11/2013**	8.9	64.6	0.3
9/25/2013	9.4	58.6	0.1	**9/25/2013**	9.2	59.7	0.2	**9/25/2013**	9.7	59.5	0.2
10/11/2013	9.0	62.0	0.2	**10/11/2013**	8.9	61.4	0.3	**10/11/2013**	9.0	61.5	0.3

Turbidity

In addition to water temperature and DO profiles, turbidity measurements were also made at each of the six Lake Michigan locations and three upper reservoir locations. At each site, samples were collected at two depths; one meter from the water surface and one meter from the bottom. Turbidity values for all six sites in Lake Michigan and all three sites in the upper reservoir were less than 1.0 NTU over the course of the study period which are below the limits typically set for recreational uses. An acceptable range for turbidity for recreational use is typically less than 5 NTU (GLEC 2014).

Average turbidity was calculated for each site by date by averaging both turbidity results from that site (a measurement taken 1 meter below surface and a measurement taken 1 meter above the bottom) to determine a single number for turbidity for that date (Table E-4.3.2-3). Mean turbidity was less than 0.4 NTU at all sites (Figure E-4.3.2-5) and values were not significantly different (two-way ANOVA P=0.27). Reservoir sites 1 and 2 had slightly higher mean values, perhaps due to proximity to the intake/discharge structure. Lake control site 4 had the lowest value (GLEC 2014).

Figure E-4.3.2-5: 2013 Water Quality Study – Mean Turbidity at Each Sampling Station



Continuous Recording of Water Temperature and Dissolved Oxygen

While it was not a component of the 1970's study efforts, three continuous monitors were also utilized. One each was deployed near the northwest and southwest corners of the seasonal fish barrier net in Lake Michigan (Figure 4.3.2-1) and the upper reservoir in section 1R (Figure 4.3.2-2. These monitors collected water temperature and DO data on an hourly basis.

Plotting the daily average surface water measurements from the lake MiniSondes with the reservoir MiniSonde (Figure 4.3.2-6) showed agreement where reservoir temperatures temporally followed those in the lake except when not pumping or generating. Reservoir temperatures were also less varying than those in the lake indicating lake/weather conditions were driving the lake changes and not water released from the reservoir. As an inverse function of temperature, the average daily DO values exhibited a similar pattern of agreement with temporal offset between lake and reservoir changes and smaller excursions in the reservoir (Figure 4.3.2-7).

Figure E-4.3.2-6: 2013 Water Quality Study – Continuous MiniSonde Water Temperature Data

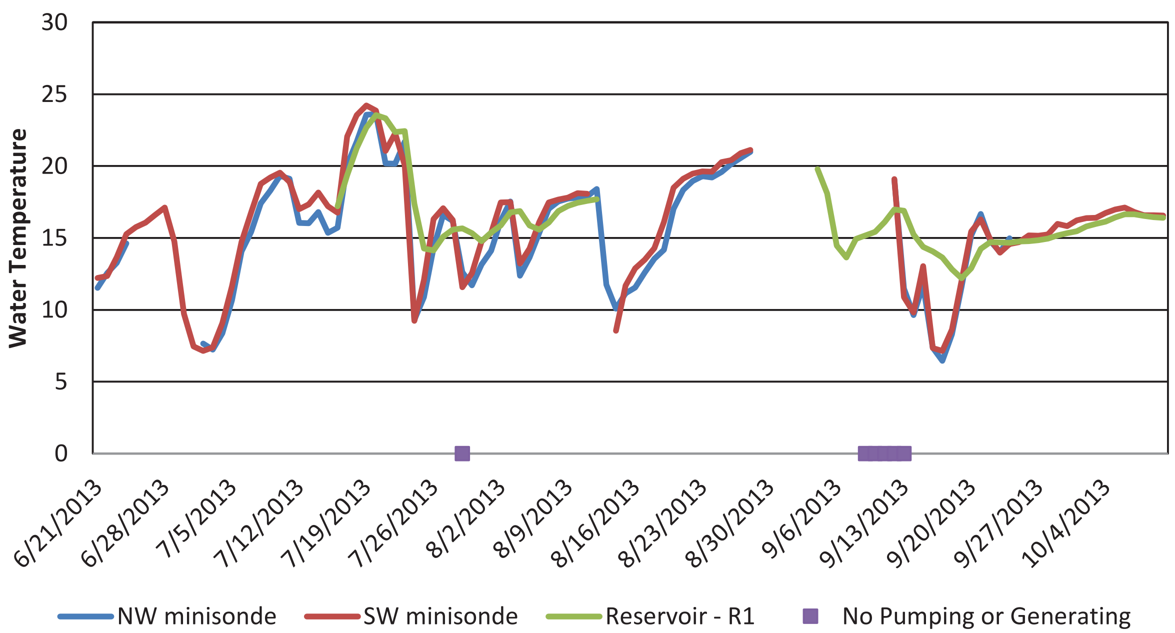
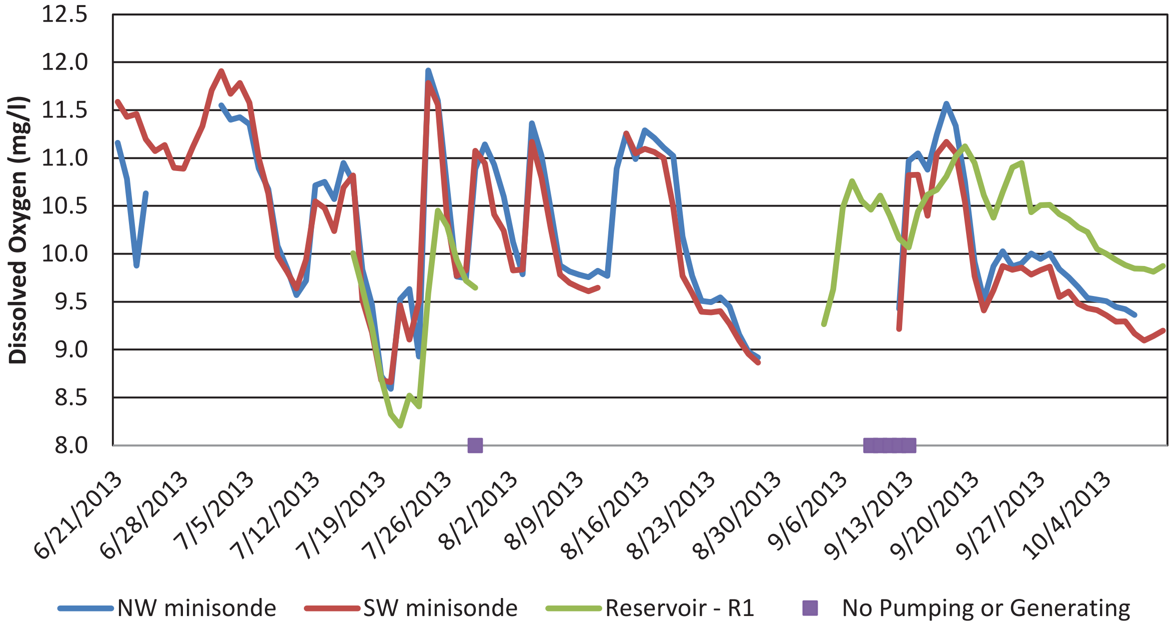


Figure E-4.3.2-7: 2013 Water Quality Study – Continuous MiniSonde Dissolved Oxygen Data



Similar to the original pre/post operational studies, the 2013 water quality data indicate that, in general, water quality conditions in the reservoir mimic those in the lake but without thermal stratification. Turbidity measurements showed no apparent pattern but mean values were largest for the reservoir sites nearest the intakes, possibly due to greater mixing. However, these means were not statistically significant from other sites and not consistently highest. Changes in temperature/dissolved oxygen in the inshore areas appear to be primarily driven by natural lake/ weather conditions.

Accidental Spills

Spills of oil, grease, and lubricants can affect water quality. These substances are routinely used for various applications throughout the Project. In order to protect Lake Michigan from the affects of accidental spills, the Licensees have corporate procedures regarding the prevention of such spills. Table E-4.3.2-4 provides a summary of the spills that have been recorded between 1992 and 2016. Of the spills listed, two (2/2008 and 10/2012) turbine oil spills reached Lake Michigan. Both of these spills were addressed quickly to avoid any spread further into the lake. Should an accidental spill occur however, the Licensees also have procedures in place for containment, clean-up and reporting consistent with existing regulations, and also maintain spill kits at the Project to assist with spill clean-up. The Project Spill Prevention, Control and Countermeasures Plan (SPCC Plan) was last reviewed and approved in February 2014. A summary of the SPCC is provided below.

Table E-4.3.2-4: Summary of Accidental Spills

Date	Material	Quantity	Description
1/1992	Betz CT-1 solution	150 gallons	not recorded
11/1993	oil	50 gallons	not recorded
5/1994	gasoline	none	leak in boat, recovered
6/1994	unknown oil	sheen	not recorded
6/1994	turbine oil	trace	not recorded
8/1995	turbine oil	<1 gallon	not recorded
10/1998	ATF	21 gallons	filter leak
11/1999	mineral oil	40 gallons	tank overflow
4/2000	unknown	unknown	"no Release" SUS PCB (EPA)
8/2000	lubricating oil	sheen	oil skimmer problem
1/2002	turbine oil	1 quart	not recorded
6/2002	hydraulic oil	2 gallons	barge leak
1/2003	mineral oil	10 gallons	overfill of equipment
12/2005	lubricating oil	1 quart	loss of oil to retention pond
7/2006	lubricating oil	5 gallons	failed pressure gauge
2/2008	turbine oil	1 gallon	turbine oil flushed through oil water separator to Lake Michigan
10/2008	mineral oil	5 gallons	release during service
11/2008	antifreeze	5 gallons	leaking equipment gasket
11/2008	turbine oil	4 gallons	valve left in wrong position during oil transfer
12/2008	turbine oil	1 pint	O-ring damage created drip
2/2009	turbine oil and gate grease	2 gallons	sump pit overflow to secondary sump pit
11/2009	turbine oil	40 gallons	loss of oil to oil water separator, no oil observed in Lake Michigan
12/2009	50% antifreeze mix	30 gallons	coolant leak onto cement and asphalt, drip pans
6/2010	hydraulic oil	2 gallons	contractor truck hose rupture
7/2010	diesel fuel	3 gallons	small piece of equipment tipped over
9/2010	diesel fuel	2 gallons	leak of contractor's equipment
9/2010	diesel fuel	2 gallons	spill during refueling
11/2010	hydraulic oil	1 gallon	contractors front end loader hose rupture
3/2011	hydraulic oil	10 gallons	snow removal equipment hose rupture
8/2011	hydraulic oil	2 pints	contractor equipment line leak
8/2011	hydraulic oil	1 quart	wood chipper hose rupture

Date	Material	Quantity	Description
8/2011	transformer oil/water mix	1 gallon	stain area discovered near pipe drain to oil water separator during underground work
10/2011	turbine oil	30 gallons	sump overflow during maintenance work
10/2012	turbine oil	1 gallon	spill to lake from overfilling turbine
5/2013	mineral oil	4 gallons	spilled during transformer refill
6/2013	compressor oil	1 pint	spilled to floor
9/2013	diesel fuel	2 gallons	diesel generator overflow
9/2013	hydraulic oil	1.5 gallons	spill to concrete when pump seal failed
10/2013	antifreeze	2 gallons	radiator vent overflowed to pavement
12/2014	turbine oil	0.5 quart	spilled to floor
6/2015	diesel fuel	1.5 gallons	spill during refueling
8/2015	hydraulic oil	<1 gal	line leak from mobile crane
10/2016	hydraulic oil	35 gallons	hydraulic oil to ground due to line rupture on dump truck

The Spill Prevention, Control, and Countermeasure (SPCC) plan has been prepared and implemented as required by the U.S. Environmental Protection Agency (U.S. EPA) Regulation contained in Title 40, Code of Federal Regulations, Part 112, (40 CFR 112).

The Ludington Project SPCC plan contains a list of the types of materials covered by the plan, the type of material, amount, building, location within the building, storage vessel type and material of construction, use for material and means of containment. The SPCC Plan also contains a list of contact information should a spill be discovered.

The likelihood of an oil spill reaching surface waters outside has been reduced with emergency spill equipment including kits, drums, drain blockers and large expanses of concrete. Additionally, the drains from various floors within the powerhouse lead to the station sump and to the oil-water separator prior to discharge to Lake Michigan. (This discharge is permitted under the Plant's National Pollution Discharge Elimination System permit and is sampled monthly for the presence of oil and grease.) Plant control operators check inventory of the materials daily as part of their rounds.

Surveillance is conducted routinely by Plant personnel. Areas such as the transformers on the powerhouse roof, emergency diesel generator, oil storage tanks, temporary storage areas, and drainage ditches and the tailrace are included as part of the surveillance. The staff is responsible for spotting any spillage or a measurable loss of oil inside the Plant from equipment such as the unit guide/thrust bearings, turbine oil storage tanks, hydraulic couplings, pumps and motors**.** Once per workday, an outfall observation is made in accordance with the Plant's NPDES

Wastewater Discharge Permit requirements. Additionally, other Plant employees may discover releases during routine work activities in and around the Plant and would notify appropriate personnel.

To reduce the potential for a spill to occur during loading and unloading operations, drivers are required to be out of the trucks, monitoring the petroleum product transfer operations. Tanker truck or mobile tanks are secured prior to transfer operations with physical barriers such as wheel chocks to safeguard against accidental movement. Parking brakes are set on tankers. The tanker truck or mobile oil tank is not moved until the transfer has been completed, transfer lines stowed, and the all of the valves checked to ensure they are secured. The transfer operation is closely monitored to prevent any product spill. Precautions taken to prevent spills during transfer operations include:

1. The delivery is completed with properly trained personnel present.
2. Nearby storm drains are covered with drain blockers.
3. A temporary containment area of sufficient capacity is set up and the tanker is parked inside this containment during the loading/unloading process.
4. The temporary containment is visually inspected for rips, tears, punctures, or other obvious perforations in the floor, sidewalls, and seams prior to driving the tanker truck into the temporary containment.
5. The level in the receiving container (tank or tanker truck) is visually checked before loading commences to determine if a potential overfill condition exists.
6. Both the driver and a properly trained plant employee will oversee the loading/unloading operation while pumping oil into the tank. The person monitoring the level (attendant) in the tank being filled and the driver must be in constant communication, so that a tank-full situation can be communicated and the oil transfer terminated immediately.
7. Bottom valves are tightened on both the tanker truck and tank that was emptied or filled.
8. Residual material is removed from lines into appropriate containers.
9. Transfer lines are checked to be disconnected before vehicle departure.
10. Bottom valves and all outlets on the tanker truck are closed and checked for leaks prior to departure.
11. The drain/fill valve on Aboveground Storage Tanks or Underground Storage Tanks are locked closed if opened.
12. Open ends of any loading/unloading connection piping are securely capped after the transfer operations are completed.

Additionally, discharge controls have been implemented to prevent release to surface water, these controls include:

1. Potential releases from the six turbine governor oil systems and other process equipment will flow onto the powerhouse floor. Floor drains are piped to the station sump that discharges to the oil/water separator for processing.
2. Potential releases from the above ground oil storage tanks or from drummed oil storage will be contained by the concrete floor and dikes. The oil storage room has a concrete floor, plugged floor drains, a curb at the doorway and will hold the volume of the largest tank within the room.
3. In general, potential oil releases from drummed storage and other miscellaneous oil storage in the powerhouse will be contained by the concrete floor and walls, drum containment pallets or by the station sump and oil/water separator.
4. Potential releases in the South Warehouse/Garage or the Parts Building are contained by concrete flooring, drum containment structures or by the underground vehicle wash-water collection tank outside the South Warehouse/Garage.
5. Potential releases from the transformers flow into a concrete containment and directed into a drain pipe which is valved at the oil-water separator with the valve maintained in a cracked open position to drain precipitation but to contain a catastrophic release from any of the transformers.
6. The emergency generator fuel tank is contained by the generator enclosure trailer.
7. Potential discharge during loading/unloading by trucks will be contained by drain blockers and portable containment. Minor drips, if any, during the tanker loading/unloading process to/from the above ground storage tanks or underground storage tanks are collected by a container placed under the connection coupling.
8. In the event of a minor release during the transfer, the attendant either initiates cleanup or contacts plant personnel for assistance. In the event of a release during fuel transfers those detecting the spill will initiate a cleanup or contact the Control Room to get assistance from other plant personnel as necessary.
9. Clean-up contractors listed in the SPCC Plan are used to handle large spills.

Personnel noticing any release of product are to notify the Control Room Operator immediately. The Control Room Operator then notifies the Plant Manager or on-call supervisor. If any petroleum product is released, personnel may initiate containment measures. If material is not petroleum or is unknown, personnel identifying the emergency shall remove themselves from the area.

Actions required to combat the emergency are taken only by personnel designated and trained for the particular function. Personnel may not enter the spill area or come in contact with spill material unless they are specifically trained for this function and equipped with all the appropriate personal protective equipment.

The Plant Manager or on-call supervisor upon receiving notification of a release will arrange for trained persons to take initial emergency responses to protect nearby persons, property and the environment. This may include assisting with evacuation, containing or otherwise preventing spread of the release, or other actions to prevent exposure. Measures that may be taken to accomplish this are:

- Shutting down process equipment; ceasing transfer operations.
- Moving containers or otherwise directing releases into bermed or diked areas.
- Moving containers away from fire areas.
- Isolating containers, tanks, chemicals or oil supplies.
- Barricades should be placed around the contaminated area to prevent pedestrians and vehicles from entering the area of the emergency until it is cleaned up and spill debris or other hazards removed.

The Control Room Operator also notifies the Emergency Coordinator who assumes the functions of an On Scene Incident Commander. The Emergency Coordinator possesses the ability, and has been granted the authority to assume control and make decisions when an emergency arises. If a release requires a response beyond the level of training detailed in the SPCC Plan then specially trained outside Emergency Response Contractors are contacted. Emergency Response Contractors that can supply qualified Hazardous Materials Technicians are listed in the SPCC Plan.

Spill kits used to clean-up minor spills are placed at several locations in the Plant. Tanker trucks are also required to maintain spill kits on the trailers.

The Emergency Coordinator will determine if cleanup can be completed by Plant personnel or whether to contact an Emergency Response Contractor. Cleanup operations involving 55 gallons or more of a release posing a risk to human health will normally be completed by Emergency Response Contractors.

All recovered materials must be classified prior to on-site accumulation, treatment, recycling or disposal and off-site shipment for storage, treatment, recycling or disposal. Waste evaluation is completed by laboratory analysis or knowledge of the waste. Each hazardous waste must be evaluated in order to determine which EPA Land Disposal parameters, if any, apply to the hazardous waste. Recovered materials and waste will be transported and disposed of by a Company approved contractor at an approved disposal facility based on the waste classification.

4.3.2.2 Proposed Environmental Measures

Studies conducted by the Licensees for the PAD demonstrate that the Project and its operation do not adversely affect water resources or water quality. Therefore, the Licensees are proposing no PME measures specifically for the further enhancement of Project water quality.

4.3.2.3 Cumulative Effects

No potential cumulative effects to water resources have been identified as a potential concern at the Ludington Project. The Licensees' proposal to continue to operate and maintain the Project under the existing operating regime is not expected to result in either geographic or temporal cumulative impacts to water resources or water quality.

4.3.2.4 Unavoidable Adverse Effects

The Licensees are proposing no change in the operation of the Project. The Licensees' site-specific studies have demonstrated that operation of the Project does not adversely affect water resources and water quality. Therefore, the proposed relicensing and continued operation and maintenance of the Project will have no significant unavoidable adverse impacts to existing Project water resources or water quality.

4.3.2.5 References

Andrew D. Gronewold, Anne H. Clites, Joseph P. Smith, Timothy S. Hunter. A dynamic graphical interface for visualizing projected, measured, and reconstructed surface water elevations on the earth's largest lakes. Environmental Modeling & Software. Volume 49. November 2013. Pages 34-39. http://dx.doi.org/10.1016/j.envsoft.2013.07.003

Holland Sentinel, June 15, 2017. "Great Lakes water levels expected to be higher than average".

Liston, C. R., Brazo, D.C. and Tack P.I. 1976. A Study of the Effects of Installing and Operating A Large Pumped Storage Project on the Shores of Lake Michigan Near Ludington, Michigan. Michigan State University, Department of Fisheries and Wildlife 1974 Ann. Rep. to Consumers Power Co., Vol. II and Twelfth Quarterly Report Physical-Chemical Aspects, 1972-1974 pp.

Great Lakes Environmental Center (GLEC). 2014. Ludington Pumped Storage Hydroelectric Project 2013 Water Quality Data Collection.

USACE Detroit District Monthly Bulletin, Historic Data-Water Levels/LTA-GLWL-Graph 2016.pdf

Wetzel, R. G. (Wetzel). 1983. Limnology, second edition, Saunders College Publishing pp 74,75.

4.3.3 Fish and Aquatic Resources

4.3.3.1 Affected Environment

Aquatic Resources

Fish Assemblage

Lake Michigan supports a rich assemblage of game and non-game freshwater fish that includes over 78 species and 22 families (FERC 1995). The most common families are the minnows (e.g., shiners, daces, and chubs); coldwater salmonids (e.g., whitefishes, trout, and salmon); coolwater species (e.g., walleye, pike, and perch); and warmwater species (e.g., sunfishes, suckers, and catfish). The Lake Michigan fishery and forage base have been and continue to be dramatically influenced by non-native invasive species that have entered the Great Lakes via the St. Lawrence Seaway. Native lake trout, lake whitefish, and ciscoes (i.e., lake herring)[6] formerly supported large commercial fisheries on Lake Michigan but stocks of these species were depleted by the parasitic sea lamprey in the 1950s. The most prolific forage species in Lake Michigan is the alewife, a non-native species, which, like the sea lamprey gained access to the upper Great Lakes through the Welland Canal.[7] Growing alewife populations eventually replaced the cisco as the principal forage species in Lake Michigan (FERC 1995). Intense management of salmonid stocks, in particular, introductions of Pacific salmon (including Chinook and coho salmon) in the late 1960s, helped control alewife populations. The introduction of Pacific salmon also created a widely successful and valuable sport fishery. Rainbow smelt, introduced to the Great Lakes in the early 1900s, have also played an important role in the forage base for sport fish and are an economically viable commercial and sport fish. Data on the Lake Michigan fishery, some of which is specific to the Project vicinity is available from a number of sources.

The Ludington Pumped Storage Project Fish and Aquatic Resources Study, Phase 2 Report, Evaluation of Entrainment Abatement Technologies provides information on historical and current fisheries information in addition to what is provided below (Alden 2015b). A fish protection technology feasibility assessment conducted by the Stone and Webster Engineering Company (SWEC) provided a brief review of biological considerations used for the evaluation of each technology. The information included in SWEC (1988) was developed from the fishery resource studies conducted in the vicinity of the Project from 1972 to 1980. As reported in Alden (2015b), these studies provided information on relative abundance and temporal presences of species and life stages that occurred near the project at the time. Alewife, rainbow smelt,

[6] Ciscoes are commonly known as lake herring, although they are in the salmonid family, not the herring family.
[7] The Welland Canal is a ship canal in Ontario, Canada, which connects several of the Great Lakes and is part of the St. Lawrence Seaway.

johnny darter, ninespine stickleback, sculpin species, yellow perch, and spottail shiner were identified as the most abundant species, whereas Chinook and coho salmon and lake, brown, and rainbow (steelhead) trout were identified as important sport fish that occurred in relatively low abundance.

The U.S. Geological Survey Great Lakes Science Center (GLSC) has conducted lake-wide surveys of the fish community in Lake Michigan each fall since 1973 using bottom trawl nets at seven indexed transects. GLSC uses the data collected (i.e., relative abundance, size and age structure, biomass estimates, and condition of individual fishes) to estimate various population parameters that are used by state and tribal agencies to manage Lake Michigan fish stocks (Bunnell et al. 2015). The GLSC provides relative abundance and biomass estimates for forage fish populations (e.g. alewives, rainbow smelt, round goby,[8] bloater, stickleback sculpin), burbot, yellow perch, and introduced dreissenid mussels (i.e., zebra mussels and quagga mussels).

Lake-wide biomass of alewives in 2014 was estimated to be approximately 1,600 metric tonnes,[9] which was a record low, equivalent to 16 percent of the average biomass estimate for alewives since 2005 (Bunnell et al. 2015). The GLSC demonstrated that the age distribution of alewives continues to be truncated; no alewives older than 5 years were collected in 2014 (Bunnell et al. 2015). The GLSC observed record low biomass in 2014 for nearly every other prey fish species, including bloater, rainbow smelt, slimy sculpin, deepwater sculpin, and ninespine stickleback (Bunnell et al. 2015). According to the GLSC, round goby was the only prey species that did not have a record-low biomass estimate in 2014 in Lake Michigan. Round goby are an invasive species first discovered in the Great Lakes system in 1990 and has since become a major component in the Lake Michigan prey forage base. The lake-wide biomass estimate of burbot, a popular freshwater game fish native to Lake Michigan, has remained below 3,000 metric tonnes since 2001. No age-0 yellow perch (i.e., < 100 mm) were captured during the 2014 survey, which is indicative of a poor year-class (Bunnell et al. 2015). Smelt have become increasingly scarce since the early 1990s (Bunnell et al. 2015); a decline coinciding with the steady decline of the formerly successful yellow perch fishery (Makauskas and Clapp 2010).

Overall, the total lake-wide prey fish biomass estimate (i.e., the sum of alewife, bloater, rainbow smelt, deepwater sculpin, slimy sculpin, round goby, and ninespine stickleback) in 2014 was approximately 66 percent lower than the fish biomass estimate completed in 2012 (Bunnell et al. 2015). In 2014, alewives and round gobies made up 71 percent of the total biomass estimate; a similar trend was documented in previous sampling efforts by the GLSC (Bunnell et al. 2015). While a collapse of the fish forage base is thought to have resulted in the demise of the Lake Huron salmon fishery, the Lake Michigan salmon fishery is still vibrant. Salmon stocking

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[8] Round goby are a non-native fish, originally from the Black and Caspian seas.
[9] A metric tonne equals 2,205 pounds.

management has been a key to achieving a balance with the forage resource. Over 50 percent of Lake Michigan Chinook salmon are thought to be from naturally reproducing stocks (Claramunt et al. 2010).

Primary conclusions presented in Bunnell et al (2015) based on the lake-wide fish community surveys illustrate the ongoing changes occurring in the Lake Michigan fishery. They include:

- Total prey fish biomass estimates indicate a record-low number every year since 2010, with the exception of 2013 when locally high catches of alewife and round goby caused a relatively high estimate that was considered to have substantial uncertainty.

- Based on the bottom trawl survey results, Lake Michigan total prey fish biomass has remained at a low level since 2007.

- Low prey fish biomass can be attributable to a suite of factors, two of which can be clearly identified: (1) a prolonged period of poor bloater recruitment since 1992 and (2) intensified predation on alewives by Chinook salmon during the 2000s.

- Over the last 10 years, adult alewife density is at a relatively low level and the age distribution of the adult alewife population has decreased in recent years. As recent as 2007, alewives as old as age 9 were sampled whereas the oldest alewife sampled in 2013-2014 was age 5.

- In addition to the importance of top-down forces, prey fishes also may be negatively influenced by reduced prey resources (i.e., “bottom-up” effects). For example, many data sets are indicating a reduction in the base of the food-web- particularly for offshore total phosphorus and phytoplankton- as a consequence of long-term declines in phosphorus inputs and the proliferation of dreissenid mussels (Evans et al. 2011; Bunnell et al. 2014b). The evidence for declines in “fish food” (e.g., zooplankton, benthic invertebrates) in Lake Michigan is somewhat less clear. Diporeia has undoubtedly declined in abundance (Nalepa et al. 2014), but whether or not crustacean zooplankton and mysids have declined depends on which data set is examined (e.g., Pothoven et al. 2010; Bunnell et al. 2014a; Madenjian et al. 2015). Even if limited food has not directly led to reductions in abundance, it has been hypothesized to underlie lower-than-expected physiological condition of deepwater sculpins (Pothoven et al. 2011) and bloaters (Pothoven et al. 2012).

- A complete collapse of the Lake Michigan alewife population in coming years ultimately depends on the consumptive demand of salmonids. Lake Michigan managers reduced Chinook salmon stocking lakewide by 50% from 2012 baseline values beginning in 2013 to lower salmon consumption on alewives and try to maintain predator: prey balance (Lake Michigan Committee 2014). In addition, alewife sustainability will depend on the ability of alewife spawning stock to produce another strong year-class, which will at least partially depend on appropriate environmental factors being met (Madenjian et al. 2005b).

- GLSC bottom trawl surveys provide an index of age-0 yellow perch numeric density which is likely a good indicator of year-class strength. Large catches in the bottom trawl during the 1980s corresponded to the strong yellow perch fishery. The 2005 year-class of yellow perch was the largest ever recorded and the 2009 and 2010 year classes also were higher than average. No age-0 yellow perch were sampled in 2014, indicative of a weak year class.

Hydroacoustic survey results of Lake Michigan pelagic prey species conducted by the GLSC also indicated reduced prey fish biomass. These surveys were conducted from 1992-1996 and from 2001-2015. In 2015, the Lake Michigan acoustic survey indicated "continued variability in alewife recruitment, persistently low biomass of rainbow smelt and bloater, and continued low abundance of native species. Peak alewife biomass occurred in 1995 and 1996 (≈40 kg/ha), and the two highest values during 2001-2015 (2009-2010) were only half as high as in 1995-1996. Total prey fish biomass in Lake Michigan (6.5 kg/ha) in 2014 was the second lowest observed in the acoustic survey." (Warner et al 2015).

Gill net sampling results in the vicinity of the LPSP exhibit similar trends to those provided by GLSC sampling, considering gear size selectivity. Table E-4.3.3-1 provides gill net catch data for the Ludington vicinity for the years 1972-1977. Table E 4.3.3-2 provides gill net catch data collected as part of the barrier net effectiveness monitoring program beginning in 1993 (post developmental stage). Examination of the two datasets represented by these tables demonstrates the similarities and changes in the fish community over time. During the 70's, yellow perch were the dominant species with alewife abundance exhibiting an increasing trend (Table E-4.3.3-1). Barrier net monitoing data in the 90s (Table E 4.3.3-2), show alewife as the clear dominant species in gill net collections by far, likely due to differences in sampling gear; though similar in length and experimental graduated mesh, gill nets used during the 70s fished only the bottom 6-feet at predominanty deeper stations while barrier net monitoring gillnets cover the entire water column. In agreement with GLSC data, alewife collections show a consistent decline since 2000. Similarly, yellow perch remained a prominent component of the fishery until approximately1997 when collections exhibited a sharp decline. Though not near their previous level of abundance, increases in yellow perch have corresponded with GLSC year-class observations, as have those for rainbow smelt.

Site specific data collected over the period between the two datasets in Table E-4.3.3-1 and Table E-4.3.3-2 provided an estimate of entrainment mortalities (Liston et al. 1981) which formed the basis for the 1995 State and FERC Settlement Agreements.

Table E-4.3.3-1: Total Number and Relative Abundance of Fish Collected with Bottom Gill Nets in Lake Michigan from 1972-1977 (Brazo and Liston 1979)

	1972 (n=150)		1973 (n=126)		1974 (n=120)		1975 (n=157)		1976 (n=119)		1977 (n=138)	
Species	Total Number	Relative Abundance	Total Number	Relative Abundance	Total Number	Relative Abundance	Total Number	Relative Abundance	Total Number	Relative Abundance	Total Number	Relative Abundance
Yellow Perch	6,857	50.7%	6,214	58.3%	5,748	56.8%	4,761	44.0%	4,376	39.9%	3,228	31.2%
Alewife	2,071	15.3%	1,126	10.6%	990	9.8%	1,397	12.9%	3,556	32.4%	3,207	31.0%
Spottai Shiner	1,323	9.8%	849	8.0%	1,110	11.0%	972	9.0%	314	2.9%	728	7.0%
Longnose Sucker	889	6.6%	345	3.2%	396	3.9%	445	4.1%	351	3.2%	591	5.7%
White Sucker	850	6.3%	628	5.9%	701	6.9%	812	7.5%	372	3.4%	547	5.3%
Rainbow Smelt	435	3.2%	927	8.7%	311	3.1%	926	8.6%	912	8.3%	392	3.8%
Lake Trout	430	3.2%	267	2.5%	314	3.1%	584	5.4%	325	3.0%	587	5.7%
Round Whitefish	374	2.8%	193	1.8%	346	3.4%	583	5.4%	534	4.9%	791	7.7%
Lake Whitefish	83	0.6%	9	0.1%	18	0.2%	29	0.3%	25	0.2%	64	0.6%
Bloater	71	0.5%	4	0.0%	8	0.1%	24	0.2%	9	0.1%	11	0.1%
Burbot	28	0.2%	11	0.1%	8	0.1%	14	0.1%	17	0.2%	15	0.1%
Trout-perch	26	0.2%	20	0.2%	8	0.1%	39	0.4%	38	0.3%	48	0.5%
Lake Chub	26	0.2%	3	0.0%	3	0.0%	11	0.1%	5	0.0%	2	0.0%
Chinook Salmon	25	0.2%	21	0.2%	21	0.2%	55	0.5%	39	0.4%	32	0.3%
Brown Trout	22	0.2%	12	0.1%	75	0.7%	74	0.7%	48	0.4%	66	0.6%
Steelhead Trout	12	0.1%	1	0.0%	11	0.1%	1	0.0%	1	0.0%	6	0.1%
Shorthead Redhorse	4	0.0%	5	0.0%	18	0.2%	9	0.1%	9	0.1%	9	0.1%
Coho Salmon	3	0.0%	16	0.2%	8	0.1%	34	0.3%	26	0.2%	5	0.0%
Lake Sturgeon	1	0.0%										
Carp	1	0.0%	4	0.0%	5	0.0%	17	0.2%	1	0.0%	2	0.0%
Northern Pike	1	0.0%			2	0.0%						
Walleye	1	0.0%			1	0.0%	3	0.0%	1	0.0%	1	0.0%
Longnose Dace			2	0.0%	2	0.0%	15	0.1%				
Lake Herring			1	0.0%								
Sea Lamprey			1	0.0%								
Gizzard Shad					8	0.1%	4	0.0%	5	0.0%	4	0.0%
Ninespine Stickleback					5	0.0%						
Slimy Sculpin					3	0.0%			1	0.0%	1	0.0%
Northern Hogsucker					1	0.0%						
Smallmouth Bass							3	0.0%			1	0.0%
Brook Trout									1	0.0%	1	0.0%
Total	**13,533**		**10,659**		**10,121**		**10,812**		**10,966**		**10,339**	

Table E-4.3.3-2: Number of target and non-target species collected in annual gill net samples outside and inside the barrier net. Other Non-target Species only include species for which more than 100 fish were collected (all size groups combined) over the 24-year sampling period.

	Target Species										Non-target Species of Concern			Other Non-target Species													
Year	**BNT**	**CHIN**	**COHO**	**LT**	**RBT**	**YP**	**AW**	**RSM**	**CHUB**		**LKH**	**LW**	**LS**	**BURB**	**CP**	**FD**	**GSD**	**LNS**	**REDH**	**RGY**	**RWF**	**SMB**	**STSH**	**TPER**	**WEYE**	**WS**	**Total**
1993	316	298	186	292	40	8,006	23,368	520	78		--	22	3	109	33	224	473	165	204	--	750	8	3,136	5	150	1,039	39,425
1994	445	417	146	206	75	3,822	37,661	1,159	14		--	2	2	89	40	322	791	63	279	--	537	8	1,572	--	190	993	48,833
1995	192	386	67	202	36	2,809	34,878	388	--		--	--	3	28	49	597	1,588	42	262	--	504	36	2,340	3	179	767	45,356
1996	516	421	69	342	178	3,472	34,342	215	1		2	--	3	19	39	310	714	27	201	--	665	8	6,270	2	98	669	48,583
1997	398	675	120	106	85	929	17,805	209	8		--	--	1	19	40	350	261	26	117	--	1,188	3	2,715	12	137	520	25,724
1998	194	261	62	143	17	193	28,206	162	20		1	--	4	15	60	406	787	11	184	--	833	15	2,314	2	238	455	34,583
1999	151	286	64	338	24	956	10,469	141	3		1	--	5	13	21	408	249	5	110	--	659	17	7,712	3	171	190	21,996
2000	132	401	111	176	6	68	34,178	21	3		--	--	1	4	29	377	145	8	191	--	477	4	724	10	140	232	37,438
2001	118	271	26	154	11	43	16,076	49	10		--	--	4	5	6	313	55	8	145	--	351	7	288	6	168	268	18,382
2002	80	205	246	76	8	18	7,848	13	8		--	2	4	2	7	291	182	6	165	--	382	3	689	25	197	261	10,718
2003	95	198	9	199	16	70	4,736	12	--		23	1	--	1	8	199	25	5	100	13	192	--	464	13	92	111	6,582
2004	84	424	22	288	15	37	16,188	10	--		29	9	3	--	18	304	213	5	61	65	241	5	943	60	124	121	19,269
2005	64	316	21	228	4	40	9,310	20	16	unaa	--	--	1	--	2	161	180	3	75	44	116	4	250	--	156	98	11,109
2006	56	265	20	118	8	911	9,025	3	--		--	66	4	3	17	234	226	--	92	127	19	5	677	--	126	34	12,036
2007	77	165	16	202	8	175	3,512	1	13		--	9	2	1	16	202	224	--	90	135	96	--	81	--	126	17	5,168
2008	65	201	12	416	13	212	7,030	13	360		--	28	2	--	9	278	40	4	59	246	82	2	67	--	149	34	9,322
2009	152	214	15	435	15	130	7,188	14	89		--	40	7	2	20	123	34	3	59	186	128	2	171	--	99	47	9,173
2010	124	62	21	279	4	50	2,218	2	14		1	7	6	1	3	177	89	1	69	415	122	8	280	--	86	42	4,081
2011	92	218	34	567	12	725	6,953	1	--		16	14	7	--	7	172	15	3	28	864	329	3	446	--	95	126	10,727
2012	113	79	43	143	12	532	7,781	2	4		10	4	6	--	3	82	86	--	33	535	203	14	308	--	44	73	10,110
2013	125	169	12	148	20	1,250	4,081	3	3		68	7	1	2	3	184	14	--	46	682	182	10	508	--	76	20	7,614
2014	192	129	16	88	34	187	1,550	--	--		41	--	1	1	9	101	2	1	26	167	80	1	70	--	37	48	2,781
2015	255	154	26	219	30	25	2,419	7	--		120	21	5	1	20	120	6		44	37	128	4	145	--	63	74	3,893
2016	159	35	17	112	20	96	3,619	8	--		254	123	10	2	20	158	392	12	46	297	63	4	133	--	86	67	5,733
Total	**4,195**	**6,250**	**1,381**	**5,477**	**691**	**24,756**	**330,441**	**2,973**	**644**		**566**	**355**	**85**	**317**	**479**	**6,093**	**6,791**	**398**	**2,686**	**3,813**	**8,327**	**171**	**32,303**	**141**	**3,027**	**6,306**	**448,636**

Species abreviations: BNT, Brown trout; CHIN, Chinook salmon; COHO, coho salmon; LT, lake trout; RBT, rainbow trout; YP, yellow perch; AW, alewife; AW, alewife; RSM, rainbow smelt; CHUB, chub (bloater); LKH, lake herring; LW, lake whitefish; LS, lake sturgeon; BURB, burbot; CP, common carp; FD, freshwater drum; GSD, gizzard shad; LNS longnose sucker; REDH, redhorse spp.; RGY, round goby; RWF, round whitefish; SMB, smallmouth bass; STSH, spottail shiner; TPER, trout perch; WEYE, walleye; WS, white sucker.

The lake-wide biomass estimate of dreissenid mussels in 2014 was similar to previous sample years (Bunnell et al. 2015). Dreissenid mussels appear to be the causative agents in the reduction of plankton biomass at certain times of the year and subsequent food web disruption. The filtering of algae and phytoplankton from the lake has created a nutrient sink and broken the food chain, which has dramatically reduced populations of important aquatic invertebrate forage such as the small shrimp-like crustaceans Diporeia and Mysis.

Fisheries Management

There are five primary fisheries management objectives for Lake Michigan, which are identified in the Lake Michigan Integrated Fisheries Management Plan for 2015-2024 (Lake Michigan Fisheries Team 2016). These objectives include:

- a balanced, healthy ecosystem;
- a multi-species sport fishery;
- a sustainable and viable commercial fishery;
- employing the principles of science-based management; and
- effective internal and external communication.

The principal sport fish caught by anglers along the eastern shore of Lake Michigan are Chinook salmon, coho salmon, lake trout, steelhead (landlocked populations of sea-run rainbow trout), brown trout, and to a lesser extent yellow perch and walleye.

Aquatic Habitat

The inshore waters of Lake Michigan at the Ludington Project contain a variety of aquatic habitats that are influenced daily by the strong multi-directional currents resulting from normal operations. The shoreline is characterized by high clay bluffs and sandy beaches. The lake bottom slopes gradually and consists mainly of fine gravel and sand, with clay and large rocks occurring at depths exceeding 40 feet. Jetties and breakwaters near the intake area provide rocky habitat for fish and other aquatic organisms. Sand deposits occur outside the jetties, where current velocities are low. Between the jetties, bottom substrates consist mostly of clay, with depths between the jetties averaging around 24 feet according to a bathymetric survey conducted for the Licensees in April 2010.

4.3.3.2 Environmental Analysis

Fish Protection

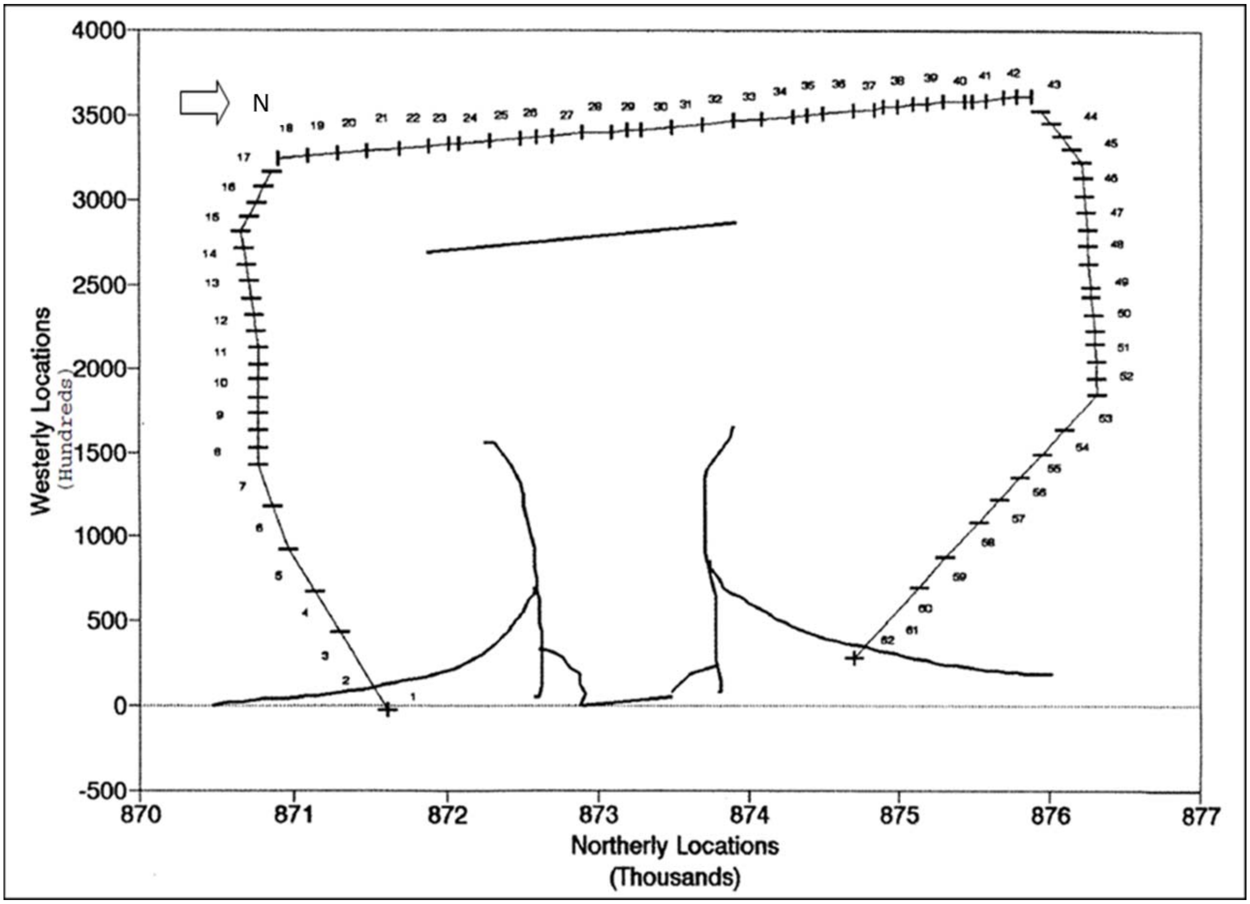
On February 28, 1995, to resolve outstanding issues concerning fish mortality resulting from operation of the Project and site access, Consumers Energy and DTEE filed an Offer of Settlement with FERC (FERC Settlement Agreement). The FERC Settlement Agreement was approved by Commission Order dated January 23, 1996 (74 FERC ¶ 61055). Another settlement (State Settlement Agreement) was concurrently reached by the courts and non-FERC agencies. The combined settlements (collectively, "Settlement") provided for the establishment of the Great Lakes Fisheries Trust (GLFT) and a Scientific Advisory Team (SAT). The purpose of the Trust was to mitigate Lake Michigan fishery resources forgone as a result of Project operation. Funding for the Trust is provided annually by the Project through compensation payments for unavoidable fish loss. The Trust is administered by a Board of Trustees as defined in the Settlement. The SAT evaluates barrier net monitoring data and information upon which the Settlement is based, the scientific activities established by the Settlement and proposals submitted to the GLFT.

The Commission determined in SD1 that the proposed action (i.e., continued operations) may affect fish populations due to entrainment during pumping operations. Species affected may include lake herring and lake sturgeon which are classified as threatened species by the state of Michigan. To reduce the potential for entrainment of these and other fish species, the Licensees have installed and maintained a 2.4-mile long seasonal barrier net in the tailwater area since 1989 in order to exclude fish from areas where they may be subjected to entrainment. The 28 years of data obtained from barrier net operation and evaluation also provide valuable biological data on the status of the fishery over that period.

The following summary of the LPSP seasonal barrier net design, deployment, maintenance and effectiveness monitoring is largely based on a detailed description from the Phase 3 Report – Evaluation of Engineering Alternatives for Entrainment Reduction (Alden 2016). Additional information on the barrier net is provided in Exhibit A of this license application and also in the 2016 annual report on barrier net operation (CEC 2016) filed with the Commission on December 20, 2016.

The seasonal barrier net is 12,850 ft in length and consists of a total of 62 individual net panels. The net is formed by five general sections: a west section, north and south sections, and an angled return from both the north and south sections to their respective shoreline anchor points (Figure E-4.3.3-1). The 62-panel barrier net is comprised of 51 panels that are 200 ft long, two panels that are 175 ft long, two panels that are 100 ft long, and seven panels that are 300 ft long.

Figure E-4.3.3-1: Overview of Primary Net Sections and Panels at LPSP



The first 1,175 ft of net from the shoreline, in both the north and south wings (panels 1-5 and 58-62), is made of ½-inch bar mesh (1-inch stretch mesh), while the remainder of the net (panels 6-57) is constructed with ¾-inch bar mesh (1½-inch stretch mesh). The intent of using the ½-inch bar mesh near shore is to improve the net's effectiveness in excluding smaller fish, which typically inhabit shallow, near-shore waters in spring/early summer.

The main mesh panels are constructed of twisted knotted netting fabricated from Spectra 900 or Dyneema SK65 material. Each net panel is completely encompassed by border lines and the main net is diamond hung which allows the net material to stretch and flex in the horizontal and vertical direction, providing a stronger net due to a more uniform distribution of forces to the riser and border lines. Each panel except Nos. 1 and 62 have a bottom skirt affixed to the main net bottom border line and a top skirt attached to the top border line. These skirts act to maintain the integrity of the area protected by the net during high discharge rates and/or turbulent lake conditions. Net panel Nos. 1 and 62 are located wholly on shore, not in the water, in order to provide protection during periods of higher Lake Michigan water levels or stormy conditions.

The netting material, the manner in which the net is hung, and the addition of skirting are adaptations implemented over the course of the net's deployment history.

The barrier net is anchored in place in Lake Michigan using a series of permanent bottom anchor piles generally spaced approximately 100 ft apart. An anchor chain is attached from each anchor pile to the barrier net panel's lead line at each of the permanent bottom anchors. The barrier net panel's lead line (also attached to the main net bottom border line) distributes the stress from the anchor points to the rest of the barrier net panels.

To characterize flow conditions, Alden (2011) measured current velocities at five locations inside the perimeter of the barrier net and at two locations in the tailrace area (between the end of each jetty and the outer breakwall) using Acoustic Doppler Current Profilers (ADCPs) during normal operations. Alden also collected ADCP data along pre-defined transects within the tailrace during generation. Flow patterns within the vicinity of the barrier net vary significantly depending on whether the plant is pumping or generating, how many units are operating, location with respect to underlying bathymetry, and proximity and position relative to the jetties and breakwater. When the plant is in pumping mode, flow patterns at the net are more uniform and lower in velocity than during generation. During generation, the flow is discharged from the tailrace at a higher velocity and in a concentrated jet (Alden 2011).

In summary, the ADCP data demonstrated that when all six units were generating:

- Maximum current velocity was approximately 9 feet per second (fps) immediately in front of the powerhouse;
- Maximum current velocity was 3.7 fps between the ends of the jetties and the outer breakwater;
- Maximum average current velocity was 3.0 fps between the ends of the jetties and the outer breakwater;
- Maximum current velocity was 2.8 fps around the perimeter of the net;
- Average current velocities ranged from 0.2 fps to 1.5 fps among the stations located around the perimeter of the net (Alden 2011).

During pumping by all six units, data indicated:

- Maximum current velocities ranged from 0.4 to 0.8 fps among the stations located around the barrier net perimeter;
- Average current velocities ranged from 0.2 fps to 0.4 fps among the station located near the perimeter of the net;
- Maximum current velocity fps was 1.7 fps between the ends of the jetties and the outer breakwater;

- Maximum average current velocity was 1.4 fps between the ends of the jetties and the outer breakwater (Alden 2011).

The barrier net is required to be deployed from April 15 through October 15. However, actual installation and removal dates may vary depending on weather and lake conditions. While the target for beginning net installation is generally around April 1st, the net is frequently deployed prior to April 15. Weather and lake conditions are the primary factors that determine the start of net deployment and when deployment is completed. As such, during some years, the April 15 deployment requirement cannot be achieved and is installed as soon as weather and lake conditions permit.

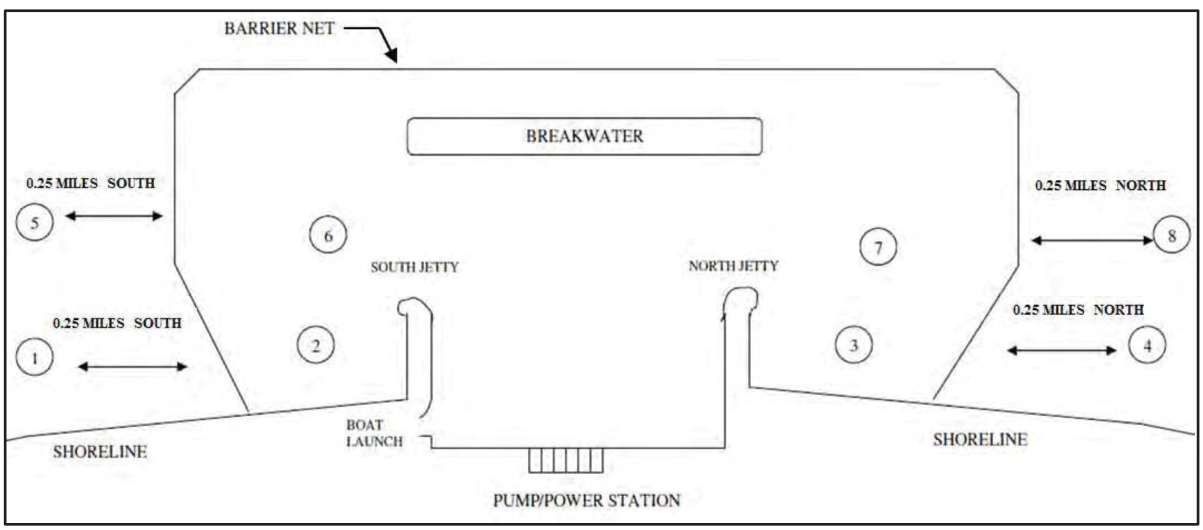
The general process for installing and removing the barrier net has remained the same since 1991. Net panels are assembled off-site and joined in lengths that fit on semi-trailers for transportation to a staging area. Major subsections of the net panels are then sewn and shackled together and loaded onto the two material barges (half of the net panels on each barge) in preparation for installation. The barges are then moved to the installation site with the aid of a tug boat (weather permitting) where the two halves are stitched together (panel 31 to panel 32). The net panels are then lowered into the water off their respective barge using a crane where divers attach the net panel lead line to the anchor piling anchor chains and each barge works toward its respective shoreline anchor. Installation typically involves two crews with cranes working in opposite directions from a common midpoint towards the shoreline anchor points so as to reduce the potential for fish entrapment. Removing the barrier net in the fall of each year involves divers, a material barge, a crane barge, and a tug boat and typically takes approximately three to four days depending on weather. Cleaning the panels is done using a high-pressure pump as the barrier net panels are transferred onshore.

While deployed, cleaning the net is an ongoing operation from May 1 through September 30. Individual net panels are typically cleaned by divers, in-situ, once per month. Cleaning is done in place with modified, pressure-washing units. The level of debris and required maintenance are highly dependent upon a variety of factors as the debris found on the net is biological in nature and growth varies with varying conditions. The most common type of debris is algae (Cladophora species), which both grows and accumulates from drifting on the net; however, Dreissenid mussels (zebra and quagga) also foul the net at times. The amount of algae at any given time is dependent upon factors including water temperature, light level, nutrient levels, lake currents, and storm events. Typically, the divers clean each panel once per month; however, panels which are in the direct discharge path (high flow areas) may be cleaned twice per month.

Annual Monitoring and Biological Effectiveness of Barrier Net – The Licensees monitor the biological effectiveness of the barrier net annually as required by the FERC-approved Settlement. The barrier net monitoring program undertaken by the Licensees consists of setting gill nets twice weekly at eight locations roughly aligned with the north and south jetties; four nets are set inside the barrier net and four nets are set outside the barrier net (Figure E-4.3.3-2). Stations are paired on both sides of the net at the same depths with the assumption that the catches should be the same in the absence of the barrier net. Barrier net effectiveness (expressed as percent) is calculated by comparing the relative fish abundance from gill net sample collections inside and outside the barrier net. Differences in catch abundance and species composition between sample stations inside and outside the net are attributed to the presence of the barrier net. It is assumed that fish that pass through the barrier net are entrained into the upper reservoir during pumping operations of the facility.

Gill nets used at nearshore locations (sample stations 1, 2, 3, and 4) are 6-ft deep and offshore locations (sample stations 5, 6, 7, and 8) are 24-ft deep, which are the approximate water depths at each location. The gill nets have eleven 30-ft long panels with 11 different stretch mesh sizes ranging from 1 to 7 inches. Gill net data from the four sample locations outside the barrier net are considered to be representative of fish species susceptible to gillnets and their relative abundance in the vicinity of the Project, whereas fish collected inside the perimeter of the barrier net are indicative of the net's ability to prevent those fish from entering the inside area, and represent those species and life stages subject to entrainment during pumping operations.

Figure E-4.3.3-2: Gill net sampling stations (numbered circles) used for barrier net effectiveness monitoring.



Since the last major barrier net improvements in 1993, the Licensees have collected approximately 450,000 fish during the barrier net monitoring program (Table E-4.3.3-2). The total number of fish collected during annual gill netting has declined considerably over time. The total catch in each of the last three years (2014-2016) ranged from 88 to 94 percent less than the peak in 1994 (Table E-4.3.3-2). Most species collected have experienced declines in catch numbers since the initial years of monitoring. Of the 45 species collected since 1993, alewife has been the most abundant, accounting for 47.5 to 91.3 percent of the annual catch. Other common species (i.e., more than 5 percent of the annual catch during one or more years) include yellow perch, lake trout, spottail shiner, and, in more recent years, round goby (Alden 2016). The percent catch composition has increased for some salmonids (brown trout, lake trout, and Chinook salmon) in recent years, but total catch numbers for these species has generally decreased from earlier years. Most notably, the abundance of alewife and yellow perch has decreased substantially from initial levels recorded when the barrier net was first evaluated in the early 90's (Table E-4.3.3-2). The declining trend in abundance is consistent with historical lake-wide trends reported by other researchers as described above (Bunnell et al. 2015; Makauskas and Clapp 2010).

In contrast to the declines observed for most species, catches of round goby (an invasive species) have increased over the last 10 years of barrier net sampling (Bunnell et al. 2015). Catch numbers of lake herring, which is a state-listed threatened species in Michigan, have also increased in the past three years; this species typically comprised less than 0.2 percent of the total number of fish collected each year during barrier net monitoring, but represented approximately 3.1 and 4.4 percent of the total catch in 2015 and 2016 respectively. Collection of lake sturgeon, another state-listed threatened species in Michigan, has remained low since 1993, ranging from 0 to 10 individuals annually; researchers have collected 85 lake sturgeon since 1993 (Table E-4.3.3-2).

Several target species were identified in the FERC-approved Settlement as species of primary interest with respect to barrier net effectiveness and for which barrier net effectiveness standards are applied annually; all other species collected during the annual evaluation of net performance are classified as non-target species. More recently, walleye have been included as a game fish species of special interest for purposes related to the Licensees' Settlement with the state of Michigan (i.e., for calculation of compensation for fish lost to entrainment during pumping operations). The Licensees develop a barrier net effectiveness monitoring report annually. The following biological performance standards were developed for the barrier net with respect to designated target species and size groups (Table E-4.3.3-3):

- 80 percent effectiveness for game fish (salmonids and yellow perch combined over five inches in length).
- 85 percent effectiveness for large forage fish (alewife and smelt combined over five inches in length).

Effectiveness is calculated using the following equation:

$$\textit{Percent Effectiveness} = [(T_O - T_I) / T_O] \times 100$$

Where T_O is the total outside catch and T_I is the total inside catch.

This approach has been used to calculate effectiveness for individual species or groups of species by size or for all size groups combined, as well as for all fish combined. The effectiveness monitoring plan and calculation method are agreed upon by FERC and the Settlement Parties.

Table E-4.3.3-3: Designated target species and size groups that are the focus of annual barrier net effectiveness assessments.

Category	Common Name	Scientific Name	Size Groups (inches)*
Game fish	chinook salmon	*Oncorhynchus tshawytscha*	>4-5, 5-12, 12-20, >20
	coho salmon	*Oncorhynchus kisutch*	>4-5, 5-12, >12
	lake trout	*Salvelinus namaycush*	>4-5, 5-12, >12
	rainbow trout (steelhead)	*Oncorhynchus mykiss*	>4-5, 5-12, >12
	brown trout	*Salmo trutta*	>4-5, 5-12, >12
	yellow perch	*Perca flavescens*	>4-5, >5
Forage fish	rainbow smelt	*Osmerus mordax*	>4-5, >5
	alewife	*Alosa pseudoharengus*	>4-5, >5
Other	bloater (chub)	*Coregonus hoyi*	>4-5, >5

*** Performance standards apply to gamefish and forage fish greater than 5 inches in length.**

Monitoring data collected from 1993 through 2015 demonstrates that the barrier net effectively excludes the majority of fish susceptible to collection. The average annual barrier net effectiveness is 83.3 percent (range: 70.1 to 96.3 percent) for gamefish and 94.2 percent (range: 80.7 to 98.9 percent) for forage fish (Table E-4.3.3-4). The barrier has attained its effectiveness target for game fish in 16 of 24 years and 23 of 24 years for forage fish (Table E-4.3.3-4).

For the period (1993-2016), the mean annual barrier net effectiveness for target species was 83.3% (range: 70.1 to 96.3%) for gamefish and 94.2% (range: 80.7 to 98.9%) for forage fish (Table E-4.3.3-4). The barrier net effectiveness target has been met in 16 of 24 years for game fish and 23 of 24 years for forage fish (Table E-4.3.3-4). Among large gamefish, mean effectiveness is 78.8% for salmonids and 93.4% for yellow perch. Among large forage species, mean effectiveness is 94.3% for alewife and 86.5% for rainbow smelt. Effectiveness estimates were not calculated for all years for rainbow smelt due to low collection numbers (< 20). The mean annual effectiveness was 86.2% for all species combined, 89.3% for all target species combined, and 70.2% for all non-target species combined (Table E-4.3.3-5).

In 2016, the most recent data available, game fish effectiveness was 72.4% and large forage fish effectiveness was 86.3%. The atypical effectiveness estimate for game fish may be attributable to sampling immediately after net installation during entrapment conditions (i.e. fish become trapped within the netted area when the net is deployed) and exacerbated by a record minimum number of game fish collected during 2016 (Table E-4.3.3-2). In addition, examination of the 2016 game fish composition reveals a significant change from when standards were developed. Yellow perch, the formerly dominant species and the species best protected by the barrier net (historical average effectiveness = 92%), comprised only 8% of the 2016 game fish collection (CEC 2016). For reference, Table E-4.3.3-6 provides net effectiveness data and total numbers collected for individual fish species by year for the period 1993-2016.

Table E-4.3.3-4: Annual barrier net effectiveness for game and forage fish > 5 inches long (1993-2015).

Year	All Game Fish > 5 inches	All Forage Fish > 5 inches
1993	76.6	80.7
1994	90.7	90.3
1995	96.3	96.3
1996	91.6	97.2
1997	83.1	97.5
1998	89.3	96.7
1999	94.3	98.9
2000	86.7	96.4
2001	81.1	97.2
2002	85.0	90.8
2003	80.0	98.2
2004	70.1	95.4
2005	90.3	92.6
2006	79.8	89.5
2007	80.4	94.3
2008	82.7	92.2
2009	77.1	97.0
2010	78.9	94.5
2011	82.1	96.2
2012	76.5	95.2
2013	91.4	94.1
2014	78.7	97.3
2015	87.1	96.6
2016	70.4	86.3
Mean	**81.8**	**94.2**
Max	**96.3**	**98.9**
Min	**70.1**	**80.7**

Year	All Game Fish > 5 inches	All Forage Fish > 5 inches
Years Below Target*	**8**	**1**
Years Above Target*	**16**	**23**

* Target is 80 percent for game fish and 85 percent for forage fish.

Table E-4.3.3-5: Annual, mean, and range of barrier net effectiveness (%) for all species combined, all target species combined, all-non target species combined, and target game and forage species greater than 5 inches in length (walleye are included as a target game fish, but are not a target species for barrier net monitoring as identified in the FERC Settlement Agreement).

				Game Fish > 5 inches				Forage Fish > 5 Inches		
Year	All Species	All Target Species	All Non-Target Species	Salmonids	Yellow Perch	Walleye[1]	All Game Fish	Alewife	Rainbow Smelt	All Forage Fish
1993	77.5	80.4	60.1	80.1	76.1	95.8	76.6	80.7	77	80.7
1994	89.4	90.6	77.5	74.3	95.1	93.3	90.7	90.2	91	90.3
1995	93.1	95.4	76.8	86.2	99.3	96.5	96.3	96.3	93.1	96.3
1996	89.1	95.6	47.7	74	98.5	94.6	91.6	97.4	78.3	97.2
1997	90.5	95.8	64.5	72.4	96.4	95.4	83.1	97.6	87.6	97.5
1998	92.7	96.3	67.8	86.1	99	95.6	89.3	96.8	90.5	96.7
1999	82.5	96	58.5	89.3	99.6	97.6	94.3	99.2	78.4	98.9
2000	85.7	86.5	71.9	86.3	90.3	99.3	86.7	96.4	100	96.4
2001	95.6	96.5	84.4	79.3	100	98.8	81.1	97.2	80.5	97.2
2002	87	90.9	69.5	84.5	100	98.5	85	90.8	--	90.8
2003	91	93.9	76.8	78.9	100	96.6	80	98.3	--	98.2
2004	91.6	93.9	69.3	69.6	80	95.8	70.1	95.5	--	95.4
2005	91.4	92.1	85	89.8	100	96.7	90.3	92.6	88.9	92.6
2006	76.9	78.3	67.7	74.2	95.4	92.3	79.8	89.5	--	89.5
2007	91.2	91.9	88.7	80.5	80	88.5	80.4	94.3	--	94.3
2008	88.1	88.5	85.4	81.7	86.1	96.5	82.7	92.2	--	92.2
2009	89.3	91.4	65.6	75.1	89.3	73.1	77.1	97	--	97
2010	82.2	89.2	64.4	77.4	100	89.7	78.9	94.5	--	94.5
2011	79.5	81.7	69.4	77.3	92.6	92	82.1	96.2	--	96.2
2012	76.4	77.8	67	70.7	81.1	58.1	76.5	95.3	--	95.2
2013	78.4	81.2	68.6	76.6	96.2	94.4	91.4	94.3	--	94.1
2014	88.6	92.1	73.3	71.9	92.9	87.9	78.7	97.3	--	97.3
2015	90.2	93.1	77.1	86.6	100	78.8	86.5	96.7	--	96.6
2016	70.4	74.1	47.2	67.8	93.1	80.6	72.5	86.2	--	86.3
Mean	86.2	89.3	70.2	78.8	93.4	91.1	83.4	94.3	86.5	94.2
Range	70.4 - 95.6	74.1 - 96.5	47.2 - 88.7	67.8 - 89.8	76.1 - 100.0	58.1 - 99.3	70.1 - 96.3	80.7 - 99.2	77.0 - 100.0	80.7 - 98.9

1. Walleye estimates include all fish greater than 4 inches in length.

Table E-4.3.3-6: Barrier net effectiveness (%) for target species, species of concern, and non-target species for which more than 1,000 total fish were collected over all sample years (catches inside and outside the barrier net combined). For all species, all size groups are combined and annual effectiveness was not calculated if less than 20 fish were collected in any given year (indicated by dashes). Effectiveness estimates of 0% indicate more fish were caught inside the barrier net than outside.

	Target Species									Species of Concern			Non-Target (>1000 fish collected over all years)							
Year	BNT	CHIN	COHO	LT	RBT	AW	RSM	YP	CHUB	LS	LW	LKH	FD	GSD	REDH	RGY	RWF	STSH	WEYE	WS
1993	71.5	82.2	85.2	85.5	0	82.1	76.5	76.2	0	--	90	--	75.6	91	82.1	--	43.4	26.7	95.8	97.9
1994	69.5	81.2	62.3	83	61.1	90.6	91	94.7	--	--		--	91.9	80.5	91	--	22.8	66.2	93.3	95.6
1995	76.9	81.6	90.2	95.9	87.5	96	93.1	90.5	--	--		--	98.5	95.5	91.7	--	57.2	38.5	96.5	96.5
1996	82.5	73.6	64.7	86.8	0	97.3	78.5	86.9	--	--	--	--	97.4	76.9	91.4	--	4.4	30.6	94.6	95.3
1997	89.4	62.2	44.2	91.8	58.3	97.5	87.6	92.2	--	--	--	--	97.7	93.9	98.3	--	27.8	54.7	95.4	94.1
1998	72.4	84	100	94.1	--	96.6	90.5	99	0	--	--	--	96.7	90.2	89.8	--	6.3	52	95.6	96.6
1999	93.7	86.1	87.7	92	50	97.3	78.4	89.6	--	--	--	--	99.5	100	99.1	--	0	53	97.6	99.5
2000	82.1	89.5	76.7	87.2	--	86.5	100	90.3	--	--	--	--	99.5	84	99.5	--	62.1	10	99.3	97.8
2001	80.8	74	70	85.9	--	97.2	80.5	100	--	--	--	--	96.7	47.2	97.9	--	81.8	33.5	98.8	96.9
2002	68.9	75.8	93.5	84.8	--	91.4	--	100	--	--	--	--	89.4	96	96.9	--	12.7	32.8	98.5	96.8
2003	82.7	71.4	--	86.9	--	95.5	--	90.6	--	--	--	72.2	99.5	95.8	93.6	--	90.9	28.1	96.6	97.2
2004	83.3	53.3	16.7	85.7	--	95	--	80.6	--	--	--	29.4	96.9	96.6	87	72.5	59.1	34.3	95.8	95.7
2005	81.5	89.1	68.8	93	--	92.3	88.9	94.7	--	--	--	--	98.7	87.5	84.6	81.1	85.1	58.8	96.7	94.6
2006	72.7	72.6	0	87.6	--	77.9	--	83.7	--	--	0	--	99.6	88.7	96.6	70.4	--	28.6	92.3	97
2007	88.4	63.6	--	90.2	--	94.2	--	75	--	--	--	--	100	87.4	96.6	86.6	82.9	52.7	88.5	--
2008	72.5	66.9	--	88.2	--	91.2	--	82.2	33.3	--	100	--	97.8	100	94.6	74.5	82.9	0	96.5	93.8
2009	73.3	79.8	--	75	--	94.4	--	83.9	0	--	94.7	--	95.8	90.3	90.7	59.1	35.9	1.2	73.1	85.4
2010	73.5	22.9	0	90.2	--	91.7	--	78	--	--	--	--	98.3	0	74.5	69.9	87	14.6	89.7	60
2011	54	54.7	78.6	87.1	--	84.2	--	60.6	--	--	--	--	98.8	--	35.3	79.7	50.5	46.7	92	22.5
2012	67.1	58.9	46.4	85.6	--	78.2	--	77.4	--	--	--	--	93.5	100	73.1	78.4	76.2	0	58.1	67.3
2013	81	60.3	--	91.2	18.2	77.3	--	94	--	--	--	82.8	97.2	--	90.5	81.6	28.3	24.8	94.4	--
2014	75.3	64.2	--	84.2	45.5	96.9	--	92.5	--	--	--	63.3	99	--	76.2	84	40	0	87.9	82.9
2015	80.3	79.7	70	96.2	75	95.2	--	100	--	--	76.5	76.3	100	--	95.2	97.2	70.7	29.4	78.8	87.9
2016	52.8	84	--	93.3	0	74.3	--	93.1	--	--	50	0	94.7	55.7	87.8	84.6	0	22.7	80.6	60.4
Mean	76.1	71.3	62.1	88.4	39.6	90.5	86.5	87.7	8.3	--	68.5	54.0	96.4	82.9	88.1	78.4	48.2	30.8	91.1	86.9
Range	52.8-93.7	22.9-89.5	0.0-100	75.0-96.2	0.0-87.5	74.3-97.5	76.5-100	60.6-100	0.0-33.3	--	0.0-100	0.0 -82.8	75.6-100	0.0-100	35.3-99.5	59.1-97.2	0.0-90.9	0.0-66.2	58.1-99.3	22.5-99.5
N (all years)	4195	6244	1381	5477	691	330432	2973	24691	644	85	355	566	6093	6718	2686	3546	8327	32303	3027	6306
% Collected	0.94%	1.41%	0.16%	0.62%	0.08%	37.74%	0.55%	4.55%	0.12%	0.02%	0.07%	0.11%	1.18%	1.32%	0.53%	0.71%	1.68%	6.61%	0.66%	1.39%

SPECIES CODES: AW, alewife; BNT, brown trout; CHIN, chinook salmon; CHUB, bloater (chub); COHO, coho salmon; FD, freshwater drum; GSD, gizzard shad; LKH, lake herring; LS, lake sturgeon; LT, lake trout; LW, lake whitefish; RBT, rainbow trout; REDH, redhorse spp.; RGY, round goby; RSM, rainbow smelt; RWF, round whitefish; STSH, spottail shiner; WEYE, walleye; WS, white sucker; YP, yellow perch.

Although the barrier net excludes the majority of fish susceptible to collection, some fish are still subject to entrainment given the seasonal nature of the barrier net installation, the net design and the dynamic environment in which it is deployed (e.g., it is sometimes over topped by water). The Settlement parties acknowledged this reality at the onset of the program, and agreed upon a monetary mitigation plan that provides for annual payments to the GLFT by the Licensees as compensation for the unavoidable losses of entrained fish. The GLFT allocates funds provided by the Licensees for mitigation of unavoidable fish losses. Initial formation of the GLFT included a cash payment by the Licensees of $5 million and the transfer of approximately 10,800 acres of company properties. The Settlement also included annual compensation payments to the GLFT for unavoidable future fish losses occurring at the Project, the transfer of over 15,600 acres of undeveloped company lands to the state of Michigan, funding of seven fishing access improvements near other Great Lakes shoreline generating facilities individually owned by the Licensees, and annual payments to support the work of a SAT.

The initial and annual payments by the Licensees are the sole source of GLFT funding and annual payments will continue until the end of the current license term in 2019. Almost $70 million in grants have been awarded to date from the GLFT. By 2020, the year of the last fish loss payment by the utilities under their current license, the GLFT will have invested approximately $100 million in mitigation projects to protect and restore the Great Lakes fishery (https://glft.org/about/history/accomplishments). Funded grant projects and related activities focus on the types of Great Lakes fishery projects specifically identified in the State Court settlement and discussed in more detail below. According to the GLFT website, of funds awarded from 1998 through 2010, nearly two-thirds of funds awarded (62 percent) have been associated with the GLFT's ecosystem health and sustainable fish populations priority. Approximately 23 percent of GLFT grant resources have supported access to the fishery, and approximately 16 percent have supported Great Lakes stewardship (https://glft.org/about/history/accomplishments). The GLFT has worked cooperatively with research institutions; state, tribal, and federal management agencies; regional authorities; non-governmental organizations; and private foundations to maximize the effectiveness of its grant programs and to encourage collaboration to address issues of common concern. The GLFT has also contributed resources to seminars, forums, and conferences to encourage collaboration and transfer of information on the Great Lakes fishery and ecosystem among researchers, managers, funders, and stakeholders (GLFT 2008). GLFT grants give preference to Lake Michigan projects with a focus on the following activities:

- Research directed at increasing the benefits associated with Great Lakes fishery resources;
- Rehabilitation of lake trout, lake sturgeon, and other native fish populations;
- Protection and enhancement of fisheries habitat, including Great Lakes wetlands;

- Public education concerning the Great Lakes fisheries; and
- Acquisition of real property for the above purposes, or to provide access to the Great Lakes fisheries.

The GLFT grants have funded 375 projects from 1999 through 2016. While these quantitative metrics are easily measured, the benefits to the Great Lakes and the people who who use them are immeasurable.

Grants are available to a range of entities. As stated on the GLFT website (https://glft.org/about/history/accomplishments): "The GLFT makes grants to nonprofit organizations, government, tribes and academic institutions. Approximately 43 percent of GLFT grant dollars have been distributed to academic institutions, predominantly in support of hypothesis-driven fisheries research. An additional 36 percent of grant resources have been distributed to units of government (both U.S. and Canadian), with federal entities and the state of Michigan receiving several fisheries research grants, and local units of government typically recipients of grants for access to the fishery. Nonprofit organizations have received 16 percent of grant resources; approximately half of these grants went to land conservancies for land acquisition projects. Approximately 5 percent of grant resources have been distributed to tribal government entities."

Relicensing Studies – On May 21, 2014, the Michigan DNR, the Michigan Attorney General, the USFWS, the Grand Traverse Band of Ottawa and Chippewa Indians, the Little Traverse Bay Bands of Odawa Indians, the National Wildlife Federation, and the Michigan United Conservation Clubs filed a study request to:

> *"comprehensively identify and evaluate the feasibility and effectiveness of all available measures, including additional technologies and Project design and operation changes, to eliminate or reduce to the greatest possible extent, fish entrainment and mortality caused by operation of the Project."*

The Licensees agreed with the study request in that the current relicensing process provides an opportunity to consider alternatives to the current fish entrainment abatement measures (i.e., the seasonal barrier net). As such, the Licensees proposed in the RSP to complete a desktop evaluation based on existing information to assess potential fish entrainment abatement measures and engineering alternatives as they may apply to the Ludington Project and the Lake Michigan fish community. In addition, the RSP also included the use of a Panel of Experts (POE) at the request of the resource agencies. As part of the RSP, a POE was established to provide expertise during the conduct of the study and provide expert opinions with regard to study results. The Licensees submitted the proposed panel of experts along with their qualifications to the SAT member organizations for concurrence and input. The POE consisted of a fisheries biologist experienced in fish protection technologies; an engineer with fish protection design and implementation expertise; and a hydro engineer experienced with pumped storage project design and operations. Candidates for participation in the panel were solicited from a range of organizations with pertinent expertise. The SAT member organizations were also solicited for names of potential candidates. The individuals chosen to participate on the POE along with a brief summary of their qualifications are:

- Fish Protection Engineer - Tom Cook, TetraTech: Mr. Cook is a civil engineer with over 40 years of experience in multiple aspects of water resource projects. He has managed teams of fisheries biologists, scientists, and engineers to evaluate fish protection at hydroelectric power intakes and for cooling water intake structures relative to the U.S. Environmental Protection Agency (EPA) Section 316(b) of the Clean Water Act. Mr. Cook has participated in fish protection studies at large hydroelectric facilities such as the Osage Hydroelectric Project at Lake of the Ozarks, MO; Elwha Hydroelectric Project in Port Angeles, WA; and Richard B. Russell Dam Pumped Storage Project on the Savannah River in Elberton, GA. While at Stone & Webster Engineering Corporation, he worked on the 1988 Fish Mortality Mitigation Study for the Ludington Pumped Storage Project. Since 1992, Mr. Cook has evaluated alternative intake technologies that could reduce fish entrainment and impingement at more than 120 power facilities.
- Hydro Engineer - Kermit Paul, Black & Veatch: Mr. Paul has over 50 years of mechanical and electrical engineering experience specializing in pumped storage and conventional hydroelectric facilities. Retired from Pacific Gas & Electric Co. as Consulting Electrical/Mechanical Engineer, he is currently a private consulting electrical/mechanical engineer, he was a past member of the FERC Boards of Consultants for the River Mountain and Summit Pumped Storage Projects and electrical/mechanical advisor to the Board of Consultants for the Diamond Valley Reservoir Project of Metropolitan Water District of Southern California. Since 1984, he served as Project Engineer for the Helms Pumped Storage Project, a 1206 MW project operating at a maximum head of 1775 feet. He is also a contributing author on several chapters of "The Guide to Hydropower Mechanical Design" written by the ASME Hydro Power Committee.
- Fish Biologist - Charles C. Coutant PhD., Independent Consultant: Mr. Coutant has over 50 years of experience conducting fisheries research. His career began at the Battelle-Pacific Northwest Laboratory and continued through his time at the Oak Ridge National Laboratory as a Distinguished Research Staff. He currently works as an independent consultant. Mr. Coutant has a wide range of experience with regard to interactions between fish and power projects and has authored in excess of 337 publications. He is a past president of the American Fisheries Society and has served in an advisory role regarding fishery concerns at numerous power generating facilities.

The objectives of the study were to evaluate existing technologies available to protect fish from entrainment mortality and consider their applicability, feasibility, effectiveness, and total cost (capital and annual operating and maintenance). The study was completed in three phases:

- The Phase 1 report compiled a comprehensive list of available fish protection technologies and species of fish that may be affected.
- The Phase 2 report provided an assessment of the entrainment abatement technologies with potential to be applied at LPSP; these are technologies that do not require substantial structural changes to the project intake.
- The Phase 3 report provided an assessment of engineering alternatives for entrainment reduction, which are the more substantive options that require civil or structural changes to the project.

During the conduct of each study phase, the researchers and Licensees worked in consultation with the POE. The POE then reviewed and commented on each draft report. Revised draft reports were subsequently provided to the SAT member organizations for review and comment prior to filing with FERC. The Phase 1 and Phase 2 reports were provided to the stakeholders and the FERC as part of the Initial Study Report (filed on December 2, 2015). The Phase 3 report was provided to the stakeholders on October 7, 2016 and filed with the Commission on December 1, 2016. A brief summary of each report is provided below.

Phase 1 study

The Phase 1 study effort included an extensive search for existing information on the Lake Michigan fishery as well as information on all available entrainment abatement technologies and engineering alternatives (existing and in development). In terms of biological information, an extensive literature search was combined with a solicitation for data from state and federal agencies, tribal entities, and NGOs associated with Lake Michigan fish sampling activities. Data obtained provided insight into the fish species and life stages present. As a result, 53 species were identified as potentially being exposed to entrainment (Alden 2015a).

In addition to an extensive literature search, researchers solicited information from 71 individuals representing 54 entities with regard to existing or developing fish protection technologies. Entities included state and federal agencies, utilities, universities, consultants, and vendors. As with the solicitation for biological information, all SAT member organizations were contacted. Organizations contacted also included entities from Canada and Europe. The resulting list of entrainment abatement technologies and engineering alternatives subsequently evaluated in the Phase 2 and Phase 3 studies is provided in Table E-4.3.3-7.

Table E-4.3.3-7: Fish Protection Technologies Considered for Application at Ludington (Alden 2015a)

Mode of Protection	Technology
ENTRAINMENT ABATEMENT TECHNOLOGIES	
Behavioral deterrence/guidance	Sound (infrasonic, sonic, ultrasonic, impulsive/high impact)
	Light (strobe, continuous)
	Chemicals
	Electric barriers
	Air bubble curtain
	Water jet curtain
	Hanging chains
	Visual keys
	Multi-technology behavioral system
	Modified flow systems (current inducers; FVES™)
Physical barrier/guidance	Barrier net
	Aquatic filter barrier
ENGINEERING ALTERNATIVES	
Behavioral deterrence/guidance	Velocity Cap
	Veneer Intake
Mechanized physical barrier w/collection	Modified (Ristroph) traveling screens
	Bilfinger Multi-Disc™ Screening System
	Hydrolox™ Screens
	Beaudrey Water Intake Protection (WIP) Screen
	Fish Pumps
Mechanized physical barrier	Standard traveling water screens (without fish collection)
	Rotary drum screens
Physical barrier	Fixed screens
	Narrow-spaced bar racks
	Infiltration intakes
	Porous dike
	Filtrex filter system
	Perforated pipe screens
	Cylindrical wedgewire screens
Physical diversion	Angled louvers and bar racks
	Angled screens (fixed or traveling)
	Angled rotary drum screens
	Inclined-plane screens

Mode of Protection	Technology
	Eicher screen Modular inclined screen (MIS) Submerged traveling screens
Physical barrier and/or diversion	Multi-technology physical system

Phase 2 study

The Phase 2 study effort evaluated the entrainment abatement technologies identified during Phase 1 efforts for their applicability to the LPSP as well as the design and operation of the existing barrier net. The first step was to develop a thorough understanding of biological and life history parameters for affected species (Alden 2015b). This included using Phase 1 information to identify what species and life stages are present in the vicinity of the LPSP lower reservoir intake and when they would likely be at risk to entrainment (i.e., diurnal, monthly, and seasonal presence). Therefore, the Phase 2 study included a matrix that identified entrainment risk, biological information and data for the species and life stages present in the vicinity of the Project intake (Alden 2015b).

Assessment of the entrainment abatement technologies identified (Table E-4.3.3-7) followed a 3-step process: Preliminary Screening, Feasibility Assessment, and Detailed Assessment of Selected Technologies. Each step in the process evaluated the technologies against selected criteria. Those deemed as being potentially viable for application at the Project in a given step were then evaluated in the subsequent step. The screening criteria used to evaluate Entrainment Abatement Technologies (Phase 2 Study) and Engineering Alternatives (Phase 3 Study) were developed in consultation with the POE and the SAT member organizations. Those criteria as stated in the Phase 3 report (Alden 2016) are:

Proven Biological Effectiveness: Entrainment abatement technologies and engineering alternatives must have a proven ability to reduce entrainment of the species (or species similar in morphology, behavior, and life history) and life-stages present at LPSP (the focus will be on barrier net target species, species of concern, and representative species as previously defined in the Phase 1 and 2 reports). The ability to reduce entrainment at water intakes must have been demonstrated during pilot or full-scale field studies, or through laboratory studies for which results indicate a strong potential for successful application if applied at projects with similar design features, velocities, and flow rates as LPSP.

Seasonal Performance: At a minimum, the biological performance of entrainment abatement technologies and engineering alternatives must be maintained under the physical, hydraulic, and/or environmental conditions at LPSP that occur during the current annual deployment period of the barrier net (April 15 to October 15). Options considered for year round application must also be able to maintain biological performance under winter conditions.

Comparison to Existing Barrier Net: Entrainment abatement technologies and engineering alternatives used alone or in conjunction with other options must demonstrate strong potential to reduce entrainment rates equivalent to or greater than the existing barrier net. Options that increase the effectiveness of the existing barrier net will also be considered.

Commercial Availability: Entrainment abatement technologies and engineering alternatives should be commercially available for water withdrawals with similar velocity and flows as LPSP or require relatively minor adaptations to prepare for full-scale application similar in size to what would be required for an installation at LPSP. For this criterion, commercially available is defined as a technology or measure that has been installed and in use on a permanent basis for multiple years and has shown to satisfactorily perform its intended function and has not resulted in significant adverse impact to the environment or plant operation. New technologies, with limited operating data will be evaluated using best professional judgment to determine if they can be considered commercially available or at a stage in development that would not require significant effort to produce a full-scale application.

Design Performance: The proposed alternative must be able to achieve applicable design and engineering performance objectives during both generating and pumping operations. Options must not have a significant effect on the reliability or efficiency of generating or pumping operations at LPSP. This includes the demonstrated ability to properly function and be maintained under current physical, hydraulic, environmental, and biofouling conditions similar to LPSP. Options designed for year-round installation should also be able to operate and be maintained under sub-freezing, frazil and pack ice conditions.

Technologies that show potential based on laboratory or pilot-scale evaluations, but have limited or no operational experience under physical, hydraulic, and environmental conditions similar to LPSP, may be retained for further analysis based on best professional judgment.

Regulatory Approval: The Project’s Licensees must be able to obtain approval for the installation and operation of a technology or measure from state and federal resource and regulatory agencies. For this criterion, the anticipated major issues associated with the application of each technology or measure that will be considered by state and federal agencies will be identified and the potential magnitude of the impact assessed. This includes meeting environmental, safety, and generating requirements.

Space Requirement: Adequate space must be available to construct a technology and operate it as designed and intended. The approximate footprint of the technology and associated infrastructure must fit within available space on the site or, alternatively, at offsite areas that will not unduly negatively impact other lake users and would likely receive regulatory approval.

Results of the Phase 2 evaluation identified four potential entrainment abatement options applicable to the LPSP. The four options, all of which included some version of the barrier net, were then evaluated in terms of costs. Table E-4.3.3-8 identifies the four along with their respective capital and annual costs.

Table E-4.3.3-8: Cost comparison of feasible entrainment abatement technologies (Alden 2015b)

Alternative	Initial Capital Costs			Annual Costs				
	Total Project Construction Costs (2015 $)	Replacement Power During Construction (2015 $) [1]	Total Capital Costs (2015 $)	Energy (2015 $) [1,2]	Labor (2015 $) [2]	Component Replacement (2015 $) [2,3]	Total Annual Costs (2015 $) [2]	Incremental Annual Costs (2015 $)
Existing Barrier Net	NA	NA	NA	$440,000	$2,053,000	$324,000	$2,817,000	$0
Modified Barrier Net	$3,767,000	$2,200,000	$5,967,000	$660,000	$2,258,000	$357,000	$3,275,000	$458,000
Modified Barrier Net with Ultrasonic Anti-biofouling	$6,200,000	$4,400,000	$10,600,000	$1,326,000	$2,274,000	$400,000	$4,000,000	$1,183,000
Longer Barrier Net with ½-inch Bar Mesh	$10,578,000	$4,547,000	$15,125,000	$0	$4,200,000	$442,000	$4,642,000	$1,825,000
Existing Barrier Net with a Full-Scale Ultrasonic Deterrent System	$15,921,000	$2,933,000	$18,854,000	$885,000	$2,143,000	$662,000	$3,690,000	$873,000

1. Assumes 1,000 Mwh per day per Unit and a cost of $55 per MWh.
2. Includes existing O&M effort required to maintain the barrier nets when applicable
3. For the existing barrier net, net replacement is considered a capital cost by the owners.
4. Does not include annual fisheries compensation costs.

Phase 3 study

The Phase 3 report considered engineering alternatives identified in Phase 1 (Table E-4.3.3-7). Similar to the Phase 2 study process, each engineering alternative was evaluated in a stepwise approach against established criteria (Alden 2016). Based on the screening of engineering alternatives, the following six alternatives were selected for a detailed evaluation in the Phase 3 report (Alden 2016):

- Alternative 13B – Offshore Intakes with Tunnels and Velocity Caps;
- Alternative 13C – Extended Tailrace with Deep Submerged Intakes;
- Alternative 13D – Extended Tailrace with Deep Submerged Intakes and Intake Tunnels;
- Alternative 13F – Offshore Intakes with Acoustic Barrier;
- Alternative 20A – Additional Structures to Better Distribute Flow at Existing Net; and
- Alternative 20B – Breakwater Modifications to Better Distribute Flow at Existing Net.

Estimated costs for the six engineering alternatives where a detailed evaluation was warranted is provided in Table E-4.3.3-9. Details on the costs and estimated biological effectiveness associated with each alternative along with the existing seasonal barrier net are provided in the Phase 3 report. The results provide the information needed by stakeholders for decision making purposes relative to fish protection options in terms of feasibility, potential effectiveness and cost. This information would inform decisions regarding information needs, design, testing, and implementation if such measures were considered feasible and warranted. The comprehensive results of the Phase 1, 2, and 3 studies however, indicate that the barrier net remains the most feasible and proven fish protection measure available for the dynamic environmental and hydraulic conditions present at the Project.

Table E-4.3.3-9: Cost Comparison of Evaluated Engineering Alternatives

Alternative	Initial Capital Costs			Annual O&M Costs				
	Total Project Construction Costs (2016 $)	Replacement Power During Construction (2016 $) [1]	Total Capital Costs (2016 $)	Energy (2016 $)[1,2]	Labor (2016 $)[2]	Component Replacement (2016 $)[2,3]	Total Annual Costs (2016 $)[2,4,5]	Incremental Annual O&M Costs (2016 $)
Existing Barrier Net	NA	NA	NA	$440,000	$2,053,000	$324,000	$3,200,000	$0
Alt 13B	$4,021,565,000	$217,800,000	$4,239,365,000	$1,221,000	$22,000	$0	$1,243,000	-$1,574,000
Alt 13C	$827,310,000	$99,000,000	$926,310,000	$863,500	$60,000	$0	$923,500	-$1,893,500
Alt 13D	$1,792,855,000	$178,200,000	$1,971,055,000	$1,457,500	$65,000	$0	$1,522,500	-$1,294,500
Alt 20A	$64,400,000	$19,800,000	$84,200,000	$781,000	$2,053,000	$324,000	$3,158,000	$341,000
Alt 20B	$33,061,000	$13,200,000	$46,261,000	$440,000	$2,053,000	$324,000	$2,817,000	$0
Alt 13B + Acoustic Barrier	$4,024,691,000	$225,017,000	$4,249,708,000	$1,223,000	$82,000	$74,000	$1,379,000	-$1,438,000
Alt 13C + Acoustic Barrier	$832,898,000	$113,222,000	$946,120,000	$867,500	$185,000	$135,000	$1,187,500	-$1,629,500
Alt 13D + Acoustic Barrier	$1,795,371,000	$185,417,000	$1,980,788,000	$1,459,500	$190,000	$60,000	$1,709,500	-$1,107,500

1. Assumes 1,000 Mwh per day per Unit and a cost of $55 per MWh.
2. Includes existing O&M effort required to maintain the barrier nets when applicable
3. For the existing barrier net, net replacement is considered a capital cost by the owners.
4. Does not include annual fisheries compensation costs.
5. Existing barrier net costs have been updated based on data from 2016 and includes installation/removal, cleaning, maintenance, effectiveness monitoring, and component replacement. Details are provided in Exhibit D.

Summary of Environmental Analysis – Effective and safe implementation of fish protection at a site as large and dynamic as the LPSP is extremely challenging. Water volume and velocity, flow direction (i.e. discharge and pumping), extreme environmental conditions, presence of multiple fish species and lifestages, complications due to debris and biofouling, minimization to project operation and reliability, and overall size of the site are among the many challenges that need to be considered when choosing a fish protection methodology for the LPSP. While many potential methodologies were considered, their estimated potential effectiveness at LPSP was speculative and remains unproven at a similar site. The barrier net however, is a proven technology at the LPSP that has regularly achieved effectiveness targets. Experience as well as investment in the barrier net program over the past 27 years has resulted in a successful fish protection program. Strong evidence of effectiveness greater than the existing barrier net would be required prior to implementation of a different technology. No such evidence was determined to exist based on the results of the Aquatic Resources Study (Alden 2015a, Alden 2015b, Alden 2016). Therefore, the Licensees propose to continue use of the Barrier Net as a fish protection measure.

The proposed action (i.e., continued operation of the Ludington Project and deployment of the seasonal barrier) is not expected to adversely affect fishery resources on a population level or aquatic habitat in the Project area relative to existing conditions including the state listed lake herring and lake sturgeon. The Licensees' existing barrier net program has been shown to meet effectiveness criteria for established target species in most years.

Use of the barrier net was originally developed in consultation with many of the stakeholders involved in the relicensing (e.g., the Michigan DNR, the Michigan Attorney General, the USFWS, the Grand Traverse Band of Ottawa and Chippewa Indians, the Little Traverse Bay Bands of Odawa Indians, the National Wildlife Federation, and the Michigan United Conservation Clubs). The monitoring data and effectiveness of the barrier net have been reviewed by these stakeholders on a regular basis since implementation; the stakeholders have consistently found that the barrier net is the most viable entrainment abatement option at the Project. The Licensees and the stakeholders previously reviewed entrainment abatement technologies every 5 years, under the FERC-approved Settlement; the 5 year reviews were conducted in 2001, 2006, and 2011. These reviews include an evaluation of current technologies, and provide recommendations pertaining to the feasibility of any new technologies for deployment at the Project. None of the 5 year reviews has resulted in additional or alternative entrainment abatement measures from FERC or the stakeholders.

The Licensees are also in the process of completing a maintenance upgrade of the turbine-generator units at the Project; the potential effects of the upgrades on fish and aquatic resources was previously evaluated and authorized by the Commission in its May 7, 2012, order amending the license.

While the seasonal barrier net has been proven as an effective fish protection method at the Project, some level of fish entrainment and entrainment mortality continues to occur. While the effects of these mortalities on the Lake Michigan fishery on a population level are not known, there are many factors that influence this fishery such as natural fluctuations due to environmental conditions and exploitation rates. The most influential factor, however, is likely the dynamic continual change throughout the ecosystem due to the continued introduction of invasive species. As described in Section 4.3.3.2, substantial changes to the Lake Michigan fishery as a whole have occurred throughout the life of the project. Not only has fish biomass decreased, but there have been substantial shifts in relative abundance that have occurred. These changes cannot be attributed to the operation of the Project. For example, during the life of the project, yellow perch were a dominant species in Lake Michigan through the mid 1990's. Alewife, while abundant in the 1970's, replaced yellow perch as the most abundant species in fisheries sampling conducted near the LPSP in subsequent years (Tables E-4.3.3-1 and E-4.3.3-2). The barrier net is very effective at protecting these two species from entering the Project intake area with average annual effectiveness estimates of 93.4 and 94.3 percent for yellow perch and alewife (> 5 inches) respectively during the period from 1993 through 2016. However, despite being effectively protected from entrainment mortality, these species have experienced continued declines in abundance from peak values observed during the early years of barrier net deployment (Table E-4.3.3-2). The numbers of yellow perch and alewife collected in 2016 were 11.9 and 9.6 percent of peak values observed respectively. While the shifts in abundance and net effectiveness vary by species, the example illustrated by yellow perch and alewife illustrate that changes to the Lake Michigan fishery are influenced by factors other than the operation of the Project.

4.3.3.3 Proposed Environmental Measures

The Licensees propose to maintain the status quo with regard to fish protection and mitigation efforts. That is, they will operate, maintain, and monitor the effectiveness of the existing barrier net seasonally to minimize fish entrainment during normal operations consistent with current practices. They will also continue to fund the GLFT through mitigation payments for unavoidable fish entrainment losses, periodically review new fish entrainment abatement technologies for application to the LPSP, and consult with stakeholders as is current practice. Details on the Licensees proposal includes:

- Deploy the seasonal barrier net from April 15 to October 15 of each year. All in-water work associated with the barrier is limited by environmental conditions suitable for safe access.

- Net specifications such as net length and mesh size will be consistent with the existing net as described in Section 4.3.3.2. That is, the net will be approximately 12,850 ft in length and cover the entire water column. Approximately 1,175 ft of the net from the shoreline on both the North and South portions of the net will consist of ½-inch bar mesh. The remainder of the net will consist of ¾-inch bar mesh.

- Net maintenance will continue consistent with current practices. While deployed, divers will typically clean the net panels in-situ once per month or as practical with areas of higher debris accumulation being cleaned more frequently. While deployed, the net will be inspected weekly for major damage such as breaches in the net. In-situ repairs will occur as identified to the extent practical. Off-season maintenance (i.e. when the net is not deployed) will consist of repair and replacement of all net panels, lines, and associated componenents as needed.

- Net effectiveness monitoring will continue consistent with existing procedures and in accordance with a Quality Assurance /Quality Control Plan approved and reviewed annually by the SAT. Effectiveness monitoring will consist of overnight gill net sampling conducted twice per week during the period that the net is in place. Sampling will be conducted at four locations outside the net and four locations inside the net as provided in Figure E-4.3.3-2. The study design will require that equivalent gill nets are fished for the same amount of time at paired stations inside and outside of the barrier net in order to achieve equal sampling effort for the comparisons of catch at outside and inside locations. Differences in catch abundance and species composition between sample stations outside and inside the net will be attributed to the presence of the net. Gill nets used at nearshore locations (sample stations 1, 2, 3, and 4) will be 6-ft deep and offshore locations (sample stations 5, 6, 7, and 8) will be 24-ft deep, which are the approximate water depths at each location. Each gill net will have eleven 30-ft long panels with 11 different stretch mesh sizes ranging from 1 to 7 inches.

- Net effectiveness will be calculated using the following method:

    - *Percent Effectiveness* = $[(T_O - T_I) / T_O] \times 100$

  Where T_O is the total outside catch and T_I is the total inside catch. This approach is consistent with current effectiveness calculation methods. The calculation method has been used to calculate effectiveness for individual species or groups of species by size or for all size groups combined, as well as for all fish combined.

- Effectiveness estimates as provided above will be used to determine net performance relative to established biological performance targets. The following are the biological performance standards that were developed for the barrier net with respect to designated target species and size groups as described in Table E-4.3.3-3:

  - 80% effectiveness for game fish (salmonids and yellow perch combined) over five inches in length.
  - 85% for large forage fish (alewife and smelt combined) over five inches in length.
- If the effectiveness targets are not being achieved, the Licensees will consult with the SAT to determine what, if any, actions need to be taken to address the issue. Given the changes to the Lake Michigan fish community documented above and the substantial decline in overall fish numbers that hamper the measurement of net effectiveness, a new standard that pools all fish >5” in length will likely be required to provide the numbers of fish necessary to adequately measure barrier net effectiveness.

- Despite the protection provided by the seasonal barrier net, unavoidable fish entrainment and entrainment mortality will continue occur to some extent. To mitigate for these losses, the Licensee will continue to fund the GLFT. The GLFT will continue to function as described in Section 4.3.3.2. The GLFT Board of Trustees will consist of representatives from the following organizations; the Michigan DNR, Michigan Attorney General (MAG), National Wildlife Federation (NWF), Michigan United Conservation Clubs (MUCC), USFWS, Grand Traverse Band of Ottawa and Chippewa Indians (GTB), Little Traverse Bay Band (LTBB) of Odawa Indians, and the Little River Band of Ottawa Indians (LRBOI). An SAT consisting of representatives from the Michigan DNR, NWF, MUCC, USFWS, GTB, LTBB and LRBOI as well as DTEE and Consumers will be established to advise on issues concerning the barrier net. The SAT will function as a collaborative group to collectively advise on issues concerning fish protection at the LPSP.

- The Licensees will provide monthly effectiveness monitoring reports to the SAT during the period the net is deployed. Monthly reports will provide the effectiveness monitoring data for the previous month along with pertinent information pertaining to net function (i.e. net damage, operation and maintenance issues). An annual report providing net performance, effectiveness monitoring collections, and net operations and maintence will be provided to the SAT and filed with FERC by December 31 of each year.

- The SAT will meet at least quarterly. The purpose of these meetings may include: review of the barrier net monitoring program, evaluate the need for additional studies or data, or make reccomendations for adjustment to the fish protection program.

- The Licencees will conduct a review of fish entrainment abatement technologies every 5 years throughout the course of the new license. The first review will be conducted 5 years after the new license is issued. The goal of this review will be to determine if any technologies are technically and economically practicable for use at the LPSP either in conjunction with or in lieu of the barrier net to substantively reduce fish entrainment relative to the existing barrier net program. A report detailing the results of this evaluation will be provided to the SAT for review. The SAT will then make reccomendations regarding any appropriate changes to the barrier net program if needed.

- Costs for the proposed fish protection measures in 2016 dollars are:
  - Annual deployment/removal, operation, maintenance, and monitoring of the barrier net - $3,200,000
  - 5 year review of fish entrainment abatement technologies - $30,000
  - Annual funding of the GLFT will vary based on estimated fish losses each year but is estimated to be $2,722,000.

4.3.3.4 Cumulative Effects

As a result of the Fish and Aquatics Resource Study, no cumulatively affected fish and aquatic resources were identified. This is consistent with the Commission's determination in SD1 that fish and aquatic resources would not be cumulatively affected by the proposed action (i.e., continued operation of the Project).

4.3.3.5 Unavoidable Adverse Effects

As acknowledged by the stakeholders since the Project was constructed, some level of unavoidable fish losses due to entrainment is likely to occur as a result of operations. There is however, no indication that Lake Michigan fisheries are affected on a population level. Fisheries resources throughout Lake Michigan are affected by many other factors, such as increasing competition and ecosystem changes due to invasive species and, as such, the unavoidable Lake Michigan fisheries effects due to Project operation are not considered to be adverse.

4.3.3.6 References

Alden. 2011. Ludington Pumped Storage Plant Fish Protection Impact Evaluation Potential Impacts to Barrier Net and Fisheries. August 2011.

Alden. 2015a. Ludington Pumped Storage Project Fish and Aquatic Resources Study – Final Phase 1 Report. Overview of Entrainment Abatement and Engineering Alternatives for Entrainment Reduction. November 2015.

Alden. 2015b. Ludington Pumped Storage Project Fish and Aquatic Resources Study – Final Phase 2 Report. Evaluation of Entrainment Abatement Technologies. November 2015.

Alden. 2016. Ludington Pumped Storage Project Fish and Aquatic Resources Study – Final Phase 3 Report. Evaluation of Engineering Alternatives for Entrainment Reduction. August 2016.

Brazo D.C. and Liston C.R., 1979 The effects of five years of operation of the Ludington Pump Storage Power Plant on the fishery resources of Lake Michigan (1972-1977). 1977 Annl. Rep., Ludington Project, Vol II, No. 1, Fisheries Research. Submitted to Consumers Power Co., Mich. State Univ., Dept. of Fish. And Wild., 406pp

Bunnell, D.B., C.P. Madenjian, J.D. Holuszko, T.J. Desorcie, and J.V. Adams. 2009. Status and Trends in Prey Fish Populations 2008. U.S. Geological Survey report to the Great Lakes Fishery Commission Lake Michigan Committee Meeting, March 26, 2009.

Bunnell, D.B., J.G. Mychek-Londer, and C.P. Madenjian. 2014a. Population-level effects of egg predation on a native planktivore in a large freshwater lake. Ecol. Freshw. Fish 23: 604-614.

Bunnell, D.B., R.P. Barbiero, S.A. Ludsin, C.P. Madenjian, G.J. Warren, D.M. Dolan, T.O. Brenden, R. Briland, O.T. Gorman, J.X. He, T.H. Johengen, B.F. Lantry, T.F. Nalepa, S,C. Riley, C.M. Riseng, T.J. Treska, I. Tsehaye, M.G. Walsh, D.M. Warner, and B.C. Weidel. 2014b. Changing ecosystem dynamics in the Laurentian Great Lakes: bottom-up and top-down regulation. BioScience 64:26-39.

Bunnell, D.B., Madenjian, C.P., Desorcie, T.J., Kostich, M.J., Woelmer, W. and Adams. J.V. 2015. U. S. Geological Survey. Great Lakes Science Center. Online: http://www.glfc.org/lakecom/common_docs/Compiled%20Reports%20from%20USGS%202015.pdf. Accessed October 27, 2016.

Claramunt, R.M., B. Breidert, D.F. Clapp, R.F. Elliott, S.P. Hansen, C.P. Madenjian, P. Peeters, S.R. Robillard, D.M. Warner, G. Wright. 2010. Status of Lake Michigan Salmonines in 2009: A Report from the Salmonid Working Group. Great Lakes Fishery Commission, Lake Michigan Committee Meeting, Windsor, Ontario, March 23, 2010. Online: http://www.in.gov/dnr/fishwild/files/fw-SWG_2009_Report_1985_to_2009.pdf. Accessed October 27, 2016.

Consumers Energy Company (CEC). 2016. Ludington Pumped Storage Project: Project No. 2680 – Annual Report of Barrier Net Operation for 2016. CEC, Jackson, MI.

Evans, M.A., G. Fahnenstiel, and D. Scavia. 2011. Incidental oligotrophication of North American Great Lakes. Environ. Sci. Technol. 45: 3297-3303.

Federal Energy Regulatory Commission (FERC). 1995. Final Environmental Assessment: Proposed Permanent Measures for Fish Protection and Angler Access at the Ludington Project (FERC Project No. 2680-017). Office of Hydropower Licensing: Washington, D.C.

Great Lakes Fishery Trust (GLFT). 2008. Investing in renewal, Ten Years of Grant Making. Available online at: https://glft.org/documents/cms/cms_file?path=/8/glft_10yearreport.pdf

Lake Michigan Committee. 2014. Lake Michigan salmonine stocking strategy. Available online at: http://www.glfc.org/lakecom/lmc/Lake%20Michigan%20Committee%20Salmon%20Stocking%20strategy%202014.pdf

Lake Michigan Fisheries Management Team. 2016. Lake Michigan Integrated Fisheries Management Plan for 2015-2024. DRAFT. Online: http://dnr.wi.gov/topic/fishing/Documents/LakeMichigan/LMIFMP2015-2024Draft.pdf. Accessed October 18, 2016.

Liston et al. 1981 Assessment of larval, juvenile, and adult fish entrainment losses at the Ludington Pump Storage Power Plant on Lake Michigan. 1980 Annual Report, Ludington Project, Vol. 1, Submitted to Consumers Power Co., Mich. State Univ., Dept. of Fish. And Wild., 276pp

Madenjian, C.P., D.W. Hondorp, T.J. Desorcie, and J.D. Holuszko. 2005. Sculpin community dynamics in Lake Michigan. J. Great Lakes Res. 31: 267-276.

Madenjian, C.P., D.P. Bunnell, D.M. Warner, S.A. Pothaven, G.L. Fahnenstiel, T.F. Nalepa, H.A. Vanderploeg, I. Tsehaye, R.M. Claramunt, and R.D. Clark. 2015. Changes in the Lake Michigan food web following dreissenid mussel invasions: a synthesis. J. Great Lakes Res. 41 (Suppl. 3): 217-231.

Makauskas, D. and D. Clapp. 2010. Status of Yellow Perch in Lake Michigan 2009, Report to the Lake Michigan Committee. March 23, 2010. Online: http://www.in.gov/dnr/fishwild/files/fw-YPTG_annual_2008_final.pdf. Accessed October 27, 2016.

Nalepa, T.F., D.L. Fanslow, G.A. Lang, K. Mabrey, and M. Rowe. 2014. Lake-wide benthic surveys in Lake Michigan in 1994-1995, 2005, and 2010: abundances of the amphopod *Diporeia* spp. And abundances and biomass of the mussels *Dreissena polymorpha* and *Dreissena rostriformis bugensis*. NOAA Technical Memorandum GLERL-164.

Pothaven, S.A., G.L. Fahnenstiel, and H.A. Vanderploeg. 2010. Temporal trends in *Mysis relicta* abundance, production, and life-history characteristics in southeaster Lake Michigan. J. Great Lakes Res. 36(Suppl. 3): 60-64.

Pothaven, S.A., D.W. Hondorp, and T.F. Nalepa. 2011. Declines in deepwater sculpin *Myoxocephalus thompsonii* energy density associated with the disappearance of Diporeia spp. In lakes Huron and Michigan. Ecol. Freshw. Fish 20: 14-20

Pothaven, S.A., D.B. Bunnell, C.P. Madenjian, O.T. Gorman, and E.F. Roseman. 2012. Energy density of bloaters in the upper Great Lakes. Trans. Am. Fish. Soc. 141: 772-780.

Stone & Webster Engineering Corporation (SWEC). 1988. Fish Mortality Study for the Ludington Pumped Storage Project. Prepared for Consumers Power Company. September 1988.

Warner, D.M., S.A. Farha, R.M. Claramunt, and D. Hanson, and T.P. O'Brien. Status of Pelagic Prey Fishes in Lake Michigan, 2014, Great Lakes Fishery Commission, Lake Michigan Committee Meeting, Ypsilanti, MI, March 26-27, 2015.

4.3.4 Wildlife Resources

4.3.4.1 Affected Environment

The Project is located on the eastern shore of Lake Michigan and uses the lake as the lower reservoir. The area surrounding the Project is a mix of forest, agricultural, residential, and industrial lands. Project lands in Mason County are relatively well distributed around the perimeter of the reservoir and discrete habitat types within these lands are relatively small in area and disjointed. Land associated with the satellite recreation site located in Ottawa County is part of Consumers Energy's J. H. Campbell Generating Complex, containing a mix of industrial land (fossil power generation) and forest, while the area along Lake Michigan is primarily residential. Wildlife habitats and associated wildlife resources in the vicinity of the Project are therefore determined primarily by the influences of the surrounding non-project lands and associated uses.

Based on the available information on habitats within the proximity of the Project, a number of wildlife species occupy, or have the potential to occupy, the immediate vicinity of the Project. The surrounding area provides a diversity of habitats such as mixed hardwood and pine forests, wetlands, agricultural land, and sand bluffs along the Lake Michigan shoreline. The Project boundary itself encompasses only a small amount of habitat outside of the wetted portions of the Project impoundment. Most of the upland habitats and the associated wildlife resources surrounding the impoundment occur outside of the Project boundary on private lands.

Wildlife Habitats

In general, the forested upland areas surrounding the Project in Mason and Ottawa Counties are comprised of patches of mature mixed softwood and hardwood habitat. These mixed habitats are usually characterized by a dense canopy and often have well-established shrub and sapling layers. They are distributed in a patchwork around the Project area, interspersed with open habitats, which include agricultural areas, old field habitat, and impoundment dike slopes. A portion of the lands surrounding the Project in Mason and Ottawa Counties contains open dunes.

Field surveys were conducted in 2015 to verify land cover types, habitats, and document wildlife observations (King & MacGregor Environmental, Inc., 2016b). The Project area was traversed using a meander approach to visually inspect and categorize wildlife habitat. Field crews walked through the Project area, documenting habitat types and wildlife observations. Surveys at the Port Sheldon Pigeon Lake Facility were limited to those areas visible from the boardwalk. The wildlife survey was conducted in late July 2015.

Habitat in the Project area surrounding the Ludington site is categorized into six main habitat types (King & MacGregor Environmental, Inc., 2016b):

- <u>Forested Areas</u>: Forested areas include young, moderate age, and mature woodlands. Common species observed include sugar maple, American beech, white ash, big-toothed aspen, white pine and hemlock.
- <u>Beach & Low Dunes</u>: Beach and low dune areas are located along the Lake Michigan shoreline and are comprised mainly of low rolling dunes at the base of a steep bluff extending to the beach. These areas contain beach grass, dune reed, beach wormwood, common milkweed and willow species. One area contains a narrow stream/wetland complex that is dominated by smooth saw grass, sedges, and various trees and shrubs.
- <u>Bluff Slope</u>: Bluff slope includes the steep slope along Lake Michigan, consisting of trees and shrubs. These areas contained species such as white cedar, paper birch, and autumn olive.
- <u>Old Field/Shrub Thickets</u>: Old field and shrub thicket habitat consists of early successional species, most of which are naturalized or invasive non-native species. Common vegetation in this habitat type includes autumn olive, spotted knapweed, smooth brome, and orchard grass.
- <u>Reservoir Slope/Meadow</u>*:* The downstream slope around the Ludington upper reservoir contains a mix of native and non-native grasses and other herbaceous vegetation. Common vegetation includes smooth brome and common milkweed.
- <u>Maintained Recreational Areas</u>: Maintained recreation areas, such as the amateur air field and the disc golf course, consist of open areas mowed and maintained for recreational use. Miscellaneous wooded and shrub areas are also located in the recreational areas. Numerous autumn olive shrubs are present in the shrub areas.

Habitat in the Project area surrounding the Port Sheldon Township Pigeon Lake Facility is categorized into four main habitat types (King & MacGregor Environmental, Inc., 2016b):

- Riparian Edge: The riparian edge consists of herbaceous and shrubby vegetation along the Pigeon River's edge including plants such as dogwood, willow, and reed canary grass.
- Wooded Dune: Steep wooded dune slopes along Lake Michigan are composed mainly of sugar maple, sassafras, red oak, and American beech.
- Beach & Low Dune: Beach and low dune habitat is located along a portion of the path to the pier along the lakeshore. This habitat is comprised mainly of American beach grass and common milkweed.
- Maintained/Developed: The maintained and developed areas include roads to access marinas and boat docks along Pigeon River. In addition, there are some home sites along this route.

Wildlife

The wildlife species assemblage known or considered likely to occur in the vicinity of the Project is typical of those found in developed areas of the Northern Lower Peninsula and Southern Lower Peninsula of Michigan. Table E-4.3.4-1 presents a representative listing of vertebrate wildlife species known or considered likely to occur in the vicinity of the Project based upon habitat and life history information. Wildlife species (or evidence of their presence through scat, feathers, tracks, calls, etc.) observed during the 2015 field survey are marked with an asterisk. Aquatic wildlife species are discussed in Section 4.3.3.

Table E-4.3.4-1: Wildlife Species Known or Likely to Inhabit the Ludington Project or Vicinity

COMMON NAME	SCIENTIFIC NAME
Mammals	
Cottontail rabbit	*Sylvilagus floridanus*
Deer mouse	*Peromyscus maniculatus*
Eastern chipmunk*	*Tamias striatus*
Eastern coyote*	*Canis latrans*
Fox squirrel	*Sciurus niger*
Gray squirrel*	*Sciurus carolinensis*
Little brown bat	*Myotis lucifugus*
Meadow vole*	*Microtus pennsylvanicus*
Opossum	*Didelphis marsupialis*
Raccoon	*Procyon lotor*
Red fox	*Vulpes vulpes*

COMMON NAME	SCIENTIFIC NAME
Shortailed shrew	*Blarina brevicauda*
Southern flying squirrel	*Glaucomys volans*
Striped skunk*	*Mephitis mephitis*
White-footed mouse	*Peromyscus leucopus*
White-tailed deer*	*Odocoileus virginianus*
Woodchuck	*Marmota monax*
Birds	
American crow*	*Corvus brachyrhynchos*
American goldfinch*	*Carduelis tristis*
American kestrel	*Falco sparverius*
American tree sparrow*	*Spizella arborea*
American redstart	*Setophaga ruticilla*
American robin	*Turdus migratorius*
Bald eagle*	*Haliaeetus leucocephalus*
Bank swallow	*Riparia riparia*
Barred owl	*Strix varia*
Black-capped chickadee	*Poecile atricapillus*
Blue jay	*Cyanocitta cristata*
Bonaparte's gull	*Larus philadelphia*
Broad winged hawk	*Buteo platypterus*
Brown thrasher	*Toxostoma rufum*
Brown-headed cowbird	*Molothrus ater*
Canada goose	*Branta canadensis*
Caspian tern*	*Hydroprogne caspia*
Chipping sparrow	*Spizella passerine*
Common grackle	*Quiscalus quiscula*
Common merganser	*Mergus merganser*
Common raven*	*Corvus corax*
Common tern*	*Sterna hirundo*
Common yellowthroat	*Geothlypis trichas*
Double-crested cormorant*	*Phalacrocorax auritus*
Downy woodpecker	*Dendrocopus pubescens*
Eastern bluebird*	*Sialia sialis*
Eastern kingbird	*Tyrannus tyrannus*
Eastern phoebe	*Sayornis phoebe*
Eastern towhee	*Pipilo erythrophtalmus*

COMMON NAME	SCIENTIFIC NAME
European starling	*Strunus vulgaris*
Field sparrow	*Spizella pusilla*
Gray catbird	*Dumetella carolinenius*
Great blue heron	*Ardea herodias*
Great Crested flycatcher	*Myiachus crinitus*
Herring gull*	*Larus argentatus*
Horned lark	*Eremophilia alpestris*
House sparrow	*Passer domesticus*
House wren*	*Troglodytes aedon*
Indigo bunting	*Passerina cyanea*
Least sandpiper	*Calidris minutilla*
Mallard duck*	*Anas platyrhynchos*
Meadowlark	*Sturnella magna*
Mourning dove	*Zenaida macroura*
Northern cardinal*	*Cardinalis cardinalis*
Northern flicker	*Colaptes auratus*
Osprey	*Pandion haliaetus*
Pileated woodpecker*	*Dryocopus pileatus*
Purple martin*	*Progne subis*
Red-eyed vireo	*Vireo olivaceus*
Red-shouldered hawk*	*Buteo lineatus*
Red-tailed hawk	*Bueto jamaicensis*
Red-wing blackbird*	*Agelaius phoeniceus*
Ring-billed gull*	*Larus delawarensis*
Rock dove*	*Columba livia*
Rose-breasted grosbeak	*Pheicticus ludovicianus*
Ruby-throated hummingbird	*Archilochus colubris*
Ruffed grouse*	*Bonasa umbellus*
Savannah sparrow	*Passerculus sandwichensis*
Song sparrow	*Melospiza melodia*
Spotted sandpiper	*Actitis macularia*
Tree swallow*	*Tachycineta bicolor*
Turkey vulture*	*Cathartes aura*
Vesper sparrow	*Pooecetes gramineus*
White-breasted nuthatch	*Sitta carolinensis*
Wild turkey*	*Meleagris gallopavo*

COMMON NAME	SCIENTIFIC NAME
Yellow warbler	*Dendroica petechia*
Reptiles	
Blanding's turtle	*Emys blandingii*
Common map turtle	*Graptemys geographica*
Common snapping turtle	*Chelydra serpentina*
Eastern garter snake*	*Thamnophis sirtalis*
Eastern hog-nosed snake	*Heterodon platyrhinos*
Eastern massasauga	*Sistrurus catenatus*
Eastern milk snake	*Lampropeltis triangulum*
Northern ribbon snake	*Thamnophis sauritus septentrionalis*
Painted turtle	*Chrysemys picta*
Amphibians	
Blue spotted salamander	*Ambystoma laterale*
Eastern American toad	*Bufo americanus*
Eastern tiger salamander	*Ambystoma tigrinum*
Fowler's toad	*Bufo fowleri*
Gray tree frog	*Hyla versicolor and H. chrysoscelis*
Green frog	*Rana clamitans*
Northern leopard frog	*Rana pipiens*
Northern spring peeper	*Pseudacris crucifer*
Western chorus frog	*Pseudacris triseriata*
Wood frog	*Rana sylvatica*
Insects	
Monarch butterfly	*Danaus plexippus*
Cabbage white butterfly	*Pieris rapae*

* Wildlife species (or evidence of their presence through scat, feathers, tracks, calls, etc.) observed during the August 2015 survey (King & MacGregor Environmental, Inc., 2016b).
Source: Michigan State University, 2013 & Michigan DNR, 2016, King & MacGregor Environmental, Inc., 2016b

Temporal and Spatial Distribution of Wildlife Resources

Some of the wildlife species that occur at the Project are likely to be present year-round. Other species may migrate seasonally, utilizing separate and distinct breeding and wintering areas. The range of these movements varies significantly among species. Many migratory avian species that utilize the Project vicinity during temperate seasons are absent from the region in winter. Other species tend to display more moderate seasonal shifts in habitat usage, utilizing seasonally distinct areas within the Project vicinity and surrounding region in summer versus winter. Deer exemplify this type of movement, gravitating between preferred breeding and wintering habitats. Some species make only very limited movements between closely associated habitats within a small geographical area, using proximate yet distinctly different habitats or microhabitats by season. Examples of this may include some small mammal species. The specific habits of major species are further described below.

Large Mammals

The large mammal species that is most abundant in the Project vicinity is white-tailed deer. This game animal is found throughout the state of Michigan (Michigan DNR, 2016). White-tailed deer are resident species in the area surrounding the Project and white-tailed deer were observed during the wildlife survey performed in 2015. White-tailed deer are highly selective herbivores, concentrating on whatever plants or plant parts are currently most nutritious. During the course of the year, deer may browse several hundred species of plants. Major habitats that provide food and cover for white-tailed deer in Michigan are forest lands, wetlands, reverting farmlands, and active farmlands. Several of these preferred habitats are available within and near the Project area. For this reason, deer are expected to be present in and near the Project area.

Eastern coyote has also been observed in the Project area. Coyotes are found throughout Michigan in both urban and rural areas. They are highly adaptable and may be found in virtually all habitat types common in Michigan where food, cover, and water are available. Coyotes primarily feed on small mammals, but will also eat insects, fruits, berries, birds, frogs, snakes, plants, and seeds. Home range size depends on available resources, but it generally averages between 8 and 12 square miles (Michigan DNR, 2016). Habitat and food resources are available within and near the Project area, therefore coyotes are expected to be present in and near the Project area.

Small Mammals

The various habitats in the immediate vicinity of the Project provide year-round homes to a number of small mammal species. Examples of species that are widespread throughout the region are gray squirrel, cottontail rabbit, woodchuck, raccoon, opossum, red fox, and striped skunk. These species inhabit a variety of habitats consisting of forest, old field habitat, and developed areas. These species are opportunistic generalists and feed on a number of different food sources.

Eastern chipmunk and flying squirrels may be found in forests in the Project vicinity. While eastern chipmunks can be found in most forested areas, flying squirrels prefer mature woodlands and use cavities in large trees for nesting and winter denning (Michigan DNR, 2016). Eastern chipmunks have been observed in the forests in the Project area. Flying squirrels have not been directly observed, as they are more elusive and active at night, but are likely to be a year-round inhabitant within the Project area.

A number of bat species occur within Michigan. Little brown bat is the most common (Michigan DNR, 2016). Habitat and behavior of this species varies seasonally. Mating occurs in the early fall, followed by over-wintering in hibernacula such as caves, tunnels, and hollow trees. Females form small groups in spring and move into summer roosts where they bear and nurse their young (Michigan DNR, 2016). Males may be found in caves, forests, and occasionally attics in the spring and summer months. Little brown bats are expected to occur in the Project area spring through fall before moving to a hibernacula for winter. Little brown bat was recently listed as special concern in the state of Michigan; this species is discussed further in Section 4.3.7 below.

Other small mammal species that are likely to occur in the Project vicinity include numerous squirrel, mouse, vole, and shrew species. Example species include fox squirrel, gray squirrel, meadow vole, short-tailed shrew, deer mouse, and white-footed mouse.

Birds

Bird species that were observed, or are considered likely to occur within the Project boundary are those that are typical of the lower peninsula of Michigan.

Waterfowl and shorebirds observed in the Project area field investigations in 2015 included Caspian tern, common tern, double-crested cormorant, herring gull, and mallard ducks. Other common waterfowl, shorebirds, and avian species associated with aquatic environments species such as Bonaparte’s gull, Canada goose, common merganser, great blue heron, and least sandpiper are also likely to occur.

A diverse array of other species, such as corvids, woodpeckers, raptors, passerines, and game birds are also expected to occur in upland, shoreland, and wetland habitats of the Project area. Many of these are migratory species, but some, such as black-capped chickadee, white-breasted nuthatch, woodpecker species, and corvid species, are expected to remain in the Project vicinity year-round. A red-shouldered hawk, a species designated as Threatened by the State of Michigan, was heard flying over the Project area during the wildlife survey. This species is discussed further in Section 4.3.7 below.

Bank swallow, chipping sparrow, common yellowthroat, eastern phoebe, eastern towhee, field sparrow, great crested flycatcher, gray catbird, purple martin, red-eyed vireo, savannah sparrow, tree swallow, vesper sparrow, and yellow warbler are all migratory species (The Cornell Lab of Ornithology, 2016). These birds are likely to inhabit various respective habitats in the Project vicinity during temperate seasons. All of these species have potential to forage and/or breed within the Project area and immediate vicinity. All of these species are expected to migrate to warmer climates to overwinter.

According to the listing of Midwest Birds of Concern provided on the USFWS website (last updated January 9, 2015) (USFWS, 2016), several Birds of Concern are known or likely to occur within the Project area. Birds of Concern that are rare or declining include: bald eagle, common tern, northern flicker, and field sparrow. Birds of Concern that are migratory game birds (species that are of management concern due to their population status and/or recreational and socioeconomic value as a game species) include: Canada goose, mallard, and mourning dove. Birds of Concern that are superabundant (species whose abundance can sometimes cause conflicts with natural resources or human interests) include: Canada goose and double-crested cormorant. Of these, bald eagle, common tern, mallard, and double-crested cormorant were observed at the Project during the wildlife survey in 2015 (King & MacGregor Environmental, Inc., 2016b).

Bald eagles, once nearly extirpated in the United States, have made a successful comeback in recent years. Bald eagles have been re-established to the extent that the species was removed from the Federal endangered species list in 2007. Bald eagles are protected by the Federal Bald and Golden Eagle Protection Act. Bald eagles eat primarily fish, but are highly opportunistic and will consume various items including birds, reptiles, amphibians, crustaceans, small mammals, and carrion. Bald eagles are closely associated with water and frequently forage along the shorelines of lakes, reservoirs, rivers, marshes, and coasts. While bald eagles generally nest in the northern peninsula, they may be found throughout Michigan in the winter by areas of open water (Michigan DNR, 2016). An immature bald eagle was observed flying over the reservoir during the wildlife survey. Although no nests were observed, the forested portions of the Project could provide nesting opportunities for the bald eagle. Bald eagle is also listed as a special concern species in the state of Michigan; this species is discussed further in Section 4.3.7 below.

Double-crested cormorants (DCCO) are abundant along the shoreline of Lake Michigan. This species was almost driven to extinction between 1940 and 1970 due to the presence of dichlorodiphenyltrichloroethane (DDT) and other contaminants (Michigan DNR, 2005). Since this time, the DCCO population has rebounded and is now considered to be a nuisance. This species forages on fish in open water habitat. Individuals in the vicinity of the Project facilities have expressed concern that DCCO are too abundant and are causing declines in sport, commercial, and forage fish populations. Conflicts also arise with DCCO foraging on fish at aquaculture facilities, damaging vegetation and habitat used by other wildlife, damaging private property, and posing a risk of aircraft collisions near airports. An Environmental Assessment (EA) was prepared by several federal agencies to evaluate ways the agencies may work together to resolve conflicts with DCCOs in Michigan (USDA, 2011). The EA documented the need for cormorant damage management (CDM) in Michigan and assessed potential impacts on the human environment.

Comments on the PAD, filed by Pere Marquette Charter Township (PMCT), note that the DCCO, utilizes the Project breakwater. PMCT cites the report "Final Environmental Assessment: Double-crested cormorant damage management in Michigan" (USDA, et al. 2011), and states that use of the breakwater is discussed at length in the report. This report presents an assessment of alternatives for management of DCCO damage in Michigan.

King & MacGregor Environmental, Inc. (2016a) conducted a cormorant evaluation of the breakwater and tailrace at the Ludington Pumped Storage Plant. Observations ranged from approximately 1,000 individuals in the late afternoon on September 12, 2016 to approximately 500 individuals in the morning on September 13, 2016. 10-minute counts of DCCO between the breakwater and the pump station resulted in 21 individuals observed in-flight on September 12, 2018 and 12 individuals on September 13, 2016. DCCO were observed flying between the impoundment and the tailrace. Little cormorant feeding activity was observed in the tailrace. Overall, the colony was fairly inactive and individuals were easily counted.

Amphibians and Reptiles

A variety of amphibians and reptiles are likely to utilize the shorelines, wetlands, and adjacent upland areas in the Project area.

Turtles are located throughout Michigan in most aquatic habitats. They feed on plants, invertebrates, fish, birds, small mammals, and amphibians and spend much of their day basking on logs or buried in the mud. Examples of turtles that may be found in the vicinity of the Project include Blanding's turtle, common map turtle, common snapping turtle, and painted turtle.

Snakes use a variety of upland and wetland habitats for foraging and breeding. Their diets primarily include insects and small mammals. Examples of snakes that may be found in the vicinity of the Project include eastern garter snake, eastern hog-nosed snake, eastern massasauga, eastern milk snake, and northern ribbon snake. Eastern massasauga, a federally threatened and state special concern species, is described in further detail in Section 4.3.7 below. Eastern garter snake was observed during the wildlife survey. Snakes in the Project area are likely found adjacent to the Lake Michigan shoreline, in wetlands, grasslands, and woodlands.

Frogs, toads, and salamanders require open aquatic habitats for breeding. Eggs are typically laid on floating vegetation near the water surface and grow into tadpoles. Tadpoles primarily feed on aquatic invertebrates. Adults spend time in wetland environments or adjacent uplands foraging on a variety of insects. Examples of amphibians that may be found in the vicinity of the Project include American toad, blue spotted salamander, eastern tiger salamander, Fowler's toad, green frog, gray tree frog, northern leopard frog, northern spring peeper, western chorus frog, and wood frog. Amphibians in the Project area are likely found adjacent to the Lake Michigan shoreline, in wetlands, grasslands, and woodlands. The upper reservoir has little to no habitat for amphibians as natural vegetation is not present along the asphalt-lined slope.

4.3.4.2 Environmental Analysis

In SD 1, the Commission identified the following issues pertaining to wildlife under the category of Terrestrial Resources that the proposed relicensing of the Ludington Project could affect:

- Effects of continued project operation, including reservoir fluctuations on riparian, littoral and wetland habitats and associated wildlife.
- Effects of continued project operation, including maintenance activities (e.g., road maintenance, transmission line maintenance, and rights-of-way vegetation management), on wildlife habitat and associated wildlife.

Wetland Habitat and Associated Wildlife

Wetland, riparian, and littoral habitats within the Project boundary are primarily associated with the margins and near shore areas of Lake Michigan. Very little of these habitats are contained within the Project boundary. The NWI classifies Lake Michigan and the upper reservoir as lacustrine, limnetic deepwater habitats (L1BH) and Pigeon Lake as a river with an unconsolidated bottom and a permanently flooded waterway (RUBH) (Figure E 4.3.6-1). It should be noted, however, that while the reservoir holds water, it is a man-made structure with an asphaltic-concrete lined earthen embankments, and does not function as a natural wetland. As such, fluctuations in the upper reservoir water levels have no effect on wetlands or wildlife habitat neither of which are present within the upper reservoir impoundment.

The release of water from the upper reservoir to the lower reservoir has no influence upon the water level of the lower reservoir because of the large difference in the relative sizes of the two reservoirs. That is, Lake Michigan contains so much more water than the Project's upper reservoir that even if the upper reservoir was fully drained into Lake Michigan, the Lake's water level would not measurably change. Therefore Project induced fluctuations in the lower reservoir water levels have no effect on wetlands or wildlife habitat.

During the wildlife survey, one small stream and associated wetland was observed near the shoreline of Lake Michigan. This wetland is fed by groundwater and contains saw grass, sedge species and various trees and shrubs (King & MacGregor Environmental, Inc., 2016b). Groundwater flow is a result of springs located near the area of powerhouse excavation (contributes about 30 gallons per minute (gpm)) and the pumping relief wells along the downstream toe of the upper reservoir embankment (contributes approximately 200 gpm). Continued Project operation is not expected to negatively affect this wetland or associated wildlife.

Maintenance Activities

Maintenance activities, such as mowing, take place along roadways, and maintained recreational areas within the Project boundary. Mowing activities are primarily conducted in grasslands to maintain low-growing vegetation for the purpose of public safety, visibility, access, and public enjoyment. No rare species or host plants were observed in the maintained areas. Wild lupine, the host plant of Karner blue butterfly, was not observed in the Project area, therefore, Karner blue butterfly is unlikely to exist in the Project area and would not be affected by mowing.

Autumn olive is present within the Project boundary and surrounding areas. Shrubs are managed using cutting followed by herbicide application along the embankment. Mowing helps to control the spread of this invasive shrub in recreation areas, keeping grassland habitat open for deer, mice, raptors, and a variety of wildlife. A variety of other habitat, such as forests, dunes, bluffs, old fields, and meadows, are available in the Project area for wildlife that may be displaced following mowing.

The Project operation and maintenance has been consistent for over 40 years with little to no effect on wildlife resources within the Project boundary. Wildlife habitats and associated wildlife resources in the vicinity of the Project are determined primarily by the influences of the surrounding lands and associated uses. The Licensees are proposing no changes in operation. As a result, the Licensees anticipate that continued operation of the Ludington Project will not adversely affect wildlife or wildlife habitats.

4.3.4.3 Proposed Environmental Measures

In the past, the Licensees provided access to the breakwater for the USDA for a DCCO control program, which was consistent with the proposal in the report for control of DCCO (USDA, 2011). A recent federal court ruling, however, has rescinded USFWS depredation orders for DCCO in 24 states, including Michigan (PEER. 2016; US Federal Register 2014). The ruling means states no longer have broad authority to remove large numbers of DCCO, though they can still request permits on a much smaller scale (Outdoor News, 2016). The USDA ceased DCCO culls in 2016 to comply with the federal ruling. It is not currently known when, or if, the federal DCCO management program will resume. The USFWS is reviewing a potential DCCO management permit process, which may allow for management under certain circumstances. (USFWS consultation, 2016) The Licensees will support any future DCCO control activities proposed by the USDA and/or MDNR as sanctioned by the courts.

There are no other PME measures in-place relative to wildlife resources, and because there are no adverse impacts to these resources anticipated under proposed Project operations, none are proposed with respect to wildlife resources.

4.3.4.4 Cumulative Effects

In SD1, no potential cumulative effects to wildlife resources were identified as a potential concern at the Ludington Project. The Licensees' proposal to continue to operate and maintain the Project under the existing operating regime is not expected to result in either geographic or temporal cumulative impacts to wildlife.

4.3.4.5 Unavoidable Adverse Impacts

Continued operation of the Ludington Project, as proposed, will have no significant unavoidable adverse impacts to Project wildlife or their habitats.

4.3.4.6 References

King & MacGregor Environmental, Inc. 2016a. Ludington Pumped Storage Hydroelectric Project (FERC No. 2680-108) Cormorant Evaluation Summary.

King & MacGregor Environmental, Inc. 2016b. Ludington Pumped Storage Hydroelectric Project (FERC No. 2680-108) Wildlife Resources Report. Consumers Energy Company, DTE Electric Company.

Michigan Department of Natural Resources (Michigan DNR). 2005. Double-crested Cormorants in Michigan: A review of history, status, and issues related to their increased population. Report No. 2. August 2005. Available online: http://www.michigan.gov/documents/Cormorant_Report_136470_7.pdf

Michigan Department of Natural Resources (Michigan DNR). 2016. Available online: http://www.michigan.gov/dnr

Michigan State University Extension. 2013. Michigan Natural Features Inventory. http://mnfi.anr.msu.edu/

Outdoor News. 2016. Judge Puts Cormorant Management on Hold. June 16, 2016. Available online: http://www.outdoornews.com/2016/06/16/judge-puts-cormorant-management-on-hold/

PEER. 2016. Ken Stromborg, et al., v. United States Fish and Wildlife Service, et al. Case No. 14-1807-JDB. Plantiff's Supplemental Brief Regarding Remedy. Available online: https://www.peer.org/assets/docs/fws/5_26_16_PEER_brief.pdf

The Cornell Lab of Ornithology. 2016. All About Birds. Available online: http://www.birds.cornell.edu

U.S. Department of Agriculture (USDA), et al. 2011. Final Environmental Assessment: Double-Crested Cormorant Damage Management in Michigan. June 2011. Available online: https://www.fws.gov/midwest/midwestbird/documents/FINAL%20Michigan%20DCCO%20EA%206-14-11.pdf

U.S. Federal Register. 2014. Migratory Bird Permits; Extension of Expiration Dates for Double-Crested Cormorant Depredation Orders. Federal Register Volume 79, Number 102 (Wednesday, May 28, 2014). Available online: https://www.fws.gov/policy/library/2014/2014-12318.html

U.S. Fish and Wildlife Service (USFWS). 2016. Midwest Birds of Concern. Available online: https://www.fws.gov/midwest/midwestbird/concern.html

U.S. Fish and Wildlife Service (USFWS consultation). 2016. Personal communication/consultation between Rachael Pierce, USFWS, and Rita L. Hayen, TRC, regarding DCCO management.

4.3.5 Botanical Resources

The Project's location in Mason and Ottawa counties includes areas that lie within the Michigan Lake Plain Ecoregion. The Project satellite recreation area in Ottawa County is limited to the parking area, walking path and boardwalk, which are also part of the Consumers Energy's J.H. Campbell Generating Complex. This sandy coastal strip region has beaches, high dunes, beach ridges, mucky interior-dune depressions, and swales. The climate moderation by Lake Michigan, as well as the beach and dune plant communities, differentiate it from inland areas of Michigan. Plant communities include oak and pine forest found on stabilized dunes and beech-sugar maple forest on dunes and moraines. The relatively moderate climate has also made this area a center for fruit and vegetable farming in Michigan (USEPA 2012), and it is the most heavily farmed region in the state.

4.3.5.1 Affected Environment

Upland Habitat Communities and Species

Much of the land in this area has been altered significantly by agricultural practices. Lands abutting the Project boundary are largely agricultural with some year-round residential areas. Agricultural uses include fruit orchards and row crops.

Upland plant communities within the Project vicinity are dominated by second growth of hardwood mixed with eastern white pine and oaks. Other upland plant communities within the

Project area include early successional communities, open field and maintained lawn, and shrubland-meadow.

A botanical survey was conducted in August of 2015. (See Figures E-4.3.5-12 and E-4.3.5-13 for cover types within the Project boundary.) Based on this survey, habitat in the Project area surrounding the Ludington site is categorized into six main habitat types (King & MacGregor Environmental, Inc., 2015):

- Forested Areas: Forested areas include young, moderate age, and mature woodlands. Common species observed include sugar maple, American beech, white ash, big-toothed aspen, white pine and hemlock.
- Beach & Low Dunes: Beach and low dune areas are located along the Lake Michigan shoreline and are comprised mainly of low rolling dunes at the base of a steep bluff extending to the beach. These areas contain beach grass, dune reed, beach wormwood, common milkweed and willow species. One area contains a narrow stream/wetland complex that is dominated by smooth saw grass, sedges, and various trees and shrubs.
- Bluff Slope: Bluff slope includes the steep slope along Lake Michigan, consisting of trees and shrubs. These areas contained species such as white cedar, paper birch, and autumn olive.
- Old Field/Shrub Thickets: Old field and shrub thicket habitat consists of early successional species, most of which are naturalized or invasive non-native species. Common vegetation in this habitat type includes autumn olive, spotted knapweed, smooth brome, and orchard grass.
- Reservoir Slope/Meadow***:*** The downstream slope around the Ludington upper reservoir contains a mix of native and non-native grasses and other herbaceous vegetation. Common vegetation includes smooth brome and common milkweed. This area is occasionally spot treated to manage invasive shrubs and maintain grassland habitat.
- Maintained Recreational Areas: Maintained recreation areas, such as the amateur air field and the disc golf course, consist of open areas that are mowed and maintained for recreational use. Miscellaneous wooded and shrub areas are also located in the recreational areas. Numerous autumn olive shrubs are present in the shrub areas.

Habitat in the Project area surrounding the Port Sheldon Township Pigeon Lake Facility is categorized into four main habitat types (King & MacGregor Environmental, Inc., 2015):

- Riparian Edge: The riparian edge consists of herbaceous and shrubby vegetation along the Pigeon River's edge including plants such as dogwood, willow, and reed canary grass.

- Wooded Dune: Steep wooded dune slopes along Lake Michigan are composed mainly of sugar maple, sassafras, red oak, and American beech.
- Beach & Low Dune: Beach and low dune habitat is located along a portion of the path to the pier along the lakeshore. This habitat is comprised mainly of American beach grass and common milkweed.
- Maintained/Developed: The maintained and developed areas include roads to access marinas and boat docks along Pigeon River. In addition, there are some home sites along this route.

A list of common vegetation observed during the botanical survey is located in Table E-4.3.5-1 below. Comprehensive botanical survey data are located in the King & MacGregor Environmental, Inc. report (2015).

Table E-4.3.5-1: Common Upland Vegetation Observed within the Project Area

Common Name	Scientific Name	Ludington Site	Port Sheldon Site
Allegheny blackberry	*Rubus allegheniensis*	X	
American beach grass	*Ammophila breviligulata*	X	X
Autumn olive	*Elaeagnus umbellate*	X	
Basswood	*Tilia americana*	X	
Bayberry willow	*Salix myricoides*	X	
Beach wormwood	*Artemisia campestris*	X	X
Big-tooth aspen	*Populus grandidentata*	X	
Black locust	*Robinia pseudoacacia*	X	X
Bladder-campion	*Silene vulgaris*	X	
Blue spruce	*Picea pungens*	X	
Brittle-leaf sedge	*Carex eburnean*	X	
Broad loose-flower sedge	*Carex laxiflora*	X	
Bull thistle	*Cirsium vulgre*	X	X
Burdock	*Arctium minus*	X	
Butter-and-eggs	*Linaria vulgaris*	X	
Choke cherry	*Prunus virginiana*	X	X
Common milkweed	*Asclepias syriaca*	X	
Common St. John's-wort	*Hypericum perforatum*	X	
Common yarrow	*Achillea millefolium*		X
Crown vetch	*Coronilla varia*	X	X
Eastern arborvitae	*Thuja occidentalis*	X	

Common Name	**Scientific Name**	**Ludington Site**	**Port Sheldon Site**
Eastern bottle-brush grass	*Elymus hystrix*	X	
Eastern hemlock	*Tsuga canadensis*	X	
Eastern hop-hornbeam	*Ostrya virginiana*	X	X
Eastern serviceberry	*Amelanchier canadensis*	X	
Eastern white pine	*Pinus strobus*	X	
European white birch	*Betula pendula*	X	
Everlasting pea	*Lathyrus latifolius*	X	
Flat-top goldentop	*Euthamia graminifolia*	X	
Flat-stem blue grass	*Poa compressa*	X	X
Freshwater cordgrass	*Spartina pectinata*		X
Garden yellow-rocket	*Barbarea vulgaris*	X	
Garlic mustard	*Alliaria petiolata*		X
Glossy buckthorn	*Frangula alnus*	X	
Great mullein	*Verbascum thapsus*	X	X
Heart-leaf willow	*Salix cordata*	X	
Hedge parsley	*Torilis japonica*	X	
Herb-Robert	*Geranium robertianum*	X	
Japanese barberry	*Berberis thunbergii*	X	
Japanese knotweed	*Fallopia japonica*	X	
Large-leaf wood-aster	*Eurybia macrophylla*	X	
Little false bluestem	*Schizachyrium scoparium*	X	
Maple-leaf arrow-wood	*Viburnum acerifolium*	X	
Morrow’s honeysuckle	*Lonicera morrowii*	X	X
Multiflora rose	*Rose multiflora*	X	
Northern bracken fern	*Pteridium aquilinum*	X	X
Northern red oak	*Quercus rubra*	X	X
Orchard grass	*Dactylis glomerata*	X	X
Paper birch	*Betula papyrifera*	X	
Pennsylvania sedge	*Carex pensylvanica*	X	
Purple loosestrife	*Lythrum salicaria*		X
Quaking aspen	*Populus tremuloides*	X	X
Queen Anne’s lace	*Daucus carota*	X	X
Red bearberry	*Arctostaphylos uva-ursi*	X	
Redtop	*Agrostis gigantea*	X	
Reed canary grass	*Phalaris arundinacea*	X	X
Sassafras	*Sassafras albidum*	X	X

Common Name	Scientific Name	Ludington Site	Port Sheldon Site
Scotch pine	*Pinus sylvestris*	X	
Small-head rush	*Juncus brachycephalus*	X	
Smooth brome	*Bromus inermis*	X	X
Smooth saw-grass	*Cladium mariscoides*	X	
Smooth scouring-rush	*Equisetum laevigatum*	X	
Spotted knapweed	*Centaurea maculosa*	X	X
Staghorn sumac	*Rhus typhina*	X	
Sugar maple	*Acer saccharum*	X	
Tall goldenrod	*Solidago altissima*	X	X
Uptight sedge	*Carex stricta*	X	X
Wallflower cabbage	*Coincya monensis*		X
White ash	*Fraxinus americana*	X	
White spruce	*Picea glauca*	X	
Wild sarsaparilla	*Aralia nudicaulis*	X	
Wreath goldenrod	*Solidago caesia*	X	X

Source: King & MacGregor Environmental, Inc., 2015

Unique Plant Communities and Botanical Resources

No known unique plant communities or botanical resources are in the vicinity of the Project.

Invasive Plants and Noxious Weeds

The Michigan Department of Natural Resources (Michigan DNR) has published a plan that describes and documents the status and distribution of invasive plants within the State of Michigan (Michigan DNR 2009). Table E 4.3.5-2 lists potential invasive species within the Project vicinity and those observed during the botanical survey as marked with an "X." Due to the land use history in Mason and Ottawa Counties, many of these invasive species are present in the Project area; however, their presence or absence within the Project vicinity is not expected to be affected by the continued operation of the Project.

Invasive species locations in the Project area were mapped during the botanical survey (King & MacGregor Environmental, Inc., 2015). (Figures E-4.3.5-1 to E-4.3.5-4) Species included autumn olive, black locust, crown vetch, glossy buckthorn, great mullein, hedge parsley, Japanese barberry, Morrow's honeysuckle, purple loosestrife, reed canary grass, Russian olive, scotch pine, spotted knapweed, and wallflower cabbage. Autumn olive was the most abundant invasive species in the Project area, covering approximately 12 acres.

Figure E-4.3.5-1: Ludington Invasive Species Location 2a

Figure E-4.3.5-2: Ludington Invasive Species Location 2b

Figure 2b. Ludington Site

Aerial source: USDA, 2014

King & MacGregor Environmental, Inc.
2520 Woodmeadow SE
Grand Rapids, MI 49546
Tel: 616/957-1231 Fax: 616/957-2198

Figure E-4.3.5-3: Ludington Invasive Species Location 3c

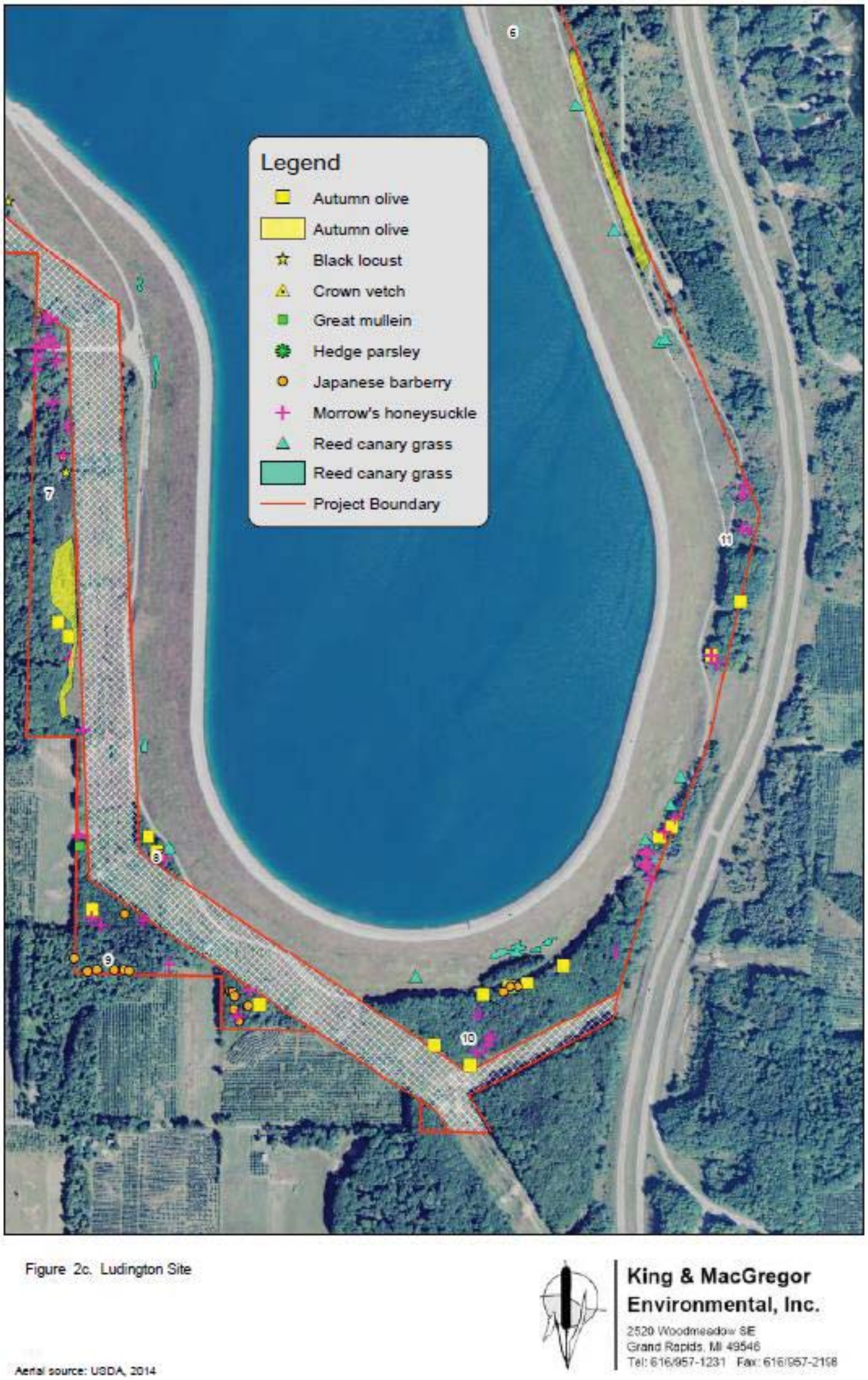


Figure E-4.3.5-4: Port Sheldon Invasive Species Location

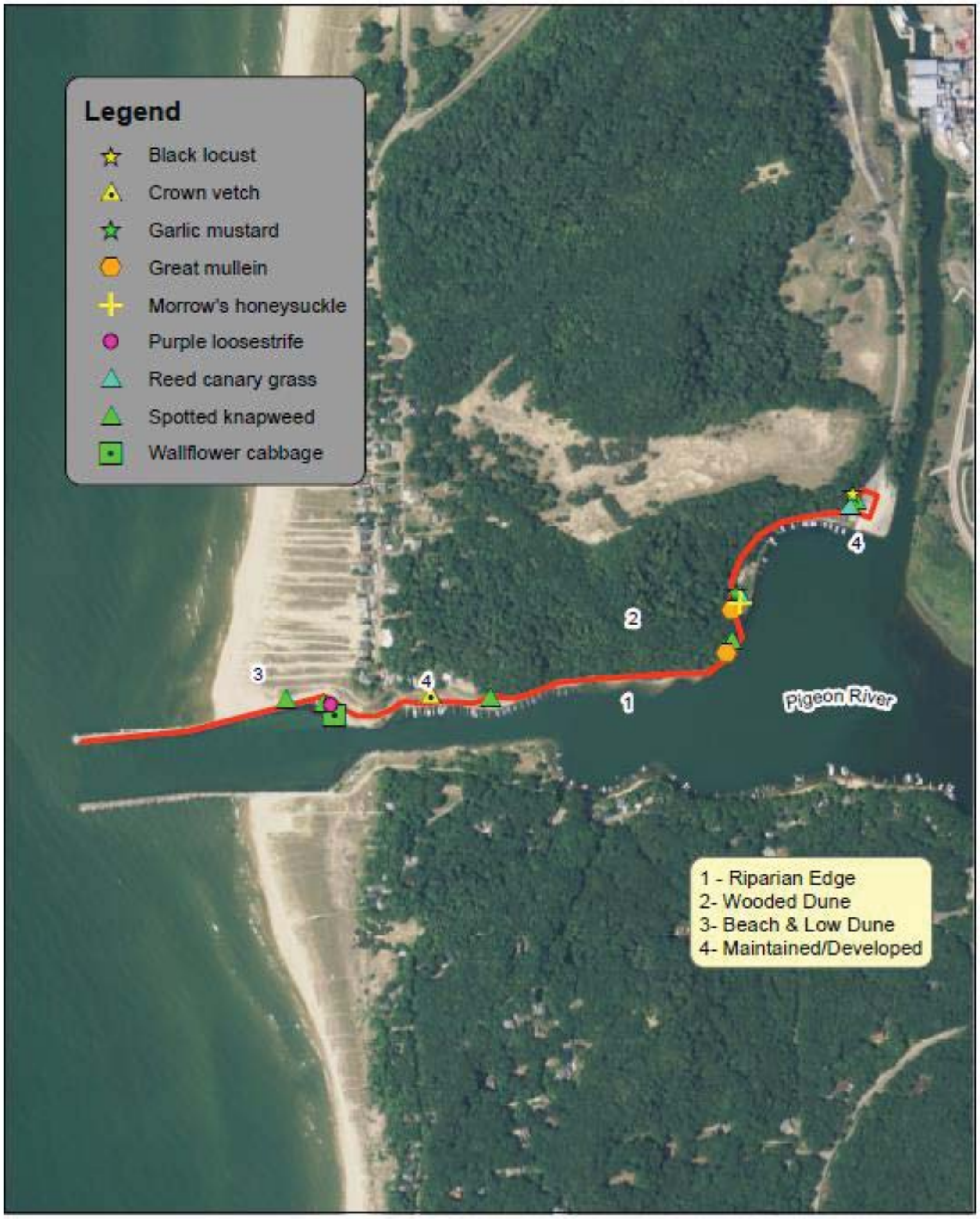


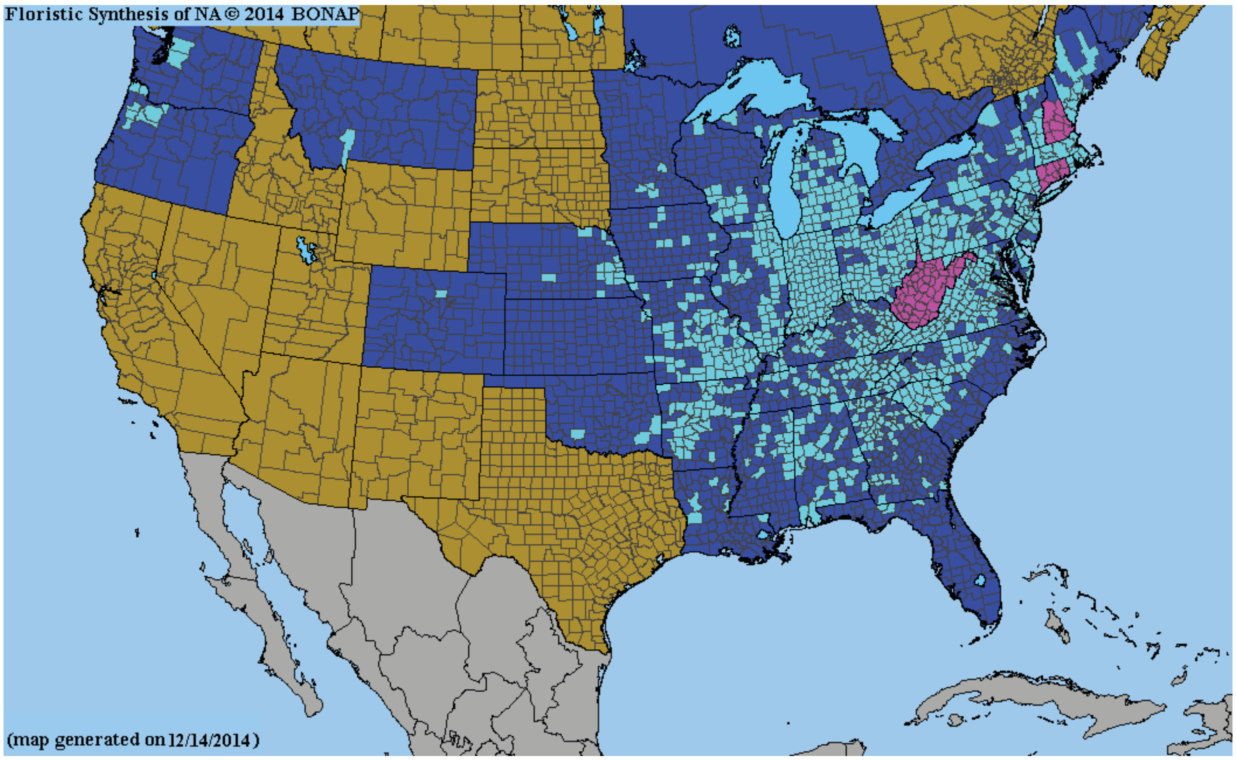
Figure 3. Port Sheldon Site

King & MacGregor Environmental, Inc.
2520 Woodmeadow SE
Grand Rapids, MI 49546
Tel: 616/957-1231 Fax: 616/957-2198

Aerial source: USDA, 2012

A map showing presence and absence of autumn olive by county across the United States was developed by the Biota of North America Program (BONAP). (Figure 4.3.5-5) According to this figure, autumn olive are present in many counties in midwestern and eastern states. In Michigan autumn olive is present in most counties located in the lower peninsula of Michigan, including Mason County.

Figure E-4.3.5-5: Autumn olive observations (BONAP VERSION)



BONAP Map Key:

Species present in state and exotic	Species noxious (includes noxious-weed seeds)
Species not present in state	Species exotic and present

Invasive species observation maps generated by the Midwest Invasive Species Information Network (MISIN) highlight the fact that these species are present throughout the Midwest and are not specific to the Project area. Species distribution data are based on user-supplied observations, which show relative abundance and are not intended to be range maps. Example observation maps generated by MISIN are depicted below (MISIN 2016). (Figures 4.3.5-6 through 4.3.5-11)

MISIN Map Key

- 1 – 9 Reported observations
- 10 – 99 Reported observations
- 100 – 999 Reported observations
- ≥ 1,000 Reported observations

Figure E-4.3.5-6: Autumn olive observations

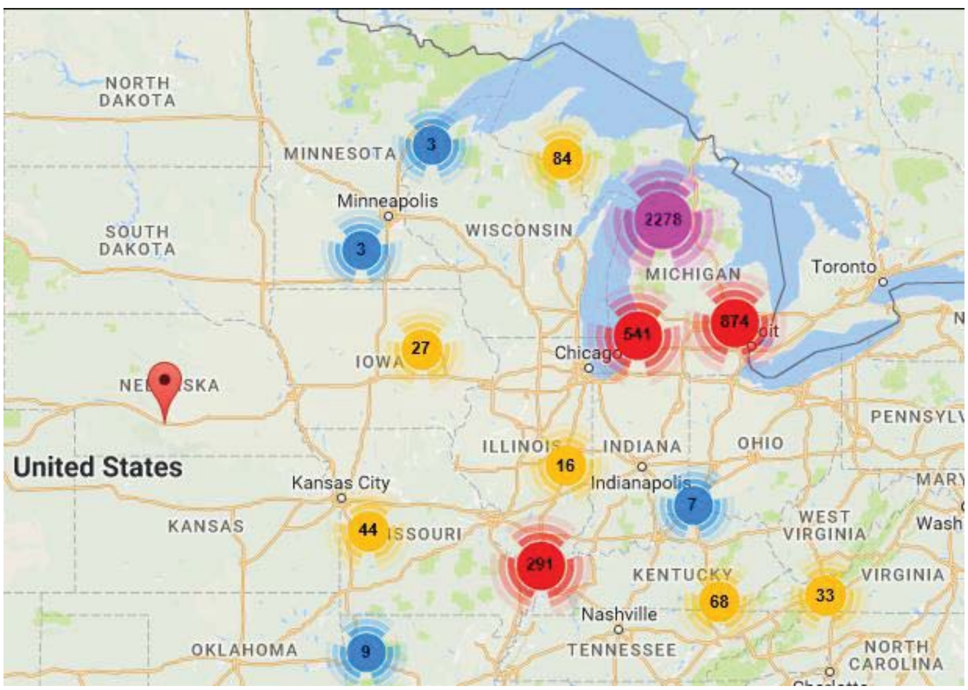


Figure E-4.3.5-7: Crown vetch observations

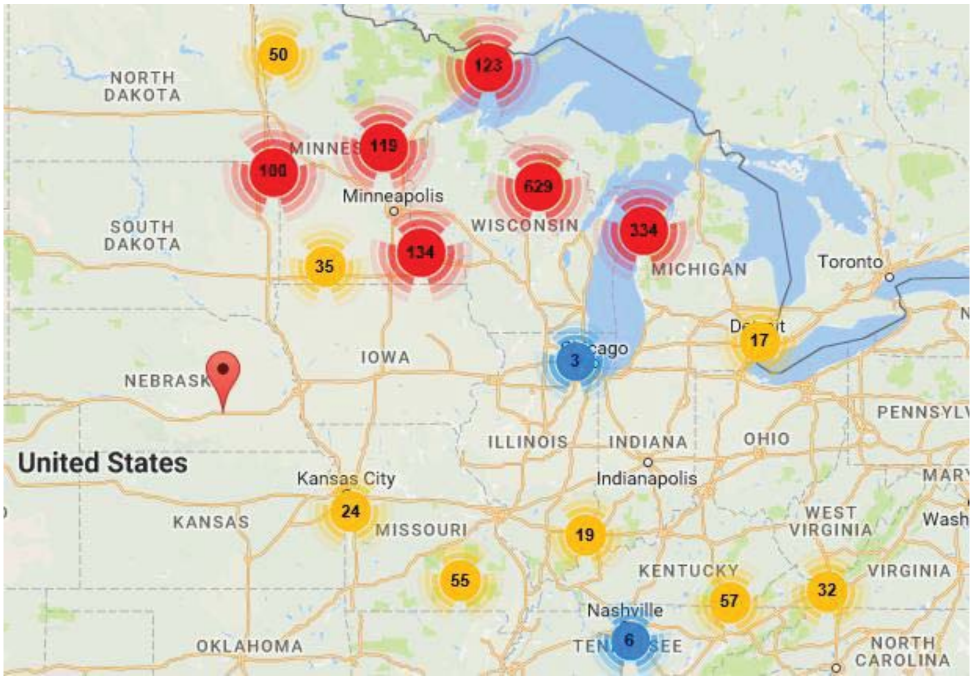


Figure E-4.3.5-8: Glossy buckthorn observations

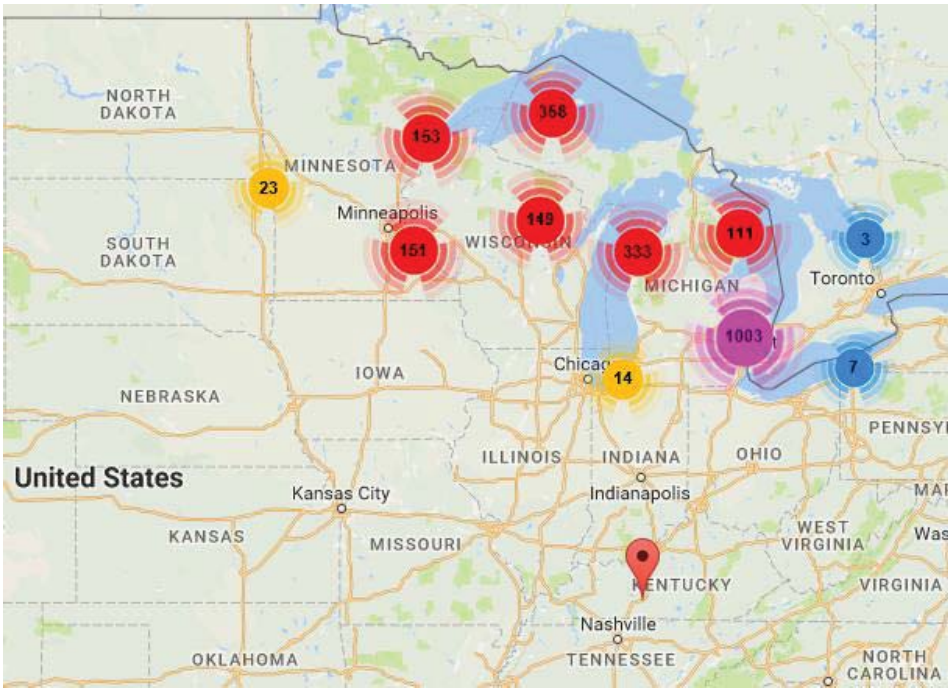


Figure E-4.3.5-9: Morrow's honeysuckle observations

Figure E-4.3.5-10: Purple loosestrife observations

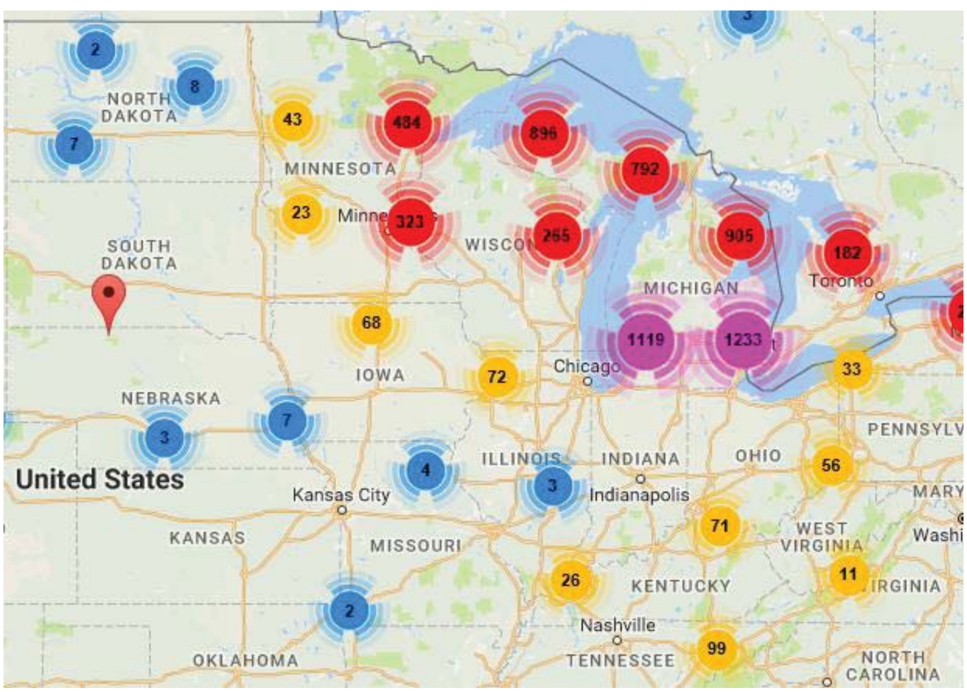


Figure E-4.3.5-11: Spotted knapweed observations

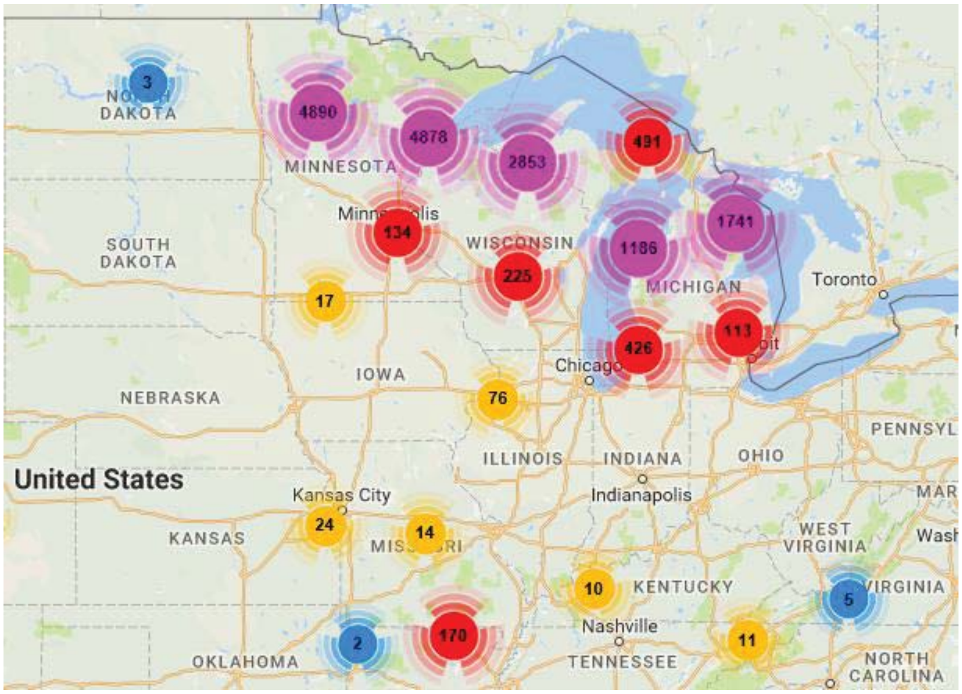


Table E-4.3.5-2: Potential Invasive Species within the Project Vicinity

Common Name	Scientific Name	Ludington Site	Port Sheldon Site
Terrestrial Plants			
Amur cork-tree	*Phellodendron amurense*		
Amur honeysuckle	*Lonicera maackii*		
Autumn olive	*Elaeagnus umbellate*	X	
Baby's breath	*Gypsophila paniculatus*		
Bell's honeysuckle	*Lonicera X bella*		
Black alder	*Alnus glutinosa*		
Black jetbead	*Rhodotypos scandens*		
Black locust	*Robinia pseudoacacia*	X	X
Canada thistle	*Cirsium arvense*		
Common buckthorn	*Rhamnus cathartica*		
Common reed	*Phragmites australis*		
Common St. John's-wort	*Hypericum perforatum*	X	
European fly honeysuckle	*Lonicera xylosteum*		
European highbush cranberry	*Viburnum opulus*		
Flowering rush	*Butomus umbellatus*		
Garlic mustard	*Alliaria petiolata*		X
Giant hogweed	*Heracleum mantegazzianum*		
Giant knotweed	*Polygonum sachalinensis*		
Glossy buckthorn	*Frangula alnus*	X	
Great mullein	*Verbascum thapsus*	X	X
Japanese barberry	*Berberis thunbergii*	X	
Japanese hedge-parsley	*Torilis japonica*	X	
Japanese honeysuckle	*Lonicera japonica*		
Japanese knotweed	*Fallopia japonica*	X	
Japanese stilt grass	*Microstegium vimineum*		
Kudzu	*Pueraria lobata*		
Leafy spurge	*Euphorbia esula*		
Money-wort	*Lysimachia nummularia*		
Morrow's honeysuckle	*Lonicera morrowii*	X	X
Multiflora rose	*Rosa multiflora*	X	
Norway maple	*Acer platanoides*		
Oriental bittersweet	*Celastrus orbiculatus*		
Privet	*Ligustrum obtrusifolium*		
Purple loosestrife	*Lythrum salicaria*		X

Common Name	Scientific Name	Ludington Site	Port Sheldon Site
Reed canary grass	*Phalaris arundinacea*	X	X
Reed mannagrass	*Glyceria maxima*		
Russian olive	*Elaeagnus angustifolia*	X	
Scotch pine	*Pinus sylvestris*	X	
Spotted knapweed	*Centaurea maculosa*	X	X
Swallowwort	*Vincetoxicum* species		
Swamp thistle	*Cirsium palustre*		
Tartarian honeysuckle	*Lonicera tatarica*		
Tree-of-heaven	*Ailanthus altissima*		
Wild parsnip	*Pastinaca sativa*		
Aquatic Plants			
Curly-leaf pondweed	*Potamogeton crispus*		
Eurasian water-milfoil	*Myriophyllum spicatum*		
European frog-bit	*Hydrocharis morsus-ranae*		
European water-clover	*Marsilea quadrifolia*		
Hydrilla	*Hydrilla verticillata*		
Lesser naiad	*Najas minor*		
Variable water-milfoil	*Myriophyllum heterophyllum*		
Water-hyacinth	*Eichhornia crassipes*		

Source: Michigan DNR 2009 and King & MacGregor Environmental, Inc., 2015.

Figure E-4.3.5-12: Cover Type Map Ludington Site

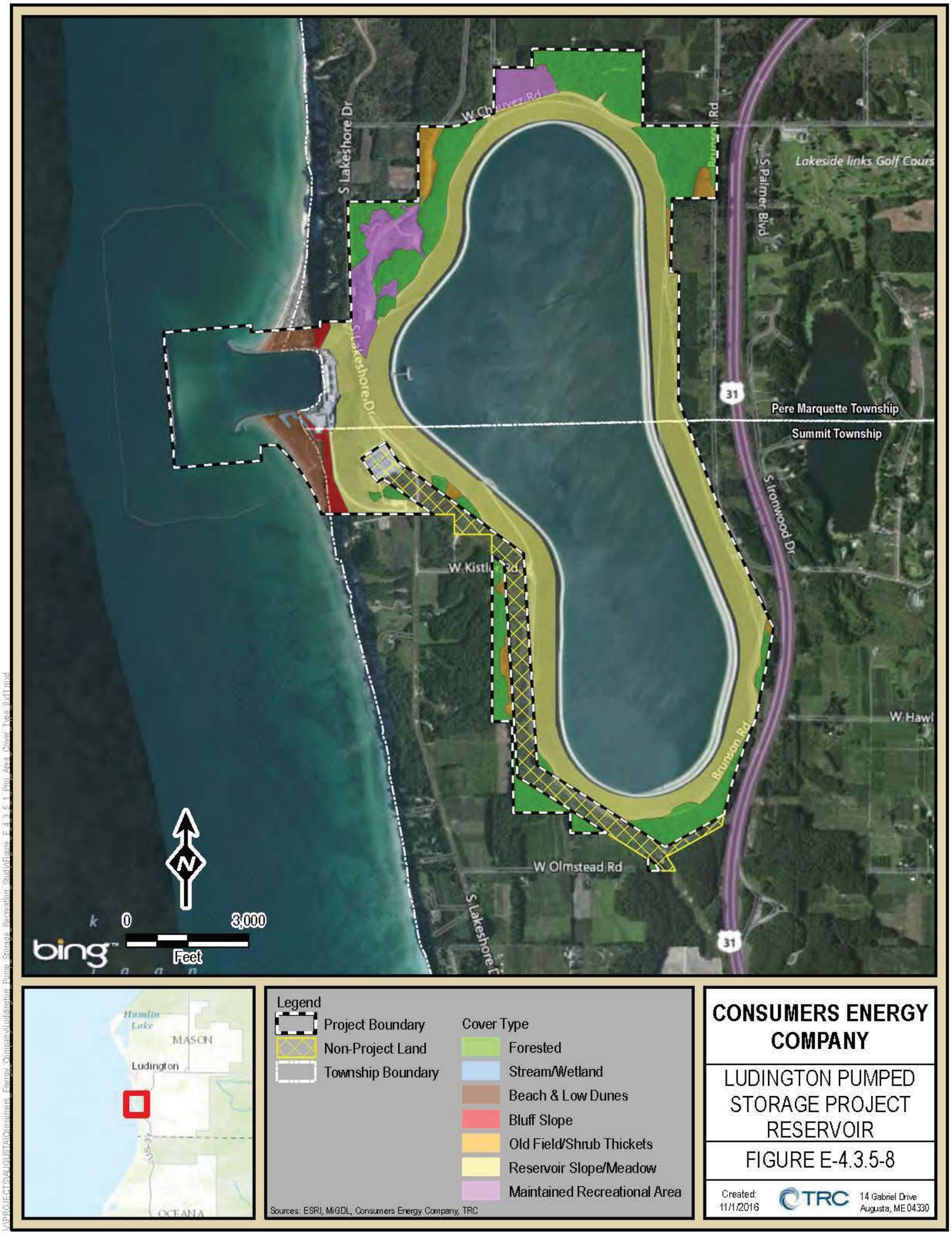


Figure E-4.3.5-13: Cover Type Map Port Sheldon Site

4.3.5.2 Environmental Analysis

In SD 1, the Commission identified the following issues pertaining to botanical resources under the category of Terrestrial Resources that the proposed relicensing of the Ludington Project could affect:

- Effects of continued Project operation, including reservoir fluctuations on riparian, littoral and wetland habitats and associated wildlife.

- Effects of continued Project operation, including maintenance activities (e.g., road maintenance, transmission line maintenance, and rights-of-way vegetation management), on wildlife habitat and associated wildlife.

- Effects of continued Project operation and maintenance on the introduction and establishment of invasive plant species in the Project area.

Wetland Habitat and Associated Wildlife

Very little wetland habitat is contained within the Project boundary. While the reservoir holds water, it is a man-made structure with an asphaltic-concrete lined earthen embankment, and does not support any wetland vegetation. The release of water from the upper reservoir to the lower reservoir has no influence upon botanical resources. As such, project related fluctuations in the upper and lower reservoir water levels have no effect on botanical resources.

During the wildlife survey, one small stream and associated wetland was observed near the shoreline of Lake Michigan. This wetland is fed by groundwater and contains saw grass, sedge species and various trees and shrubs (King & MacGregor Environmental, Inc., 2016). Continued Project operation will not negatively affect botanical resources in this wetland.

The SD1 comment pertaining to wetland habitat and associated wildlife was discussed in more detail in Section 4.3.4 Wildlife Resources above.

Maintenance Activities and Invasive Species

Maintenance activities, such as mowing, takes place along roadways, the maintained recreational areas and for dam safety inspections and security purposes within the Project boundary. The Licensees periodically mow small areas around the observation wells, pumping relief wells and lateral drains along the downstream toe of the upper reservoir embankment to facilitate visual inspections by Plant Operators and Security personnel. Mowing is also periodically conducted along the perimeter fence line for security purposes. Limited brush removal and herbicide treatments have also been conducted on the upper reservoir embankment to help facilitate dam safety inspections. Mason County maintains the campground and picnic/disc golf area and a path from the campground to the picnic area The County also maintains the public roads adjacent to and inside the project boundary (Lakeshore Drive). The Licensees reimburse Mason County for their costs maintaining and repairing Lakeshore Drive Bridge over the penstock slope. The Twisted Stick R/C Club maintains the grass runway for Hull air field. Mowing activities are primarily conducted in grasslands to maintain low-growing vegetation for the purpose of public safety, visibility, access, and public enjoyment. Mowing is conducted on an as-needed basis without the guidance of a formal vegetation maintenance plan. Herbicide is used occasionally by the Licensees or Mason County for spot treatment of weeds in maintained recreational areas, primarily around the camping area and for poison ivy control when it appears. Limited herbicide applications have occurred in natural areas within the Project area to facilitate ease of visual inspections for dam safety purposes.

No rare botanical species were observed in the maintained areas or other habitats within the Project area.

Areas that are regularly mowed are dominated by cool season grasses. While not native, these grasses are generally considered to be naturalized and pose little risk of further spread into natural areas. The grassland communities stabilize the soil and prevent erosion while providing a safe, aesthetically appealing feature on the landscape.

A variety of invasive species are present within the Project area and surrounding vicinity. While invasive species in the Project area are not actively controlled, mowing is a useful management tool for suppressing the growth of a variety of invasive species. Mowing helps to suppress growth of invasive shrubs, such as autumn olive, glossy buckthorn, honeysuckles, barberry, and multiflora rose.

Approximately 12 acres of autumn olive are found within Project area. This species is prevalent in the Project vicinity.

The presence of invasive species, such as autumn olive, in the vicinity of the Project is determined primarily by the influences of the surrounding lands and associated uses beyond the Licensees' control. The Project operation and maintenance has been consistent for over 40 years with little to no effect on botanical resources, including invasive species, within the Project boundary. The Licensees are proposing no changes in operation. As a result, the Licensees anticipate that continued operation of the Ludington Project will not adversely affect botanical resources and invasive species management is not proposed.

The SD1 comment pertaining to maintenance activities was also discussed in Section 4.3.4 Wildlife Resources above.

4.3.5.3 Proposed Environmental Measures

There are no existing PME measures in-place relative to botanical resources, and because there are no impacts to botanical resources anticipated under proposed Project operations, none are proposed.

Mason County maintains the grounds associated with the campground, and the picnic area (including the disc golf course). Hull air field is maintained by the Twisted Sticks R/C Club. The Licensees do not have a formal vegetative management program. The annual payment made by the licensees to Mason County includes maintenance of the campground and picnic areas, including mowing. The 2017 payment to Mason County was approximately $29,000. The Licensees propose to continue to provide annual payment to Mason County for maintenance of these areas.

4.3.5.4 Cumulative Effects

No potential cumulative effects to botanical resources have been identified as a potential concern at the Ludington Project. The Licensees' proposal to continue to operate and maintain the Project under the existing operating regime is not expected to result in either geographic or temporal cumulative impacts to botanical resources.

4.3.5.5 Unavoidable Adverse Impacts

Continued operation of the Ludington Project, as proposed, will have no significant unavoidable adverse impacts to existing Project botanical resources.

4.3.5.6 References

King & MacGregor Environmental, Inc. 2015. Ludington Pumped Storage Hydroelectric Project (FERC No. 2680-108) Botanical Resources Report. Consumers Energy Company, DTE Electric Company.

King & MacGregor Environmental, Inc. 2016. Ludington Pumped Storage Hydroelectric Project (FERC No. 2680-108) Wildlife Resources Report. Consumers Energy Company, DTE Electric Company.

Michigan DNR. 2009. Meeting the Challenge of Invasive Plants: A Framework for Action. Michigan Department of Natural Resources. Prepared by Michigan Natural Features Inventory. Report No. 2009-11. March 9, 2009.

Midwest Invasive Species Information Network (MISIN). 2016. Reported Species Observations. Available online: http://www.misin.msu.edu/browse/

The Biota of North America Program (BONAP). BONAP's North American Plant Atlas (NAPA). (US County-Level Species Maps: List by Genus) Available online: http://bonap.net/NAPA/Genus/Traditional/County

USEPA. 2012. Level III Ecoregions of Michigan. U.S. EPA Office of Research and Development (ORD) - National Health and Environmental Effects Research Laboratory (NHEERL). Corvallis, OR. [Online] URL: ftp://ftp.epa.gov/wed/ecoregions/mi/mi_eco_l3.zip.

USEPA. 2012. Level IV Ecoregions of Michigan. U.S. EPA Office of Research and Development (ORD) - National Health and Environmental Effects Research Laboratory (NHEERL). Corvallis, OR. [Online] URL:ftp://ftp.epa.gov/wed/ecoregions/mi/mi_eco_l4.zip.

4.3.6 Riparian, Wetland and Littoral

4.3.6.1 Affected Environment

Wetland, riparian, and littoral habitats within the Project boundary are primarily associated with the margins and near shore areas of Lake Michigan. (Figures E-4.3.5-12 and E-4.2.5-13) Very little of these habitats are contained within the Project boundary and what is included is not significantly affected by Project operations. US Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) data and digital orthophotography of the Project vicinity show that vegetated wetlands within and adjacent to the Project boundary include palustrine and lacustrine wetlands with unconsolidated bottoms (Figure E-4.3.6-1). Riparian habitat and each of the wetland types mapped by the NWI adjacent to, and within, the Project boundary are discussed in more detail below.

Riparian, Wetland and Littoral Habitat Types

Riparian Habitat

Riparian habitat is located along streams, rivers, and lakes, and provides important ecosystem functions related to hydrology and flooding, nutrient cycling, and plant and wildlife habitat (Mitsch and Gosselink, 2000). Riparian habitat in the Project area is located along the Pigeon River, Lake Michigan shoreline, and small stream near the Lake Michigan Shoreline in Mason County. Riparian habitat in the Project vicinity along Lake Michigan is largely dune area on the immediate shoreline surrounding the Plant’s powerhouse, which is situated on the shoreline. Areas inland from the dunes are residential in nature north of the powerhouse, and industrial and related to Project operations to the south of the powerhouse.

Wetlands

Wetlands have the potential to provide a variety of ecological functions including groundwater discharge/recharge, floodflow alteration, fish and shellfish habitat, sediment/toxicant/pathogen retention, nutrient removal/retention/transformation, production export, sediment/shoreline stabilization, and wildlife habitat. Wetlands also support human-defined values such as recreation, educational/scientific use, uniqueness/heritage, visual quality/aesthetics, and threatened/endangered species habitat (USACE, 1999). Understanding the distribution and characteristics of wetlands on the landscape is therefore useful for land use planning and management.

The NWI classifies Lake Michigan and the upper reservoir as lacustrine, limnetic deepwater habitats (L1BH) and Pigeon Lake as a river with an unconsolidated bottom and a permanently flooded waterway (RUBH) (Table E-4.3.6-1). It should be noted, however, that while the upper reservoir holds water, it is a man-made structure with an asphaltic-concrete lined earthen embankment, and does not function as a natural wetland. The NWI data indicate that there are no other wetlands in the Project area. Small wetlands classified as palustrine unconsolidated bottom (PUB) and palustrine forested (PFO) are located within the Project vicinity. Table E-4.3.6-2 lists vegetation common to the wetlands and shorelines of the region, as indicated by NWI data. Table E-4.3.6-3 lists wildlife that may utilize wetlands and shorelines in the vicinity of the Project.

Palustrine Unconsolidated Bottom – Palustrine unconsolidated bottom wetland includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones, and a vegetative cover less than 30%. These wetlands are characterized by the lack of large stable surfaces for plant attachment (Cowardin, 1979).

Palustrine Forested – Palustrine forested wetlands include wetlands characterized by wood vegetation 6 meters in height or taller. Wetlands typically contain an overstory of trees, understory of young trees and shrubs, and an herbaceous layer (Cowardin, 1979).

Table E-4.3.6-1: Wetlands within the Project Area

Riparian, Wetland and Littoral Habitat Types	Linear Feet (ft) or Acreage (ac)
Riparian Habitat	
Pigeon River	4,479 ft
Lake Michigan shoreline	2,544 ft
Stream near the Lake Michigan Shoreline in Mason County*	725 ft
Lacustrine Habitat	
Lake Michigan	115 ac
Upper Reservoir	842 ac
Palustrine Wetland Habitat	
Wetland associated with stream near the Lake Michigan Shoreline in Mason County*	1 ac

* This wetland/stream complex was observed during the wildlife and botanical surveys and is not mapped on the NWI

Table E-4.3.6-2: Common Wetland and Shoreline Vegetation within the Project Vicinity

Common Name	Scientific Name	Woody	Herbaceous
Arrowhead species	*Sagittaria*		X
Arrowwood	*Viburnum dentatum lucidum*	X	
Balsam fir	*Abies balsamea*	X	
Beggar-ticks species	*Bidens*		X
Black chokeberry	*Aronia melanocarpa*	X	
Black spruce	*Picea mariana*	X	
Bladderwort species	*Utricularia*		X
Bog laurel	*Kalmia polifolia*	X	
Bog rosemary	*Andromeda polifolia glaucopylla*	X	
Boneset	*Eupatorium perfoliatum*		X
Bunchberry	*Cornus canadensis*		X
Buttonbush	*Cephalanthus occidentalus*	X	
Canada mayflower	*Maianthemum canadense*		X
Cinnamon fern	*Osmunda cinnamomea*		X
Common cat-tail	*Typha latifolia*		X
Common horsetail	*Equisetum arvense*		X
Coontail	*Ceratophyllum demersum*		X
Cotton-grass species	*Eriophorum*		X
Cranberry species	*Vaccinium*	X	
Deer tongue grass	*Panicum clandestinum*		X
Eastern hemlock	*Tsuga canadensis*	X	
Eastern white pine	*Pinus strobus*	X	
Gray birch	*Betula populifolia*	X	
Green ash	*Fraxinus pennsylvanica*	X	
Highbush blueberry	*Vaccinium corymbosum*	X	
Labrador-tea	*Rhododendron groenlandicum*	X	
Leatherleaf	*Chamaedaphne calyculata*	X	
Maleberry	*Lyonia ligustrina*	X	
Marsh fern	*Thelypertis palustris pubescens*		X
Meadowsweet	*Spiraea alba latifolia*	X	
Mountain holly	*Nemopanthus mucronatus*	X	
Northern panic grass	*Panicum boreale*		X
Northern white-cedar	*Thuja occidentalis*	X	
Pickerelweed	*Pontedaria cordata*		X
Poverty oatgrass	*Danthonia spicata*		X

Common Name	Scientific Name	Woody	Herbaceous
Red maple	*Acer rubrum*	X	
Red osier dogwood	*Cornus stolonifera*	X	
Royal fern	*Osmunda regalis spectabilis*		X
Sedge species	*Carex*		X
Sensitive fern	*Onoclea sensibilis*		X
Silky dogwood	*Cornus amomum*	X	
Softstem bulrush	*Schoenoplectus tabernaemontanii*		X
Speckled alder	*Alnus incana Rugosa*	X	
Spike-rush species	*Eleocharis*		X
Swamp candles	*Lysimachia terrestris*		X
Sweet gale	*Myrica gale*	X	
Switchgrass	*Panicum virgatum var. spissum*		X
Tamarack	*Larix laricina*	X	
Tuberous white water-lily	*Nuphar odorata*		X
Water-parsnip	*Sium suave*		X
Wild-raisin	*Viburnum nudum cassinoides*	X	
Willow species	*Salix*	X	
Winterberry	*Ilex verticillata*	X	
Yellow birch	*Betula alleghaniensis*	X	

Table E-4.3.6-3: Common Wildlife Expected to Utilize Wetland and Shoreline Habitat within the Project Vicinity

COMMON NAME	SCIENTIFIC NAME
Mammals	
Eastern coyote*	*Canis latrans*
Little brown bat	*Myotis lucifugus*
Meadow vole*	*Microtus pennsylvanicus*
Opossum	*Didelphis marsupialis*
Raccoon	*Procyon lotor*
White-footed mouse	*Peromyscus leucopus*
White-tailed deer*	*Odocoileus virginianus*
Woodchuck	*Marmota monax*
Birds	
American crow*	*Corvus brachyrhynchos*
American robin	*Turdus migratorius*
Bald eagle*	*Haliaeetus leucocephalus*
Bank swallow	*Riparia riparia*
Barred owl	*Strix varia*
Black-capped chickadee	*Poecile atricapillus*
Blue jay	*Cyanocitta cristata*
Bonaparte’s gull	*Larus philadelphia*
Broad winged hawk	*Buteo platypterus*
Canada goose	*Branta canadensis*
Caspian tern*	*Hydroprogne caspia*
Common grackle	*Quiscalus quiscula*
Common merganser	*Mergus merganser*
Common raven*	*Corvus corax*
Common tern*	*Sterna hirundo*
Common yellowthroat	*Geothlypis trichas*
Double-crested cormorant*	*Phalacrocorax auritus*
Eastern bluebird*	*Sialia sialis*
Eastern kingbird	*Tyrannus tyrannus*
Eastern towhee	*Pipilo erythrophtalmus*
European starling	*Sturnus vulgaris*
Field sparrow	*Spizella pusilla*
Great blue heron	*Ardea herodias*

COMMON NAME	SCIENTIFIC NAME
Great Crested flycatcher	*Myiachus crinitus*
Herring gull*	*Larus argentatus*
House sparrow	*Passer domesticus*
Least sandpiper	*Calidris minutilla*
Mallard duck*	*Anas platyrhynchos*
Mourning dove	*Zenaida macroura*
Northern cardinal*	*Cardinalis cardinalis*
Northern flicker	*Colaptes auratus*
Osprey	*Pandion haliaetus*
Red-shouldered hawk*	*Buteo lineatus*
Red-tailed hawk	*Bueto jamaicensis*
Red-wing blackbird*	*Agelaius phoeniceus*
Ring-billed gull*	*Larus delawarensis*
Rock dove*	*Columba livia*
Savannah sparrow	*Passerculus sandwichensis*
Song sparrow	*Melospiza melodia*
Spotted sandpiper	*Actitis macularia*
Turkey vulture*	*Cathartes aura*
Wild turkey*	*Meleagris gallopavo*
Reptiles	
Blanding's turtle	*Emys blandingii*
Common map turtle	*Graptemys geographica*
Common snapping turtle	*Chelydra serpentina*
Eastern garter snake*	*Thamnophis sirtalis*
Eastern massasauga	*Sistrurus catenatus*
Painted turtle	*Chrysemys picta*
Amphibians	
Blue spotted salamander	*Ambystoma laterale*
Eastern American toad	*Bufo americanus*
Eastern tiger salamander	*Ambystoma tigrinum*
Fowler's toad	*Bufo fowleri*
Gray tree frog	*Hyla versicolor and H. chrysoscelis*
Green frog	*Rana clamitans*
Northern leopard frog	*Rana pipiens*
Northern spring peeper	*Pseudacris crucifer*

COMMON NAME	SCIENTIFIC NAME
Western chorus frog	*Pseudacris triseriata*
Wood frog	*Rana sylvatica*
Insects	
Monarch butterfly	*Danaus plexippus*
Cabbage white butterfly	*Pieris rapae*

* Wildlife species (or evidence of their presence through scat, feathers, tracks, calls, etc.) observed during the August 2015 survey (King & MacGregor Environmental, Inc., 2016b).

Source: Michigan State University, 2013 & Michigan DNR, 2016, King & MacGregor Environmental, Inc., 2016b

Figure E-4.3.6-1: Wetlands in the Project Vicinity

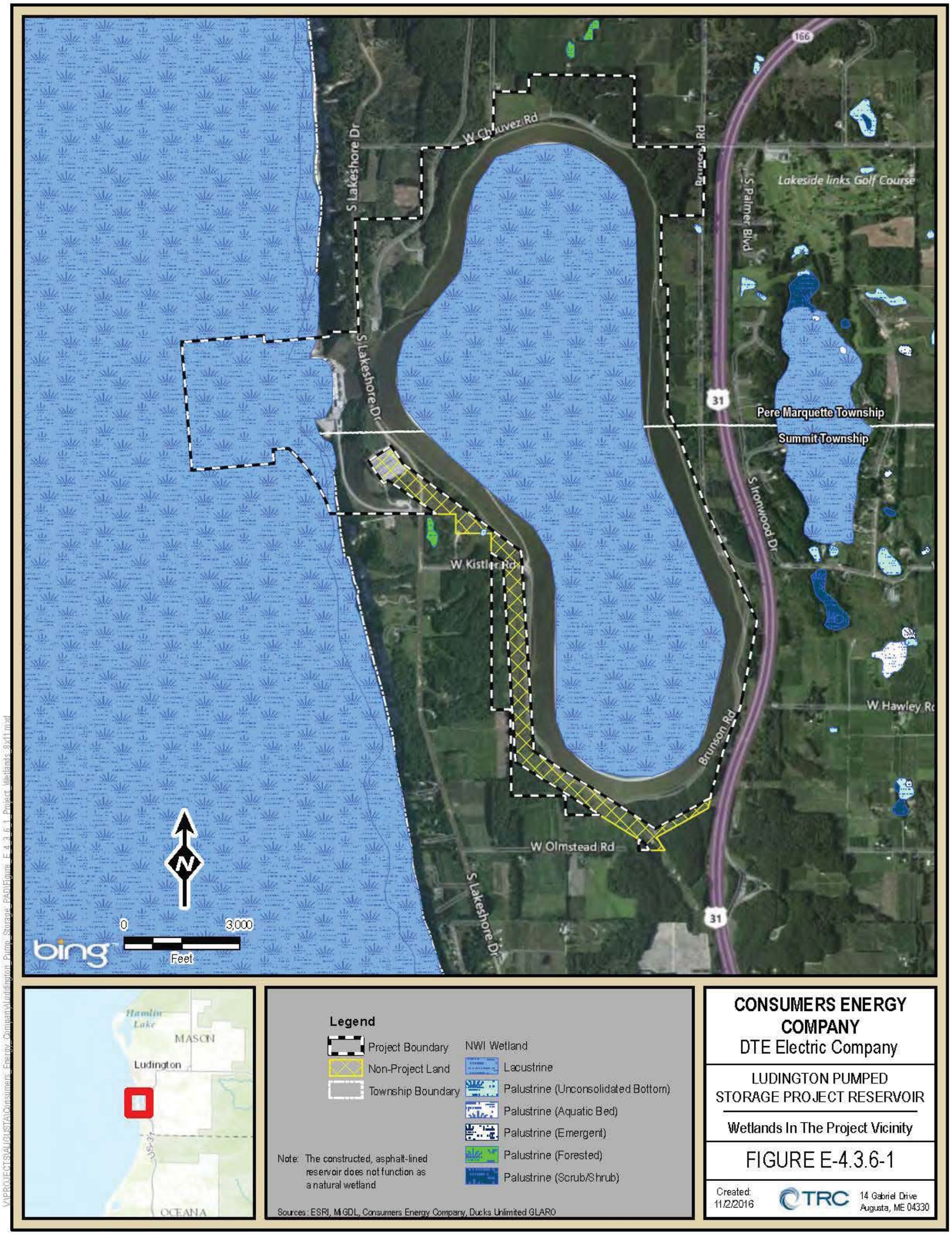
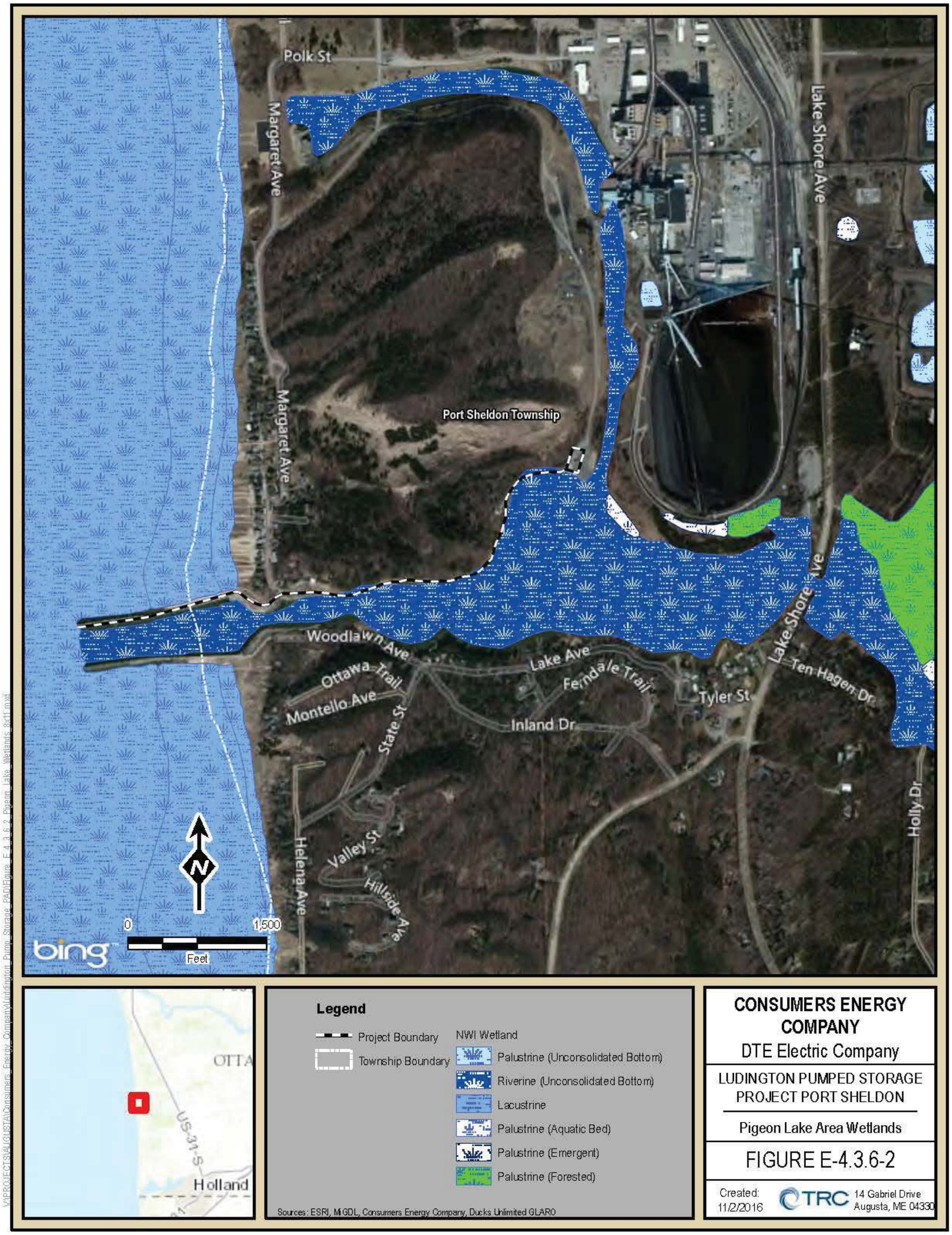


Figure E-4.3.6-2: Pigeon Lake Area Wetlands



Littoral Habitat

The littoral zone acts as an interface between the open water aquatic environment and that of the terrestrial environment. The size and extent of the littoral zone within a waterbody varies depending upon geomorphology and sedimentation within the aquatic system (Wetzel, 2001). Lake Michigan shoreline within the Project Boundary is limited and largely consists of the Project structures including the powerhouse. However, the two 1,600-foot long armor stone and sheet pile jetties that extend from the shoreline into Lake Michigan along with the 1,700-foot-long armor stone and rubble breakwater provide some functions of more traditional littoral habitat. These structures provide rocky substrate within the photic zone, which does not support submerged or emergent vegetation but likely supports algae and macroinvertebrate communities. As such, it also provides fish habitat in a form that is uncommon relative to nearby Lake Michigan littoral habitat consisting of finer substrates. Sand and gravel is the most common substrate along the shore of the lake within the Project boundary.

Few to no aquatic plant species vegetate the littoral zones and no mapped NWI submerged aquatic bed wetlands in Lake Michigan are in the Project Boundary.

Invasive Plants and Noxious Weeds

Invasive plants and noxious weeds that potentially exist within the Project Boundary are discussed in detail in Section 4.3.5. Invasive species observed during the botanical survey in wetland and shoreline areas are outlined in Table E-4.3.6-4 below.

Table E-4.3.6-4: Invasive Species Observed in Wetland and Shoreline Areas within the Project Boundary

Common Name	Scientific Name	Woody	Herbaceous
Autumn olive	*Elaeagnus umbellata*	X	
Black locust	*Robinia pseudoacacia*	X	
Crown vetch	*Coronilla varia*		X
Garlic mustard	*Alliaria petiolata*		X
Great mullein	*Verbascum thapsus*		X
Morrow's honeysuckle	*Lonicera morrowii*	X	
Purple loosestrife	*Lythrum salicaria*		X
Reed canary grass	*Phalaris arundinacea*		X
Scotch pine	*Pinus sylvestris*	X	
Spotted knapweed	*Centaurea biebersteinii*		X
Wallflower cabbage	*Coincya monensis*		X

4.3.6.2 Environmental Analysis

In SD 1, the Commission identified the following issues pertaining to riparian, wetland, and littoral habitat that the proposed relicensing of the Ludington Project could affect:

- Effects of continued project operation, including reservoir fluctuations on riparian, littoral and wetland habitats and associated wildlife.

Wetland Habitat

Wetland, riparian, and littoral habitats within the Project boundary are primarily associated with the margins and near shore areas of Lake Michigan. Very little of these habitats are contained within the Project boundary. The NWI classifies Lake Michigan and the upper reservoir as lacustrine, limnetic deepwater habitats (L1BH) and Pigeon Lake as a river with an unconsolidated bottom and a permanently flooded waterway (RUBH) (Figure E 4.3.6-1 and Figure 4.3.6-2). It should be noted, however, that while the reservoir holds water, it is a man-made structure with an asphaltic-concrete lined earthen embankment, and does not function as a natural wetland. As such, fluctuations in the upper reservoir water levels have no effect on wetland habitat.

The release of water from the upper reservoir to the lower reservoir has no influence upon the water level of the lower reservoir because of the vast difference in the relative sizes of the two reservoirs. That is, Lake Michigan contains so much more water than the Project's upper reservoir that even if the upper reservoir was fully drained into Lake Michigan, the Lake's water level would not measurably change. Project related fluctuations in the lower reservoir water levels, therefore, have no effect on wetland habitat.

During the wildlife survey, one small stream and associated wetland was observed near the shoreline of Lake Michigan. This wetland is fed by groundwater and contains saw grass, sedge species and various trees and shrubs (King & MacGregor Environmental, Inc., 2016). Groundwater flow is a result of springs located near the area of powerhouse excavation (contributes approximately 30 gallons per minute (gpm)) and the pumping relief wells along the downstream toe of the upper reservoir embankment (contributes approximately 200 gpm). Continued Project operation will not negatively affect this wetland.

4.3.6.3 Proposed Environmental Measures

There are no existing PME measures in-place relative to riparian, wetland, and littoral resources, and because there are no impacts to riparian, wetland, and littoral resources anticipated under proposed Project operations, none are proposed.

4.3.6.4 Cumulative Impacts

No potential cumulative effects to riparian, wetland, and littoral resources have been identified as a potential concern at the Ludington Project. The Licensees' proposal to continue to operate and maintain the Project under the existing operating regime is not expected to result in either geographic or temporal cumulative impacts to riparian, wetland, or littoral resources.

4.3.6.5 Unavoidable Adverse Impacts

Continued operation of the Ludington Project, as proposed, will have no significant unavoidable adverse impacts to existing Project riparian, wetland, or littoral resources.

4.3.6.6 References

Cowardin, L.M., V.C. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. United States Fish and Wildlife Service, Washington, D.C. 131 pp.

King & MacGregor Environmental, Inc. 2016. Ludington Pumped Storage Hydroelectric Project (FERC No. 2680-108) Wildlife Resources Report. Consumers Energy Company, DTE Electric Company.

Mitsch, W.J. and J.G. Gosselink. 2000. Wetlands. John Wiley & Sons, Inc, New York, New York. 920 pp.

United States Army Corps of Engineers New England District (USACE). 1999. The Highway Methodology Workbook Supplement. 32 pp.

United States Fish and Wildlife Service National Wetlands Inventory. Updated 2013. http://www.fws.gov/wetlands/Data/Mapper.html. [Accessed Sep 27, 2013]

Wetzel, R.G. 2001. Limnology: Lake and River Ecosystems. Academic Press.

4.3.7 Rare, Threatened and Endangered Species

4.3.7.1 Affected Environment

To assess the potential occurrence of terrestrial wildlife and botanical rare, threatened, and endangered (RTE) species in the Ludington Project area, the Licensees consulted several resources. Information requests were made to the USFWS and the Michigan Natural Features Inventory (MNFI) database and watershed element data were analyzed. The State of Michigan also identifies State Species of Special Concern. These special concern species do not meet the criteria established for being Federally listed, but are particularly vulnerable and could become threatened or endangered due to restricted distribution, low or declining numbers, specialized habitat needs, or other factors. Lists of Federal and State RTE and special concern species with documented occurrences in Mason County and Ottawa County and the potential to occur in the Project vicinity are provided in Tables E-4.3.7-1 to E-4.3.7-3.

A letter from the USFWS, dated July 1, 2011, indicated that piping plover, Karner blue butterfly, Indiana bat, Pitcher's thistle, and massasauga rattlesnake are listed for Mason County. The USFWS stated that they agreed with the determination of no effect to the listed species within the Project area (the request was made in reference to the unit upgrades). Since this time, the northern long-eared bat and Rufa red knot have also been added to the Mason County Federal RTE list. Consumers consulted with the USFWS on April 24, 2017 to confirm the potential RTE species in Mason and Ottawa Counties. The USFWS responded in an email dated May 16, 2017 indicating the messasauga rattlesnake be added to the Ottawa County list of threatened species.

Rare, Threatened and Endangered Aquatic Species

A few aquatic species, including the river redhorse (*Moxostoma carinatum*) and the cisco or lake herring (*Coregonus artedi*), are listed by the State of Michigan.[10] Table E-4.3.7-1 lists species documented by county in the MNFI that may be found in the vicinity of the Project.

Table E-4.3.7-1: Rare, Threatened, and Endangered (RTE) Aquatic Fauna Species that May Occur in the Project Vicinity

COMMON NAME	SCIENTIFIC NAME	STATUS[a]	COUNTY
Bigmouth shiner	*Notropis dorsalis*	SC	Ottawa
Cisco (lake herring)	*Coregonus artedi*	T	Mason[b]; Ottawa
Lake sturgeon	*Acipenser fulvescens*	T	Mason[b]
River redhorse	*Moxostoma carinatum*	T	Ottawa

[a] E (State Endangered), T (State Threatened), SC (State Special Concern), FE (Federal Endangered), FT (Federal Threatened), FC (Federal Candidate)
Source: Michigan Natural Features Inventory. 2016. Watershed Element Data (Web Application). Available online at http://mnfi.anr.msu.edu/data/watshd.cfm [Accessed October 24, 2016]
[b] Cisco and lake sturgeon are not listed as occurring in Mason County by the MNFI, however, cisco and lake sturgeon have been observed during barrier net monitoring.

[10] Rare, threatened and endangered fish species are also addressed in the Fisheries section, Section 4.3.3 of this document. A discussion of the protective fish net is also located in Section 4.3.3. The Licensees entered into an ongoing settlement to reduce the effects of project operation on RTE fish species. This Settlement Agreement was filed wih FERC on September 28, 1995.

Bigmouth shiner is a small minnow, attaining a maximum length of three inches. It is a special concern species in Michigan. Spawning occurs from late May through mid-August (MNFI, 2016). The bigmouth shiner prefers flowing water in streams less than three feet deep, and is occasionally found in larger rivers (MNFI, 2016). There is a low likelihood of this species occurring in Pigeon Lake. A County occurrence map for bigmouth shiner is included in Figure E-4.3.7-1 below.

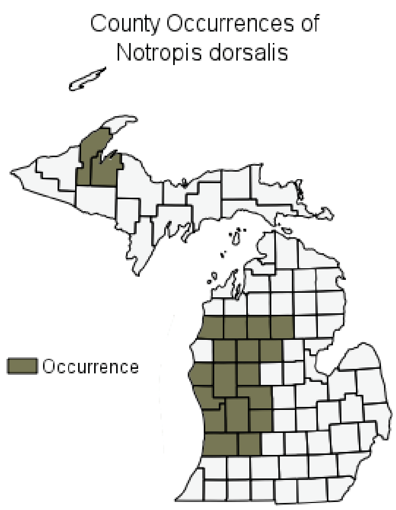


Figure E-4.3.7-1: County occurrence of bigmouth shiner

Image source: MNFI, 2016

Cisco, a native salmonid species, is a state-listed threatened species in Michigan (Figure E-4.3.7-2). They prefer deep water habitats of the Great Lakes and inland lakes. They may be found in shallower depths when spawning, which occurs late September through early December (MNFI 2016). Ciscos have become a relatively common fish in the barrier net monitoring program at LPSP in recent years, despite not being shown to be present in Mason County in the map below. There also is potential habitat for cisco in the Pigeon River and Lake Michigan immediately adjacent to the Port Sheldon Site (King & MacGregor Environmental, Inc., 2016).

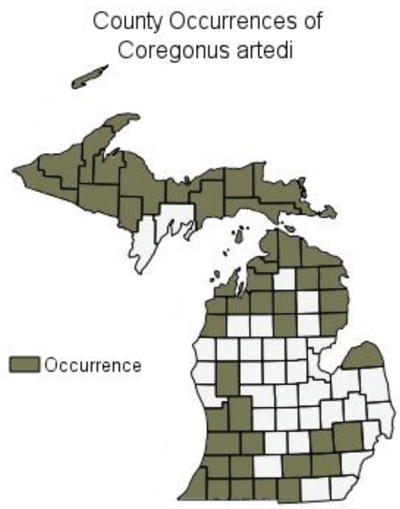


Figure E-4.3.7-2: County occurrence of cisco

Image source: MNFI, 2016

Lake sturgeon is a threatened species in Michigan (Figure E-4.3.7-3). It occurs in large rivers and shallow areas of large lakes, including Lake Michigan. Lake sturgeon return to the waters in which they were born to spawn, which occurs from the first week of May to the fourth week of June (MNFI, 2016). Although not specifically included in the range map (below) from MNFI, there is potential habitat for lake sturgeon in the waters of Lake Michigan adjacent to the Project.

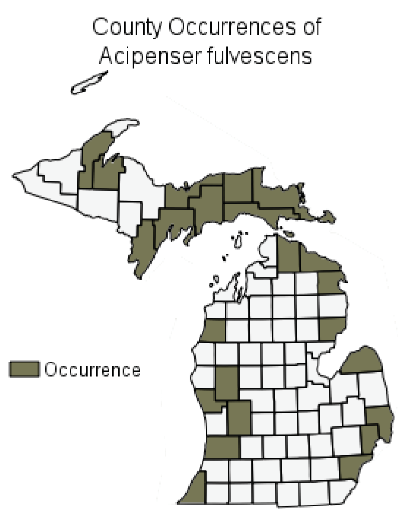


Figure E-4.3.7-3: County occurrence of lake sturgeon

Image source: MNFI, 2016

River redhorse is a threatened species in Michigan (Figure E-4.3.7-4). It prefers medium to large rivers with clean, swift flowing water (MNFI, 2016). There is potential habitat for river redhorse in the Pigeon River directly adjacent to the Port Sheldon Site (King & MacGregor Environmental, Inc. 2016).

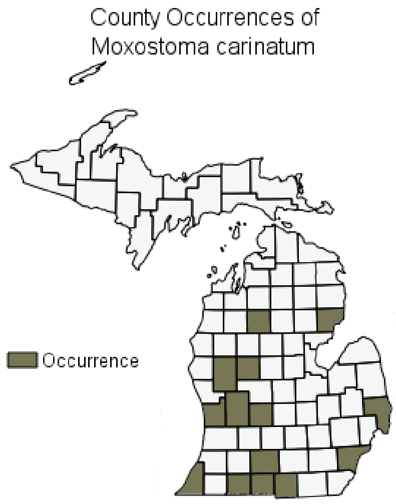


Figure E-4.3.7-4: County occurrence of river redhorse

Image source: MNFI, 2016

Essential Fish Habitat

Pursuant to the amended Magnuson-Stevens Fishery Conservation and Management Act (Act), Congress mandated that habitats essential to federally managed commercial fish species be identified, and that measures be taken to conserve and enhance habitat. In the amended Act, Congress defined essential fish habitat (EFH) for federally managed fish species as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NOAA Fisheries, 2017). There is no EFH mapped in the Project vicinity.

Rare, Threatened and Endangered Wildlife Resources

A review of the MNFI indicated that the species listed in Table E-4.3.7-2 have been documented within the vicinity of the Project.

Table E-4.3.7-2: Rare, Threatened, and Endangered (RTE) Terrestrial Fauna Species that May Occur in the Project Vicinity

COMMON NAME	SCIENTIFIC NAME	STATUS[a]	COUNTY
Birds			
Bald eagle	*Haliaeetus leucocephalus*	SC	Mason
Marsh wren	*Cistothorus palustris*	SC	Mason
Piping plover	*Charadrius melodus*	FE, E	Mason
Red-shouldered hawk	*Buteo lineatus*	T	Mason
Rufa red knot	*Calidris canutus rufa*	FT	Mason, Ottawa
Insects			
Karner blue butterfly	*Lycaeides melissa samuelis*	FE, T	Mason
Mammals			
Indiana bat	*Myotis sodalist*	FE, E	Mason, Ottawa
Little brown bat	*Myotis lucifugus*	SC	Mason
Northern long-eared bat	*Myotis septentrionalis*	FT, SC	Mason
Reptiles and Amphibians			
Blanchard's cricket frog	*Acris crepitans blanchardi*	T	Ottawa
Eastern box turtle	*Terrapene carolina carolina*	SC	Mason
Eastern massasauga	*Sistrurus catenatus*	FC, SC	Mason,Ottawa

[a] E (State Endangered), T (State Threatened), SC (State Special Concern), FE (Federal Endangered), FT (Federal Threatened), FC (Federal Candidate)
Source: Michigan Natural Features Inventory. 2016. Watershed Element Data (Web Application). Available online at http://mnfi.anr.msu.edu/data/watshd.cfm [Accessed October 24, 2016]. Source: U.S. Fish and Wildlife Service. 2016. Michigan County Distribution of Federally-Listed Threatened, Endangered, Proposed, and Candidate Species. http://www.fws.gov/midwest/endangered/lists/michigan-cty.html [Accessed October 21, 2016]

Wildlife surveys were performed at the Ludington Project in late July 2015 (King & MacGregor Environmental, Inc., 2016). Red-shouldered hawk was documented flying over the Project area. No other rare, threatened, or endangered wildlife species are documented to occur within the Project boundary.

Bald eagle is classified as Special Concern in Michigan (Figure E-4.3.7-5). They are also protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.), which states one cannot, "…take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or in any manner any bald eagle commonly known as the American eagle or any golden eagle, alive or dead, or any part, nest, or egg thereof ..." Bald eagles are large birds of prey that tend to nest near open water habitat. Nesting generally occurs between late March and mid-July (MNFI, 2016). They are sensitive to human disturbance during the first 12 weeks of the breeding season and a quarter mile buffer from nest sites is recommended (MNFI, 2016). An immature bald eagle was observed flying over the reservoir during the wildlife survey. Although no nests were observed, the forested portions of the Project could provide nesting opportunities for the bald eagle (King & MacGregor Environmental, Inc., 2016).

Figure E-4.3.7-5: County occurrence of bald eagle

Image source: MNFI, 2016

Marsh wren is classified as special concern in Michigan (Figure E-4.3.7-6). It lives in marshes dominated by dense stands of cattail and cord grass, with nests built in vegetation above standing water (MNFI, 2016). The only emergent wetland identified at the Project was associated with a stream along the lakeshore. That area does not appear large enough nor does it contain thick enough stands of vegetation to harbor the marsh wren (King & MacGregor Environmental, Inc., 2016).

Figure E-4.3.7-6: County occurrence of marsh wren

Image source: MNFI, 2016

Piping plover is both a federally and state endangered species (Figure E-4.3.7-7). These small shorebirds live on the beaches of Lake Michigan in areas with sparse vegetation and cobble. This migratory species arrives in Michigan during the end of April, nests between the end of April through the end of July, and then flies south for the fall migration between the end of July and mid-September (MNFI, 2016). The wildlife assessment determined that the piping plover may utilize the lakeshore beach with its scattered cobbles or the low dunes (King & MacGregor Environmental, Inc., 2016).

Figure E-4.3.7-7: County occurrence of piping plover

Image source: MNFI, 2016

Red-shouldered hawk is listed as threatened by the state of Michigan (Figure E-4.3.7-8). They prefer to nest in mature forests adjacent to wet meadows and swamps (MNFI, 2016). In Michigan, spring migration occurs between the end of February through mid-March, followed by nesting in late March through the end of June, and fall migration between the end of August and the end of October (MNFI 2016). Red-shouldered hawk was identified by its call, flying over the Project area during the wildlife survey (King & MacGregor Environmental, Inc., 2016). This bird was not visually verified and did not appear to stay in the area during the survey.

Figure E-4.3.7-8: County occurrence of red-shouldered hawk

Image source: MNFI, 2016

Rufa red knot is a federally threatened species (Figure E-4.3.7-9). It is one of the longest-distance migrants, traveling more than 9,300 miles between Tierra del Fuego and the central Canadian Arctic (USFWS, 2016). Food resources at stopover habitats along this migration route are critical to their survival. The migratory window extends between May and September (USFWS, 2016). While undetected during the wildlife survey, King & MacGregor Environmental, Inc. (2016) determined that the rufa red knot may utilize the Lake Michigan shoreline during migration.

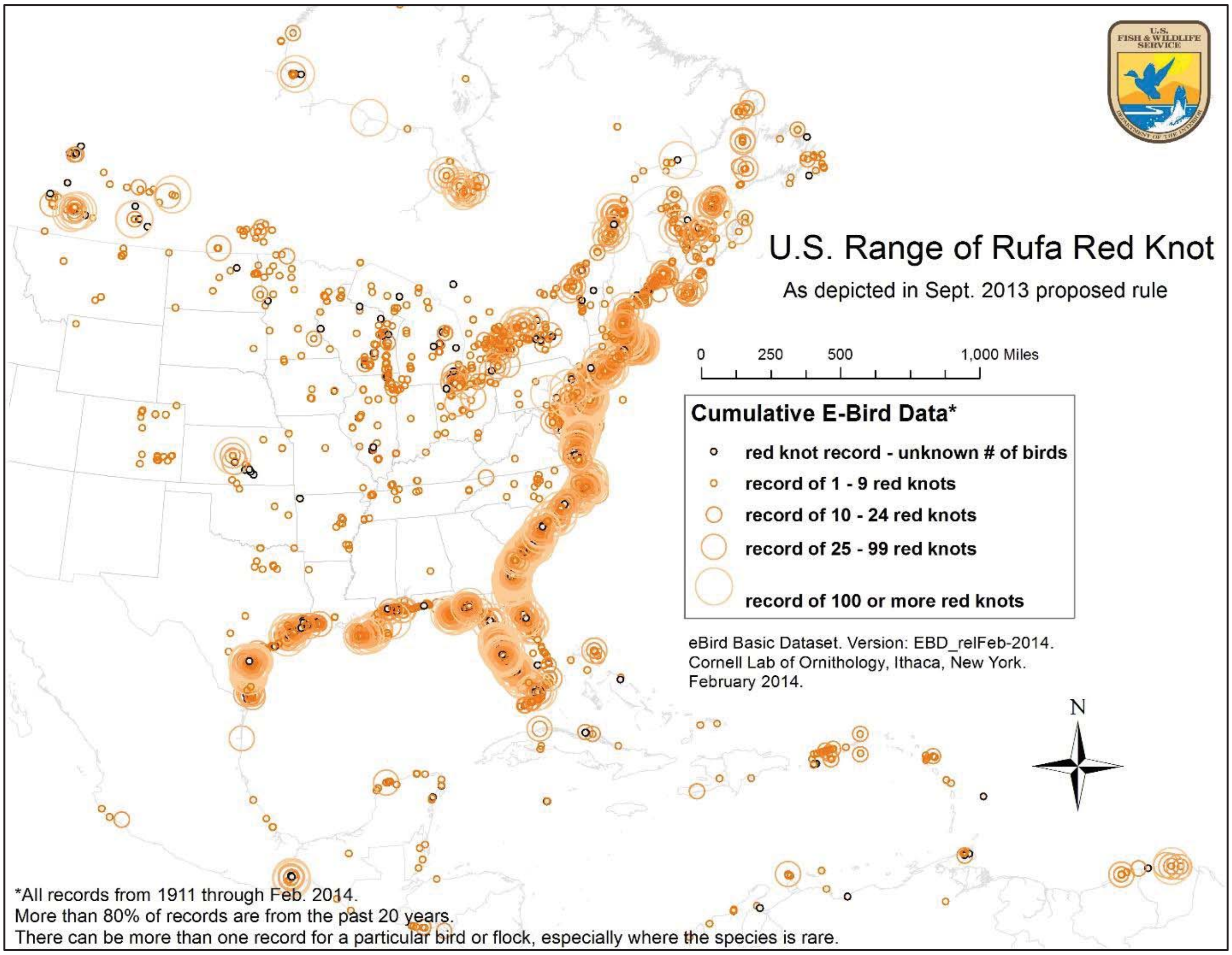


Figure E-4.3.7-9: U.S. range of rufa red knot

Image source: USFWS, 2016

Karner blue butterfly is a federally endangered and state threatened species in Michigan (Figure E-4.3.7-10). The larvae of Karner blue butterfly is dependent on wild lupine (*Lupinus perennis*), which typically grows in sandy soil in open habitats, such as savanna, and oak and pine-barrens. Adults feed on a variety of nectar plants. Adults have two flight periods in Michigan: mid-May through mid-June and mid-July through mid-August (MNFI, 2016). The wildlife survey determined that the Project area does not appear to contain adequate habitat for the Karner blue butterfly; lupine was not encountered in the open areas during this survey (King & MacGregor Environmental, Inc., 2016).

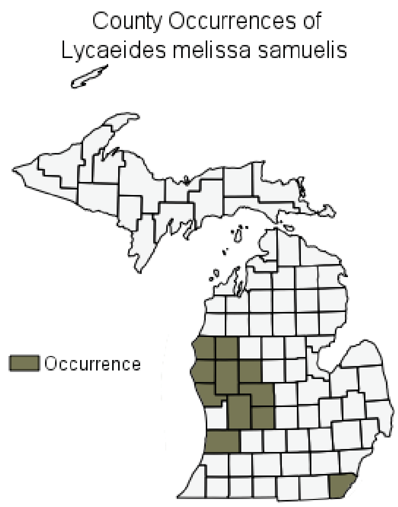


Figure E-4.3.7-10: County occurrence of Karner blue butterfly

Image source: MNFI, 2016

Three bat species, Indiana bat (federally and state endangered), little brown bat (state special concern), and northern long-eared bat (federally threatened and state special concern) are listed in Michigan. Bat populations are declining at alarming rates due to white-nose syndrome (WNS). WNS is a fungus that affects hibernating bats and causes high levels of mortality (USFWS, 2016). The current range of WNS is depicted in Figure E-4.3.7-11 below.

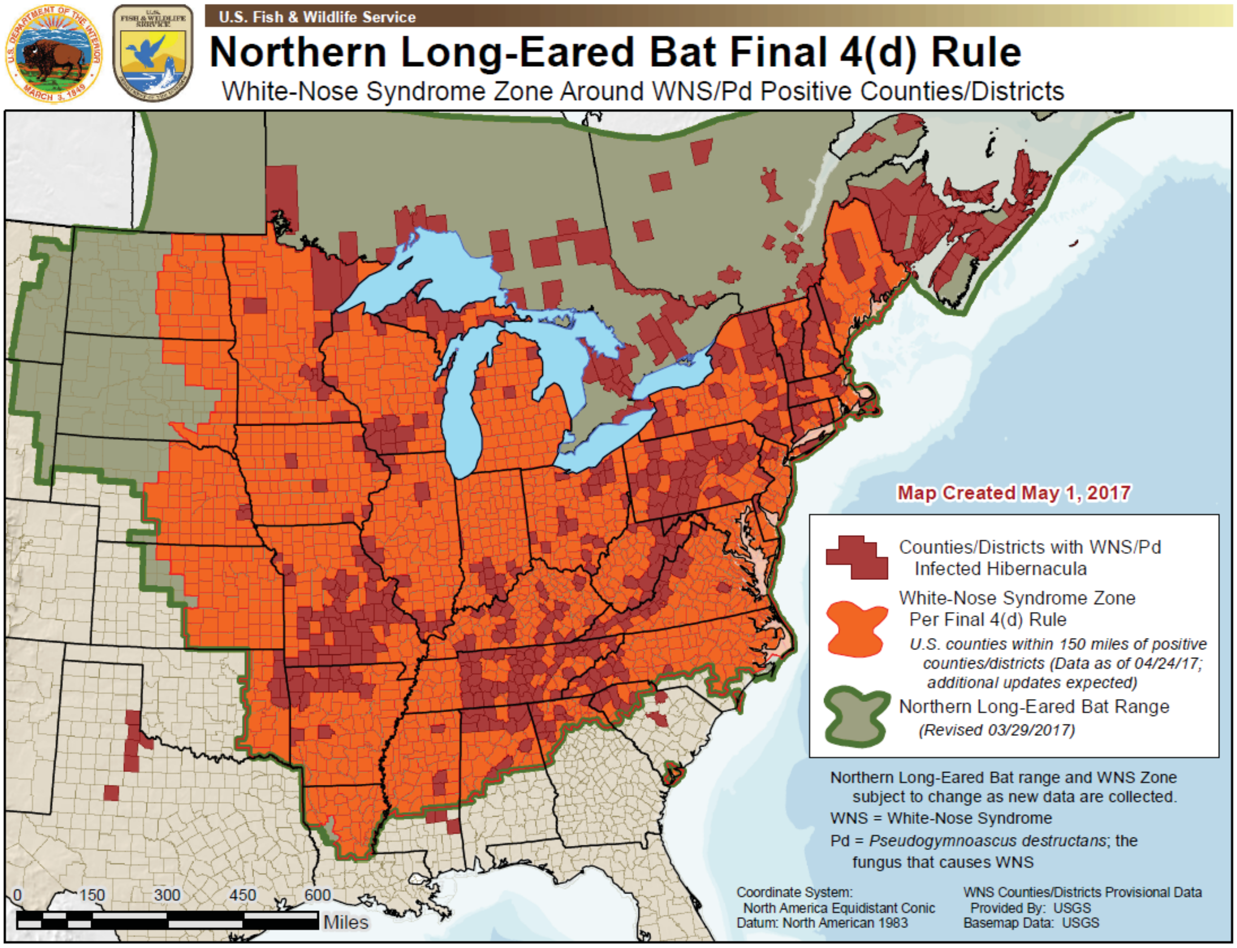


Figure E-4.3.7-11: White nose syndrome zone

Image source: USFWS, 2017

Indiana bats form maternity colonies and utilize roost trees during the summer months. During winter months, they hibernate in caves in Kentucky, Indiana, Missouri, and northern Michigan (MNFI, 2016). Spring migration in Michigan occurs between the end of April and the end of May and breeding occurs in October (MNFI, 2016). The MNFI does not list any documented occurrences of this species in Mason or Ottawa County (MNFI, 2016); however, the USFWS includes both counties within the species range (USFWS, 2016). The county occurrence in Michigan of Indiana bat is in Figure E-4.3.7-12. The wildlife survey stated that no Indiana bat habitat was identified in the Project area (King & MacGregor Environmental, Inc., 2016).

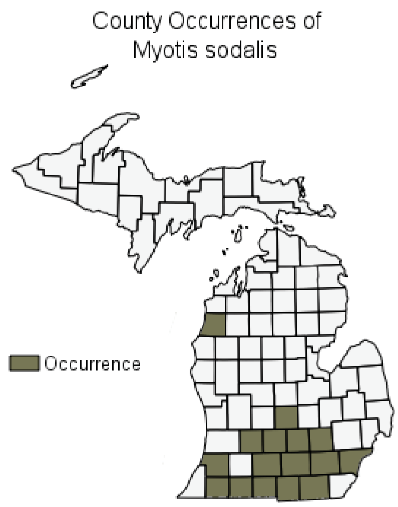


Figure E-4.3.7-12: County occurrence of Indiana bat

Image source: MNFI, 2016

Little brown bat is considered to be one of the most common bat species in the Midwest (Figure E-4.3.7-13). It has recently been listed as special concern in the state of Michigan due to concerns of WNS. Habitat and behavior of this species varies seasonally. Mating occurs in the early fall, followed by over-wintering in hibernacula such as caves, tunnels, and hollow trees. Females form small groups in spring and move into summer roosts where they bear and nurse their young (Michigan DNR, 2016). Males may be found in caves, forests, and occasionally attics in the spring and summer months. Little brown bats are expected to occur in the Project area spring through fall before moving to a hibernacula for winter. A site-specific search of the MNFI database indicated that little brown bat are documented to occur within the Project area.

Figure E-4.3.7-13: Range map of little brown bat

Image source: Discover Life, 2017

Northern long-eared bats are one of the species most affected by WNS (USFWS, 2016). In the summer, northern long-eared bats roost singly or in colonies underneath bark, in cavities or crevices in both live trees and in snags. Non-reproductive females and males sometimes also roost in cooler places, like caves or mines (USFWS, 2016). Northern long-eared bats spend the winter hibernating in hibernacula, which generally include caves or mines of varying sizes, with constant temperatures, high humidity, and no air current. Pregnant females roost in small colonies (generally 30 to 60 females and young) and give birth in the summer (USFWS, 2016). The county occurrence in Michigan of long-eared bats is in Figure E-4.3.7-14. The MNFI lists occurrences of this species in Mason County (MNFI, 2016). Potential habitat for Northern long-eared bats is present in most wooded areas, especially the mature woods within the Project area (King & MacGregor Environmental, Inc., 2016).

Figure E-4.3.7-14: County occurrence of northern long-eared bat

Image source: MNFI, 2016

Blanchard's cricket frog is listed as threatened by the state of Michigan Michigan (Figure E-4.3.7-15). This species inhabits areas of open water along the edges of ponds, lakes, bogs, seeps, and slow-moving streams and rivers (MNFI, 2016). Blanchard's cricket frog is active between late March and late October, with breeding occurring between late May and late July (MNFI, 2016). Blanchard's cricket frog is known to exist in the vicinity of the Port Sheldon Site and could inhabit the areas adjacent to the boardwalk and path, although no amphibians were encountered during the wildlife survey (King & MacGregor Environmental, Inc., 2016).

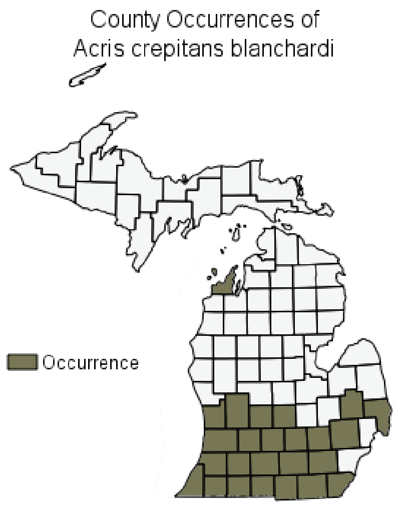


Figure E-4.3.7-15: County occurrence of Blanchard's cricket frog

Image source: MNFI, 2016

Eastern box turtle is listed as a special concern species by the state of Michigan (Figure E-4.3.7-16) This terrestrial turtle prefers forested habitats with sandy soil, but may also be found in thickets, old fields, pastures, or vegetated dunes near open water (MNFI, 2016). Nesting sites in sunny, sandy locations is necessary for successful reproduction (MNFI, 2016). The wildlife survey stated that due to the relative lack of wetland within the forested areas in the Project area, little if any potential box turtle habitat is likely present (King & MacGregor Environmental, Inc., 2016).

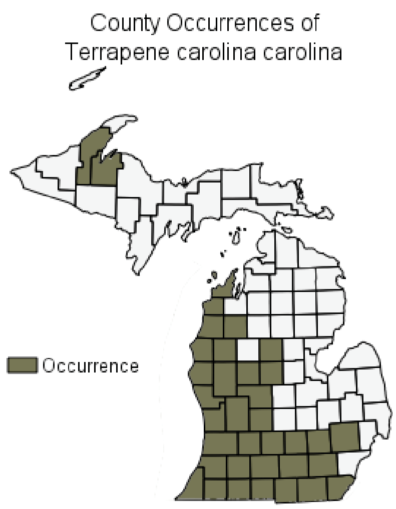


Figure E-4.3.7-16: County occurrence of eastern box turtle

Image source: MNFI, 2016

Eastern massasauga has recently been listed as a federally threatened species and is also a special concern species by the state of Michigan (Figure E-4.3.7-17). The eastern massasauga is a small venomous rattlesnake that prefers wetland habitats such as prairie fens, open wetlands, and lowland coniferous forests (MNFI, 2016). They hibernate below the frost line in crayfish burrows, small animal burrows, tree root networks, or rock crevices in or near wetlands or areas with a high water table (MNFI, 2016). The wetland habitat associated with the wetland and stream along the Lake Michigan shoreline area of the Project could provide habitat for the eastern massasauga (King & MacGregor Environmental, Inc., 2016).

Figure E-4.3.7-17: County occurrence of eastern massasauga

Image source: MNFI, 2016

Rare, Threatened and Endangered Botanical Resources

The Project area and immediate vicinity includes upland and shoreline habitat associated with Lake Michigan and Pigeon Lake. No records for rare or exemplary natural communities within the Project area were found. A review of the MNFI indicated that the species listed in Table E-4.3.7-3 have been found in the Project vicinity; however, these species have not been documented within the Project boundary.

Table E-4.3.7-3: Rare, Threatened, and Endangered (RTE) Floral Species that May Occur in the Project Vicinity

COMMON NAME	SCIENTIFIC NAME	STATUS[a]	COUNTY
Plants			
Ginseng	*Panax quinquefolius*	T	Mason, Ottawa
Pitcher's thistle	*Cirsium pitcheri*	FT, T	Mason, Ottawa

[a] E (State Endangered), T (State Threatened), SC (State Special Concern), FE (Federal Endangered), FT (Federal Threatened), FC (Federal Candidate), PFE (Proposed Federal Endangered)
Source: Michigan Natural Features Inventory. 2016. Watershed Element Data (Web Application). Available online at http://mnfi.anr.msu.edu/data/watshd.cfm [Accessed October 24, 2016]
Source: U.S. Fish and Wildlife Service. 2016. Michigan County Distribution of Federally-Listed Threatened, Endangered, Proposed, and Candidate Species. http://www.fws.gov/midwest/endangered/lists/michigan-cty.html [Accessed October 21, 2016]

Botanical surveys were performed at the Port Sheldon Site on August 3, 2015 and at the Ludington Site on August 27 and 28, 2015. No RTE botanical species were observed within the Project area.

Ginseng is listed as a threatened species by the state of Michigan (Figure E-4.3.7-18). This perennial forb is found in rich forests with loamy soils (MNFI, 2016). Populations have declined throughout the state due to illegal harvesting of the plant's roots for herbal remedies. The botanical survey identified three locations within the Project area that, given the vegetative and physical characteristics of the woods, appeared more likely to contain ginseng. Thorough observations were conducted in these areas; however, no ginseng was identified in these or other areas (King & MacGregor Environmental, Inc., 2015).

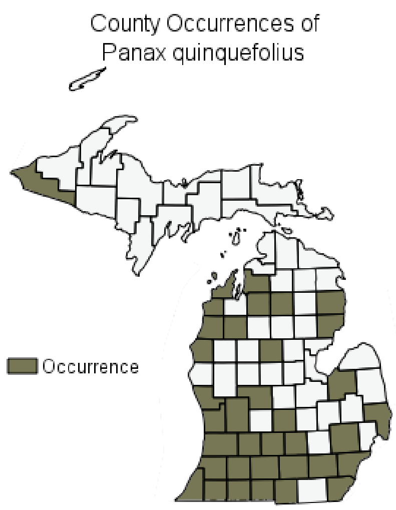


Figure E-4.3.7-18: County occurrence of ginseng

Image source: MNFI, 2016

Pitcher's thistle is both a federal and state threatened species. This perennial plant is endemic to the Great Lakes shorelines and is found in open dune habitat (MNFI, 2016). Figure E-4.3.7-19 depicts the Michigan counties in which Pircher's thistle has occurred. The beach and low dunes areas at the Ludington and Port Sheldon sites consist of potential habitat for the Pitcher's thistle; however, despite a thorough evaluation, no Pitcher's thistle was observed during the botanical survey (King & MacGregor Environmental, Inc., 2015).

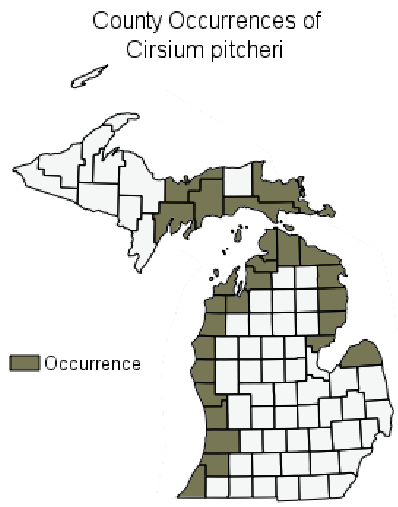


Figure E-4.3.7-19: County occurrence of Pitcher's thistle

Image source: MNFI, 2016

4.3.7.2 Environmental Analysis

In SD 1, the Commission identified the following issues pertaining to RTE resources under the category of Terrestrial Resources that the proposed relicensing of the Ludington Project could affect:

- Effects of continued Project operation and maintenance on the federally endangered Indiana bat, piping plover, Karner blue butterfly and the federally threatened pitcher's thistle.
- Effects of continued Project operation and maintenance on Michigan state species of special concern, including bald eagle, marsh wren, eastern box turtle and ginseng.

Effects on Federally Listed Species

Indiana bat has not been documented to occur within Mason or Ottawa County (MNFI, 2016), nor was appropriate habitat found during the wildlife survey. Therefore, continued Project operation and maintenance is highly unlikely to have an affect on this species.

Northern long-eared bat may, however, occur within the Project area. This species would be negatively affected by tree clearing activities during the female roosting period. The northern long-eared bat was listed as federally threatened on April 2, 2015 with an interim 4(d) rule. The final 4(d) rule was posted to the Federal Register on January 14, 2016. Section 4(d) of the ESA allows the USFWS to use special rules for species listed as threatened (not endangered) that provide flexibility in implementing the ESA. Targeted activities that do not harm the species continued existence are allowed, while the USFWS focuses their efforts on the threats that make a difference to the species' recovery. Under the 4(d) rule, purposeful take is prohibited except for removal of northern long-eared bats from human structures, defense of human life, and removal of hazardous trees for the protection of human life and property. For areas not affected by WNS (see Figure E-4.3.7-11 above), there are no prohibitions on incidental take. For areas impacted by WNS, incidental take is prohibited if it occurs within a hibernaculum, if it results from tree removal activities within 0.25 mile (0.4 km) of a known hibernaculum or the activity cuts or destroys a known, occupied maternity roost tree or other trees within a 150 foot radius from the maternity roost tree during the pup season from June 1 through July 31. (USFWS, 2017) As of May 1, 2017, WNS infected hibernacula are not known to occur in the Project area, thus there are currently no prohibitions on incidental take. While tree clearing is rarely conducted as a maintenance activity, the Licensees will only clear trees while the bats are hibernating, therefore, having no affect on this species.

Piping plover may utilize the shoreline next to Lake Michigan in the Project area. Installation and retrieval of the barrier net occurs in the spring (by April 15) and fall (October 15), outside of the piping plover's nesting period (late April through July). The Licensees will minimize foot traffic and prohibit the use of vehicular equipment during the active nesting period, to ensure nests are not destroyed. Continued operation of the hydroelectric facility will not have an affect on piping plover, if present.

Rufa red knot may utilize the shoreline next to Lake Michigan in the Project area during migration. Rufa red knot use shoreline habitat for a brief time during spring and fall migration for foraging. Continued operation and maintenance of the hydroelectric facility are highly unlikely to have an affect on rufa red knot, if present.

Neither Karner blue butterfly nor its host plant, wild lupine, were observed in the Project area. Therefore, project operation and maintenance are highly unlikely to have an affect on this species as appropriate habitat was not observed in the Project area.

While eastern massasauga was not observed during the wildlife survey, appropriate habitat was observed in the wetland and stream areas near the shoreline of Lake Michigan in the Project area. No regular maintenance activities are conducted in this area and continued operation and maintenance of the hydroelectric facility are highly unlikely to have an affect on eastern massasauga, if present.

Appropriate habitat for Pitcher's thistle is found on the open dunes in the Project area. This perennial species was not observed during the botanical survey. The Licensees will minimize foot traffic and restrict the use of vehicular equipment during the active growing season to ensure plants are not destroyed. Continued operation of the hydroelectric facility will not have an affect on Pitcher's thistle, if present.

Effects on State Listed Species

Four state-listed fish species are likely to occur within Ottawa and Mason Counties or the adjacent waters of Lake Michigan (Table E-4.3.7-1). No collections of bigmouth shiner or river redhorse could be found among the historical studies (including trawl and beach seine sampling) or long term barrier net monitoring conducted for the facility. While appropriate habitat for bigmouth shiner is not likely present, cisco and river redhorse may utilize the water resources adjacent to the Port Sheldon recreation site and cisco have been observed in Lake Michigan adjacent to Mason County during barrier net monitoring. Lake sturgeon are known to inhabit the waters of Lake Michigan including the Project vicinity. Gill net collections from 1972 through 1977 documented 1 lake sturgeon and no ciscoes (Table E-4.3.3-1), and the entrainment mortality study conducted during 1979-1980 found 1 lake sturgeon in October (Liston et. al 1981).

A seasonal barrier net, installed outside the effect of the powerhouse discharge area in Lake Michigan, is designed to minimize fish entrainment by preventing fish from approaching the units during pumping. Entrainment of lake sturgeon and cisco is possible during pumping operation, especially when the seasonal barrier net is not in place. When in place, the seasonal barrier net excludes most sizes of lake sturgeon and cisco from being entrained. During the barrier net monitoring from 1993 through 2016, nearly 450,000 fish have been collected. Of these, 85 have been lake sturgeon and 566 have been ciscoe. The majority of ciscoe have been collected in the last several years with 254 individuals being collected in 2016 (Table E-4.3.3-2). The approved barrier net monitoring procedures require all lake sturgeon caught to be processed in accordance with USFWS protocol. This involves tagging with Passive Integrated Transponder tags (if not previously tagged), recording of length and girth, and collection of a small amount of fin tissue. All sturgeon have been released in good condition and the data collected emailed within a short period to a prescribed list of researchers and to the SAT in monthly reports. Nearly all sturgeon processed have not been previously tagged. Overall sample sizes for these two species however are low and with few individuals collected during some years. Among the 85 lake Sturgeon collected since 1993, 7 were found inside the barrier net (91% effective). Annual barrier net effectiveness for ciscoe has ranged from 0% to 83% (Table E-4.3.3-6). Currently all ciscoes are measured for length and kept frozen for MDNR investigation into morphometric characterization of species hybrids.

While deployed, the barrier net has demonstrated effectiveness of protecting lake sturgeon and ciscoe. When the barrier net is not deployed, there is strong evidence from fisheries studies and fish behavior that the abundance of fish decreases substantially in the vicinity of the Project (i.e. near shore areas) during winter months thereby reducing entrainment risk (Alden 2016). There appears to be a low risk of lake sturgeon entrainment during the winter based on their likely lack of presence in the vicinity of the project and winter movement patterns that would put them at risk to entrainment. Based on life history information available in “Handbook of Freshwater Fishery Biology”, which states “The fish spend the winter in deep well aerated holes in relative inactivity” (Carlander 1969) would indicate that lake sturgeon would avoid, the dynamic, swift flowing areas associated with LPSP. In addition, unpublished results from telemetry studies in southern Lake Michigan indicate the fish overwinter offshore (6/2/14 email from former Michigan DNR Senior Fisheries biologist Kregg Smith). An early winter presence of Ciscoe near the plant however, is possible as they are known to migrate into shallow waters of the Great Lakes from mid-November to mid-December for spawning (Carlander K.D. 1969; Koelz 1929)

Project maintenance activities at the recreation facility do not affect Pigeon Lake or Lake Michigan, therefore the Project will not have an affect on these species.

Bald eagles are known to fly through the Project area. While no nest sites occupy the Project area, appropriate nesting habitat does exist. Project operation and maintenance are highly unlikely to affect bald eagles.

Appropriate habitat for marsh wren was not observed in the Project area. Therefore, project operation and maintenance are highly unlikely to have an affect on this species.

Red-shouldered hawk was identified by its call, flying over the Project area during the wildlife survey (King & MacGregor Environmental, Inc., 2016). This bird was not visually verified and did not appear to stay in the area during the survey. Their preferred habitat, mature forests adjacent to wet meadows and swamps, is limited in the Project area. No known nests occupy the project area.

Little brown bats are likely to occur within the Project area. The main threat to this species is WNS. Project operation and maintenance will not further the spread of WNS or have a negative affect on this species.

Blanchard’s cricket frog may utilize stream habitat adjacent to the Port Sheldon recreation site. Project maintenance activities at the recreation facility do not affect Pigeon Lake, therefore the Project will not have an affect on this species.

Little, if any, appropriate habitat for eastern box turtle was observed in the Project area. Therefore, project operation and maintenance is highly unlikely to have an effect on this species, if present.

While appropriate forest habitat exists in the Project area, ginseng was not observed. Ginseng is a perennial species and will not be permanently harmed if the vegetation is crushed as long as the root is maintained. Maintenance activities are rarely conducted in the forest areas, therefore disturbance of this species, if present, is unlikely. Continued operation of the hydroelectric facility will not have an affect on ginseng, if present.

4.3.7.3 Proposed Environmental Measures

The seasonal barrier net provides protection from entrainment for lake sturgeon and cisco during the pumping operation. The seasonal barrier net is proposed in the fishery section as a PME for all fish species, including lake sturgeon and cisco. There are no other existing PME measures in-place relative to RTE resources, and, because there are no impacts to other Species of Special Concern or RTE resources anticipated under proposed Project operation, none are proposed. Bald eagles and red-shouldered hawks are present in the Project area but no nest have been documented and presence may be limited. If there is a planned modification to Project operation in the future that may cause disturbance of bald eagle or red-shouldered hawk nest, the Licensees will conduct a raptor nest survey. If nests for bald eagles or red-shouldered hawks are found, the Licensees will follow USFWS guidelines for eagle and raptor nest disturbance avoidance and establish a buffer.

4.3.7.4 Cumulative Effects

No potential cumulative effects to RTE resources have been identified as a potential concern at the Ludington Project. The Licensees' proposal to continue to operate and maintain the Project under the existing operating regime is not expected to result in either geographic or temporal cumulative impacts to Species of Special Concern or RTE resources.

4.3.7.5 Unavoidable Adverse Impacts

Continued operation of the Ludington Project, as proposed, will have no significant unavoidable adverse impacts on RTE species.

4.3.7.6 References

Carlander K.D. 1969. Handbook of Freshwater Fishery Biology, Iowa State University Press.

Discover Life. 2017. Available online: http://www.discoverlife.org/

King & MacGregor Environmental, Inc. 2015. Ludington Pumped Storage Hydroelectric Project (FERC No. 2680-108) Botanical Resources Report. Consumers Energy Company, DTE Electric Company.

King & MacGregor Environmental, Inc. 2016. Ludington Pumped Storage Hydroelectric Project (FERC No. 2680-108) Wildlife Resources Report. Consumers Energy Company, DTE Electric Company.

Koelz 1929: Coregonid fishes of the Great Lakes. Bull. U.S. Bur. Fish. Doc. 1048:297-643

Liston et al. 1981 Assessment of larval, juvenile, and adult fish entrainment losses at the Ludington Pump Storage Power Plant on Lake Michigan. 1980 Annual Report, Ludington Project, Vol. 1, Submitted to Consumers Power Co., Mich. State Univ., Dept. of Fish. And Wild., 276pp.

Michigan Natural Features Inventory (MNFI). 2016. Available online: http://mnfi.anr.msu.edu/data/index.cfm

NOAA Fisheries. 2017. Available online: http://www.fpir.noaa.gov/HCD/hcd_efh.html

U.S. Fish and Wildlife Service (USFWS). 2017. Northern Long-eared Bat. Available online: https://www.fws.gov/midwest/endangered/mammals/nleb/archives.html

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered, Threatened, Proposed, and Candidates in the Upper Midwest. Available online: https://www.fws.gov/midwest/endangered/mammals

4.3.8 Recreation and Land Use

4.3.8.1 Affected Environment

Project Area Land Use

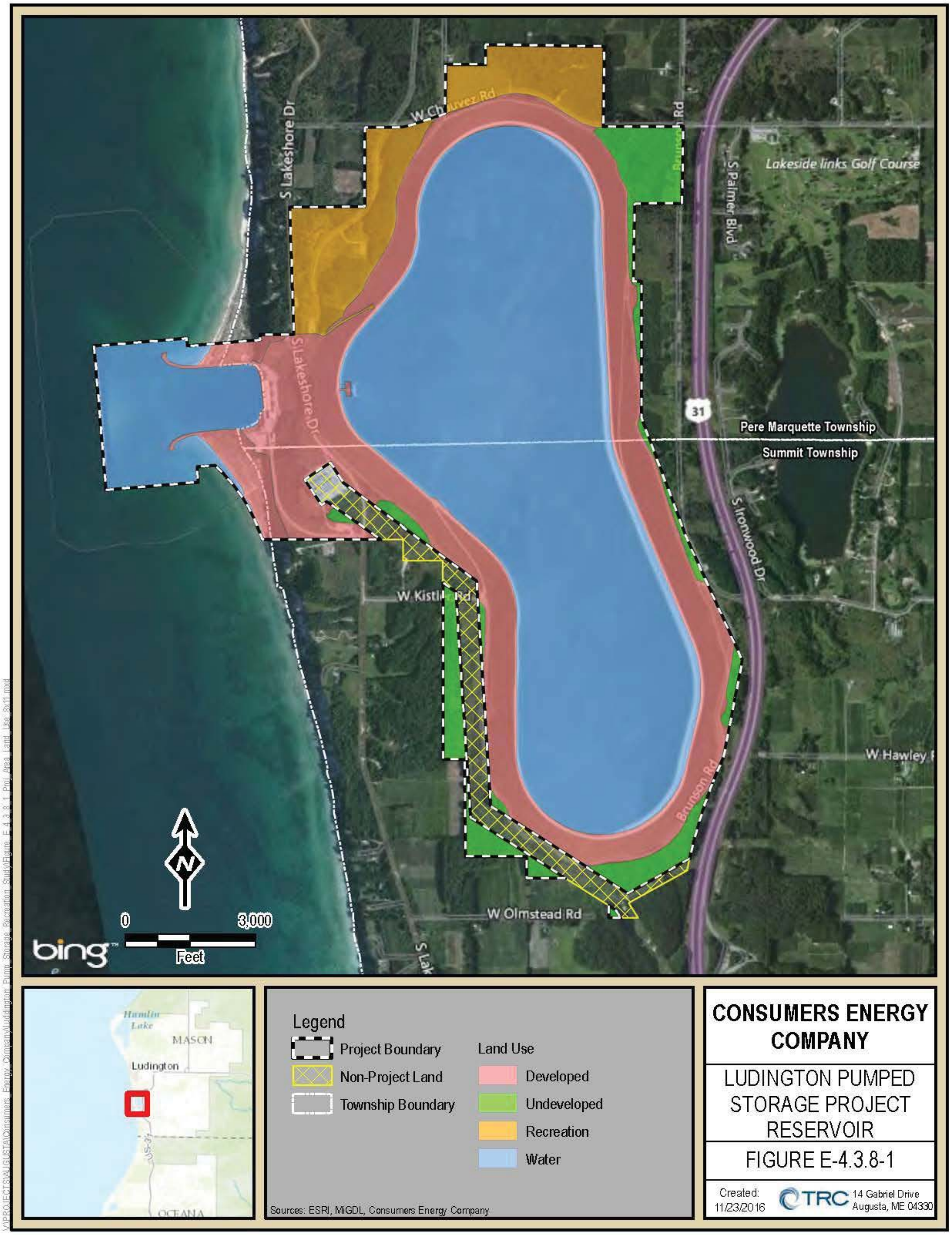
The Project boundary includes approximately 1,670 acres of which 982 acres are open water. The majority of the land within the Project boundary is developed. Remaining lands are either "undeveloped" lands or lands utilized for recreation. Table E-4.3.8-1 shows a breakdown of land use within the Project boundary and Figure E-4.3.8-1 shows the land use within the Project Boundary. Figures E-4.3.8-2 and E-4.3.8-3 show the project recreation sites. Approximately 410 acres or 60 percent of lands within the Project boundary are developed. The majority of this development is associated with the Project powerhouse, dike, and other Project structures. Recreation lands account for 144 acres of Project lands and are further described later in this section. Of the 133 undeveloped acres, approximately 37 acres (located in the North-East corner of the Project boundary, are open to the public and easily accessible. The remaining undeveloped property has limited or no accessibility for the public.

Table E-4.3.8-1: Land Use within the Project Boundary

Land Use Category	Description	Acres	Percent of Project Lands
Developed	Developed land not open to the public.	410-	60
Recreation	Lands that are developed for recreational use, and open to the public offering access to Project lands or, at Port Sheldon, to Lake Michigan.	144	21
Undeveloped	Undeveloped lands.	133	19
Total		687	100

The Project boundary also encompasses approximately 982 acres of open water which consist of the Upper Reservoir and the portion of Lake Michigan located between the shoreline and breakwater. While these waters are open to the plic, for safety purposes the public is encouraged to avoid entering the area enclosed by the jetties and the breakwater.

Figure E-4.3.8-1: Ludington Project Area Land Use



Regional Recreation Opportunities

Two regionally important recreation areas, the North Country Trail and the Lake Michigan Water Trail, are located near the Ludington Project. The North Country Trail, which is a National Scenic Trail, is located approximately 21 miles east of the Project. The Lake Michigan Water Trail extends along the lake, stopping north of the Project near Buttersville Park and starting up again south of the Project. A portion of the Lake Michigan Water Trail is designated as a National Recreation Trail.

The Ludington State Park is located 6.5 miles north of the Project between Hamlin Lake and Lake Michigan. The Park is comprised of almost 5,300 acres of scenic sand dunes, shoreline vistas, ponds, marshlands and forests. The Park includes a beach that stretches for miles along Lake Michigan. Three campgrounds within the Park provide 355 campsites including three mini-cabins (PAD, 2014).

The Pere Marquette River, located approximately 2 miles north of the Project, was the first designated Scenic River under the Wild and Scenic River program in the State of Michigan. The river is also a State Natural River under the State of Michigan's Natural Rivers Program. The river is used by recreationists for paddling, motor-boating, fishing and wildlife viewing (PAD, 2014).

Local, State and Federal agencies also provide the public with recreation opportunities near the Ludington Project. The City of Ludington operates Stearns Park, Waterfront Park, Cartier Park, Copeyon Park and Loomis Street Boat Launch. These recreation sites provide a variety of opportunities such as swimming, picnicking, volleyball, camping, fishing, walking, jogging, and biking. Amenities include playgrounds, a skate park, shuffle board, mini golf, boat launches, picnic areas, and campground (PAD, 2014). Stearns Park is located approximately 4.5 miles north of the Project and provides a beach on Lake Michigan. The Loomis Street Boat Launch provides public boating access to Lake Michigan.

The Pere Marquette Charter Township provides several recreation opportunities for the public near the Ludington Project. Buttersville Park and the Father Marquette Shrine are located approximately two miles north of the Project on South Lakeshore Drive. Buttersville Park provides camping south of the Ludington Harbor with direct access to Lake Michigan. It includes 48 campsites, improved facilities, and a swimming beach on Lake Michigan. The Father Marquette Shrine has special historic significance and includes 400 feet of frontage on Pere Marquette Lake and a boat launch that provides access to Pere Marquette Lake and Lake Michigan. Suttons Landing is a 34-acre riverfront park located along the South Fork of the Pere Marquette River. Suttons Landing includes approximately 425 feet of river frontage, a small boat launch facility, a boardwalk along the riverbank, a pavilion, restrooms, and improved parking facilities (Pere Marquette Charter Township, 2017). The Pere Marquette River empties into Pere Marquette Lake approximately two miles north of the Ludington Project in the Pere Marquette Charter Township. There are no developed facilities at Pere Marquette Lake but Pere Marquette Lake is popular with anglers for fishing Lake Michigan salmonids and other fish species. Anglers park along the Pere Marquette Highway (old US-31).

Summit Township operates Summit Township Park approximately two miles south of the Ludington Project. Summit Township Park provides a beach on Lake Michigan (Lake Michigan Beach) a tennis court, ball fields, picnic area and a pavilion (Summit Township, 2013)

Michigan DNR manages several areas in the vicinity of the project, which provide hunting, fishing, camping, hiking, swimming, picnicking and boating opportunities. In addition to the Ludington State Park, these areas include: Pere Marquette State Game Area, and Charles Mears State Park (PAD, 2014).

The United States Forest Service (USFS) manages the Huron-Manistee National Forest, located approximately 8 miles east of the Project, and the Nordhouse Dunes Wilderness (National Wilderness Area) located directly north of the Ludington State Park. These two areas provide hiking, picnicking, fishing, boating, biking, camping, hunting, nature study, cross-country skiing, paddling, and wildlife viewing (USFS, 2016).

Finally, there are numerous privately owned/operated facilities in the vicinity of the Ludington Project including golf courses, campgrounds and marinas.

Project Recreation Opportunities

Six Project recreation sites are located within the Ludington Project boundary: Mason County Campground, Hull Field, Mason County Day Use/Picnic Area, Reservoir Overlook, Lake Michigan Overlook and Pigeon Lake North Pier. These sites provide a variety of recreation opportunities such as fishing, camping, picnicking, walking/hiking/jogging, disc golfing, flying model aircraft, sightseeing, and snowshoeing.[11] Although the sites are closed and not maintained during the winter, the property itself is still open to the public allowing informal winter activities to take place.

[11] Snowshoeing became highlighted as a recreation opportunity in January 2017 with the designation of the 1.7-mile snowshoe trail at the Mason County Day/Use Picnic Area.

Formal Recreation Areas

The recreation site and facility inventory identified the following recreation sites, within the Project boundary: Mason County Campground, Hull Field, Mason County Day Use/Picnic Area, Reservoir Overlook, Lake Michigan Overlook and Pigeon Lake North Pier.

Mason County Campground: The Mason County Campground, located in the northeastern corner of the Project boundary, is owned by the Licensees and managed by Mason County. The site provides camping and picnicking opportunities to the public on a seasonal basis (generally from Memorial Day Weekend to Labor Day Weekend). There is a restroom/shower building which is compliant with the Americans with Disabilities Act (ADA), 56 campsites, four cabins, picnic shelter with eight tables, one playground [12], three benches, an interpretive display and a foot path to Hull Field.

Hull Field: Hull Field is located adjacent to the Mason County Campground along the northern edge of the Project boundary. This site is owned by the Licensees, managed by Mason County and operated by the Twisted Sticks Radio Control Club. The site is open to the public for viewing. Those who wish to fly a radio controlled plane must possess a current Academy of Model Aeronautics card. Site amenities include 18 parking spaces, portable sanitation, two benches, five picnic tables, a pavilion, 14 airplane platforms, a large mowed field and a footpath to Mason County Campground.

Mason County Day Use/Picnic Area: The Day Use/Picnic Area is located in the northwestern corner of the Project boundary. The site is owned by the Licensees and managed by Mason County. Amenities include 62 vehicle parking spaces, a picnic pavilion with 34 tables, ADA compliant restrooms, a 72 goal disc golf course, and a playground[13]. A 1.7- mile snowshoe trail was designated at the site in January 2017. The snowshoe trail loop is accessed at the Chauvez Road entrance to the Mason County Day Use/Picnic Area and follows a pathway used by walkers and disc golfers. The site is open to the public seasonally (generally April – October) for day use activities.

Reservoir Overlook: The overlook is located on the northwestern side of the Upper Reservoir embankment and provides views of Lake Michigan as well as the Upper Reservoir. The site is owned and managed by the Licensees. Amenities include 83 parking spaces, portable sanitation (1 standard and 1 ADA), a pagoda shelter, and 9 benches which are located along a steep footpath to the pagoda. An interpretive panel is located in the pagoda which describes the

[12] Mason County is reviewing plans to upgrade the existing playground equipment.
[13] Mason County is evaluating plans to replace the existing playground equipment and provide ADA accessibility to the playground.

Project structures and how they work. The site is generally open to the public between April and October for day use activities.

Lake Michigan Overlook: The overlook is located north of the powerhouse on the eastern shore of Lake Michigan. The site is owned and managed by the Licensees. Recreation amenities include portable sanitation (shared with Reservoir Overlook), a footbridge and multiple interpretive displays. Parking for the overlook is located on the east side of Lakeshore Drive, just north of the overlook. The site is open to the public generally between April and October for day use recreation.

Pigeon Lake North Pier: This site is located approximately 70 miles south of the Ludington Pumped Storage Project's Upper Reservoir. The site is owned and managed by the Licensees. Amenities include 18 parking spaces, two fishing platforms, eight benches, and a boardwalk which leads to the Pigeon Lake North Pier. The pier extends approximately 700 feet west into Lake Michigan and provides fishing opportunities and walking/hiking/jogging opportunities to the public. The site is open seasonally for daytime recreational use.

There are no Project lands currently under study for inclusion in the National Trails System or designated as or under study for inclusion as a Wilderness Area.

Figure E-4.3.8-2: Recreation Facilities Location Map

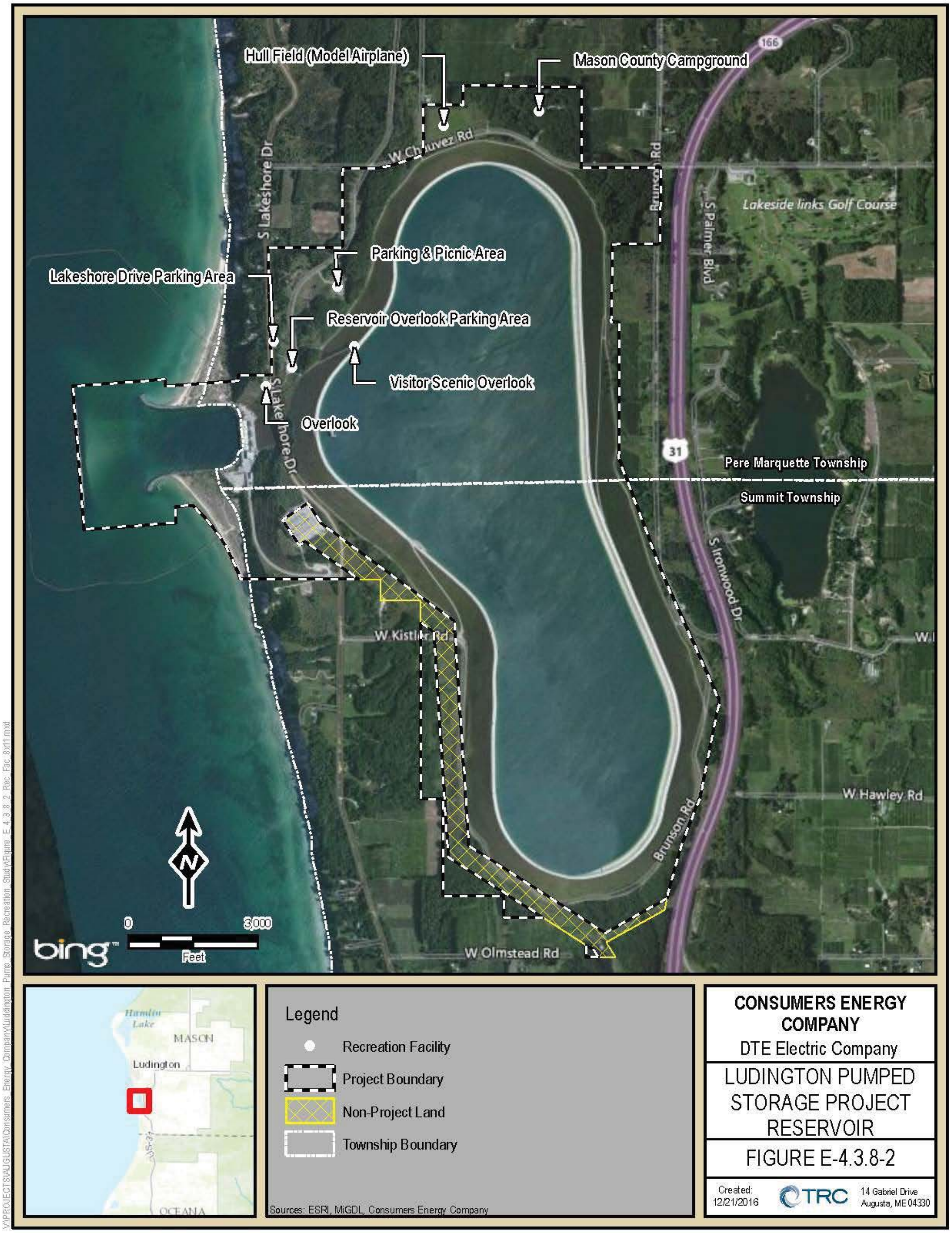


Figure E-4.3.8-3: Port Sheldon Recreation Site

Project Recreation Use

The Licensees conducted a recreation use and user survey between April 2015 and October 2015 to determine the types and amount of use occurring at Project recreation sites within the Ludington Project boundary. Total annual recreation use in 2015 was estimated to be 49,876 recreation days. A recreation day is defined by FERC as "each visit by a person to a development for recreational purposes during any portion of a 24-hour period." The majority of the recreation use occurred during the summer, while fall and spring accounted for a small amount of the overall use. This can be seen in Table E-4.3.8-2.

Table E-4.3.8-2: Estimated Use at the LPSP Recreation Sites; Annual Total Use for 2015 and by Season

Recreation Site	Estimated Annual Use (2015)	Estimated Spring Use	Estimated Summer Use	Estimated Fall Use
Reservoir Overlook	6,064	159	4,739	1,166
Lake Michigan Overlook	8,675	445	5,922	2,308
Mason County Day Use/Picnic Area	14,044	497	10,577	2,970
Mason County Campground	13,667	447	10,693	2,527
Hull Field	1,047	0	941	106
Pigeon Lake North Pier	6,379	852	4,859	668
Total	49,876	2,400	37,731	9,745

Generally, Project recreation sites are utilized well below their capacity. Some exceptions may occur during special events such as disc golf tournaments or during summer holiday weekends. Table E-4.3.8-3 provides a breakdown of percent capacity utilized for each Project recreation site.

Table E-4.3.8-3: Recreation Site Capacity Utilization by Site

Recreation Site	Recreation Days	Average Summer Weekend Percent Capacity Utilized	Maximum Observed Percent Capacity Utilized
Reservoir Overlook	6,064	2%	6%
Lake Michigan Overlook	8,675	5%	17%
Mason County Day Use/Picnic Area	14,044	11%	100%-special event 39%-non-special event
Mason County Campground	13,667	57%	98%
Hull Field	1,047	3%	13%
Pigeon Lake North Pier	6,379	12%	38%

Notes: Maximum Observed use at the Mason County Day Use/Picnic Area was during the disc golf tournament when the parking lot was at capacity and attendees parked roadside. For the rest of the summer recreation season, maximum use observed was 39%.
Campground data are based on average summer use as opposed to average summer weekend use.

Table E-4.3.8-4 shows a breakdown of recreation use by activity at each of the Project recreation sites. The most popular activities that recreationists participated in included camping and disc golf. This was followed by sightseeing, walking/jogging/hiking, flying remote control planes, and fishing. Other activities observed occurring included picnicking, riding bikes, sightseeing, and photography.

Table E-4.3.8-4: Recreation Use by Activity Type based on Spot Counts and Calibration Counts in 2015

Recreation Activity	Estimated Use (Recreation Days)	Percent (%) of Recreation Use
Camping	13,667	27.4%
Disc Golf	13,531	27.1%
Sightseeing	10,621	21.3%
Walking/Hiking/Jogging	9,332	18.7%
RC Aircraft	800	1.6%
Fishing	702	1.4%
Picnicking	516	1.0%
Bike riding	416	0.8%
Other Recreation Activity	146	0.3%
Photography	146	0.3%
Total	49,877	100.0%

Recreation Use at Project Recreation Sites

***Mason County Campground*:** Annual recreation use at the Mason County Campground was estimated to be 13,667 recreation days in 2015. Based on utilization of the existing campsites, the utilization for this site was estimated to be at 57% capacity use in the summer, with peak holiday capacity use at 98%.[14] Camping accounts for the primary recreation use for those at the campground (Table E-4.3.8-5).

Hull Field: Annual recreation use at Hull Field was estimated to be 1,047 recreation days in 2015. Based on parking lot capacity, the site was estimated to be utilized at 3% capacity (summer weekend average). The maximum observed capacity use, based on parking lot usage, was 13%. On an annual basis, 76% of the use was for flying remote control (R/C) planes. Other recreation activities included walking/hiking/jogging at 17% of use and disc golfing at 7%.

Mason County Day Use/Picnic Area: Annual recreation use of the Mason County Day Use/Picnic Area was estimated to be 14,044 recreation days in 2015. Based on parking lot usage, the site was estimated to be utilized at 11% of capacity (summer weekend average), with peak observed use at 39% of capacity. Usage did reach 100% once during a special event disc golf tournament. Disc golfing accounted for 88% of the recreation use at this site, followed by walking/hiking/jogging at 7% of the use and picnicking at 4% of the use.

Reservoir Overlook: Estimated annual use of the Reservoir Overlook was 6,064 recreation days in 2015. The overlook was estimated to be utilized at 2% of capacity on average during summer weekends, based on parking area usage, with peak usage observed at 6% of capacity. Sightseeing (65%) was the most popular recreation use at the Reservoir Outlook followed by walking/jogging/hiking (23% of the use) and disc golfing (10% of the use).

Lake Michigan Overlook: There were a total 8,675 recreation days spent at the Lake Michigan Overlook in 2015. The site was estimated to be utilized at 5% of capacity, based on the summer weekend average parking area usage for average summer weekend. The maximum observed level of capacity use at the site was 17%. Seventy-three percent (73%) of recreation use at the overlook was sightseeing, followed by walking/hiking/jogging, which accounted for 20% of use.

Pigeon Lake North Pier: The estimated total number of recreation days at the Pigeon Lake's North Pier during 2015 was 6,379. Based on parking lot usage, it is estimated that the site is utilized at 12% of its capacity on average during summer weekends. The maximum observed capacity use of the parking lot was 38%. Walking/hiking/jogging use was the most popular recreation activity, with 79% of the observed use at the pier. Fishing accounted for 11% of recreation uses, with bike riding (6%), sightseeing (2%), and photography (1%) also observed.

[14] The peak holiday capacity of 98% use was observed on July 4, 2015.

Table E-4.3.8-5: Percent of Recreation Use by Activity at Each Site

Recreation Site	Camping	Fishing	Picnicking	Walk/ Hike/ Jog	Riding Bikes	Sightseeing	R/C Planes	Disc Golf	Photography	Other Recreation Use
Reservoir Overlook	0%	0%	0%	23%	0%	65%	0%	10%	1%	1%
Lake Michigan Overlook	0%	0%	0%	20%	0%	73%	0%	6%	0%	0%
Mason County Day Use/Picnic Area	0%	0%	4%	7%	0%	1%	0%	88%	0%	0%
Mason County Campground	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Hull Field	0%	0%	0%	17%	0%	0%	76%	7%	0%	0%
Pigeon Lake North Pier	0%	11%	0%	79%	6%	2%	0%	0%	1%	1%

Totals shown may not sum to 100% because of rounding.

Recreationist's Opinions of Project Recreational Opportunities

During the recreation user surveys, recreationists were asked their opinions regarding a number of aspects related to the available Project recreation opportunities, along with some basic information questions. Based on the results of the survey, recreationists traveled an average of 122 miles to recreate at the Project's Ludington recreation sites, though one-third of the recreationists traveled ten miles or less. The Pigeon Lake North Pier recreationists traveled an average of 23 miles with roughly half of the recreationists traveling 10 miles or less.

As shown in Table E-4.3.8-6 the overall quality of the recreation sites/facilities and amenities was rated highly, with 63% of respondents rating the overall quality of the facilities as Excellent, (5) and 22% rating them as Fair-Excellent (4). Thirteen percent (13%) gave the facilities/amenities a Fair (3) rating, while two percent (2%) of respondents considered the overall quality to be less than Fair. Surveyed visitors were asked to rate their perception of the amount of use at the Project recreation sites. More than half of the respondents perceived the amount of use at Project recreation sites to be Not Crowded (59%). Only 4 percent of respondents perceived the use at the Project sites to be Extremely Crowded.

Table E-4.3.8-6: Recreational User Ratings of Recreation Sites, Facilities and Amenities, Reported as Percent of Respondents

Site/Facility/Amenity	Number of Responses	5 Excellent	4	3 Fair	2	1 Poor
Parking	94	66%	19%	10%	5%	0%
Facility Condition	95	65%	23%	9%	2%	0%
Variety of Amenities	94	39%	19%	38%	2%	1%
Accessibility	94	69%	19%	10%	2%	0%
Overall Quality	95	63%	22%	13%	2%	0%

Percentages shown may not sum to 100% due to rounding.

Recreationists were given the opportunity to provide their opinions with respect to recreation amenities and conditions. Parking rated well with 66 percent of respondents rating the parking as Excellent, 19 percent rating parking as Fair-Excellent, and 10 percent rating the parking as Fair. Facility conditions also received positive responses, with 65 percent rating the conditions as Excellent, 23 percent as Fair-Excellent and 9 percent as Fair. Regarding the variety of amenities, 39% of respondents rated the existing variety of amenities as Excellent (5), 19% as Fair-Excellent (4), and 38% as Fair (3). The Mason County Day Use/Picnic Area received ratings of Fair-Poor (2) for parking (4 percent) and Hull Field received ratings of Fair-Poor (2) for parking (1 percent). Both Pigeon Lake North Pier and Hull Field both received ratings of Fair-Poor (2) for facility condition, variety of amenities, accessibility, and overall quality. Pigeon Lake North Pier received the only Poor (1) rating and this was for the variety of amenities.

4.3.8.2 Environmental Analysis

The continued operation of the Ludington Project as proposed supports continued provision of the six existing Project recreation sites owned by the Licensees. These sites provide the public with a variety of recreation opportunities including walking/hiking/jogging, disc golfing, fishing, sightseeing, picnicking, camping, remote control aircraft flying and snowshoeing.[15]

The Licensees' studies of recreational use within the Project indicate that current use of the Ludington Project recreation sites occurs within the existing capacity and the sites are anticipated to meet projected recreation use for the foreseeable future. The majority of recreation users gave "Excellent" or "Fair-Excellent" rating for facility conditions, variety of amenities and the overall quality of the sites and facilities. Continued operation of the Project and the associated recreation sites will ensure that the public continues to benefit from the recreation opportunities that are provided.

4.3.8.3 Proposed Environmental Measures

The Licensees propose to continue to provide the six Project recreation sites, along with the associated facilities and amenities. These sites are the Reservoir Overlook, Lake Michigan Overlook, Mason County Day Use/Picnic Area, Mason County Campground, Hull Field, and Pigeon Lake North Pier. The Licensees also propose to meet with Mason County on an annual basis to discuss the continued operation of the Mason County Day Use/Picnic Area and the Mason County Campground over the course of the new license period. A draft Recreation Management Plan was provided to Pere Marquette Township, Mason County and the Michigan Department of Natural Resources on May 5, 2017. The draft Recreation Management Plan has been revised and is submitted in this Final License Application (Appendix E-2). No negative effects to the existing recreation resources would result from the proposed licensing of the Project, therefore, the Licensees are not proposing mitigation measures.

[15] Snowshoeing became available in January 2017 with the designation of the 1.7-mile snowshoe trail at the Mason County Day/Use Picnic Area.

4.3.8.4 Cumulative Effects

In SD1, no potential cumulative effects to recreational resources were identified as a potential concern at the Ludington Project. The Licensees' proposal to continue to operate and maintain the Project under the existing operating regime will not result in negative cumulative impacts to recreational resources.

4.3.8.5 Unavoidable Adverse Impacts

Continued operation of the Project will not result in any unavoidable significant adverse impacts to recreation resources.

4.3.8.6 References

Consumers Energy Company & DTE Electric Company. 2014. (PAD, 2014) Pre-Application Document for the Ludington Pumped Storage Hydroelectric Project (FERC No. 2680). January, 2014.

Pere Marquette Charter Township. 2017. (Pere Marquette Charter Township, 2017) Pere Marquette Charter Township website http://www.pmtwp.org/residents/recreational_parks.php

Summit Township. 2013. (Summit Township, 2013) Summit Township website http://summittownship.org/attractions/

USFS. 2016. (USFS, 2016) Interactive Visitor Map http://www.fs.fed.us/ivm/index.html

4.3.9 Cultural Resources

The Licensees conducted several studies to identify cultural resources eligible for listing on the National Register of Historic Places (NRHP) in accordance with Section 106 of the National Historic Preservation Act (NHPA). Studies were conducted for Prehistoric resources (i.e., Native American archaeological resources), Postcontact resources (i.e., Euroamerican archaeological resources), and historic structures (i.e. architectural resources).

4.3.9.1 Affected Environment

Area of Potential Effect

According to 36 CFR 800.16(d), the area of potential effect (APE) is defined as the geographic area within which an undertaking may alter the character or use of historic properties, if present. The APE is influenced by the scale and nature of the undertaking, and may be different for different kinds of effects that may result from it. In defining the APE, the potential direct, indirect, and cumulative effects to historic properties should be considered, in terms of the aspects of integrity from which the property derives its significance. Under FERC regulations, the APE specifically includes "the lands enclosed by the project's boundary and lands or properties outside of the project's boundary where project construction and operation or project-related recreational development or other enhancements may cause changes in the character or use of historic properties, if any historic properties exist."

For the current Project, the undertaking is the FERC license renewal. Project activities are entirely limited to the Project boundaries. No change in operation or addition of facilities is proposed as part of the re-licensing at the Project, nor is there any change in the capacity of the facility. Likewise, no impacts from continued hydroelectric pumped storage operations are anticipated as a result of the relicensing, and no physical, visual or auditory effects will result outside the permit boundaries. Because the effects of the current proposed Project will be confined exclusively to the Project facilities, the Licensees have proposed that the Ludington APE includes all lands within the FERC Project Boundary, which includes both the Mason County and Ottawa County recreation sites. Figures 3.1.2-1 and 3.1.2-2, Project boundary maps, show the current project APE. (Section 3.1.2)

Precontact Period History

The Precontact (or prehistoric) occupation of Michigan is generally divided into three broad periods: Paleo-Indian, Archaic and Woodland. The Paleo-Indian period encompasses the cultural remains of the earliest recorded occupations of the region, after approximately 12,000 B. P. *[Note: B.P. refers to Before Present]*, during early postglacial times. The Archaic is identified by archaeologists as the period where more localized seasonal settlement and subsistence patterns replaced the broad seasonal migration patterns of the Paleo-Indian period. The innovation of ceramic technology and the emergence of cultigens generally identify the transition to the Woodland time period.

Paleo-Indian Period (ca. 12,000-10,000 B.P.). Early occupants of the region would have encountered a boreal grassland/spruce parkland environment with caribou, bison, and larger Pleistocene mega-fauna species such as mastodon, mammoth and musk oxen (Fitting 1975; Ogden 1977). The Paleo-Indians were nomadic and moved to intercept large herd animals during their migratory cycles (Gramly 1988; Stothers 1996). Over time, the focus likely shifted from large-scale hunting expeditions to a more regular procurement of game accompanied by a decrease in the overall size of territory exploited by these groups (Shott and Wright 1999). Paleo-Indian sites are most easily recognized by the presence of fluted spear-points. Five types of Paleo-Indian fluted biface have been identified in Michigan: Enterline, Gainey, Barnes, Crowfield, and Holcombe (Shott and Wright 1999).

Archaic Period (ca. 10,000-3,000 B.P.). Environmental changes marked the beginning of the Archaic period as the Great Lakes began to retreat and approach modern day levels. Mega-fauna populations were decreasing and new subsistence regimens were adapted.

The Archaic is further divided into the Early Archaic (10,000-8,000 B.P.), Middle Archaic (8,000-5,000 B.P.), and Late Archaic (5,000-3,000 B.P.).

The Early Archaic time period (10,000-8,000 B.P.) is often identified in the archaeological record by the transformation from large, lanceolate bifaces of Paleo-Indian assemblages to smaller, notched and bifurcated bifaces. These bifaces are temporally distinctive and have consequently been interpreted in terms of various biface style-horizons. In the northern Lower Peninsula, the Early Archaic is divided into the Plano Horizon and the Kirk Horizon.

The Plano Horizon (10,000-9,500 B.P.) is represented by two biface types, Agate Basin and Eden-Scottsbluff (Shott 1989). While only a few Agate Basin sites are known in Michigan, the Samels Field site located on Skegemog Point (Cleland and Ruggles 1996) near Traverse City has yielded Agate Basin bifaces among other Early Archaic biface types. The Kirk Horizon (10,000 to 8,000 B.P.) is represented by several stemmed and notched biface types, including Kirk Corner Notched, Kirk Stemmed, St. Albans, Le Croy and Kanawha (Shott 1999).

This transformation in tool technology (lanceolate to stemmed/notched) has been interpreted as an adaptive response in subsistence strategies, which had been altered as a result of the extinction of most megafauna. Populations were still highly mobile, but were exploiting a greater number of resources such as small animals, nuts and fish (Munson 1988; Neusius 1986). A great deal remains unknown about the Early Archaic period in Michigan. Certainly, the changing environment played an important role in both the settlement and subsistence systems of the inhabitants. Although few Early Archaic sites have been investigated in Michigan, this is likely due to the fact that lake levels were lower at that time than they are today. Therefore, it is probable that many Early Archaic sites exist on the old shorelines, but are currently underneath the Great Lakes (Shott 1999).

Like the Early Archaic, the Middle Archaic period (8,000-5,000 B.P.) in Michigan is not well defined (Lovis 1999); however, this period is generally considered to have been characterized by intensified procurement of seasonally available resources, visible in the archaeological record by a variety of ground and polished stone tools and artifacts suited to harvesting resources. Settlements also appear to have been more focused toward the exploitation of seasonal resources such as nuts, wild grains, fish and deer (Ellis et al. 1990; Stothers et al. 2001). In the Great Lakes region, the Middle Archaic time period is represented by several side-notched variants of Matanzas, Raddatz and Otter Creek projectile points (Robertson 1989).

The Late Archaic period (5,000-3,000 B.P.) represents the first period during which populations relied on modern vegetative communities in Michigan (Roberston et al. 1999). Although the increased number of Late Archaic sites over previous periods has been interpreted as a substantial population increase, it is likely that the high levels of the Great Lakes may be partially responsible for the disparity. During the Early and Middle Archaic, lake levels were low compared to present-day levels, and therefore, it is likely that these sites are now submerged. During the Late Archaic, lake levels were higher than current levels and therefore the sites are not submerged. The Late Archaic is also characterized as the initial period of intensive interaction and trade with widespread regions of North America. The settlement system indicates larger and more permanent occupations, at which exploitation of resources used in earlier times was supplemented by the emergence of the first cultigens (Ford 1977). The Late Archaic settlement patterns also included large seasonal band aggregation for activities such as harvesting the spring fish runs. This seasonal aggregation also facilitated group ceremonial and mortuary activities for Late Archaic and Early Woodland populations.

Woodland Period (ca. 3,000-350 B.P.). Native Americans in this region made the shifts from seasonal settlement and foraging to a sedentary, agricultural lifeway. Cultural complexity and traditions exploded. Technology also changed, as the first ceramic technology was developed and stemmed (rather than notched) projectile points appeared. By the end of the Woodland Period, Michigan was home to a mosaic of cultural traditions.

The Early Woodland period in Michigan dates to approximately 3,000-2,000 B.P. Archaeologists have generally identified the division between Late Archaic and Early Woodland material culture by the advent of distinctive, cordmarked ceramics. Some theories suggest that the initial purpose of pottery was to boil and process nuts, thus altering the basic subsistence regimen of the Late Archaic period even further (Ozker 1977). It is important to note, however, that the introduction of ceramics into Michigan did not occur simultaneously in all areas. Ceramics appear in southern Michigan earlier than in the northern part of the state. Certain stemmed and side-notched projectile point styles also carry over from the Late Archaic. Research suggests that innovations that are typically associated with the Archaic/Woodland transition do not appear simultaneously across Michigan, nor are they derived from a single source (Garland and Beld 1999). Although a transition between periods cannot simply be defined by one attribute characteristic, ceramic vessels remain a useful marker for the Early Woodland period.

The settlement pattern during the Early Woodland period appears to have been a seasonal pattern of aggregation during the warmer months with dispersal to small camps in the colder months. Other aspects of material culture include stemmed projectile points, chert scrapers and drills, bone harpoons, and various copper implements reminiscent of the "Old Copper Culture." Early Woodland pottery has been discovered at sites in central and western Michigan, including types such as Marion Thick (Helman 1950) and Schultz Thick (Fischer 1972).

The Middle Woodland period (2,000-1,600 B.P.) in Michigan is dynamic in that groups associated with the Hopewellian cultural system existed alongside various “non-Hopewellian” groups. Research suggests that the development of the Norton Tradition of west-central Michigan was due to an influx of Hopewellian peoples into the area. Evidence suggesting a gradual shift from Early Woodland to Hopewellian attributes is limited. Kingsley (1999) argues that Middle Woodland Hopewell appears abruptly and fully developed at 10 B.C. at the Norton Mounds Site. This is contrary to the Saginaw Tradition in the eastern part of the state, where Hopewellian attributes tend to appear inconsistently and incompletely, reflecting a diffusion of Hopewellian ideas rather than a migration of Hopewellian peoples.

Although the distribution of sites and population of the Norton Tradition groups is not entirely clear, some patterns are evident. There appear to be relatively few Middle Woodland Hopewell sites in Michigan. When present, Norton Tradition sites tend to focus around riverine environments. Population numbers also appear to be lower when compared to Illinois Hopewell. Kingsley (1981) argues that the relative lack of sites suggests a settlement pattern focused on reoccupation of the same sites over a long period of time. This may be supported by the fact that while Hopewell mound groups are more rare in Michigan, they tend to be more extensive than Hopewell mound groups in Illinois (Kingsley 1999). Also, the scarcity of Norton Tradition sites in Michigan may be explained by the nature of resource availability along the western Michigan river valleys. When compared to the more extensive, mature drainage systems of Illinois, resource availability along the Muskegon River valley is irregularly distributed (Kingsley 1999).

Norton Tradition mortuary practices reflect typical Hopewellian characteristics. Burial mounds were built, and the individuals were typically buried with various types of grave goods. Prestige goods such as decorated Hopewell pottery, copper goods, beads and turtle carapace bowls and utilitarian materials such as bone awls and chipped stone are some example of these funerary items. The presence of prestige goods in funerary contexts suggests some level of social organization and status; however, evidence for a complex ranking system is not present (Kingsley 1999).In contrast with the Middle Woodland Hopewellian groups in this part of Michigan, archaeologists understand relatively little about the non-Hopewellian groups. Although the non-Hopewellian Western Basin Tradition of southeastern Michigan has been subject to study (Stothers 1975), archaeologists understand less about non-Hopewellian groups in the northern half of the Lower Peninsula. Generally, many of these groups are described as living an as yet unrecognized lifestyle that is essentially a continuation of the Late Archaic-Early Woodland (Kingsley 1999).

The Late Woodland period (1,600-350 B.P.) in Michigan was characterized by substantial cultural change. In western Michigan, the Late Woodland is characterized by the Spring Creek Tradition. The local ceramic tradition during this period is known as Spring Creek Ware, which was made in the Muskegon and Grand River Valleys. Similarities between this ware and other southern Lower Peninsula wares (i.e., Allegan Ware in the Kalamazoo Valley and Western Basin Tradition ceramics of southeastern Michigan) indicate that populations interacted with each other in these areas (Holman and Brashler 1999).

The Late Woodland in the extreme northeastern Lower Peninsula reflects variation in ceramic traditions. In the Straits of Mackinac archaeologists have recorded sequential regional ceramic sequences such as Mackinac Phase (1,150-950 B.P.), Bois Blanc Phase (950-650 B.P.), and Juntunen Phase (650-350 B.P.) (Fitting 1975; McPherron 1967). The Upper Buff Creek Site (20AA128) in Alcona County reflects evidence for groups from Saginaw Valley in this part of the state (Holman and Brashler 1999).

Mortuary treatment at this time generally lacked the elaborate grave goods that were the hallmark of the Late Archaic through Middle Woodland periods. The construction of conical mounds and extensive ossuary pits are still evident, however, at some sites in the northern portion of the Lower Peninsula. One example of this elaborate mortuary practice is the Juntunen site, which exhibited five ossuary pits with several examples of dismemberment and skull plaque removal (McPherron 1967).

Late Woodland groups tended to utilize a broad spectrum food procurement strategy, relying on foods such as fish, deer, mussels, turtles, berries and other riverine resources. Previous research suggests that Spring Creek Tradition peoples participated in a seasonal round which involved summer encampments at the mouth of the Muskegon River and hunting camps in the interior headwater regions during the winter season (Hambacher and Holman 1995). The summer aggregation was used to exchange goods and to maintain social relationships to secure against times of scarce resources. This exchange was represented in the trade of Norwood and Bayport cherts (Brashler et al. 2000; Holman and Brashler 1999). Another aspect of this seasonal round in west-central Michigan was the use of subterranean cache pits. Assuming an analog with recorded early historic Native American use of such features, these pits were likely used to store surplus foodstuffs, hides, and equipment. Cache pits are sometimes found in association with seasonal residential sites, but are often located independently along seasonal travel routes, in areas where seasonal resources were abundant and faunal and floral habitat zones overlapped. Some cache pit sites have been recorded that contain dozens of emptied pits (Holman and Krist 2001).

In the later part of the Late Woodland period (after A. D. 1000) a greater heterogeneity of ceramic styles indicates that intergroup interaction decreased. There is also little evidence for the exchange of Norwood and Bayport chert types (Holman and Brashler 1999). It has been suggested that the Late Woodland sequence along the Muskegon River was disturbed either ca. A.D. 1200 by groups from the east or later, ca. A.D. 1400, by Upper Mississippian peoples from the southwest (Brashler et al. 2000). This disturbance is supported by the appearance of "Iroquois-like" pottery attributes in the ceramic assemblage (Holman and Brashler 1999).

Precontact Archaeological Resources

A Phase I Historical and Archaeological Resources study was conducted for the Project area (Mannik Smith Group, Inc., 2015). A literature review was completed within a 2.0-km (1.2-mi) study area around the Ludington Project area in Mason County in July 2015. A search of the Michigan State Historic Preservation Office (Michigan SHPO) data system revealed that there are no cultural resources within the Project area that are listed in or eligible for the National Register of Historic Places (NRHP) or the Michigan State Register of Historic Places. Thirteen previously recorded Precontact archaeological sites are located in the study area. Two of the Precontact archaeological sites, 20MN48 and 20MN49, are located directly within the Project area; however, both were destroyed during the initial construction of the facility from 1969-1972 and were determined not eligible for the NRHP. 20MN48 (a prehistoric camp) and 20MN49 (a prehistoric habitation) are shown in the Michigan SHPO records to be located adjacent to each other within the area now occupied by the penstocks. The state site files note that both sites are ineligible for the NRHP because they have been destroyed.

A literature review encompassing a 2.0-km (1.2-mi) buffer around the Pigeon Lake recreation site in Ottawa County similarly revealed that no known archaeological sites are located within this study area.

The archaeological survey was completed between August 10th and 21st, 2015. Survey methods included a combination of visual inspection of areas that were likely disturbed during the construction of the Ludington Project between 1969 and 1972, and shovel testing of undisturbed areas at 15-meter (50-foot) intervals. The survey confirmed the destruction of previously recorded sites 20MN48 and 20MN49. The survey resulted in the identification of five previously unrecorded Precontact archaeological sites, which have been assigned state trinomial site numbers, listed in Table E-4.3.9-1. Site types include four lithic isolates and one small lithic scatter. All five of the prehistoric archaeological sites appear to represent ephemeral uses of the landscape at undetermined times during prehistory, and are recommended not eligible for the NRHP due to a lack of research potential (criterion D).

In addition to the archaeological sites identified during the archaeological survey, the Project Area contains both eroding bluff faces and stabilized dune formations that may have the potential for deeply buried prehistoric archaeological sites. Typical Phase I survey methods such as shovel testing are not designed to identify such deeply buried sites. Therefore, any future development or changes in plant operations will require an evaluation of the potential for deeply buried archaeological resources that may be affected.

Postcontact Period History

The discussion below focuses exclusively on historic contexts relevant to the Ludington Project area in Mason County. A formal archaeological survey was not conducted within the Pigeon Lake recreation site in Ottawa County.[16]

The area of western Michigan was originally ceded to the newly independent United States by the British after their defeat in the Revolutionary War. The area was considered part of the larger Northwest Territories until it became part of the Indiana Territory in 1800. Five years later, the Michigan Territory was formed. In 1837, Michigan became the nation's 26th state.

Father Jacques Marquette (also known as James Marquette and Père Marquette), a French Jesuit missionary, was sent to the New World in 1666. In 1668, he built a church at Sault Ste. Marie, thus establishing the first permanent European settlement in the lands that would eventually become the Upper Peninsula of Michigan. An important historical figure, Père Marquette has been memorialized throughout the region. Many towns, parks, and landmarks have been named Marquette in his honor, such as the Pere Marquette River, Pere Marquette Lake, and Pere Marquette Township. The Father Marquette Shrine, commemorating the location where Father Jacques Marquette died in 1675, is located on South Lakeshore Drive north of Historic White Pine Village on Pere Marquette Lake in Mason County. The settlement that would eventually become the city of Ludington was also originally called Père Marquette, but it was renamed after the successful 19th-century industrialist James Ludington, who was instrumental in developing the city itself as well as the early lumber industry in the area (MCBG 1933).

The first appearance of white settlers in Mason County dates to 1840 to hunt, fish and trade with the Indians. One mill was established for a brief period of time at Free Soil Mills, the first permanent white settlement, established in Mason County in 1847. Burr Caswell first traveled to the area from Illinois in 1845 to engage in fishing and trapping. Two years later, he and his family settled in the Pere Marquette area and constructed the first frame house in the county in 1849.

As forests in the eastern states were becoming depleted, lumbermen turned their attention to this region for its abundance of white pine timber and the economic potential it represented. Sawmills were soon established in the area. A sawmill was constructed on the northern end of Pere Marquette Lake in 1849 and was acquired by James Ludington in 1859. Thus began his development of the town that would eventually bear his name. In 1873, the village of Pere

[16] Based on the cultural resources study report, three Phase I archaeological surveys were conducted in the vicinity of the recreation site and a literature search found no listed sites or historic districts. The recreation area was not surveyed due to the limited APE of the site and that the site is not proposed to change.

Marquette became the incorporated City of Ludington (Advantage Marketing & Publications [AMP] 2014).

Ludington also developed as a major Great Lakes shipping and transportation center. As the lumber industry grew in the second half of the 19th century, the means to get the product to market also developed. In December 1874, the Flint and Pere Marquette Railroad was completed into Ludington. By 1875, the Great Lakes shipping extension of the railroad began with a leased sidewheel steamer running from the docks at Ludington to Sheboygan, Wisconsin. Even with the decline of lumbering in the region in the late 19th century and the subsequent decline in the rail shipment of logs, the shipping operations' earnings continued to grow, as the ships transported wood products, flour and grain (Ivey 1919).

In 1897, the Flint and Pere Marquette Railroad established their Great Lakes railway car ferry line running from Ludington to Manitowoc. The world's first all-steel car ferry, the Pere Marquette, allowed fully loaded railcars to be brought into the ship's hold, using tracks running up to the edge of the dock and meeting up with tracks permanently installed on the ship (Ivey 1919). Eventually, the ferries would carry passengers, cars and trucks; Ludington grew to be the largest car ferry port in the world by the mid-1950s. Today, the last remnant of this historic line is still operating a vehicle and passenger service using the SS Badger, a coal-fired ferry listed on the National Register of Historic Places in 2009 (AMP 2015a).

As the lumbering era boom years wound down in the first decades of the 20th century, agriculture gained prominence in Mason County. In particular, the Mason County area became known for its fruit production. The favorable conditions for agriculture, especially fruit trees, are tied to the county's proximity to Lake Michigan.

All these factors led to the transformation of Mason County from its 19th-century origins as a lumber capital, to an agricultural region and shipping center in the 20th century, to popular recreation area in the decades following the 1980s. Where there were once numerous sawmills surrounding Pere Marquette Lake, there are now upscale condominium developments, the city's municipal marina, another private marina, and a waterfront park complete with playground equipment, a picnic pavilion, and an amphitheater. Year round recreational opportunities abound throughout the county, including hunting, fishing and camping. While Mason County still has a strong agricultural component, especially in the townships, a significant portion of its economic activity is now tied to tourism (AMP 2015b).

Postcontact Archaeological Resources

A Phase I Historical and Archaeological Resources Study was conducted for the Project area (Mannik Smith Group, Inc., 2015). A literature review was completed within a 2.0-km (1.2-mi) study area around the Ludington Project area in Mason County in July 2015. A search of the

Michigan SHPO data system revealed that there are no Postcontact cultural resources within the Project area that are listed in or eligible for the NRHP or the Michigan State Register of Historic Places. Four previously recorded Postcontact archaeological sites are located in the study area.

A literature review encompassing a 2.0-km (1.2-mi) buffer around the Pigeon Lake recreation facility in Ottawa County similarly revealed that no known Postcontact archaeological sites are located within this study area.

The archaeological survey was completed between August 10th and 21st, 2015. Survey methods included a combination of visual inspection of areas that were likely disturbed during the construction of the Ludington Project between 1969 and 1972, and shovel testing of undisturbed areas at 15-meter (50-foot) intervals. The survey resulted in the identification of 10 previously unrecorded archaeological sites, which have been assigned state trinomial site numbers, listed in Table E-4.3.9-1. Site types include nine historic homestead / farmstead sites and one historic site related to the construction of the Ludington Project. Eight of the ten Postcontact archaeological sites have been heavily disturbed and/or represent ephemeral fragments of 20th-century activity and are also not recommended eligible for the NRHP.

A total of 15 archaeological sites were identified within the Project Area; no archaeological sites were identified within the Port Sheldon Recreation Area. The sites identified within the Project Area have been assigned state trinomial site numbers 20MN324 – 20MN338, Table E.4.3.9-1. The 15 formally designated sites can be divided into five basic types: prehistoric lithic isolates, prehistoric lithic scatters, historic artifact scatters associated with known farm/orchard parcels, farmstead/orchard sites, and a historic artifact scatter associated with the construction of the Project.

Table E-4.3.9-1: 15 Newly Identified Archaeological Sites

Trinomial Site	Site Type	NRHP Eligibility	Recommendations
20MN324	Farmstead/Orchard	Potentially Eligible (Criterion D)	Phase II evaluation *only if future development is planned in this location*
20MN325	Farm/Orchard-Associated Artifact Scatter	Not Eligible	No further investigation

Trinomial Site	Site Type	NRHP Eligibility	Recommendations
20MN326	Farm/Orchard-Associated Artifact Scatter	Not Eligible	No further investigation
20MN327	Prehistoric Lithic Scatter	Not Eligible	No further investigation
20MN328	Farm/Orchard-Associated Artifact Scatter	Not Eligible	No further investigation
20MN329	Farmstead/Orchard	Potentially Eligible (Criterion D) – *historic component only*	Phase II evaluation *only if future development is planned in this location*
20MN330	Farmstead/Orchard	Not Eligible	No further investigation
20MN331	LPSF-Associated Artifact Scatter	Not Eligible	No further investigation
20MN332	Farm/Orchard-Associated Artifact Scatter	Not Eligible	No further investigation
20MN333	Prehistoric Lithic Isolate	Not Eligible	No further investigation
20MN334	Prehistoric Lithic Isolate	Not Eligible	No further investigation
20MN335	Prehistoric Lithic Scatter	Not Eligible	No further investigation
20MN336	Farmstead/Orchard	Not Eligible	No further investigation
20MN337	Prehistoric Lithic Scatter	Not Eligible	No further investigation
20MN338	Farm/Orchard-Associated Artifact Scatter	Not Eligible	No further investigation

Site Summaries

Sites 20MN333 and 20MN334 were classified as prehistoric lithic isolates. In addition, a third prehistoric isolated find was incorporated into site 20MN329, a multicomponent site that includes a 20th-century farmstead remnant. Isolated find sites are generally not eligible for the NRHP due to a lack of potential to yield significant information regarding prehistory. All that can usually be said about such sites is that they represent ephemeral, transient occupations of the locale by an unknown person or persons at some time during the prehistoric period for the purpose of tool manufacture and/or maintenance.

Sites 20MN327, 20MN335, and 20MN337 were classified as prehistoric lithic scatters. All three of these sites consist of fewer than five pieces of non-diagnostic lithic debitage. The scatter was spread among three positive shovel tests at 20MN327, but both 20MN335 and 20MN337 consist of single shovel tests that yielded multiple pieces of debitage. Furthermore, 20MN337 is located within the boundaries of a larger historic site (20MN336), and is in a location that appears to have been extensively disturbed by historic-period activity, including the construction of the Project and the creation of the current disc golf course. As with the prehistoric isolated finds, all that can be said about sites 20MN327, 20MN335 and 20MN337 is that they represent ephemeral, transient occupations of the locale by an unknown person or persons at some unknown time during the prehistoric period for the purpose of tool manufacture and/or maintenance. No evidence for subsurface features was identified at any of these three sites.

Sites 20MN325, 20MN326, 20MN328, 20MN332, and 20MN33 were classified as historic-period artifact scatters associated with former farm/orchard parcels. What distinguishes these sites from the farmstead/orchard sites discussed below is the lack of any observed surface or subsurface features associated with farmstead or orchard activity. However, these five also vary in the amount of artefactual material identified within the sites as well as the degree of apparent modern disturbance.

Both 20MN325 and 20MN326 are relatively dense, discrete surface refuse dumps that date to the mid-20th-century and can therefore be directly associated with documented occupations based on cadastral atlas and plat maps. Both sites are likely components of larger sites that extend outside the current Project area boundary. 20MN326, in particular, demonstrates one potential pitfall of the piecemeal nature of much archaeological survey work conducted pursuant to Section 106 of the NHPA. This site appears to be associated with previously recorded sites 20MN98 and 20MN308. The former was recorded during a 1978 survey conducted in advance of the construction of modern U.S. Route 31, and the latter was identified during a 2013 survey of 95-acres conducted for the purpose of removing unused land from the FERC-licensed Project boundary. The authors of the 1978 survey report and a subsequent Phase II investigation of the site could only consider the archaeological remains within the original survey area. While the authors of the 2013 survey report explored the apparent connection between 20MN98 and 20MN308, they could not re-locate 20MN98 in the field (it was likely destroyed by the construction of U.S. Route 31) and ultimately determined that 20MN308 was not eligible for the NRHP in part because it was an apparently isolated farmstead remnant). No significant yard scatters were identified at 20MN326. While 20MN326 appears to represent a concentrated refuse disposal area, the artifact assemblage can be tightly dated to the 1940s and does not coincide with the known tenant occupation of the property (ca. 1900-1935).

The evaluation of 20MN325 suffers from the same problem as sites 20MN98 and 20MN308: necessarily incomplete information due to current survey boundaries. 20MN325 consists of two closely-spaced surface refuse dumping locales, both dating to the 1940s. It is currently unclear who the property owner at that time was, although the larger parcel on which the site was located appears to have been a working orchard. It is possible, indeed likely, that 20MN325 is part of a larger site that includes farmstead remnants located outside of the current project area boundary. No subsurface component of 20MN325 was identified, and no surface or subsurface features appear to be present.

Unlike sites 20MN325 and 20MN326, sites 20MN328, 20MN332 and 20MN338 are low-density scatters of historic-period artifacts that do not represent intensive refuse dumping activity and that are likely located in disturbed contexts. 20MN328 consists of three subsurface artifact findspots dating to the late 19th or early 20th centuries and spread out over nearly half a kilometer, connected only in their location on two former parcels owned by the Seymour family. This site has been heavily disturbed by the construction of the Project and the consequent re-alignment of Brunson Road. 20MN332 consists of a very sparse 19th-century surface artifact assemblage located on a small bench in an otherwise sloped and eroded backdune setting. While the 20th-century occupants of the parcel are known, it is not currently known who the 19th-century occupants of the parcel were. 20MN338 also consists of a low-density, subsurface artifact scatter dating to the 19th-century and located in an area that has been heavily disturbed by the construction of the Project and an electrical substation on the west side of Lakeshore Drive. No surface or subsurface features were encountered at any of these sites.

Four farmstead/orchard sites were identified during the current survey: 20MN324, 20MN329, 20MN330, and 20MN336. These four sites are distinguished from the sites in the Farm/Orchard-Associated Historic Artifact Scatter category in that each of these sites include features associated with farm/orchard activity.

20MN324 was the most complex site identified during the relicensing survey. Although the domestic core of this former parcel appears to have been located within the modern overhead power transmission corridor to the east of the site, a significant portion of the site remains in a wooded, stabilized dune setting. A total of 21 features were identified within 20MN324.

Although only one of these features (a collapsed shed) appears to represent in situ structural remains, a variety of feature types are present. Combined with the extensive artifact assemblage, it appears that multiple activity areas are present. The site dates to the 1940s-1950s, at which time the parcel was owned by either William Long or Ronald Van Dyke. Site 20MN324 appears to have a high degree of potential significance. While a portion of the site has been disturbed by the adjacent transmission corridor, that part of the site that remains appears to have experienced little if any disturbance since its creation. While the artifact assemblage dates primarily to the 1940s and 1950s, the parcel was occupied from at least 1900 to the time it was sold to Consumers in the late 1960s. Furthermore, the majority of the 21 features within the site cannot be firmly dated and may represent older, different uses of the area than do the refuse dumps. Additionally, it appears likely that 20MN324 contains several different, distinct activity areas, possibly including a maple sugaring locale.

20MN329 is also a 20th-century farmstead/orchard remnant. This site straddles the current Project boundary, and it is highly likely that additional components of the site are present outside of the survey area and remain unrecorded. Recorded components include a house foundation with an extensive refuse scatter adjacent to it as well as a cistern (both outside of the Project Area), a concrete stock tank, the remnant of a brick wall, and a sparse subsurface artifact scatter (all within the Project area). The artifact assemblage (including both artifacts that were collected and those that were not) appears to represent a broad 20th-century date range, and historic atlas and plat maps indicate that the original property was owned by the Cole family from at least ca. 1900 to the late 1960s, when it was sold to Consumers. As with sites 20MN325 and 20MN326, however, the evaluation of 20MN329 is limited by the fact that the entire original property was not included within the survey boundaries. Nevertheless, some preliminary observations can be made. While a portion of the original property was destroyed by the construction of the Project's reservoir, that portion of the property that remains does not appear to have been much disturbed. Subsurface testing was not conducted in the area around the house foundation, so it is currently unknown whether a yard scatter exists. Similarly, while the extensive refuse scatter adjacent to the house foundation is likely associated with the abandonment of the property, it is not currently known whether other refuse deposits exist outside of the Project Area. Diagnostic artifacts were observed in the scatter adjacent to the house foundation, and the occupation of the parcel has been traced back to at least ca. 1900. Unfortunately, the paucity of artifacts recovered from that portion of the site within the Project boundary does not provide enough data to address the ratio of domestic to architectural artifacts.

20MN330 is located in a wooded area within a stabilized backdune setting on the east side of the Project's reservoir. This site consists of two features – a depression of unknown origin and the remnant of a barbed-wire fence. Two large chunks of concrete with embedded cobbles were observed near the depression, suggesting the former presence of a structure in this location. However, no artifacts were recovered from the site. While it is possible that additional elements of this site exist outside of the Project area, the only such area is immediately to the south an area that appears to have been extensively disturbed during the construction of the reservoir. Thus, a large portion of the original farm parcel appears to have been heavily disturbed. The domestic component of the site could not be identified, and shovel testing throughout the area failed to identify any subsurface deposits. Similarly, shovel testing and visual inspection failed to identify any concentrated refuse disposal areas. No diagnostic artifacts were recovered from the site. While the property history was traced back to ca. 1900, multiple property owners/occupants were identified and it is unknown which of them the site may be associated with.

Site 20MN336 is also located within a stabilized dune setting. Three surface features were identified at the site, all of them unidentified depressions (one with an associated concrete foundation remnant). Four discrete subsurface artifact scatters were also identified, although three of these are quite small and almost certainly located within disturbed contexts. The fourth scatter is associated with two of the three depressions and is located in an area near the documented location of a former farm house on the east side of Lakeshore Drive. The artifact assemblage from the site generally dates to the late 19th or early 20th century. However, this area has been disturbed by an underground brine line. Thus, a majority of 20MN336 has been subject to extensive disturbance during the second half of the 20th century. This area does appear to represent a yard scatter, but no concentrated refuse disposal areas were identified. No tightly diagnostic artifacts were recovered from the site. While the 20th-century history of the original property has been traced, it is unknown whether the identified components of 20MN336 are associated with the early 20th-century Cowell family occupation of the property, an unknown, earlier occupation, or both. Site 20MN336 yielded an approximately equal number of architectural and domestic artifacts.

One archaeological site that appears to be associated with the construction of the Project (1969-1972) was identified during the survey: 20MN331. This site consists of a low-density but discrete surface refuse deposit. A number of glass beer and soft drink bottles bearing date codes from the early 1970s were recovered from this site. However, no surface or subsurface features were encountered during the survey. Despite the fact that this site has not yet reached 50 years of age, it was recorded and assigned a state trinomial site number due to its association with the NRHP-eligible LPSF.

Due to various factors including small artifact assemblages, lack of identified surface or subsurface features, evidence for modern disturbance, and a lack of apparent associations with important persons or events, historic sites 20MN325, 20MN326, 20MN328, 20MN330-20MN332, 20MN336 and 20MN338 do not meet criteria A, B or D, and therefore do not appear to be eligible for the NRHP. No further archaeological investigations of these sites are recommended. However, historic sites 20MN324 and 20MN329 are farmstead/orchard sites that exhibit many factors associated with significant farmstead archaeological sites in Michigan.

These two sites are potentially eligible for the NRHP under Criterion D. Neither site is currently threatened by either natural or man-made forces, and Consumers does not propose any changes to Project operations or expansion of the physical plant. Therefore, no additional investigation of these two sites is recommended at this time. However, should future operational changes or physical plant expansion occur, the impact of such development on these two sites will need to be considered and Phase II archaeological investigations may be required.

Historic and Architectural Resources History

Consumers began land acquisitions for the planned Ludington Project in the early 1960s. Approximately 1,500 acres of farmland and orchards were cleared from March-October 1969; construction began in July of that year following issuance of the FERC license on June 30, 1969. This first stage of construction included excavation for the penstocks, construction of the powerhouse access road, and construction of the unloading dock in Ludington Harbor and a 3.5-mile long haul road from the harbor to the Ludington Project. In January 1970 construction of the cofferdam began, and the powerhouse was begun in June of that year. The first section of the reservoir embankment was completed in May 1971, and major electrical construction began in June. The tailrace was flooded for the first time during the summer of 1972 and reservoir filling commenced later that fall. The facility’s six power generating units were gradually placed online over the course of 1973, and the plant was fully operational by the end of September. Restoration of the area impacted by construction was completed by the summer of 1974 (Demeter 2011:4-1 – 4-3).

Since the completion of the Ludington Project in 1973, only incremental changes have been made to the facility. One of the most important was the installation of a barrier net in Lake Michigan around the cofferdam/jetties and breakwall in 1996. The barrier net was installed as a result of a settlement agreement necessitated by stakeholder concern that the Project was causing harm to local fish populations (Demeter 2011:4-21). In addition, the Licensees facilitated the creation of several recreational facilities on Project land, including a day use park/picnic area and disc golf course on the northwest side of the Project reservoir, a remote-control model airplane flying field (Hull Field), a recreational vehicle campground on the north side of the reservoir, scenic overlooks that provide views of the Project reservoir and Lake Michigan, and the Pigeon Lake North Pier in Ottawa County.

Historic and Architectural Resources

The Project was constructed between 1969 and 1973, and while properties less than 50 years old are not typically considered eligible for the NRHP, the Licensees are aware that properties less than 50 years old that are considered exceptionally important may be considered eligible for listing.

The Project is unique in that it is Michigan's first and only hydroelectric pumped storage facility. At the time it was constructed, the Project had the largest generating capacity in the world for pumped storage facilities, and it remains the third largest pumped storage facility in the world and the second largest in the United States.

Due to its uniqueness, the Licensees voluntarily conducted a NRHP-eligibility study for the Project in 2011 prior to pump-turbine/motor-generator unit upgrades. Consumers contracted with Commonwealth Cultural Resources Group (CCRG), of Jackson, Michigan, to perform an historic assessment of the Project. This assessment found that the Project meets several of the eligibility criteria for NRHP listing under Criteria A, C and D, and Criteria Consideration G[17]. CCRG also reviewed the actions associated with the overhaul/upgrade and in their professional judgment found that proposed work would not adversely impact the Plant's eligibility for listing on the NRHP.

The Licensees informally consulted with, and requested concurrence from, Michigan SHPO that the proposed Project upgrades and associated upgrade or routine maintenance activities would not adversely affect the integrity of location, design, setting, materials, workmanship, feeling, and associations that make the Project potentially eligible for inclusion in the NRHP. In a February 21, 2012 letter to the Commission, the SHPO provided their opinion that, based on its review of the draft application for amendment and the historic assessment, the Project upgrades would have no adverse effect on the Project's eligibility for listing on the NRHP. The Project upgrades are ongoing (Exhibit E Section 1.0).

No properties listed on the Michigan State Register of Historic Sites are present within the Project study area.

[17] According to the National Park Service, **National Register Criteria for Evaluation:**
The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
A. That are associated with events that have made a significant contribution to the broad patterns of our history; or
B. That are associated with the lives of significant persons in our past; or
C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
D. That have yielded or may be likely to yield, information important in history or prehistory.
Criteria Considerations:
G. A property achieving significance within the past 50 years if it is of exceptional importance.

4.3.9.2 Environmental Analysis

The Licensees are not proposing any changes to the Ludington Project or any changes in the operation of the Project that would affect any of the identified archaeological or architectural resources found within the Project APE. At this time, the Licensees are not proposing the construction of any new project facilities or recreation facilities, or ground disturbing activities that have the potential to impact identified cultural resources.

To protect any cultural resources at the Project during the term of a new license, the Licensees are proposing to prepare and implement a Historic Properties Management Plan (HPMP), which will provide background information on cultural resources at the Project, including maps of the APE and archaeological and historic sites, preservation goals and priorities, project effects, and consultation requirements.

No Precontact archaeological sites located within the Project APE were determined to be eligible or recommended for NRHP listing.

Two Postcontact archaeological sites are recommended NRHP-eligible under Criterion D and will be incorporated into the HPMP. Should new construction or changes in plant operations be considered in the future that have the potential to impact the sites, formal evaluation of these two sites in the form of Phase II archaeological testing may be necessary.

One historic site (Project pumped storage hydroelectric facility) is recommended NRHP-eligible under Criteria A, C and D, and Criteria Consideration G and will be incorporated into the HPMP. This historic site would not be impacted by the relicensing of the Project as proposed. Michigan SHPO agreed that the current ongoing Project upgrades would have no adverse effect on the Project's eligibility for listing on the NRHP.

By letter dated March 4, 2016 a copy of the December 2015 Phase I Historic-Archaeological Study Report prepared by Mannik & Smith was provided to Michigan SHPO and the Saginaw Chippewa Indian Tribe of Michigan (Saginaw Tribe). On March 6, 2017 the Licensees provided Michigan SHPO and the Saginaw Tribe with a copy of the proposed Historic Properties Management Plan (HPMP) for the Ludington Pumped Storage Project. Neither the Michigan SHPO nor the Saginaw Tribe provided comments on these documents. The Licensees contacted Michigan SHPO and the Saginaw Tribe on May 5, 2017, requesting comments or recommendations by Friday, May 12, 2017. Michigan SHPO responded by email on May 5, 2017, indicating that staff accepted the report without comment or recommendation. This correspondence indicates that Michigan SHPO concurs with the eligibility recommendations for all Precontact and Postcontact sites within the APE and that the project is not affecting the two potentially eligible Postcontact sites.

4.3.9.3 Proposed Environmental Measures

The Licensees have enclosed as Appendix E-3 a Historic Properties Management Plan (HPMP), developed in consultation with the Michigan SHPO and the Saginaw Tribe. The HPMP will ensure that appropriate consultation occurs prior to any future activity that may affect the eligible historic properties associated with the Project. The HPMP will be filed with the Michigan SHPO and FERC under separate covers as "privileged," because it contains confidential archaeological site location information. The HPMP addresses the NRHP-eligible properties listed in Table E-4.3.9-2.

Table E-4.3.9-2: Eligible Historic Properties Addressed in the HPMP

Site	Site Type	Eligibility Criteria	Site Location
20MN324	Postcontact	D	Section 11, Summit Township, west of upper reservoir
20MN329	Postcontact	D	Section 11, Summit Township, west of upper reservoir
Ludington Hydroelectric Pumped Storage Facility	Historic	A, C and D, and Criteria Consideration G	Along Lake Michigan Shoreline, west of upper reservoir

The continued operation of the Ludington Project, as proposed, will not have an effect on the identified historic or archaeological resources because the proposed Project would not involve any new construction or ground disturbing activities that would impact the identified eligible sites. In order to protect the sites from the effects of any future modification or activities that could potentially affect historic properties at the Ludington Project, the HPMP would be implemented in accordance with the conditions of a new license. Therefore, pursuant to the National Historic Preservation Act, Section 106 (16 U.S.C. § 470f), the proposed relicensing of the Project would not have any adverse effects on historic properties located at the Project.

4.3.9.4 Cumulative Effects

No potential cumulative effects to cultural resources have been identified as a potential concern at the Ludington Project. The Licensees' proposal to continue to operate and maintain the Project under the existing operating regime is not expected to result in either geographic or temporal cumulative impacts to cultural resources.

4.3.9.5 Unavoidable Adverse Effects

Continued operation of the Project will result in no unavoidable adverse effects on cultural resources.

4.3.9.6 References

Advantage Marketing & Publications. 2014. "Ludington, Michigan History – James Ludington, City Founder." *Visit Ludington: Your Complete Guide to the Ludington, Michigan Area*. Electronic document available at http://www.visitludington.com/stories/ludington_michigan_history_city_founder_james_ludington. Last accessed November 23, 2015.

Advantage Marketing & Publications. 2015a. "History of the Lake Michigan Carferry, the S.S. Badger." *Visit Ludington: Your Complete Guide to the Ludington, Michigan Area*. Electronic document available at http://www.visitludington.com/stories/historic_lake_michigan_carferry_ss_badger_history_ludington_manitowoc. Last accessed November 24, 2015.

Advantage Marketing & Publications. 2015b. *Visit Ludington: Your Complete Guide to the Ludington, Michigan Area.* Electronic document available at http://www.visitludington.com/. Last accessed November 24, 2015.

Brashler, J. G., E. B. Garland, M. B. Holman, W. A. Lovis, and S. R. Martin. 2000. Adaptive Strategies and Socioeconomic Systems in Northern Great Lakes Riverine Environments: The Late Woodland of Michigan. In Late Woodland Societies: Tradition and Transformation across the Midcontinent, edited by T. E. Emerson, D. L. McElrath and A. C. Fortier, pp 543-579. University of Nebraska Press, Lincoln.

Cleland, C. E. and D. L. Ruggles. 1996. The Samels Field Site: An Early Archaic Base Camp in Grand Traverse County. In Investigating the Archaeological Record of the Great Lakes State: Essays in Honor of Elizabeth Baldwin Garland, edited by M. B. Holman, J. G. Brashler, and K. E. Parker, pp. 55-99. New Issues Press, Western Michigan University, Kalamazoo.

Demeter, N. F. 2011. *Historic Assessment of the Ludington Pumped Storage Plant (FERC Project No. 2680), Ludington, Mason County, Michigan.* Report submitted to Consumers Energy, Cadillac, MI by Commonwealth Cultural Resources Group, Jackson, MI.

Ellis, C. J., I. T. Kenyon, and M. W. Spence. 1990. The Archaic. In The Archaeology of Southern Ontario to A.D. 1650, edited by C. J. Ellis and N. Ferris, pp. 65-124. Occasional Publication No. 5, The London Chapter, Ontario Archaeological Society, London.

Fischer, F. W. 1972. Schultz Site Ceramics. In The Schultz Site at Green Point: A Stratified Occupation Area in the Saginaw Valley of Michigan, edited by J. E. Fitting, pp. 137-190. Memoirs No. 4, Museum of Anthropology, University of Michigan, Ann Arbor.

Fitting, J. E. 1975. *The Archaeology of Michigan: A Guide to the Prehistory of the Great Lakes Region*. Cranbrook Institute of Science, Bloomfield Hills, MI.

Ford, R. I. 1977. Evolutionary Ecology and the Evolution of Human Ecosystems: A Case Study from the Midwestern U.S.A. In Explanation of Prehistoric Change, edited by J. N. Hill, pp. 153-184. University of New Mexico Press, Albuquerque.

Garland, E. B. and S. G. Beld. 1999. The Early Woodland: Ceramics, Domesticated Plants, and Burial Mounds Foretell the Shape of the Future. In Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State, edited by J. R. Halsey, pp. 125-146. Bulletin No. 64, Cranbrook Institute of Science, Bloomfield Hills, MI.

Gramly, R. M. 1988. Paleo-Indian Sites South of Lake Ontario, Western and Central New York State. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. Miller and D. Steadman, pp. 265-280. Bulletin No. 33, Buffalo Society of Natural Sciences, Buffalo, NY.

Hambacher, M. J. and M. B. Holman. 1995. Camp, Cache, and Carry: The Porter Creek South Site (20MN100) and Cache Pits at 20MN31 in the Manistee National Forest. The Michigan Archaeologist 41:47-94.

Helman V. R. 1950. The Cultural Affiliations and Relationships of the Oliver Farm Site, Marion County, Indiana. Master's Thesis, Department of Anthropology, Indiana University, Bloomington.

Holman, M. B. and J. G. Brashler. 1999. Economics, Material Culture, and Trade in the Late Woodland Lower Penninsula of Michigan. In Retrieving Michigans's Buried Past: The Archaeology of the Great Lakes State, edited by J. R. Halsey, pp. 212-220. Bulletin No. 64, Cranbrook Institute of Science, Bloomfield Hills, MI.

Holman, M. B. and F. J. Krist, Jr. 2001. Late Woodland Storage and Mobility in Western Lower Michigan. In "Papers in Honor of Carol I. Mason," ed. T. C. Pleger, R. A. Birmingham, and C. I. Mason, pp. 7-32. The Wisconsin Archaeologist 82(1-2).

Ivey, P. 1919. *The Pere Marquette Railroad Company*. Michigan Historical Commission, Lansing.

Kingsley, R. G. 1981. Hopewell Middle Woodland Settlement Systems and Cultural Dynamics in Southern Michigan. Midcontinental Journal of Archaeology 6:131-178.

Kingsley, R. G. 1999. The Middle Woodland Period in Southern Michigan. In Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State, edited by J. R. Halsey, pp.148-172. Bulletin No. 64, Cranbrook Institute of Science, Bloomfield Hills, MI.

Lovis, W.A. 1999. The Middle Archaic: Learning to Live in the Woodlands. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State,* edited by J. R. Halsey, pp. 83-94. Bulletin No. 64, Cranbrook Institute of Science, Bloomfield Hills, MI.

Lovis, W. A., A. F. Arbogast, and G. W. Monaghan. 2012. The Geoarchaeology of Lake Michigan Coastal Dunes. Michigan Department of Transportation Environmental Research Series, Vol. 2. Michigan State University Press, East Lansing.

Mannik Smith Group, Inc. 2015. Phase I Historical and Archaeological Resources Study. Ludington Pumped Storage Project. Mason and Ottawa Counties, Michigan. December 2015.

Mason County Business Guide (MCBG). 1933. History of Mason County. Commercial Printing Company, Ludington, MI.

McPherron, A. 1967. The Juntunen Site and the Late Woodland Prehistory of the Upper Great Lakes Area. Anthropological Papers No. 30, Museum of Anthropology, University of Michigan, Ann Arbor.

Munson, P. J. 1988. Late Woodland Settlement and Subsistence in Temporal Perspective. In Interpretations of Culture Change in the Eastern Woodlands during the Late Woodland Period, edited by R. Yerkes, pp. 7-16. Occasional Papers in Anthropology No. 3, Ohio State University, Columbus.

Neusius, S. W. 1986. Generalized and Specialized Resource Utilization During the Archaic Period: Implications of the Koster Site Faunal Record. In Foraging, Collecting, and Harvesting: Archaic Period Subsistence and Settlement in the Eastern Woodlands, edited by S. Neusius, pp. 117-143. Occasional Paper No. 6, Center for Archaeological Investigations, Southern Illinois University-Carbondale.

Ogden, J. G., III. 1977. The Late Quaternary Paleoenvironmental Record of Northeastern North America. In "Amerinds and Their Paleoenvironments in Northeastern North America," edited by W. S. Newman and B. Salwen, pp. 16-34. *Annals of the New York Academy of Sciences* 288.

Ozker, D. 1977. The Naugle Site, 20MD30, Midland County, Michigan: Early Late Woodland and Late Archaic Components on a Pine River Site. The Michigan Archaeologist 22:315-355.

Robertson, J. A. 1989. The Lithic Assemblage of 20SA581: Description and Analysis. In Archaeological Investigations at the Weber I (20SA581) and Weber II (20SA582) Sites, Frankenmuth Township, Saginaw County, Michigan, edited by W. A. Lovis, pp. 51-137. Michigan Cultural Resource Investigation Series Vol. 1, Michigan Department of the State and Michigan Department of Transportation, Lansing.

Robertson, J. A., W. A. Lovis, and J. R. Halsey. 1999. The Late Archaic: Hunter-Gatherers in an Uncertain Environment. In Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State, edited by J. R. Halsey, pp. 95-124. Bulletin No. 64, Cranbrook Institute of Science, Bloomfield Hills, MI.

Shott, M. J. 1989. Technological Organization in Great Lakes Paleoindian Assemblages. In Eastern Paleoindian Lithic Resource Use, edited by C. J. Ellis and J. C. Lothrop, pp. 221-237. Westview Press, Boulder, CO.

Shott, M. J. 1999. The Early Archaic: Life After the Glaciers. In Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State, edited by J. R. Halsey, pp. 71-82. Bulletin No. 64, Cranbrook Institute of Science, Bloomfield Hills, MI.

Shott, M. J. and H. T. Wright. 1999. The Paleo-Indians: Michigan’s First People. In Retrieving Michigan’s Buried Past: The Archaeology of the Great Lakes State, edited by J. R. Halsey, pp. 59-70. Bulletin No. 64, Cranbrook Institute of Science, Bloomfield Hills, MI.

Stothers, D. M. 1975. The Emergence and Development of the Younge and Ontario Iroquois Traditions. Ontario Archaeology 25:21-30.

Stothers, D. M. 1996. Resource Procurement and Band Territories: A Model for the Lower Great Lakes PaleoIndian and Early Archaic Settlement System. *Archaeology of Eastern North America* 24:173-216.

Stothers, D. M., T. J. Abel, and A. M. Schneider. 2001. Archaic Perspectives in the Western Lake Erie Basin. In Archaic Transitions in Ohio and Kentucky Prehistory, edited by O. H. Prufer, S. E. Pedde, and R. S. Meindl, pp. 233-289. The Kent State University Press, Kent, OH.

4.3.10 Socioeconomics

4.3.10.1 Affected Environment

General Land Use Patterns

Much of Mason County is rural in nature. According to the decennial Census undertaken in 2010, 67 percent of the population lives in a rural area, with 33 percent inside an urban cluster (US Census Bureau, 2013).[18] An urban cluster is a densely settled territory with at least 2,500 people, but fewer than 50,000.

[18] Rural and Urban data are only collected during the decennial censuses. Therefore, 2010 data are the most current available. The results of the 2010 decennial Census were published in 2013. The years associated with the Census Bureau citations, as shown in parantheses, are the publication dates for the data. Therefore, the citation is shown as: (US Census Bureau, 2013).

The area immediately surrounding the Project is primarily classified as grassland/herbaceous with some light deciduous forest. Private residences and undeveloped private property are located to the north and south of the Project along Lakeshore Drive. Land use to the east of the Project can be characterized as primarily agricultural. Recently, a 56-turbine wind farm has been built east of the Project area.

Ottawa County is more urban, with just 20 percent of the residents categorized as living in a rural area at the time of the 2010 US Census. Seventy-nine percent of the population can be found in urbanized areas, a densely-settled area of at least 50,000 people. The remaining one percent is in urban clusters (US Census Bureau, 2013).

The J. H. Campbell Generating Complex is a coal-fueled generating facility owned by Consumers Energy and located on approximately 2,000 acres just west of the Pigeon Lake North Pier. Approximately half of the land, to the east and north, is undeveloped wildlife habitat and preserve, and contains a Biological Field Station. To the south is Pigeon Lake, which has a number of private residences on its shores.

From 2010 through 2014, the total population of the United States grew by 11.5 percent. The state of Michigan, however, experienced a slight decline in population. Most of the cities and townships in the vicinity of the Project also saw a decrease in population. Only Mason County, as a whole, and Pere Marquette increased in population during the 14-year period.

The population of Mason County grew by two percent from 2000 to 2010 to 28,705, according to the US Census Bureau (US Census Bureau, 2016). In 2014, Mason County had an estimated population of 28,783 residents, up slightly from the 2010 population of 28,705 residents. After increasing slightly from 2000 to 2010, Pere Marquette Township's population remained static from 2010 to 2014 at 2,470. The smaller Summit Township saw its population drop by roughly one hundred people to 924 between 2000 and 2010, before declining further to 795 persons by 2014. Summit has experienced an overall 22 percent decline in population since 2000.

From 2000 to 2010, Port Sheldon Township saw a 6 percent decline in population to 4,240. Over the next four years, the township reversed the trend and grew slightly to 4,331. In contrast to Michigan as a whole, Ottawa County experienced strong growth from 2000 to 2010, growing in population by 10 percent to 263,801. The population growth has continued into this decade, with an additional 3 percent increase to 269,795. In 2013, the US Census Bureau changed the definition of the Grand Rapids-Wyoming Metropolitan Statistical Area (MSA) to include Ottawa County. The revised MSA had a population of just over one million residents in 2014, with Ottawa County representing 26 percent of the MSA's total population.

Table E-4.3.10-1 provides a comparison of the 2000 and 2010 Census counts and the 2014 Census estimates for the Project communities.

Table E-4.3.10-1: Populations in the LPSP Study Area

Area	2000	2010	2014	Change 2000 to 2014
State of Michigan	9,938,444	9,883,640	9,889,024	-0.5%
Mason County	28,274	28,705	28,783	1.8%
Pere Marquette Township	2,228	2,366	2,470	10.9%
Summit Township	1,021	924	795	-22.1%
Ottawa County	238,314	261,376	269,795	13.2%
Port Sheldon Township	4,503	4,302	4,331	-3.8%

Source: US Census Bureau, 2016

The West Michigan Shoreline Regional Development Commission forecasts that between 2015 and 2040 the population of the West Michigan Shoreline Region within which the Project is located will grow by 3.8 percent from 340,162 to 353,086 (West Michigan Shoreline Regional Development Commission, 2014). Based on this growth rate, the total population would increase to 363,361 by 2060. Table E-4.3.10-2 presents the projected populations of the study area and the state through 2060. Mason County is forecasted to grow by 2.3 percent from 2015 to 2040, with 4.0 percent total growth from 2015 to 2060. Within the West Michigan Shoreline Region, the most rapid growth is anticipated to be from Ottawa County, a portion of which is within the Region. Growth in this portion of Ottawa County is projected to be 21.0 percent growth from 2015 to 2040 and 40.2 percent growth from 2015 to 2060.

Table E-4.3.10-2: Population Projections for the Counties within the Project's Region

County	Census 2010	Projection 2015	Projection 2040	% Change, 2015 to 2040	2060 Extrapolated Projection	% Change, 2015 to 2060
Lake	11,539	11,394	11,497	0.9%	11,577	1.6%
Mason	28,705	28,656	29,305	2.3%	29,814	4.0%
Muskegon	172,188	171,133	172,698	0.9%	173,912	1.6%
Newaygo	48,460	48,021	48,266	0.5%	48,455	0.9%
Oceana	26,570	26,150	24,987	-4.4%	24,128	-7.7%
Ottawa (portion)*	52,826	54,808	66,333	21.0%	76,822	40.2%
Total	**340,288**	**340,162**	**353,086**	**3.8%**	**363,361**	**6.8%**

**Note that only a portion of Ottawa County is included in the West Michigan Shoreline Regional Development Commission's population projections.*
Source: Census 2010 counts and 2015 and 2040 population projection are from the West Michigan Shoreline Regional Development Commission, 2014. For the purposes of this study, the 2060 population projection was extrapolated based on the projected 2015 to 2040 growth.

While total population figures provide an opportunity to identify trends over time, population density allows for the comparison of the number of persons per square mile (or other measure of area) across geographic areas of varying sizes. The 2014 population density of Mason County was 58 people per square mile with a land area of 495.1 square miles, approximately a third the population density of the State of Michigan. In 2010, the County ranked 43rd out of the State's 83 counties in terms of population density. The density of counties in Michigan varied widely, from a low of 4 persons per square mile in Keweenaw County to a high of 2,974.4 persons per square mile in Wayne County, which includes Detroit. In 2014, Pere Marquette Township, with 175.2 persons per square mile more closely approximates the population density of the state of Michigan. Summit Township has a density of 62 persons per square mile.

In 2014, the population density of Ottawa County was roughly 479 people per square mile, nearly three times the population density of Michigan as a whole. This level of development placed Ottawa County eighth in the state in terms of population density in 2010. Port Sheldon Township is less densely populated, with 194 people per square mile in 2014.

In Summit Township, 28.1 percent of the residents were aged 65 or older during the period from 2010 through 2014 (US Census Bureau, 2015e).[19] The State of Michigan as a whole had a much lower proportion (14.6 percent) of persons in this age category. Mason County and Pere Marquette Township also had a higher percentage of older people than the State average, with 20.1 percent and 22.8 percent of the population, respectively. In Pere Marquette, Mason County, and the state of Michigan the proportion of children exceeded 20 percent. Summit Township, however, had relatively fewer children, at 17.9 percent.

The area around the Project had a higher percentage of Caucasian residents than Michigan as a whole (79.2 percent) during the 2010 through 2014 period. Less than 5 percent of residents identified themselves as non-Caucasian in Pere Marquette and Summit Townships and in Mason County.

In Port Sheldon Township, the proportion of residents aged 65 or older between 2010 and 2014 was 16.1 percent, slightly higher than the proportion of the state. Ottawa County had a lower percentage of older people than the state, with 12.5 percent. Port Sheldon had relatively fewer children under 18 (21.6 percent of the residents) than Ottawa County (25.4 percent) and the state of Michigan (23 percent).

The area in the vicinity of the Pigeon Lake North Pier had a higher percentage of Caucasian residents than the state of Michigan (79.2 percent) during the 2010 to 2014 period. In Port Sheldon Township, 91.7 percent of residents identified themselves as Caucasian. In Ottawa County, 89.8 percent reported being Caucasian.

Additional detail for the Project area is shown in Table E-4.3.10-3 below, with the state of Michigan shown for reference.

[19] The American Community Survey collects and produces information on demographic, social, economic, and housing characteristics. Although data are collected annually, the American Community Survey publishes town-level data from an average of the previous 5 years; thus, the 2014 data presented in this socioeconomic study are 5-year averages covering the period from 2010 through 2014 unless otherwise noted.

Table E-4.3.10-3: Selected Demographic Characteristics of the Project Area, 2014*

	Pere Marquette Township	Summit Township	Mason County	Port Sheldon Township	Ottawa County	State of Michigan
Population, 2014	2,470	795	28,783	4,331	269,795	9,889,024
Geography						
Land Area in Square Miles	14.1	12.8	495.1	22.3	563.5	56,538.90
Population Density, 2014	175.2	62.1	58.1	194.2	478.8	174.9
Gender						
Male	50.3%	49.6%	49.7%	53.7%	49.1%	49.1%
Female	49.7%	50.4%	50.3%	46.3%	50.9%	50.9%
Age						
under 5 years old	5.5%	4.0%	5.4%	3.5%	6.5%	5.9%
under 18 years old	24.7%	17.9%	21.1%	21.6%	25.4%	23.0%
18 to 64 years old	52.5%	54.1%	58.8%	62.3%	62.1%	62.4%
65 years old & older	22.8%	28.1%	20.1%	16.1%	12.5%	14.6%
Race						
Caucasian	95.4%	95.6%	95.2%	91.7%	89.8%	79.2%
Black	0.0%	2.6%	0.8%	0.0%	1.6%	14.0%
American Indian & Alaska Native	0.5%	0.5%	0.9%	0.6%	0.4%	0.6%
Asian	1.1%	1.3%	0.6%	1.9%	2.8%	2.6%
Other	0.9%	0.0%	0.6%	4.9%	3.1%	1.1%
Two or more races	2.1%	0.0%	1.9%	1.0%	2.3%	2.6%
Ethnicity						
Hispanic or Latino	4.7%	3.1%	4.2%	6.3%	9.1%	4.6%

**Population and population density are 2014 estimates. Other figures are vintage 2014 data covering the period from 2010 through 2014. Percentages shown may not sum to 100% because of rounding.*
Source: US Census Bureau, 2015e

Mason County and Ottawa County both have local educational institutions to serve the adult population seeking associate degrees. Ottawa County also is home to 4-year institutes offering bachelor's degrees. Table E-4.3.10-4 presents the education level of the population of the communities in the Project area.

Table E-4.3.10-4: Highest Level of Education, Population Aged 25 to 64 (Percent), 2014*

	Pere Marquette Township	Summit Township	Mason County	Port Sheldon Township	Ottawa County	State of Michigan
Less than high school graduate	6.2%	4.5%	6.8%	8.3%	6.6%	8.8%
High school graduate or equivalency	25.5%	29.0%	32.9%	28.7%	27.9%	28.2%
Some college or associate's degree	42.7%	39.6%	38.6%	27.1%	33.0%	34.9%
Bachelor's degree or higher	25.5%	26.8%	21.8%	35.8%	32.5%	28.1%

** Vintage 2014 data covering the period from 2010 through 2014; percentages shown may not sum to 100% because of rounding.*
Source: U.S. Census Bureau, 2015a

Housing

The housing units[20] of the Project communities are newer than those in Michigan as a whole, which has a median year built of 1969 (US Census Bureau, 2015b). Within the Project area, the median year built ranges from 1973 (Pere Marquette and Mason County) to 1988 (Port Sheldon). Housing units in the Project area tend to be owner-occupied, rather than renter-occupied, at a higher rate than those in the state of Michigan.

The median value of owner-occupied housing in Michigan was $120,200 for the period from 2010 through 2014 (US Census Bureau, 2015d). With the exception of Mason County as a whole, the median value of housing in the Project areas exceed the state median value. Among the townships, Pere Marquette had the lowest median value of housing at $152,700, while Port Sheldon had the greatest at $207,900.

For the 2010 through 2014 period, median gross rent in Michigan as a whole was $780 a month. Rental rates in the Project area varied widely, from a low of $346 per month in Summit Township to a high of $1,238 a month in Port Sheldon Township. Table E-4.3.10-5 presents the general housing characteristics of the Project area.

[20] A housing unit is a house, an apartment, a mobile home or trailer, a group of rooms, or a single room that is occupied or, if vacant, is intended for occupancy as separate living quarters. Separate living quarters are those in which the occupants live separately from any other persons in the building and which have direct access from the outside of the building or through a common hall.

Table E-4.3.10-5: Housing Characteristics, 2014*

	Pere Marquette Township	Summit Township	Mason County	Port Sheldon Township	Ottawa County	State of Michigan
Housing Units[1]	1,281	896	17,259	1,964	103,306	4,532,719
Median Year House Built[2]	1973	1980	1973	1988	1982	1969
Occupied Housing[1]	76.0%	41.2%	70.3%	86.7%	92.3%	84.4%
Owner-Occupied[1]	82.1%	93.8%	75.0%	95.4%	77.7%	71.5%
Median Value, Owner-Occupied	$152,700	$156,800	$118,600	$207,900	$153,500	$120,200
Median Gross Monthly Rent, Renter-Occupied	$697	$346	$672	$1,238	$782	$780

** Vintage 2014 data covering the period from 2010 through 2014; percentages shown may not sum to 100% because of rounding.*
Sources:
[1]US Census Bureau, 2015d
[2]US Census Bureau, 2015b

Employment and Income

A member of the labor force is one who is either employed or actively seeking work. For the LPSP area, the lowest level for which Bureau of Labor Statistics data are available is the county-level. In July 2016, Mason County had a labor force of 15,384 persons. Of those, 14,663 were employed, leaving 4.7 percent unemployed. Mason County's unemployment rate in July 2016 was lower than that of Michigan (5.4 percent). Ottawa County's labor force totaled 155,706 in July 2016. Of the labor force, 3.6 percent were unemployed (US Bureau of Labor Statistics, 2016).

Median income for Michigan was $49,087 for the 2010 to 2014 period. The median income for the townships ranged from $48,500 (Pere Marquette Township) to $62,264 (Port Sheldon Township). Port Sheldon Township also had the highest per capita income at $35,030, roughly one-third higher than that of Michigan. Mason County had a median family income of $42,156 and per capita income of $23,536. Ottawa County's median family income was $58,160, with a per capita income of $25,919. All of the communities in the Project vicinity have poverty rates below that of Michigan (16.9 percent) (US Census Bureau, 2015c). Table E-4.3.10-6 summarizes the income and poverty level data for the Project area.

Table E-4.3.10-6: Selected Demographic Characteristics of the Project Area, 2014*

	Pere Marquette Township	Summit Township	Mason County	Port Sheldon Township	Ottawa County	State of Michigan
Income						
Median Family Income	$48,500	$53,405	$42,156	$62,264	$58,160	$49,087
Per Capita Income	$27,406	$29,554	$23,536	$35,030	$25,919	$26,143
Poverty						
Persons below Poverty Level	10.2%	6.3%	15.9%	3.7%	10.7%	16.9%

** Vintage 2014 data covering the period from 2010 through 2014, percentages shown may not sum to 100% because of rounding.*
Source: US Census Bureau, 2015c

Major employers in both Mason County and Ottawa County include a local hospital, a school district, and Meijer, a regional grocery store. Manufacturing concerns are also present in both counties. Table E-4.3.10-7 below presents the largest employers in the LPSP area.

Table E-4.3.10-7: Largest Employers

Largest Employers in Mason County, 2012[1]
Dow Chemical Company
Harsco Rail
Ludington Area School District
Meijer
Metalworks, Inc.
Spectrum Health Ludington Hospital
Largest Employers in Ottawa County[2]
Gentex Corporation
Herman Miller
Grand Valley State University*
Shape Corporation
Holland Hospital
Haworth, Inc.**
Manga Mirrors
YanFeng
Meijer
Grand Haven Public Schools

**Based on employment at 3 locations (Ottawa, Kent, and Muskegon Counties).*
***Facilities located within Ottawa County and/or the City of Holland portion of Allegan County.*
[1]*Mason County, Michigan, 2012.*
[2]County of Ottawa, *Michigan, 2016*

4.3.10.2 Environmental Analysis

The Licensees are not proposing any changes to the Ludington Project or any changes in the operation of the Project that would affect the land use, population, employment, income or other socioeconomic resources.

4.3.10.3 Proposed Environmental Measures

The Licensees are proposing to continue to operate and maintain the Project under the existing regime. Thus continued Project operation is not anticipated to have any direct or indirect adverse effects on land use, population, employment, income or other socioeconomic resources. For this reason, no measures directly aimed at enhancing area socioeconomic resources are proposed.

4.3.10.4 Cumulative Effects

The Licensee's proposal to continue to operate and maintain the Ludington Project under the existing operating regime is not expected to result in negative cumulative impacts to socioeconomic resources.

4.3.10.5 Unavoidable Adverse Impacts

No unavoidable adverse impacts to socioeconomic resources are expected to occur as a result of the continued operation of the Ludington Project.

4.3.10.6 References

County of Ottawa, Michigan. (2016). County of Ottawa Principal Employers, *2015 Comprehensive Annual Financial Report*. Retrieved December 14, 2016 from URL https://www.miottawa.org/Departments/FiscalServices/pdf/Audit/2015CAFR.pdf .

Mason County, Michigan. (2012). Appendix: Mason County Master Plan Update. Retrieved October 27, 2016 from URL http://www.masoncounty.net/userfiles/filemanager/324/.

US Bureau of Labor Statistics. (2016). Local Area Unemployment Statistics, Mason County, Ottawa County, and the State of Michigan. Retrieved October 26, 2016 from URL http://www.bls.gov/lau.

US Census Bureau. (2013). H2: 2010 Census Summary File 1: Urban and Rural, Mason County, MI and Ottawa County, MI. Retrieved October 26, 2016 from URL http:/factfinder2.census.gov.

US Census Bureau. (2015a). Table B23006: Educational Attainment by Employment Status for the Population 25 to 64 Years, *2010-2014 American Community Survey 5-Year Estimates*. Retrieved October 26, 2016 from http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

US Census Bureau. (2015b). Table B25035: Median Year Structure Built, *2010-2014 American Community Survey 5-Year Estimates*. Retrieved October 26, 2016 from URL http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

US Census Bureau. (2015c). Table DP03: Selected Economic Characteristics, *2010-2014 American Community Survey 5-Year Estimates*. Retrieved October 26, 2016 from URL http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

US Census Bureau. (2015d). Table DP04: Selected Housing Characteristics, *2010-2014 American Community Survey 5-Year Estimates*. Retrieved October 26, 2016 from URL http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

US Census Bureau. (2015e). Table DP05: Demographics and Housing Estimates, *2010-2014 American Community Survey 5-Year Estimates*. Retrieved October 26, 2016 from URL http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

US Census Bureau. (2016). Population Estimates: Historical Data. Retrieved October 26, 2016 from URL 2016). Population Estimates: Historical Data. Retrieved June 24, 2016 from URL U.S. Census Bureau. (2016). Population Estimates: Historical Data. Retrieved June 24, 2016 from URLhttp://www.census.gov/popest/data/historical/index.html.

West Michigan Shoreline Regional Development Commission. (2014). Demographic and Economic Projections. Retrieved October 26, 2016 from URL http://wmsrdc.org/wp-content/uploads/2015/08/2013-Demographic-and-Economic-Projections.pdf.

5.0 DEVELOPMENTAL ANALYSIS

This section analyzes the cost of continued operation and maintenance of the Project under the No Action and Proposed Alternatives. Costs are associated with the operation and maintenance of the the Ludington Project facilities as well as the cost of providing proposed PME measures.

5.1 Power and Economic Benefits of the Project

The Project has six 297.5 MW generating units operating in a pump storage facility with an installed capacity of 1,785 MW and a total estimated hydraulic capacity of 76,290 cfs during generation and 84,000 cfs during pumping.

5.1.1 Current Annual Value of Developmental Resources Associated with the Project

The Project receives operating revenues from power sales to wholesale customers, market-based power sales, and the provision of ancillary services to the MISO electricity market.

The Project revenue based on 2016 energy values is $42.48/MWH, or estimated to be $100,125,360.

Therefore, under the No-Action Alternative, the Project is expected to generate approximately $100.1 million annually.

5.1.2 Current Annual Cost of Operations, Maintenance, and Administration

The average production cost of $22.16/MWH (based on 2016 costs), or $52,231,120 using a long term average energy generation of 2,357,000 MWH. (Exhibit H, Section 2.3.1 and Exhibit B, Table B-1.4-1.) This includes the 2016 operations and maintenance costs, property taxes, and annual cost of capital and depreciation. Pumping cost is $22.01/MWH (based on day ahead and real time costs), or $71,730,590 using a long-term average pumping energy requirement of 3,259,000 MWH. (Exhibit B, Table B-1.4-1)

Therefore, under the No-Action Alternative, the Project is expected to have operational costs of approximately $52.2 million annually.

5.2 Comparison of Alternatives

5.2.1 No Action Alternative

The No-Action Alternative would allow the Licensees to continue Project operations under the terms and conditions of the current license, including maintaining the current Project boundary, facilities, existing PME measures listed below, and operation and maintenance procedures.

The Licensees currently implement several measures that contribute to the protection and enhancement of environmental resources:

- Implement the Barrier Net program for the protection of fish at the Project, as defined in the existing Settlement Agreement
- Study and report on potential net improvement technologies, as defined in the existing Settlement Agreement
- Through the existing Settlement Agreement, fund Lake Michigan fishery studies, enhancements and fish stocking through funds provided to the GLFT
- Support operation and maintenance of, and improvements to six (6) recreational facilities associated with the Project

5.2.2 Proposed Action

Under the Proposed Action, the Licensees would continue to operate the Project as it currently does under the current license. The unit upgrades will be completed as will several other planned capital projects. (Table D-3.2-1) The total capital expenditures planned for 2019 to 2021 are $67.1 million in 2019, $36.9 million in 2020 and $15.7 million in 2021.

PME measures under the current license would continue with additional PME measures including:

- Develop and implement a Recreation Management Plan
- Develop and implement a Historic Properties Management Plan
- Protect historic properties according to the Plan

The cost of all proposed PME measures at the Project is estimated to be $6.142 million dollars (in 2016 $) in the first year and $6.097 million dollars (in 2016 $) annually thereafter during the term of the license. The annual expenditures would be escalated as described in Table D-4.6-1.

Under the Proposed Action the average annual value of Project power is expected to remain the same as the No-Action Alternative, valued at $100.1 million.

5.3 Costs of Proposed PMEs

The cost of proposed PMEs total $6.097 million annually with an additional one-time cost of $45,000 (occurring in 2019). (Exhibit D Section 4.6 and Table D-4.6-1 and Table E-5.3-1) Based on expected annual generation of 2,357,000 MWH per year, the annual cost of the PMEs is $2.59/MWH.

Some of these PMEs are a continuation of PMEs in the current license and are already included in the operating and maintenance costs, reflected in the production cost. The additional cost for PME's represents the cost of Historic Properties Management Plan and the Recreation Management Plan. These represent a total additional cost of $105,000 in 2019 and $60,000 for each year thereafter.

Table E-5.3-1: Summary of PME costs

Proposed Environmental Measure	Initial cost (To Occur in 2019, using 2016 $) ($)	Initial cost per MWH (2016 $) ($)	Annual costs (2016 $) ($)	Annual PME costs per MWH (2016 $) ($)
Historic Properties Management Plan	25,000	0.011	20,000	0.009
Recreation Plan	20,000	0.008	40,000	0.017
Barrier Net Program	-		3,285,000	1.394
Periodic study of fish protection technology (every 5 years)	-		6,000	0.003
Annual payments to GLFT	-		2,722,148	1.155
TOTAL	45,000	0.019	6,097,148	2.578

6.0 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

This section will be completed by FERC in its NEPA document.

7.0 UNAVOIDABLE ADVERSE IMPACTS

Continued Project operation is not expected to adversely affect geology and soils, water, wildlife, botanical, recreation, land use, aesthetic, socioeconomic, cultural, and tribal resources, and rare, threatened or endangered species. While the entrainment risk to fish species at the Project is low with the use of the seasonal barrier net (part of the PME), some level of unavoidable fish losses due to entrainment is likely to occur as a result of operations. There is however, no indication that Lake Michigan fisheries are affected on a population level. Fisheries resources throughout Lake Michigan are affected by many other factors, such as increasing competition and ecosystem changes due to invasive species and, as such, the unavoidable Lake Michigan fisheries effects due to Project operation are not considered to be adverse.

8.0 CONSULTATION DOCUMENTATION

Appendix E-1 contains a list of the documents comprising the consultation by the Licensees with Federal and, state agencies, Indian tribes, local communities, and members of the public in the preparation of the Ludington relicensing application. Electronic copies of the correspondence and other referenced documents are included on an enclosed CD.

APPENDIX E-1
CONSULTATION RECORD

(Electronic copies of the correspondence and other referenced documents are included on an enclosed CD)

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LUDINGTON PUMPED STORAGE
FERC PROJECT No. 2680
Consultation Correspondence Summary

Date	To	From	Topic
5/24/11	USFWS	Consumers	Letter requesting TES review for Unit Upgrade Application
6/23/11	Consumers	USFWS	Reply to Consumers 5/25/2011 TES Review Request
12/16/11	FERC	Consumers	Non-Capacity License Amendment Application
2/21/12	FERC	SHPO	SHPO Review of Draft Non-Capacity Application
5/7/12	Consumers	FERC	FERC Approval (and errata) Upgrade Amendment
3/6/13	Sault Saint Marie Tribe	Consumers	Request for Interest in Relicensing
3/19/13	Michigan Department of Environmental Quality	Consumers	May Meeting Interest Request
3/26/13	Bay Mills Indian Community	Consumers	Request for Tribal Interest in Relicensing
3/26/13	Burt Lake Band of Ottawa and Chippewa Indians	Consumers	Request for Tribal Interest in Relicensing
3/26/13	Chippewa – Ottawa Treaty Fishery Management Authority	Consumers	Request for Interest in Relicensing Gorenflo
3/26/13	City of Ludington - Clerk	Consumers	Request for Interest in Relicensing
3/26/13	Department Of Interior, National Park Service	Consumers	Request for Tribal Interest in Relicensing
3/26/13	Grand Traverse Band of Ottawa and Chippewa Indians	Consumers	Request for Tribal Interest in Relicensing
3/26/13	Great Lakes Fisheries Advisory - Allen	Consumers	Request for Interest in Relicensing
3/26/13	Hannahville Indian Community	Consumers	Request for Tribal Interest in Relicensing
3/26/13	Keweenaw Bay Indian Community	Consumers	Request for Tribal Interest in Relicensing
3/26/13	Lac Vieux Desert Band	Consumers	Request for Tribal Interest in Relicensing
3/26/13	Little River Band of Ottawa Indians	Consumers	Request for Tribal Interest in Relicensing Sam
3/26/13	Little River Band of Ottawa Indians	Consumers	Request for Interest in Relicensing - Holtgren
3/26/13	Little Traverse Bay Band of Odawa Indians	Consumers	Request for Tribal Interest in Relicensing
3/26/13	Mason County	Consumers	Request for Interest in Relicensing Hasenbak
3/26/13	Mason County - Riffle	Consumers	Request for Interest in Relicensing
3/26/13	Match-e-be-nash-she-wish	Consumers	Request for Interest in Relicensing

Date	To	From	Topic
3/26/13	Michigan Attorney Generals Office	Consumers	Request for Interest in Relicensing
3/26/13	Michigan Department of Natural Resources	Consumers	Request for Interest in Relicensing
3/26/13	Michigan Historic Center - Clark	Consumers	Request for Interest in Relicensing
3/26/13	Michigan Hydro Relicensing Coalition	Consumers	Request for Interest in Relicensing
3/26/13	Michigan United Conservation Club	Consumers	Request for Interest in Relicensing McDonough
3/26/13	Michigan United Conservation Club	Consumers	Request for Interest in Relicensing Robertson
3/26/13	Mountain Beach Association - O'Lareau	Consumers	Request for Interest in Relicensing
3/26/13	MSU - Department of Fisheries and Wildlife	Consumers	Request for Interest in Relicensing Taylor
3/26/13	National Wildlife Foundation	Consumers	Request for Interest in Relicensing Bachsbaum
3/26/13	National Wildlife Foundation	Consumers	Request for Interest in Relicensing Dennison
3/26/13	Nottawaseppi Band of Huron Potawatomi - rodwan	Consumers	Request for Interest in Relicensing
3/26/13	Ottawa county Clerk - Krueger	Consumers	Request for Interest in Relicensing
3/26/13	Ottawa Tribe of Oklahoma	Consumers	Request for Interest in Relicensing
3/26/13	Pere Marquette Township - Enbody	Consumers	Request for Interest in Relicensing
3/26/13	Pokagon band	Consumers	Request for Interest in Relicensing
3/26/13	Red Lake Band	Consumers	Request for Interest in Relicensing
3/26/13	Saginaw Chippewa	Consumers	Request for Interest in Relicensing
3/26/13	State Representative - Franz	Consumers	Request for Interest in Relicensing
3/26/13	State Representative - Huzinga	Consumers	Request for Interest in Relicensing
3/26/13	State Senator - Booher	Consumers	Request for Interest in Relicensing
3/26/13	Summit Township Clerk - Samuels	Consumers	Request for Interest in Relicensing
3/26/13	U.S. Army Corps of Engineers- Ells	Consumers	Request for Interest in Relicensing

LUDINGTON PUMPED STORAGE
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Consultation Correspondence Summary

Date	To	From	Topic
3/26/13	U.S. EPA - Hedman	Consumers	Request for Interest in Relicensing
3/26/13	USFWS	Consumers	Notification of Intention to Relicense and Request for Contact Information
3/26/13	Wyandotte Tribe	Consumers	Request for Interest in Relicensing
4/8/13	Consumers	Michigan Hydro Relicensing Coalition	Request for Interest in Relicensing
4/8/13	Consumers	Mountain Beach - Bowman	email expressing interest in LPS relicensing activities
4/9/13	Mountain Beach Association - Bowman	Consumers	Consumers acknowledgement of 4/8/2013 email
4/11/13	Consumers	Pere Marquette Township	Rely to LPSP Information Request
4/11/13	Pere Marquette Township - Enbody	Consumers	Reply to 4/11/2013 email
4/15/13	MDNR	Consumers	email regarding MDNR contacts for relicensing
4/16/13	Consumers	USFWS	Relicensing Contact Information
4/17/13	Consumers	Michigan Department of Environmental Quality	email regarding MDEQ involvement
4/17/13	Consumers	Michigan Department of Natural Resources	letter regarding relicesing contacts
4/19/13	Consumers	MUCC- - Robertson	Consumers acknowledgement of 4/19/2013 email
4/19/13	MUCC - Robertson	Consumers	email expressing interest in LPS relicensing activities
4/23/13	Consumers	Michigan Attorney Generals Office	MAG response to Consumers request
4/23/13	Consumers	USFWS	Email Request for meeting information
5/2/13	USFWS	Consumers	email response to 4/23/2013 email
5/7/13	Consumers	Little Traverse Bay Band of Odawa Indians	email from K Donner meeting atttendance
5/8/13	Little Traverse Bay Band of Odawa Indians	Consumers	email to K Donner information request
5/13/13	Consumers	Consumers	email to K Donner providing meeting slides
5/13/13	Various	Consumers	Email with information regarding PAD Requirements
9/18/13	Various Tribes	FERC	Letter to Tribes regarding participation in the LPSP relicensing process

LUDINGTON PUMPED STORAGE
FERC PROJECT No. 2680
Consultation Correspondence Summary

Date	To	From	Topic
1/18/14	FERC	Pere Marquette Township	Comments on Revised Study Plan
1/20/14	FERC	Consumers	Pre-application Document and Notification of Intent to Relicense
1/29/14	Consumers	Michigan Department of Environmental Quality	email from MDEQ regarding Water Quality Certificate for LPSP
2/11/14	Consumers	DEQ	Email indicating receipt of 2013 Water Quality Report
2/11/14	MDEQ, MDNR	Consumers	Email Providing 2013 GLEC Water Quality Report
2/11/14	MDEQ-MDNR	Consumers	Phone Call to Discuss Water Quality Data Collection and WQC
2/19/14	Consumers	Department Of Interior, National Park Service	Letter from National Park Service regarding the Land and Water Conservation Fund Program
3/5/14	MDNR	Consumers	phone call record regarding LWCF
3/20/14	Public Notice	FERC	Notice of Intent to Relicense the Ludington Pumped Storage Project
3/20/14	Various	FERC	Letter providing Scoping Document 1 for review and comment
5/7/14	FERC	Pere Marquette Township	PAD Comments and Recreation Study Request
5/13/14	FERC Order	FERC	Order amending license to remove the 95 acre MDOT property parcel form the project boundary
5/16/14	Consumers	FERC	FERC review of Pre-Application Document and Scoping meeting minutes and transcripts - No Additional Study Requests
5/19/14	FERC	Mason County	Recreation Study Request
5/20/14	FERC	Little River Band of Ottawa Indians	Request for Study Plan
5/20/14	FERC	Little River Band of Ottawa Indians	Fisheries Study Request filing with FERC
5/21/14	FERC	Little Travers Bay Band of Odawa Indians	Fisheries Study Request filing with FERC
5/21/14	FERC	Michigan Department of Natural Resources	MDNR Comments on PAD
5/21/14	FERC	MDNR and others	Joint comments on study requests
5/21/14	Little Traverse Bay Band of Odawa Indians	FERC	Tribal Comments on Proposed Study Plan
7/1/14	Consumers	FERC	FERC letter indicating that Scoping Document 2 is not warranted

Date	To	From	Topic
7/7/14	FERC	Consumers	Proposed Study Plan for the LPSP
7/7/14	FERC	Consumers	Proposed Study Plan for the LPSP
8/4/14	Little River Band of Ottawa Indians	Consumers	Contacted LROBI representative to the obtain the tribal contact for cultural resource issues. Received name of the tribal Historic preservation Officer.
8/5/14	Little Traverse Bay Band of Odawa Indians	Consumers	Phone call to discuss tribal cultural resource contact information
8/20/14	SHPO	TRC	Phone call discussing Area of Potential Effects for Cultural Resource Information
8/25/14	Grand Traverse Band of Ottawa and Chippewa Indians	Consumers	Email message requesting current tribal contact for cultural resource issues.
8/28/14	Burt Lake Band of Ottawa and Chippewa Indians	Consumers	Phone call to update tribal contact and discuss tribal participation in LPSP relicensing consultation
8/28/14	Grand River Band of Ottawa Indians	Consumers	Phone call to update tribal contact and discuss tribal participation in LPSP relicensing consultation (message left)
8/28/14	Grand Traverse Band of Ottawa and Chippewa Indians	Consumers	Phone call to update tribal contact and discuss tribal participation in LPSP relicensing consultation
8/28/14	Gun Lake Band of Potawatomi Match-e-be-nash-shee-wish	Consumers	Phone call to update tribal cultural resource contact (message left)
8/28/14	Little River Band of Ottawa Indians	Consumers	Phone call to update tribal cultural resource contact (message left)
8/28/14	Little Traverse Bay Band of Odawa Indians	Consumers	Phone call with tribal cultural resource contact to discuss tribal interest in participating in relicensing issues (left message)
8/28/14	Nottawaseppi Band of Huron Potawatomi	Consumers	Call to update tribal contact information and interest in participating in relicensing.
8/29/14	Nottawaseppi Band of Huron Potawatomi	Consumers	Letter to Tribal Historic Preservation Officer transmitting electronic copies of the Ludington Project NOI and PAD
9/3/14	Hannahville Indian Community	Consumers	Phone call to update tribal cultural resource contact (message left)
9/15/14	FERC	Pere Marquette Township	Comments on Draft Study Plan
9/25/14	Consumers	FERC	Staff comments on the Proposed Study Plan
10/3/14	Consumers	Little River Band of Ottawa Indians	Comments on the Proposed Study Plan

LUDINGTON PUMPED STORAGE
FERC PROJECT No. 2680
Consultation Correspondence Summary

Date	To	From	Topic
10/3/14	FERC	Little Traverse Bay Band of Odawa Indians	Comments on PSP
10/3/14	FERC	MDNR and others	Joint comments on PSP
10/3/14	FERC	Little Travers Bay Band of Odawa Indians	Tribal comments on Proposed Study Plan
10/3/14	Little River Band of Ottawa Indians	Consumers	Comments on the Proposed Study Plan
11/3/14	FERC	Consumers	Revised Study Plan filing
11/3/14	FERC	Consumers	Revised Study Plan filing
11/6/14	Keweenaw Bay Indian Community	Consumers	Phone call to update tribal cultural resource contact (message left)
11/6/14	Lac Vieux Desert Band	Consumers	Phone call to update tribal cultural resource contact (message left)
11/6/14	Notes	Consumers	Meeting Notes with Pere Marquette Township
11/6/14	Ottawa Tribe of Oklahoma	Consumers	Call to update tribal contact information and interest in participating in relicensing. (left message)
11/6/14	Pokagon band	Consumers	Phone message regarding contact informaiton for tribe
11/6/14	Pokagon Band of Potawatomi	Consumers	Call to update tribal contact information and interest in participating in relicensing. (left message)
11/6/14	Red Lake Band	Consumers	Phone message regarding contact informaiton for tribe
11/6/14	Red Lake Nation	Consumers	Call to update tribal contact information and interest in participating in relicensing. (left message)
11/6/14	Saginaw Chippewa	Consumers	Phone Call with W. Johnson regarding tribal contact
11/6/14	Saginaw Chippewa Indian Tribe	Consumers	Phone call with Tribal Historic Preservation Officer regarding tribal participation in project re-licensing. There was interest expressed.
11/7/14	Bay Mills Indian Community	Consumers	Phone call to discuss tribal participation in LPSP relicensing consultation
11/12/14	FERC	Little River Band of Ottawa Indians	Letter to FERC providing comments on the Revised Study Plan
11/12/14	Little River Band of Ottawa Indians	FERC	Comments on Revised Study Plan
12/1/14	Consumers	FERC	Directors letter regarding Study Plan Determination
12/18/14	FERC	Consumers	Response to 12/2/2014 Directors Letter
1/30/15	FERC	Consumers	Revised Fisheries Study Plan Schedule
2/24/15	SHPO - Sag Chip	Consumers	Historical and Archaeological Study Plan Scope Review Request
3/5/15	Consumers	Saginaw Chippewa	No Known Cultural Resource Sites at LPSP and Interest in Relicensing

LUDINGTON PUMPED STORAGE
FERC PROJECT No. 2680
Consultation Correspondence Summary

Date	To	From	Topic
3/5/15	Saginaw Chippewa Indian Tribe	Consumers	Response from tribe regarding known cultural resource sites in the LPSP project area (none).
10/22/15	FERC	Consumers	First Year Study Report Meeting Notification
10/22/15	Various	Consumers	Email to interested stakeholders regarding First Year Study Report Meeting
12/2/15	FERC	Consumers	Initial Year Study Report
12/15/15	FERC	Consumers	Initial Year Study Report Meeting Summary
12/18/15	FERC	Pere Marquette Township	Comments on Initial Study Request
1/19/16	FERC	Consumers	Initial Year Study Report Meeting Summary Comment Response
1/26/16	FERC	Consumers	Reply to 1/13/2016 Letter From FERC
3/4/16	FERC	Consumers	Study Report Public Filing
3/4/16	FERC,SHPO,Sag Tribe	Consumers	Transmittal of Non-Public Version of Historic/Archaeological Report
3/7/16	Consumers	Michigan Department of Environmental Quality	email from MDEQ regarding timing for requesting Water Quality Certificate for LPSP
3/11/16	Notes	Pere Marquette Township	Preliminary notes on 3/14/2016 Study Report
3/26/16	Grand River Band of Ottawa Indians	Consumers	Request for Tribal Interest in Relicensing
5/3/16	FERC	Pere Marquette Township	Corrected Initial Year Study Report and Meeting comments
5/3/16	FERC	Pere Marquette Township	Initial Year Study Report and Meeting comments
5/20/16	FERC	Consumers	Final Recreation Study Report
6/16/16	MDEQ	Consumers	CE Contact with MDEQ Relicensing Contacts for WQC and CZM
9/30/16	FERC	Consumers	LPSP Major Overhaul Units 2 and 4 Completion Notification
10/24/16	FERC	Consumers	Seperated Staff Request
10/25/16	FERC	Consumers	Request for Seperated Staff Assitance with Fisheries and Aquatic Resource Settlement
12/1/16	FERC	Consumers	Study Report Update
12/20/16	USFWS (Rachel Pierce)	TRC (Rita Hayen)	Discuss USFWS approach to DCCO regulations
12/22/16	FERC	Consumers	Second Year Study Update Teleconference Meeting Summary
1/12/17	Consumers	NPS	Update contact information, check in on how the relicensing process is going, and discuss proposed recreation for the Project.

LUDINGTON PUMPED STORAGE
FERC PROJECT No. 2680
Consultation Correspondence Summary

Date	To	From	Topic
1/17/17	Consumers	Pere Marquette Township	PMCT's letter outlines its request for funding support for an off-site recreational facility.
1/25/17	Pere Marquette Township	Consumers	Consumers acknowlegement of PMT's 1/17/17 letter
1/30/17	FERC	Consumers	Consumers files Draft License Application
3/6/17	SHPO, Saginaw Tribe Chippewa	Consumers	Transmittal of HPMP for Review
3/29/17	Consumers	FERC	Staff Comments on Draft License Application
4/6/17	SHPO	Consumers	Email to BGrennel Historic-Archaeological Report Review
4/24/17	FERC	Consumers	Letter notification of Initiation of Unit 6 Upgrade
4/25/17	USFWS and MDNR	Consumers	Letter requesting current information on RTE in the Project Vicinity
5/5/17	Consumers	SHPO	Email indicating no SHPO comments
5/5/17	Pere Marquette, Mason County, DNR	Consumers	Email providing LPSP Draft Recreation Plan for Comment
5/5/17	SHPO - Sag Chip	Consumers	Email requesting review comments for Phase I and HPMP Reports
5/5/17	SHPO - Sag Chip	Consumers	Email Delivery Reciept for 5/5/2017 message
5/15/17	USFWS,MDNR	Consumers	Email Clarifying Consumers request on TES at LPSP
5/16/17	Consumers	USFWS	Email reply to Consumers 4-25-2017 Request
5/19/17	Consumers	PMT	PMT's Comments on the Draft Recreation Plan
6/6/17	FERC	Consumers	Unit 5 Upgrade Completion Notification

APPENDIX E-2

DRAFT RECREATION FACILITIES MANAGEMENT PLAN

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CONSUMERS ENERGY COMPANY
JACKSON, MICHIGAN

DTE ELECTRIC COMPANY
DETROIT, MICHIGAN

DRAFT RECREATION MANAGEMENT PLAN

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

Submitted by:

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June 2017

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

DRAFT OUTLINE
DRAFT RECREATION MANAGEMENT PLAN

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LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ADA	Americans with Disabilities Act
Consumers	Consumers Energy
DTEE	DTE Electric
FERC	Federal Energy Regulatory Commission
ILP	Integrated Licensing Process
Licensees	Consumers Energy and DTE Electric
Michigan DNR	Michigan Department of Natural Resources
PAD	Pre-Application Document
Project	Ludington Pumped Storage Hydroelectric Project
PMCT	Pere Marquette Charter Township
RMP	Recreation Management Plan
USFS	United States Forest Service

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)
DRAFT RECREATION MANAGEMENT PLAN

1.0 INTRODUCTION

1.1 Background

The Ludington Pumped Storage Hydroelectric Project (Project) is an existing hydroelectric project owned by Consumers Energy (Consumers) and DTE Electric (DTEE) companies (Licensees) and is operated by Consumers. The Project consists of an 842-acre upper reservoir within a man-made embankment and uses Lake Michigan as the lower reservoir. There is a 2,715-foot long tailrace area in the lower reservoir area (Lake Michigan).

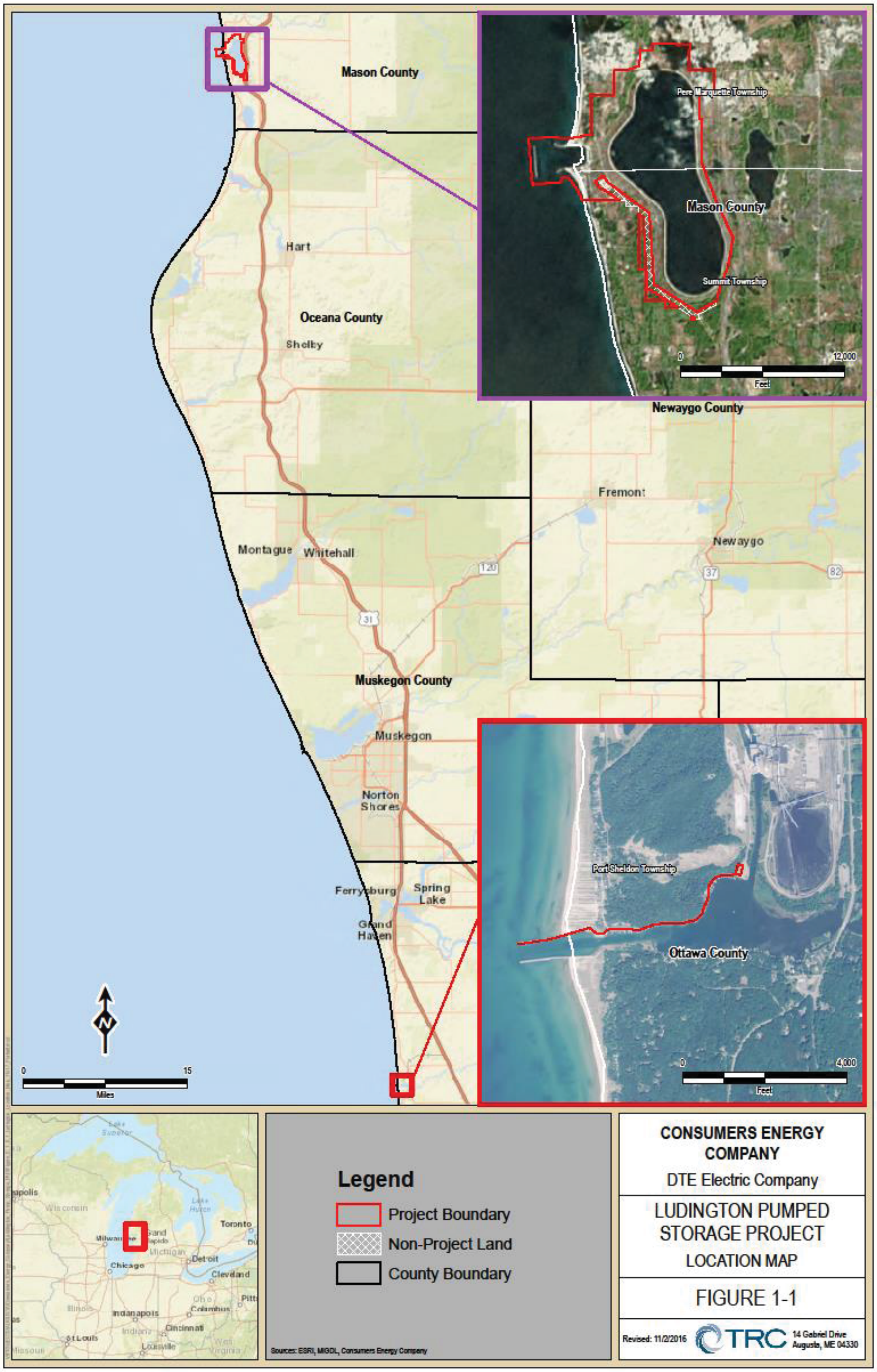
The Licensees are using the Federal Energy Regulatory Commission's (FERC) Integrated Licensing Process (ILP) for the relicensing of Project. Pursuant to the process and schedule requirements of the ILP (18 CFR Part 5), the Licensees are filing a Final License Application with FERC by June 30, 2017 and have included this Draft Recreation Management Plan (RMP) as part of the Final License Application.

1.2 Project Location

The Project is located on the east shore of Lake Michigan near the City of Ludington, in the townships of Pere Marquette and Summit in Mason County, Michigan and in Port Sheldon in Ottawa County, Michigan[1]. The Ottawa County portion is limited to a 1.8 acre satellite recreation site (established as part of the federal Settlement Agreement, FERC's January 23, 1996 order approving a settlement agreement). A map of the Project is included as Figure 1-1.

[1]Pigeon Lake North Pier, a recreation site associated with the Project, is located in Port Sheldon, Ottawa County, approximately 70 miles south of the pump storage facility. This is the only portion of the Project in Ottawa County and consists of approximately 1.8 acres. This recreation site was developed as part of FERC's January 23, 1996 order approving a settlement agreement and provides amenities including a parking lot, boardwalk and Lake Michigan fishing access. The site is open from spring through fall. While the land associated with this recreation site is not contiguous with the remainder of the Project boundary at the pump storage facility, the recreation site is discussed in this Recreation Management Plan.

Figure 1-1: Ludington Pumped Storage Project Location



1.3 Recreation Opportunities

1.3.1 Regional Recreation Opportunities

Two regionally important recreation areas, the North Country Trail and the Lake Michigan Water Trail, are located near the Ludington Project. The North Country Trail, which is a National Scenic Trail, is located approximately 21 miles east of the Project. The Lake Michigan Water Trail extends along the lake, stopping north of the Project near Buttersville Park and starting up again south of the Project. A portion of the Lake Michigan Water Trail is designated as a National Recreation Trail.

The Ludington State Park is located 6.5 miles north of the Project between Hamlin Lake and Lake Michigan. The Park is comprised of almost 5,300 acres of scenic sand dunes, shoreline vistas, ponds, marshlands and forests. The Park includes a beach that stretches for miles along Lake Michigan. Three campgrounds within the Park provide 355 campsites including three mini-cabins (PAD, 2014).

The Pere Marquette River, located approximately 2 miles north of the Project, was the first designated Scenic River under the Wild and Scenic River program in the State of Michigan. The river is also a State Natural River under the State of Michigan's Natural Rivers Program. The river is used by recreationists for paddling, motor-boating, fishing and wildlife viewing (PAD, 2014).

Local, State and Federal agencies also provide the public with recreation opportunities near the Ludington Project. The City of Ludington operates Stearns Park, Waterfront Park, Cartier Park, Copeyon Park, and Loomis Street Boat Launch. These recreation sites provide a variety of opportunities such as swimming, picnicking, volleyball, camping, fishing, walking, jogging, and biking. Amenities include playgrounds, a skate park, shuffle board, mini golf, boat launches, picnic areas, and campground (PAD, 2014). Stearns Park is located about 4.5 miles north of the Project and provides a beach on Lake Michigan. The Loomis Street Boat Launch provides public boating access to Lake Michigan.

The Pere Marquette Charter Township provides several recreation opportunities for the public near the Ludington Project. Buttersville Park and the Father Marquette Shrine are located about two miles north of the Project on South Lakeshore Drive. Buttersville Park provides camping south of the Ludington Harbor with direct access to Lake Michigan. It includes 48 campsites, improved facilities, and a swimming beach on Lake Michigan. The Father Marquette Shrine has special historic significance and includes 400 feet of frontage on Pere Marquette Lake and a boat launch that provides access to Pere Marquette Lake and Lake Michigan. Suttons Landing is a 34-acre riverfront park located along the South Fork of the Pere Marquette River. Suttons Landing includes approximately 425 feet of river frontage, a small boat launch facility, a boardwalk along the riverbank, a pavilion, restrooms, and improved parking facilities (Pere Marquette Charter Township, 2017). The Pere Marquette River empties into Pere Marquette Lake about two miles north of the Ludington Project in the Pere Marquette Charter Township. There are no developed facilities at Pere Marquette Lake but Pere Marquette Lake is popular with anglers for fishing Lake Michigan salmonids and other fish species. Anglers park along the Pere Marquette Highway (old US-31).

Summit Township operates Summit Township Park about two miles south of the Ludington Project. Summit Township Park provides a beach on Lake Michigan (Lake Michigan Beach), a tennis court, ball fields, picnic area and a pavilion (Summit Township, 2013).

Michigan Department of Natural Resources (Michigan DNR) manages several areas in the vicinity of the project, which provide hunting, fishing, camping, hiking, swimming, picnicking and boating opportunities. In addition to the Ludington State Park, these areas include: Pere Marquette State Game Area, and Charles Mears State Park (PAD, 2014).

The United States Forest Service (USFS) manages the Huron-Manistee National Forest, located approximately 8 miles east of the Project, and the Nordhouse Dunes Wilderness (National Wilderness Area) located directly north of the Ludington State Park. These two areas provide hiking, picnicking, fishing, boating, biking, camping, hunting, nature study, cross-country skiing, paddling, and wildlife viewing (USFS, 2016).

Finally, there are numerous privately owned/operated facilities in the vicinity of the Ludington Project including golf courses, campgrounds and marinas.

1.3.2 Project Recreation Opportunities

There are a total of six Project recreation sites located within the Ludington Project boundary: Mason County Campground, Hull Field, Mason County Day Use/Picnic Area, Reservoir Overlook, Lake Michigan Overlook and Pigeon Lake North Pier. These sites provide a variety of recreation opportunities such as fishing, camping, picnicking, walking/hiking/jogging, disc golfing, flying model aircraft, sightseeing, and snowshoeing.[2] Although the sites are closed and not maintained during the winter, the property itself is still open to the public allowing informal winter activities to take place.

[2] Snowshoeing became highlighted as a recreation opportunity in January 2017 with the designation of the 1.7-mile snowshoe trail at the Mason County Day/Use Picnic Area.

1.4 Purpose of the Recreation Management Plan

The purpose of the RMP is to identify the Project recreation sites and describe the facilities and amenities at each site, and describe the operation and maintenance of each site, including responsible parties.

1.5 Consultation During Development of the Recreation Management Plan

The Licensees provided Michigan DNR, Pere Marquette Charter Township, and Mason County with a draft RMP for review and comment by email dated May 5, 2017 for a 30-day comment period. Comments were due on June 5, 2017. The Licensees have provided responses to comments in Attachment A. A summary of consultation and copies of all comments received are provided in Attachment B.

2.0 PROJECT RECREATION SITES/AREAS

2.1 Existing Project Recreation Sites

The recreation site and facility inventory identified the following recreation sites within the Project boundary: Mason County Campground, Hull Field, Mason County Day Use/Picnic Area, Reservoir Overlook, Lake Michigan Overlook and Pigeon Lake North Pier. (Recreation site locations are shown on Figures 2.1 and 2.2 and site amenities are summarized in Table 2-1)

2.1.1 Mason County Campground

The Mason County Campground, located in the northeastern corner of the Project boundary (Figure 2.1), is owned by the Licensees and managed by Mason County. The site provides camping and picnicking opportunities to the public on a seasonal basis (generally from Memorial Day Weekend to Labor Day Weekend). There is a restroom/shower building which is compliant with the Americans with Disabilities Act (ADA), 56 campsites, four cabins, picnic shelter with eight tables, one playground[3], three benches, an interpretive display, and a foot path to Hull Field.

2.1.2 Hull Field

Hull Field is located adjacent to the Mason County Campground along the northern edge of the Project boundary. (Figure 2.1) This site is owned by the Licensees, managed by Mason County and operated by the Twisted Sticks Radio Control Club. The site is open to the public for viewing. Those who wish to fly a radio controlled plane must possess a current Academy of

[3] Mason County is reviewing plans to upgrade the existing playground equipment.

Model Aeronautics card. Site amenities include 18 parking spaces, portable sanitation, two benches, five picnic tables, a pavilion, 14 airplane platforms, a large mowed field, and a footpath to Mason County Campground.

2.1.3 Mason County Day Use/Picnic Area

The Day Use/Picnic Area is located in the northwestern corner of the Project boundary. (Figure 2.1) The site is owned by the Licensees and managed/operated by Mason County. Amenities include 62 vehicle parking spaces, a picnic pavilion with 34 tables, ADA compliant restrooms, a 72 goal disc golf course, and a playground[4]. A 1.7- mile snowshoe trail was designated at the site in January 2017. The snowshoe trail loop is accessed at the Chauvez Road entrance to the Mason County Day Use/Picnic Area and follows a pathway used by walkers and disc golfers. The site is open to the public seasonally (generally April – October) for day use activities.

2.1.4 Reservoir Overlook

The overlook is located on the northwestern side of the Upper Reservoir embankment and provides views of Lake Michigan as well as the Upper Reservoir. (Figure 2.1) The site is owned and managed by the Licensees. Amenities include 83 parking spaces, portable sanitation (1 standard and 1 ADA), a pagoda shelter, and 9 benches which are located along a steep footpath to the pagoda. An interpretive panel is located in the pagoda which describes the Project structures and how they work. The site is generally open to the public between April and October for day use activities.

2.1.5 Lake Michigan Overlook

The overlook is located north of the powerhouse on the eastern shore of Lake Michigan. (Figure 2.1) The site is owned and managed by the Licensees. Recreation amenities include portable sanitation (shared with the Reservoir Overlook), a footbridge, and multiple interpretive displays. Parking for the overlook is located on the east side of Lakeshore Drive, just north of the overlook. The site is open to the public generally between April and October for day use recreation.

2.1.6 Pigeon Lake North Pier

This site is located approximately 70 miles south of the Ludington Pumped Storage Project's Upper Reservoir. (Figure 2.2) The site is owned and managed by the Licensees. Amenities include 18 parking spaces, two fishing platforms, eight benches, and a boardwalk which leads to

---

[4] Mason County is evaluating plans to replace the existing playground equipment and provide ADA accessibility to the playground.

the Pigeon Lake North Pier. The pier extends approximately 700 feet west into Lake Michigan and provides fishing opportunities and walking/hiking/jogging opportunities to the public. The site is open seasonally for daytime recreational use.

Figure 2-1: Recreation Facilities Location Map

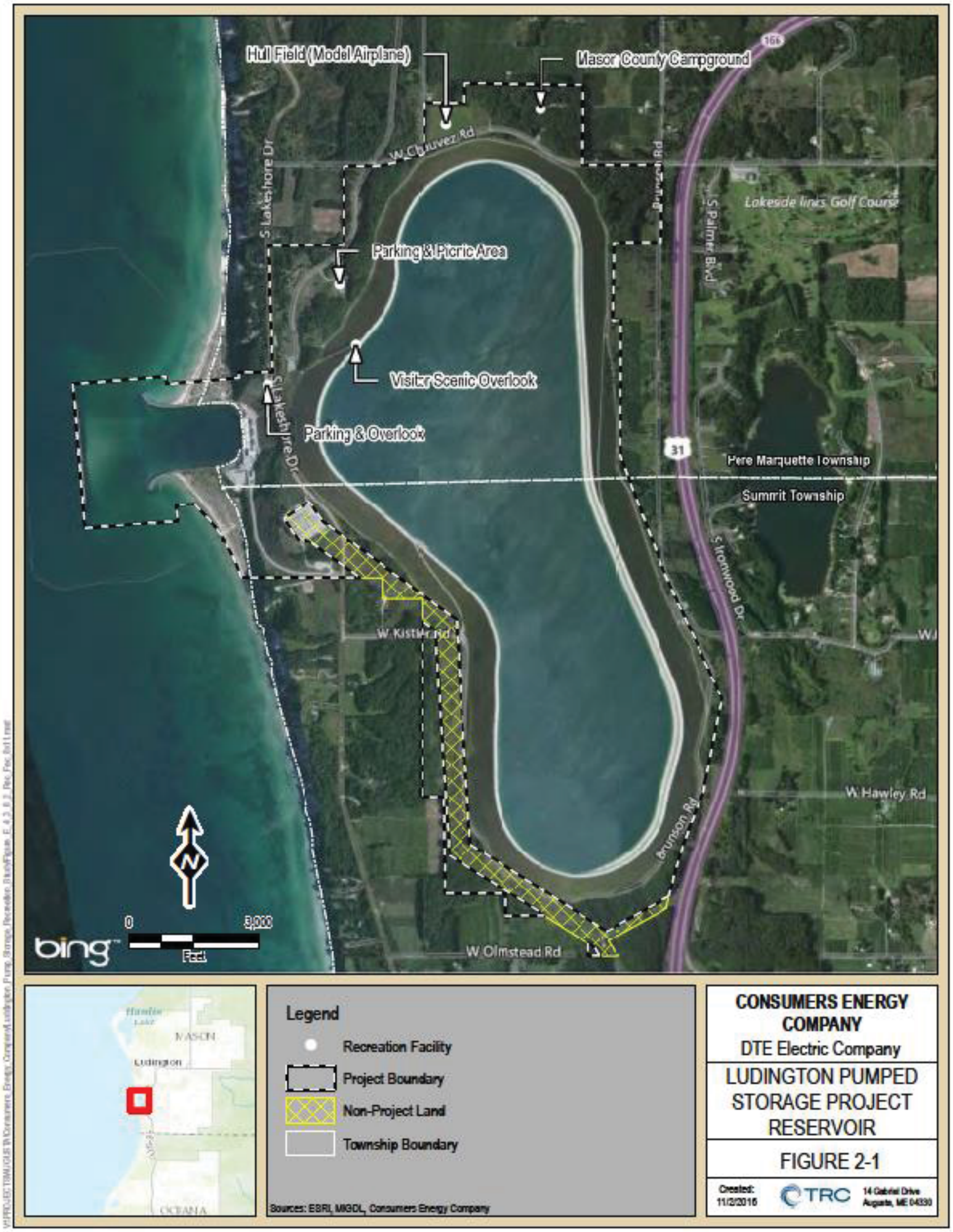


Figure 2-2: Port Sheldon Recreation Site

Table 2-1: Recreation Facilities

Site Name	Site Owner	Site Operator/ Manager	Amenities
Mason County Campground	Licensees	Mason County	restroom/shower building (ADA compliant), 56 campsites, four cabins, picnic shelter with eight tables, one playground, three benches, an interpretive display, foot path to Hull Field
Hull Field	Licensees	Mason County (manager) Twisted Sticks Radio Control Club (operator and responsible for site maintenance)	18 parking spaces, portable sanitation, two benches, five picnic tables, a pavilion, 14 radio controlled airplane platforms, a large mowed field, footpath to Mason County Campground
Mason County Day Use/Picnic Area	Licensees	Mason County	62 vehicle parking spaces, a picnic pavilion with 34 tables, ADA compliant restrooms, a 72 goal disc golf course, a playground
Reservoir Overlook	Licensees	Licensees	83 parking spaces, portable sanitation (1 standard and 1 ADA), a pagoda shelter, 9 benches, interpretive panel
Lake Michigan Overlook	Licensees	Licensees	portable sanitation (shared with Reservoir Overlook), a footbridge, multiple interpretive displays, parking
Pigeon Lake North Pier	Licensees	Licensees	18 parking spaces, two fishing platforms, eight benches, a boardwalk which leads to the Pigeon Lake North Pier

3.0 PROJECT RECREATION SITE OPERATIONS AND MAINTENANCE

The Licensees will continue to provide the six Project recreation sites, the Reservoir Overlook, Lake Michigan Overlook, Mason County Day Use/Picnic Area, Mason County Campground, Hull Field, and Pigeon Lake North Pier, along with the associated facilities and amenities. The Licensees will manage these FERC-approved Project recreation sites to provide safe and appropriate recreation access to the Project. The Licensees will ensure that all Project recreation sites remain usable over the term of the license.

Typical routine maintenance activities will include on a periodic basis: litter clean-up; removal of fallen trees, lawn mowing, and other vegetation management that hinders site use; and checking that Project signage is in-place and readable. The Licensees will conduct improvements and/or repairs on an observed, as-needed basis.

The Licensees will continue to meet annually with Mason County to discuss the operation and maintenance, and potential enhancements, of the Mason County Campground and Mason County Day Use/Picnic Area, consistent with historical practice.

4.0 MONITORING AND REPORTING

The Licensees will conduct periodic (every six years) recreation use monitoring during the license term for the FERC Form 80. The recreation use data will be reported in the FERC Form 80 submitted to FERC.

5.0 DETERMINING THE NEED FOR ADDITIONAL MEASURES OR EXPANSION OF EXISTING SITES

If FERC Form 80 data or facility comments indicate a need to review rec site amenities, the Licensees will initiate consultation with the agencies and local stakeholders in order to address these specific issues identified during the Form 80 process.

6.0 MODIFICATIONS TO THE RECREATION MANAGEMENT PLAN

Any proposed modification to the RMP will be discussed with the Michigan DNR, Pere Marquette Charter Township, and Mason County for review and comment prior to submittal to FERC. After consultation, the Licensees will submit proposed modifications to FERC for approval.

7.0 REFERENCES

Consumers Energy Company & DTE Electric Company. 2014. (PAD, 2014) Pre-Application Document for the Ludington Pumped Storage Hydroelectric Project (FERC No. 2680). January, 2014.

Pere Marquette Charter Township. 2017. (Pere Marquette Charter Township, 2017) Pere Marquette Charter Township website http://www.pmtwp.org/residents/recreational_parks.php

Summit Township. 2013. (Summit Township, 2013) Summit Township website http://summittownship.org/attractions/

USFS. 2016. (USFS, 2016) Interactive Visitor Map http://www.fs.fed.us/ivm/index.html

ATTACHMENT A - RESPONSES TO COMMENTS ON THE DRAFT RMP

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Comment	Response and Revisions
Paul Keson, Pere Marquette Charter Township (PMCT), Letter Dated May 19, 2017 Section 1.3.1 The Lake Michigan Water Trail is not accurately described in the draft Recreation Plan. The Lake Michigan Water Trail Plan Phase I, prepared by the West Michigan Shoreline Regional Development Commission, includes the Lake Michigan shoreline between Buttersville Beach and Summit Beach and discusses the Project portion of the trail as presenting access challenges due to the Project's barrier net. The Licensees could acquire property and develop a viable portage near the beginning and end of the barrier net location but it makes more sense and would better serve the public to develop a viable portage operation based from Buttersville Campground and Beach that can transport users to Summit Beach.	The Lake Michigan Water Trail in the vicinity of the Project is described based on Michigan Heritage Water Trails Program website mapping located at http://www.michiganwatertrails.org/west.asp (accessed May 19, 2017) and the West Michigan Shoreline Regional Development Commission website mapping located at http://wmsrdc.org/project/lake-michigan-water-trail-plan/ (accessed May 23, 2017). Both websites show the Lake Michigan Water Trail stopping north of the Project near Buttersville Park and starting up again south of the Project. The Lake Michigan Water Trail Plan Phase I, prepared by the West Michigan Shoreline Regional Development Commission, is dated 2014. In Michigan and Wisconsin, there are areas where the Lake Michigan Water Trail can be either farther out into Lake Michigan, have a break in the trail, or may be across land to go around an impediment. In the Study Plan Determination letter issued on 12/1/2014, FERC Staff determined that Buttersville Beach is not affected by Project operation and maintenance and does not provide access to Project lands or water.
Paul Keson, PMCT, Letter Dated May 19, 2017 Section 1.4 PMCT has previously noted in previous filings that the license application must include a "Report on recreational resources" that is prepared in consultation with local, state and regional recreation agencies, and must address an estimate of existing and potential recreational use, a description of measures or facilities recommended by the agencies consulted for creating or enhancing recreational opportunities at the Project and in its vicinity. The recommendations that PMCT has previously made and reiterates address recreational opportunities and needs in the vicinity of the Project, but there is no	Consultation during the relicensing process is described in Section 1.2 of Exhibit E in the Final License Application and responses to comments on the Draft License Application are discussed in Section 1.3 and provided in E-5. In the Study Plan Determination letter issued on 12/1/2014, FERC Staff determined that the two recreation sites identified by PMCT (Buttersville Beach and the Twin Bridges Site) are not affected by project operation and maintenance and do not provide access to project lands or waters. Because of their lack of nexus between the two sites and the Project there was no justification for requiring the Licensees to include them in the study. The partnering opportunities suggested between PMCT and the Licensees are outside FERC jurisdiction since the nexus between the sites

Comment	Response and Revisions
reference to or discussion of that consultation in the RMP.	and the Project was not established. While the Licensees may agree with the nature of the PMCT proposed recreational opportunities, they do not believe they should be considered part of the new license for the Project. The partnering opportunities suggested between PMCT and the Licensees are outside FERC jurisdiction since the nexus between the sites and the Project was not established.
Paul Keson, PMCT, Letter Dated May 19, 2017 Section 2.1.6 The Pigeon Lake facility primarily provides a recreational walking opportunity, not a public fishing opportunity, as the Recreation Study showed.	Section 2.1.6 of RMP has been revised to also reference walking/hiking/jogging as an opportunity provided by the Pigeon Lake facility.
Paul Keson, PMCT, Letter Dated May 19, 2017 Section 6.0 PMCT recommends that the Licensees include the following provision in the Final RMP: 1) submittal of a RMP within 6 months of license issuance developed in consultation with PMCT projects planned to provide improved access to the Lake Michigan fishery at the mouth of the Pere Marquette River (the Twin Bridges site) and to improve beach and water trail access at Buttersville Park Beach on Lake Michigan; 2) financial support of up to $800,000 for these projects; and 3) preparation of the RMP in consultation with PMCT, Michigan DNR., U.S. Fish and Wildlife Service, and the U.S. Park Service.	In the Study Plan Determination letter issued on 12/1/2014, FERC Staff determined that the two recreation sites identified by PMCT (Buttersville Beach and the Twin Bridges Site) are not affected by project operation and maintenance and do not provide access to project lands or waters. Because of their lack of nexus between the two sites and the Project there was no justification for requiring the Licensees to include them in the study. The partnering opportunities suggested between PMCT and the Licensees are outside FERC jurisdiction since the nexus between the sites and the Project was not established. The Licensees pay property taxes to Pere Marquette Township which can be used to offset the costs of the proposed recreation upgrades. Property tax payments increased 8% from 2014 to 2015, and 18% from 2015 to 2016, and will continue to increase to Pere Marquette Township with the completion of each unit upgrade without additional burden to the township, since the powerhouse portion of the project lies soley in Pere Marquette Township. This additional tax revenue can be used at the Township's discretion, including for the proposed recreation improvements.While the Licensees may agree

Comment	Response and Revisions
	with the nature of the PMCT proposed recreational opportunities, they don't believe they should be considered part of the new license for the Project.
Paul Keson, PMCT, Letter Dated May 19, 2017 Section 7.0 The Recreation Plan includes a reference to an outdated PMCT website.	Section 7.0 of the RMP, as well as references to this website, has been updated in the RMP.

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ATTACHMENT B – CONSULTATION RECORD

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From: Hayen, Rita
To: Foster, Joyce
Subject: Fwd: Draft LPS Recreation Plan for Comment
Date: Friday, May 05, 2017 7:57:41 AM
Attachments: Ludington RMP_5-4-2017_Stakeholder Review Draft.docx
ATT00001.htm

FYI

Sent from my iPhone

Begin forwarded message:

> **From:** "David C. Mcintosh" <DAVID.MCINTOSH@cmsenergy.com>
> **To:** "Paul Keson" <paul@PMTWP.ORG>, "Terry Wahr" <terry@PMTWP.ORG>, "david maclean" <kdmaclean@frontier.com>, "jmbassoc@charter.net" <jmbassoc@charter.net>, "Newcomb, Tammy (DNR) (NEWCOMBT@michigan.gov)" <NEWCOMBT@michigan.gov>, "kyle kruger (krugerk@michigan.gov)" <krugerk@michigan.gov>
> **Cc:** "DAVID S. BATTIGE" <DAVID.BATTIGE@cmsenergy.com>, "Richard D. Castle" <RICHARD.CASTLEJR@cmsenergy.com>, "Hayen, Rita" <RHayen@trcsolutions.com>
> **Subject: Draft LPS Recreation Plan for Comment**
>
> All,
>
> Attached please find a draft copy of the Recreation Management Plan for the Ludington Pumped Storage Project, FERC No. 2680. This Recreation Plan was developed as part of the relicensing for the Project and will be included in the Final License Application. The purpose of this Recreation Plan is to identify the recreation sites included within the Project boundary and describe the facilities and amenities at each site and the responsible parties.
>
> The Final License Application is scheduled to be filed with the Federal Energy Regulatory Commission no later than Friday, June 30, 2017. In order for your comments to be included with the Final License Application package the Licensees (Consumers Energy and DTE Energy) are requesting that any comments on the attached Recreation Management Plan be provided no later than Monday, June 5, 2017.
>
> Please provide any comments, or reply indicatng that you have no comments to me, my contact information is included below.
>
> Please let me know if you have any questions regarding the Recreation Management Plan.
>
> Thank-you,

David McIntosh
Hydro and Renewable Generation
330 Chestnut St, Cadillac, MI 49601
(O) 231 779-5506
David.McIntosh@cmsenergy.com

CONSUMERS ENERGY COMPANY
JACKSON, MICHIGAN

DTE ELECTRIC COMPANY
DETROIT, MICHIGAN

DRAFT RECREATION MANAGEMENT PLAN

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT (FERC NO. 2680)

Submitted by:

Consumers Energy Company
One Energy Plaza
Jackson, MI 49201

DTE Electric Company
One Energy Plaza
Detroit, MI 48226

Prepared by:

TRC
14 Gabriel Drive
Augusta, ME 04330

May 2017

Results you can rely on

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

DRAFT OUTLINE
DRAFT RECREATION MANAGEMENT PLAN

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LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ADA	Americans with Disabilities Act
Consumers	Consumers Energy
DTEE	DTE Electric
FERC	Federal Energy Regulatory Commission
ILP	Integrated Licensing Process
Licensees	Consumers Energy and DTE Electric
Michigan DNR	Michigan Department of Natural Resources
PAD	Pre-Application Document
Project	Ludington Pumped Storage Hydroelectric Project
RMP	Recreation Management Plan
USFS	United States Forest Service

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)
DRAFT RECREATION MANAGEMENT PLAN

1.0 INTRODUCTION

1.1 Background

The Ludington Pumped Storage Hydroelectric Project (Project) is an existing hydroelectric project owned by Consumers Energy (Consumers) and DTE Electric (DTEE) companies (Licensees) and is operated by Consumers. The Project consists of an 842-acre upper reservoir within a man-made embankment and uses Lake Michigan as the lower reservoir. There is a 2,715-foot long tailrace area in the lower reservoir area (Lake Michigan).

The Licensees are using the Federal Energy Regulatory Commission's (FERC) Integrated Licensing Process (ILP) for the relicensing of Project. Pursuant to the process and schedule requirements of the ILP (18 CFR Part 5), the Licensees are filing a Final License Application with FERC by June 30, 2017 and have included this Draft Recreation Management Plan (RMP) as part of the Final License Application.

1.2 Project Location

The Project is located on the east shore of Lake Michigan near the City of Ludington, in the townships of Pere Marquette and Summit in Mason County, Michigan and in Port Sheldon in Ottawa County, Michigan[1]. The Ottawa County portion is limited to a 1.8 acre satellite recreation site (established as part of the federal Settlement Agreement, FERC's January 23, 1996 order approving a settlement agreement). A map of the Project is included as Figure 1-1.

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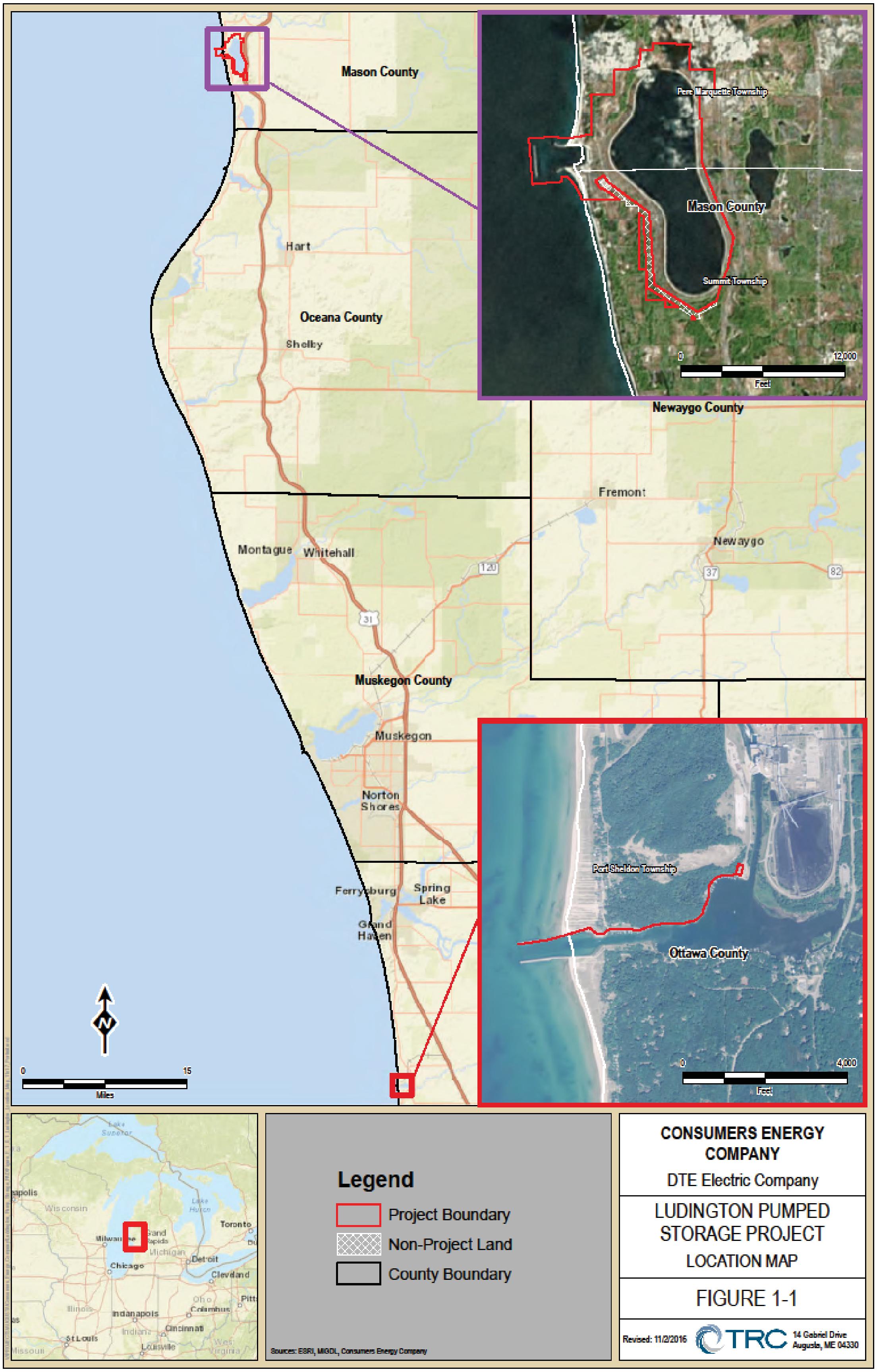
[1]Pigeon Lake North Pier, a recreation site associated with the Project, is located in Port Sheldon, Ottawa County, approximately 70 miles south of the pump storage facility. This is the only portion of the Project in Ottawa County and consists of approximately 1.8 acres. This recreation site was developed as part of FERC's January 23, 1996 order approving a settlement agreement and provides amenities including a parking lot, boardwalk and Lake Michigan fishing access. The site is open from spring through fall. While the land associated with this recreation site is not contiguous with the remainder of the Project boundary at the pump storage facility, the recreation site is discussed in this Recreation Management Plan.

Figure 1-1: Ludington Pumped Storage Project Location



1.3 Recreation Opportunities

1.3.1 Regional Recreation Opportunities

Two regionally important recreation areas, the North Country Trail and the Lake Michigan Water Trail, are located near the Ludington Project. The North Country Trail, which is a National Scenic Trail, is located approximately 21 miles east of the Project. The Lake Michigan Water Trail extends along the lake, stopping north of the Project near Buttersville Park and starting up again south of the Project. A portion of the Lake Michigan Water Trail is designated as a National Recreation Trail.

The Ludington State Park is located 6.5 miles north of the Project between Hamlin Lake and Lake Michigan. The Park is comprised of almost 5,300 acres of scenic sand dunes, shoreline vistas, ponds, marshlands and forests. Three campgrounds within the Park provide 355 campsites including three mini-cabins (PAD, 2014).

The Pere Marquette River, located approximately 2 miles north of the Project, was the first designated Scenic River under the Wild and Scenic River program in the State of Michigan. The river is also a State Natural River under the State of Michigan's Natural Rivers Program. The river is used by recreationists for paddling, motor-boating, fishing and wildlife viewing (PAD, 2014).

Local, State and Federal agencies also provide the public with recreation opportunities near the Ludington Project. The City of Ludington operates Stearns Park, Waterfront Park, Cartier Park, Copeyon Park, and Loomis Street Boat Launch. These recreation sites provide a variety of opportunities such as swimming, picnicking, volleyball, camping, fishing, walking, jogging, and biking. Amenities include playgrounds, a skate park, shuffle board, mini golf, boat launches, picnic areas, and campground (PAD, 2014).

The Pere Marquette Charter Township provides several recreation opportunities for the public near the Ludington Project. Buttersville Park and the Father Marquette Shrine are located about two miles north of the Project on South Lakeshore Drive. Buttersville Park provides camping south of the Ludington Harbor with direct access to Lake Michigan. It includes 35 campsites, improved facilities, and a swimming beach on Lake Michigan. The Father Marquette Shrine has special historic significance and includes 400 feet of frontage on Pere Marquette Lake and a boat launch that provides access to Pere Marquette Lake and Lake Michigan. Suttons Landing is a 34-acre riverfront park located along the South Fork of the Pere Marquette River. Suttons Landing includes approximately 425 feet of river frontage, a small boat launch facility, a boardwalk along the riverbank, a pavilion, restrooms, and improved parking facilities (Pere Marquette Charter Township, 2016). The Pere Marquette River empties into Pere Marquette Lake about two miles north of the Ludington Project in the Pere Marquette Charter Township.

There are no developed facilities at Pere Marquette Lake but Pere Marquette Lake is popular with anglers for fishing Lake Michigan salmonids and other fish species. Anglers park along the Pere Marquette Highway (old US-31).

Summit Township operates Summit Township Park near the Ludington Project. Summit Township Park provides Lake Michigan Beach, a tennis court, ball fields, picnic area and a pavilion (Summit Township, 2013).

Michigan Department of Natural Resources (Michigan DNR) manages several areas in the vicinity of the project, which provide hunting, fishing, camping, hiking, swimming, picnicking and boating opportunities. In addition to the Ludington State Park, these areas include: Pere Marquette State Game Area, and Charles Mears State Park (PAD, 2014).

The United States Forest Service (USFS) manages the Huron-Manistee National Forest, located approximately 8 miles east of the Project, and the Nordhouse Dunes Wilderness (National Wilderness Area) located directly north of the Ludington State Park. These two areas provide hiking, picnicking, fishing, boating, biking, camping, hunting, nature study, cross-country skiing, paddling, and wildlife viewing (USFS, 2016).

Finally, there are numerous privately owned/operated facilities in the vicinity of the Ludington Project including golf courses, campgrounds and marinas.

1.3.2 Project Recreation Opportunities

There are a total of six Project recreation sites located within the Ludington Project boundary: Mason County Campground, Hull Field, Mason County Day Use/Picnic Area, Reservoir Overlook, Lake Michigan Overlook and Pigeon Lake North Pier. These sites provide a variety of recreation opportunities such as fishing, camping, picnicking, walking/hiking/jogging, disc golfing, flying model aircraft, sightseeing, and snowshoeing.[2] Although the sites are closed and not maintained during the winter, the property itself is still open to the public allowing informal winter activities to take place.

[2] Snowshoeing became highlighted as a recreation opportunity in January 2017 with the designation of the 1.7-mile snowshoe trail at the Mason County Day/Use Picnic Area.

1.4 Purpose of the Recreation Management Plan

The purpose of the RMP is to identify the Project recreation sites and describe the facilities and amenities at each site, and describe the operation and maintenance of each site, including responsible parties.

1.5 Consultation During Development of the Recreation Management Plan

The Licensees provided Michigan DNR, Pere Marquette Charter Township, and Mason County with a draft RMP for review and comment by email dated May 5, 2017 for a 30-day comment period. Comments were due on June 5, 2017. The Licensees have provided responses to comments in Attachment A. A summary of consultation and copies of all comments received are provided in Attachment B.

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2.1.1 Mason County Campground

The Mason County Campground, located in the northeastern corner of the Project boundary (Figure 2.1), is owned by the Licensees and managed by Mason County. The site provides camping and picnicking opportunities to the public on a seasonal basis (generally from Memorial Day Weekend to Labor Day Weekend). There is a restroom/shower building which is compliant with the Americans with Disabilities Act (ADA), 56 campsites, four cabins, picnic shelter with eight tables, one playground[3], three benches, an interpretive display, and a foot path to Hull Field.

2.1.2 Hull Field

Hull Field is located adjacent to the Mason County Campground along the northern edge of the Project boundary. (Figure 2.1) This site is owned by the Licensees, managed by Mason County

[3] Mason County is reviewing plans to upgrade the existing playground equipment.

and operated by the Twisted Sticks Radio Control Club. The site is open to the public for viewing. Those who wish to fly a radio controlled plane must possess a current Academy of Model Aeronautics card. Site amenities include 18 parking spaces, portable sanitation, two benches, five picnic tables, a pavilion, 14 airplane platforms, a large mowed field, and a footpath to Mason County Campground.

2.1.3 Mason County Day Use/Picnic Area

The Day Use/Picnic Area is located in the northwestern corner of the Project boundary. (Figure 2.1) The site is owned by the Licensees and managed/operated by Mason County. Amenities include 62 vehicle parking spaces, a picnic pavilion with 34 tables, ADA compliant restrooms, a 72 goal disc golf course, and a playground[4]. A 1.7- mile snowshoe trail was designated at the site in January 2017. The snowshoe trail loop is accessed at the Chauvez Road entrance to the Mason County Day Use/Picnic Area and follows a pathway used by walkers and disc golfers. The site is open to the public seasonally (generally April – October) for day use activities.

2.1.4 Reservoir Overlook

The overlook is located on the northwestern side of the Upper Reservoir embankment and provides views of Lake Michigan as well as the Upper Reservoir. (Figure 2.1) The site is owned and managed by the Licensees. Amenities include 83 parking spaces, portable sanitation (1 standard and 1 ADA), a pagoda shelter, and 9 benches which are located along a steep footpath to the pagoda. An interpretive panel is located in the pagoda which describes the Project structures and how they work. The site is generally open to the public between April and October for day use activities.

2.1.5 Lake Michigan Overlook

The overlook is located north of the powerhouse on the eastern shore of Lake Michigan. (Figure 2.1) The site is owned and managed by the Licensees. Recreation amenities include portable sanitation (shared with the Reservoir Overlook), a footbridge, and multiple interpretive displays. Parking for the overlook is located on the east side of Lakeshore Drive, just north of the overlook. The site is open to the public generally between April and October for day use recreation.

[4] Mason County is evaluating plans to replace the existing playground equipment and provide ADA accessibility to the playground.

2.1.6 Pigeon Lake North Pier

This site is located approximately 70 miles south of the Ludington Pumped Storage Project's Upper Reservoir. (Figure 2.2) The site is owned and managed by the Licensees. Amenities include 18 parking spaces, two fishing platforms, eight benches, and a boardwalk which leads to the Pigeon Lake North Pier. The pier extends approximately 700 feet west into Lake Michigan and provides fishing opportunities to the public. The site is open seasonally for daytime recreational use.

Figure 2-1: Recreation Facilities Location Map

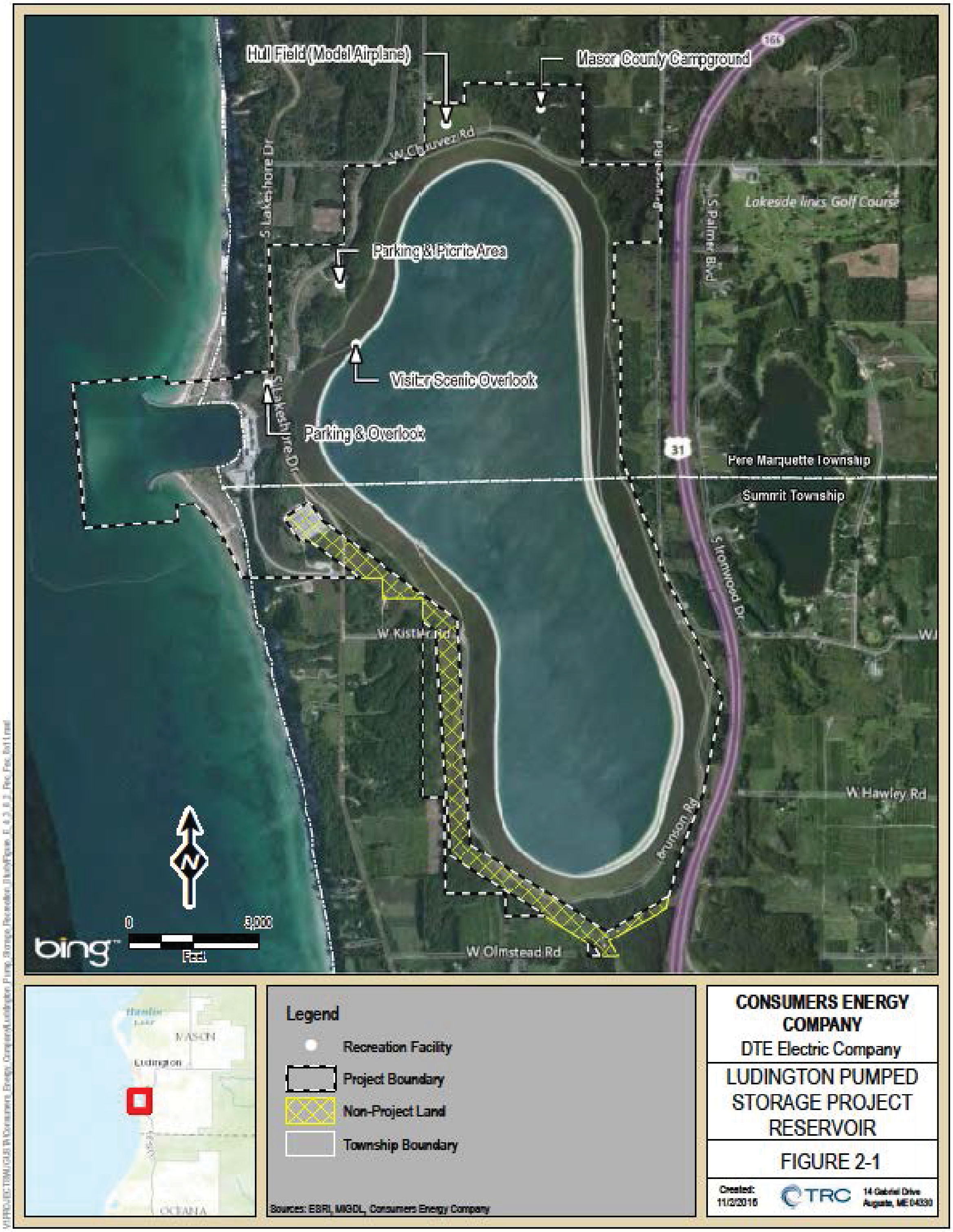

Figure 2-2: Port Sheldon Recreation Site

Table 2-1: Recreation Facilities

Site Name	Site Owner	Site Operator/ Manager	Amenities
Mason County Campground	Licensees	Mason County	restroom/shower building (ADA compliant), 56 campsites, four cabins, picnic shelter with eight tables, one playground, three benches, an interpretive display, foot path to Hull Field
Hull Field	Licensees	Mason County (manager) Twisted Sticks Radio Control Club (operator and responsible for site maintenance)	18 parking spaces, portable sanitation, two benches, five picnic tables, a pavilion, 14 airplane platforms, a large mowed field, footpath to Mason County Campground
Mason County Day Use/Picnic Area	Licensees	Mason County	62 vehicle parking spaces, a picnic pavilion with 34 tables, ADA compliant restrooms, a 72 goal disc golf course, a playground
Reservoir Overlook	Licensees	Licensees	83 parking spaces, portable sanitation (1 standard and 1 ADA), a pagoda shelter, 9 benches, interpretive panel
Lake Michigan Overlook	Licensees	Licensees	portable sanitation (shared with Reservoir Overlook), a footbridge, multiple interpretive displays, parking
Pigeon Lake North Pier	Licensees	Licensees	18 parking spaces, two fishing platforms, eight benches, a boardwalk which leads to the Pigeon Lake North Pier

3.0 PROJECT RECREATION SITE OPERATIONS AND MAINTENANCE

The Licensees will continue to provide the six Project recreation sites, the Reservoir Overlook, Lake Michigan Overlook, Mason County Day Use/Picnic Area, Mason County Campground, Hull Field, and Pigeon Lake North Pier, along with the associated facilities and amenities. The Licensees will manage these FERC-approved Project recreation sites to provide safe and appropriate recreation access to the Project. The Licensees will ensure that all Project recreation sites remain usable over the term of the license.

Typical routine maintenance activities will include on a periodic basis: litter clean-up; removal of fallen trees, lawn mowing, and other vegetation management that hinders site use; and checking that Project signage is in-place and readable. The Licensee will conduct improvements and/or repairs on an observed, as-needed basis.

The Licensees will continue to meet annually with Mason County to discuss the operation and maintenance, and potential enhancements, of the Mason County Campground and Mason County Day Use/Picnic Area, consistent with historical practice.

4.0 MONITORING AND REPORTING

The Licensees will conduct periodic (every six years) recreation use monitoring during the license term for the FERC Form 80. The recreation use data will be reported in the FERC Form 80 submitted to FERC.

5.0 DETERMINING THE NEED FOR ADDITIONAL MEASURES OR EXPANSION OF EXISTING SITES

If FERC Form 80 data or facility comments indicate a need to review rec site amenities, the Licensees will initiate consultation with the agencies and local stakeholders in order to address these specific issues identified during the Form 80 process.

6.0 MODIFICATIONS TO THE RECREATION MANAGEMENT PLAN

Any proposed modification to the RMP will be discussed with the Michigan DNR, Pere Marquette Charter Township, and Mason County for review and comment prior to submittal to FERC. After consultation, the Licensees will submit proposed modifications to FERC for approval.

7.0 REFERENCES

Consumers Energy Company & DTE Electric Company. 2014. (PAD, 2014) Pre-Application Document for the Ludington Pumped Storage Hydroelectric Project (FERC No. 2680). January, 2014.

Pere Marquette Charter Township. 2016. (Pere Marquette Charter Township, 2016) Pere Marquette Charter Township website http://peremarquette.itright.biz/Parks/SuttonsLanding.aspx

Summit Township. 2013. (Summit Township, 2013) Summit Township website http://summittownship.org/attractions/

USFS. 2016. (USFS, 2016) Interactive Visitor Map http://www.fs.fed.us/ivm/index.html

ATTACHMENT A - RESPONSES TO COMMENTS ON THE DRAFT RMP

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ATTACHMENT B – CONSULTATION RECORD

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Pere Marquette Charter Township

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May 19, 2017

David McIntosh
Hydro and Renewable Generation
330 Chestnut St, Cadillac, MI 49601
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SENT ELECTRONICALLY

RE: LUDINGTON PUMPED STORAGE PROJECT RELICENSING - - RECREATION MANAGEMENT PLAN

Pere Marquette Charter Township (PM Township) has reviewed the draft Recreation Management Plan (Plan) for the Ludington Pumped Storage Project (LPS) that you transmitted on May 5, 2017. As you are aware, PM Township has participated throughout the ongoing relicensing process for the project. PM Township's principal interest in the relicensing process has been and continues to be the role of LPS in enhancing recreational opportunities at the project and in its vicinity, as provided for in the Federal Power Act licensing regulations. On April 28, 2017 PM Township filed comments on the LPS draft License Application with the Federal Energy Regulatory Commission (FERC). Those comments generally apply to the draft Recreation Plan and are incorporated here by reference, but are not restated in their entirety. Additionally, PM Township would like to offer the following comments on the draft LPS Recreation Plan.

Section 1.3.1 Regional Recreation Opportunities

This Plan describes the Lake Michigan Water Trail as "extend[ing] along the lake, stopping north of the Project near Buttersville Park and starting up again south of the Project." In the draft License Application, the trail was described as "extend[ing] along the lake, just to the west of the LPSP." Neither description accurately describes the trail.

As discussed in our previous comments, the trail, as described in the Lake Michigan Water Trail Plan Phase I, prepared by the West Michigan Shoreline Regional Development Commission clearly includes the Lake Michigan shoreline between Buttersville Beach, north of LPS and Summit Beach, south of LPS. The trail plan discusses the LPS portion of the trail as "present[ing] unique access challenges" due to the LPS barrier net. We view this issue as being no different from canoe portages that are routinely required at FERC licensed facilities. One solution is that LPS could acquire property and develop a viable portage near the beginning and end of the barrier net location, but any such portage would be lengthy and difficult to construct and use. PM Township believes it makes more sense and would better serve the public to develop a viable portage operation that is based from Buttersville Campground and Beach that can transport users to Summit Beach, because of the campground infrastructure and facilities that are located there. However, without making improvements to the Buttersville Beach site that would provide support facilities for the trail, such as restrooms, canoe / kayak racks, decent parking, etc., that concept cannot be achieved. PM Township cannot afford to finance such improvements independently, and these public recreation needs would benefit greatly from support of the LPS Licensees in response to current and future recreation demand.

Section 1.4 Purpose of the Recreation Management Plan

The Plan states that "the purpose of the RMP is to identify the Project recreation sites and describe the facilities and amenities at each site, and describe the operation and maintenance of each site, including responsible parties." As PM Township has discussed in previous filings, 18 CFR §4.51(f)(5) provides for inclusion in the license application a "*Report on recreational resources that is prepared in consultation with local, state and regional recreation agencies, and must address an estimate of existing and potential recreational use (§4.51(5)(ii)); a description of any measures or facilities recommended by the agencies consulted for the purpose of creating, preserving, or enhancing recreational opportunities at the project and in its vicinity (including opportunities for the handicapped), (§4.51(5)(iii)); and new measures or facilities proposed by the applicant for the purpose of creating, preserving, or enhancing recreational opportunities at the project and in its vicinity (§4.51(5)(iv)); along with other provisions.* The recommendations that PM Township has previously made and reiterates here address recreational opportunities and needs in the vicinity of LPS, but there is no reference to or discussion of that consultation in the Plan.

Section 2.1.6 Pigeon Lake North Pier

This facility is described in the Plan as "provid[ing] fishing opportunities to the public." As PM Township has noted in previous comments, including the incorporated reference to our draft License Application comments, the LPS Recreation Study found that the public fishing opportunity provided by the Pigeon Lake access site amounts to only 1% of the total project recreation use, and about 10% of the use at the Pigeon Lake site. This is because the Campbell Plant, a fossil fuel plant, operates a warm water discharge in Lake Michigan about one mile west of the pier. That discharge is attractive to fish in the area (and hence fisherman) and as a result, while a group of fishing boats are routinely observed at the warm water discharge out in Lake Michigan, there are few, if any, game fish and correspondingly few fisherman found at the Pigeon Lake pier. The Pigeon Lake facility primarily provides a recreational walking opportunity, not a public fishing opportunity, as the Recreation Study showed.

Section 6.0 Modifications To The Recreation Management Plan

The Plan states that "any proposed modification to the RMP will be discussed with the Michigan DNR, Pere Marquette Charter Township, and Mason County for review and comment prior to submittal to FERC." PM Township looks forward to the opportunity to discuss its recommendations with the Licensees.

PM Township has recommended recreation enhancements in the immediate vicinity of the LPS plant that would be consistent with the role the facility is intended to play at relicensing. Partnering with PM Township to provide these recreation opportunities serves community needs in the vicinity of LPS and would serve the public interest as a component of the Licensee's environmental and recreational enhancement at relicensing

Specifically, PM Township is recommending that the Licensees include the following provision in the final LPS Recreation Management Plan:

> Within six (6) months of license issuance, the LPS Licensees propose to submit a Recreation Enhancement Plan for FERC approval to address the needs for public access to shoreline and small boat fishing opportunity for Lake Michigan fish species and for access to Lake Michigan beach and water trail resources. The Plan should be developed in conjunction with Pere Marquette Charter Township (PM Township) projects currently being planned to provide improved access to the Lake Michigan fishery at the mouth of the Pere Marquette River (the Twin Bridges site) and to improve beach and water trail access at the Buttersville Park Beach on Lake Michigan. The Plan shall provide for financial support of these projects in an amount not to exceed $800,000 (in 2019 dollars, adjusted for the CPI), and shall include a schedule for completion of the projects. The Licensees shall have no ongoing responsibility for operation and maintenance of these projects, which will be provided by PM Township. The Plan shall be prepared in consultation with Pere Marquette Charter Township, the Michigan DNR, the US Fish and Wildlife Service, and the US Park Service. A minimum of 30 days shall be provided for comment on the final Plan prior to submittal to the Commission for approval.

Section 7.0 References

The Plan includes the reference:
Pere Marquette Charter Township. 2016. (Pere Marquette Charter Township, 2016) Pere Marquette Charter Township website http://peremarquette.itright.biz/Parks/SuttonsLanding.aspx

This is a reference to an outdated website that has not been maintained since 2015.

The PM Township website is:
www.pmtwp.org

The correct link to the PM Township Parks page is:
http://www.pmtwp.org/residents/recreational_parks.php

The PM Township Parks, Recreation and Open Space Plan can be accessed at:
http://www.pmtwp.org/contact_us/docs/PM%20Township%20Recreation%20Plan%202015-2019.pdf

PM Township appreciates the opportunity to provide this input on the draft Recreation Management Plan and looks forward to working with the Licensee to incorporate these proposals in the final Recreation Management Plan. If you have any questions, please don't hesitate to contact me.

Paul C. Keson

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APPENDIX E-3

HISTORIC PROPERTIES MANAGEMENT PLAN

FILED SEPARATELY AS A PRIVILEGED DOCUMENT

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APPENDIX E-4

GLEC WATER RESOURCES REPORT

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FINAL REPORT

FOR

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT 2013 WATER QUALITY DATA COLLECTION

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January 13, 2014

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT 2013 WATER QUALITY DATA COLLECTION

1.0 EXECUTIVE SUMMARY

Great Lakes Environmental Center, Inc. (GLEC) collected water quality data for Consumers Energy Company at the Ludington Pumped Storage Project (LPSP) between June and October, 2013. Data collected include water temperature and dissolved oxygen (DO) profiles twice per month at six sites in Lake Michigan and three sites in the upper reservoir, near bottom and near surface turbidity measurements at each Lake Michigan and upper reservoir site, continuous hourly monitoring of water temperature and DO at two sites in Lake Michigan and one site in the upper reservoir, and macroinvertebrate community composition data at six sites in Lake Michigan and three sites in the upper reservoir. Data collected at these sites were compared to identify differences and similarities between locations.

Based on profile data, DO and water temperature stratification in the upper reservoir was rare while Lake Michigan generally showed a decrease in water temperature and an increase in DO with an increase in depth. This pattern was less distinct at the Lake Michigan sites closer to shore and more distinct at the deeper Lake Michigan sites. Surface water mean values for both water temperature and DO were not significantly different among both reservoir and lake sites. Lake water temperatures at sites closest to the plant were closer to reservoir water temperatures on only one of 9 sampling occasions. In general water quality conditions in the reservoir mimic those in the lake but without thermal stratification. Changes in temperature/dissolved oxygen in the inshore areas appear primarily driven by natural lake/ weather conditions making it difficult to determine any plant impacts. Turbidity measurements showed no apparent pattern but mean values were largest for the reservoir sites nearest the intakes, possibly due to greater mixing. However, these means were not statistically significant from other sites and not consistently highest. Results from the limited macroinvertebrate sampling showed dramatically greater concentrations at the north and central reservoir sites. Dressenidae and Oligochaeta were the dominant taxa in the upper reservoir while Chironomidae and Oligochaeta were the dominate benthic macroinvertebrate taxa at the Lake Michigan sites (Dreissenidae was also dominant at Lake Michigan deep water site 4). The lake control site and the north reservoir site exhibited the highest diversity of macroinvertabrate species, though with a different suite of minor species.

2.0 INTRODUCTION AND PURPOSE

The objective of this monitoring effort was to collect baseline water quality information (water temperature, dissolved oxygen (DO) concentration, and turbidity) at the Ludington Pump Storage Plant (LPSP) for comparison to historical water quality data collected during the initial plant start-up to assess the potential effects of project operations. The LPSP, Federal Energy Regulatory Commission (FERC) Project No. 2680, is a 1,872 megawatt (nameplate rating) hydroelectric pumped storage generating facility located on the eastern shoreline of Lake Michigan in Pere Marquette Township of Mason County, Michigan. The LPSP is five miles south of the City of Ludington, Michigan.

Constructed between 1969 and 1973, the LPSP is the only hydroelectric pumped storage facility in the State of Michigan and is one of the largest pumped storage generating plants in the world. Water is pumped from Lake Michigan, which serves as the lower reservoir, into an 842-acre manmade upper reservoir with six reversible pump-turbine/motor-generator units. The maximum drawdown of the reservoir is 67 feet. The mean depth of the water in the reservoir is about 98 feet and ranges from approximately 97 feet in the south end to approximately 112 feet in the north end. For electric generation, water flow is reversed traveling from the upper reservoir back into Lake Michigan through the pump-turbine/motor-generating units. The LPSP can go from a complete shutdown condition to full generation (i.e. water release) on all six units in approximately 30 minutes.

The LPSP includes a 1,700-foot long break-wall located approximately 2,700 feet out in Lake Michigan from the powerhouse and two jetties (one on either end of the powerhouse) extending approximately 1,600 feet into Lake Michigan, perpendicular to the shoreline. The LPSP is co-owned by Consumers Energy (51%) and DTE Energy (49%) with Consumers Energy performing the operation and maintenance of the project.

From June 20 through October 11, 2013, GLEC (on behalf of Consumers Energy) collected water temperature and DO profile data twice per month from six sites in Lake Michigan and three sites in the upper reservoir (Figures 1 and 2). Turbidity samples were taken concurrently with profile data and the macroinvertebrate community was also assessed at these locations. Additionally, continuous hourly monitoring of water temperature and DO was conducted at two locations in Lake Michigan and at one location in the upper reservoir.

The results of this study are provided in this report and include: 1) a summary and comparison of DO, water temperature, and turbidity among the nine locations across nine sampling dates, 2) a comparison among the two lake sites and the reservoir of the continuously monitored DO and water temperature and a compareison to the average daily air temperature, and 3) macroinvertebrate community assessment.

3.0 METHODS

Water Temperature and Dissolved Oxygen Profiles

GLEC collected water temperature and DO profiles twice per month with a calibrated Hydrolab DS3 multiparameter sonde at six Lake Michigan locations and three upper reservoir locations (Figures 1 and 2). The coordinates for the Lake Michigan locations were established during the original monitoring study (Liston, Brazo and Tack, 1976). However, the original study did not specify coordinates in the upper reservoir but simply divided the upper reservoir into three general sections: 1R, 2R, and 3R. For the purpose of this study, GLEC defined sampling coordinates in the upper reservoir by placing the sampling sites near the center of each of the three previously defined general sections. Table 1 provides the coordinates of the sampling stations used by GLEC during this study. Water temperature and DO profile data were collected by GLEC approximately once every two weeks between June 20 and October 11, 2013 at 1-meter increments from the surface to the bottom at each site in Lake Michigan and at each of the three upper reservoir sites. The data were evaluated to determine if temperature stratification occurred. Stratification is typically defined as a 1°C or greater temperature change within a one meter depth interval.

Turbidity

In addition to water temperature and DO profiles, turbidity measurements were also made at each of the six Lake Michigan locations and three upper reservoir locations. GLEC collected turbidity samples using a VanDorn sampler at two depths at each profile location; at a depth of one meter from the water surface and one meter from the bottom. Each sample was placed in a 250 mL Nalgene bottle, stored on ice, and transported to the GLEC laboratory for analysis. Turbidity samples were stored between 0-6 °C at GLEC until analysis. An acceptable range for turbidity for recreational use is typically less than 5 NTU.

Continuous Recording of Water Temperature and Dissolved Oxygen

GLEC deployed two calibrated Hydrolab Minisonde optical DO and temperature monitors near the northwest and southwest corners of the seasonal fish barrier net in Lake Michigan (Figure 1 and Table 1). Water temperature and DO measurements were recorded on an hourly basis between June 21 and October 7-10, 2013, with a few noted exceptions (see below). Data were retrieved approximately once every two weeks in conjunction with the DO and water temperature profiling. During data retrieval, each monitor was checked to ensure it was in good working condition and was cleaned. A quick review of the recorded data was performed on-site. If it looked like there was a sudden and unusual change in the recorded data, it was assumed that the monitor had malfunctioned and that data was not used. In these instances, the monitor was recalibrated and re-deployed, or replaced with a back-up unit.

<u>Exceptions to continuous monitoring due to monitor malfunction:</u>

Northwest corner minisonde:	No data were collected June 25 - July1, 2013
	No data were collected August 29 – September 11, 2013
Southwest corner minisonde:	No data were collected August 12 - 13, 2013
	No data were collected August 29 – September 11, 2013

GLEC also deployed one Hydrolab MiniSonde optical DO and temperature monitor in the upper reservoir in section 1R (Figure 2 and Table 1). Water temperature and DO measurements were recorded on an hourly basis between July 16 and October 10, 2013 with a few noted exceptions (see below). Data were retrieved approximately once every two weeks in conjunction with the DO and water temperature profiling. During data retrieval, the monitor was checked to ensure it was in good working condition and was cleaned and calibrated. A quick review of the recorded data was performed on-site. If it looked like there was a sudden and unusual change in the recorded data, it was assumed that the monitor had malfunctioned and that data was not used. In these instances, the monitor was recalibrated and re-deployed, or replaced with a back-up unit.

<u>Exceptions to continuous monitoring due to monitor malfunction:</u>

1R upper reservoir minisonde:	DO data were not collected July 30 – August 12, 2013.
	No data were collected August 13 – September 3, 2013

Benthic Macroinvertebrate Collection

GLEC collected benthic macroinvertebrate samples at the six Lake Michigan water quality monitoring locations and at the three upper reservoir monitoring locations (Figures 1 and 2). Samples were collected from the Lake Michigan sites on August 12, 2013 and from the upper reservoir sites on September 11, 2013. For each sample collected, a replicate sample at the site was also collected. Samples were collected using a standard ponar dredge which yields approximately one square foot of sediment. To process the samples, collected sediment was rinsed through a 500 micron mesh sieve and the debris and macroinvertebrates remaining on the sieve were placed in 1 Liter jars and preserved with ethanol. Samples were brought back to the GLEC laboratory where macroinvertebrates were identified to a similar level as in the 1978 studies (Duffy and Liston, 1978).

4.0 RESULTS

Water Temperature and Dissolved Oxygen Profiles

Water temperature and DO profiles were collected from all nine study sites (Table 1, Figures 1 and 2) on nine occasions between June 20, 2013 and October 11, 2013 (Tables 2 – 5). Table 2 provides the ranges recorded (from surface to bottom) for water temperature and DO profiles by date. All profile data is also provided as a Microsoft Excel file in Appendix A.

For each sampling date, an average DO and average water temperature were calculated for each site by averaging all the profile data points (Table 3). For all nine study sites, average water temperature increased from June 20 to August 29 and then began to decline from August 29 to October 11 (Table 3). Average DO showed a general decline over the study period for all sites (Table 3).

Mean DO and mean temperature were calculated for each site over the course of the study period by averaging every DO and water temperature data point from every profile taken to delineate a range and mean of DO and water temperature for each site over the course of the study period (Tables 4 and 5). Over the study period, the DO ranged from 8.2 to 11.7 mg/L in the upper reservoir and from 8.2 to 12.8 mg/L in Lake Michigan (Table 4). The mean DO over the study period was slightly lower in the upper reservoir (1R = 9.5 mg/L, 2R = 9.5 mg/L, and 3R = 9.5 mg/L) than in Lake Michigan (Lake MI 1 = 9.9 mg/L, Lake MI 2 = 9.7 mg/L, Lake MI 3 = 9.8 mg/L, Lake MI 4 = 10.0 mg/L, Lake MI 5 = 9.8 mg/L, and Lake MI 6 = 9.7 mg/L (Table 4)). Water temperature ranged from 11.0 to 21.6 °C in the upper reservoir and from 5.2 to 22.8 °C in Lake Michigan (Table 5).

Water Temperature Statistical Analyses

Results of statistical analyses performed on water temperature data collected as part of this study are provided as a Microsoft Excel file in Appendix B.

Means of the difference between surface and bottom temperatures were statistically significant among the Lake Michigan stations ($P < 0.001$, two-way ANOVA), and directly associated with depth of sample site (Figure 3). Mean differences ranged from less than 2 °C at Lake MI 2 (5.9 m) to greater than 7 °C at Lake MI 4 (19.0 m) (Figure 3). Differences between surface and bottom water temperature at sites within the reservoir were relatively small despite greater depth, averaging 1.3 °C at Site 1R (20 meters), 1.3 °C at Site 2R (20 meters), and 0.9°C at site 3R (25 meters) (Appendix B). Means of surface water temperature were not significantly different among the Lake Michigan stations ($P = 0.14$, two-way ANOVA, Figure 4). However, when examining data from individual sampling dates, the surface temperatures from those sites nearest the plant tailrace (Lake MI 3 and Lake MI 5) on the first sampling date (6/20/2013) were more similar to those measured in the reservoir than to other lake sites (Figure 5). Moreover, Lake MI 3 and Lake MI 5 were the only Lake Michigan stations showing no stratification on that date, as indicated by the small differences between surface and bottom temperatures for that date shown in Figure 6. Such an apparent plant effect was not observed on any other sampling date.

While sampling on 9/11/2013 the plant was undergoing scheduled maintenance and so no water was released from the reservoir on that day. Nearly homogeneous water temperatures, both with depth and among Lake Michigan stations, were recorded on that date. However, this condition was also observed on the last sampling date (10/11/2013) when the plant was in operation (Figures 5 and 6).

Dissolved Oxygen Statistical Analyses

Results of statistical analyses performed on DO data collected as part of this study are provided as a Microsoft Excel file in Appendix B.

The minimum DO reading throughout the study was 8.2 mg/L taken at the surface of Lake MI 4 (the deepest site) on 8/12/2013. Means of surface to bottom DO differences were not found to be statistically different among the stations (Figure 7) but the pattern mimics that seen with temperature, where it is associated with depth (Figure 3). Mean differences did not exceed 1 mg/L (Figure 7) with a maximum observed difference of 3.0 mg/L at Lake MI 1 (the control site) on 7/15/2013 where the surface reading was 9.4 mg/L and the bottom reading was 12.5 mg/L. Mean surface DO was nearly identical among all sites (around 9.6 mg/L) (Figure 8), including sites in the upper reservoir. Surface DO data from 6/20/2013 did not exhibit the same pattern of plant influence as surface temperature did. Concentrations measured in the upper reservoir on that date were more similar to Lake Michigan stations 1, 2, 4, 5 than to Lake MI 3 (near the tailrace opening) or Lake MI 6 (Figure 9).

Turbidity

Turbidity data was collected from all nine study sites (Table 1, Figures 1-2) on nine occasions between June 20, 2013 and October 11, 2013 (Tables 3 and 6). All turbidity data is also provided as a Microsoft Excel file in Appendix A.

For each sampling date, an average turbidity was calculated for each site by averaging results from a measurement taken 1 meter below surface and a measurement taken 1 meter above the bottom (Table 3). Using this method, no trend in average turbidity over time was detected over the course of the study period (Table 3).

Mean turbidity was calculated for each site over the course of the study.The range and mean of turbidity for each site is shown in Table 6. Over the study period, turbidity readings ranged from 0.08 to 0.91 NTU. Mean turbidity was less than 0.4 NTU at all sites (Figure 10) and values were not significantly different (two-way ANOVA P = 0.27, Appendix B).

Continuous Recording of Water Temperature and Dissolved Oxygen

Water quality data collected by Hydrolab Minisondes throughout the monitoring period are provided as a Microsoft Excel file in Appendix C.

Water temperature and DO measurements were recorded on an hourly basis between June 21 and October 7-10, 2013 at two locations near the fish net (northwest and southwest corners) in Lake Michigan and at one location in section 1R of the upper reservoir, with some exceptions (noted above). An average water temperature and DO were calculated for each day of the study period and were plotted together for the time period overlapping the study in order to identify any trends among the data.

When the daily average surface water temperatures from both the Lake Michigan minisondes were plotted with the daily average surface water temperatures from the upper reservoir minisonde, reservoir temperatures temporally tracked temperatures in Lake Michigan, except when there was no pumping or generating (Figure 11). Reservoir temperatures did not vary as greatly as Lake Michigan temperatures, which suggests that lake conditions and weather influence changes in lake water temperature more so than water released from the reservoir.

Because DO is generally an inverse function of temperature, the DO values show a similar pattern of temporal offset between lake and reservoir changes (Figure 12).

Continuous water temperature and DO data were also plotted against average daily air temperature obtained from Weather Underground (www.wunderground.com/history and as a Microsoft Excel file in Appendix D). For all locations monitored with a MiniSonde, increased air temperature appears to precede an increase in average daily water temperature (Figures 13 - 15).

Water Temperature and DO data were plotted against precipitation data, but no trends were observed between average water temperature, average DO, and daily precipitation totals (Appendix C).

Benthic Macroinvertebrate Collection

An investigative benthic macroinvertebrate sample and a replicate were collected from the six Lake Michigan water quality monitoring sites on August 12, 2013 and from the three upper reservoir water quality monitoring sites on September 11, 2013. The total number of organisms recovered per site, and the percent total for each taxa per site can be found in Table 7.

In Lake Michigan, Chironomidae was the dominant taxa at sites 1, 2, 3, and 6 where it made up between 41.1% and 67.7% of the total organisms found (Table 1, Figure 20). Lake Michigan site 4 (deep water site) was dominated by Dreissenidae which made up between 59.3% and 87.7% of the total organisms found. Oligochaeta was the dominant taxa at Lake Michigan site 5 where it made up between 64.9% and 69.0% of the total organisms found. Lake Michigan site 1 (the control site) exhibited the greatest diversity with eight individual taxa identified (Table 7, Figure 16).

In the upper reservoir, sites 1R and 2R were dominated by Dreissenidae (31.5% to 71.6% of total organisms found) and Oligochaeta (24.1% to 51.7% of total organism found) (Table 7, Figure 16). The number of organisms recovered from site 3R in the upper reservoir were an order of magnitude greater than the number recovered at any of the Lake Michigan sites and more than twice the number found at the upper reservoir site 2R (Figure 16). Collections from upper reservoir site 3R exhibited a level of diversity comparable to Lake Michigan site 1 (eight taxa) though half of the taxa were different, including a notable number of amphipods (Table 7).

5.0 DISCUSSION AND SUMMARY

Water quality data were collected by GLEC for Consumers Energy Company at the LPSP in order to compare current conditions to historic water quality analyses conducted during plant start-up. Data collected included water temperature and DO profiles at six sites in Lake Michigan and three sites in the

upper reservoir, near surface and near bottom turbidity measurements at each of the Lake Michigan and upper reservoir sites, continuous hourly monitoring of water temperature and DO at two locations in Lake Michigan and one location in the upper reservoir, and macroinvertebrate community data at six sites in Lake Michigan and three sites in the upper reservoir.
Using trends in profile data, we were able to identify similarities and, in other instances, differences when we compared the Lake Michigan sites to each other and when we compared the Lake Michigan sites to the upper reservoir sites. The data shows that the upper reservoir rarely thermally stratifies. Site 1R in the upper reservoir showed stratification once over the study period (on July 15, 2013) while sites 2R and 3R were never stratified (Table 2). More instances of thermal stratification were observed in the Lake Michigan sites (Table 2):

- Lake Michigan sites 1 and 4 showed stratification in seven out of nine visits
- Lake Michigan site 5 showed stratification in five out of nine visits
- Lake Michigan sites 2 and 3 showed stratification in four out of nine visits
- Lake Michigan site 6 showed stratification in three out of nine visits

Over the course of the study, thermal stratification was observed fewer times at Lake Michigan sites 6, 2, and 3. Sites 2 and 6 are the two most shallow of the Lake Michigan sites so wave action is likely responsible for more mixing of the water and consequently a more homogeneous water temperature was observed at these locations (Table 1). Lake Michigan sites 1 and 4 showed stratification the most often over the course of the study period probably because these are the two deepest sites and are less impacted by wave action near the shore (Table 1). Additionally, these two sites are the furthest away from the plant outlet and consequently less likely to be influenced by water released from the upper reservoir (Figure 1). Sites 5 and 3 showed stratification during five and four (respectively) out of nine visits. Both of these sites are approximately the same depth (11.3 and 11.1 meters) and are the two closest sites to the plant outlet (Table 1, Figure 1). Stratification at these sites is more likely to be influenced by water released from the upper reservoir than it is at sites 1, 2, 4 and 6.

Over the study period, the water temperature in Lake Michigan ranged from a minimum of 5-6 °C to a maximum of 21-22 °C, while the water temperature in the upper reservoir ranged from a minimum of 11 °C to a maximum of 21 °C (Table 5). The water temperature in the upper reservoir was generally warmer than the water temperature in Lake Michigan due to constant mixing in the upper reservoir and instances of stratification in Lake Michigan. DO ranged from 8-12 mg/L in Lake Michigan and from 8-11 mg/L in the upper reservoir (Table 4). The maximum DO in the upper reservoir was likely not as high due to the fact that we observed warmer water temperatures in the upper reservoir than we did in Lake Michigan, leading to lowered dissolved oxygen capacity in the warmer water.

While data from one sampling event suggested that water released from the reservoir may influence lake water temperatures (and consequently DO levels), the continuous minisonde data clearly shows that the reservoir water quality tracks the changes in lake conditions, dampened by its existing state. Changes in temperature/dissolved oxygen in the inshore areas appear primarily driven by natural lake/ weather conditions making it difficult to determine any plant impacts.

Turbidity values for all six sites in Lake Michigan and all three sites in the upper reservoir were less than 1.0 NTU over the course of the study period which fall below the limits typically set for recreational uses. Mean turbidity values were largest for the reservoir sites nearest the intakes, possibly due to greater mixing. However, these means were not statistically significant from other sites and not consistently highest.

Results from the limited macroinvertebrate sampling showed organisms were much more abundant at sites 3R and 2R in the upper reservoir, heavily dominated by Dreissenidae (zebra/quagga mussels) and Oligochaeta (Table 7, Figure 16). Similar composition was found at the Lake Michigan deep water site 4, but smaller in magnitude. Chironomidae and Oligochaeta were the dominant taxa at all other Lake Michigan sites where they made up between 59 and 100 percent of the total organisms found (Table 7, Figure 16). . The Lake Michigan control site 1 and the resevior site 3R exhibited more diversity in taxa than other sites but with different minor taxa. With the exception of the presence of the exotic invasive dreissenids, these results are consistent with the historic pre/post operational studies (Duffy and Liston 1978a&b). These studies concluded that the significantly greater benthic abundance in the reservoir was attributable to more favorable current and substrate, depth and organic enrichment.

6.0 LITERATURE CITED

Duffy, W.G., Liston, C.R. 1978a. An Analysis of the Percentage Composition and Abundance of Benthic Macroinvertebrates in Lake Michigan Adjacent to the Ludington Pumped Storage Power Plant, 1972-1976 (1976 Annual Report, Ludington Project Volume II, Number 1, Limnological Research). Michigan State University: Department of Fisheries and Wildlife.

Duffy, W.G., Liston, C.R. 1978b. The Appearance and Colonization of Benthic Macroinvertebrates in the New Ludington Pumped Storage Reservoir during the First Five Years of Power Plant Operation (1977 Annual Report, Ludington Project, Volume I, Number 1, Limnological Research). Michigan State University: Department of Fisheries and Wildlife.

Liston, C.R., Brazo, D.C., and Tack, P.I. 1976. A Study of the Effects of Installing and Operating a Large Pumped Storage Project on the Shores of Lake Michigan near Ludington, Michigan (1974 Annual Report, Volume II and Twelfth Quarterly Report Physical-Chemical Aspects, 1972-1974). Michigan State University: Department of Fisheries and Wildlife.

7.0 FIGURES

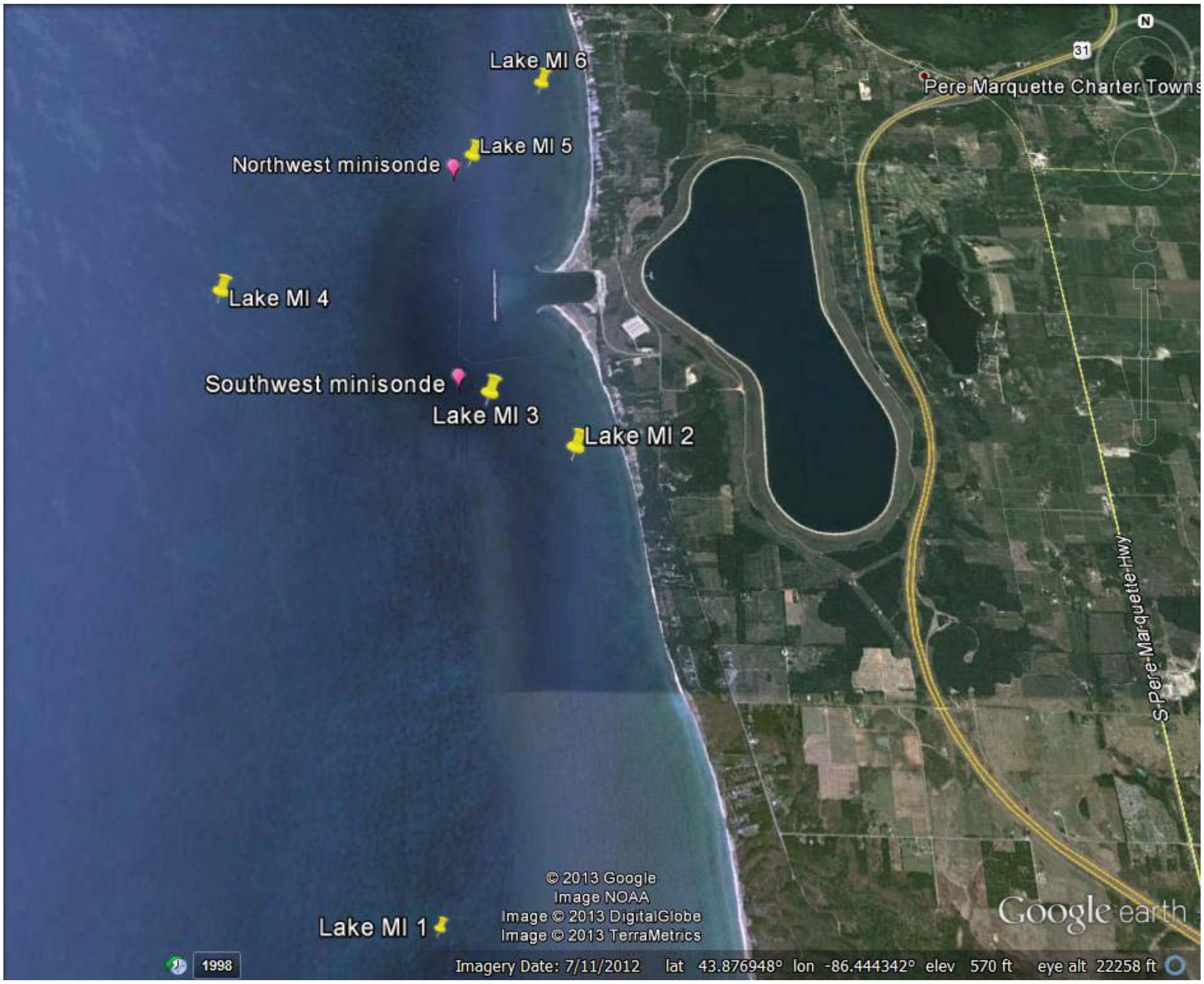

Figure 1. Map of Six Lake Michigan Sampling Sites and Two Lake Michigan (Northwest and Southwest) Hydrolab Minisonde Deployment Locations.

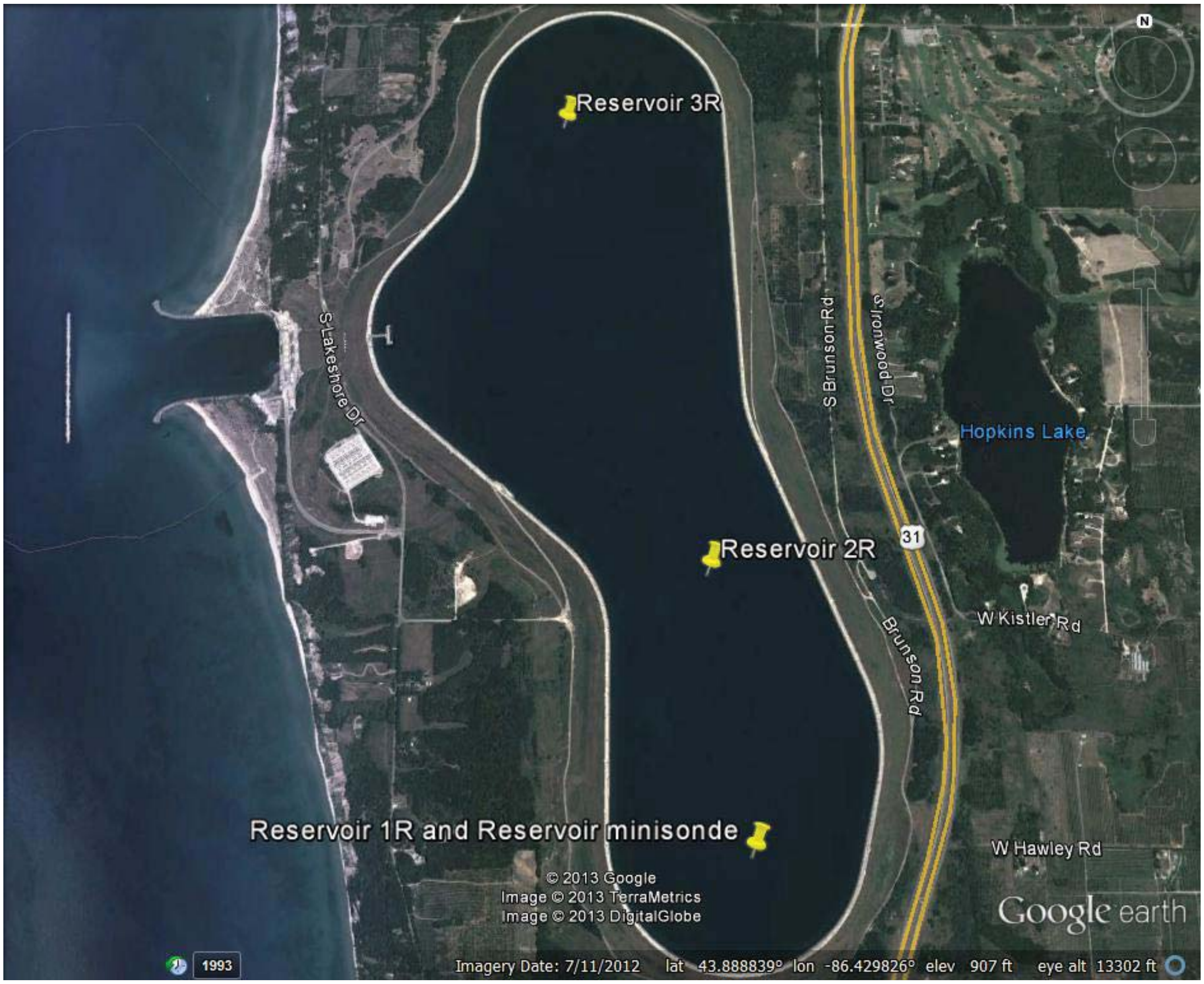

Figure 2. Map of Three Upper Reservoir Sampling Sites and Upper Reservoir Hydrolab Minisonde Deployment Location.

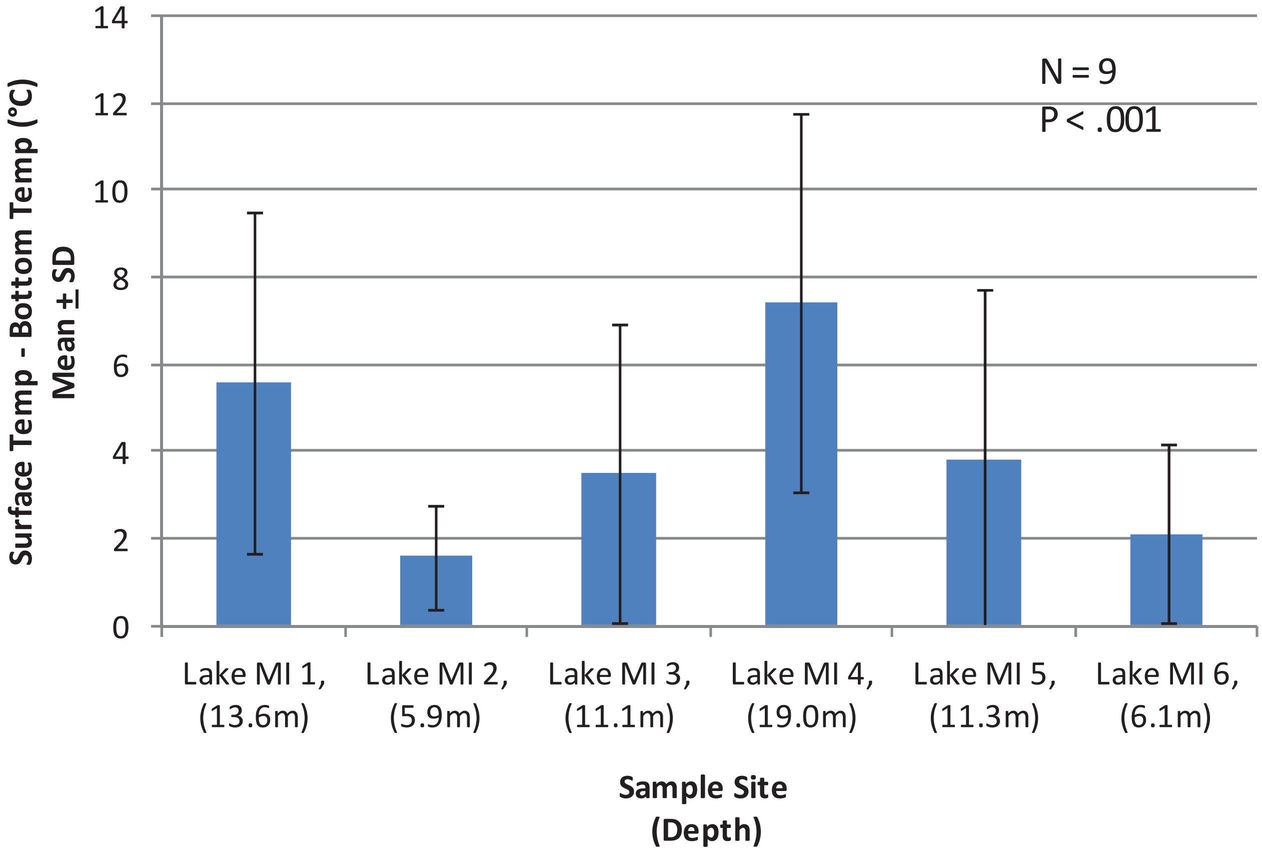

Figure 3. **Mean and Standard Deviation of Surface Temperature Minus Bottom Temperature for Six Lake Michigan Sampling Sites.**

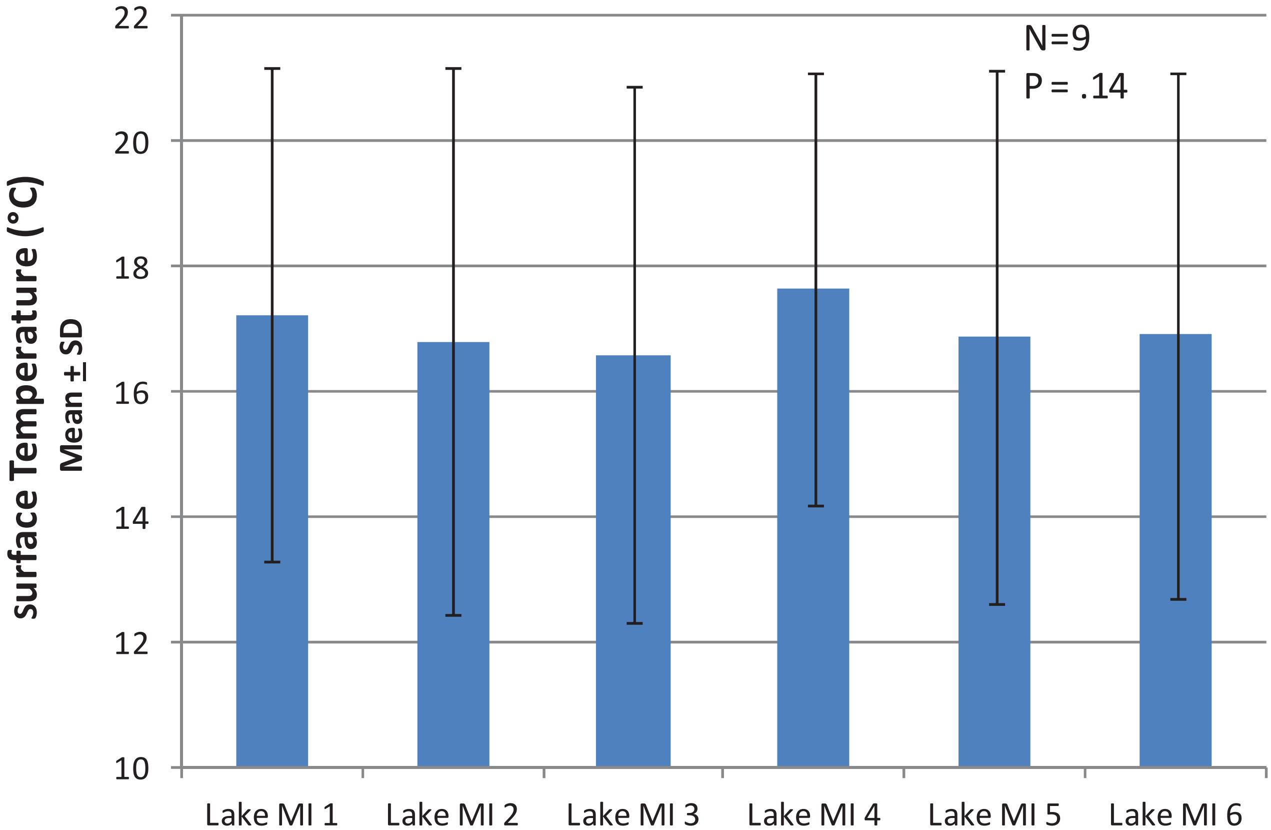

Figure 4. Mean and Standard Deviation of Surface Temperature for Six Lake Michigan Sampling Sites.

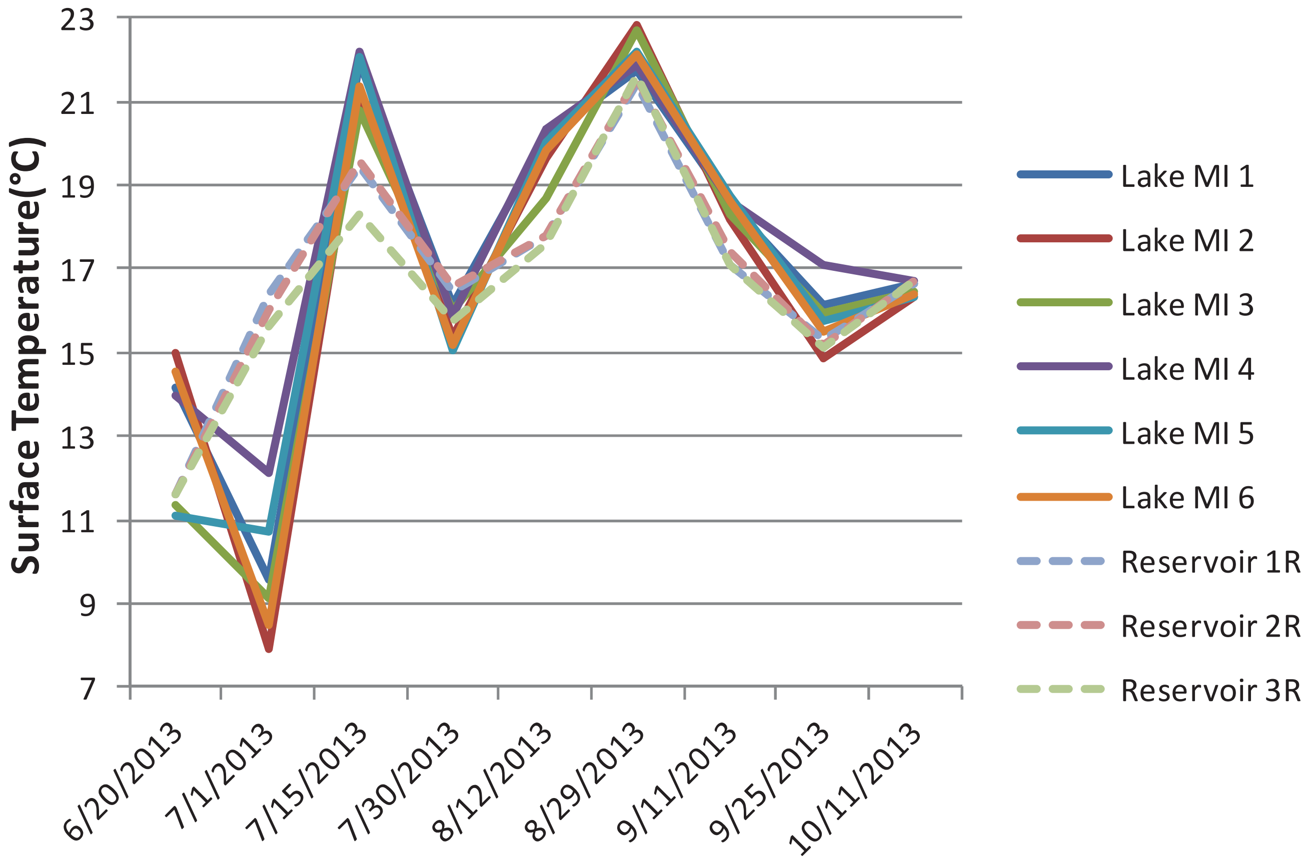

Figure 5. **Surface Temperature for Six Lake Michigan and Three Upper Reservoir Sampling Sites.**

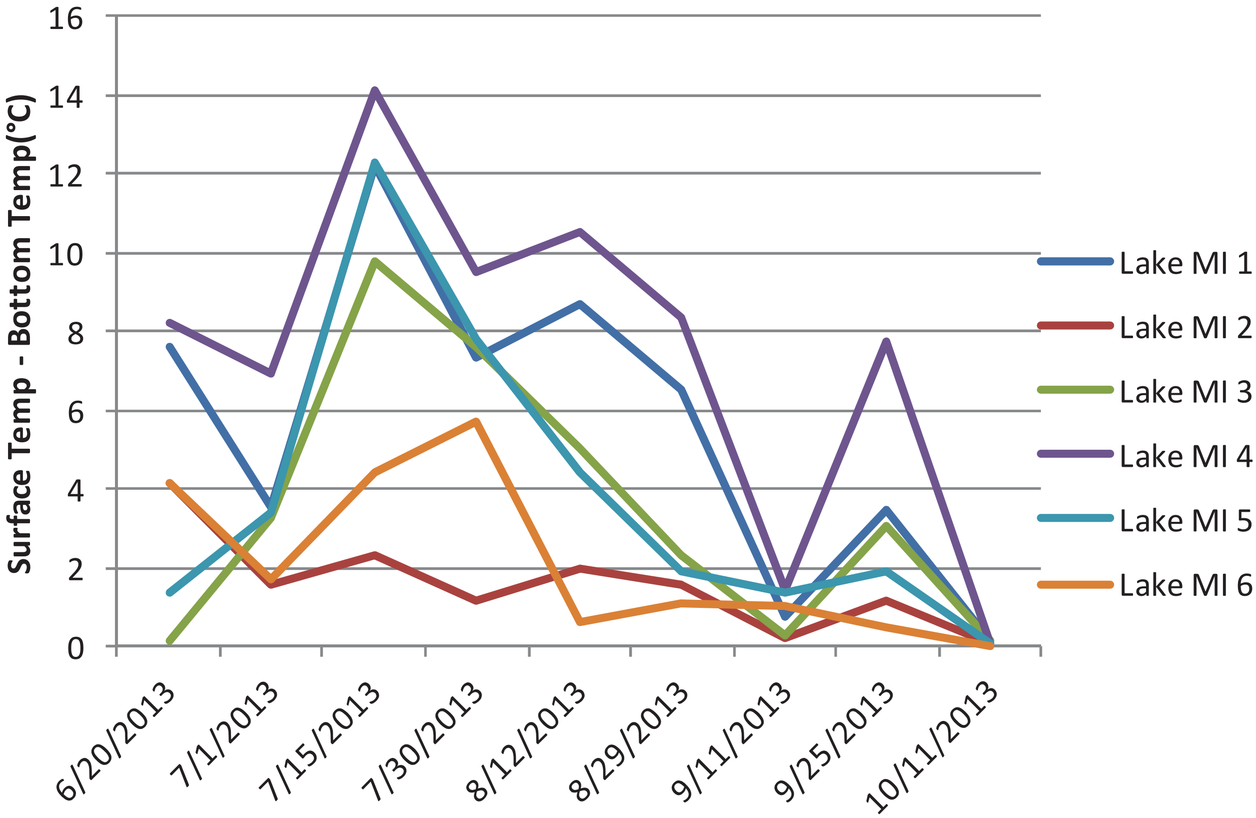

Figure 6. Surface Temperature Minus Bottom Temperature for Six Lake Michigan Sampling Sites.

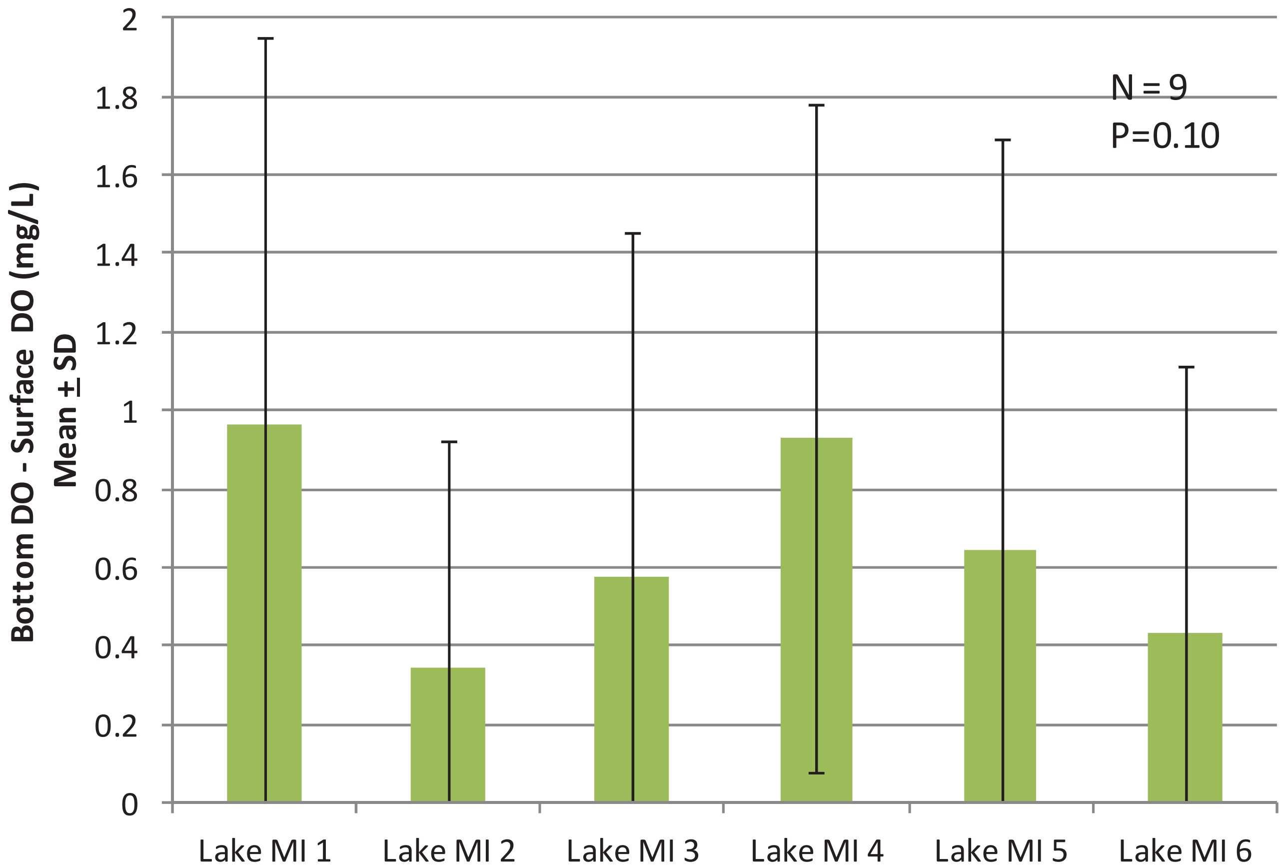

Figure 7. **Mean and Standard Deviation of Bottom Dissolved Oxygen Minus Surface Dissolved Oxygen for Six Lake Michigan Sampling Sites.**

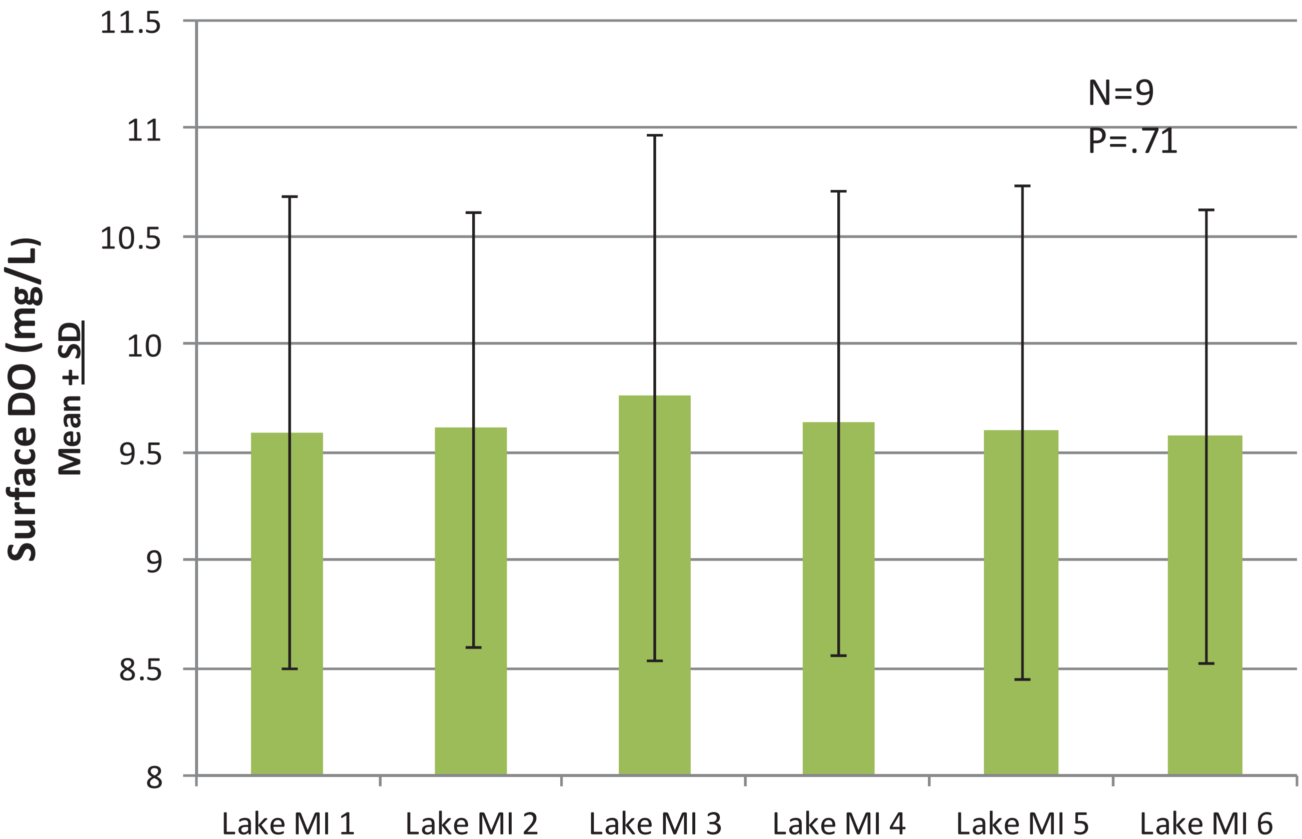

Figure 8. Mean and Standard Deviation of Surface Dissolved Oxygen for Six Lake Michigan Sampling Sites.

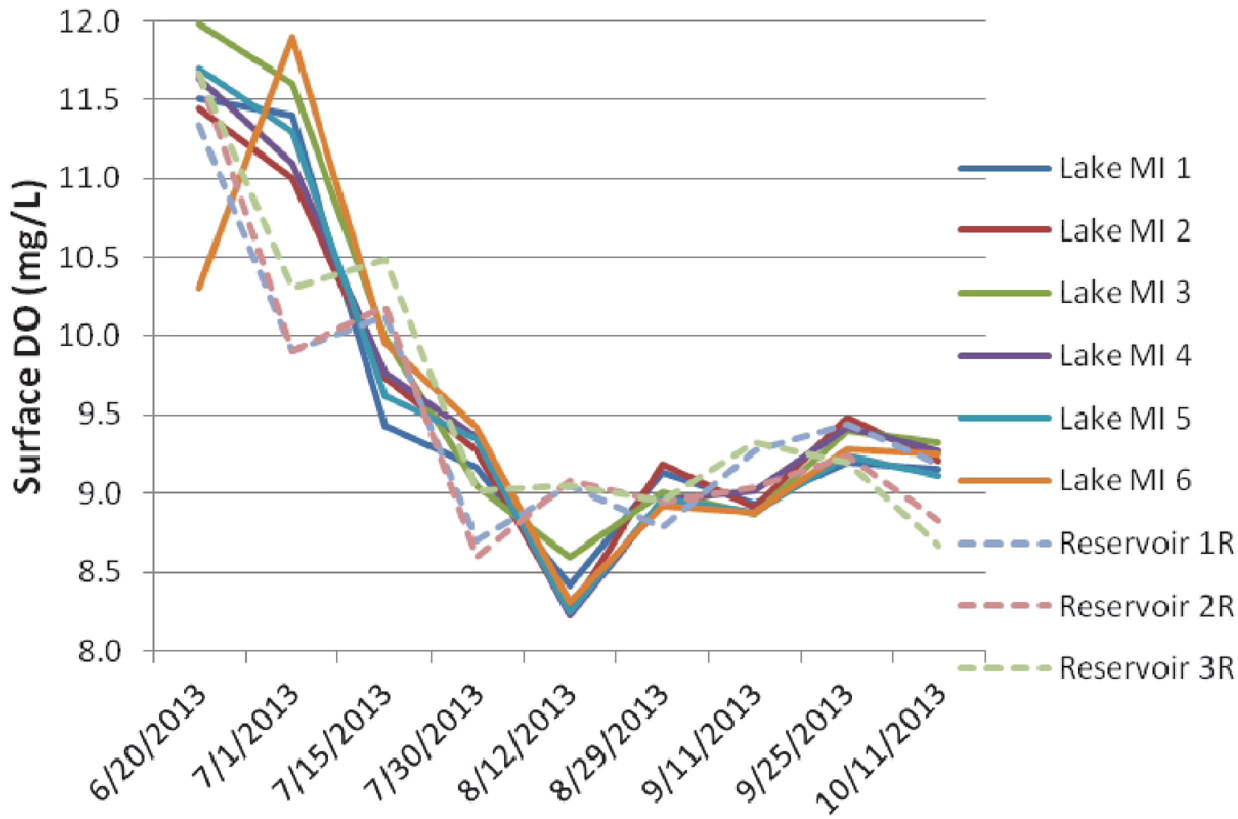

Figure 9. Surface Dissolved Oxygen for Six Lake Michigan and Three Upper Reservoir Sampling Sites.

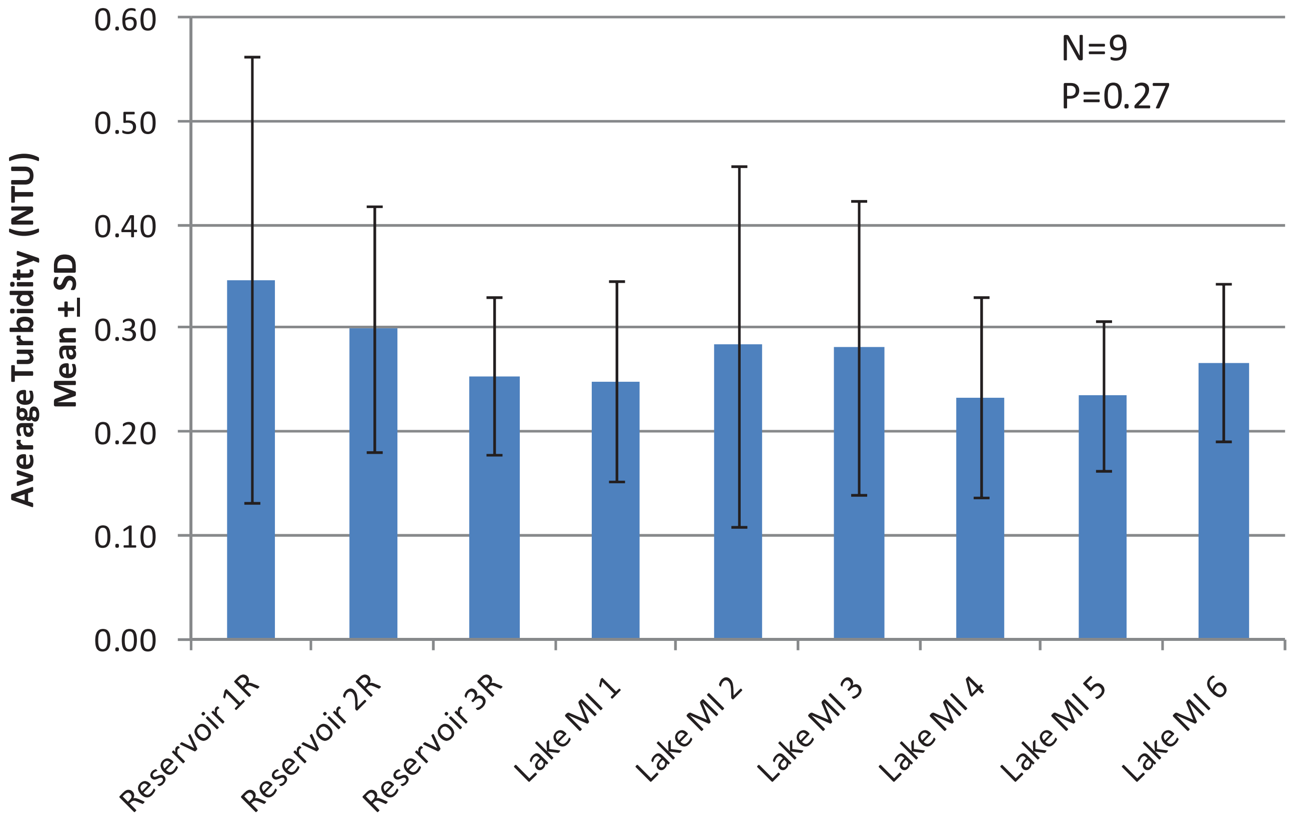

Figure 10. Mean and Standard Deviation of Average Turbidity (NTU) for Six Lake Michigan and Three Upper Reservoir Sampling Sites.

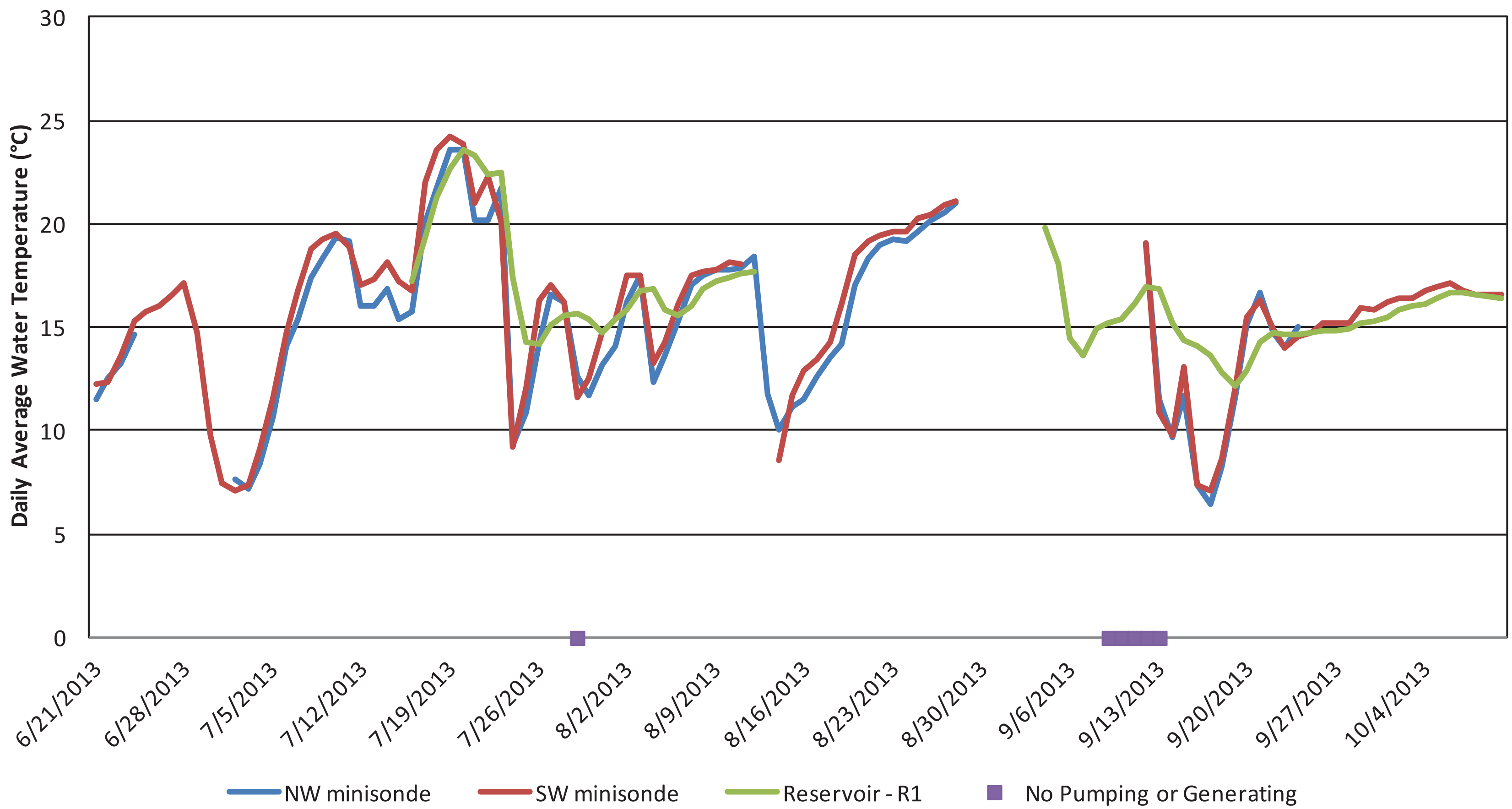

Figure 11. **Daily Average Water Temperature Measured at the Northwest Minisonde, Southwest Minisonde, and Upper Reservoir Minisonde.**

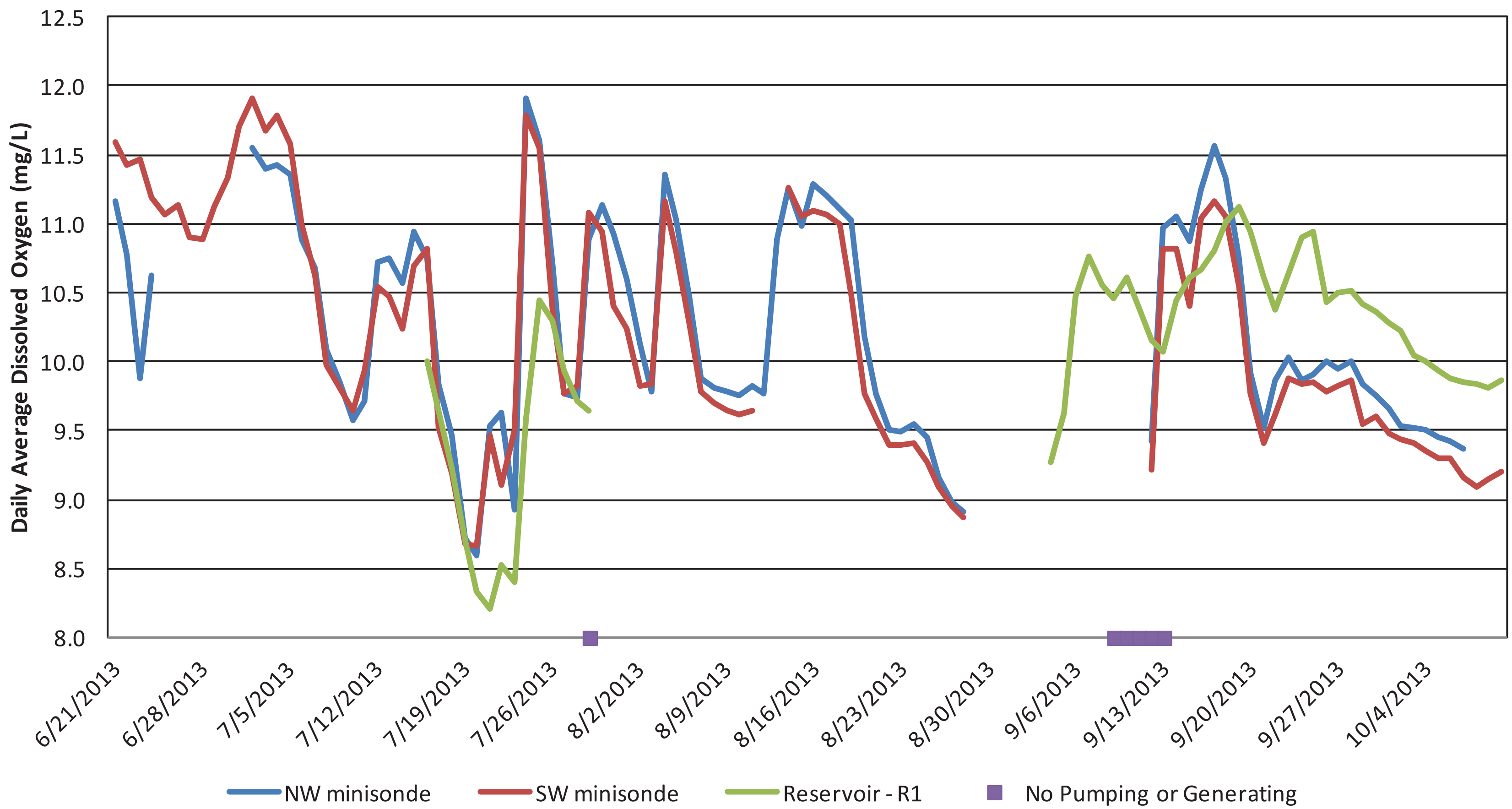

Figure 12. **Daily Average Dissolved Oxygen Measured at the Northwest Minisonde, Southwest Minisonde, and Upper Reservoir Minisonde.**

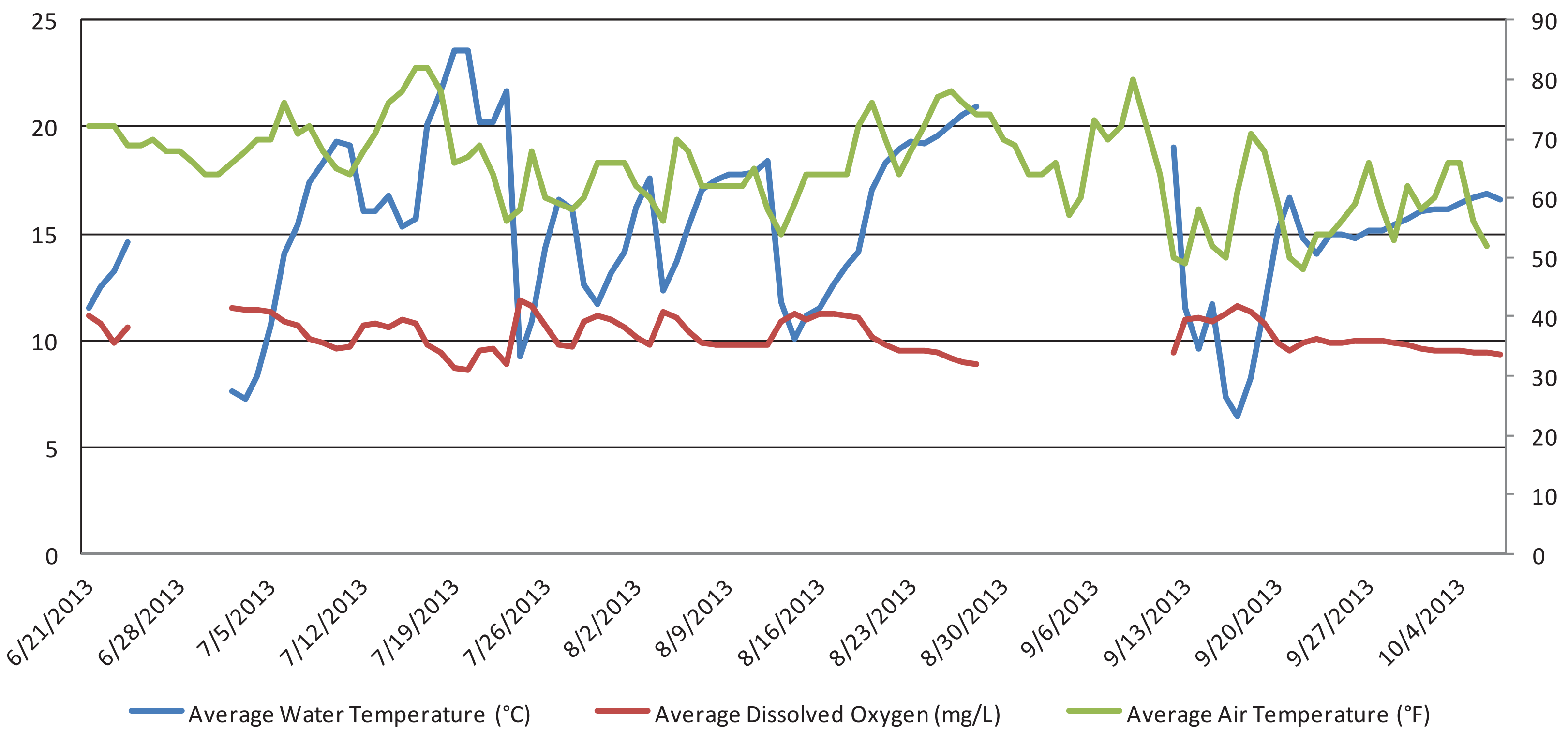

Figure 13. Northwest Minisonde: Water Temperature and Dissolved Oxygen Plotted Against Average Daily Air Temperature.

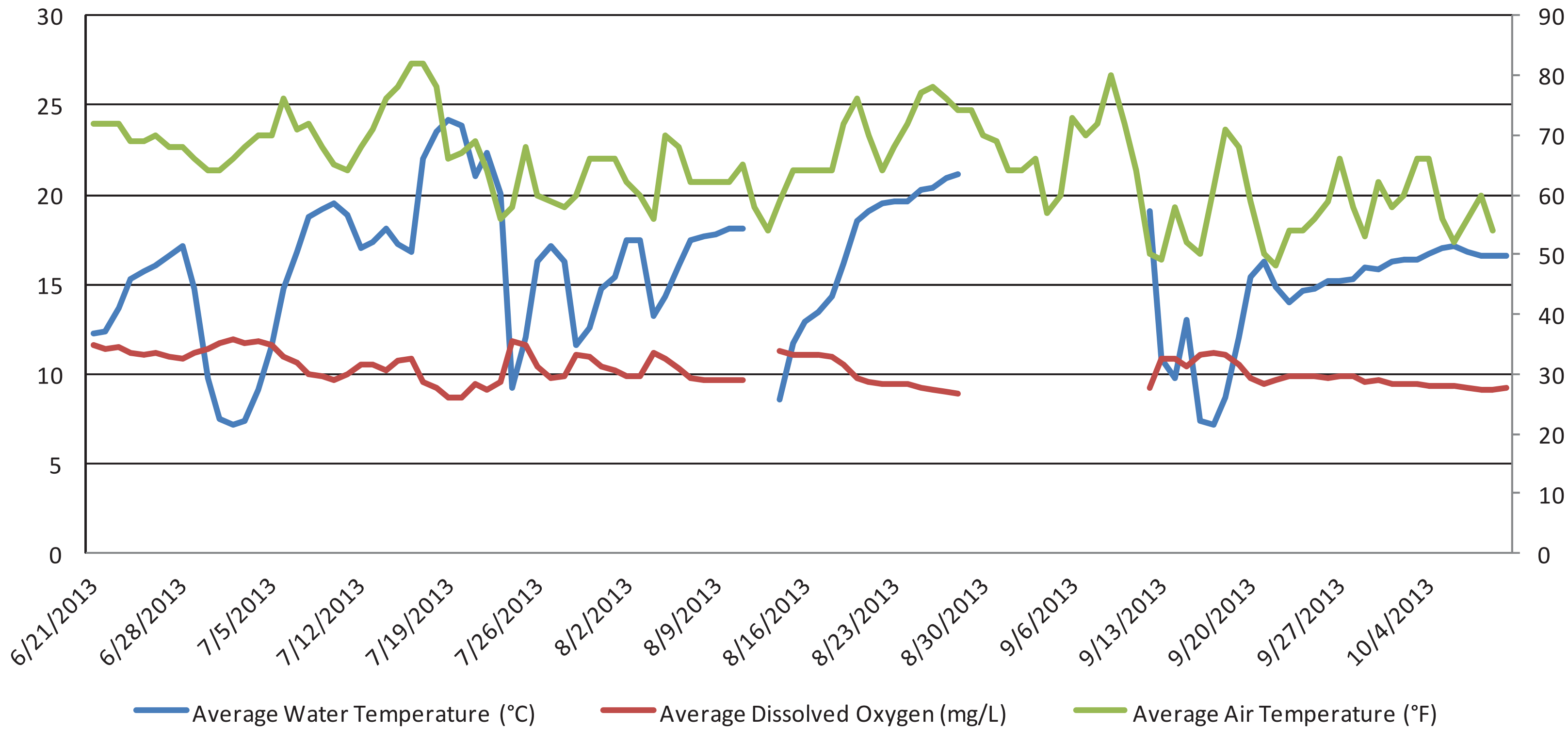

Figure 14. Southwest Minisonde: Water Temperature and Dissolved Oxygen Plotted Against Average Daily Air Temperature.

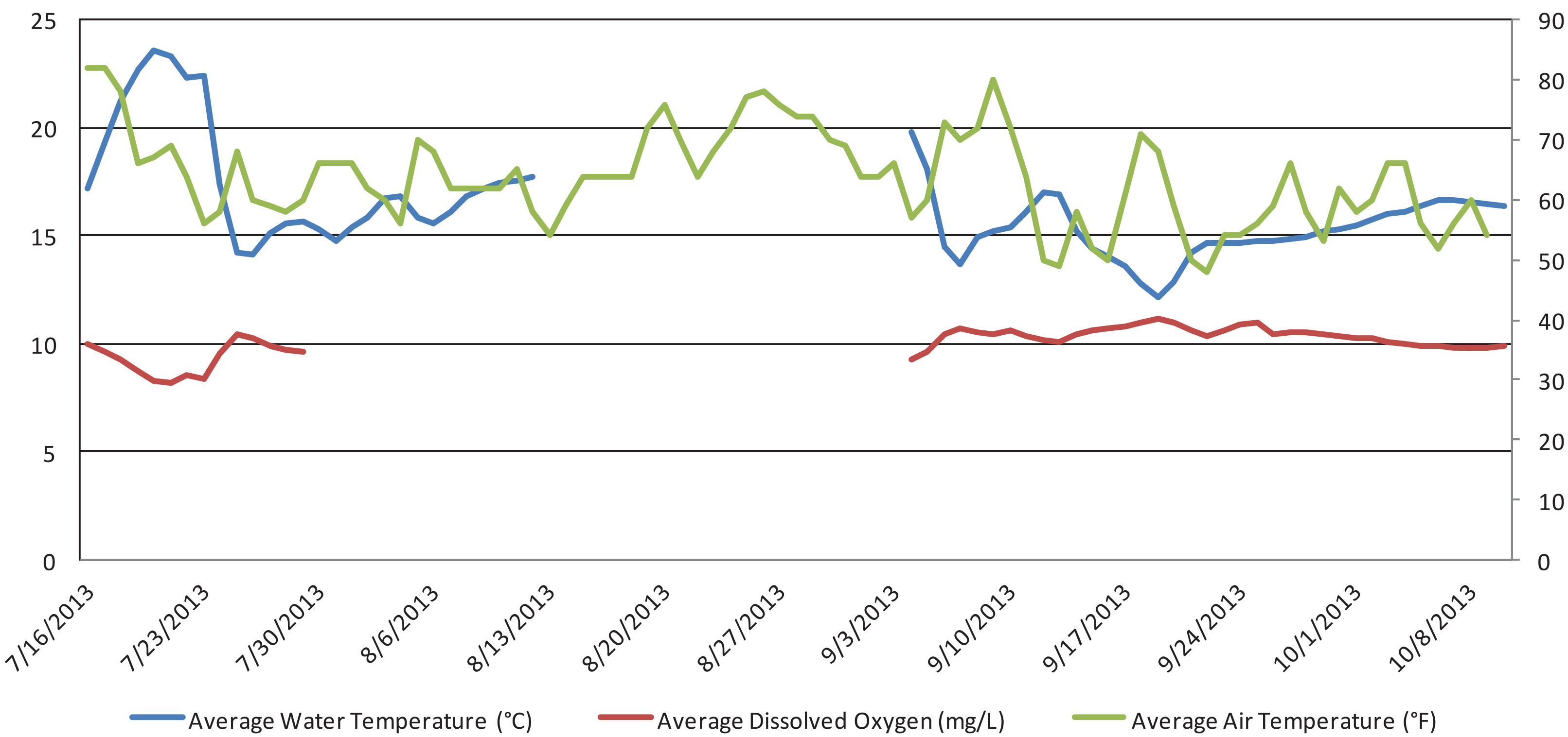

Figure 15. Upper Reservoir Minisonde: Water Temperature and Dissolved Oxygen Plotted Against Average Daily Air Temperature.

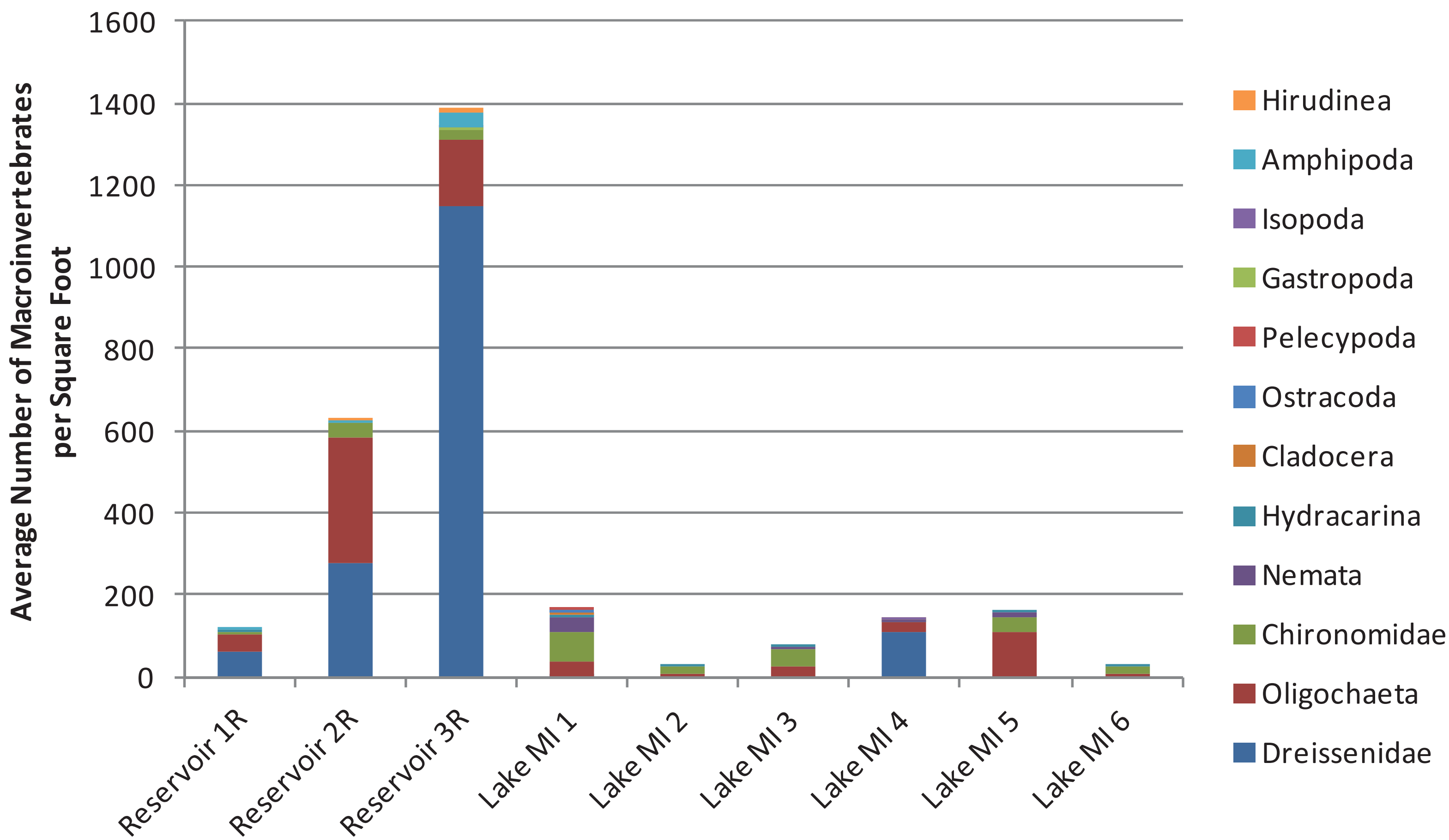

Figure 16. **Average Number of Macroinvertebrates Collected per Square Foot for Six Lake Michigan and Three Upper Reservoir Sampling Sites.**

8.0 TABLES

Table 1. Description of Sampling Stations and Minisonde Locations.

Station	Latitude	Longitude	Depth (m)*
Lake Michigan 1	43.850000	-86.455556	13.6
Lake Michigan 2	43.879167	-86.447222	5.9
Lake Michigan 3	43.883350	-86.455533	11.1
Lake Michigan 4	43.891667	-86.483333	19.0
Lake Michigan 5	43.905556	-86.459722	11.3
Lake Michigan 6	43.913889	-86.452778	6.1
Reservoir 1R	43.877180	-86.423330	20.0
Reservoir 2R	43.886040	-86.425060	19.9
Reservoir 3R	43.901890	-86.431700	24.8
Lake Michigan NW minisonde	43.904050	-86.461170	11.0
Lake Michigan SW minisonde	43.884570	-86.458230	11.0
Reservoir 1R minisonde	43.877180	-86.423330	20.0

*For Lake Michigan and Reservoir sites, depth is an average based on maximum depth measured during profiles. For minisonde sites, depth is based on one measurement taken at minisonde deployment.

Table 2. Dissolved Oxygen and Water Temperature Readings at the Surface and Bottom of Profiles.

Station 1R

	DO Surface	DO Bottom	Water Temp Surface	Water Temp Bottom
6/21/2013	11.3	11.4	11.64	11.01
7/1/2013	9.9	9.9	16.40	12.80
7/15/2013	10.1	10.1	19.45	17.24
7/30/2013	8.7	8.7	16.47	14.78
8/13/2013	9.1	9.0	17.78	17.36
8/29/2013	8.8	8.5	21.44	20.97
9/11/2013	9.3	9.3	17.11	15.87
9/25/2013	9.4	9.2	15.33	14.67
10/11/2013	9.2	8.6	16.64	16.35

Station 2R

	DO Surface	DO Bottom	Water Temp Surface	Water Temp Bottom
6/21/2013	11.7	11.3	11.59	11.01
7/1/2013	9.9	9.8	16.00	13.00
7/15/2013	10.2	10.1	19.56	17.24
7/30/2013	8.6	8.6	16.60	14.82
8/13/2013	9.1	9.1	17.78	16.89
8/29/2013	8.9	8.4	21.58	20.96
9/11/2013	9.0	9.8	17.38	15.98
9/25/2013	9.2	9.2	15.17	14.66
10/11/2013	8.8	8.5	16.68	16.35

Table 2. (cont'd). Dissolved Oxygen and Water Temperature Readings at the Surface and Bottom of Profiles.

Station 3R

	DO Surface	DO Bottom	Water Temp Surface	Water Temp Bottom
6/21/2013	11.7	11.2	11.62	11.50
7/1/2013	10.3	9.7	15.60	12.80
7/15/2013	10.5	10.1	18.30	17.14
7/30/2013	9.0	8.8	15.78	14.59
8/13/2013	9.1	9.0	17.62	16.92
8/29/2013	9.0	8.2	21.62	21.04
9/11/2013	9.3	9.2	17.07	16.15
9/25/2013	9.2	9.0	15.10	14.65
10/11/2013	8.7	8.5	16.72	16.41

Lake Michigan Station 1

	DO Surface	DO Bottom	Water Temp Surface	Water Temp Bottom
6/20/2013	11.5	12.6	14.16	6.58
7/1/2013	11.4	11.3	9.56	6.00
7/15/2013	9.4	12.5	21.96	9.70
7/30/2013	9.2	10.6	16.11	8.74
8/12/2013	8.4	9.7	20.18	11.50
8/29/2013	9.1	10.3	21.72	15.19
9/11/2013	8.9	9.1	18.57	17.81
9/25/2013	9.2	10.0	16.12	12.65
10/11/2013	9.2	9.0	16.67	16.52

Table 2. (cont'd). Dissolved Oxygen and Water Temperature Readings at the Surface and Bottom of Profiles.

Lake Michigan Station 2

	DO Surface	DO Bottom	Water Temp Surface	Water Temp Bottom
6/20/2013	11.5	12.5	15.01	10.85
7/1/2013	11.0	11.4	7.90	6.30
7/15/2013	9.7	10.7	21.21	18.92
7/30/2013	9.3	9.5	15.36	14.21
8/12/2013	8.3	9.3	19.65	17.64
8/29/2013	9.2	8.6	22.80	21.20
9/11/2013	8.9	8.9	18.20	18.00
9/25/2013	9.5	9.8	14.83	13.65
10/11/2013	9.2	9.0	16.32	16.26

Lake Michigan Station 3

	DO Surface	DO Bottom	Water Temp Surface	Water Temp Bottom
6/20/2013	12.0	11.8	11.36	11.19
7/1/2013	11.6	11.6	9.10	5.80
7/15/2013	10.0	12.0	20.76	11.00
7/30/2013	9.1	10.8	15.98	8.36
8/12/2013	8.6	9.8	18.69	13.67
8/29/2013	9.0	9.2	22.72	20.39
9/11/2013	8.9	8.9	18.29	18.03
9/25/2013	9.4	10.0	15.94	12.89
10/11/2013	9.3	8.9	16.44	16.32

Table 2. (cont'd). Dissolved Oxygen and Water Temperature Readings at the Surface and Bottom of Profiles.

Lake Michigan Station 4

	DO Surface	DO Bottom	Water Temp Surface	Water Temp Bottom
6/20/2013	11.6	12.8	13.97	5.72
7/1/2013	11.1	11.3	12.10	5.20
7/15/2013	9.8	11.7	22.22	8.10
7/30/2013	9.4	10.8	15.86	6.32
8/12/2013	8.2	9.5	20.37	9.83
8/29/2013	9.0	10.9	21.87	13.53
9/11/2013	9.0	9.1	18.59	17.14
9/25/2013	9.4	10.3	17.09	9.34
10/11/2013	9.3	8.8	16.68	16.62

Lake Michigan Station 5

	DO Surface	DO Bottom	Water Temp Surface	Water Temp Bottom
6/20/2013	11.7	12.1	11.08	9.69
7/1/2013	11.3	11.5	10.70	7.30
7/15/2013	9.6	12.5	22.08	9.80
7/30/2013	9.3	10.9	15.03	7.20
8/12/2013	8.3	9.2	20.05	15.60
8/29/2013	9.0	8.3	22.16	20.26
9/11/2013	8.9	9.1	18.76	17.42
9/25/2013	9.2	9.8	15.75	13.83
10/11/2013	9.1	8.8	16.35	16.30

Table 2. (cont'd). Dissolved Oxygen and Water Temperature Readings at the Surface and Bottom of Profiles.

Lake Michigan Station 6

	DO Surface	DO Bottom	Water Temp Surface	Water Temp Bottom
6/20/2013	10.3	11.8	14.56	10.43
7/1/2013	11.9	11.8	8.50	6.80
7/15/2013	10.0	10.7	21.37	16.97
7/30/2013	9.4	11.0	15.17	9.47
8/12/2013	8.3	8.5	19.86	19.24
8/29/2013	8.9	9.0	22.14	21.05
9/11/2013	8.9	9.0	18.59	17.58
9/25/2013	9.3	9.4	15.52	15.02
10/11/2013	9.3	8.9	16.41	16.41

Table 3. Summary of Average Dissolved Oxygen, Temperature, and Turbidity for Each Site Using Data Obtained During Profile Measurements.

Station 1R

	Avg DO	Avg Temp	Avg Turbidity
6/21/2013	11.3	11.39	0.33
7/1/2013	10.0	14.15	0.49

7/15/2013	10.2	17.73	0.14
7/30/2013	8.7	15.19	0.27
8/13/2013	9.0	17.67	0.30
8/29/2013	8.5	21.09	0.55
9/11/2013	9.2	16.44	0.32
9/25/2013	9.2	14.80	0.15
10/11/2013	8.7	16.42	0.59

Station 2R

	Avg DO	Avg Temp	Avg Turbidity
6/21/2013	11.3	11.44	0.22
7/1/2013	10.0	14.13	0.41
7/15/2013	10.3	17.71	0.42
7/30/2013	8.6	15.31	0.41
8/13/2013	9.0	17.47	0.27
8/29/2013	8.7	21.13	0.34
9/11/2013	9.1	16.80	0.20
9/25/2013	9.2	14.80	0.21
10/11/2013	8.6	16.42	0.24

Station 3R

	Avg DO	Avg Temp	Avg Turbidity
6/21/2013	11.3	11.53	0.18
7/1/2013	10.0	13.64	0.24
7/15/2013	10.3	17.39	0.33
7/30/2013	8.9	15.13	0.40
8/13/2013	9.0	17.15	0.20
8/29/2013	8.6	21.14	0.24
9/11/2013	9.0	16.81	0.27
9/25/2013	9.1	14.76	0.23
10/11/2013	8.6	16.46	0.22

Table 3. (cont'd). Summary of Average Dissolved Oxygen, Temperature, and Turbidity for Each Site Using Data Obtained During Profile Measurements.

Lake Michigan Station 1

	Avg DO	Avg Temp	Avg Turbidity
6/20/2013	12.0	9.83	0.24
7/1/2013	11.4	7.52	0.15
7/15/2013	11.0	16.02	0.32

7/30/2013	9.4	14.18	0.28
8/12/2013	9.0	16.71	0.22
8/29/2013	9.1	20.19	0.33
9/11/2013	9.0	18.03	0.18
9/25/2013	9.3	14.88	0.33
10/11/2013	9.0	16.59	0.20

Lake Michigan Station 2

	Avg DO	Avg Temp	Avg Turbidity
6/20/2013	12.0	12.05	0.16
7/1/2013	11.2	6.91	0.20
7/15/2013	9.9	19.98	0.18
7/30/2013	9.3	14.73	0.72
8/12/2013	8.5	19.04	0.20
8/29/2013	8.9	21.62	0.22
9/11/2013	8.8	18.14	0.34
9/25/2013	9.6	14.14	0.27
10/11/2013	9.1	16.30	0.27

Lake Michigan Station 3

	Avg DO	Avg Temp	Avg Turbidity
6/20/2013	11.9	11.24	0.35
7/1/2013	11.6	7.40	0.21
7/15/2013	10.7	16.91	0.41
7/30/2013	9.4	14.08	0.40
8/12/2013	8.8	17.18	0.30
8/29/2013	8.8	21.18	0.28
9/11/2013	8.9	18.20	0.18
9/25/2013	9.5	14.47	0.18
10/11/2013	9.0	16.38	0.25

Table 3. (cont'd). Summary of Average Dissolved Oxygen, Temperature, and Turbidity for Each Site Using Data Obtained During Profile Measurements.

Lake Michigan Station 4

	Avg DO	Avg Temp	Avg Turbidity
6/20/2013	12.2	9.01	0.14
7/1/2013	11.3	9.26	0.30
7/15/2013	11.2	13.96	0.35

7/30/2013	10.0	10.87	0.25
8/12/2013	8.9	16.31	0.21
8/29/2013	9.5	18.89	0.37
9/11/2013	9.0	17.98	0.15
9/25/2013	9.3	14.79	0.12
10/11/2013	9.0	16.66	0.23

	Lake Michigan Station 5		
	Avg DO	**Avg Temp**	**Avg Turbidity**
6/20/2013	11.9	10.25	0.16
7/1/2013	11.3	8.79	0.29
7/15/2013	10.9	15.59	0.29
7/30/2013	10.3	10.60	0.25
8/12/2013	8.5	18.77	0.16
8/29/2013	8.7	21.10	0.29
9/11/2013	8.9	18.09	0.21
9/25/2013	9.2	15.39	0.22
10/11/2013	8.9	16.33	0.28

	Lake Michigan Station 6		
	Avg DO	**Avg Temp**	**Avg Turbidity**
6/20/2013	11.4	11.59	0.22
7/1/2013	11.9	7.41	0.19
7/15/2013	10.2	19.09	0.35
7/30/2013	9.8	12.87	0.30
8/12/2013	8.4	19.45	0.19
8/29/2013	8.8	21.44	0.36
9/11/2013	8.9	18.12	0.26
9/25/2013	9.3	15.30	0.24
10/11/2013	9.0	16.41	0.32

Table 4. Descriptive Statistics of Lake Michigan and Reservoir Dissolved Oxygen Readings (mg/L) From June to October 2013*.

	Station								
	Reservoir 1R	**Reservoir 2R**	**Reservoir 3R**	**Lake MI 1**	**Lake MI 2**	**Lake MI 3**	**Lake MI 4**	**Lake MI 5**	**Lake MI 6**
Number of Readings	194	185	229	130	62	110	181	110	65
Range (mg/L)	8.3 - 11.6	8.4 - 11.7	8.2 - 11.7	8.4 - 12.6	8.3 - 12.5	8.5 - 12.0	8.2 - 12.8	8.3 - 12.5	8.3 - 11.9
Mean (mg/L)	9.5	9.5	9.5	9.9	9.7	9.8	10.0	9.8	9.7
Variance	0.88	0.89	0.86	1.58	1.24	1.41	1.70	1.66	1.40
Standard Deviation	0.94	0.95	0.93	1.26	1.11	1.19	1.30	1.29	1.18
Standard Error	0.07	0.07	0.06	0.11	0.14	0.11	0.10	0.12	0.15
Coefficient of Variation	9.9%	10.0%	9.8%	12.7%	11.5%	12.1%	13.0%	13.1%	12.1%

* Sampling dates were June 20-21, July 1, July 15, July 30, August 12-13, August 29, September 11, September 25, and October 11, 2013

Table 5. Descriptive statistics of Lake Michigan and Reservoir Temperature Readings (°C) From June to October 2013*

	Station								
	Reservoir 1R	**Reservoir 2R**	**Reservoir 3R**	**Lake MI 1**	**Lake MI 2**	**Lake MI 3**	**Lake MI 4**	**Lake MI 5**	**Lake MI 6**
Number of Readings	194	185	229	130	62	110	181	110	65
Range (°C)	11.01 - 21.44	11.01 - 21.58	11.48 - 21.62	6.00 - 21.96	6.20 - 22.8	5.80 - 22.72	5.20 - 22.22	7.20 - 22.16	6.80 - 22.21
Mean (°C)	15.97	15.95	15.78	14.97	16.00	15.31	14.20	14.99	15.88
Variance	7.81	7.68	7.13	19.21	19.39	16.97	22.58	20.12	19.21
Standard Deviation	2.80	2.77	2.67	4.38	4.40	4.12	4.75	4.49	4.38
Standard Error	0.20	0.20	0.18	0.38	0.56	0.39	0.35	0.43	0.54
Coefficient of Variation	17.5%	17.4%	16.9%	29.3%	27.5%	26.9%	33.5%	29.9%	27.6%

Table 6. Descriptive statistics of Lake Michigan and Reservoir Turbidity Readings (NTU) From June to October 2013*

Station

	Reservoir 1R	Reservoir 2R	Reservoir 3R	Lake MI 1	Lake MI 2	Lake MI 3	Lake MI 4	Lake MI 5	Lake MI 6
Number of Readings	18	18	18	18	18	18	18	18	18
Range (NTU)	0.13 - 0.91	0.09 - 0.57	0.17 - 0.41	0.09 - 0.43	0.10 - 0.75	0.11 - 0.61	0.09 - 0.38	0.08 - 0.36	0.13 - 0.41
Mean (NTU)	0.35	0.30	0.25	0.25	0.28	0.28	0.23	0.24	0.27
Variance	0.05	0.01	0.01	0.01	0.03	0.02	0.01	0.01	0.01
Standard Deviation	0.21	0.12	0.08	0.10	0.18	0.14	0.10	0.07	0.08
Standard Error	0.05	0.03	0.02	0.02	0.04	0.03	0.02	0.02	0.02
Coefficient of Variation	61.9%	39.2%	29.9%	38.8%	61.9%	50.4%	41.4%	30.8%	28.5%

* Sampling dates were June 20-21, July 1, July 15, July 30, August 12-13, August 29, September 11, September 25, and October 11, 2013

Table 7. Benthic Macroinvertebrate Community Composition (Number Recovered and Percent of Total) from Standard Ponar Grabs, August 12 and September 11, 2013.

	Taxa				
Site	**Dreissenidae**	**Oligochaeta**	**Chironomidae**	**Nemata**	**Hydracarina**
Lake Michigan 1	1 (0.9%)	20 (17.9%)	46 (41.1%)	36 (32.1%)	1 (0.9%)
Lake Michigan 1 Rep	----	50 (23.3%)	105 (48.8%)	38 (17.7%)	3 (1.4%)
Lake Michigan 2	----	10 (32.3%)	21 (67.7%)	----	----
Lake Michigan 2 Rep	----	8 (30.8%)	17 (65.4%)	----	1 (3.8%)
Lake Michigan 3	----	35 (46.1%)	38 (50.0%)	3 (3.9%)	----
Lake Michigan 3 Rep	----	17 (22.4%)	49 (64.5%)	9 (11.8%)	1 (1.3%)
Lake Michigan 4	67 (59.3%)	33 (29.2%)	5 (4.4%)	5 (4.4%)	----
Lake Michigan 4 Rep	150 (87.7%)	14 (8.2%)	2 (1.2%)	1 (0.6%)	----
Lake Michigan 5	1 (0.6%)	107 (69.0%)	30 (19.4%)	15 (9.7%)	2 (1.3%)
Lake Michigan 5 Rep	----	109 (64.9%)	45 (26.8%)	10 (6.0%)	4 (2.4%)
Lake Michigan 6	----	17 (37.0%)	27 (58.7%)	----	2 (4.3%)
Lake Michigan 6 Rep	----	2 (13.3%)	9 (60.0%)	----	4 (26.7%)
Reservoir 1R	83 (71.6%)	28 (24.1%)	3 (2.6%)	----	2 (1.7%)
Reservoir 1R Rep	35 (31.5%)	55 (49.5%)	20 (18.0%)	----	----
Reservoir 2R	241 (47.3%)	237 (46.6%)	29 (5.7%)	----	----
Reservoir 2R Rep	309 (41.8%)	382 (51.7%)	46 (6.2%)	----	1 (0.1%)
Reservoir 3R	1286 (80.8%)	199 (12.5%)	22 (1.4%)	1 (0.1%)	----
Reservoir 3R Rep	1015 (84.4%)	125 (10.4%)	24 (2.0%)	----	----

Table 7. (cont'd). Benthic Macroinvertebrate Community Composition (Number Recovered and Percent of Total) from Standard Ponar Grabs, August 12 and September 11, 2013.

	Taxa				
Site	**Ostracoda**	**Pelecypoda**	**Gastropoda**	**Isopoda**	**Amphipoda**
Lake Michigan 1	2 (1.8%)	3 (2.7%)	----	----	----
Lake Michigan 1 Rep	2 (0.9%)	3 (1.4%)	----	----	----
Lake Michigan 2	----	----	----	----	----
Lake Michigan 2 Rep	----	----	----	----	----
Lake Michigan 3	----	----	----	----	----
Lake Michigan 3 Rep	----	----	----	----	----
Lake Michigan 4	----	----	----	3 (2.7%)	----
Lake Michigan 4 Rep	----	----	----	3 (1.8%)	----
Lake Michigan 5	----	----	----	----	----
Lake Michigan 5 Rep	----	----	----	----	----
Lake Michigan 6	----	----	----	----	----
Lake Michigan 6 Rep	----	----	----	----	----
Reservoir 1R	----	----	----	----	----
Reservoir 1R Rep	----	----	----	----	1 (0.9%)
Reservoir 2R	----	----	----	----	----
Reservoir 2R Rep	----	----	----	----	1 (0.1%)
Reservoir 3R	----	----	1 (0.1%)	5 (0.3%)	65 (4.1%)
Reservoir 3R Rep	----	----	3 (0.2%)	2 (0.2%)	23 (1.9%)

Table 7. (cont'd). Benthic Macroinvertebrate Community Composition (Number Recovered and Percent of Total) from Standard Ponar Grabs, August 12 and September 11, 2013.

	Taxa		
Site	**Cladocera**	**Hirudinea**	**Total Number**
Lake Michigan 1	3 (2.7%)	----	**112**
Lake Michigan 1 Rep	14 (6.5%)	----	**215**
Lake Michigan 2	----	----	**31**
Lake Michigan 2 Rep	----	----	**26**
Lake Michigan 3	----	----	**76**
Lake Michigan 3 Rep	----	----	**76**
Lake Michigan 4	----	----	**113**
Lake Michigan 4 Rep	1 (0.6%)	----	**171**
Lake Michigan 5	----	----	**155**
Lake Michigan 5 Rep	----	----	**168**
Lake Michigan 6	----	----	**46**
Lake Michigan 6 Rep	----	----	**15**
Reservoir 1R	----	----	**116**
Reservoir 1R Rep	----	----	**111**
Reservoir 2R	----	2 (0.4%)	**509**
Reservoir 2R Rep	----	----	**739**
Reservoir 3R	----	12 (0.8%)	**1591**
Reservoir 3R Rep	----	11 (0.9%)	**1203**

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APPENDIX E-5

RESPONSES TO DRAFT LICENSE APPLICATION COMMENTS

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Number	Source	Reference	Exhibit	Comment	Revisions
1	FERC	20170329 letter	A	Exhibit A, section 2.1.4, *Jetties and Breakwater* , states that the breakwater is about 1,850 feet long, but Exhibit E, sections 1.0 and 3.1.1, states the breakwater is 1,700 feet long. Please revise the final license application (FLA) to clarify the length of the breakwater.	As indicated in an as-built drawing, the breakwater length of 1,700 feet is correct and used throughout FLA.
2	FERC	20170329 letter	A	In section 4.1, *Existing Turbines and Generators* , the footnote numbers in table A-4.1-2 of the draft license application (DLA) do not correspond with the footnotes at the bottom of the page. Please ensure that all footnotes are appropriately numbered and spelled out in the FLA.	The footnotes have been corrected in the Final Application.
3	FERC	20170329 letter	B	Section 4.51(c)(2)(ii) of the Commission's regulations requires that a license application include an area-capacity curve showing the gross storage capacity and useable storage capacity of the impoundment and a rule curve showing the proposed operation of the impoundment and how the useable storage capacity is to be used. Exhibit B does not present curves for the upper reservoir, but rather contains a note indicating that these curves will be provided in the FLA. Please provide this information in the FLA.	The area capacity curve for the reservoir and the plant capacity range (all units) were added to Exhibit B..
4	FERC	20170329 letter	B	Section 4.51(c)(2)(iii) of the Commission's regulations requires that a license application report the minimum flow, as well as the maximum flow that was provided in Exhibit B, section 2.4, through the power plant during operation. Exhibit B, section 2.4, does not present this flow information. Please provide this information in the FLA.	The units are operated at a best gate flow of about 12,715 cfs. Maximum unit flow is 15,000 cfs for a total project flow is 90,000 cfs. Minimum unit flow is 9,700 cfs, which corresponds with a minimum capacity of 250 MW per unit. The flow information was added to Exhibit B, Section 2.4.
5	FERC	20170329 letter	B	Section 4.51(c)(2)(v) of the Commission's regulations requires that the license application provide a curve showing power plant capability versus head and specify maximum, normal, and minimum heads. Exhibit B does not present that curve, but rather contains a note indicating that this information will be provided in the FLA. Please provide this information in your FLA.	The curves were added to Exhibit B.
6	FERC	20170329 letter	B	Exhibit B, section 2.6, *Power plant Capability vs. Head* , states, "At a gross head of 908.5 feet NGVD 29…," which appears to be the elevation of the upper reservoir, not the gross head. Please provide the correct gross head in the FLA.	908.5 ft NGVD 29 is at the mid pond of the upper reservoir. Gross head is pond level minus lake level. The nominal lake level used is 575 feet and represents the minimum design level from the Toshiba O&M manual. Gross head equals 908.5 - 575, or 329.5 ft. To avoid the ambiguity involved when defining Gross Head (i.e. which lake level to use), the text was revised in Exhibit B and uses the mid-reservoir level; references to "gross head" were deleted.

Number	Source	Reference	Exhibit	Comment	Revisions
7	FERC	20170329 letter	D	Section 4.51(e)(4) of the Commission's regulations requires that a license application include financial and economic information for the project. The DLA includes a draft of Exhibit D; however, most of the critical information required in Exhibit D is not provided and only contains a note indicting that this information will be provided in the FLA. In the FLA, please provide all costs incurred in the operation and maintenance of the project and the value of project alternative power (energy, capacity, and any ancillary services) in 2017 dollars. Please explain the basis of the alternative power value. For the energy value, specify if it's determined from current regional fuel and variable operating costs, newly issued power sales contract prices (short term), current energy costs from a specific likely alternative resource type, or other basis. For capacity value, specify if it's determined from least expensive, most likely capacity addition available such as a combined-cycle combustion turbine plant, in dollars per kilowatt-year, or from another source.	Exhibit D contains the annual costs associated with the Project (capital, taxes, depreciation, o&m and the anticipated costs for proposed environmental measures). Exhibit H includes the cost of alternative energy sources. These exhibits have been revised to include the cost information that was not available for the DLA.
8	FERC	20170329 letter	D	The DLA presents the amount of annual pumping energy (megawatts per hour (MWh)) necessary to refill the upper reservoir but not the cost of that energy ($/MWh). Because the purchase of pumping energy is a significant project expense, please provide the projected energy rate that would need to be purchased to pump water from Lake Michigan into the upper reservoir. The cost of pumping energy is a project operating cost that should also be included in the developmental analysis section of Exhibit E of the FLA.	Exhibit D of the Final Application has been revised to include an average cost of pumping ($/MWH).
9	FERC	20170329 letter	D	Exhibit D, section 4.6, *Costs of Proposed Environmental Measures* , states that additional cost information for the proposed barrier net will be provided in the FLA. Please provide the actual total estimated annual costs (in 2017 dollars) for the proposed barrier net (page D-4-2 indicates $2.9 million, while page E-4-40 indicates that the costs are closer to $2.8 million) in the FLA. Additionally, please ensure the FLA provides a detailed breakdown (in 2017 dollars) of the specific components of the proposed barrier net and the individual annual costs (e.g., costs for spring installation, fall removal, and spring/summer/fall inspection; cleaning and maintenance; spring/summer/fall effectiveness monitoring; and over-winter net panel repairs).	FInancial data is being provided in 2016$ and other data provided is consistent with the 2016 financial data. Barrier net cost information is located in Exhibit C page C-1-3, Exhibit D page D-4-2 and Exhibit E Table E-4.3.3-5. The Exhibit E table is from the Alden report, and Alden data is from 2015. Exhibits C and D values are from 2016. Costs were updated , and the total for the barrier net with is 3.2 million per year. Expected costs associated with the Cultural Resource work (HPMP, NRHP and two site protection/periodic survey) were also added.
10	FERC	20170329 letter	E	Section 5.18(b)(5)(i)(E) of the Commission's regulations requires that a license application include a developmental analysis as part of Exhibit E. However, Exhibit E of the DLA did not include a developmental analysis. Please provide a developmental analysis as part of Exhibit E in the FLA.	The developmental analysis was added to Exhibit E.

Number	Source	Reference	Exhibit	Comment	Revisions
11	FERC	20170329 letter	E	Exhibit E, section 2.1, *Section 401 of the Clean Water Act* , states that a "date-stamped copy" of the application for water quality certification to be filed with Michigan Department of Environmental Quality (Michigan DEQ) will be included in the FLA. Please ensure that if this information is included in the FLA, proof of the date that Michigan DEQ *receives* any request for water quality certification is provided. [Section 5.23(b) of the Commission's regulations require that the following be provided no later than 60 days from the issuance date of the notice accepting the license application and indicating it is ready for environmental analysis: (1) a copy of the water quality certification; (2) a copy of the request for certification, including proof of the date on which the certifying agency received the request; or (3) evidence of waiver of water quality certification.]	In consultation with Michigan DEQ, it requires a formal request for a WQC when the FLA is filed. Consumers will submit the request to Michigan DEQ at the time the FLA is filed and will provide the request to FERC in a separate filing.
12	FERC	20170329 letter	E	Exhibit E, section 2.4, *Coastal Zone Management Act* , states that the applicants will submit a letter in June 2017 to Michigan DEQ requesting a consistency certification for the project under the Coastal Zone Management Act (CZMA). Please file with the Commission a copy of the consistency certification and request for concurrence from Michigan DEQ along with documentation showing the date Michigan DEQ received the request. Any correspondence received from Michigan DEQ regarding the CZMA consistency certification must also be filed with the Commission.	In consultation with the Michigan DEQ, a formal request for a CZMA is to be provided when the FLA is filed. Consumers will provied this request to FERC in a separate filing.
13	FERC	20170329 letter	E	Exhibit E, section 4.3.2, *Water Resources, Water Quantity, Storage, and Use* , describes the project's National Pollution Discharge Elimination System (NPDES) permit. However, the description is unclear and must be revised in the FLA. For example, it states that eight outfalls are monitored under the permit, but it then describes two other outfalls from the Upper Penstock Encasement Joint that have been closed because of the discovery of polychlorinated biphenyls (or PCBs) and further notes that one of those (outfall number 9 under the NPDES permit) continues to be monitored, totaling nine monitored outfalls, not eight as initially stated. Further, the sentence beginning, "Two large outfalls from the Upper Penstock Encasement Joint have been closed….," appears to be missing text and is unclear; therefore, this sentence must also be revised in the FLA.	Section 4.3.2 of Exhibit E of the Final Application has been revised to clarify the NPDES outfalls.

Number	Source	Reference	Exhibit	Comment	Revisions
14	FERC	20170329 letter	E	Exhibit E, section 4.3.2, *Water Resources*, *Water Quality*, states that the results of previous water quality studies conducted by Consumers Energy Company between 1972 and 1974 and in 2013 are presented in the Preliminary Application Document (PAD), but those results are not included in Exhibit E, except for a general summary of the data. For example, Exhibit E describes the differences in mean surface and bottom water temperatures and mean dissolved oxygen levels at each of the water quality sampling stations. A more typical presentation of these types of data is to show the actual water temperature and dissolved oxygen profiles, which are more informative than presenting general averages. Similarly, figures E-4.3.2-6 and E-4.3.2-7 illustrate continuous mini-sonde data, which are informative; however, the source data should also be presented in an appendix along with a description of the depth of the mini-sondes. Because the FLA must be a stand-alone document, please include all water quality data (including the data discussed above) that are necessary to describe the existing environment and substantiate conclusions made regarding project effects on water quality in the project area in the FLA.	A copy of the 2013 GLEC water quality report is included in the FLA.
15	FERC	20170329 letter	E	Exhibit E, section 4.3.2, *Water Resources*, *Profile Data*, defines "stratification" as a 1.8°Fahrenheit (1°Celsius) or greater water temperature change within a 3.3 foot (1 meter) interval. Please ensure the FLA presents a citation for this definition, and a definition (and citation) for dissolved oxygen stratification, if this term is also used in the FLA. Also, table E-4.3.2-3, page E-4-18, presents average dissolved oxygen, water temperature, and turbidity readings by date at three upper reservoir stations and six Lake Michigan stations, but these data are not sufficient to determine the extent of stratification that may occur at each station by date. Please provide the source data (by depth) collected during all profile sampling to allow for an analysis of the extent of water temperature and dissolved oxygen stratification that may occur at these sites in the FLA.	A reference for the definition of thermal stratification has been included. A copy of the 2013 GLEC Water Quality Study is included in the FLA.
16	FERC	20170329 letter	E	Please ensure that all table and figure references/links in the FLA correctly refer to the appropriate table or figure. For example, in section 4.3.2, *Continuous Recording of Water Temperature and Dissolved Oxygen*, the figure references/links in the second paragraph refer to incorrect figures. In addition, please check all footnotes to ensure they are accurate. For example, in section 4.3.3.2, footnote 4 in table E-4.3.3-4 does not correspond to any cell in the table.	The Final Application has been checked to ensure the Tables are numbered and cross reference correctly

Number	Source	Reference	Exhibit	Comment	Revisions
17	FERC	20170329 letter	E	Exhibit E, section 4.3.2.1, *Water Resources*, *Affected Environment*, includes a short paragraph under the *Accidental Spills* heading, stating that existing procedures are in place to prevent, contain, and clean up chemical spills. However, it does not describe whether any such spills have occurred during the current license term, and it does not describe any impacts those spills have had on natural resources. In addition, the DLA does not describe existing spill procedures in detail. Please ensure the FLA describes the types, duration, and volume of any spills that have occurred at the project during the current license term and any effects these spills have had on aquatic or terrestrial resources. Also, please ensure the FLA describes current and proposed procedures for preventing, containing, cleaning up, and reporting any spills, and for any proposed measures, please provide the estimated capital and operation and maintenance costs associated with the measures.	A discussion of the Spill Prevention Control and Countermeasures Plan was added to discussion in Exhibit E for the Final Application. A table of recorded spills has also been included.
18	FERC	20170329 letter	E	Throughout Exhibit E, Alden (2011) is cited. However, a reference for this citation is not provided in section 4.3.3.6, *References*. In the FLA, please provide a reference for Alden (2011).	A citation for the Alden 2011 report has been added to the reference list.

Number	Source	Reference	Exhibit	Comment	Revisions
19	FERC	20170329 letter	E	Exhibit E, section 4.3.3.2, *Water Resources*, *Environmental Analysis*, describes the current annual gill net sampling program on Lake Michigan that is conducted to assess the effectiveness of the project's barrier net at reducing project-related fish entrainment. However, section 4.3.3.2 only summarizes the overall barrier net effectiveness data and states that the declining trends in fisheries abundance observed during the annual gill net sampling program mimic historical lake-wide fisheries abundance trends. While citations are provided for the current barrier net monitoring program (Alden, 2016) and for other lake-wide fisheries studies (Bunnell et al., 2015; Makauskas and Clapp, 2010), this section provides very little specific data that would allow Commission staff or other stakeholders to independently verify the conclusions made in this section of the DLA. In addition, the lack of specific data in the DLA would not allow staff to describe the existing environment (i.e., relative abundance of fish populations) in the vicinity of the project or to analyze the level of protection afforded by the barrier net. Therefore, please provide specific data on the fisheries sampling that has occurred at the project, both for the earlier studies conducted in the 1970s and 1980s and more current data collected since installation of the barrier net in the FLA. [The results of the 2016 Annual Report of Barrier Net Operation were not incorporated into the DLA. Because this report is currently available (filed on December 20, 2016) and contains the most recent data on the effectiveness of the barrier net (i.e., 2016 data), the relevant data from this report should be incorporated into the FLA.] Providing these data in the FLA will better enable staff to quantify the level of protection afforded by the current (and proposed) fish barrier net.	Additional information pertaining to fish sampling prior to and during barrier net operation as well as barrier net effectiveness monitoring has been provided in Exhibit E, section 4.3.3

Number	Source	Reference	Exhibit	Comment	Revisions
20	FERC	20170329 letter	E	Exhibit E, section 4.3.3.2, *Water Resources*, *Environmental Analysis*, also discusses the existing Settlement Agreement, which, in part, provides for the annual deployment/removal, maintenance, and effectiveness monitoring of the fish barrier net, and 5-year fish abatement technology reviews. Although this section of the DLA states that the applicants propose to continue to operate, maintain, and monitor the effectiveness of barrier net on an annual basis, it does not state whether the applicants propose to continue with the 5-year reviews of fish entrainment technologies. In addition, section 4.3.3.3 includes only a brief, two-sentence description of the proposal to continue operating and maintaining the fish barrier net, and monitoring its effectiveness. Overall, the level of detail provided in the DLA is inadequate to enable staff to analyze the potential benefits and costs of the various aspects of the proposed fish protection measures. Therefore, please provide a detailed description of all aspects of the proposed fish barrier net in the FLA, including: (a) the physical specifications of the net itself, including where and when it is deployed; (b) net maintenance; (c) net effectiveness monitoring; (d) the annual costs. Additionally, please describe all aspects of agency consultation (e.g., agency names, frequency and timing of consultation, etc.) that are part of this proposal and referenced in the last sentence of section 4.3.3.3, *Proposed Environmental Measures*.	The Licensees will continue the barrier net program, which includes the 5-year fish abatement technology review. Additional information is included in Section 4.3.3.2.
21	FERC	20170329 letter	E	Exhibit E, section 4.3.3.2, *Water Resources*, *Environmental Analysis*, describes an investigation of potential alternatives for reducing fish entrainment and mortality at the project, conducted as part of the relicensing studies. While the study was a thorough review of fish protection technologies that may be applicable to the Ludington Project, neither the study nor the DLA provide an assessment of the effects of project fish entrainment on the fisheries of Lake Michigan. Quantifying the effects of entrainment on the overall fish community of Lake Michigan may not be scientifically possible, however, providing additional data on fish populations and known fish entrainment (studies conducted since the 1970s) at the project would allow for an assessment of the "near-field" effects of the project. Therefore, in the FLA please include the data as described in item 19 to allow staff to assess the effects of the project on fisheries resources in Lake Michigan.	Quantifying population level effects of LPSP operation on the Lake Michigan fishery is not feasible. Additional data, literature refernces, and text was added to Exhibit E, section 4.3.3 to illustrate the changes to the Lake Michigan fishery since the 1970s. There is no indication that these changes are a result of project operations.

Number	Source	Reference	Exhibit	Comment	Revisions
22	FERC	20170329 letter	E	Exhibit E, section 4.3.7.2, *Rare, Threatened and Endangered Species, Environmental Analysis* , states that a lake sturgeon restoration program is proposing to release lake sturgeon fry near the project, but does not describe any other aspects of this restoration program. Please ensure the FLA presents a detailed description of this restoration program, including the entities responsible for implementing the program, the program objectives and schedule, the planned stocking locations and the frequency of stocking, and the size classes and numbers of sturgeon to be released. The FLA must also provide an assessment of the potential for entrainment of stocked lake sturgeon at the project, the expected efficiency of the existing barrier net in preventing sturgeon entrainment, and any additional measures proposed to reduce the potential for lake sturgeon entrainment at the project.	The Draft License Application incorrectly stated that a lake sturgeon restoration program was being implemented in Mason County near the LPSP. Additional information on lake sturgeon stocking efforts in the Lake Michigan portion of Michigan within 100 mile of LPSP is provided in Exhibit E, section 4.3.3.
23	FERC	20170329 letter	E	Exhibit E, section 4.3.7.5, *Rare, Threatened and Endangered Species, Unavoidable Adverse Impacts* , describes potential effects on state-listed fish species—lake sturgeon and cisco—by stating that continued operation of the project would have no “significant, unavoidable, adverse impacts” on listed species. However, it also states that entrainment of both lake sturgeon and cisco could occur when the barrier net is not in place (in the winter), although the DLA states that overall fish abundance in the winter would be low in the vicinity of the project, and thus reduce the potential for entrainment. While these assumptions about winter entrainment may be reasonable, they provide insufficient basis for a “no-effect” conclusion. Therefore, please provide quantitative data on the number and size classes of lake sturgeon and cisco that occur in Lake Michigan in the project vicinity (based on current studies, both inside and outside of the barrier net) and the basis (other data or literature) for concluding that fish abundance would be low in the winter period in the FLA. These data could be provided as part of the data requested under item 19.	Additional information pertaining to the life-history characteristics, potential for entrainment, and relative abundance of these species in the vicinity of the project has been provided in Exhibit E, section 4.3.7.
24	FERC	20170329 letter	E	Exhibit E, section 1.2, *Consultation* , states that first and second year study results were filed on December 2, 2015, and December 1, 2016, respectively. However, results of the wildlife and botanical surveys are not included in Exhibit E, except for a general summary of the data. These surveys provide information pertinent to existing wildlife and habitats in natural areas of the project and along the Lake Michigan shoreline and identify the presence and habitat of rare, threatened, or endangered (RTE) species at the project. Because the FLA should be a stand-alone document and not all reviewers may have access to the project record, please include an appendix containing all the surveys and reports used to develop the resource sections in the FLA.	A column was added to Table E1.2-2 in Exhibit E showing the report filing dates.

Number	Source	Reference	Exhibit	Comment	Revisions
25	FERC	20170329 letter	E	Exhibit E, section 4.3.6.1, *Riparian, Wetland and Littoral, Affected Environment* , states that limited wetland habitat is present within the project boundary and that project operation does not significantly affect wetland habitat. Wetland maps show palustrine, riparian, and lacustrine wetland types within the Ludington Project and Port Sheldon facility areas; however, approximate acreages of these wetlands within project boundaries (pursuant to section 5.18 and 5.6 of the Commission's regulations) are lacking. In the FLA, please provide the approximate acreages, by type, of the current wetlands and any anticipated effects on these wetlands during project operation so that staff can evaluate the potential effects of project operation on these wetland resources. Table E-4.3.6-1, section 4.3.6.1, lists common wetland and shoreline vegetation within the project vicinity. Please also provide a list of wildlife and invasive plant species that use this habitat.	Table E-4.3.6-1, Wetlands within the Project Area, was added to section 4.3.6.1. A small wetland within the Project boundary was identified during the wildlife and botanical survey; this wetland type is from the small spring and pumping relief well outfall (30 and 200 gpm) and is not included in NWI mapping. Common wildlife and invasive plant species are listed in Tables E-4.3.6-3 and E-4.3.6-4, respectively.
26	FERC	20170329 letter	E	Exhibit E, section 4.3.7.1, *Rare, Threatened and Endangered Species, Affected Environment* , indicates the last updated threatened and endangered species information was obtained from FWS on July 1, 2011, and that FWS concurred with a no effect determination for the piping plover, Karner blue butterfly, Indiana bat, Pitcher's thistle, and eastern massasauga rattlesnake within the project area. However, since 2011, the northern long-eared bat and rufa red knot have been federally listed as threatened species; therefore, consultation with FWS is required. So that Commission staff has the most current information to analyze project effects on federally listed and state-listed species occurring within the project boundary, please provide an updated list and consultation record for threatened and endangered species, candidate species, species proposed for listing under the Endangered Species Act (ESA), and migratory birds of conservation concern that occur within the project boundary in the FLA. Please also include a discussion of how the proposed project would comply with the ESA and, specifically, with the recent final 4(d) rule for northern long-eared bats.	Consumers consulted with the USFWS to update list of species. USFWS concurs with revised list and indicated that a formal request for concurrence with Consumers determination of no affect must be made when the FLA is filed. A formal request to USFWS was made, and the USFWS responded stating that the only species to be added would be eastern massasagua . The NLEB comment was addressed by adding the Massasagua to Mason and Ottawa Counties in Table E-4.3.7-2.

Number	Source	Reference	Exhibit	Comment	Revisions
27	FERC	20170329 letter	E	Exhibit E, section 4.3.7.1, *Rare, Threatened and Endangered Species, Affected Environment*, briefly describes the status, habitat requirements, and range for the RTE species listed in table E-4.3.7-2. However, a description of the potential effects of proposed project operation and maintenance on these species or measures for protection, mitigation, or enhancement with respect to each RTE species affected was not provided. Please provide this information in the FLA. Section 4.3.7.1, Rare, Threatened and Endangered Species, Affected Environment, also briefly describes the life histories and occurrences, by county, of the RTE species that may occur in the project vicinity, including the little brown bat. However, a corresponding county occurrence figure for little brown bat was not provided as had been done for the other RTE species. Please provide a figure for the little brown bat and renumber the sequence in the FLA. Also, please provide in-text references for all the species occurrence figures in the corresponding text and, more specifically, correct the figure for the current range of white nose syndrome to refer to figure E-4.3.7-11, not figure E-4.3.7-10.	The requested information was included in Exhibit E, Section 4.3.7.1.
28	FERC	20170329 letter	E	Exhibit E, section 4.3.5.2, *Botanical Resources, Environmental Analysis*, indicates that maintenance activities, such as mowing, currently occur along roadways and maintained recreational areas within the project boundary. To better evaluate the effects of continued project operation and maintenance activities on wildlife and associated habitat, as well as the introduction, establishment, and spread of invasive plant species in the project area, please include detailed information about the current vegetation management activity at the project, including who would maintain vegetation and where it would occur, a typical annual schedule of activity, and whether methods such as mowing and/or herbicide application would be used for vegetation control of both native and non-native invasive species (including along shoreline areas, if any) in the FLA. Please also provide estimated annual costs for vegetation management. In addition, the Wildlife Resources Report states that most open or unmaintained land has or is being colonized by autumn olive. In the FLA, please provide an estimate of autumn olive abundance within the project boundary, presented as percent coverage or estimated acreage. If any measures are proposed to control this invasive species at the project, please provide the costs.	Exhibit E Section 4.3.5.3 has been edited to identify Mason County's role in maintaining the grounds and 2017 lease payment.
29	FERC	20170329 letter	E	Exhibit, E, section 4.3.8.1, *Recreation and Land Use, Affected Environment*, includes a land use classification system that includes *Developed*, *Recreation*, or *Undeveloped* classifications. Although it is clear from the definitions for *Developed* and *Recreation* whether the public is allowed on these lands, it is not clear for the *Undeveloped* classification whether the public is allowed on these lands. Please clarify whether *Undeveloped* lands are open to the public in the FLA.	There are approximately 37 acres of undeveloped lands on the northeast corner of the Project boundary, which are open to the public. The remaining property open to the public has limited accessibility. Exhibit E, Section 4.3.8.1 has been revised to provide the additional detail regarding undeveloped land.

Number	Source	Reference	Exhibit	Comment	Revisions
30	FERC	20170329 letter	E	Exhibit E, section 4.3.8.1, *Recreation and Land Use, Affected Environment,* table E-4.3.8-6, summarizes interview responses collected during the recreation study related to the quality of the recreation site; however, it is not clear from the presentation in the table which recreation sites received scores less than the rating of "3–Fair" for the specific amenities presented. Please provide additional detail about which recreation sites (and the specific facility amenity) received the lowest scores, to enable Commission staff to determine which, if any, sites exhibited deferred maintenance more than others in the FLA.	Section 4.3.8.1 has been revised to provide additional detail about which recreation sites (and the specific facility amenity) received the lowest scores.
31	FERC	20170329 letter	E	Exhibit E, section 4.3.9.1, *Cultural Resources, Affected Environment,* briefly describes the "Precontact Period History" of the project area in the discussion of the three general prehistoric periods. However, it does not include a detailed discussion of the prehistoric context of the project area. Please provide a detailed discussion of the prehistoric context, one similar to that which is provided in section 2.2 of the December 2015 Historic and Archaeological Study Report (Mannik & Smith Group, Inc., 2015) in the FLA.	Text from the December 2015 Historic and Archaeological Study Report was added to Exhibit E, Section 4.3.9.1 providing the prehistoric context of the Project area.
32	FERC	20170329 letter	E	Exhibit E, section 4.3.9.1, *Cultural Resources, Affected Environment,* Precontact *Period History* is followed by a discussion of *Postcontact Archaeological Resources*. It appears that the heading of this section was intended to be *Precontact Archaeological Resources*, but please confirm. Also, please ensure the FLA presents a more detailed description (excluding confidential information) of the two previously recorded prehistoric sites, 20MN48 and 20MN49, and the five prehistoric sites documented during the field studies conducted under the Archaeological Resources Study Plan. Additionally, section 4.3.9.1 states that archival research indicated that four historic-era archaeological sites had been previously documented within the "study area" and that during field studies, 10 new historic-era sites were documented. Please ensure that the FLA presents a detailed description or table (excluding confidential information) of the seven prehistoric sites and 14 historic-era archaeological resources, including site numbers and National Register of Historic Places (National Register) eligibility.	The "Study Area" included area outside of the project boundary (and area of potential effects) for the project. Sites outside of the boundary were included in the discussion for context (13 pre-historic and 4 historic sites). No previously recorded sites were within the project boundary, with the exception of the two sites destroyed during construction (20MN48 and 20MN49). There were five prehistoric and 10 historic sites identified during the Phase I study, one of the historic sites is the project itself, which is eligible for listing on the NRHP. A table listing the 15 new sites plus a brief summary of each taken from the Phase I report were added to the end of Exhibit E Section 4.3.9.1 in the Final Application.

Number	Source	Reference	Exhibit	Comment	Revisions
33	FERC	20170329 letter	E	Exhibit E, section 4.3.9.1, *Cultural Resources, Affected Environment*, does not clearly state which prehistoric and historic-era National Register-eligibility determinations have been formally approved by the Michigan State Historic Preservation Office (Michigan SHPO). This section states that the two previously documented prehistoric sites (20MN48 and 20MN49) were "determined to be not eligible for listing" on the National Register, and "recommends" that none of the five newly documented prehistoric resources are eligible for listing. However, on page E-4-122 it states that all prehistoric sites were "determined" to be ineligible. Similarly, eight of the historic-era archaeological resources are described as having been heavily disturbed, and therefore not eligible for listing in the National Register, and the remaining two sites (20MN324 and 20MS329) are described as eligible for listing in the National Register under Criterion D for their potential to provide important information related to regional farming history. This section also concluded that project activities are not affecting these historic-era sites. Please provide documentation that the Michigan SHPO concurs with the eligibility recommendations for all prehistoric and historic-era sites within the project area of potential effect (APE). Please also provide documentation that the Michigan SHPO concurs that the project is not affecting the two potentially eligible historic-era sites.	The Phase I Study Report and the Draft HPMP were provided to the SHPO and Saginaw Tribe for review. No response was provided by the Saginaw Tribe to either report review request. SHPO provided a response in an email dated 5/5/17 indicating that they accepted the report without comment or modification. Clarification was requested on 5/17 regarding if the SHPO review applied to both documents or if only one, which one. Text was added to Exhibit E, Sectoin 4.3.9.1.
34	FERC	20170329 letter	E	Exhibit E, section 2.5, *National Historic Preservation Act*, states that the Michigan SHPO and Indian tribes that may have an interest in the project were consulted. While Appendix E-1 provides a listing of consultation efforts, Exhibit E does not include a summary of these efforts or the results of section 106 consultation. In particular, on March 4, 2016, a copy of the December 2015 Historic and Archaeological Study Report (Mannik & Smith Group, Inc., 2015) was provided to Commission staff, the Michigan SHPO, and the Saginaw Chippewa Tribe of Michigan for review and comment. However, no comments or a summary of responses from the Michigan SHPO and Saginaw Chippewa Tribe of Michigan are included DLA. Furthermore, appendix E-1, Consultation Record, mentions that the Little Traverse Bay Band of Odawa Indians and the Little River Band of Ottawa Indians also provided comments during study plan development. Please ensure the FLA clarifies why only the Saginaw Chippewa Tribe of Michigan received a copy of the Historic and Archaeological Study Report in March 2016, and whether other tribes have expressed an interest in the project relicensing. Please also ensure that the FLA presents a summary of all other section 106 consultation efforts conducted to date, including consultation with participating Native American tribes. Provide copies of all letters to and from consulting parties (including all pertinent letters from the Michigan SHPO and others) in a separate consultation appendix.	The LTBBOI and LTBB commented on the Fisheries Studies and maintained involvement during the study. There was no response or interest expressed by LTBBOI, LRBOI, or LTBB in participating in the Cultural Resource study. The Saginaw Tribe was the only tribe expressing interest/responding. One tribal member contacted indicated that as long as one tribe was involved they were satisfied. Text was added to Exhibit E, Section 2.5.

Number	Source	Reference	Exhibit	Comment	Revisions
35	FERC	20170329 letter	E	Exhibit E, section 4.3.9.2, *Cultural Resources, Affected Environment,* states that a Historic Properties Management Plan (HPMP) will be prepared in consultation with the Michigan SHPO and will be filed with the FLA. The HPMP should address all project-related effects on cultural resources identified within the project APE that have been determined by the Michigan SHPO to be eligible for listing on the National Register and would be adversely affected by project operation and/or maintenance. Also, the HPMP should be prepared after consultation with federally recognized Indian tribes who have expressed an interest in the project. Please ensure that the HPMP adheres to the Advisory Council on Historic Preservation and Commission's joint document, *Guidelines for the Development of Historic Property Management Plans for FERC Hydroelectric Projects* (Advisory Council and FERC, 2002) and that Exhibit D of the FLA presents the cost for the HPMP.	The HPMP was provided to SHPO and Saginaw Tribe on 3/6/2017 and the 2015 Phase I study was provided on 3/4/2016. No comments were received on either report. Consumers contacted Brian Grennell (SHPO) on 4/6/2017 via email inquiring about the SHPO review. SHPO responded on 5/5/2017 with an email indicating that they accepted the report without comment. The communications are made part of the consultation record.
36	FERC	20170329 letter	E	Exhibit E, appendix E-1, *Consultation Record* , provides a list containing the name, and address of every federal, state, and interstate resource agency, Indian tribe, or member of the public consulted during the preparation of the Ludington relicensing documents. Please provide copies of all correspondence, including more recent communications that occurred after the filing of the PAD and DLA so that Commission staff can independently review the content of these letters, including requests to, responses from, and/or determinations from entities regarding potential effects on resources.	Copies of the correspondence will be included with the Final Application
37	FERC	20170329 letter	E	The Exhibit F drawings provided do not reference the vertical datum used for elevations. The elevations shown in Exhibit F appear to match the elevations provided in the project description (Exhibit A), which are stated to be in accordance with National Geodetic Vertical Datum of 1929 (NGVD 29). Please ensure that each of the Exhibit F drawings filed with the FLA includes a note that states that all elevations are provided in NGVD 29 datum, if that is the case.	The Exhibit F drawings included with the Final Application have been revised to include the NGVD 29 reference.
38	FERC	20170329 letter	E	Section 4.39 of the Commission's regulations requires that Exhibit G drawings must be stamped by a registered land surveyor. Although Exhibit G maps are provided in the DLA, sheet G-2 does not include a licensed surveyor's stamp. Please ensure that each of the Exhibit G maps filed with the FLA includes a licensed surveyor's stamp.	Revised Exhibit G drawings will be included with the Final Application.
39	FERC	20170329 letter	E	Section 5.18(c) of the Commission's regulations requires that a license application provide additional information about the project in Exhibit H. However, the DLA is missing several items that are required under section 5.18(c), subsections (1)(B), (1)(C), (1)(I), (2)(B)(2), and (2)(B)(5), In each case, the DLA states that the information will be filed in the FLA. Please provide all of the required information in Exhibit H in the FLA.	The information that was not available at the time the Draft Application was filed with the Commission has been incorporated into the Final Application.

Number	Source	Reference	Exhibit	Comment	Revisions
40	PMT	20170117 letter		PMT - Request - Within six (6) months of license issuance, the LPS Licensees propose to submit a Recreation Enhancement Plan for FERC approval to address the needs for public access to shoreline and small boat fishing opportunity for Lake Michigan fish species and for access to Lake Michigan beach resources. The Plan should be developed in conjunction with Pere Marquette Charter Township (PM Township) projects currently being planned to provide improved access to the Lake Michigan fishery at the mouth of the Pere Marquette River (the Twin Bridges site) and to improve beach and water trail access at the Buttersville Park Beach on Lake Michigan. The Plan shall provide for financial support of these projects in an amount not to exceed $800,000 (in 2019 dollars, adjusted for the CPI), and shall include a schedule for completion of the projects. The Licensees shall have no ongoing responsibility for operation and maintenance of these projects, which will be provided by PM Township. The Plan shall be prepared in consultation with Pere Marquette Charter Township the Michigan DNR, the US Fish and Wildlife Service, and the US Park Service. A minimum of 30 days shall be provided for comment on the final Plan prior to submittal to the Commission for approval.	The Licensees have developed a draft Recreation Plan which was provided to both Michigan DNR and PMCT on May 5, 2017 for a 30 day review. On May 19, 2017, PMCT commented on the plan and these comments are addressed in the plan's comment and response table. PMCT's request for additional funds to support the projects it outlined in its comment letter were not included in the Final License Application. The reasons for not including these requests are that: (1) the PMCT proposed projects are located about two miles from the Project and outside the influence of the Project operation and Project impacts; (2) the water trail contains other sections that have breaks and obstacles that require a canoeist to traverse Lake Michigan around the obstacle (such as river entrances, shipping channels, and large marinas), and there is no restriction on traversing the area across the breakwater as long as a recreationalist does not enter the power canal; (3) the Licensees pay property taxes to Mason County and PMCT which can be used to offset the costs of these upgrades. The Licensees pay property taxes to Pere Marquette Township which can be used to offset the costs of the proposed recreation upgrades. Property tax payments increased 8% from 2014 to 2015, and 18% from 2015 to 2016, and will continue to increase to Pere Marquette Township with the completion of each unit upgrade without additional burden to the townships, since the powerhouse portion of the project lies solely in Pere Marquette Township. This additional tax revenue can be used at the Township's discretion, including for the proposed recreation improvements.
41	DLA	Section 3.3.3	E	Operation Management Plan - left TBD in DLA - will probably end up Not Applicable to LPSP	Project operation is dictated by MISO request for both generation and pumping and is based on a combination of energy and capacity needs and availability, and price.. Since the Project is not located on a river, it does not have minimum flow or other operational requirements that would impact other non-developmental resources. The text of Section 3.3.3. of Exhibit E has been revised removing the reference to an Operations Plan.
42	DLA	4.3.8.3	E	Recreation Management Plan	A Recreation Management Plan has been prepared and provided to Pere Marquette Township, Mason County and the MDNR for comment. Comments were provided by Pere Marquette Township. No other comments were received on the Plan.

Number	Source	Reference	Exhibit	Comment	Revisions
43	DLA	2.2.1	H	Reasonable Cost and Availability of Alternate Power - Update all costs (in 2016$): Project Production cost System Marginal production cost System Marginal capacity cost Combustion turbines and combined cycle – capital cost ($/KW) and operating cost ($/MWH) Total peak demand for CMS and DTEE in 2016.	For the Final Application, Exhibit H Section 2.2.1 has been revised to include the values that were not available at the time the Draft Application was filed with the Commission.
44	DLA	2.2.1	H	Table H.2.2.2-1 Licensees' System Data for 2016, from above	Table H-2.2.2-1 in the Final Application has been revised to include values that were not available for the Draft Application.
45	DLA	2.2.1	H	Effects on operating and load characteristics: We will need an explanation of operating and load characteristics associated with pumping and generation cycles. This is the effect on the transmission system, primarily.	On the west side of the state, Michigan Electric Transmission Company (METC), a subsidiary of ITC Holdings, owns all of the high voltage electric transmission system. Ludington is directly connected to the METC system at a transformer located at the Project. Since the Licensees are not proposing to change operation, the rest of the 138 kV system in the area will not be directly impacted by Ludington pumping vs. generating cycles as long as METC can support service quality at the interconnection points (e.g. voltage levels & frequency).
46	DLA	2.3.1	H	Average Annual Cost of Project Power. We will need cents/kwh for the Project power	Exhibit H in the Final Application has been revised to include the values that were not available at the time the Draft Application was filed with the Commission.
47	DLA	2.2.2	H	Effect on communities served by the project -	Exhibit H in the Final Application has been revised to include the values that were not available at the time the Draft Application was filed with the Commission.
48	DLA	2.3.2	H	Short and Long Term Capacity and Energy Requirements - Baseload and peaking capacity numbers, plus baseload and peaking capacity by resource (coal, gas, nuclear, etc.) (Use 2016 as current year) Amount of long term capacity contracts Any publically announced power projects (wind/solar)? 10% renewable requirement Amount of conservation	Exhibit H in the Final Application has been revised to include the values that were not available at the time the Draft Application was filed with the Commission.

Number	Source	Reference	Exhibit	Comment	Revisions
49	DLA	2.6.1	H	Effects on power flow redistribution; Does having or not having a FERC license effect the power flow in the Ludington area. An analysis or explanation why this is not a Licensee's issue.	On the west side of the state, Michigan Electric Transmission Company (METC), a subsidiary of ITC Holdings, owns all of the high voltage electric transmission system. Ludington is directly connected to the METC system at a transformer located at the Project. Since the Licensees are not proposing to change operation, the rest of the 138 kV system in the area will not be directly impacted by Ludington pumping vs. generating cycles as long as METC can support service quality at the interconnection points (e.g. voltage levels & frequency).
50	DLA	2.9	H	Financial and Personnel Requirements - input from both CE and DTEE needed	Exhibit H in the Final Application has been revised to include the values that were not available at the time the Draft Application was filed with the Commission.
51	DLA	2.9.1	H	Financial Requirements - input from both CE and DTEE needed	Exhibit H in the Final Application has been revised to include the values that were not available at the time the Draft Application was filed with the Commission.
52	DLA	2.9.2	H	Personnel Requirements - input from both CE and DTEE needed	Exhibit H in the Final Application has been revised to include the values that were not available at the time the Draft Application was filed with the Commission.
53	DLA	3.2	H	Plant employee accidents	Section 3.2 of Exhibit H has been revised in the final application.
54	DLA	3.2.2	H	Public Safety Plan	A copy of the current Public Safety Plan that has been provided to the FERC's Chicago Regional Office will be included with the Final Application
55	DLA	PMT Letter 2014-04-28	E	Dates of SDI and Study Plan Determination letters in error	Exhibit E, Section 1.2 has been revised to provide the correct dates for SD1 and Study Plan Determination. SD1 dated 3/20/2014 and Study Plan Determination was issued 12/1/2014.

Number	Source	Reference	Exhibit	Comment	Revisions
56	DLA	PMT Letter 2014-04-28 and PMT Letter 2017-05019	E	PMT has previously noted during the relicensing process that the license application must include a "Report on recreational resources" that is prepared in consultation with local, state and regional recreation agencies, and must address an estimate of existing and potential recreational use, a description of measures or facilities recommended by the agencies consulted for creating or enhancing recreational opportunities at the Project and in its vicinity. PMT has made such recommendations to the Licensees but there was not reference to or discussion of that consultation and the recreation development needs that PMT has discussed with the Licensee during the Scoping and Study Phases in the draft application. PMT recommends that the Licensees include a provision in the Final License Application for submission of Recreation Plan and include financial support of up to $800,000 for projects currently being planned (Twin Bridges site and Buttersville Park Beach water trail access).	Consultation during the relicensing process is described in Section 1.2 of Exhibit E in the FLA and responses to comments on the DLA are discussed in Exhibit E, Section 1.3 and provided in Appendix E-1. In the Study Plan Determination letter issued on 12/1/2014, FERC Staff determined that the two recreation sites identified by Pere Marquette Township (Buttersville Beach and the Twin Bridges Site) are not affected by project operation and maintenance and do not provide access to project lands or waters. Since these two sites lack of nexus to the Project, there was no justification for requiring the Licensees to include them in the study. These two sites continue to lack a nexus to the Project and the Licensees believe that the request for funding upgrades at these sites should not be included in the License order. The partnering opportunities suggested between the Township and Licensees are outside FERC jurisdiction because the nexus to the Project has not been established. While the Licensees may support the nature of the PMT proposed recreational opportunities, they don't believe they should be considered part of the new license for the Project.
57	DLA	PMT Letter 2014-04-28	E	The description of the Lake Michigan Water Trail in Section 4.3.8 is described as extending just to the west of the Project. Being located west of the Project means further out in Lake Michigan (due to the seasonal barrier net), in potentially hazardous circumstances for small watercraft intended to be served by the water trail. The Lake Michigan Water Trail Plan described this trail segment as being a gap zone and notes that pick-up zones are available at Buttersville Beach Access and at Summit Township Park. In order to make this segment of the water trail viable, a method to bridge the gap is needed and a transport service based at Buttersville Campground and Beach would require improvements.	Section 4.3.8.1 of Exhibit E of the Final License Application has been revised to reflect the Lake Michigan Water Trail in the vicinity of the Project based on Michigan Heritage Water Trails Program website mapping located at http://www.michiganwatertrails.org/west.asp (accessed May 19, 2017) and the West Michigan Shoreline Regional Development Commission website mapping located at http://wmsrdc.org/project/lake-michigan-water-trail-plan/ (accessed May 23, 2017). Both websites show the Lake Michigan Water Trail stopping north of the Project near Buttersville Park and starting up again south of the Project. The Lake Michigan Water Trail Plan Phase I, prepared by the West Michigan Shoreline Regional Development Commission, is dated 2014. In Michigan and Wisconsin, there are areas where the Lake Michigan Water Trail can be either farther out into Lake Michigan, have a break in the trail, or may be across land to go around an impediment. In their Study Plan Determination letter issued on 12/1/2014, FERC Staff determined that Buttersville Beach is not affected by Project operation and maintenance and does not provide access to Project lands or waters.

Number	Source	Reference	Exhibit	Comment	Revisions
	DLA	PMT Letter 2014-04-28	E	PMT has focused its input to the Licensees on two areas of recreation need in the community - adequate Lake Michigan beach and water trail access facilities, and the need for improved pedestrian and boating access to the Lake Michigan fishery.	Section 4.3.8.1 has been revised to more accurately reflect the Lake Michigan Water Trail in the vicinity of the Project based on Michigan Heritage Water Trails Program web site mapping located at http://www.michiganwatertrails.org/west.asp. In Michigan and Wisconsin, there are areas where the Lake Michigan Water Trail can be either farther out into Lake Michigan, have a break in the trail, or may be across land to go around an impediment. In the Study Plan Determination letter issued on 12/1/2014, FERC Staff determined that Buttersville Beach is not affected by Project operation and maintenance and does not provide access to Project lands or water. Section 4.3.8 has also been revised to better describe access to Lake Michigan offered in surrounding communities close to the Project.
	Rec Plan	PMT Letter 2017-05	E	Comments on the Draft Recreation Management Plan: The description of the Lake Michigan Water Trail in draft License Application and in the draft Recreation Plan accurately described the trail. The Lake Michigan Water Trail Plan Phase I, prepared by the West Michigan Shoreline Regional Development Commission, includes the Lake Michigan shoreline between Buttersville Beach and Summit Beach and discusses the Project portion of the trail as presenting access challenged due to the Project's barrier net.	Section 4.3.8.1 of Exhibit E of the Final License Application has been revised to reflect the Lake Michigan Water Trail in the vicinity of the Project based on Michigan Heritage Water Trails Program website mapping located at http://www.michiganwatertrails.org/west.asp (accessed May 19, 2017) and the West Michigan Shoreline Regional Development Commission website mapping located at http://wmsrdc.org/project/lake-michigan-water-trail-plan/ (accessed May 23, 2017). Both websites show the Lake Michigan Water Trail stopping north of the Project near Buttersville Park and starting up again south of the Project. The Lake Michigan Water Trail Plan Phase I, prepared by the West Michigan Shoreline Regional Development Commission, is dated 2014. In Michigan and Wisconsin, there are areas where the Lake Michigan Water Trail can be either farther out into Lake Michigan, have a break in the trail, or may be across land to go around an impediment. In the Study Plan Determination letter issued on 12/1/2014, FERC Staff determined that Buttersville Beach is not affected by Project operation and maintenance and does not provide access to Project lands or water.
	Rec Plan	PMT Letter 2017-05	E	The Pigeon Lake facility primarily provides a recreational walking opportunity, not a public fishing opportunity, as the Recreation Study showed.	Section 4.3.8.1 of Exhibit E of the Final License Application has been revised to also reference walking,/hiking, and/jogging as opportunities provided at the Pigeon Lake Pier. The Recreation Use discussion within Section 4.3.8 already acknowledges that walking,/hiking, and /jogging were the most popular recreation activity at this site.
	Rec Plan	PMT Letter 2017-05	E	The Recreation Plan includes a reference to an outdated PMT website.	References to this website have been updated in Section 4.3.8.1 and 4.3.8.6 of Exhibit E in the Final License Application.

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT F
GENERAL DESIGN DRAWINGS

CONTAINS CRITICAL ENERGY INFRASTRUCTURE INFORMATION (CEII)

The design drawings showing plan, elevations, and sections of the principal Ludington Pumped Storage Hydroelectric Project (Project) works are included as follows:

Sheet No.	Title
Sheet 1	General Plan (CEII)
Sheet 2	General Plan – Sections (CEII)
Sheet 3	Intake and Berm (CEII)
Sheet 4	Powerhouse Section (CEII)
Sheet 5	Lakefront (CEII)
Sheet 6	Berm and Emergency Overflow (CEII)
Sheet 7	Barrier Net (Public)

In order to protect critical energy infrastructure information (CEII), the Commission has enacted regulations to govern public access to certain information. The Exhibit F drawings referenced herein contain sensitive and detailed engineering information that, if used improperly, may compromise the safety of the Project and those responsible for its operation. Therefore, the Exhibit F drawings have been labeled "Contains Critical Energy Infrastructure Information - Do Not Release." The drawings have been submitted to the Federal Energy Regulatory Commission (FERC) under separate cover. Agencies may file a CEII request under 18 CFR § 388.113 to obtain the Exhibit F drawings.

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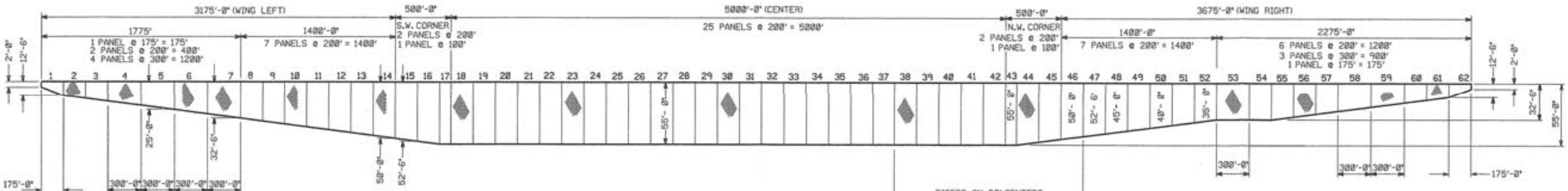
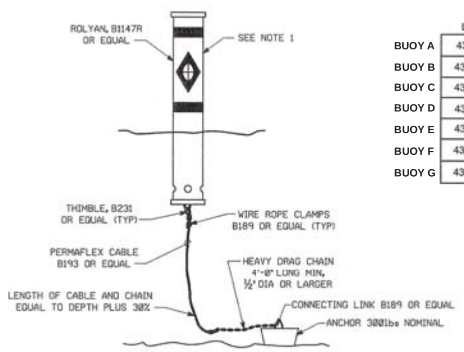


BARRIER NET ELEVATION

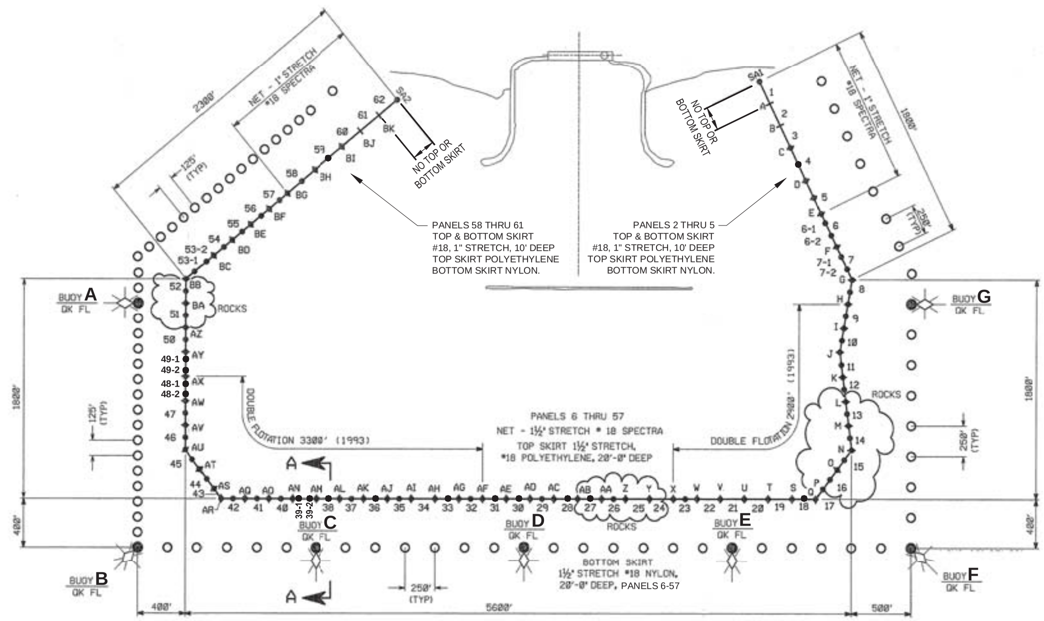
SCALE: NONE



DETAIL 1
REGULATORY BUOY

SCALE: NONE

	LATITUDE	LONGITUDE
BUOY A	43°54'13.22898"	-86°27'13.71978"
BUOY B	43°54'11.74842"	-86°27'42.27648"
BUOY C	43°53'55.97964"	-86°27'40.4046"
BUOY D	43°53'37.1709"	-86°27'38.5197"
BUOY E	43°53'18.4095"	-86°27'36.40884"
BUOY F	43°53'07.73682"	-86°27'35.17668"
BUOY G	43°53'09.47802"	-86°27'06.64974"



LOCATION PLAN

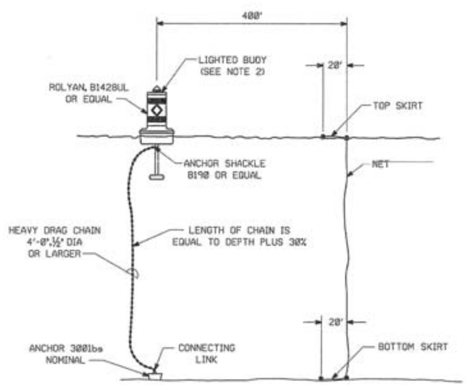
SCALE: 1" = 400'

LEGEND:

- REGULATORY BUOY (SEE NOTE 1)
- LIGHTED BUOY (SEE NOTE 2)
- PERMANENT ANCHOR

1, 2, 3, etc. DESIGNATES PANEL NUMBERS

A, B, C, etc. DESIGNATES PANEL JOINTS



SECTION A-A
LIGHTED BUOY

SCALE: NONE

NOTES:

1. REGULATORY BUOYS (WHITE AND ORANGE) SHALL CONTAIN SIGNS READING: "DANGER - SHALLOW NET" AND "KEEP OUT - SHALLOW NET" ON ALTERNATE SIDES.
2. LIGHTED BUOYS (WHITE WITH A WHITE LIGHT AND ORANGE LETTERING) SHALL BE LOCATED ON EACH CORNER WITH THREE (3) ADDITIONAL LIGHTED BUOYS ALONG THE NORTH-SOUTH LINE AND ONE (1) EACH ALONG EAST-WEST LINE.

REVISION: A - 04/25/17
ISSUED FOR RECORD
(FERC FINAL LICENSE APPLICATION)

EXHIBIT-F7

CONSUMERS ENERGY COMPANY &
THE DETROIT EDISON COMPANY
LUDINGTON, MICHIGAN
LUDINGTON PUMPED STORAGE PROJECT
BARRIER NET
PLAN AND DETAILS

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT G
PROJECT MAP

The following map shows the location of the Ludington Pumped Storage Hydroelectric Project, principal features, and Project boundary, as set forth in the existing license:

Sheet No.	Title
Sheet G-1 (1 of 1)	Ludington Project Plan View
Sheet G-2 (1 of 4)	Pigeon Lake North Pier Detail Map
Sheet G-2 (1 of 1)	Pigeon Lake North Pier Plan View

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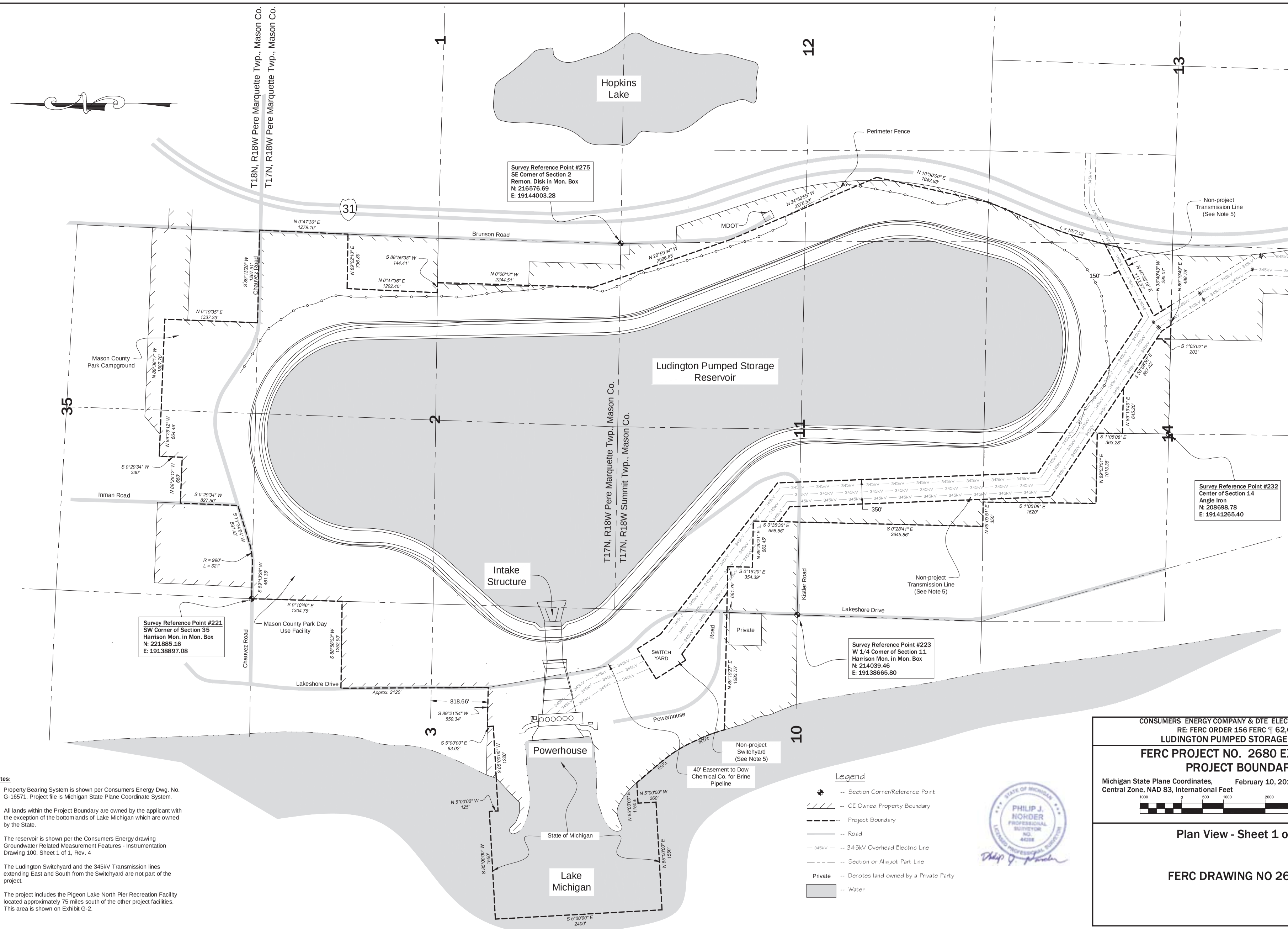

Notes:

1. Property Bearing System is shown per Consumers Energy Dwg. No. G-16571. Project file is Michigan State Plane Coordinate System.
2. All lands within the Project Boundary are owned by the applicant with the exception of the bottomlands of Lake Michigan which are owned by the State.
3. The reservoir is shown per the Consumers Energy drawing Groundwater Related Measurement Features - Instrumentation Drawing 100, Sheet 1 of 1, Rev. 4
4. The Ludington Switchyard and the 345kV Transmission lines extending East and South from the Switchyard are not part of the project.
5. The project includes the Pigeon Lake North Pier Recreation Facility located approximately 75 miles south of the other project facilities. This area is shown on Exhibit G-2.

Legend

- -- Section Corner/Reference Point
- -- CE Owned Property Boundary
- -- Project Boundary
- -- Road
- 345kV -- 345kV Overhead Electric Line
- -- Section or Aliquot Part Line
- Private -- Denotes land owned by a Private Party
- -- Water

CONSUMERS ENERGY COMPANY & DTE ELECTRIC COMPANY
RE: FERC ORDER 156 FERC ¶ 62,097
LUDINGTON PUMPED STORAGE PLANT

FERC PROJECT NO. 2680 EXHIBIT G-1
PROJECT BOUNDARY

Michigan State Plane Coordinates, Central Zone, NAD 83, International Feet

February 10, 2017

1 inch = 1000 feet

1000 0 500 1000 2000 4000

STATE OF MICHIGAN
PHILIP J. NOHDER
PROFESSIONAL SURVEYOR
NO. 44208
LICENSED PROFESSIONAL SURVEYOR

Philip J. Nohder

Plan View - Sheet 1 of 1

FERC DRAWING NO 2680 -

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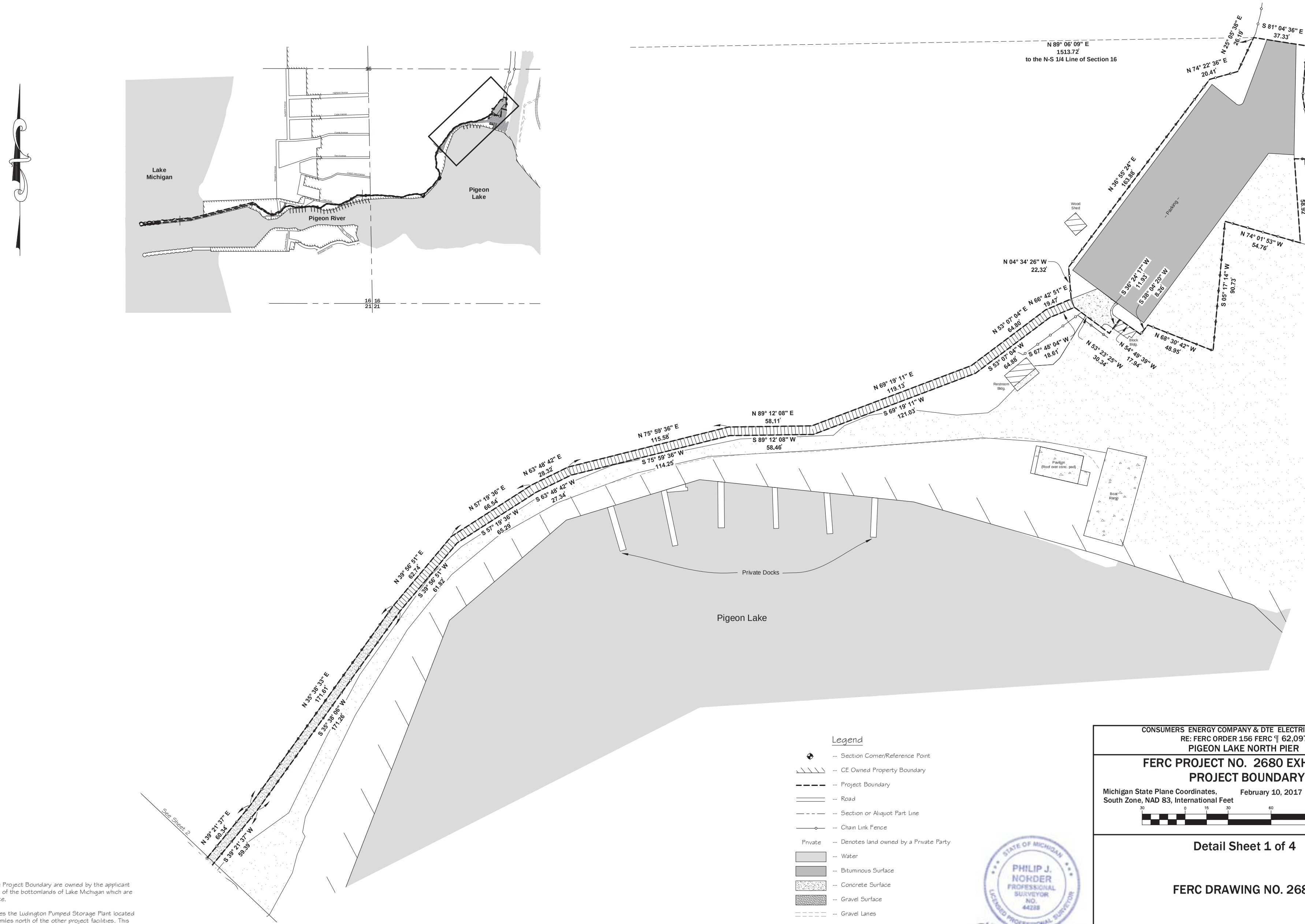

Legend

- -- Section Corner/Reference Point
- -- CE Owned Property Boundary
- -- Project Boundary
- -- Road
- -- Section or Aliquot Part Line
- -- Chain Link Fence
- Private -- Denotes land owned by a Private Party
- -- Water
- -- Bituminous Surface
- -- Concrete Surface
- -- Gravel Surface
- -- Gravel Lanes
- -- Wood Walkway

Notes:

1. All lands within the Project Boundary are owned by the applicant with the exception of the bottomlands of Lake Michigan which are owned by the State.
2. The project includes the Ludington Pumped Storage Plant located approximately 75 miles north of the other project facilities. This area is shown on Exhibit K-1.

CONSUMERS ENERGY COMPANY & DTE ELECTRIC COMPANY
RE: FERC ORDER 156 FERC ¶ 62,097
PIGEON LAKE NORTH PIER

FERC PROJECT NO. 2680 EXHIBIT G-2
PROJECT BOUNDARY

Michigan State Plane Coordinates, South Zone, NAD 83, International Feet

February 10, 2017

1 inch = 30 feet

30 0 15 30 60 120

Detail Sheet 1 of 4

FERC DRAWING NO. 2680

STATE OF MICHIGAN
PHILIP J. NORDER
PROFESSIONAL SURVEYOR
NO. 44238
LICENSED PROFESSIONAL SURVEYOR

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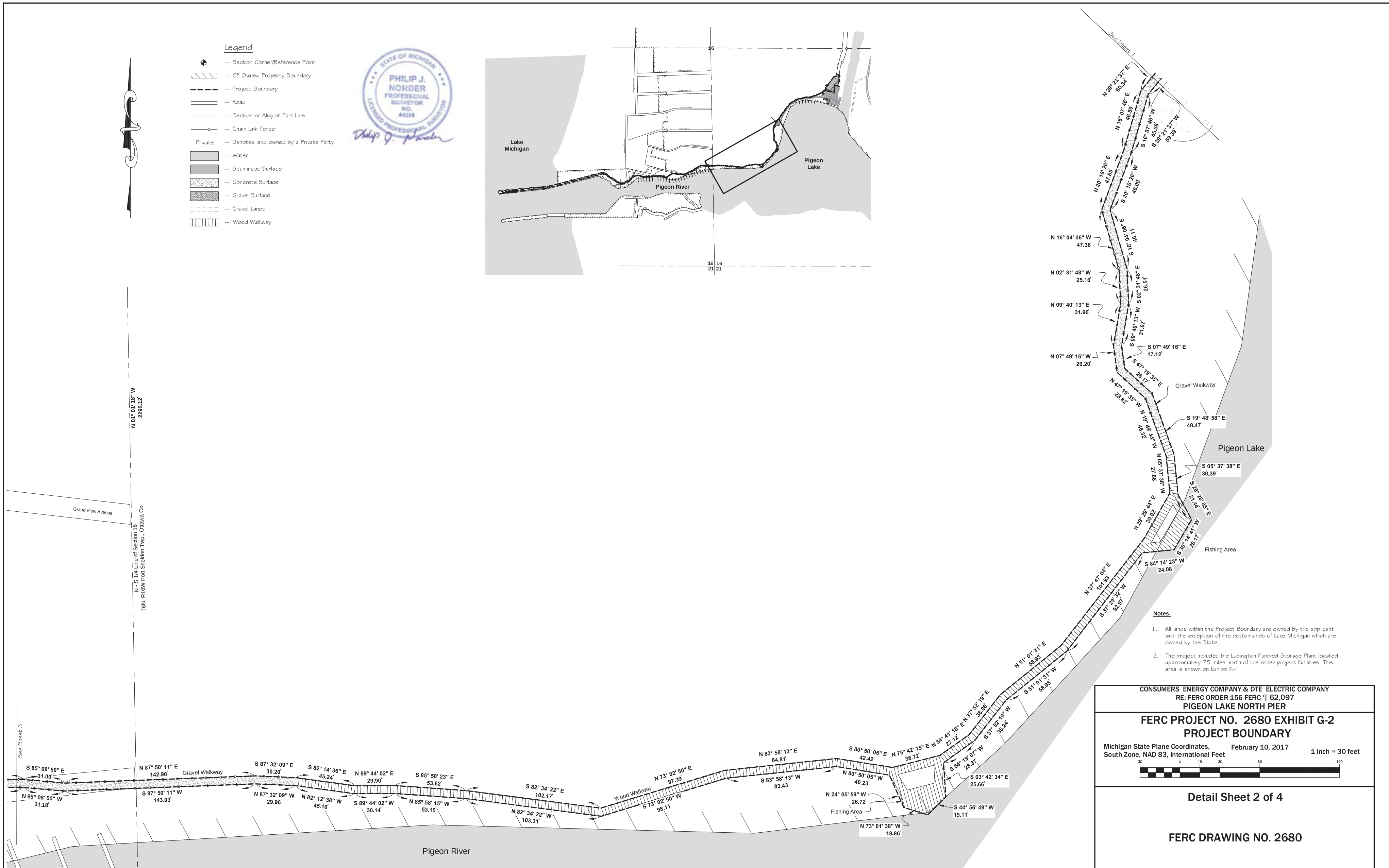

Notes:

1. All lands within the Project Boundary are owned by the applicant with the exception of the bottomlands of Lake Michigan which are owned by the State.
2. The project includes the Ludington Pumped Storage Plant located approximately 75 miles north of the other project facilities. This area is shown on Exhibit K-1.

CONSUMERS ENERGY COMPANY & DTE ELECTRIC COMPANY
RE: FERC ORDER 156 FERC ¶ 62,097
PIGEON LAKE NORTH PIER

FERC PROJECT NO. 2680 EXHIBIT G-2
PROJECT BOUNDARY

Michigan State Plane Coordinates,
South Zone, NAD 83, International Feet

February 10, 2017

1 inch = 30 feet

30 0 15 30 60 120

Detail Sheet 2 of 4

FERC DRAWING NO. 2680

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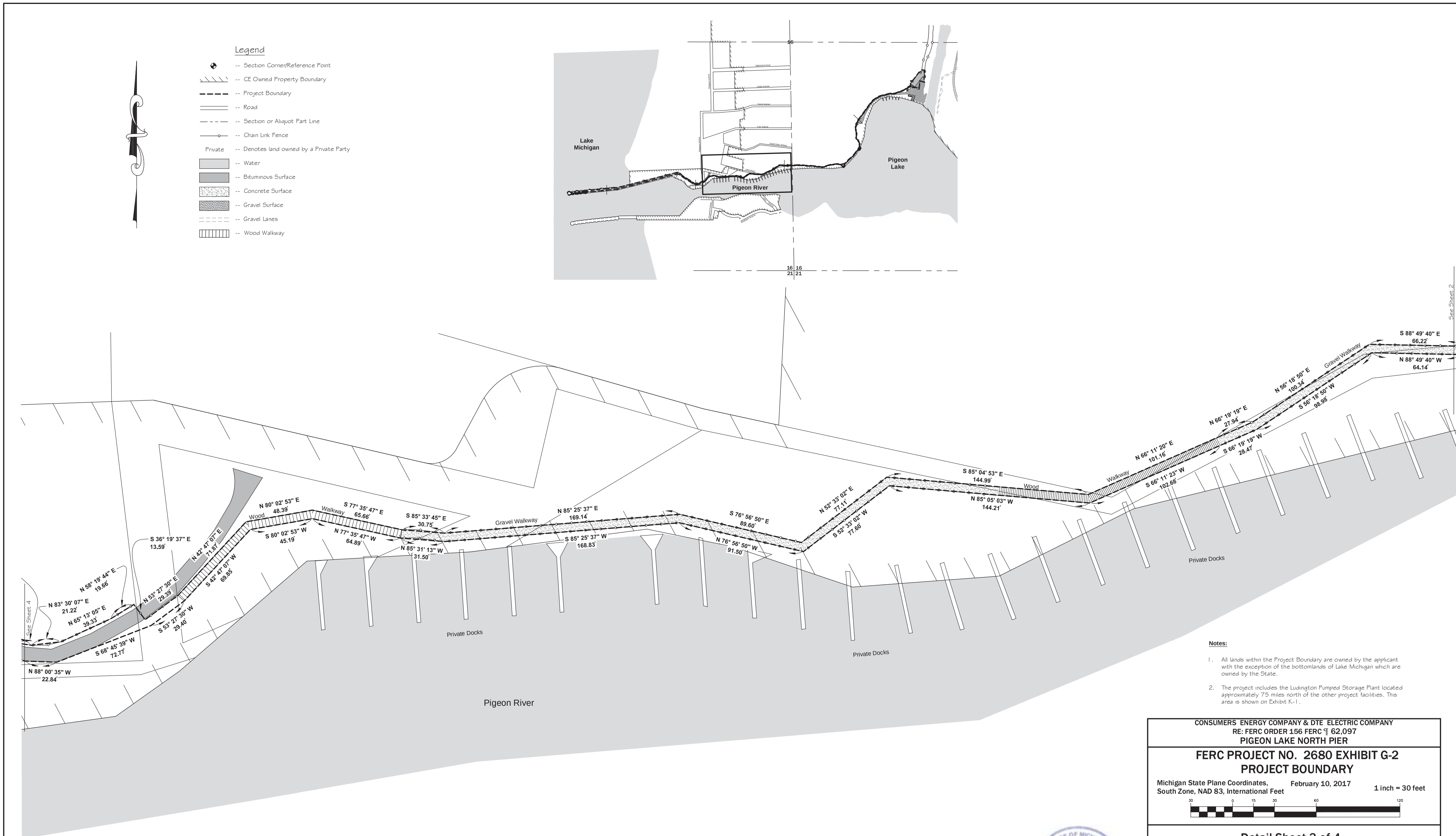

Notes:

1. All lands within the Project Boundary are owned by the applicant with the exception of the bottomlands of Lake Michigan which are owned by the State.
2. The project includes the Ludington Pumped Storage Plant located approximately 75 miles north of the other project facilities. This area is shown on Exhibit K-1.

CONSUMERS ENERGY COMPANY & DTE ELECTRIC COMPANY
RE: FERC ORDER 156 FERC ¶ 62,097
PIGEON LAKE NORTH PIER

FERC PROJECT NO. 2680 EXHIBIT G-2
PROJECT BOUNDARY

Michigan State Plane Coordinates, South Zone, NAD 83, International Feet

February 10, 2017

1 inch = 30 feet

30 0 15 30 60 120

Detail Sheet 3 of 4

FERC DRAWING NO. 2680

STATE OF MICHIGAN
PHILIP J. NORDER
PROFESSIONAL SURVEYOR
NO. 44258
LICENSED PROFESSIONAL SURVEYOR

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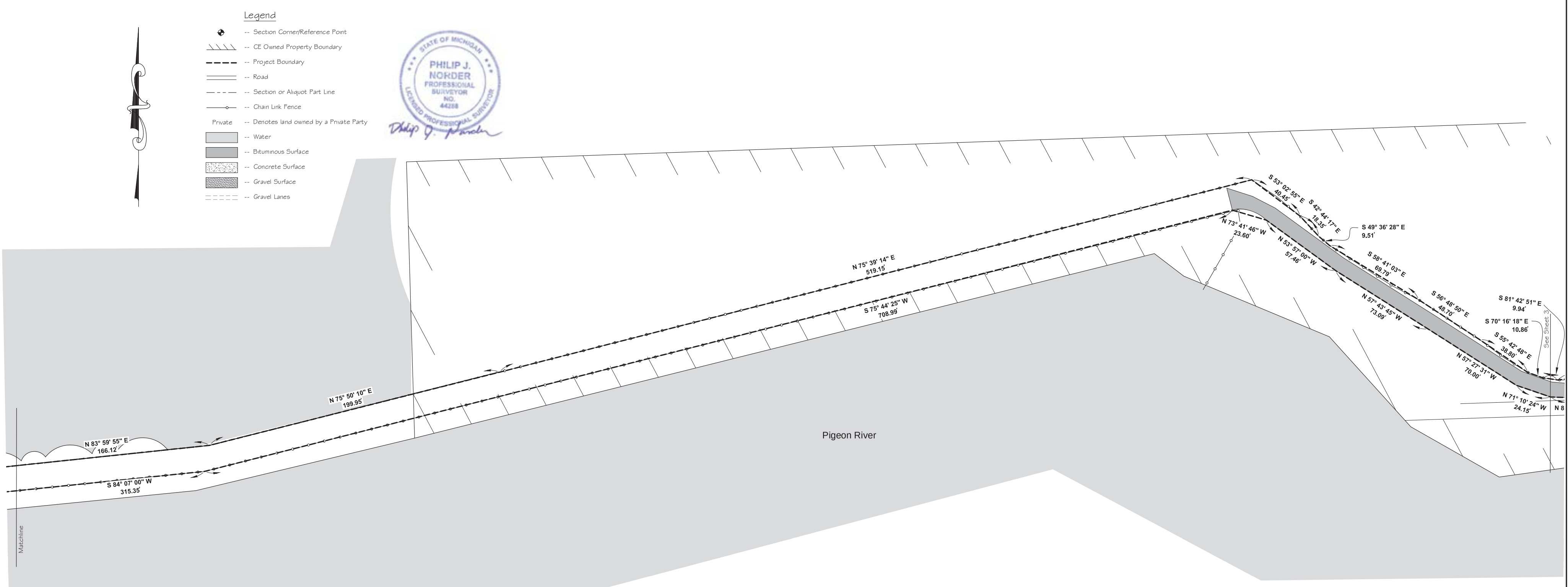

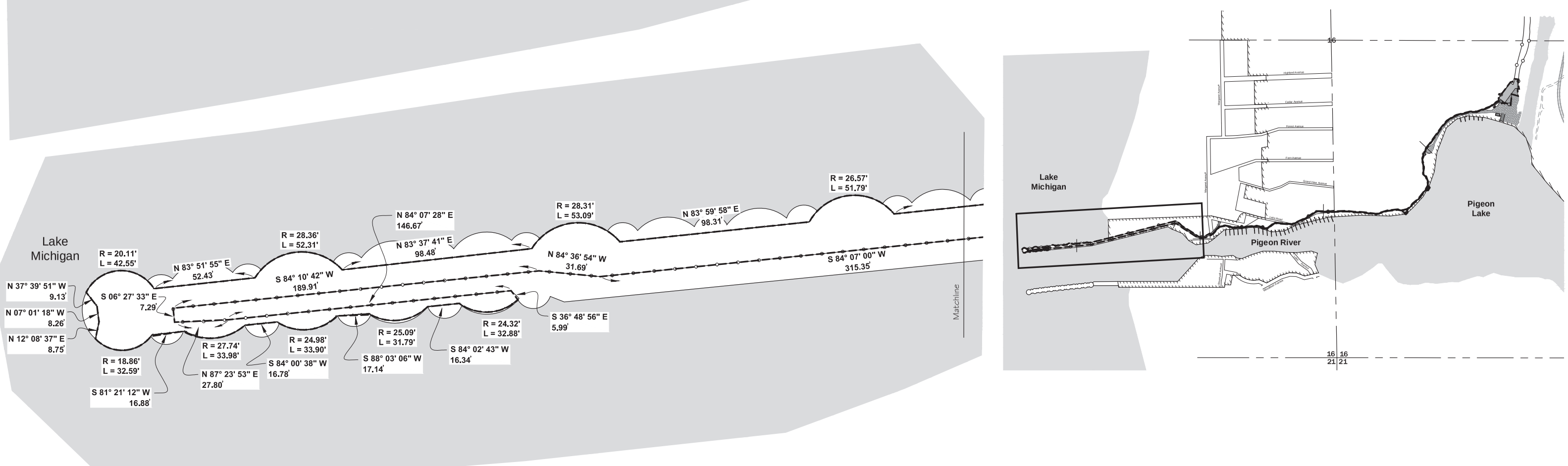

Notes:

1. All lands within the Project Boundary are owned by the applicant with the exception of the bottomlands of Lake Michigan which are owned by the State.

2. The project includes the Ludington Pumped Storage Plant located approximately 75 miles north of the other project facilities. This area is shown on Exhibit K-1.

CONSUMERS ENERGY COMPANY & DTE ELECTRIC COMPANY
RE: FERC ORDER 156 FERC ¶ 62,097
PIGEON LAKE NORTH PIER

FERC PROJECT NO. 2680 EXHIBIT G-2
PROJECT BOUNDARY

Michigan State Plane Coordinates,
South Zone, NAD 83, International Feet

February 10, 2017

1 inch = 30 feet

30 0 15 30 60 120

Detail Sheet 4 of 4

FERC DRAWING NO. 2680

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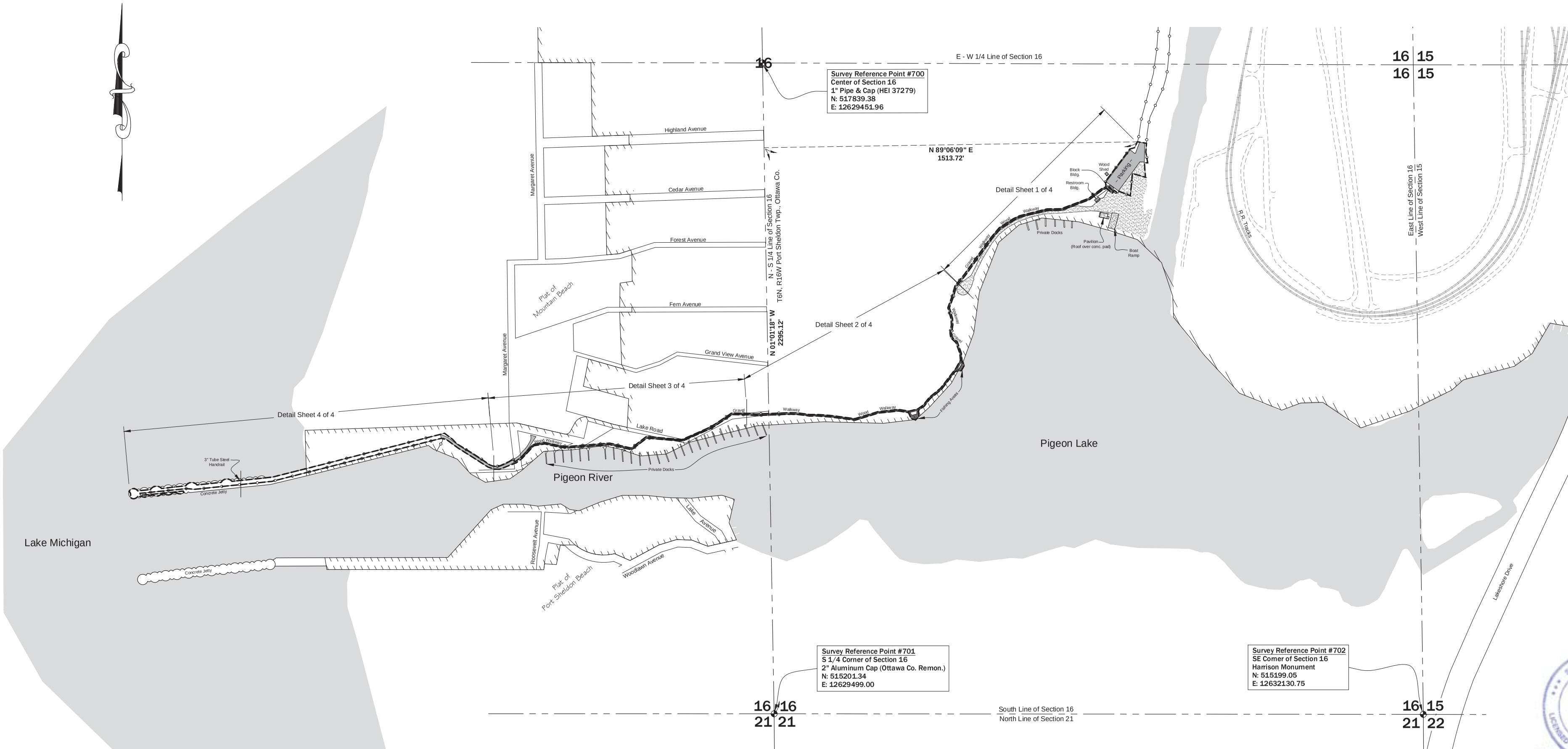

STATE OF MICHIGAN
PHILIP J. NORDER
PROFESSIONAL SURVEYOR
NO. 44288
LICENSED PROFESSIONAL SURVEYOR

Legend

- -- Section Corner/Reference Point
- -- CE Owned Property Boundary
- -- Project Boundary
- -- Road
- -- Section or Aliquot Part Line
- -- Chain Link Fence
- Private -- Denotes land owned by a Private Party
- -- Water
- -- Bituminous Surface
- -- Concrete Surface
- -- Gravel Surface
- -- Gravel Lanes

Notes:

1. All lands within the Project Boundary are owned by the applicant with the exception of the bottomlands of Lake Michigan which are owned by the State.
2. The project includes the Ludington Pumped Storage Plant located approximately 75 miles north of the other project facilities. This area is shown on Exhibit K-1.

CONSUMERS ENERGY COMPANY & DTE ELECTRIC COMPANY
RE: FERC ORDER 156 FERC ¶ 62,097
PIGEON LAKE NORTH PIER

FERC PROJECT NO. 2680 EXHIBIT G-2
PROJECT BOUNDARY

Michigan State Plane Coordinates,
South Zone, NAD 83, International Feet
February 10, 2017
1 inch = 200 feet
200 0 100 200 400 800

Plan View - Sheet 1 of 1

FERC DRAWING NO. 2680

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT H
DESCRIPTION OF PROJECT MANAGEMENT AND NEED FOR PROJECT POWER

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

EXHIBIT H
DESCRIPTION OF PROJECT MANAGEMENT AND NEED FOR PROJECT POWER

1.0 INTRODUCTION

The Ludington Pumped Storage Hydroelectric Project (Project) is an existing hydroelectric project owned by, and licensed to Consumers Energy Company (Consumers) and DTE Electric Company (DTEE) as Licensees. (Figure H-1.0-1) The Licensees are electric utilities in Michigan and, as such, generate electricity and provide electric service to a variety of groups or classes of customers. The Project generates power that is currently sold into the wholesale market administered by the non-profit Midcontinent Independent Operating System (MISO). MISO administers all significant aspects of the Midwest power market including: (i) the MISO Open Access Transmission Tariff; (ii) the dispatch, billing and settlement system for interchange power in MISO; (iii) MISO energy and automatic generation control markets; and (iv) the MISO installed capability market.

2.0 INFORMATION TO BE SUPPLIED BY ALL APPLICANTS

2.1 Plans and Ability of Owners of the Ludington Project to Operate and Maintain the Project

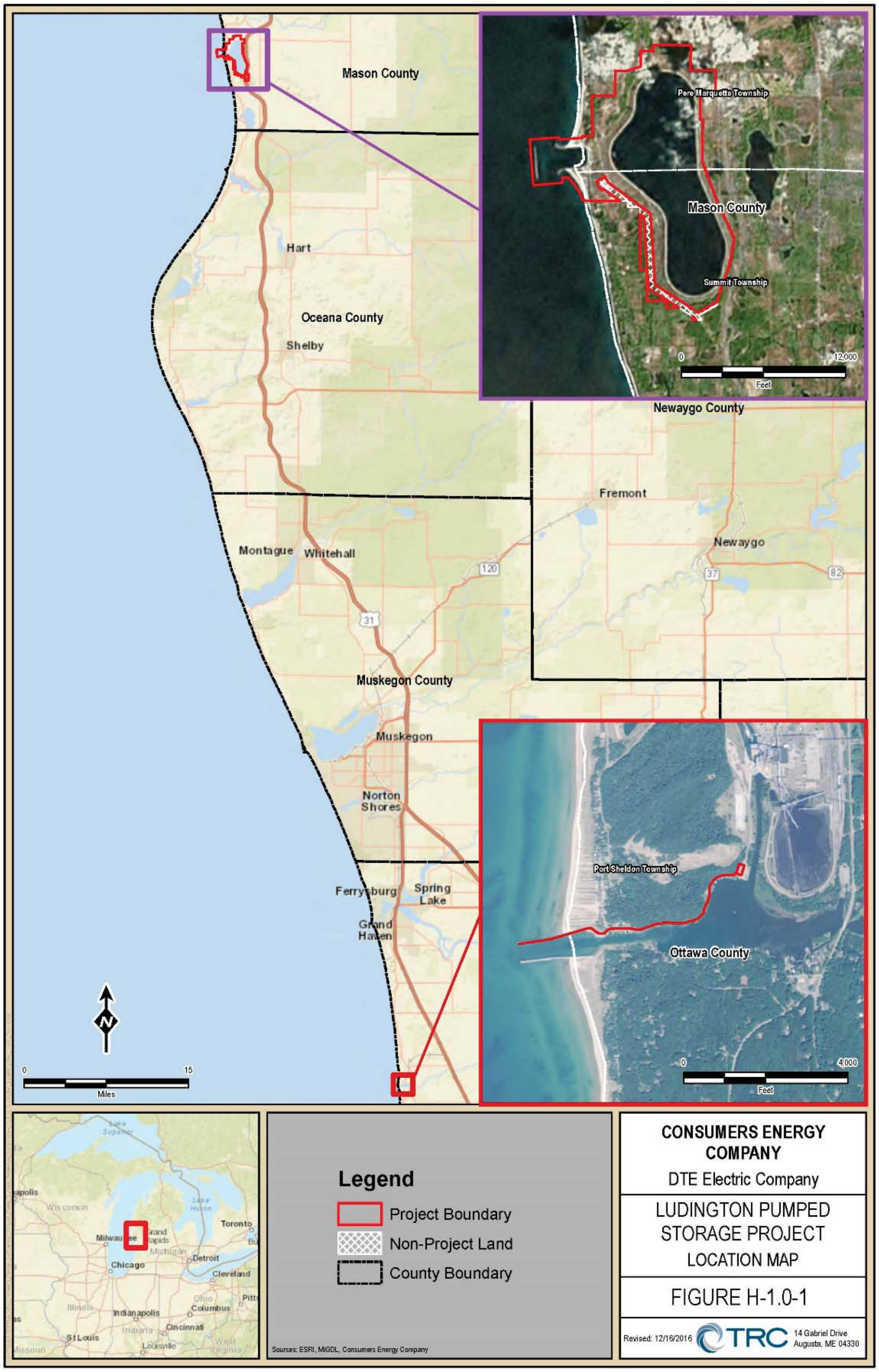
2.1.1 Plans to Increase Capacity or Generation

The Licensees are completing an upgrade of all six units, and, at this time, have no additional plans to increase the capacity or generation of the Project.

2.1.2 Plans to Coordinate the Operation of the Project with Other Water Resource Projects

The Project is located along the eastern shore of Lake Michigan, and operates using a man-made upper reservoir and Lake Michigan as its lower reservoir. (Figure H-1.0-1) Since the Project is not located on a river, the Licensees do not, nor is there any need to coordinate Project operation with any other water resource projects.

Figure H-1.0-1: Ludington Pumped Storage Project Location



2.1.3 Plans to Coordinate the Operation of the Project with Other Electrical Systems

The Licensees are combination gas and electric utilities in Michigan and, as members of MISO, sell Project power into the MISO wholesale market. MISO serves as the independent system operator to operate the regional bulk power system and to administer the wholesale marketplace. MISO's primary responsibilities are to coordinate, monitor, and direct the operations of the major generating and transmission facilities in the region.

The electric facilities of MISO member companies are operated as if they comprise a single power system. MISO accomplishes this by central dispatching of available power resources, and using the lowest cost generation and transmission equipment available at any given time consistent with meeting reliability requirements. MISO participants also have strengthened the reliability of the bulk power system through shared operating reserves and coordinated maintenance scheduling.

The MISO staff constantly monitors and directs the operation of one of the world's largest energy and operating reserves markets, consisting of more than 175,000 MW of market capacity, over 190,000 MW of reliability capacity, and more than 65,800 miles of transmission lines in the central part of the United States and Canada. (MISO, September 2016.) MISO's Energy and Operating Reserves Market includes a Day Ahead market, Real-Time Market, and Financial Transmission Rights Market which are operated and settled separately. These markets include responsibility for daily electrical demand forecasting in the region, scheduling resources to meet the demand, and forecasting long-term electrical needs.

2.2 Need for the Electricity Generated by the Project

2.2.1 The Reasonable Costs and Availability of Alternative Sources of Power

The electricity the Project generates is generally used to meet daily peak electrical demand. The electrical output from the Project is sold wholesale into the MISO administered wholesale market.

The Project's authorized capacity under a new license is 1,785 MW. At the time of filing, three of the six upgrades were completed and the Project has an authorized capacity of 1,700 MW. In 2016, the Project's production cost was approximately $22.16 per MWH.

In 2016, the Licensees' peak load, marginal annual production costs and marginal capacity costs are in Table H-2.2.1-1.

Table H-2.2.1-1: Licensees' system data for 2016

Licensee	Peak Load (MW)	Marginal annual production cost ($/MWH)	Marginal Capacity cost ($/MW)
Consumers	7,635[1] MW	$28.88[2] / MWh	$26,280[3] / MW-year
DTEE	10,441[4] MW	$28.21[5] / MWh	$26,280[3] / MW-year

[1] 2016 peak bundled load (does not contain retail open access load) for Consumers Energy achieved on August 11, 2016.
[2] Average Day-Ahead Locational Marginal Price in 2016 as measured at Consumers Energy's MISO Load Node, CONS.CETR.
[3] Capacity value for Local Resource Zone 7 (Lower Michigan) as determined by MISO in its 2016/2017 Planning Resource Auction.
[4] 2016 peak bundled load (does not contain retail open access load) for DTE Energy achieved on August 12, 2016.
[5] Average RTC Day-Ahead Locational Marginal Price in 2016 as measured at DTE Energy's MISO Load Node, DECO.NEC.

Michigan allows customer choice and, as a result, the Licensees provide Retail Open Access (ROA) service in addition to full service. Marginal costs of capacity and energy are expected to be greater in future years. If the Licensees are denied a license to operate the Project, the Licensees and its customers would incur short term and long-term increased costs resulting from the necessary acquisition of replacement capacity and energy. Combustion turbines are expected to have a capital expense of approximately $773/kW and an operating cost of approximately $52.34/MWh Gas combined cycle plants are expected to have capital expenses of approximately $999/kW and operating costs of approximately $26.68/MWh These values are in year 2017 dollars assuming an average gas price of $4.18/MMbtu. Loss of the license for Ludington Project can be expected to lead to higher energy costs for the Licensees and their customers.

Increase in Costs if the Licensee is not Granted a License

If the Licensees are not granted a license, the Project would cease to provide clean, and affordable electricity to MISO from its generation. An unquantified increase in costs would likely occur to the Michigan electric consumer if a license for continued operation of the Project was not granted.

2.2.2 Effects of Alternative Sources of Power

Effects on Licensee's Customers

The Project is a large energy storage project, with an authorized capacity of 1,785 MW after the unit maintenance upgrades are complete, and is the only pumped storage project located in MISO. The Project's annual generation has averaged approximately 2,357,066 MWH during the period from October 1999 to September 2016. The energy generation competes favorably in price with alternative sources of power. If the Project is not relicensed, the capacity and energy would be replaced at the costs reflected in Section 2.2.1 resulting in higher costs to the Licensees' customers.

The fuel mix data for the electricity supplied by the Project includes the regional average fuel mix data from Michigan, Illinois, Indiana, Ohio, and Wisconsin as a proxy for the actual fuel mix of certain electricity purchased by Consumers Energy because the actual fuel mix characteristics of that purchased electricity could not be discerned. Based on this MISO profile for the period October 2015 to September 2016, the MISO NOx rate is 2.0 Lbs/MWh and the SO2 rate is 7.6 Lbs/MWh.

Effect on Licensee's Operating and Load Characteristics

Given the Project's large size, its loss would have a significant effect on load characteristics both during generation and pumping activities.

Effect on Communities Served by the Project

The economic effect on the communities served by and in which the Project is located can be significant. In the state of Michigan, power plant property taxes are received directly by the community(s) hosting the project. For a large generating project such as the Ludington Project, this tax income has a significant benefit to the local community. As each unit upgrade is commissioned, the property tax for the Project is expected to increase. In addition to local tax income, the Project hosts recreation areas that supplement local community recreation, bringing tourism and recreation income to the communities. The Project also employs 41 employees at the plant. Additional economic benefits flow to the local communities from employee spending.

2.3 Need, Reasonable Cost, and Availability of Alternative Sources of Power

The Licensees are electric utilities and have an obligation to serve load and provide capacity in their electric service territories.

2.3.1 Average Annual Cost of Project Power

The average cost of producing electricity at the Project is $22.16 dollars per megawatt-hour ($/MWH). Production costs are expected to change annually by the change in the Consumer Price Index (CPI). This estimate is based on historical routine Operating and Maintenance (O&M) expenses, including Commission fees, property taxes, labor costs and routine/repetitive non-labor costs. It also includes an estimate of annual depreciation expenses, non-routine construction and maintenance and license initiatives. The estimate assumes annual generation of approximately 2,357,066 MWH, which is the average annual generation produced by the Project between October 1999 and September 2016.

2.3.2 Short and Long Term Capacity and Energy Requirements

Energy and Capacity Resources

For 2017, Consumers' base load capacity is forecasted to be approximately 3,010 megawatts (MW) consisting of 1,974 MW of coal fired, and 32 MW of conventional hydro power, and 199 MW derived from other renewable sources (biomass, anaerobic digesters, landfill gas, and solid waste). In addition, Consumers has approximately 3,433 MW of intermediate capacity (including the Ludington Project), 1,929 MW of peaking capacity which includes 520 MW from oil/gas fired plants, 558 MW of intermittent resources (wind and solar). Consumers also contracts up to 215 MW of capacity on a long-term and seasonal basis for 2017, and has long-term capacity contracts with non-utility generators in the amount of 3,014 MW. The impact of conservation/load management measures is reflected in the Licensees' forecasted peak bundled load demand for year 2017 of approximately 7,599 MW.

As of 2017, DTEE has approximately 7,457 MW of base load capacity and 3,247 MW of peaking capacity (excluding its share in the Ludington facility). DTEE's share of the Ludington Project is 833 MW (49% of 1,700 MW). Additionally, DTEE owns approximately 517 MW of renewable generation, which includes 451 MW of wind generation and 66 MW of solar generation. DTEE also contracts up to 581 MW of additional installed capacity on an annual basis. The impact of conservation/load management measures is reflected in DTEE's forecasted peak bundled load demand for year 2017 of approximately 10,423 MW.

Resource Analysis Including System Reserve Margins

Consumers' reserve margin is currently approximately 8.30% of forecasted summer peak load. As of 2017, full service load is expected to grow at an average annual rate of 0.61% per year through 2030. Any additional peak load requirements beyond the current generation capability will be met through purchases of power from other power producers or from additional generation capability developed by Consumers Energy.

The service territory for DTEE load is expected to decline 1.37% by 2030. Despite the decreasing load forecast, there will be a future need for additional base load capacity due to the projected retirement of three coal units. In June 2016, DTEE announced the proposed retirements of River Rouge, St. Clair and Trenton Channel power plants projected to occur between 2020 and 2023. Forecasted declining reserve margins within the state of Michigan and across the MISO market emphasize the need for the exploration of additional capacity resources to meet future reliability requirements. The Company plans to transform the generation fleet to more advanced and cleaner technologies.

Effects of Load Management Measures

The Licensees have been actively involved in a number of load management or energy conservation programs. See Section 2.11 of this Exhibit for a more in-depth discussion of the Licensees' energy conservation programs.

2.4 Effect of Power on Licensees' Industrial Facilities

This section is not applicable to the Licensees, who do not own industrial facilities.

2.5 Need of Indian Tribe Licensee for Electricity Generated by the Project

This section is not applicable to the Licensees.

2.6 Impacts on the Operations and Planning of Licensees' Transmission Systems

The Ludington Project is connected directly to the 345 kV electric transmission system, which is an independent transmission system owned and operated by subsidiaries of ITC Holdings. Neither Consumers nor DTEE own and operate the electric 345 kV transmission system, and energy generated by the Project is transmitted directly into that transmission system, which is ultimately overseen by MISO. Consumers Energy owns a limited amount of 138kV transmission facilities that are also overseen by MISO. The Licensees purchase pumping energy directly from MISO. ITC's existing transmission system studies for pumping and generation indicate there are no unmitigated transmission constraints. The Project provides both transmission system stability and black start capability to the electric transmission system.

2.6.1 Effects of Power Flow Redistribution

The power flow analysis was not conducted as current studies indicate there are no unmitigated transmission constraints.

2.6.2 Advantages of Applicants' Transmission Systems

The Licensees do not own or operate the electric transmission system.

2.6.3 Detailed Single-Line Diagrams

A detailed single-line diagram showing transmission/distribution system for the Project is in Figure A-5-1, in Exhibit A of this License Application.

2.7 Statement of Need for Modifications

The Licensees are not proposing changes to the Project facilities or operation beyond completion of the approved unit upgrades. These upgrades are scheduled to be completed before 2020.

2.8 Consistency with Comprehensive Plans

Section 10(a)(2) of the Federal Power Act (FPA) requires the Federal Energy Regulatory Commission (FERC or Commission) to consider the extent to which a project is consistent with Commission approved federal and state comprehensive plans for improving, developing, and conserving waterways affected by the project. In accordance with Section 10(a)(1) of the FPA, the list of Commission approved federal and state comprehensive plans was reviewed to determine applicability to the Project. The federal resource agencies, as well as the State of Michigan, have prepared a number of comprehensive plans, which provide a general assessment of a variety of environmental conditions in Michigan. These plans address water quality, water pollution control, invasive species management, recreation, and fisheries issues. The Project's consistency with FERC-approved state and federal comprehensive plans is discussed below. Comprehensive Plans listed below have not been updated with FERC since their development unless otherwise noted.

Based on an October 2016 review of FERC approved plans, 4 federal and 5 state plans have been identified that may apply to the Project. The state plans include SCORP (addressing recreation planning), aquatic invasive species, strategic fishery plans for the Great Lakes, and species specific fishery plans (Lake Sturgeon). Federal plans focus on piping plover recovery and three related waterfowl management plans for the Great Lakes. Specific plans are listed and discussed below; plan dates are also included. (Table H-2.8-1)

Table H-2.8-1: State and Federal plans applicable to the Ludington Pumped Storage Project

Agency	Plan Title	Year	Plan Summary
Michigan Department of Environmental Quality	Non-indigenous aquatic nuisance species, State management plan: A strategy to confront their spread in Michigan	1996	MDEQ's approved Aquatic Nuisance Species (ANS) Plan includes Michigan's goals and approach to limiting the spread of ANS and abate the impacts resulting from ANS. The Plan is in response to federal law (Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (Public Law 101-646)). The Plan lists the key target ANS species (zebra and quagga mussels, ruffe, round goby, spiney water flea, Eurasian watermilfoil, and purple loosestrife and identifies funding

Agency	Plan Title	Year	Plan Summary
			levels needed for implementation. The Plan outlines the three ways it intends to meet the plan goals: - Information and education - Research and monitoring - Policy and regulations The Plan was updated in 2002, conforming with the National Invasive Species Act of 1996, which reauthorized the 1990 law. The 2002 Plan continues to list the same ANS as the prior plan, provides an update on progress and outlines how it intends to address the three means of achieving the Plan goals.
Michigan Department of Natural Resources	Fisheries Division strategic plan	1994	Based on more recent plans (2002 and 2013-2017) the MDNR strategic plan addresses all aspects of fishery management and protection. The plan includes fishery monitoring, stocking, water quality, recreation, fish species, angler limits, and tribal considerations for statewide inland waters and the Great Lakes. The plan also addresses partnerships and funding levels needed to implement the plan.
Michigan Department of Natural Resources	Statewide Comprehensive Outdoor Recreation Plan (SCORP): 2008-2012	2009	The SCORP identifies current recreational opportunities, reviews population and recreational trends in the state, and addresses recreation plans for the state.
Michigan Department of Natural Resources	Lake Sturgeon rehabilitation strategy	1997	The Lake Sturgeon Rehabilitation strategy presents river-based strategies and strategies to improve fish passage around river-based hydroelectric projects, with additional focus on sea lamprey and water quality as contributing factors in recovery of the species.
US Fish and Wildlife Service	Great Lake and Northern Great Plains Piping Plover Recovery Plan	1988	The recovery plan designates critical nesting and over-wintering habitat, defines cooperative state and federal actions, addresses both state and federal legal protection, and identifies landowner education. (Nordhouse Dunes (MI-17) in Mason County are protected critical

Agency	Plan Title	Year	Plan Summary
			nesting habitat. This area is located 14 miles north of the Project.)
US Fish and Wildlife Service; Canadian Wildlife Service	North American waterfowl management plan	1986	Originally published in 1986, this plan was updated in 2011/2012, with an addendum of revised objectives issued in 2014. This plan addresses management and protection of waterfowl (defined in the plan as 37 species of the Anatidae family that regularly occur in the United States and Canada) and their habitat.
US Fish and Wildlife Service	The Lower Great Lakes/St Lawrence Basin: A component of the North American Waterfowl Management Plan (NAWMP)	1988	The Plan implements habitat goals established under NAWMP and cover the states of Michigan, Ohio, Pennsylvania, New York and Vermont. The goals include protection of an additional 10,000 acres of breeding and migratory habitat; a 25% increase in carrying capacity of land managed for waterfowl by wildlife agencies; improve habitat quality of other areas in the region; and maintain overall waterfowl habitat values and minimize exposure to contaminants. The area of Michigan covered by this plan is the eastern portion of Michigan bordering Lake Erie. This plan does not apply to the Project.
US Fish and Wildlife Service	Upper Mississippi River & Great Lakes Region (UMR/GLR) Joint Venture implementation plan: A component of the North American Waterfowl Management Plan (NAWMP)	1993	The Plan implements habitat goals established under NAWMP and covers the Upper Mississippi River and Great Lakes regions of Michigan, Wisconsin, Indiana, Illinois, Minnesota, Iowa and Missouri. The goal of the UMR/GLR joint Venture plan is to increase population of waterfowl and other wetland dependent wildlife by protecting, restoring, creating, and enhancing wetlands within the Joint Venture region. Specific population and habitat goals include contributing an additional 309,000 breeding ducks to the spring population and an additional 539,000 ducks to fall flight; protecting about 1.3 million acres of wetland and

Agency	Plan Title	Year	Plan Summary
			associated upland on public and/or private land through acquisition, easements and agreements; enhancing, restoring, and/or creating over 600,000 acres of wetland and upland habitat on public and private lands; developing a communications plan to inform the public on the multiple values of wetlands and protecting wetland habitat through strengthening and/or initiating new legislation. In Michigan, the Plan's population objectives are to contribute an additional 41,500 breeding ducks to the spring population annually; to contribute an additional 7,000 ducks to the annual fall flight. Habitat objectives are to permanently protect an additional 30,000 acres of wetland and upland habitat via fee title acquisition and long-term easements (~ 10 years); to protect an additional 5,000 acres of wetland and upland habitat on private land via short-term agreements (~10 years); to enhance, create and/or restore 42,500 acres of wetland and upland habitat on public land; to enhance, create and/or restore 20,000 acres of wetland and upland habitat on private lands via short-term agreements (~10 years). The Plan also includes strategies to meet the objectives and targets six areas in the state with specific management targets. One specific target is the Drowned River Mouth Focus Area. Western Michigan's Lower Peninsula shoreline is characterized by a series of "drowned river mouth" wetlands set behind dunes and barrier beaches. These river floodplain marshes and timbered swamps have low gradients and are affected by the levels of the Great Lakes. The most important and largest of these river wetlands include the Galien, Kalamazoo, Grand, Muskegon, White,

Agency	Plan Title	Year	Plan Summary
			Pentwater, Pere Marquette, Manistee, and Benzie. Some of these units extend inland 4 to 15 miles from the lakeshore. The lower reaches are typically herbaceous with cattails, sedges, and pond lilies dominating, but these units grade upstream into timbered swamps in which silver maple, black ash, and elm are dominant. About 40 percent of this 40,000-acre focus area remains in private ownership. Major threats to wetlands include marina and residential development associated with the Lake Michigan boating and commercial fishing markets. These river marshes were encroached upon years ago for industrial and commercial navigation development. Acquisition of critical wetlands is a high priority. The Project is not located along a river mouth and does not affect these priority areas.

The comprehensive plans listed above have several main objectives:

- To maintain and promote wildlife in desirable numbers for hunting, fishing and observation
- To increase recreational activities
- To manage the spread of aquatic invasive species
- To promote recovery of threatened and endangered species.

The proposed operation of the Project will not change from the current/historic operation, and activities proposed by the Licensees generally support the intent of these plans. Furthermore, the Licensees intend to continue to work with the federal and state agencies (as they have done historically) to address resource concerns. Therefore, continued operation of the Project should continue to support consistency with these plans.

2.9 Financial and Personnel Resources

2.9.1 Financial Resources

Consumers is a subsidiary of CMS Energy. As such, Consumers is in a superior position to operate and maintain all of its current hydroelectric projects including the Project. As a large corporation with assets of approximately 19 billion dollars, Consumers has the necessary resources to continue the efficient operation and maintenance of the Project and to ensure the comprehensive management of the resources in the vicinity of the Project.

Additional information on Consumers' financial position can be obtained from Consumers' FERC Form 1, which is filed annually with the Commission.

DTEE is a wholly-owned subsidiary of DTE Energy. DTEE is a public utility operating company engaged in the generation and distribution of electric energy in MISO's Local Resource Zone 7 in the lower peninsula of the State of Michigan. DTEE provides retail electric service to approximately two million customers throughout Detroit and portions of southeastern Michigan, and also engages in wholesale sales of electric energy at market-based rates pursuant to authority granted by the Commission. In addition, DTEE is a non-transmission owning member of the MISO. The Company's retail electric service is subject to the jurisdiction of the Michigan Public Service Commission. In addition, DTEE is also regulated by other federal and state regulatory agencies including the NRC, the EPA, the MDEQ, and the CFTC.

As a large corporation with assets of approximately $20 billion dollars, DTEE has the necessary resources to continue the efficient operation and maintenance of the Project and to ensure the comprehensive management of the resources in the vicinity of the Project. (DTE Energy 10K, 2016)

2.9.2 Personnel Resources

As of December 31, 2016, Consumers had 7,465 employees and DTE Energy had more than 10,000 employees. Consumers owns and operates baseload generation consisting of 13 hydroelectric facilities and five coal fired plants, with a combined summer net demonstrated capability of approximately 2,078 MW. In addition, Consumers has approximately 3,433 MW of intermediate capacity (including the Ludington Project), 1,929 MW of peaking capacity which includes 520 MW from oil/gas fired plants, 558 MW of intermittent resources (wind and solar). All generating facilities are located in Michigan's Lower Peninsula. Consumers also owns and operates electric and gas distribution facilities serving customers in 62 counties in Michigan's Lower Peninsula.

DTEE owns and operates base load generation consisting of one nuclear facility and five coal fired plants, with a combined summer net demonstrated capability of approximately 7,457 MW.

DTE Electric also has peaking capability totaling approximately 4,080 MW consisting of various oil/gas fired units, combustion turbines, and a 49% ownership (833 MW (authorized capacity) in the Ludington Pumped Storage Project. All generating facilities are located in Michigan's Lower Peninsula.

Under an arrangement with DTEE, Consumers operates and maintains the Ludington Project since it is located within its electric service territory. Consumers' Manager of Hydro and Renewable Generation supervises the 41 employees responsible for the operation and maintenance of the hydro projects including the Ludington Pumped Storage (LPS) Plant.

Day-to-day operations of the Ludington Plant are overseen by the Plant's Operations and Maintenance (O&M) Manager who reports directly to the Manager of Hydro and Renewable Generation. A Production Supervisor Lead reports to the O&M Manager and is directly responsible for the daily operation of the Ludington Project through three Operations Supervisors. The Plant Control Operators are responsible for putting the generating/pumping units on- and off-line, scheduling and monitoring equipment, and a multitude of other responsibilities in operating the Ludington Project. A minimum of two Plant Control Operators are on duty in the LPS Plant Control Room 24 hours a day, 7 days a week.

The Ludington Operations Group coordinates daily Ludington Plant operations directly with Consumers' Electric Sourcing and Trading (ES&T) Electric Supply Department, and does not normally coordinate directly with DTEE's equivalent. Consumers' ES&T personnel relay any operational information to DTEE's Electric Supply Department as the need arises.

As a jointly owned facility, Consumers and DTEE compute total energy available as well as each individual company's energy share. As Consumers is contractually the 51% owner of the facility, Consumers Energy has responsibility for physical operation and maintenance of the LPSP facility. Consumers Energy Electric Supply department has the function of monitoring and scheduling all of Consumers' power producing units including Consumers' share of the Ludington Project's units based on the economic value of the energy produced and the operating limitations of the generator. The Electric Supply department coordinates all offers, bids and awards with MISO and advises MISO of any operational limitations. This department operates on a continuous basis with multiple teams of power supply coordinators and supervisors to cover the 24 hour per day, seven day per week operation. The Electric Supply department is physically headquartered in Jackson, Michigan.

Consumers uses a resource pool of maintenance personnel which includes individuals that are experienced and highly trained as electricians, machinists, mechanics and welders for major maintenance and outage support. Consumers responds as soon as possible to any operating emergencies that may arise. Personnel from other locations can be moved as necessary to handle current problems while still maintaining the integrity of the remaining system.

On a more routine basis, experienced maintenance personnel perform a variety of service and repair tasks on the Ludington Project units and auxiliary equipment to maintain them in good operating condition. The prime objective of both the routine and preventive maintenance programs is to achieve maximum generation availability and hold forced outage and associated generation losses to a minimum.

Consumers has long recognized the importance, as well as the benefits, associated with implementing and supporting an effective preventive maintenance program. Daily checks of each unit and auxiliary equipment are performed by Plant Control Operators to verify bearing temperatures, cooling water and lube oil flow conditions. Such activities help detect problems with equipment at an earlier stage, and corrective maintenance can then be performed in a timely manner. Periodic inspections are also conducted. Early detection of abnormal equipment wear, broken or defective parts or diminished unit performance reduces unscheduled outages. Local operating personnel often perform repairs at the time of inspection or can schedule unit overhauls for more convenient times so operation or reliability of the unit is not compromised. Through the preventive maintenance program, Consumers can avoid more costly repairs and extended outages on the units.

In addition to the daily inspections of the units and auxiliary equipment in the powerhouse, Consumers personnel conducts various levels of dike inspections on a daily, monthly, quarterly and/or annual basis and surveillance of other project structures and monitoring instrumentation on a periodic basis. These inspections and surveillance are performed by onsite operating personnel. Periodic surveillance is also conducted by Project supervisory personnel and consists of a “visual inspection” of the entire Project. The primary purpose of this surveillance is to note any changes or abnormal operation of control structures and equipment. A surveillance monitoring report is prepared every even month for the preceding two-month period and is reviewed by a committee comprised of both Project and off-site personnel including DTEE representatives. Because of their familiarity with the Project facilities, Consumers’ personnel can identify unusual occurrences and initiate appropriate procedures prior to a formal inspection.

Consumers also conducts an annual inspection of both powerhouse gantry cranes and the intake gantry crane in compliance with OSHA and company required safety inspections. This inspection also provides a means of noting any problem areas with crane operation or conditions which require correction.

Consumers’ exemplary operation and maintenance performance of the Project is demonstrated by the low number of forced outages recorded over the past five years as shown in Section 3.5 (18CFR16.10(b)(5)) of this Exhibit H document.

In addition to the day to day operation of the Ludington units, Project staff members are assigned to coordinate and oversee project modification and maintenance activities and regulatory and emergency planning activities. A Dam Safety Engineer is responsible for maintenance projects, modifications, coordinating engineering support and compliance with Commission regulations related to such activities. Project support personnel are also responsible for environmental monitoring and compliance, emergency action plan, commitment (from Commission orders) work order tracking program and environmental enhancements. Additional staff members are responsible for preparation of the application for a new license including the required exhibits, environmental studies and Resource Agency consultation as necessary.

For added support and specialty needs, Consumers has other departments from which the necessary personnel are drawn for activities requiring their expertise. These departments include Legal, Environmental and Lab Services, Communications, and Engineering.

2.10 Notification of Affected Land Owners

The Licensees do not propose to expand the Project to encompass additional lands of others. Therefore, notification of adjacent landowners is not applicable.

2.11 Applicants' Electricity Consumption Efficiency Improvement Programs

In 2.11.1 of this section, the Licensees provide a statement of their record encouraging or assisting customers to conserve energy and a description of their plans and capabilities for promoting electricity conservation. In 2.11.2 of this section, the Licensees describe compliance with any applicable regulatory requirements for their energy conservation programs. Programs for both Consumers and DTEE are discussed in these sections.

2.11.1 Conservation Programs

Consumers

Since the current Michigan energy law was adopted in 2008, Consumers Energy has taken major steps to help Michigan shape a secure, stable and reliable energy landscape, including:

- Making significant investments to improve electric reliability and customer service while building a balanced and diversified energy portfolio.
- Becoming a leading supplier of renewable energy in Michigan. Consumers Energy utilizes sources such as wind, solar, hydro, landfill gas, anaerobic digestion and biomass for the electricity supplied to customers.
- Achieving the state's required standard for renewables a full year ahead of schedule and below initial cost estimates.
- Installing billions of dollars of emissions control equipment at coal-fueled generating plants to help make Michigan's air the cleanest it has been in decades.

- Installing smart meters in the Company's service territory to improve reliability, help provide customers more control over their energy use and promote energy conservation.
- Helping customers save $1 billion since 2009 by creating and implementing energy efficiency programs to reduce their use of electricity and natural gas.

The majority of programs contained in Consumers Energy's energy efficiency portfolio were a continuation of programs launched in 2009. The development of these programs was based on a national review of leading energy efficiency programs, and they achieved significant and immediate energy savings, while also building on established trade ally and retailer partnerships. The programs targeted all major sectors and customer classes, including low-income and small business customers. Programs were designed to capture both electric and natural gas savings. For those Consumers Energy customers with only electric or only natural gas service, efforts were made to coordinate and align with other utilities so that customers could easily take advantage of efficiency program offerings across both fuel types, thereby producing an overall benefit for Michigan's energy efficiency goals. The Company offered a diverse portfolio of "tried and true" programs across the residential, commercial and industrial (C&I) sectors. Additionally, the Company continued to plan and/or implement several residential and business pilots targeting experimental opportunities.

DTEE

DTE's Energy (DTE or DTE Energy)) Optimization (EO) Program launched in June 2009 as a result of the Clean, Renewable and Efficient Energy Act, also known as Public Act 295 (PA 295). DTE continued to build on its momentum from the 2009 launch by enhancing the scope of existing programs and adding new program options to the portfolio. Since 2009, more than 1.8 million electric customers served by DTE Electric (DTEE) and over 1.1 million gas customers served by its affiliate DTE Gas Company have directly participated in DTE Energy's EO Programs. Customers have upgraded equipment in their homes and their businesses, helping them to become more energy efficient, and they have been provided with education, tips, strategies and tools to help them save money on their energy bills. As a result, DTE has saved approximately 3,703 gigawatt hours (GWh) or almost 8 percent of planned retail sales for electric customers, and over 7,893 million cubic feet (MMcf) or more than 5 percent of planned retail sales for gas customers since the program started. The savings achieved so far will continue for years into the future.

DTE utilizes implementation contractors and has built strong networks to deliver energy efficiency programs throughout the State of Michigan. The Company has continued to provide energy efficiency education and raise awareness of EO offerings by enhancing the content of its website and expanding social media and contests to gain further awareness by its customers. The

Company continued to utilize target marketing to meet segment specific needs for energy efficiency information.

DTE's EO Programs are designed to help reduce customers' energy use by increasing customer awareness and use of energy saving technologies, and providing products and services such as rebates, tips, tools, strategies and energy efficiency education to help customers make informed energy saving decisions. Many of the programs DTE has today were continuations of programs launched in 2009, with a number of new programs subsequently implemented. DTE continually works to offer EO Programs that assure all customer segments are encouraged to participate. Programs are designed to capture both electric and natural gas savings. For those DTE customers with only electric or only natural gas service, efforts were made to coordinate and align with other utilities so that these customers could easily take advantage of energy efficiency program offerings across both fuel types. DTE's EO Programs include:

1. Residential Programs – Offers homeowners products, services and rebates encompassing appliance recycling; lighting; heating, ventilating and air conditioning (HVAC); weatherization; home energy assessments; low-income; energy education; and behavioral programs. Residential programs include:

    - Appliance Recycling – Produce cost-effective, long-term annual energy savings by promoting the early retirement and recycling of operable, inefficient appliances from DTE Electric households in an environmentally safe manner.

    - Multifamily – Produce energy savings in multifamily buildings with five or more units under one contiguous roof through the direct installation of energy saving measures.

    - Residential Energy STAR Products – The program helps customers reduce the cost of being energy efficient by providing rebates and/or discounts on ENERGY STAR® certified products.

    - HVAC and Water Heating – The program serves residential customers in single- and multifamily dwellings of four units or less who purchase new high-efficiency central air conditioning units, high-efficiency natural gas furnaces or boilers and/or water heating equipment

    - Online Energy Audit – The program motivates customers by offering rebates for installation, window and HVAC improvements by rewarding them with bonus incentives for completing three or more measures.

- Home Energy Consultation – Provides a no-cost energy education program that is available to all residential customers with a single family home while producing immediate energy savings through the direct installation of energy saving measures in the home.

- Schools Program – Provides non-traditional opportunities to raise awareness and the adoption of energy efficiency measures and behaviors and to help the environment. Teachers and students received a kit filled with energy efficient technologies and a guide with information on energy resources and energy saving tips.

- Behavior Program – Encourages select customers to be more energy efficient by means of social competition and social norming.

- Residential Emerging Measures and Approaches – promotes the installation of energy efficient technologies that have recently been commercialized in DTE's residential program offerings. The EM&A program technology in 2015 includes the DTE Insight app electric behavior measure.

2. Commercial and Industrial (C&I) Programs – Offers businesses products; services; prescriptive rebates for specific equipment replacement such as lighting, boilers, pumps, compressors, etc.; custom programs providing rebates per kilowatt hour (kWh) of electricity savings or per thousand cubic feet (Mcf) of natural gas savings for a comprehensive system or industrial process improvement; and energy education and pilot programs. Commercial and Industrial Programs include:

   - Prescriptive Program – Provides predetermined measures and incentives to C&I customers for the installation of energy efficient equipment.

   - Non-prescriptive Program – Promotes the installation of energy efficient technologies among DTE's commercial and industrial customers.

   - Emerging Measures and Approach (EM&A) – Promotes the installation of energy efficient technologies that have recently been commercialized in DTE's C&I Program offerings. The EM&A programs include; Retro Commissioning (RCx) and Business Energy Consultation (BEC).

3. Education and Awareness Programs – Designed to raise customer energy efficiency awareness in an effort to help save energy and to reduce energy costs. A secondary objective is to raise awareness of the DTE website and other social media, which provide channels for customers to engage in specific EO Programs offered.

4. Pilot Programs – Focuses on new and emerging experimental programs to fit longer-term program portfolio needs, test the cost-effectiveness of emerging technologies, and assess customer adoption of new technologies and market acceptance of existing technologies using new approaches. As designed, the Pilot Programs support Residential, Commercial and Industrial (C&I), and Energy Management Tools Programs.

Through participation in DTE Energy's EO programs, customers have upgraded equipment, enabling them to be more energy efficient year after year. Customers have also been educated on simple actions they can take to save on their on-going use of energy. Based on survey results, over 95 percent of participating customers were satisfied with the EO Program

DTE Energy is well-positioned to continue to provide value to its customers and other stakeholders through a robust and well-run energy efficiency program. DTE's strategic efforts have resulted in increased awareness, improved experiences and higher satisfaction among its customers.

In addition to DTE's EO Programs, DTE also supports many other conservation efforts. DTE operates facility specific environmental management programs that set targets and objectives for continual environmental improvements. Additionally, through DTE's Waste and Recycling program, the program minimizes impacts and conserves resources by reducing the volume of waste that would otherwise go into landfills for disposal. Lastly, DTE Electric operates multiple demand response programs as part of its residential and commercial demand response portfolio. The residential programs provide over 160 MW of load reduction capability and consists of:

- Interruptible Space Conditioning
- Water Heating Service Rate
- Dynamic Peak Pricing
- Behavioral Demand Response

2.11.2 Compliance with applicable regulatory requirements

Energy conservation programs in Michigan are approved by and implemented based on MPSC orders. Electric utilities are also required to submit reports updating the MPSC on the program's compliance with the requirements of the MPSC orders.

2.12 Identification of Indian Tribes Affected by the Project

There are no Indian tribes affected by the Project. The four federally-recognized Indian tribes likely to be interested in the relicensing are included on current distribution lists for the Project.

3.0 INFORMATION TO BE PROVIDED BY AN APPLICANT WHO IS AN EXISTING LICENSEE

3.1 Measures Planned to Ensure Safe Management, Operation, and Maintenance of the Project

Consumers operates and maintains the Project consistent with its commitment to public and employee safety, taking advantage of its unique resources to satisfy this commitment. Consumers attains these goals by:

(1) Providing an in-depth management and technical support organization;

(2) Establishing and implementing specific operating procedures including standard bulletins and Emergency Action Plans;

(3) Training qualified operation and maintenance personnel;

(4) Inspecting all project facilities regularly and monitoring indicators of project condition and dam safety;

(5) Implementing a rigorous inspection and maintenance program for operating equipment and facilities vital to public and employee safety;

(6) Limiting public access and providing warning signs and sirens where project operations could endanger the public; and

(7) Complying with all applicable local, state and Federal laws and regulation regarding the safe operation of industrial and electric utility facilities.

The Licensees also have a sound compliance history for the Project.

3.2.1 Existing and Planned Operation of the Project During Flood Conditions

The Project, located on the eastern shore of Lake Michigan, is not located on a river. Therefore, flood precautions normally implemented for conventional riverine hydroelectric projects, are not applicable for this Project. Should the region see a large quantity of rain, the potential for overtopping the upper reservoir is unlikely. The volume of water the upper reservoir could store before overtopping is large and would require a very large rain event. The change in elevation between maximum pond level (942 feet) and either the overflow spillway (948 feet) or the top of the dike (950 feet) over the area of the upper reservoir would provide sufficient storage for a large range of large rain events. During such a rain event, the Project would be operated to release water into Lake Michigan in order to accommodate any high rainfall and avoid overtopping the upper reservoir.

3.2.2 Warning Devices Used to Ensure Downstream Public Safety

An audible siren sounds when the Ludington units are started in both the pumping and generation cycles. This siren is augmented by three 4' x 6' warning signs located along the face of the powerhouse (one in the middle and one on either end) that warn visitors to leave the vicinity of the discharge when the siren sounds. In addition, Consumers has issued a brochure titled "Hydro Safety For Visitors, Boaters, and Anglers", which it has distributed widely and continues to be made available as opportunities permit. Furthermore, the seasonal installation of the barrier net and its associated navigational (lighted) and warning buoys (generally from April 15 through October 15) also serves to deter recreational boaters from entering the tailrace area. Since the Project discharges into Lake Michigan, there are no private or public structures located immediately downstream of the Project.

The Public Safety Plan is included in Appendix H-1 of this Exhibit.

3.2.3 Proposed Changes Affecting the Existing Emergency Action Plan

An Emergency Action Plan (EAP) for the Project has been filed with the Commission to comply with requirements contained in 18 CFR § 12.20 through 12.25. The purpose of the EAP is to provide a notification procedure for varying degrees of dam failure which could threaten the lives and property of the public and to provide information that aids in the responses (internal and external) to the incident. The EAP is reviewed, tested, and updated annually.

In addition to the EAP, Consumers has adopted the National Incident Management System (NIMS) and the Incident Command System (ICS) for addressing emergencies. Additional response plans have been established that address such incidents as chemical spills and security threats to establish procedures for initially preventing and then responding to such events should they occur. The Project has an Oil Spill Prevention, Control and Countermeasure Plan (SPCC) for oil storage exceeding 1,320 gallons, as required under EPA's SPCC regulations. The SPCC plan identifies the oil spill, collection and clean-up materials kept on site.

3.2.4 Existing and Planned Monitoring Devices

The Project is staffed 24 hours per day, 365 days a year. Included is the continuous monitoring of upper reservoir water elevations, along with the rate of change of these elevations. Detection of any unusual occurrence is promptly communicated to the Operations Supervisor or On-Call Supervisor if after normal business hours.

3.2.5 Project's Employee and Public Safety Record

Consumers' Health and Safety Department provides training for employees, accident prevention programs and record keeping functions for the entire Company, including the Ludington Project.

Consumers conducts a comprehensive employee safety program that includes regularly scheduled safety meetings to increase employee safety awareness. Safety meetings conducted in 2016 covered such topics as: winter readiness/safety, workplace violence, distracted driving, poisonous plants, insect bites, dog bite prevention, summer safety tips, sprains and strains, ergonomics, fire safety, and holiday safety.

Each employee has electronic access to an Accident Prevention Manual for their personal use and is required to become familiar with its contents. Accident Prevention Notices that highlight safety incidents/accidents from throughout Consumers' generation and distribution areas are e-mailed to employees on a regular basis to share areas of concern with all company employees including the Hydro and Renewables Generation Department. On a regular basis, poster boards are posted in lunch areas, lobbies, and break rooms highlighting various safety concerns. The Accident Prevention Manual is updated periodically.

Between 2006 and 2016, 10 recordable employee injuries have occurred at the Project.

Serious injuries occurring at the Project involving employees or the public, are reported to the Commission's Regional Chicago Office as required under the Commission regulations at 18CFR12.10(b).

3.3 Current Operation of the Project

A description of the Project operation is contained in Exhibit B of this License Application.

3.4 Project History

A description of the Project construction history and a record of upgrades to the Project are contained in Exhibit C of this License Application.

3.5 Lost Generation Due to Unscheduled Outages

Table H-3.5-1 lists the record of unscheduled outages and related lost availability (calculated as outage duration times unit capacity) during the last five years (through December 31, 2016). The table provides the date, cause, duration and corrective action for each instance of lost availability. (Calculation of lost availability is provided due to the complexity of calculating lost generation given the multiple units available and dual ownership of the Project. Lost availability is a conservative calculation in comparison to lost generation as the calculation is based upon all outage hours including overnight hours when the Ludington units would ordinarily be pumping rather than generating.)

Table H-3.5-1: Ludington Pumped Storage Project
Unscheduled Outages and Lost Availability, 2012-2016

Unit	Date/Time Unavailable	Date/Time Available	Reason for Unit Unavailability (corrective action taken)	Estimated Lost Avail. (MWH)
6	10/10/16 @ 0621	10/12/16 @ 1428	Broken bolts on retaining plate for wicket gate operating ring link pin (replaced broken bolts)	17,228
2	9/23/16 @ 1800	9/28/16 @ 1555	Lower wear ring inspection cover plates found broken/loose (installed new cover plates)	45,398
4	9/23/16 @ 1800	9/28/16 @ 1240	Lower wear ring inspection cover plates found loose (refastened existing cover plates)	44,147
1	7/21/16 @ 1110	7/22/16 @ 1920	Lightning arrestor failure on Y-Phase of #1 Main Transformer Bank (replaced lightning arrestors - all phases)	10,036
2				12,384
3	5/9/16 @ 1100	5/11/16 @ 1500	20 KV isophase bus contamination (cleaned isophase bus)	16,224
2	4/27/16 @ 2006	4/28/16 @ 2020	20 KV isophase bus and 416 LBS issues (unknown – to be determined)	9,330
6	3/15/16 @ 0801	4/8/16 @ 1718	High thrust bearing oil level (replaced thrust bearing oil coolers)	179,682
2	3/10/16 @ 1641	3/12/16 @ 1545	20 KV isophase bus damper adjusting rod came loose (fixed damper opening and removed adjusting rod from bus)	18,121
3	7/13/15 @ 1200	7/14/15 @ 1625	Automatic voltage regulator cut out (replaced AVR potentiometers)	8,866
3	3/13/15 @ 0042	7/2/15 @ 1540	Rapid increase in thrust bearing temps (replaced wiped thrust bearing shoes)	835,838
2	5/22/15 @ 0201 6/14/15 @ 1336	6/14/15 @ 1242 6/15/15 @ 2327	Unit overspeed on pump shut down – loss of governor DC control power (restored DC control power/added alarm)	229,665
1	5/26/15 @ 1555	6/12/15 @ 2045	#1 Main Transformer Bank trip – fault on station power 4160 V conductor (replaced faulty 4160 V conductor)	128,804
6	6/9/15 @ 2140	6/12/15 @ 1700	Unit 5 thrust bearing wipe – cooling water concerns (subsequent investigation ruled out any issue with cooling water)	21,008
2	4/22/15 @ 0700	5/21/15 @ 1425	High bearing vibration investigation (turbine guide bearing inspection)	270,815
1	1/22/15 @ 0049 4/29/15 @ 1710	4/29/15 @ 1630 5/1/15 @ 1435	Wiped thrust bearing (replaced thrust bearing shoes)	737,798
6	4/26/15 @ 1955	4/27/15 @ 2048	Exciter failed to start (replaced faulty 4160 V exciter breaker)	7,764
2	4/16/15 @ 0140	4/20/15 @ 0700	High thrust bearing oil temperature (corrected cooling water supply problem)	39,013

Unit	Date/Time Unavailable	Date/Time Available	Reason for Unit Unavailability (corrective action taken)	Estimated Lost Avail. (MWH)
6	5/13/14 @ 0645	5/15/14 @ 1400	Generator circuit breaker air leak (replaced parts to repair air leak)	17,238
5	11/18/13 @ 1640	11/21/13 @ 2131	Failed thrust bearing oil pump (replaced failed oil pump & changed oil)	23,977
3	9/13/13 @ 1046	9/14/13 @ 1544	Failed thrust bearing oil pump (replaced failed oil pump & changed oil)	9,009
6	3/16/13 @ 1420 3/14/13 @ 0731	3/20/13 @ 1557 3/15/13 @ 0846	Thrust bearing oil cooler leak (replaced oil cooler & changed oil)	38,334
1	1/23/13 @ 1855	1/25/13 @ 1530	Generator circuit breaker failed to open (replaced faulty master control valve)	12,929
4	1/7/13 @ 1918	1/9/13 @ 2235	Excessive leakage from shaft packing (replaced worn carbon/resin packing)	15,949
3	5/3/12 @ 0826	5/4/12 @ 1347	20 KV isophase bus contamination (cleaned isophase bus)	9,128
4				9,157
2	1/16/12 @ 0742	1/17/12 @ 1600	Starting bus circuit breaker (115) air leak (removed 203 isolation links)	9,335

3.6 Licensees' Record of Compliance

Consumers and DTEE are committed to demonstrating strong compliance with all regulating agencies, including the FERC. To that effect, Consumers, as the Project operator, has added a regulatory compliance provision in its Code of Conduct and Statement of Ethics handbook, and has developed a detailed FERC Compliance Policy. The Chief Compliance Officer has the responsibility to assure the Board of Directors that employees comply with FERC requirements, including those related to Hydro Operations. Concerns or violations regarding compliance can be reported through the Company's compliance hotlines and will be investigated, corrected, and reported as appropriate.

For Consumers, compliance assurance is systematically built into its operations. In addition to its extensive monitoring, operation and maintenance program, its Compliance Monitoring System have resulted in a commendable compliance record at the Project.

When faced with a compliance issue, Consumers responds in a timely manner and has often acted under its own initiative without waiting for formal directions from the Commission or other governmental agency(s). If Consumers identifies an area of non-compliance, it not only fixes the issue, but it also self reports this to the appropriate agency(s). Overall, the Licensees have an exemplary record of compliance with respect to the Project license terms and conditions.

3.7 Actions Affecting the Public

Consumers and DTEE have cooperated with Mason County to provide a variety of outdoor recreation opportunities at the Project. A comprehensive recreation plan has been developed for the Project which has identified outdoor recreation and passive recreation as the primary areas of interest. The recreation plan is discussed in detail in Exhibit E of this application. The major recreation facilities associated with the Project boundary include a large day use site that includes disk golf, picnic areas and a playground, a camping area, overlooks, and a remote Lake Michigan fishing access pier located in Port Sheldon, Michigan.

3.7.1 Safety Record

Public safety is also a major concern of the Licensees. Project works are fenced and signs are posted to warn anglers and boaters of the potential for changing conditions in the tailrace associated with unit starts/stops, and to keep the public from entering areas used for operations and maintenance. As noted earlier, Consumers has published the brochure “Hydro Safety For Visitors, Boaters and Anglers” which is intended to help the public understand hazards associated with its hydroelectric projects (including Ludington) and how to safely enjoy them. Consumers employees actively survey the Project for conditions which could result in an accident or injury to employees or the public. Consumers has no records of any drownings in the vicinity of the Project since issuance of the original Project license issued in 1969. In 2003, Consumers reported a single fatality that occurred on maintenance barge with the firm contracted to install, remove, and maintain the barrier net. This incident was reported verbally to FERC on the same day it occurred and a written report of the incident was filed with FERC on May 15, 2003, as required. Any serious injuries, involving an employee or the public, occurring at the Project are reported to the Commission’s Chicago Regional Office and other Federal and state agencies as required under the Commission regulations at 18CFR12.10(b).

3.8 Ownership and Operating Expenses That Would Be Reduced if the License Were Transferred

The current Licensees are applying for a long-term license to continue to maintain and operate the Project. Additionally, there is no competing application to take over the Project. Because there is no proposal to transfer the Project license, this section is not applicable to the Project.

3.9 Annual Fees for Use of Federal or Native American Lands

This section is not applicable to the Project because it uses no federal or Native American lands.

4.0 INFORMATION TO BE SUPPLIED BY AN APPLICANT WHO IS NOT AN EXISTING LICENSEE

This section is not applicable to this application for a new license.

5.0 LITERATURE CITED

DTE Electric Company 10K Report, 2016.

General references:

Consumers Energy Company 2016, FERC Form No. 1, Annual Report of major electric utilities, licenses and others. (This report is for the 2016 calendar year.)

DTE Electric Company 2016, FERC Form No. 1, Annual Report of major electric utilities, licenses and others. (This report is for the 2016 calendar year.)

MISO Fact Sheet, September 2016. (https://www.misoenergy.org/Library/Repository/Communication%20Material/Corporate/Corporate%20Fact%20Sheet.pdf)

APPENDIX H-1

PUBLIC SAFETY PLAN

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Consumers Energy

A CMS Energy Company

Ludington Pumped Storage Plant
3525 S. Lakeshore Drive
Ludington, MI 49431-9756

Tel: 231 843 5227

William A. Schoenlein
Plant Manager

March 27, 2008

Ms. Peggy A. Harding, PE
Regional Engineer
Federal Energy Regulatory Commission
230 South Dearborn Street, Room 3130
Chicago, IL 60604

D2SI-OHL-CH
PROJECT NUMBER 2680
NATDAM NO. MI00180
LUDINGTON PUMPED STORAGE PLANT
CONSTRUCTION DOCUMENT RELOCATION/PUBLIC SAFETY PLAN UPDATE

As a result of the 2006 annual FERC inspection, FERC staff recommended that "By March 31, 2008, the construction documents currently stored above the powerhouse in a building with no climate control should be moved to a suitable storage facility located outside of the estimated inundation limits for the project" (see FERC letter dated June 9, 2006). Those documents have since been moved to Consumers Energy Company's Ludington Service Center. The Service Center is a secure location outside of the estimated inundation limits in the event of a failure of the Project's earthen embankment and/or steel penstocks. In addition, FERC staff had indicated that "thought should also be given to making digital copies of these documents for ease of use and to prevent loss of the data". At this time, Consumers does not feel that digital copies of these documents are necessary given their relocation to a secure Company facility located outside of the Plant's estimated inundation limits.

As a result of the 2007 annual FERC inspection, FERC staff noted that the latest public safety plan for the Project was dated 1992 and recommended that the "public safety signage and details should be confirmed and an updated public safety plan should be developed" and the updated public safety plan should be submitted by the end of the first quarter of 2008. The signage and details of the Project's public safety plan have since been confirmed and an updated plan is attached to this letter in the form of three copies each of two full size drawings (1140-4-002, Public Safety Devices - Safety Signs and 1140-4-003, Public Safety Devices - Barrier Net Buoys) and three copies of a seven page document showing the details of each of the public safety signs.

If there are any questions concerning either of the above two items, please call me at 231-843-5227 or David Battige of my staff at 231-843-5229.

Sincerely,

William Schoenlein

William Schoenlein
Plant Manager

Enclosures

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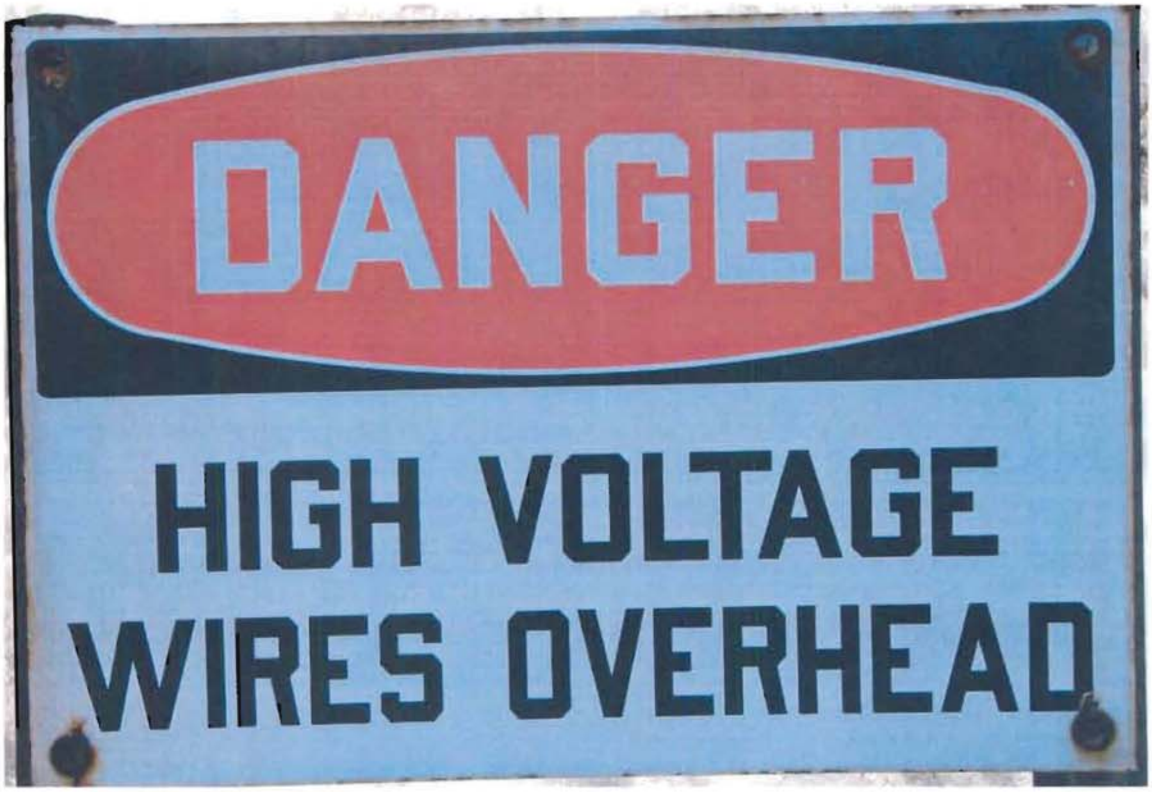


Sign Legend - DH

DANGER

HIGH VOLTAGE

WIRES OVERHEAD

There are three of these signs, one located west of the entrance gate to Ramp 9 on Kistler Road (sign faces west) and two east of the entrance gate to Ramp 9 (inside the security fencing with one sign at the bottom of Ramp 9 facing northeast and one sign south of the entrance gate facing south along the reservoir embankment patrol road at the downstream toe of the embankment) warning of the overhead power lines.

Sign size:	20 inches wide by 14 inches high
Sign color:	upper portion is a red oval on a black background; lower portion is a white background
Letter size:	DANGER is 2-3/4 inch lettering; all other lettering is 2 inches
Letter color:	DANGER is white letters on a red oval background; all other lettering is black on a white background

Sign Legend - A

NO
TRESPASSING
CONSUMERS POWER CO.

These signs are generally located every 200 feet along the entire perimeter fence line.

Sign size: 21 inches wide by 12 inches high
Sign color: blue
Letter size: top two lines is 2-1/2 inch lettering; all other lettering is 1 inch
Letter color: white letters on a blue background

Sign Legend - HV

DANGER HIGH VOLTAGE WIRES NO TRESPASSING ON THESE TOWERS KEEP AWAY TRESPASSERS WILL BE PROSECUTED CONSUMERS POWER CO.

These signs are generally located on each non-project 345 kV transmission tower.

Sign size:	21 inches wide by 14 inches high
Sign color:	upper portion is a red oval on a black background; lower portion is a white background
Letter size:	DANGER is 2-3/4 inch lettering; the words HIGH VOLTAGE WIRES KEEP AWAY is 2 inch lettering, all other lettering is 1 inch except CONSUMERS POWER CO. is 1/2 inch lettering
Letter color:	DANGER is white letters on a red oval background; all other lettering is black on a white background

Sign Legend - SI

NOTICE ALL VEHICLES AND PARCELS ARE SUBJECT TO SECURITY INSPECTION CONSUMERS POWER CO.

There are three of these signs, one located at the entrance gate to Ramp 9 on Kistler Road (facing west), one at the northeast entrance gate to the non-project 345 kV substation (facing north) and one at the main Plant entrance gate (facing east).

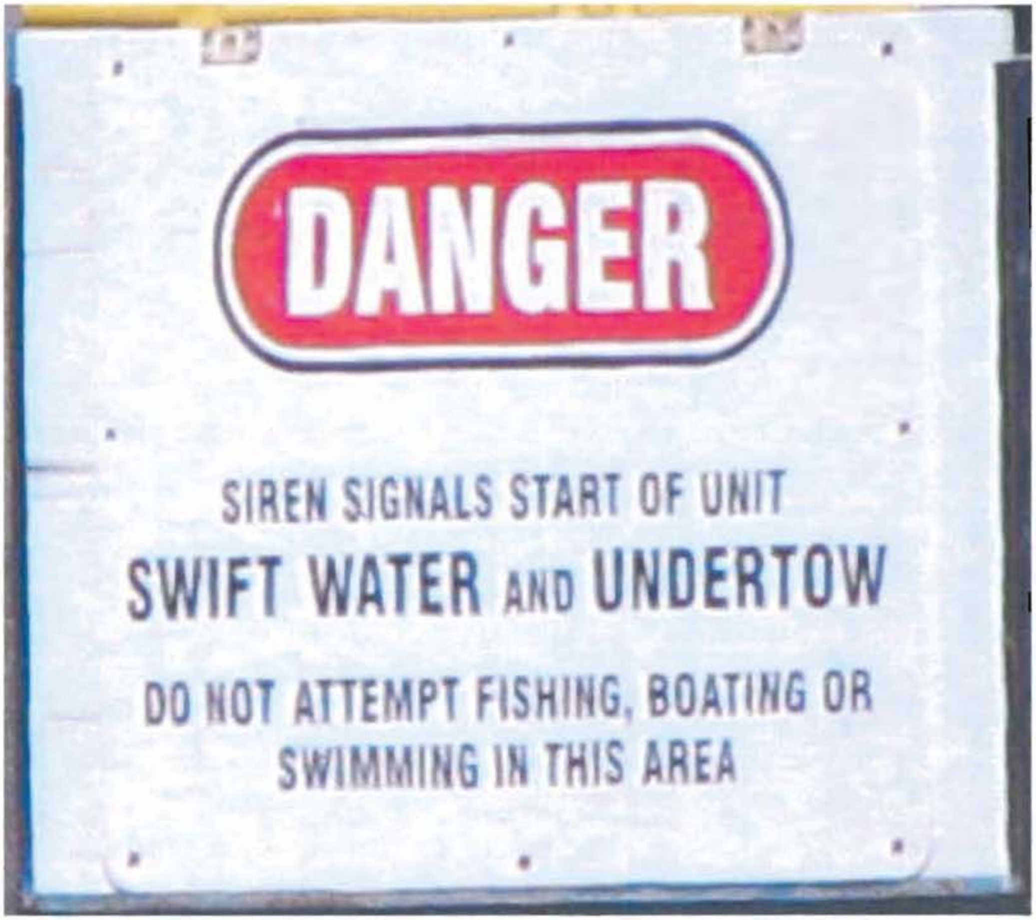
Sign size:	28 inches wide by 20 inches high
Sign color:	upper portion is a blue rectangle on a white background; lower portion is a white background
Letter size:	NOTICE is 3-1/4 inch lettering; lettering of next four lines is 2 inches while bottom line is 1 inch lettering
Letter color:	NOTICE is white letters on a blue rectangular background; all other lettering is black on a white background

Sign Legend - SR

DANGER
SUBMERGED ROCKS, UNDERTOW
NO SWIMMING OR BOATING
NO TRESPASSING

There are two of these signs located on the fencing extending from the shore to the jetties (one sign on the north and one on the south fencing) facing Lake Michigan.

Sign size:	60 inches wide by 48 inches high
Sign color:	upper is red and lower is white
Letter size:	DANGER is 7 inch lettering; all other lettering is 3-1/2 inches
Letter color:	DANGER is white letters on a red oval background; all other lettering is black on a white background

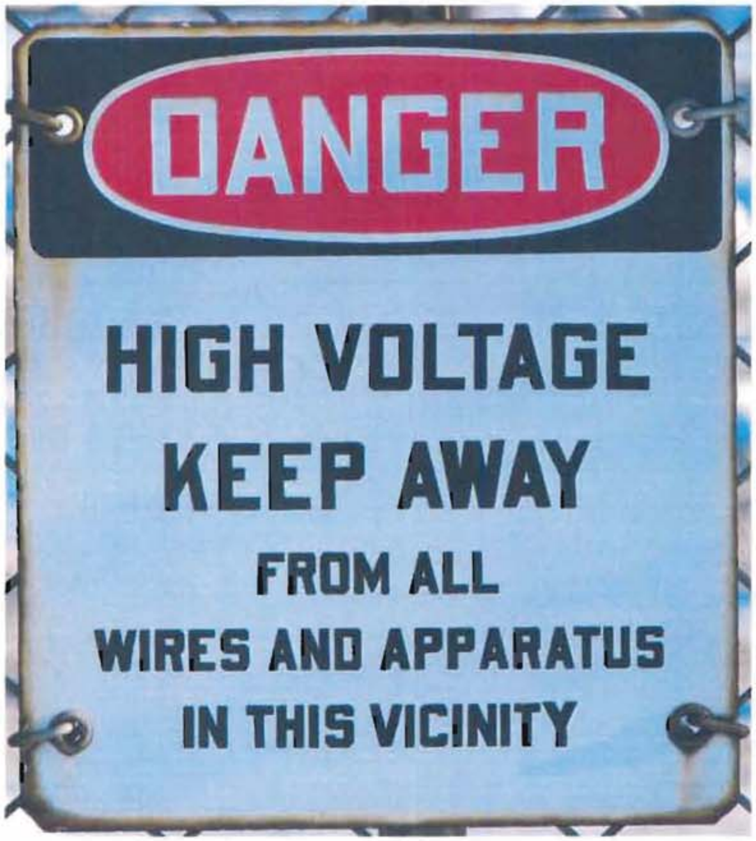


Sign Legend - SW

DANGER SIREN SIGNALS START OF UNIT SWIFT WATER AND UNDERTOW DO NOT ATTEMPT FISHING, BOATING OR SWIMMING IN THIS AREA

Three of these signs are located on the powerhouse facing the Lake Michigan tailrace.

Sign size:	60 inches wide by 48 inches high
Sign color:	upper is red and lower is white
Letter size:	DANGER is 7 inch lettering, the words SWIFT WATER UNDERTOW is 4-1/2 inch lettering, all other lettering is 3 inches
Letter color:	DANGER is white letters on a red oval background; all other lettering is black on a white background



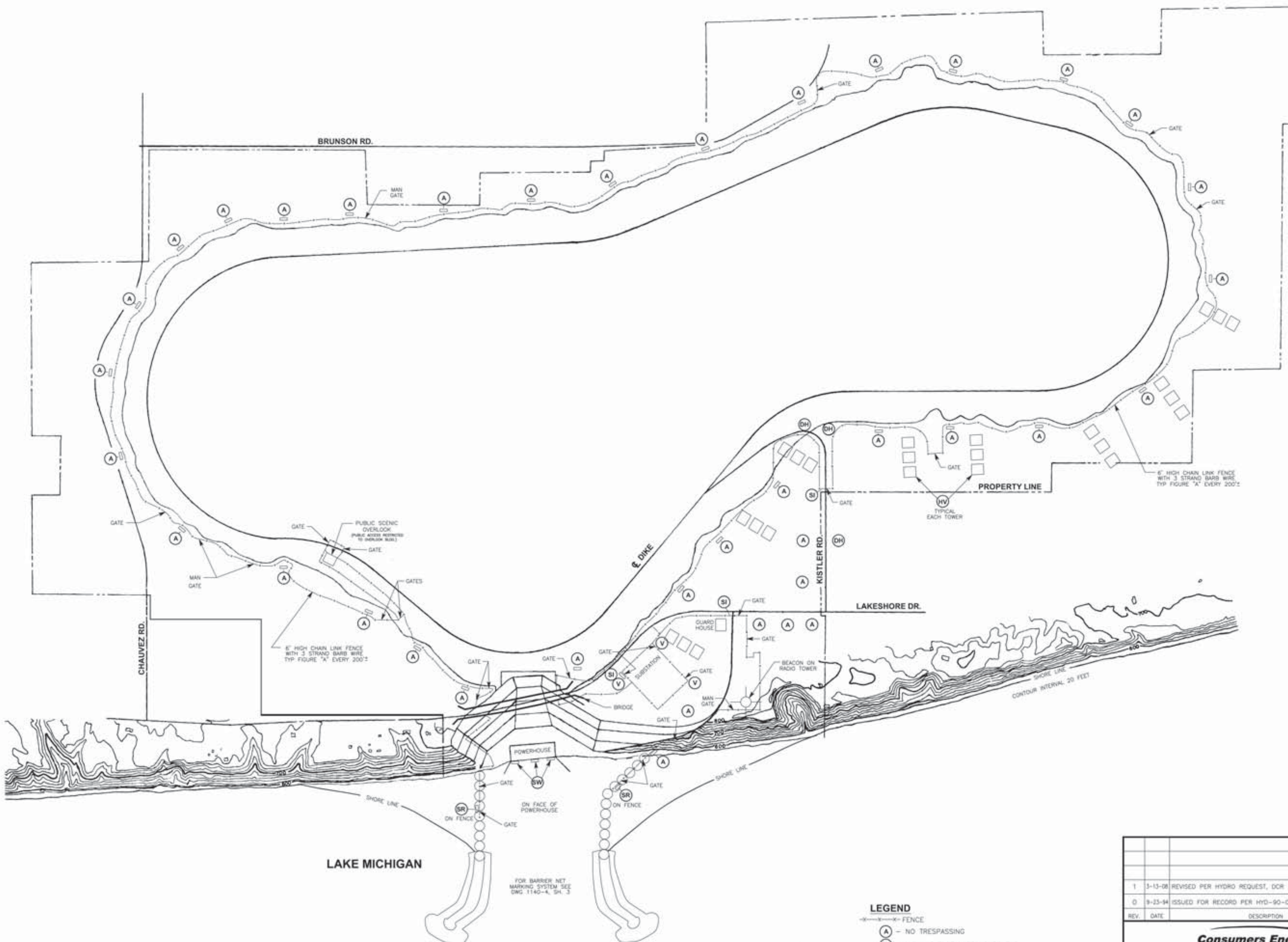
Sign Legend - V

DANGER HIGH VOLTAGE KEEP AWAY FROM ALL WIRES AND APPARATUS IN THIS VICINITY

This sign is on the northeast entrance gate off of Lakeshore Drive and the two east gates (accessed from inside the security fence) leading to the non-project 345 kV switchyard.

Sign size:	10-1/2 inches wide by 12 inches high
Sign color:	upper portion is a red oval on a black background; lower portion is a white background
Letter size:	DANGER is 1-1/2 inch lettering; the words HIGH VOLTAGE KEEP AWAY is 1 inch lettering, all other lettering is 5/8 inch
Letter color:	DANGER is white letters on a red oval background; all other lettering is black on a white background

BCC: DSBattige, LPSP
LPGraham, Washington
BMcTaggart, Cadillac
WRNeal, DTE
RNeustifter, EP11-233
JNorkey, EP1-420
TSikavitsas, JHC Annex
TJTanciar, DTE
File - 002-003-001-003



LEGEND

- —x—x—x— FENCE
- (A) – NO TRESPASSING
- (DH) – HIGH VOLTAGE WIRES OVERHEAD
- (HV) – HIGH VOLTAGE WIRES ON TOWERS
- (SI) – SECURITY INSPECTION
- (SR) – SUBMERGED ROCKS, UNDERTOW – NO SWIMMING OR BOATING, TRESPASSING
- (SW) – SIREN SIGNALS START OF UNIT/SWIFT WATER & UNDERTOW
- (V) – HIGH VOLTAGE KEEP AWAY

REV.	DATE	DESCRIPTION	BY	APP
1	3-13-08	REVISED PER HYDRO REQUEST, DCR 1140-08-03 (DSB)	NCED	DSB
0	9-23-94	ISSUED FOR RECORD PER HYD-90-001	RCM	

Consumers Energy

LUDINGTON PUMPED STORAGE
LUDINGTON, MICHIGAN

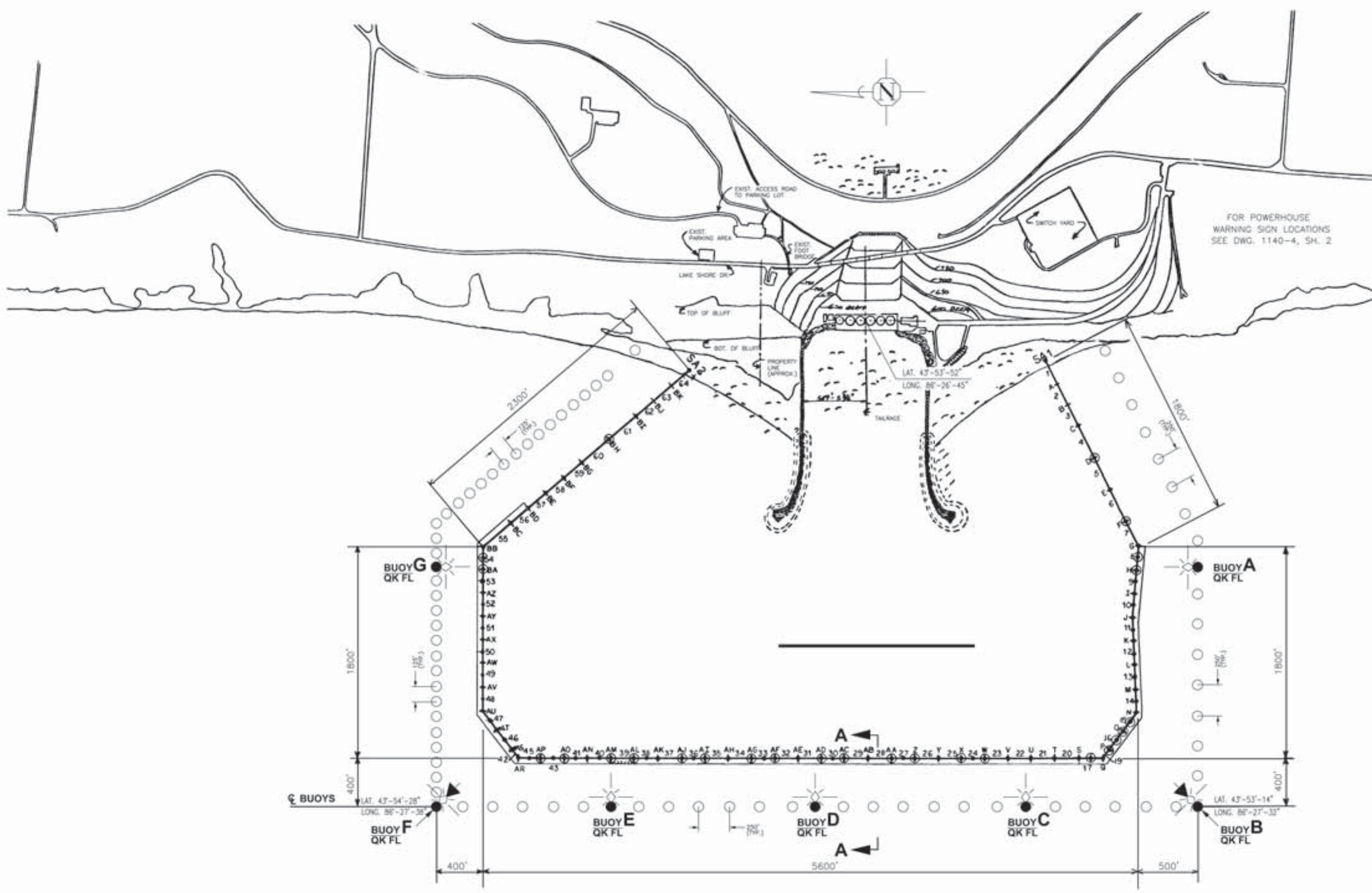
1140-4-002-REV-1.TIF 1140-4-002-REV-1.DWG

PUBLIC SAFETY DEVICES
SAFTEY SIGNS

LUDINGTON PUMPED STORAGE

SCALE	DRAWING NO.	SHEET	REV
NONE	1140-4	2	1

JOB –



PLAN
SCALE: 1"=400'

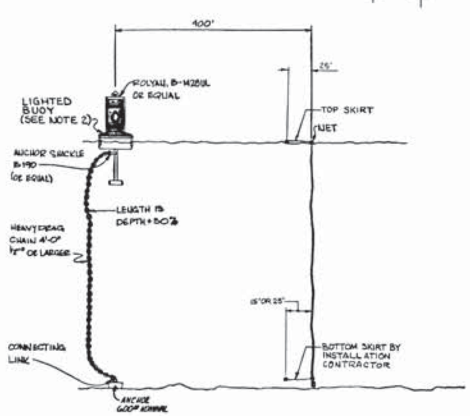
NOTES:

1.) REGULATORY BUOYS (WHITE & ORANGE) SHALL CONTAIN SIGNS READING "DANGER–SHALLOW NET" AND "KEEP OUT–SHALLOW NET" ON ALTERNATE SIDES.

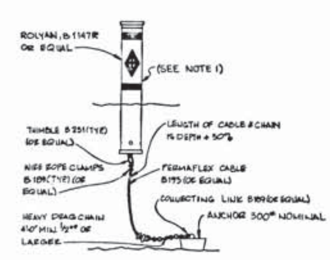
2.) LIGHTED BUOYS (WHITE WITH A WHITE LIGHT) SHALL BE LOCATED ON EACH CORNER WITH 3 ADDITIONAL LIGHTED BUOYS SPACED EVENLY ALONG THE NORTH–SOUTH LINE AND 1 EACH ALONG EAST–WEST LINE.

LEGEND

● LIGHTED BUOY (SEE NOTE 2)
○ REGULATORY BUOY (SEE NOTE 1)



SECTION A-A
SCALE: NONE
7 REQUIRED



REGULATORY BUOY
DETAIL 1
SCALE: NONE
64 REQUIRED
(TYPICAL)

REV.	DATE	DESCRIPTION	BY	APP
1	3-13-08	REVISED PER HYDRO REQUEST, DCR 1140-08-03 (DSB)	NCED	DSB
0	9-23-94	ISSUED FOR RECORD PER HYD-90-001	RCM	

Consumers Energy

LUDINGTON PUMPED STORAGE
LUDINGTON, MICHIGAN

1140-4-003-REV-1.TIF — 1140-4-003-REV-1.DWG

PUBLIC SAFETY DEVICES
BARRIER NET BUOYS

LUDINGTON — PUMPED STORAGE

SCALE	NONE	DRAWING NO.	SHEET	REV
JOB	–	1140-4	3	1