

January 30, 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
DRAFT 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 a Draft License Application (DLA) for the Ludington Pumped Storage Hydroelectric Project (Project) with the Federal Energy Regulatory Commission (FERC). The DLA is being filed in accordance with the Integrated Licensing Process (ILP) and consists of draft technical exhibits and a draft environmental assessment (Exhibit E, Section 4.4). Portions of the draft Exhibit F – General Design Drawings contains Critical Energy Infrastructure Information (CEII) and are being filed under separate cover with the Commission only.

The Project is located on the east shore of Lake Michigan in Mason and Ottawa Counties, Michigan. The Project's powerhouse and impoundment are located in Pere Marquette and Summit Townships (Mason County). A small satellite recreation area is located in Port Sheldon (Ottawa County), 70 miles south of the powerhouse and impoundment. The PAD and 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 Phases 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 and second year cormorant count).

The Licensees are providing a copy of the DLA to relevant resource agencies, tribes, non-governmental organizations, and other potential interested parties included in the attached mailing list. A hard copy of the filing will be available at the Consumers Energy Company, Cadillac Service Center, 330 Chestnut Street, Cadillac, Michigan 49601 and at the Mason County District Library in Ludington, Michigan. A copy of the draft application will also be available on the Consumers LPSP's relicensing webpage: <https://www.consumersenergy.com/ludingtonrelicensing>.

The Draft 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 portions are filed under separate cover)
- Exhibit G – Project Map
- Exhibit H – Description of Project Management and Need for Project Power

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

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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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**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:	City of Ludington
	Summit and Pere Marquette Townships
	Port Sheldon Township (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
One Energy Plaza	One Energy Plaza
Jackson, MI 49201	Detroit, MI 48226
(800) 477-5050	(800) 477-4747

The exact name and address of each person authorized to act as agent for the Applicant in this application are:

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(616) 738-3400

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It is requested that copies of all correspondence pertaining to this application be provided to:

William Schoenlein
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David McIntosh
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It is requested that copies of all correspondence pertaining to this application also be provided to:

Ms. Rita L Hayen, P.E.
TRC Companies, Inc.
1450 W. Spruce Ct
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Telephone: (414) 331-9286

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.**

Licenses 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 south of the city of Ludington, Mason County, in the townships of Summit and Pere Marquette. A satellite recreation area is located in Ottawa County in the township of Port Sheldon.

The following political subdivisions have a population of 5,000 or more, and are located within 15 miles of the Project facilities:

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

Summit Township
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 Satellite 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

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

Blendon Township
7161 72nd Avenue
Hudsonville, MI 49426

Park Township
52 152nd Avenue
Holland, MI 49424

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

Robinson Township
12010 120th Avenue
Grand Haven, MI 49417

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

Spring Lake Township
106 South Buchanan
Spring Lake, MI 49456

City of Holland
270 South River Avenue
Holland, MI 49423

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

SUBSCRIPTION

This Application for New License for the Ludington Pumped Storage Hydroelectric Project, FERC No. 2680 is executed in the State of Michigan, County of **XXXXXX**, by **(Name and position for DTEE signatory)**, 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 ____ day of June, 2017.

DTE Electric Energy

By _____
Matthew T. Paul
Vice President - Fossil Generation

VERIFICATION

Subscribed and sworn to before me, a Notary Public of the State of Michigan this day of **(Month, year)**.

(Notary Public)

(My Commission Expires _____)/seal

SUBSCRIPTION

This Application for New License for the Ludington Pumped Storage Hydroelectric Project, FERC No. 2680 is executed in the State of Michigan, County of **XXXXXX**, by John Broschak, Consumers Energy Vice President Generation Operations and in the State of Michigan, County of **XXXXXX** 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 ___ day of June, 2017.

Consumers Energy Company

By _____
John Broschak
Vice President Generation Operations

VERIFICATION

Subscribed and sworn to before me, a Notary Public of the State of Michigan this day of **(Month, year)**.

(Notary Public)

(My Commission Expires _____)/seal

**CONSUMERS ENERGY COMPANY
JACKSON, MICHIGAN**

**DTE ELECTRIC COMPANY
DETROIT, MICHIGAN**

**DRAFT APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM
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**

January 2017



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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

**APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM**

**DRAFT 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**

**DRAFT 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 (about 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	69,830 cfs (at time of DLA 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

<p>Intake and Penstock for Powerhouse</p>	<p>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.</p>
<p>Powerhouse</p>	<p>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.</p>
<p>Reversible Pump-Turbine/Motor-Generator Units</p>	<p>6</p>
<p>Units 1 – 6 (post-upgrade)</p>	<p>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</p>
<p>Transmission Facilities</p>	<p>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.</p>

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 about 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 about 1,600 feet into Lake Michigan. The breakwater is approximately 1,850 feet long and is about 2,700 feet from shore. The design crest elevation of the jetties and breakwall is about 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 Project², 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 about 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 panels are constructed of a synthetic twine Dyneema SK75 as manufactured by DSM. 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 the top border line of each main net panel. Float lines are also attached to the outer edge of each panel's top skirt.

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 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-2.1.6-2: 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. 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](#)).

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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 (about 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 about 1.5 or 1.7 foot per hour for each operating unit at full and minimum pond, respectively.

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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 first quarter of 2020. [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.

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 Capacities⁴

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	276.25	276.25	11,100
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

Unit No.	Turbine (MW) ⁷	Generator (MW) ⁵	Hydraulic Capacity (cfs) ⁶	Scheduled Completion Date
1	311	297.5	12,715	1st quarter 2020
2	311	297.5	12,715	Complete
3	311	297.5	12,715	1st quarter 2019
4	311	297.5	12,715	Complete
5	311	297.5	12,715	2nd quarter 2017
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

⁷ 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.

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.

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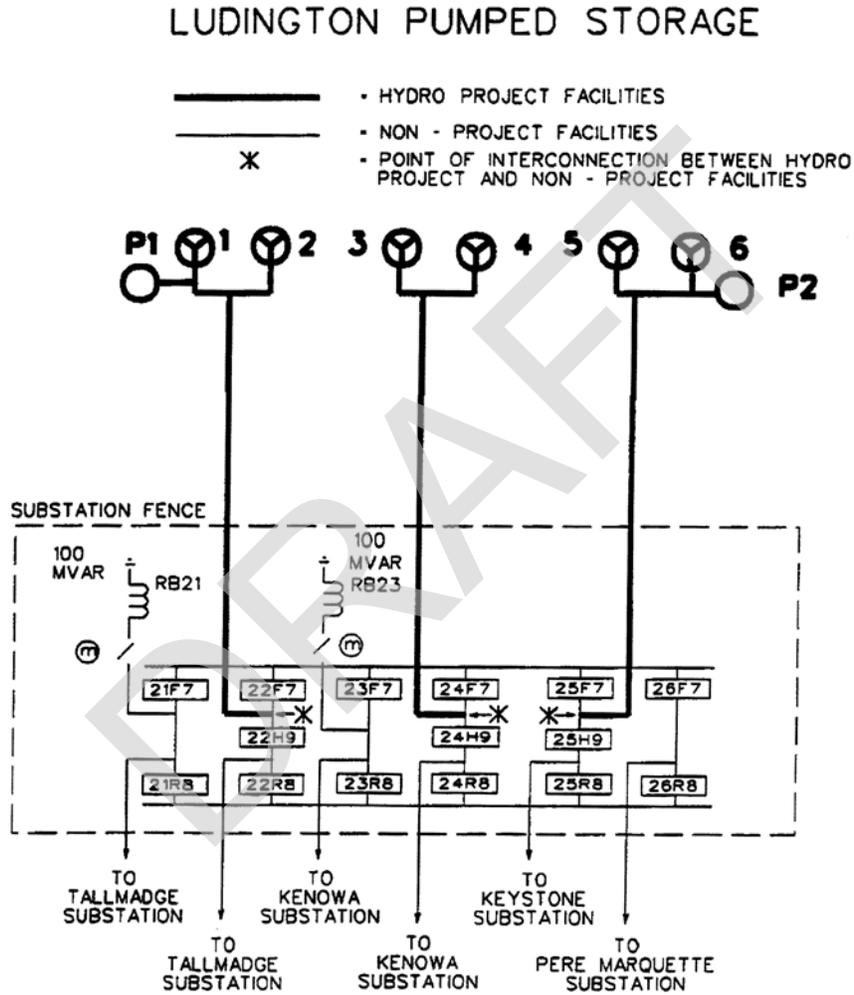
5.0 TRANSMISSION LINES

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](#))

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

**LUDINGTON SWITCHYARD:
 NON-PROJECT TRANSMISSION FACILITIES**



6.0 ADDITIONAL EQUIPMENT

There is no additional equipment associated with the Project.

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7.0 LANDS OF THE UNITED STATES

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

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

DRAFT 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**

**DRAFT 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 about 7 hours, starting with a full upper reservoir. Refilling the upper reservoir requires about 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:

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

The Project currently has a gross average annual energy production of approximately 2,398,400 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 monthly generation for 2002 through 2015.

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 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.

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.

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
10/01/05 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 the Unit 5 upgrade began on 4/26/2016 and is scheduled to be completed by 4/26/2017 (a bearing failure resulted in Unit 5 taken out of service on 6/9/2015).

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 Michigan 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 MW², 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. [These curves will be provided in the Final Application]

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.

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 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 these structures will not be measurably different from the water level of Lake Michigan outside the structures. In addition, 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 two reasons, no tailwater rating curve is submitted with this exhibit.

² The installed capacity represents the total authorized installed capacity after completion of the FERC approved unit maintenance upgrades.

2.6 Powerplant Capability vs. Head

At a gross head of 908.5 feet NGVD 29, the Project has a total rated generating capacity of 1,785 MW. Figure B-2.6-X located in Appendix B-1 provides the plant capability curve for the Project. (Curve to be provided in final license application.)

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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.

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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.

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APPENDIX B-1
CHARACTERISTIC CURVES FOR PROJECT

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**LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)**

**APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM**

**DRAFT 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

DRAFT 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-1.) 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 starting bus breakers and disconnect switches
 - Installing new static exciters and voltage regulators
- 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 about \$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 about \$2.9 million dollars (2016 dollars).

2.0 PROJECT SCHEDULE OF NEW DEVELOPMENT

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

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**LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)**

**APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM**

**DRAFT 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**

**DRAFT 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.

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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 as of the end of 2016 [To be provided in the Final License Application]. [Table D-2.2-1](#) shows original costs, 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
 [To be provided in the Final License Application]**

FERC	Production Plant	Original Cost (\$) (1974?)	Accumulated Depreciation	Net Investment
330	Land and Water Rights	3,347,200		
331	Structures and Improvements	24,20,617		
332	Reservoirs, Dams and Waterways	142,171,509		

FERC	Production Plant	Original Cost (\$) (1974?)	Accumulated Depreciation	Net Investment
333	Waterwheels, Turbines and Generators	34,327,005		
334	Accessory Electrical Equipment	8,388,493		
335	Misc. Power Plant Equipment	3,822,597		
336	Roads, Railroads and Bridges	2,433,362		
Totals		218,710,786		
302	Relicensing Costs	9,140		
Total including Relicense Costs				

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. Current completed maintenance upgrades to the units have been included in the current value of the Project. The anticipated cost for the additional maintenance upgrades that will be completed by 2019 is \$ X (To be provided in Final License Application.).

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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 \$X per year, based on a 10-year period of analysis [To be provided in the Final Application]. This estimate includes costs¹ 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

The Licensee uses a X.X percent rate [To be provided in the Final Application] to approximate its average cost of capital. 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 \$ [To be provided in the Final Application]. 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 approximately X.X percent [To be provided in the Final Application].

4.4 Operation and Maintenance Expenses

The estimated annual operation and maintenance expense for 2017 at the Project will be approximately \$ including corporate support costs [To be provided in the Final Application].

4.5 Costs to Develop the License Application

The approximate cost to prepare the application for a new license for the Project is \$ (which is included in the above cost of net investment) [To be provided in the Final Application].

4.6 Costs of Proposed Environmental Measures

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

¹ Including major maintenance costs.

- 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 recreation management plan;

The cost to develop the historic properties management plan is approximately \$X. Implementation of these measures will cost approximately \$X annually. [To be provided in the Final Application].

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 about \$2.9 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 about \$0.3 million dollars. [Additional costs to be provided in the Final Application].

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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 2,580,850 megawatt-hours², which will be sold at the prevailing market rates. The average market clearing price for energy can be estimated based on the MISO website. (To be provided in the Final Application.)

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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.

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

**DRAFT APPLICATION FOR NEW LICENSE
FOR MAJOR WATER POWER PROJECT**

**DRAFT EXHIBIT E
ENVIRONMENTAL REPORT**

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Appendix E-4 Operations Compliance Management Plan (being developed)
Appendix E-5 Historic Properties Management Plan (being developed)

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
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
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
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**

**DRAFT 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 Draft License Application (DLA) with FERC. The DLA is being provided to interested parties including participating federal and state agencies, tribes, non-governmental organizations (NGOs), local governments, and the public for comment. Comments on the DLA are due within 90 days of the filing of the DLA. Comments will be addressed by the Licensees in the final license application, which will be filed with the Commission by June 30, 2017.

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, Michigan¹. 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

¹Pigeon 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).

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 License Article 26 (see Section 4.5.1), 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

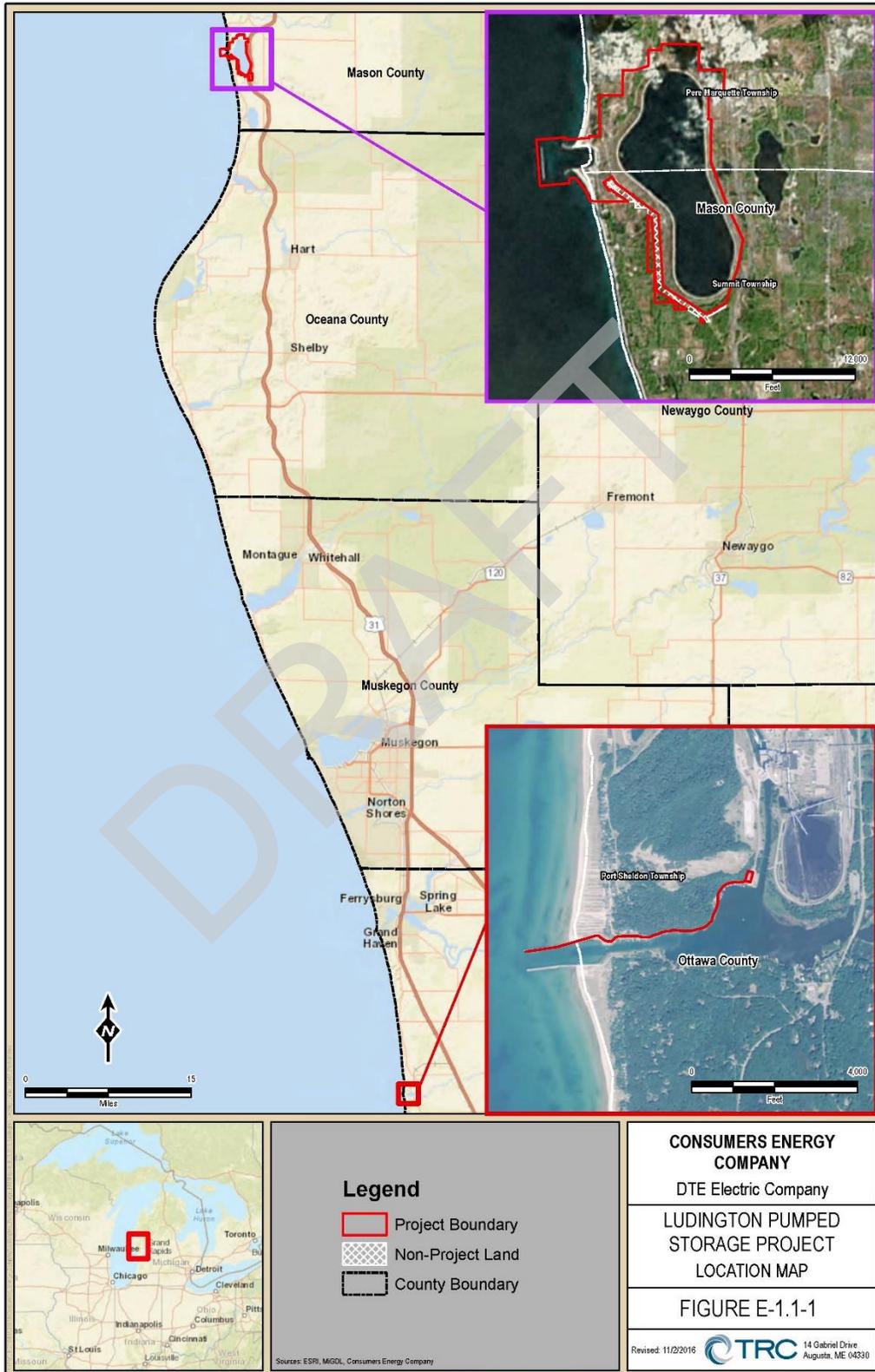
There are six (6) generating units with a total authorized installed capacity of 1,785 MW² with an average annual generation of 2,357,066 MWh from 1998-2016.³ The Project is operated to provide power during peak electrical demand periods which typically occurs during daytime hours. The upper reservoir is partially refilled at night and completely refilled on the weekends by pumping water from Lake Michigan.

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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
USDOJ	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 December 2, 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 2, 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
Fish and Aquatic Resources Evaluation
Wildlife and RTE Reconnaissance Surveys
Botanical, and RTE Reconnaissance Surveys
Recreation Inventory and Recreation Use Assessment
Cultural Resources Survey, including Archaeological and Historic Structures Surveys

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 will be included in the Final License Application.

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.

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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. A date-stamped copy of the application to Michigan DEQ will be included in [Appendix E-2](#), of the Final License Application.

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, Michigan⁴. 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.

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.

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

⁴Pigeon 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).

architectural surveys of the Project area. A draft HPMP will be submitted to the SHPO for comment prior to the filing of the FLA, and a final HPMP will be filed with 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 MW⁵ with an average annual generation of 2, 357,066 MWh from 1998-2016. 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 (about 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 at 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	69,830 cfs (at time of DLA 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.

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 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](#)).

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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 about 7 hours, starting with a full upper reservoir. Refilling the upper reservoir requires about 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 renewable source of power to the region. If the Project were decommissioned, its contribution to renewable 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 upgrade 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-3.1-1](#) and [E-3.1-2](#).

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](#). (Operations Compliance Management Plan, Appendix E-4, to be included in the Final License Application.) 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.
- Develop an HPMP to provide for management of historic properties throughout the term of the license.
- Install a seasonal barrier net and monitor the net 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, 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 about 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.

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 about 950 feet, initiate a thick sequence of limestones and dolomite with minor amounts of anhydrite and salt to about 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 about 2,850 to 3,100 feet, is approximately 100 feet thick beneath the Project's upper reservoir area and reaches a maximum thickness of about 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 marker 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, Anhydrite 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 about 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 about 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.

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 about 97 feet in the south end to about 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. Two large outfalls from the Upper Penstock Encasement Joint (UPEJ) have been closed due to the discovery of PCBs in the grout of that area on either side of the powerhouse/tailrace are connected to the site storm water drainage system which also includes seepage water (ground water). The southernmost of these outfalls is designated outfall #9 under the NPDES permit as it formerly drained the UPEJ of storm water. Drains from the UPEJ have been closed due to the discovery of PCBs in the grout of that area in 1999.. The UPEJ was remediated and storm water continues to be collected, tested for PCBs, and properly disposed of in accordance with Part I Section (A)(5 and 7) of the NPDES permit. The Project has remained 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 about 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 about 97 feet in the south end to about 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 coarse 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-3.1-1](#)). The long-term (1918-2012) average Lake Michigan water surface elevation as measured at Harbor Beach, MI is 578.8 feet (IGLD 85). However, water levels have been consistently below average since 1999 with a record low level of 576.1 feet (IGLD 85) being established in January, 2013. During the period from commencement of Project operations (1973) until 1999, lake elevations were consistently above the long-term average (Gronewold et al, 2013).

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 (Michigan WQS).

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 following monthly maximum temperature:

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	40 °F	40 °F	50 °F	55 °F	70 °F	75 °F	75 °F	75 °F	65 °F	60 °F	45 °F
(4.4 °C)	(4.4 °C)	(4.4 °C)	(10 °C)	(12.8 °C)	(21.1 °C)	(23.9 °C)	(23.9 °C)	(23.9 °C)	(18.3 °C)	(15.6 °C)	(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 4.3.2-1](#) (Lake Michigan) and [4.3.2-2](#) (Upper Reservoir).

**Table E-4.3.2-2: Locations for the 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)

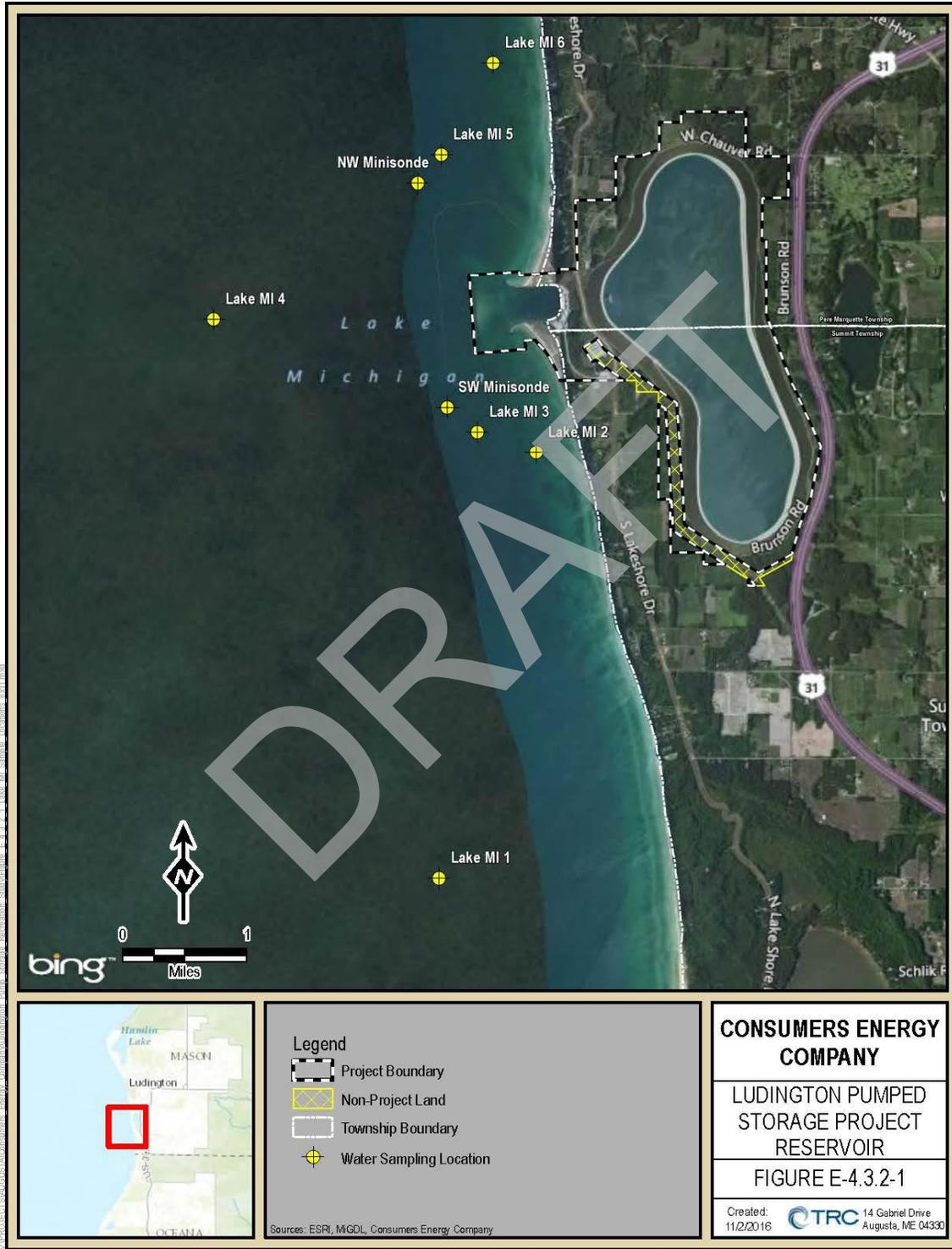
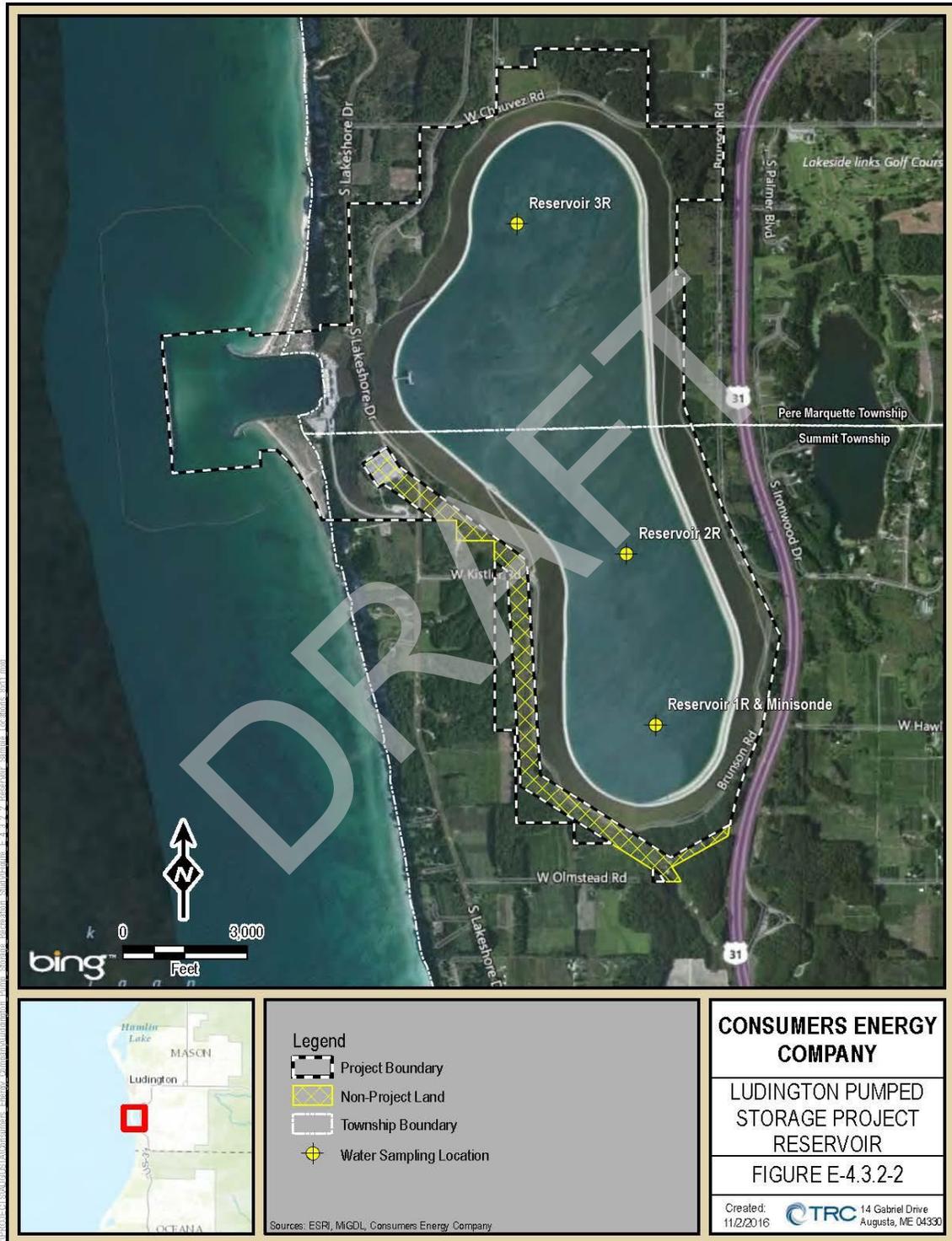


Figure E-4.3.2-2: Upper Reservoir Sampling Locations Utilized During 1972-1974 and 2013. (GLEC, 2014)



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

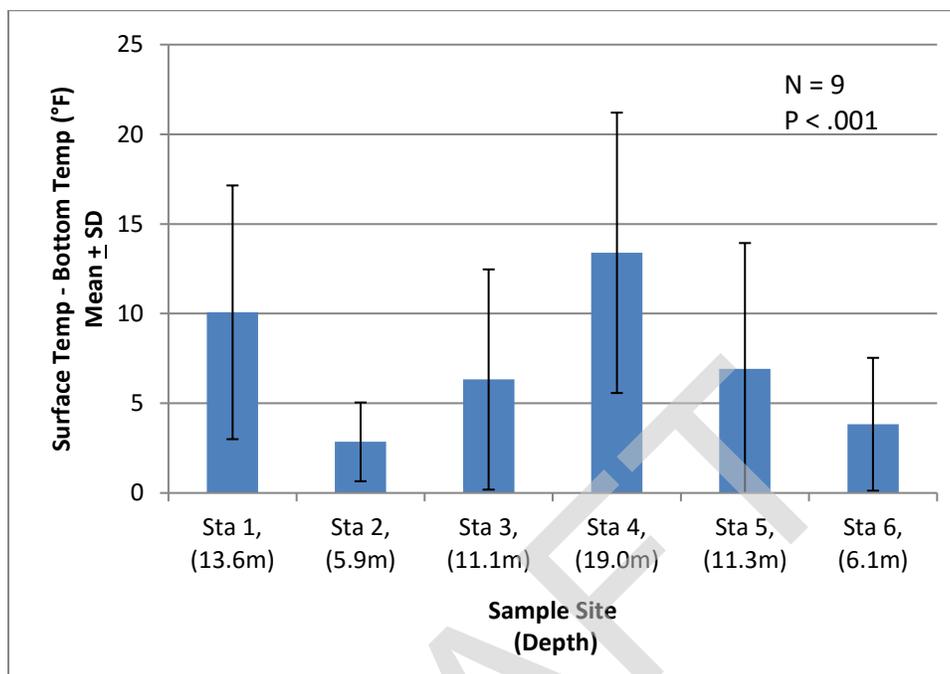
Water temperature and DO profiles were collected twice per month from June 20th to October 11th. Six Lake Michigan locations and three upper reservoir locations are consistent with those monitored by Liston et al ([Figures 4.3.2-1](#) and [4.3.2-2](#)) with the exception that some 2013 study depths measured 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. 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

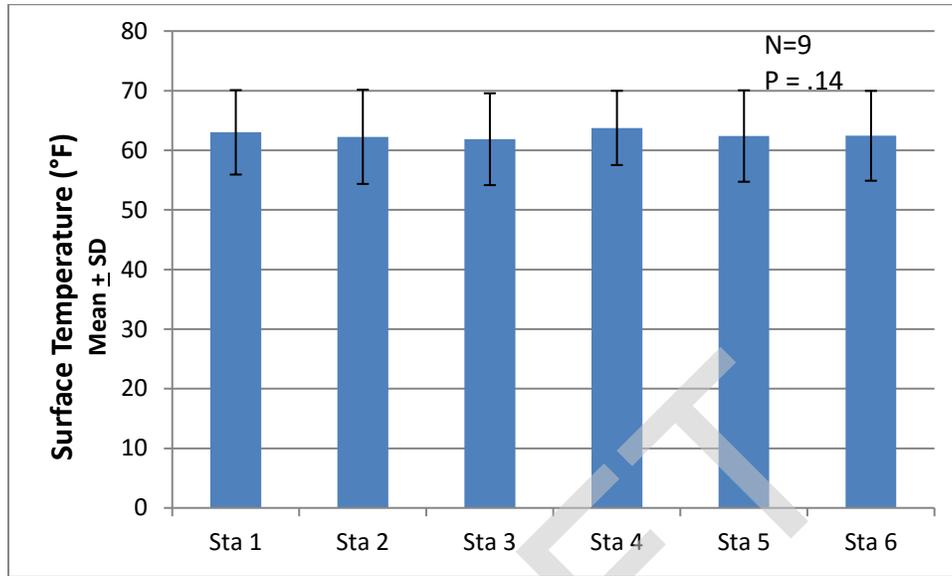
In addition, an analysis of variance (ANOVA) of the differences between top and bottom temperatures revealed that the means were significantly different among the sites ([Figure 4.3.2-3](#)), consistent with the stratification frequencies.

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 ($P=0.10$). 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

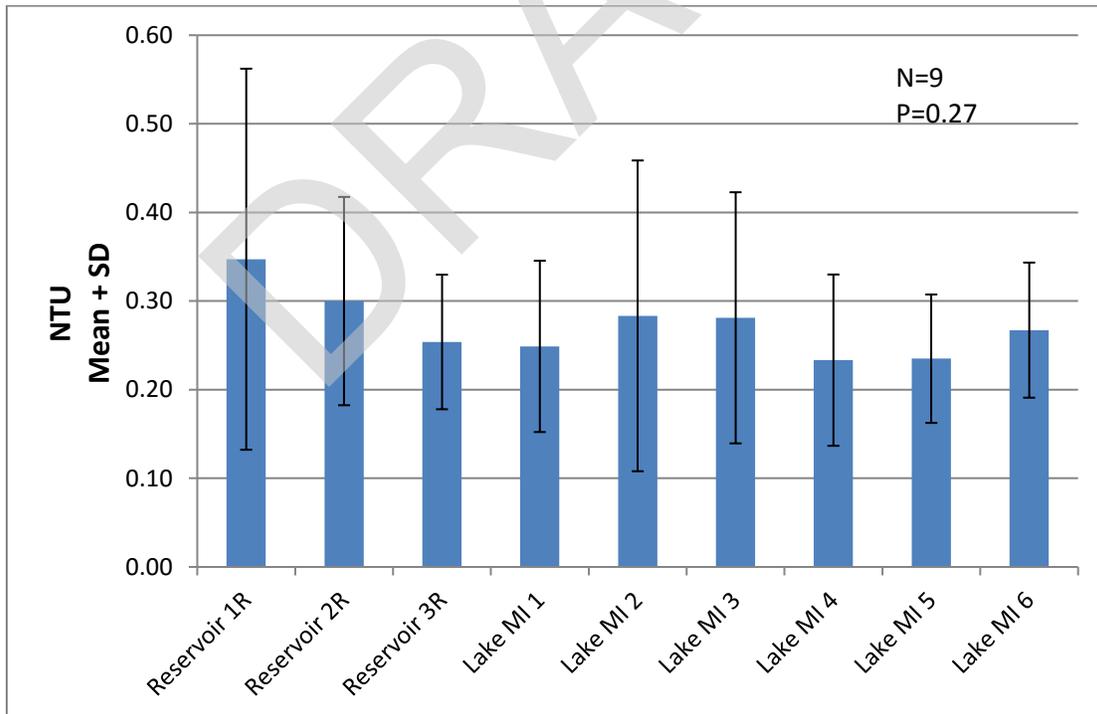
Station 1R				Station 2R				Station 3R			
	Avg DO	Avg Temp	Avg Turbidity		Avg DO	Avg Temp	Avg Turbidity		Avg DO	Avg Temp	Avg Turbidity
6/21/2013	11.3	52.5	0.3	6/21/2013	11.3	52.6	0.2	6/21/2013	11.3	52.8	0.2
7/1/2013	10.0	57.5	0.5	7/1/2013	10.0	57.4	0.4	7/1/2013	10.0	56.6	0.2
7/15/2013	10.2	63.9	0.1	7/15/2013	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 4.3.2-3). Mean turbidity was less than 0.4 NTU at all sites (Figure 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 4.3.2-3](#)). 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 4.3.2-5](#)) 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 4.3.2-6](#)).

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

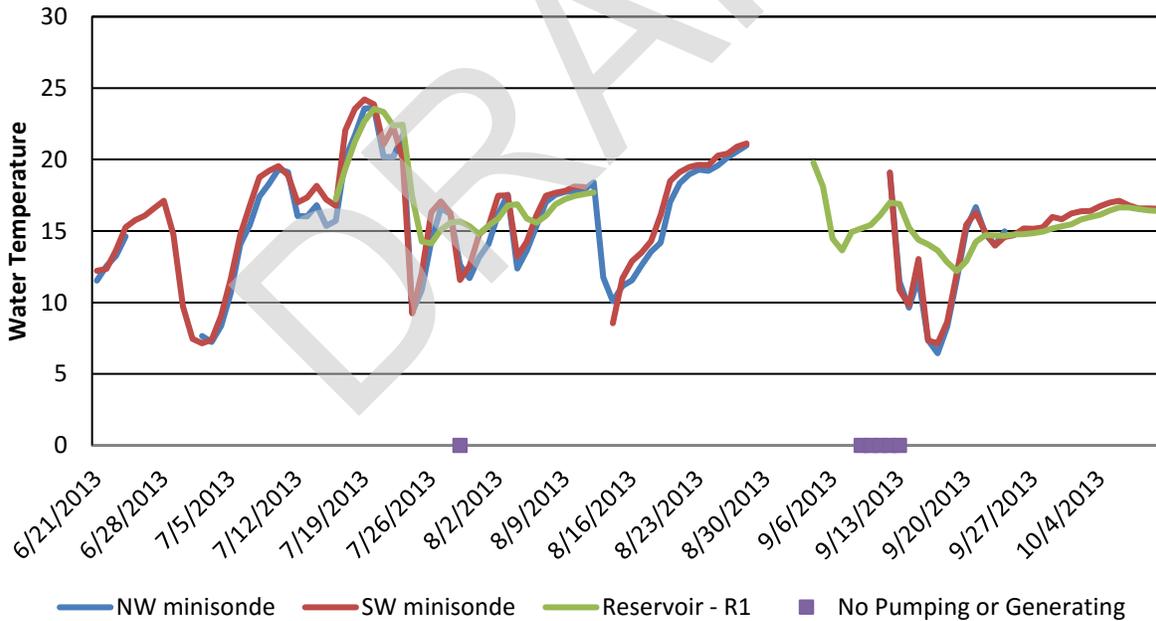
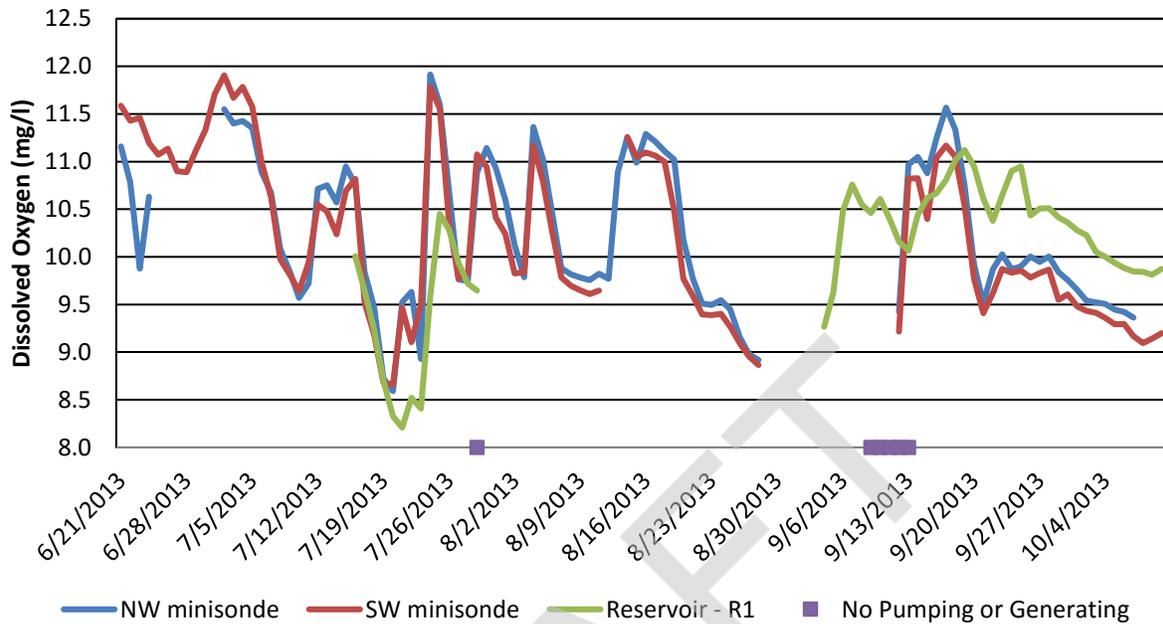


Figure E-4.3.2-7: 2013 Water Quality Study – Continuous MiniSonde Dissolved Oxygen Data



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. Should an accident 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.

4.3.2.3 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.

4.3.2.4 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.

4.3.2.5 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.

4.3.2.6 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>
- 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.

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.

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).

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.

⁸ Round goby are a non-native fish, originally from the Black and Caspian seas.

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. 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 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).

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:

⁹ A metric tonne equals 2,205 pounds.

- 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 coarse-gravel 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 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 the 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 in 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 barrier net in the tailwater area for the past 27 years to exclude fish from areas where they may be subjected to entrainment.

The barrier net is installed by April 15 and removed by October 15 each year. Winter conditions prevent the Licensees from using the barrier net during the remainder of the year. However, 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). The first 1,175 feet of net extending from the shoreline is made of ½-inch bar mesh (1-inch stretch), while the remainder of the net is constructed with ¾-inch bar mesh (1½-inch stretch). 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 waters in spring/early summer. The majority of the barrier net is deployed outside of the project boundary. A detailed description of the barrier net is provided in Exhibit A (Section 2.1.5) and in Alden (2016).

Alden (2011) measured current velocities at five locations inside the perimeter of the barrier net and at two locations in the tailrace area using Acoustic Doppler Current Profilers (ADCPs) during normal operations. 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 around the perimeter of the net (Alden 2011).

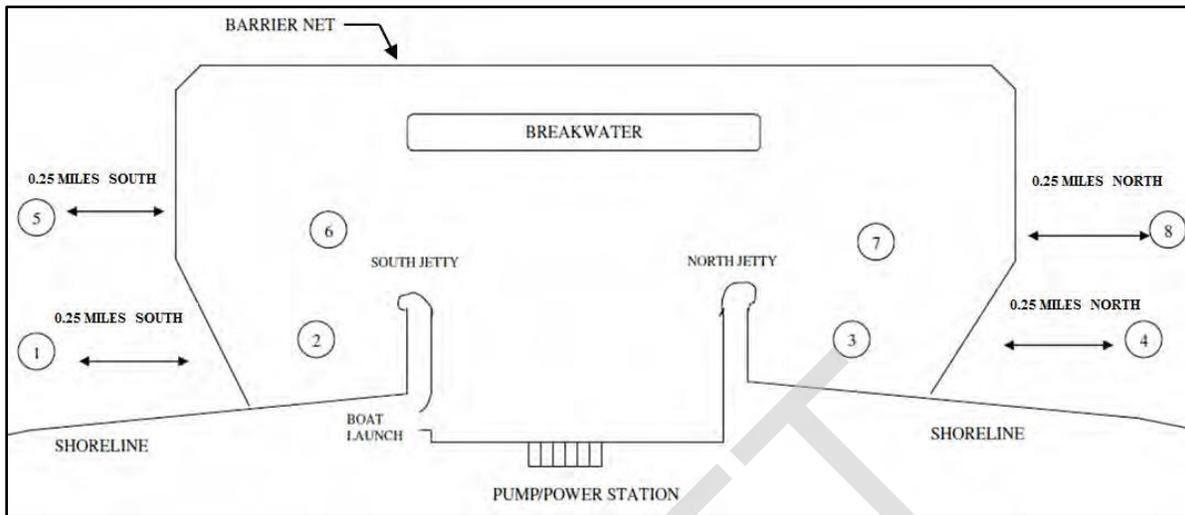
During pumping by all six units, data indicated:

- Maximum current velocities ranged from 0.4 to 0.8 fps around the barrier net perimeter;
- Average current velocities near the perimeter of the net ranged from 0.2 fps to 0.4 fps;
- 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).

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 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 4.3.3-1). 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. No studies have been undertaken to estimate the number of fish actually entrained or their fate after entrainment to the upper reservoir.

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 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 fish from entering the inside area, and represent those species and life stages subject to entrainment during pumping operations.

Figure 4.3.3-1: Gill net sampling stations (numbered circles) used for barrier net effectiveness monitoring.



Since 1993, the Licensees have collected approximately 450,000 fish during the barrier net monitoring program (Alden 2016). The total number of fish collected during annual gill netting has declined considerably over time. The total catch in 2015 was about 92 percent less than the peak in 1994 (Alden 2016). Most of the 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 1989. The declining trends in abundance is consistent with historical lake-wide trends reported by other researchers (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 about 3 percent of the total catch in 2015 (Alden 2016). Collection of lake sturgeon, another state-listed threatened species in Michigan, has remained low since 1993, ranging from 0 to 7 individuals annually; researchers have collected 75 lake sturgeon in the barrier net since 1993 (Alden 2016).

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-4.3.3-1](#)):

- 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:

$$\text{Percent Effectiveness} = [(T_o - T_i) / T_o] \times 100$$

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-4.3.3-1: 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	<i>Oncorhynchus tshawytscha</i>	>4-5, 5-12, 12-20, >20
	coho salmon	<i>Oncorhynchus kisutch</i>	>4-5, 5-12, >12
	lake trout	<i>Salvelinus namaycush</i>	>4-5, 5-12, >12
	rainbow trout (steelhead)	<i>Oncorhynchus mykiss</i>	>4-5, 5-12, >12
	brown trout	<i>Salmo trutta</i>	>4-5, 5-12, >12
	yellow perch	<i>Perca flavescens</i>	>4-5, >5
Forage fish	rainbow smelt	<i>Osmerus mordax</i>	>4-5, >5
	Alewife	<i>Alosa pseudoharengus</i>	>4-5, >5
Other	Bloater (chub)	<i>Coregonus hoyi</i>	>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 for target species is 83.9 percent (range: 70.1 to 96.3 percent) for gamefish and 94.5 percent (range: 80.7 to 98.9 percent) for forage fish ([Table E-4.3.3-2](#)). The barrier has attained its effectiveness target for game fish in 16 of 23 years and 22 of 23 years for forage fish ([Table E-4.3.3-2](#)).

Table E-4.3.3-2: 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	86.5	96.6
Mean	83.9	94.6
Max	96.3	98.9
Min	70.1	80.7
Years Below Target*	7	1
Years Above Target*	16	22

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

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. Approximately \$50 million in grants have been awarded to date from the GLFT. 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. 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.

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-4.3.3-3](#).

Table E-4.3.3-3: Fish Protection Technologies Considered for Application at Ludington (Alden 2015a)

Mode of Protection	Technology
<i>ENTRAINMENT ABATEMENT TECHNOLOGIES</i>	
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
<i>ENGINEERING ALTERNATIVES</i>	
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

Mode of Protection	Technology
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
	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-4.3.3-3](#)) 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-4.3.3-4](#) identifies the four along with their respective capital and annual costs.

Table E-4.3.3-4: Cost comparison of feasible entrainment abatement technologies (Alden 2015b)

Alternative	Initial Capital Costs			Annual Costs				Incremental Annual Costs (2015 \$)
	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	
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-4.3.3-3](#)). 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-4.3.3-5](#). 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-4.3.3-5: 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}	Incremental Annual O&M Costs (2016 \$)
Existing Barrier Net	NA	NA	NA	\$440,000	\$2,053,000	\$324,000	\$2,817,000	\$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.

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 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.

4.3.3.3 Proposed Environmental Measures

The Licensees propose to operate, maintain, and monitor the effectiveness of the existing barrier net seasonally to minimize fish entrainment during normal operations consistent with current practices. This includes consultation with stakeholders as is current practice.

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 fisheries effects due to Project operation are not considered to be adverse.

4.3.3.6 References

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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):

- 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.
- Maintained Recreational Areas: 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 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	<i>Sylvilagus floridandus</i>
Deer mouse	<i>Peromyscus msniculatus</i>
Eastern chipmunk*	<i>Tamias striatus</i>
Eastern coyote*	<i>Canis Latrans</i>
Fox squirrel	<i>Sciurus niger</i>
Gray squirrel*	<i>Sciurus carolinensis</i>
Little brown bat	<i>Myotis lucifugus</i>
Meadow vole*	<i>Microtus pennsylvanicus</i>
Opossum	<i>Didelphis marsupialis</i>
Raccoon	<i>Procyon lotor</i>
Red fox	<i>Vulpes vulpes</i>
Shorttailed shrew	<i>Blarina brevicauda</i>
Southern flying squirrel	<i>Glaucomys volans</i>
Striped skunk*	<i>Mephitis mephitis</i>
White-footed mouse	<i>Peromyscus leucopus</i>
White-tailed deer*	<i>Odocoileus virginianus</i>
Woodchuck	<i>Marmota monax</i>
Birds	
American crow*	<i>Corvus brachyrhynchos</i>
American goldfinch*	<i>Carduelis tristis</i>
American kestrel	<i>Falco sparverius</i>
American tree sparrow*	<i>Spizella arborea</i>
American redstart	<i>Setophaga ruticilla</i>

COMMON NAME	SCIENTIFIC NAME
American robin	<i>Turdus migratorius</i>
Bald eagle*	<i>Haliaeetus leucocephalus</i>
Bank swallow	<i>Riparia riparia</i>
Barred owl	<i>Strix varia</i>
Black-capped chickadee	<i>Poecile atricapillus</i>
Blue jay	<i>Cyanocitta cristata</i>
Bonaparte's gull	<i>Larus Philadelphia</i>
Broad winged hawk	<i>Buteo platypterus</i>
Brown thrasher	<i>Toxostoma rufum</i>
Brown-headed cowbird	<i>Molothrus ater</i>
Canada goose	<i>Branta Canadensis</i>
Caspian tern*	<i>Hydroprogne caspia</i>
Chipping sparrow	<i>Spizella passerine</i>
Common grackle	<i>Quiscalus quiscula</i>
Common merganser	<i>Mergus merganser</i>
Common raven*	<i>Corvus corax</i>
Common tern*	<i>Sterna hirundo</i>
Common yellowthroat	<i>Geothlypis trichas</i>
Double-crested cormorant*	<i>Phalacrocorax auritus</i>
Downy woodpecker	<i>Dendrocopus pubescens</i>
Eastern bluebird*	<i>Sialia sialis</i>
Eastern kingbird	<i>Tyrannus tyrannus</i>
Eastern phoebe	<i>Sayornis phoebe</i>
Eastern towhee	<i>Pipilo erythrophthalmus</i>
European starling	<i>Strunus vulgaris</i>
Field sparrow	<i>Spizella pusilla</i>
Gray catbird	<i>Dumetella carolinensis</i>
Great blue heron	<i>Ardea Herodias</i>
Great Crested flycatcher	<i>Myiachus crinitus</i>
Herring gull*	<i>Larus argentatus</i>
Horned lark	<i>Eremophila alpestris</i>
House sparrow	<i>Passer domesticus</i>
House wren*	<i>Troglodytes aedon</i>
Indigo bunting	<i>Passerina cyanea</i>
Least sandpiper	<i>Calidris minutilla</i>
Mallard duck*	<i>Anas platyrhynchos</i>

COMMON NAME	SCIENTIFIC NAME
Meadowlark	<i>Sturnella magna</i>
Mourning dove	<i>Zenaida macroura</i>
Northern cardinal*	<i>Cardinalis cardinalis</i>
Northern flicker	<i>Colaptes auratus</i>
Osprey	<i>Pandion haliaetus</i>
Pileated woodpecker*	<i>Dryocopus pileatus</i>
Purple martin*	<i>Progne subis</i>
Red-eyed vireo	<i>Vireo olivaceus</i>
Red-shouldered hawk*	<i>Buteo lineatus</i>
Red-tailed hawk	<i>Bueto jamaicensis</i>
Red-wing blackbird*	<i>Agelaius phoeniceus</i>
Ring-billed gull*	<i>Larus delawarensis</i>
Rock dove*	<i>Columba livia</i>
Rose-breasted grosbeak	<i>Pheicticus ludovicianus</i>
Ruby-throated hummingbird	<i>Archilochus colubris</i>
Ruffed grouse*	<i>Bonasa umbellus</i>
Savannah sparrow	<i>Passerculus sandwichensis</i>
Song sparrow	<i>Melospiza melodia</i>
Spotted sandpiper	<i>Actitis macularia</i>
Tree swallow*	<i>Tachycineta bicolor</i>
Turkey vulture*	<i>Cathartes aura</i>
Vesper sparrow	<i>Pooecetes gramineus</i>
White-breasted nuthatch	<i>Sitta carolinensis</i>
Wild turkey*	<i>Meleagris gallopavo</i>
Yellow warbler	<i>Dendroica petechia</i>
Reptiles	
Blanding's turtle	<i>Emys blandingii</i>
Common map turtle	<i>Graptemys geographica</i>
Common snapping turtle	<i>Chelydra serpentina</i>
Eastern garter snake*	<i>Thamnophis sirtalis</i>
Eastern hog-nosed snake	<i>Heterodon platirhinos</i>
Eastern massasauga	<i>Sistrutus catenatus</i>
Eastern milk snake	<i>Lampropeltis triangulum</i>
Northern ribbon snake	<i>Thamnophis sauritus septentrionalis</i>
Painted turtle	<i>Chrysemys picta</i>

COMMON NAME	SCIENTIFIC NAME
Amphibians	
Blue spotted salamander	<i>Ambystoma laterale</i>
Eastern American toad	<i>Bufo americanus</i>
Eastern tiger salamander	<i>Ambystoma tigrinum</i>
Fowler’s toad	<i>Bufo fowleri</i>
Gray tree frog	<i>Hyla versicolor and H. chrysoscelis</i>
Green frog	<i>Rana clamitans</i>
Northern leopard frog	<i>Rana pipiens</i>
Northern spring peeper	<i>Pseudacris crucifer</i>
Western chorus frog	<i>Pseudacris triseriata</i>
Wood frog	<i>Rana sylvatica</i>
Insects	
Monarch butterfly	<i>Danaus plexippus</i>
Cabbage white butterfly	<i>Pieris rapae</i>

* 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, 2016 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 (LIBH) 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., 2016). 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 about 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.

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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. 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 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	<i>Rubus allegheniensis</i>	X	
American beach grass	<i>Ammophila breviligulata</i>	X	X
Autumn olive	<i>Elaeagnus umbellata</i>	X	
Basswood	<i>Tilia Americana</i>	X	
Bayberry willow	<i>Salix myricoides</i>	X	
Beach wormwood	<i>Artemisia campestris</i>	X	X
Big-tooth aspen	<i>Populus grandidentata</i>	X	
Black locust	<i>Robinia pseudoacacia</i>	X	X
Bladder-campion	<i>Silene vulgaris</i>	X	
Blue spruce	<i>Picea pungens</i>	X	
Brittle-leaf sedge	<i>Carex eburnean</i>	X	
Broad loose-flower sedge	<i>Carex laxiflora</i>	X	
Bull thistle	<i>Cirsium vulgre</i>	X	X
Burdock	<i>Arctium minus</i>	X	
Butter-and-eggs	<i>Linaria vulgaris</i>	X	
Choke cherry	<i>Prunus virginiana</i>	X	X
Common milkweed	<i>Asclepias syriaca</i>	X	
Common St. John's-wort	<i>Hypericum perforatum</i>	X	
Common yarrow	<i>Achillea millefolium</i>		X
Crown vetch	<i>Coronilla varia</i>	X	X
Eastern arborvitae	<i>Thuja occidentalis</i>	X	
Eastern bottle-brush grass	<i>Elymus hystrix</i>	X	
Eastern hemlock	<i>Tsuga canadensis</i>	X	
Eastern hop-hornbeam	<i>Ostrya virginiana</i>	X	X
Eastern serviceberry	<i>Amelanchier canadensis</i>	X	
Eastern white pine	<i>Pinus strobes</i>	X	
European white birch	<i>Betula pendula</i>	X	
Everlasting pea	<i>Lathyrus latifolius</i>	X	
Flat-top goldentop	<i>Euthamia graminifolia</i>	X	
Flat-stem blue grass	<i>Poa compressa</i>	X	X
Freshwater cordgrass	<i>Spartina pectinata</i>		X
Garden yellow-rocket	<i>Barbarea vulgaris</i>	X	
Garlic mustard	<i>Alliaria petiolata</i>		X
Glossy buckthorn	<i>Frangula alnus</i>	X	

Common Name	Scientific Name	Ludington Site	Port Sheldon Site
Great mullein	<i>Verbascum thapsus</i>	X	X
Heart-leaf willow	<i>Salix cordata</i>	X	
Hedge parsley	<i>Torilis japonica</i>	X	
Herb-Robert	<i>Geranium robertianum</i>	X	
Japanese barberry	<i>Berberis thunbergii</i>	X	
Japanese knotweed	<i>Fallopia japonica</i>	X	
Large-leaf wood-aster	<i>Eurybia macrophylla</i>	X	
Little false bluestem	<i>Schizachyrium scoparium</i>	X	
Maple-leaf arrow-wood	<i>Viburnum acerifolium</i>	X	
Morrow's honeysuckle	<i>Lonicera morrowii</i>	X	X
Multiflora rose	<i>Rose multiflora</i>	X	
Northern bracken fern	<i>Pteridium aquilinum</i>	X	X
Northern red oak	<i>Quercus rubra</i>	X	X
Orchard grass	<i>Dactylis glomerata</i>	X	X
Paper birch	<i>Betula papyrifera</i>	X	
Pennsylvania sedge	<i>Carex pensylvanica</i>	X	
Purple loosestrife	<i>Lythrum salicaria</i>		X
Quaking aspen	<i>Populus tremuloides</i>	X	X
Queen Anne's lace	<i>Daucus carota</i>	X	X
Red bearberry	<i>Arctostaphylos uva-ursi</i>	X	
Redtop	<i>Agrostis gigantea</i>	X	
Reed canary grass	<i>Phalaris arundinacea</i>	X	X
Sassafras	<i>Sassafras albidum</i>	X	X
Scotch pine	<i>Pinus sylvestris</i>	X	
Small-head rush	<i>Juncus brachycephalus</i>	X	
Smooth brome	<i>Bromus inermis</i>	X	X
Smooth saw-grass	<i>Cladium mariscoides</i>	X	
Smooth scouring-rush	<i>Equisetum laevigatum</i>	X	
Spotted knapweed	<i>Centaurea maculosa</i>	X	X
Staghorn sumac	<i>Rhus typhina</i>	X	
Sugar maple	<i>Acer saccharum</i>	X	
Tall goldenrod	<i>Solidago altissima</i>	X	X
Uptight sedge	<i>Carex stricta</i>	X	X
Wallflower cabbage	<i>Coincya monensis</i>		X
White ash	<i>Fraxinus americana</i>	X	
White spruce	<i>Picea glauca</i>	X	

Common Name	Scientific Name	Ludington Site	Port Sheldon Site
Wild sarsaparilla	<i>Aralia nudicaulis</i>	X	
Wreath goldenrod	<i>Solidago caesia</i>	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.

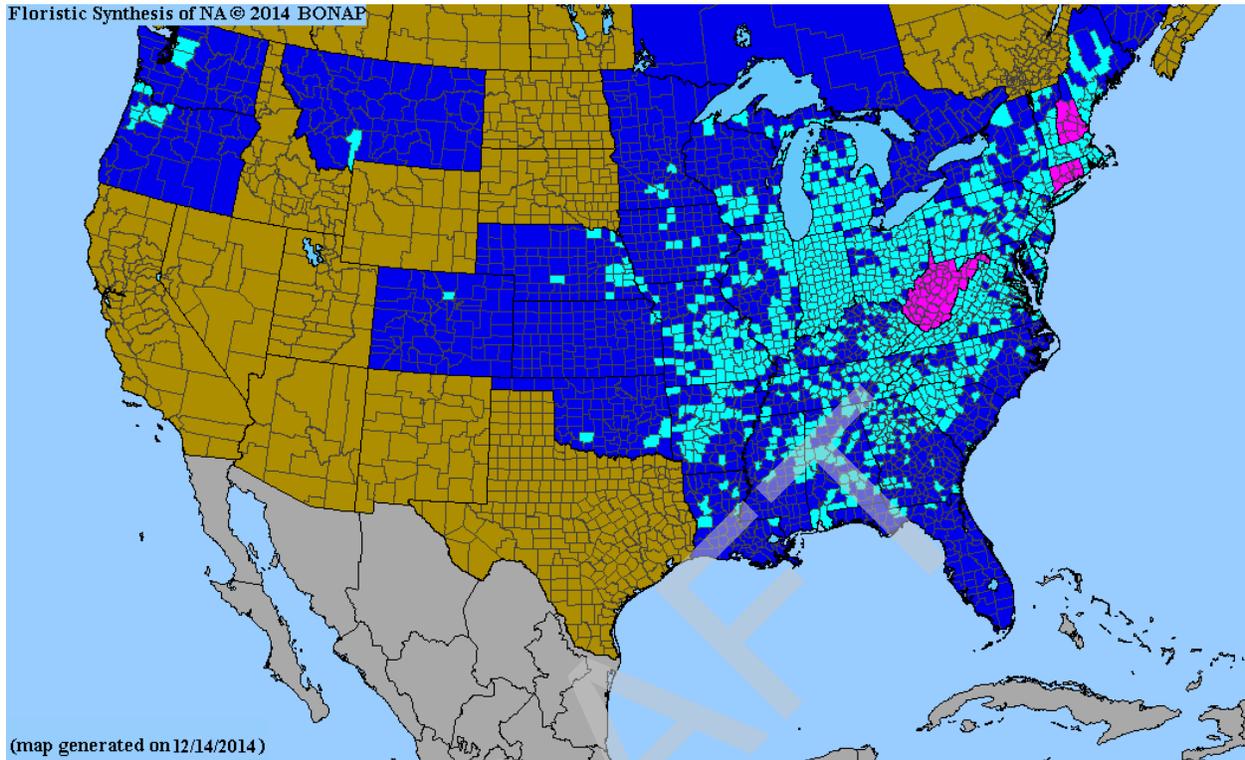
Invasive Plants and Noxious Weeds

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. 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). 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.

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 4.3.5-1](#)) 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-4.3.5-1: 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 4.3.5-2 through 4.3.5-7](#))

MISIN Map Key

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

Figure E-4.3.5-2: Autumn olive observations

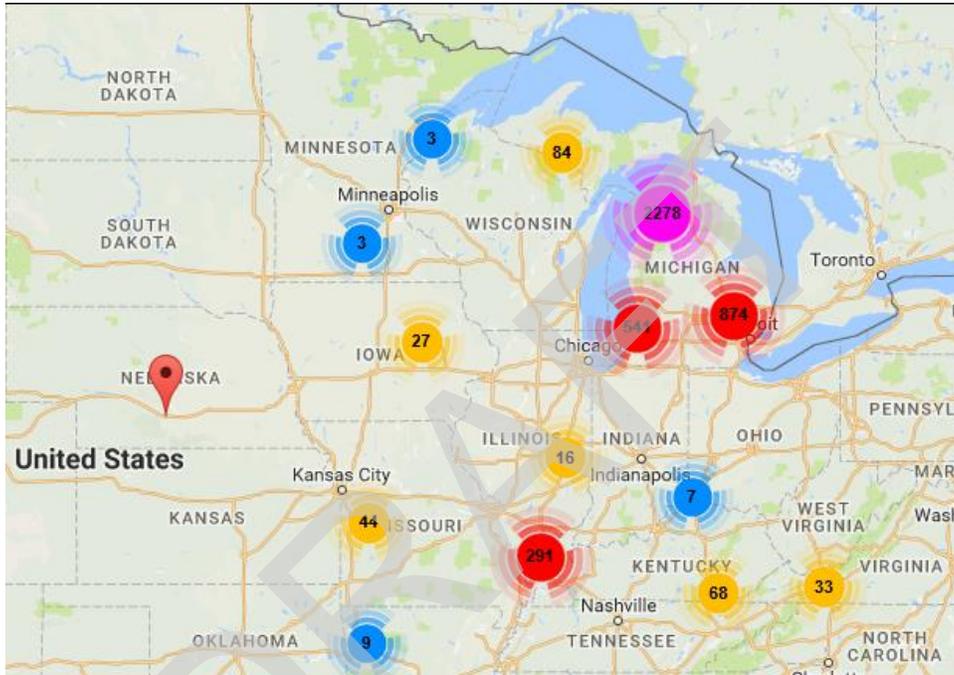


Figure E-4.3.5-3: Crown vetch observations

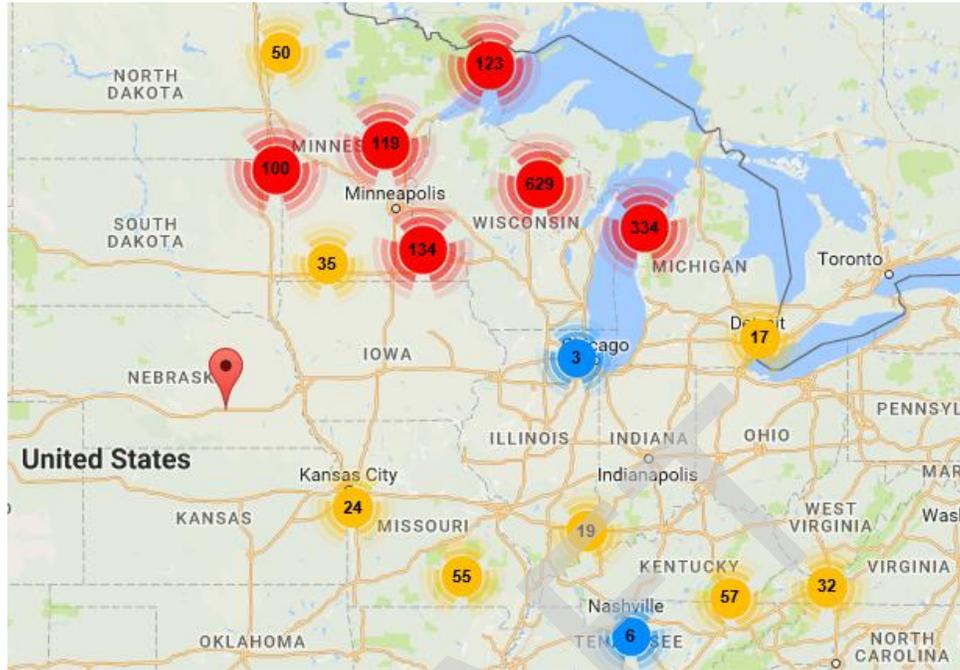


Figure E-4.3.5-4: Glossy buckthorn observations

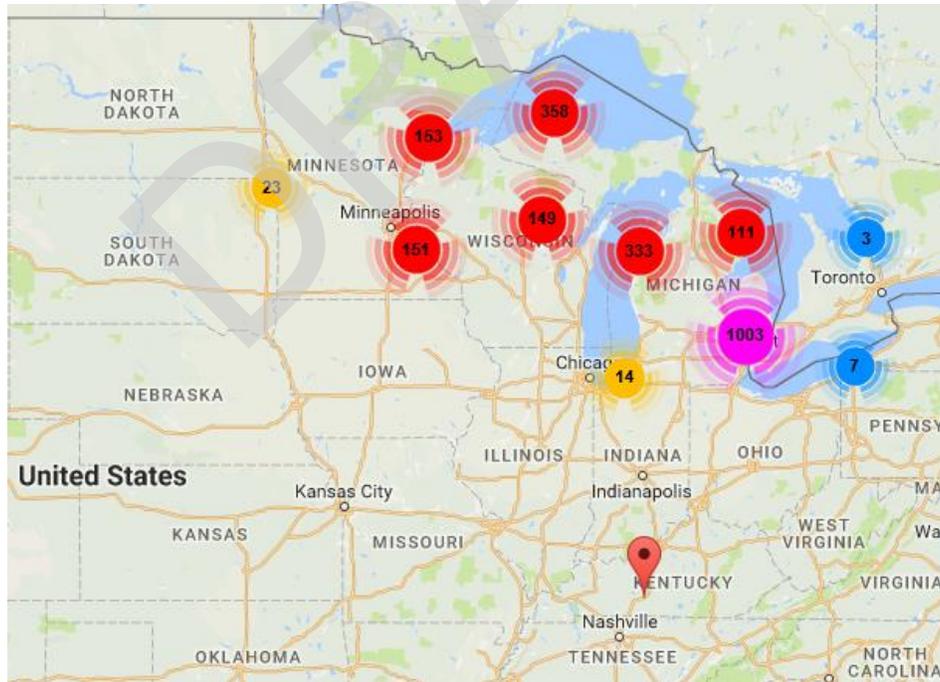


Figure E-4.3.5-7: Spotted knapweed observations

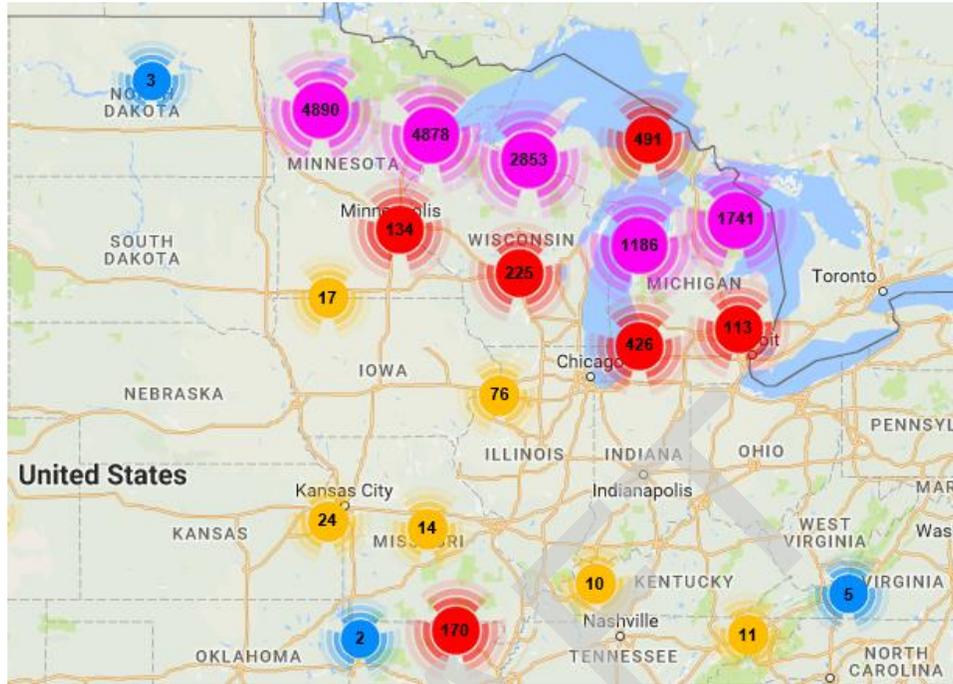


Table E-4.3.5-2: Potential Invasive Species within the Project Vicinity

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

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

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

Figure E-4.3.5-8: Cover Type Map Ludington Site

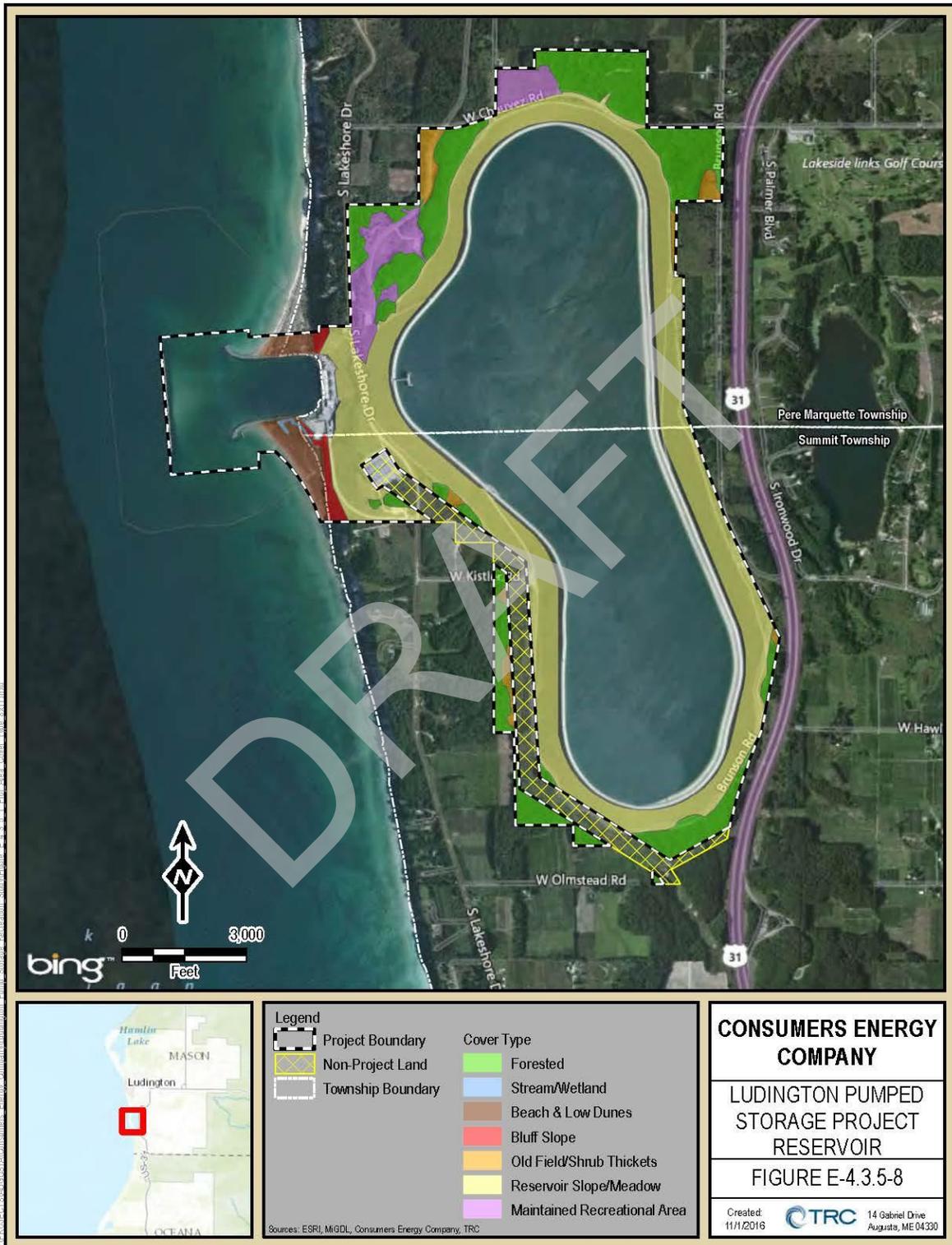


Figure E-4.3.5-9: Cover Type Map Port Sheldon Site



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, 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 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. Mowing is a useful management tool for controlling a variety of invasive species. Mowing helps to suppress growth of invasive shrubs, such as autumn olive, glossy buckthorn, honeysuckles, barberry, and multiflora rose.

The presence of invasive species 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.

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.

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.

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>

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

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. 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 (LIBH) and Pigeon Lake as a river with an unconsolidated bottom and a permanently flooded waterway (RUBH) (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-4.3.6-1](#) lists vegetation common to the wetlands and shorelines of the region, as indicated by NWI data.

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: Common Wetland and Shoreline Vegetation within the Project Vicinity

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

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

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

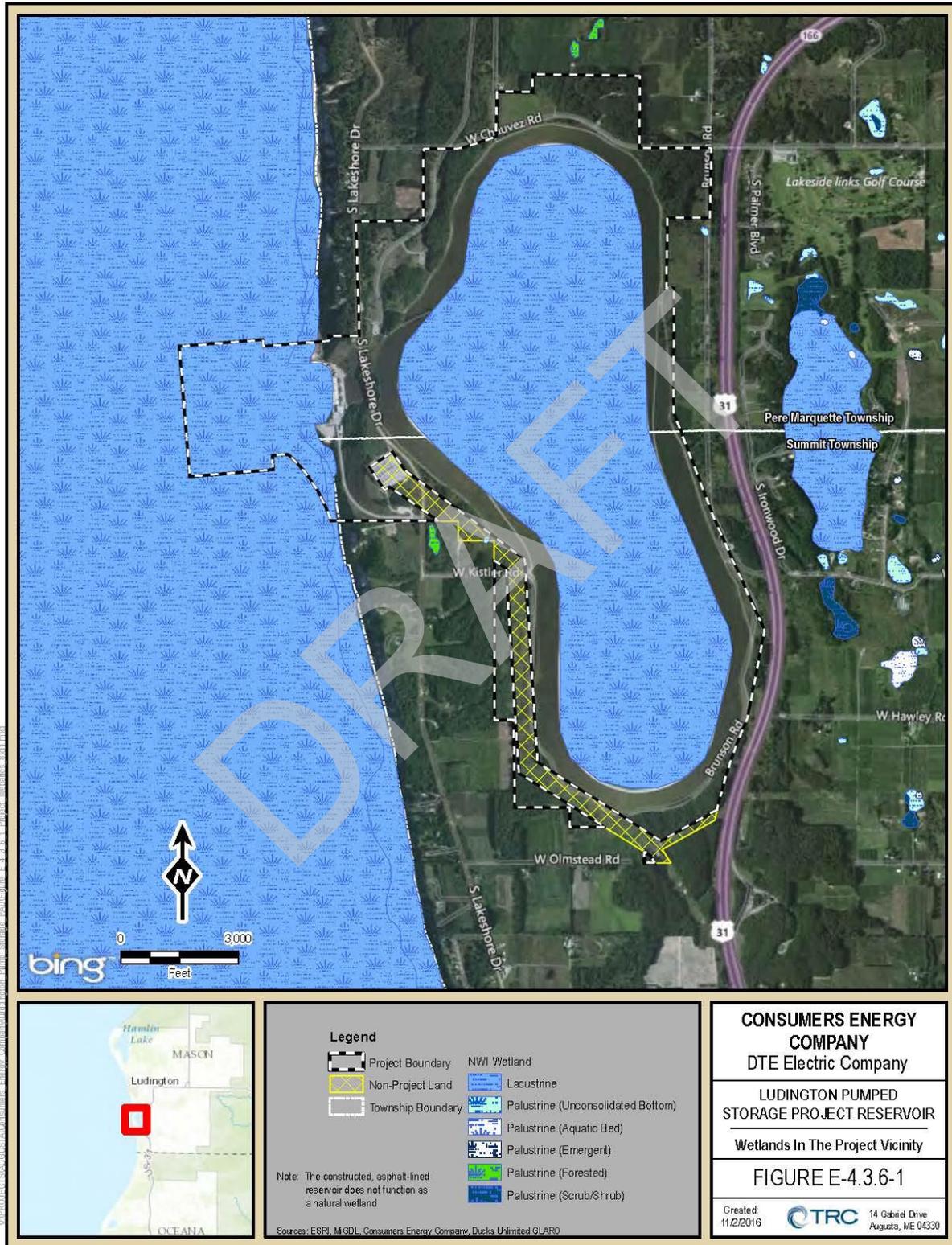
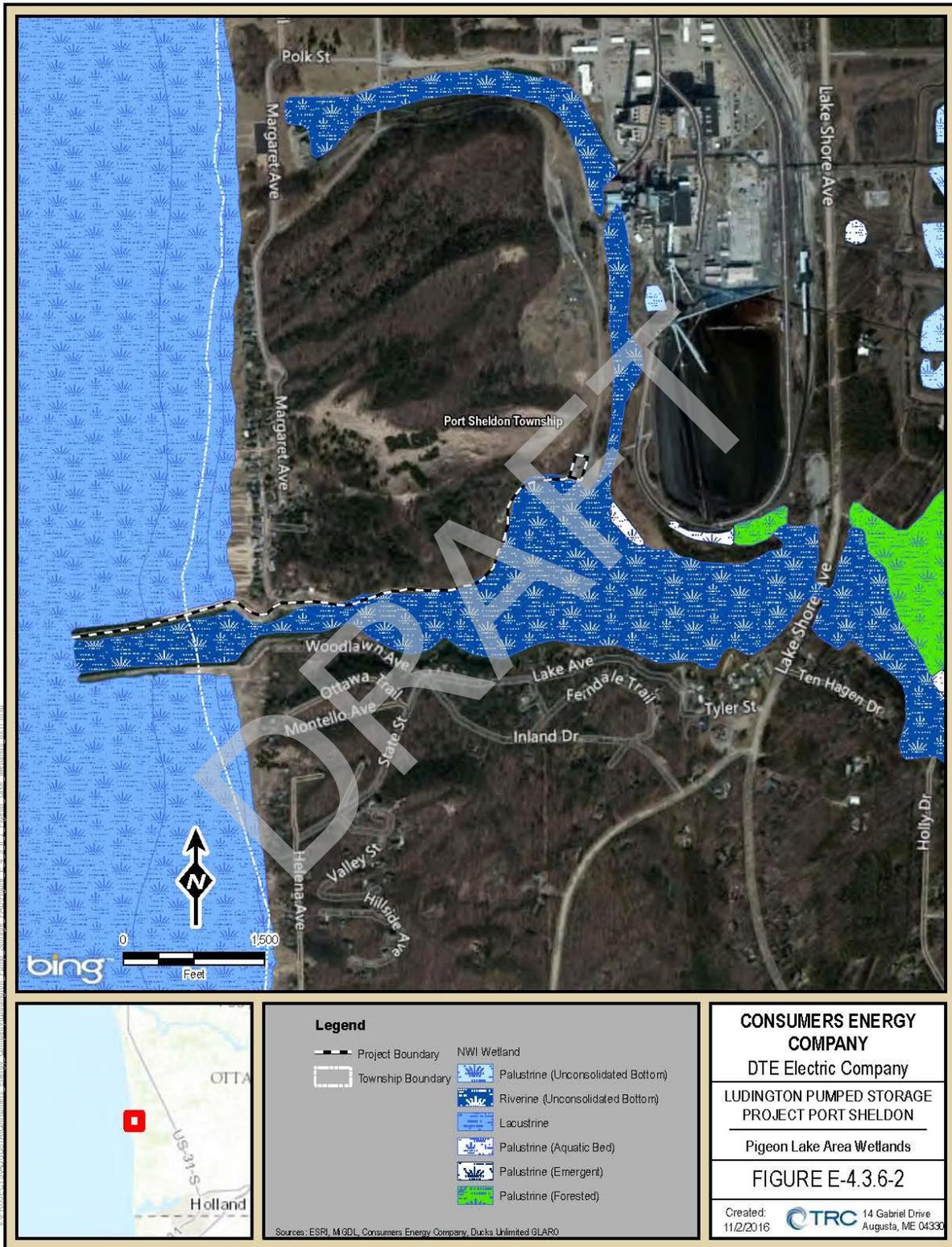


Figure E-4.3.6-2: Pigeon Lake Area Wetlands



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 1,850-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](#).

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 (LIBH) 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 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 about 30 gallons per minute (gpm)) and the pumping relief wells along the downstream toe of the upper reservoir embankment (contributes about 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 (ACOE). 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. Since this time, the northern long-eared bat and Rufa red knot have also been added to the Mason County Federal RTE list.

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.

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 that was intended to reduce the effects of project operation on RTE fish species. This Settlement Agreement was filed with FERC on September 28, 1995.

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	<i>Notropis dorsalis</i>	SC	Ottawa
Cisco (lake herring)	<i>Coregonus artedi</i>	T	Mason ^b ; Ottawa
Lake sturgeon	<i>Acipenser fulvescens</i>	T	Mason ^b
River redhorse	<i>Moxostoma carinatum</i>	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 have been observed during barrier net monitoring and lake sturgeon are expected to occur adjacent to the Project in Lake Michigan.

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.

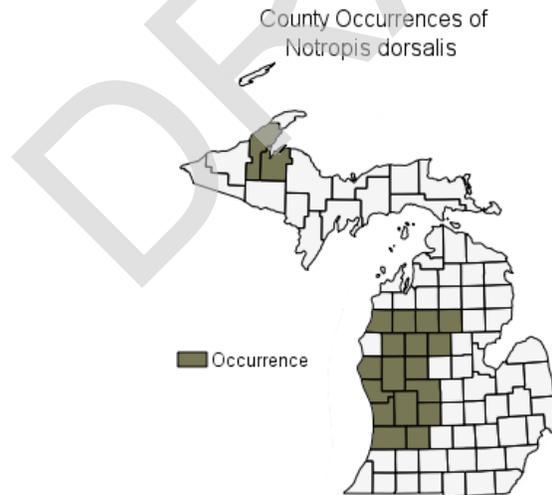


Figure E-4.3.7-1: County occurrence of bigmouth shiner

Image source: MNFI, 2016

Cisco, a native salmonid species, is a state-listed threatened species in Michigan. 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).

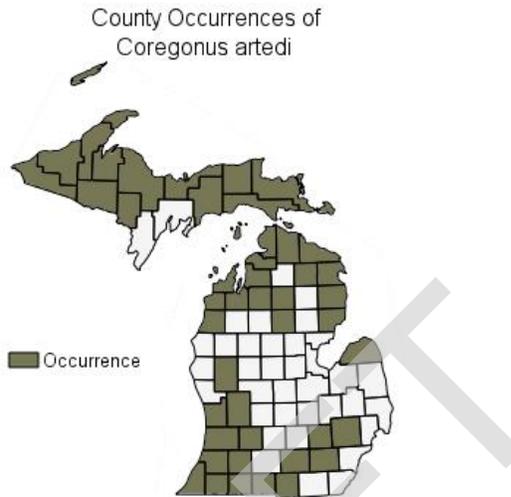


Figure E-4.3.7-2: County occurrence of cisco

Image source: MNFI, 2016

Lake sturgeon is a threatened species in Michigan. 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.

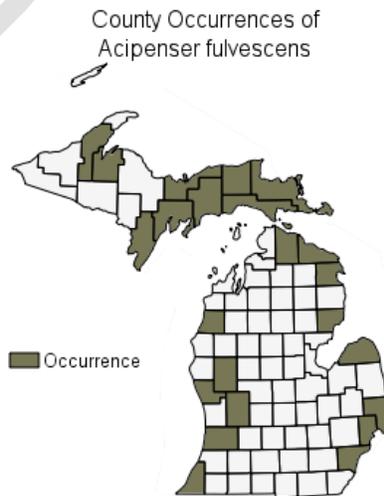


Figure E-4.3.7-3: County occurrence of lake sturgeon

Image source: MNFI, 2016

River redhorse is a threatened species in Michigan. 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).

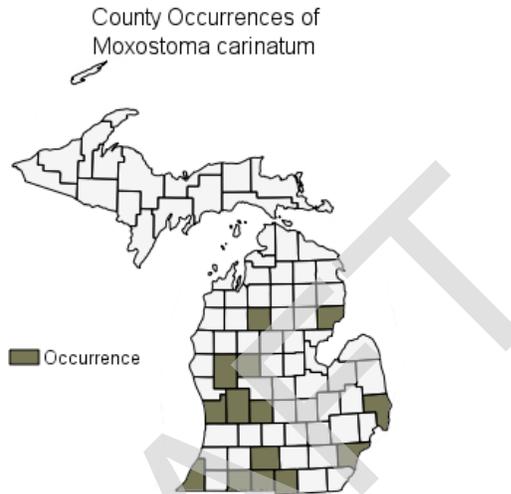


Figure E-4.3.7-4: County occurrence of river redhorse

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” (NMFS, 2011). 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	<i>Haliaeetus leucocephalus</i>	SC	Mason
Marsh wren	<i>Cistothorus palustris</i>	SC	Mason
Piping plover	<i>Charadrius melodus</i>	FE, E	Mason
Red-shouldered hawk	<i>Buteo lineatus</i>	T	Mason
Rufa red knot	<i>Calidris canutus rufa</i>	FT	Mason, Ottawa
Insects			
Karner blue butterfly	<i>Lycaeides Melissa samuelis</i>	FE, T	Mason
Mammals			
Indiana bat	<i>Myotis sodalist</i>	FE, E	Mason, Ottawa
Little brown bat	<i>Myotis lucifugus</i>	SC	Mason
Northern long-eared bat	<i>Myotis septentrionalis</i>	FT, SC	Mason
Reptiles and Amphibians			
Blanchard's cricket frog	<i>Acris crepitans blanchardi</i>	T	Ottawa
Eastern box turtle	<i>Terrapene carolina carolina</i>	SC	Mason
Eastern massasauga	<i>Sistrurus catenatus</i>	FC, SC	Mason

^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. 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).

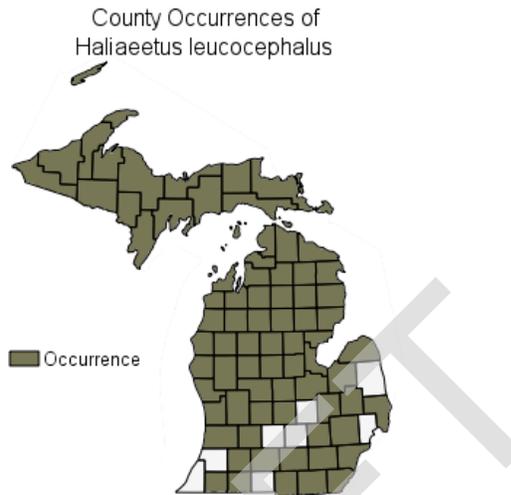


Figure E-4.3.7-5: County occurrence of bald eagle

Image source: MNFI, 2016

Marsh wren is classified as special concern in Michigan. 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. 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).

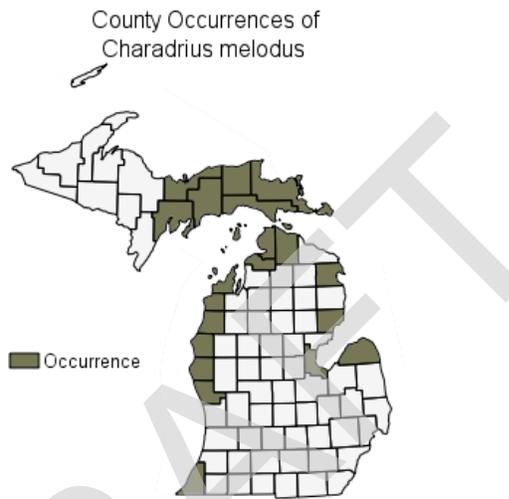


Figure E-4.3.7-7: County occurrence of piping plover

Image source: MNFI, 2016

Red-shouldered hawk is listed as threatened by the state of Michigan. 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. 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.

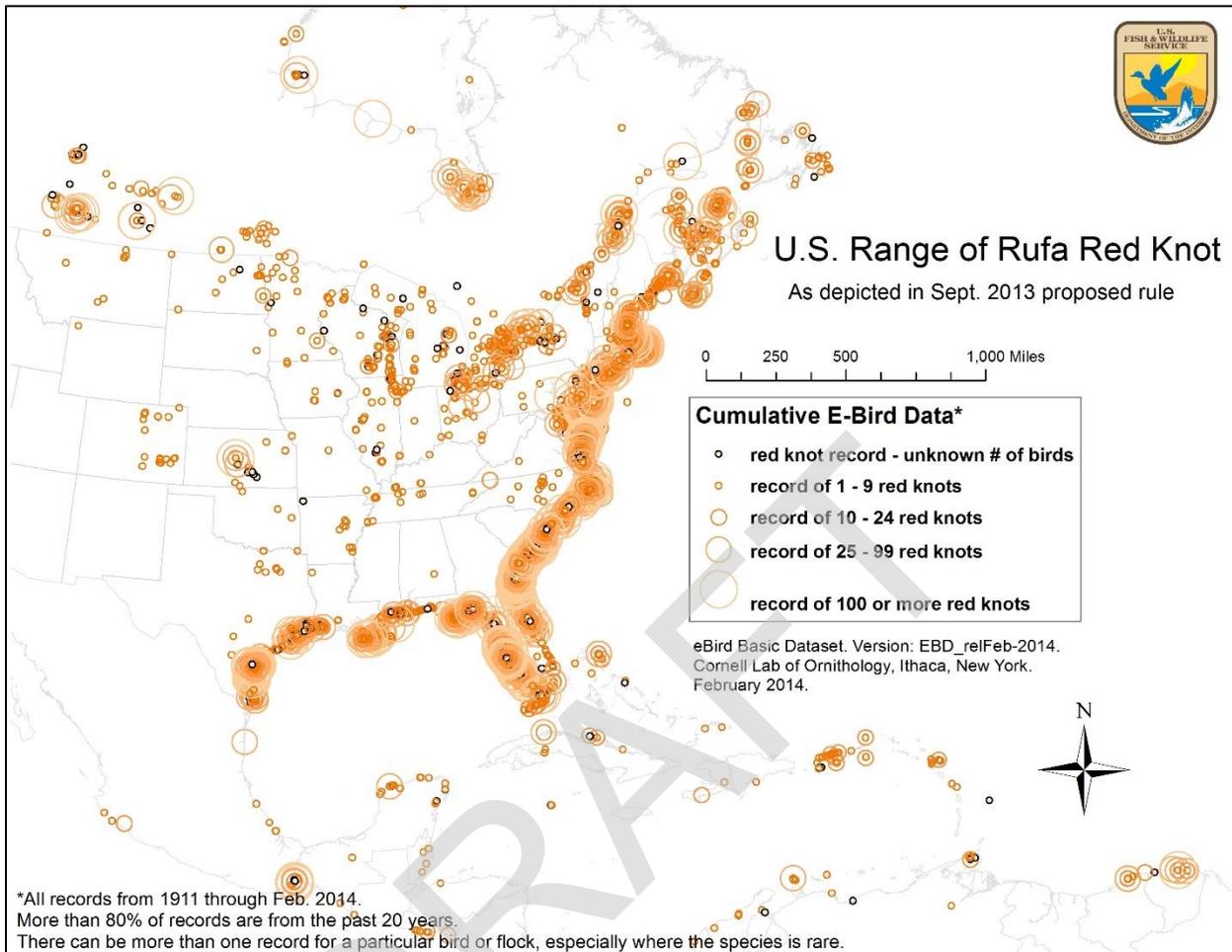


Figure E-4.3.7-9: U.S. range of rufa red knot

Image source: USFWS, 2016

Karner blue butterfly is a federally endangered and state threatened species in Michigan. 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-4.3.7-10](#) below.

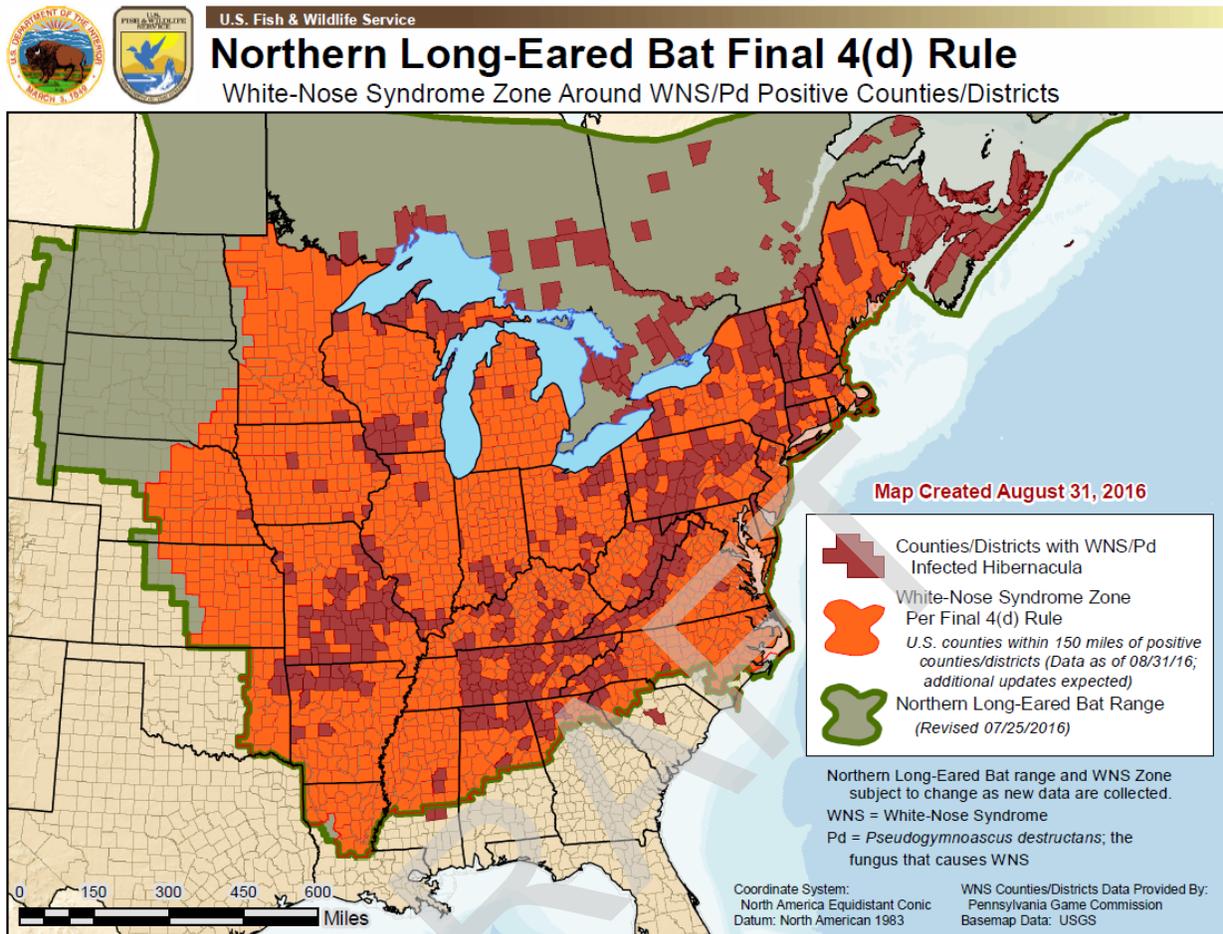


Figure E-4.3.7-11: White nose syndrome zone

Image source: USFWS, 2016

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 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. 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 overwintering 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.

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 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-4.3.7-13: County occurrence of northern long-eared bat

Image source: MNFI, 2016

Blanchard's cricket frog is listed as threatened by the state of Michigan. 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-4.3.7-14: 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. 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).

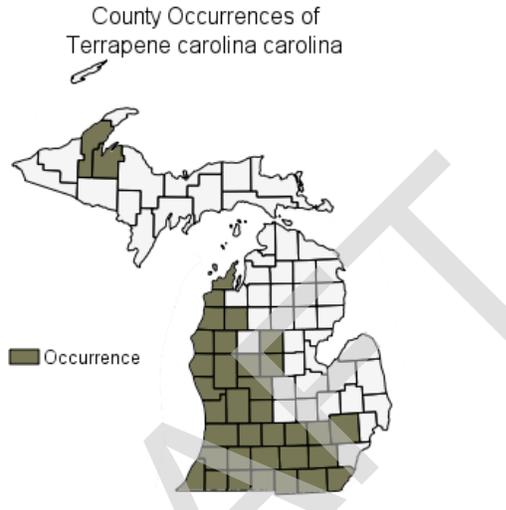


Figure E-4.3.7-15: County occurrence of eastern box turtle

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. 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-4.3.7-16: 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	<i>Panax quinquefolius</i>	T	Mason, Ottawa
Pitcher’s thistle	<i>Cirsium pitcher</i>	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. 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-4.3.7-17: 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). 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-4.3.7-18: 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. 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. 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 and a reintroduction program is planning to release lake sturgeon fry close to the Project in Mason County. 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 when the seasonal barrier net is not in place. However, 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). When in place, the seasonal barrier net excludes most sizes of lake sturgeon and cisco from being entrained.

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 caused by 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 affect 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

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

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

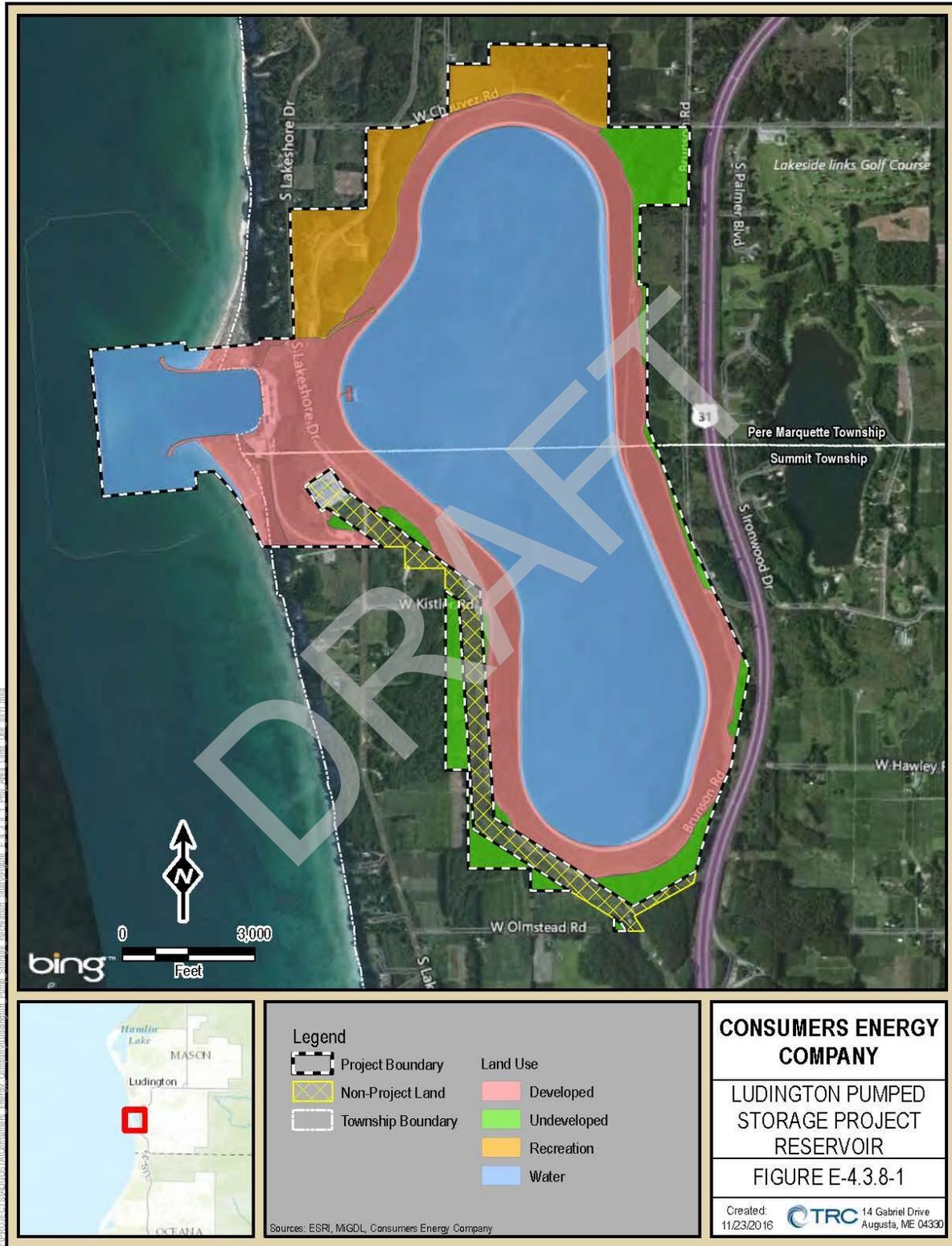
“undeveloped” lands or lands utilized for recreation. [Table E-4.3.8-1](#) shows a breakdown of land use within the Project boundary, while [Figures E-4.3.8-1](#) shows the lands within the Project Boundary and [E-4.3.8-2](#) and E-4.3.8-3 show the project recreation sites. Approximately 410 acres or 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.

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.	411	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		688	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. These waters are not open to the public for safety purposes.

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, just to the west of the LPSP. A portion of the 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 DNR manages several areas in the vicinity of the project, which provide hunting, fishing, camping, hiking, swimming, picnicking and boating opportunities. 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 and the Nordhouse Dunes Wilderness (National Wilderness Area). 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

There are a total of six Project recreation sites located within the Ludington Project boundary. These provide a variety of recreation opportunities such as fishing, camping, picnicking, walking, disc golfing, flying model aircraft, and sightseeing.

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 ADA compliant, 56 campsites, four cabins, picnic shelter with eight tables, playground, three benches, an interpretive display and a foot path to Hull Field. 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.

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 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. 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 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 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%.¹¹ 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

¹¹ The peak holiday capacity of 98% use was observed on July 4, 2015.

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.

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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).

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.¹²

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 Recreation Management Plan will be developed and submitted in the Final License Application. (Appendix E-3) 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.

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.

¹² Snowshoeing became available in January 2017 with the designation of the 1.7-mile snowshoe trail at the Mason County Day/Use Picnic Area.

4.3.8.6 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. 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>

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 Precontact 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.

Precontact Period History

The prehistoric occupation of Michigan is generally divided into three broad periods: Paleo-Indian, Archaic and Woodland.

Paleoindian Period (ca. 12,000-10,000 B.P.). [Note: B.P. refers to Before Present'] 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). Paleo-Indian sites are most easily recognized by the presence of fluted spear-points.

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.

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.

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 State Historic Preservation Office (MISHPO) 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.

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. 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.¹³

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

¹³ 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.

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 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. 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.

Two of the Postcontact sites, however, are recommended as potentially eligible for the NRHP under Criterion D for an ability to yield significant information relevant to important research questions in regional farmstead archaeology.

These are sites 20MN324 and 20MN329, both located in Section 11 of Summit Township. As no changes in the operation of the Project are currently planned and no new construction is under consideration, these two sites are not in imminent danger of disturbance or destruction.

Therefore, no additional investigation of these sites was recommended at this time. Should new construction or changes in plant operations be considered in the future that have the potential to impact the sites then formal evaluation of these two sites in the form of Phase II archaeological testing will be necessary.

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 G¹⁴. 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).

¹⁴ 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.

No properties listed on the Michigan State Register of Historic Sites are present within the Project study area.

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 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.

4.3.9.3 Proposed Environmental Measures

The Licensees have proposed to file with the final license application a Historic Properties Management Plan (HPMP), developed in consultation with the Michigan SHPO. The HPMP will ensure that appropriate consultation occurs prior to any future activity that may affect the eligible historic properties associated with the Project. A draft 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 will address the NRHP-eligible properties listed in [Table E-4.3.9-1](#). (Appendix E-5)

Table E-4.3.9-1: Eligible Historic Properties to be 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.

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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](#)).¹⁵ An urban cluster is a densely settled territory with at least 2,500 people, but fewer than 50,000.

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 about 2,000 acres just west of the Pigeon Lake North Pier. About 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

¹⁵ 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 parentheses, are the publication dates for the data. Therefore, the citation is shown as: (US Census Bureau, 2013).

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, about 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](#)).¹⁶ 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

¹⁶ 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.

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.

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%

	Pere Marquette Township	Summit Township	Mason County	Port Sheldon Township	Ottawa County	State of Michigan
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 units¹⁷ 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.

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](#)

¹⁷ 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.

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, 2012¹
Dow Chemical Company
Harsco Rail
Ludington Area School District
Meijer
Metalworks, Inc.
Spectrum Health Ludington Hospital
Largest Employers in Ottawa County²
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.*

¹Mason County, Michigan, 2012.

²County 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 URL <http://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>.

4.4 Economic Analysis

4.4.1 Costs and Value of Developmental Resources Associated with the Project

[To be provided in Final Application]

4.4.2 Costs of Proposed PMEs

[To be provided in Final Application]

4.5 Consultation Documentation

A list containing the name, and address of every Federal, state, and interstate resource agency, Indian tribe, or member of the public with which the applicant consulted in the preparation of the Ludington relicensing documents is set forth in [Appendix E-1](#).

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APPENDIX E-1
CONSULTATION RECORD

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LUDINGTON PUMPED STORAGE
 FERC PROJECT No. 2680
 Consultation Correspondence Summary

Date	To	From	Topic
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
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

LUDINGTON PUMPED STORAGE
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Date	To	From	Topic
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
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	Reply to LPSP Information Request
4/11/13	Pere Marquette Township -Enbody	Consumers	Reply to 4/11/2013 email
4/15/13	Michigan Department of Natural Resources	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 relicensing contacts
4/19/13	Consumers	MUCC- - Roberson	Consumers acknowledgement of 4/19/2013 email

LUDINGTON PUMPED STORAGE
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 Consultation Correspondence Summary

Date	To	From	Topic
4/19/13	MUCC - Roberson	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 attendance
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
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	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	Michigan Department of Natural Resources	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 from 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

LUDINGTON PUMPED STORAGE
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 Consultation Correspondence Summary

Date	To	From	Topic
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
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 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
10/3/14	FERC	Little Traverse Bay Band of Odawa Indians	Comments on PSP

LUDINGTON PUMPED STORAGE
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 Consultation Correspondence Summary

Date	To	From	Topic
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 information 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 information 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
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

LUDINGTON PUMPED STORAGE
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Date	To	From	Topic
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
3/7/16	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	Michigan Department of Environmental Quality	Consumers	CE Contact with MDEQ Relicensing Contacts
9/30/16	FERC	Consumers	LPSP Major Overhaul Update
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.
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 acknowledgement of PMT's 1/17/17 letter

APPENDIX E-2
APPLICATIONS FOR WATER QUALITY CERTIFICATION
AND
MICHIGAN CZMA CONSISTENCY DETERMINATION
[TO BE INCLUDED IN FINAL LICENSE APPLICATION]

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APPENDIX E-3
DRAFT RECREATION FACILITIES MANAGEMENT PLAN
(TO BE INCLUDED IN FINAL LICENSE APPLICATION)

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APPENDIX E-4
OPERATIONS COMPLIANCE MANAGEMENT PLAN
(TO BE INCLUDED IN FINAL LICENSE APPLICATION)

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APPENDIX E-5
HISTORIC PROPERTIES MANAGEMENT PLAN
(TO BE INCLUDED IN FINAL LICENSE APPLICATION)

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM

DRAFT EXHIBIT F
GENERAL DESIGN DRAWINGS

CONTAINS CRITICAL ENERGY INFRASTRUCTURE INFORMATION
(CEII)

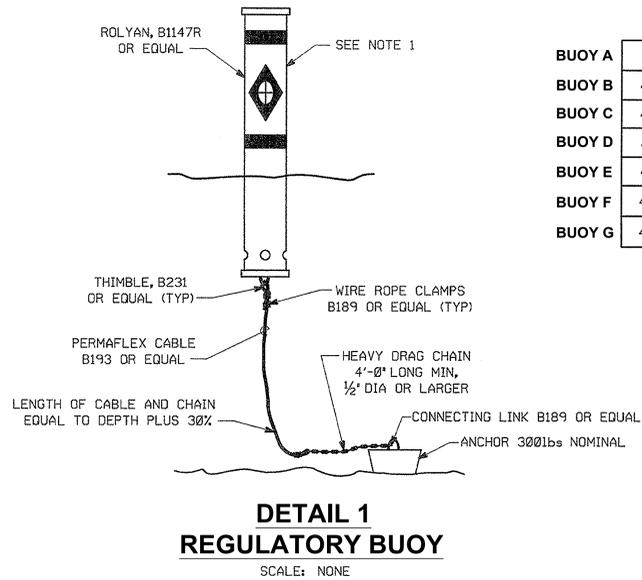
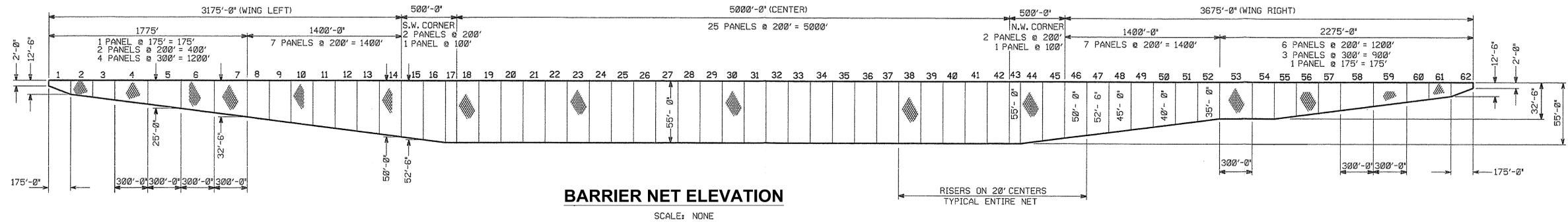
The design drawings showing plan, elevations, and sections of the principal Ludington Pumped Storage Hydroelectric Project (Project) works are included as follows:

<u>Sheet No.</u>	<u>Title</u>
Sheet 1	General Plan (CEII)
Sheet 2	General Plan – Sections (CEII)
Sheet 3	Intake and Berm (CEII)
Sheet 4	Powerhouse Section (CEII)
Sheet 5	Berm and Emergency Overflow (CEII)
Sheet 6	Barrier Net (Public)

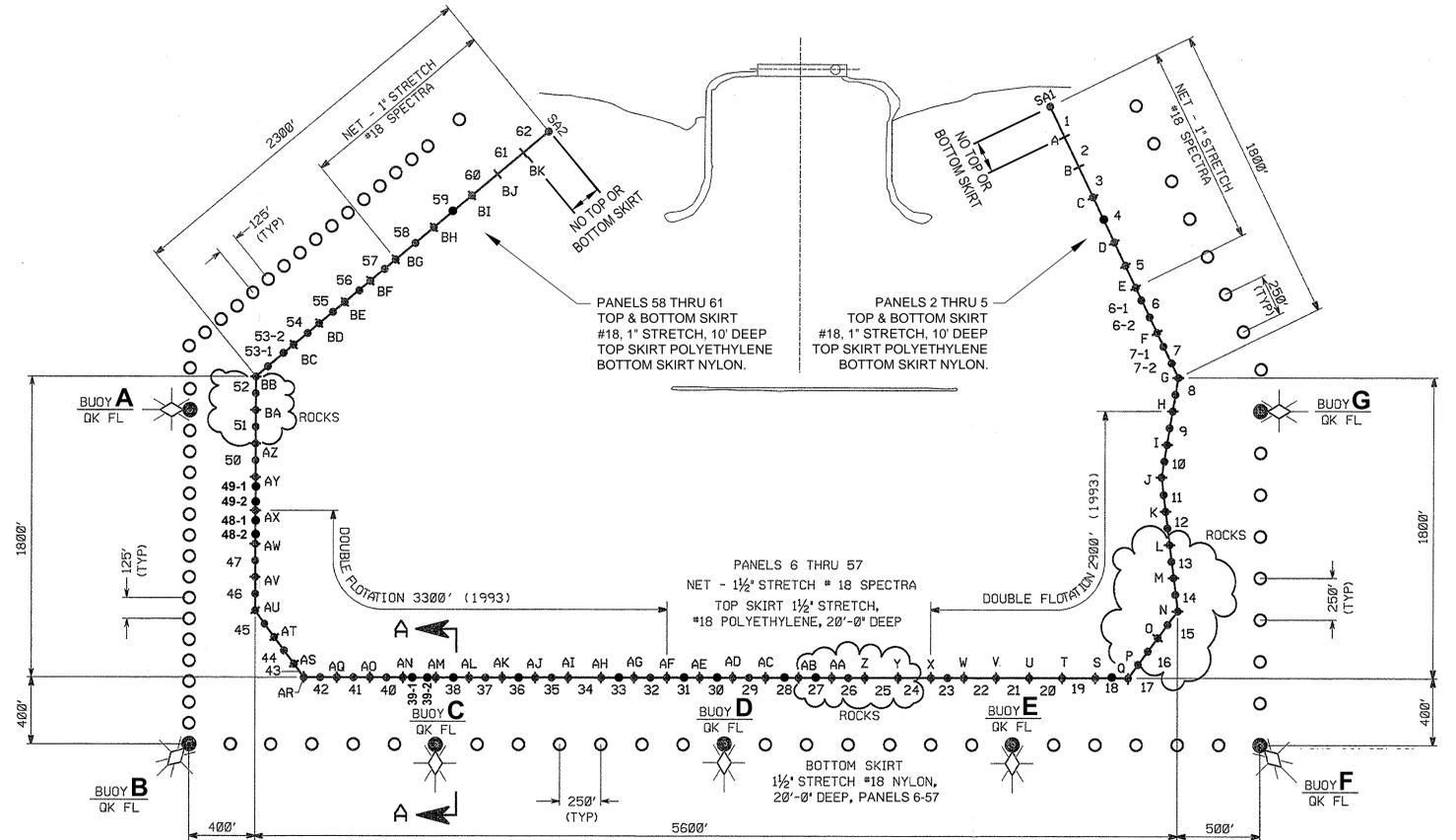
In order to protect critical energy infrastructure information (CEII), the Commission has enacted regulations to govern public access to certain information. The Exhibit F drawings referenced herein contain sensitive and detailed engineering information that, if used improperly, may compromise the safety 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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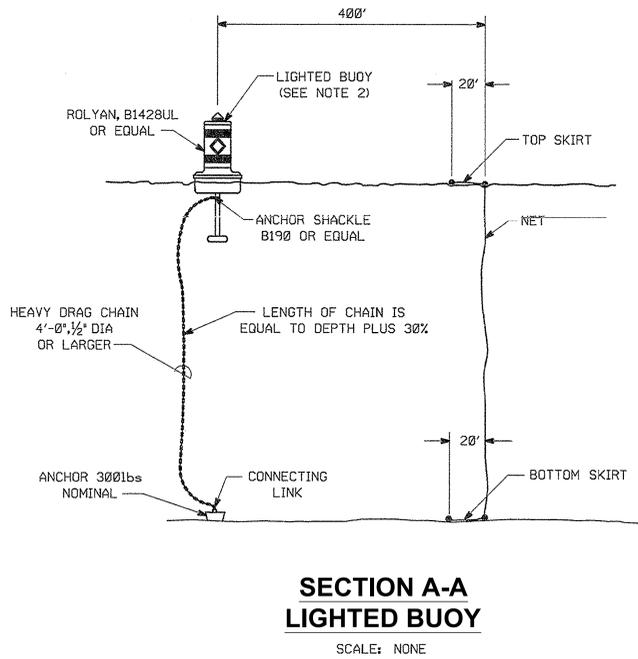
DRAFT



	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"



- 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



- NOTES:**
- REGULATORY BUOYS (WHITE AND ORANGE) SHALL CONTAIN SIGNS READING: "DANGER - SHALLOW NET" AND "KEEP OUT - SHALLOW NET" ON ALTERNATE SIDES.
 - 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.
- DATED: 30 JANUARY 2017

REVISION: APPROVED FOR RECORD

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

DRAFT 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:

<u>Sheet No.</u>	<u>Title</u>
Sheet 1	Ludington Project Detail Map
Sheet 2	Pigeon Lake North Pier Detail Map

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T18N, R18W Pere Marquette Twp., Mason Co.
T17N, R18W Pere Marquette Twp., Mason Co.

1

12

13

Survey Reference Point #275
SE Corner of Section 2
Remon. Disk in Mon. Box
N: 216576.69
E: 19144003.28

Non-project
Transmission Line
(See Note 5)

Brunson Road

MDOT

Ludington Pumped Storage Reservoir

T17N, R18W Pere Marquette Twp., Mason Co.
T17N, R18W Summit Twp., Mason Co.

Survey Reference Point #232
Center of Section 14
Angle Iron
N: 208698.78
E: 19141265.40

Mason County
Park Campground

Inman Road

Intake
Structure

Survey Reference Point #221
SW Corner of Section 35
Harrison Mon. in Mon. Box
N: 221885.16
E: 19136897.08

Mason County Park Day
Use Facility

Survey Reference Point #223
W 1/4 Corner of Section 11
Harrison Mon. in Mon. Box
N: 214039.46
E: 19138665.80

Lakeshore Drive

Powerhouse

Powerhouse

Non-project
Switchyard
(See Note 5)

State of Michigan

Lake
Michigan

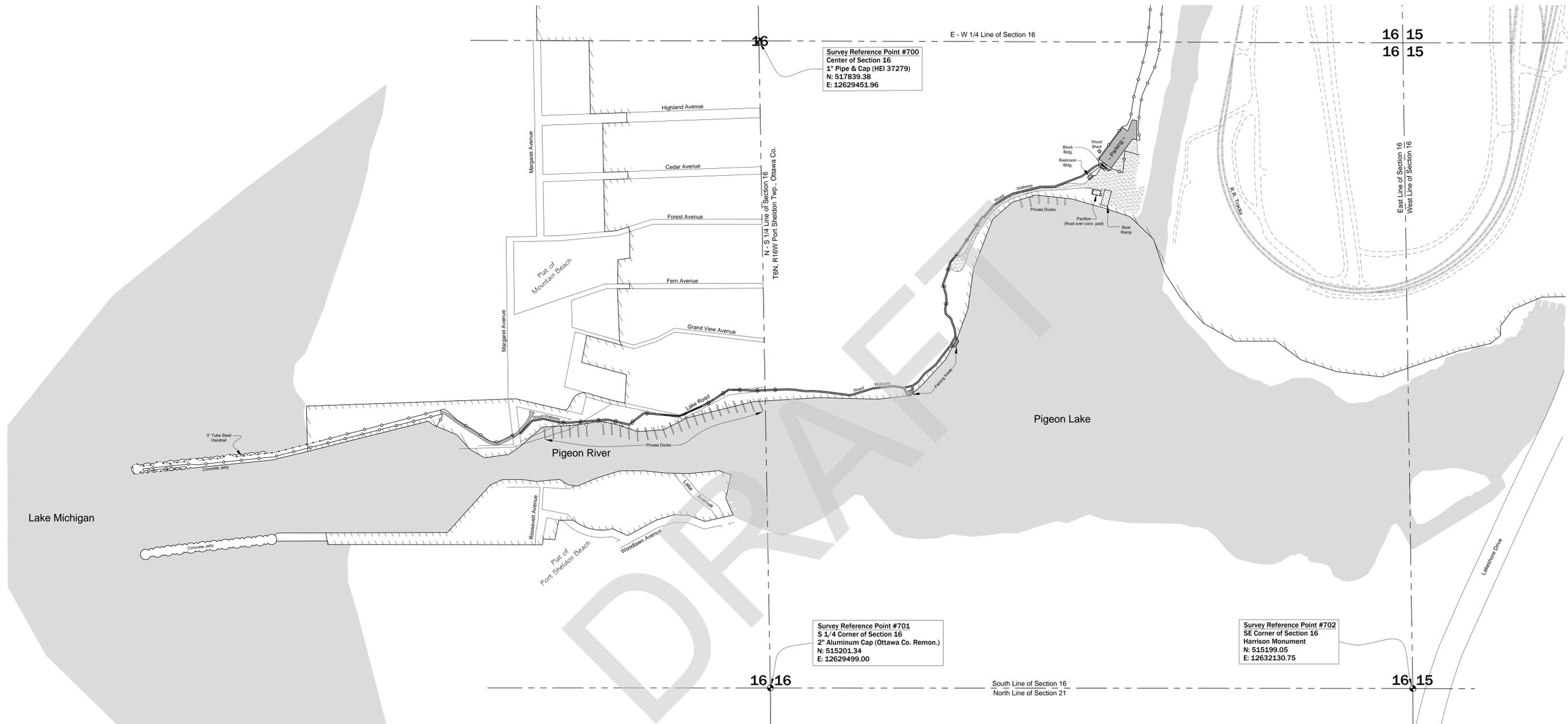
- Notes:**
- Property Bearing System is shown per Consumers Energy Dwg. No. G-16571. Project file is Michigan State Plane Coordinate System.
 - All lands within the Project Boundary are owned by the applicant with the exception of the bottomlands of Lake Michigan which are owned by the State.
 - The reservoir is shown per the Consumers Energy drawing Groundwater Related Measurement Features - Instrumentation Drawing 100, Sheet 1 of 1, Rev. 4
 - The Ludington Switchyard and the 345kV Transmission lines extending East and South from the Switchyard are not part of the project.
 - 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 Overhead Electric Line
 - Section or Aliquot Part Line
 - Private -- Denotes land owned by a Private Party
 - Water



CONSUMERS ENERGY COMPANY &
DTE ELECTRIC COMPANY
LUDINGTON PUMPED STORAGE PLANT
FERC PROJECT NO. 2680 EXHIBIT G-1
PROJECT BOUNDARY

Michigan State Plane Coordinates, October 28, 2016
Central Zone, NAD 83, International Feet 1 inch = 1000 feet



Lake Michigan

Pigeon River

Pigeon Lake

- Notes:**
- 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.
 - The project includes the Ludington Pumped Storage Plant located approximately 75 miles north of the other project facilities. This area is shown on Exhibit G-1.

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

CONSUMERS ENERGY COMPANY &
DTE ELECTRIC COMPANY
PIGEON LAKE NORTH PIER

**FERC PROJECT NO. 2680 EXHIBIT G-2
PROJECT BOUNDARY**

Michigan State Plane Coordinates, October 28, 2016
South Zone, NAD 83, International Feet 1 inch = 200 feet

DRAFT

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

**APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM**

**DRAFT EXHIBIT H
DESCRIPTION OF PROJECT MANAGEMENT AND NEED FOR PROJECT POWER**

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APPENDICES

Appendix H-1 – Public Safety Plan [To be included in Final License Application]

LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
(FERC NO. 2680)

**APPLICATION FOR NEW LICENSE
FOR MAJOR PROJECT – EXISTING DAM**

**DRAFT 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. 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 renewable 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

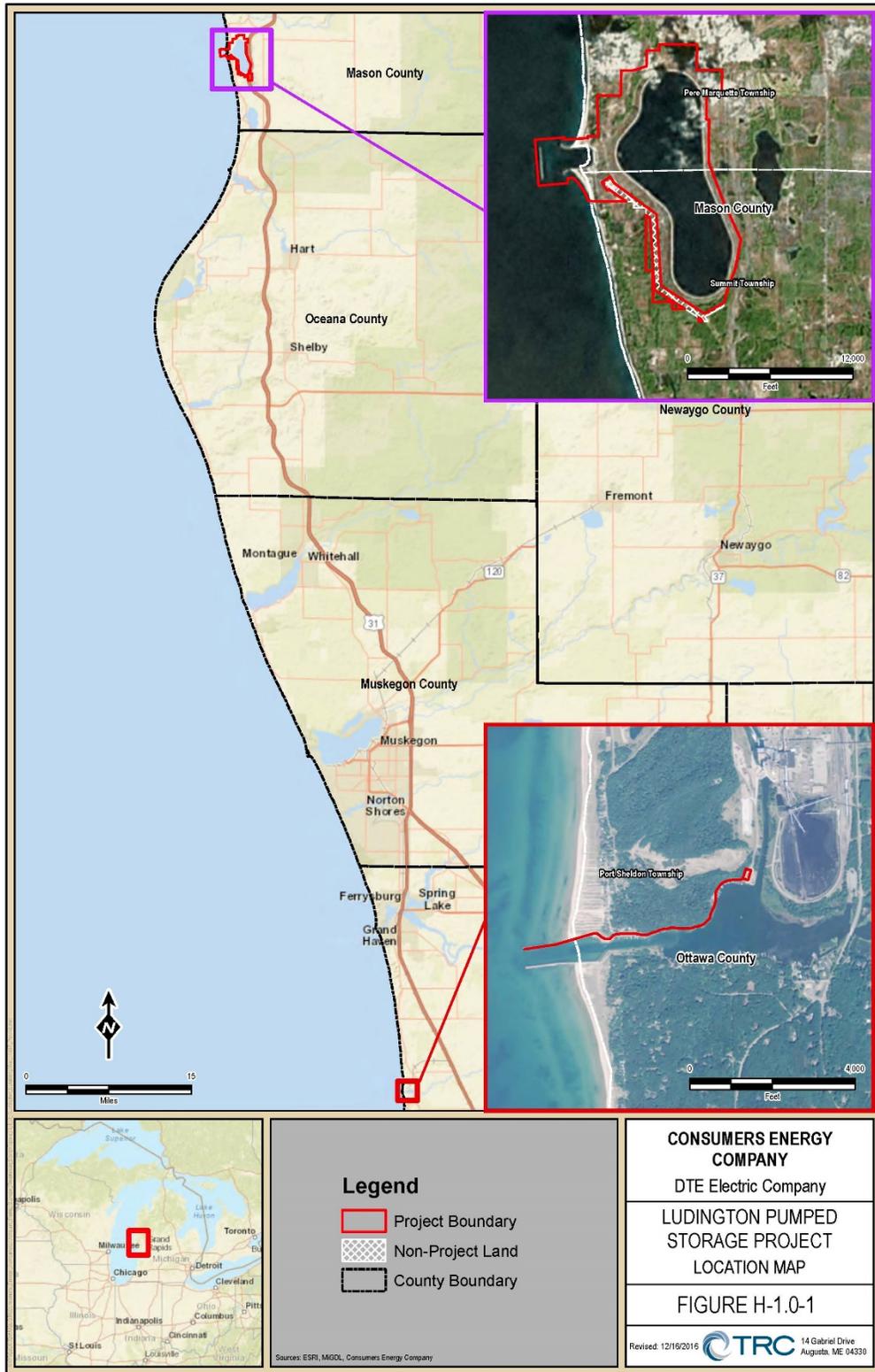
2.1.1 Plans to Increase Capacity or Generation

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. 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, and 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

(All numbers in this section will be submitted in the Final License Application.)

The Project generates renewable power, with energy generally used to meet daily peak electrical demand. The electrical output from the Project is sold wholesale into the MISO administered wholesale market. All costs below will be filed in the Final License Application (FLA).

The Project currently has a net demonstrated capacity rating of approximately 1,700 MW, with a capacity of 1,785 MW after unit upgrade completion in 2020. In 2016, the Project's production cost was approximately \$XX 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

(Information in the table to be included in the Final License Application)

Licensee	Peak Load (MW)	Marginal annual production cost (\$/MWH)	Marginal Capacity cost (\$/MW)
Consumers			
DTEE			

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. Initially, such replacement capacity and energy would likely be in the form of purchased power and, in later years, would be expected to be in the form of either purchased power or gas-fired capacity with expected costs ranging from \$XX - \$XX. These values are in year 2016 dollars assuming an average gas price of \$XX/MMBtu. Loss of the license for Ludington Project can be expected to lead to higher energy costs for the Licensees and their customers. (Numbers in this paragraph to be submitted in the Final License Application.)

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, renewable, 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, rated at 1,785 MW after currently ongoing unit 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 1999 to 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 NO_x 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. And, beginning in 2019 with the upgraded Project, 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 44 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 XX cents per kilowatt-hour (¢/kWh). Production costs are expected to change annually by the change in the Consumers 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 1999 and 2016. (Production cost to be included in the Final License Application.)

2.3.2 Short and Long Term Capacity and Energy Requirements

(All missing numbers in this section will be provided in the Final License Application)

Energy and Capacity Resources

As of 2017, Consumers' base load capacity is approximately XX megawatts (MW) consisting of XX MW of coal fired, and 74 MW of conventional hydro power. In addition, Consumers has approximately XX MW of peaking capacity which includes XX MW from oil/gas fired plants, XX MW of combustion turbines and 867 MW (51% of 1,700 MW) from the Ludington Pumped Storage Project. Consumers also contracts up to XX MW of capacity on a long-term basis, XX MW on a seasonal basis for 2017, and has long-term capacity contracts with non-utility generators in the amount of XX MW. The impact of conservation/load management measures is reflected in the Licensees' forecasted peak bundled load demand for year 2017 of approximately XX MW. (All values in this section will be provided in the FLA.)

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 588 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 XX% of installed load. As of 2016, full service load is expected to grow at an average annual rate of XX% per year through 2030. Any additional load beyond the current generation capability will be met through purchases of power from other power producers. (All values in this section will be provided in the FLA.)

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 Licensee's' 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

2.6.1 Effects of Power Flow Redistribution

The power flow analysis will be included in the FLA.

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-3, 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 in 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](#))

DRAFT

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	<p>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, spiny water flea, eurasian watermilfoil, and purple loosestrife) and identifies funding levels needed for implementation. The Plan outlines the three ways it intends to meet the plan goals:</p> <ul style="list-style-type: none"> - Information and education - Research and monitoring - Policy and regulations <p>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.</p>
Michigan Department of Natural Resources	Fisheries Division strategic plan	1994	<p>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.</p>
Michigan Department of Natural Resources	Statewide Comprehensive Outdoor Recreation Plan (SCORP): 2008-2012	2009	<p>The SCORP identifies current recreational opportunities, reviews population and recreational trends in the state, and addresses recreation plans for the state.</p>

Agency	Plan Title	Year	Plan Summary
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 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	1993	The Plan implements habitat goals established under NAWMP and covers the

Agency	Plan Title	Year	Plan Summary
	(UMR/GLR) Joint Venture implementation plan: A component of the North American Waterfowl Management Plan (NAWMP)		<p>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 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.</p> <p>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</p>

Agency	Plan Title	Year	Plan Summary
			<p>meet the objectives and targets six areas in the state with specific management targets.</p> <p>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, 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.</p> <p>The Project is not located along a river mouth and does not affect these priority areas.</p>

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

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 XX billion dollars (to be provided in the Final License Application), 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 XX billion dollars (to be provided in the Final License Application), DTE 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.

2.9.1 Financial Resources

Consumers' and DTEE's financial information for 2016 will be included in the FLA.

2.9.2 Personnel Resources

As of December 31, 2016, Consumers had XX employees and DTEE had XX employees. Consumers owns and operates baseload generation consisting of 13 hydroelectric facilities and six coal fired plants, with a combined summer net demonstrated capability of approximately XX MW. Consumers also has peaking capability totaling approximately XX MW consisting of five oil/gas fired units (XX MW), XX combustion turbines (XX MW) and 51% ownership (or 910.35 MW) in the Ludington Pumped Storage Project. 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. (All values will be included in the Final License Application.)

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 4,122 MW consisting of various oil/gas fired units, combustion turbines, and a 49% ownership (874.65 MW) 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 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 H.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 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 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. This involves using water from lakes and rivers to cool thermal electric power plants. 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.

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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 will be included in the Final License Application.]

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, XX employee accidents have occurred at the Project. (This number will be included in the Final License Application.)

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 arrester failure on Y-Phase of #1 Main Transformer Bank	10,036
2			(replaced lightning arrestors - all phases)	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.

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5.0 LITERATURE CITED

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>)

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**APPENDIX H-1
PUBLIC SAFETY PLAN**

[TO BE PROVIDED IN THE FINAL LICENSE APPLICATION]

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