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Via Electronic Filing

January 26, 2022

The Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 Fist Street, N.E.
Washington, D.C. 20426

SUBJECT: Constantine Hydroelectric Project (FERC No. 10661)
Response to Final License Application Additional Information Requests

Dear Secretary Bose:

Indiana Michigan Power Company (I&M or Applicant), a unit of American Electric Power (AEP), is the Licensee, owner, and operator of the 1.2-megawatt Constantine Hydroelectric Project (FERC No. 10661) (Project or Constantine Project), located on the St. Joseph River in the Village of Constantine in St. Joseph County, Michigan.

The existing license for the Project was issued by the Federal Energy Regulatory Commission (FERC or Commission) for a 30-year term on October 20, 1993 and expires September 30, 2023. I&M is pursuing a subsequent license for the Project pursuant to the Commission's Integrated Licensing Process (ILP), as described at 18 Code of Federal Regulations (CFR) Part 5. In accordance with the applicable regulations at 18 CFR § 5.17(a), I&M filed the final application for a subsequent license (Final License Application or FLA) with the Commission on September 30, 2021. On October 28, 2021, FERC filed a letter requesting additional information to be provided within 90 days. I&M is hereby providing the additional information requested by FERC.

General Content Requirements

FERC Comment:

Section 4.32(b)(6) of the Commission's regulation requires that an applicant must publish a notice twice of the filing of its application, no later than 14 days after the filing date, in a daily or weekly newspaper of general circulation in each county in which the project is located. Indiana Michigan Power Company (Indiana Michigan Power) has not provided the Commission with proof of the publications of this notice. Therefore, to comply with the Commission's regulations, please provide proof of the two publications of this notice.

I&M Response:

A public notice of the filing of the FLA was published in the Sturgis Journal on October 8 and 9, 2021. A copy of the affidavit of publication is included in Attachment A this filing.

Exhibit A

FERC Comment:

Section 5.18(a)(5)(i) of the Commission's regulations, which references section 4.61(c)(1)(vi) requires, in part, that an application include the net and gross storage capacity of the reservoir, if known. The application for the Constantine Project does not provide the net and gross storage capacity of the reservoir. Therefore, to comply with the Commission's regulations, please revise the application to include the net and gross storage capacity of the reservoir.

I&M Response:

The Constantine Project is operated in run-of-river mode whereby inflows at the dam match outflows, to the greatest extent possible. Therefore, there is no storage at the Project, and water flow to the turbines is adjusted to match available river flow, while flows in excess of the powerhouse's hydraulic turbine capacity are discharged over the uncontrolled overflow spillway.

FERC Comment:

Section 5.18(a)(5)(i) of the Commission's regulations, which references section 4.61(c)(1)(vii) requires, in part, that an application include the estimated minimum and maximum hydraulic capacity of the turbines. Although the application for the Constantine Project does provide the maximum hydraulic capacity, the minimum hydraulic capacity is not provided. Therefore, please provide the minimum hydraulic capacity of the turbines. Please also provide the hydraulic capacity at normal operation.

I&M Response:

The minimum hydraulic capacity of the Project is 160 cfs. Under normal operations, the Project operates at a range of flows between 160 cfs and 1,600 cfs. The annual average outflows at the Project from January 1, 2016 to December 31, 2020 is 2,269 cfs. Based on the maximum flow through the units, the hydraulic capacity of the plant is 1,600 cfs if all four units are operating. Flow in excess of 1,600 cfs is passed over the spillway.

FERC Comment:

Section 5.18(a)(5)(i) of the Commission's regulations, which references section 4.61(c)(1)(viii) requires, in part, that an application include the sizes, capacities, and construction materials, of project facilities. Section A.8.1, *Existing Project Facilities*, page A-7, states the abandoned fish chute has been converted to a sluice gate. However, the details and characteristics of the sluice gate, its purpose, and operation were not provided. Therefore, to comply with the Commission's regulations, please provide the details and characteristics of the sluice gate including:

a. its intended function;
b. its components including gate, stem, and gate guides;
c. its dimensions, invert, and construction material;
d. how the sluice gate is operated; and
e. the conditions that require its use.

I&M Response:

The abandoned fish ladder was permanently closed off with 4-inch by 4-inch wooden boards covered with a plate consisting of A36 steel and strapped together from outside face to outside face. The fish chute opening is approximately 4 feet wide by 6 feet 4 inches tall. There is no way to open/close or allow water to pass without removing this structure.

FERC Comment:

Section 5.18(a)(5)(i) of the Commission's regulations, which references section 4.61(c)(1)(ix) requires, in part, that an application include the estimated capital costs and estimated annual operation and maintenance expense of each proposed environmental measure. Section A.9.2, table A.9-1, page A-12, includes costs for proposed environmental measures including a Historic Properties Management Plan and a Recreation Management Plan (RMP). However, the application does not include costs described in Exhibit E including addressing erosion issues at the existing portage trail, section E.3.6; the continuation of deployment of nesting structures along the project reservoir, section E.7.7; and enhancement of the existing canoe portage trail, section E.8.7. Therefore, please include the estimated capital costs and estimated annual operation and maintenance expense of each proposed environmental measure.

I&M Response:

The estimate costs of proposed environmental measures are detailed in the table below.

Proposed Environmental Measure	Estimated Capital Cost (2021 USD)	Estimated Annual O&M Expense (2021 USD)
Bank stabilization along existing portage trail	$35,000	$0
Continuation of deployment of nesting structures along the Project reservoir	$0	$9,900
Enhancement of the existing canoe portage trail	$20,000	$500

FERC Comment:

In section A.2.1, table A.2-2, page A-3, Indiana Michigan Power Company (Indiana Michigan Power) states that each turbine has a rated horsepower of 426 and a rated capacity of 300 kilowatts (kW). However, a turbine with a rated horsepower of 426 corresponds to a rated capacity of 320 kW. Please provide a rated turbine horsepower and a rated generator capacity consistent with 18 CFR 11.1(i) of the Commission's regulations.

I&M Response:

Each turbine has a rated horsepower of 426 and rated generator capacity of 318 kilowatts.

FERC Comment:

Section A.3.1, *Daily Operation*, page A-4, states that the project is operated in run-of-river mode by adjusting the water flow to the turbines to match available river flow. Indiana Michigan Power

states that generation units are operated locally through a programmable logic controller (PLC) and float controller. However, the process to adjust water flow to the turbines is not described. To allow staff to understand project operation, please describe:

a. the parameter or parameters used to determine when flow to the turbines needs to be adjusted;
b. the value or values of each parameter that would trigger an adjustment;
c. the range of water elevations in the reservoir under normal run-of-river operation;
d. the lowest reservoir level allowed under run-of-river operation;
e. the range of flow through the turbines under run-of-river operation; and
f. the process of adding and removing turbine units to match inflow.

I&M Response:

a. When water levels drop below PLC setpoint, the units are automatically adjusted and throttled back until there is only one unit operating at 40 percent of its hydraulic capacity.
b. Within 0.1 foot of the PLC setpoint, the units are automatically adjusted. They continue to be adjusted as water levels drop to maintain the setpoint.
c. The elevations in the Project's reservoir range between 781.9 feet NGVD29 (without flashboards) and 782.9 feet NGVD29 (with flashboards) under normal run-of-river operations. Although not required by the existing license, I&M generally tries to maintain the reservoir's elevation at an elevation of 782.9 feet NGVD29, regardless of whether flashboards are installed.
d. At present, there is not a required minimum reservoir level associated with the Project's run-of-river operations, and I&M is not aware of low reservoir elevations requiring Project shutdown. Pursuant to the existing license, I&M manages the Project's tailrace to maintain a minimum elevation of 770.0 feet NGVD29. If the elevation of the tailrace were to fall below 770.0 feet NGVD29 and river flows were to drop below the minimum hydraulic capacity of the Project (i.e., one unit operating at a 40 percent capacity of 160 cfs), I&M would dispatch flows over the spillway to meet the minimum tailrace elevation requirement. To I&M's knowledge, this has never occurred during the term of the current license.
e. Flows through the turbines range from 160 cfs (i.e., one unit operating at a 40 percent capacity) to the full hydraulic capacity of the Project of 1,600 cfs. (i.e., four turbines operating at 400 cfs each).
f. There is no priority sequencing at for the Project's units. The PLC can be adjusted based on unit maintenance, availability, and other factors.

FERC Comment:

Throughout Exhibit A, normal reservoir elevation is provided as 782.90 feet National Geodetic Vertical Datum of 1929 (NGVD29). However, Exhibit F and Exhibit G provide the normal reservoir elevation as 782.94 feet NGVD29. Please describe why Exhibit A provides a normal reservoir elevation different from that provided in Exhibit F and Exhibit G, and explain those differences.

I&M Response:

The normal reservoir elevation is 782.94 feet National Geodetic Vertical Datum of 1929 (NGVD29) with the flashboards in place and 782.00 feet NGVD29 without the flashboards.

FERC Comment:

Section A.3.1, *Daily Operation*, page A-4, states that the flashboards on the spillway generally fail when the reservoir level is about 785.0 feet NGVD29. However, Exhibit A does not describe how the project is operated during high flow, low flow, and cold weather conditions. Therefore, please describe how the project is operated during, and how projection generation is affected by, high flow, low flow, and cold weather conditions. Furthermore, please describe the high flow, low flow, and cold weather conditions that result in a cessation or curtailment of project generation.

I&M Response:

Project Operations During High Flow

During high flow, all units will normally be operated in Float Mode to maintain headwater at the desired level.

When the reservoir elevation reaches 784.4 feet NGVD29, Hydro Dispatch will call the Maintenance Supervisor. When the reservoir elevation reaches 784.5 feet NGVD29, plant mechanics will start to close bottom sections of the head gates to prevent debris from washing over the trashracks and into the turbines.

A water level transducer is provided in the intake channel to control the water level when some or all of the head gates are closed. Control and readouts are switched from the reservoir water level transducer to the intake channel water level transducer by use of toggle switch in the control room.

When the first head gate sections are closed, controls will be adjusted to operate units from the intake channel water level transducer. Additionally, when the first head gate sections are closed, unit controls are set to maintain intake channel elevation at 783.0 feet NGVD29. Plant mechanic will continue to close the bottom sections of head gates, as necessary, to maintain intake channel levels.

If intake channel water elevation continues to rise to elevation 783.5 feet NGVD29, plant mechanics will close top sections of head gates, as needed, starting with the outside gates first, to maintain intake channel levels. When river flow reaches 5,000 cfs or all the head gate sections are closed, whichever occurs first, the plant will be manned continuously.

Project Operations During Low Flow

During low flow conditions, the units are automatically adjusted by the PLC and float controller. As described above, when water levels drop below PLC setpoint, the units are automatically adjusted and throttled back until there is only one unit operating at 40 percent of its hydraulic capacity. To I&M's knowledge, low flow conditions have never required the Project to shutdown.

Project Operations During Cold Winter Conditions

I&M does not modify Project operations during cold weather conditions.

FERC Comment:

Section A.8.1, *Existing Project Facilities*, page A-7, states that the brick powerhouse has dimensions of 140 feet by 30 feet. However, section A.8.1.3, *Powerhouse*, page A-11, states that the powerhouse is 140 feet by 58 feet. Please provide consistent dimensions of the powerhouse.

I&M Response:

The powerhouse is 140 feet long and 30 feet wide.

FERC Comment:

Section A.8.1, *Existing Project Facilities*, page A-7, states that average annual production for the project typically ranges between 4,574 and 5,438 megawatt hours (MWh). However, table A.4-1, page A-5, provides annual generation from 2016 through 2020 that range from 4,007 to 5,607 MWh. It is not clear where the range of average annual production provided in section A.8.1 was obtained and what they represent. Therefore, please describe the source of the average annual production provided in section A.8.1 and why the production values are different from those presented in table A.4-1.

I&M Response:

The average annual production ranges of 4,574 and 5,438 were carried over from the Pre-Application Document that included average values for 2012 through 2016. The average annual production for the Project on page A-7 should match the values represented in Table A.4-1 and be listed as 4,007 to 5,607 megawatt hours.

FERC Comment:

Section A.8.1.1, *Dam*, page A-10, states that a steel sheet pile wall extends across the upstream side of the spillway and upstream along the spillway's abutment wall. The application states that the top elevation of the steel sheet pile wall is about 760 feet NGVD29, which is about 10.5 feet below the base of the structure. This would indicate that there is a 10.5-foot gap between the bottom of the base of the spillway structure and the top of the steel sheet pile wall. Please describe the purpose of the 10.5-foot gap between the bottom of the base of the spillway structure and the top of the steel sheet pile wall. Also, please include an estimate of the bottom of the steel sheet pile wall and the geologic conditions at the base of the steel sheet pile wall.

I&M Response:

This statement was a typo in the FLA. The sentence should read as follows: "*The tip (bottom) elevation of this sheeting is about elevation 760 feet NGVD29, 10.5 feet below the base of the structure.*" There is no gap between the base of the spillway structure and the top of the steel sheet pile wall. The sheets are driven from about 777.0 feet NGVD29 top or cut-off elevation plus or minus to 760 feet NGVD29 elevation.

The local surface geology at the Project consists of thick, sandy lacustrine and outwash deposits. The foundations for the Project structures generally consist of sands, silty sands, and silts. These soils are known to occur at the site as a result of subsurface exploration programs that have been conducted. Logs of borings made at the Project indicate that the underlying foundation strata vary from loose to dense in relative density.

FERC Comment:

Section A.8.1.1, *Dam*, page A-10, states that a steel sheet pile wall, with a top elevation of about 760 feet NGVD29, extends across the upstream side of the spillway and upstream along the spillway's abutment wall. Exhibit F, sheet 2 of 3, *Typical Spillway Section*, shows steel sheet piling at the upstream side of the spillway having a top elevation of about 778 feet NGVD29. Please describe the function of these two steel sheet pile walls.

I&M Response:

As explained in the previous comment, there was a typo in the FLA that should have indicated that the tip (bottom) elevation of the sheeting was at elevation 760 feet NGVD29. There is only one contiguous sheet pile at this particular location, and it is intended to create a hydraulic barrier to prevent seepage under the spillway.

FERC Comment:

Section A.8.1.2, *Forebay and Intake*, page A-11, states the repair of the headgates included new gates. Please indicate the material composition of the new gates.

I&M Response:

The new gates are made of wood and steel.

FERC Comment:

Section A.8.1.2, *Forebay and Intake*, page A-11, states that the headgate structure is protected against piping by steel sheet piling to an elevation of about 753.5 feet NGVD29. It is unclear whether the 753.5 foot NGVD29 elevation is the top of the bottom of the steel sheet piling. Therefore, please provide the top and bottom elevations of the steel sheet piling.

I&M Response:

The top elevation of the steel sheet piling is 770.0 feet NGVD29 and the bottom of the steel sheet piling is 753.5 feet NGVD29.

FERC Comment:

Section A.8.1.3, *Powerhouse*, page A-11, states the discharge at full gate and normal full reservoir level is about 400 cubic feet per second (cfs), for a total plant flow rate of 1,600 cfs when all four units are operating. However, section A.3.1, *Daily Operation*, page A-3, states that the hydraulic capacity is 382 cfs per unit for a total hydraulic capacity of 1,528 cfs at a 11.3-foot head and a capacity is 430 cfs per unit for a total hydraulic capacity of 1,720 cfs at a 12.5-foot head. Please provide the head providing a 400 cfs unit flow rate and 1,600 cfs total hydraulic capacity.

I&M Response:

Project head at 1,600 cfs total hydraulic capacity (400 cfs per unit) is 11.44 feet.

FERC Comment:

Section A.8.1.5, *Transmission and Switchyard*, page A-11, states that the 2.4 kilovolt (kV) distribution line is about 50 feet long. Please indicate whether this line is above ground or below ground.

I&M Response:

The 50-foot-long 2.4 kilovolt distribution line is below ground.

FERC Comment:

Section A.8.1.5, *Transmission and Switchyard*, page A-11, states there are three step-up transformers. Please provide both the incoming and stepped-up voltages.

I&M Response:

The incoming voltage from the generators is 2.4 kV. The stepped-up voltage is 12 kV.

FERC Comment:

Section A.9.8, *Annual Operation and Maintenance Costs*, page A-13, provides the project operation and maintenance cost, which include annualized capital and general costs. Please state whether the operation and maintenance cost includes federal tax, local tax, property tax, or insurance.

I&M Response:

The operation and maintenance costs provided in the FLA do not include taxes or insurance.

FERC Comment:

Please describe Indiana Michigan Power's electricity consumption improvement program, including its plans, performance, and capabilities for encouraging or assisting its customers to conserve electricity cost-effectively, taking into account the published policies, restrictions, and requirements of state regulatory authorities. Also, please describe Indiana Michigan Power's compliance of its energy conservation programs with any applicable regulatory requirements.

I&M Response:

I&M is an Independent Power Producer (IPP) and does not sell electricity directly to customers. Therefore, I&M does not believe that this requirement applies to this Project. However, to address FERC's comment, I&M is providing the following information. Every three years, I&M files its Demand Side Management (DSM) Plan, which includes its Energy Efficiency Programs and associated accounting and ratemaking, with the Indiana and Michigan Utility Regulatory Commissions. The DSM Plan includes energy efficiency goals, a portfolio of energy efficiency programs and other DSM Programs designed to achieve the energy efficiency goals and demand savings goals, as well as program budgets and program costs and evaluation measurement and three verification procedures that include independent evaluation, measurement and verification. The DSM Plan includes offerings to all customer classes, including low-income customers, and

provides for industrial customer opt out. Additional information regarding I&M's energy efficiency programs can be found at https://www.indianamichiganpower.com/savings/.

Exhibit E

FERC Comment:

Section 5.18(b)(5)(ii)(C) of the Commission's regulations require that an applicant provide, by resource area, any proposed new environmental measures. The Fish and Aquatic resource section, section E.5 of the application, does not include a section describing any protection, mitigation, or enhancement measures proposed by the applicant, resource agencies, and / or other consulting parties. Therefore, please include a discussion of whether environmental measures are proposed for the fish and aquatic resources and, if so, how each proposed measure would protect or enhance the existing environment, including, where possible, a non-monetary quantification of the anticipated environmental benefits of the measure. If a measure is proposed, please include the estimated capital costs and estimated annual operation and maintenance expense of each proposed environmental measure.

I&M Response:

Sections E.5.7 Project Impacts on Fish and Aquatic Resources and E.5.8 PM&E Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties were inadvertently left out of the FLA and are provided below.

E.5.7 Project Impacts on Fish and Aquatic Resources

The Project supports a diverse and abundant fish community. Results of the 2019 Fisheries Survey indicate that the fish community has not changed significantly since the last major survey. Results of the 2019 Mussel Survey indicate that there appears to be a stable, recruiting mussel community below the dam that has likely persisted for several years based on the diversity and abundances observed in the survey and historical records. Based on the results of the Fisheries Survey and Mussel Survey, and the continued run-of-river (ROR) operation of the Project, I&M does not anticipate any adverse impacts to fish and aquatic resources.

E.5.8 PM&E Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties

The results of the Fisheries Survey and Mussel Survey indicate that fish and mussel communities in the Project area are diverse and stable, and species diversity and abundance are similar to historical records. Therefore, I&M is not proposing any new PM&E measures related to fish and aquatic resources but plans to continue the current ROR operations that lend to the protection of fish and aquatic resources at the Project. Additionally, no resource agencies or consulting parties have requested PM&E measures related to fish and aquatic resources.

FERC Comment:

Section E.2.5, *Reservoir Characteristics and Shoreline*, page E-11, states that in 2011, the west downstream riverbank was damaged due to erosion. The section goes on to state that the erosion has been repaired and is monitored. Please provide additional details of this erosion including: (1) the exact location of the erosion; (2) the cause of the erosion; (3) a description of the damage;

(4) how the erosion was repaired; and (5) a description of the monitoring including frequency and evaluation methodology.

I&M Response:

The minor slough was detected near the toe of the embankment downstream of the sheet pile retaining wall located approximately 50 feet downstream of the spillway. The erosion occurred due to the steep, granular nature of the unprotected part of the embankment at the end of the west spillway sheet pile retaining wall and due to high water in 2009. This minor erosion was repaired in August 2011 by placing 41 tons of 6-inch by 9-inch limestone riprap on top of geotextile fabric. An additional 20 tons of #1 (4-inch) limestone riprap was placed overtop the larger riprap. At the toe of the slope, 15 tons of large concrete pieces were placed to anchor the limestone riprap. The sheet pile wall and embankment are visually inspected by the Chief Dam Safety Engineer and quarterly by the Civil Coordinator.

Geology and Soils

FERC Comment:

Section E.3.2, *Soils and Sediment*, page E-15, states that a shoreline stability assessment was conducted of the project's reservoir, bypassed reach, and tailrace area to identify sites of erosion or shoreline instability. The results of the assessment is described in the Shoreline Stability Assessment Report, which is included as appendix C of the application. The results of the assessed locations are presented in table 2 and table 3 of the Shoreline Stability Assessment Report. However, there is no figure showing the location of assessed locations, whose absence is described in section 2.3 of the Summary of Initial Study Report Meeting filed on May 8, 2020. Therefore, please provide a figure showing the location of assessed locations.

I&M Response:

I&M's subconsultant that conducted the Shoreline Stability Assessment developed a figure showing the locations of the sites assessed during the study. The figure is included in Attachment B (Figure 1) of this filing.

FERC Comment:

Section E.3.2, *Soils and Sediment*, page E-15, states that Indiana Michigan Power would address erosion issues located along the bypassed reach near the existing portage trail. This section identifies the area as site BA16, which the Shoreline Stability Assessment Report gave a score of "NA" due to a high degree of armoring along the bank within the assessment site. However, the Shoreline Stability Assessment Report also stated that this isolated point has no vegetation and soil is actively falling into the bypass reach. Please describe the erosion issues at this location and describe how these erosion issues would be addressed.

I&M Response:

BA16 was misidentified in the FLA as a location along the existing portage trail. This location is actually located near the spillway along the power canal embankment During the development of the figure to address FERC's previous comment, it became apparent to I&M's subconsultant who completed the study that there were some corrections needed in the report. Therefore I&M's subconsultant has revised the report which is included in Attachment B of this filing. The site that

was formerly referred to as BA16 is now referred to as BA07V2 in the revised report. I&M will assess any erosion issues that exist along the existing portage trail during the design phase of recreation improvements and implement appropriate control measures to address any future issues. Details of the issue and remediation will be included in the Recreation Management Plan developed by I&M.

Water Quantity and Quality

FERC Comment:

Section E.4.1.2, *River Flows*, page E-20, states the median flow for the project is about 1,398 cfs. The section also says the median flow for the St. Joseph River is 1,690 cfs. Please describe the location of the median flow for the St. Joseph River and how it relates to the project.

I&M Response:

The median flow for the St. Joseph River was determined using stream flow data from the U.S. Geological Survey (USGS) Gage 0409900 St. Joseph River at Mottville, MI approximately seven river miles downstream of the Project at the location of the stream gage. Flows for the Project were determined by prorating the stream gage's drainage area to that of the Project's drainage area. This stream gage was selected because it is the nearest stream gage to the Project location and would therefore be most hydrologically similar than other stream gages which are further from the Project site. The Constantine Project drainage area is 1,544 square miles and the drainage area at the USGS gage is 1,866 square miles.

FERC Comment:

Section E.4.2.4 *Recent Water Quality Data*, page E-31, states that sediment contaminant sampling was conducted. This section describes the locations of sampling and the methods used, but does not present or discuss the results of the sampling. Please present the results of the sampling and discuss the results of the sampling.

I&M Response:

Pace Analytical Laboratory conducted the analysis on the Constantine reservoir sediment samples collected on September 25, 2019. A summary of the results is listed in the table below, and the full report from Pace Analytical is presented in Appendix D of the final study report that was filed with the Initial Study Report on April 14, 2020 (Appendix D). The results are reported on a "dry weight" basis and are adjusted for percent moisture, sample size and any dilutions.

Summary of Sediment Results for the Constantine Reservoir, Collected September 25, 2019

Analyte (Method)	Units	LRSS: Lower Reservoir Sediment Sample	LRSSD: Lower Reservoir Sediment Sample Duplicate	MRSS: Middle Reservoir Sediment Sample	URSS: Upper Reservoir Sediment Sample
		(MDL)	(MDL)	(MDL)	(MDL)
PCB, Total	ug/kg	<110 (110)	<111 (111)	<94.0 (94.0)	<155 (155)
(EPA 8082)					
Mercury	mg/kg	**0.16** (0.043)	**0.19** (0.044)	**0.13** (0.035)	0.12[1] (0.060)
(EPA 7471)					
Percent Moisture	%	**77.2** (0.10)	**77.6** (0.10)	**73.4** (0.10)	**83.8** (0.10)
(ASTM 02974-87)					
Oil and Grease	mg/kg	**1,900[1]** (1,810)	<1,720 (1,720)	2,120[1] (1,540)	2,800[1] (2,480)
(EPA 9071)					
Total Phosphorus	mg/kg	**830** (77.0)	**828** (63.2)	**808** (59.7)	**1,190** (109)
EPA 365.4)					
Mean Total Organic Carbon	mg/kg	**98,200** (7,560)	**103,000** (9,030)	**82,100** (9920)	**131,000** (15,700)
(EPA 9060)					
Total Metals					
(EPA 6010)					
Arsenic	mg/kg	28.8 (6.2)	23.9 (6.1)	18.7 (5.1)	**30.2** (8.6)
Cadmium	mg/kg	0.78[1](0.57)	0.93[1] (0.56)	<0.47 (0.47)	**<0.78** (0.78)
Chromium	mg/kg	**16.4** (1.2)	**17.0** (1.2)	**13.4** (0.98)	**20.3** (1.6)
Copper	mg/kg	**24.2** (1.2)	**26.4** (1.2)	**22.6** (0.97)	**24.5** (1.6)
Lead	mg/kg	**30** (2.5)	**35.0** (2.5)	**24.4** (2.1)	**29.4** (3.5)
Nickel	mg/kg	**11.2** (1.1)	**12.3** (1.1)	**9.3** (0.93)	**14.8** (1.6)
Selenium	mg/kg	<5.6 (5.6)	<5.5 (5.5)	<4.6 (4.6)	<7.7 (7.7)
Silver	mg/kg	<1.3 (1.3)	<1.3 (1.3)	<1.1 (1.1)	<1.8 (1.8)
Zinc	mg/kg	**93.2** (5.1)	**104** (5.0)	**84.2** (4.2)	**87.8** (7.0)

MDL = Adjusted Method Detection Limit.
[1]Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

Sediment Chemistry

Sediment analysis results were compared to published sediment quality guidelines (SQG) (MacDonald et al. 2000, Ingersoll et al. 2002, GeoEngineer 2015, and WDNR 2003) to determine the relative risk to aquatic life and human health. Relative risk to aquatic life was determined by comparing the sediment analysis to Probable Effect Levels (PEL), Threshold Effect Levels (TEL), Effect Range Median (ERM) and Effect Range Low (ERL). Sediment concentrations of various contaminants that exceed the SQG may adversely affect aquatic life. Total PCB and mercury were also assessed, but those chemicals are likely to have a greater effect on human health than aquatic life and are also discussed in the fish tissue results section of the Fisheries Survey study report.

With the exception of mercury, lead and arsenic, each analyte concentration in the Constantine reservoir sediments were measured at concentrations less than the most restrictive SQG (TEL).

Mercury

The sediment mercury concentration in the LRSS duplicate sample slightly exceeded the TEL (0.17 mg/kg) at 0.19 mg/kg in the duplicate sample. Mercury was measured at 0.16 mg/kg in the

other sample. These concentrations were less than the other three SQG values. Mercury concentrations at or below the TEL are unlikely to cause adverse effects to aquatic life.

Lead
Lead concentrations in the LRSS duplicate sample were equal to the TEL and ERL SQG at 35 mg/kg. Lead concentrations in the other LRSS sample and in the other two reservoir locations (middle reservoir and upper reservoir) were all less than any of the SQGs used. Lead concentrations at or below the TEL and ERL are unlikely to cause adverse effects to aquatic life.

Arsenic
Arsenic concentrations in the LRSS samples exceeded the PEL (17 mg/kg). The LRSS lead concentration was measured at 28.8 mg/kg. Arsenic levels at this concentration would likely cause adverse effects to aquatic life.

With the above noted exceptions, the contaminants measured in the Constantine reservoir are not likely to have an adverse effect on aquatic life or human health. Mercury and lead concentrations were measured at or near the TEL and ERL which would indicate a very low risk to aquatic life. Arsenic concentrations in the LRSS were measured at concentrations that may adversely affect aquatic life, but were at concentrations less than the median effects level (85 mg/kg). Site specific conditions (e.g., total organic carbon, pH, biotic ligands) will affect the bioavailability and are likely to lessen the effect of arsenic at these concentrations. Consequently, this concentration of arsenic in sediment is likely not a great concern to aquatic life in the sediment.

Terrestrial Resources

FERC Comment:

Section E.7.7, *PM&E Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties*, states that Indiana Michigan Power proposes to continue deploying nesting structures along the project reservoir. Please state if the nesting structures are for wood duck, eastern blue bird, or both species.

I&M Response:

I&M plans to continue deploying nesting structures along the Project reservoir for both wood ducks and eastern blue birds.

Project Boundary

FERC Comment:

Figure A.8-2 shows a map of project facilities including lands located adjacent to the access roads that are proposed to be removed from the project boundary. The portion of land appears to be forested; however, there is no discussion of why this forested parcel of land is proposed to be removed from the project boundary. Please provide a description of size and composition of the land, including an explanation for removing the lands from the project boundary. In addition, please describe if the land is needed for project purpose, including any measures for environmental resources (e.g., recreation or terrestrial resources).

I&M Response:

I&M is proposing to remove approximately nine acres of land from the FERC Project Boundary based on verbal comments from FERC during the original site visit to the Project on August 28, 2018 and written comments on the Draft License Application (DLA) filed on July 29, 2021 (see I&M's response to FERC's DLA comments in Table E.1.1 of the FLA), regarding how this parcel of land is being used for the Project. I&M is proposing to remove this parcel of land from the FERC Project Boundary because it is not necessary for the operation and maintenance of the Project. I&M made sure to include sufficient area in the revised Project Boundary to encompass all existing and proposed recreation facilities. I&M stated the following in Section E.12 *Summary of Proposed Action and PM&E Measures* of the FLA:

> *"I&M is also proposing to remove a parcel of land from the Project boundary that is not needed for project purposes. Specifically, I&M is proposing to remove an approximately 9-acre parcel of land adjacent to the Constantine Portage Park. This parcel is classified as a Palustrine Wooded Wetland and does not include any recreational facilities. At this time, I&M has no plans to develop this 9-acre parcel but is proposing to remove it from the FERC Project boundary because it is not needed for Project operations, maintenance, or recreation."*

Additionally, I&M provided a description of this area and rationale for proposing to remove it from the Project Boundary in Exhibit G Section G.1 *Project Boundary Maps* of the FLA.

Recreation Resources

FERC Comment:

Section E.8, *Recreation Resource*s, states that Indian Michigan Power would develop a Recreation Management Plan (RMP) for the project that details proposed recreation enhancements. So that we can assess proposed mitigation and enhancement measures in its environmental analysis, please describe any specific proposed enhancement measures that would be included in the RMP. Also, please clarify what operation and maintenance (O&M) measures are included in the $5,000 annual O&M cost presented in table A.9-1.

I&M Response:

I&M is proposing to implement the following recreation enhancements that will be included in the RMP: (1) replace/repair any deteriorating or damaged signage and/or provide additional recreation and safety signage as needed, (2) address erosion along the existing portage trail, and (3) widen the existing portage trail as needed and formalize the portage trail (i.e., provide a gravel path or other material that provides good footing).

Annual O&M costs are associated with maintaining the recreation facilities which include, but not limited to, (1) maintaining recreational and safety signage, (2) maintenance of recreation facilities (i.e., tailrace fishing access platform and path, portable toilets, portage trail and stairs, and reservoir fishing platform and reservoir boat launch), and (3) vegetation management at all recreation facilities. Additionally, I&M makes lease payments of $2,500 per year to the City of Constantine for the parks.

FERC Comment:

Section E.8, *Recreation Resource*s, states that the canoe portage and shoreline fishing sites do not have formal parking, but street-side parking is available for approximately five vehicles close to the intersection of Hull Street and Wells Street. Please state who owns and maintains the street-side parking and if there is any signage at the gate between the parking area and the access road indicating access to the canoe portage and shoreline fishing sites.

I&M Response:

The street-side parking is owned and maintained by the Village of Constantine. There currently are no signs posted.

Cultural Resources

FERC Comment:

Appendix B does not contain a letter of concurrence from the Michigan State Historic Preservation Office (Michigan SHPO) regarding the cultural resources study completed for this project. Please again contact the Michigan SHPO to ask for concurrence for the study and provide correspondence from Michigan SHPO that shows concurrence for the cultural resources study.

I&M Response:

I&M provided a hardcopy of the Cultural Resources Study report to Michigan SHPO on April 28, 2020 and never received a response. I&M sent an electronic version of the report to Michigan SHPO on January 5, 2022. Michigan SHPO confirmed receipt of the electronic version of the report on January 5, 2022. I&M has not received a response from Michigan SHPO to date. Documentation of the report submittal to Michigan SHPO is provided in Attachment C of this filing.

Exhibit F

FERC Comment:

Section 5.18(a)(5)(i) of the Commission's regulations, which references section 4.61 [*see* section 4.41(g) and section 4.39(a)] requires drawings show all major project features to provide a full understanding of the project including (i) plans, (ii) elevations, (iii) profiles and (iv) sections.

a. Sheet 1 of 3, *General Plan*, shows a storage building west of the powerhouse that had been removed. Exhibit F must be revised to remove the storage building.
b. Sheet 1 of 3, *General Plan*, does not show the project's interconnection with Indiana Michigan Power's electrical grid. Exhibit F must be revised to identify and label the project's interconnection with Indiana Michigan Power's electrical grid.
c. Sheet 1 of 3, *Section A-A* and *Section F-F* of the race embankment do not include: (1) top elevation, (2) cross slope of the embankment crest; (3) top width; or (4) the slope of the right side of the embankment. Exhibit F must be revised to provide this relevant information.
d. Sheet 1 of 3, *General Plan*, shows two sections of the dam and spillway, sections C-C and D-D, but there are no sections labeled C-C or D-D on any of the three sheets in Exhibit F related to the spillway. Exhibit F must be revised to provide this relevant information.

e. Sheet 1 of 3, *Section F-F*, shows material placed along the east side of the race embankment that is denoted with a "B" but "B" is not provided in the legend. Exhibit F must be revised to describe the material placed along the east side of the race embankment that is denoted with a "B."
f. Exhibit F does not include the sheet piling protecting the headgate structure against piping. Exhibit F must be revised to include the sheet piling.
g. Sheet 1 of 3, *General Plan*, and Sheet 2 of 3, *Plan View of Dam & Spillway* and *Longitudinal Section of Spillway*, each show a fish chute. Exhibit A, section A.8.1, *Existing Project Facilities*, states that the fish chute has been abandoned and has been replaced with a sluice gate. Exhibit F must be revised to show current conditions at the spillway, which include replacement of the abandoned fish chute with the sluice gate. The drawings should provide sufficient detail of the sluice gate including size, invert, and material to allow complete understanding of the sluice gate and its operation.
h. Sheet 2 of 3, *Section E-E,* does not include the following information for the powerhouse: (1) length and height of the powerhouse; (2) generator floor elevation; (3) length and floor elevation of the forebay intake section; (4) angle of the trash racks; (5) turbine pit floor elevation; (6) and draft tube invert. Exhibit F must be revised to provide this relevant information.
i. Exhibit A, Section A.8.1.1, describes a steel sheet pile wall, with a top elevation of about 760 feet National Geodetic Vertical Datum of 1929 (NGVD29), extending across the upstream side of the spillway and upstream along the spillway's abutment wall. Exhibit F, sheet 2 of 3, *Typical Spillway Section*, shows steel sheet piling at the upstream side of the spillway having a top elevation of about 778 feet NGVD29. Exhibit F must be revised to show the location of both steel sheet pile walls.
j. Sheet 3 of 3 does not show the recent upgrades to the detached dike. Exhibit F must be revised to include the as-built information for the detached dike.

I&M Response:

In response to item (h) above, the turbine pit floor elevation is already included on Exhibit F-2 and is 769.2 feet NGVD29. In response to item (i) above, as mentioned in previous responses, the statement about the top elevation being 760 feet NGVD29 was a typo and should have been "tip (bottom)". There is only one steel sheet pile at this location, and it is already shown on the Exhibit F drawing. I&M is still compiling information and revising the Exhibit F drawings to address the above items. I&M will file the revised Exhibit F drawings with FERC within 30 days of this filing.

FERC Comment:

Elevations are shown on the Exhibit F drawings, but the elevations do not include a datum reference. Therefore, please revise the Exhibit F drawings to include a note on each of the three sheets that provides the datum reference.

I&M Response:

The Exhibit F drawings will be revised to include the appropriate datum associated with the elevations listed on the drawings and filed with FERC within 30 days of this filing.

FERC Comment:

Sheet 1 of 3, *Section B-B*, provides a deck elevation as 790.1 feet and a sill elevation of 770.1 feet. However, Exhibit A, section A.8.1.2, provides a deck elevation as 790.0 feet NGVD29 and a sill elevation of 770.0 feet NGVD29. Please describe why Exhibit A provides a deck elevation and a sill elevation different from that provided in Exhibit F, and explain those differences.

I&M Response:

The values provided on the Exhibit F drawings are accurate and Exhibit A should be corrected to match those values.

FERC Comment:

Sheet 2 of 3, *Longitudinal Section of Spillway*, provides a flashboard elevation of 782.94 feet and a spillway crest elevation of 782.0 feet. However, Exhibit A, section A.8.1.1, provides a flashboard elevation of 782.90 feet NGVD29 and a spillway crest elevation of 781.96 feet NGVD29. Please describe why Exhibit A provides a flashboard elevation and a spillway crest elevation different from that provided in Exhibit F, and explain those differences.

I&M Response:

The values provided on the Exhibit F drawings are accurate and Exhibit A should be corrected to match those values.

Exhibit G

FERC Comment:

Section 5.18(a)(5)(i) of the Commission's regulations, which references section 4.61 [*see* section 4.41(h)] requires, in part, that an application show the relative locations and physical interrelationships of the principal project works and other features described under paragraph (b) of this section (Exhibit A) that complies with section 4.41(h)(1). The project's interconnection with Indiana Michigan Power's electrical grid and portage route are not identified on Exhibit G. Therefore, please revise the Exhibit G drawings to clearly identify and label the project's interconnection with Indiana Michigan Power's electrical grid and portage route.

I&M Response:

I&M has revised the Exhibit G drawings to label the interconnection with Indiana Michigan Power's electrical grid and portage route. The revised drawings are included in Attachment D of this filing.

FERC Comment:

Section 5.18(a)(5)(i) of the Commission's regulations, which references section 4.61 [*see* section 4.41(h)] requires, in part, that an application includes an Exhibit G with a map or series of maps that complies with section 4.41(h)(4) and identify by legal subdivision non-federal lands within the project boundary. The boundaries and ownership of non-federal lands that are located within the project boundary are not indicated on Exhibit G. Therefore, please revise the Exhibit G drawings to identify by legal subdivision non-federal lands within the project boundary.

I&M Response:

All lands within the Project Boundary are owned by I&M and a note has been added to the Exhibit G drawings. The following note has been added to the drawings: “The Licensee either owns in simple fee or possesses flowage easements over all lands within the Project Boundary required to operate the facility.”

FERC Comment:

Exhibit G shows the project boundary crossing a corner of the Constantine Project tailwater fishing access parking area, excluding most of the parking area from the project boundary. Please clarify if the tailwater fishing access parking area is within or outside of the project boundary and modify Exhibit G accordingly.

I&M Response:

I&M has revised the Exhibit G drawing to include the tailwater fishing access parking area.

FERC Comment:

Exhibit G shows an area adjacent to Featherstone Road, which is identified by points 21, 22, 23 and 24. The project purpose of the area is unknown. Therefore, please describe the project purpose of the area adjacent to Featherstone Road and label the project purpose on Exhibit G.

I&M Response:

The parcel shown at Featherstone Road contains the detached dike and the access point to the detached dike for monitoring, maintenance and inspection. I&M has revised the Exhibit G drawing to denote access to the dike.

Literature Cited

GeoEngineer. 2015. Sediment Quality Guidelines (SQGs): A Review and Their Use in Practice. https://www.geoengineer.org/education/web-class-projects/cee-549-geoenvironmental-engineering-fall-2015/assignments/sediment-quality-guidelines-sqgs-a-review-and-their-use-in-practice

Ingersoll, Christopher G., Wenning, Richard J. 2002. “Use of Sediment Quality Guidelines and Related Tools for the Assessment of Contaminated Sediments: Executive Summary of a SETAC Pellston Workshop”. Society of Environmental Toxicology and Chemistry.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20- 31.

Indiana Michigan Power Company (I&M). 2016. Supporting Technical Information Document Constantine Hydroelectric Project Number 10661-MI. Indiana Michigan Power Company. Rev. 4 April 29, 2016.

Wisconsin Department of Natural Resources (WDNR). 2003. “Consensus-Based Sediment Quality Guidelines: Recommendations for Use & Application.” Contaminated Sediment Standing Team.

If there are any questions regarding this submittal, please do not hesitate to contact the undersigned by phone at (614) 716-2240 or by email at jmmagalski@aep.com.

Sincerely,

Jonathan M. Magalski
Environmental Supervisor, Renewables
American Electric Power Services Corporation

Attachments
Attachment A – Affidavit of Publication for Final License Application Public Notice
Attachment B – Revised Shoreline Stability Assessment Study Report
Attachment C – Documentation for Submittal of Cultural Resources Study Report to Michigan SHPO
Attachment D – Revised Exhibit G Drawings

ATTACHMENT A
AFFIDAVIT OF PUBLICATION FOR FINAL LICENSE APPLICATION PUBLIC NOTICE

AFFP
UNITED STATES OF AMERICA FEDER

HDR
1304 Buckley Road
Suite 202
Syracuse, NY 13212

Affidavit of Publication

STATE OF WISCONSIN
COUNTY OF BROWN

I, said Legal Clerk, being duly sworn, says:

That I am the Legal Clerk of the Sturgis Journal, a daily newspaper of general circulation, printed and published in Sturgis, St. Joseph County, Michigan; that the publication, a copy of which is attached hereto, was published in the said newspaper in the issues dated:

October 08, 2021, October 09, 2021

That said newspaper was regularly issued and circulated on those dates.
SIGNED:

Linda Tutt

Legal Clerk

Subscribed to and sworn to me this 9th day of October 2021.

Amy Kokott

Notary Public, State of Wisconsin, County of Brown

My commission expires: 6/30/2025

00035895 00167923

AMY KOKOTT
Notary Public
State of Wisconsin

PUBLIC NOTICE
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY
COMMISSION
CONSTANTINE HYDROELECTRIC PROJECT (FERC No. 10661)
PUBLIC NOTICE

Indiana Michigan Power Company (I&M), a unit of American Electric Power, is the Licensee, owner, and operator of the 1.2-megawatt Constantine Hydroelectric Project (FERC No. 10661) (Project or Constantine Project), located on the St. Joseph River in the Village of Constantine in St. Joseph County, Michigan. The Project consists primarily of an uncontrolled concrete gravity overflow spillway dam, a concrete headgate structure, an earthen embankment between the headgate structure and overflow spillway, an earthfill reservoir impoundment dike, a power canal, and a powerhouse. I&M is pursuing a subsequent license from the Federal Energy Regulatory Commission (FERC or Commission) for the continued operation of the Project in accordance with the Commission's Integrated Licensing Process (ILP) as defined at 18 Code of Federal Regulations (CFR) Part 5. The Project's current operating license expires on September 30, 2023. In accordance with the applicable regulations at 18 CFR § 5.17(a), I&M must file a final application for a subsequent license with the Commission no later than September 30, 2021.

PLEASE TAKE NOTICE THAT American Electric Power Service Corporation (AEPSC), located at 1 Riverside Plaza, Columbus, Ohio 43215, filed on behalf of I&M a Final License Application (FLA) for the Project with the Commission on September 30, 2021 pursuant to the Commission's regulations at 18 CFR § 5.18(a)(5)(i). In accordance with 18 CFR § 5.17(d)(2), I&M is providing public notice of the filing of the FLA.

The proposed action described in the FLA is to relicense the continued operation and maintenance of the Project. The FLA describes Project facilities and operations, summarizes the results of resource studies, and assesses the potential effects of the proposed action on environmental, cultural, recreational, and socioeconomic resources. I&M proposes to continue the Project's run-of-river operation. The FLA does not propose the development of any new hydroelectric facilities or increased generation capacity but provides for protection, mitigation, and enhancement (PM&E) measures related to aquatic habitat, terrestrial resources, historic properties, and recreation associated with the Project. Proposals presented by in the FLA reflect careful consideration of available information, the results of studies conducted, and issues specific to the Project. I&M believes that the proposed PM&E measures as described in the FLA adequately take into consideration the important power and non-power values of the Project, the diverse interests of stakeholders, and the context of the Project within the overall flow regime of the St. Joseph River.

I&M is making public portions of the FLA available to resource agencies, Indian tribes, local governments, non-governmental organizations, and members of the public on the Project's distribution list. A digital copy of the application will be available on the Project's public relicensing website at http://www.aephydro.com/HydroPlant/Constantine, or via FERC's online e-Library at https://elibrary.ferc.gov/eLibrary/search, by searching FERC Project No. P-10661. The FLA can also be reviewed during normal business hours at the Constantine Township Library, located at 165 Canaris Street, Constantine, Michigan 49042. In addition, paper copies of the applications can be reproduced at a cost of $0.10/page, plus postage (both prepaid) by contacting Mr. Jonathan Magalski with AEPSC, at 1 Riverside Plaza, Columbus, Ohio 43215, or at (614) 716-2240 (except as provided at 18 CFR § 5.2(b)(4)). Upon acceptance of the FLA for filing, the Commission will publish subsequent notices soliciting public participation. Any questions regarding this notice or the application should be directed to Mr. Jonathan

Magalski at the contact information provided above.

ATTACHMENT B
REVISED SHORELINE STABILITY ASSESSMENT STUDY REPORT

Shoreline Stability Assessment Report

Constantine Project (FERC No. 10661)
January 26, 2022

Contents

Tables

Figures

Appendices

1. Project Introduction and Background

Indiana Michigan Power Company (I&M), a unit of American Electric Power (AEP), is the Licensee, owner, and operator of the run-of-river, 1.2 megawatt Constantine Hydroelectric Project (Project) (FERC No. 10661). The Project is located along the St. Joseph River in the Village of Constantine in St. Joseph County, Michigan.

I&M operates and maintains the Project under a license from the Federal Energy Regulatory Commission (FERC or Commission). The Project's existing license expires on September 30, 2023. I&M is pursuing a subsequent license for the Project using the Commission's Integrated Licensing Process (ILP) as defined in 18 Code of Federal Regulations (CFR) Part 5.

In accordance with 18 CFR § 5.15, I&M has conducted studies as provided in the March 15, 2019 Revised Study Plan (RSP) and schedule approved in the Commission's April 9, 2019 Study Plan Determination (SPD) for the Project. This report describes the methods and results of the Shoreline Stability Assessment Study conducted in support of preparing an application for a subsequent license for the Project.

During the preparation of the Pre-Application Document (PAD), I&M proposed to conduct a Shoreline Stability Assessment Study at the Project to identify sites of erosion or shoreline instability. Comments on the PAD were received from Michigan Department of Natural Resources (MDNR) related to geology and soil resources, specifically related to potential erosion as a result of Project operations. In their comments on the November 16, 2018 Proposed Study Plan (PSP), FERC suggested additional requirements for the study, which have been incorporated into Section 7.6.2 of the RSP and performed as part of the 2019 study.

Shoreline erosion is a common concern at hydroelectric projects. While the Project's run-of-river mode of operation provides protection against erosion, I&M recognizes that aspects of the Project's geological setting may contribute to the potential for shoreline erosion. Additionally, private shoreline activities may also contribute to shoreline erosion and instability.

2. Study Goals and Objectives

In accordance with I&M's RSP and the Commission's SPD for the Project, the goal of the Shoreline Stability Assessment Study was to identify sites of erosion and shoreline stability in the Project area. The specific objectives of this study were as follows:

- Survey the Project's reservoir, bypass reach and tailrace area to characterize the shoreline, with the focus on erosion or shoreline instability;
- Inventory, map, and document any areas of erosion or shoreline instability;
- Develop a scoring system to identify areas that have a potential to erode at unnaturally high rates; and
- Prioritize any areas where remedial action or further assessment may be needed.

3. Study Area

The study area for the Shoreline Stability Assessment Study is the Project's reservoir, from the Constantine Road bridge downstream to the dam, bypass reach and tailrace area downstream of the powerhouse to the Business Route 131 Bridge (Figure 1). The reservoir embankment is approximately 650 feet long. The dike has a maximum height of approximately 20 feet and is constructed of sand. In 2014, the top of the embankment was raised to elevation 790. The downstream side of the embankment was reshaped to the present slope in 1987 and 2004. In 2004, sheet piles were installed on the downstream right end of the embankment (the length of the line of sheeting was 150 feet). The side slopes are about 2:1, horizontal to vertical (estimated in the field) on the upstream side and 2:1, horizontal to vertical, to nearly flat (flush with native ground) on the downstream side (I&M 2018).

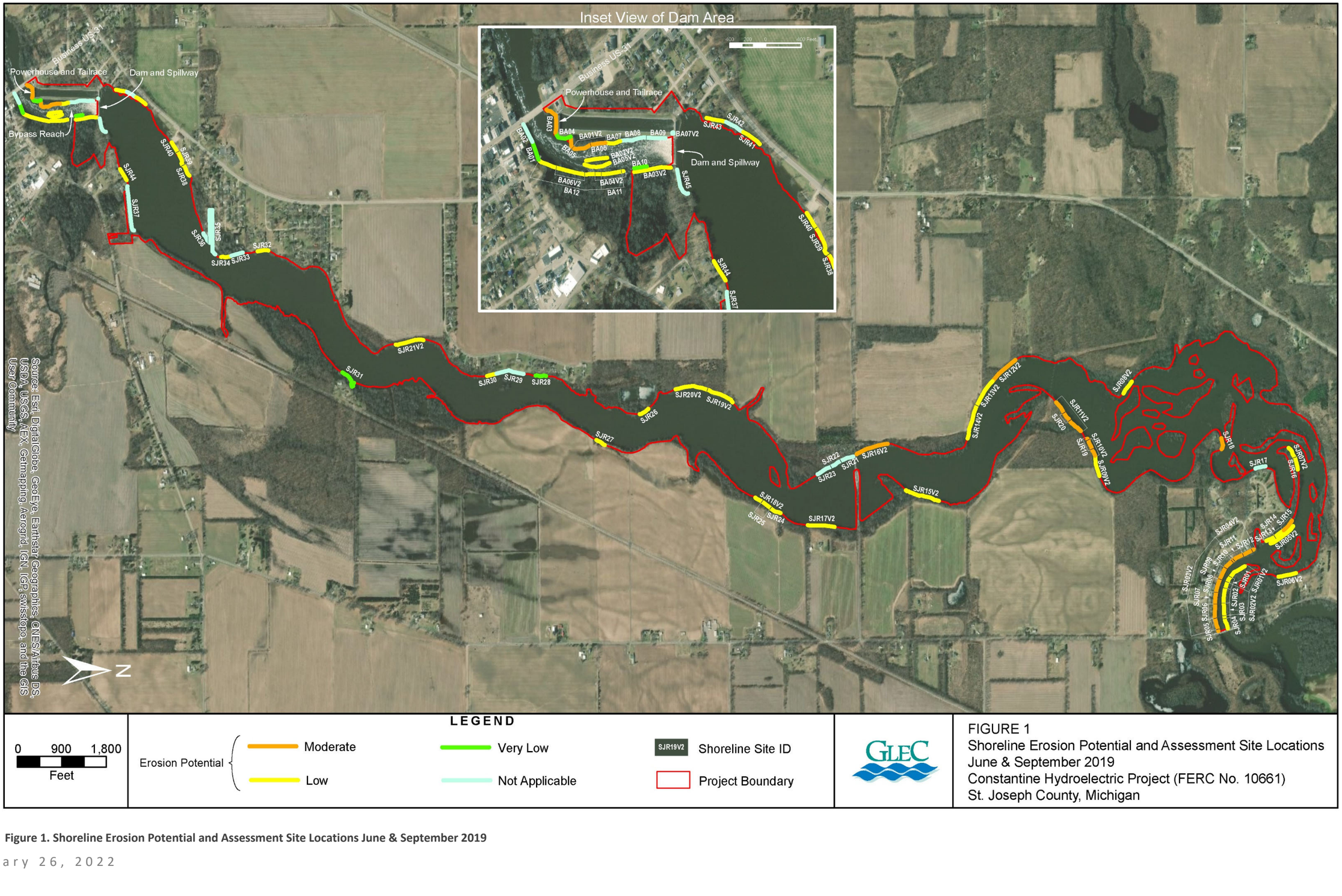


Figure 1. Shoreline Erosion Potential and Assessment Site Locations June & September 2019

4. Methodology

4.1. Literature Review

Great Lakes Environmental Center (GLEC) reviewed existing information on soils in the study area including soil survey maps and geologic maps as provided in Pre-Application Document (PAD) (I&M 2018) in Sections 5.2 Geology and 5.6 Wetlands, Littoral, and Riparian Habitat as well as the USDA soil survey of St. Joseph County (United States Department of Agriculture [USDA] 1983). Existing information was combined with information collected through field observations and field measurements to assess bank composition and erosion potential in the Project study area.

4.2. Shoreline Survey

Field surveys were conducted on June 2-4 and September 24-27, 2019 to characterize the shoreline of the Project's reservoir from the Constantine Road Bridge downstream to the US 131 Business Route Bridge in Constantine, Michigan. GLEC conducted the shoreline survey when the St. Joseph River was at a normal flow rate for June and September. Additionally, GLEC obtained hourly flow data from the U.S. Geological Survey (USGS) gage on the St. Joseph River at Mottville, Michigan (gage no. 04099000) (Appendix C) and a record of the daily maximum and minimum water surface elevations in the Constantine reservoir during the shoreline survey.

GLEC used the modified Bank Erosion Hazard Index (BEHI) method proposed by David Rosgen (Rosgen 2001) as the Standard Operating Procedure for assessing bank erosion and estimating erosion potential at the Project (Appendix A). For each area assessed, observations of vegetative cover, quantity of material, height, and slope of bank, existing erosion control mechanisms, soil or rock type, composition, and thickness of various bank materials or strata, and other relevant data were recorded on standardized field forms (Appendix B). Other factors contributing to bank erosion in the study area were identified and recorded. A Global Positioning System (GPS) was used to locate each of the assessed areas and representative photographs were taken at each location and are provided as figures in Section 7 of this report. A thematic map describing the erosion potential of the assessed areas is provided in Figure 1.

4.2.1. Modified Bank Erosion Hazard Index

The modified BEHI procedure consists of four observational metrics. A brief description of each metric is provided below. Point values for these metrics (Table 1) were assigned after a sufficient length of the river channel was examined (at least 200 feet), so that representative conditions were identified. Conditions on both banks were assessed, and scored independently.

Table 1. Metric Scores for the Modified BEHI used for the 2019 AEP Constantine Hydroelectric Project Shoreline Stability Study.

BEHI Category	Root Depth Values	Root Depth Scores	Root Density (%)	Root Density Scores	Surface Protection (Avg. %)	Surface Protection Scores	Bank Angle (degrees)	Bank Angle Scores	Total Score, by Category
Very low	90-100	1.45	80-100	1.45	80-100	1.45	0-20	1.45	**≤ 5.8**
Low	50-89	2.95	55-79	2.95	55-79	2.95	21-60	2.95	**5.8 – 11.8**
Moderate	30-49	4.95	30-54	4.95	30-54	4.95	61-80	4.95	**11.9 – 19.8**
High	15-29	6.95	15-29	6.95	15-29	6.95	81-90	6.95	**19.9 – 27.8**
Very high	5-14	8.5	5-14	8.5	10-14	8.5	91-119	8.5	**27.9 – 34.0**
Extreme	< 5	10	< 5	10	< 10	10	> 119	10	**34.1 – 40**

Ratio of root depth to bank height. Root depth is the ratio of the average plant root depth to the bank height, expressed as a percent (e.g., roots extending 2' into a 4' tall bank = 0.50).

Root density. Root density, expressed as a percent, is the proportion of the stream bank surface covered (and protected) by plant roots (e.g., a bank whose slope is half covered with roots = 50%).

Surface protection. Surface protection is the percentage of the stream bank covered (and therefore protected) by plant roots, downed logs and branches, rocks, etc. In many streams in southern Michigan, surface protection and root density are synonymous.

Bank angle. Bank angle is the angle of the bank from the waterline at base flow to the top of the bank, as opposed to benches that are higher on the floodplain. Bank angles greater than 90 degrees occur on undercut banks. Bank angle can be measured with a clinometer, though given the broad bank angle categories (Table 1), visual estimates are generally sufficient. Bank angle is perhaps the metric most often estimated incorrectly.

It is important to note that the BEHI procedure was originally developed for un-impounded rivers and streams, and BEHI scoring is confounded by hardened (armored) shorelines (e.g., rip rap, concrete, pilings etc.). Consequently, any field observation must take that into consideration and best professional judgment was exercised in this instance to account for that on the field data sheets.

4.2.2. Index Scoring and Interpretation

A draft field sheet for recording observations for the modified BEHI procedure is provided in Appendix A. Overall scores for the modified BEHI are calculated by summing the scores for each individual metric using the values in Table 1. The overall BEHI score corresponds to an erosion hazard category. Score categories are based on a scale from 5.8 to 40; a score of 5.8 or below is rated as Very Low, 5.9 to 11.8 is rated as Low, 11.9 to 19.8 is rated as Moderate, 19.9 to 27.8 is rated as High, 27.9 to 34.0 is rated as Very High, and a score greater than 34.0 is rated as Extreme. It should be noted that the overall BEHI scores and categories were created by Rosgen's work in the Rocky Mountain States, and in the future, these may be modified for conditions in Michigan.

4.2.3. Index Quality Control

Due to the subjective nature of this procedure, BEHI metric scores were verified by review of the photographs taken at each assessed site. The review was conducted by a GLEC senior field biologist familiar with the Project site. Several sites within the Project were visited in June and again in September to assess the precision of observations recorded. The senior field biologist was on the Project site during the September assessment. Several assessed sites were located in high traffic areas. According to the method outlined in Appendix A, shoreline areas located in high traffic areas such as parks, livestock crossings, highly landscaped lawns, etc. are not representative of average conditions and should be avoided unless they are the specific focus of the study. In the instances where sites were located in these high traffic areas, values for each metric were recorded, but score categories were not calculated and recorded as NA (Not Applicable). NA sites were also the result of complete armoring of the bank near the dam and powerhouse and/or extensive landscaping near homes and in parks.

5. Study Results

Observations for the 2019 Shoreline Stability Assessment of the reservoir and bypass reach were made during the June 2-4 and September 24-27, 2019 sampling events. Assessed sites were located at various points along the shoreline within the reservoir and bypass reach. Sites were labeled according to their location in the bypass reach or the reservoir. During the June sampling event, 57 sites were evaluated, and the results are listed in Table 2 in **Section 8** of this report. Of the 57 sites evaluated, 12 were located in the bypass reach (BA01-BA12) and 45 were located in the reservoir (SJR01-SJR45). During the September sampling event, 28 sites were evaluated, and the results are listed in Table 3. Of the 28 sites evaluated, 7 were located in the bypass reach (BA01V1-BA07V2) and 21 were located in the reservoir (SJR01V2-SJR21V2). All site numbers ending in V2 correspond to the second assessment visit in September. Examples of the assessed locations are given in Figures 2-20 in **Section 7** of this study report.

5.1. Bypass Reach

5.1.1. June Assessment

Twelve individual sites were assessed during the June sampling event in the bypass reach (Table 2). BEHI scores ranged from Very Low to Moderate in applicable sites in this area. Three sites were listed as NA due to shoreline armoring. Figure 2 shows the complete armoring of the shoreline at site BA02.

Three bypass reach sites did show some limited signs of erosion and scored in the Moderate category. Site BA03 showed an area of erosion against the Business Route 131 Bridge at the downstream end of the assessment area (Figure 3). The increase in slope and a decrease in plant root density places site BA03 in the Moderate category. Sites BA05 and BA06 scored in the Moderate category due to the increased slope of the bank in this area and the decrease in surface protection of the bank at the water surface (Figures 4 and 5). The remaining sites were assessed as Very Low to Low due to the shallow bank angle, and increased surface protection and root density at these locations (Figures 6 and 7).

5.1.2. September Assessment

Seven sites were assessed during the September sampling event in the bypass reach (Table 3). BEHI scores ranged from Low to Moderate in applicable sites. The tailrace water surface elevations were 0.8-0.9 feet lower than the June assessment period (Table 4).

One localized spot of erosion was observed in September in the bypass reach. Figure 8 shows one localized erosion area of concern near the dam. The lack of vegetation above the steel bulkhead and concrete are allowing for increased erosion in this localized area. This site was not observed in June due to the higher water levels (Table 4) and current velocity in the bypass reach. The lower water levels in September allowed for access to the entire bypass reach up to the dam.

5.2. Reservoir Area

5.2.1. June Assessment

A total of 45 individual reservoir sites were assessed during the June sampling event. Sites were located from the Constantine Road Bridge downstream to the dam. BEHI scores ranged from Very Low to Moderate in applicable sites. Eleven sites were set aside as NA due to the high degree of armoring along the banks or the presence of intensive landscaping in the areas near homes (Table 2). An example of shoreline armoring within the reservoir from site SJR45 is shown in Figure 9, and an example of intensive landscaping from SJR17 is shown in Figure 10.

An area along the left descending bank downstream of the Constantine Road Bridge scored in the Moderate erosion category. Sites SJR05 through SJR12 are located in a more riverine section of the Project. These sites are located along an outside bend with homes located within 100 feet of the shoreline. The steep slope of the bank, removal of some riparian vegetation for lawns, and the increased current velocity along the outside bend, place this section in the Moderate erosion category. Figures 11 and 12 show the steep slopes and addition of homes along this 1,600-foot section of shoreline. Moderate erosion was also present at sites SJR15, SJR18, SJR19, and SJR20 due to an increase in the bank angle and a decrease in root density at these sites. Figures 13 and 14 show examples of the increased slope and reduced root density at these locations.

The remainder of the applicable reservoir sites assessed in June scored in the Low or Very Low category. The decrease in the bank angle and increase in root density and surface protection reduce the risk of erosion at these locations. Sites SJR27 (Figure 15) and SJR39 (Figure 16) are developed with buildings and lawns, but a decreased risk of erosion.

5.2.2. September Assessment

A total of 21 reservoir sites were assessed during the September sampling visit. The BEHI scores ranged from Low to Moderate at all 21 locations. Moderate erosion was observed from the area along the left descending bank downstream of the Constantine Road Bridge SJR03V2-SJR04V2. These sites are located along an outside bend with homes located within 100 feet of the shoreline. The steep slope of the bank, removal of some riparian vegetation for lawns, and the increased current velocity along the outside bend, place this section in the Moderate erosion category. Sites SJR10V2-SJR11V2 also scored in the Moderate category due to an increase in the bank angle and a decrease in root density. Two additional

sites were scored as Moderate in September. Site SJR12V2 (Figure 17) and SJR16V2 (Figure 18) scored in the Moderate category due to their bank angle. The remaining sites scored in the low category. Figures 19 and 20 show adequate surface protection, root depth, and root density along with less steep bank angles to score in the Low erosion risk category.

5.3. Reassessed Areas

During the September sampling visit, 13 sites that were assessed in June were reassessed (Table 5). Four areas were located in the bypass reach and 9 were located in the reservoir. The 9 reservoir sites were primarily located at the upstream portion of the Project area near the Constantine Road Bridge. Score categories remained the same between visits at 9 of the 13 sites. Three sites in the bypass reach BA03V2, BA04V2, and BA06V2 changed in score from the Very Low category to Low. This slight change in score is likely due to the subjectivity of scoring of the Modified BEHI. Site SJR05V2, scored Low, overlaps with Site SRJ15, scored Moderate. The scoring difference between these two visits is due to the difference in the length of shoreline in each assessment. The September visit assessed a longer section of shoreline which resulted in a lower score for the bank angle.

6. Summary and Discussion

In summary, primary observations and conclusions from the Shoreline Stability Study are:

- In June, modified BEHI scores in the Project area ranged from Very Low to Moderate at 57 individual sites. In the bypass reach, sites were scored as; 5 Very Low, 1 Low, 3 Moderate, and 3 NA. In the reservoir area, sites were scored as; 2 Very Low, 20 Low, 12 Moderate, and 11 NA.
- In September, BEHI scores in the Project area ranged from Low to Moderate at 28 sites. In the bypass reach, sites scored as; 5 Low, 1 Moderate, and 1 NA. In the reservoir area, sites were scored as; 15 Low and 6 Moderate.
- Based on observations used to calculate the modified BEHI, three areas may require additional assessment to confirm and possibly mitigate potential future erosion hazards within the Project:

  1) Site BA03 located at the downstream end of the Project. This site has an area of erosion located against concrete at the base of the bridge extending under the overhanging vegetation. This erosion area is likely caused by current hitting the bank from the tailrace.

  2) Site BA07V2 located at the upstream end of the bypass reach. This isolated point has no vegetation and soil is actively falling into the bypass reach.

  3) In the reservoir, the area from site SJR05 to SJR12 (SJR03V2 to SJR04V2). This area is located in a more riverine section of the Project along an outside bend in the river channel. This area has had the riparian vegetation removed for home construction and maintained turf grass lawns.

6.1. Variances from FERC-Approved Study Plan

There were no variations from the study approach, methods, and reporting requirements as prescribed in the March 15, 2019 RSP for the Shoreline Stability Assessment Study (RSP Section 7).

7. Shoreline Survey Photographs - AEP Constantine Project Area 2019

Figure 2. Site BA02: Example of shoreline armoring in the bypass reach area.

Figure 3. Site BA03: Area of Moderate erosion located at the Business Route US-131 Bridge.

Figure 4. Site BA05: Moderate erosion near the water surface.

Figure 5. Site BA06: Moderate erosion near the water surface.

Figure 6. Site BA10:Very Low erosion category.

Figure 7. Site BA12:Very Low erosion category.

Figure 8. Area of localized very high erosion risk in the bypass reach area

Figure 9. Site SJR45: Example of shoreline armoring.

Figure 10. Site SJR17: An example of intensive landscaping along the shoreline within the reservoir area.

Figure 11. Site SJR09: Erosion along outside bend with roof of home in the background.

Figure 12. Site SJR10: Moderate erosion located along outside bend of river with home in background.

Figure 13. Site SJR15: Moderate erosion associated with an increase in bank angle.

Figure 14. Site SJR18: Moderate erosion associated with an increase in bank angle and a decrease in root density.

Figure 15. Site SJR27: Developed site along reservoir with Low erosion.

Figure 16. Site SJR39: Shoreline along VFW Hall.

Figure 17. Site SJR12V2: Moderate erosion category present due to an increase in bank angle.

Figure 18. Site SJR16V2: Moderate erosion only due to the bank angle.

Figure 19. Site SJR02V2: Low erosion score category with low bank angle and adequate surface protection across site.

Figure 20. Site SJR19V2: Low erosion score category.

8. Tables

Table 2. Modified Bank Erosion Hazard Index Scores for the Assessed Locations within the AEP Constantine Hydroelectric Project Area – Data Collected June 2-4, 2019.

Site ID	Root Depth Score	Root Density Score	Surface Protection Score	Bank Angle Score	Total Score	Score Category
Bypass Area						
BA01	1.45	1.45	1.45	1.45	5.80	Very Low
BA02	2.95	2.95	1.45	6.95	14.30	NA
BA03	2.95	8.50	1.45	2.95	15.85	Moderate
BA04	1.45	1.45	1.45	1.45	5.80	Very Low
BA05	1.45	2.95	6.95	6.95	18.30	Moderate
BA06	1.45	2.95	6.95	6.95	18.30	Moderate
BA07	1.45	1.45	1.45	2.95	7.30	Low
BA08	10.00	10.00	1.45	4.95	26.40	NA
BA09	10.00	10.00	1.45	4.95	26.40	NA
BA10	1.45	1.45	1.45	1.45	5.80	Very Low
BA11	1.45	1.45	1.45	1.45	5.80	Very Low
BA12	1.45	1.45	1.45	1.45	5.80	Very Low
Reservoir Area						
SJR01	1.45	2.95	2.95	1.45	8.80	Low
SJR02	1.45	4.95	2.95	1.45	10.80	Low
SJR03	1.45	2.95	2.95	2.95	10.30	Low
SJR04	1.45	2.95	2.95	2.95	10.30	Low
SJR05	1.45	2.95	2.95	4.95	12.30	Moderate
SJR06	1.45	4.95	1.45	4.95	12.80	Moderate
SJR07	1.45	2.95	2.95	4.95	12.30	Moderate
SJR08	1.45	4.95	1.45	4.95	12.80	Moderate
SJR09	1.45	4.95	2.95	6.95	16.30	Moderate
SJR10	1.45	2.95	2.95	6.95	14.30	Moderate
SJR11	1.45	4.95	2.95	6.95	16.30	Moderate
SJR12	1.45	4.95	2.95	6.95	16.30	Moderate
SJR13	1.45	2.95	1.45	4.95	10.80	Low
SJR14	1.45	2.95	1.45	4.95	10.80	Low
SJR15	1.45	2.95	2.95	4.95	12.30	Moderate
SJR16	1.45	2.95	4.95	1.45	10.80	Low
SJR17	1.45	8.50	1.45	4.95	16.35	NA
SJR18	2.95	4.95	2.95	4.95	15.80	Moderate
SJR19	1.45	4.95	2.95	4.95	14.30	Moderate
SJR20	1.45	4.95	4.95	2.95	14.30	Moderate
SJR21	10.00	10.00	1.45	4.95	26.40	NA

SJR22	1.45	8.50	1.45	2.95	14.35	NA
SJR23	1.45	2.95	1.45	2.95	8.80	NA
SJR24	1.45	2.95	2.95	1.45	8.80	Low
SJR25	1.45	1.45	1.45	2.95	7.30	Low
SJR26	1.45	2.95	1.45	2.95	8.80	Low
SJR27	1.45	1.45	1.45	2.95	7.30	Low
SJR28	1.45	1.45	1.45	1.45	5.80	Very Low
SJR29	1.45	1.45	1.45	6.95	11.30	NA
SJR30	1.45	2.95	1.45	1.45	7.30	Low
SJR31	1.45	1.45	1.45	1.45	5.80	Very Low
SJR32	1.45	1.45	1.45	2.95	7.30	Low
SJR33	1.45	1.45	1.45	1.45	5.80	NA
SJR34	1.45	1.45	1.45	2.95	7.30	Low
SJR35	1.45	2.95	2.95	2.95	10.30	NA
SJR36	1.45	2.95	1.45	2.95	8.80	NA
SJR37	1.45	2.95	1.45	2.95	8.80	NA
SJR38	1.45	2.95	1.45	1.45	7.30	Low
SJR39	1.45	1.45	2.95	2.95	8.80	Low
SJR40	1.45	1.45	2.95	2.95	8.80	Low
SJR41	1.45	2.95	2.95	2.95	10.30	Low
SJR42	1.45	2.95	1.45	2.95	8.80	NA
SJR43	1.45	1.45	1.45	2.95	7.30	Low
SJR44	1.45	2.95	1.45	2.95	8.80	Low
SJR45	2.95	2.95	1.45	2.95	10.30	NA

NA – Not applicable due to a high degree of armoring along bank within assessment site.

Table 3. Modified Bank Erosion Hazard Index Scores for the Assessed Locations within the AEP Constantine Hydroelectric Project Area– Data Collected September 24-27, 2019.

Site ID	Root Depth Score	Root Density Score	Surface Protection Score	Bank Angle Score	Total Score	Score Category
Bypass Area						
BA01V2	1.45	4.95	4.95	2.95	14.30	Moderate
BA02V2	1.45	2.95	4.95	1.45	10.80	Low
BA03V2	1.45	2.95	2.95	2.95	10.30	Low
BA04V2	1.45	2.95	1.45	2.95	8.80	Low
BA05V2	1.45	2.95	2.95	2.95	10.30	Low
BA06V2	1.45	2.95	2.95	2.95	10.30	Low
BA07V2	10.00	8.50	10.00	4.95	33.45	NA

Reservoir Area						
SJR01V2	2.95	2.95	2.95	1.45	10.30	Low
SJR02V2	1.45	2.95	2.95	1.45	8.80	Low
SJR03V2	4.95	4.95	4.95	4.95	19.80	Moderate
SJR04V2	1.45	4.95	6.95	4.95	18.30	Moderate
SJR05V2	2.95	2.95	2.95	2.95	11.80	Low
SJR06V2	1.45	2.95	2.95	2.95	10.30	Low
SJR07V2	1.45	2.95	2.95	1.45	8.80	Low
SJR08V2	1.45	1.45	1.45	2.95	7.30	Low
SJR09V2	2.95	2.95	2.95	2.95	11.80	Low
SJR10V2	2.95	4.95	2.95	2.95	13.80	Moderate
SJR11V2	2.95	4.95	2.95	2.95	13.80	Moderate
SJR12V2	2.95	2.95	2.95	4.95	13.80	Moderate
SJR13V2	2.95	2.95	2.95	2.95	11.80	Low
SJR14V2	2.95	2.95	2.95	2.95	11.80	Low
SJR15V2	1.45	2.95	2.95	2.95	10.30	Low
SJR16V2	1.45	2.95	2.95	4.95	12.30	Moderate
SJR17V2	1.45	2.95	2.95	2.95	10.30	Low
SJR18V2	1.45	2.95	2.95	2.95	10.30	Low
SJR19V2	1.45	2.95	2.95	2.95	10.30	Low
SJR20V2	1.45	2.95	2.95	2.95	10.30	Low
SJR21V2	1.45	2.95	2.95	2.95	10.30	Low

NA - Not applicable due to a high degree of armoring along bank within assessment site.

Table 4. Water surface elevations at the Constantine Project during the Shoreline Stability Assessment (June and September 2019).

Date	Forebay Elevation (ft)			Raceway Elevation (ft)			Tailwater Elevation (ft)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
6/2/2019	783.3	783.3	783.3	783.3	783.3	783.3	772.2	772.2	772.3
6/3/2019	783.2	783.2	783.3	783.2	783.2	783.3	772.2	772.1	772.2
6/4/2019	783.2	783.2	783.2	783.2	783.2	783.3	772.1	772.1	772.2
9/24/2019	782.9	782.9	782.9	782.9	782.9	782.9	771.3	771.3	771.4
9/25/2019	782.9	782.9	782.9	782.9	782.9	782.9	771.3	771.2	771.4
9/26/2019	782.9	782.9	782.9	782.9	782.9	782.9	771.3	771.2	771.3
9/27/2019	782.9	782.9	783.0	782.9	782.9	782.9	771.3	771.2	771.5

Table 5. Site IDs and Scores for Areas Reassessed during the September Sampling Visit.

September Site ID	Score Category	June Site ID	Score Category
Bypass Area			
BA01V2	Moderate	BA05	Moderate
		BA06	Moderate
BA03V2	Low	BA10	Very Low
BA04V2	Low	BA11	Very Low
BA06V2	Low	BA12	Very Low
Reservoir Area			
SJR01V2	Low	SJR01	Low
		SJR02 (part)	Low
SJR02V2	Low	SJR02 (part)	Low
		SJR03	Low
SJR03V2	Moderate	SJR05	Moderate
		SJR06	Moderate
		SJR07	Moderate
		SJR08	Moderate
		SJR09	Moderate
		SJR10	Moderate
SJR04V2	Moderate	SJR11	Moderate
		SJR12	Moderate
SJR05V2	Low	SJR13	Low
		SJR14	Low
		SJR15	Moderate
SJR07V2	Low	SJR16	Low
SJR10V2	Moderate	SJR19	Moderate
SJR11V2	Moderate	SJR20	Moderate
SJR18V2	Low	SJR24	Low
		SJR25	Low

9. References

Indiana Michigan Power Company (I&M). 2018. Constantine Hydroelectric Project (FERC No. 10661). Notice of Intent and Pre-Application Document. Federal Energy Regulatory Commission, Washington, D.C. June 4, 2018.

Rosgen, D.L. 2001. A Practical Method of Computing Streambank Erosion Rate. Proceedings of the Seventh Federal Interagency Sedimentation Conference, Vol. 2, pp. II - 9-15, March 25-29, 2001, Reno, NV.

Appendix A. Rosgen SOP

STANDARD OPERATING PROCEDURE

ASSESSING BANK EROSION POTENTIAL USING ROSGEN'S BANK EROSION HAZARD INDEX (BEHI)

1.0 Overview

While stream bank erosion is a natural process that occurs in every watershed, excessive erosion has serious adverse consequences for the physical and biological function of rivers. Eroding stream banks can be a major source of sediment to a stream (up to 80% of the annual load; Simon and Thorne, 1996), and human activities such as urbanization or dam construction can accelerate bank erosion rates by more than an order of magnitude. It is often difficult, however, to distinguish between stream banks that are eroding at a natural rate from those that are or have the potential to erode at unnaturally high rates due to altered watershed hydrology or sediment loads. The Bank Erosion Hazard Index (BEHI), created by Dave Rosgen of Wildland Hydrology, Inc. (Rosgen, 2001), is one of several procedures for assessing stream bank erosion condition and potential. It assigns point values to several aspects of bank condition and provides an overall score that can be used to inventory stream bank condition over large areas, prioritize eroding banks for remedial actions, etc. This standard operating procedure (SOP) describes two versions of the BEHI technique.

2.0 Procedure

Below are descriptions of two BEHI procedures. The first describes the complete BEHI procedure created by Rosgen, including identification of bankfull width. The second describes a modified BEHI procedure, which does not require identification of bankfull width. The modified BEHI procedure is intended for use by workers who lack experience in identifying bankfull indicators, including volunteer monitors. Correctly identifying appropriate bankfull indicators requires considerable experience, and is the most subjective step in the original BEHI procedure.

In truth, both procedures described below are 'modified', in that the step of calculating BEHI scores has been simplified such that there is only a single score for each metric, rather than the range of possible scores provided in Rosgen's original paper. This simplification is intended to remove some unnecessary subjectivity from the field observations, without overly reducing the utility of the procedure.

A. Complete BEHI Procedure

The complete BEHI procedure consists of five metrics; four observational and one requiring some measurements. They are:

1. Ratio of bank height to bankfull height
2. Ratio of root depth to bank height

3. Root density, in percent
4. Bank angle, in degrees
5. Surface protection, in percent

Brief descriptions of each metric are provided below.

Point values for these metrics (Table 1) should only be assigned after a sufficient length of the stream channel (the 'stream reach') has been examined (at least 100'; 2 to 3 meander lengths is preferable), so that representative conditions are identified. Conditions on both banks should be assessed, and scored separately if they are consistently different. See Section 4 for further advice on where to make – and not make – the observations.

Ratio of bank height to bankfull height. This is the most challenging of the BEHI metrics, as it requires accurate identification of bankfull indicators. A full discussion of different bankfull indicators is beyond the scope of this SOP, but it is thoroughly discussed in Williams (1978), and a useful free video is available from the U.S. Forest Service (2003). Common bankfull indicators in stable southern Michigan streams include top of bank, top of point bars, and other changes in channel slope. Vegetative indicators are seldom useful in southern Michigan streams. Bankfull indicators in unstable streams (i.e., incising or aggrading streams) can be more difficult to identify, but are usually less than top of bank.

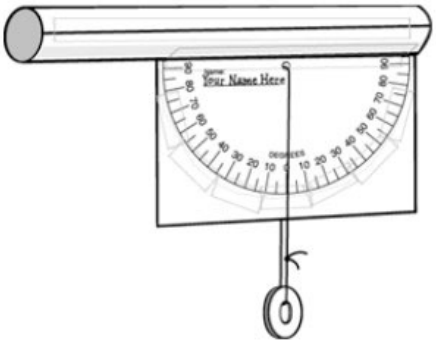
Ratio of root depth to bank height. Root depth is the ratio of the average plant root depth to the bank height, expressed as a percent (e.g., roots extending 2' into a 4' tall bank = 0.50.)

Root density. Root density, expressed as a percent, is the proportion of the stream bank surface covered (and protected) by plant roots (e.g., a bank whose slope is half covered with roots = 50%).

Surface protection. Surface protection is the percentage of the stream bank covered (and therefore protected) by plant roots, downed logs and branches, rocks, etc. In many streams in southern Michigan, surface protection and root density are synonymous.

Bank angle. Bank angle is the angle of the "lower bank" – the bank from the waterline at base flow to the top of the bank, as opposed to benches that are higher on the floodplain. Bank angles great than 90º occur on undercut banks. Bank angle can be measured with an inclinometer (Figure 1), though given the broad bank angle categories (Table 1), visual estimates are generally sufficient. Bank angle is perhaps the metric most often estimated incorrectly.

Figure 1. Simple and More Expensive (~ $100) Inclinometers



B. Modified BEHI Procedure

If the field staff lack experience with identifying bank full indicators, it is recommended that the bank height/bankfull height ratio metric be dropped from the BEHI calculation, leaving four metrics:

1. Ratio of root depth to bank height
2. Root density, in percent
3. Surface protection, in percent
4. Bank angle, in degrees

Observations for these metrics are made as described in Section 2A, and the overall BEHI score is calculated using Table 2.

3.0 Data Calculation and Interpretation

A draft field sheet for recording observations for the modified BEHI procedure is in Appendix 1. Overall scores for the Complete BEHI are calculated by summing the scores for each individual metric using the values in Table 1, and scores for the Modified BEHI are similarly calculated using the values in Table 2. The overall BEHI score corresponds to an erosion hazard category. It should be noted that the overall BEHI scores and categories were created by Rosgen's work in the Rocky Mountain states, and in the future these may be modified for conditions in Michigan. Illustrated examples from southern Michigan streams are in Appendix 2.

BEHI scores have several potential uses, including ranking multiple stations for further study or remedial actions (Figure 2).

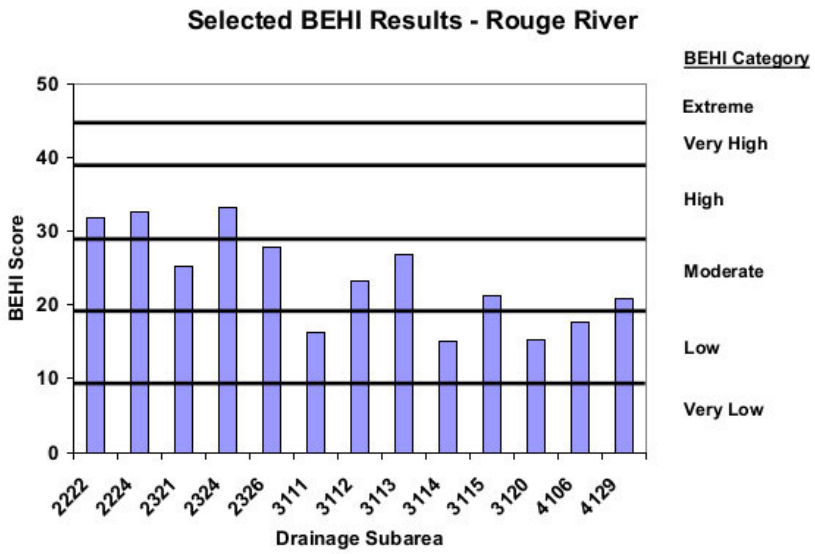
Table 1. Scores for the Complete BEHI.

BEHI Category	Bank Height/ Bankfull Height	BH/BFH Score	Root Depth (% of BFH)	Root Depth Score	Root Density (%)	Root Density Score	Surface Protection (Avg. %)	Surface Protection Score	Bank Angle (degrees)	Bank Angle Score	Total Score, by Category
Very low	1.0-1.1	1.45	90-100	1.45	80-100	1.45	80-100	1.45	0-20	1.45	≤ 7.25
Low	1.11-1.19	2.95	50-89	2.95	55-79	2.95	55-79	2.95	21-60	2.95	7.26 – 14.75
Moderate	1.2-1.5	4.95	30-49	4.95	30-54	4.95	30-54	4.95	61-80	4.95	14.76 – 24.75
High	1.6-2.0	6.95	15-29	6.95	15-29	6.95	15-29	6.95	81-90	6.95	24.76 – 34.75
Very high	2.1-2.8	8.5	5-14	8.5	5-14	8.5	10-14	8.5	91-119	8.5	34.76 – 42.50
Extreme	>2.8	10	< 5	10	< 5	10	< 10	10	> 119	10	42.51 - 50

Table 2. Scores for the Modified BEHI.

BEHI Category	Root Depth Values	Root Depth Scores	Root Density (%)	Root Density Scores	Surface Protection (Avg. %)	Surface Protection Scores	Bank Angle (degrees)	Bank Angle Scores	Total Score, by Category
Very low	90-100	1.45	80-100	1.45	80-100	1.45	0-20	1.45	≤ 5.8
Low	50-89	2.95	55-79	2.95	55-79	2.95	21-60	2.95	5.9 – 11.8
Moderate	30-49	4.95	30-54	4.95	30-54	4.95	61-80	4.95	11.9 – 19.8
High	15-29	6.95	15-29	6.95	15-29	6.95	81-90	6.95	19.9 – 27.8
Very high	5-14	8.5	5-14	8.5	10-14	8.5	91-119	8.5	27.9 – 34.0
Extreme	< 5	10	< 5	10	< 10	10	> 119	10	34.1 - 40

Figure 2. BEHI Score Example



4.0 Quality Control Issues

(1) Accuracy: Accuracy as traditionally defined is difficult to assess for this largely subjective, observational procedure. When performed by volunteers, however, the accuracy of their observations can be maximized by training from others more experienced in river morphology studies, and verified by spot-checks of their work by the trainers.

(2) Precision: Precision as traditionally defined is also difficult to assess for this largely subjective, observational procedure. Spot-checks within a few weeks of volunteer observations can be used to assess precision as well as accuracy.

(3) Reference reaches: In addition to the erosion hazard categories generated by this procedure, it can also be useful to make these observations at reference reaches – stream reaches in portions of the same watershed, or an adjacent watershed, that are believed to be (relatively) undisturbed by urban development, stream channelization, etc. A good document describing how to choose and document conditions at a reference site is the U.S. Forest Service report by Harrelson, et al. (1994). Alternatively, contact the author of this SOP for advice on selecting a representative reference reach. In general, reference reaches are best established in the same watershed as the stream reach of interest, in a stream of the same size (e.g., same stream order, or baseflow wetted width) and with similar soil type and channel slope.

(4) Stream reach selection (Representativeness): Selection of specific stream reaches for BEHI observations will depend on the objectives of the study, but a few general rules apply:

- Stream bank conditions are naturally variable even in stable streams, and to characterize a stream reach it is recommended that at least 200' of the stream reach be viewed before the BEHI observations are made.
- Stream banks adjacent to riffle areas tend to be the most stable section of a stream channel, while banks in meander bends tend to have the highest erosion rates – even in geomorphically stable streams.
- Stream banks in 'high traffic' areas (parks, livestock crossings, etc.) are not representative of average conditions and should be avoided – unless they are the specific focus of the study.

While volunteers can collect large amounts of useful BEHI data with adequate training and supervision, experience has shown that they are prone to overemphasizing small, atypical bank erosion "hot spots," even when asked to score more representative banks.

5.0 References

Harrelson C. C., Rawlins, C. L. and Potyondy J. P. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique, General Technical Report RM-245, USDA - Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, 61 pages. Available from: http://www.stream.fs.fed.us/publications/documentsStream.html

Rosgen, D.L. 2001. A Practical Method of Computing Streambank Erosion Rate. Proceedings of the Seventh Federal Interagency Sedimentation Conference, Vol. 2, pp. II - 9-15, March 25-29, 2001, Reno, NV. Available on the Wildland Hydrology website: http://www.wildlandhydrology.com/html/references_.html

Simon, A., and C. Thorne. 1996. Channel Adjustment of an Unstable Coarse-Grained Alluvial Stream: Opposing Trends of Boundary and Critical Shear Stress, and the Applicability of Extremal Hypothesis. Earth Surface Processes and Landforms 21:155-180.

U.S. Forest Service. 2003. Identifying Bankfull Stage in Forested Streams in the Eastern United States. Free from: http://www.stream.fs.fed.us/publications/videos.html

Williams, G.P. 1978. Bank-Full Discharge of Rivers. *Water Resources Research* 14(6):1141-1154.

SOP Prepared by:

Joe Rathbun
Michigan Department of Environmental Quality – Water Bureau – Nonpoint Source Unit
(517) 373-8868 rathbunj@michigan.gov

Modified Bank Erosion Hazard Index (BEHI) Field Form

Date:________________________ **Personnel:**____

Location:____

(Circle one in each column)

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Comments:

Date:________________________ **Personnel:**____

Location:____

(Circle one in each column)

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Comments:

Date:________________________ **Personnel:**____

Location:____

(Circle one in each column)

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Comments:____

Appendix 2. Examples of Different Bank Conditions in Southern Michigan Streams

Figure A. Tributary, Kalamazoo River watershed

Bank Height/Bankfull Height ≈ 1.0-1.1

Root Depth/Bank Height ≈ 0.9-1.0

Root Density ≈ 80-100%

Bank Angle ≈ 0-20° ?

Surface Protection ≈ 80-100%

BEHI Score = 7.25 (Very low)

Figure B. Kalamazoo River

Bank Height/Bankfull Height ≈ 1.0-1.1

Root Depth/Bank Height ≈ 0.9-1.0

Root Density ≈ 30-54%, not counting sod slump

Bank Angle ≈ 81-90°

Surface Protection ≈ 30-54%

BEHI Score = 19.75 (Moderate)

Note sod slumping into channel – a sure indication of an unstable bank, presumably because streamside vegetation = mowed grass, not woody vegetation. Otherwise the channel is in pretty good shape.

Figure C. Rouge River

Bank Height/Bankfull Height ≈ 1.0-1.1 (assuming top of bank = bankfull)

Root Depth/Bank Height ≈ 0.9-1.0

Root Density ≈ 5-14%

Bank Angle ≈ 81-90°

Surface Protection ≈ 10-14%

BEHI Score = 26.85 (High)

Interesting site – roots extend to waterline, but are so few that they provide minimal bank protection. Also, this site is downstream from a dam, where erosion is usually atypically high due to "hungry water" created by the impoundment.

Figure D. Hagar Creek , Ottawa County

Bank Height/Bankfull Height ≈ > 2.8

Root Depth/Bank Height ≈ 0.3-0.49 at best

Root Density ≈ 5-14%

Bank Angle ≈ 81-90°

Surface Protection ≈ 10-14%

BEHI Score = 38.9 (Very high)

Appendix B. Field Form

Modified Bank Erosion Hazard Index (BEHI) Field Form

Date:________________________ **Personnel:**____

Location:____

(Circle one in each column)

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Comments:

Date:________________________ **Personnel:**____

Location:____

(Circle one in each column)

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Comments:

Date:________________________ **Personnel:**____

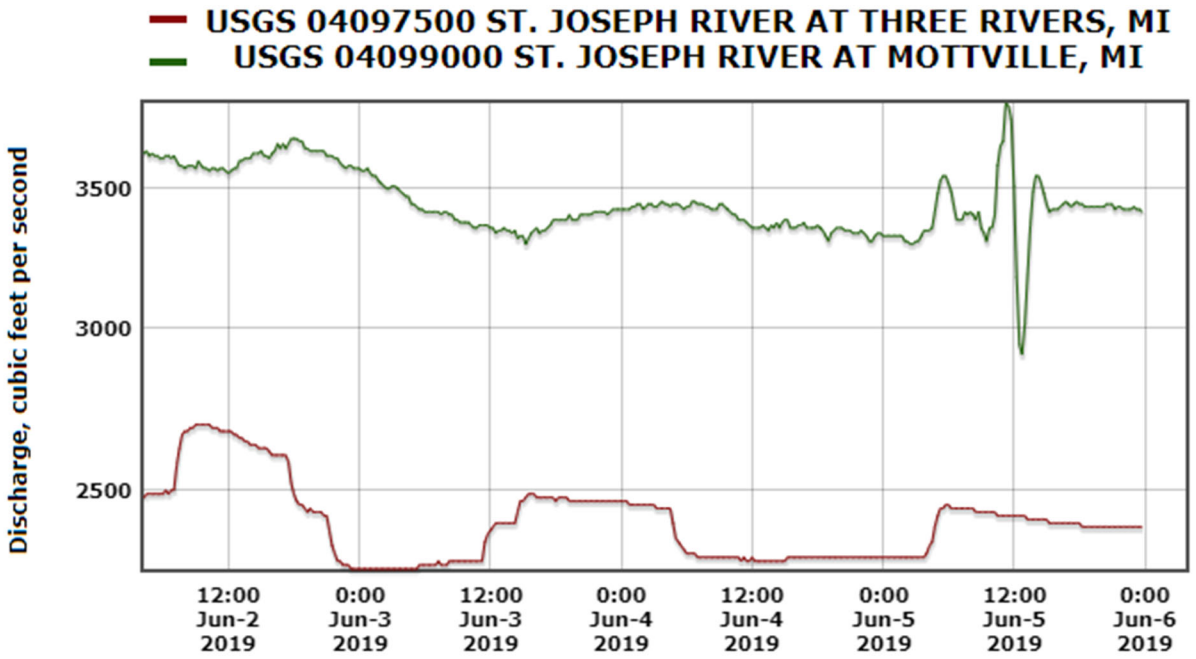
Location:____

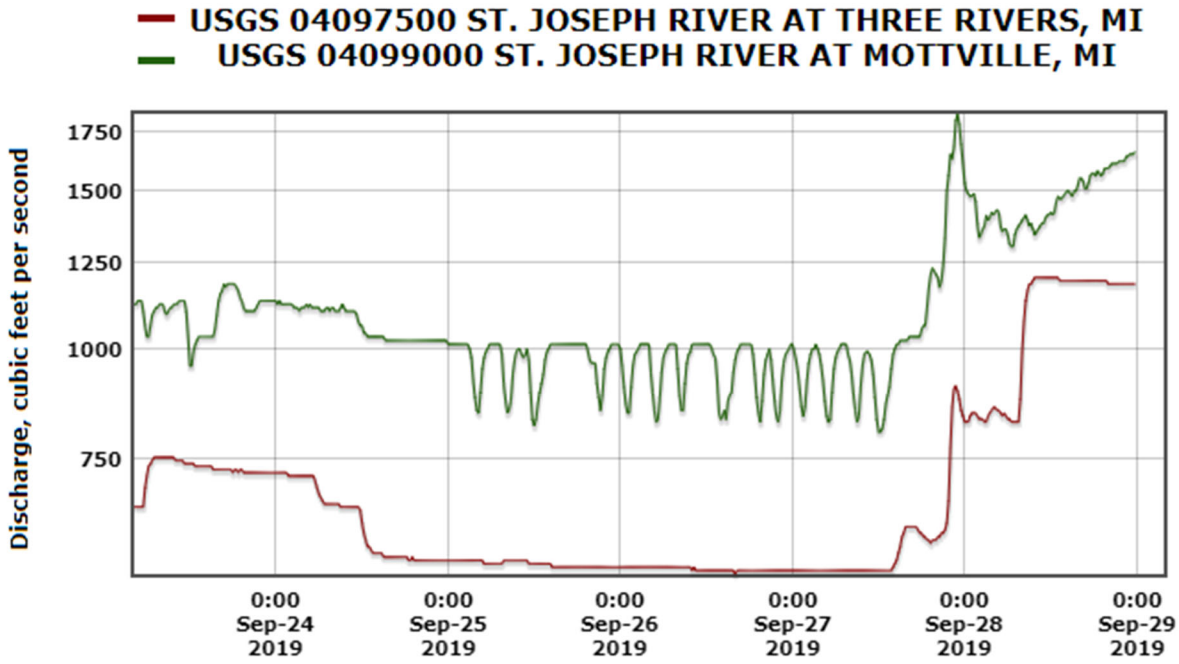
(Circle one in each column)

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Comments:____

Appendix C. Flow Graphs


USGS 04097500 ST. JOSEPH RIVER AT THREE RIVERS, MI
USGS 04099000 ST. JOSEPH RIVER AT MOTTVILLE, MI
Discharge, cubic feet per second
3500
3000
2500
12:00 Jun-2 2019
0:00 Jun-3 2019
12:00 Jun-3 2019
0:00 Jun-4 2019
12:00 Jun-4 2019
0:00 Jun-5 2019
12:00 Jun-5 2019
0:00 Jun-6 2019


USGS 04097500 ST. JOSEPH RIVER AT THREE RIVERS, MI
USGS 04099000 ST. JOSEPH RIVER AT MOTTVILLE, MI
Discharge, cubic feet per second
1750
1500
1250
1000
750
0:00 Sep-24 2019
0:00 Sep-25 2019
0:00 Sep-26 2019
0:00 Sep-27 2019
0:00 Sep-28 2019
0:00 Sep-29 2019

ATTACHMENT C
DOCUMENTATION FOR SUBMITTAL OF CULTURAL RESOURCES STUDY REPORT TO MICHIGAN SHPO

From: UPS Quantum View
To: Brandon Gabler
Subject: UPS Ship Notification, Tracking Number 1Z29V3E50395175180
Date: Monday, April 27, 2020 9:08:57 AM

You have a package coming.

Scheduled Delivery Date: Tuesday, 04/28/2020

This message was sent to you at the request of Commonwealth Heritage Group to notify you that the shipment information below has been transmitted to UPS. The physical package may or may not have actually been tendered to UPS for shipment. To verify the actual transit status of your shipment, click on the tracking link below.

Shipment Details

From:	COMMONWEALTH HERITAGE GROUP
Tracking Number:	**1Z29V3E50395175180**
Ship To:	Brian Grennell/Stacy Tchorzynski State Historic Preservation Office 300 North Washington Square Michigan Economic Development Corp LANSING, MI 48933 US
UPS Service:	UPS GROUND
Number of Packages:	1
Scheduled Delivery:	04/28/2020
Weight:	1.0 LBS
Reference Number 1:	J-1044 Reports

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For Questions, Visit Our Help and Support Center

From: Brandon Gabler <bgabler@chg-inc.com>
Sent: Wednesday, January 5, 2022 5:47 AM
To: grennellb@michigan.gov
Cc: Hanson, Danielle <Danielle.Hanson@hdrinc.com>
Subject: FERC - Constantine Hydro project

Hi Brian,
Happy New Year!

We're working with HDR to get final review of the Constantine hydro project complete. Danielle Hanson at HDR wrote to me that FERC still hasn't received SHPO response, with this note:

We're working on responses to FERC's Additional Information Requests in the attached letter and FERC has once again requested a letter from MI SHPO stating concurrence on the Cultural Resources Study (see comment below).

"Appendix B does not contain a letter of concurrence from the Michigan State Historic Preservation Office (Michigan SHPO) regarding the cultural resources study completed for this project. Please again contact the Michigan SHPO to ask for concurrence for the study and provide correspondence from Michigan SHPO that shows concurrence for the cultural resources study."

The attached UPS notification is from April 2020 showing that we shipped the reports to you/Stacy. I've also attached a PDF of the reports here. Please let me know if SHPO can respond, and if you need any additional information. Thanks in advance!

Brandon

COMMONWEALTH
HERITAGE GROUP
Brandon M. Gabler, PhD, RPA
Chief Operating Officer
Commonwealth Heritage Group, Inc.
3215 Central Street, Dexter, MI 48130
c: (571) 488-5912
e: bgabler@chg-inc.com
www.commonwealthheritagegroup.com

Click here to learn more about the Section 106 process!

From: Brandon Gabler <bgabler@chg-inc.com>
Sent: Thursday, January 6, 2022 7:19 AM
To: Hanson, Danielle <Danielle.Hanson@hdrinc.com>
Cc: Quiggle, Robert <robert.quiggle@hdrinc.com>
Subject: FW: FERC - Constantine Hydro project

FYI, Brian received the reports at SHPO.

Brandon

Brandon M. Gabler, PhD, RPA
Chief Operating Officer
Commonwealth Heritage Group, Inc.
c: (571) 488-5912
e: bgabler@chg-inc.com
Click here to learn more about the Section 106 process!

From: Grennell, Brian (LEO) <GrennellB@michigan.gov>
Sent: Thursday, January 6, 2022 9:09 AM
To: Brandon Gabler <bgabler@chg-inc.com>
Subject: RE: FERC - Constantine Hydro project

Received, thanks.

Brian G. Grennell

Cultural Resource Management Coordinator
State Historic Preservation Office
300 N. Washington Square | Lansing, MI 48913
Direct Phone (517) 335-2721
Grennellb@michigan.gov
www.michigan.gov/shpo

Get the latest news with the SHPO and MEDC Community Development newsletters!

From: Brandon Gabler <bgabler@chg-inc.com>
Sent: Wednesday, January 5, 2022 8:14 AM
To: Grennell, Brian (LEO) <GrennellB@michigan.gov>
Subject: RE: FERC - Constantine Hydro project

By the way, Brian – the last email I sent was about 20 MB with attachments, so I wanted to send a follow-up to make sure you got it. Thanks!

Brandon

Brandon M. Gabler, PhD, RPA
Chief Operating Officer
Commonwealth Heritage Group, Inc.
c: (571) 488-5912
e: bgabler@chg-inc.com
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ATTACHMENT D
REVISED EXHIBIT G DRAWINGS

PROJECT BOUNDARY

POINT	COURSE	DISTANCE (FT)
1-2	S 60d58'30.24" E	75.00
2-3	S 57d23'2.04" W	471.38
3-4	S 0d2'21.58" W	412.94
4-5	ALONG 772.0' SHORELINE CONTOUR	524.84
5-6	N 88d50'27.09" W	240.00
6-7	S 11d46'5.84" E	50.00
7-8	ALONG 772.0' SHORELINE CONTOUR	1666.71
8-9	N 27d23'0.62" W	280.00
9-10	N 65d9'27.40" E	128.56
10-11	N 15d19'17.44" E	57.29
11-12	N 1d6'34.07" E	857.88
12-13	N 47d43'34.72" E	44.90
13-14	N 41d33'9.41" W	266.36
14-15	N 50d44'15.84" E	224.29
15-16	N 29d55'53.44" W	57.50
16-17	ALONG 782.94' CONTOUR	39807.21
17-18	S 14d28'13.06" E	193.38
18-19	ALONG 782.94' CONTOUR	41995.24
19-20	S 6d1'56.41" W	158.39
20-21	N 82d32'21.96" E	123.44
21-22	S 0d44'21.33" E	451.73
22-23	S 73d50'33.58" W	162.32
23-24	N 0d11'58.69" E	418.18
24-25	S 82d26'56.40" W	632.02
25-26	N 21d59'28.07" W	81.71
26-1	ALONG 782.94' CONTOUR	869.87

5.52 DEG MAG 2021

BOAT LAUNCH AND RESERVOIR FISHING ACCESS
LAT: 41.847508
LON: -85.669626

TAILWATER FISHING ACCESS
LAT: 41.843493
LON: -85.669589

TAILWATER FISHING ACCESS PARKING AREA

INTERCONNECTION WITH INDIANA MICHIGAN POWER'S ELECTRICAL GRID

RACE BANK CIRCUIT, 12 kV

RACE BANK CIRCUIT

HEADGATES

RACE

DAM & SPILLWAY

2.4 kV

SUB-STATION

BYPASS REACH

PORTAGE TRAIL

PORTAGE PUT-IN AND TAILWATER FISHING ACCESS
LAT: 41.845944
LON: -85.667737

VILLAGE CIRCUIT

POWERHOUSE

PORTAGE TAKE-OUT RESERVOIR FISHING ACCESS & PICNIC AREA
LAT: 41.847604
LON: -85.667087

POWERHOUSE AREA ENLARGEMENT MAP
SCALE: 1 " = 200 '

SEE ENLARGEMENT MAP

N WASHINGTON ST
BROAD ST
BIRCH ST
LOCUST ST
RACE ST
GARDEN ST
SPRING ST
CANAL ST
BUS 131
E WATER ST
MILL ST
E 2ND ST
DEPOT ST
STATION ST
PROSPECT ST
CENTREVILLE RD
FAWN
RIVER
FEATHERSTONE RD
SIDE DIKE
COREY-FLORENCE ROAD 69 kV TRANSMISSION LINE
T 07S R 12W SN 14
T 07S R 12W SN 23
T 07S R 12W SN 24
T 07S R 12W SN 13
T 07S R 12W SN 11
T 07S R 12W SN 12
T 07S R 11W SN 07

N: 131316.17
E: 12770126.43

TIE: 5080.1' ±, N 11d48'49.16" E
UNITED STATES COAST AND GEODETIC SURVEY
BENCHMARK D344 1992,
PID AH8448
N: 134474.52
E: 12770194.99

N: 136571.73
E: 12770133.77

N: 136582.75
E: 12774135.60

ROBERT SHORE DR
DIANE DR
SANDRA DR
CONNIE ST
N N PARK DR
E N PARK DR
ZERBE RD
RIVER HEIGHTS RD
131
CONSTANTINE BYPASS
OLD US 13

PROJECT BOUNDARY
ELEV. 782.94 FEET
NGVD 1929

ST. JOSEPH RIVER

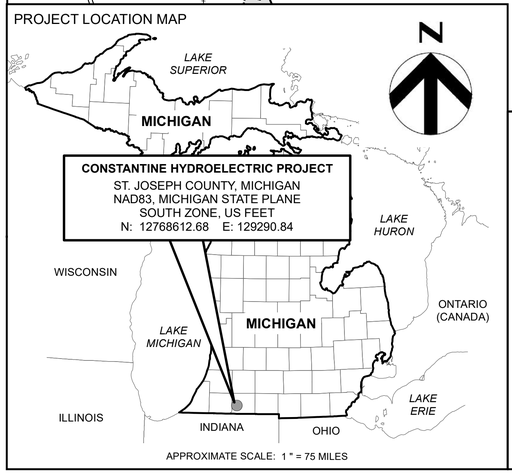
CONSTANTINE TWP.
FLORENCE TWP.

EXHIBIT G-2

NOTES

1. THE LICENSEE EITHER OWNS IN SIMPLE FEE OR POSSESSES FLOWAGE EASEMENTS OVER ALL LANDS WITHIN THE PROJECT BOUNDARY REQUIRED TO OPERATE THE FACILITY.
2. THE PARCEL SHOWN AT FEATHERSTONE ROAD CONTAINS THE DETACHED DIKE AND THE ACCESS POINT TO THE DETACHED DIKE FOR MONITORING, MAINTENANCE AND INSPECTION.
3. SEE EXHIBIT G-1 PROJECT BOUNDARY TABLE.

PROJECT LOCATION MAP



APPROXIMATE SCALE: 1 " = 75 MILES

LEGEND

- RECREATION PONT
- FERC COORDINATE REFERENCE POINT
- NGS BENCHMARK
- 14 PROJECT BOUNDARY POINT NUMBER
- PROJECT BOUNDARY
- PORTAGE TRAIL
- POLITICAL BOUNDARY
- TOWNSHIP SECTION
- SHORELINE/STREAM
- TRANSMISSION/DISTRIBUTION LINE
- RAILROAD LINE
- PRIMARY ROADS
- SECONDARY ROADS

PROJECT BOUNDARY TIE DATA

THE PROJECT BOUNDARY IS TIED TO ST. JOSEPTH COUNTY NATIONAL GEODETIC SURVEY BENCHMARK D344, 1992, PID AH8448: N: 134474.52 E: 12770194.99
TIE POINT 1: 5080.1' ±, N 11d48'49.16" E

REFERENCE COORDINATE METADATA

PROJECTION - MICHIGAN STATE PLANE
DATUM - NAD83, SOUTH ZONE
UNITS - U.S. SURVEY FEET

ELEVATIONS ARE REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1929, NGVD29.

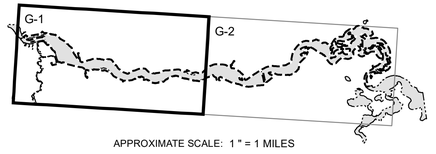
GEOREFERENCE SOURCE DATA

DIGITIZED DATA:
ARCGIS IMAGE SERVICE, MICHIGAN DEPARTMENT OF NATURAL RESOURCES (DNR)
URL: https://imagery.michigan.gov/server/services/Michigan_imagery_public/ImageServer
SHORELINE WITHIN PROJECT BOUNDARY BASED ON IMAGERY DATED SEPTEMBER 8, 2014
ADDITIONAL DATA:
MICHIGAN GIS OPEN DATA
https://gis-michigan.opendata.arcgis.com/
UNITED STATES GEOLOGICAL SURVEY (USGS) THE NATIONAL MAP
https://www.usgs.gov/core-science-systems/national-geospatial-program/national-map

BOUNDARY DATA: FERC EXHIBIT G1 AND G2, CONSTANTINE HYDROELECTRIC PROJECT AREA & BOUNDARY MAPS, 10661-10 AND 10661-11, MAY 2 2016

MAP KEY

ST. JOSEPH COUNTY



APPROXIMATE SCALE: 1 " = 1 MILES

SURVEYORS STATEMENT

I HEREBY CERTIFY TO THE FEDERAL ENERGY REGULATORY COMMISSION (FERC) THAT THIS PLAN MEETS THE CONDITIONS SET FORTH BY FERC FOR ITS EXPRESSED PURPOSE. THE PURPOSE OF THIS MAP IS TO PROVIDE A GEOREFERENCED VISUAL DEPICTION OF THE LOCATION OF PROJECT FEATURES AND BOUNDARIES BASED ON THE BEST AVAILABLE HISTORICAL DRAWINGS AND DIGITAL REFERENCE SOURCES INCORPORATED INTO THE GEOGRAPHIC INFORMATION SYSTEM (GIS). LOCATIONS HAVE NOT BEEN VERIFIED BY PHYSICAL FIELD SURVEYS AND THIS DRAWING SHOULD NOT BE USED FOR PURPOSES OF DEVELOPING PROPERTY BOUNDARY DESCRIPTIONS.

STATE OF MAINE
STEPHEN W. EVERETT 2161
PROFESSIONAL LAND SURVEYOR

EXHIBIT G-1 SHEET 1 OF 2

CONSTANTINE HYDROELECTRIC PROJECT
MICHIGAN
BOUNDARY MAP

400 200 0 400 800 1,200 1,600

INDIANA MICHIGAN POWER **FERC No. 10661**

DATE: JANUARY 2022	SCALE: 1 " = 400 '	APPROVED: PENDING

FERC NO. P-10661-XXXX

EXHIBIT G-1

5.52 DEG
MAG 2021

N

131

N: 144506.55
E: 12771500.61

WITHERS RD

FABIUS TWP.
CONSTANTINE TWP.

ST JOSEPH RIVER

PROJECT BOUNDARY
ELEV. 782.94 FEET
NGVD 1929

PROJECT BOUNDARY
ELEV. 782.94 FEET
NGVD 1929

PROJECT BOUNDARY
ELEV. 782.94 FEET
NGVD 1929

CONSTANTINE TWP.
FLORENCE TWP.

T 07S R 12W SN 12
T 07S R 11W SN 07

N: 141967.83
E: 12775489.93

T 07S R 12W SN 01
T 07S R 11W SN 06

T 07S R 12W SN 01
T 07S R 11W SN 06

T 06S R 12W SN 36
T 06S R 11W SN 31

T 06S R 12W SN 36
T 07S R 12W SN 01

T 06S R 11W SN 31
T 07S R 11W SN 06

FABIUS TWP.
LOCKPORT TWP.

COREY-STURGIS 69 kV TRANSMISSION LINE

LOCKPORT TWP.
FLORENCE TWP.

FAIRCHILD RD

CONSTANTINE RD

CONSTANTINE RD

T 06S R 12W SN 25
T 06S R 12W SN 36

OAKSHORE DR

FARMSTEAD LN

T 06S R 12W SN 25
T 06S R 11W SN 30

N: 152425.95
E: 12775626.80

SHOREWOOD DR

T 06S R 11W SN 30
T 06S R 11W SN 31

CONSTANTINE RD

17

18

PRAIRIE RIVER

NOTES

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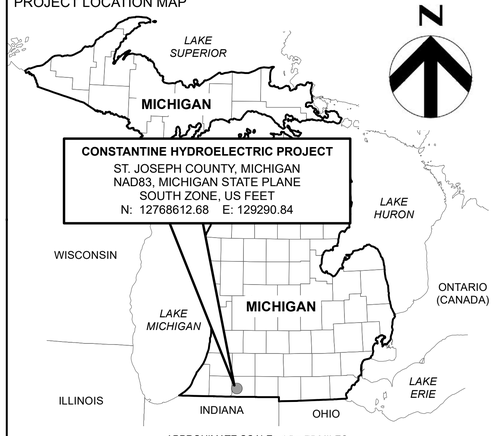
PROJECT LOCATION MAP



APPROXIMATE SCALE: 1 " = 75 MILES

LEGEND

- RECREATION PONT
- FERC COORDINATE REFERENCE POINT
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BENCHMARK D344, 1992, PID AH8448: N: 134474.52 E: 12770194.99
TIE POINT 1: 5080.1' ±, N 11d48'49.16" E

REFERENCE COORDINATE METADATA

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DATUM - NAD83, SOUTH ZONE
UNITS - U.S. SURVEY FEET

ELEVATIONS ARE REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1929, NGVD29.

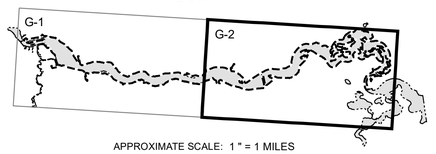
GEOREFERENCE SOURCE DATA

DIGITIZED DATA:
ARCGIS IMAGE SERVICE, MICHIGAN DEPARTMENT OF NATURAL RESOURCES (DNR)
URL: https://imagery.michigan.gov/server/services/Michigan_Imagery_public/ImageServer
SHORELINE WITHIN PROJECT BOUNDARY BASED ON IMAGERY DATED SEPTEMBER 8, 2014
ADDITIONAL DATA:
MICHIGAN GIS OPEN DATA
https://gis-michigan.opendata.arcgis.com/
UNITED STATES GEOLOGICAL SURVEY (USGS) THE NATIONAL MAP
https://www.usgs.gov/core-science-systems/national-geospatial-program/national-map

BOUNDARY DATA: FERC EXHIBIT G1 AND G2, CONSTANTINE HYDROELECTRIC PROJECT AREA & BOUNDARY MAPS, 10661-10 AND 10661-11, MAY 2 2016

MAP KEY

ST. JOSEPH COUNTY



APPROXIMATE SCALE: 1 " = 1 MILES

SURVEYORS STATEMENT

I HEREBY CERTIFY TO THE FEDERAL ENERGY REGULATORY COMMISSION (FERC) THAT THIS PLAN MEETS THE CONDITIONS SET FORTH BY FERC FOR ITS EXPRESSED PURPOSE. THE PURPOSE OF THIS MAP IS TO PROVIDE A GEOREFERENCED VISUAL DEPICTION OF THE LOCATION OF PROJECT FEATURES AND BOUNDARIES BASED ON THE BEST AVAILABLE HISTORICAL DRAWINGS AND DIGITAL REFERENCE SOURCES INCORPORATED INTO THE GEOGRAPHIC INFORMATION SYSTEM (GIS). LOCATIONS HAVE NOT BEEN VERIFIED BY PHYSICAL FIELD SURVEYS AND THIS DRAWING SHOULD NOT BE USED FOR PURPOSES OF DEVELOPING PROPERTY BOUNDARY DESCRIPTIONS.

STATE OF MAINE
STEPHEN W. EVERETT 2161
PROFESSIONAL LAND SURVEYOR

EXHIBIT G-2 SHEET 2 OF 2

CONSTANTINE HYDROELECTRIC PROJECT
MICHIGAN
BOUNDARY MAP

400 200 0 400 800 1,200 1,600

INDIANA MICHIGAN POWER **FERC No. 10661**

DATE: JANUARY 2022	SCALE: 1 " = 400 '	APPROVED: PENDING

FERC NO. P-10661-XXXX