

**REVIEW OF APPLICATION FOR
LIHI RECERTIFICATION
OF THE
HOLTWOOD HYDROELECTRIC PROJECT, LIHI #116**

**(FERC No. 1881)
Brookfield Renewable Energy Group
Susquehanna River, Holtwood, Pennsylvania**



**April 13, 2022
Thomas N. Russo, Certification Reviewer**

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**REVIEW OF APPLICATION FOR
RECERTIFICATION
BY THE LOW IMPACT HYDROPOWER INSTITUTE
OF THE HOLTWOOD PROJECT, LIHI #116**

1. INTRODUCTION

This report provides final review findings and recommendations related to the recertification application submitted to the Low Impact Hydropower Institute (LIHI) by BIF III Holtwood, LLC a subsidiary of Brookfield Renewable Energy Group (Brookfield) for the Hydroelectric Project (FERC No. 1881), LIHI #116. The Holtwood Project is a run-of-the-river project with an installed capacity of 252 megawatts (MW). The final recertification application was filed on December 10, 2021 and supplemented on January 19, 2022. The reviewer used the current 2nd Edition LIHI Handbook (Revision 2.04 which was in effect at the time of application submittal) to complete the review.

The Project was first certified by LIHI in 2014 for an 8-year term which expired on January 20, 2022. The term was extended to May 31, 2022. The original certification included two conditions discussed in Section 4.3.

RECERTIFICATION PROCESS AND MATERIAL CHANGE REVIEW

Under the 2nd Edition LIHI Handbook, reviews are a two-phase process starting with a limited review of a completed LIHI application, focused on three questions:

- (1) Is there any missing information from the application?
- (2) Has there been a material change in the operation of the certified facility since the previous certificate term?
- (3) Has there been a change in LIHI criteria since the Certificate was issued?

In accordance with the Recertification Standards, if the only issue is some missing information, a Stage II review may not be required. These standards also state that "material changes" mean non-compliance and/or new or renewed issues of concern that are relevant to LIHI's criteria. If the answer to either question (2) or (3) is "Yes", a more thorough review of the application using the LIHI criteria in effect at the time of the recertification application, and completion of a Stage II report is required. As a result, all projects currently applying for renewal must go through a full review unless their most recent certification was completed using the 2nd Edition Handbook.

A review of the initial application submitted December 10, 2021 resulted in a Stage I report dated January 13, 2022. The Stage I assessment found no adverse "material" changes, but other changes have occurred at the Project (see Section 3) and determined that only a small amount of additional information was needed to conduct the review. That information was provided by the Applicant on January 19, 2022. The application was posted for public comment on February 3, 2022 and the 60-day public comment period was scheduled to end on April 4, 2022 but was extended to April 11th at the request of agencies. This Stage II assessment included

review of the recertification application package, the FERC eLibrary, other publicly available information, and annual compliance statements submitted during the past term of Certification.

2. PROJECT LOCATION

The Holtwood Hydroelectric Project is located on the Lower Susquehanna River at approximately River Mile 25 (39.827N, 76.333W), in Lancaster and York Counties in south-central Pennsylvania (Figure 1). The Project passes inflows from a drainage area of approximately 26,794 square miles and is situated approximately seven miles north of the Pennsylvania/Maryland border.

It is one of five independently owned and operated hydroelectric projects on the lower Susquehanna River licensed by the FERC. Four of these projects are on the main stem of the river; the fifth project (Muddy Run) is a pumped storage hydropower project that uses the Conowingo Pond as its lower storage pond. The most upstream of these projects is the York Haven Hydroelectric Project (FERC No. 1888) at river mile (RM) 55 from the mouth of the river¹. Proceeding downstream from the York Haven Project are the Safe Harbor Hydroelectric Project (FERC No. 1025-PA) at RM 33 also owned by Brookfield, the Holtwood Project at RM 25, and the Conowingo Hydroelectric Project (FERC No. 405-MD) at RM 10. The Muddy Run Pumped Storage Project (FERC No. 2355-PA) is located between the Holtwood and Conowingo Projects and uses the Conowingo Pond as its lower reservoir. (Figure 2).



¹ LIHI #126, certificate currently suspended.

Figure 1. Susquehanna River Watershed with Project circled in red

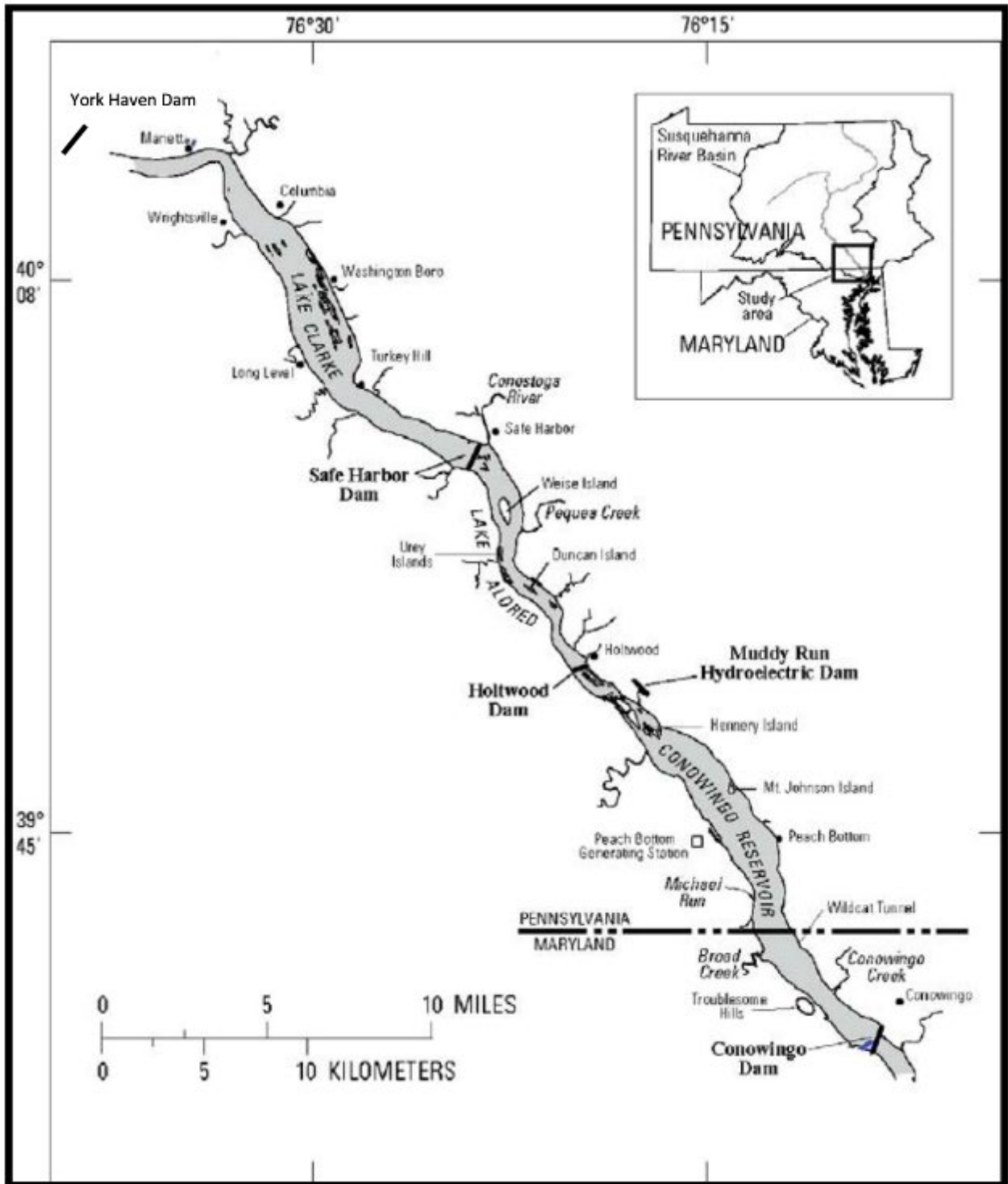


Figure 2. Susquehanna River with all five hydroelectric projects labeled

3. PROJECT DESCRIPTION

The Holtwood Hydroelectric Project and original powerhouse were constructed in 1905 and began commercial operation in 1910. A new powerhouse and generating units went into service in 2013. The purpose of the Project is to produce 252 MW of hydroelectric power and to provide regulated storage for users downstream. The original and new powerhouses contain approximately 120 MW and 133 MW turbine-generator units, respectively. Currently, the Holtwood Project consists of:

1. a concrete spillway,
2. two powerhouses (a legacy station and a new station)
3. a connecting bulkhead between the spillway and the original powerhouse, and a connecting bulkhead between the two powerhouses
4. a skimmer wall for the protection of the powerhouse forebay,
5. a diversion (or deflection) wall between the tailrace and the river channel downstream of the dam, and
6. a fish lift facility located along the diversion wall between the dam and the original powerhouse for upstream fish passage (Figure 3).



Figure 3. Holtwood Project major features

The existing Holtwood Dam is a run-of-the-river, overflow type structure. The spillway is a 2,368-foot (ft) long, 55ft high, concrete gravity dam with a crest elevation of 165.0 ft and a maximum spillway capacity of 1,000,000 cubic feet per second (cfs).

The crest of the spillway includes both Obermeyer gates and wooden flashboard sections. The wooden flashboards are supported by steel posts anchored into the crest of the dam. The Obermeyer gates and wooden flashboards effectively raise the dam crest height by 4.75 ft to an elevation of 169.75 ft, with the exception of the 40-ft Obermeyer section adjacent to the connecting bulkhead, which is 10 ft high (Figure 4). Closest to the right abutment is the first section, which consists of an Obermeyer gate that is approximately 35 ft long above a recreational “chute” which is used for whitewater boating (Figure 3).



Figure 4. Holtwood Dam and Obermeyer Gates

Downstream of the dam, a diversion wall connects the western side of the original powerhouse to a long, narrow river island known as Piney Island which effectively separates the tailrace from the remainder of the Susquehanna River. Along the western shore of Piney Island, another narrow channel is formed between Piney Island on the east and a series of smaller islands on the west; this channel is referred to as Piney Channel (Figure 5).

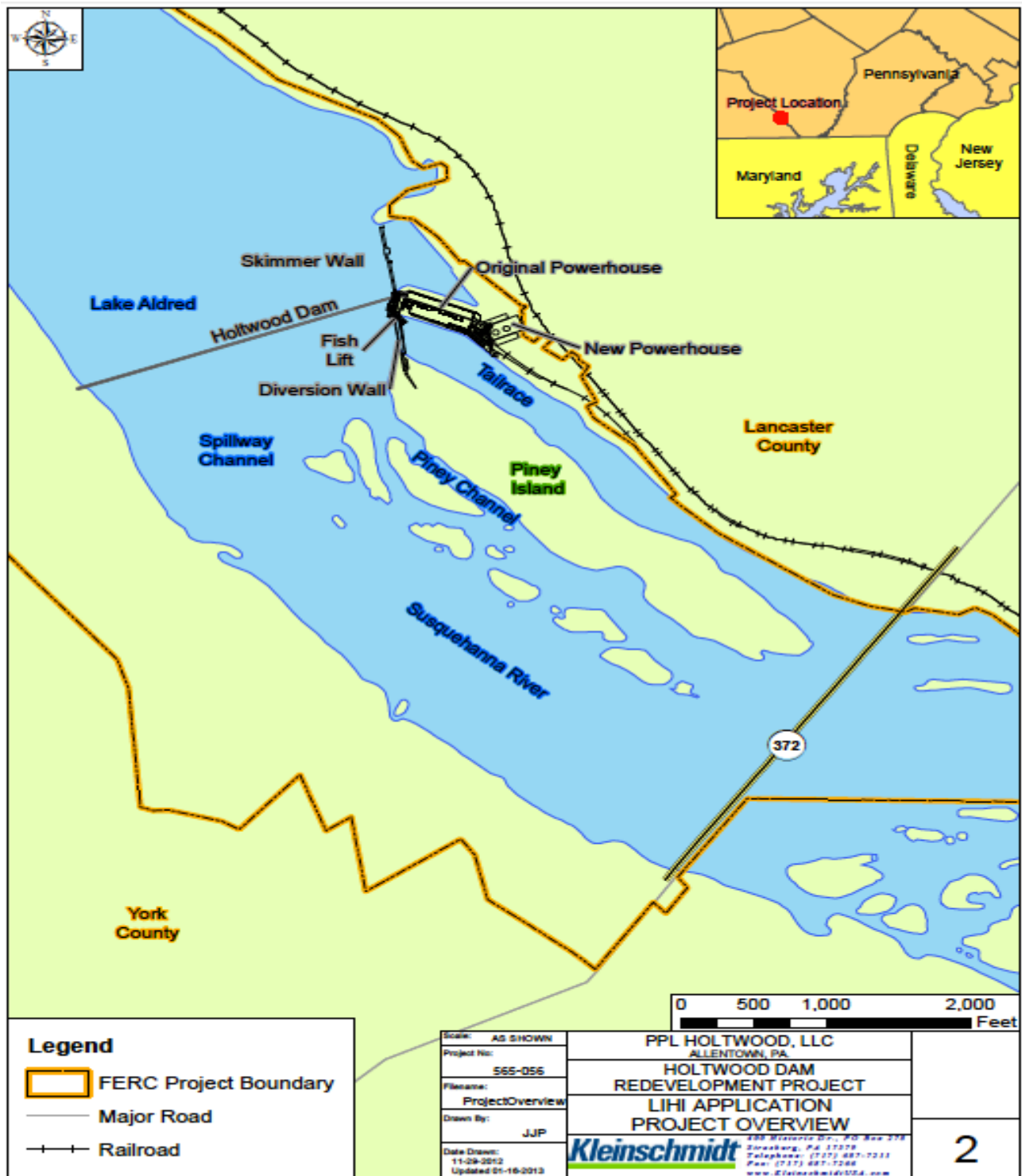


Figure 5. FERC project boundary and focal points upstream and downstream of the Holtwood Project

The Project's impoundment, Lake Aldred, extends about eight miles upstream, to the base of the Safe Harbor Hydroelectric Project. Lake Aldred's current maximum usable storage capacity is 15,224 ac-ft (acre-feet) between the top of the dam flashboards (elevation 169.75 ft) and elevation 163.5 ft, equivalent to 184,210 cfs-hours of stored water. The usable storage provides approximately six hours of operation for the generating units. Brookfield maintains a maximum normal operating head pond at elevation 169.75 feet. The minimum operating level of Lake Aldred varies from elevation 167.5 ft from May 15 through September 15 to support recreational use and access. Lake levels are maintained at elevation 163.5 ft to provide fire protection water to the powerhouses the remainder of the year. Lake storage above these minimums is used to permit Brookfield to operate the Project on a peaking basis by concentrating lake inflow into releases during the peak electrical demand hours of the day or week.

The overall Project has an installed capacity of 252 MW. The original powerhouse contains 10 similarly sized vertical Francis turbine-generator units (1-10) with a total capacity of 118 MW. Also included are two 1.2 MW vertical Francis units (11/13) (Figure 6). The total hydraulic capacity of the legacy station is 31,500 cfs. In the new powerhouse, there are two vertical Kaplan turbine generator units (18/19) rated at 66-67 MW each, with a hydraulic capacity of 30,000 cfs.



Figure 6. Holtwood Project Features with Powerhouses and Tailrace on right

The Project has trash racks installed at most of the intakes of the turbine-generator units with the following spacing between the bars: Units 1-7 – 3 15/16 inch, Units 8-10 – 6 inches, Units 11-13 – 2 inches and Units 18-19 – 7 inches. There are no penstocks or conveyance systems at the Project. The intakes of the new and legacy powerhouses feed directly into the units, and flow continues out the draft tubes to the tailrace.

The Project operation is coordinated with the other lower Susquehanna River projects. Each project uses its storage capabilities to generate power on a daily and weekly basis, although due to the limited storage ability of Lake Aldred, Holtwood generally operates in a run-of-river mode using flows from the upstream Safe Harbor Project and the approximately 680-square-mile drainage area between the Safe Harbor and Holtwood dams.

Changes since LIHI Certification in 2014

The following changes have taken effect at the Project since certification in 2014:

1. The Project was sold, and the license was transferred to BIF III Holtwood, LLC (a subsidiary of Brookfield Renewable Energy Group) in 2015.
2. The new whitewater boating facility on the York County side of the dam was completed.
3. As required, the fall resident fish passage facility began operating in 2014.
4. The valve actuators in the fish lift have been upgraded.
5. Three new boat barriers were installed for public safety including in the tailrace, Piney Channel and upstream of the dam.
6. New Oil Water Separator (OWS) systems were installed and have had a significantly positive impact on water quality at non-generating water discharge outfalls.
7. The Project's newly issued NPDES permit (July 1, 2021) now requires a different frequency in stormwater inspections.
8. Turbine-Generator Unit 4 was disassembled and rebuilt with water lubricated bushings and turbine bearing.

4. REGULATORY AND COMPLIANCE STATUS

4.1 Summary of Project Redevelopment and Agency Consultation Process

The Federal Energy Regulatory Commission (FERC) issued an original license for the Project in August of 1980 to Pennsylvania Power and Light Company (PPL)². The licensee redeveloped and expanded the installed capacity of the Project, and FERC granted a 16-year extension of the license term to August 31, 2030. The installed capacity of the Project has not increased since the last LIHI certification review in 2014; however, the Project was sold to Brookfield in 2016 since the last certification.

The final FERC order amending the Project license was issued on October 30, 2009³. The order authorized construction of a new powerhouse with two turbine-generating units totaling 133 MW of capacity. The order incorporates conditions from the PADEP Section 401 WQC, the Department of the Interior's Section 18 Fishway Prescription, and a Settlement Agreement

² https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20010128-1898&optimized=false

³ https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20091030-3039&optimized=false

regarding operation of the Project, minimum flows, upstream and downstream fish passage and whitewater boating. The current license FERC will expire on August 31, 2030.

4.2 Water Quality Certification

A 401 Water Quality Certification (WQC) was issued to the Holtwood Project on June 15, 2009⁴ and was integrated into the current FERC license.

Field studies indicated that the lowest dissolved oxygen (DO) levels generally occur in late August and early September, when water temperatures are highest, although generally, DO concentrations fell well within state water quality standards for the river.

Lake Aldred does not thermally stratify and exhibits only a small gradient in DO due to its shape and size relative to flows. However, when the Project is not spilling water, several pools become isolated and stagnant. These pools are then susceptible to algal processes that can reduce DO concentrations. This is particularly characteristic of the upstream portion of Piney Channel. The MSFOP is designed to provide a 200-cfs minimum conservation flow in order to protect water quality in the Piney Channel. In addition, a 10-inch pipe through the dam continuously delivers water to the spillway area to connect many of these pools, providing a constant source of fresh, oxygenated water.

4.3 Compliance Status

There have been some deviations from minimum flows and DO levels during certain parts of the year, discussed in Section 7 below. FERC concluded that the deviations would not be considered a violation of the license.

Brookfield and the fishery agencies are continuing to study the efficiency of the fish lift and make improvements to achieve upstream passage of 85% of the American shad that enter Project waters. FERC and USFWS (see below) believe that Brookfield is complying with its license.

The current LIHI certification includes the following conditions:

Condition 1: In its annual compliance statement to LIHI, PPL-Holtwood shall provide LIHI with a copy of the Fish Passage Technical Advisory Committee Report, developed in accordance with FERC License, Article 55, which describes the status of all fish passage and protection efforts over the prior year. PPL shall summarize the latest interactions with state and federal fish management agencies concerning this report and confirm via email that the agencies agree that these monitoring efforts show sufficient progress toward the goals specified in the PADEP Water Quality Certification, Section III, entitled Fish Passage. If established FOP goals are not being achieved, PPL shall propose solutions and implement those consistent with the PADEP Water Quality Certification. In 2018 at the completion of Tier 1 monitoring, LIHI shall evaluate overall progress on upstream fish passage and protection for compliance with the PADEP Water Quality certification and the FERC Operating License. LIHI certification may either be suspended or terminated if the state and federal fish management agencies do not agree that sufficient, long-term progress is being made in actual fish passage. This decision would be at the sole discretion of LIHI.

⁴ https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20090623-0100&optimized=false

Condition 2: PPL-Holtwood maintains Minimum Stream Flow (MSF) Operating Procedures and Requirements, in accordance with the PA DEP Water Quality Certification, Section IV. PPL Holtwood shall work to establish improved information sharing and understanding of on-going monitoring results for flows, water quality, and fish passage at their facility and others along the lower Susquehanna River, as requested and to the extent possible. Temporal resolution of data shall be sufficient to resolve sub daily fluctuations (e.g., hourly, or instantaneous) in each Holtwood dam release and upstream reservoir elevations. This reporting work will begin with development of a draft plan for an annual “Integrated Monitoring Report (IMR) for Flows and Fish Passage” that will focus on existing environmental monitoring activities. The purposes of this new, annual IMR will be to synthesize monitoring results for the previous year at Holtwood in a format compatible with results from other FERC licensed projects on the river, promote understanding among relevant stakeholders, and provide easy access to Holtwood’s monitoring data. The IMR may be implemented either in an annual meeting (virtual or in-person) or a paper report, or both. The IMR will include evaluation of progress made relative to flow and fish goals established for the river. If agencies believe this IMR would be redundant with other reporting requirements already in place under FERC licenses, then PPL-Holtwood may explain how the IMR purposes will be achieved by means other than a new IMR and may propose dropping this LIHI condition, as long as monitoring data is being fully shared and better understanding of fish passage issues is being promoted. A draft plan for the IMR will be circulated to LIHI and to the U.S. Fish & Wildlife Service, the PA Fish & Boat Commission, and the MD Department of Natural Resources within 60 days of LIHI certification for review and comment. The draft IMR plan will summarize current reporting requirements under the amended license and explain how monitoring data will be made electronically accessible to resource agency and LIHI staff, if so requested. Within 120 days of LIHI certification, the final plan for an annual IMR will be distributed to LIHI and the agencies, including response to comments received on the draft. The IMR will then be produced annually. Holtwood will report back to LIHI annually on the results of discussions and comments on the IMR in their annual compliance report for LIHI certification.

Condition Status: Both conditions remains active. Annual status reports and related documents have been submitted to LIHI, and Brookfield continues to consult with resource agencies on fish passage improvements and operations and flows. Section 7 below discusses the current status of monitoring efforts.

5. PUBLIC COMMENTS RECEIVED

LIHI made public notification and requested public comment on Brookfield’s application for LIHI certification on February 3, 2022. The comment period was extended to April 11, 2022 upon request of resource agencies. The USFWS filed a letter dated April 8, 2022 commenting on upstream fish passage issues and dissolve oxygen levels at the Project. Their comments are addressed in Section 7 and included in Appendix A.

6. ZONES OF EFFECTS

Brookfield presented three designated zones of effect for the Holtwood Hydroelectric Project:

Zone 1 is defined as the **Impoundment** covering 2,400 acres extending from the Holtwood Dam 8 miles upstream to the Safe Harbor Dam (Figure 7).



Figure 7 – Zone 1 – Impoundment

Zone 2 is defined as the **Bypass Reach** beginning at the dam and extending downstream 1 mile to the confluence with the tailrace. This includes the spillway and Piney Channel as shown in Figure 8).



Figure 8 – Zone 2 – Bypass Reach

Zone 3 is defined as the **Tailrace** beginning at the dam and extending downstream 1 mile to the Normanwood Bridge (Figure 9).

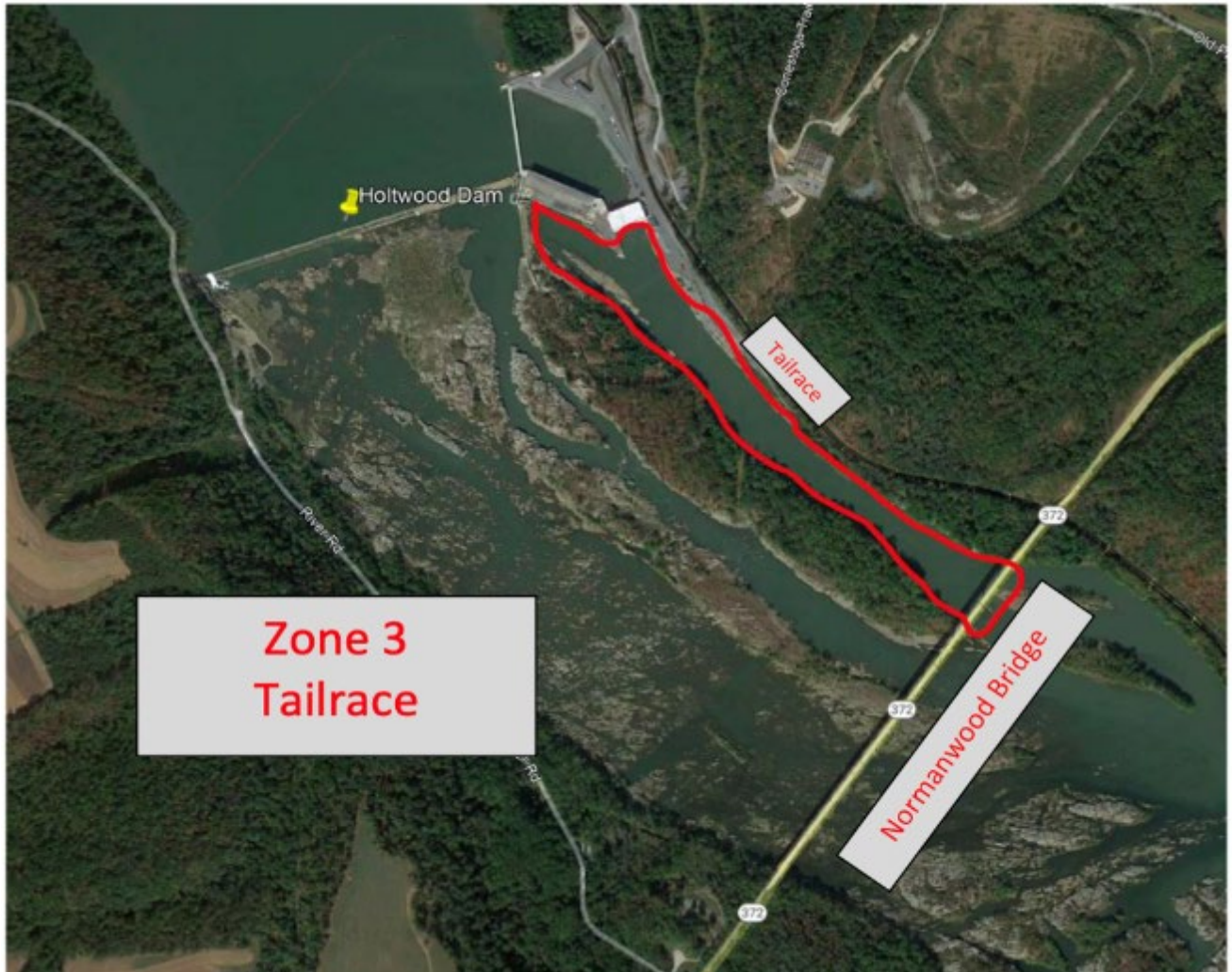


Figure 9 – Zone 3 – Tailrace

7. DETAILED CRITERIA REVIEW

Brookfield selected the standards for each of the criterion as shown in Table 1. This review agrees that the selected standards are appropriate based information in the application, Brookfield responses to comments and comments from the USFWS.

Table 1. Summary of Brookfield's Rating of the Holtwood Hydroelectric Project

Zone No. and Name	CRITERION AND STANDARD SELECTED							
	A	B	C	D	E	F	G	H
	Ecological Flows	Water Quality	Upstream Fish Passage	Downstream Fish Passage	Shoreline and Watershed Protection	Threatened and Endangered Species	Cultural and Historic Resources	Recreational Resources
1- Impoundment (RM 33-25)	2	3	1	2	2, Plus	2	2	2
2- Bypass (RM 25-24)	2	3	2	2	2, Plus	2	2	2
4- Tailrace (RM 25-24)	2	3	2	1	2, Plus	2	2	2

A: Ecological Flow Regimes

Goal: The flow regimes in riverine reaches that are affected by the facility support habitat and other conditions suitable for healthy fish and wildlife resources.

Assessment of Criterion: Brookfield selected Standard A-2 for all ZoEs.

Discussion:

Past Flows

The former licensee provided minimum flows as part of an agreement with Exelon, owner and operator of the downstream Conowingo Project, and Federal and State agencies for environmental enhancement.

Prior to the October 30, 2009 license amendment, Holtwood had no minimum flow requirement. This was due in part to the fact that the tailrace of the Project is backwatered by the downstream Conowingo reservoir and that inflows are almost completely governed by the upstream Safe Harbor flow releases. During the amendment process, the former licensee worked with agencies to identify potential impacts that the proposed redevelopment could have on downstream flows, as well as the effects that the new flow regime would have on environmental resources. The licensee conducted environmental studies downstream of the Holtwood dam to determine what, if any, environmental effects would result from a modified flow regime in the spillway.

Specifically, the licensee identified state listed endangered plants in the spillway including Sticky Goldenrod and White Doll's Daisy. The licensee and the resource agencies determined that the daisy would have the greatest potential to be impacted by a change in flow regime. However, due to the dynamic nature of flows in this area, the extent of impact, if any, was difficult to predict. The White Doll's Daisy thrives in the spillway because of occasional flushing flows in combination with periods of low flow. To maintain healthy populations for both species, the licensee and the agencies developed a plan to release periodic flushing flows into the spillway to protect habitat for the daisy. The licensee also agreed to a long-term monitoring plan developed in conjunction with the PA Department of Conservation and Natural Resources (PADCNR) to assess the health of the daisy population and make adjustments to the flow regime as required.

The licensee also conducted a detailed minimum flow study in Piney Channel to determine optimum flows for fishery habitat, water quality, and other purposes. This study showed that a continuous 200 cfs minimum flow⁵ to Piney Channel provides a significant amount of the suitable habitat potentially available for a number of resident fish species and life stages. The continuous 200-cfs minimum flow could also prevent isolated pools from forming in Piney Channel during the summer months such that depleted DO concentrations can be prevented.

Exelon's downstream Conowingo Project (FERC No. 405) has minimum flow requirements in their FERC license issued in 2021⁶ to maintain adequate flows in the river downstream of Conowingo to the Chesapeake Bay. The Holtwood licensee had previously entered into a settlement agreement with Exelon⁷ as part of the Holtwood redevelopment to provide a continuous base flow⁸ of 800 cfs and a daily volumetric flow equivalent to 98.7% of the minimum flow requirements of the Conowingo Project.

All of these minimum flow changes were supported by resource agencies, as evidenced by letters submitted in response to the final 2009 license amendment application and by the Minimum Stream Flow Operating Plan (MSFOP) developed in conjunction with resource agencies and modified and approved by FERC⁹.

Recent Flows

Streamflows at Holtwood vary throughout the year. The flows from the Project at the USGS Marietta, PA Gage (USGS No. 01576000) ranged between 3,000 cubic feet per second (cfs) to almost 400,000 cfs in the last four years (Figure 10).

⁵ Minimum flow cannot be supplied using any flow through the powerhouse.

⁶ https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20210319-3034&optimized=false

⁷ https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20090803-5123&optimized=false

⁸ Base flow can be supplied from all downstream releases, including powerhouse flows.

⁹ https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20120419-3049&optimized=false

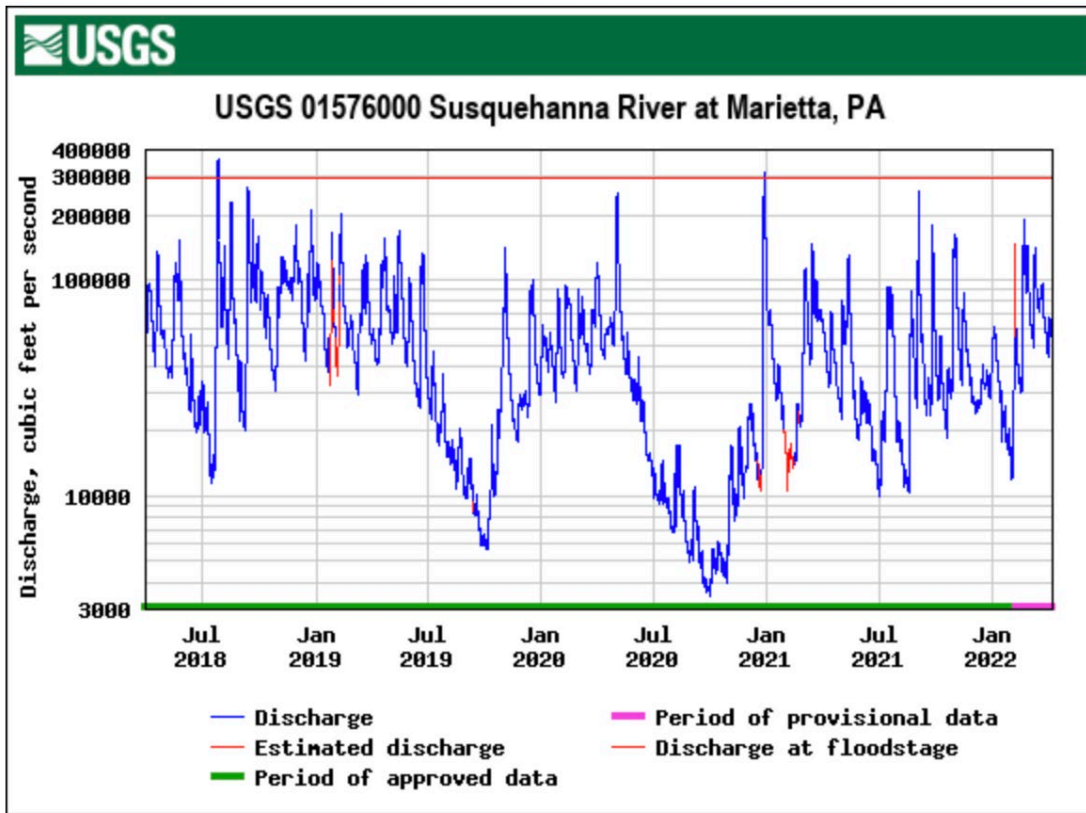


Figure 10. Mean daily river flow as recorded by the USGS Marietta Gage during the Dissolved Oxygen monitoring period from March 31, 2018 to April 4, 2022 at the Holtwood Hydroelectric Project.

The minimum flow regime at the Holtwood Project is complex. Brookfield is required to implement a daily volumetric flow release equal to either (a) 98.7 percent of the daily minimum flow requirement at Conowingo or (b) daily net inflow to Lake Aldred, whichever is less.

In 2007, the former licensee, PPL Holtwood, LLC (PPL) conducted a Minimum Flow Analysis to demonstrate a scientific/technical basis for the flow regime using several flow and fishery habitat models. The licensee then prepared a Minimum Stream Flow Operations Procedures Manual (MSFOP) pursuant to Article 51 of the FERC license and Condition IV.A of the Water Quality Certificate. The plan sets forth how Holtwood will achieve and monitor minimum stream flows in the spillway, the Piney Channel and the tailrace. The minimum flow releases from the Holtwood Project are also authorized and required by the Susquehanna River Basin Commission (SRBC) as part of a settlement agreement with Exelon Generation, LLC, licensee for the downstream Conowingo Project (Table 2).

Table 2. Holtwood Project Minimum Flow Release Plan

<ol style="list-style-type: none">1. Implementation of the QFERC daily volumetric flow release (including leakage) equal to the lesser of net inflow or 98.7 percent of the Conowingo project's minimum flow obligation.2. A continuous minimum flow from the Project of 800 cfs or net inflow, if less.3. A continuous 200 cfs continuous conservation release to Piney Channel.4. Continuation of a continuous minimum stream flow to the spillway area below the dam at least equivalent to the present rate of leakage through the dam flashboards plus the present rate of flow through the 10-inch pipe in the dam.5. The initiation of a periodic wetting flow to the spillway area during June through September whenever river flow exceeds 31,000 cfs and is less than 61,500 cfs. This is to mimic a natural spill frequency and help provide sufficient root wetting for plant species of concern. <p>As required, any deviations are reported to agencies, along with an annual compliance report and annual meeting.</p>
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Source: Brookfield Application for LIHI Recertification

FERC issued a new license for the Conowingo Project on March 19, 2021. The new license and settlement agreement between the Maryland Department of the Environment (MDE) and Exelon will require minimum flow modifications at Conowingo. Minimum stream flows at the Holtwood Project will now also be adjusted to enhance fishery and wildlife resources in Zone 2 and Zone 3. Federal and state agencies are currently reviewing the MSFOP and plan and revisions to Holtwood's flow releases will be made to reflect the changes at the Conowingo Project. The changes taking place at the Holtwood Project include increasing the minimum flow from 1,750 cfs to 3,500 from December 1 to February 28. Because of that change, the continuous 800-cfs flow will be increased to 1,600 cfs during the same time period. Additional modifications will take place starting in March of 2024.

To date, Brookfield's compliance with the minimum flow requirements has been satisfactory. However, there were two short-term deviations in the minimum flow release requirements in the Piney Channel in 2017 and 2020, and an impoundment level deviation in 2017. The deviations in minimum flows were caused by unit or station trips and lasted between 14 and 30 minutes only and were reported promptly to FERC and other federal and state agencies. Brookfield quickly took action to bring flow releases up to their minimum requirements and released additional flows in 2017 to make up for the earlier losses. The impoundment level deviation was caused by flashboard failure requiring a two-day drawdown for repairs, considered an emergency situation and allowed under the FERC license. Brookfield reported that the deviations were minor and did not affect water quality, recreational or fish and wildlife resources. By letters dated January 17, 2018, April 30, 2018 and October 29, 2020, FERC concluded that none of the deviations would be considered a violation of the license.

Based on the application, supporting documentation and other documents, this review finds that the Project continues to satisfy the Ecological Flow Regimes criterion.

B: Water Quality

Goal: Water Quality is protected in waterbodies directly affected by the facility, including downstream reaches, bypassed reaches, and impoundments above dams and diversions.

Assessment of Criterion: Brookfield selected Standard B-3 in all ZoEs.

Discussion: Articles 47A and 53 of the FERC license amendment and the Water Quality Certificate issued by the Pennsylvania Department of Environmental Protection (PADEP) requires Brookfield to operate the Project so that it does not cause a violation of state water quality standards. The current water quality standards for dissolved oxygen (DO) are a minimum daily average DO concentration of 5 mg/l and a minimum of 4.0 mg/l. FERC and PADEP also required Brookfield to monitor DO levels at the Holtwood forebay, tailrace, and Piney Channel and submit annual reports for agency review.

LIHI also required Brookfield to comply with Condition 2 of the original LIHI Certification in 2014. Condition 2 requires Brookfield to maintain Minimum Stream Flow Operating Procedures and Requirements, in accordance with the PADEP WQC, Section IV. Brookfield is also required to establish improved information sharing and understanding of on-going monitoring results for flows, water quality, and fish passage at their facility and others along the lower Susquehanna River, as requested and to the extent possible.

Per the approved DO Monitoring Plan, the monitoring was to be conducted for five years after completion of the new powerhouse from April 1 to September 30 each year. Monitoring was extended for two additional years at the request of PADEP, with the final monitoring conducted in 2021. Brookfield measured stream flows, water temperatures and DO levels from the Project's sampling points. During the season, the adjusted DO values at the Project met the Pennsylvania Water Quality Standards for the 7-day average (7-day average of 5.5 mg/L) at the Piney Channel, Forebay and Tailrace locations throughout each monitoring season. There were various low adjusted instantaneous readings below the state standard (minimum 5.0 mg/L instantaneous) in the Forebay, Piney Channel and Tailrace. The low adjusted DO readings occurred periodically from mid- June to mid-August during low river flows. These low DO values only fell below the state water quality standard in 0.53%, 0.15% and 0.52% of the samples collected at the forebay, Piney Branch and tailrace locations, respectively. From 2017 to 2021, DO monitoring also showed specific instantaneous readings during the sampling period that were below the 5.0 mg/l state standard.

Dissolved oxygen levels are affected during periods of low flow. Daily river flows in 2021 at the USGS Marietta, PA Gage (USGS No. 01576000) ranged from a low of 9,980 cfs on July 1, 2021 to a high of 258,000 cfs on September 2, 2021 (Figure 11). River flows were near or below the mean daily values during the first month of the monitoring period, then they fluctuated both above and below the daily mean values for the next two months. The last three months of the monitoring period the river flows were above the mean daily values.

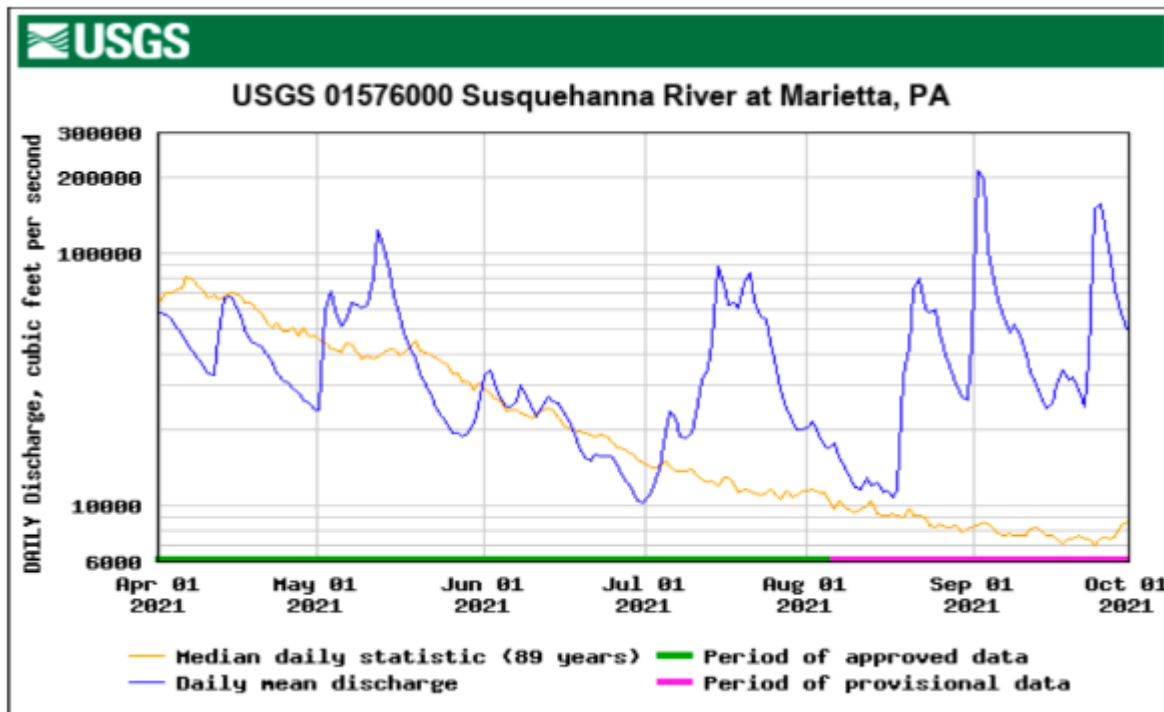


Figure 11. Mean daily river flow as recorded by the USGS Marietta Gage during the Dissolved Oxygen monitoring period from April 1 through September 30, 2021 at the Holtwood Hydroelectric Project.

On March 17, 2022, Brookfield requested that FERC suspend the monitoring requirement with concurrence of PADEP which indicated that the Project meets state dissolved oxygen criteria required under the WQC¹⁰. FERC has not yet responded to the request. Brookfield consistently filed required deviation reports with FERC and the PADEP, indicating that all deviations were due to thermal stratification in the forebay and/or biofouling of the DO measuring equipment. Brookfield also believes that the aeration capabilities at their Safe Harbor Hydroelectric Project, located 8 river miles upstream of the Holtwood Project, likely mitigate for any naturally-occurring low DO concentrations in the stretch of the Susquehanna River between Safe Harbor and the Holtwood Forebay. In all the reported cases, FERC concluded that the deviations would not be considered a violation of the license.

The USFWS in its LIHI comment letter acknowledges that the annual reports suggest that low DO levels during the warmer months are a result of natural processes in the forebay. However, the USFWS contends that the low DO levels are a Project effect since the impoundment created by the Project increases water temperatures in summer months, and the higher temperatures and the impounded river condition are likely resulting in low DO conditions in the Project forebay, which are then transferred to the Project tailrace. The agency believes that Brookfield should give future consideration to improving DO levels at the Project to be safe for fish that may be in the forebay and tailwaters in the summer months. This reviewer believes that Brookfield should look into this, but only after the new minimum streamflow and Project operations are coordinated with the new requirements at the Conowingo Project and settlement

¹⁰ https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20220317-5088&optimized=false

agreement. If low DO levels persist during summer months, then Brookfield can look into measures if needed to maintain DO levels at the state standard.

Based on the application, supporting documentation and other documents, this review finds that other than the minor deviations in some instantaneous DO readings and with PADEP concurrence that the Project satisfies the WQC conditions, the Project continues to satisfy the Water Quality criterion.

C: Upstream Fish Passage

Goal: The facility allows for the safe, timely, and effective upstream passage of migratory fish. This criterion is intended to ensure that migratory species can successfully complete their life cycles and maintain healthy populations in areas affected by the facility.

Assessment of Criterion: Brookfield selected Standard C-1 for ZoE 1 and Standard C-2 for ZoE 2 and ZoE 3.

Discussion: Brookfield selected standard C-1 for ZoE 1 since once the fish pass upstream of the dam into the impoundment, they are not restricted in any way by Project operations and there is no facility-related barrier to restrict further upstream movement. Brookfield selected standard C-2 for ZoEs 2 and 3.

In connection with Article 47 of its FERC License, the Prescription for Fishways, and Conditions III.A.1 and III.B.1 of the WQC, Brookfield is required to operate a fishway for the passage of American Shad. The annual migratory fish passage season begins when the Conowingo Project starts to pass American Shad and ends when agencies determine the season is complete. The season runs nominally from April 15 – June 15 each year but dates can change each year. Brookfield is also required to operate fall season fish passage from September 1 to October 15 annually. Besides American Shad, an additional 20 species of fish use the Holtwood Fish Lifts to gain access to upstream habitat (Table 3).

Table 3. List of all migratory fish that passed through the Holtwood fish lifts in spring of 2019 (Source: 2020 Annual Fish Passage Report).

- | | |
|-----------------------|---------------------------|
| 1. American Shad | 11. White Perch |
| 2. Gizzard Shad | 12. Striped Bass |
| 3. Rainbow Trout | 13. Rock Bass |
| 4. Muskellunge | 14. Pumpkinseed |
| 5. Carp | 15. Bluegill |
| Brown Bullhead | 16. Smallmouth Bass |
| 6. Northern Hogsucker | 17. Largemouth Bass |
| 7. Quillback | 18. Yellow Perch |
| 8. Shorthead Redhorse | 19. Walleye |
| 9. Channel Catfish | 20. Striped Bass (Hybrid) |
| 10. Flathead Catfish | 21. Brook Trout |

Fish Passage Facilities

The fish passage facilities at Holtwood include a tailrace lift with two entrances and a spillway lift for upstream passage, and a pipe built at the west side of the powerhouse for downstream fish passage and debris sluicing. The two upstream lifts have their own fish handling systems that sluice fish into a common flume through which fish swim into Lake Aldred. The lifts or "hoppers" raise the water (and fish) entering the facility about 50 feet to the level of the forebay. Fish swim through the flume and enter the lake outside the plant skimmer wall.

The former licensee developed a Fishway Operating Plan (FOP) in consultation with resource agencies. The plan provides guidance for annual startup, shut-down, measures to be followed in case of emergency or Project outages, routine maintenance, and debris management. In addition, it presents measures pertaining to dam and powerhouse operation that the licensee will undertake during fish passage season including the use, monitoring and reporting of flows. It also includes fish passage reporting requirements which are required in the final WQC.

Under the amended license and WQC approved on October 30, 2009, the licensee is required to successfully pass 75% of the American Shad upstream that pass through the Conowingo facility, and that 50% of the shad that pass through the Conowingo facility pass through Holtwood within 5 days of passage at Conowingo. Should Holtwood not meet these targets, the licensee agrees to first make operational modifications to enhance fish passage; and, if passage is still below targets, to make physical modifications to enhance fish passage. A detailed plan to measure and evaluate performance and conduct follow-up studies as needed was developed as part of the license amendment process.

The Fish Lift in the tailrace has two entrances at Gates A and B and the spillway lift has one entrance Gate C (Figure 12). Each lift has its own fish handling system which includes a mechanically operated crowder, picket screen(s), hopper and hopper trough gate. Attraction water, in, through, and from the lifts is supplied through a water piping system and five diffusers that are gravity fed. There is a total of 800-cfs attraction flow. Fish swim upstream through a counting facility and into Lake Aldred through a pre-existing 14-ft-wide debris chute.

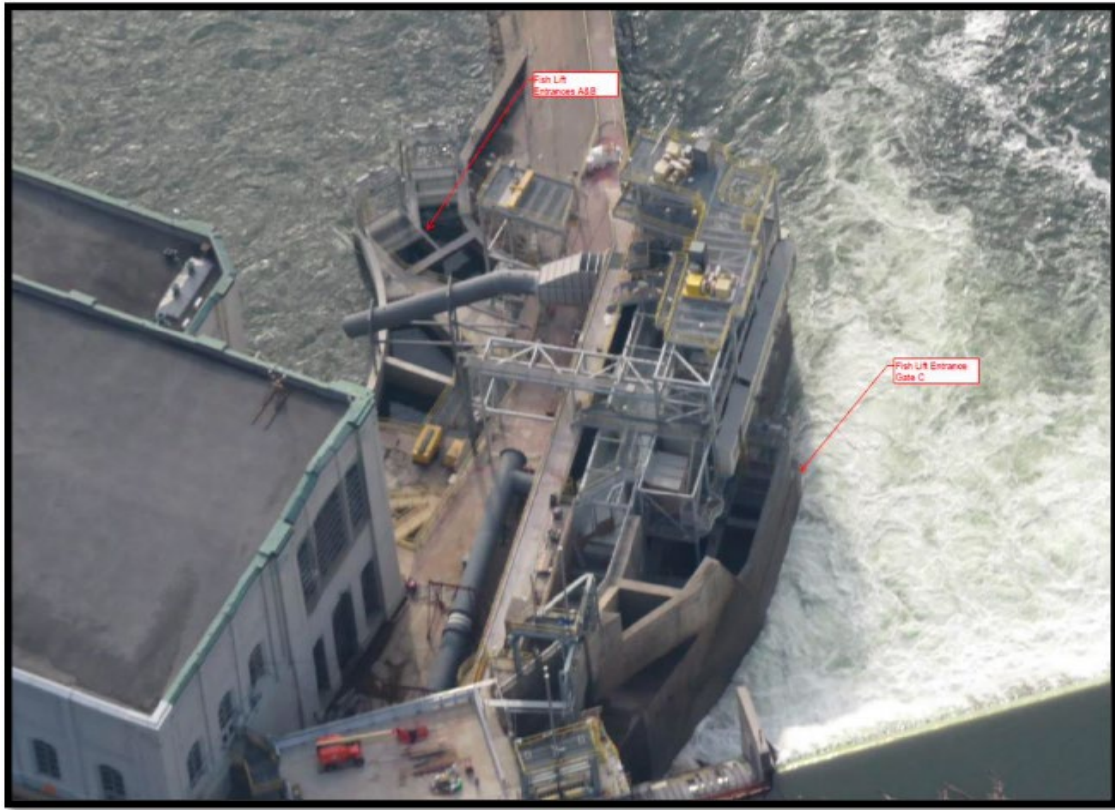


Figure 12. *Fish Lift Facility*

Fish Passage Efficiency Study Results

Brookfield is required to achieve 85% upstream passage efficiency for American Shad that enter the Project's waters. Achieving that goal depends on the efficient operation and improvements to the fish passage facility based on completion of the Tier II radio telemetry studies and completion of the zone of passage work in the Project's tailrace. As discussed below, Brookfield is not meeting this goal due to a number of factors beyond its control but remains committed to completing studies and achieving the 85% passage goal and the Project is fully complying with the requirement of its FERC license.

The factors affecting the Project's ability to pass 85% of the American Shad entering Project waters includes issues with the fish lifts, fishery agency decisions to prevent the invasive Northern Snakehead from spreading into Lake Aldred, and completing debris removal from the Project tailrace. The main problem lies with the fish lifts which Brookfield and the fishery agencies have been studying and trying to correct for several years.

After three years of Tier I fish tagging studies in 2015, 2016 and 2017, PADEP notified Brookfield on October 11, 2017 that Tier I conditions had not been met (75% passage of shad that passed Conowingo's East Fish Lift, and that 50% pass within 5 days), and therefore Tier II telemetry studies would be required. Tier II studies conducted in 2018 and 2019 showed the efficiency of the Project's fish lift was very poor with only 12.4% and 10.4% of the shad that were radio tagged in 2018 and 2019 respectively, successfully passed upstream. In the 2019 test year, 63 or 47% of the 133 tagged fish entered the fish lift but only 14 fish passed successfully to Lake Aldred. Of the 14 fish that passed the lift, 13 passed using the spillway lift.

Brookfield, Normandeau Associates, and fishery agencies in their annual meetings have continued to focus on telemetry noise reduction, flow reduction, and the use of crowders to successfully move fish out of the fish lifts. However, there appears to have been a shift of thinking among all participants because a high percentage of fish are getting to the entrance gate of the fish lift. The participants are discussing the effectiveness of V-shaped crowders and/or operating the lifts without crowders. Fishery agencies also suggested looking into oxygen injection as a way to attract fish or using a bubble curtain to crowd/scare fish upstream instead of a crowder gate. A sonar gate was also suggested as an option to view tagged fish at the crowder to see their behavior.

In its April 8, 2022 comment letter on the LIHI application USFWS noted the low fish passage efficiency of the lifts. Although operation of the fish passage facility and Tier II studies were temporarily suspended in 2020 due to Covid 19, and in 2021 and 2022 at the request of the resource agencies due to invasive fish presence, USFWS encourages Brookfield to continue to make improvements to the fish lifts based on the issues identified in the first two years of the Tier II telemetry study. Continued improvements to the facilities will ensure that once fish passage operations are re-initiated and studies can be resumed, the Project will have a higher likelihood of achieving the 85% upstream passage efficiency.

CFD Modeling in Fish Lifts

Computational Fluid Dynamics Models (CFD) attempt to simulate the interaction of liquids and gases where the surfaces are defined by boundary conditions. They also track the flow of solids through a system and are related to attracting fish to the lift entrances and through the facility upstream.

In 2020, Gomez & Sullivan performed a field test to determine if the current automatic settings for the flow distribution valve matrix produced the recommended flow velocities within the fish lifts. Eddying and upwelling was observed. In 2021, they evaluated alternative flow distributions and CFD models were developed for each lift and used to model hydraulics for different tailwater conditions. The draft report was received on December 6, 2021 so only a high-level update was provided at the annual agency meeting. The highlights are:

- Current automatic settings are intended to result in a drop through the entrance gates of 1 ft, which appears to result in overly turbulent flow at the entrances,
- Current automatic settings do not produce the proper flow through the lift,
- Analyses indicate that flow conditions at the entrances would be improved by reducing the drop at the entrances to 0.5 feet, which will result in less turbulence where the attraction flow enters the downstream channel,
- The CFD models and observations during the site visit indicate that increasing the proportion of flow introduced upstream of the hoppers would improve overall flow conditions,
- Tailrace crowder velocity will need to be ~3ft/s to eliminate eddies at the A/B entrance, and
- It was found that there is significant upwelling which occurs in the spillway crowder during automatic matrix operations with the old and new settings.

In 2022 Brookfield plans to investigate the cause of the spillway attraction flow upwelling in the crowder area, permanently update the valve operating matrix, evaluate lift frequency due to

higher flows within the tailrace lift, and evaluate operating either A or B entrance gate independently. Once the operating matrix is updated to align with the new settings, the Fishways Operating Plan will be updated. Brookfield considers these changes to be operational changes. Per the approved study plan, if operational modifications are implemented, only the results from those years following the operational modifications shall be considered to determine whether the 85% passage percentage is achieved.

As required by the current LIHI Certificate Condition 1, article 55 of the FERC license and the WQC, Brookfield regularly communicates with the Fish Passage Technical Advisory Committee (FPTAC), comprised of resource agencies, and meets with them annually to discuss all ongoing studies and operations of the lifts.

Delays Associated with Invasive Fish

Brookfield was prepared to conduct year 3 of the Tier II telemetry study in 2021. However, state and federal agencies have increasing concerns about passing invasive fish species like the Northern Snakehead upstream into Lake Aldred. Due to the poor fish passage efficiency observed in 2018 and 2019, USFWS, PFBC and PADEP informally requested a study involving the placement of a small sample size of tagged and trucked fish into the Holtwood fish lifts, with the entrance and exit screened to contain the fish. The lift would be operated to see their behavior inside of it and they would then need to be captured and not allowed to pass. Brookfield expressed concerns with this type of study including the logistics, safety, and the validity of the data. Brookfield voluntarily conducted a historical research study, flow study, and CFD modeling.

Based on a call with agencies on October 20, 2020, Brookfield requested suspension of the 2021 spring and fall fish passage as well as the Tier II radio telemetry study due to concerns with the spread of invasive species. PADEP and USFWS sent letters of support in December 2020 and Brookfield filed a request with FERC on January 5, 2021 for the suspension of fish passage and Tier II study in 2021, which was approved on February 26, 2021 by FERC. FERC noted that if Brookfield or resource agencies determined that permanent modifications are needed to reduce the spread of invasive species, a request for amendment will be required to be submitted to the FERC prior to the 2022 spring fish passage season.

Also in 2020, PADEP recommended that Brookfield evaluate the ability and/or mechanisms to manage invasive species in preparation for the 2022 fish passage season. Brookfield conducted a site visit to the Conowingo fish lifts in May of 2021 to see how they operate, and how they are sorting invasive fish species. The sorting process was found to be a manual and labor intensive task detracting attention from anadromous fish. Holtwood and Safe Harbor lifts are not designed the same as Conowingo and have no safe or viable method for fish removal/sorting. The lifts are designed to volitionally pass fish, not exclude them. USFWS noted that Conowingo is more conducive to invasive removals and that Holtwood currently has no requirement in place for invasive species. It is a continually discussed topic with no resolution yet and operations are reviewed annually.

Another request was filed with FERC on March 28, 2022 to suspend fish passage and the Tier II study for the 2022 season based on resource agency requests. FERC has not yet responded to that request.

Zone of Passage Issues in New Powerhouse Tailrace

When the new powerhouse was constructed, the former licensee was required to remove excess materials left in the tailrace. The excess materials affect upstream migration of American Shad and other migratory fish. In its LIHI comment letter, USFWS indicated that Brookfield has not completed this requirement since the results of the telemetry study could inform it of what work remains to be done in the tailrace. Nevertheless, removing excess material in the tailrace will be done in the future.

Conclusion on Upstream Fish Passage

The Project is in compliance with Standard C-2 in that Brookfield is implementing agency recommendations. However, the telemetry data collected in 2018 and 2019 show that the goal of providing 85% passage for American Shad has not yet been achieved due to a number of issues out of Brookfield's control. However, the major challenge to satisfying the fishery goals lies chiefly in addressing the fish lifts themselves. This review recommends that Brookfield prioritize making improvements to increase the efficiency of the fish lifts to attract and pass shad upstream, while investigating in parallel, ways to sort and remove invasive fish species from the fish lift and removing excess debris from the tailrace.

The reviewer recommends a condition to require Brookfield to focus its efforts on improving the fish lifts' efficiency, completion of the telemetry study, sorting out invasive species and removing excess materials from the tailrace. Based on the application, agency comments, supporting documentation and other documents, this review finds that the Project with the aforementioned conditions would continue to satisfy the Upstream Fish Passage criterion.

D: Downstream Fish Passage

Goal: The facility allows for the safe, timely, and effective downstream passage of migratory fish. For riverine (resident) fish, the facility minimizes loss of fish from reservoirs and upstream river reaches affected by Facility operations. Migratory species can successfully complete their life cycles and maintain healthy populations in the areas affected by the Facility.

Assessment of Criterion: Brookfield selected Standard D-2 for ZoE 1 and ZoE 2, and Standard D-1 for ZoE 3. Zone 3 is using Standard 1 to justify meeting the downstream fish passage standard since once the fish pass downstream of the dam into the tailrace, they are not restricted in any way. There is no facility-related barrier to restrict further downstream movement. Zones 1 and 2 are using Standard 2 to justify meeting the downstream fish passage standard as discussed below.

Discussion: The Project does not have a dedicated downstream fish passage facility. Rather, the turbines and/or spillway are used to pass fish. The upstream fish lift bypass intended to pass juvenile and post-spawned shad downstream was shown to not be effective based on studies conducted in 1998, although turbine survival was shown to be between 83% and 90%. As a result, USFWS issued mandatory prescriptions to require a turbine survival study, incorporated into the 2009 license amendment article 47, as well as the WQC. The licensee must also meet a target of 95% survival of juvenile shad and 80% survival of adult shad. As is the case with

upstream passage, should the Project not meet the target survival, there would be operational and potentially physical modifications made to meet the target.

A proposed turbine survival study plan was submitted to USFWS and PADEP for review and approval on June 28, 2018. The study proposed using the HI-Z Tag recapture technique, which involves a release of tagged fish into a turbine with a concurrent release of similarly tagged fish in the tailrace as controls and their subsequent immediate recapture. Due to complications, low fish populations, and small sized fish available, agencies tabled this topic and is still under review with agencies pending upstream passage issues.

The WQC also required that fish passage enhancements include excavation within the Project boundary to significantly minimize velocity barriers to migrating fish. The prior licensee conducted studies and excavation in 2014 and removed loose debris. The objective of the studies was to vary the point source of the discharge to determine downstream velocity sensitivities with varying unit operation settings that could potentially meet the “Zone of Passage (ZoP)” requirements identified in the license amendment proceeding.

In October 2015, a new tailwater curve was developed for the new tailrace based on additional velocity studies conducted in April 2015. The study results were used to validate the tailrace model and obtain results for flow simulations. The baseline model, run at high flows, identified three potential pinch points in the tailrace along Piney Island and a high velocity area in the fish passage channel that was associated with tailrace excavation.

When Brookfield purchased the Project in 2016, an update to the tailrace modeling was provided. Preliminary results of the study were then shared with agencies. The study (Alden Report) was sent to agencies in 2018. In the 2018 fish passage meetings, agencies agreed to keep ZoP requirements on the annual agenda as a placeholder but focus on the upstream Tier II telemetry studies to see if conditions in the lift itself could be improved first. The telemetry showed that a high percentage of fish were making it to the lift but not entering the lift. Brookfield subsequently commissioned a study to determine why the entrances were not attractive to the fish.

American eel do not currently have access to Project waters due to a lack of upstream passage at the Conowingo Hydroelectric Project located downstream, but the USFWS anticipates that eels will have access to the Project tailwater when passage facilities or trap and truck operations for eels are made available at the downstream Conowingo Hydroelectric Project. In 2021, Brookfield voluntarily agreed to provide a total of \$50,000 of funding over 4 years towards a downstream eel migration study that USFWS is leading in the Susquehanna River Basin.

Based on the application, supporting documentation and other documents, this review finds that the Project collaborates with resource agencies related to downstream passage, and continues to satisfy the Downstream Fish Passage criterion. A condition is recommended relative to completion of the turbine survival study.

E: Shoreline and Watershed Protection

Goal: The facility has demonstrated that sufficient action has been taken to protect, mitigate or enhance the condition of soils, vegetation and ecosystem functions on shoreline and watershed lands associated with the facility.

Assessment of Criterion: Brookfield selected Standard E-2 and the PLUS Standard for all ZoEs.

Discussion: The Holtwood Project shoreline in all ZoEs along the Susquehanna River and principal tributaries have been largely preserved in their natural state. With the exception of a few areas, mainly around Pequea Creek, there is an approximate 200-foot forested buffer provided along all areas of the Susquehanna River as well as along many of the principal tributaries within the Project Boundary.

Brookfield has a Land and Shoreline Management Plan (LSMP) in place in accordance with Article 62 of the FERC license. The plan was approved by FERC in 2013 and required several measures including:

- An assessment of the lands to be included within a shoreline buffer and lands to be included within the project boundary for the protection of project resources, such as protection of fish and wildlife habitat, providing public access for recreation, and protecting sensitive, unique, or scenic areas.
- Measures for the coordination of the plan with other resource management plans and programs for the project, such as the Historic Properties Management Plan, long-term monitoring program of wetlands and state threatened and endangered plants, and the bald eagle protection plan.
- Provisions for purchasing and removing privately-owned cottages within the project boundary and restoring the project lands to a natural state.
- 6-year reporting starting in 2019 including detailed information on the status of any changes in regional plans or policies that affect the management of project lands; and an update on the number and location of cottage properties purchased, and the amount of land restored as proposed, as well as the number of remaining cottages the licensee plans to purchase and restore.

The LSMP was developed in cooperation with the Pennsylvania Department of Conservation and Natural Resources (DCNR), Lancaster and York Counties, the Susquehanna Gateway Heritage Area, the Lancaster County Conservancy (LCC), and The Conservation Fund; and in consultation with other state and federal resource agencies, as well as non-governmental organizations. The LSMP provides a framework for the management of Project lands and river shoreline areas consistent with much broader local, regional, state, and federal initiatives to preserve, protect, and enhance the lower Susquehanna River Corridor and to foster a stewardship ethic in support of broad federal, state, and regional efforts to protect and preserve the Chesapeake Bay. The plan is comprehensive in scope covering the licensee's landholdings within the Project boundary along the lower Susquehanna River corridor that sets a policy framework for future decisions regarding permissible private and public uses of Project lands. It provides details on the uses of Project lands, non-essential lands that were transferred to other entities for preservation, and the many preservation initiatives occurring in the Project vicinity.

The plan was last updated in 2020¹¹. All Project-owned cottages have been removed and the areas revegetated (email from Brookfield, March 30, 2020).

In 2011, the licensee entered into the Lower Susquehanna Fund Agreement with LCC, DCNR, York County, and the Susquehanna Gateway Heritage Area. Almost 2,000 acres of lands were transferred to the LCC for long term preservation and public use. Smaller amounts of land were transferred to York County. The Lower Susquehanna Fund was established to provide revenue to protect, operate, maintain, improve, and promote the property in the Conservation Landscape Initiative. Brookfield makes annual contributions of approximately \$115,000 (3% increase annually) to this account until 2031. The Lower Susquehanna Fund Advisory Council is responsible for the management and distribution of the funds. The funds are used for maintenance of property transferred.

Based on the application, supporting documentation and other documents, this review finds that the Project has actively managed Project lands for preservation purposes and continues to satisfy the Shoreline and Watershed Protection criterion. The review also finds that a PLUS is warranted since Brookfield will continue to contribute to the Lower Susquehanna Fund which will have positive effect on the 2,000 acres of lands transferred to LCC.

F: Threatened and Endangered Species

Goal: The facility does not negatively impact federal, or state listed species.

Assessment of Criterion Passage: Brookfield selected Standard F-2 in all ZoEs for the threatened and endangered species criterion.

Discussion: A list of all federally listed species was obtained from the US Fish and Wildlife Service's IPaC website and can be found in Section 10.0 of the LIHI application. Several species were listed to be potentially present include:

- Indiana Bat (endangered),
- Northern Long-eared Bat (threatened), and
- Monarch Butterfly (candidate species).

The critical habitat for Indiana Bat is not available and no critical habitat has been designated for the Northern Long-eared Bat and Monarch Butterfly. Brookfield only cuts down trees in campgrounds that are potentially hazardous to the public.

USFWS indicated that bald eagle nests are in the Project vicinity. Also, a number of species are on the USFWS list of Birds of Conservation Concern (BCC) are present in the Project area. The BCC list included:

- Black-billed Cuckoo
- Cerulean Warbler
- Kentucky Warbler
- Prairie Warbler

¹¹ https://elibrary.ferc.gov/eLibrary/filelist?accession_Number=20200529-5124&optimized=false

- Prothonotary Warbler
- Red-headed Woodpecker
- Rusty Blackbird
- Wood Thrush

When the new powerhouse was constructed in 2008, the licensee developed a Bald Eagle Management Plan which required monitoring during construction. However, since no additional construction activities are currently planned according to the application, the reviewer believes that no adverse impact to bald eagles or any BCC listed birds are anticipated. Brookfield still consults with agencies regarding nesting bald eagles in the Project area.

Surveys for State endangered and threatened species by the PA Game Commission (PGC) and correspondence from other state agencies showed several species in the Project area:

- Great Blue Heron (special concern species),
- Peregrine Falcon (threatened),
- Prothonotary Warbler (special concern species)
- Chesapeake Logperch (threatened)
- Broad-headed Skink
- Northern Red-bellied Cooter

The Great Blue Heron is abundant throughout the Project area. In 2012, two small heron rookeries were established below the Project on Oakes and Piney Islands, in the midst of active construction areas. PPL and the PGC developed buffer zones around these rookeries to avoid impacting heron during the active nesting season.

PA DCNR indicated that there are also 32 species of plants that are considered rare, threatened or endangered in the Project area. Because no earth-moving activity or changes to hydrology are proposed, the state agencies do not foresee any adverse impacts to these species, nor does the LIHI reviewer.

As part of the redevelopment project, Brookfield conducted plant surveys to identify species of special concern Pursuant to Article 51 of the FERC License and Condition IV.A of the 401 Water Quality Certificate. Brookfield complied with all DCNR guidelines to ensure that the species would be properly protected during and after construction. DCNR required a post-construction monitoring plan be established, which included that White Doll's Daisy and Sticky Goldenrod (both state endangered) be monitored because the species were critically endangered in Pennsylvania at the time and the change in hydrology potentially could affect these populations.

On March 26, 2020, the frequency of future monitoring was reviewed by Brookfield and DCNR, and an agreement was made that Brookfield will continue to monitor the White Doll's Daisy annually for three additional years and monitor the Sticky Goldenrod every three years with the next survey being in 2022. Brookfield will continue to submit the monitoring data to DCNR after each monitoring season. In 2023, Brookfield will request a meeting with DCNR to again review the data and discuss the future of monitoring.

Based on the application, supporting documentation and other documents, this review finds that the Project is not likely to adversely affect sensitive species that may be present, and continues to satisfy the Threatened and Endangered Species criterion. A condition is recommended related to ongoing monitoring of the state endangered species.

G: Cultural and Historic Resources Protection

Goal: The facility does not unnecessarily impact cultural or historic resources that are associated with the facility's lands and waters, including resources important to local indigenous populations such as Native Americans.

Assessment of Criterion: Brookfield selected Standard G-2 for all ZoEs.

Discussion: No archaeological or historic properties within the Project are currently listed in the National Register, but two properties are eligible. Of these, one is an above-ground property with multiple components, and one is an archaeological site. Brookfield has a Historic Properties Management Plan in accordance with license Article 61, monitors activities in these areas, and submits annual reports to FERC and the PA State Historic Preservation Office (SHPO). The HPMP includes a list of routine activities that do not require SHPO consultation, but consultation is initiated by Brookfield for any non-routine activities in accordance with license Article 36.

The licensee preserved Lock No. 12 of the Susquehanna and Tidewater Canal system for its historic and cultural significance (Figure 13). The canal system, abandoned since 1894, transported lumber, coal, iron, and grain between Baltimore, Philadelphia, and New York. The licensee installed interpretive displays denoting the operation of the lock and canal system and its contribution to the economic growth of the region. There are interpretive displays denoting the operation of the lock and canal system and its contribution to the economic growth of the region.



Figure 13. Preserved walls of Lock No. 12 of the Susquehanna and Tidewater Canal system

Unit 5 at the Project was the first hydroelectric turbine-generator to utilize a Kingsbury thrust bearing (Figure 14) which has been operating continually since its initial installation in 1912. The American Society of Mechanical Engineers noted this achievement with a commemorative plaque on the unit (Figure 15).

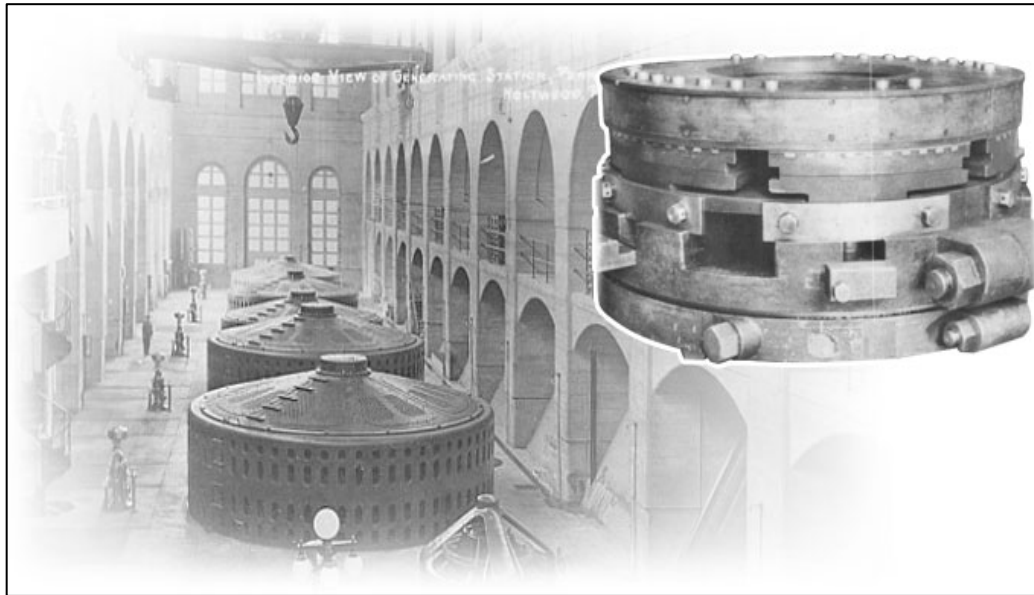


Figure 14. Kingsbury Thrust Bearing Holtwood Generating Station, 1912. (Source: Lancasterhistory.org)



Figure 15. Plaque denoting an International Historic Mechanical Engineering Landmark on Unit 5

Based on the application, supporting documentation and other documents, this review finds that the Project is in compliance with cultural and historic resource protection requirements, has taken steps to preserve such resources, and continues to satisfy the Cultural and Historic Resources Protection criterion.

H: Recreational Resources

Goal: The facility accommodates recreation activities on lands and waters controlled by the facility and provides recreational access to its associated lands and water without fee or charge.

Assessment of Criterion: Brookfield selected Standard H-2 for all ZoEs.

Discussion: Multiple recreation sites associated with the Project provide access to Project resources for public enjoyment. After the construction of the new powerhouse in 2008, the licensee enhanced recreational opportunities by expanding some boat areas and extending boat ramps to lower elevations.

Lake Aldred provides opportunities for walleye, bass, catfish, panfish and muskellunge angling. Public boat access is provided at multiple public launches and commercially operated marinas, boatyards and campgrounds. Private access from shoreline residences is available from a small number of residential properties leased by Brookfield to individuals. Recreational uses downstream of the Project include shoreline fishing. The tailrace channel is located between the steep sided ledge of the Lancaster County shore and the eastern shore of Piney Island and remains fully wetted by backwater from Conowingo Pond, regardless of Project operations. Public access to the river downstream from the dam is provided at the Tailrace Fishing Area and Lock 12 Historic Area.

The five recreation sites for public use include:

- Otter Creek Recreation Area (Otter Creek Campground, Picnic Area, and York Furnace Boat Launch),
- Pequea Creek Recreation Area (Pequea Creek Campground, Picnic Area, and Pequea Creek Boat Launch),
- Lock 12 Historic Area,
- Tailrace Fishing Area (handicap accessible fishing pier), and
- The Whitewater Boating Features (park) found on the York County side of the dam (Figure 16). In accordance with the Whitewater Boating Plan (license Article 60).



Figure 16. Whitewater facility on west shore of dam and whitewater boater (Sources: <https://vimeo.com/111790402> and <https://www.americanwhitewater.org/content/Project/view/id/5/>)

Brookfield operates the whitewater features for 264 hours per year and coordinates with a whitewater boating group pursuant to the Settlement Agreement. Flow forecast information is also provided via <https://safewaters.com/facility/holtwood>. Islands within the Project boundary are available for informal recreational use and Brookfield provides portage services for through-boaters at the Holtwood development.

Based on the application, supporting documentation and other documents, this review finds that the Project provides recreational opportunities without fee or charge continues to satisfy the Recreational Resources criterion.

8. GENERAL CONCLUSION AND REVIEWER RECOMMENDATION

Based on my review, I believe the Project meets the requirements of Low Impact facilities and recommend it be recertified for 13-year period reflecting the PLUS for the shoreline and watershed protection criterion, and with the following conditions that supersede the existing Certificate conditions (as modified by the Technical Committee of the LIHI Governing Board).

Condition 1: Since the Project will begin relicensing during the new LIHI Certification term, the facility Owner shall provide to LIHI as part of the annual compliance report, a status report on the FERC licensing progress listing significant agency interactions that have occurred in the past year that are relevant to any LIHI criteria and highlighting major topics of agreement or disagreement. LIHI reserves the right to request additional details, if necessary, if highlighted topics are relevant to the LIHI criteria and their associated goals. LIHI also reserves the right to modify the Certificate conditions again if needed.

Condition 2: In annual compliance reports to LIHI, the facility Owner shall provide a summary of the status on progress toward meeting fish passage targets including: a) the status of fishway

operations and agency-recommended fish passage facility improvements; b) re-initiation of the Tier II telemetry study, study results when available, and agency comments on them; c) any efforts made to investigate methods to sort and remove invasive fish species; d) zone of passage improvements including removal of excess material in the tailrace; e) the status, results, and agency comments on the planned turbine survival study; and f) a summary of the annual Fish Passage Technical Advisory Committee meetings and any other agency consultation related to fish passage.

Condition 3: In annual compliance reports to LIHI, the facility Owner shall provide a summary of results from the ongoing monitoring for White Doll's Daisy and Sticky Goldenrod, and any agreements reached with DCNR regarding changes in monitoring scope or frequency.

APPENDIX A



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mid-Atlantic Fish and Wildlife Conservation Office
177 Admiral Cochrane Drive
Annapolis, MD 21401



April 8, 2022

Low Impact Hydropower Institute
1167 Massachusetts Avenue
Office 407
Arlington, MA 02467
comments@lowimpacthydro.org

RE: U.S. Fish and Wildlife Service comments on the Low-Impact Hydropower Institute Certification Application for the Holtwood Hydroelectric Project (FERC No. 1881), dated December 2021.

Dear Low Impact Hydropower Institute:

The U.S. Fish and Wildlife Service (Service) is submitting the following comments to be considered by the Low Impact Hydropower Institute (LIHI) for recertification of the Holtwood Hydroelectric Project (Project) owned by BIF III Holtwood LLC (Company). The Service is interested in several items at the Project, namely operation of the fish passage facilities, implementation of the Tier II radio telemetry study, completion of the zone of passage work in the Project's tailrace, and records of periodic low dissolved oxygen in the Project area.

The Project is required to operate upstream fish passage at the facility for migratory fish in the spring. The Project last operated fish passage in spring 2020, and operation was terminated early at the request of the resource agencies due to concern over passing invasive species (northern snakehead) that were passed into Conowingo Pond by the fish passage facilities at Conowingo Dam, the next downstream dam. The Project has no mechanism currently to remove or isolate any fish from the fish lifts, so operation of the fish passage facility at the Project has the potential to pass invasive species upstream into Lake Aldred. Due to continued agency concern over the upstream expansion of invasive species and the unknown threat of passage of northern snakehead at the Project, the agencies have requested the Project not operate its fish passage facilities in the 2021 or 2022 seasons. The Company has complied with the resource agency requests. Moving forward, continued discussions around fish passage operation and invasive species will need to occur between the agencies and the Company.

The Tier II radio telemetry study has been conducted for two of the required three-year minimum study period. The first two years of study (2018-2019) found that upstream fish passage efficiency for American shad at the Project was very poor (12.4%, 10.5% respectively). The Project is required to achieve 85% passage efficiency for American shad that enter the Project's waters. Although operation of the fish passage facility is temporarily suspended at request of the

resource agencies, the Service encourages the Company to continue to make fish passage improvements to the fish lifts based on the issues identified in the first two years of the radio telemetry study. Continued improvements to the facilities will ensure that once fish passage operations are re-initiated and studies can be resumed, the Project will have a higher likelihood of achieving the 85% upstream passage efficiency.

In addition to fish passage concerns around conducting the Tier II telemetry study, the zone of passage requirements in the Project tailwaters were not fully implemented during, or after, the Project's redevelopment. The agencies have not waived the requirement to address the issue of excess material being left in the zone of passage, but have considered delaying addressing the zone of passage issue until results from the radio telemetry study can further inform areas of concern for fish passage within the Project boundary. At this time, the most significant concern impacting upstream fish passage efficiency appears to be at the fish lifts themselves, but future study is needed to further evaluate the completion of debris removal from the zone of passage.

Dissolved oxygen (DO) monitoring has been required at the Project impoundment and tailwaters by the Pennsylvania Department of Environmental Protection (PADEP). As part of that monitoring, there have been instances where the Project has not achieved the minimum DO level of 5.0 mg/L required at the Project by PADEP. Although annual DO reporting from the Company suggests that the low DO levels are a result of natural processes in the forebay, the Service contends that the low DO levels are a Project effect. DO concentrations downstream of the Safe Harbor Hydroelectric project were in excess of 7.0 mg/L during the time of the low DO events at the Project in 2021. The impoundment created by the Project increases water temperatures in summer months, and the higher temperatures and the impounded river condition are likely resulting in low DO conditions in the Project forebay, which are then transferred to the Project tailrace. Future consideration should be given to improving DO levels at the Project to be safe for fish that may be in the forebay and tailwaters in the summer months.

At this time, the Service acknowledges that the Project is in compliance with its License requirements around fish passage and the Company has been responsive to the temporary modifications to fish passage operations that have been requested by the resource agencies. We look forward to our continued work with the Company to ensure that fish passage improvements are made in a timely manner at the Project and that invasive species passage and low dissolved oxygen levels can also be addressed in future. Thank you for the opportunity to provide comments to their LIHI recertification. Feel free to reach out to me if you have any questions or need additional information.

Sincerely,



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