TECHNICAL MEMORANDUM

To:	Randy Dorman, Brookfield
From:	Kleinschmidt
Date:	September 15, 2021
Re:	**Review of MDMR's Comments and NLF Conceptual Designs Filed with FERC for the Shawmut Project (P-2322)**

EXECUTIVE SUMMARY

- In comments filed with FERC on August 16, 2021 the Maine Department of Marine Resources (MDMR) asserts that an approximately 1,260-foot-long continuous rock ramp nature-like fishway (NLF) at the Shawmut Project (Project), using a conceptual design developed for MDMR by Inter-Fluve, is feasible and is recommended for implementation in conjunction with the existing agency-approved design for a fish lift at the Project.
- A 2019 feasibility assessment (2019 Feasibility Study) of fish passage alternatives was conducted by Kleinschmidt on behalf of Brookfield, in consultation with agencies, including MDMR. One of the alternatives evaluated for feasibility was the concept of an NLF at Shawmut in the same general area as the 2021 MDMR conceptual design, on the western shore adjacent to the powerhouses. However, the 2019 Feasibility Study concluded that insufficient space was available to build an NLF given the expected width and length of the structure necessary to comply with USFWS design criteria and given surrounding property and infrastructure limitations. Therefore, this alternative was eliminated from further consideration in the 2019 assessment.
- The NLF conceptual design put forth by MDRM includes two potential layouts but does not effectively advance the potential for an NLF in this location. Many of the same impediments that eliminated the alternative from further consideration in the 2019 Feasibility Study have been identified in the 2021 MDMR conceptual design, but with no supporting research or information to assess how these design issues could be resolved, if even possible.
- It is our understanding that the NLF conceptual design put forth by MDMR was not developed in consultation with or previously reviewed by Brookfield or the other fishery resource agencies, some of which may have competing resource interests and management goals, and different goals for fishway performance criteria.

- The MDMR's NLF conceptual design is based, in part, on the NLF at the Howland dam.[1] However, the two sites differ in significant ways (hydraulic head, overall dam length, and flow control type). Further, the Howland NLF has never been quantitatively evaluated for upstream passage effectiveness, thus its effectiveness is unproven.
- The NLF conceptual design put forth by MDMR relies upon three key assumptions that are largely speculative and unsupported:
    - Adding an NLF at Shawmut will more effectively meet agency fish passage goals than the proposed, agency-approved, fish lift;
    - Property and infrastructure issues at the Shawmut Project site are not limiting; and
    - The proposed NLF concept would meet current federal agency design criteria and be acceptable to the other fishery resource agencies.
- The conceptual design presented by MDMR lacks sufficient supporting details regarding geotechnical conditions, potential environmental contamination, hydraulic analysis, land ownership, local zoning setback requirements, existing or potential rights-of-way, access, recreational use, and other issues that may affect feasibility.
- In summary, Kleinschmidt has substantial concerns regarding the technical feasibility of an NLF at this location for the following reasons:
    - The MDMR conceptual design puts the fishway entrance at the most downstream point of the Project tailwater, which is not the most effective location for successful fish passage and is not a location substantially supported by the siting study conducted at the Project during agency consultation on fish lift design;
    - The MDMR conceptual design does not include resting pools which is contrary to current federal fishery resource agency design criteria. The lack of resting pools and the high estimated average velocities[2] that result along the entire 1,260-foot-long fishway are not consistent with the USFWS criteria (USFWS 2019), or recommendations, and guidelines put forth by the federal fishery resource agencies (Turek, et. al. 2016). By not including resting pools, the excessive velocities may result in an impassible fishway for the target species.

[1] *The Howland bypass NLF is located at the Howland dam on the Piscataquis River (Penobscot River basin), in Maine.*

[2] Potentially e*xceeding 6 feet per second (fps) at the low end of the operating range and potentially exceeding 9 fps at the high end of the operating range; depending on channel roughness.*

- The hydraulic inlet control structure proposed in the MDMR conceptual design is unprecedented for an NLF with irregularly shaped channel and varying bed elevation; would be inordinately complicated to design, construct, and operate; could result in debris accumulation at the fishway exit; and could be a barrier to fish passage.
- Without establishing the basic viability of the NLF designs, there is no basis to recommend an NLF as a viable alternative to be included with the fish passage design already proposed by Brookfield and approved by the agencies.

BACKGROUND

The Shawmut Project is located on the lower Kennebec River, where the Project dam is the third dam on the river, upstream of the Lockwood and Hydro-Kennebec projects. Since the early 1980s the lower Kennebec River has been the focus of restoration efforts for anadromous fish including Atlantic salmon, American shad, and river herring (alewife and blueback herring). In support of these efforts Brookfield proposed the installation of a new upstream fish passage facility at the Shawmut Project as part of the 2013 Interim Species Protection Plan (ISPP) that was developed in consultation with state and federal fishery resource agencies and approved by FERC in 2016.

Brookfield conducted a preliminary evaluation of fish passage alternatives at Shawmut as part of the 2019 Feasibility Study. This evaluation, conducted in consultation with MDMR and other stakeholders, considered the potential feasibility of an NLF and concluded that an NLF was not feasible at Shawmut, primarily due to limited physical space and potential conflicts with existing infrastructure.

In December 2019, in accordance with the provisions of the ISPP and the conditions of the Shawmut Project FERC license, Brookfield filed final design plans for a fish lift to be installed at the Shawmut Project. The fish lift designs were developed in consultation with the fishery resource agencies, and at that time the fish lift was proposed to be constructed in 2021 and operational in 2022.

In January 2020, Brookfield submitted an application to relicense the Shawmut Project with FERC. The current FERC license for the Project expires in 2022. As part of that license application, Brookfield proposed to continue to operate the new proposed fish lift (which presumably would be operational by the time the new license was issued), to make additional improvements to the Shawmut downstream fish passage facilities, and to monitor and test both upstream and downstream fish passage facilities, to ensure that the facilities were providing effective fish passage for the target species, relative to certain performance standards.

In July 2020, FERC noticed that the license application was ready for review and requested agency preliminary terms and conditions. In August 2020, NMFS, USFWS, MDIFW and MDMR all filed comments in response to FERC's notice, along with Section 10(a), 10(j), and Section 18 recommendations and preliminary prescriptions. The Section 18 preliminary prescriptions filed by NMFS included prescriptions for the construction and operation of an upstream fish lift at Shawmut. MDMR's 10(a) recommendation was that the Shawmut Project be decommissioned and removed. No agency suggested or recommended a nature-like fishway (NLF) for the Shawmut Project.

In July 2021 FERC issued a draft Environmental Assessment (DEA) for the Project. In August 2021 MDMR filed comments on the DEA. As part of their comments, MDMR included a conceptual design for an NLF at the Shawmut Project developed by Inter-Fluve. This was the first time that any agency had recommended an NLF for Shawmut, and the design had not been reviewed by Brookfield, or agencies other than MDMR.

The following memo provides an initial review of the conceptual NLF designs for Shawmut filed with FERC by MDMR. As further background, the memo also reviews the 2019 Feasibility Study, and revisits assumptions and conclusions that were drawn regarding the feasibility of an NLF at Shawmut at that time.

This initial review is intended as a preliminary assessment of the conceptual designs including feasibility and potential effectiveness. The recently filed concepts lack additional investigation of site constraints identified by the 2019 Feasibility Study, nor are current USFWS design criteria addressed. Without significantly more detailed analysis, the feasibility of constructing an NLF and the likelihood it would meet agency fish passage effectiveness goals is unsubstantiated.

KENNEBEC FEASIBILITY STUDY (2019) FINDINGS

In 2018 and 2019, Kleinschmidt evaluated options for enhanced fish passage options at three of Brookfield's hydroelectric projects on the lower Kennebec River with the goal of maintaining renewable energy production (Kleinschmidt 2019). The study focused on the projects within the Brookfield White Pine Hydro portfolio, which includes Lockwood, Shawmut, and Weston. The objectives of the study were to explore a range of fish passage improvements at each site; to evaluate the benefits to the aquatic resources; and to explore a range of energy enhancements that could be pursued to offset lost generation as a result of fish passage improvements. The 2019 Feasibility Study was undertaken as a screening level analysis and Kleinschmidt did not prepare conceptual drawings for any fish passage concepts considered or develop hydraulic models of the concepts; however, the concepts were evaluated based on Kleinschmidt's decades worth of experience in fish

passage in this region, and based on readily available site information, and a general layout/footprint developed for each alternative.

Four major categories for improving fish passage were evaluated for each site, including Shawmut. These included full dam removal, decommissioning in place with installation of an NLF similar to that of Howland, installation of an NLF while maintaining the generating facility, and installation of the currently planned, agency-approved, fish lift at Shawmut. For the option that maintained generation, two possible alignments for an NLF were considered.

The first NLF alignment considered at Shawmut was an excavated channel south of the existing canal and 1982 powerhouse, similar to the concept put forward by MDMR. This option was dismissed at the time due to the estimated width required to excavate the channel and install the required side slopes in accordance with USFWS design criteria known at the time.

Scaled aerial photographs of the Shawmut Project site demonstrated that that the available space between an adjacent private residence and the existing Central Maine Power (CMP) substation was approximately 230 feet. The review concluded that this would provide an inadequate buffer between the existing structures and property boundaries to construct the NLF channel at an assumed maximum width of at least 200 ft, and acknowledged that the hydraulic head at this site may require deeper excavations that could yet increase the overall fishway width. Being located in the Town of Fairfield's Industrial land use category, minimum front, side, and rear setback requirements of 25 feet is unachievable, assuming the entire NLF would be categorized as a "regulated area" (Town of Fairfield 1999). In contrast, the MDMR NLF designs filed with FERC includes two alternatives, one with a similar footprint and one with a narrower footprint which resulted in a narrower overall channel of approximately 170 feet.

The 2019 evaluation also identified a concern about the proximity to the existing railroad and the potential for the NLF to project into the railroad's right of way. The MDMR NLF concepts assume that this may not be a concern, but this conclusion requires confirmation with the railroad and town regarding right-of-way and set back restrictions, which is missing from the MDMR conceptual design effort.

During the development of the 2019 Feasibility Study the Chinet Groundwood (formerly Keyes Fibre) mill building adjacent to the Shawmut Project was still standing and was not yet decommissioned. Thus, the conceptual NLF considered in 2019 was assumed to be routed around the mill building. Since then, the mill buildings have been removed and the land turned over to the Maine Department of Inland Fisheries and Wildlife (MDIFW)

to provide public access and a hand carry boat launch. Because both of the MDMR NLF conceptual designs would traverse the site of the former mill, unknown soils, contaminants, geotechnical concerns, and the potential for buried utilities and conduits exists which are acknowledged but not otherwise addressed by MDMR.

BROOKFIELD CONCEPTUAL DESIGN EFFORTS

As part of agency consultation efforts for the 2019 Feasibility Study, studies conducted to evaluate several fish passage alternatives were vetted with state and federal agency and non-governmental organization (NGO) representatives. At the time no participants expressed a need or interest in further pursuit of an NLF.

In addition, Kleinschmidt understands that the design efforts for the currently proposed fish lift took place over the course of several years with the fishery resource agencies, including MDMR. It is our understanding that Brookfield's current proposal to construct a fish lift at Shawmut is primarily based on a siting study that used both CFD modeling and empirical study data that demonstrated a clear location where upstream migrants congregate. The entrance location for the MDMR NLF conceptual design is *not* a location where fish congregated. This fact raises significant concern about the ability for upstream migrants to find the NLF entrance as it is shown in the MDMR conceptual designs.

MDMR NLF CONCEPTUAL DESIGNS (2021)

The following sections provide the review of the NLF conceptual designs proposed by MDMR, as filed with FERC on August 13, 2021.

NLF CONCEPTUAL OPTIONS

MDMR's conceptual designs are based on the Howland bypass NLF, citing "*indications of effectiveness*" of the Howland bypass and are cited as a path to improve fish passage performance in addition to Brookfield's proposed fish lift at Shawmut. The MDMR NLF concepts were not compared to the currently proposed fish lift, and provides no discussion or analysis to demonstrate that an NLF would address any perceived limitation of Brookfield's proposed fish lift design or would improve fish passage performance in any way. The MDMR NLF conceptual design materials provide no data, discussion, or analysis to demonstrate that an NLF would enable achievement of MDMR's performance standard goals for target species at the site. Furthermore, the MDMR NLF design materials do not consider the effects of adding an NLF at the Shawmut Project along with the agency-approved fish lift on fish lift operations or effectiveness, nor does it consider the fish lift's effects on NLF operation and effectiveness. There is no reason to conclude that adding an NLF, as suggested by MDMR, would improve the expected effectiveness

of upstream fish passage for the four target species at Shawmut over what would be provided by the proposed, agency-approved, fish lift.

The Howland NLF provides an example of an operational NLF in Maine, designed to pass the same anadromous species of interest in the lower Kennebec. However, there are significant and important differences between the Howland site and Shawmut that must be considered:

- Howland dam is the site of a decommissioned hydroelectric project rather than an active generating facility, so comparisons between the two are limited, particularly in terms of flow management.
- The hydraulic head at Howland dam is only 17.2' at low flow vs. 24' at Shawmut and the Shawmut Dam is twice as long as the Howland Dam.
- There is no need for an actively-managed hydraulic control structure at Howland because all river flow passes through the NLF during most of the fish passage season.
- The Howland NLF is untested and its effectiveness has not been established so there is no factual basis to conclude that the effectiveness of the Howland NLF meets the performance standard sought by DMR, or that similar success could be anticipated at Shawmut. [3]

The two primary alternatives developed in the MDMR design concepts at Shawmut consist of an excavated channel extending from the existing canoe put-in, located approximately 250 feet downstream of the 1982 powerhouse, upstream along the south shore to the headpond at the canoe portage take-out, with the primary difference between the two alternatives being the width of the channel. Both alternatives are routed along a narrow

[3] In 2015, as a prerequisite for building the Howland NLF, the Penobscot Restoration Trust agreed to develop an effectiveness monitoring plan (Plan) in consultation with federal and state fishery agencies, Including Maine DMR. The Lower Penobscot River Basin Comprehensive Settlement Accord (Accord) requires that the Penobscot Trust demonstrate that the Bypass provides "*safe, timely and effective fish passage*" for targeted diadromous fish species. The Accord further specifies monitoring of the effectiveness of the Proposed Bypass, in consultation with the Resource Agencies and Penobscot Indian Nation (PIN), and make minor adjustments, as necessary, for a period of 15 years from installation of the fish passage facility at Milford." The Penobscot Trust also must comply with the terms and conditions of the December 23, 2009 Biological Opinion (as amended November 29, 2012) (BO). Term and condition No. 6 requires the Penobscot Trust to monitor the effectiveness of the Howland fish bypass in passing Atlantic salmon upstream and downstream for three years. Specific study methods for Atlantic salmon upstream effectiveness were identified but the Plan recognized that studies could not commence until sufficient adult salmon of Piscataquis River origin could be obtained. The plan calls for a telemetry study that would target returning Piscataquis-native adult fish passing through the Milford fishway for tag insertion. In order to identify these individuals, the telemetry study phase will need to be preceded by programmatically marking sufficient numbers of Piscataquis-native juvenile salmon. The telemetry phase will await the subsequent return of sufficient numbers of these marked fish to Milford as adults. To date this has not occurred.

corridor that is bound by a private residence, railroad, and a substation owned by CMP. Of the two conceptual designs put forward by MDMR, the maximized width NLF uses a wetted width of approximately 100 feet while the reduced width NLF uses a wetted width of 80 feet.

The MDMR conceptual design considered two alternative entrance locations for the NLF, though both alternatives have issues that preclude them from serious additional consideration. One alternative would require the demolition of the 1982 powerhouse by shifting the entrance further upstream, locating it just downstream of the 1912 powerhouse. This alternative would eliminate nearly half (4 MW) of the Project's 8.65 MW total generating capacity—and as such, is not a reasonable alternative to provide fish passage and retain existing generating capability.

The other alternative would shift the entrance downstream approximately 250 feet, resulting in a longer and less steep fishway. However, any improvements in efficiency resulting from the shallower slope would likely be offset by the entrance being located further downstream from the competing attraction flows lessening the ease of detection by fish and thereby adding to migration delay[4].

DESIGN REVIEW

As noted above the two NLF bypass alternatives are similar in concept and loosely based on the design of the Howland bypass NLF. Key concerns with the MDMR conceptual designs are:

- The designs do not appear to meet existing USFWS criteria (USFWS 2019) for NLFs in terms of dimensions, specifications, and hydraulics. The Howland NLF was designed prior to the release of either the 2016 Interagency Guidelines (Turek, et. al. 2016) or 2019 USFWS design criteria (USFWS 2019); both documents are frequently cited by fishery resource agencies, including MDMR, when proposing passage requirements. Using the Howland NLF as the basis for an NLF at Shawmut may result in a concept that fails to conform to current fishway design guidance.
- A flow control structure at the NLF hydraulic inlet would be needed to properly operate the NLF across a wide range of flow and Project operational conditions. Such a structure would be inordinately complicated, unprecedented for an NLF with irregularly shaped channel and varying bed elevation, and could result in a velocity barrier to the target species.

[4] This entrance location would be away from competing station flow and therefore could undermine attainment of agency performance criteria.

- The designs raise significant concerns with abutting properties, access and infrastructure, including the CMP substation and powerlines, as wells as the dam structures themselves, that were not addressed.
- The designs were developed using publicly available LiDAR rather than survey grade terrain data and lack any detailed subsurface data such as the depth and type of soil, the depth of bedrock, and rock quality.
- The designs do not address the potential presence of contaminated soils, the location of any underground structures or utilities, or the potential need to relocate existing utilities.

Also as noted above, the two sites are not appropriate for comparison due to Howland being a decommissioned generating facility while Shawmut is not. Head and flow conditions are significantly different between the two sites, which will drive design slopes, length and width of the channel, and flow management between the hydro facility and the fishway. From a conceptual design perspective, the limitations and unknowns surrounding site conditions and footprint of an NLF are the same as identified by Kleinschmidt in 2019 during the Feasibility Study. Pursuit of an NLF design as presented in MDMR's proposal requires significantly more detailed investigation to sufficiently evaluate viability of an NLF at Shawmut.

NLF DIMENSIONS

Both MDMR NLF alternatives consist of a broadly sweeping meander bend that extends around the south side of the dam, and are longer and steeper than the Howland bypass. When measured along the low-flow portion, the maximum width channel is approximately 1,273 feet long, with an average hydraulic gradient of approximately 2 percent; while the reduced width channel is approximately 1,266 feet long, with a similar gradient. Although this is within the published acceptable slopes for an NLF for these target species (Turek et. al., 2016), by contrast, the Howland NLF is only 1,050 feet long with an average gradient of 1.5 percent.

The Howland bypass has a low-flow hydraulic head differential of up to 17 feet, whereas the stated hydraulic head at Shawmut across its operating range is 24 feet. The MDMR conceptual NLF at Shawmut has a 40 percent increase in hydraulic head, but only an approximately 20 percent increase in length compared to the Howland site. This is likely due to the fact that the concept developed for Shawmut does not include any resting pools, which is contrary to standard NLF design practice (Turek, et. al. 2019) and USFWS design criteria (USFWS 2019) and will further decrease passage effectiveness.

The Howland NLF had a design minimum flow depth of 1.5 feet; the NLF depth criteria has since been set at a minimum recommended flow depth of 2.25 feet for Atlantic salmon and American shad (Turek, et. al. 2016). Thus, reliance upon the Howland NLF design for an NLF design at Shawmut in 2021 may not be appropriate for complying with the current design criteria put forth by the federal fishery resource agencies.

The stated lengths for the conceptual NLF designs put forward by MDMR appear to include a portion of the sloping surface of at the downstream end of the NLF that would be backwatered under low-flow tailwater conditions, thereby effectively shortening the length of the proposed fishway. As stated in the Inter-Fluve memo prepared for MDMR, the proposed NLF was already "*spread along the maximum channel length available within constraints*"; thus, a longer fishway may not be feasible at this site.

However, as presented the conceptual NLF length is shorter than what Kleinschmidt believes will be required by the agencies due to its lack of resting pools and backwatered portion at the downstream end, which is not consistent with USFWS (USFWS 2019) and resource agency design criteria (Turek, et. al., 2016) and which would compromise the effectiveness of the NLF. The addition of resting pools in conformance with USFWS criteria (USFWS 2019) would significantly increase the length of the NLF design that would require the design to either incorporate a revised alignment connecting to an entrance located even further downstream, or implement berms on either side of the downstream end of the existing alignment to extend the fishway further downstream.

Both options would further isolate the NLF entrance and attraction flow from the generating flow and would likely reduce effectiveness. An alternative to increase the radius of the fishway curve to generate the necessary additional length is not feasible as this would encroach on the private landowner and not meet local ordinance requirements for setbacks from abutting properties (e.g., private landowner and CMP transmission facilities and corridor).

Both NLF alternatives put forward by MDMR include a multi-stage cross section, with a 20-foot wide (flat bottom width) low-flow channel that sweeps to the outside of the bend, and a mildly sloping high flow overbank area that extends to the inside of the bend. The deeper low-flow portion of the channel (4-4.8' deep) helps to concentrate lower flow conditions while the overflow bank provides a zone of passage as flows increase and velocities in the low-flow channel increase. The high flow overbank is approximately 70' wide for the maximum width alternative and 50 feet wide for the reduced with alternative with depths ranging from approximately 0-3 feet.

Unlike the Howland NLF, the MDMR NLF concepts for Shawmut do not include a pool and riffle profile along the low-flow channel. The low-flow channel proposed by MDMR for a Shawmut NLF appears to be designed as a continuous riffle with no pools. These pools provide critical resting areas for fish as they ascend the channel and are standard practice in fishway design and are part of the USFWS design criteria for NLFs. The Howland bypass NLF, for example, includes 75 foot long, zero gradient resting pools every 120 to 150 feet along the length of the low-flow channel, whereas, the designs developed for the Shawmut Project do not even though the higher head, would necessitate a longer and/or more steeply sloped fishway, making resting pools more critical for the NLF to meet performance standards.

NLF Flow Control And Velocities

One of the most critical elements of any successful fish passage design, and one of the most significant unknowns about the MDMR NLF design is the hydraulic inlet control structure that would regulate flows in the NLF. The proposed concept for an NLF at Shawmut is intended to be operational for river flows of 2,540 cubic feet per second (cfs) to 20,270 cfs, while the powerhouse generation capacity is 6,700 cfs. Without a hydraulic inlet control the proposed fishway (reduced width option) is reported to pass 1,500-2,000 cfs across the proposed operational range of river flows. Based on fish passage design guidance, (USFWS, 2019), agencies usually require that fishways at hydroelectric projects have a minimum attraction flow of 5 percent of powerhouse capacity. At Shawmut, that equates to a low design flow of 340 cfs.

In addition, Kleinschmidt preliminary review indicates that velocities may exceed target species' sustained swimming speeds and guidance criteria for maximum weir notch velocity criteria for two of the four target species at the low flow conditions in the NLF. The conceptual designs lack detailed evaluation of fishway hydraulics, a necessity in order to determine the feasibility of this design to effectively provide fish passage for the four target species. Specifically, there is no evidence that MDMR used resource agency guidance regarding the applicability of the weir notch velocity criteria in Turek et. al. (2016), along with consideration of lower sustained swimming speeds being more applicable to a 1,200-foot long continuous riffle.

Flow Control

Although the MDMR NLF conceptual design materials note that a hydraulic inlet control structure may be required to limit flow into the fishway during low river flows, a review of the feasibility of a hydraulic inlet control structure that could regulate flow into the NLF while maintaining effective fish passage was omitted from the conceptual designs. Kleinschmidt believes that such a structure *is necessary* in order to accommodate the

range of flows from 340 cfs to 2,000 cfs within the channel, as the NLF would need to be capable of passing this full range of flows all while the headpond remains constant at the normal pond level of 112 feet. As noted below, based on the proposed geometry of the channel, if only 340 cfs were discharged into the channel, the flow depth would likely be in the range of 3.15 to 3.8 feet. Since the proposed upstream invert of the channel is set 5 feet below the normal pond elevation, this means that there would be a hydraulic drop of 1.2 to 1.85 feet across the proposed hydraulic inlet control structure.

A single gate with a hydraulic drop of 1.2 to 1.85 feet would be a barrier to fish passage; therefore, a set of two or three weir gates would have to be arranged in series to spread this hydraulic drop into multiple smaller increments that are passable for fish. To Kleinschmidt's knowledge, such a design has never been implemented in an NLF with an irregular channel geometry due to the complexity of the hydraulics that such a structure would introduce to the fishway. Designing a set of gates that can control flow across the full width of an irregularly shaped channel with a varying bed elevation would be a complex challenge in and of itself. An additional challenge is that the gate(s) in-line with the low-flow channel would need to have one or two additional gates sistered in series downstream to reduce the hydraulic drop to a level that is passable for fish. This would be an unprecedented hydraulic feature for an NLF.

Design of an effective hydraulic inlet control structure would need to be very carefully evaluated to ensure that it does not create unfavorable hydraulics (e.g., high velocities, excess turbulence) in the low-flow channel and that it does not create a passage barrier when its gates are in the lowered position. The need for mid-channel abutments between the gates would also have to be evaluated, as this could become a debris trap or adversely impact flow and fish passage.

VELOCITY

If a reasonable hydraulic inlet control can be established to limit flow in the fishway to 340 cfs, the flow depth would likely be in the range of 3.15 and 3.8 feet and the average velocity would likely be in the range of 4.6 fps to 6.8 fps, depending on the channel roughness[5]. This higher velocity exceeds the resource agency recommended maximum weir notch velocity of 6 fps for river herring (Turek, et. al. 2016). Further, the 6 fps notch velocity criteria assumes the fish are capable of a quick burst to get through that short area of higher flow at a weir, not a 1,200-foot long riffle sequence flowing at that velocity.

[5] Based on preliminary calculations for the reduced width fishway with the stated hydraulic gradient of 2 percent and Manning's "n" values of 0.045 up to 0.080.

At the higher flows in the proposed MDMR NLF concept at Shawmut, average velocities in the fishway are anticipated to range from approximately 5.2 fps up to 9.2 fps[6]. The upper limit of this range exceeds the recommended maximum weir notch velocity for three of the four target species (Turek, et. al. 2016), let alone swimming 1,200 feet at these velocities. The MDMR design fails to provide a basic evaluation of these velocities and their location (and corresponding depth) to determine suitability for fish passage in this NLF.

SITE CONSIDERATIONS

As acknowledged in the MDMR NLF conceptual design materials, the conceptual NLF layout is already "spread along the maximum channel length available within constraints." Kleinschmidt agrees without reservation that the conceptual designs are located in a constrained space that presents a series of potential limitations that have significant implications to feasibility, particularly if a longer fishway is required due the proposed concept's lack of resting pools and backwatered portion at the downstream end.

For example, the NLF concepts filed by MDMR are routed along the south side of the dam, through a narrow corridor that is bounded by private property, a railroad, and a substation. Both alternatives show the proposed fishway abutting the property line of the private residence located adjacent to the existing railroad. Further, as the proposed 2:1 slope will require armoring with stone and, depending on the design details, this stone may need to extend several feet along the horizontal (existing) surface) towards (or potentially crossing) the property line. As previously noted, assuming an NLF associated with a FERC-licensed project is considered a regulated area, local zoning setback requirements cannot be met, and would require Code Enforcement to consider a variance.

Further, the MDMR NLF concept design documentation lacks assessment of any easements that likely must be secured in order to construct an NLF. Obtaining such easements can potentially add considerable delay, cost, and uncertainty to construction. The maximum width NLF is noted to project onto CMP's property and utility corridor. The area needed for construction of the bypass channel on the CMP property is estimated to be approximately 1,000 square feet. However, additional real estate may be required to maintain access to the property owned by MDIFW and Brookfield that would be located south of the NLF and isolated from the rest of the property.

While the reduced width NLF eliminates the portion of the NLF that would be constructed within CMP's utility corridor, an easement may still be required to allow access to the

[6] Based on preliminary calculations for the reduced width fishway with the stated hydraulic gradient of 2 percent, depths in the low flow channel of 5 feet, and Manning's "n" values of 0.045 up to 0.080.

isolated property owned by MDIFW and Brookfield and local setback requirement would still not be met. In addition to the potential easement needed from CMP they also have several (9 for the maximum width NLF and 6 for the reduce width NLF) high voltage utility poles within the footprint of the proposed fishways. As acknowledged in the concept design materials filed by MDMR with FERC, feasibility of relocating these poles was omitted. A similar analysis is required for any other utilities that may be in the area including the existing hydrant that would need to be relocated or any subsurface utilities (e.g., sewer and water) that have not been identified to date.

The MDMR NLF concept design information includes a minimum setback of 16 feet from the substation to the edge of grading but lacks any assessment of whether the stability of the substation would be affected by the required excavation or assessment of whether the breaching of the upstream earthen berm for the fishway installation would increase potential for flooding of the substation. The supporting information filed with the concepts also lacks any analysis of potential adverse effects on the grounding grid for the substation by the required excavation.

The MDMR NLF concept design information neglects to consider dam safety concerns associated with the designs. Both NLF concepts will extend through the existing earthen dike and cut off wall that extends across the upland area west of the dam for about 250 feet. This structure currently provides flood protection for the low-lying areas located downstream of this structure, which includes the existing substation. With the construction of the proposed NLF, the section of ground between the bypass channel and the river upstream of the existing earthen dike will become part of the water retaining structure of the dam. As a result, this proposed embankment will need to be evaluated and designed to meet FERC dam safety requirements and provide the same level of flood protection as the existing structures. Such an evaluation was not considered or included in the design information filed with FERC. Based on the existing ground elevations upstream of the earthen dike the proposed embankment may need to be raised. Additionally, a new cutoff wall that extends from the existing cutoff wall to the upstream end of the NLF and that is tied into the proposed hydraulic control structure may be required to prevent seepage through the embankment, but the design concepts appear to have neglected consideration of potentially critical dam safety issues.

Both NLF concepts will run through the site of the former China Groundwood (previously Keyes Fibre) mill (Figure 1). Concept design information acknowledged the potential presence of unknown material and indicated potential contaminated soil issues. However, no assessment of the impacts of the presence of legacy structures or historic contamination has been conducted. According to Brookfield operations personnel familiar with the mill demolition, remnant infrastructure (e.g., sewer and drainage) remains

buried at the site. None of these factors nor how they could be addressed are analyzed in the MDMR NLF conceptual design materials. Encountering such issues can add considerable delay, cost, and uncertainty to construction. A thorough assessment of potential legacy contamination at an historic industrial site is critical to evaluating the feasibility of the MDMR NLF designs.

Also noted in MDMR's filing with FERC but omitted from concept design information is a detailed evaluation of how NLF layouts will interfere with access to the dam. This will require construction of a new access bridge spanning the bypass channel suitable for heavy equipment. A new bridge would likely consist of, at a minimum, a two-span steel girder bridge to accommodate necessary equipment. The access bridge at Shawmut will need to be wider and larger than that constructed at the Howland NLF to accommodate heavier loads required for maintenance and emergency access of the dam and powerhouse, as well as mobile substation equipment by CMP for the adjacent substation. Assessment of a new access bridge is a significant component necessary to fully consider the viability and cost of constructing the NLF concept.

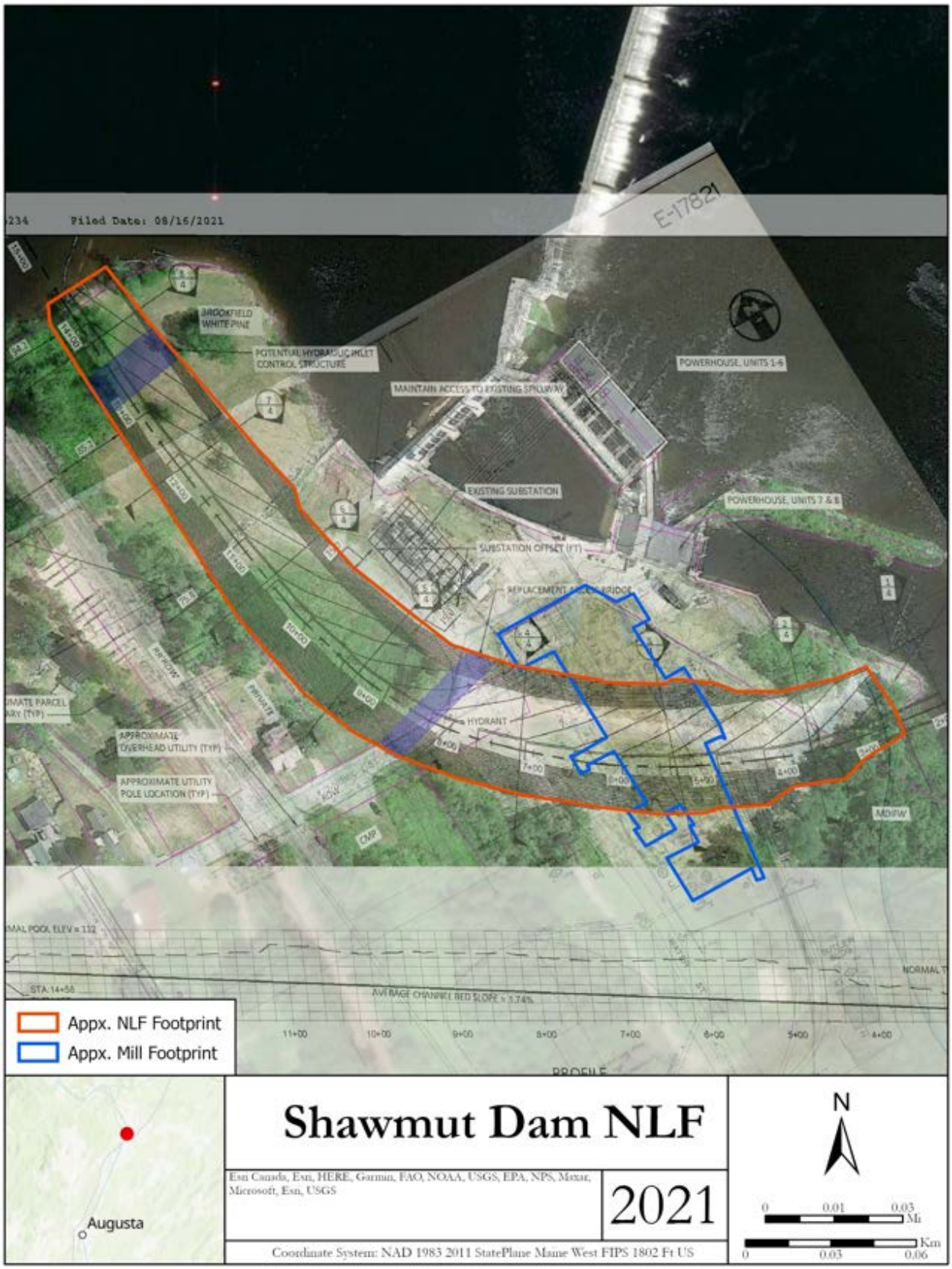

Figure 1. NLF Map.

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FISH PASSAGE CONSIDERATIONS

Per agency recommendations, it is Kleinschmidt's understanding that Brookfield's proposed fish lift for Shawmut is designed to accommodate 1,535,000 blueback herring, 134,000 alewives, 177,000 American shad, and 12,000 Atlantic salmon.

The NLF concept designs lack resting pools. But based on the USFWS design criteria (USFWS, 2019), resting pools would be required in an NLF fishway that is more than 1,000 feet long. Conservatively assuming that the peak runs overlap, and that 10 percent of the run could be present on any given day, and that 15 percent of the peak day total could be present in the fishway in any given hour; this equates to a potential hourly peak of approximately 25,000 river herring, 2,700 shad, and 180 Atlantic salmon.

Assuming an average herring size of 0.5 lbs, shad size of 4 lbs, and salmon size of 8 lbs (USFWS, 2019), a minimum pool volume of 0.5 cubic feet per pound of fish (USFWS, 2019), and accounting for potential non-target species (10 percent) a total volume of approximately 13,500 cubic feet of water would be required to accommodate the peak run. (By way of comparison, the total residual pool volume provided at Howland was 21,600 cubic feet.) This volume should be provided in the residual volume of the resting pools (volume below the channel invert), with additional small resting areas provided downstream of the roughness boulders.

In summary, based on typical NLF design, following current resource agency criteria, resting pools would likely be required for an NLF at Shawmut, yet the conceptual designs submitted to FERC by MDMR lack resting pools in the two alternatives. Addition of resting pools to the NLF concepts would require either lengthening the fishway (to maintain the current hydraulic gradient) or steepening the gradient (thereby increasing velocities). As noted previously, the feasibility of lengthening the fishway is very low, given the site constraints, thus steepening the hydraulic gradient of the riffles would be the only alternative. Critically, the lack of inclusion of resting pools and the resulting effects on hydraulics in the fishway fails to demonstrate suitable fish passage in the NLF design.

The MDMR NLF conceptual design information filed with FERC neglects to account for, much less limit, any potential loss of renewable energy generation associated with the conceptual designs. Any proposed NLF would need to pass 5% of station capacity (340 cfs) as the minimum flow within the NLF for river flows up to the total of the station capacity and maximum flow in the NLF (7,040 cfs). Beyond that, the inlet flow control structure could be used to incrementally increase the flow in the NLF up to the maximum capacity of the NLF as river flow increases. This maximum NLF flow may also be limited by suitable depths and velocities in the fishway once detailed hydraulic modeling has

been completed. For the proposed NLF, the majority of the river flow could be provided through the generating station or the fishway up to approximately 8,500 – 9,000 cfs, or most of the lower half of the fishway operating range.

At flows greater than 9,000 cfs spill via the log sluice or spillway would become a potential for false attraction to migrating fish. One of MDMR's primary expressed concerns during fish passage design for Brookfield's proposed fish lift was false attraction. While providing a total attraction flow of up to 2,000 cfs through the proposed NLF would reduce the potential for spill in May from 65 percent to 55 percent and from 50 percent to 35 percent in June, a significant potential for false attraction remains—as well as the associated concerns for effectiveness of the proposed NLF entrance located downstream of the powerhouse and spillway. The potential for such false attraction was the primary reason that Brookfield's proposed fish lift entrance was located closer to the spillway than the conceptual NLF designs.

SUMMARY

In summary, the NLF conceptual designs lack detailed assessment of fishway hydraulics. Preliminary review of the concepts raises significant concerns for fish passage effectiveness under high and low-flow hydraulics (omission of resting pools, channel slope, and suitability of the proposed fishway for passage by the target species). The NLF concepts do not address physical space constraints, existing infrastructure issues, or potential dam safety issues. In contrast, it is Kleinschmidt's understanding that the proposed Shawmut fish lift was thoroughly sited, reviewed, designed and approved through a detailed and lengthy consultation process with fish passage experts and engineers from NOAA, USFWS, MDMR, MDEP, MDIFW and Brookfield's fish passage engineering consultants. This process resulted in the selection, in full consultation, of the best location and the most effective technology for the Shawmut Project. The MDMR conceptual designs filed with FERC, have not been vetted or developed in consultation with agency fish passage engineers or biologists nor Brookfield. In the absence of these fundamental assessments, the feasibility of the MDMR NLF designs is questionable. And without establishing the basic viability of the NLF designs, there is no basis to recommend an NLF as a viable alternative to be included with the fish passage design already proposed by Brookfield and approved by the agencies. In the event that post-construction studies of the fish lift reveal that additional attraction flow is required, an NLF is not necessarily the only or best way to provide it.

REFERENCES

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