STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

JANET T. MILLS
GOVERNOR

MELANIE LOYZIM
COMMISSIONER

January 3, 2022

Mr. Luke Anderson
Brookfield Renewable for
Brookfield White Pine Hydro LLC
150 Main Street
Lewiston, ME 04240

Subject: FERC No. 2302 – Lewiston Falls Hydroelectric Project
Pre-Application Document Comments
Study Request Submission

Dear Mr. Anderson:

The Maine Department of Environmental Protection (Department or MDEP) has received and reviewed the Notice of Intent to File License Application and Pre-Application Document (PAD), submitted on behalf of Brookfield White Pine Hydro (BWPH) on August 4, 2021. The PAD was submitted for the Lewiston Falls Hydroelectric Project (Project) (FERC No. 2302), located on the Androscoggin River in the Towns of Lewiston and Durham in Androscoggin County, Maine.

The proposed relicensing is subject to Water Quality Certification provisions of Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act). By Executive Order of the governor of the State of Maine, the Maine Department of Environmental Protection is the State certifying agency for projects located wholly or in part in organized towns and cities, and as such, has jurisdiction over the Lewiston Falls Hydroelectric Project. BWPH requested and was authorized to use the Traditional Licensing Process (TLP).

Project Description

The Project consists of a dam comprised of four stone masonry sections, a concrete dam section, and an island spillway; a 200-acre impoundment; a powerhouse near the east end of Dam #4 containing two turbine/generators; two gatehouse buildings; electrical connections; and appurtenant facilities. The Project impoundment has a normal maximum surface area of 200 acres at a full pond elevation of 168.17 feet msl. A 1.34 -foot-high flashboard system is installed on the dam crest of the concrete dam (dam #5), a split rubber bladder is installed on Dam #4, and a single rubber bladder is installed on each of Dams #1, 2, and 3. The Project has a normal pond elevation of 168.17 feet, with negligible useable storage when operated in run-of-river-mode.[1] The powerhouse is located at the east end of the falls and contains two vertical Kaplan turbine/generators with a combined FERC authorized rating of 36.354 MW.

[1] The PAD indicates that the Project is licensed to draw down up to four feet of impounded water but that the Project typically operates as a run-of-river facility with impoundment fluctuations limited to one foot or less.

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Comments on PAD

The Department appreciates the effort that BWPH and their consultants have made to prepare the PAD. The PAD provides an understanding of the project, the surrounding resources, and proposed Project operation. The PAD also provides information from which issues related to relicensing can be readily identified. The Department understands that no changes to Project operations are proposed. After review of the available documents, the Department has the following comments on the PAD:

1. **Section 3.3 Existing Operations** discusses Project operation coordination with the upstream Gulf Island-Deer Rips Project. In this section, the licensee states that the impoundment has no appreciable storage capacity and that the Project operates as a run-of-river facility with impoundment fluctuations of one foot or less on a daily basis. However, the PAD goes on to say that the Project is licensed to operate with up to four feet of impoundment fluctuation to allow adjustments between inflow and minimum flow requirements, or in response to operating emergencies. The Department notes that a Project cannot be operated as a run-of-river facility and also have an allowable fluctuation of four feet; run-of-river means inflow equal to outflow, with fluctuations one foot or less. Project descriptions provided in the PAD are inconsistent with accepted descriptions of the operational mode and the correct definition of proposed operations should be used. The Project operations should be clarified as run-of-river, store and release, or re-regulating.

2. **Section 4.3.2.3 Existing Water Quality Data** references water quality monitoring data that was collected in the impoundment and downstream of the Project by the Licensee and others to monitor water quality in the lower Androscoggin River. Studies that collected water quality data pertinent to water quality standards and the Project area include
    - Lewiston Falls Project Article 402Post-Operational Water Quality Monitoring (1990-1994);
    - Center for Applied Bioassessment & Biocriteria (CABB) 2002-2003 study on thew Spatial and Relative Abundance Characteristics of the Fish Assemblages in Three Maine Rivers;
    - MDEP 2011 Lower Androscoggin River Basin Water Quality Monitoring Study Modeling Report;
    - MDEP Volunteer River Monitoring Program (VRMP); and MDEP Dioxin Monitoring Program (DMP) and Fish Consumption information.

    The PAD discusses each of these datasets and concludes that based on its review, the Project meets Class C water quality classification standards, however it is not clear that the studies were conducted in accordance with the Department's Sampling Protocol for Hydropower Studies, or that the data reflects current conditions. The Applicant proposes and the Department supports conducting water quality studies to support this current relicensing, in consultation with the Department and other resource agencies to

demonstrate that current water quality conditions in the impoundment and in the tailrace meet water quality standards. As discussed below in the Water Quality Certification Data Requirements section, the Department requires several studies to demonstrate attainment of Maine Water Quality Standards in the Project area.

Water Quality Classifications and Standards

Water Quality Standards and the water quality classifications of all surface water of the State have been established by Maine Legislature (Title 38 M.R.S. §§ 464-468). The following classification applies to the waters affected by the Lewiston Falls Project:

"Androscoggin River, main stem, including all impoundments, from its confluence with the Ellis River to a line formed by the extension of the Bath-Brunswick boundary across Merrymeeting Bay in a northwesterly direction - Class C."[2]

Class C waters must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing, agriculture, recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation[3], navigation, and as a habitat for fish and other aquatic life.

The dissolved oxygen content of Class C waters may not be less than 5 parts per million or 60% of saturation, whichever is higher, except that in identified salmonid spawning areas where water quality is sufficient to ensure spawning, egg incubation and survival of early life stages, that water quality is sufficient for these purposes must be maintained.

Discharges to Class C waters may cause some changes to aquatic life, except that the receiving waters must be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

MDEP is aware of a proposed bill to the State Legislature which is an act to reclassify a section of the Androscoggin River to Class B[4]. The proposed legislation may impact the reach of the Androscoggin River in which the Lewiston Falls Project resides and may cause a change in water quality standards. Further, a proposal for upgrade to Class B is currently before the Board of Environmental Protection, which views the proposed change favorably. Therefore, classification of the Androscoggin River may change during the relicensing of the Lewiston Falls Project, and so MDEP recommends that, when conducting the studies outlined below, BWPH consider the results of the water quality studies in accordance with both Class C and Class B Water Quality Standards and water quality classifications.

Water Quality Certification Data Requirements

[2] Title 38 M.R.S. §467(1)(A)(2)
[3] Except as prohibited under Title 12, section 403.
[4] http://legislature.maine.gov/LawMakerWeb/summary.asp?ID=280079141

Water quality studies in the impoundment and tailrace reaches are typically required to evaluate compliance with Maine Water Quality Standards before the Department issues a water quality certification for a hydropower Project. It has been the Department's practice to determine the metrics, methods, timing, and duration of water quality monitoring necessary to ensure that the water quality studies meet data quality objectives. The Department requests that the Applicant conduct water quality studies that include the following parameters, and that adhere to the Department's established sampling protocols in support of water quality certification. Formal study requests are attached to this comment letter.

Water Quality Studies

Impoundment Trophic State Study – The goal of this study is to demonstrate that the trophic state of the impoundment is steady or declining[5]. BWPH presented baseline data collected by the Department and by others, including post-operational dissolved oxygen monitoring (1990-1994) by the then-licensee Central Maine Power, dissolved oxygen data collected for a bioassessment and biocriteria report (2003), and a DEP water quality sampling program in the lower Androscoggin that included a sample location in the impoundment and a river reach between the discharge of the Lewiston Falls Project and the Little Androscoggin River. Some of this data included sampling locations within the Lewiston Falls impoundment, however there is no indication that the data was collected in accordance with standard sampling protocols for Hydropower Studies and does not demonstrate that the impoundment exhibits a steady or improving (declining) trophic state. Therefore, the Department requires an Impoundment Trophic State Study, as outlined in the *DEP Sampling Protocol for Hydropower Studies* (March 2021) to determine if Maine's water quality standards are met under the proposed operating conditions.

Impoundment Aquatic Habitat Study – The purpose of this study is to determine the effect of impoundment drawdowns on the impoundment's littoral zone and the ability of the impoundment to support fish and other aquatic life. The Project is reportedly operated as a run-of-river facility but is licensed for a drawdown of up to four feet; therefore, operations may affect the littoral zone unless a change is made limiting operations to run-of-river (where run-of-river means inflow equal to outflow, with water level fluctuations one foot or less). The Applicant should conduct an impoundment aquatic habitat study following the "Habitat Study" protocol under "Lakes, Ponds, and Impoundments" in the *DEP Sampling Protocol for Hydropower Studies* (March 2021) which is attached to this comment letter. Such a study may require the collection of bathymetric data in the impoundment, to be used in conjunction with Secchi disk measurements collected during the Trophic State Study to determine the impact to impoundment habitats.

Temperature and Dissolved Oxygen Study – Temperature and dissolved oxygen (DO) must be monitored downstream of the Lewiston Falls dams in the large ledge pool and downstream of the powerhouse tailrace to demonstrate whether the Project meets Maine's Class C (and B) DO numeric criteria. Data must be collected in accordance with the Department's "Temperature and

[5] A declining trophic state indicates improved water quality conditions.

Dissolved Oxygen Study" protocol under "Rivers and Streams" in the *DEP Sampling Protocol for Hydropower Studies* (March 2021), which is attached to this comment letter. As noted in the protocol, the Applicant will need to consult with the Department to verify representative sampling locations as the study plan is developed.

Benthic Macroinvertebrate (BMI) Studies – The purpose of this study is to demonstrate whether current in-stream flow releases affect attainment of aquatic life and habitat criteria in the Androscoggin River downstream of the Lewiston Falls dams, including in the large ledge pool.

A BMI study will be required to determine the current macroinvertebrate community structure and to evaluate any impacts caused by project operations. The Applicant must conduct the benthic macroinvertebrate study downstream and in the vicinity of the Lewiston Falls Project dams following the DEP's standard protocol in *Methods for Biological Sampling and Analysis of Maine's Rivers and Streams (*April 2014), attached to this comment letter.

Downstream Habitat and Aquatic Life Cross-Section Flow Study – The purpose of this study is to evaluate whether proposed Project operations affect attainment of habitat standards for fish and other aquatic life in the river below the Lewiston Falls Project. The Applicant will need to test the proposed minimum flow, the range of flows associated with current operations, as well as other flow regimes to determine the flow at which at least 75% of the bank full cross-sectional area of the river is continuously watered. The Applicant must evaluate the impact to downstream habitats from operations that would result from the (currently) allowed four-foot drawdown and/or other operational schemes used at this facility. It is the Department's position that there must be both sufficient quality and quantity of habitat for aquatic organisms to meet aquatic life and habitat standards. The applicant must conduct the Cross-Section Flow Study following the "Habitat and Aquatic Life Studies" protocol under "Rivers and Streams" in the *DEP Sampling Protocol for Hydropower Studies* (March 2021), which is attached to this comment letter.

The Applicant must demonstrate that all designated uses, numeric DO standard and narrative criteria are maintained in all water affected by Project operations. Such demonstrations may require additional studies, such as a fish assemblage study, or a recreational access study. Therefore, in addition to standard water quality studies, the Department supports a study to evaluate the impact of a potential four-foot impoundment drawdown on access to the impounded reach of the Androscoggin River, to demonstrate whether the Project meets the designated uses of recreation in and on the water and navigation in the impoundment through the complete range of operational conditions, including full drawdown, as well as a fish assemblage study to determine if Project waters support all species of fish indigenous to the receiving waters.

MDEP also supports study requests prepared by other natural resource agencies, including but not limited to, Maine Department of Inland Fish and Wildlife (MDIFW), Maine Department of Marine Resources (MDMR), US Fish and Wildlife (USFWS), National Marine Fisheries Service (NMFS).

Thank you for the opportunity to comment on the Pre-Application Document for the Lewiston Falls Hydroelectric Project. If you have any questions, please contact me by phone at (207) 446-2642 or by email at Kathy.Howatt@maine.gov.
Sincerely,

Kathy Davis Howatt
Hydropower Coordinator, Bureau of Land Resources
Maine Department of Environmental Protection

Attachment:

DEP sampling Protocol for Hydropower Studies (March 2021)

Cc: Kimberly Bose (FERC), efile

Maine Department of Environmental Protection
Study Request
Lewiston Falls Hydropower Project (FERC No. 2302)

Impoundment Trophic State Study

1. **Describe the goals and objectives of each study proposal and the information to the obtained.**
   Trophic state is an important indicator of water quality within the impoundment. Assessment of this criteria provides information to evaluate the health of the Lewiston Falls impoundment and the impact of the dam structures on water quality in the Androscoggin River. The objective of this study proposal is to determine if the project impoundment meets Maine Water Quality Standards, including the dissolved oxygen standards and the designated use of recreation in and on the water. This study will assess whether the trophic state of the impoundment is stable or improving.

2. **If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.**
   The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

3. **If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.**
   Requestor is a resource agency.

4. **Describe existing information concerning the subject of the study proposal, and the need for additional information.**
   The Applicant proposes to conduct water quality studies in the Project PAD. As described in the Department's PAD comment letter, the applicant will need to conduct a trophic state study to demonstrate whether the Project meets water quality standards, including dissolved oxygen in the impoundment and that the trophic state is stable or declining (improving) in order to obtain water quality certification.

5. **Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.**
   Data collected will identify trophic state and may identify stratification effects on the impounded water and habitat. Information will be used to evaluate whether the Project meets Maine designated uses, habitat and aquatic life criteria, and dissolved oxygen criteria, which will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**
The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**
Trophic state samples are collected twice each month for five consecutive months during open water season. The impoundment aquatic habitat study, requested in a separate Study Request, relies in part on data collected during the Trophic State Study. The Trophic State Study can be completed in a single field season. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Lewiston Falls Hydropower Project (FERC No. 2302)

Impoundment Aquatic Habitat Study

1. **Describe the goals and objectives of each study proposal and the information to the obtained.**
   The objective of this study proposal is to determine if the project impoundment meets Maine Water Quality Standards including habitat and aquatic life criteria. Measurements of Secchi disk transparency and bathymetric data are applied to determine the extent of the littoral zone in the impoundment and an assessment of the volume and surface area dewatered under normal operating conditions is made to determine if at least 75% of the littoral zone remains watered at all times. Assessment of the shoreline littoral environment is necessary to evaluate the impact of Project operations on habitat there to determine if the Project attains Maine's aquatic life criteria, a narrative water quality standard.

2. **If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.**
   The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

3. **If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.**
   Requestor is a resource agency.

4. **Describe existing information concerning the subject of the study proposal, and the need for additional information.**
   The PAD does not indicate that the Lewiston Falls impoundment meets Maine Water Quality Standards, specifically aquatic life and habitat criteria. The Applicant proposes to conduct water quality studies, which must include assessment of proposed Project operations on the littoral zone in the impoundment.

5. **Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.**
   Data collected will identify any drawdown effects and may identify stratification effects on the impounded water and habitat. Information will be used to evaluate whether the project meets Maine designated uses including habitat and aquatic life criteria, which will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**
   The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**
   The impoundment aquatic habitat study can be completed in one field season and can be designed as a desktop study utilizing data collected in the Trophic State Study along with bathymetric data. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Lewiston Falls Hydropower Project (FERC No. 2302)

Downstream Temperature and Dissolved Oxygen Study

1. **Describe the goals and objectives of each study proposal and the information to the obtained.**
   Temperature and dissolved oxygen (DO) are important indicators of water quality to ensure that discharges from the hydropower Project are sufficient to maintain the resident biologic community downstream of the Lewiston Falls dams. Assessment of temperature and DO data in the downstream reaches will be used to determine if the hydropower Project meets Maine Water Quality Standards including Class C DO criteria.

2. **If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.**
   The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act)

3. **If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.**
   Requestor is a resource agency.

4. **Describe existing information concerning the subject of the study proposal, and the need for additional information.**
   Dissolved oxygen concentrations downstream of the Lewiston Falls dams must meet Maine water quality criteria for Class C waters. A review of data summaries included in the PAD indicates temperature and dissolved oxygen data is dated and may have been collected in a manner inconsistent with approved protocols for hydropower studies, and therefore is insufficient to assess current attainment of these criteria. The PAD indicates that the Applicant intends to conduct water quality studies and the Department determines that a study of this nature is necessary to assess impacts of Project operations on DO.

5. **Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.**
   Data collected will be used to evaluate Project effects on water temperature and DO concentrations in the Androscoggin River downstream of the Lewiston Falls dams. Information will be used to evaluate whether the project meets Maine DO criteria for Class C waters and will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**
The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**
The DEP Sampling Protocol for Hydropower Studies (March 2021) offers two options for the temperature and DO study that can be completed in one field season. Temperature and DO samples can be collected one day per week for at least 10 weeks or measured hourly using data sondes placed at designated locations during summer low flow, high water temperature conditions (e.g. July through August, or mid-August through mid-September). The Department prefers the second method. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Lewiston Falls Hydropower Project (FERC No. 2302)

Benthic Macroinvertebrate Study

1. **Describe the goals and objectives of each study proposal and the information to the obtained.**
   Assessment of the benthic macroinvertebrate community is critical to determine whether current in-stream flow releases affect attainment of Maine habitat and aquatic life criteria for Class C waters in the Androscoggin River below the Lewiston Falls dam. The assessment provides biological data to evaluate potential impacts caused by Project operations.

2. **If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.**
   The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act)

3. **If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.**
   Requestor is a resource agency.

4. **Describe existing information concerning the subject of the study proposal, and the need for additional information.**
   The Androscoggin River must meet Maine's habitat and aquatic life criteria in the vicinity of the Lewiston Falls Project. Agency file review indicates data is insufficient to evaluate the current aquatic community in the tailrace reaches downstream of the Lewiston Falls dams. The PAD indicates that water quality studies will be conducted but does not indicate that a study of this nature is planned for the Project.

5. **Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.**
   Data collected will be used to evaluate the benthic macroinvertebrate community in the tailrace reach downstream of the Lewiston Falls dam and in the large ledge pool downstream of dam #3. Information will be used to evaluate whether the project meets Maine aquatic life criteria and will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**

The DEP Methods for Biological Sampling and Analysis of Maine's Rivers and Streams (April 2014) was established by Department staff and has been used successfully throughout the state by DEP and others since 1983. A copy of the Department manual is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**
Replicate benthic macroinvertebrate sample collectors (rock baskets or cones) are deployed for a 28-day study period in the tailrace reach of the hydropower Project during low flow, high temperature conditions. Samples must be collected by a professional aquatic biologist and evaluated by a professional freshwater macroinvertebrate taxonomist. Methods are documented in the DEP manual Methods for Biological Sampling and Analysis of Maine's River and Streams (April 2014). Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Lewiston Falls Hydropower Project (FERC No. 2302)

Aquatic Habitat Cross-Section Flow Study

1. **Describe the goals and objectives of each study proposal and the information to the obtained.**
   Assessment of aquatic habitat downstream of the Lewiston Falls dams is required to determine whether current in-stream flow releases meet Maine habitat and aquatic life criteria. A cross-section flow study measures width and depth at various flows along established transects at various discharges to determine flows at which at least 75% of the bankfull cross-sectional area is sufficiently watered[6] to provide habitat for fish and other aquatic organisms. Data will be evaluated to determine if the downstream waters provide sufficient quantity of water to maintain riverine aquatic habitat in the bypass and tailrace reaches.

2. **If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.**
   The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

3. **If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.**
   Requestor is a resource agency.

4. **Describe existing information concerning the subject of the study proposal, and the need for additional information.**
   The Androscoggin River downstream of the Lewiston Falls dams must meet Maine habitat and aquatic life criteria. The PAD does not present data for the tailrace reach of the Lewiston Falls Project that examines these criteria. The PAD indicates that the Applicant intends to conduct water quality studies, but does not specify that a study of this nature is planned for the Project.

5. **Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.**
   Data collected will be used to evaluate aquatic habitat in the Androscoggin River downstream of the Lewiston Falls Project. Information will be used to evaluate whether the Project meets Maine habitat and aquatic life criteria and will inform the water quality certification process.

[6] Sufficiently watered means providing a continuously watered zone of passage with a water depth of at least one foot that allows indigenous fish or other aquatic life freedom of movement without harm.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**
   The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**
   A cross-section flow study measures depth and wetted width along established transects in the bypass and tailrace reaches at various discharges to determine flows where at least 75% of the bankfull cross-sectional area has enough water to provide habitat for fish and other aquatic organisms. This type of study can typically be accomplished in one or two days. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

LAKES, PONDS, AND IMPOUNDMENTS

Applicability

This impoundment sampling protocol shall apply to existing hydropower impoundments regardless of their waterbody classification, where existing data are insufficient (in terms of density or quality) to determine water quality.

Trophic State Study

Overview & Sampling Stations

Each basin or station shall be sampled at the deepest location twice each month, at approximately 2-week intervals for at least five consecutive months during one open-water season. Sampling will consist of obtaining physical measurements as well as water samples. Water samples will be obtained using an integrated core sampler that is 10-meters long, and, when water is of adequate depth, a grab device. During August, additional water samples will be obtained. Sampling personnel must be certified for this sampling protocol annually, prior to data collection by DEP's Division of Environmental Assessment, Lake Assessment Section staff. If sampling is inadequate or certification is bypassed, a second open water season of data may be required. Additional sampling may be required due to the hydraulic or physical characteristics of a given waterbody or to the presence of significant water quality problems. Refer to Table 1 for an overview of parameters, frequency, sampling methods and detection/reporting limits.

Table 1. Summary of parameters, frequency, sampling methods and detection/reporting limits for hydropower impoundment sampling.

Parameter	Frequency	Sampling Method	Detection/Reporting Limits
Secchi disk transparency	2x/month	disk and water scope	0.1 meter
Temperature	2x/month	electronic meter (profile)	0.1 °C
Dissolved oxygen	2x/month	electronic meter (profile)	0.2 mg/l
Trichromatic Chlorophyll-a (uncorrected)	2x/month	core tube	0.001 mg/L
Water Chemistry	2x/month; additional samples in August	core tube or grab device	See Table 2 below

Physical measurements

Physical measurements will include the determination of water transparency using a Secchi disk and water scope following the Maine Lake Assessment SOP for *Secchi Disk Transparency* (DEPLW0947R2). In addition, profiles for temperature and dissolved oxygen will be taken from the water surface to the bottom of the impoundment. Readings will be obtained, recorded, and submitted on DEP lake monitoring forms. Readings will be obtained in 1-meter increments from the surface to 15 meters in depth, then in 2 meter increments from 15 meters to 25 meters, and every 5 meters in water deeper than 25 meters; if between 15 and 25 meters, a rapid change in temperature or oxygen is discovered, readings will be taken at 1 meter intervals until they stabilize. Refer to the Maine Lake Assessment SOP for obtaining Dissolved Oxygen/Temperature Profiles using electronic meters for additional details (DEPLW0941R2). If a multiparameter device is used that can also measure pH and specific conductance, these data may be substituted for lab data, providing that calibration and quality control check records are maintained and submitted with the data.

Epilimnetic core samples

The depth to which an integrated epilimnetic sample will be obtained using a core tube will be determined according to the Maine Lake Assessment SOP for *Epilimnetic Core Sample Collection* (DEPLW0946R2). Water samples collected through the season will be analyzed for uncorrected chlorophyll-a by the trichromatic method, total phosphorus, color, pH and alkalinity. Water samples collected in August will be additionally analyzed for nitrate, TKN, DOC, iron, calcium, magnesium, total and dissolved aluminum, sodium, potassium, silica, specific conductance, chloride, and sulfate. Refer to Table 2 for specific requirements; obtain bottles and preservatives from the analytical lab. In impoundments that do not thermally stratify (no change in temperature greater than or equal to 1°C per meter below a depth of 2 meters from the water surface), the core sample will be collected to 1 meter above the bottom, unless dissolved oxygen is less than or equal to 2 ppm, in which case the sample should be collected to the meter above that depth.

During warmer times of the year, if the lake is deep enough to stratify, examine the dissolved oxygen / temperature profile to determine the depth of the true seasonal epilimnion using the 1°C change over 1 meter of depth rule below a depth of 2 meters. Be aware that within the true or seasonal epilimnion, a shallow, secondary ephemeral (temporary) epilimnion can form in the top few meters of water as a result of a few calm, warm days. Take the core sample to 1-meter below the bottom of the true epilimnion so as to include neutrally-buoyant algal growth at the epi/metalimnion interface. Elevated dissolved oxygen lower in the profile may indicate need to extend the core deeper to capture the algae responsible for the oxygen spike. Because Chlorophyll samples are generally obtained from the core sample, never incorporate any water having 2 ppm of oxygen or less into the sample.

Grab samples

During late summer (mid to late August depending on latitude and weather conditions), in stratified lakes, grab samples will be obtained using a Kemmerer, Van Dorn or similar device, according to the Maine Lake Assessment SOP for the *Collection of Grab (discrete) Samples* (DEPLW0949R2). The grab samples will be analyzed for total phosphorus, color, pH, alkalinity, TKN, DOC, iron, calcium, magnesium, total and dissolved aluminum, sodium, potassium, silica, specific conductance, chloride, and sulfate. Refer to Table 2 for additional details.

If the lake does not stratify, no grab samples are needed. Otherwise, the number of grab samples taken is determined by the depth and thermal stratification pattern in the lake. In lakes deep enough to thermally stratify into 3 layers, grabs will be obtained from the metalimnion and hypolimnion. The metalimnetic sample will be taken 1 meter below the depth to which the integrated epilimnetic core sample was taken, and the hypolimnetic sample will be taken a meter above the bottom of the impoundment. In lakes that only stratify thermally into 2 layers, only one grab depth is necessary; in this case the grab sample will be obtained a meter above the bottom of the impoundment.

Table 2. Summary of water sampling parameters, reporting levels, frequency, and sample types limits for hydropower impoundment sampling.

Parameter	Reporting Level	2x per month	August	Sample types
Trichromatic Chlorophyll a (uncorrected)	0.001 mg/L	X	X	core
Total phosphorus	0.001 mg/L	X	X	core & grab(s)
Nitrate	0.01 mg/L	X	X	core & grab(s)
TKN	0.01 mg/L	X	X	core & grab(s)
Color	5.0 SPU	X	X	core & grab(s)
DOC	1.0 mg/L	X	X	core & grab(s)
pH	0.1 pH units	X	X	core & grab(s)
Total alkalinity	1.0 mg/L	X	X	core & grab(s)
Total iron	0.05 mg/L		X	core & grab(s)
Total & dissolved aluminum	0.002 mg/L		X	core & grab(s)
Total calcium	0.05 mg/L		X	core & grab(s)
Total magnesium	0.05 mg/L		X	core & grab(s)
Total sodium	0.05 mg/L		X	core & grab(s)
Total potassium	0.05 mg/L		X	core & grab(s)
Total silica	0.05 mg/L		X	core & grab(s)
Specific conductance	2 µS/cm		X	core & grab(s)
Chloride	0.5 mg/L		X	core & grab(s)
Sulfate	1 mg/L		X	core & grab(s)

Habitat Study

For lakes, ponds, and riverine impoundments, determination of attainment of the designated use 'habitat for fish and other aquatic life' will be determined as follows. Using a depth of twice the mean summer Secchi disk transparency, determined from the Trophic State Study or historic DEP data, as the bottom of the littoral zone, the volume and surface area dewatered by the drawdown will be calculated to determine if at least 75% of the littoral zone remains watered at all times. Alternatively, studies of fish and other aquatic life communities, including freshwater mussels, may be conducted to demonstrate that the project maintains 'structure and function of the resident biological community' despite a drawdown that results in less than 75% of the littoral zone remaining watered at all times.

Fishing (Mercury Contamination) Study

To ensure that the project does not contribute to the Statewide Fish Consumption Advisory due to mercury, projects with excessive drawdowns (generally >10 feet) may be required to analyze sport fish from the project waterbody and one or more reference waters for mercury. Contact DEP for specific requirements for each project.

RIVERS AND STREAMS

Temperature and Dissolved Oxygen Study

Applicability

This rivers and streams sampling protocol shall apply to tailwater areas that are not impoundments where existing data are insufficient to determine existing and future water quality.

Sampling Stations

Sampling shall occur in the tailwater downstream from the turbine/gate outlet or dam at a location representative of downstream flow as agreed by DEP on a case by case basis. Initially, measurements of temperature and dissolved oxygen should be made along a transect across the stream at the first, second and third quarter points across the width. If there is no violation of dissolved oxygen criteria and no significant (<0.4 mg/l) difference in concentrations among the quarter points, subsequent measurements may be made at the location shown to be representative of the main flow. Otherwise, measurements should be made at the location of the lowest concentration and the location of the main flow. Sampling should also occur in any bypassed segment of the river created by the project. Additional sampling stations may be required in the upstream or downstream areas where significant point or nonpoint sources exist or where slow moving or deep water occurs. The number and spacing of any additional stations will be determined by DEP on a case-by-case basis.

Parameters

Temperature and dissolved oxygen shall be sampled at mid-depth in rivers less than 2 m deep or in a profile of 1-meter increments of depth in rivers greater than 2 m deep. In rivers where it is already known that attainment of required statutory dissolved oxygen criteria is questionable, sampling for additional parameters (e.g. BOD, nitrogen, phosphorus) may be necessary.

Frequency and Timing

Sampling should be conducted during the summer low flow high temperature period, with the ideal conditions being the 7Q10 flow (the 7-day average low flow with a 10-year recurrence interval) combined with daily average water temperatures exceeding 24 ^{O}C. Measurements of temperature and dissolved oxygen shall be made every hour with a data sonde in remote unattended mode continuously during July and August, unless high flows well above seasonal median flows occur.

Alternatively, with concurrence by DEP, sampling could be undertaken one day per week for a minimum of ten weeks throughout the summer low flow, high temperature period. Each discrete grab sampling event for temperature and dissolved oxygen would consist of a minimum of two daily runs, the first of which should occur before 7 AM and the second of which should occur after 2 PM. Sampling results will not be considered complete unless a minimum of 5 sampling days meets the following conditions: The product of the water temperature (^{O}C) and the flow duration (the percentage of the time a given flow is statistically exceeded) at the time of sampling exceeds 1500. For cycling hydropower projects, in addition to twice daily monitoring, continuous monitoring may be required at some locations for a duration equivalent to the period of one cycle of the storage and the release of flow.

For either method, a summer in which low flows and high temperatures are not experienced may result in additional sampling requirements for the next summer. Low flow conditions may occur naturally, as an unregulated river or may be artificially induced, as in the case of upstream flow regulation or flows downstream from a cycling or peaking power project or in the case of a bypassed segment which receives flow only by spillage, leakage or specific releases.

Available Data

The use of data already available is encouraged provided that adequate QA/QC procedures have been followed. Old data may not be acceptable for considerations of meeting minimum sampling requirements but could still provide useful information. Acceptance/rejection of data will be determined on a case by case basis, but generally data more than 10 years old may be rejected.

Habitat and Aquatic Life Studies

For rivers and streams, determination of attainment of the designated use 'habitat for fish and other aquatic life' and "structure and function of the resident biological community" will be determined as follows. A Cross-Section Flow Study is required that measures width and depth at various flows to determine the flow at which at least 75% of the bank full cross-sectional area of the river or stream is continuously watered. At least three cross-sections representative of the river or stream must be measured. Alternately, a combination of ambient measurements in one cross-section, flow data from existing flow gages, and/or modelling may be approved by DEP.

In addition, to determine if the project 'attains the aquatic life criteria, i.e. 'maintains the structure and function of the resident biological community', biological monitoring of the benthic macroinvertebrate community must be conducted following DEP's standard protocol in Methods for Biological Sampling and Analysis of Maine's Rivers and Streams, DEP LW0387-B2002.
A copy can be found at www.maine.gov/dep/water/monitoring/biomonitoring/material.html

Methods for Biological Sampling and Analysis of Maine's Rivers and Streams

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Leonidas Tsomides

DEP LW0387-C2014
Revised April, 2014

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

METHODS

FOR

BIOLOGICAL SAMPLING AND ANALYSIS OF

MAINE'S RIVERS AND STREAMS

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CONTENTS

FOREWORD

This manual describes the field, laboratory and data preparation methods required by the Maine Department of Environmental Protection to collect and analyze benthic macroinvertebrate samples for the River and Stream Biological Monitoring Program. The biological classification of Maine's inland waters was authorized by the Maine State Legislature with the passage of Public Law 1985 Chapter 698 - The Classification System for Maine Waters. This law states that it is the State's objective "to restore and maintain the chemical, physical and biological integrity" of its waters, and establishes a water quality classification system to enable the State to manage its waters so as to protect their quality. The classification system further establishes minimum standards for each class, which are based on designated uses, and related characteristics of those uses, for each class of water.

Each water quality class contains standards that, among other things, describe the minimum condition of the aquatic life necessary to attain that class. The Maine Department of Environmental Protection (the Department) has developed numeric criteria in support of the narrative aquatic life standards in the Water Quality Classification Law. The Department has collected a large, standardized database consisting of benthic macroinvertebrate samples from above and below all significant licensed discharges in the State, from areas impacted by non-point sources, as well as from relatively unperturbed areas. These sampling locations were chosen to represent the range of water quality conditions in the State. This information has been used to develop numeric criteria which are specific to the natural biotic community potential of the State of Maine (see Davies et al., 1995 and 1999 for a description of the development and application of numeric criteria) and is established in DEP regulation Chapter 579 : Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams.

Standardization of data collection and analytical methods is fundamental to the consistent, unbiased and scientifically sound evaluation of aquatic life impacts. This manual sets forth the standardized practices and procedures used by the Department to acquire or accept benthic macroinvertebrate data for use in regulation, assessment or program development.

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I GENERAL METHODS FOR RIVER AND STREAM AQUATIC LIFE CLASSIFICATION ATTAINMENT EVALUATION

Each water quality class is defined by standards that describe the minimum condition of the aquatic community necessary to attain that class. The benthic macroinvertebrate community is used as an indicator community of the general state of the aquatic life in flowing waters for the purpose of assessment of classification attainment. Standardized sampling techniques and sample analysis are required for assessment of biological attainment of stream water quality classification. This manual presents the standard practices and procedures that have been adopted by the Department to acquire benthic macroinvertebrate data for purposes of aquatic life classification attainment evaluation.

Purpose:

To determine the water quality class attained by a particular river or stream reach in terms of the aquatic life standards set forth in 38 MRSA Sec. 465 (The Classification System for Maine Waters).

Requirements:

All samples of aquatic life that are collected for purposes of classification attainment evaluation, whether collected by the Department or by any party required to make collections by the Department, must be collected, processed and identified in conformance with the standardized methods outlined in this manual. Selection of appropriate sampling sites and micro-habitat to sample, as well as procedures for quantitative analysis of the sample must conform to methods set forth in this manual. Data submitted by any party required to make collections by the Department must be accompanied by a Quality Assurance Plan, approved by the Commissioner.

1. Qualifications of Sampling Personnel

Biological sampling must be performed by a professional aquatic biologist or by qualified personnel under the supervision of a professional aquatic biologist. The professional aquatic biologist must have, as a minimum, a Bachelor of Science degree in biological sciences with aquatic entomology, invertebrate zoology, fisheries or closely related specialization, and greater than 6 months experience working with macroinvertebrate sampling methods and taxonomy. (See also Qualifications of Laboratory Personnel, Sec. II-1.)

2. Apparatus, Equipment, Supplies, Instruments

(1) Sampling devices

a) Rock-filled wire basket introduced substrate

Use: flowing wadeable, eroded, mineral-based bottom rivers and streams.

Description: cylindrical plastic coated or chrome wire, baskets with at least 1.5 cm spaces between wires, a hinged opening, and secure closure (Klemm, D.J. et al, 1990).

Substrate material: clean, washed, bank-run cobble, graded to uniform diameter range of 3.8 to 7.6 cm (1.5 to 3 inches) in size (#2 roofing stone).

Baskets must be filled to 7.25 +/- 0.5 kg (16 lbs +/-1 lb) of substrate material.

b) Rock-filled mesh bag introduced substrate

Use: small flowing streams, too shallow for rock baskets to be fully submerged.

Description: mesh bags of sufficient size to hold 7.25 +/- 0.5 kg of cobble substrate as described above, with at least 2.54 cm aperture mesh, and secure closures.

c) Closing introduced substrate cone

Use: deep, non-wadeable rivers having sufficient flow to have an eroded, mineral based bottom.

Description: cone shaped wire, or plastic coated wire basket filled with substrate material and closed by means of an inverted, weighted funnel (Courtemanch, 1984).

Substrate material: (see above Rock-filled wire basket substrate material).

(2) Sieves, sieve buckets, nets

Samples are concentrated on sieves having a mesh size between 500 - 600 microns (USA Standard Testing Sieve ASTM-E-11 Specification size No. 30 or No. 35).

(3) Optical equipment

a) Binocular microscope: Magnification range from 10x or less to 30x or greater.

b) Compound microscope: Magnification range from 10x to at least 400x; 100x with oil immersion lens is advisable.

3. Sampling Season, Sampler Exposure Period, Placement and Retrieval

(1) Sampling season

The standard sampling season upon which all macroinvertebrate classification criteria are based is the late summer, low flow period (July 1 to September 30). All baseline data for the biological classification program has been collected during this time period. This period often presents conditions of maximal stress to the biological community due to decreased dilution of pollutional material and increased stream water temperatures. Furthermore, because the composition of the benthic macroinvertebrate community changes with season, due to natural life history features, this period defines a standardized seasonal community.

As noted, the Department's linear discriminant models define biological classification criteria derived from a macroinvertebrate community defined by the specific sampling methods and index season under which they were collected. Samples collected at other times of year may yield valuable water quality related information, however classification attainment may not be assigned solely on the basis of results of the linear discriminant models for these non-standard samples.

(2) Exposure period

Standard methods require that substrate samplers be exposed in the water body for a period of 28 days +/- four days within the above-specified sampling season. However, extended exposure periods may be necessary to allow for adequate colonization in the case of assessments of low velocity or impounded habitats. If such conditions exist a 56 days +/- four days exposure period may be used.

(3) Sampler placement

Rock Baskets/Bags

The actual sampler location should be approached so as to avoid any disturbance in, or upstream of, the sampled site. Position baskets in locations of similar habitat characteristics. Orient baskets with the long axis parallel to stream flow. Provide for relocation of baskets by flagging trees in the vicinity and/or by drawing a diagram with appropriate landmarks indicated.

Cones

Cone samplers should be marked with individual marker buoys (milk jugs or other suitable float) leaving about 5 extra feet of line to allow for water level changes and to provide for easy retrieval. They should be placed on the substrate with a minimum of disturbance, in an apex-up position, and located in the approximate middle fifty percent of the channel. (Note however, care should be taken not to create an obstruction to boat traffic.) In areas subject to vandalism, or in rivers having extensive macrophyte beds, it may be necessary to attach the sampler lines to a common anchor and thence to one unobtrusive surface float. Retrieval funnels will not properly close when lines are fouled with drifting macrophytes.

(4) Sampler retrieval

Rock Baskets/ Bags

Baskets are approached from downstream. Excessive accumulations of macrophytes, algae or debris clinging to the outside of the basket should be carefully removed, taking care to avoid jarring the basket itself. An aquatic net or drift net (mesh size 500 - 600 microns) is positioned against the substrate immediately downstream of the basket which is then quickly lifted into the net. The contents of the basket and all net washings are emptied into a sieve bucket (500 - 600 microns); the basket wires are carefully cleaned first, then rocks are hand washed and inspected and returned to the basket. All sieve bucket contents are placed in sample jars. A small amount of stream water and 95% ethyl alcohol is added to yield an approximately 70% solution of alcohol. Especially dense samples should be re-preserved in the laboratory, with fresh 70% ethyl alcohol. Rock baskets should be thoroughly cleaned and allowed to desiccate prior to re-use.

Cones

Cone samplers should be retrieved with the boat anchored directly upstream of the samplers. Once the float is retrieved and removed, the line should be held as vertically as possible while the weighted funnel is released down the line to enclose the cone. Cone and funnel should be retrieved quickly and smoothly from the bottom, and released directly into a sieve bucket or tub. Field processing should then proceed as described above for rock baskets.

4. Site Selection Criteria

Classification criteria apply to a strictly defined sample of the benthic macroinvertebrate community. Habitat type from which the community is obtained is a significant determinant of the make-up of the target community. Benthic macroinvertebrate communities of flowing streams and rivers having a hard, eroded substrate comprise the majority of samples in the baseline data set. This habitat is characteristic of the majority of the river and stream waters of the State. Exceptions to these conditions may require special consideration and the exercise of professional judgment. (Note: See Section III-2. (3) "Classification attainment evaluation of waters subjected to flow regulation" page 13, for procedures relating to the assessment of regulated flow sites.) While it is useful to obtain both an upstream and downstream sample to evaluate the effect of a pollution source, classification attainment evaluation does not require data from a matched reference site in order to arrive at a determination of aquatic life class. Analytical methods for classification attainment evaluation are described in Section III.

(1) Site attributes

a) The area selected should be generally representative of the habitat of the stream reach as a whole;
b) Where there is alternating riffle/pool habitat, the riffle/run is the habitat of choice;
c) A location should be selected where there is a high degree of certainty that the rock basket samples will remain fully submerged even if the water level drops significantly.

(2) Precautions

a) Avoid atypical influences such as bridges, entering culverts, channelized areas such as road crossings, culverts, or obstructions to flow;
b) Avoid bank effects: samplers should be located in the middle 50% of the bank to bank width, or in an area with a flow regime typical of the overall character of the stream segment;
c) Avoid slackwater areas and eddies immediately upstream or downstream of large rocks or debris.

(3) Matching reference and effluent impacted sites

If possible both stream reaches should be viewed prior to selection of sampling sites. Efforts should be made to sample habitats which are comparable in the following characteristics:

a) Water velocity;
b) Substrate composition (i.e., size ranges and proportions of particles making up the substrate);
c) Canopy coverage;
d) Depth;
e) Other upstream influences except the pollution source in question (for example, use caution when one site is just below a lake outfall and the other is not).

(4) Factors to be considered in site selection below point sources

The area of initial dilution of an effluent should be determined by visual observation of the plume pattern; by observations of biotic effects attributable to the plume, if evident (periphyton growth, die-off patterns); and by transects of specific conductance measurements from the outfall, in a downstream direction. The site selected should be in an area where reasonable opportunity for mixing of the effluent has occurred. If a mixing zone has been defined in a license, sampling should occur immediately downstream of it. In cases where the effluent plume channels down one bank for great distances (>1 km), or where localized effluent impact is expected to be severe for a distance beyond the zone of initial dilution, it is advisable to have a sampling site upstream of the source, one or more in the plume, and at least two farther downstream. One downstream site should be located at the point of presumed bank to bank mixing and subsequent sites should be located to assess the extent of impact downstream.

5. Sample Size

The biological community is evaluated on the basis of benthic macroinvertebrates obtained from at least three samplers which yield an average of at least 50 organisms per sampler. Matched upstream and downstream sites must be sampled using identical methods and level of effort, preferably by the same personnel.

Subsampling may be performed on samples if the mean number of organisms in a sampler exceeds 500 and subsampling will yield at least 100 organisms per rock/cone sampler. All samplers in a site should be treated consistently. Subsampling methods are described in Section II-5. Note: Subsampling will

reduce sample richness by an indeterminate amount. This may affect the outcome of linear discriminant analysis. See Section III-2. (2).

6. Physical Habitat Evaluation

A field data sheet (Appendix A) is to be completed at the time of sampler placement. This form records site specific information concerning natural variables that may affect community structure. Items addressed include exact site location (latitude and longitude, narrative description of the mapped location and/or a topographic map with site indicated); substrate composition; canopy coverage; land use and terrain characteristics; water velocity, temperature, dates of exposure and investigator name. The form is to be completed by observation as well as instrument measurement of water velocity, specific conductance, dissolved oxygen, global positioning device, temperature, etc.

II LABORATORY METHODS

1. Qualifications of Laboratory Personnel

Sample processing and taxonomy in the laboratory must be performed or supervised by a professional freshwater macroinvertebrate taxonomist who is certified by the Society of Freshwater Science in the identification of eastern US taxa. Certification must include Genus level categories, such as Ephemeroptera, Plecoptera and Trichoptera (EPT), General Arthropods and Chironomidae taxa. Taxonomic data will not be accepted without verification that the supervising laboratory taxonomist has been certified in relevant categories.

2. Sample Preservation, Sorting

All sample material collected in the field, as described in Section I, is preserved in 70% ethyl alcohol. Samples are stored in airtight containers until sorted. Sorting of macroinvertebrates from detritus and debris should follow methods described in Appendix B. One out of every ten samples is evaluated by a biologist for sorting completeness.

After sorting, recommended storage for macroinvertebrates is in 70% ethyl alcohol with 5% glycerin, in vials sealed with tightly fitting rubber stoppers.

3. Sample Labeling

All samples are labeled in the field immediately upon collection. The label must include the following information:

Date of sample retrieval
Waterbody
Town or target discharge
Whether above or below the discharge (if applicable)
Replicate number

4. Sample Log Book

In the laboratory, the samples from each sampled site are to be assigned a sample log number, written on all items generated by the sample (e.g., sample vials, slides, records, count sheets, etc.). Log numbers are sequentially recorded in a master log book. The log book shall also contain site identification, date of placement and retrieval, investigator name, sampler type and any comments regarding sampler retrieval or data quality.

5. Subsampling

(1) Methods

If it is determined that a sample should be subsampled (see criteria in Section I-5 Sample Size) methods of Wrona et al, (1982) are followed. These are summarized below:

a) Fit a plastic or glass Imhoff-type settling cone with an aquarium air stone sealed in the bottom and connected to a compressed air supply.

b) Place the sorted macroinvertebrate sample in the cone and fill the apparatus with water to a total volume of one liter.

c) Agitate gently for 2 to 5 minutes with the air stone.

d) Remove 25% of the sample in 5 aliquots with a wide-mouth 50 ml dipper and combine into one sample vial. The dipper should be submerged and withdrawn over a five second interval.

e) Ascertain whether or not the required 100 organisms have been obtained in the subsample.

f) Indicate clearly on the sample label and on the data sheet the fraction of the sample that the subsample represents.

(2) Precautions

a) Especially large or dense organisms such as crayfish, molluscs or caddisflies with stone cases, which do not suspend randomly in the sample, should not be included in the subsample. They should be counted separately.

b) When removing aliquots, the subsampler should be careful to avoid biased capture of organisms in the cone. Avoid watching the cone as the dipper is withdrawn.

This method has been tested by the Department and has been found to randomly distribute the sample. The five separate counts conform to a Poisson series and thus can be combined into one sample (Elliott, 1979).

(3) Chironomidae subsampling

A subsampling plan for Chironomidae shall be approved by the Department. A Department recommended subsampling plan follows the following criteria:

a) For samples having less than 100 midges, all midges will be identified to genus/species level.

b) For samples having 100 to 199 midges, a subsample of one half (0.5) will be removed by randomly selecting the specimens to be identified and identified to genus/species level. Remaining unsampled midges will be examined for unusual or rare specimens, which will be removed and identified to genus/species level separate from the subsample of the sample.

c) For samples having 200 to 499 midges, a subsample of one quarter (0.25) will be removed by randomly selecting the specimens to be identified and identified to genus/species level. Remaining unsampled midges will be examined for unusual or rare specimens, which will be removed and identified to genus/species level separate from the subsample of the sample.

d) For samples having 500 or more midges, midges will be grouped by genus for those for which it is possible to confidently identify them to genus level without mounting. For remaining midges not grouped by genus, a subsample of 100 specimens will be randomly selected and identified to genus/species level. Remaining unsampled midges will be examined for unusual or rare specimens, which will be removed and identified to genus/species level separate from the subsample of the sample.

e) Reporting of the subsample of the sample will be as follows. Numbers reported on the Excel spreadsheet will be converted to reflect the sample total. Any round-off errors between the subsample total and the sample total will be equalized by adding or deducting the difference from the most numerous taxon. If unusual or rare specimens are removed from the sample following the subsample removal, the conversion of the subsample total to a "partial" sample total will be based on the sample total minus the number of unusual or rare specimens. Following this procedure, the number of unusual or rare specimens will be added to the "partial" sample total to bring it back to the sample total.

6. Sample Taxonomy

All taxonomic data submitted to the Department must be accompanied by the name(s) of the individual(s) actually performing the identifications. A list of taxonomic references used, and a reference collection of organisms must also be submitted (see below).

(1) Taxonomic resolution

Macroinvertebrate organisms are identified to genus in all cases where possible. If generic keys are not available or taxonomic expertise is lacking for a taxon it should be identified to the lowest level possible. Identification of organisms to species is highly recommended whenever possible. Although quantitative analysis of benthic macroinvertebrate samples by the Department is based on counts adjusted to the generic level of resolution, species designations are recorded in the Department database and can contribute to the final stage of data analysis, Professional Judgment Evaluation of the model outcome. This is especially important for Class Insecta. Taxonomists submitting data for use by the Department must use current taxonomic references.

(2) Identification of Chironomidae

Specimens of chironomid midges are identified from slide mounts of the cleared head capsule and body parts. Euparol or Berlese mounting medium is recommended for preparation of slides. CMCP-9 is recommended for the preparation of permanent slide mounts of reference material, for voucher specimens or for permanent collections. These slides should be prepared under a fume hood. Instructions for preparation and slide mounting may be found in Wiederholm, (1983). In samples in which a given taxon is represented by a large number of individuals, the identification to genus may be made from slide mounts of a sufficient proportion of the individuals to give a high degree of certainty that they are all the same (10-50% depending on

the distinctiveness of the taxon visible under binocular microscope). A subsampling plan for Chironomidae is described in Section II-5. Each permanent slide mount is to be fully labeled or coded in a manner which positively associates the slide with the sample from which it originated.

(3) Quality control

All organisms and records from any sampling event intended to serve regulatory purposes must be preserved for a period of at least ten years. In the course of identifying taxa collected as part of the Department's biological monitoring program, or in other collection activities, a special reference collection of separate taxa is established. This collection allows subsequent identifications of the same taxon to be confirmed and thus serves to standardize taxonomy for the program.

Each contracted taxonomist, working for the Department or working for anyone submitting data to the Department, will be required to submit a reference collection of taxa identified, as well as a list of the taxonomic references used in the identifications. Organism identifications will be checked against the Department's collection by a Department taxonomist.

III ANALYTICAL METHODS

In general, it is the responsibility of the Department, or its agents, to conduct sampling for the purpose of making decisions on the attainment of water quality classification. Under certain conditions, sampling may be required of applicants for waste discharge licenses, or applicants requiring Section 401 Water Quality Certification. Sampling may be performed by corporations, businesses, organizations or individuals who can demonstrate their qualifications and ability to carry out the Department's sampling and analytical protocol, described in this manual. Such monitoring will be conducted according to a quality assurance plan provided to the Department and approved by the Commissioner.

Classification attainment evaluation is established in DEP regulation Chapter 579: Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams. Davies et al, 1995 details the conceptual and technical basis for the State’s application of linear discriminant analysis to assess attainment of aquatic life standards. A synopsis of Chapter 579 follows in this section.

1. Minimum Provisions

Properly collected and analyzed samples that fail to achieve the following criteria are unsuitable for further analysis through the numeric criteria statistical models:

- Total Mean Abundance must be at least *50* individuals (average per basket/bag/cone);
- Generic Richness for three replicate basket/bag/cone samplers must be at least *15*.

Samples not attaining these criteria shall be evaluated by Professional Judgment. A determination will be made whether the affected community requires re-sampling or whether the community demonstrates non-attainment of minimum provisions of the aquatic life standards.

2. Aquatic Life Statistical Decision Models

The four statistical decision models consist of linear discriminant functions developed to use quantitative ecological attributes of the macroinvertebrate community (Appendix C-1) to determine the strength of the association of a test community to any of the water quality classes (Appendix D). The coefficients or weights are calculated using a linear optimization algorithm to minimize the distance, in multivariate space, between sites within a class, and to maximize the distance between sites between classes.

(1) Linear discriminant models

The discriminant function has the form:

$$Z = C + W_1X_1 + W_2X_2 + ...W_nX_n$$

Where: Z = discriminant score
C = constant
W_i = the coefficients or weights
X_i = the predictor variable values

Association values are computed, using variable values from a test sample, for each classification using one four-way model and three two-way models. The four-way model uses nine variables pertinent to the evaluation of all classes and provides four initial probabilities that a given site attains one of three classes (A, B, or C), or is in non-attainment (NA) of the minimum criteria for any class. These probabilities have a possible range from 0.0 to 1.0, and are used, after transformation, as variables in each of the three subsequent final decision models. The final decision models (the three, two-way models)

are designed to distinguish between a given class and any higher classes as one group and any lower classes as the other group (i.e., Classes A+B+C vs. NA; Classes A+B vs. Class C+NA; Class A vs. Classes B+C+NA). The equations for the final decision models use the predictor variables relevant to the class being tested (Appendix E). The process of determining attainment class using association values is outlined in Appendix F.

(2) Application of professional judgment

Where there is documented evidence of conditions which could result in uncharacteristic findings, allowances may be made to account for those situations by adjusting the classification attainment decision through use of professional judgment as provided in DEP regulation Chapter 579: Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams. The Department may make adjustments to the classification attainment decision based on analytical, biological, and habitat information or may require that additional monitoring of affected waters be conducted prior to issuing a classification attainment decision.

Professional Judgment may be utilized when conditions are found that are atypical to the derivation of the linear discriminant model. Factors that may allow adjustments to the model outcome include but are not limited to:

a) Habitat factors
- Lake outlets
- Impounded waters
- Substrate characteristics
- Tidal waters

b) Sampling factors
- Disturbed samples
- Unusual taxa assemblages
- Human error in sampling

c) Analytical factors
- Subsample vs. whole sample analysis
- Human error in processing

(3) Classification attainment evaluation of waters subjected to flow regulation

The Maine State Legislature, in 38 MRSA Article 4-A Sec. 464 (9)-(10), *The Water Classification Program*, acknowledges that changes to aquatic life and habitat occur as the result of the impoundment of riverine waters and has modified the standards of waters so affected. The habitat and aquatic life criteria of riverine impounded waters of Class A, Class B or Class C are

deemed to be met if the impoundment attains the standards of Class C (e.g., maintenance of structure and function of the resident biological community). Impoundments managed as Great Ponds must also attain Class C aquatic life standards. If the actual water quality attains any more stringent characteristic or criterion than the Class C standards dictate, then the waterbody must be managed so as to protect those higher characteristics. Class C standards also apply to the *downstream* waters below certain specified riverine impoundments on the Kennebec River and the Saco River (Wyman Dam, Moosehead East Outlet Dam, West Buxton Dam and Skelton Dam) that are classified as A or B. All other waters subjected to flow regulation are managed according to standards of the water quality classification assigned by the Legislature.

(4) Adjustments of a decision

It is the responsibility of the Department to decide if adjustments of a decision should occur. The following adjustments may be made to correct for these conditions:

a) Resample
The Department may require that additional monitoring of the test community be done before a determination of class attainment can be made, based on documented evidence of specific sampling factors that may have influenced the results.

b) Raise the finding
   i. The Department may raise the classification attainment outcome predicted by the model from non-attainment of any class to indeterminate or to attainment of Class C, based on documented evidence of specific conditions, as defined above.

   ii. The Department may raise the classification attainment outcome predicted by the model from attainment in one class to attainment in the next higher class, based on documented evidence of specific conditions, as defined above.

c) Lower the finding
The Department may decide to lower the classification attainment finding, on the basis of documented, substantive evidence that the narrative aquatic life criteria for the assigned class are not met.

d) Determination of non-attainment: minimum provisions not met
Samples having any of the ecological attributes not attaining the minimum provisions, and where there is no evidence of conditions which could result in uncharacteristic findings, as defined above, must be determined to be in non-attainment of the minimum provisions of the aquatic life criteria for any class.

e) Determination of attainment: minimum provisions not met
Where there is evidence of factors that could result in minimum provisions not being met, professional judgment may be used to make a professional finding of attainment of the aquatic life criteria for any class. Such decisions will be provisional until appropriate resampling is carried out.

(5) Sampling procedures do not conform

For classification attainment evaluation of test communities that do not conform to criteria provided in Section I General Methods, or Section III-1, Minimum Provisions, of this manual, and are therefore not suitable to be run through the linear discriminant models, the Department may make an assessment of classification attainment or aquatic life impact in accordance with the following procedures:

a) Approved assessment plan
A quantitative sampling and data analysis plan must be developed in accordance with methods established in the scientific literature on water pollution biology, and shall be approved by the department.

b) Determination of sampling methods
Sampling methods are determined on a site-specific basis, based on habitat conditions of the sampling site, and the season sampled:

i. Soft-bottomed substrates shall, whenever ecologically appropriate and practical, be sampled by core or dredge of known dimension or volume.

ii. The preferred method for sampling hard-bottomed substrates shall be the rock basket/cone/bag as described in Section I-2.

iii. Other methods may be used where ecologically appropriate and practical.

c) Classification attainment decisions
Classification attainment decisions may be based on a determination of the degree to which the sampled site conforms to the narrative aquatic life classification criteria provided in 38 MRSA Section 465 and found in Appendix D. The decision is based on established principles of water pollution biology and must be fully documented.

d) Site-specific impact decisions
Site-specific impact decisions may rely on established methods of analysis of comparative data between a test community and an approved reference community.

e) Determination of detrimental impact
A determination of detrimental impact to aquatic life of a test community without an approved reference community may be made if it can be documented, based on established methods of the interpretation of macroinvertebrate data, and based on established principles of water pollution biology, that the community fails to demonstrate the ecological attributes of its designated class as defined by the narrative aquatic life standards in the water quality classification law.

Appendix A

Maine DEP Biological Monitoring Unit
Stream Macroinvertebrate Field Data Sheet

Log Number _____ Directions_____ Type of Sample_____
Station Number_____ _____ Date Deployed_____
Waterbody_____ _____ Number Deployed_____
River Basin_____ Lat-Long Coordinates (WGS84, meters) Date Retrieved_____
Municipality_____ Latitude_____ Number Retrieved_____
Stream Order_____ Longitude_____ Agency/Collector(s)_____

1. Land Use (500 m radius upstream)
- ☐ Urban
- ☐ Cultivated
- ☐ Pasture
- ☐ Upland hardwood
- ☐ Upland conifer
- ☐ Swamp hardwood
- ☐ Swamp conifer
- ☐ Marsh

2. Terrain (500 m radius upstream)
- ☐ Flat
- ☐ Rolling
- ☐ Hilly
- ☐ Mountains

3. Canopy Cover (upstream view)
- ☐ Dense (75-100% shaded)
- ☐ Partly open (25-75% shaded)
- ☐ Open (0-25% shaded)

(% daily direct sun) _____

4. Physical Characteristics of Bottom (estimate % of each component over 12 m stretch of site; total = 100%)

[ ] Bedrock [ ] Rubble (3" – 10") [ ] Sand (<1/8") [ ] Boulders (<10") [ ] Gravel (1/8" – 3") [ ] Silt-clay-muck [ ] Detritus

5. Habitat Characteristics (immediate area)

Time _____AM PM	Time _____AM PM
Width (m) _____	Width (m) _____
Depth (cm) _____	Depth (cm) _____
Flow (cm/s) _____	Flow (cm/s) _____
Diss. O_2 (ppm)_____	Diss. O_2 (ppm)_____
Temp (°C) _____	Temp (°C) _____
pH _____	pH _____
SPC (µS/cm) _____	SPC (µS/cm) _____
TDS (ppm) _____	TDS (ppm) _____

Temperature Probe # _____

☐ deployed ☐ retrieved

6. Observations (describe)
Fish_____
Algae_____
Macrophytes_____
Habitat quality_____
Dams/impoundments_____
Discharges_____
Nonpoint stressors _____

7. Water Samples
- ☐ Standard
- ☐ Metals
- ☐ Pesticides

Lab Number

8. Photographs

9. Landmarks of Sampler Placement (illustrate or describe landmarks to be used for relocation)

Appendix B

Instructions for Macroinvertebrate Sorters

1. Pick the sample **in small portions** (1-2 TBS of material) at a time.

2. Pick all organisms you can see. If in doubt it's usually best to include it.

3. Some types of samples can be easily floated by adding a saturated solution of Epsom salt or sugar to the water. Maintain the saturated solution for the lab by adding enough salt or sugar to water to maintain a thick layer of crystals on the bottom of the storage jar. Use the supernatant solution for picking. Large numbers of organisms can be removed with a sieve spoon from the water surface. After the floaters have been removed, proceed to pick the rest of the sample as usual. A significant portion of the sample will not float and must be picked out with forceps.

4. The sample can be considered done when a careful 45 second search, after swirling the sample, yields no further organisms.

5. The samples are picked in water but should not remain unpreserved for more than 8 hours. Be certain that the final sample vial is preserved with 70% alcohol and 5% glycerin solution when done.

6. Return the detrital material to the original sample jar and preserve with 70% alcohol.

7. Write on the sample jar label "Picked X1 (your initials)".

8. Include in the vial of organisms a slip of index card label in hard pencil (No. 2) including **all information appearing on the original jar label**:

   Log Number — River
   Date - month/day/year — Location (Town or industry name)
   whether above or below
   Basket or Cone number
   Vial number if more than 1 vial is needed per basket

   ex. Log 621 Sandy R. 9/5/97
   Below Farmington (disturbed)
   Basket 2 vial #1 of 2

9. Complete all samples from one log number before beginning a new log number.

10. Keep a record of samples picked including log number

    Basket number — Time spent per basket
    Your name — Date

Appendix C-1

Methods for the Calculation of Indices and Measures of Community Structure Used in the Linear Discriminant Models

Variable Number

1 **Total Mean Abundance**

Count all individuals in all replicate samples from one site and divide by the number of replicates to yield mean number of individuals per sample.

2 **Generic Richness**

Count the number of different genera found in all replicates from one site.

Counting rules for Generic Richness:

a) All population counts at the species level will be aggregated to the generic level.

b) A family level identification which includes no more than one taxon identified to the generic level is counted as a separate taxon in generic richness counts.

c) A family level identification with more than one taxon identified to generic level is not counted towards generic richness. Counts are to be divided proportionately among the genera that are present.

d) Higher level taxonomic identifications (Phylum, Class, Order) are not counted toward generic richness unless they are the only representative.

e) Pupae are ignored in all calculations.

3 **Plecoptera Mean Abundance**

Count all individuals from the order Plecoptera in all replicate samplers from one site and divide by the number of replicates to yield mean number of Plecopteran individuals per sampler.

4 **Ephemeroptera Mean Abundance**

Count all individuals from the order Ephemeroptera in all replicate samplers from one site and divide by the number of replicates to yield mean number of Ephemeropteran individuals per sampler.

5 **Shannon-Wiener Generic Diversity (Shannon and Weaver, 1963)**

After adjusting all counts to genus following counting rules in Variable 2:

$$\bar{d} = \frac{c}{N}\left(N \log_{10} N - \sum n_i \log_{10} n_i\right)$$

where: $\bar{d}$ = Shannon-Wiener Diversity
c = 3.321928 (converts base 10 log to base 2)
N = Total abundance of individuals
n_i = Total abundance of individuals in the i^{th} taxon

6 **Hilsenhoff Biotic Index (Hilsenhoff, 1987)**

$$HBI = \sum \frac{n_i a_i}{N}$$

where: HBI = Hilsenhoff Biotic Index
n_i = number of individuals in the i^{th} taxon
a_i = tolerance value assigned to that taxon
N = total number of individuals in sample with tolerance values.

7 **Relative Chironomidae Abundance**

Calculate the mean number of individuals of the family Chironomidae, following counting rules in Variable 4, and divide by total mean abundance (Variable 1).

8 **Relative Diptera Richness**

Count the number of different genera from the Order Diptera, following counting rules in Variable 2, and divide by generic richness (Variable 2).

9 ***Hydropsyche* Mean Abundance**

Count all individuals from the genus *Hydropsyche* in all replicate samplers from one site, and divide by the number of replicates to yield mean number of *Hydropsyche* individuals per sampler.

10 **Probability (A + B + C) from First Stage Model**

Sum of probabilities for Classes A, B, and C from First Stage Model.

11 ***Cheumatopsyche* Mean Abundance**

Count all individuals from the genus *Cheumatopsyche* in all replicate samplers from one site and divide by the number of replicates to yield mean number of *Cheumatopsyche* individuals per sampler.

12 **EPT - Diptera Richness Ratio**

EPT Generic Richness (Variable 19) divided by the number of genera from the order Diptera, following counting rules in Variable 2. If the number of genera of Diptera in the sample is 0, a value of 1 is assigned to the denominator.

13 **Relative Oligochaeta Abundance**

Calculate the mean number of individuals from the Order Oligochaeta, following counting rules in Variable 4, and divide by total mean abundance (Variable 1).

14 **Probability (A + B) from First Stage Model**

Sum of probabilities for Classes A and B from First Stage Model.

15 **Perlidae Mean Abundance (Family Functional Group)**

Count all individuals from the family Perlidae (Appendix C-3) in all replicate samplers from one site and divide by the number of replicates to yield mean number of Perlidae per sampler.

16 **Tanypodinae Mean Abundance (Family Functional Group)**

Count all individuals from the subfamily Tanypodinae (Appendix C-3) in all replicate samplers from one site and divide by the number of replicates to yield mean number of Tanypodinae per sampler.

17 **Chironomini Mean Abundance (Family Functional Group)**

Count all individuals from the tribe Chironomini (Appendix C-3) in all replicate samplers from one site and divide by the number of replicates to yield mean number of Chironomini per sampler.

18 **Relative Ephemeroptera Abundance**

Variable 4 divided by Variable 1.

19 **EPT Generic Richness**

Count the number of different genera from the Order Ephemeroptera (E), Plecoptera (P), and Trichoptera (T) in all replicate samplers, according to counting rules in Variable 2, generic richness.

20 **Variable Reserved**

21 **Sum of Mean Abundances of**: ***Dicrotendipes, Micropsectra, Parachironomus* and *Helobdella***

Sum the abundance of the 4 genera and divide by the number of replicates (as performed in Variable 4).

22 **Probability of Class A from First Stage Model**

Probability of Class A from First Stage Model.

23 **Relative Plecoptera Richness**

Count number of genera of Order Plecoptera, following counting rules in Variable 2, and divide by generic richness (Variable 2).

24 **Variable Reserved**

25 **Sum of Mean Abundances of *Cheumatopsyche, Cricotopus, Tanytarsus* and *Ablabesmyia***

Sum the number of individuals in each genus in all replicate samplers and divide by the number of replicates (as performed in Variable 4).

26 **Sum of Mean Abundances of *Acroneuria* and *Stenonema***

Sum the number of individuals in each genus in all replicate samplers and divide by the number of replicates (as performed in Variable 4).

27 **Variable Reserved**

28 **Ratio of EP Generic Richness**

Count the number of different genera from the order Ephemeroptera (E), and Plecoptera (P) in all replicate samplers, following counting rules in Variable 2, and divide by 14 (maximum expected for Class A).

29 **Variable Reserved**

30 **Ratio of Class A Indicator Taxa**

Count the number of Class A indicator taxa as listed in Appendix C-2 that are present in the community and divide by 7 (total possible number).

Appendix C-2

Indicator Taxa: Class A

Brachycentrus (Trichoptera: Brachycentridae)
Serratella (Ephemeroptera: Ephemerellidae)
Leucrocuta (Ephemeroptera: Heptageniidae)
Glossosoma (Trichoptera: Glossosomatidae)
Paragnetina (Plecoptera: Perlidae)
Eurylophella (Ephemeroptera: Ephemerellidae)
Psilotreta (Trichoptera: Odontoceridae)

Appendix C-3

Family Functional Groups

PLECOPTERA

Perlidae
Acroneuria
Attaneuria
Beloneuria
Eccoptura
Perlesta
Perlinella
Neoperla
Paragnetina
Agnetina

CHIRONOMIDAE

Tanypodinae
Ablabesmyia
Clinotanypus
Coelotanypus
Conchapelopia
Djalmabatista
Guttipelopia
Hudsonimyia
Labrundinia
Larsia
Meropelopia
Natarsia
Nilotanypus
Paramerina
Pentaneura
Procladius
Psectrotanypus
Rheopelopia
Tanypus
Telopelopia
Thienemannimyia
Trissopelopia
Zavrelimyia

Appendix C-3

Family Functional Group (continued)

Chironomini
Pseudochironomus
Axarus
Chironomus
Cladopelma
Cryptochironomus
Cryptotendipes
Demicryptochironomus
Dicrotendipes
Einfeldia
Endochironomus
Glyptotendipes
Goeldichironomus
Harnischia
Kiefferulus
Lauterborniella
Microchironomus
Microtendipes
Nilothauma
Pagastiella
Parachironomus
Paracladopelma
Paralauterborniella
Paratendipes
Phaenopsectra
Polypedilum
Robackia
Stelechomyia
Stenochironomus
Stictochironomus
Tribelos
Xenochironomus

Appendix D

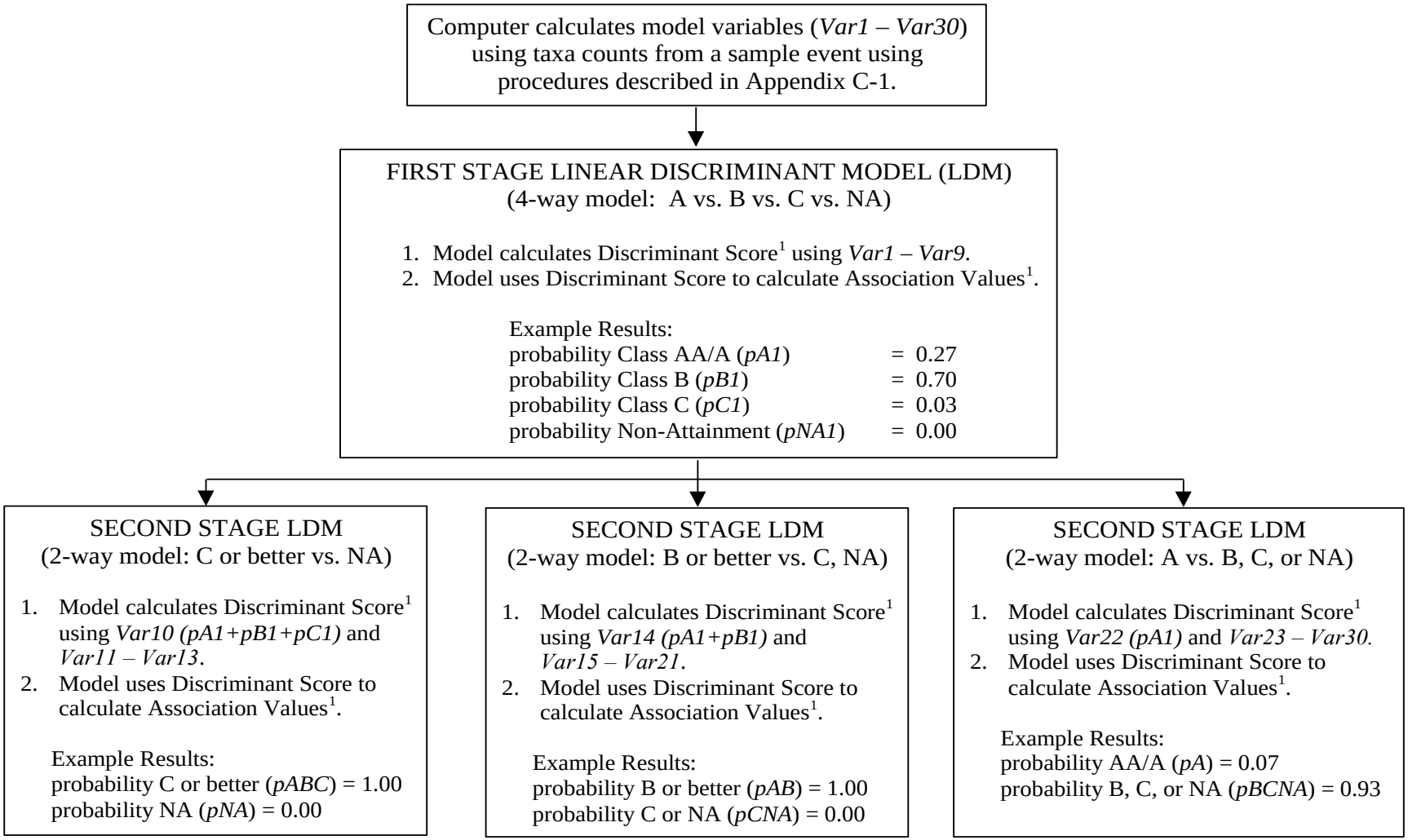
MRSA 38, 4-A Sec 464-465

Aquatic Life Standards for the State of Maine

Classification	Biological Standards
AA	No direct discharge of pollutants; aquatic life shall be as naturally occurs.
A	Natural habitat for aquatic life; aquatic life shall be as naturally occurs.
B	Unimpaired habitat for aquatic life; discharges shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.
C	Habitat for aquatic life; discharges may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

Appendix E

Process of Calculating Model Variables and Association Values Using Linear Discriminant Models

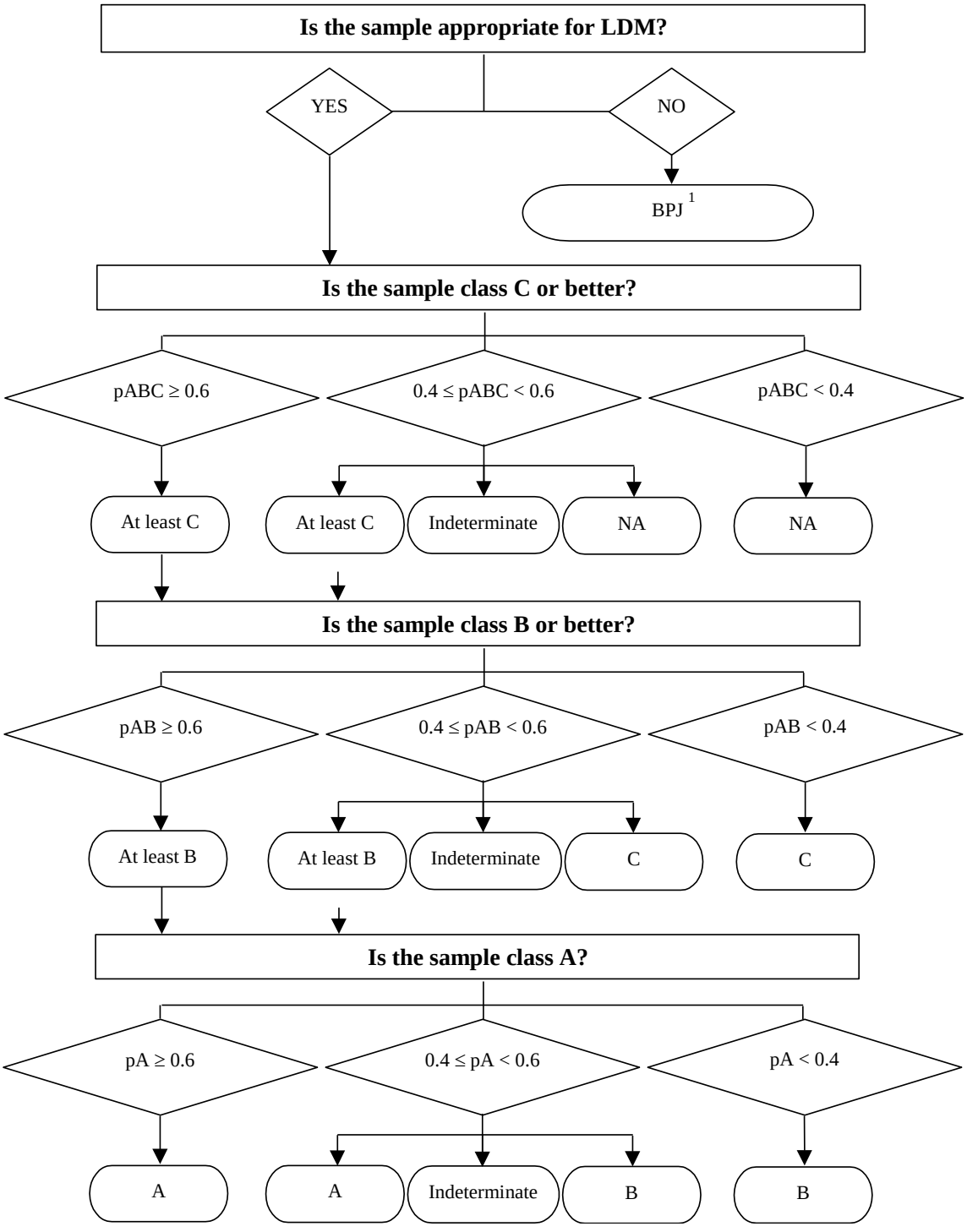


[1] Discriminant Score and Association Values are defined in Section III-2.(1).

Chart by Thomas J. Danielson

Appendix F

Process for Determining Attainment Class Using Association Values



[1] Best Professional Judgment (BPJ) is defined in Section III-2. (2), (4), and (5)

Chart by Thomas J. Danielson

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Maine DEP Biological Monitoring Unit
Stream Macroinvertebrate Field Data Sheet

Location: _____

_____

Potential Stressor: _____

_____

Log Number _____
Station Number_____
Waterbody_____
River Basin_____
Town_____
Stream Order_____

Directions_____
_____
_____
Lat-Long Coordinates (WGS84, meters)
Latitude_____
Longitude_____

Type of Sampler_____
Date Deployed_____
Number Deployed_____
Date Retrieved_____
Number Retrieved_____
Agency/Collector(s) Put-In:
Take-Out:

1. Land Use (surrounding watershed)
- ☐ Urban
- ☐ Cultivated
- ☐ Pasture
- ☐ Upland hardwood
- ☐ Upland conifer
- ☐ Swamp hardwood
- ☐ Swamp conifer
- ☐ Marsh

2. Terrain (surrounding watershed)
- ☐ Flat
- ☐ Rolling
- ☐ Hilly
- ☐ Mountains

3. Canopy Cover (surrounding view)
- ☐ Dense (75-100% shaded)
- ☐ Partly open (25-75% shaded)
- ☐ Open (0-25% shaded)

(% daily direct sun) _____

4. Physical Characteristics of Bottom (estimate % of each component over 12 m stretch of site; total = 100%)

[ ] Bedrock [ ] Cobble (2.5" – 10") [ ] Sand (<1/8") [ ] Clay
[ ] Boulders (>10") [ ] Gravel (1/8" – 2.5") [ ] Silt [ ] Muck [ ] Detritus

5. Habitat Characteristics (immediate area)

Flag location where measured

Time _____ AM PM	Time _____ AM PM
Wetted Width (m)_____	Wetted Width (m) _____
Bank Full Width (m) _____	Bank Full Width (m) _____
Depth (cm) _____	Depth (cm) _____
Velocity (cm/s) _____	Velocity (cm/s) _____
Diss. O_2 ___ (ppm) ___ (%)	Diss. O_2 ___ (ppm) ___ (%)
Temp (°C) _____	Temp (°C) _____
SPC (µS/cm) _____	SPC (µS/cm) _____
pH _____	pH _____
DO Meter #_____ Cal? Y / N	DO Meter #_____ Cal? Y / N
SPC Meter # _____ Cal? Y / N	SPC Meter # _____ Cal? Y / N

Temperature Probe # _____
☐ deployed ☐ retrieved

6. Observations (describe, note date)

7. Water Samples
- ☐ Standard
- ☐ Other

Lab Number:

8. Photograph #

Put-In
- Up
- Down

Take-Out
- Up
- Down

9. Landmarks of Sampler Placement (illustrate or describe landmarks to be used for relocation)

Options for Potential Stressor:

Agricultural Runoff
Altered Habitat
Altered Hydrology
BOD (Low DO)
Bog Headwaters
Chlorine
Gravel Pit
Impounded
Inorganic Solids
Lake Outlet
Logging
Low Gradient
Low pH
Metals
NPS Pollution
Nutrients
Organic Solids
Pesticides
Regulated Flows
Sedimentation
Superfund Site
Thermal
Tidal/Estuary
Toxic Organics
Urban Runoff

Options for 6. Observations:

Fish
Algae
Macrophytes
Habitat quality
Dams/impoundments
Discharges
Nonpoint stressors

Options for Location:

Above Road Crossing
Below Road Crossing
Above Town
Below Town
Above Fish Hatchery
Below Fish Hatchery
Above POTW
Below POTW
Above Landfill
Below Landfill
Below Airport
Below In-Place Contamination
Above In-Place Contamination
Above Point Source
Below Point Source
Above Urban NPS
Below Urban NPS
Above Agriculture NPS
Below Agriculture NPS
Above Forestry NPS
Below Forestry NPS
Above Dam
Below Dam
Impoundment
Lake Outlet
Main Stem (only for larger systems)
Above Confluence
Below Confluence
Below Falls
Pristine Landscape
Designated Ecoreserve
Minimally Disturbed