The State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES

Thomas S. Burack, Commissioner

Commissioner's Declaration

Declaration of the Establishment of Protected Instream Flows for the Lamprey Designated River

Lamprey River Protected Instream Flows Established

RSA 483:9-c, IV requires that the protected instream flow levels established by the Commissioner "shall be maintained at all times, except when inflow is less than the protected instream flow level as a result of natural causes or when the commissioner determines that a public water supply emergency exists which affects public health and safety." RSA 483:9-c, V requires that, "The maintenance of protected instream flows shall constitute a condition of any permit issued by the [Department of Environmental Services] for any project or activity within a designated river or segment and corridor." Env-Wq 1907.02 states that protected instream flows established by the Commissioner shall serve as water quality criteria for the purpose of administration of water quality standards by DES under the federal Clean Water Act.

Protected Instream Flows are hereby established for the 12.1 mile stretch of the Lamprey Designated River as established by an act of the NH Legislature in 1990 and as described in the Lamprey River Protected Instream Flow Report dated July 2009. Table 1 of this Establishment Declaration provides a summary of these protected instream flow requirements. The full Report is available at http://des.nh.gov/organization/divisions/water/wmb/rivers/instream/lamprey/study.htm and at the following locations:

File Review Room
NH Dept. of Environmental Services
29 Hazen Drive
Concord, NH 03301

Lee Public Library
7 Mast Road (Rt. 155)
Lee, NH 03861

Durham Public Library
7 Mill Road Unit H
Durham, NH 03824

Thomas S. Burack

Thomas S. Burack, Commissioner
NH Department of Environmental Services

8/30/2013
Date

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Authority

Paragraphs RSA 483:9-c, I and RSA 483:11, IV of the Rivers Management and Protection Act require the Commissioner of the Department of Environmental Services (DES) to establish rules specifying the standards, criteria, and procedures for establishment and enforcement of protected instream flows (PISF) for each designated river or segment. Env-Wq 1900, Rules for the Protection of Instream Flow on Designated Rivers, fulfill this requirement. Env-Wq 1905, Procedure for Establishment of Protected Instream Flows, describes the procedure for establishing protected instream flows. Laws of 2002, Chapter 278:3, III (b) require the Commissioner of DES to establish protected instream flows for that portion of the Lamprey Designated River that had been designated as such by the Laws of 1990, Chapter 233.15.

This document serves as the written decision required by Env-Wq 1905 to establish the Lamprey Designated River Protected Instream Flows. The process for establishing protected flows is described in Env-Wq 1905.04. The rules require a written decision, after study and public input, stating the scientific basis for the protected flows, including an assessment of how the protected instream flows will meet applicable water quality standards. The rules also require a summary of the comments and an explanation of how the comments affected the final instream flows. The review of impacts required under RSA 483:9-c, IV has been and will continue to be conducted pursuant to the Water Management Plan portion of the Protected Instream Flow Pilot Program.

Overview

These protected instream flows apply to the Lamprey Designated River, to water users in the watershed required to be registered under RSA 488 (known here as Affected Water Users), and to dam owners in the watershed with impoundments greater than 10 acres (known here as Affected Dam Owners). For the purposes of this Declaration, the portion of the Lamprey River designated in 1990 comprises 12.1 miles beginning where it crosses the town boundary into Lee and continuing to the Durham town boundary where it crosses into Newmarket, as described in RSA 483:15, I. Unless otherwise specified, all references herein to the "Lamprey Designated River" or "Lamprey River" apply only to this 21.1 mile section of the river. The other segments of the Lamprey River and tributary streams subsequently designated by the Legislature in 2011 are not covered by nor subject to the Declaration or the associated Water Management Plan.

The Lamprey River Protected Instream Flow Report (Report) details the methods and results used to identify the Protected Instream Flows for the Lamprey Designated River. Copies of the Report are available at the public libraries in Lee and Durham and the DES file review room in Concord, New Hampshire. The entire Report is accessible in convenient segments at http://des.nh.gov/organization/divisions/water/wmb/rivers/instream/lamprey/study.htm.

Scientific basis for the protected flows

The following section summarizes the scientific basis for the protected flows as required by Env-Wq 1905.04 to establish the protected flows. The Lamprey Instream Flow Report (July 2009) describes the scientific process used to develop the protected flows. The Report is incorporated herein by reference.

The study defining instream protected flows began by identifying what was to be protected. Instream flow legislation in RSA 483:9 describes flow protection as a requirement for specific entities listed in the statute. These entities include a variety of riverine uses, characteristics, and resources such as recreation, hydropower, aquatic life, public water supply, rare species or habitat, geologic resource, and others. Protected Instream Flows were defined by the study for those flow-dependent members of the listed protected entities.

The flow requirements for fish, riparian wildlife and vegetation were found to be the determining constituents for instream flow protection. Protected instream flows for fish were developed using the Mesohabitat Simulation Model (MesoHABSIM), a habitat simulation model, and those for riparian wildlife and vegetation were developed using a transect survey method. The study found that other flow-dependent protected entities made use of flow conditions as they occurred. By protecting the natural range of flows these entities will continue to be protected[1]. Protection of the natural range and variability of flow is a key component of the Natural Flow Paradigm[2]. The instream flow assessments were evaluated using the conceptual framework of the Natural Flow Paradigm.

Natural Flow Paradigm

The development of the Protected Instream Flow values for the flow-dependent, protected entities was performed within the framework of the Natural Flow Paradigm (Poff and others, 1997). The Natural Flow Paradigm recognizes that the natural variability of stream flows is what determines the geomorphic and biologic characteristics of a river. The native riverine ecosystem contains multiple species, some of which thrive in wet years and others of which thrive in dry years. Variability in the stream flow conditions allow these different species to coexist. The native riverine ecosystem is adapted to a flow regime that is not affected by diversions, discharges or withdrawals. If the riverine ecosystem is altered significantly, then the ecosystem will become impaired. However, the adaptation of these species to variability in the flow regime does allow flexibility for water use by other entities.

The Natural Flow Paradigm also recognizes that minimum flows, once commonly used as instream flow limits, are not adequate for sustaining the riverine ecosystem or for the protection of its instream resources. The description of protected flows requires the use of the other stream flow components: flow frequency, duration, timing, and rate of change, as well as magnitude.

The application of the Natural Flow Paradigm concept in this study implies that the principal management objective is to allow streams to flow as close to their natural flow regime as possible. Low flows and floods are expected to occur as natural conditions and take place within the range of natural flows. Typical human influences tend to reduce flow variability by removing floods and droughts. This may make the availability of stream flow more reliable for human use, but is detrimental to biological integrity. Understanding the potential for the human alteration of the natural flow regime of the Lamprey River and the impact on its protected entities is a major objective of this study.

It is important to recognize that the natural river flow (even in the absence of any human intervention or water use) will not always meet all of the riverine ecosystem flow needs, nor should it. Native communities are adapted to meet periods of stress that occur within the natural ranges of frequency and duration. The Natural Flow Paradigm recognizes that rare natural extremes such as

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[1] DES guidance document "Application of the Natural Flow Paradigm to Protected Instream Flows"

[2] Poff, N. L. et al. 1997. The Natural Flow Regime. *BioScience* Vol. 47, No. 11: pp. 769-784.

floods and droughts have important functions in supporting riverine ecosystems. For example, periods of flooding help sustain the floodplain plant communities found along the river by replenishing nutrients, eliminating competing plants and dispersing seeds. While periods of low flow, such as during droughts, allow for the development of river channel plant communities.

Protecting flow variability is necessary to ensure that the ecosystem provides the variety of habitat conditions necessary to support the entire ecosystem. Water management measures will be required when and where human uses increase the durations or frequencies of flow conditions below specified protected flows and their associated durations.

Protected Instream Flow Assessment

Defining protected instream flows begins with identification of the entities that need protection. Using the statutory listing of river features to be protected, a preliminary list of Lamprey-specific entities was generated from electronic mapping sources, personal interviews and study reports for the Lamprey. The river was then surveyed to confirm specific occurrences of these entities and to identify others. A subset of the entities that are flow-dependent was identified for assessment. The subset was used to choose the assessment methods to determine their flow needs. Assessment methods were selected that are appropriate for the type of entity being assessed and are generally divided between methods for (1) human uses, and (2) fish, and riparian wildlife and vegetation.

Human use of flow-dependent river characteristics was assessed by surveys and questionnaires. Human-related instream flow needs include such activities as swimming, boating, hydropower, and pollution abatement. These flows are not always available, thus resulting in seasonal or opportunistic use of the river, especially for recreation. Kayakers, for example, use the flows during spring high flows and when they occur following storms throughout the year, but do not expect these flows to be continuously available. Surveys of swimming flows for designated beaches had contradictory results, but indicated that flow was not the important condition for swimming opportunities. Public water supplies were determined initially to be flow-dependent because there are flow conditions attached to some withdrawals, but this decision was reversed when it was realized that there is no relationship between stream flow and water demand. There are no hydropower or waste treatment facilities on the Lamprey Designated River.

Water use by fish and riparian wildlife and vegetation is different from human uses. Their use is time dependent in that their life cycles require differing flows through the year. For assessment of riparian wildlife and vegetation, a floodplain transect method (described below) was used that compares bank elevations to the magnitude of flow needed to inundate those elevations. Flow timing, frequency and duration were keyed to life cycle needs. For fish, a habitat simulation model, MesoHABSIM (described below) was used. Habitat availability was defined relative to flow. Then criteria for instream flows were defined based on the timing, duration, and frequency of the flow magnitudes that maintain those levels of habitat availability.

Floodplain Transect Model

Protected instream flow requirements for wetlands, floodplains, and river bank habitats and their associated flora and fauna were determined by surveying transects across the river channel and floodplain. This method, known as the Floodplain Transect Method, uses a habitat's elevation on the stream bank to determine flow magnitudes based on the flow that occurs when the river is at this level. Species' life cycle needs are determined to describe the timing, frequency and duration needed for these flows.

Cross sections and maps were constructed showing plant community boundaries and wildlife habitats associated with their topographic position. Surface water elevations along transects during low, moderate and high flow events and simultaneous stream flows from the gage station at Packers Falls were recorded and added to the transect cross-section. Protected instream flows were defined as the flows associated with the water level at each identified plant community or wildlife habitat, and that are critical to important life cycle events. These include, for example:

- Filling oxbow/backwater marshes, swamps and floodplain pools during spring for plant development and breeding wildlife;
- Avoid flooding of turtle and bird nests in the high floodplain during nesting seasons;
- Maintaining sufficient water levels for hibernating turtles and amphibians over the winter; and,
- Periodic (every one to three years) flooding and scouring of floodplain forest floors to maintain flood-tolerant plant communities and prepare seedbeds.

The floodplain transect method defines protected flows using the magnitude, timing, and frequency of flows needed to support riparian wildlife and vegetation. Both low flow requirements and high flow requirements were identified. The low flow criteria focus on preventing desiccation of wetlands. High flow criteria identify the flows necessary for rejuvenating habitat and flushing sediment through the river. Protected flows were retained if they filled a niche not already covered by other flow protections.

MesoHABSIM (habitat simulation model)

Flow requirements for fish were developed using the MesoHABSIM model. The MesoHABSIM model establishes the river-specific relationship between stream flow and habitat availability. The model evaluates the temporal distribution of habitat area to identify significant changes in frequency and duration. Consistent with the Natural Flow Paradigm, protected flows are identified that will limit the duration of flows below defined magnitudes to the natural frequency.

MesoHABSIM is an adaptation of the well known Physical Habitat Simulation (PHABSIM) model developed by the U.S. Fish and Wildlife Service. Both models assume that habitat availability correlates positively with fish density. Both are methods of evaluating habitat change relative to stream flows. MesoHABSIM takes measurements at a biologically-significant scale that is more representative of watershed-wide conditions than PHABSIM.

MesoHABSIM estimates habitat availability as a function of flow in representative reaches. Each reach is made up of a variety of river forms and structures called hydromorphologic units such as pools, riffles, runs, glides and cascades. These river structures represent different riverine habitat, and MesoHABSIM maps each of these hydromorphologic units of the river. The representative reaches are selected by quantitative assessment of their hydromorphologic makeup based on the percentage of hydromorphological unit types in the reach relative to the river's makeup as a whole. The representative reaches assessed for the Lamprey model comprised 42% of the Designated River. MesoHABSIM uses measurements of habitat criteria collected at several locations within each hydromorphologic unit type within the representative reaches.

Baseline conditions for flow and river structure were defined as inputs to the MesoHABSIM model. Human modification of flow and river structure can result in a mismatch between the river's biological and physical templates. The determination of flow patterns that would be protective of fish is very limited when using modified flow patterns or river structures. The flows used in the modeling were calculated as they would occur in the river without some of the modifications. In other words, the

recorded stream flows for the Lamprey River gage were adjusted to reflect the quantified values for net registered water use (withdrawal minus return flow) and the storage and release of water from Pawtuckaway Lake. Major physical modifications of the river channel were also taken into account as they may also create unpredictable habitat levels. Impoundments do not have features that would support fluvial fish and, therefore, impounded conditions were removed from the physical habitat model. With the baseline condition established, the habitat levels and corresponding flows were identified and used to establish the protected instream flow thresholds.

To carry out the MesoHABSIM model, a Target Fish Community was established for the river to identify the species expected in the Lamprey Designated River. The Target Fish Community represents the baseline fish community for meeting biological integrity. The species in the Target Fish Community are identified from fish data collected from minimally-impacted reference rivers in the northeast that have similar characteristics to the Lamprey. The fish community data show the critical species and the timing of their life-cycle flow needs.

Fish species in the Target Community were evaluated to define their significant life-cycle phases throughout the year. This defines the timing component of protected flows for fish. These significant life-cycle phases are called bioperiods. The Lamprey Designated River study identified six bioperiods: Overwintering, Spring Flood, Shad Spawning, Generic Resident Adult Fish (GRAF) Spawning, Rearing and Growth, and Salmon Spawning. Each bioperiod is identified with one or more species in the Target Fish Community. Protected instream flows were determined for appropriate species for each bioperiod.

Habitat preference criteria were developed for fish species and life stages to determine the protected flow magnitudes, durations, and frequencies for each bioperiod. The habitat needs of the fish species were evaluated individually and collectively to define the criteria for habitat suitability. Using these criteria, the river was assessed for its suitability as habitat for the species of the target fish community. Field measurements were made of habitat parameters (depth, velocity, substrate, presence of submerged and overhanging vegetation, presence of canopy cover, presence of woody debris, presence of shallow margins, characteristics of adjacent shoreland, and characteristics of each bank) within the representative reaches. Habitat parameter measurements were made over a range of five flows from 0.1 to 2.0 cfsm. The model for habitat was modified where dams currently create impoundments so that the proper proportions of habitat types would be used. Habitat conditions at each flow were assessed against the habitat suitability criteria to develop the relationship between flow and habitat availability.

Although flow is related to habitat availability, it is not a linear relationship. Long term records of flow exist, but not of habitat availability. To establish the natural variability of habitat availability over time, the flow-habitat relationship is used to transform long-term records of naturalized stream flow into records of daily habitat over time. Naturalized stream flow was derived from 30 years of flow measurements corrected for reported water use and dam storage and release operations. These records combining habitat suitability and stream flow comprise the history of habitat availability for each bioperiod. In winter and early spring time periods for which habitat criteria are not well established, protected flows are based on stream flow variability alone.

Habitat availability in each representative reach for each bioperiod was assessed using time-series analysis. The time-series analysis yields habitat availability in terms of its duration and cumulative frequency for discrete increments of habitat magnitude. The result is a set of frequency

distribution curves of habitat magnitude and duration starting at the lowest level of habitat availability that is always present. Curves are developed for incrementally higher levels of habitat availability describing their frequency and duration.

The distribution and shape of these curves were evaluated to identify the habitat magnitudes which represent significant changes in the frequency of habitat availability. These habitat magnitudes were identified using defined frequency conditions. Three habitat magnitudes were identified to represent the protected instream flows for each bioperiod. These three magnitudes were converted from habitat availability back into flow magnitude using the relationship between habitat availability and flow. The three flow magnitudes of protected instream flows are named "common," "critical," and "rare."

Each flow magnitude was further characterized by two durations: allowable and catastrophic. These durations are identified by characteristic inflections on the habitat magnitude curve representing a discernible change in frequency of occurrence. The durations define limits on the consecutive days when flow is below a protected flow magnitude. The catastrophic durations describe lengths of times for events that occur on a decadal frequency, whereas the allowable durations describe those events which would occur less than once in three consecutive years.

Protected instream flows were defined for each of the six bioperiods using MesoHABSIM results. Each bioperiod has a common, critical, and rare flow magnitude in cubic feet per second (cfs). Each flow magnitude has an associated allowable and catastrophic duration in days. The purpose of having three flows with two sets of durations each is to provide flexibility in defining stream flow conditions that mimic the natural variability as illustrated by the Natural Flow Paradigm. Very low flow conditions can recur for limited durations without being considered water quality standard impairments. The durations are defined by frequency analysis such that the natural low-flow occurrences are allowed, but longer or more frequent than natural events represent impairments. Flows are described at three biologically significant levels so that moderate, very low and critically low thresholds are defined for protection. The three levels protect the conditions at these important thresholds.

Identifying Protected Instream Flows from the Various Methods

The protected instream flows for a variety of flow-dependent riverine or riparian entities including recreation, fish, floodplain forests, wetlands, and turtles were defined using the several methods as described above. To determine which protected instream flows to use, the timing and magnitude of flow needs for all the various entities were compared. This comparison determined the controlling flow by determining the highest flow need of all entities and the time when that flow is needed. By satisfying the highest flow need, all other flow needs are met. There may be exceptions to this practice, but these were not evident in the Lamprey Designated River. In addition, maximum flows were identified for the instances in which too much water would be damaging. These flows will not be managed when they are occurring naturally. The purpose of identifying these flows is to ensure that management alternatives selected under the Water Management Plan will not cause unintended harm.

The comparison of flow needs shows that the controlling protected instream flows for the Lamprey Designated River are fish and riparian wildlife and vegetation as determined by the floodplain transect method and the MesoHABSIM model. The selection of the highest flow need as the protected flow magnitudes is tempered by the description of allowable and catastrophic durations keyed to their natural frequency of occurrence. Flows below these magnitudes are expected to occur frequently, but

not for durations longer than naturally occurring. Recreational, aesthetic beauty, mussel, and public water supply flows will be maintained by maintaining the flows within the natural flow regime, thus ensuring that the frequency and duration of flows appropriate to these protected entities will be retained.

The protected instream flows described here are keyed to an index location on the Lamprey Designated River. The index location is the US Geological Survey (USGS) stream flow gage 01073500 Lamprey River near Newmarket, NH, also known as the Packers Falls gage. (A new gage was installed in Raymond upstream of the Lamprey Designated River in July 2008. This gage will not be used actively in the management of the protected flows, but will serve as a reference to upstream conditions when desired.) The protected flows are described for the index location as a daily mean flow in cubic feet per second or cfs. One cubic foot per second is roughly 449 gallons per minute or 0.65 million gallons per day. The protected flows are also described in terms of flow per unit area as cfs per square mile (cfsm) by dividing the flows in cfs by the index location's drainage area. Flows in cfsm can be defined at other locations using these values. From the index location, the protected instream flow can be transposed to an upstream or downstream location by prorating the cfsm value to its drainage area.

Evaluating Flow Conditions for Management Under the Protected Instream Flows

Comparison of the daily mean stream flow at the index location to the protected instream flow conditions determines if the protected flow is being maintained or if flow management should be considered. Evaluation of flow conditions will be based on tracking and comparing the current and historical river flows with the protected instream flow magnitudes and durations.

Stream flow conditions relative to the protected instream flows can be identified as being "typical," "persistent," or "catastrophic." These conditions occur when daily mean stream flow is below a protected flow for a certain number of days. Days when flows are below a protected instream flow threshold will be counted to determine whether the allowable or catastrophic durations have been exceeded. Flows exist within the desirable range when stream flows are at levels above a protected magnitude or below a protected magnitude for durations shorter than the allowable duration. These flow conditions are termed typical. No management is needed under typical conditions. A persistent event occurs when stream flow is below a flow threshold for longer than the allowable duration. A catastrophic event occurs when stream flow is below a flow threshold for longer than the catastrophic duration. Neither of these events by themselves will result in a management activity under the Water Management Plan. A combination of persistent events or catastrophic events will result in conditions requiring management. Persistent conditions requiring management occur when more than two persistent events occur within a bioperiod within three years. Catastrophic conditions may also occur when more than one catastrophic event happens within any ten-year cycle. The protected flows were defined based on frequency analysis using these conditions.

The count of flow durations below a protected magnitude can be reset to zero by relief flows represented by a two-day increase in mean daily flow above the next higher protected flow magnitude. For example, flows that increased above the critical flow magnitude for two days would reset the count of the number of days of duration below that flow magnitude. These relief flow events can be created naturally or artificially by management activities. Flow durations are also reset to zero at the beginning of a new bioperiod.

How the Protected Instream Flows meet Water Quality Standards

Water Quality Standards are defined under the Clean Water Act and under the New Hampshire Surface Water Quality Standards. These Lamprey Protected Instream Flows were developed to maintain and protect flow-dependent designated uses under the Clean Water Act. Flow-dependent designated uses applicable to instream flow include aquatic life and recreation. Further, the protected flows quantify the narrative standards under New Hampshire Surface Water Quality Standards Env-Wq 1703.01 (b) and (c) requiring that all surface waters shall be restored to maintain the chemical, physical, and biological integrity of surface waters, and that all surface waters shall provide, wherever attainable, for the protection and propagation of fish, shellfish and wildlife, and for recreation in and on surface waters. Env-Wq 1703.01 (d) requires that unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses. Under Env-Wq 1703.19, surface waters are required to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

Summary of public comments

This section summarizes the public comments received and DES responses to those comments on the Lamprey Proposed Protected Instream Flow report (Dec. 9, 2008.) The summary of comments is divided below into comments that resulted in changes to the protected instream flows, other technical issues, regulatory issues, editorial issues and general comments. Each comment summary includes a summary of DES's response. The original comments and full DES responses may be found in *Appendix 14 – Formal Comments and DES Responses* of the final Lamprey Protected Instream Flow report.

Comment letters were received from the following eleven individuals or groups:

Dr. Loren D. Meeker
Mr. Jamie Fosburgh, National Park Service
Lamprey Local River Management Advisory Committee
Lamprey River Instream Flow Program Technical Review Committee
Mr. Sean Grieg, Supervisor Newmarket Department of Public Works
Emery & Garrett Groundwater Inc.
Town of Raymond Public Works Department
UNH/Durham Water System (UDWS)
Dr. Bill McDowell, NH Water Resources Research Center
Ms. Michelle Daley, NH Water Resources Research Center
Lamprey River Watershed Association

Comments resulting in changes to the proposed protected instream flows

Comment: The **statistical method** used by the logistical regression to select habitat criteria should be revised to select the model parameters critical to explaining fish behavior.

DES Response: The commenter recommended removing parameters that are less important in explaining the presence or absence of fish. The original model selected the habitat parameters that resulted in the best fit in predicting fish use. This model is predictive and not exploratory. That is, the correctness of the final result is what was considered important rather than explaining which individual parameters are important in affecting fish behavior.

The model was rerun with the suggested changes. These changes applied only to the Rearing and Growth bioperiod. The results changed the Common Flow magnitude from 110 cfs (0.60 cfsm) to 104 cfs (0.57 cfsm); the Critical Flow from 22 (0.12 cfsm) to 18 cfs (0.10 cfsm); and the Rare Flow Allowable duration from 6 to 5 days and the Catastrophic duration from 28 to 15 days. These changes were incorporated in the final protected flows.

Other Comments

Technical issues

Comment: The PISF Report should state what the **precise goal of the proposed protected instream flows** are, and should acknowledge the criteria/limits of the desired enhancements of aquatic and fish life. The commenter went on to say that the study appears to be assessing, appropriately, but in too great a focus, habitat enhancements.

DES Response: The goals of the Instream Flow Program as expressed in Env-Wq 1901.01 are "to specify standards, criteria, and procedures by which a protected instream flow shall be established and enforced for each designated river segment on the Lamprey River and the Souhegan River in order

to maintain water for instream public uses and to protect the resources for which the river or river segment is designated." The program's goals are also to complement and reinforce existing state and federal water quality laws as required by RSA 483:2. This requirement regarding water quality standards includes Env-Wq 1703.01(b), which requires that surface water be restored to maintain biological integrity.

Habitat enhancements have no part in the flow assessment. Documentation that defines baseline river conditions for the inputs to the MesoHABSIM model may have appeared to be habitat assessments, because human modifications were removed from the model. Basing flows on riverine habitat that is now impounded would result in illogical flow protections because no amount of available flow will re-create riverine habitat there, so human modifications are removed to define the protected instream flows.

Comment: It is not clear from the statute or regulations what **standard** DES must apply in determining the appropriateness of the proposed PISFs.

DES Response: One standard DES uses to define the protected instream flows is that of biological integrity. Water quality standards requiring the protection of biological integrity already exist. Biological integrity is defined as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region." (Env-Wq 1702.07)

DES also uses the Natural Flow Paradigm (Poff and others, 1997) as the conceptual model for meeting biological integrity goals and supporting other uses of the river. The Natural Flow Paradigm recognizes that stream flow is highly variable and that variability allows species with different flow preferences to live in the same river. DES recognizes that maintaining the river's variability also provides continuing opportunities for boating and public water supply uses. High flow boating opportunities are not always available, but the protection of variability ensures the frequency and occurrence of quality events. The protected flows leave open the ability for public water supplies to make withdrawals so long as flow variability is maintained.

To identify the community of fish species, DES developed a Target Fish Community as the standard of biological integrity. For the standard for recreational use, DES used users' current habits and preferences to determine flow levels that will protect recreational interests. For riparian wildlife and vegetation, the standard is maintaining the frequency and magnitude of flows sufficient to provide life-cycle needs for their existing locations.

There are no similar standards to define a protected flow for the increasing water demand of public water supply. No allocations of water should be made that would specify a flow amount for public water supply. An allocation for public water supply would not necessarily meet future needs and would have to be redefined as demand grows.

Comment: Public water suppliers and others requested more clarity on how protected instream flows should be applied to their uses.

DES Response: DES has developed guidance[1] that applies the Natural Flow Paradigm to protected flows for public water supply, swimming, boating, aesthetic beauty, and hydropower. Under this guidance, if the characteristics of a natural daily flow hydrograph are preserved, then these uses obtain the same opportunities as would occur in the absence of human influence on the flow regime.

Protected flows were developed for fish, riparian vegetation and wildlife, and recreation. The protected flows as described will maintain the river's functions, including public water supply. The protected flows will maintain the river's variability. Under the protected flows, the opportunity to withdraw water for off-stream uses will be protected through the Water Management Plan. However, public water supply represents a consumptive use that alters the hydrograph. Water withdrawals will

need to operate within the water management plan implementing the protected flows to maintain water availability for both their own use, that of other downstream users, and instream public uses.

Baseline or reference conditions

Comment: What are the baseline or reference conditions used in the flow assessments.

DES Response: Baseline conditions were developed as model inputs for the protected flows for fish. This was done to define flow conditions, not for the existing conditions which are modified by human activity, but for reference conditions that define biological integrity. The following two sections summarize the comments and responses concerning the use of baseline or reference conditions (naturalized flow, Target Fish Community, and baseline river structure) used in the assessment of protected flows for fish in the Lamprey River.

Comment: Several commenters questioned the use of **naturalized flow** in the model that was used to define fish flows. These comments questioned the following: (1) whether appropriate data sets were used to define the naturalized flow or whether the naturalized flows included enough of the naturalizing elements to be completely naturalized; (2) the use of naturalized data where the conditions have now changed; (3) the use of naturalized flow because all the human impacts such as land use change are not included, thereby arguably invalidating the naturalized flow data as inaccurate; assessment of such alleged errors was requested; (4) the methodology and data for the naturalized flow; (5) the list of withdrawals and dams used to develop the naturalized flows; (6) whether the groundwater withdrawals removed totaled; (7) why these corrections do not adversely alter the accuracy of the flow duration curves and the resulting protected instream flows; and (8) the naturalized flow is not the recorded values from the stream gage.

DES Response: Naturalized flow is an estimate of the baseline condition for flow, derived from the measured flows at a gage corrected for the net withdrawals and results of impoundment operations. Naturalized flows are used to define flow conditions for biological integrity under the Natural Flow Paradigm concept, which is based on the premise that aquatic species are best adapted to the natural conditions under which they evolved. The naturalized flow, or flow without human modification, is not the flow protection goal, but the tool used to define the flow parameters that support biological integrity.

The naturalized flows do not represent a hydrograph completely corrected for effects of human use—there are other unquantified effects that were not incorporated, such as flow modifications resulting from other dam operations, water use by unregistered users, and watershed-wide effects of development and land use changes. The naturalized flows are the closest correction possible using quantified values. These data better define flows needed to meet biological integrity than do the modified flow conditions being measured at the stream flow gage.

The assessment of protected flows did not use flow duration curves: the assessment used thirty years of naturalized daily flows for each bioperiod.

Error assessment related to the resulting effects of the unquantified conditions such as land use changes or impervious surfaces was not attempted.

The report has been expanded to include some descriptive information and data identifying the water users and dams used to create the naturalized flow and the flow quantities. Data for water users were aggregated and not segregated by groundwater sources: the total water use information was provided. Appendix 13 includes a detailed description of the inputs to the naturalized flow.

The description in the report of the naturalized flow as being based on a long-term record has been revised to make clear that the naturalized flow is not a recorded value, but is based on the recorded gage values.

Comment: Several comments were made questioning the use of **baseline or reference conditions** to define the protected flows when those conditions no longer exist. One commenter thought the idea of reference conditions implied a restoration project under the instream flow program that may include dam removals or other changes. There was confusion between defining protected flows using reference conditions and applying protected flows to existing conditions: one comment suggested these results might be too conservative or irrelevant if developed using baseline conditions. One comment requested an analysis of the variability of the **Target Fish Community**. One comment requested details of the development of the Target Fish Community and evidence that the Target Fish Community is appropriate for the study. One comment expects the use of baseline fish and river conditions to produce unrealistic PISFs for species and habitat that are potentially incompatible with their public water supply's withdrawals. One comment suggested the **baseline river structure** should reflect the pre-colonial influence of beaver.

DES Response: The use of baseline or reference conditions are fundamental aspects of defining protected flows based on biological integrity instead of on existing conditions. The assessment method included a baseline component called the Target Fish Community that used similar reference rivers to define the fish population that should occupy the Lamprey. The percent composition of the species in the Target Fish Community was based on collections from free-flowing segments in reference rivers comparable to the Lamprey Designated River. The assessment method also included modeling of re-created riverine physical structures in the sections where dams had replaced the riverine environment with impoundments. The modeled baseline river structures put the Lamprey conditions on a footing equal to conditions in the reference rivers that support the Target Fish Community by providing a similar habitat distribution for the assessment. The protected flows defined using these baseline conditions will support the Target Fish Community within the existing Lamprey Designated River, although the Target Fish Community may not be achieved under the existing, physically altered conditions.

DES did not include an analysis of the Target Fish Community variability in the Lamprey pilot project's scope of work. The variation in species composition in different rivers is a consequence of natural and spatial variability. To reduce the influence of variability, fifteen fish collections from six rivers were used, but only if they met specific criteria for comprehensiveness in the numbers of fish collected. The Target Fish Community was developed and approved by the Technical Review Committee in 2007 prior to the start of the field assessments.

A reference web link to the June 2007 Target Fish Community report describing the details of the development and results of the Target Fish Community has been added to the report.

DES has no quantified data describing the influence of beaver on pre-colonial river conditions. The reference conditions that were used relied on available data.

The Instream Flow Protection has only flow criteria and management for flow and does not include restoration efforts. This means the protected flows are appropriate for the river regardless of existing or future restoration or alteration.

Comment: A variety of statistical analyses should be conducted including **error assessments and sensitivity analyses** of variables such as fish populations, vegetation, stream flows, habitat suitability, habitat mapping surveys flow requirement assessments, and flood plain transects. How will potential errors in the analysis impact the accuracy of the designation of PISF values?

DES Response: The Report contains an Error and Uncertainty Section for the MesoHABSIM assessment that discusses the limitations of developing error assessments on these parameters. However, some components of the MesoHABSIM modeling process were validated as part of the study and the results were included in Appendix 6 (Habitat Suitability). The standard errors of the ecological variables used in the modeling have now been included in the coefficient tables that can be found in the revised version of Appendix 6. Sensitivity analyses could be conducted, but were not part of the scope of work as these analyses are not routinely conducted for incremental flow models.

Comment: One commenter asserted that the assessment of **recreational needs** was poorly done because the survey was limited in location, number of participants, and recreational type. The comment stated that the recommended minimum flow levels are inadequate to meet recreational needs on the river.

DES Response: The qualitative evaluations of both boating and swimming recreation were based on surveys, interviews and field observations, all of which are common methods for assessing flow and recreation. Swimming was determined to be more influenced by weather than by stream flow, and given contradictory survey responses, no protected flow was recommended. DES recognizes that by maintaining the natural flow regime of the river, swimming opportunities will continue to be available. In order to protect this and other resources on the river, DES will apply the Natural Flow Paradigm as explained in a separate guidance document Application of the Natural Flow Paradigm to Protected Instream Flows (DES publication WD-09-13).

A minimum boating flow was identified by the survey methods. Boaters have traditionally used the white water sections when flows were above the minimum boating flow. Maintaining the natural flow regime will continue to provide the frequency, duration and magnitude of flows expected by boaters. Water Management Plan actions will recognize the threshold between boatable and non-boatable flows and avoid actions that reduce boating opportunities. No fishing flow was defined. Because fishing success is dependent on the presence of fish, protected flows for fish were determined to meet the needs of recreational fishing.

Comment: Why are higher flows need to be maintained in order to accommodate rearing and growth needs of common shiner? The commenter concluded that the rearing and growth bioperiod's protected instream flows and/or the allowable durations are **overly stringent** due to the fact that they are exceeded in seven of the eight years of very low summer flows over the last 28 years.

DES Response: This analysis by the commenter is based upon only a select sample of years and, as the commenter himself admits, these were years with very low flows. Furthermore, only five of these events exceeded a catastrophic duration. Low flows are allowed to happen periodically without management because low flows are expected conditions within the range of flows.

Comment: What was the source of the recommendation by the project team that flows not be allowed to fall below **4 cfs** under any circumstances. They questioned how that recommendation would be managed. One commenter questioned why flows would ever be allowed to get this low at all.

DES Response: A flow of 4 cfs was proposed as a minimum flow because it was the lowest flow observed in the river. The description of the lowest flow was a new concept in the pilot program that had not been used in the Souhegan study. The naturalized flows for the period 1976 through 2005 were observed to contain no flows lower than 3.7 cfs. The 3.7 cfs value was the lowest measured flow after correction for human effects of water withdrawals and management of Pawtuckaway Lake. The conclusion was that stream flow in the Lamprey Designated River should not be lower than these historical naturalized flows. The 3.7 cfs value was rounded up to 4 cfs.

Management issues were not investigated in this study and would have been defined for this condition in the water management plan, but the decision was made that the 4 cfs criteria were redundant under the flow protections and that flow conditions below 4 cfs would likely result in emergency conditions being declared by the commissioner. The use of a 4 cfs minimum flow as a stream flow criterion has been dropped from the protected flow recommendations.

Low flows are important stressors in maintaining biological integrity. Under the Natural Flow Paradigm, low flows are expected to occur, but because they are naturally infrequent, low flows should be limited, by management if necessary, to their natural ranges of duration and frequency in order to maintain biological integrity.

Comment: The protected flows should be adjusted because the species of Rare, Threatened and Endangered (RTE) **turtles** were not seen during the field survey of the river. The commenter states that the protected flow elevates the protected status of an absent protected entity, and the protected flow is also indiscriminately applied to the entire designated segment. It suggested that the protected flows for turtles should not apply to the Wiswall Dam impoundment because a lack of habitat combined with human disturbance meant that no turtles would be present. The commenter posited that the protected flow defined for this species applies indiscriminately to the whole river, despite the finding that the habitat for this species is not found in the Wiswall Dam impoundment.

DES Response: Only one RTE turtle was seen during the field survey. All of New Hampshire's six turtle species are found in the Lamprey Designated River corridor. Lack of observation does not preclude the presence of or diminish the protection to be provided by a PISF for these species. The Lamprey River protected flows for turtles apply to the Designated portion of the river as a whole because current modifications should not determine flow protections that would preclude re-establishment of these species.

Comment: Why are **protected instream flows based on salmon** included since conditions of water quality, land use, thermal regime and substrate would limit salmon on the river even if fish passage were available, and also considering that the NH Fish & Game Department has abandoned its salmon restoration program on the entire Lamprey River for those reasons?

DES Response: Salmon are one of the species making up the Target Fish Community for the Lamprey River. They are expected to occur in coastal watersheds like the Lamprey River Watershed. The flows that would support Atlantic salmon are also supposed to occur in the Lamprey Designated River. The protected instream flows define flow conditions to support the ecosystem needs and not those of any one particular species. Flows for Atlantic salmon are surrogates for the ecosystem needs during the salmon spawning bioperiod. The habitat requirements for the Atlantic salmon indicate the flows that should occur in the river.

Comment: Trout should not be included as a species in the assessment because the temperature regime was not suitable for them and they are found only in the Lamprey's tributaries except for stocked individuals.

DES Response: Trout were not included in the analysis.

Comment: Three comments discussed **stream flow gaging**. Two pointed out the importance of accurate measurements in the 100 to 1 cfs range. One comment believes that one gage is inadequate and requested an analysis or discussion of this topic in the report. One comment asked if the new gage [installed July 2008] would be used to implement the water management plan.

DES Response: DES believes that one gage is adequate to monitor the 12.1 miles of Designated River and feels no that further analysis or discussion is necessary. The new gage, located approximately 10 miles upstream of the Lamprey Designate River at Langford Road in Raymond, is not needed for management but may be used to supplement the Packers Falls gage. USGS provided documentation of its data quality measurements. In response to a query from DES about the accuracy of flow measurements at the Packers Falls gage, Mr. Richard Kiah of the USGS New Hampshire/Vermont Water Science Center in Pembroke, New Hampshire, stated that since the time of water year 2000 (when the current rating curve was established for the Packers Falls gage), eight measurements have been used to check the stage-discharge rating curve between 1-100 cfs and have ranged from -2.4% to +4.7% of the expected flows. These values indicate that the gage is accurately measuring the stream flows in this range.

Comment: Four comments had questions about the **third-party review** of the results of the instream flow study. One comment applauded DES for conducting the review as an extra precaution. One comment asked why it had not been done already and another asked when it would be completed. One comment suggested that the selected reviewers lacked impartiality.

DES Response: This review was proposed by DES following US Fish and Wildlife Service (US F&WS) comments on the Souhegan River Proposed Instream Flow Report. US F&WS said they would like more testing and critical review of the MesoHABSIM model. DES planned to conduct a review of both rivers' methods and results. DES contracted with the Instream Flow Council (IFC), made up of instream flow experts from throughout the United States and Canada, to provide a third party review of the Final Souhegan River Protected Instream Flow Report and the Draft Lamprey River Proposed Protected Instream Flow Report. DES notes that the IFC and the IFC panelists have no interest in the results of their review other than providing the best instream flow process and results and, therefore, are well suited reviewers.

Comment: Two commenters asked whether the **MesoHABSIM** model had been vetted by industry and one asked where it had been used successfully before. One commenter said there was no comparison of MesoHABSIM to other methods in the report and asked why MesoHABSIM had been selected.

DES Response: The MesoHABSIM model was conceived by Dr. Piotr Parasiewicz in 1991 and was first applied on the Quinebaug River in Massachusetts and Connecticut in 1999. For examples of where MesoHABSIM has been applied, project examples and literature, see www.MesoHABSIM.org. The MesoHABSIM model follows the same principles as the widely recognized Instream Flow Incremental Methodology (IFIM), which has been used in the determination of instream flows by the US Fish and Wildlife Service and USGS since the 1970s and vetted in many court cases. MesoHABSIM is an improvement of the PHABSIM model and comparative studies of these two models have been performed.

No comparison between MesoHABSIM and other methods was conducted as part of this protected instream flow study. There are hundreds of flow assessment methods in use. Other methods were presented during the proposal process for hiring the project team. DES staff and elected members of the Lamprey Technical Review Committee and Water Management Planning Area Advisory Committee formed the selection committee that chose the project team. The project teams' assessment methods were a major part of the selection criteria. The selection committee gave the highest ranking to the method using the MesoHABSIM model.

Comment: Three commenters thought that the **signs of the [MesoHABSIM] model parameters** should be the same for the "abundance model for fish" and for the "presence or absence model for fish," that is, that a positive (or negative) parameter for presence should be positive or negative for abundance.

DES Response: These components of MesoHABSIM are not descriptive models, but predictive models. The habitat suitability requirements are based on logistic regression coefficients developed from empirical fish capture data. The combination of variables is what defines habitat. The presence/absence and the abundance models are two different assessments. Only the sites at which fish were present are included in the abundance model. The analysis uses logistic regression to select the most significant parameters for defining habitat suitability. One combination may best define when a species is present. This combination may not be the same for the presence of a few individuals as for an abundance of individuals. The results may elevate or downplay different parameters in the two different models.

Comment: The report should include the **relative importance of variables** included in final models.

DES Response: Appendix 6 identifies those attributes that were studied and found to have a correlation with the presence and abundance of the fish species and insect families. Their standard errors were included in the coefficient tables which can be found in the revised version of Appendix 6. Where the standard error is less than the coefficient (b), then the variable is more important in determining the results of the habitat use by fish.

Comment: Can the **protected flows be changed** if the model were found to be flawed?

DES Response: There is a process in the rules for revising the protected flows in the event modeling errors are found.

Comment: Four comments discussed **upstream water users**, and asked why they are not discussed in the report and noted the limited ability of downstream water users to compensate if upstream water users were not part of the watershed management.

DES Response: This protected instream flow report discussed only water users and expected water users within the 12.1 mile stretch of the Designated Lamprey River because they are resources and outstanding characteristics of the river. Upstream water users are not discussed in the report. However, the upstream water users will play a part in the management of the river under the Water Management Plan for the Lamprey Designated River. Management by upstream water users is not part of this protected instream flow study.

Comment: How can common flows, as defined in the report, **exceed the mean** of the daily mean flows and would not such a result would invalidate the analysis?

DES Response: First, the definition in the report describes common flow magnitude as "near optimal habitat availability conditions that are exceeded during approximately 45 percent of the bioperiod." The definition in the report was meant to give an approximation of the range of flows represented by Common Flows. The selection of the Common Flow is not done using the approximation and in some cases the Common Flow is higher or lower than this approximation in the definition. The approximated value (45% of the bioperiod) has been removed from the definition to eliminate any apparent contradiction. Similarly, the approximate conditions in the Rare Flow and Critical Flow definitions have been removed.

Second, this question ignores the Natural Flow Paradigm's principle that stream flow exists as more than just magnitude. Stream flow must also be described with components of timing, duration,

frequency and rate of change. Each of the Lamprey Designated River protected flows have components of magnitude and duration (based on frequency analysis for each bioperiod). The Common Flow is higher than the median flow, but the allowable duration described for the common flow during summer is 46 days and the catastrophic duration is 81 days. This range allows stream flow to be below the Common Flow some of the time. Summer flows frequently fluctuate above the Common Flow to restart the count. As a result, stream flow may go below the Common Flow for a considerable part of the summer, without requiring management.

Comment: Comments were received asking about **Part Two** of the report. One commenter asked on which protected flows the analysis was conducted: Common, Critical, Rare or all flows. Another commenter noted that some protected flows are met nearly all the time, while another stated that clarification is needed to explain whether the terms "met" or "meets" the protected instream flows should be interpreted as complying with or as intersecting the flow.

DES Response: Part Two of the report includes the evaluations of the protected flows under several flow scenarios to estimate the effect of the protected instream flows under various hydrologic conditions. Conditions identified as representative hydrographs were wet years, dry years, average years and the most recent five years. Evaluation of the protected flows under these conditions show the range of the influence of the protected flows.

Protected flows were identified for fish, recreation and riparian vegetation and wildlife. The only entities that have Common, Critical or Rare protected flows are fish. Non-fish protected flows have their own prescribed periods and flows. In Part Two, the protected flows for each protected entity were first presented, and then the number of times they were met or not met was reported for each of the representative hydrographs. The comparison of the hydrographs with the Common, Critical or Rare flow PISFs, as proposed for fish, appears in Tables 45 to 48, in which the Common, Critical and Rare flows are labeled. The comparisons for protected entities other than fish are based on their specific protected flow values, which don't include Common, Critical or Rare flows.

Some protected entities have survival strategies not shared by fish that reduce their flow sensitivity (such as mobility, dormancy, leaf drop, delayed reproduction), and therefore their protected flow values, durations and/or frequencies are easily met in most years.

The comment response clarifies the use of terms in Part Two relative to whether protected flows are sustained or violated.

Water management

Comment: One comment asked what would be the **legal consequences** if the water management plan, once adopted, were not followed.

DES Response: The protected instream flows are statutorily required interpretations of the water quality standards and the water management plans are enforceable in meeting those standards.

Comment: What **role do the watershed towns would play** in maintaining flows.

DES Response: The watershed towns will only have responsibilities if they are Affected Water Users or Affected Dam Owners subject to a Water Management Plan.

Comment: Several commenter requested details of how the protected flows would be **used in the management plan**; one asked in particular about flow releases from Wiswall impoundment.

DES Response: The protected flows define when management events are needed. The DES website will be developed to identify the current conditions. The Lamprey Designated River Water

Management Plan includes conservation plans, water use plans and dam management plans. If these plans are followed, then the protected flow should be met.

Comment: One commenter asked why flow protection went as low as **16 cfs**, and stated that this seemed too low.

DES Response: A flow of 16 cfs is one of the protected flows for fish and so it has associated durations for allowable and catastrophic conditions. Naturalized and measured flows on the Lamprey historically do go below 16 cfs. Despite this being a very low flow, flows at and below this magnitude are natural parts of the flow regime that will continue to be allowed to occur without management unless they occur with greater frequency or for longer durations than occurs in the naturalized record.

Comment: Who will **decide** if protected flows have been met?

DES Response: DES will be responsible for tracking protected flows and for maintaining a website of the conditions for the Affected Water Users and Affected Dam Owners to refer to in conducting the management activities in their part of the Water Management Plan.

Comment: Determine whether the party monitoring flows will have the **authority to release water** to maintain protected flows.

DES Response: The people who would release water are the Affected Dam Owners, who have the authority to store and release water for this purpose. The Water Management Plan defined the Affected Dam Owners which play a role in creating relief flows. In the case of the Lamprey Designated River, the dam which will be utilized for flow management are owned by the State of New Hampshiore and managed by DES.

Comment: One commenter asked for a **table of the number of times that management would be needed** as a result of times when protected flows were not met and asked for the duration of the required management.

DES Response: A table was created showing the historical management events during the following periods: representative three-year wet, dry and average; most recent 5-years; and the thirty years from 1976 through 2005. The table and method description are part of Appendix 14.

Comment: Why are **three seasons of low flow** allowed before management is required?

DES Response: The Natural Flow Paradigm recognizes that low flows are part of the natural flow regime and should occur without management. Repeated exceedences of flow magnitude and associated durations together determine when management is required. Management is required when flows go below the natural range of magnitude for longer than, or more frequently than, the natural conditions. The protected flows assessment incorporates the Natural Flow Paradigm's acceptance of occasional occurrences of even very low flows. The protected flows are defined based upon three flow magnitudes, each with two durations: a persistent duration and a catastrophic duration. As defined, the low flows exceeding the persistent durations typically occur every two to three years and are expected occurrences under these described conditions. The assessment used three consecutive events below a flow magnitude occurring for longer than the persistent duration to define one of the conditions for management. As defined, the low flows exceeding catastrophic durations typically occur no more than once in ten years and are expected occurrences under these described conditions. The assessment used two events within ten years below a flow magnitude occurring for longer than the catastrophic duration to define a catastrophic condition requiring management. These criteria allow the appropriate low flows to continue to occur, but not overly frequently.

Comment: Do **public water supply needs come before** the needs of the river and its inhabitants?

DES Response: There is no hierarchy of needs under the Instream Flow Program. DES has an interest in defining a process that will protect both the long-term interests of public water supplies (PWS) and maintain flow protection for instream public uses. Protected flows are defined for instream public uses that will be, once established, the criteria for water quality standards for the Designated River. The balance between competing needs will be maintained by management under the Water Management Plan, which will define how to support public water supply needs as a valued river resource while maintaining the protected flows.

Comment: Aa public water supply entity pointed out that the report did not discuss **their reliance on the Lamprey** or their plans to use the Lamprey to meet future growth. Another public water supply entity commented that the report did not consider the practical limitation for public water supply such as that the possible alternatives to reduce consumptive use of the Lamprey that are listed in the report may not be available to them and may be limited in effect; that the population of water users in Durham and UNH is expected to more than double in the near future and so Lamprey water is their planned supply; and, that the Oyster River's nomination as a Designated River may affect them by developing protected flows for that river which is used as their main water supply as a public water supplier.

DES Response: These considerations are appropriately considered in the Water Management Plan development process, as they are not science-based stream flow needs, but instead are demand-driven and, therefore, water management issues.

Comment: One commenter asked whether the protected flows would replace the conditions in Durham's existing **401 Water Quality Certificate (401 WQC)** for the withdrawal at the Wiswall Dam impoundment, or will it be overlaid on the conditions of the 401 WQC.

DES Response: The conditions in the 401 WQC will be amended to reflect the adoption of the Protected Instream Flow and the Water Management Plan for the Lamprey Designated River.

Comment: Why was **aesthetic beauty** not considered flow-dependent?

DES Response: Prior to conducting the protected instream flow assessments, DES identified the protected entities that were considered flow-dependent and presented them in a report in 2006 to the Technical Review Committee and the Water Management Planning Area Advisory Committee for their opinion. DES determined that, of the protected entities, only the flow-dependent entities would be assessed for protected instream flows. Aesthetic beauty was defined as not being flow-dependent by the project team in consultation with the Technical Review Committee and the Water Management Planning Area Advisory Committee. DES feels in retrospect that it was a mistake not to include aesthetic beauty as a flow-dependent protected entity. Nevertheless, the protection of aesthetic beauty will still be maintained through the existing flow protections. In order to protect this and other resources on the river, DES will apply the Natural Flow Paradigm as explained in a separate guidance document, Application of the Natural Flow Paradigm to Protected Instream Flows (DES publication WD-09-13). The application of the Natural Flow Paradigm as the conceptual model for the protected flows will maintain stream flows within the natural range of variability.

Comment: A number of comments concerned the **protection of public water supplies.** Commenters asked why no protected flows were identified for public water suppliers. One stated that

the use of the Lamprey River as a public water supply source must be considered as flow-dependent and, therefore, sufficient flow must be made available to meet public water supply needs. Another comment asserted that DES did not consider the flow demands needed to maintain public water supplies and artificially elevated the value of the minimum protected flow requirements estimated for all other instream public uses through an overreaching goal of enhanced baseline conditions. One comment stated that it is imperative that a PISF be established that considers public water supply needs prior to development of the Water Management Plan.

DES Response: DES recognizes public water supply as an outstanding characteristic and a resource of the Lamprey Designated River. As such, public water supplies will be maintained and protected. However, the appropriate mechanism for doing so is not as an instream flow protection, but through management of flows to maintain adequate opportunity for withdrawal for public water supply comparable to that of a natural river system under the Natural Flow Paradigm.

In 2006, early in the pilot project, DES published a report describing the protected entities that would be assessed because they are flow-dependent. The UNH/Durham Water System was identified as a flow-dependent, protected entity that would be assessed. This was because it had a Clean Water Act Section 401 Water Quality Certification # 2001-001 (401 WQC) with conditions tied to flow in the river. Upon further consideration, DES determined that this flow-dependency of the withdrawal is an artificial construct generated for the 401 WQC. Other than the management conditions defined in the 401 WQC, there is no relationship between water demand and stream flow from which to derive a protected instream flow.

This situation was discussed with the Technical Review Committee. The Proposed Lamprey Protected Instream Flow Report was presented to the Technical Review Committee (TRC) over two meetings, one held on October 23, 2008 and one held on November 13, 2008. At the November meeting, the recommendation that no specific protected instream flows were to be proposed for public water supplies was presented along with the plan to maintain protected flows and public water supply through the development of the Water Management Plan. The Technical Review Committee did not comment on this in their February 27, 2009 comment letter.

In order to protect this and other resources on the river that rely on the inherent variability of flow in a river system, DES will apply the Natural Flow Paradigm as explained in a separate guidance document, Application of the Natural Flow Paradigm to Protected Instream Flows (DES publication WD-09-13).

The Lamprey protected instream flows follow the Natural Flow Paradigm, which emphasizes keeping stream flow within its natural range of variability. By maintaining flows close to the natural regime, all non-consumptive protected entities, which are not affecting stream flow, are supported. By maintaining the essential characteristics of the natural flow regime, DES protects public water suppliers' opportunity to withdraw water. Management will support public water supply withdrawals. Consumptive uses, like public water supply withdrawals, will change the flow regime. This consumptive use will require management to offset the impacts that exceed the variability. The greater the consumptive use, the more management will be required.

The baseline conditions are part of the assessment method and do not represent proposed enhancements. No part of the Instream Flow Pilot Program suggests or recommends habitat enhancement. This program applies strictly to identification and maintenance of flow needs as the means to protect instream public uses, outstanding characteristics, and the resources for which the river was designated. (See also the comments above discussing baseline conditions.)

Comment: Three comments were received concerning the status of **mussels**. One comment pointed out that mussels were not discussed in detail in the report and that no protected flows were

defined for mussels despite their being identified in the 2006 report describing flow-dependent status and the assessment methods. A comment observed that mussels (and other species) were stranded (and their burrow entrance holes exposed) when the Wiswall Dam impoundment was lowered for inspection of the dam. Elaboration was requested on how the flow needs of mussels would still be satisfied.

DES Response: The assessment of protected instream flows for mussels was attempted during the Souhegan study. The Souhegan Instream Flow Pilot Study's MesoHABSIM model demonstrated no habitat change as a result of changing flow conditions within the investigated flow range of that study. This is in part due to a broad range of habitat used by mussel species, which may be fast or slow flowing: the result is that a generic model for mussels is not sensitive enough to capture the habitat changes for individual species. As the observations of the drawdown of the Wiswall Dam impoundment documented, mussels seem to be more vulnerable to rapid change in water depth than to change in stream flow.

Protection for mussels is maintained by three factors: maintaining fish species upon which the mussel larvae are dependent, keeping shear stresses within ranges that allow juvenile mussel settlement, and avoiding dewatering of habitat at rates that will strand mussels.

If applicable, protection from stranding will be developed in the Water Management Plan where criteria for rate of change, one of the components of flow described in the Natural Flow Paradigm, will be part of the management scenario. Because of the results from the Souhegan study, and the expectation of DES that the factors that support mussels will be met by flows that meet the Natural Flow Paradigm, or by the conditions for rates of flow change caused by dam storage or release or use rates to be developed in the Water Management Plan, no assessment of mussels was conducted on the Lamprey.

Comment: One commenter was uncomfortable with suspected **anomalies** related to differences in flow rates that were higher in dry years than in wet years.

DES Response: Subsequent discussion with the commenter identified that the anomaly referred to was related to a question raised during the January 8, 2009 Lamprey Water Management Planning Area Advisory Committee meeting. The presentation was reviewed and no anomalies were identified. However, conditions that were initially counterintuitive were possibly the source of the comment.

Regulatory issues

Comment: One commenter asked if upgradient parties had been **notified** of the PISF study and potential impacts on water resources.

DES Response: Notification of various parties including specified upgradient communities and organizations is required in the rules and in statute for public meetings, public hearings and the Technical Review Committee and Water Management Area Advisory Committee meetings. The comment response in Appendix 14 of the Lamprey Protected Instream Flow Report describes in detail the certified mailings, emails, meeting announcements, and website documentation and notifications that have been ongoing since the beginning of the study. Notifications for all meetings and hearings have been sent to all upstream Affected Water Users, Affected Dam Owners, watershed towns, and to other interested parties.

Comment: A comment asked how the **assessment of the effect** of a protected instream flow on existing hydroelectric power generation, water supply, flood control, and other riparian users required by RSA 483:9-c, III was addressed in the report.

DES Response: This assessment was not addressed as part of the Protected Instream Flow report. There is no effect on existing users merely from the establishment of the protected flows. The

effect of the protected instream flows comes with the implementation of the water users' and dam owners' individual components of the Water Management Plan. Each Affected Water User and Affected Dam Owner will have their own water management plan, which taken together will comprise the Water Management Plan. Water users and dam owners will assist in the development of their individual plans. Hydroelectric power generation, water supply, flood control, and other riparian users will have management actions described in their plans. These management actions represent the effect of the instream flows on the RSA 483 listed entities. This assessment of the effect of the protected instream flows will be conducted as part of the Water Management Plan development and review.

Comment: Three commenters stated they did not believe there was sufficient **time** to produce a well thought out Water Management Plan within the **statutory deadlines**. One comment suggested that the Technical Review Committee may not have had enough time to review the draft report prior to voting to send it before a public hearing.

DES Response: After the release of the Draft Protected Instream Flow for the Lamprey Designated River, the Legislature approved an extension of the duration of the pilot program to September 1, 2010 (Chapter 201, Laws of 2009). The deadline for the issuance of the Protected Instream Flow and Water Management Plan for the both the Lamprey and Souhegan Designated Rivers was subsequently extended to September 1, 2013.

The Lamprey Technical Review Committee's duty was to advise DES on technical aspects of the study. DES began presenting the methods and results used in the Lamprey Study to the Lamprey Technical Review Committee beginning in April 2007. DES has made the study methods used to define the protected flows part of its continued interaction with the advisory committees (i.e., the Technical Review Committee and the Water Management Planning Area Committee) and with the public. DES has made numerous presentations describing these methods over the years during both this study and the Souhegan study. DES first presented the Lamprey Study results at the Technical Review Committee meeting on June 9, 2008. The Technical Review Committee's review period did not end with its approval of the report to go to the public hearing in November 2008. The Technical Review Committee had over 20 weeks to review and comment on the draft report before the end of the public hearing comment period in March 2009.

Comment: One comment said the **public hearing** on January 14, 2009 did not follow the requirements of Chapter 5 of the Laws of 2008, Section 5:3, III (a) because the hearing was held before the submittal of the final report and because the hearing was conducted by two DES staff, and no Senate Environment Committee members were in attendance and only one member of the House Resources Committee was present.

DES Response: The purpose of the public hearing is to hear comments before the protected flows are established. RSA 483:9-c, II states, "One public hearing shall be held in at least one municipality along the designated river or segment to receive public comment on the establishment of a proposed protected instream flow." DES coordinated the hearing with the appropriate legislative groups and cannot require the legislature to attend.

General Comments

Comment: One comment representing a public works department expressed **concerns** with the accuracy of the report and ramifications of its conclusions. The comment pointed out there were a number of questions raised about the methods and results. The commenter, based upon his layman's impression of the report, opposes the conclusions of the report and any water management plan

promulgated from or based upon its conclusions. Another comment from a public works department also expressed concern regarding the accuracy of the report and the resultant possible impacts this could have on maintaining their public drinking water supplies and future water supply needs.

DES Response: DES appreciates the concerns of public water suppliers in this process and recognizes public water supply as a valued resource and outstanding characteristic to be protected on the Lamprey Designated River.

Comment: The comment letter from the **Lamprey Technical Review Committee** should be made public.

DES Response: This letter is posted on the website with all of the comments received.

Comment: One comment was received asking that **raw habitat data** collected for the project be made available on the web.

DES Response: DES is collecting these data and will make them available through a document library on the web.

Comment: Consideration should be given to the effects of water withdrawals on **invasive species** such as zebra mussels and Didymo (*Didymosphenia geminata*).

DES Response: DES did not evaluate the effects of water withdrawals on the flow regime and its resulting consequences for invasive species because they are not protected entities. Didymo and zebra mussels are not known to inhabit the Lamprey Designated River, and water management alone will neither prevent nor encourage invasion by these species, so they were not addressed in this study. Nonetheless, we recognize that invasive species can be a threat to the protected entities and may also be flow-dependent. Therefore, we included a discussion of the potential effects of stream flow on invasive species observed or known to be within the riparian corridor (see, Assessment of Flows, Section B. 3).

Comment: One comment pointed out that the **report text had changed** following the two meetings held by the Lamprey Technical Review Committee and suggested that it contained policy that should have been reviewed by the Lamprey Technical Review Committee.

DES Response: The text referred to by this comment documented DES's plan to not define a specific protected instream flow for public water supply withdrawals. Public water supplies will have the opportunity to continue to withdraw water so long as the natural flow regime is maintained in the river. This issue was discussed at the second meeting of the Lamprey Technical Review Committee and incorporated into the text following that meeting. The Lamprey Technical Review Committee did not comment on this issue in their subsequently issued comment letter.

Comment: One comment expressed confusion caused by the **different date** on the draft report that was posted to the DES website and the draft report posted to the DES file transfer protocol site (ftp) for the use of the Lamprey Technical Review Committee.

DES Response: This was subsequently fixed to ensure that that the same version of the report was available for comment.

Comment: There is **too much information** and that the size of the report with its preponderance of information was designed to overwhelm reviewers.

DES Response: Given the technical nature of the subject matter and, by virtue of being a pilot project (this is the first time such an endeavor has taken place in New Hampshire), a high degree of documentation is both warranted and required. DES attempted through the production of summary

tables and charts to present the final Protected Instream Flows in such as way as to be understandable by a broad audience.

Comment: One commenter said they appreciate that DES has provided substantial **opportunity for public input** in what is a very open process.

DES Response: No response necessary, but thank you.

Comment: One comment stated that a **survey** by Shannon Rogers was not incorporated in the report.

DES Response: This survey was conducted as part of the Water Management Plan. The results of that survey will be incorporated in the Water Management Plan process.

Editorial issues

Comment: **Clarifications** were requested for the terms used to describe flow data and for the circumstances when naturalized flows were used versus use of measured flows during the assessment process.

DES Response: This information has been provided in the comment responses in Appendix 14 of the report and clarified where appropriate in the report text.

Comment: Several comments were received stating that the report was **large, complex, confusing or lacking adequate information**. One comment stated that the **executive summary** did not adequately describe the background reasons for the study or completely describe the results and ramifications. One found the executive summary confusing and lacking information and suggested that if this is the only part of the document many people read, it should contain a timeline, legislative authority, and results of Tasks 1 through 4 of the Lamprey River Flow studies. (These are the earlier reports developing the list of protected entities and defining which are flow-dependent, defining the Target Fish Community, and defining the assessment methods proposed prior to the field studies to assess the flow-dependent entities.) One comment requested a brief/one sentence explanation of how the results of **Table 1** [protected flows for fish] were determined and how the results will determine the management plan; more detailed explanation of the table and terms was suggested. Two comments stated that **Table 1** was unclear and asked how the values would be used in the water management plan. Another comment asked that the table be revised and a graph of the protected flow magnitudes be added to the report.

DES Response: The **executive summary** has been redrafted and some of the information requested has been added to provide additional background information.

The discussion of how the protected flows result in a water quality impairment requiring management has been expanded. The project's previous reports are now referenced in the Executive Summary.

Table 1 has been revised and definitions provided. Table 1 was replaced with a reformatted version and text was added to describe in more detail what constitutes an occasion requiring management under the water management plan. A graph of the protected flow magnitudes during the bioperiods was not added because comments received on the Souhegan report indicated that without the durations such a graph was misleading.

The length of the report and the technical nature of the discussion in the report reflect the amount of information gathered through the study's investigations and the level of technical analysis required for the assessment of the proposed protected instream flows. The project team attempted to provide

sufficient detail as to the methods used, the results obtained and the conclusions drawn so that they could be reviewed by the public and other stakeholders engaged in the process.

Comment: A number of editorial comments were received including: (1) certain **references** in the bibliography were missing; (2) all the **sections and subsections should be numbered**; (3) the graphs, tables, and supporting calculations should be reviewed and **clearly and consistently labeled**; (4) there is a **typo** in Table 44; and (5) a **bathymetry** figure appeared incorrect.
DES Response: All of these issues have been corrected in the final report.

Comment: One commenter objected to the **characterization of its particular water use conditions and future water development plans**.
DES Response: The text has been revised.

Comment: One commenter stated that they declined to answer a **survey** by Shannon Rogers because they considered the survey too subjective.
DES Response: No response required.

How the Comments Affected the Final Protected Instream Flows

One comment letter resulted in changes to the protected instream flows. Dr. Meeker suggested changes in the statistical selection of habitat suitability criteria that were incorporated in a re-running of the MesoHABSIM model for the applicable Rearing and Growth bioperiod. The revised calculations resulted in the following changes: the Common Flow magnitude was reduced from 110 cfs (0.60 cfsm) to 104 cfs (0.57 cfsm); the Critical Flow was reduced from 22 (0.12 cfsm) to 18 cfs (0.10 cfsm); the Rare Flow Allowable duration was reduced from 6 to 5 days and the Catastrophic duration was reduced from 28 to 15 days. These changes were incorporated in the final protected instream flows.

The remaining comments resulted in explanations or clarifications that were added to the report or carried in *Appendix 14 – Formal Comments and DES Responses*. These comments resulted in increased detail of documentation describing the process of developing the Lamprey Designated River protected instream flows.