NHDES-R-WD-11-9

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Lamprey River
Water Management Plan

28 August 2013

This Page Intentionally Blank

Lamprey River
Water Management Plan

Prepared by

Watershed Management Bureau
NH Department of Environmental Services

With contractor assistance from

Normandeau Associates, Inc.,
University of New Hampshire,
and
Rushing Rivers Institute

NHDES
PO Box 95 - 29 Hazen Drive
Concord, NH 03302-0095

http://www.des.state.nh.us/rivers/instream/

Thomas S. Burack
Commissioner

Vicki V. Quiram
Assistant Commissioner

Harry T. Stewart. P. E., Director
Water Division

This Page Intentionally Blank

Table of Contents

Appendices:

Glossary:

ADO	Affected Dam Owner
AWU	Affected Water User
cfs	cubic feet per second
cfsm	cubic feet per second per square mile of watershed at the point of interest
de minimis	5 percent of 7Q10 at a point of interest
GIS	Geographic Information System
GRAF	Generic Resident Adult Fish
IPUOCR	Instream Public Uses, Outstanding Characteristics and Resources
NHDES	New Hampshire Department of Environmental Services (DES)
NHF&GD	New Hampshire Fish & Game Department (NHFGD)
NRCS	Natural Resources Conservation Service
PISF	protected instream flow
RSA	Revised Statutes Annotated
RTE	Rare, Threatened and Endangered Species
7Q10	Lowest continuous seven day discharge having a ten year recurrence interval
USEPA	United States Environmental Protection Agency (EPA)
UNH	University of New Hampshire
USGS	United States Geological Survey
WMP	Water Management Plan
WMPA	Water Management Planning Area
WMPAAC	Water Management Planning Area Advisory Committee

List of Figures

List of Tables

Executive Summary – Lamprey River Water Management Plan

Introduction and Purpose

Effective June 1990, the Lamprey River in the towns of Lee and Durham was listed as a Designated River under the New Hampshire Rivers Management and Protection Program Act (RSA 483). This designation means that the Lamprey River has been acknowledged, through a public nomination and legislative process, as important to the state for its outstanding natural and cultural resources. A designated river is managed in order to protect these resources.

Without enough water, the Lamprey River cannot support the human and natural uses that depend on it. Water in varying amounts is needed to keep wildlife, plants and their habitats healthy and thriving in the Lamprey River. Many human uses are also tied to the river's flow including swimming, boating and fishing. **The purpose of this water management plan is to guide water use to minimize negative consequences to any particular user or natural use.**

In 2002, the state legislature created a pilot program through Chapter 278 (HB 1449-A), which directed the N.H. Department of Environmental Services (NHDES) to study and establish protected instream flows and watershed management plans for the designated portions of the Lamprey[1] and Souhegan rivers. **A protected instream flow is the amount of water needed to support the human and natural uses that depend on the river: the management plans details the action to be implemented to maintain the protected flows.** The Lamprey and Souhegan rivers are the first rivers in the state to have water management plans for instream flows.

The Lamprey geographic study area is 212 square miles in size and includes all or portions of 14 communities located within southeast coastal New Hampshire (see Figure 1). Water moving over this land area drains to the Lamprey Designated River.

The state administrative rules Env-Wq 1900 provided guidance for how the Lamprey River flows were calculated as well as what had to be included in the plan. Visit http://des.nh.gov/organization/divisions/water/wmb/rivers/instream/categories/rules.htm for a list of links to related state laws and administrative rules.

Lamprey River Protected Instream Flows

Protected instream flows for the portion of the Lamprey River that was designated in 1990 are presented in the Lamprey River Protected Instream Flow Report, published in draft in 2009 by NHDES. The protected flows were subsequently established by the NHDES Commissioner in 2013 as numerical translations of the narrative water quality standards for flow in Env-Wq 1700, specifically adapted to the Lamprey Designated River. The Lamprey River Water Management Plan implements the protected flows described in that Lamprey River Protected Instream Flow report with input from the affected users and from lakefront property owners. Adherence to this Management Plan should allow for the attainment of water quality standards in the Lamprey River.

[1] This legislation applies to the section of the river designated in 1990 but does not apply to the sections of the Lamprey and associated rivers in the Lamprey watershed that were designated into the Rivers Management and Protection Program in June 2011.

The Lamprey River protected instream flows recognize that wildlife, plants and habitats, and most human uses, are best supported by maintaining natural river flows – both the highs and the lows. Even floods and droughts have important roles in natural river environments. All of the flow dependent uses were studied to determine the flows necessary to support them, taking into account the river's range of natural conditions at different times of the year. Flow characteristics considered for each use include magnitude, timing, frequency, and duration. In general, when the flow needs of the one resource that has the most stringent flow needs are satisfied, then the other resource needs are also satisfied.

- The protected instream flows for **humans** consider boating, swimming, and fishing.
- The protected instream flows **for fish and aquatic life** take into account: native fish; introduced fish; fish that travel back and forth between fresh and saltwater to lay their eggs; mussels; insects; and rare, threatened or endangered fish species. Instream flows were calculated for six distinct biological periods or "bioperiods," describing different times of year when various species of fish have critical flow needs.
- Protected instream flows for **wildlife and plants growing near and around the river** account for reptiles, frogs and plants**.**

Protected flows for wildlife and plants were only established when those flow needs were not already met by the flows established for fish and aquatic life, which typically had the most stringent flow needs of all of the users.

Lamprey River Water Management Plan

The Lamprey River Water Management Plan presents the actions to be taken in order to support and maintain the protected instream flows. The water management plan was developed with oversight and input from a stakeholder advisory committee, which included affected water users and dam owners, who met during and after the draft plan's development. In addition, feedback from residents in the affected communities was gathered at a public hearing in May of 2011 and through written comments. See Appendix I for a description of the comments and how they were addressed by DES. Appendix J contains the complete text of the comments received. DES continued to engage with local stakeholders through 2012 and 2013 by meeting with Pawtuckaway Lake Improvement Association leaders, the Town of Nottingham Board of Selectmen, and the public.

Affected Users

The Water Management Plan applies to each **Affected Water User** and **Affected Dam Owner** in the Lamprey River Water Management Planning Area

Affected Water Users are those water users that are required to be registered under the State's Water Use Registration and Reporting Rule (Env-Wq 2102) and have a withdrawal or discharge within 500 feet of a designated river or within 500 feet of a river or stream in its tributary drainage. Four Affected Water Users are included in this Plan: Epping Water Works, Raymond Water Department, University of New Hampshire/Town of Durham Water System, and Scenic Nursery & Landscaping, a commercial nursery. An **Affected Dam Owner** is an owner of a dam with an impoundment with a surface area greater than 10 acres in the watershed area of a designated river. This plan includes 19 Affected Dam Owners including privately owned (5), municipally owned (4), and state owned (10) dams used to variously support recreation, water supply and waterfowl habitat.

How the Water Management Plan Works

Recognizing that all users compete for a finite resource in times of low flow, **the goal of the water management plan is to identify, quantify and organize water uses to minimize the impact on all.** The Lamprey River Water Management Plan includes three sets of management sub-plans**: Conservation Plans, Water Use Plans, and Dam Management Plans.** As river flows reach certain flow and duration thresholds, more actions under the sub-plans take effect. Each of the sub-plans present the activities recommended to best meet the needs of users and resources while at the same time meeting the protected instream flows. The Conservation Plans (Appendix A) and Water Use Plans (Appendix B) are tailored to each Affected Water User, and the Dam Management Plans (Appendix C) are specific to each Affected Dam.

River flow can be higher or lower than the flow thresholds established by DES and still be protected – it is the length of time combined with the level of flow that determines whether and what type of management action is necessary. More management is required as flows fall below thresholds for longer durations. Table 1 describes the seasonal instream protected flow levels and durations for the Lamprey Designated River. The allowable duration of low flows depends on the natural flow conditions. Counting the days when stream flow is below the protected instream flows determines whether the flow protection goals are being met. DES tracks the Lamprey River flows at the U.S. Geological Survey stream gage 01073500 Lamprey River near Newmarket and compares them to the protected instream flows.

Management of flows is needed to prevent *catastrophic* conditions. Conservation and implementation of Water Use Plans reduce the frequency of *catastrophic* conditions. Dam Management Plans help offset the effects of *catastrophic* conditions. When low flows exceed the *Allowable* timeframe, it is deemed a *Persistent* condition. When a third consecutive *persistent* condition occurs or the *catastrophic* duration is exceeded, a *catastrophic* condition has been reached, which activates the Dam Management Plans.

Conservation Plans

Conservation Plans are used to reduce the overall water demand. Conservation applies at all times. **The purpose of Conservation Plans is to identify potential reductions in water use and system losses.** Under the Conservation Plans, the Affected Water Users are required to meet the State's Water Conservation Rule requirements, which focus on accurate recording of water use and minimizing water losses.

Water Use Plans

The **purpose of the Water Use Plans is to reduce and spread the impacts of water use on surface waters during low flows.** Under the Water Use Plans, the Affected Water Users that directly or indirectly withdraw water from the Lamprey Designated River or its tributaries may have to reduce their water use or find alternate sources during low flow periods, typically summer and early fall. **Methods include incorporating outdoor water use restrictions and reducing direct surface water withdrawals.** These will be mostly noticed by the public through infrequent outdoor watering restrictions.

Dam Management Plans

The primary component of the Dam Management Plans, a two-day flow pulse, comes into play only during rarely-occurring catastrophic conditions, when management is needed to relieve stress in the river environment system. **The purpose of Dam Management Plans is to reset stream flow conditions**. This is accomplished by mimicking a precipitation event though the release of a two-day "relief pulse" from affected dams. **In a two-day "relief pulse," the water level change in the dam impoundments would be very small,** only a few inches for the entire summer period. However, the resulting **downstream flow benefit would be large** enough to "reset" the system during low flow periods.

In the case of the Lamprey River, **two lakes play a role in flow management: Pawtuckaway Lake and Mendums Pond.** These are the only two bodies of water of sufficient size to influence downstream flow without detrimental impacts to their own natural and human uses. During the spring, the summer, and the fall until the annual drawdown, water levels in the impoundments will **not be lowered more than 18 inches** from normal full pool as a result of the combined effects of routine lake declining and relief flow releases for instream flow purposes.

Next Steps and Implementation

The protected instream flows will be maintained by implementing this Water Management Plan designed for the Lee to Durham segment of the Lamprey Designated River. Adoption of this Plan is only the beginning of the process to protect instream flows. Many actions are needed to implement the components of the Plan. For example, the Affected Water Users will submit Water Conservation Plans to the DES Drinking Water and Groundwater Bureau for review and approval. During the implementation of these plans, adjustments will be made as needed to support existing and future human uses as equitably as possible.

In some cases there are costs associated with implementing the Management Plans. Cost was a consideration when developing the sub-plans with the water users and dam owners. Much of the Plan's cost is borne by DES as the owners operating the dams at Pawtuckaway Lake and Mendums Pond.

The objective of the Water Management Plan is to maintain the protected instream flows while supporting managed water needs. Since the proposed water management actions are new approaches to the management of water resources, adaptive management will be applied when needed. Once implemented, the Water Management Plan will be reviewed and its success in meeting its objectives will be evaluated. If the results of the evaluation indicate that parts of the plan need revision, then DES will work with the Affected Water Users and Affected Dam Owners to address these issues.

DES expects that this document will be revised at the end of the pilot study period to improve its effectiveness as well as to accommodate any new water users or dam owners. In 2015, the NH General Court will review the two pilot projects – the Lamprey and the Souhegan Rivers – to determine future actions pertaining to protected instream flow for these and other designated rivers.

LAMPREY RIVER WATER MANAGEMENT PLAN

I. INTRODUCTION

Protected instream flows are to be established and enforced for each designated river pursuant to the 1988 Rivers Management and Protection Program (RSA 483:9-c.) Later legislation, Chapter 278, Laws of 2002, created a pilot program to study and establish protected instream flows and adopt water management plans for only the Lamprey and Souhegan Designated Rivers.

The development of the Lamprey River Water Management Plan was completed in two phases. The first phase was the development of the protected instream flows for the Lamprey Designated River (Lee-Durham segment). During the development of the protected instream flows, the flow-dependent protected entities on the Lamprey Designated River were identified and their protected instream flows established. The second phase was the development of this Water Management Plan. The Water Management Plan's purpose is to maintain the protected instream flows on the Lamprey Designated River.

This introduction provides a summary of the findings of the protected instream flow study, which are the foundation of the Water Management Plan presented in this document. The Water Management Plan includes Conservation, Water Use and Dam Management Plans for Affected Water Users or Affected Dam Owners located within the Lamprey River Water Management Planning Area.

Effective as of June 1990, the Lamprey River in the Towns of Lee and Durham, New Hampshire was listed as a Designated River. In accordance with New Hampshire RSA 483, the Rivers Management & Protection Program, a designated river is a river managed and protected for its outstanding natural and cultural resources. In 2002, state legislation directed the New Hampshire Department of Environmental Services (DES) to establish protected instream flows and adopt a Water Management Plan for the Lamprey Designated River. The procedures for defining the protected flows followed the New Hampshire Code of Administrative Rules Env-Wq 1900 Rules for the Protection of Instream Flow on Designated Rivers, also known as the Instream Flow Rules. The Lamprey River Protected Instream Flows were proposed in December 2008 (DES 2008), presented at a Public Hearing in January 2009, and, after public comment, described in the Lamprey River Protected Instream Flow Report in July 2009 (DES 2009), and established in 2013.

The Final Lamprey River Protected Instream Flow Report (DES 2009, available at: http://www.des.state.nh.us/organization/divisions/water/wmb/rivers/instream/lamprey/study.htm#task7) delineated the flows needed in the Lamprey Designated River throughout the year to meet the needs of all water-dependent users including humans and ecosystems, or to preserve cultural resources. The Protected Instream Flow Report also demonstrates that the instream flows will not always be met. In such events, management strategies are warranted in order to maintain or restore sufficient water in the river. As directed by Laws of 2002, Chapter 278, the Pilot Instream Flow legislation, the management strategies are to focus on flow and flow regulation.

Recognizing that all users compete for a finite resource in times of low flow, the Water Management Plan identifies, quantifies, organizes and guides future water use to minimize the impact on all users while avoiding negative consequences to any particular user or natural use. The implementation of this Water Management Plan is intended to result in maintenance of the established protected

instream flows without diminution of the enjoyment of outstanding river characteristics. The Plan accounts for all of the instream public uses of the river segment including recreation, fisheries, and wildlife as well as environmental, cultural, historical, archaeological, scientific, ecological, aesthetic and community significance, plus the river's use for agriculture and public water supply.

The Water Management Plan for the Lamprey Designated River represents the integration of the characteristics and needs of all affected water users and affected dams with the instream flow needs. Management actions under the plan have also been revised to consider the values and interests of the residents and users of the lakes affected by the Plan as well as the lakes' health.

To identify these values and interests, DES contacted and interviewed all the affected water users and dam owners in order to develop their individual management plans. In addition, numerous meetings were held with the Lamprey River Water Management Planning Area Advisory Committee (LR WMPAAC) to solicit comments from stakeholder groups regarding the development of the Water Management Plan. The draft Water Management Plan was distributed for review, and after thirty days a public hearing was held to present the Plan and invite public comment. Comments were received and revisions made in response to these comments. These comments identified a need to develop the Water Management Plan further with respect to the interests of lakefront owners and users on Pawtuckaway Lake and Mendums Pond.

Addressing the interests of lake users, DES held a Science Roundtable on September 28, 2012 engaging Pawtuckaway Lake residents and environmental experts in a discussion of environmental issues affecting Pawtuckaway Lake and the downstream river reaches. On October 30, 2012 DES held a forum to discuss ongoing lake testing and what the results indicated for recreational and other human uses and interests on Pawtuckaway Lake. In 2012 and 2013, DES conducted a Lake Level Investigation to evaluate a change in the proposed winter drawdown at Pawtuckaway Lake. A public hearing was held June 26, 2012 to hear comments on the change. Comments were not addressed at that meeting so on October 30, 2012, DES held a public information meeting to answer questions on the lake level investigation or any other topics. DES met with Pawtuckaway Lake Improvement Association leadership on August 2, 2012 to develop work plans from the Association's concerns. Later in August, DES augmented the 2011 bathymetry data with additional surveys. From September 2012 through April 2013, DES conducted phosphorus sampling and other water quality monitoring in and around the lake. In early September 2012, DES tested water quality and flow conditions during a two-day test of a lake release typical of a summer management action. In December and January DES tested whether a winter lake release could be met at the proposed winter lake level and at a lower starting level. On May 20, 2013, DES presented the results of the release tests and water quality sampling before a televised meeting with the Town of Nottingham Board of Selectmen and Pawtuckaway Lake Improvement Association leaders.

Since the release of the draft Water Management Plan, revisions to the Plan include, among other items, results of: 1) studies pertaining to Pawtuckaway Lake water quality and on release flow implementation and effects; 2) a Lake Level Investigation evaluating a revision to the large annual fall drawdown of the lake; and 3) a test pause in the 2012 fall drawdown to assess the water level on docks left in the lake.

A. Definition of Protected Instream Flows and Identification of Protected Entities

The Instream Flow Pilot Program's legislatively-defined protection goals are to maintain water for instream public uses, protect the resources for which the segment is designated, and to regulate the

quantity and quality of instream flow along a designated river to conserve and protect outstanding characteristics. Maintaining the protected instream flows attains the water quality standards for flow quantity. Management of this waterbody, therefore, should be conducted so as to maintain the protected flows.

Specific categories of the instream public uses, outstanding characteristics and resources are described in RSA 483, the New Hampshire Rivers Management and Protection Program. Collectively, the instream public uses, outstanding characteristics and resources are called the "protected entities" in the Instream Flow Program. The protected entities in the Lamprey River watershed include: boating; recreation (fishing, swimming); hydropower; public water supply; archaeological resources; the natural riparian corridor ecosystem; rare, threatened, and endangered species; and, aquatic flora and fauna.

The processes for defining the protected flows and developing the water management plan are described in administrative rule Chapter Env-Wq 1900 Rules for the Protection of Instream Flow on Designated Rivers, commonly called the Instream Flow Rules. Each of the protected entities identified in statute was studied to determine its relationship to the Lamprey River, and specifically whether the entity was flow-dependent. Those entities that were not flow dependent were not studied further.

The Lamprey River's protected entities were identified and listed as described under the Scope of Work for the Lamprey Instream Flow Pilot Program project (Normandeau Associates, Inc. et al. 2005). The protected entities were verified and assessed for their flow dependence in a report (DES 2006). Only the flow-dependent members of the protected entities were assessed for instream flow protection needs. The determination of whether an identified entity was considered to be flow-dependent was based on biological or physical needs. The list of identified entities includes:

- Recreation (boating, fishing, and swimming);
- Maintenance and enhancement of fish and aquatic life (native fish, introduced fish, anadromous fish, mussels, and insects);
- Fish and wildlife habitat (fish life stages, floodplains, wetlands, and associated waterbodies); and
- Rare, threatened and endangered species (RTE) (fish, wildlife, vegetation and natural/ecological communities).

Public water supplies were initially identified as flow dependent because water quality standards contained flow conditions for withdrawals. However, it has since been determined that public water supplies should not have an instream flow determined for them. First, public water supply does not represent an instream public use as defined in statute as an entity requiring a protected instream flow. Second, a defined protected flow specifically for a public water supply would be an allocation of water. An allocation process is not sustainable since any new water system would also require an allocation. Further, there are no flow-related criteria for quantifying such an allocation. Instead, public water supplies will be sustained, as will all other uses, by maintaining the natural variability of flows as defined by the Natural Flow Paradigm.

B. Natural Flow Paradigm

The development of the protected instream flow values was performed within the framework of the Natural Flow Paradigm developed by Leroy Poff et al. 1997. The Natural Flow Paradigm recognizes

that the natural variability of stream flows determines the geomorphic and biologic characteristics of a stream or river. The natural flow pattern is the stream flow that is not affected by diversions, discharges, or withdrawals. Substantial changes from the natural flow pattern cause ecosystem impairment, whether it is habitat loss, mortality, or loss of function; however, there is flexibility within the natural flow variability that allows for water use.

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 pattern as possible. Low flows and floods are expected to occur as natural conditions 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 pattern of the Lamprey River and the impact of alteration on its protected entities was a major objective of the Instream Flow study.

It is important to recognize that the natural stream flow (even in the absence of any human intervention or water use) will not always meet all of the 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 uncommon natural extremes such as flood and droughts have important functions in supporting riverine ecosystems. Protecting flow variability is necessary to ensure that the ecosystem provides the variety of habitat conditions necessary to support the entire ecosystem. This is why the description of protected flows requires the use of the flow components: flow magnitude, frequency, duration, timing and rate of change. Water management measures are required where uses and changes in watershed-wide conditions increase the durations or frequencies of flow conditions above or below specified flows.

C. Protected Flow Assessment for Flow-Dependent, Instream Public Uses

Protected instream flows were developed for specific, flow-dependent, instream public uses as required by RSA 483 and Env-Wq 1900. The instream public uses were divided into three groups: human uses; riparian wildlife and vegetation; and fish and aquatic life. Each of these three groupings of flow-dependent uses was assessed using methods appropriate for their flow needs. Human instream uses were assessed using surveys and questionnaires. A floodplain transect method was used to assess riparian wildlife and vegetation. Fish and aquatic life were assessed using an incremental habitat model that evaluates habitat quality versus stream flow.

Flow-dependent protected entities were studied to determine the flow components necessary for their function, as well as any constraints, such as season-specific needs. The detailed delineation, flow needs, discussion, and assessment of each water use/resource is described in the report Instream Public Uses, Outstanding Characteristics, and Resources of the Lamprey River and Proposed Protective Flow Measures for Flow Dependent Resources (DES 2006). In summary, they fell into the following categories:

- Human Instream Public Uses
  - Boating
  - Swimming
  - Fishing
- Fish and Aquatic Life

Native Fish
Introduced Fish
Anadromous and Catadromous Fish
Mussels
Macroinvertebrates
Rare, Threatened, or Endangered Fish Species

- Riparian Wildlife and Vegetation
  Reptiles and Amphibians
  Birds
  Reptiles and Amphibians
  Vegetation
  Ecological Communities
  Rare, Threatened, or Endangered Riparian Species

D. Lamprey River Protected Instream Flows

The Lamprey River Instream Flow Report (DES 2009), established through Commissioner declaration in 2013, defines the instream flows for the Lamprey Designated River. The protected instream flows represent the important thresholds for maintaining the ecological and human uses. The protected flows are described using terms of magnitude, timing, frequency and duration following the Natural Flow Paradigm, which recognizes that the needs of instream entities are best supported by maintaining the natural variability of stream flows.

Table 1 presents the protected flows that maintain the patterns of the natural flow variability. These protected flows come from comparing the timing and magnitude of the various flow needs for fish, riparian vegetation, riparian wildlife, and human uses. The emphasis of this comparison was to determine the controlling protected flow. The protected instream flow magnitudes include durations, which are tied into natural frequencies of occurrence. By maintaining the flow magnitudes within their appropriate durations, the natural variability of stream flows is protected.

Fish tend to be the most sensitive to flow, and so the flow needs for fish are the most stringent. The flow needs of riparian wildlife and vegetation that are not met by fish flows are incorporated in additional protected instream flow recommendations.

1. Protected Instream Flow for Boating

Due to its size, depth and impoundments, the Lamprey Designated River only supports non-motorized boating which is composed of both flat water (impounded by bedrock outcrops or dams) and rapids (whitewater). Running the entire Lamprey Designated River involves both types of experiences and requires a sufficient flow so that paddlers can pass through the rapids sections unimpeded. Based on the information gathered as part of this study, a flow of 275 cfs is required to support recreational boating of the full length of the Lamprey Designated River (Table 1). Boaters only using the flat water sections stated that the only flow limitation to their use of these sections of the river were high (flood) flows, which create dangerous conditions.

In the context of the Natural Flow Paradigm, the opportunity for boating throughout the length of the Lamprey Designated River is dependent upon the natural availability of the supporting flow. This flow is dependent upon runoff and groundwater recharge, which is affected by climate, but may also be affected by dam operations and/or water withdrawals along portions of the Lamprey Designated

River. The impact of any water uses on the magnitude, frequency and timing of flows that affect boating recreation were considered during the Water Management Plan process. Boating instream flows represent a high flow condition which, as a continuous goal, would represent an unnatural flow condition and would therefore exceed existing management capability.

The recommended protected instream flow for recreation is 275 cfs (1.5 cfsm), which in an average year is met over 30 percent of the time (Table 1). If this human-related instream flow were to be the controlling protected instream flow, the protected instream flow for the Lamprey Designated River would be equal to the flows occurring only during spring snowmelt runoff, during the fall when water stored in Pawtuckaway Lake is released and/or during large storm events, and as a result would not be continuously sustainable.

2. Protected Instream Flows for Fish and Aquatic Life

Protected instream flow values for fish and aquatic life were defined in the Lamprey Instream Flow Study report for each of the six biologically significant periods or bioperiods (overwintering, spring flood, Clupeid[2] spawning, General Resident Adult Fish (GRAF) spawning, rearing and growth, and salmon spawning[3]) by both magnitude and duration (Table 1). Each bioperiod's protected flows consist of three flow magnitudes including Common, Critical and Rare, where:

- The Common flow is the flow corresponding to the optimal habitat conditions, above which the frequency of occurrence begins to decline significantly.
- The Critical flow is the flow corresponding to the second to the lowest habitat state. Critical flow magnitudes result in less habitat availability than that provided by the common flow, but this habitat magnitude is not unusual.
- The Rare flow is the flow corresponding to the lowest of habitat states. Rare flow habitat is severely reduced and very uncommon.

Each protected flow magnitude is characterized by two durations: *Allowable* and *Catastrophic*. The durations define limits on the consecutive days when flow is below a protected magnitude. Counting the days when flow is less than the flow magnitudes is the first step in determining whether protected flow conditions are met. Repeated occurrences when stream flow is below a flow magnitude for longer than these durations result in a *catastrophic* condition. A c*atastrophic* condition is a water quality violation requiring management.

Stream flow at levels below a protected magnitude for durations shorter than the Allowable duration is acceptable and is a typical condition. Flow below a protected magnitude for more than the Allowable duration, but less than the *catastrophic* duration, is a *persistent condition*. A persistent condition that occurs for three consecutive years within the same bioperiod is a *catastrophic condition* representing an impaired flow regime requiring management. Flow below a protected magnitude for durations longer than the catastrophic duration that occurs twice in one bioperiod within ten years is a catastrophic condition representing impaired water quality requiring management.

The protected instream flows for fish and aquatic life in the Lamprey Designated River are summarized in Table 1. The protected flow and duration prescriptions described in the table are

[2] Fish of the family Clupeidae such as alewife and river herring.

[3] Salmon no longer inhabit the Lamprey River, but the Salmon Spawning bioperiod is named for the flow conditions that occur during that period when salmon would be spawning.

intended to be used as thresholds to determine when management actions are necessary to maintain and support fish and aquatic life in the Lamprey Designated River.

3. Protected Instream Flows for Riparian Wildlife and Vegetation

Protective flows vary greatly among the numerous plants, natural communities, and wildlife species associated with the Lamprey Designated River riparian corridor. To facilitate discussion, flow-dependent riparian entities can be sorted into five groups with similar flow needs:

1. Periodic flood protected instream flows (annually or less in frequency);
2. Minimum seasonal protected instream flows (every winter, spring, and/or summer);
3. Maximum summer protected instream flows;
4. Generic Resident Adult Fish (fish) protected instream flows (for eagles, osprey); and,
5. Protected instream water levels (not flows).

Group 1 includes high and low floodplain forests and oxbow/backwater swamps that depend on periodic flooding (annually or less often) to fill basins, deposit nutrients, and eliminate flood intolerant plants. Depending on landscape position, these communities may flood once a year to once every hundred years, occurring typically in late winter/early spring, for days to weeks (Table 1). Flows that are greater than 500 cfs every one to three years, and flows that are at least 1,500 cfs once every five years (with greater flows occurring less frequently) are typical under natural conditions, based on tree flood tolerance data, plant community descriptions, and soil characteristics. There is no intent to create floods for these entities, nor should such flood events be deliberately prevented through management practices.

Group 2 includes the instream plants and communities that have annual minimum winter, spring and early summer flows to set up optimum conditions for early vegetative growth and development. Herbaceous low riverbanks, riverweed river rapids, and marshes, along with their associated Rare, Threatened and Endangered (RTE) plants, are in this group, as well as hibernating wood turtles, which have minimum flow requirements in winter. Minimum monthly flows that are protective of all of these entities are 130 cfs from December through February, 100 cfs from May through June, and 10 cfs during July (Table 1). During the winter, daily flows should be at least 50 cfs, and flows of 500 cfs should occur for at least one week. These flows occur naturally in most years, and should not be prevented by management activities.

Group 3 are the plants and animals that are sensitive to the rare summer flood events. Turtle eggs and nestlings in the high floodplain, larval amphibians in floodplain pools, and blooming aquatic and emergent plants may be harmed by summer floods. Daily flows that are less than 500 cfs in June, July and October, and are less than 60 cfs in August and September are protective of all of these entities (Table 1). However, high flow criteria for these sensitive entities are discussed in this report to inform regulators contemplating management actions that might result in unnatural flood events (such as a dam release); it is not intended to imply that naturally occurring floods, regardless of timing, should be controlled for the protection of these particular sensitive resources.

Group 4 are the fish-eating raptors, including bald eagles and osprey that may feed in the Lamprey Designated River at any time of year. The flows protective of these species are those that support Generic Resident Adult Fish (GRAF).

Group 5 includes the plants and animals of the Lamprey's larger impoundments. They include, for example, pied-billed grebes, sedge wren (habitat exists along the river but neither avian species was

observed) and the aquatic plants, water marigold and star duckweed. Protected flows for these species were not determined, as their required water levels were not well correlated with changes in flow in these impoundments. Instead, protective water levels were identified. These are summer water levels within 18 inches of the mean high water mark, with no reductions exceeding six inches for more than seven days from 15 March through 31 July.

The requirements of most riparian wildlife and vegetation are lower than those of fish. The needs of riparian life that are not obviously secured by fish-specific flows are listed below and in Table 1, and are included in the five groups discussed above.

Winter Survival and Development

>130 cfs seasonal mean – wood turtle (December 1 through February 28).
>500 cfs for one week or more – Herbaceous Low Riverbank, mannagrass, hempweed (December 1 through April 30).

Spring Spawning/Growth

>100 cfs seasonal mean – riverweed, knotty pondweed (May 1 through June 30).
<1,500 cfs daily mean except for natural events - floodplain vernal pools (March 15 through July 31).

Summer Survival and Development

<500 cfs daily mean except for natural events – wood turtle (June 1 through October 15).
≤60 cfs daily mean in August/September except for natural events – Herbaceous low riverbank.
<100 cfs seasonal mean – August /September except for natural events – riverweed, knotty pondweed.

The requirement for ≤60 cfs of daily mean in August and September for maintenance of herbaceous low riverbank conflicts to some extent with the needs of the common shiner. During this time the flows for common shiner should fluctuate between 22 and 110 cfs. However, because the flows between 60 and 110 cfs will not occur very often, the rearing and growth criteria specified in Table 1 were used for development of the Water Management Plan.

Table 1. Protected Instream Flows for the Lamprey Designated River

Lamprey Protected Instream Flows for Fish		Common Flow				Critical Flow				Rare Flow			
Time of Year/ Bioperiod	**Protected Entity Controlling Flows**	**Common Flow (cfs)**	**Common Flow (cfsm)**	**Allowable Duration (days)**	**Cata-strophic Duration (days)**	**Critical Flow (cfs)**	**Critical Flow (cfsm)**	**Allowable Duration (days)**	**Cata-strophic Duration (days)**	**Rare Flow (cfs)**	**Rare Flow (cfsm)**	**Allowable Duration (days)**	**Cata-strophic Duration (days)**
Dec 9 - Feb 28 Overwintering	Flow	238	1.3	20	57	110	0.60	10	37	73	0.40	7	30
Mar 1 - May 4 Spring Flood	Flow	622	3.4	14	42	238	1.3	10	19	146	0.80	3	9
May 5 - Jun 19 Clupeid Spawning	Shad spawning	143	0.78	13	28	62 / **156**	0.34 / **0.85**	5	13	57 / **242**	0.31 / **1.3**	4	10
Jun 20 - Jul 4 GRAF Spawning	GRAF spawning	101 / **101**	0.55 / **0.55**	-- / **11***	15*	18 / **156**	0.10 / **0.85**	5*	10*	16 / **242**	0.087 / **1.3**	2*	3*
Jul 5 - Oct 6 Rearing & Growth	Common Shiner	104	0.57	46	82	18	0.10	15	32	16	0.087	5	15
Oct 7 - Dec 8 Salmon Spawning	Atlantic Salmon	90	0.49	17	55	40	0.22	11	33	20	0.11	6	11

Bold values are upper limits for instream flow for protection of clupeid and GRAF spawning. Management activities should not create flows that exceed these magnitudes and durations.

Watershed area for calculating cfsm is 183 square miles at the index location used. Index location is the gage USGS 01073500 LAMPREY RIVER NEAR NEWMARKET, NH

-- No Common Flow Allowable duration is described for this bioperiod because high flows and catastrophic durations are limiting.

* GRAF spawning and Clupeid spawning partly overlap, so durations during the GRAF Spawning bioperiod begin counting May 5 (previous bioperiod) but apply only during this bioperiod.

Table 1. (continued)

Lamprey Protected Instream Flows for Natural Communities, Wildlife Habitats and Rare, Threatened or Endangered Wildlife and Plants	
Wood Turtle - Winter Survival	>130 cfs seasonal mean - December 1 through February 28
Herbaceous Low Riverbank, mannagrass, hempweed - habitat maintenance	>500 cfs for one week or more - December 1 through April 30
Riverweed, Knotty Pondweed - growth and development	>100 cfs seasonal mean - May 1 through June 30
Wood Turtle - avoid nest flooding during management	<500 cfs daily mean - June 1 through October 15, except for natural events
Floodplain vernal pools - protection/isolation	<1,500 cfs daily mean - March 15 through July 31, except for natural events
Herbaceous Low Riverbank - growth and development	≤ 60 cfs daily mean - August through September, except for natural events
Lamprey Protected Instream Flows for Boating	
Boating recreational use	≥275 cfs

II. LAMPREY RIVER WATER MANAGEMENT PLAN

Chapter 278 (Laws of 2002) created a pilot program to study and establish protected instream flows and adopt water management plans for the designated portions of the Lamprey and Souhegan Rivers. Under the Instream Flow Rules (Env-Wq 1906), the Water Management Plan (WMP) will define how the protected instream flows of the Lamprey Designated River will be maintained. The WMP will include a Conservation and Water Use Plan for each Affected Water User (AWU) and a Dam Management Plan for each Affected Dam Owner (ADO) within the Water Management Planning Area (WMPA). The terms AWUs, ADOs and WMPA are defined as follows:

- Affected Water User – means a water user required to be registered under Env-Wr 700, or successor rules (Env-Wq 2102 Water Use Registration and Reporting) and having a withdrawal or return location within 500 feet of a designated river or within 500 feet of a river or stream in its tributary drainage area.
- Affected Dam Owner – means an owner of a dam wit an impoundment possessing a surface area greater than 10 acres in the watershed area of a designated river.
- Water Management Planning Area – means the tributary drainage to a designated river for which a water management plan is required.

The characteristics of the Lamprey River Water Management Planning Area and its Affected Dam Owners and Affected Water Users are discussed in the following sections.

A. Lamprey River Water Management Planning Area

The protected instream flows were developed for the protected entities identified in the Lamprey Designated River (Lee-Durham segment) only. However, the water use and management activities in the upstream watershed area also affect the flow in the Designated River segment. As a result, the Protected Instream Flow study focused on the Lamprey Designated River, but the Water Management Plan examines water use and dam operations within and in the upstream watershed of the Lamprey Designated River. This watershed area is referred to as the Lamprey River Water Management Planning Area. Lamprey Designated River and the Lamprey River Watershed Management Planning Area are depicted in Figure 1.

1. Watershed Description

The Lamprey River watershed drains an area of 549 km^2 (212 mi^2) in coastal southeast New Hampshire as it flows into the Great Bay at Newmarket, NH. The watershed's maximum elevation is approximately 348 meters (1,142 feet), but the Lamprey River itself drops about 183 meters (600 feet) along its course (Figure 2). Major tributaries include Hartford Brook, Nicholls Brook, North Branch River, Pawtuckaway River, Little River, North River and Piscassic River. The towns in the watershed are Barrington, Brentwood, Candia, Deerfield, Durham, Epping, Exeter, Fremont, Lee, Newfields, Newmarket, Northwood, Nottingham, and Raymond.

The Lamprey begins in the Saddleback Mountains in Northwood, NH and flows east 76.1 km (47.3 miles) to Great Bay, which empties into the Atlantic Ocean (Figure 1). The river flows

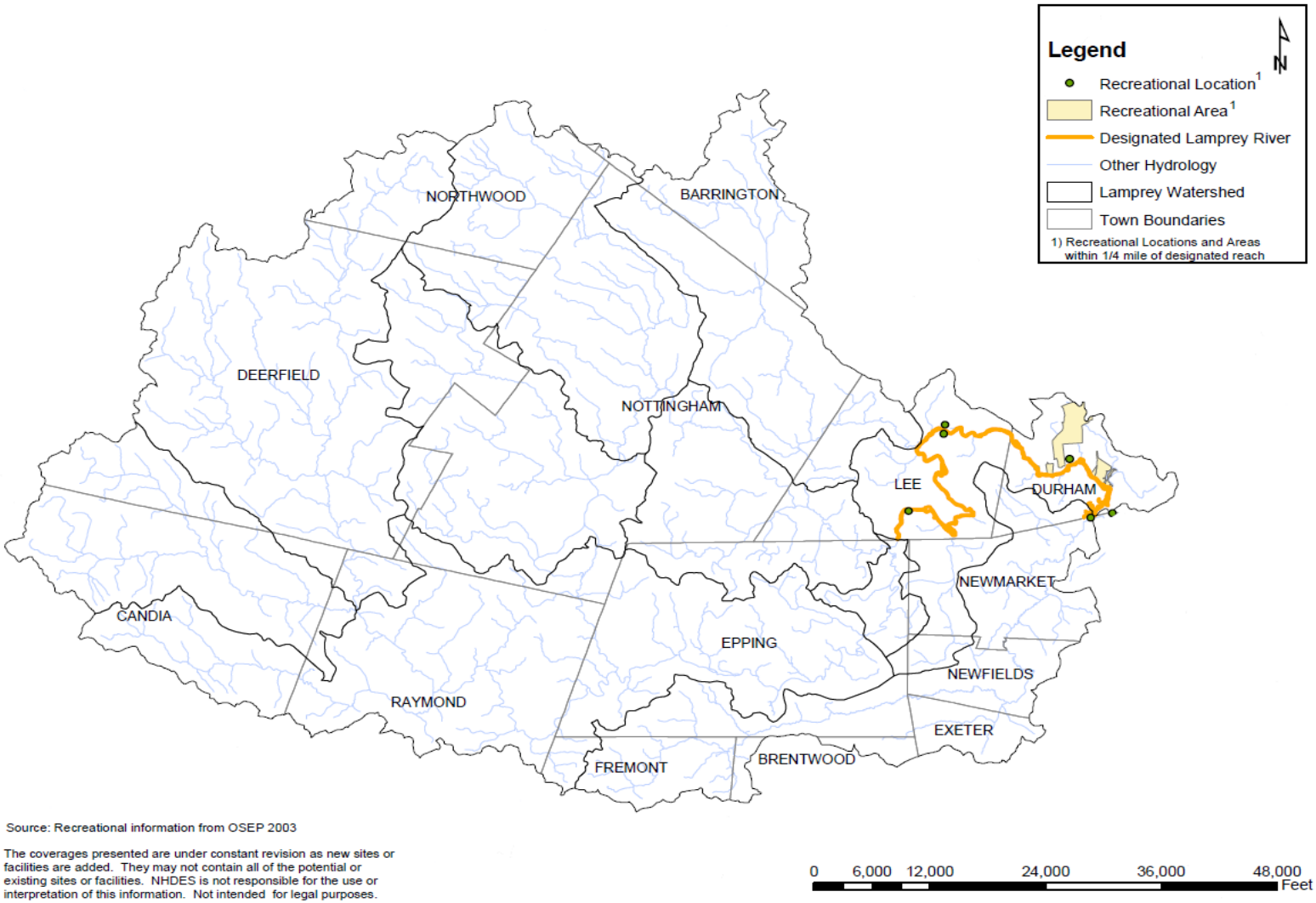

Figure 1. Lamprey Designated River and the Lamprey River Watershed Management Planning Area.

Note: The Lamprey River Watershed Management Planning Area is denoted on the legend as the Lamprey Watershed.

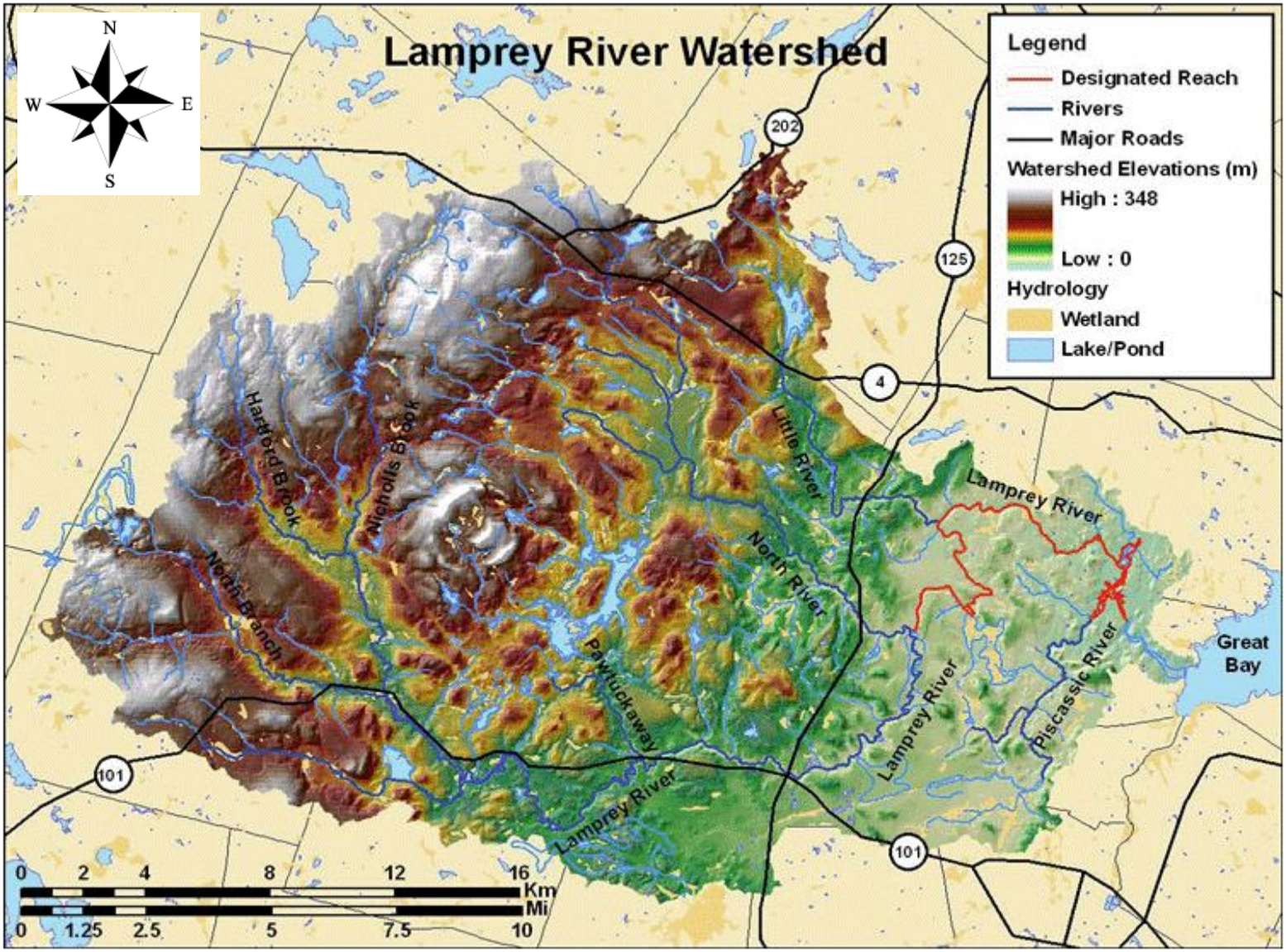

Figure 2. Lamprey River Watershed.

2.95 km (1.83 miles) below the head of tide at MacCallen Dam to Great Bay. The river in this short section is subject to tidal influences.

The land at the headwaters of the Lamprey River is largely undeveloped and forested, and the river corridor is relatively undisturbed with the exception of some commercial areas where the river passes through downtown Raymond and Epping. Residential and some agricultural land uses are the other primary forms of development elsewhere along the river.

Several notable dams exist along the main stem of the Lamprey River. These include the MacCallen Dam in Newmarket (downstream of the Lamprey Designated River), Wiswall Dam in Durham, and the partially breached Wadleigh Falls Dam in Lee. The Bunker Pond Dam in West Epping was removed in 2011. Dams are also found on the major tributaries to the Lamprey River and impound several notable waterbodies including: Freeses Pond; Meadow Lake; Mendums Pond; Nottingham Lake; Onway Lake; and, the largest water body in the watershed, Pawtuckaway Lake in Nottingham.

In November of 1996, Congress amended the National Wild and Scenic Act to include 18.5 km (11.5 miles) of the Lamprey River. An additional 19.3 km (12 miles) were added in May of 2000. The Lamprey River Wild and Scenic designation extends from the former Bunker Pond Dam in the town of Epping to the confluence with the Piscassic River in the vicinity of the Durham-Newmarket town line. The federal designation of this part of the Lamprey River means the river will be preserved in its free-flowing condition and additional protections will be applied to the river and its surrounding area. The federal Wild and Scenic designation is a separate program from the State's Rivers Management and Protection Program that administers the Instream Flow Program.

2. Designated River Description

In June of 1990, New Hampshire designated a portion of the Lamprey River under the Rivers Management and Protection Program. The Lamprey Designated River comprises approximately 19.4 km (12.05 mi) beginning at the Lee-Epping town boundary and continuing through Lee and Durham to the Durham-Newmarket town boundary (Figure 3). The Designated River watershed area is the upstream 183 square mile portion of the Lamprey River

The Lamprey Designated River (Lee-Durham segment) is a low-gradient, coastal stream punctuated with step-like gradient changes caused by the underlying bedrock geology. These geologic underpinnings result in changes in valley width and river gradient. The geology is expressed in the substrate of the relatively dynamic, short sections of river where coarse grained sediment (cobble sized material and larger with sand and gravel) is dominant and bedrock outcrops are abundant. In the sections impounded by bedrock outcrops or dams, the substrate of the channel bed is more fine grained (fine to coarse grained sand and gravel sized sediment) reflecting these low velocity environments.

There are no significant changes in river characteristics over the length of the Lamprey Designated River. The stream order does not change in the Lee-Durham segment; there are no major tributaries; the impoundments, both natural and otherwise, are spread throughout it; and the watershed area does not change significantly between the beginning of the Lamprey Designated River near the North River confluence and its end in the Newmarket impoundment.

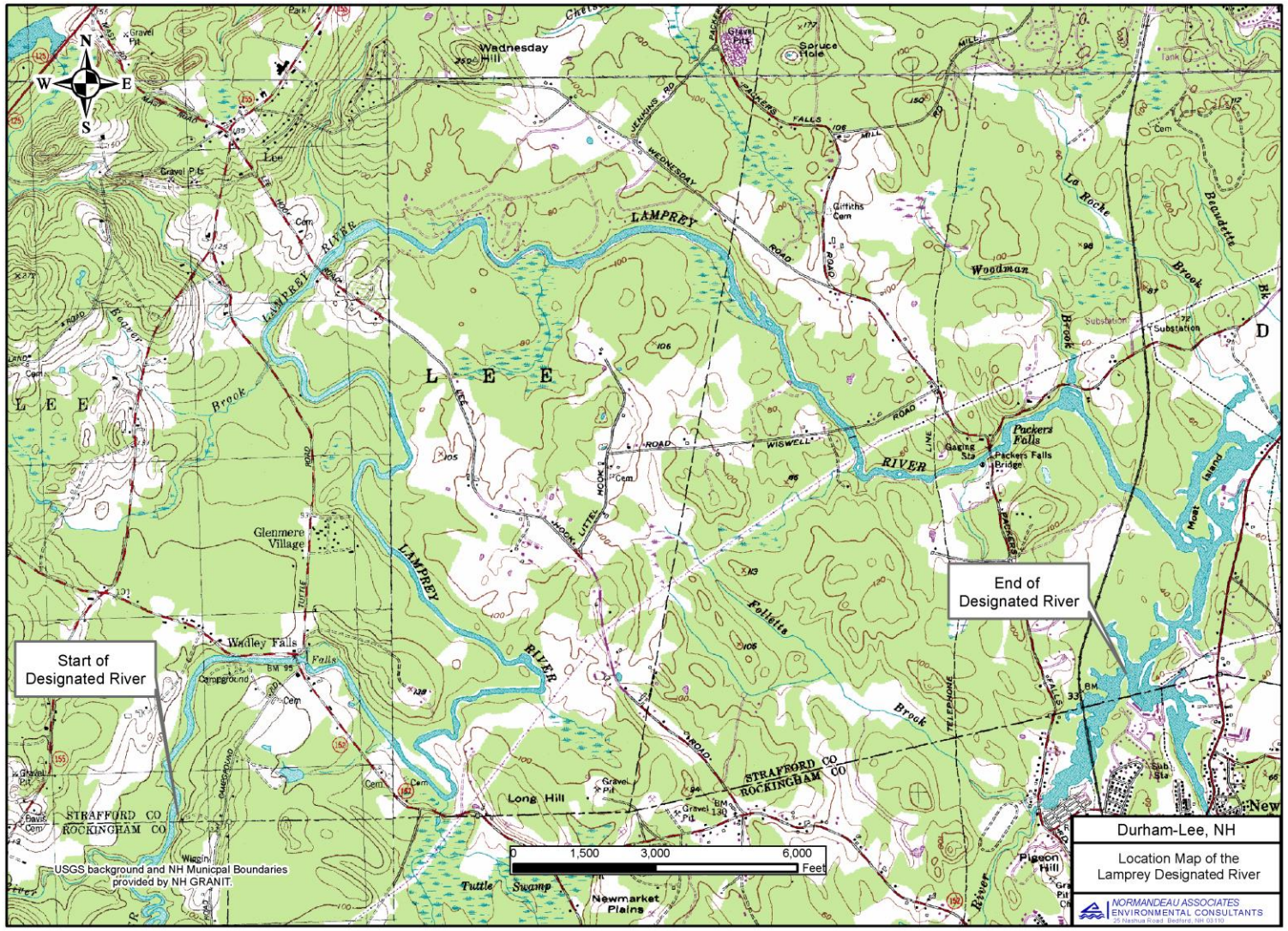

Figure 3. USGS topographic map of the Lamprey Designated River in Lee and Durham, NH.

B. Individuals Affected by the Water Management Plan

The Lamprey River Water Management Plan applies to the Affected Water Users and the Affected Dam Owners in the Lamprey River Water Management Planning Area (LRWMPA). The Affected Water Users and the Affected Dam Owners included in this Water Management Plan are introduced in the following sections.

1. Affected Water Users

Affected Water Users under the Instream Flow Rules are required to have a Conservation Plan and a Water Use Plan as their part of the Water Management Plan. The Affected Water Users included in the Lamprey River Water Management Planning Area are listed in Table 2 and their locations are shown in Figure 4. Brentwood Springs was determined to be using less than the registration threshold of 600,000 gallons per month. Newmarket Water Works is not an Affected Water User because its well withdrawals are more than 500 feet from a tributary. Nottingham Lake Dam is both an Affected Water User because of its hydropower use, and an Affected Dam, but was given a Dam Management Plan only which covers all of its management requirements.

Table 2. Affected Water Users in Lamprey River Water Management Planning Area.

DES Registration ID	Name of Water User	Description of Water User
20045	Epping Water Works	Water Works
20061	Raymond Water Department	Water Works
20066	University of NH	Water Works
20747	Scenic Nursery Inc	Commercial Nursery

2. Affected Dam Owners

An "Affected Dam Owner" as defined by Env-Wq 1902.02 means an owner of a dam with an impoundment that possesses a surface area greater than 10 acres in the watershed area of a designated river. Affected Dam Owners under the Instream Flow Rules are required to have a Dam Management Plan as their part of the Water Management Plan. After review of all dams that met this definition, Bunker Pond Dam was dropped because it was scheduled for removal[4] and the Burnhams Marsh dams were removed from consideration because they impound and protect a wetland marsh area.

The Affected Dams and the Affected Dam Owners in the Lamprey River Water Management Area are listed in Table 3 and the locations of the Affected Dams are shown in Figure 5.

[4] Bunker Pond Dam removal was subsequently completed in 2011.

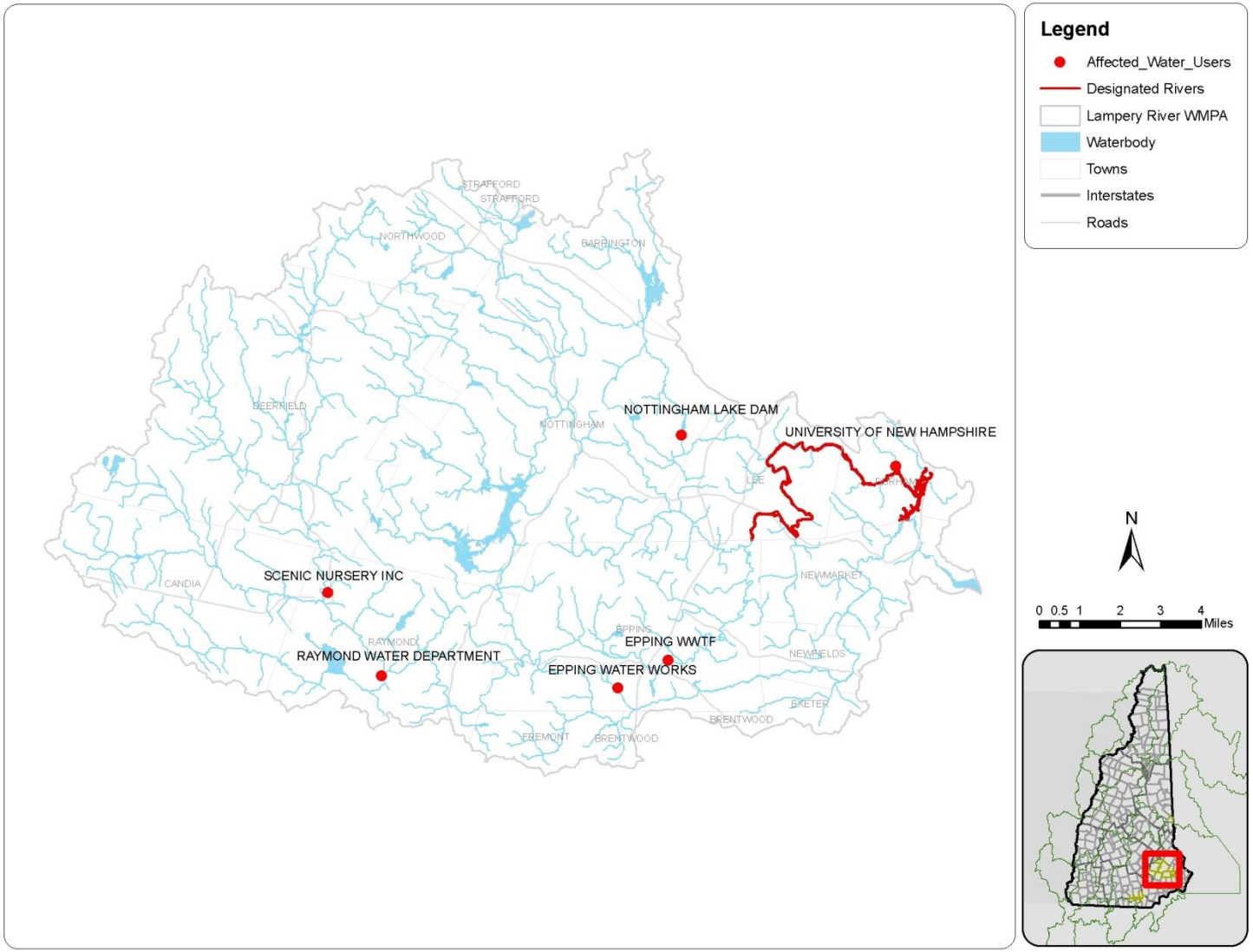

Figure 4. Affected Water Users in the Lamprey River Water Management Planning Area

Table 3. Affected Dams and Affected Dam Owners in Lamprey River Water Management Planning Area.

DES ID #	Affected Dam Name	Affected Dam Owner
037.03	Socha Dam	Ms. Marie Socha
061.02	Freeses Pond Dam	Town of Deerfield
061.07	Beaver Pond Dam	NH DRED
061.18	Thurston Pond Dam	Town of Deerfield
071.04	Wiswall Dam	Town of Durham
078.07	Hoar Pond Dam	Town of Epping
171.01	Piscassic Ice Pond Dam	Mr. Gilbert Lang
183.08	Lucas Pond Dam	NH F&G
183.16	Meadow Lake Dam	NH DRED
183.18	Dole Marsh Dam	NH F&G
184.01	Mendums Pond Dam	NH DES
184.02	Pawtuckaway Lake/Dolloff Dam	NH DES
184.03	Pawtuckaway Lake/Gove Dike	NH DES
184.04	Pawtuckaway Lake/Drowns Dam	NH DES
184.05	North River Pond Dam	NH DES
184.08	Nottingham Lake Dam	Mill Pond View, LLC
184.11	Deer Pond Dam	Mr. Chris Stillbach
184.19	Pawtuckaway Lake/Drowns Dike	NH DES
201.01	Onway Lake Dam	J & D Realty Trust

NH DES– New Hampshire Department of Environmental Services, managed by the Dam Bureau
NH DRED – New Hampshire Department of Resources and Economic Development
NH F&G – New Hampshire Fish and Game Department

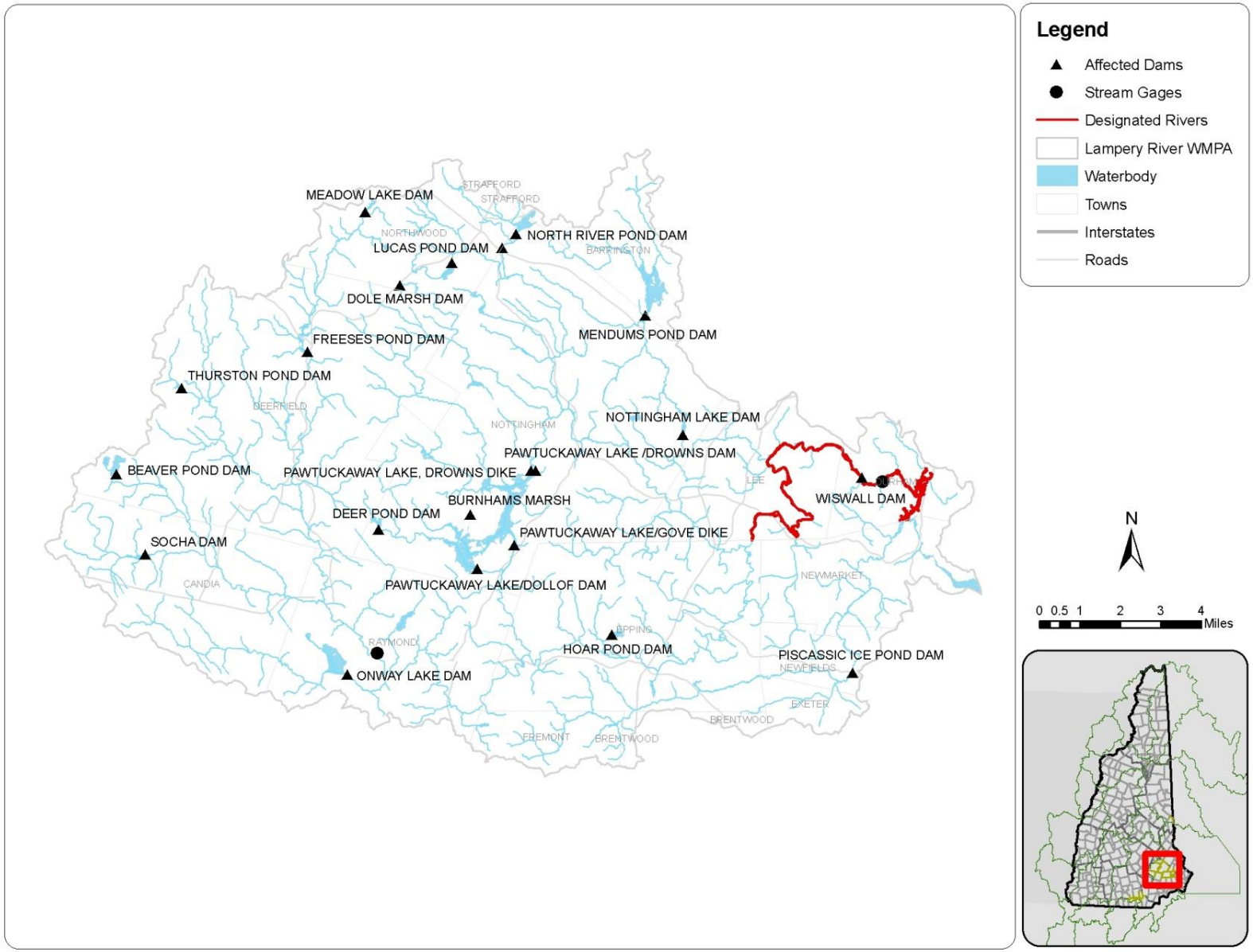

Figure 5. Affected Dams in the Lamprey River Water Management Planning Area.

C. Is There a Present Need for Management of the Lamprey River Instream Flows?

Management of Lamprey River stream flows is driven by the need to balance the goal of natural variability in stream flow with the competing effects on stream flow of off-stream water use and watershed development. Conditions working against meeting the Instream Flow Program's goals include both increasing water use as well as changes in watershed-wide conditions that affect stream flow. If either of these conditions result in not meeting the protected flows, then management is required to meet the instream and off-stream protected entities' needs and to avoid water quality impairment.

1. Indications of Watershed-wide Changes

Fundamentally, instream flow management is a supply versus demand issue. When supply exceeds demand, the instream flows are met. When supply does not meet demand, instream flows are not being met. Comparing the protected flow values in Table 1 to the flow duration curve in Figure 6 shows that there will be times when the instream flows are not met.

The flow duration curve for the Lamprey River at the Packers Falls gage (which is the probability distribution of average daily flows) for the period of 1934 to 2010 appears in Figure 6. To interpret values from the curve, the vertical axis identifies the fraction of time that flows exceed the average daily flow magnitude on the horizontal axis. For example, the average daily flow of 1,840 cfs is exceeded 1% (exceedance probability = 0.01) of the time.[5]

Upon further scrutiny of the data underlying Figure 6, of the highest 25 flows, only three occurred prior to 1970, and of the lowest 25 flows, only two occurred prior to 1970. Regionally, there appears to have been a shift in climate patterns, or perhaps effects of development, since 1970 that has resulted in a shift in stream flow hydrology. The median flow for the entire record, 1934 to 2010 (Table 4) is 174 cfs, but since 1970 has increased to 187 cfs. (Some flows of common interest from the flow duration curve are listed in Table 4.) The hydrologic shift since the 1970's indicates more runoff on average combined with a greater number of extreme events: wetter wet periods and drier dry periods.

The flow statistic called 7Q10 meaning the lowest 7-day average flow expected on the average of once in ten years for the full record from 1934 to 2010 at the USGS gage at Packers Falls is 4.25 cfs, and for the hydrologic record since 1970 (when climate change consequences in the New England hydrologic record seems to have occurred) is 4.14 cfs. This is further evidence that over the long term hydrologic changes should be expected.

Whether these changing flow conditions result from climate change or changes in watershed conditions related to impervious surface increases, land use changes, effects from construction of culverts, bridges, dams and riprap in rivers, or the loss of riparian areas is not quantified. Management of flows resulting from these conditions may be partially successful, but a more direct and effective response may require management of the causes.

[5] This exceedance probability should not be confused with peak instantaneous flows like the 100-year event. The peak flow data set is a completely different data set (largest flow each year) and a different type of data values (instantaneous flow).

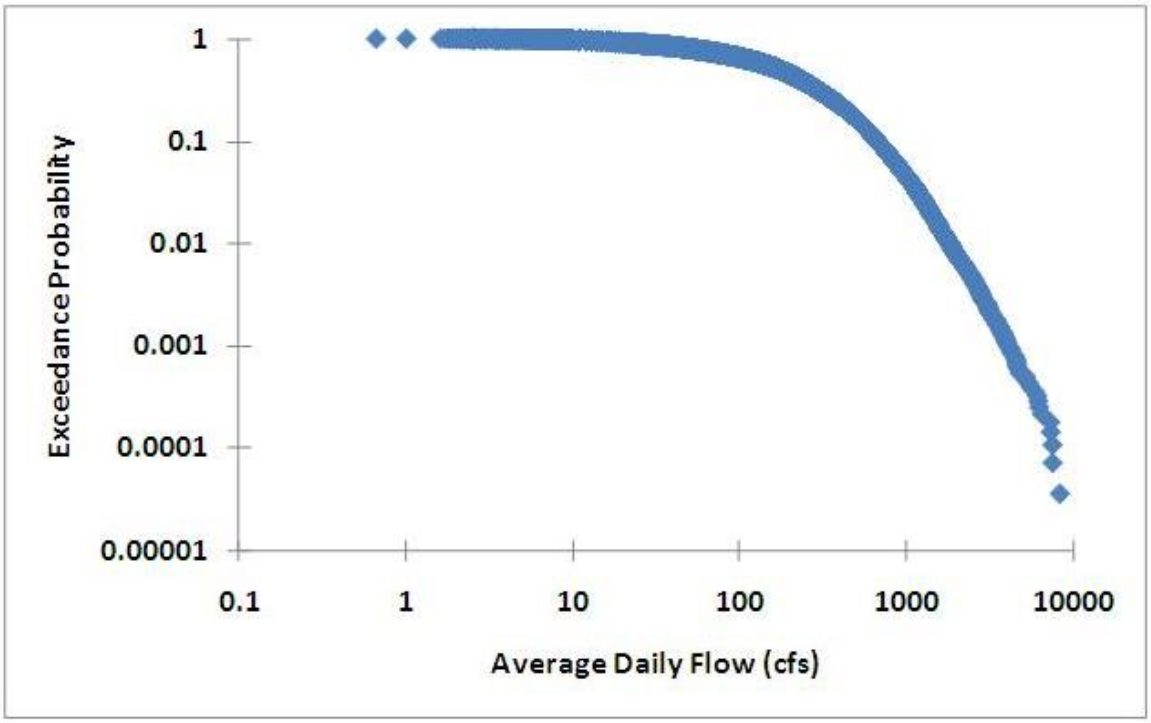

Figure 6. Flow duration curve, Lamprey River at Packers Falls 1934-2010.

Table 4. Probabilities of specific average daily flows from the Lamprey River flow duration curve of Figure 6.

Exceedance Probability (%)	Non-Exceedance Probability (%)	Flow (cfs)	Flow (cfsm)
99	1	6.2	0.0339
95	5	14	0.0765
93.8	6.2	16	0.0874
90	10	23	0.1257
50	50	174	0.9508

2. Changing Water Use

Water use is also changing in the Lamprey River. The average direct annual withdrawal from the river (1998 – 2008), in and upstream of the Lamprey Designated River, is just less than 100,000 gallons per day (0.155 cfs). However, from 2009 through 2012, one water user alone averaged 386,000 gallons per day (0.598 cfs) from the Lamprey. The lowest flow ever recorded at the Packers Falls gage to date occurred in 1994 when 0.66 cfs was recorded (426,500 gallons per day). Clearly, water use/diversion varies over the year; however, water withdrawals have the capacity to take all the water from the Lamprey River during extremely low flows.

In addition, population in the watershed is increasing. Table 5 tracks the census populations of the Towns of Candia, Deerfield, Durham, Epping, Lee, Northwood, Nottingham, and Raymond, which are Towns within or upstream of the Lamprey Designated River. For this 20-year snapshot, population increased on average 1.3% per year.

Table 5. Population in the Lamprey River Watershed Towns from the US Census.

1990	2000	2010
51,899	58,426	65,951

The hydrologic analysis of the Lamprey River stream gage indicates that average median river flow has increased slightly since 1970. At the same time, however, low flows are more frequent and lower. In addition, present day water demand has the capacity to exceed river flow. Increasing population in the watershed suggests that demand for water may exceed supply more frequently and by greater amounts in the future. The comparison of supply and demand in this discussion reveals that supply is increasing at 0.2% per year and demand is increasing at 1.3% per year.

To put this in perspective, on average, the Lamprey River flows at 120 million gallons per day and the demand for water to serve domestic purposes (based on today's population and assuming a conservative value for water use as 150 gallons per capita per day) is 10 million gallons per day: most of the time, supply exceeds demand. Yet 6% of the time the river flows at 10 million gallons per day or less. So while on average there is plenty of water, 6% of the time demand exceeds supply. In the future, population increases and climate change effects will likely result in demand exceeding supply more frequently and more dramatically.

D. Are the Lamprey River Protected Instream Flows Manageable?

Management of the Lamprey River flows under the Water Management Plan will be accomplished by three methods. The Conservation Plan component of the Water Management Plan will reduce water loss and waste. Water Use Plans will spread and flatten water use when flow conditions are stressed. Under the Dam Management Plans, releases of water to provide relief pulses will increase flows downstream of the dams to offset stressed conditions. DES evaluated what is needed from these management components and whether they are sufficient to manage stream flow deficits. See also Appendix D - Frequency of not meeting the protected instream flows.

When comparing the protected instream flows to the flow duration curve, a picture starts to develop about the possible manageable flows versus the protected instream flows that exceed management capacity. Flow management capacity in the watershed is limited to the amount of water use and the amount of useable lake storage.

1. Management of Water Use

The average daily direct withdrawals from the river of 0.155 cfs (through 2008), and maximum historical withdrawals of 2.06 cfs have the potential to be very significant at low flows. The University of New Hampshire/Durham Water Supply (UDWS) has the capacity to pump up to 2.8 cfs. However, at higher river flows greater than 50 cfs, 2.8 cfs is an increasingly smaller percentage compared to the river flow, and in fact is within the order of

measurement accuracy (5 to 10%) of the flow itself. A strategy that focuses only on managing water withdrawals to achieve the protected instream flows will only exhibit significant success when both the river flow and the protected instream flow are in the range of 0 to 50 cfs. Management of higher flow conditions requires additional management options to achieve the protected instream flows.

2. Management by Dam Releases

Another mechanism to manage the river is to use stored water to offset flow deficits. Water stored behind dams and other impoundments could be released as a relief flow at times when the protected instream flows are not being met to raise the flow above the protected flow.

Evaluation of impoundment conditions determined which impoundments represent the most effective and efficient management alternatives. Table 6 identifies the various Affected Dams within and upstream of the Designated River. Many of these dams have limited capability to control outflows—although inadequate outlet structures can be remedied. Some of the dams' impoundments have large surface areas reflecting their potential storage. Dams with larger watershed areas have a higher recovery potential. Management of a larger number of dams would require more complicated scheduling for timing of opening and closing of releases. Adding more, but less suitable dams increases the management effort with a diminishing

Table 6. Impoundments within and upstream of the Lamprey Designated River.

Dam	*Surface Area at Normal Full Pool (acres)	Normal or Permanent Pool Volume (acre-feet)	**Watershed Drainage Area (sq. mi.)
Thurston Pond Dam	13.5	6	1.14
Piscassic Ice Pond Dam	13.7	27	14.19
Meadow Lake Dam	17	85	0.45
Doles Marsh Dam	25	41	0.39
Socha Pond Dam	30	45	4.35
Wiswall Dam	30	360	183.9
Deer Pond Dam	38	100	0.56
Lucas Pond Dam	40	40	1.01
Nottingham Lake Dam	41	172	14.51
Beaver Pond Dam	50	16.5	0.87
Freeses Pond Dam	55.3	66.3	8.5
North River Pond Dam	80	106	1.25
Onway Lake Dam	192	305	8.48
Mendums Pond Dam	265	1,960	6.90
Pawtuckaway Lake	783+	11,500	20.4

* Surface areas from the DES Dam Bureau Dam Database
** Watershed drainage area from StreamStats:
http://water.usgs.gov/osw/streamstats/new_hampshire.html
+ Surface area from GIS coverage

return because desired management effects from these ponds are less. For these reasons, two state-owned dams, Pawtuckaway Lake and Mendums Pond, were selected for management strategies that involved the release of water to increase flows in the designated reach when protected instream flows are not being met. Such releases would be for the purpose of protecting aquatic life in the river, and may have other environmental or ecological benefits for those waterbodies.

3. Deficit Flow Analysis

If sources of stored water are to be used to relieve catastrophic conditions, then how much water is needed to offset the deficits? There are two parts to answering these questions: 1) What release flow rate is needed to relieve a catastrophic condition, and 2) For what length of time should it be applied? To answer the first question, calculation of the volumes sufficient to raise the low flow above the 30 year average protected flow magnitude was completed. Each deficit will differ because the stream flow under catastrophic conditions will vary in magnitude below the protected flow. The relief flow rate for each event was equal to the difference in flow rate between the protected instream flow and the actual river flow. The volume of water needed for a relief flow is the difference in rate multiplied by the duration that this flow will be released.

How long will a relief flow from storage be released? A relief flow replicates the natural variability of flows by interrupting the duration of a catastrophic low flow condition. A two-day relief flow period was suggested by the aquatic experts on the project team: this flow relief duration is believed to be sufficient to significantly reduce the stress on the aquatic ecosystem during extended periods of low flow. When studying the historic record of Lamprey River low flows, a typical small storm has a similar effect, increasing stream flow above the protected instream flow value for about two days.

The 30-year stream flow record used to develop the protected instream flows was also used to compute the relief flow volumes needed to meet the protected instream flows when catastrophic conditions occurred. The distribution of these volumes in each bioperiod was studied to understand the range of flow deficits. The results of these analyses are presented in Appendix F where the probability distributions of the two-day deficit volumes are depicted.

4. Spring Flood Bioperiod and Common Flows Excluded

Flows during the Spring Flood bioperiod are not manageable because of the volume of water needed to do so. With no management options of sufficient size available and recognizing the small effect of current diversions on springtime flows, DES determined that Spring Flood Bioperiod conditions would not be managed.

Similarly, the Common flows for all of the bioperiods are not manageable because of volume requirements. Common flows represent optimal fish habitat conditions; not meeting these conditions is a chronic stress on flow dependent fish, but not an acute or immediate life threatening stress as are catastrophic conditions under the rare and critical flows. As noted, the scope of Common flow management exceeds existing storage for most scenarios, and if implemented, inadequate water in storage for the rare or critical flows may result. In addition, the Common flows themselves are much larger than aggregate water uses. DES conjectures that when flows are not meeting Common flows, these conditions represent watershed-wide changes that should be addressed with watershed-scale management.

Note that while active management will not be attempted for the Spring Flood Bioperiod or Common flows, DES will monitor the frequency of events when these flows are not met to identify long-term trends. If long-term trends indicate increased frequency of below-Common or low Spring Flood flows, then this determination will be re-evaluated.

5. Relief Flow Release Rates Determined for Each Bioperiod

A single release rate value was defined for each bioperiod. Table 7 shows that the range of relief flows is 6 to 65 cfs. These flows would increase stream flows above the protected flows for 90 percent of the occurrences in the historical data. Meeting 90 percent of occurrences is the goal because catastrophic conditions are defined as naturally occurring once in ten years. In other words, meeting 90% of the conditions would allow a catastrophic low flow condition to occur 10% of the time or one year out of ten. To allow for losses along the river and uncertainty, a 20% buffer was added to these values. The equivalent range of volumes for a two-day release is 24 to 259 acre-feet. See the Dam Management Strategy section for further discussion on the criteria.

6. Effects of Relief Flows on Lake Levels

It was clear from the assessment of deficit volumes that management of the rare and critical protected instream flows was possible using some of the volume in Pawtuckaway Lake and Mendums Pond. Table 6 indicates that there are 11,500 acre-feet of storage in Pawtuckaway Lake alone; however, all of this volume is not available for management. Water level is a critical factor for people who recreate at the lake, property owners, and ecosystems, and therefore any strategies to provide relief flows from Pawtuckaway Lake should only do so with minimal impact to the lake level. Pawtuckaway Lake has a surface area of 783 acres and Mendums Pond has a surface area of 265 acres, so an inch of water from each is equivalent to 87 ac-ft. Figure 7 displays the relationship between the change of Pawtuckaway Lake water level versus relief flow in cfs and versus the two-day volume represented by that relief flow (releasing the relief flow for 48 hours). Although this section focuses on relief flows from Pawtuckaway Lake, Mendums Pond is also part of the management plan. At this point of the report, the decision logic is to determine if relief flows are even feasible. Relief flows, with volumes shown in Table 7, appear feasible for managing the rare and critical protected instream flows.

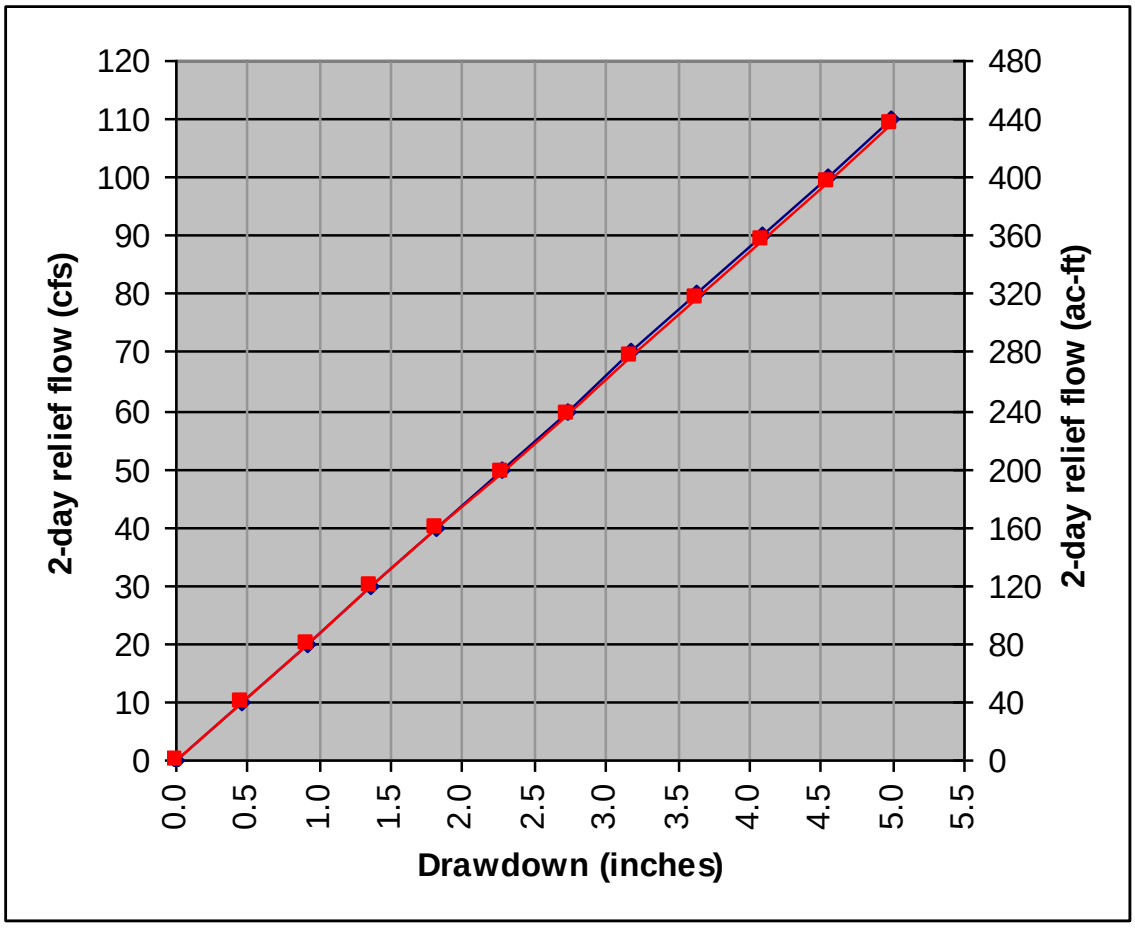

Figure 1 Effects of summer time relief flows on Pawtuckaway Lake water level.

Table 7. Flow releases meeting 90 percent of the historical 30-year Protected Instream Flow deficits (1976-2005) and the calculated changes in water level from full pool.

Bioperiod	Time of Year	Volume needed to meet 90% of historical deficits (ac-ft)	Volume needed to meet 90% of historical deficits with 20% buffer (ac-ft)*	Equivalent two-day flow release (cfs)*	Change in water level from full pool using releases that meet 90% of historical deficits w/ 20% buffer (feet)*	Water source
Overwintering	Dec 9 – Feb 28	216	259	65	0.65 from a starting level of -4.8 feet – not from full pool	Mendums Pond not used. Retained in Pawtuckaway Lake from annual Fall drawdown.
Spring Flood	Mar 1 – May 4	-	-	-	-	No active management is planned.
Clupeid Spawning	May 5 – Jun 19	118	142	36	0.14	From drawdown of storage
GRAF Spawning	Jun 20 – Jul 4	20	24	6	0.02	From drawdown of storage
Rearing &Growth	Jul 5 – Oct 6	47	56	14	0.05	From drawdown of storage
Salmon Spawning	Oct 7 – Dec 8	75	90	23	As available	Annual Winter drawdown timed to correct deficits within the bioperiod

* Two day flow release volumes and rates are from both Mendums Pond and Pawtuckaway Lake unless otherwise stated. Division of release is based on lake surface areas of 783 acres for Pawtuckaway Lake and 265 acres for Mendums Pond, or a ratio of 3:1.
**Change in May 5-October 6 water levels are based on a starting point of full pool. Lower starting points will result in larger (by <13%) changes in water level. Overwintering change is factored for the winter pool starting level.

E. Strategies for Maintenance of Protected Instream Flows

The protected instream flows will be maintained by implementing management actions under the three sub-plans of the Water Management Plan. The three water management sub-plans are: Conservation Plan – to reduce water losses and unnecessary water use; Water Use Plan – to shift, spread and reduce water use impacts on stream flow; and Dam Management Plan – to manage catastrophic flow events. Implementation of management actions will be based on tracking daily river flows at the USGS gage 01073500 Lamprey River near Newmarket and comparing them to the protected instream flows.

Another management component is assessing hydrologic conditions using parts of the Ecologically Sustainable Water Management (ESWM) Method developed by Richter and others (2003) to track changes in flow conditions. This tool will be used during the implementation period following the Water Management Plan adoption to show whether the protected flows are meeting the variability expectations of the Natural Flow Paradigm.

Lastly, there is the *de minimis* amount of water that is always available for use regardless of stream flow. The *de minimis* amount is distributed among water users who have a direct effect on stream flow.

1. *De Minimis* Amount

The Instream Flow Rules require that a *de minimis* amount of water is always available for off-stream use. "*De minimis* amount" means an aggregate water use at any river location equal to 5 percent of 7Q10 at that location. The *de minimis* amount represents a small amount of flow to large water users, yet the amount may be of significant value to smaller users. The *de minimis* amount will be apportioned between water users with surface water impacts. Unless otherwise required, the *de minimis* flows will be applied mainly to small users and then used to buffer management errors (too little flow released, too much withdrawn, etc.) *De minimis* amounts may need to be reapportioned if new surface water users are added to the Water Management Plan.

2. Conservation Plan Strategy

A Conservation Plan is required if the Affected Water User meets the requirements for submitting a Water Conservation Plan under Env-Wq 2101. Plans developed under these rules apply Best Management Practices according to water use type. These plans focus on improving water efficiency through water audits, leak detection and the use of appropriate water conservation measures. Implementation of these plans will result in reduction of both water losses and unnecessary water use to support the protected instream flows. The Instream Flow Program will coordinate the Instream Flow Conservation Plans with the DES Drinking Water and Groundwater Bureau.

3. Water Use Plan Strategy

The Water Use Plans vary by water use type and primarily focus management actions on direct withdrawals and on water uses that induce recharge from out of the river. Wells that do not induce recharge are currently excluded from management because of the delay between management and an effect on the river flows. All direct withdrawals or wells that induce recharge have management actions that apply when flows drop below the Critical flow magnitude. The purpose of the Water Use Plans is to reduce, shift, and spread the effects of water use on stream flow. For

example, public water system customers may be asked to reduce outside water use during persistent low flow periods. In-river storage in impoundments may be used to continue withdrawals during low flows so long as stream flow through the dam is equal to inflow into the impoundment. Alternate sources of water are required when stream flow conditions fall below Critical magnitudes during summer and early fall.

4. Dam Management Plan Strategy

Dam management is employed to provide relief flow pulses when conservation and water use actions are not sufficient. The relief pulse is released from stored water for the two days immediately after a catastrophic condition occurs. The relief pulse volume will result in raising stream flow above the Critical and Rare protected flow magnitudes. A relief flow is defined as a two-day pulse, or release of water, intended to interrupt the duration of the catastrophic flow condition for the Rare and Critical protected instream flows. The release of the relief flow pulse will reset the instream system by reducing the duration when flow is below protected levels.

In any particular year, dam management activities may never occur or may occur on a frequency of one or more events per bioperiod in five of the six bioperiods. DES calculates that under the worst case scenario for stream flow, the cumulative effect of relief pulses over the course of a year drop lake levels by less than one foot. Relief flows will be limited during loon nesting and will be managed to minimize premature out-migration of anadromous fish.

Relief Flows Applied to Catastrophic Conditions

A relief flow is applied when persistent or catastrophic flow conditions occur as shown in Table 1. When the river flow is less than the protected instream flow, and the allowable duration is exceeded, the system enters a *persistent duration*. The third consecutive persistent condition represents a *catastrophic condition* requiring management. Dam management actions will be triggered at the beginning of the onset of the third persistent event. If a low flow event continues and the catastrophic duration is exceeded, then a catastrophic condition requiring management occurs. Catastrophic conditions (as flows and durations) are, by definition, expected to occur in a bioperiod once within a ten-year period, so relief pulses may not occur every time a Catastrophic condition is reached in order to better mimic natural conditions. If the frequency of catastrophic events is found to increase, then long term, watershed-scale management actions may be required to offset or reduce the frequency of these events.

Relief Flow Volumes Calculated

The management goal is to prevent catastrophic events from occurring more than once in ten years, which is equivalent to achieving protected instream flows 90% of the time. To release flows to create the protected flow condition requires calculation of the flow deficits when catastrophic conditions occur. Defining a relief flow volume that meets or exceeds the deficit 90 percent of the time will meet the management goal.

Events when catastrophic conditions occur will be managed by releasing a defined volume specific to each bioperiod to raise stream flow above the Critical or Rare magnitude. To define the release volume for each bioperiod, the flow deficits between the protected flows and the historical stream flows were evaluated for the Common, Critical and Rare protected flows using the 30-years of naturalized flow data. The deficits during the first two days of a catastrophic condition were computed and these data established the distribution of flow deficits. The 90^{th} percentile

volume was identified for each bioperiod. The probability distributions of the deficit volumes for Common, Rare, and Critical flows appear in Appendix F.

Flow release pulses are expected to be attenuated by the distance between the release locations and the end of the Lamprey Designated River and by evaporation and storage losses into river banks and wetlands. As a conservative measure, a 20% buffer was added to each bioperiod's 90th percentile deficit as a safety factor. Most deficits will be less than the 90th percentile value, so the buffer will ensure protected flows are met when the larger deficit events are occurring. More finely tuned releases may be possible after sufficient management experience, at which point, this strategy may be revisited with added complexity.

Relief Flows Applied

Relief pulses will only be applied to catastrophic events in the Rare and Critical range of protected flows. The Common flow events will be tracked and if attainment of these flows and durations indicate an expanding problem, recommendations will be advanced by DES for implementing watershed-wide measures, such as reducing impervious surfaces, more rigorous stormwater management with green infrastructure, improving riparian buffers, dam operations, etc. Similarly, no management is planned for Spring Flood bioperiod flows because its deficits are larger than the management capacity in the watershed and the assumption that these flows are beyond the current need for management. Tracking will determine whether trends in meeting the Spring Flood protected instream flow support the latter assumption.

Sources of Relief Flow

Mendums Pond and Pawtuckaway Lake will be used for relief flows according to the Dam Management Plan. Most of the Affected Dams in the watershed are not part of the current Water Management Plan. These dams may play a role in future Water Management Plans under changed conditions, but their use at this time would add complexity with little benefit.

In developing the conceptual model for applying relief flows under the Dam Management Plan, the assumption was that Mendums Pond and Pawtuckaway Lake will be at full pool at the end of the Spring Flood bioperiod. Management events from late spring through early fall bioperiods[6] will be shared releases from Mendums Pond and Pawtuckaway Lake. Release rates defined for each waterbody are at the same ratio as their surface areas (Table 8) such that each will have an equal drawdown. The resulting water level changes in each impoundment are small, generally less than an inch during the summer bioperiods. If, during those summer bioperiods, a combination of natural decline and management actions results in a cumulative lake level drop of 18 inches, DES will cease to use that lake for relief pulses.

In the fall, both Mendums Pond and Pawtuckaway Lake are currently drawn down during the Salmon Spawning bioperiod, resulting in few stream flow management requirements based on historical conditions. Timing of some of these annual releases may be scheduled to ensure they cover future management events. Mendums Pond has gates that may be damaged by ice in the winter and so releases for the Overwintering bioperiod will use only Pawtuckaway Lake, which has stoplog bays. Pawtuckaway Lake will have enough water in winter storage for one Overwintering bioperiod release of 0.65 feet.[7] As the Spring Flood bioperiod approaches, DES

[6] Clupeid Spawning, GRAF Spawning, and Rearing and Growth bioperiods occur from May 5 through October 6.
[7] See Lake Level Investigation for Pawtuckaway Lake (DES 2013).

Dam Bureau, which operates the Pawtuckaway Lake dams, will use snow pack estimates, as commonly practiced, to determine whether to release existing stored water in order to reserve more space for flood storage, or retain the stored water to supplement lake filling if snow melt potential is low.

Other Dam Management Strategies

Another dam management strategy is that no dam operations should create excessively low flows, and especially not reduce flows when the river is already below critical instream flows. If operations are necessary for maintenance, etc., these should be coordinated in advance with the DES Instream Flow Program and the river flow monitored by the dam owner during such episodes.

Dams such as the Nottingham Lake Dam and Wiswall Dam will be operated to pass stream flow during a relief flow release so the effects of the pulse are maintained downstream. The Wiswall Dam will also be operated so that downstream flows are maintained during summer low flows when water is being withdrawn from the Wiswall Reservoir.

5. Strategy for Management of Other Protected Instream Flow Criteria

The protected flow conditions for non-motorized boating and riparian vegetation and wildlife will be tracked and managed on a multi-year timescale. For recreational boating, the number of days of occurrence of flows equal to 275 cfs will be tracked annually by DES to ensure that the frequency trend of these events continues to match historical occurrence rates. The management strategy will consider this protected instream flow in the context of preserving the frequency of its occurrence. The instream flow for recreational boating use will continue to be met as it has been historically (that is, opportunistically). Management will not attempt to meet recreation needs on a continuous basis.

The instream flows supporting riparian wildlife and vegetation will be assessed by DES each year, so that management of these protected flows will respond to the previous year's conditions and apply flow protections the following year. If the watershed did not meet these instream flows, then management actions for the following year may have to be implemented to ensure the conditions are met or to prevent actions that would preclude them. This approach recognizes the ability of many plants and semi-aquatic wildlife to survive occasional water level changes through relocation, dormancy, or other physiological adaptations not available to fish.

6. Strategy for Ensuring Continued Flow Variability

Supporting and maintaining a sustainable water resource for the range of protected entities is the major goal of the Instream Flow Program. This requires maintaining flow variability as described by the Natural Flow Paradigm (Poff et al. 1997). Richter (Richter et al. 2003) delineated a hydrologic assessment framework to track whether operational activities represented Ecologically Sustainable Water Management (ESWM). Under this approach, the flow of the Lamprey Designated River will be tracked on a regular basis and compared with short, intermediate and long term hydrologic characteristics to identify positive and negative trends. DES will use the assessments of short, intermediate, and longer term conditions described by the ESWM protocols to diagnose maintenance of the Natural Flow Paradigm and determine whether flow variability is being maintained.

F. Application of Components of the Lamprey River Water Management Plan

The Water Management Plan is composed of three sub-plans: Conservation Plans, Dam Management Plans, and Water Use Plans. The strategies for applying these sub-plans have been described above. The following sections summarize the individual plans contained under each sub-plan. Each of these sub-plans represents the activities and procedures determined to best meet the needs of all users and resources while maintaining the protected instream flows.

The prompts for management actions in these plans are determined from flow measurements at the United States Geological Survey stream gage called 01073500 Lamprey River near Newmarket, NH. The actions in this Water Use Plan are based on mean daily flow conditions and protected flow conditions recorded and defined on the DES web page at: http://www2.des.state.nh.us/onestoppub/watershed/lamprey_pisf_tracking.xls.

1. Conservation Plans

The purpose of conservation plans is to reduce water losses and waste. The individual Conservation Plans are tailored to each Affected Water User, the details of which may be found in Appendix A. The content required in each Conservation Plan is described in Env-Wq 1906.02. To summarize, under the Conservation Plans, each Affected Water User is characterized as to their historic water use, opportunities for conservation delineated, the existing conservation efforts, and conservation measures that could be implemented in the near term. Conservation Plan requirements under the Instream Flow Program will be met if the Affected Water User meets the requirements for Conservation Plans under Env-Wq 2101.

Conservation Plans are regulated by the DES Drinking Water and Groundwater Bureau. Several water users have existing Water Conservation Plans that have been approved by, or are drafting plans with, the DES Drinking Water and Groundwater Bureau. In the following paragraphs, a summary of the Conservation Plans is presented for each of the four Affected Water Users.

Epping Water Works

Epping Water Works provides drinking water to many of the residents and businesses located in the Town of Epping, New Hampshire. The sources for the Town's water supply are four ground water wells located within the drainage of the Lamprey Designated River. Of the four registered wells, three are currently in use and one has been abandoned and is not expected to be reactivated for future use. The system withdraws an average of 39 million gallons of water per year (through 2008), which is equivalent to 0.06 percent of the annual flow of the Lamprey River.

A fifth well is currently being developed in the vicinity of Hoar Pond. Epping Water Works submitted a proposed Water Conservation Plan to DES's Drinking Water and Groundwater Bureau in support of its permit application for the development of this well and a Water Conservation Plan was recently approved by DES.

All public sector water users, private water users and the water sources are metered. The water meters at the Hoar Pond wells have been calibrated for each of the past two years, while the commercial and residential water meters are not calibrated or tested at this time. The public and private water user meters are read on a quarterly basis, while the source meters are read on a daily basis.

Beginning in 2011, Epping implemented a program to check for leaks within the distribution system, which will check 20 percent of its system each year. As a result, every five years the distribution system will have been completely surveyed for leaks.

The recommended working range for water pressure in water distribution systems is 60 to 80 psi. High system pressures could result in leakage and unaccounted-for water. The Epping system pressure is 70 psi or less.

Conservation rules require that water rates must promote conservation by charging level or increasing rates for greater volumes. Epping Water Works charges its residential and commercial customers a flat rate for water use, with commercial customers paying a slightly higher rate. It also charges a quarterly fee, which gets applied to every 50,000 gallons used. So water users consuming more than 50,000 gallons per quarter will pay a higher total amount based on their water use.

The Town of Epping requires low flow fixtures for new homes and businesses and it requires that any new irrigation systems be designed by a certified installer and approved by the Water and Sewer Commission. The Epping Board of Water and Sewer Commissioners actively performs public outreach to educate water users on water conservation issues. These efforts include discussion of water conservation issues at its meetings and the posting of notices in the local newspaper. Conservation issues are also discussed during the monthly televised water and sewer commission meeting. Water conservation educational materials are also occasionally included in the bills sent to water users quarterly.

Raymond Water Works

The Raymond Water Department provides domestic water for the Town of Raymond, New Hampshire. The water supply is sourced from three sand and gravel wells located in the Town of Raymond on town-owned property adjacent to the Lamprey River. Groundwater is withdrawn daily from two of the three wells 24 hours per day. The system withdraws an average of 113.5 million gallons of water per year (2008-2012), which is equivalent to 0.14 percent of the annual flow of the Lamprey River.

Raymond is investigating the development of additional water supply wells. As part of the permit required for the wells, the Town has submitted a preliminary groundwater withdrawal permit application. The Town is developing a Water Conservation Plan as part of the permitting process.

All water sources and users are metered. The production well meters are tested and calibrated every two years. The last calibration occurred in May 2013. System water meters are read monthly and water bills are mailed out quarterly.

Conservation rules require that water rates must promote conservation by charging level or increasing rates for great volumes. Water use is billed based on consumption with the rate increasing with increasing use.

The Raymond Water Department continually looks for leaks, monitors the system records to identify anomalous water use, and repairs leaks as soon as they are detected or reported. Unaccounted-for water is monitored by comparing pumped amounts of water versus billed volumes. In 2010, unaccounted-for water was calculated at 19 percent, which is higher than the recommended maximum of 15 percent. In response, the Town performed a leak detection study which located one 20 gallons per minute (gpm) leak. A subsequent study in 2013 located two

additional leaks with a combine rate of 18 gpm. The Town has applied for funding from DES for another leak detection survey in 2014.

The Raymond Water Department has several water conservation outreach initiatives. These include discussions with and presentations to local groups and municipal boards (Boy and Girl Scouts, Planning Board and Board of Selectmen), bill stuffers, and the Town newsletter.

Scenic Nursery & Landscaping

Scenic Nursery & Landscaping (Scenic Nursery) is a full service garden center and nursery, which also provides landscape design services. Scenic Nursery has three registered water sources on the property. The first source is a 15 foot deep dug well and is located within 70 feet of the river. The second registered water source was a dug well, but due to excessive siltation problems, this well is currently not used. In its place, an intake pump was placed in the Lamprey River and the piping from the temporary intake ties into the irrigation system in the former dug well. The third water source is a small pond located in the northwest portion of the property. Annual usage averaged 1.7 million gallons (through 2008), which is equivalent to 0.002 percent of the annual flow of the Lamprey River.

Scenic Nursery presently employs several water conservation practices for agricultural irrigation. The irrigation system is regularly monitored for leaks to reduce water loss and the expense associated with running the pumps. The irrigation system is charged to a water pressure up to 60 pounds per square inch (psi) before operation. If there is a leak in the system, a drop in pressure is evident on the system pressure gauge before any water is distributed to the sprinklers or drip heads. The leak is then identified and repaired.

Scenic Nursery will work with the DES Drinking Water and Groundwater Bureau's Conservation Program to assess its water use measurement accuracy. Meters will be installed if measurement accuracy cannot be maintained within 10 percent. If meters are installed, they will be tested and calibrated in accordance with the manufacturer's specification.

University of New Hampshire/Town of Durham (UDWS)

The University of New Hampshire (UNH)/Town of Durham water supply consists of three water sources: the Oyster River, through a diversion from the impoundment formed by the Oyster Reservoir Dam; the Lee Well; and the Lamprey River, through a diversion from an impoundment formed by Wiswall Dam. The UDWS provides water to the entire university community as well as most of Durham. The water system is operated by UNH Water Supply personnel and receives guidance from a Water, Wastewater, and Stormwater Committee, which is staffed by representatives from both the University and the Town of Durham. The maintenance of the system is shared by UNH and the Town of Durham. UDWS is presently finalizing a Water Conservation Plan to the DES Drinking Water and Groundwater Bureau for a proposed well under the Large Groundwater Withdrawal permit process.

In November 2008, the Lamprey River diversion became the principal year round source of water for the UDWS. When flows in the Lamprey River begin to approach the protected instream flow, the Oyster River is used. The Lee well is used continuously. Annual water use from the Lamprey River by the UDWS averages 21.9 million gallons (through 2008), which is equivalent to 0.03 percent of the annual flow of the river. Annual water use for 2009 and 2010 averaged 152 million gallons, equivalent to 0.20 percent of the annual flow.

In 2008, the UDWS submitted a proposed Water Conservation Plan to DES's Drinking Water and Groundwater Bureau in support of their permit application for the development of a new water supply in the Spruce Hole Aquifer in Durham. That application was approved in 2012. The proposed Water Conservation Plan documents the water conservation measures employed by both UNH and the Town of Durham and how its operations meet the water conservation requirements for existing Large Community Water Systems pursuant to Env-Wq 2101. The plan is the final stages of completion and should be approved by DES in 2013.

The Water Conservation Plan describes the existing and planned actions that UNH has implemented as part of its campus sustainability initiative (parts of which are described at UNH's sustainability web site at www.sustainableunh.unh.edu). The plan includes testing and calibration schedules for meters. UNH requires all new buildings and renovations to use low flow water fixtures including urinals, toilets, showers and any dishwashers or cooling systems. UNH is also installing waterless urinals and dual flush toilets in two of its most recently renovated buildings. Students at UNH are educated on the water conservation techniques through an annual or biannual outreach effort which includes informational postings and fliers. They are instructed to report leaks and drips in sinks, showers and toilets. They are also encouraged to wash full loads of laundry, to turn the water off while brushing their teeth and to take shorter showers. Water meters in campus buildings are read monthly.

The Town has metered all of its customers and reads its meters twice a year. The Town's water customers pay for their water based on a unit price and the rate structure is the same for all customer classes. The Town periodically sends out water conservation outreach materials with its bi-annual water bills and includes water conservation tips in the weekly Town newsletter that is emailed to Town residents. The Town's engineering department staff present updates to Town committees on water and water conservation issues.

A comprehensive leak detection study was performed on the UDWS system in 2007. The results of the study identified 8 percent unaccounted losses, which is lower than the 15 percent limit in the Water Conservation Rules (Env-Wq 2101). To minimize unaccounted-for water, water use is actively monitored and reported leaks are addressed immediately.

2. Water Use Plans

The purpose of the water use plans is to reduce the effects of water withdrawals on stream flow by applying outdoor water use restrictions and alternative sources during summertime low flows. The Water Use Plans apply to each Affected Water User. Individual Water Use Plans were developed for the four Affected Water Users identified in this document.[8] The content required in each Water Use Plan is described in Env-Wq 1906.04. The elements of these individual plans include defining water use patterns and needs of the Affected Water User (AWU), identifying the potential for water use modification and sharing, and developing an implementation schedule and costs.

A summary of the individual water use plans appears in the following paragraphs. The management actions focus on direct surface water withdrawals and on groundwater sources that induce recharge. Actions are applied to reduce and spread peak water usage during low flows in the summer through early fall bioperiods (June 20 to October 6). The water use plans include reductions in outside water use for public water supplies and use of alternate water supplies during

[8] Part II. Section B. Individuals Affected by the Water Management Plan

low flow periods. Discussions with some public water suppliers indicated an interest and willingness to coordinate summertime reductions in outside water use that is linked with stream flow conditions in order to reduce system demand and support the protected flows. The individual Water Use Plans summarized below may be found in Appendix B.

Epping Water Works

Epping Water Works has three active wells, one inactive well, and one well in development. Epping Water Works has limited potential to manage its water use to support the protected instream flows because only one well was identified as inducing recharge from stream flow. Also, this well is in the Piscassic River watershed, which is a tributary at the downstream end of the Lamprey Designated River. The active wells are constructed in bedrock meaning that they are less likely to have an immediate effect on stream flow than wells developed in sand and gravel.

Although the Epping water supply wells are not expected to have an immediate effect on stream flow, the extraction of groundwater that would otherwise recharge the river requires management. Management is required in the summer and early fall, when flows in the river are at a minimum and flow in the river is dependent on groundwater recharge.

Management will be accomplished by implementing provisions in Epping Water Works' established Emergency Action Plan (Town of Epping Water Department 2009) for multi-stage, outside water use reductions that apply during periods of drought. The water use plan management actions are the implementation of outdoor water use reductions or bans during summer and early fall if a low flow occurs. Under this Water Use Plan, during the period from June 20 to October 6, outdoor water use may be reduced in two stages: an alert with voluntary water conservation and an enforced water use ban.

Raymond Water Works

Raymond Water Department has limited potential to manage its water use to support the Protected Instream Flows on the Lamprey Designated River. Raymond's existing water supply consists of three stratified drift groundwater wells located within 500 feet of the Lamprey River. The effects of the well withdrawal impacts on Lamprey River stream flow were evaluated (DES, 2009) and none of the wells were found to induce recharge from the Lamprey River. Pumping all wells simultaneously was not evaluated and there is a chance that all three wells pumping simultaneously could induce recharge.

Although the Raymond Water Department's supply wells may not have an immediate effect on the Lamprey River, the extraction of groundwater that would otherwise recharge the river does require management, particularly when flow in the river is mostly dependent on groundwater recharge. This condition typically occurs during the summer and early fall when flows in the river are at a minimum.

Under this Water Use Plan, outdoor water use from June 20 to October 6 will be reduced in three stages: (1) an alert with voluntary water conservation; (2) voluntary water use restrictions; and (3) an enforced water use ban. The Town of Raymond will notify residents of the water use restrictions.

Whenever operational considerations of the water system allow, during periods when voluntary outdoor water use restrictions are recommended or during a ban on outdoor water use, the Town will manage pumping from the three water supply wells to further minimize potential impacts to the Lamprey Designated River.

Scenic Nursery & Landscaping

The potential for water use management at Scenic Nursery to meet the protected instream flows is limited. This is due to the low volume of water used by Scenic Nursery for their operations. Based on a review of the historical water use by Scenic Nursery, their maximum daily use is equivalent to 0.05 cfs, which was related to higher than average irrigation use to establish new plants during the recovery of their operations following a significant flood event in 2007. Otherwise, their highest use, 0.04 cfs, occurred in August 2002, during a drought.

Although the overall water use by Scenic Nursery is low, it utilizes a temporary direct withdrawal from the Lamprey River for irrigation. The de minimis flow for the Lamprey River at the USGS gage is 0.21 cfs or 135,725 gallons per day. The de minimis flow is apportioned between the two surface water withdrawals at Scenic Nursery (20747-S02) and the UDWS withdrawal (20066-S02). During low flow periods, Scenic Nursery will limit its direct withdrawal from the Lamprey River to a portion of the de minimis flow equal to 0.01 cfs (4.5 gallons per minute).

University of New Hampshire/Town of Durham Water System (UDWS)

UDWS has significant potential to manage water use to support the Protected Instream Flows due to the availability of multiple alternative water sources and the potential for reducing system water demand through the use of summertime water conservation measures. The alternative sources include the Oyster River Reservoir, the Lee Well, and storage in the Wiswall Reservoir on the Lamprey River. UDWS has unique water use conditions in that some of its sources are not within the Lamprey River watershed. Moreover, UDWS' pattern of water use differs from other users of the Lamprey River because UDWS operates to take less water during the summer when other water users' demand is generally higher. UDWS's peak demand is during the fall and spring when the University of New Hampshire is in session.

The proposed water use management actions are: 1) withdrawal from Wiswall Reservoir is available so long as the limits on drawdown are met; 2) acknowledgment of DES notification of an imminent relief flow release; 3) during the effective period of a relief flow release, withdrawals must be coordinated with Wiswall dam management to maintain downstream flow; 4) implementation of summertime, outdoor water use reductions or bans; and 5) whenever possible, water withdrawals from the Lamprey will be conducted at a lower rate for shorter durations instead of longer durations of higher rates.

The de minimis flow for the Lamprey River at the USGS gage is 0.21 cfs or 135,725 gallons per day. The de minimis flow is apportioned between the two surface water withdrawals at Scenic Nursery (20747-S02) and the UDWS withdrawal (20066-S02). During low flow periods, UDWS will have 129,272 (approximately 90 gpm) of the de minimis flow.

3. Dam Management Plans

The purpose of the Dam Management Plans is to reset stream flow conditions when the protected instream flows are not being met. This is done chiefly through a release of water from storage to artificially create conditions that mimic a small rainfall event. These releases will be conducted when catastrophic stream flow conditions occur. Management is also applied to maintain flow downstream of a dam when affected by other impoundment uses. The content required in each Dam Management Plan is described in Env-Wq 1906.04. The Dam Management Plans are specific to each Affected Dam. The individual Dam Management Plans are found in Appendix C.

There are 19 dams or dikes in the Lamprey River Water Management Planning Area. These structures and their impoundments are listed in Table 8. Dam Management Plans describe how management of these facilities will be integrated to assist in achieving the protected instream flows. Many of the impoundments in the watershed are not currently part of the management of the Lamprey River protected instream flows for reasons discussed above in the Dam Management Plan Strategy section and, therefore, the Dam Management Plans for those dams are not discussed in this section.

Dam management plans for maintaining downstream flows are described for Nottingham Lake Dam and Wiswall Dam. Because these dams are actively in use, for hydropower production and as a water supply, respectively, their operation has the ability to affect downstream flows. Their dam management plans describe how they will be operated to ensure the passage of stream flow downstream.

Pawtuckaway Lake and Mendums Pond have Dam Management Plans describing how they will be managed to create relief flow pulses for instream flow management. Releases have been defined to affect both lakes' water levels equally. Appendix E demonstrates the results of releasing water from Pawtuckaway Lake on downstream flow conditions.

Table 8. Affected Dams and their surface area (in acres).

Municipal Dams	
Freeses Pond Dam	55.3
Hoar Pond Dam	26
Thurston Pond Dam	13.5
Wiswall Dam	30
Private Dams	
Deer Pond Dam	38
Nottingham Lake Dam	41
Onway Lake Dam	192
Piscassic Ice Pond Dam	13.7
Socha Pond Dam	30
State-Owned Dams	
Beaver Pond Dam (DRED)	50
Doles Marsh Dam (F & G)	25
Lucas Pond Dam (F & G)	40
Meadow Lake Dam (DRED)	17
Mendums Pond Dam (DES)	265
North River Pond Dam (DES)	80
Pawtuckaway Lake Dams (Dolloff, Drowns) and Dikes (Drowns and Gove)	783

The details of all Dam Management Plans may be found in Appendix C. A summary of the active Dam Management Plans under the current Water Management Plan is presented below.

Nottingham Lake Dam

Nottingham Lake Dam is a privately owned hydropower dam located approximately 3.5 miles downstream of Mendums Pond Dam. Nottingham Lake Dam is operated both for recreation and the production of hydroelectricity. The dam has the potential to affect stream flow, but is currently operated in run-of-river mode. Any releases from Mendums Pond Dam must be coordinated with the owner of the Nottingham Lake Dam to ensure that the water released would not be impounded, thereby reducing the effectiveness of the release or negatively impacting hydroelectric power production.

This Dam Management Plan ensures that water released from Mendums Pond for flow relief pulses will be passed downstream. Nottingham Lake Dam will continue to be operated as a run-of-river hydroelectric facility.

The Affected Dam Owner may use the relief flow released from Mendums Pond to generate power so long as they continue to pass flows and meet Surface Water Quality Standards. The required actions for the Affected Dam Owner are to ensure that relief flows resulting from dam management actions taken upstream of Nottingham Lake Dam at Mendums Pond Dam are conveyed through Nottingham Lake downstream of the dam with minimal attenuation.

Wiswall Dam

Wiswall Dam is located on the Lamprey River, immediately downstream of the Wiswall Road Bridge crossing in Durham, New Hampshire. The primary use of Wiswall Dam is described as recreational (NH Dams Data Sheet 071.04), but the owner describes its current use as largely to impound Wiswall Reservoir, a water supply source for UDWS. Non-motorized boating, fishing and swimming are commonly observed recreational activities in the impoundment.

Wiswall Dam has a role in maintaining protected flows by passing water needed to maintain stream flow downstream during relief pulses and when water is being withdrawn by UDWS for water supply. Water withdrawals have the potential to significantly affect stream flow under low flow conditions so that dam management is required to offset the effects of withdrawals. Coordination of water withdrawals and dam management are needed because of the effects of one upon the other. Management includes limiting water level change in the Wiswall Reservoir.

Dolloff and Drowns Dams (Pawtuckaway Lake)

Pawtuckaway Lake is the largest water body in the Lamprey watershed and is located upstream of the Lamprey Designated River. The lake has two dams, Dolloff Dam and Drowns Dam, each with operable outlet structures. Releases from Pawtuckaway Lake may come from either dam or from a combination of both dams. Dolloff Dam and Drowns Dam impound Pawtuckaway Lake for recreational purposes—its primary use as described by the DES Dam Bureau. The specific actions associated with the implementation of the Dam Management Plan include the placement or removal of stop logs from the dams.

Winter lake level conditions for Pawtuckaway Lake were defined by DES, first, under a DES Notice of Decision (DES 2000), and then revised under a subsequent Lake Level Investigation (DES 2013.) Some components of the historical operation of the Pawtuckaway Lake water levels were modified to improve lake quality management and for instream flow protection.

When water management activities are necessary, water will be released from Dolloff Dam, Drowns Dam, or both, to create relief flows. Relief flows may be released to support the protected instream flows during five of the six bioperiods. No relief flows will be released during the

Spring Flood bioperiod (March 1 to May 4). For the Clupeid Spawning, GRAF Spawning, and the Rearing and Growth bioperiods (May 5 to October 6), relief flows will be generated by releases from both Mendums Pond and Pawtuckaway Lake, with the volume released proportional to their surface area. Protected instream flows for the Salmon Spawning bioperiod will continue to be met by the annual fall drawdown of Mendums Pond and Pawtuckaway Lake with attention to the timing and volumes of releases. Relief flows during the Overwintering bioperiod (December 9 to February 28) will be from some of the water retained in Pawtuckaway Lake from the annual fall drawdown.

Due to the presence of two known loon nests on Pawtuckaway Lake, the release of relief flows during May 15 to July 15 will be contingent upon loon nesting activity. Decline of the lake level could impact the ability of the loons to access their nest. In order to minimize impacts to nesting loons, if loons are observed actively nesting, no drawdown will occur that combined with the natural decline of Pawtuckaway Lake would exceed 0.5 feet (6 inches) below the normal pool level.

In order to maintain recreation uses and reflect natural variability in summer lake levels, the total amount of allowable level impact from management events will be limited. During the spring, the summer, and the fall until the annual drawdown, water levels in the impoundments will not be lowered more than 18 inches from normal full pool as a result of the combined effects of routine lake declining and relief flow releases for instream flow purposes.

Alewives are stocked in Pawtuckaway Lake. The removal of stop logs to release the relief flows may create attraction flows that allow juvenile alewives to migrate at a time when conditions downstream are not optimal for their migration to the Atlantic Ocean. The release of relief flows from Pawtuckaway Lake during the summer (GRAF Spawning and Rearing and Growth) may initiate the downstream migration of alewives. To reduce the potential for premature release of juvenile alewives, an avoidance mechanism will be placed on the upstream side of the dam outlet to prevent their release.

Mendums Pond Dam

Mendums Pond is the second largest water body in the Lamprey watershed and is located upstream of the Lamprey Designated River. Mendums Pond Dam is located on the Little River off Route 4 in Nottingham, New Hampshire. The specific actions associated with the implementation of the Dam Management Plan include the opening or closing of outlet gates in the dam.

When water management activities are necessary, water will be released from Mendums Dam to create relief flows to support the protected instream flows on the Lamprey Designated River. Relief flows from Mendums Pond will be released during three of the six bioperiods. Relief flows will be released from May 5 to October 6 during the Clupeid Spawning, GRAF Spawning, and the Rearing and Growth bioperiods. Relief flows during these bioperiods will be created by releases from both Mendums Pond and Pawtuckaway Lake with the volumes proportional to their respective surface areas. Protected instream flows for the Salmon Spawning bioperiod from October 6 through December 8 will continue to be met by the annual fall drawdown beginning in November with attention to the timing and volumes of releases. No relief flows will be released from Mendums Pond following the annual drawdown during the Overwintering or Spring Flood bioperiods.

Due to the presence of loon nests on Mendums Pond, the release of relief flows during May 15 to July 15 will be contingent upon confirmation of any loon activity at the nesting sites. Decline of the lake level could impact the ability of the loons to access their nests. If loons are observed actively nesting, in order to minimize impacts to any nesting loons, no drawdown will occur that, combined with the natural decline of Mendums Pond, would exceed 0.5 feet (6 inches) below the normal pool level.

G. Financial Assistance

Under the Instream Flow Rules (Env-Wq 1906.06) the Water Management Plan is to identify any local, state or federal financial assistance programs that could provide funding for plan implementation for AWUs engaged in agriculture or public water supply. Several financial assistance programs are available that could assist agricultural AWUs through the Natural Resources Conservation Service (NRCS). Potential financial assistance may be available from the Agricultural Management Assistance, Conservation Innovation Grants and Conservation Stewardship Program.

The Agricultural Management Assistance program provides grants to agricultural producers to address several conservation related issues, including water management. The agricultural producer works with NRCS staff to develop a conservation plan, which becomes the basis for the contract. Payments are limited to $50,000 per person per fiscal year and funds are awarded on a competitive basis. The Conservation Innovation Grants program is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies. The funds are awarded annually through a competitive process. The availability of funding varies and requires a 50 percent match from non-federal funds. The Conservation Stewardship Program is voluntary conservation program that supports ongoing stewardship of private, working agricultural land. Through the Conservation Stewardship Program, the NRCS provides financial and technical assistance to eligible agricultural producers to conserve and enhance soil and water resources. The Conservation Stewardship Program pays participants for conservation performance; the higher the performance, the higher the payment. Funding is based on a competitive process and a person or legal entity may not receive more than $40,000 in any year or more than $200,000 during any five-year period.

The cost of implementing the plans by the public water supplies is not expected to be significant, but there are several potential sources of financial assistance that may be available. Several federal funded and state managed programs that might be able to provide assistance exist, including the Drinking Water State Revolving Loan Fund, Local Source Water Protection Grants and Watershed Restoration Grants. The availability of funding varies depending on the program and the awarding of assistance may be based on a competitive selection process. A summary of the financial assistance programs potentially available to these AWUs is included in Appendix G.

H. Water Management Plan Implementation

Affected Water Users and Affected Dam Owners will begin implementing their Conservation, Water Use and Dam Management Plans upon adoption of the Water Management Plan by DES.

1. Implementation Prompted by Stream Flow Gage Conditions

The actions in this Water Use Plan are initiated based on mean daily flow conditions recorded at the USGS gaging station identified as 0173500 Lamprey River near Newmarket, NH. Daily data for this gage station can be found at http://waterdata.usgs.gov/nh/nwis/. DES posts the river flow from this station and a table and charts describing the protected instream flow status on its website at: http:www2.des.state.nh.us/onestoppub/watershed/lamprey_pisf_tracking.xls. Affected Water Users and Affected Dam Owners are expected to refer to these data and know the current conditions relevant to implementing their management plans. They may also contact the DES Instream Flow Program for current and forecasted conditions.

2. Management Plan Recordkeeping and Documentation

Upon the implementation of the Lamprey River Water Management Plan, Affected Water Users and Affected Dam Owners will keep records to document the actions and the dates and times that management actions were taken to meet their Water Management Plans. Recordkeeping by Affected Water Users and Affected Dam Owners shall include documentation of the actions and the dates and times that management actions were taken to meet their Water Management Plans. From time to time, DES will conduct audits of the management activities taken by the Affected Water Users and Affected Dam Owners in response to protected stream flow conditions. Documentation of existing conditions that cannot be gathered elsewhere (such as from a continuous stream gage) should be made prior to undertaking management activities. This documentation shall include records of conditions affected by the management activities described in their individual Water Management Plans, including but not limited to changes in dam gate conditions, number of stoplogs in place, static water levels in impoundments, and pumping rates. These records will be retained and made available to DES on request. DES recommends, but does not require, that Affected Water Users and Affected Dam Owners create and retain documentation of the costs associated exclusively with water management activities defined by their Water Management Plans.

3. Adaptive Management

Since the protected instream flows and the water management actions are new approaches to the management of water resources in the Lamprey River Water Management Planning Area, adaptive management will be employed. Once implemented, DES will evaluate the Water Management Plan for its success in maintaining the protected instream flows. Also, expectations for results of actions taken by Affected Water Users and Affected Dam Owners will be reviewed. If these actions are not meeting expectations, an Affected Water User or Affected Dam Owner may apply for a waiver to revise its management actions. The waiver request must apply to conditions that affect only that Affected Water User or Affected Dam Owner and that do not affect others' uses or operations. If the results of this review indicate to DES that parts of the Water Management Plan should be revised, then DES will work with the Affected Water Users and Affected Dam Owners to address this change.

4. Plans Required for New or Increased Water Use

At present, Affected Water User management focuses on the summertime low flow. These are times when water use and conservation by the Affected Water Users can have a measurable impact on river flows. Any new water users or dams in the watershed management area will be required to develop Conservation Plans and Water Use Plans, or Dam Management Plans. There

are at least two proposals to artificially recharge aquifers with Lamprey River water (aquifer storage and recovery – ASR) to provide water to surcharge a groundwater supply. ASR would normally remove water from the river at high flow periods. When such proposals are put forth, they will need to demonstrate how they affect attainment of the protected instream flows, and follow management strategies to ensure attainment of the protected instream flows.

5. Long-Term Management Plan

DES is developing a program of long-term monitoring of ecosystem conditions to evaluate the effectiveness of the instream flows and the Water Management Plan in meeting water quality standards as demonstrated by long-term trends in biological conditions. Currently, funding and staff levels are not available to conduct this monitoring.

6. Compliance and Enforcement

DES will also be determining how compliance with the Water Management Plan will be enforced. The Instream Flow Rules (Env-Wq 1907) state that "affected water users and affected dam owners shall comply with the provisions of an adopted water management plan." Currently no guidance is provided on how non-compliance will be established and what enforcement actions will be taken.

III. Summary

The Lamprey Water Management Plan's goal is to protect the Lamprey Designated River while managing uses of its water. This Water Management Plan presents the management actions to be taken by each Affected Water User and Affected Dam Owner in the Lamprey River Water Management Planning Area in order to support and maintain the protected instream flows established for the Lamprey Designated River.

An Instream Flow Study for the Lamprey Designated River delineated the protected instream flows (DES 2009). The protected flows were established in 2013 as translators of the narrative water quality standards specifically for the Lamprey Designated River. The State of New Hampshire recognizes this Water Management Plan as the means to ensure compliance with the narrative standards set forth in Administrative Rules. The communities and water users in the Lamprey watershed not only benefit from the direct use of the river, but also from the health of the river. In order to maintain the instream flows, water users and dam owners must be considerate of the impact of their individual and collective use on stream flows. This Water Management Plan was developed to help guide those entities.

The Water Management Plan comprises Conservation Plans, Water Use Plans and Dam Management Plans to meet flow protection goals. DES has developed individual management plans for all Affected Water Users and Affected Dam Owners. DES presented a draft report describing the proposed Water Management Plan to the public at a hearing in May of 2011. After considering the comments received through the hearing process, the report was revised, resulting in this Water Management Plan.

Changes from the draft plan were made in the application of flow releases during loon nesting and to mitigate the effect these releases may have on alewife out-migration from Pawtuckaway Lake.

Maximum changes in water levels in Mendums Pond and in Pawtuckaway Lake were also defined.

An important issue that has been reiterated during the development of this Water Management Plan is that it should embrace an adaptive management approach. Adaptive management has been incorporated in the plan implementation such that if the desired outcomes are not being achieved, management strategies may be adapted to meet objectives.

References

Normandeau Associates, Inc., University of Massachusetts, University of New Hampshire, 2005, Final List of Instream Public Uses, Outstanding Characteristics, and Resources (IPUOCR) For the Lamprey River Protected Instream Flow (PISF) Study. Prepared for the New Hampshire Department of Environmental Services, Concord, NH. Dated October 28, 2005.

New Hampshire Department of Environmental Services, 2013, Notice of Decision on Determination of Lake Level. Dated August 29, 2013.

New Hampshire Department of Environmental Services (DES), 2009. FINAL Lamprey River Protected Instream Flow Report. Prepared by Normandeau Associates, Inc., Rushing Rivers Institute and University of New Hampshire. NHDES-R-WD-08-26, Concord, NH

New Hampshire Department of Environmental Services (DES), 2008. DRAFT Lamprey River Proposed Protected Instream Flow Report. Prepared by Normandeau Associates, Inc., Rushing Rivers Institute and University of New Hampshire. NHDES-R-WD-08-26, Concord, NH.

New Hampshire Department of Environmental Services (DES), 2006, Final Report: Instream Public Uses, Outstanding Characteristics, and Resources of the Lamprey River and Proposed Protective Flow Measures for Flow Dependent Resources. Prepared by Normandeau Associates, Inc., University of Massachusetts and University of New Hampshire. NHDES-R-WD-06-49, Concord, NH.

New Hampshire Department of Environmental Services, 2000, Notice of Decision on Determination of Lake Level. Dated December 19, 2000.

Poff, N. L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg, 1997, The Natural Flow Regime. *BioScience* 47 (11): 769-784.

Richter, B. D., R Matthews, D. L. Harrison, and R. Wigington, 2003, Ecologically Sustainable Water Management: Managing River Flows for Ecological Integrity. *Ecological Applications* 13 (1): 206–224.

Town of Epping Water Department, 2009, Emergency Action Plan for the Municipal Water System. Prepared by Epping Water Department, Town of Epping Water Administrator and the Epping Water and Sewer Commission. Effective date March 2003, revised version March 2009.

Town of Raymond, 2009, Emergency Plan. Town of Raymond, Public Works Department, Water Division.

UNH/Durham Water Supply, 2009, UNH/Durham Water Supply Emergency Response Plan. Prepared by Wesley R. East, Chief Operator. Original Date: August 2002 and revised March 2009.

Websites

New Hampshire General Court - http://www.gencourt.state.nh.us/

RSA 483 - http://www.gencourt.state.nh.us/rsa/html/NHTOC/NHTOC-L-483.htm
Laws of 2002, Chapter 278 -
http://www.gencourt.state.nh.us/legislation/2002/HB1449.html
Laws of 2009, Chapter 201 -
http://www.gencourt.state.nh.us/legislation/2009/HB0102.html

New Hampshire Surface Water Quality Regulations
http://des.nh.gov/organization/commissioner/legal/rules/documents/env-wq1700.pdf

New Hampshire Rivers Management Program
http://www.des.state.nh.us/organization/divisions/water/wmb/rivers/index.htm
Lamprey River
http://www.des.state.nh.us/organization/divisions/water/wmb/rivers/instream/lamprey/index.htm