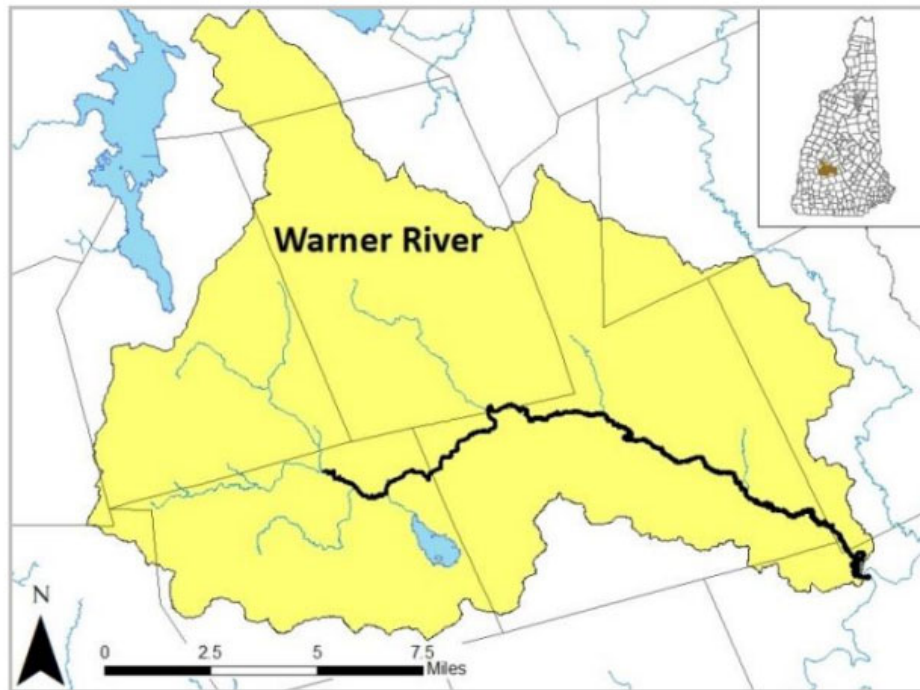


NHDES Commissioner's Declaration of the Establishment of Protected Instream Flows for the Designated Warner River

R-WD-23-07

September 25, 2023



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Prepared by

**Watershed Management Bureau
NH Department of Environmental Services
R-WD-23-07**

September 25, 2023

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NHDES Commissioner's Declaration of the Establishment of Protected Instream Flows for the Designated Warner River

This document establishes protected instream flow criteria as water quality criteria for stream flow for the designated Warner River. The Instream Flow Rules state that protected instream flows established by the New Hampshire Department of Environmental Services (NHDES) Commissioner "shall serve as water quality criteria for the purpose of administration of water quality standards by NHDES under the federal Clean Water Act and RSA 485-A."

NHDES calculated the Warner River's protected instream flow criteria as part of a river-specific study. NHDES then drafted the flow criteria into a report. Table 1 (attached) compiles the protected instream flow criteria. These flows are indexed to the USGS stream flow gage [01086000 WARNER RIVER AT DAVISVILLE, NH](#). NHDES held a public information meeting at the Warner Town Hall to present the report's findings on January 24, 2023. NHDES held a public information meeting followed by a public hearing to receive comments on February 23, 2023. The public comment period closed March 24, 2023. The full study report, [Protected Instream Flow Study Report - Warner River \(June 2023\)](#), is available on the NHDES website. This Declaration of Establishment document is the final step in the process by which the NHDES Commissioner issues a decision establishing protected instream flows for the designated river as water quality standards.

RSA 483:9-c, IV requires that the protected instream flow criteria established by the Commissioner be maintained at all times. NHDES will use these criteria to guide development of the Warner River's Water Management Plan. The water management plan applies to certain impoundments and water users within the watershed. The water management plan will describe actions water users will take to satisfy their water use needs while maintaining the protected instream flow criteria. Dam operations will be defined to support instream flows and protect lake interests.

I hereby establish the protected instream flows, as described in the Warner River Protected Instream Flow Study Report as the water quality standards for flow for the designated Warner River.

Robert R. Scott, Commissioner, NHDES

9/25/23

Date



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

1. Authority

The Rivers Management and Protection Act (RSA 483) and Env-Wq 1900 (Instream Flow Rules) describe how protected instream flows are to be established as water quality standards. This Establishment Declaration follows the procedures in Env-Wq 1904.05, which describes the process for a decision and lists the required content of this document. This rule requires a written decision, after study and public input, stating the scientific basis for the protected flows, including an assessment of how the protected instream flows will meet applicable water quality standards.

RSA 483 directs the Instream Flow Program to establish protected instream flow criteria that meet water quality standards on the State's Designated Rivers and prioritizes meeting water quality standards over other river characteristics. Narrative water quality standards for instream flow are set out in RSA 485-A and Env-Wq 1700. The protected instream flow criteria apply numerical values to these narrative water quality standards.

The Instream Flow Rules also specify a review of impacts required under RSA 483:9-c, V as part of the establishment. This statute requires an assessment of the effect of a protected instream flow upon existing hydroelectric power generation, water supply, flood control, and other riparian users. Estimates of the impacts will be described here, but the final impacts will only be known as part of developing and approving the Warner River's Water Management Plan under which actions are taken to meet the protected instream flows. RSA 483 also requires a summary of the comments and an explanation of how the comments affected the final protected instream flows.

For the purposes of this Establishment Declaration, the designated Warner River is described in RSA 483:15, XIX and includes the 20.5 miles of river beginning at the confluence of the West Branch Warner River and Hoyt Brook in Bradford, NH and continues to the Warner River's confluence with the Contoocook River in Hopkinton, NH. These protected instream flows apply to this Designated segment. Key features of the Warner River watershed are shown below in **Figure 1 – Warner River Watershed**.

2. Scientific basis for the protected flows

The [Protected Instream Flow Study Report - Warner River \(June 2023\)](#) is incorporated by reference and describes the scientific assessment methods applied on the Warner River to determine its protected instream flow criteria. Description of the protected instream flow criteria follows the concepts of the Natural Flow Paradigm by Poff and others (1997) that recognizes flow protection needs to protect biology and hydrology by maintaining natural flow patterns.

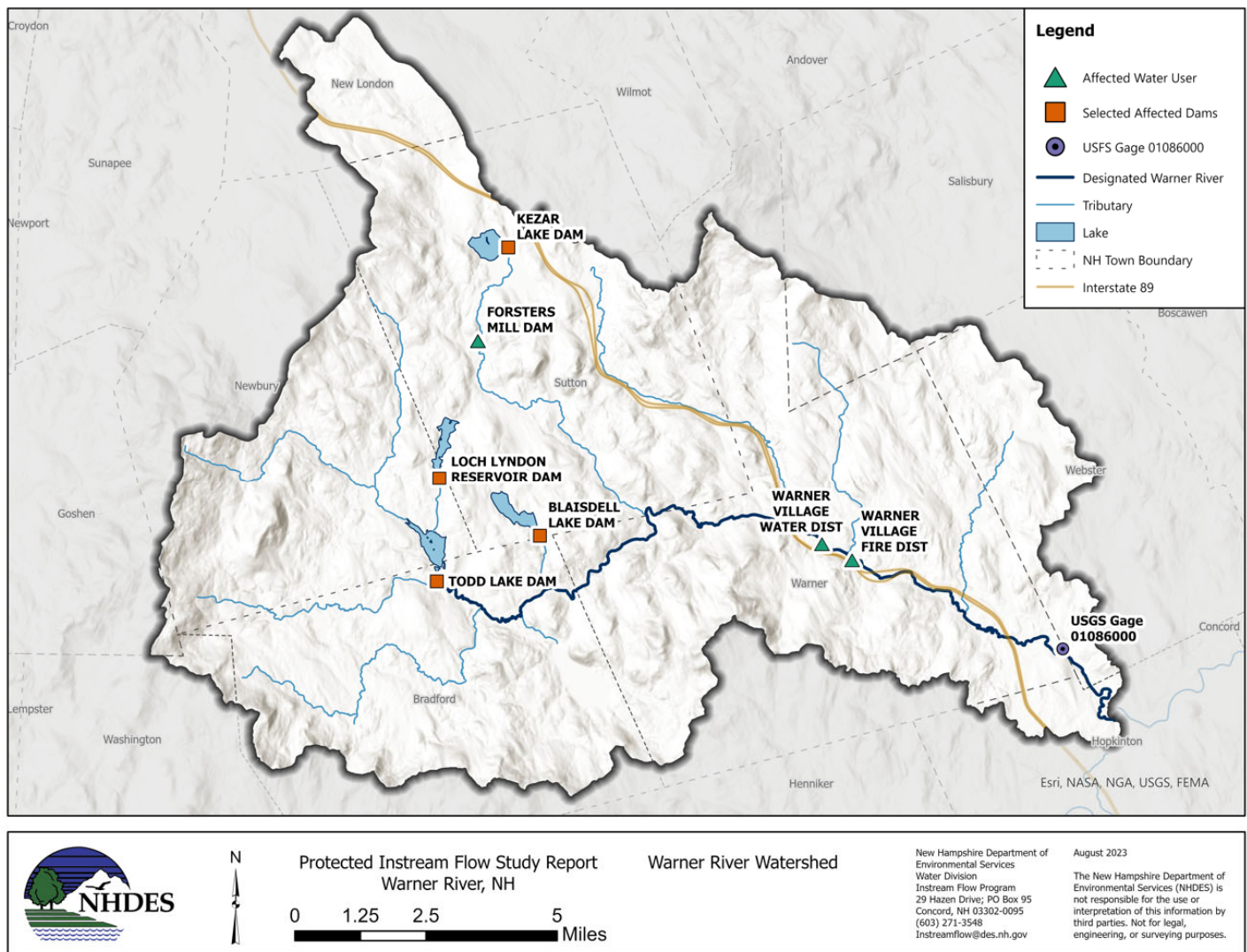


Figure 1 – Warner River Watershed

The scientific basis for these Warner River assessments was determined by the Instream Flow Pilot Program, which concluded in 2013. The methods used on the Warner River were developed during the Instream Flow Pilot Program and applied on the designated Lamprey and Souhegan rivers. These methods were closely scrutinized by experts in fisheries, statistics, riparian species, and modeling. Upon completion, NHDES documented the Pilot Program’s conclusions and recommendations describing the methods for future protected instream flow studies in the [Report of the Instream Flow Pilot Program](#).¹

The Warner River’s protected instream flow study applied the assessment methods to determine the protected instream flows for flow-dependent entities. These protected flows result from applying three assessment methods to flow-dependent, riverine entities: an incremental flow model for fish habitat; floodplain transect surveys at unique riparian ecosystems; and surveys and interviews of recreationalists combined with online research for recreational uses. The flow protections for the three areas of assessment were defined by describing components of stream flow in order to maintain the variability identified in the Natural Flow Paradigm.

¹ *The Report of the Instream Flow Pilot Program* (December 1, 2015) R-WD-15-1 is incorporated by reference.

A. The Natural Flow Paradigm

The foundation of New Hampshire's protected instream flow protection is the Natural Flow Paradigm. The Natural Flow Paradigm recognizes that the principal management objective is to allow streams to flow as close to the pattern of their natural flows as possible. The Natural Flow Paradigm is based on evidence that natural variability of flows is necessary to support the biological integrity of aquatic ecosystems. By framing protected instream flows within the Natural Flow Paradigm, flow-dependent entities are protected, yet unrealistic flows are not required because variability, including low flow, is allowed.

The Natural Flow Paradigm provides the necessary framework for describing protected instream flows that allow daily to seasonal variability. Stream flow variability requires using terms that recognize other stream flow parameters in addition to magnitude. The Warner River protected instream flow criteria were described in terms of timing, duration, and frequency, as well as magnitude. By describing stream flow in these terms, the complexity of natural stream flow pattern variability is preserved. The Warner River's protected instream flow assessments used these terms in their results.

B. Protected Instream Flow Assessments

The Warner River protected instream flow study used three assessment methods to determine the protected instream flow criteria that protect aquatic life, riparian wildlife and vegetation, and human recreational use. Each of the three entities was assessed using a different scientific assessment method, described below. The resulting protected instream flows based on these assessments for the Warner River are in Table 1.

The protected instream flow criteria were assessed using stream flow measurements collected at a USGS stream flow gage - [USGS 01086000 WARNER RIVER AT DAVISVILLE, NH](#). This gage is the stream flow index location for the designated Warner River. To determine the instream flow condition of the river, NHDES compares the daily stream flows from this gage to the protected instream flow criteria in Table 1. NHDES evaluates the flow conditions in a publicly-available tracking tool, which is available on the NHDES website at [Current Warner River Instream Flow Conditions](#).

NHDES determined a single set of protected instream flow criteria for the Warner River as a whole. In 2018, the Warner River was characterized to determine whether the river should be subdivided ([Warner River Target Fish Community Report](#) by Gomez and Sullivan, 2018.) The Warner River was characterized using a number of factors including stream order and watershed size, rock and soil types, fish collections, ecoregion, slope and stream gradient, and water chemistry. The assessment determined that dividing the river into smaller segments was not needed because there was no combination of factors that would result in a major shift in the fish community.

i. Fish Habitat Assessment Using an Incremental Flow Model

Protected instream flows for the river's key fish species were developed using a physical habitat simulation model (PHABSIM) shown in Table 1. PHABSIM is a well-known model, developed by the U.S. Fish and Wildlife Service, to estimate habitat availability as a function of flow. Protected instream flow criteria were calculated for Warner River fish species and life stages identified in the [Warner River Target Fish Community Report](#). Criteria were described using values of magnitude, duration, and frequency for each biologically-significant period of the year (bioperiod). Five bioperiods were identified based on the Warner River's hydrology and the needs of the target aquatic species and life stages.

The PHABSIM model was applied separately to each bioperiod to incorporate timing to the flow criteria. The model results were analyzed to identify three separate stream flow magnitudes for each of these bioperiods. The magnitudes from highest to lowest flow, are called Common, Critical and Rare. Flows are described at three

biologically-significant magnitudes so that flow thresholds of moderate, very low and critically low flows are defined for protection. Each magnitude represents a biologically important threshold of change in the flow/habitat relationship. Falling below these magnitudes represents increased levels of stress for fish and aquatic life. The protected magnitudes are described in cubic feet per second (cfs) and in cubic feet per second per square mile of watershed (cfs/m) in Table 1.

Durations of flows are key parts of the instream flow protection criteria. Stream flows below the protected flow magnitudes are both expected and necessary for habitat conditions for brief durations. There is an allowable duration below the protected magnitudes representing stress levels to which aquatic species are adapted. Extended durations below these magnitudes represent increased levels of stress beyond the historic range. Using frequency analysis, each flow magnitude in Table 1 was characterized to determine two durations representing excessive stress conditions. These durations identify when flow-dependent species are under chronic (Persistent) or acute (Catastrophic) levels of stress. Catastrophic conditions represent flow magnitudes and durations that do not meet the protected instream flow criteria.

Management is applied to avoid or recover from Catastrophic conditions representing excessive levels of stress. Note that a Catastrophic condition also occurs when repeated Persistent conditions happen. A Catastrophic condition occurs when three Persistent conditions occur uninterrupted in a bioperiod within three years. Note that more than one Persistent condition could happen within a bioperiod in one year.

The protected instream flow criteria for aquatic species describe a stream flow pattern by using terms of timing, magnitude, duration and frequency. The purpose of having three flow magnitudes with two sets of durations each applied to each bioperiod is to define stream flow conditions as a pattern with the flexibility to mimic the natural variability recommended by the Natural Flow Paradigm. Together, these criteria allow very low flow conditions to occur but for limited durations without being considered water quality standard impairments because they fall into the normal ranges of stress. NHDES will assess the daily stream flows against the timing, magnitude, duration and frequency criteria to determine the instream flow condition and the need for flow management.

ii. Floodplain Transect Method to Assess Riparian Species

The Floodplain Transect Method was used to assess flows that are necessary to inundate critical riparian habitats. Riparian plant communities rely on moderate and high stream flow conditions that wet the bank or floodplain to maintain their habitat. Bank inundations support critical life stages of plants and wildlife. This generally describes conditions of low to moderate flooding.

Species and communities that prefer more frequent inundation will occupy lower positions on the bankings. Higher flows occur less frequently than moderate flows. Species that prefer less frequent inundation or can tolerate higher flows may occupy positions higher on the bank. The biological objective is to maintain the species types and quantities similar to the distribution mapped during the protected flow studies. Maintaining the magnitude and duration of inundations will support the riparian species' flow needs.

Surveys were conducted to identify riverbank (riparian) plants and their communities and their elevations on the riverbanks and in floodplains. Because of the relationship between a stream's water level and its flow, the flows that will inundate these communities can be determined. Studies of species' life cycles were examined to determine the preferred frequency of the inundations, or the historical frequency of the flows required to inundate the plant community were identified.

Flow protections were identified by magnitude and frequency that maintain flow conditions that support the life cycles of plants found in these communities. These flows are prescribed for durations of at least one day. Higher

flows defined for riparian plant protection also support fish by rejuvenating the river structure and bottom conditions vital to the long-term sustainability of the fish community. NHDES will track the occurrences of these flow conditions to ensure the existing trends are continued.

iii. Surveys to Assess Recreation Flow Preferences

The needs of flow-dependent recreation were identified by performing surveys and interviews of recreationalists, and by conducting online research to identify usage preferences. To provide continued opportunities for boating, flows in the preferred range must be maintained at the expected timing, frequency and duration. The middle and higher range of river flows that support the riparian plants and wildlife also lend support to human recreational uses of a river. In the Warner River, surveys identified flow preferences for boating between 565 and 800 cfs. As a result, protected instream flow criteria for recreational use have not been made for the Warner River. NHDES will track the occurrences of these flow conditions to ensure the existing trends are continued.

3. The Protected Instream Flows Meet Water Quality Standards

As required by Env-Wq 1904.05(b)(3), this section describes how the established flows meet applicable water quality standards. The protected instream flows are required to meet applicable water quality standards. The Rivers Management and Protection Act gives priority to meeting these water quality standards over protection of all other river uses. The Warner River Protected Instream Flows were developed to maintain and protect water quality standards and the Clean Water Act's existing and designated uses related to stream flow.

Narrative standards related to stream flow are found in the Surface Water Quality Standards (Env-Wq 1703). Env-Wq 1703.01 describes water quality standards requiring:

- That all surface waters be restored to maintain the chemical, physical, and biological integrity of surface waters.
- That all surface waters provide for the protection and propagation of fish, shellfish and wildlife, and for recreation.
- That, barring naturally occurring conditions, surface water shall be maintained at levels that protect existing and designated uses.

In addition, Env-Wq 1703.19 defines biological integrity as requiring that all surface waters support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

The designated uses under the Clean Water Act and RSA 485-A applicable to instream flow include protection of recreation and aquatic life. Water quality is required to be sufficient to protect recreation and aquatic life. These flow-dependent designated uses are also required to be protected under RSA 483.

A strong correlation has not been identified between chemical water quality standards and stream flow. However, maintaining flows in their natural patterns of variability supports water quality parameters affected by flow. Physical and biological integrity are also met by developing these protected instream flows under the concepts of the Natural Flow Paradigm. These protected flows maintain the pattern of stream flows within ranges consistent with natural conditions to which aquatic species have adapted. Maintaining flow in their historical patterns supports aquatic and riparian species' life and reproduction needs. Recreational opportunities are consistently available within the natural variability of flows.

4. Assessment of the Effect of the Protected Instream Flow

An assessment of the effect of a protected instream flow upon existing hydroelectric power generation, water supply, flood control, and other riparian users is required by RSA 483:9-c, V and Env-Wq 1904.05. The establishment of protected flow criteria by itself has no impact on any of these uses until the criteria are applied to define management actions for the affected parties. Management actions will be developed and compiled in the upcoming Warner River Water Management Plan. The Water Management Plan is the next step following establishment of the protected instream flows.

Under a Water Management Plan, the protected instream flows apply to the designated Warner River, and also to certain water users and dams in the watershed. These water users and dams include water users who are required to be registered under RSA 488 (Affected Water Users), and dam owners in the watershed with impoundments greater than 10 acres (Affected Dam Owners).

Three sub-plans will make up the Warner River Water Management Plan. Water conservation plans and water use plans are components of a water management plan for affected water users. A dam management plan applies to each affected dam and to hydroelectric dams. NHDES also considers homeowners and lake users at impoundments with affected dams as having an interest in the water management plan. These sub-plans of the water management plan define the actions to be taken by affected users. There are currently two affected water users and nine affected dams in the watershed.

Water management plans are developed to maintain the established protected instream flow criteria. Until the water management plan is completed, a general description of likely impacts can be developed. The historical frequency of management events and the circumstances of the affected parties can be described. Detailed accounting of the effects on the affected parties will be described for public review and comment in the draft Warner River Water Management Plan.

A. Assessment of Historic Recurrence of Stream Flows Not Meeting the Protected Instream Flow Criteria

A general description of the frequency and duration historical stream flow conditions can be used to estimate management that may be applied to the water users, dams, and riparian users affected by the rules.

NHDES conducted an assessment by comparing the protected instream flows to many years of the historical daily stream flow data to identify the timing and magnitude of protected instream flow deficits. NHDES found Catastrophic conditions would have occurred for 2.0 percent of the days for the thirty years between 10/1/1992 and 9/30/2022. Stream flow was below the Rare magnitude for 479 days (4.4 %) of the 10,957 days during those thirty years. This number includes days before and after reaching a Catastrophic duration.

In the thirty years, there were 11 years when management events would have occurred under Catastrophic conditions. Five of these years, Catastrophic conditions lasted between one and six days. The longest Catastrophic conditions were in 2001 with 70 days over three events. There were a number of years when no Catastrophic conditions occurred.

B. Affected Parties and Water Management Plan Impacts

NHDES will coordinate with the water users and dam owners to identify the actions under their part of the Warner River Water Management Plan. A water management plan may not require management actions. Management actions under a water management plan balance the protected instream flows with the Affected

parties' water needs and their operational management capacity. These needs and operational capacities will be identified during the water management plan's development.

Management by Affected users is applied to maintain the protected instream flows. Catastrophic conditions represent flow magnitudes and durations that do not meet water quality standards. Management under the Warner River Water Management Plan will be applied when Catastrophic conditions occur and when stream flows fall below the Rare flow magnitude. NHDES will apply management actions generally when the stream flow condition is under the Critical or Rare flow magnitudes and of Catastrophic duration. Management is also applied during the low flow bioperiods when flow falls below the Rare magnitude. This precaution is applied to avoid the occurrence of a Rare Catastrophic condition when stream flows are particularly critical for supporting aquatic life.

An Affected Water User will have a Water Conservation Plan as their part of the Water Management Plan. They will also have a Water Use Plan which will explain how they will get the water they need and the actions they will take to maintain the protected instream flows. Affected Dams and hydropower dams will each have a Dam Management Plan describing their operations to maintain the protected instream flows. Dam Management Plans may apply a 48-hour relief pulse to restore the protected instream flow criteria. The size of these pulses is determined by the bioperiod-specific stream flow deficits between the protected instream flows and the daily stream flows. If a relief pulse requirement is applied to these impoundments, management of these pulses would affect the lakes' levels. Management is limited to less than two feet, but in practice, is measured in inches or less. When identifying dam management options, NHDES considers the balance between an impoundment's existing recreational uses, ecological needs and the impacts of management.

Management is tailored to flow and water use conditions. Water use management is applied more directly when the use has a significant impact on stream flow and less when it does not. Water use may be insignificant during some bioperiods or at Common flows and would not warrant management. Management may be revised if conditions change. The public will be afforded the opportunity to comment on the Water Management Plan before it is adopted.

C. Affected Parties in the Warner River Watershed

There is currently one active Affected Water User in the Warner River watershed that is withdrawing water. Warner Village Water District², a public water supply in Warner, is the only registered water withdrawal in the Warner River watershed. Warner Village Fire District³ is a wastewater treatment facility that discharges water and is operated by the Warner Village Water District. Warner Village Water District will develop a Water Conservation Plan and may have management actions under its Water Use Plan.

Warner Village Water District has two active wells adjacent to the Warner River. These wells are developed in sand and gravel to a depth of 38.66 feet with 32.5 feet of casing and are about 60 feet from the river. Pumping the wells likely induces recharge from the river and therefore would affect stream flow. However, its water use has historically been small relative to the Warner River flow. Much of the water is returned by way of the wastewater treatment facility located in Warner, located 0.98 river miles downstream of the wells.

The District's monthly withdrawals are reported quarterly to NHDES Drinking Water and Groundwater Bureau. NHDES evaluated the monthly withdrawals against the daily stream flows and found that Warner Village Water District's withdrawal is a very small proportion the river flow. Warner Village Water District's water

² Water user identification #20068.

³ Water user identification #20274

management plan is likely to rarely need application and be of limited extent such as taking conservation measures to reduce outside watering during extended droughts.

There are nine dams in the watershed that may be affected under the Water Management Plan because they impound greater than 10 acres of water. Of these, four dams in the headwaters of the designated Warner River are most likely to have actions under their Dam Management Plans. Actions are generally a two-day relief pulse applied when stream flows reach Catastrophic conditions. The remaining dams are less effective in providing flow to the designated river because of their location within the watershed.

Four of the nine affected dams are likely to have actions to support stream flow under the water management plan: Loch Lyndon, Todd Lake, Blaisdell Lake and Kezar Lake. These are recreational dams. The interests of lake front owners and lake users will be considered in the development of dam management plans. Dam management plans sometimes apply relief pulses for 48-hours after extended low flows in order to reset the protected instream flow pattern. A relief pulse applies a small amount of flow that mimics a small rainstorm. Water levels in these impoundments would be impacted if they are used for relief pulses. The size of a relief pulse, and the resulting water level change, depend on the flow deficit in the river. The Instream Flow Program takes steps to minimize lake level change from management actions by considering impacts on the impoundment's other purposes and its ecological health.

Forsters Mill Hydro Dam (Otter Lake Hydro, LLC) is a hydroelectric power generation facility in Sutton on the Lane River downstream of Kezar Lake. Water use reporting indicates this dam was inactive during 2022. Relief pulses from Kezar Lake, if adopted, may offer an opportunity for Otter Lake Hydro to generate power. Otter Lake Hydro will be required to pass any relief pulse flow from Kezar Lake.

Flood control is not likely to be affected by management. No other riparian users affected by the Water Management Plan have been identified.

5. Summary of Comments and Changes to the Report

Comments were solicited at the informational meeting and at the public hearing and via the email notifications. The NHDES online calendar also provided the details of the information meeting and public hearing. NHDES published the draft Protected Instream Flow Study Report - Warner River (R-WD-22-03) online and sent notifications by email on January 6, 2023. NHDES emailed these notifications to the entities listed in Env-Wq 1904.04 and to people in the NHDES notifications database. A second email notification specific to the public hearing was sent January 31, 2023.

The informational meeting was held January 24, 2023 from 7 to 9 pm both virtually and at the Warner Town Hall, 55 East Main Street, Warner, NH. NHDES and their consultant, Gomez and Sullivan Engineers, presented the report, described the processes used to determine the protected flows and answered questions at the informational meeting. A public hearing was held February 23, 2023 from 7:00 pm to 8:30 pm at the Warner Town Hall, 55 East Main Street, Warner, NH. NHDES and their consultant, Gomez and Sullivan Engineers, were in attendance to receive comments. Some technical questions focused on clarifications were asked and answered.

The 30-day comment period following the public hearing ended at 4:00 pm on March 24, 2023. Fourteen comments were received during the comment period. The final Warner Report was largely unchanged from the draft report presented at the informational meeting. The comments and a summary of the comments with NHDES' response were added to the report as Appendix I. A synopsis of the comments and NHDES responses is below.

Many of the comments received were interested in the effects of the Water Management Plan. These concerns will be addressed as part of the Water Management Plan development and approvals. Comments about identifying dams and water users and documenting their operations are part of the Water Management Plan and were not addressed in the report. Concerns were raised that lowering of lake levels during dam management actions of the water management plan may affect algal blooms or cyanobacteria on the lake. These are also part of the Water Management Plan and were not addressed in the report.

Concerns were raised that dam management actions might cause flooding. NHDES explained in the comment responses that dam management actions are not at a flow that would cause flooding. A staff gage was installed on a pond to demonstrate water level changes that can be compared with the stream flow record. These are also part of the Water Management Plan and were not addressed in the report.

Several comments requested clarifications or edits. NHDES addressed these issues in the report.

Comments were received concerned with the inclusion of Atlantic Salmon and other anadromous species as part of the assessment of the river's flow needs stating that these species cannot pass dams on the Contoocook River. NHDES acknowledge that these species are not able to access the river because of the dams. However, it is very likely that salmon were in the river, so the flows that would support them are appropriate. Of importance to note is that, while salmon may not be present today, other biota associated with salmon habitat are present and evolved to the same conditions that favor salmon. In this way, salmon is a proxy for the all the aspects of the habitat that are impacted by the same flow regime. NHDES based this on the 2018 Target Fish Community Report that looked at similar rivers and found they had salmon, and on the opinions of NH Fish and Game and US Fish and Wildlife Service fisheries experts, and on the presence of suitable spawning substrate and temperatures in the river. NHDES retained Atlantic salmon and the protected flows for the fall bioperiod based on salmon.

A comment asked about recreational surveys stating that more people use the river for boating that the report indicates. The report addressed preferences where limited people were found using the river by researching online paddling information.

A comment pointed out that NHDES provided online access to the information meeting, but not to the public hearing despite a winter snowstorm earlier that day. While an online option is not required, NHDES believes that access for the information meeting was critical to public understanding of the study, and that the public hearing process including the 30-day comment period allowed people to raise their questions and comments.

One comment from a lake association stated they support NHDES' efforts to improve water conditions in the Warner River watershed and look forward to working with NHDES to balance the water needs of the Warner River watershed and its human and aquatic communities.

REFERENCES

Gomez and Sullivan. 2018. [Warner River Target Fish Community Report](#).

NH Department of Environmental Services (December 1, 2015) [Report of the Instream Flow Pilot Program \(December 1, 2015\)](#).

NH Department of Environmental Services (June 2023) [Protected Instream Flow Study Report - Warner River](#) (R-WD-21-09).

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

Table 1: Protected Instream Flows for the Warner River⁴

Date Range	Common Flow (cfs)	Common Flow (cfsm)	Common Allowable Duration (days)	Common Persistent Duration (days)	Common Catastrophic Duration (days)	Critical Flow (cfs)	Critical Flow (cfsm)	Critical Allowable Duration (days)	Critical Persistent Duration (days)	Critical Catastrophic Duration (days)	Rare Flow (cfs)	Rare Flow (cfsm)	Rare Allowable Duration (days)	Rare Persistent Duration (days)	Rare Catastrophic Duration (days)
Dec 1 – Feb 28/29	317	2.17	0 -45	46 -76	77+	80	0.55	0 -22	23 -39	40+	39	0.27	0 -10	11 -15	16+
March 1 – April 30	1,062	7.27	0 -26	27 -43	44+	148	1.01	0 -13	14 -26	27+	109	0.75	0 -7	8 -10	11+
May 1 – June 30	244	1.67	0 -15	16 -36	37+	44	0.30	0 -7	8 -10	11+	31	0.21	0 -4	5	6+
July 1 – Sept 30	76	0.52	0 -30	31 -70	71+	11	0.08	0 -14	15 -23	24+	6	0.04	0 -8	9 -14	15+
Oct 1 – Nov 30	106	0.73	0 -20	21 -38	39+	29	0.20	0 -11	12 -21	22+	23	0.16	0 -8	9 -14	15+

Key:

Green shaded columns mean Common.

Yellow shaded columns mean Critical.

Peach shaded columns mean Rare.

Retain Flood Frequencies:

- Inter-annual flow events of at least 400 cfs multiple times per year for emergent and riverine wetlands.
- Annual flood frequency of at least 1,160 cfs for shrub scrub and seasonally/semi-permanently flooded floodplain forests.
- 2-year flood frequency of at least 2,225 cfs for higher elevation floodplain forests.

Optimum Recreational Boating Flows (Spring and Fall): Provide flow events of 565 cfs to 800 cfs.

⁴ Note: Flows provided are indexed to the USGS gage at Davisville, NH (USGS Gage No. 01086000), drainage area of 146 mi²

Instream Protected Flows for the designated Warner River as described in RSA 483:15, XIX.
Table 1 - Attachment - Definitions
Bioperiod - biologically-significant periods - time segments within a year having biological significance for survival or propagation of one or more aquatic species or life stages.
cfs - cubic feet per second - a measure of flow - one cubic foot is 7.48 gallons. One cfs is equivalent to ~459 gallons per minute.
cfs/m - cubic feet per second per square mile of watershed. CFSM may be derived from a stream flow gage with known stream flow and known watershed drainage area. The cfs/m at a stream flow gage may be used to determine stream flow in cfs at an ungaged location by multiplying the gage's cfs/m value by the drainage area of the ungaged location.
PISF - Protected Instream Flows - stream flow protection criteria that are described for each bioperiod with Common, Critical and Rare flow magnitudes, each of which has an Allowable and a Critical duration.
Flow levels, flow durations, flow condition, and relief flow definitions
Flow magnitudes - Common, Critical and Rare flow magnitudes - assigned to a bioperiod and have an associated Allowable and Catastrophic durations.
Common Flow - the flow corresponding to the highest habitat magnitude above which the frequency of occurrence begins to decline significantly. Common flow magnitudes represent near optimal habitat availability conditions for species dependent on flow.
Critical Flow - the flow corresponding to the second to the lowest habitat magnitude for which the frequency of occurrence increases significantly with incremental increase in habitat magnitude. Critical flow magnitudes describe less habitat availability than that provided by the Common flow and more than Rare flow. This habitat magnitude is not unusual.
Rare Flow - the flow corresponding to the lowest of habitat magnitudes for which the frequency of occurrence increases significantly with incremental increase in habitat magnitude. Habitat availability is severely reduced for species dependent on flow. Flows below this magnitude are uncommon.
Durations – Allowable, Persistent or Catastrophic - limits on the number of consecutive days when flow is below a protected flow magnitude. Count of durations are reset at the beginning of each new bioperiod and when the flow magnitude is exceeded for two days.
Allowable - duration occurring in an average year. Flow below protected flow levels may often continue for this duration.
Persistent - duration exceeding the allowable, but not the Catastrophic duration and representing a chronic level of stress.
Catastrophic - duration occurring once in ten years. Flows below protected levels for catastrophic durations initiate management activities pursuant to a Water Management Plan.
Conditions - the result of stream flow relative to protected flow magnitude and duration.
Persistent condition - when stream flow is below a Critical or Rare protected instream flow magnitude for more than the Allowable duration, but less than the Catastrophic duration. Three repeated Persistent conditions become a Catastrophic condition usually resulting in a relief pulse pursuant to a Water Management Plan. Persistent conditions are rescinded after stream flow levels rise above the protected flow magnitude for two days as a result of increased flow from natural conditions or a relief pulse.

Catastrophic condition - when stream flow is below a **Critical** or **Rare** protected instream flow magnitude for longer than the catastrophic duration; or if a **Persistent** condition occurs repeatedly. Repeated **Persistent** conditions become a Catastrophic condition if **Persistent** conditions occur during the same **bioperiod** for three consecutive years, or if three **Persistent** events occur during the same **bioperiod** three times in one year. A Catastrophic condition usually initiates a **relief pulse** as a management activity pursuant to a Water Management Plan. Catastrophic conditions are rescinded after stream flow levels rise above the protected flow magnitude for two days as a result of increased flow from natural conditions or a relief pulse.

Relief pulse - an artificial release of water from one or more dams that may provide relief from **Catastrophic** conditions. A relief pulse is a release of water for a duration of two days designed to raise flows above the protected flow magnitude. Relief pulses reset the duration count of days below the protected flow magnitude to zero.