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PHASE I PRELIMINARY REPORT

INFORMATION AVAILABLE RELATED TO EFFECTS OF THERMAL DISCHARGE AT MERRIMACK STATION ON ANADROMOUS AND INDIGENOUS FISH OF THE MERRIMACK RIVER

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Public Service Company of New Hampshire

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EXECUTIVE SUMMARY

This report was prepared as part of Public Service Company of New Hampshire's (PSNH's) initial response relative to six issues concerning thermal discharge effects on anadromous and resident fish that were raised in the NPDES Permit for Merrimack Station. The report summarizes presently available information relative to the six issues and, where appropriate, provides analyses relevant to resolution of the issues. The report is intended primarily to serve as a working document supporting consultation among participants in the Merrimack Station Technical Advisory Committee (TAC), which comprises representatives from the U.S. Environmental Protection Agency (EPA), New Hampshire Department of Environmental Services (NHDES), New Hampshire Fish and Game Department (NHFGD), U.S. Fish and Wildlife Service (USFWS) and PSNH.

The review of available information concentrates on seven anadromous and resident "target" species that were selected in consultation with the TAC. The target species, American shad, alewife, Atlantic salmon, smallmouth bass, largemouth bass, pumpkinseed and yellow perch, are considered representative of the present and future fish community of the Hooksett Pool of the Merrimack River, which is the segment of river affected by the discharge of heated water from the cooling system at Merrimack Station. The major sources of information used for preparation of this report included reports from monitoring studies conducted at Merrimack Station by Normandeau Associates, Inc. and the NHFGD from 1967 through 1978, scientific and technical literature, and unpublished data available from PSNH and other utilities.

A summary of information on the temperature requirements and thermal tolerances of the target species was prepared to support discussions relative to several of the issues. The available information indicates that maximum summer ambient temperatures fall within the range of summer preferred temperatures for adults of all target species except Atlantic salmon. Maximum summer ambient temperatures may approach lethal levels for adult salmon if they are present. Juvenile life stages of the target species generally appear to have higher temperature preferences and tolerances than adults. The upper thermal tolerance limits of American shad, alewife and yellow perch are similar (in the low 30°C range). Smallmouth bass, largemouth bass and pumpkinseed are increasingly more tolerant of higher temperatures (upper incipient lethal temperatures for these species range from around 35°C for smallmouth bass to the upper 30°C range for pumpkinseed). Both adults and juveniles of the target species respond to temperature gradients and seek areas of preferred temperature.

Anadromous fish migrations are controlled by water temperatures, which largely determine the specific time of the year at which migrations will occur. In the Merrimack River, operation of fish passage facilities may modify the adult upstream migration period because fish will not be able to move upstream until passage facilities begin operating. Presently there are no fish passage facilities at Hooksett dam and upstream migrating alewives are able to enter the Hooksett Pool only when spill conditions are favorable.

Salmon and shad have not yet reached the Amoskeag dam in appreciable numbers and probably will not have access to the Hooksett Pool for at least a decade.

Adult alewives migrate upstream in early spring, followed by shad and salmon. Alewife and shad migrations are substantially complete by early and late June, respectively. Peak salmon migration occurs from May through July but fish may enter the river through October. Adult shad and alewife migrate downstream in June and July, shortly after spawning. Salmon remain in the river until spawning is completed in October and November and either migrate downstream immediately or overwinter and migrate downstream in early spring. Young shad and alewife migrate from the river during September and October. Salmon smolts migrate downstream from mid-April through mid-June.

Studies of upstream migrating adult shad and downstream migrating juvenile shad and salmon indicate that their migrations are not impeded by thermal plumes if an opportunity to pass under or around the plume exists. Prolonged periods of ambient temperatures outside the range in which migration normally occurs will, however, inhibit migration by most anadromous fish.

The configuration of the thermal plume is important in determining whether anadromous fish migrations may be affected by the Merrimack Station thermal discharge. Thermal plume monitoring data were reviewed and the data for two dates considered representative of low flow conditions, high ambient temperatures and high station thermal output were selected for analysis. The analysis established that there is a substantial area of water temperatures within 1-2°C of ambient in those portions of the river cross section that are more than 1-1.5 m below the surface. With the exception of the discharge transect, this region of near-ambient temperatures comprises approximately 45% or more of the river cross sectional area downstream from the discharge. At the discharge transect the near-ambient region comprises about one third of the cross sectional area. This region of near-ambient temperatures is present at flows that are exceeded at least 80% of the time during any anadromous fish migration season, thus constituting a "zone of passage" for migrating fish.

During the summer low flow period surface temperatures in some parts of the thermal plume may exceed the acute thermal preference of most resident target species. Since there is an area of near-ambient temperatures extending from a depth of a meter or so below the surface to the bottom, resident fish are expected to avoid the warmest areas of the plume and seek out nearby areas of preferred temperatures.

Because adults and juveniles of the target species can readily avoid areas that are too warm, and because eggs of the target species are likely to remain in a fixed location or tend to remain near the bottom, it was determined that the surface-oriented larvae of yellow perch and American shad were likely to be most vulnerable to elevated temperatures associated with the thermal plume. Laboratory studies of yellow perch indicate that prolonged exposure to maximum discharge temperatures likely to occur when larval yellow perch are present in the Hooksett Pool overlap the reported range of upper incipient lethal temperatures for juvenile perch. Temperature restrictions based on such studies may be overly conservative because they do not simulate the transitory exposure to maximum plume temperatures that would occur in the

river. Both in situ and laboratory studies of larval shad temperature tolerances were conducted at Merrimack Station in 1975-1976. Laboratory studies that simulated passage through the thermal plume established that decreased survival of temperature on shad larvae could be observed at temperatures above 33.3°C. There was insufficient information available to draw any conclusions as to the magnitude of ΔT's that might affect larval perch survival. Larval shad were found to tolerate ΔT's of 11.1°C or greater to maximum temperatures above 34°C.

Fisheries field sampling data for the period from 1967 through 1978 indicated a decreasing trend in yellow perch abundance. The initial decreases in abundance occurred sooner than would have been expected if they were due to the startup of Unit II, thus they may have been an artifact of natural variability in population size. Available thermal tolerance information in conjunction with the abundance data does suggest that further study of larval perch temperature tolerances, larval distribution and/or population structure should be conducted.

Restrictions on maximum discharge temperatures and ΔT's at the point of discharge may be necessary in the future to protect larval shad. Presently, however, only a few, or no, adult shad spawn in the Hooksett Pool in any given year. Until shad reach Hooksett Pool in appreciable numbers, discharge temperature restrictions designed to protect shad are unnecessary. Studies of temperature effects on later shad larval stages may be necessary because there is evidence that older test specimens in the original studies conducted at Merrimack Station were affected by starvation and thus may have been more susceptible to thermal stress than "wild" larvae would be.

Sudden winter shutdowns of the cooling system at Merrimack Station are a concern because resident fish attracted to the warm temperatures of the thermal plume may suffer cold shock. Attraction to thermal plumes when ambient temperatures are below preferred temperatures was noted for largemouth and smallmouth bass, yellow perch and pumpkinseed. Telemetry studies indicated that perch are not subject to entrapment in thermal plumes and readily move between near 0°C, ambient temperatures and areas of thermal plumes at 10°C or more above ambient. Laboratory studies of smallmouth bass provided a basis for defining conditions that could potentially result in cold shock for bass. A review of plant operating data indicated that such conditions occur several times each winter and that there have been no reported incidents of related fish kills or fish in distress in the discharge canal. The likely explanation for the discrepancy between laboratory studies and the actual situation is that fish do not seek out the warmest areas of the plume and are able to adjust to the temperature change because the canal typically cools at a rate of less than 1.4°C per hour. On this basis it appears that winter temperature restrictions are unwarranted.

The discharge canal may be attractive to various of the target species at different times of the year. The portion of the Hooksett pool fish population that is present in the canal may be of concern if it represents a substantial portion of the total population and if it is also vulnerable to changes in the thermal environment that are likely to occur as a result of station operation. The data available to assess this issue were limited. Relative abundance data

for the summer period of 1972-1976 did indicate that relative abundances of pumpkinseed and bass in the old canal were high relative to their mean abundances in the Hooksett Pool. Temperatures at the time of sampling, however, were generally within or below the preferred temperature ranges of those species. The results indicate that, as expected, resident target species were preferentially occupying an area of favorable temperatures when collected from the old canal. The lack of reported incidents of fish kills or distressed fish that could be related to high temperatures in the canal indicates that as temperatures increase to unfavorable levels, fish leave the canal. There were no data available to support an analysis of relative abundances of target species for the winter months. The need for a population assessment for the winter months is, however, questionable because the assessment of chill events indicates that fish present in the canal during winter are not adversely affected by station outages.

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