AR-1554

Response to EPA's "Statement of Substantial New Questions for Public Comment"

Lawrence W. Barnthouse, Ph. D.
LWB Environmental Services, Inc.
1620 New London Rd.
Hamilton, OH 45013

Prepared for
Public Service Co. of New Hampshire
Merrimack Station
Bow, NH

December 2017

LWB
Environmental Services, Inc.

Introduction

On Page 40 of its Statement of Substantial New Questions for Public Comment ("Statement") regarding the Merrimack Station draft NPDES permit, EPA included the following request:

EPA invites additional public comment addressing the above-discussed issues and materials relevant both to EPA's decision on PSNH's CWA § 316(a) variance application and to EPA's application of New Hampshire's water quality standards with regard to thermal effects. In particular, EPA invites public comment on:

- *The import of PSNH's new data submissions for EPA's application of CWA § 316(a) and New Hampshire's water quality standards in developing thermal discharge standards for the Merrimack Station permit;*
- *The question of how shorter-term and longer-term thermal data should be factored into the evaluation under CWA § 316(a) and New Hampshire's water quality standards of the effects of Merrimack Station's thermal discharge limits for the Merrimack Station permit.*

This document responds to EPA's request for comments on these topics, based on the new information provided by PSNH to EPA.

PSNH's submissions demonstrate that EPA's analysis of thermal exposures and thermal tolerance values in its § 316 Determination were incorrect.

As pointed out in PSNH's submissions and acknowledged by EPA, the agency misinterpreted temperature data provided in Appendix A to the thermal modeling report prepared by Normandeau Associates (2007a). For each date between April 1 and October 31, this appendix provides a minimum, mean, and maximum value for each of four thermal monitoring stations in the Merrimack River over the period 1984-2004. EPA interpreted the maximum values as the average maximum temperatures reached on each date during 1984-2004. Under this interpretation, the maximum values in Appendix A would represent the average maximum temperature reached on each date for every year in the 21-year time series. In fact, the temperatures listed in Appendix A of Normandeau (2007a) are 24-hour average values. The minimum values are the lowest 24-average temperatures measured over the time series, the mean values are the mean 24-hour average temperatures over the time series, and the maximum values are the highest 24-hour average temperatures over the time series. The maximum temperature listed for each date, which was interpreted by EPA as occurring every year during 1984-2004, actually occurred during only one of the 21 years of the time series. By misinterpreting the thermal data in Appendix A of Normandeau (2007a), EPA greatly overstated the actual temperatures to which fish would have been exposed during those years.

In response to a §308 request from EPA, Enercon and Normandeau (2016) compiled data on the average minimum, mean, and maximum temperatures on each date from April 1 through October 31 for the years 2002-2015[1]. The average maximum temperatures provided in Enercon and Normandeau (2016) are all substantially lower than the values from Appendix A of Normandeau (2007a). Whereas EPA concluded based on its erroneous interpretation of Normandeau (2007a) that the average maximum temperatures at stations affected by the thermal discharge regularly exceeded thermal tolerance criteria for alewife, American shad, yellow perch, and white sucker, the data submitted in response to the §308 request show that most of the thermal tolerance limits used in EPA's analysis were never exceeded on dates at which the species and life stages in question are present in the river (Barnthouse 2016a). In those few cases in which EPA's criteria were exceeded, the number of dates on which they were exceeded, and the durations of the period when any exceedances occurred, were much smaller than was asserted by EPA and do not support a finding of appreciable harm.

PSNH's submissions (Barnthouse 2016a) also demonstrate that the thermal tolerance limits EPA used to establish water-quality based thermal standards were in many cases incorrect or inappropriately applied. Limits that are not supported by the literature cited by EPA include the winter limit for yellow perch maturity (8°C), yellow perch egg development (18°C), long-term exposure for yellow perch larvae (21.3°C), and long-term exposure for yellow perch juveniles and adults (25.1°C). Limits that were inappropriately applied include the short-term limit for yellow perch larvae, the short-term limit for yellow perch juveniles and adults, and both the short-term and long-term limits for American shad larvae and juveniles. Each of these issues were discussed at length in Barnthouse (2016a).

Further analyses of shorter term and longer-term exposure temperatures are unnecessary

On page 39 of its Statement, EPA provides its rationale for considering temperatures reached on only a single day out of a 21-year time series as being relevant to the permit:

[1] These years were selected because digitized temperature data were unavailable for the years 1984-2001.

> “While considering long-term averages has utility for evaluating thermal discharge impacts, looking *only* at long-term averages would obscure more extreme conditions that fish and other aquatic life might be exposed to over shorter, but still biologically significant periods of time. For example, such shorter, but impactful periods could occur during the summer when the plant is in full operation during low river flow and high ambient temperature conditions. Such temperature and flow extremes would be masked by only considering the data averaged over the full 21-year period. Consequently, in response to PSNH’s clarification of the data it had submitted, EPA is now also reevaluating the effects of shorter-term thermal conditions, particularly on species that may be especially sensitive to such temperature excursions in relation to their ability to survive and compete with more thermally-tolerant species.”

There are four reasons why EPA’s proposed reevaluation will not provide useful information relevant to a permitting decision.

<u>Acute lethality is the only endpoint that is relevant to exposure periods as short as a single day, and laboratory-derived lethal temperatures may not be relevant to field conditions</u>

EPA’s proposed reevaluation is based on the highest 24-hour average temperature observed on each date from April through October over the 21-years of data provided in Appendix A to Normandeau (2007a). For an exposure duration of only 24 hours, the chronic thermal tolerance data relied on in most of EPA’s thermal effects analyses are not relevant. Only data on acute lethality related to short-term exposures would be relevant to such an evaluation. Upper Incipient Lethal Temperature (UILT) values have historically been the most common measures of acute thermal effects in fish (EPRI 2011). UILT values for the species addressed in EPA’s §316 Determination are provided in Appendix C of Normandeau (2007b). None of the other values provided in Appendix C or other sources utilized by EPA would be relevant to an analysis of short-term exposures. Even the UILT values are of questionable relevance, for two reasons. First, the exposure durations in thermal mortality experiments are typically 4-7 days (EPRI 2011) and most likely understate temperatures that could be tolerated for a period of only 24 hours. Second, the values themselves are strongly influenced by experimental conditions, especially acclimation temperature. EPRI (2011) found that UILT estimates for the same species can vary by 10°C or more depending on acclimation temperature. Evaluating the potential exceedance of these highly uncertain UILT values during rare, high-temperature events would not provide credible evidence for appreciable harm.

Fish can detect and avoid regions with potentially harmful temperatures

Except in the case of eggs and larvae, fish can detect and avoid regions where temperatures are elevated to potentially harmful levels. EPRI (2011) stated that: "It is important to note that none of the laboratory methods accurately reproduces what happens in the field where fish are exposed to spatially and temporally varying thermal fields and have the ability to select specific locations." Moreover, Hokanson (1977) stated that "fish kills from heat are rare in nature and generally occur only when escapement is blocked or when the coolest water available to fish exceeds the lethal temperature or is deficient in oxygen." These are not the conditions present in the vicinity of the Merrimack Station discharge. As shown in Figures 3-5 of Enercon (2016) the station's thermal plume is confined to the right (when facing downstream) bank of the river, leaving ample habitat available for fish to escape regions with elevated temperatures.

Appendix C of Normandeau (2007b) provides avoidance temperatures for all of the species addressed in EPA's §316 Determination. In all relevant cases the listed avoidance temperatures are equal to or lower than the corresponding UILTs[2]. During the rare events that EPA has proposed to evaluate, fish would simply avoid the affected water until the temperature declined to a more suitable level.

Only a small fraction of the fish present in the Hooksett Pool are exposed to the thermal plume from Merrimack Station

Enercon (2016) performed an analysis of the behavior of Merrimack Station's thermal plume over three representative seasonal periods: early spring, when river flows are high and ambient river temperatures are relatively low; late spring, when ambient river temperatures are rising and flows are falling, and mid-summer, when ambient river temperatures are high and flows are low. Barnthouse (2016b) evaluated the impacts of these three plume scenarios on the fish species present in Hooksett Pool. The mid-summer period is the most relevant for addressing EPA's contention that "…shorter, but impactful periods could occur during the summer when the plant

[2] No avoidance temperature was listed for Atlantic salmon, however, this species is not relevant to the permit because Atlantic salmon are not currently being stocked in the Merrimack River.

is in full operation during low river flow and high ambient temperature conditions." Enercon's calculations were made based on average ambient river conditions and plant operational parameters for the years 2006-2015. The analysis for the mid-summer period was performed using average ambient conditions and plant operations over the week of July 29-August 4.

Enercon (2016) calculated the percent of the river area and volume between the mouth of the discharge canal (Station S0) and Hooksett Dam within which the plume temperature would exceed 80°F, 83°F, and 87°F. The two lower temperatures, 80°F and 83° would not have exceeded the UILT of any of the relevant species listed in Appendix C of Normandeau (2007b). The highest temperature, 87°F, exceeds the listed UILT for yellow perch, however at this temperature the plume includes only 0.02% of the area and 0.01% of the volume of the river between the discharge canal and Hooksett Dam. Since 87° F is within the range of avoidance temperatures listed for this species (79° F - 88°F), any yellow perch encountering this plume temperature would be expected simply to avoid it.

<u>There is no evidence that "thermally sensitive" species have been or are being replaced by more thermally tolerant species</u>

EPA justified its proposed evaluation of short-term high-temperature exposures in part by speculating that such exposures might impair the ability of temperature-sensitive species to survive and compete with more thermally tolerant species. However, as discussed below, intensive biological study spanning 40+ years of the fish communities present in the Hooksett, Garvins, and Amoseag pools of the Merrimack River show that there is no evidence that species with low thermal tolerances have been replaced by species with higher thermal tolerances.

Site-specific fish community data show no evidence of appreciable harm to the fish community in Hooksett Pool

PSNH's earlier submissions (Barnthouse 2016a), as supplemented by more recent data (Barnthouse 2017) show that historical data do not support a finding of appreciable harm to the fish community in Hooksett Pool.

<u>Changes in the fish community since the 1960s are consistent with expected effects of pollution control, not the thermal discharge from Merrimack Station</u>

As discussed by Barnthouse (2016a), historical data show that during the 1960s the section of the Merrimack River that includes Hooksett Pool was adversely affected by water pollution. USDI's (1966) report on pollution of the Merrimack River identified 11 untreated waste discharges to the Merrimack River and tributaries upriver from Manchester, NH. These included municipal sewage discharges from Concord, Pembroke, Allentown, and Hooksett (USDI, Table 3). Minimum dissolved oxygen levels measured at all stations between Concord and Manchester were below 5 PPM, the limit established by EPA for protection of aquatic life (USDI 1966, Figure 19). Data summarized in Normandeau's report on "Historic water quality and selected biological conditions of the upper Merrimack River, New Hampshire" (Normandeau 2011) indicate that nitrate and phosphate concentrations in the vicinity of Merrimack Station declined by 90% between 1967 and 1972. All of the untreated discharges identified in the USDI (1966) report ceased by 1972. The resulting improvements in water quality would have been expected to lead to biological changes in the Merrimack River, including replacement of highly pollution-tolerant species by species with lower pollution tolerance. An increase in the number of species present in the community would be expected (Rapport et al. 1985).

Three of the species that EPA claimed in its §316 Determination have declined in abundance, i.e., white sucker, brown bullhead, and yellow bullhead, are identified by EPA (1999) as being pollution-tolerant. Moreover, the number of species collected in the Hooksett Pool has increased from 16 during the 1960s to 29 in recent years (Normandeau 2017a).

<u>Merrimack Station's thermal plume occupies only a small fraction of the available habitat below the discharge and affects only a small number of fish species.</u>

Enercon (2016) used the CORMIX thermal plume model to calculate average plume characteristics over the period 2006-2015 for three representative time periods: early spring (May 2 – May 8), late spring (June 9 – June 15), and mid-summer (July 29-August 4). Barnthouse (2016b) used the results of the CORMIX modeling to estimate the area and volume of Hooksett Pool within which various species would be excluded because of elevated temperatures. In none of the cases examined would the thermal plume from Merrimack Station affect more than a negligible fraction of the fish habitat present downriver from the cooling water discharge. On average, 0.48% of the surface area and 0.19% of the habitat volume present between Station S0 and Hooksett Dam would be affected during the early spring period. For the late spring period, at most 0.27% of the surface area and 0.09% of the habitat volume present between Station S0 and Hooksett Dam would be affected. For the mid-summer period, at most 3.47% of the area and 0.88% of the volume present between Station S0 and Hooksett Dam would be affected. Given the small proportion of the available habitat within the pool that is influenced by the thermal plume, measurable impacts on the fish community would not be expected and, as discussed below, none have been found.

<u>Coolwater fish species have not been replaced by warmwater species</u>

EPA asserted in its §316 Determination that "coolwater" species in the Hooksett Pool were replaced by more thermally tolerant "warmwater" species after startup of Merrimack Station. However, as noted both by Kendall (1978) and EPRI (2011) classification of species as "coolwater" or "warmwater" is based primarily on geographic ranges, not on thermal tolerance data. As noted by Barnthouse (2016a), all of the species discussed in the §316 Determination are widely distributed throughout eastern North America, from Canada to the U.S. mid-Atlantic or even Gulf Coast states. Each species inhabits a wide variety of thermal regimes and possesses a wide range of thermal tolerances. Of the species that EPA asserted had declined since the 1970s, only chain pickerel, yellow perch, and white sucker have been classified as "coolwater" species. Yellow bullhead has been classified as a "warmwater" species, and brown bullhead and pumpkinseed have been classified as both "coolwater" and "warmwater" by different authorities.

Barnthouse (2017) used data compiled by Normandeau (2017b) to show that Garvins, Hooksett, and Amoskeag Pools all support a mix of "warmwater" and "coolwater" species. Comparing these three pools across the four years 2010-2013, the percent of all fish collected that were classified as "coolwater" was actually higher in thermally-influenced Hooksett Pool than in the upstream Garvins Pool for 3 of the 4 years (Barnthouse 2017, Table 5).

Hence, to the extent that there is any meaningful distinction between "coolwater" and "warmwater" fish species, the available data provide no evidence that the thermal discharge from Merrimack Station has caused "coolwater" species in Hooksett Pool to be replaced by "warmwater" species.

<u>Population and community characteristics in Hooksett Pool are intermediate between Garvins and Amoskeag Pools, as predicted by established ecological principles</u>

For more than 100 years, it has been known that natural upstream-downstream gradients in physical and biological conditions lead to upstream-downstream gradients in fish community structure (Shelford 1911, Vannote et al. 1980). According to these ecological principles, the fish communities in Garvins, Hooksett, and Amoskeag pools should be different, but should differ in ways that are consistent with the expected upstream to downstream gradient in environmental conditions. Specifically, Garvins and Amoskeag Pools should be less similar to each other than either is to Hooksett Pool.

Barnthouse (2017) used data collected by Normandeau (2017b) to show that the fish communities in these 3 pools fit the expected pattern. Data on the relative abundance of species, trends in catch-per-unit-effort (CPUE), quantitative indices of fish community composition, and biocharacteristics of important species consistently show that the fish community in Hooksett Pool is intermediate between the communities present in Garvins and Amoskeag Pools and shows no anomalous characteristics that would indicate an adverse impact of Merrimack Station's thermal discharge.

Conclusion

Available data, documented both in PSNH's previous submissions and in more recent supplemental analyses (Normandeau 2017b, Barnthouse 2017), demonstrate that Merrimack Station's thermal discharge has not caused any measurable impairment of the fish community present in the Hooksett Pool of the Merrimack River. These data are derived from multiple, rigorous fish community studies conducted over 40 years of operation of Merrimack Station. Analyses of these data clearly demonstrate that the Station's thermal discharge satisfies both the "no appreciable harm" standard in EPA's §316(a) rule and the narrative thermal discharge standard specified in New Hampshire water quality regulations (discussed in Section 8.2 of EPA's §316 Determination). No further analyses of rare, short-term, high temperature discharge events would change this conclusion.

References

Barnthouse, L. W. 2016a. Review of technical documents related to NPDES permitting determinations for the thermal discharge and cooling water intake structures at Merrimack Station. Prepared for Public Service Co. of New Hampshire.

Barnthouse, L. W. 2016b. Influence of Merrimack Station's thermal plume on habitat utilization by fish species present in lower Hooksett Pool. Prepared for Public Service Co. of New Hampshire.

Barnthouse, L. W. 2017. Analysis of Merrimack Station Fisheries Survey Data for 2010-2013. Prepared for Public Service Co. of New Hampshire.

Enercon 2016. CORMIX thermal plume modeling technical report. PSNH Merrimack Station Units 1 & 2, Bow, New Hampshire. Prepared for Public Service Company of New Hampshire D/B/A Eversource Energy.

Enercon and Normandeau. 2016. Response to United States Environmental Protection Agency §308 letter. PSNH Merrimack Station Units 1 and 2, Bow, New Hampshire. Prepared for Public Service Company of New Hampshire.

Electric Power Research Institute (EPRI). 2011. Thermal toxicity literature evaluation. Report no. 1023095, Electric Power Research Institute, Palo Alto, CA.

Hokanson, K. E. F. 1977. Temperature requirements of some percids and adaptations to the seasonal temperature cycle. *Journal of the Fisheries Research Board of Canada* **34**:1524-1550.

Kendall, R. L. 1978. *Selected Coolwater Fishes of North America*. Special Publication No. 11, American Fisheries Society, Washington, D.C. 437 p.

Normandeau Associates. 2007a. A probabilistic thermal model of the Merrimack Riuver downstream of Merrimack Station. Prepared for Public Service Company of New Hampshire.

Normandeau Associates. 2007b. Merrimack Station fisheries survey and analysis of 1967 through 2005 catch and habitat data. Prepared for Public Service Company of New Hampshire.

Normandeau Associates. 2011. Historic water quality and selected biological conditions of the upper Merrimack River, New Hampshire. Prepared for Public Service Company of New Hampshire.

Normandeau Associates. 2017a. Comments on EPA's draft permit for Merrimack Station Prepared for Public Service Company of New Hampshire.

Normandeau Associates. 2017b. 2012-2013 data supplement to the Merrimack Station fisheries survey analysis of 1972-2011 catch data. Prepared for Public Service Company of New Hampshire.

Rapport, D. J., H. A. Regier, and T. C. Hutchinson. 1985. Ecosystem behavior under stress. *American Naturalist* **125**:617-640.

Shelford, V. E. 1911. Ecological Succession. I. Stream fishes and the method of physiographic analysis. *Biological Bulletin* **21** (1): 9-35.

U.S. Department of the Interior (USDI). 1966. Report on pollution of the Merrimack River and certain tributaries. Part II – stream studies – physical, chemical & bacteriological. U.S. Department of the Interior, Federal Water Pollution Control Administration, Northeast Region, Lawrence, MA.

U.S. Environmental Protection Agency (EPA). 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic invertebrates, and fish. Second Edition. EPA 841-B-99-002, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Vannote, R. L., G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. The river continuum concept. *Canadian Journal of Fisheries and Aquatic Sciences* **37**: 130-137.