STATE OF VERMONT

ENVIRONMENTAL COURT

In re: Entergy Nuclear/ Vermont Yankee Thermal Discharge permit amendment (Appeal of Connecticut River Watershed Council, Trout Unlimited (Deerfield/Millers 349 Ch.), and Citizens Awareness Network) (Appeal of New England Coalition on Nuclear Pollution) (Cross-Appeal of Entergy Nuclear Vermont Yankee, LLC)	Docket No. 89-4-06 Vtec

Decision and Order

Appellants Connecticut River Watershed Council, Trout Unlimited (Deerfield/Millers 349 Chapter), Citizens Awareness Network (Massachusetts Chapter) and New England Coalition on Nuclear Pollution, and Cross-Appellant Entergy Nuclear Vermont Yankee, LLC, appealed from a decision of the Vermont Agency of Natural Resources, approving an amendment of the thermal discharge conditions in a direct discharge (NPDES) permit issued to Entergy Nuclear Vermont Yankee, LLC.

Appellants Connecticut River Watershed Council (CRWC), Trout Unlimited, and Citizens Awareness Network (CAN) (collectively: the CRWC Appellants) are represented by Patrick A. Parenteau, Esq., and David K. Mears, Esq.;[1] Appellant New England Coalition on Nuclear Pollution (NECNP) is represented by Phoebe Mills, Esq.; Cross-Appellant-Applicant Entergy Nuclear Vermont Yankee, LLC (Entergy) is represented by

[1] In addition, Benjamin R. Rajotte, Esq., participated in the preparation of the CRWC parties' memoranda, but has not entered an appearance, pending his admission in Vermont.

Elise N. Zoli, Esq., Sarah Heaton Concannon, Esq., U. Gwyn Williams, Esq., Matthew S. Borick, Esq., Robert A. Miller, Jr., Esq., R. Bradford Fawley, Esq., Zachary R. Gates, Esq., Haimavathi Marlier, Esq., and Kevin C. Hartzell, Esq.; and the Vermont Agency of Natural Resources (ANR) is represented by Catherine Gjessing, Esq. and Warren T. Coleman, Esq. In addition, the Water Resources Panel of the Natural Resources Board entered an appearance, represented by John H. Hasen, Esq., but did not participate in the evidentiary hearings or file memoranda on the merits of this appeal.

An evidentiary hearing was held in this matter before Merideth Wright, Environmental Judge, spanning more than twenty-one days from late June through late August of 2007. The parties were given the opportunity to submit written memoranda and requests for findings.[2] Upon consideration of the evidence and of the written memoranda and requests for findings filed by the parties, the Court finds and concludes as follows.

<u>Procedural Status - Application for Amendment of Existing Permit, not for Renewal Permit</u>

To place the present proceeding in the context of the Vermont Agency of Natural Resources' regulation of the Vermont Yankee facility, it is very important to bear in mind that what the Court has before it is an application for an amendment to the thermal (heat) discharge terms of an existing water discharge permit, not an application for a renewal permit.

The federal National Pollutant Discharge Elimination System (NPDES) is a program under the federal Clean Water Act (CWA) requiring discharge permits to be issued for

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[2] The parties requested and were granted at least five extensions of time for that purpose through the end of October of 2007 to complete their extensive requests for findings and memoranda of law. These extensions made it necessary to reschedule time that had previously been set aside in the Court's schedule in September and October of 2007 for work on the decision in this matter.

direct discharges of pollutants to the nation's waters, setting specific limitations on the discharge of pollutants. As described, for example, in Sierra Club v. Meiburg, 296 F.3d 1021, 1024 (11th Cir. 2002):

> Section 301(a) of the Act prohibits the discharge of any pollutants except those that are sanctioned by a permit. 33 U.S.C. § 1311(a). The statute gives EPA the authority to issue permits for point sources, and those permits are to establish technology-based effluent limitations that incorporate increasingly stringent levels of pollution control technology over time. 33 U.S.C. §§ 1311(b)(1)(A), (B), (b)(2). The limits set out in the permits are to be based on how low current technology can push pollution levels, and those limits are to be lowered as pollution-reducing technology improves. Permits are issued to individual dischargers through the National Pollutant Discharge Elimination System (NPDES) program. Id. at § 1342.

Under a so-called delegation agreement with the federal Environmental Protection Agency, since 1974 Vermont has been authorized to administer the NPDES program in Vermont. The Vermont ANR issues permits to facilities that discharge to state waters, applying both the federal and state statutory and regulatory requirements. The discharge of heated water is defined as a pollutant, but one that is subject to special considerations under § 316(a) of the Clean Water Act, 33 U.S.C. § 1326(a), and § 3-01(B)(1) of the Vermont Water Quality Standards (VWQS).

Under 10 V.S.A. § 1263(d)(4), a discharge permit is valid for a specific period of time, not to exceed five years.[3] The permit may contain effluent limits and other standards governing the discharge of pollutants, and may contain monitoring and data collection

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[3] During the permit's five-year term, the ANR may initiate a proceeding to modify, suspend or revoke a permit "for cause," Vermont Water Pollution Control Permit Regulations §13.8, including "a change in any condition that requires . . . [a] reduction or elimination of the permitted discharge." Id. §13.4(e)(2)(c).

requirements "as may be reasonably required,[4]" applicable during the term of the permit. Vermont Water Pollution Control Permit Regulations, §§ 13.4(c), 13.6. Such monitoring and reporting assists the ANR in determining whether the permit needs to be amended during its term and provides data for determining the appropriate limitations or conditions of succeeding permits for the facility.

After the initial permit, each successive five-year permit is sometimes referred to as a "renewal" permit. 10 V.S.A. § 1263(e). A renewal permit application must undergo "all the determinations and procedures required for initial permit application," although the ANR may determine the filing requirements for a renewal permit, from a "simple written request for reissuance" up to and including "the submission of all information required by the initial application." 10 V.S.A. § 1263(e). That is, in each successive five-year renewal permit proceeding, the burden is on the applicant to show that the operation of the facility qualifies for the requested discharge, including, if applicable, the special analysis under §316(a) to allow thermal discharges, discussed further below. Information submitted in support of the application may include data from monitoring or studies required to be conducted by the terms of the prior operating permits.

The renewal permit proceeding takes account of whether the proposed or continued operation of the discharging source will comply with all applicable standards and requirements, including any changes to those requirements that had been put in place during the term of the prior expiring permit. Vermont Water Pollution Control Permit Regulations, §13.5(b)(2)(c).

If an applicant for a renewal permit files the renewal application at least 180 days

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[4] The Court in this de novo proceeding must apply the substantive standards that were applicable before the ANR, including to "reasonably require" monitoring, as contrasted with the monitoring found to be unsupported in In re Appeal of LiCausi, 2008 VT 59, ¶ 9 (May 2, 2008).

prior to the existing permit's expiration, the applicant may continue to discharge under the conditions of its existing expiring or expired permit, while the ANR is processing the renewal application. Id. § 13.5(b)(1); and see 3 V.S.A. § 814(b). In the present case, Entergy's then-existing permit was set to expire on March 30, 2006. Because it applied for its renewal permit on September 30, 2005, it is operating under the expired prior permit until the ANR rules on the renewal permit application.

The application on appeal in the present case, by contrast, requests an amendment to the thermal discharge terms of the expired prior permit, until the ANR rules on the renewal permit application. Permittees are required to report any changes to their operations that result in new or increased discharges of pollutants. § 13.4(e)(1). If the discharge would violate the effluent limitations in the permit, the permittee must submit a "new application." Id. From the way the present application was treated, as well as from the past four unappealed minor amendments to the 2001 permit, such an application appears to be treated routinely by the ANR as an application for an amendment of the terms and conditions of a permit during the term of the permit. Any such amendments are only applicable to the remainder of the duration of the amended expired permit.

As the existing expired permit was not appealed, Entergy may operate under the terms of that permit during its five-year duration and until the renewal permit is issued. In re Unified Buddhist Church, Inc., 2006 VT 50, ¶¶ 13–14, 180 Vt. 515, 518–19 (precluding collateral attack on unappealed permit in appeal of amendment of that permit); Re: Town of Shoreham Wastewater Treatment Facility, No. WQ-00-11, at 7 (Water Res. Bd. May 2, 2001).[5]

Because the application before the Court requests an amendment to the existing

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[5] Available at http://www.nrb.state.vt.us/wrp/decisions/wrbdecisions/2001/wq00-11-mod.pdf The Environmental Court is directed to give decisions of the former WRB the same weight and consideration as its own prior decisions. 10 V.S.A. § 8504(m).

(though expired) permit, in the present proceeding the Court only has before it the issue of the additional thermal discharge proposed by the amendment application. As discussed in the pretrial proceedings and at trial, it is beyond the scope of the present proceeding for the Court to consider any amendment of the summer thermal discharge already allowed to be discharged by the unappealed existing expired permit, or whether any other aspects of the Vermont Yankee thermal regime are working well or should be changed — such issues will be for the ANR to consider in the first instance in its work on the pending renewal permit application.

Scope of De Novo Hearing and Issue of Deference

The issue of the scope of this proceeding and the deference to be accorded to the ANR was dealt with in pre-trial rulings in this matter, but the parties have again raised it in their memoranda. Their arguments have conflated three distinct issues: the standard of review of the facts of this particular application, the deference which is accorded administrative agencies with regard to the interpretation of the regulations which the agency is responsible for administering, and the weight to be given to the testimony of agency witnesses.

The applicant bears the burden of showing that the requested permit amendment should be approved. This proceeding is de novo by statute,[6] meaning that "the case is heard as though no action whatever had been held prior thereto. All of the evidence is heard anew, and the probative effect [is] determined by the appellate tribunal . . . as though no decision had previously been rendered." In re Poole, 136 Vt. 242, 245 (1978)

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[6] It is presumed that the legislature made this choice advisedly, In re Munson Earth Moving Corp., 169 Vt. 455, 465 (1999), especially as, in the same statutory revision, the legislature specifically chose to retain certain other types of appeals as an on-the-record judicial review of agency action. § 8504(h)(1) & (2).

Unlike federal review of administrative agency decisions, and unlike judicial review in Vermont prior to the adoption of the current appeals legislation, the present proceeding is not a 'substantial evidence' review of a record made in the administrative level, and therefore the 'substantial evidence' standard of review is inapplicable. Rather, by statute, the Court is required to apply the same substantive standards that the ANR was required to apply. 10 V.S.A. § 8504(h); V.R.E.C.P. 5(g).

In the environmental appeals statute, the legislature specifically distinguished between appeals from the Act 250 District Commissions, in which the Court is required to give deference to the ANR's technical determinations, 10 V.S.A. § 8504(i), and appeals from ANR decisions, such as the present one. This analysis of the legislative intent is consistent with VWQS 1-05, which specifies that, in a de novo appeal of a discharge permit application, the appellate decisionmaker is not bound by an ANR determination made "relative to an application."

By contrast, if any of the regulations which the agency is responsible for carrying out require interpretation in this proceeding, the Court does give deference to an agency's interpretation of its own regulations, e.g., Conservation Law Foundation v. Burke, 162 Vt. 115, 121 (1993), and of a statute it administers. E.g., Levine v. Wyeth, 2006 VT 107, ¶ 30, citing Chevron, U.S.A., Inc. v. Natural Res. Def. Council, 467 U.S. 837, 844 (1984).

While no deference is given per se to the ANR's permit decision in an appeal from that decision, there is no question that the Agency's staff have had a great deal of experience working with, and applying in the field, the regulations and the types of scientific and monitoring information at issue in this appeal. In making its de novo decision on the evidence presented, the Court will give the evidence proffered by the ANR the weight it deserves in light of the ANR witnesses' experience, training, education and familiarity with the subject matter of the application.

Vermont Yankee Nuclear Power Station

The Vermont Yankee Nuclear Power Station ("Vermont Yankee" or "the facility") is a boiling water nuclear reactor. In the course of its operation, the Vermont Yankee Station heats water[7] using the nuclear energy released in its reactor, and uses the steam to drive turbines to generate electricity.[8] It has an approximate core thermal power level of 1912 megawatts, approximately 650 megawatts of which is converted to electricity output, and the remainder of which is discharged as unused or waste heat. The waste heat is removed in a condenser, which is cooled by a circulating cooling water system. The water used to cool the condenser is drawn into the facility from the Connecticut River.

The Vermont Yankee facility has two ways to discharge the waste heat from the heated cooling water: either by circulating the heated cooling water into mechanical draft cooling towers, in which the hot water is blown by large fans into the air and cooled by evaporation (closed cycle), or by discharging the heated cooling water to the river (open

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[7] This so-called 'contact' water is not discharged outside the facility; it circulates in closed pipes through a condenser within which the waste heat is transferred to the cooling water.

[8] Although in the course of these proceedings some of the parties have sought to make various public policy arguments regarding the generation of electricity, the choice of those policies is a legislative, regulatory, or economic one that is not before this court in this proceeding. The relative merits of generating electricity from nuclear fission as compared with that from coal-fired or other combustion power plants, from the point of view of air pollution or global warming, is a policy choice not before the court in this proceeding. The relative merits of generating electricity from hydropower dams as compared with that from nuclear fission, from the point of view of the ecology of river systems, is a policy choice not before the court in this proceeding. The relative merits of generating electricity as compared with conserving, reducing or stabilizing demand for electricity is a policy choice not before the court in this proceeding. The relative environmental burden of any power plant operation on its immediate locality as compared with the benefits to more distant localities from the distribution of the electricity generated by that power plant is a policy choice not before the court in this proceeding.

cycle). In once-through or open-cycle operation, the heated water is discharged into the river, where it mixes with the river water and ultimately dissipates the heat throughout the river water and to the atmosphere. Vermont Yankee is capable of operating entirely in open-cycle cooling mode, in which all the heated water is discharged to the river, or entirely in closed-cycle cooling mode, in which all the heated water is pumped to the cooling towers. In closed-cycle cooling, the cooled water that has not evaporated is recirculated through the plant; a portion is discharged to the river as cooling tower blowdown water. Vermont Yankee also has the capability of directing only a portion of the heated cooling water to the cooling towers and a portion to the river.[9] This hybrid operation may range from completely open cycle, with the recirculation gate entirely closed and the cooling tower pumps and fans off, so that all the cooling water is discharged to the river, through operation with the recirculation gate partially to fully open and the cooling tower pumps on but some of the fans off, to operation with all of the cooling tower pumps and fans on, so that only cooling tower blowdown water is discharged to the river.

The amount of heated water discharged to the river thus may vary from close to zero to approximately 800 cubic feet per second (cfs), which is the maximum pumping capacity of cooling water in the once-through cycle. The temperature of the heated cooling water also varies: at the point of discharge to the river in the summer period it typically

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[9] The relative economic costs and benefits to Entergy of these modes of operation are not at issue in this proceeding, as neither the federal (316(a)) nor the state (VWQS 3-01(B)(1)(d)) assessment methods provide for a cost-benefit analysis. Riverkeeper, Inc. v. U.S. E.P.A., 475 F.3d 83, 97 (2d Cir. 2007). Open-cycle operation avoids the energy costs of operating the cooling tower pumps and fans with electricity generated by the plant (that could otherwise be sold), and avoids generation losses of up to 25 MW caused by increased turbine backpressure at elevated condenser temperatures. Closed-cycle operation withdraws water from the river and transfers much of it as water vapor to the air, resulting in a smaller volume being returned to the river, while the circulation of river water through the plant in open-cycle operation returns the water to the river, but with the added heat.

ranges from 80°F[10] to 90°F, with a maximum of approximately 100°F, (characterized by the 2004 316(a) Demonstration report (Joint Exh. 3) at p. 11 as "very infrequent.")

The Connecticut River

The Connecticut River[11] flows southerly for 410 miles from its source at the northern border of New Hampshire, forms the boundary between Vermont and New Hampshire, and extends through Massachusetts and Connecticut to its outlet in Long Island Sound, dropping a total of about 2625 feet in elevation over its length.

The Vermont Yankee facility is located on the western (Vermont) shore of the Connecticut River in Vernon, Vermont, three-quarters of a mile north of the Vernon Dam,

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[10] The permit and its compliance formula are expressed in degrees F (Fahrenheit) which are smaller (5/9 the size of) degrees C (Celsius). Although some of the evidence was expressed in degrees C, and almost all of the scientific literature (and the rest of the world) uses degrees C, this decision uses solely degrees F to avoid confusion. A conversion table was provided by agreement of the parties; the Court takes judicial notice that the conversion formula is expressed as: degrees F = 32+ (9/5 x degrees C).

[11] This decision uses the term "Connecticut River" or "the river" to refer to the main stem of the Connecticut River, not including its tributaries. If reference is made to the entire river basin, including its tributaries, the decision will use the term Connecticut River system or will refer specifically to the tributaries. Within Chapter 4 of the VWQS , which divides Vermont's rivers into seventeen different river basins, the river basin designations refer to the tributaries of the Connecticut River as separate river basins, as well as separating the Connecticut River itself into a lower and an upper portion, treated for the purposes of Chapter 4 as two separate river basins. VWQS §§ 4-13, 4-16. The "Lower Connecticut River Basin," for the purposes of the VWQS, essentially consists of the Connecticut River main stem from the White River south to the Massachusetts border. See map available at http://www.anr.state.vt.us/dec/waterq/planning/htm/pl_basins.htm. However, the New England regional studies in evidence that consider the entire Connecticut River from northern New Hampshire to southern Connecticut treat all of the portion of the river in Vermont as the "upper" Connecticut River. To avoid confusion this decision therefore does not use the terms 'upper' and 'lower' with reference to the river.

which is a hydroelectric generating facility owned and operated by an unrelated entity. The Vernon Dam is a run-of-the-river dam (without an impoundment reservoir) located at river mile 142, measured from the mouth of the river. Two other operating hydroelectric dams are located on the Connecticut River to the south of Vernon, in Massachusetts: the Holyoke Dam at river mile 86 and the Turners Falls Dam at river mile 123. In addition, a pumped-storage electric generating facility draws water from and returns water to the river at Northfield, Massachusetts, between the Turners Falls Dam and the Vernon Dam.

The existence and operating characteristics of the Holyoke and Turners Falls dams and their fish passage facilities will be discussed as necessary in this decision in relation to the requirements for the life cycles of migrating (diadromous) fish in the river, and particularly with respect to the anadromous fish selected as representative important species in the 2004 § 316(a) Demonstration Report submitted as part of the application before the Court.

<u>The Connecticut River at Vermont Yankee and the Vernon Dam</u>

Vermont Yankee is located approximately a half-mile upstream of the Vernon Dam, adjacent to a wide portion of the Connecticut River known as the lower Vernon Pool. The flow of the river in this location is regulated by the operation of the Vernon Dam and the various upstream dams. The river flow during the mid-May through mid-October period at issue in the present case, averaged over each month, ranges from a high of 35,164 cfs in May to 10,784 cfs in September, and ranges from a low of 3563 cfs in May to 1157 in September. Under the operating license for the Vernon Dam, the minimum flow now required to be allowed through the Vernon Dam is 1,250 cfs (or the actual river flow if it is less than that amount).

The Vernon Dam itself is 1,200 feet long, with the generating facility (powerhouse) located adjacent to the westerly (Vermont) side. It has nine hydroelectric units which can use a total of 13,280 cfs of river flow; any additional flow greater than that capacity is spilled through crest gates or deep gates.

Facilities have been installed at Vernon Dam for the passage of migrating fish. A fish "ladder" or "fishway[12]" for upstream passage is located near the westerly (Vermont) bank of the river. It is a concrete structure consisting of one type of fish ladder leading to a fish trap area and viewing gallery, and another type of fish ladder extending up from that level to Vernon Pool. It has been in operation since 1981.

The Vernon Dam fishway is operated from mid-May through the end of June[13] of each year, with a continuous flow of 65 cfs, plus an additional piped flow of 40 cfs through a separate pipe with an outlet at the foot of the ladder to provide a so-called attraction flow, which encourages the migrating fish to approach and enter the ladder structure. Since 1994 this piped flow also provides a supplemental downstream fish passage pipe.

Downstream fish passage may occur during periods of high flow over or through the dam gates. However, to facilitate downstream fish passage during all flow conditions, a fish conduit or "fish pipe"was installed in 1991 in the middle of the powerhouse.[14] This primary fish conduit has a 9' x 6' opening at its upper end, constricting to a 4' x 5' opening

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[12] The term fish ladder or fishway is used for the facility providing for the upstream passage of migrating fish, as distinct from the fish conduit, pipe, or tube providing for the downstream passage of migrating fish.

[13] The series of data reflecting the 1998 through 2002 counts of various species of fish in the fishway, reported in the 2004 § 316(a) Demonstration Report (Joint Exh. 3) at pp. 144–148 suggests that it is or was operated at least through July 7, the latest date on which fish were counted in the year 2000.

[14] Although one witness referred to this pipe as being in "the middle of the river," it is unclear whether the phrase was intended as a reference to its vertical or horizontal location. In any event, the credible evidence is that it is located within the powerhouse and therefore closer to the Vermont side of the river.

at its lower end, and carries 350 cfs of flow that bypasses the generator units. The 40 cfs attraction flow pipe at the fishway is also operated as a secondary downstream fish pipe. When the flow of the river is below the generating capacity of the Vernon Dam hydroelectric station, all the river flow either goes through the generating facility or goes through the fish conduit and additional fish pipe. The downstream fish pipes are operated from April through July and from September through October.

Due to their location close to the Vermont side of the river below the Vermont Yankee outfall, the upstream fish ladder, the downstream fish conduit and additional fish pipe are all within the influence of the plume of heated water discharged from Vermont Yankee.

Monitoring stations have been established at a number of stations in the River above and below Vermont Yankee. Station 7 is located 3.5 miles upstream of Vermont Yankee at a location at which the river is approximately 700 feet wide and 34 feet deep. The intake for the monitoring station is at a depth of approximately 17 feet and provides a representative temperature of the river above Vermont Yankee, unaffected by its thermal plume, and relatively unaffected by solar gain.

Station 3 is located .65 of a mile below Vernon Dam and 1.4 miles below Vermont Yankee. The river is approximately 400 feet wide and 30 feet deep at Station 3. Due to the turbulence just below (in the tailrace of) Vernon Dam the river water is well-mixed at this location. Although the intake for the monitoring station is only at a depth of 8 feet, it provides a representative temperature of the well-mixed river as a whole.

The temperatures at the monitoring locations report electronically to Vermont Yankee on a continuous basis.

Although the fishway is operated by the operators of the Vernon Dam, and is not controlled by the operators of Vermont Yankee, Vermont Yankee's existing expired permit requires it to monitor the temperature in the fishway once per hour when the fishway is "officially operating;" although the data is required to be reported as hourly, daily, and monthly means. A comparison of the temperatures in the fishway with the temperatures at Station 3 from 1997 through 2002 shows that, depending on the ambient temperature and flow volume conditions, the temperature at the fishway can be as much as 2.55 °F higher or 4.68 °F lower than that at Station 3. See Table 5-15 at pp. 141–143 of the 2004 § 316(a) Demonstration Report (Joint Exh. 3).

No monitoring is required and no data was presented in evidence regarding the water temperature at the downstream fish conduit during its dates of operation, or the relation of that temperature to the temperatures at Station 3 or at the fishway.

<u>Vermont Yankee Discharge Permits and § 316(a) Alternative Thermal Effluent Limitations</u>

Vermont Yankee began operating in 1973. At the outset it was required to operate in closed-cycle mode, while a testing program was designed to determine the ecological effects of open-cycle cooling. During 1974 through 1978, Vermont Yankee was allowed to discharge heated water to the river during a biological and hydrological testing program in preparation for its 1978 application under § 316(a) to discharge heated water to the river during the period from October 15 through May 15, annually ("the winter period").

Federal water pollution control law recognized from the outset that the discharge of heat should receive special consideration in the NPDES permitting program. Section 316(a) of the federal Clean Water Act (33 U.S.C. §1326(a)) allows a discharging source to qualify for an alternative effluent limitation by demonstrating that the effluent limitation otherwise required for the control of the thermal component of its discharge is "more stringent than necessary" to "assure the protection[15] and propagation of a balanced,

[15] This word appears as 'projection' in the statute as originally adopted, but the federal regulations and all other references refer to it as 'protection.'

indigenous population[16] of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made . . . ."

The federal regulations that govern the 316(a) demonstration require it to show that the proposed alternative effluent limitation "considering the cumulative impact of [the] thermal discharge together with all other significant impacts on the species affected, will assure the protection and propagation of a balanced indigenous community of shellfish, fish and wildlife . . . ." 40 C.F.R. § 125.73.

The federal regulations allow existing dischargers to base their demonstration on the lack of prior appreciable harm, in lieu of predictive studies. Section 125.73(c)(1) states that "any such demonstration shall show" (i) that "no appreciable harm has resulted" from the existing thermal discharge, taking into account its interaction with other pollutants and "the additive effect of other thermal sources;" or[17] (ii) that "despite the occurrence of such

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[16] This phrase, also defined in the applicable federal regulation as "balanced, indigenous community," means a "biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species and by a lack of domination by pollution tolerant species." 40 C.F.R. § 125.71(c). It is prohibited from including species "whose presence or abundance is attributable to alternative effluent limitations imposed pursuant to § 316(a)," although it may include historically non-native species introduced in a wildlife management program and species "whose presence or abundance" results from "substantial, irreversible environmental modifications," such as hydropower dams. Id. This prohibition ensures that the health of the balanced, indigenous community is assessed as if the facility were not discharging heat, rather than being assessed in whatever condition it may have stabilized under the operating conditions of the prior five-year permit's allowed thermal discharge.

[17] Entergy seeks to show, in its 316(a) demonstration in the present case, both that no prior appreciable harm has resulted, and that the proposed amended thermal effluent limitation will assure the protection and propagation of the balanced, indigenous community. Appellants argue that the federal regulations do not allow an applicant to make the latter showing unless it has admitted that there has been prior appreciable harm. When the Clean Water Act was first enacted, existing facilities discharging pollutants into

previous harm," the proposed alternative effluent limitations "will nevertheless assure the protection and propagation" of the balanced, indigenous community.

The Vermont equivalent to § 316(a) is found in VWQS 3-01(B)(1)(d), which requires a showing that a 200-foot-long mixing zone is not adequate "to provide for assimilation of the thermal waste," that the discharge will comply with all other applicable provisions of the VWQS, and that "after taking into account the interaction of thermal effects and other wastes, that change or rate of change in temperature will not result in thermal shock or prevent the full support of uses of the receiving waters." VWQS 3-01(B)(1)(d)(3).

Appendix A to the VWQS classifies certain listed waters within the state as "warm water[18] fish habitat," and by default all waters not listed (including the Connecticut River

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the nation's waters were required to obtain discharge permits. Simply from the text and the history of the section, the provision allowing a showing of "no prior appreciable harm" makes sense in the context of a facility that had been discharging heat prior to applying for its first five-year NPDES permit. Such a facility had the option of either showing that its pre-CWA discharge had not resulted in harm (and therefore that it should be allowed to continue at the same level), or to show that, despite prior harm, its new proposed alternative effluent limitation (which could be different from or differently managed than the existing discharge) would nevertheless maintain the biological population.

However, in the present day, a facility that has been operating under an existing NPDES permit, and seeks an increase in the amount of thermal discharge, will always have to show that the proposed increase will protect the biological community, without necessarily claiming or admitting that the existing <u>permitted</u> discharge has caused harm. (If harm results from the permit limits of an existing five-year permit, the ANR retains authority to modify, suspend, or revoke the permit for cause, Vermont Water Pollution Control Permit Regulations, § 13.4(e)(2), or to address the issue in the next renewal permit proceedings.) Therefore the so-called hybrid approach, allowing an applicant to show both no prior appreciable harm from the existing permitted level, and protection of the biological community from the proposed level, is a rational regulatory approach.

[18] Discharges to waters designated as warm water fish habitat are allowed certain allowable increases above ambient temperature, depending on the ambient temperature, as provided in two tables. VWQS 3-01(B)(1)(c).

are "designated as cold water fish habitat for purposes of these rules." Appendix A and the VWQS do not include an intermediate "cool water" fish habitat classification.

Credible scientific evidence supports the finding that, in fact, the main stem of the Connecticut River near Vernon does not provide resident life cycle habitat for any cold water fish species; it only provides transient habitat for a cold water fish species, the Atlantic salmon, during its annual migrations (of young smolts downriver to the ocean, and of adults upriver to spawn). Rather, this regulatory designation of the river as "habitat" for "cold water fish" was included in the VWQS to ensure that discharges to the Connecticut River main stem would be managed so as to protect the migratory phases of this cold water species' life cycle, especially given major regional efforts to reestablish this species in the Connecticut River system and the fact that the Connecticut River system is at the southern extent of this species' range.

The regulatory consequence of the designation of the Connecticut River near Vernon as cold water fish habitat is that the "otherwise applicable" effluent limitation for temperature is that: "the total increase from the ambient temperature due to all discharges and activities shall not exceed 1.0°F, except as provided in [VWQS 3-01(B)(1)(d)]." VWQS 3-01(B)(1)(b).

For this reason, and because technology exists to control the thermal discharge by using the cooling towers in closed-cycle mode, which would keep almost all of the heat out of the river, Vermont Yankee applied for an alternative temperature limit under federal 316(a) and Vermont VWQS 3-01(B)(1)(d).

In 1978 Vermont Yankee received an NPDES permit allowing it to discharge heated water to the river during the period from October 15 through May 15 so that the temperature at Station 3 did not exceed 65°F, the increase above the ambient water temperature at Station 3 did not exceed 13.4°F, and the rate of temperature change at Station 3 did not exceed 5°F per hour. During the period from May 16 through October 14, annually, ("the summer period") Vermont Yankee was required to operate in closed cycle mode, that is, using the cooling towers.

In 1981, the upstream fishway at Vernon Dam went into operation.

Vermont Yankee's 1986 NPDES permit provided the same limitations on the discharge of heated water to the river in the winter period, but also allowed a 1°F increase in the summer period, plus an experimental program of summer discharge and biological monitoring intended to provide data for assessment of the next renewal permit application. Vermont Yankee's 1990 application for its renewal NPDES permit included an application under § 316(a) to discharge heated water to the river during both the winter and the summer periods.

Although the modeling techniques available in the 1980s were not as sophisticated as those available for the present application, from the outset the effort was to estimate reliably the volume of water within the lower Vernon Pool area of the river that would be affected by the plume of heated water sought to be discharged from the facility. The 1990 § 316(a) Demonstration essentially was aimed first at establishing the extent of heating of the water within the river that represented the natural variability of the river temperature in the summer period. Depending on the ambient water temperature, the 1990 § Demonstration proposed allowable plant-induced temperature increases calculated to stay within the normal variability of summer period temperatures in lower Vernon Pool, as they would exist absent the thermal discharge from the plant.

Of course, as the temperature at Station 3 represents the well-mixed river more than half a mile below the dam, the plume of heated water from the plant would necessarily contain hotter water than that measured at Station 3. The assumption of this approach was and is that sufficient habitat suitable for the balanced indigenous population would remain within lower Vernon Pool, and that fish would be able to avoid any unduly hot water within the plume by avoidance behaviors, that is, by swimming down or away from the hotter water to avoid it.

Vermont Yankee's 1991 NPDES permit established a new methodology to calculate compliance with the thermal discharge limits by calculating the increase in the temperature of the river at Station 3 due to the operation of the plant, based on the rate of heat placed in the river from the plant, the flow of the river, and the characteristics (specific heat and density) of the river water. This methodology is generally referred to as "the compliance equation." Each successive renewal permit has used this methodology. The calculated temperature at Station 3 due to the operation of the plant is lower by several degrees than the actual measured temperature at Station 3. The compliance equation was calibrated for accuracy; the difference between the two temperatures represents the solar and atmospheric heating of the river that would be occurring without the discharge from Vermont Yankee, but recognizing the existing conditions of the dam impoundment.

The 1991, 1996, and 2001 renewal NPDES permits allowed Vermont Yankee to discharge heated water to the river in both the winter and the summer periods. The summer period limits are expressed in a table of values depending on the ambient temperature of the river measured upstream at Station 7. The table of values is similar in structure to that allowed in VWQS 3-01(B)(1)(c)(Table 2) for warm water fish habitat. This decision will refer to the schedule or table of temperature increases used in Vermont Yankee's management of the discharge of heat from the plant as the summer or winter "thermal regime" of the facility.

The facility's most recent renewal NPDES permit: the 2001 renewal permit, had an expiration date of March 30, 2006. Vermont Yankee has continued to operate under the terms of that 2001 Permit, as it filed its application on September 30, 2005, and proceedings on the next renewal permit have not yet concluded. The 2001 permit was amended several times on issues unrelated to the thermal limits. Neither the 2001 Renewal Permit nor its other amendments were appealed, and they became final.

For the summer period, from May 16 through October 14, the thermal regime in the existing expired 2001 Permit allows a calculated temperature increase at Station 3 due to the operation of the plant, over the ambient river temperature at Station 7, of 5°F when the ambient river temperature is below 55°F, and allows a calculated temperature increase at station 3 of 2°F when the ambient river temperature is above 63°F. When the ambient river temperature is between 55°F and 59°F, it allows an increase of 4°F; when the ambient river temperature is between 59°F and 63°F, it allows an increase of 3°F; and when the ambient river temperature is above 63°F, it allows an increase of 2°F.

In the thermal variance permit amendment application that is at issue in the present appeal, Vermont Yankee applied to increase the summer period calculated temperature at Station 3 by an additional 1°F, not for the colder or warmer extremes of the existing schedule, but when the ambient river temperature is between 55°F and 78°F. That is, this amendment application does not seek any additional increase in the already-allowed temperature increases when the ambient river temperature is either below 55°F or above 78°F. When the ambient river temperature is between 55°F and 59°F, the requested permit amendment would allow an increase of 5°F; when the ambient river temperature is between 59°F and 63°F, the requested permit amendment would allow an increase of 4°F; and when the ambient river temperature is between 63°F and 78°F, the requested permit amendment would allow an increase of 3°F.

The Agency of Natural Resources granted the thermal variance permit amendment for the period from June 16 through October 14, but denied it for the May 16 through June 15 period,[19] due to the potential for adverse effects on Atlantic salmon during that time period. The thermal variance permit amendment was granted on March 30, 2006, making

[19] Entergy initially cross-appealed the denial of the increase for the May 16 through June 15 period, but later withdrew its appeal on that issue in this proceeding.

it part of Vermont Yankee then-expiring 2001-2006 NPDES Permit. In the 2006 thermal variance permit amendment, on appeal in the present case, the Agency of Natural Resources required that Vermont Yankee's annual environmental monitoring report include a time series trend analysis for each of the nine Representative Important Species used in the 2004 § 316(a) Demonstration, using the statistical method (non-parametric Mann-Kendall) used in the 2004 § 316(a) Demonstration report. The Agency also imposed a new maximum average hourly temperature of 85°F, measured at Station 3. In its cross-appeal, Entergy has appealed the conditions requiring the time series trend analysis and the setting of a maximum temperature of 85°F at Station 3.

The time series trend analysis required by the ANR is useful in assessing the ecological effects of the thermal discharge from Vermont Yankee, not merely in connection with the additional heat sought to be discharged by this amendment application. No credible evidence was presented to support the elimination of this requirement.

Hydrothermal Model

For the 2004 § 316(a) Demonstration, Entergy's consultants developed and calibrated a three-dimensional hydrothermal computer model of lower Vernon Pool, capable of simulating over time the effect of the proposed thermal discharge plume on the thermal conditions in lower Vernon Pool, under different conditions of ambient water temperature, solar gain, and river flow. Bathymetric measurements were taken to characterize the three-dimensional shape of the river bottom and the location of the intake and outfall from the facility. A series of temperature measurements were taken in a three-dimensional array at three depths at each of nine locations across three transects of the river. The measurements were taken in late June through early July, and again in August, which can be expected to experience lower flow and higher temperature conditions. Temperature data was also available from Station 3, Station 7, and at the fishway, as required to be recorded under the existing expired permit. The model did not reflect conditions below Vernon Dam nor the location or locations at which water was passing over or through the dam at any given date. The temperature of the river below the dam and at Station 3 is considered to be well mixed. With regard to modeling temperatures within lower Vernon Pool, the model is accurate and reliable.

The model was run to prepare predictive data for the 2004 § 316(a) Demonstration including under conservative (that is, low flow and elevated temperature) assumptions. The model predicts that even under the lower flow and higher ambient temperature model inputs, unlikely to occur very often, no more than approximately an additional 5% of the available habitat would be rendered unavailable by the additional heat.

Entergy argued that this would be a negligible or de minimis loss of habitat and presented evidence that this amount of habitat loss would not have an adverse effect on the balanced indigenous population. However, it is necessary not only to predict the expected volume or area of habitat loss, but also to analyze whether the location and extent of the plume of heated water prevents any of the species making up the balanced indigenous community from carrying out all stages of their life cycle, and therefore assure protection and propagation of the species within the community.

Representative Important Species

Each § 316(a) analysis, whether for the entire thermal regime requested in a five-year renewal permit or for an amendment of an existing thermal regime, must begin with the selection of a group of "representative important species" (RIS). The selection of a group of representative important species allows an assessment of the balanced indigenous population or community without studying all of the species of fish, shellfish and other wildlife that make up that community.

In the case of Vermont Yankee, studies of phytoplankton, zooplankton and benthic macroinvertebrates in lower Vernon Pool have been carried out in connection with past permit conditions and as required by the Environmental Advisory Committee[20] (EAC) as well as in connection with past applications. These communities of species are maintaining themselves and propagating successfully in lower Vernon Pool, and are not in controversy with regard to the present amendment application for the existing expired permit.

With regard to the fish community, the Connecticut River in the vicinity of Vernon hosts a complex community of approximately thirty-two fish species, some adapted to the lentic (standing water) habitat of lower Vernon Pool above Vernon Dam, some adapted to the lotic (running water, including riffle) habitat in the tailwaters below Vernon Dam in upper Turners Falls Pool, and some migrating through the area affected by Vermont Yankee's thermal discharge at different stages of their life cycles.

Diadromous or migratory fish conduct a portion of their life cycle in the ocean and a portion in freshwater rivers and their tributaries. Anadromous fish, including the Atlantic salmon (*Salmo salar*)[21] and the American shad (*Alosa sapidissima*[22]), move upriver to spawn in fresh water, and conduct the adult portions of their life cycle in the ocean. (Other species, such as the American eel (*Anguilla rostrata*), spawn in the ocean and migrate

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[20] The EAC includes representatives from the Vermont, New Hampshire and Massachusetts state fisheries and environmental agencies, plus the coordinator of the Connecticut River Anadromous Fish Program for the U.S. Fish and Wildlife Service.

[21] The biological evidence and supporting studies use the scientific names of the various relevant species; for ease of reading, this decision uses the common names. The scientific names are provided in parentheses the first time they occur, to enable readers to refer to the scientific names in the various studies and reports presented in evidence.

[22] The Court has disregarded the misstatement on p. 8 (1st sentence of §2.0) of the 2004 §316(a) Demonstration Report, giving the scientific name of the American shad as *Alosa pseudoharengus* (which is instead the alewife), as that error was not repeated in the supporting scientific sections of the report or in testimony.

into fresh water later in their life cycle.)

For the group of representative important species to be representative of the entire balanced indigenous population, it must take into consideration the various characteristics of the species' thermal sensitivity, and also their preferred habitat, food types (whether they eats insects, smaller fish, plants, or some combination), their ecological roles or trophic positions, and their economic importance in a commercial or sport fishery, as well as their endangered, threatened, or nuisance status, and whether they are resident or migratory species. The group of nine species was selected for the present (2004) § 316(a) Demonstration after consultation with the Environmental Advisory Committee, established in the Vermont Yankee permits to assist with reviewing monitoring results and determining needed studies.

The selected group of representative important species consists of the anadromous Atlantic salmon and American shad, and the resident species smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), walleye (*Sander vitreus* (formerly *Stizostedion vitreum*)), yellow perch (*Perca flavescens*), spottail shiner (*Notropis hudsonius*), fallfish (*Semotilus corporalis*), and white sucker (*Catostomus commersoni*). This selection of species is adequately representative of the complete balanced indigenous community that uses the areas of the Connecticut River affected or potentially affected by the thermal discharge from Vermont Yankee, as it includes species representative of the range of thermal sensitivity and other ecological requirements of that community.

The fact that brook trout, brown trout, and rainbow trout were not included does not invalidate the selection of the nine species in the RIS. Although the trout species live in and are stocked in the cold water tributaries of the Connecticut River system, they do not conduct their life cycle in the main stem of the Connecticut River, and do not pass through the main stem of the Connecticut River, at least in areas downstream of Station 7.

They may come to or be found incidentally at the mouths of the tributaries, but they would not be representative of the balanced indigenous community that uses the areas of the Connecticut River potentially affected by the thermal discharge from Vermont Yankee, even discounting any past effects of the Vermont Yankee winter or existing summer thermal discharge.

The fact that the group includes more species adapted to warm water and cool water, as well as the cold water Atlantic salmon, also does not invalidate the representativeness of the group of species, because an increase in the prevalence of the warm water representatives, as well as a decrease in the prevalence of cool water and cold water representatives, is indicative of the balance of the indigenous community.

The tessellated darter is another warm water species that is host to a life stage of the federally-endangered dwarf wedge mussel. However, the dwarf wedge mussel is not found this far down the main stem of the river, and otherwise the tessellated darter's ecological niche is represented by other species in the RIS.

The evidence as to the resident species of fish, within the group of representative important species reflects that the proposed 1°F increase in the summer thermal regime will assure the protection and propagation of those species and the other species within the balanced indigenous population having similar ecological characteristics. Even in low flow, high temperature conditions, little additional habitat within lower Vernon Pool will be rendered unuseable for these species; the increase will not have an adverse effect on their protection and propagation.

However, the summer thermal regime must also be managed to assure the protection and propagation of the migratory species[23] using lower Vernon Pool and the

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[23] The American eel was rejected as a candidate for the RIS as it is another warm water species; it is not needed for the RIS to analyze effects within lower Vernon Pool in connection with the present amendment application for the existing expired permit.

river below Vernon Dam, considering specifically the requirements of the life stages of those species that use or pass through the affected areas of the river. Accordingly, the focus of much of the evidence presented at trial was on these two species: the Atlantic salmon and the American shad, especially as these two species have been the subject of an interstate and federal program in operation since 1967 to restore them to the Connecticut River and its tributaries. It is necessary to analyze the operation of the summer thermal regime, including the higher temperatures within the plume of thermal discharge, to determine whether the proposed additional 1°F increase will nevertheless assure the propagation of the migratory species, and keep them returning to or through the affected part of the river, as well as assuring the species' protection when present, as part of the balanced indigenous community.

Atlantic Salmon

Atlantic salmon are a cold water species, and are the most thermally sensitive of the representative important species. The Connecticut River system is the most southerly of their range. The upper limit of the temperature range tolerated by adult salmon[24] is approximately 75°F.

Adult salmon migrate up the river in the spring, beginning about April 1. At the

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However, it is another indigenous migratory species, although catadromous rather than anadromous, and is an indigenous predator on the young life stages of shad. The ANR and EAC will have the opportunity to require any appropriate monitoring or studies of the migration requirements of the American eel and its effect on the shad life cycle in connection with the renewal permit.

[24] If additional studies are required to establish a correct upper incipient lethal limit, or a correct ultimate upper incipient lethal limit for adult salmon, or to establish what behavioral changes may occur in adult salmon at temperatures lower than those limits, such studies are beyond the scope of the present amendment proceeding.

present time 90% of the migrating salmon in the annual spawning run are removed at the Holyoke Dam fish lift, and are transferred by truck to fish hatcheries to provide the stock of young life stages for stocking directly in suitable tributary habitat throughout the basin. Very few if any of the 10% of migrating salmon that remain in the river above Holyoke ever reach the Vernon Dam fish ladder to pass above it into the Vermont (or New Hampshire) tributaries. Although under natural conditions the adult salmon spawning run may continue as late as early July and may occur again after mid-September, for the purposes of the present amendment application adult salmon are not present in the balanced indigenous population during the June 16 through October 14 period.

Adult salmon spawn in the tributaries, not in the main stem of the river, depositing eggs in suitable gravel-cobble substrate. The fertilized eggs incubate over the winter and hatch early the following spring. The young fish (fry and parr stages) live and grow in the tributaries for two or three years, before undergoing physiological changes to the smolt stage necessary to enable them to make the transition from living in a fresh water environment to living in a salt water environment. They then live in the ocean for approximately two more years before reaching sexual maturity and migrating upriver to spawn as adults.

Salmon smolts migrate out of the tributaries and down the river from about April 1 through June 15, with most having migrated past the area of the Vermont Yankee discharge by early June. Water temperature in the low 50s (°F) is a behavioral cue initiating salmon smolt outmigration. Juvenile salmon cease feeding behavior at about 72.5°F; the upper temperature limit for juvenile salmon survival is about 82°F, without regard to subtler behavioral changes and possible desmoltification at temperatures below that limit. The effects of the Vermont Yankee thermal discharge on salmon smolt behavior and outmigration were studied in the late 1980s in preparation for the 1990 summer thermal regime application; later studies by the operator of the Vernon Dam did not directly assess the thermal contribution from Vermont Yankee.

Because the present amendment application seeks an increase applicable only to the period of time after the salmon smolt outmigration, it is beyond the time period that a salmon life stage uses the portion of the river affected by the Vermont Yankee thermal discharge. That is, if there is any reason to look more carefully at the current winter or summer thermal regime with respect to salmon, that is for the ANR to determine in the first instance in connection with its work on the renewal permit.

American Shad

The Connecticut River is within the wide range of American shad (shad[25]), which are found in the rivers and at the Atlantic coast of North America from Northern Florida to Canada. They are a cool-to-warmwater fish and do not spawn more northerly than the St. Lawrence River. Populations of shad returning to different latitudes become differentially adapted to the conditions of those rivers. The different life stages of American shad have different thermal requirements and limitations, and use the river at different times; therefore it is necessary to examine the use of the river by shad and the vulnerability to thermal effects during the various life stages of the American shad, in order to determine whether the proposed amendment to the summer thermal regime will nevertheless assure the protection and propagation of American shad within the balanced indigenous community.

American shad grow to maturity in the ocean; they reach sexual maturity at approximately ages 3-5 years for males and ages 4-6 years for females. Shad return to their

[25] Other types of shad, including the "gizzard shad," use the Connecticut River, but for the purposes of this decision the term "shad" is only used to refer to the American shad, as one of the representative important species.

natal river to spawn.[26] The number of adults in the spawning run correlates generally with the number of juveniles that left the river approximately four to five years earlier.

Shad Upstream Adult Migration

American shad are repeat spawners, that is, unless they have completely depleted their energy resources by migrating upstream and spawning, they swim back downstream shortly after spawning to feed and grow in the ocean for another year, returning to the river the following spring. The older and therefore larger females are the most fecund; that is, they develop the largest number of eggs. The evidence reflects that the larger, more mature females spawn earlier in the run, that is, farther down the river.

At Holyoke Dam the ratio of males to females is close to equal; by Turners Falls Dam and Vernon Dam there is a much greater proportion of males to females. The decline in the ratio of females to males above Holyoke was noted in the 1990 studies in connection with the application for the summer thermal regime, and is evidently therefore not due to the existing summer thermal regime. In addition, the process of migrating upstream, including negotiating the fish ladder or fish lift facilities at the dams, takes a greater toll on the bioenergetics of females than of males, due to the energy that has already been expended by the females in egg development prior to the migration run. The studies of cortisol (stress hormone) levels conducted at Turners Falls in connection with the Turners Falls fish passage studies and proposals for fishway modifications bears out that stress

[26] It is apparent from the time series of fish count data in evidence that, over time, shad will proceed farther up river to spawn than the location in which the individual adults were reared as juveniles, thus recolonizing areas of rivers in which shad populations had been eliminated by the construction of historical dams. That is, for the first few years after the obstructions were removed or fish ladders were installed, even when shad were abundant downriver not many proceeded through the new fish passage facilities. However, the success rate increased over time so that, for example, at Vernon Dam an average of 66% of the number counted as passing the previous (Turners Falls) obstruction also passed above Vernon Dam.

levels are high in the complex fish passage facilities, Entergy Exh. 66, suggesting that gravid females may become differentially exhausted.

American shad enter the mouth of the Connecticut River in April and move up the river to spawn in the main stem of the river, in areas over a suitable gravel rather than silty bottom. They reach the area of the Vernon Dam around mid-May. The majority of the shad run coming up the fish ladder at Vernon occurs from mid-May to about the third week in June; the latest date shad were found in the Vernon fish ladder was early July. The extent of the historical shad run in the Connecticut River was to the area of Bellows Falls.

Migratory and spawning behavior in adult shad is temperature sensitive, occurring in the low 60s (°F) to mid-70s (°F) . The peak upstream passage of shad at Holyoke Dam occurred at temperatures in the range of approximately 62°F to 71°F. The peak day of passage at Vernon Dam occurred in 1991 at approximately 70°F to 73°F, with the peak four-day period that year occurring at approximately 70°F to 75.6°F. The highest temperature measured in the fishway on a day when shad were counted was 76.7°F.

With regard to the shad migration, the 2004 § 316(a) Demonstration ran the computer model of Vernon Pool to determine whether the existing discharge under the summer thermal regime could be blocking upstream migration of adult shad, and determined that water temperatures were predicted not to exceed 86°F during the migration period anywhere in Vernon Pool, the fishway, or in the tailrace of Vernon Dam, even under conservative assumptions of low river flow and warm ambient temperatures.

However, the Court does not find the evidence credible to support the assumption that an 86°F avoidance temperature is applicable to all shad life stages. That avoidance temperature was derived from a study of the behavior of juvenile shad rather than adults. As further discussed below in the section on juvenile shad, juveniles tolerate or even thrive at higher temperatures than adults, and even the tested juveniles were more likely to survive if acclimated to a higher ambient temperature rather than when encountering rapid changes to a high temperature.

As the Court does not accept the 86°F avoidance temperature at all life stages of shad, this decision will examine each life stage's temperature requirements separately for each relevant time period of the requested temperature increase during the summer thermal regime. For the upstream adult migration, the present evidence supports only a maximum temperature of 76.7°F in the fishway, as no American shad were counted in the fishway at any higher temperature.

Comparing the numbers of adult shad entering the Connecticut River with the numbers passing upstream at Holyoke Dam, Turners Falls Dam, and Vernon Dam (since the latter fish passage facilities opened in 1980 and 1981, respectively), approximately a third to a half of the shad run gets through Holyoke in any given year. In the peak years of 1983-1984 and 1991-1992, when more than a million shad each year entered the river, approximately 500,000 to 720,000 passed above Holyoke.

There has been a serious decline in American shad commercial fish landings along the Atlantic seaboard and in the Connecticut River since the early 1990s. The shad stock was assessed in 1998 by the Atlantic States Marine Fisheries Commission, which found that it could not attribute the decline to overfishing, and that there was a similar decline in the Pawkatuck River in Rhode Island, at a similar latitude to that of the Connecticut River below Holyoke, which is attributed to increased striped bass predation.

The CRASC report (Joint Exh. 251) reflects that American shad eggs, larvae and juveniles are prey for American eels, and that juvenile American shad are prey for striped bass. However, with regard to adult American shad, even if there is increased striped bass predation in the coastal portions of the Connecticut River, or up to Holyoke Dam (at river mile 86), there cannot be appreciable striped bass predation of adult shad above Holyoke Dam, as only approximately 1000 adult striped bass were lifted above Holyoke Dam in 1990, compared to hundreds of thousands of adult American shad.

The decline in the percentage of those counted as passing the Holyoke Dam that also pass the Turners Falls Dam is not likely to be due to the added heat in the river from the current summer thermal regime at Vermont Yankee, after it is well mixed at Station 3, as the Vermont Yankee summer thermal regime was designed to keep the temperatures at Station 3 and below within their naturally occurring natural variation.

Even in the peak years of shad migration, only approximately 10% or fewer of the numbers counted as passing above Holyoke were counted as passing above Turners Falls, which is a complex facility that has experienced perennial problems at its fish passage facilities, and is engaged in a current program of experiment aimed at improving that passage rate.

The Turners Falls Dam complex involves three separate fishways, because the river below the dam is divided for approximately a three-mile length into what is essentially two separate channels: the main river channel to the west, and the power canal to the east. The Cabot fishway is located at the downstream end of the power canal, next to the generating powerhouse. The Gatehouse fishway is located at the Turners Falls Dam itself. The Spillway fishway is located below the dam at the upstream end of the main river channel. Fish coming up the main river channel must go through the Spillway fishway and cross the upstream end of the power canal across the flow direction to enter the Gatehouse fishway, in order to pass above the dam. Fish using the Cabot fishway at the powerhouse must swim up the power canal and also enter the Gatehouse fishway to pass above the dam.

The complexity of this system itself is a source of exhaustion and/or confusion for the fish using it. Significant numbers either refuse to enter at the Cabot and the Gatehouse fishways, or turn around within the system, presumably spawning in the river somewhere downstream of the Turners Falls Dam complex. Under its license from the Federal Energy Regulatory Commission, the operators of the Turners Falls complex have undertaken a number of studies and design work for improvements to the fishways aimed at improving the numbers of American shad and other migratory fish that succeed in passing above Turners Falls Dam.

Vermont Yankee is not responsible for impediments to fish migration caused by dams or the design of fish passage facilities, it simply must be operated so as not to exacerbate those problems, and to allow the shad that succeed in passing above Turners Falls Dam to proceed to pass above Vernon Dam. Once improvements are made to the Turners Falls Dam complex, if the passage rate at the Vernon Dam fish ladder does not also rebound to its historical average of 66% of the fish counted as passing Turners Falls Dam, it will be for the ANR and EAC in the first instance, in connection with the renewal permit, to require any studies of the downstream thermal effects from the overall summer thermal regime on upstream migrating shad in upper Turners Falls Pool.

Of the shad that succeed in passing through Turners Falls, since improvements to the Vernon Dam fish passage facility in 1989, an average of 66% (ranging from 39% to 100%) and generally approximately 70% to 80% also succeeded in passing above Vernon, until the recent serious decline in overall numbers[27] to about 150,000 at Holyoke, about 1500 at Turners Falls, and only about 150 at Vernon.

Shad Spawning

In spawning, a female American shad releases eggs in the water column above gravel rather than above a silty bottom; the eggs are fertilized in the water column by

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[27] Since 2002 there has been an even more dramatic decline in the number of shad that arrive at the Vernon fishway, and, indeed, a dramatic decline coast wide in American shad numbers. However, there has been prior natural variability from year to year as well, due to recruitment of juveniles from the prior larger cohorts of spawning adults on an approximately five-year cycle. For example, prior to the Vermont Yankee summer thermal regime, the shad run in 1989 was counted as 9,500 at Turners Falls and nearly 1,000 at Vernon Dam, while in 1990, 27,900 shad were counted at Turners Falls and 10,900 at Vernon Dam.

several males. Spawning takes place at night[28] or in cloudy weather. In the lower Vernon Pool spawning takes place along the gravel bottom along the New Hampshire shore and above the Vermont Yankee plume, formerly as far upriver as the Bellows Falls dam.

The additional thermal discharge sought by this amendment is predicted to decrease the habitat currently considered to be suitable for spawning and egg/larval development, as it exists under the present summer thermal regime, by a no more than 5% in the worst case of low flow conditions and high ambient temperatures. This decrease is not significant in nevertheless assuring the protection of spawning of American shad and therefore of their propagation within the balanced indigenous community.

Soon after spawning, with water temperature in the low-to-mid-70s°F, the adult shad begin to return down the river to the ocean. For the downstream post-spawning adult migration, the present evidence supports a maximum temperature of 76.7°F in the fish conduit, based on the shad temperature requirements for the use of the upstream fishway, at least for the purposes of the present application to amend the existing expired permit, until further data are presented supporting any different post-spawning adult shad temperature requirements for returning downstream.[29]

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[28] The fish count data from the fishway appear to be collected twelve hours a day, presumably in the daytime. No evidence was drawn to the Court's attention as to whether shad also migrate at night.

[29] Management of the thermal discharge to achieve this result will require monitoring the temperature at the fish conduit. A sensor in that location is not now required by the existing expired permit. If the fish conduit location is close to and at a lower depth than the sensor at the fish ladder, the ANR may allow this temperature to be measured instead at the fish ladder sensor for the remaining duration of the existing expired permit.

Shad Egg and Larval Development

Shad eggs float near or roll along the bottom. The incubation period is short: approximately 6–8 days at 63°F, before the eggs develop into larvae. Shad larvae have a relatively broad tolerance of temperature and other environmental fluctuations they are likely to encounter during the spawning period, but not for rapid exposure[30] to unusually high temperatures for the period. A 1999 study of the temperature and other environmental requirements of shad larvae shows that a rapid temperature increase from 68°F to 86°F killed all the shad feeding stage larvae in one experiment. Joint Exh. 269. The recruitment of juveniles from the egg/larval stage, as well as the survival of juveniles to the adult stage, is important to protect the propagation of shad. The additional thermal discharge sought by this amendment is predicted to decrease the habitat currently considered to be suitable for spawning and egg/larval development, as it exists under the present summer thermal regime, by no more than 5% in the worst case of low flow conditions and high ambient temperatures. This decrease is not significant in nevertheless assuring the protection and propagation of the egg/larval life stage of American shad within the balanced indigenous community.

Juvenile Shad Summer Growth

Juvenile shad remain in the river throughout the summer in which they were hatched. Juveniles are relatively temperature-tolerant, and exhibit avoidance behavior (swimming down or away) when temperature approaches 86°F, depending on the ambient temperature to which they are acclimated before encountering the heated water. This

[30] No evidence was presented as to the potential for eggs or larvae spawned in or upstream of lower Vernon Pool to drift into the plume or to encounter water at the lethal temperature for eggs or larvae.

avoidance temperature is not an average over time, it is the temperature actually experienced by the juveniles. The study from which this avoidance temperature was derived reflects that the tested juveniles began exhibiting schooling behavior at about 82°F, exhibited disorientation behavior by about 88 °F and that all the tested specimens were killed within four to six minutes at 90°F. (Marcy 1972, Joint Exh. 258). A temperature cap of 85°F at Station 3 is therefore important to protect all stages of shad within lower Vernon Pool. The additional thermal discharge sought by this amendment is predicted to decrease the habitat currently considered to be suitable for juvenile shad summer growth, as it exists under the present summer thermal regime, by no more than of 5% in the worst case of low flow conditions and high ambient temperatures. This decrease is not significant in nevertheless assuring the protection and propagation of the juvenile life stage of American shad within the balanced indigenous community.

<u>Juvenile Shad Outmigration</u>

The juvenile shad then migrate downstream to the ocean in the fall. During that period they must change physiologically to enable them to regulate their body chemistry in a salt-water environment. This outmigration occurs generally from September 1 through November 15, beginning earlier in the upper reaches of the river. Although juvenile shad are generally capable of swimming to avoid temperatures approaching 86°F, they are very small and lack the ability to swim far against a strong current.

During the juvenile shad outmigration period, to assure the protection of the juveniles and their survival to return as spawning adults, any juveniles coming downriver from above the plume must be able to avoid being swept by the current into a too-hot area of the plume, and those swimming around or under the plume must find their way to the fish conduit to continue downstream. A serious delay in the conditions that allow the juvenile shad to migrate downstream can result in their mortality from cold water temperatures or delays in their adaptation to the salt water environment.

However, as the present amendment request does not propose any additional thermal discharge beyond that already allowed by the existing summer thermal regime when ambient temperatures are at or above 78°F, it is not within the scope of the present application to address either the temperature within the fish conduit during the juvenile shad outmigration period or the management of the thermal discharge to maintain a route within and through Vernon Pool to the fish conduit so that the juveniles can reach the conduit to travel downstream. Such considerations are for the ANR to address in the first instance in the renewal permit and in any necessary studies in connection with that permit. The cover letter to the 2006 amended permit suggests that such studies have already been designed. The temperature measurements at the fish conduit required by this amendment during the conduit's operation will assist in such studies.

Accordingly, based on the foregoing, it is hereby ORDERED and ADJUDGED that

1. For the period from June 16 through July 7, the requested 1°F increase in the summer thermal regime of the existing expired permit is DENIED, UNLESS the discharge can be managed so that it results in an actual measured temperature at the fishway sensor NOT TO EXCEED 76.7 °F.

2. A temperature sensor shall be installed at the fish conduit. During the period from June 16 through July 7, the discharge shall also be managed for the outmigration of post-spawned adult shad, so that it results in an actual measured temperature at the fish conduit sensor NOT TO EXCEED 76.7 °F. If the fish conduit location is close to and at a lower depth than the sensor at the fish ladder, the ANR may allow this temperature to be measured instead at the fish ladder sensor for the 2008 summer season.

3. For the period from July 8 through October 14, the requested 1°F increase in the summer thermal regime of the existing expired permit is GRANTED.

4. In addition, the conditions imposed by ANR requiring the time series trend analysis and the setting of a maximum temperature of 85°F at Station 3, are hereby imposed. The ANR's denial of the May 16–June 15 requested increase remains in effect.

Done at Berlin, Vermont, this 22nd day of May, 2008.

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Merideth Wright
Environmental Judge