

**RATIONALE FOR ESTABLISHMENT OF
TEMPERATURE EFFLUENT LIMITATIONS FOR POTWS
NR 106.59, Wis. Adm. Code (proposed)
Bureau of Watershed Management
Wisconsin Department of Natural Resources
December 22, 2008**

INTRODUCTION

Current state rule (NR 102.05(4), Wis. Adm. Code) exempts publicly owned treatment works (POTWs) from the thermal requirements of state water quality standards and, therefore, effluent temperature limitations have not been established in WPDES permits for such facilities. While the Department does not now feel that such a categorical exemption from application of water quality standards is defensible, the data available lead the Department to conclude that in all but very unusual cases, the thermal component of effluent from POTWs is not likely to impair the aquatic life uses of Wisconsin surface waters. Consistent with this, the Department is proposing to establish rules which consider dissipative cooling in deciding whether or not to impose temperature limits on POTWs. Application of these rules will mean that POTWs will not receive temperature limits except in very rare circumstances where site-specific data are available that indicate the thermal component of the POTW effluent is having a significant adverse effect on aquatic life uses in the receiving water.

CHARACTERIZATION OF POTW TEMPERATURES

Domestic wastewater (hereinafter “sewage”) temperature normally falls within a fairly well-defined range of values and is not as highly variable as may be experienced with industrial processes. Raw sewage temperatures are primarily controlled by soil temperatures because sewage collections systems are buried underground. In rare exceptional circumstances, sewage temperatures may be affected by an industrial source of high temperature wastewater. Otherwise, typical raw sewage temperatures are in the range of 50°F to 60°F.

There is a moderated seasonality associated with raw sewage temperatures, depending on the depth of sewers and soil temperatures. In addition, POTW effluent temperatures may be significantly affected by the type of treatment facility and reflect greater seasonal fluctuations than the influent. The major factor governing effluent sewage temperatures are ambient air temperature and residence time within the POTW.

The Department obtained effluent temperature information from several POTWs around the state, representing different sizes and types of systems as summarized in Table 1.

Effluent temperature data is very limited because it is not a parameter for which measurement is required by permit. Furthermore, most facilities do not routinely measure effluent temperature, even though they may measure raw sewage temperature for process control purposes. Activated sludge systems typically have effluent sewage temperatures near 70°F in the summer months and in the lower 40’s°F in the winter. Effluent temperature from lagoon systems more closely correspond to ambient water temperatures ranging from the low to mid-30’s°F in the winter to the 80’s°F in summer.

Table 1
Monthly Effluent Temperatures (°F), 2005

	J	F	M	A	M	J	J	A	S	O	N	D
Hudson	51	50	52	56	59	65	69	70	69	67	61	56
Madison Met	53	53	54	58	61	67	69	70	70	66	62	57
Elmwood							74	73	70	64	56	50
Brookfield	52	51	51	54	58	63	65	67	66	63	58	54
Weyerhauser					54					50	41	
Hammond		33	33	45	54	68	73	72	67	56	41	39
Superior			41	38		62				63	47	
Jones Island	43	42	49	63	61	66	77	72	79	65	61	59
Composite	48	43	43	50	57	65	71	70	68	58	51	49

The composite effluent temperatures, shown in Table 1, were calculated by taking the mean of the lowest and highest monthly average temperatures for the listed facilities. For example, in January, the lowest monthly average was 43°F (Jones Island), and the highest was 53°F (Madison Met). The mean of those extremes was 48°F. A problem with this method occurred for the month of September. The calculated value of 72°F was higher than the August value of 70°F. This does not comport with reality, as waterbody temperatures throughout the state begin dropping in September. As a result, a value of 68°F was used as it is believed to represent a more credible value.

EXAMPLE TEMPERATURE LIMITATIONS

The Department used data from the several wastewater systems listed in Table 1 to calculate effluent temperature limitations for a group of example facilities representing varying effluent and streamflow rates and aquatic life categories. The limitations were determined based on the rule procedures contained in the final rule order. The composite values from Table 1 are compared to the calculated effluent temperature limitations to determine if there is reasonable potential to exceed such limitations. The results are presented in Table 2.

From this analysis of example facilities, the Department concludes the following:

1. Reasonable potential to exceed limits were only associated with the sub-lethal criteria, not acute criteria.
2. Exceedances of effluent limits will typically occur in the fall to early winter (cool-season) months. A primary reason for this is that higher effluent temperatures lag behind falling ambient stream temperatures at this time of the year.
3. A primary driver in determining whether effluent temperature limits cannot be attained for discharges to flowing waters is the ratio of stream flow to effluent flow ($Q_s:Q_e$). In general, receiving streams with flow dominated by effluent would be unable to meet temperature limits without supplemental cooling.
4. Discharges to cold water streams will more likely have a reasonable potential to exceed calculated effluent limitations.
5. Discharges to limited aquatic life and limited forage fish streams can usually meet limits regardless of the $Q_s:Q_e$ ratios because the applicable water quality criteria are less stringent.
6. The largest discharger (i.e., Milwaukee Metropolitan Sewerage District – Jones Island) to the Great Lakes cannot meet the limits due to the restricted size of the code required mixing zone. Smaller discharges to inland lakes may be similarly affected due to the proportionately smaller mixing zone size.

Of the 23 example facilities subject to this analysis, six had at least one month during which the calculated effluent limits would be exceeded. Four of those six facilities would have more than one month where calculated effluent limits would be exceeded.

Table 2
Summary of Facilities Evaluated for Compliance with Effluent Temperature Limits

Facility	Discharge Category	Calculated Limits Achieved?	Month Exceeded (ΔT)
Algoma	Large	Yes	-
Amani	Very Large	Yes	-
Beaver Dam	Large	No	Nov (1)
Black Creek	Large	Yes	-
Blue Mounds	Very Large	Yes	-
Boscobel	Very Small	Yes	-
Bowler	Very Small	Yes	-
Brokaw	Very Small	Yes	-
Brookfield	Large	No	Oct (2) Nov (8) Dec (4) Jan (2)
Brooklyn	Small	Yes	-
Caroline	Very Small	Yes	-
Cedar Grove	Very Large	Yes	-
Cross Plains	Small	No	Aug (1) Sep (2)
Cumberland	Very Large	Yes	-
Delafield	Large	No	Nov (1)
Elmwood	Very Small	Yes	-
Hammond	LIMITS NOT CALCULATED		
Hudson	Very Small	Yes	-
Jones Island	Lake discharge	No	Sep (12) Oct (5) Nov (9) Dec (11)
Lake Mills	Large	Yes	-
Lancaster	Very Large	Yes	-
Madison Met.	Large	No	Oct (5) Nov (12) Dec (8) Jan (4) Feb (1)
Racine	Lake discharge	Yes	-
Superior	Lake discharge	Yes	-
Weyerhaeuser	INSUFFICIENT DATA		

Notes:

“VL” means “very large”, $Q_e/Q_s = 0$

“L” means “large”, $Q_e/Q_s > 1$

“S” means “small”, $0.1 < Q_e/Q_s < 1$

“VS” means “very small”, $Q_e/Q_s < 0.1$

“ ΔT ” represents the difference between the monthly average effluent temperature and the calculated weekly average temperature limitation, based on the draft thermal rule (as of June 11, 2007).

THERMAL IMPACT ZONES

As indicated, some POTWs would be unable to comply with temperature limits necessary to attain cool-season (fall/winter) sub-lethal temperature criteria where the ratio of receiving stream flow to effluent flow does not provide sufficient dilution. As a result, a zone will exist within the receiving stream downstream of the outfall where the sub-lethal temperature criterion is not met. Because the sub-lethal criteria are intended to protect gametogenesis in fish that require exposure to cool water to produce gametes, allowing chronic thermal impact zones where temperatures exceed these criteria may possibly have some adverse effect on the reproductive success of fish that inhabit these impact zones.

Since these impacts occur during the cooler periods of the year and since the relative difference in temperature between the POTW effluent and the criterion is small, WDNR anticipates that allowing these thermal impact zones will have no more effect on the receiving streams than the mixing zones or default dilution assumptions that are already a part of Wisconsin's permit limit calculation procedures. In nearly all cases where a receiving stream has some flow, chronic limits in WPDES permits are calculated based on an assumed dilution with the receiving stream of $\frac{1}{4}$ of the average minimum 7-day flow which occurs once in 10 years ($7Q_{10}$). Allowing dilution in this manner for attaining chronic limits is widely accepted across the country and is generally thought to have negligible impacts on aquatic organisms in the nation's surface waters. Allowed chronic thermal impact zones are similar to areas of allowed dilution because, although there may not be sufficient upstream flow to attain the chronic criteria through dilution, there is sufficient difference between the effluent temperature and the air temperature and ambient water temperatures to meet the chronic or sub-lethal criteria within a short distance from the discharge due to dissipation of heat from the POTW effluent to the cooler stream bed, receiving water, and air. The proposed rules include provisions to ensure that the area affected will be small, impacts on aquatic life minimized, and lethal conditions are prevented.

ALLOWED CHRONIC THERMAL IMPACT ZONES

As stated previously, allowed chronic thermal impact zones are limited or relatively small, restricted areas in surface waters where sub-lethal temperature criteria may not be attained as the POTW effluent cools to ambient temperatures. From the perspective of aquatic organisms in a receiving water, allowed chronic thermal impact zones function in exactly the same way as assumed dilution used in the calculation of WPDES permit limits for toxic substances based on chronic water quality criteria. In both cases, there will be a gradient of water quality from a high concentration or temperature at the point of discharge to a lower concentration or temperature at some location downstream or away from the discharge point that complies with the criterion. The theory behind both is that small areas of elevated concentrations or temperatures within a water body may be tolerated without having an unacceptable impact on the biological community of the water body as whole. The primary difference is that with allowed chronic thermal impact zones, the gradient occurs as a result of loss of heat from the effluent to the surrounding environment, rather than primarily from dilution.

Federal regulations at 40 CFR 131.13 allow states to include procedures in their water quality standards that describe how the water quality standards will be implemented. Mixing policies are identified in the Federal regulations at 40 CFR 131.13 as an example of this kind of implementation procedure. USEPA has approved state mixing procedures that allow for default dilution in the calculation of permit limits where the default dilution can be reasonably expected to not have an unacceptable impact on the biological community of a receiving water as a whole. USEPA Great Lakes Water Quality Guidance at 40 CFR 132 incorporates the concept of default dilution for limits based on chronic criteria into the implementation procedures contained in the Guidance. The State of Wisconsin has incorporated these requirements into ch. NR 106, Wis. Adm. Code.

WDNR recognizes that POTWs still must comply with acute temperature criteria to ensure that lethality does not occur in State waters. However, allowed chronic thermal impact zones are appropriate for sub-lethal temperature criteria if implemented in a way that ensures that the sub-lethal criteria are attained

within a limited or short distance from the POTW discharge location and for the waterbody as a whole. Consistent with this model, the proposed s. NR 106.59 allows for similar consideration of default assumed cooling in the calculation of limits for temperature to comply with sub-lethal temperature criteria. Since it is widely accepted practice that limited areas may be permitted within a surface water where chronic criteria are not attained provided there is sufficient area within the waterbody as a whole where chronic criteria are attained, WDNR believes that allowing for default assumed cooling to meet sub-lethal criteria is consistent with the Federal Clean Water Act and regulations and state law.

ADDITIONAL CONSIDERATIONS

To meet limits that would apply under the calculation procedures in the proposed rule, some POTWs would have to employ a cooling system for the effluent. Although cooling towers may be effective during some months, some type of mechanical cooling would be needed whenever air temperatures are higher than effluent temperatures. This can occur at any time of the year. The use of cooling towers for POTW effluent temperature reduction would also necessitate enhanced treatment and the addition of biocides or other additives to assure effective operation.

If cooling were required, WDNR believes the most practical means of cooling at smaller facilities is the use of a packaged chilled water plant utilizing an air-cooled condenser. For larger plants, the most practical means of cooling the effluent is the use of a packaged chilled water plant utilizing a water-cooled condenser and a cooling tower in conjunction with a glycol loop.

Based on this information, the following are additional considerations used in formulating the final rule:

1. There are several direct and indirect costs associated with requiring cooling systems at POTWs. There are direct capital and operating costs for the cooling equipment over and above the costs for treatment to remove other pollutants.
2. The energy needed to operate the cooling equipment will result in an increased drain on our overall electrical generating and transmission capacity. Such increases result in increased emissions of air pollutants and carbon dioxide from power plants.
3. USEPA or another state routinely evaluated POTW effluent temperatures when establishing water quality based effluent limitations.
4. POTW effluent, as stated, exhibits a very moderated temperature regime reflective of seasonal ambient surface water temperatures. The difference between ambient and effluent temperatures is usually small and not significant during most parts of the year. POTW effluent temperatures are primarily controlled by soil or ground temperatures. Raw sewage has temperature similar to groundwater that may exfiltrate into streams. Although temperatures may change within the treatment facility, the effluent temperatures are not largely different from that of ambient surface waters.
5. Related to the foregoing, § 283.17, Wis. Stats., (and § 316(a) of the Federal Clean Water Act) contains provisions that allow for the establishment of “alternative” effluent limitations for temperature provided that such limitations “...assure the protection and propagation of a balanced indigenous population of shellfish, fish and wildlife in and on the body of water into which the discharge is made.” USEPA has adopted regulations to implement the provisions of § 316(a) at 40 CFR 125. The Department’s corresponding rule at NR 209 Wis. Adm. Code, as modified and included in the proposed rule at NR 106, Subchapter VI, Wis. Adm. Code, contains provisions similar to the federal regulation.

PROPOSED RULE FOR HEARING

In the rule proposal subject to comment earlier in 2008 on this matter, WDNR contemplated establishing a variance to attaining thermal water quality standards for existing POTWs based on findings that installation of cooling systems at such facilities is prohibitively expensive and would cause substantial and widespread social and economic impacts. The proposed rule did, however, require the Department to include effluent temperature limitations in POTW permits if the following conditions were present:

- Representative effluent temperatures are greater than 120°F; or
- The Department determined that the effluent temperature has demonstrated impacts on aquatic populations at the site.

Additionally, this “variance” for POTWs would not apply to new POTW sources because new sources are better able to select sites and discharge locations for new wastewater treatment facilities where thermal effluent limitations determined according to the rule can be attained at all times.

PROPOSED RULE FOR ADOPTION

In response to the proposed rule, the Department received comments from parties that were both in support of and opposed to the proposal (Refer to Attachment A). Most significantly, USEPA commented that the data and analyses provided by the Department did not satisfy the requirements of the Federal 40 CFR 131.10(g), thus USEPA could not support a variance from water quality standards specific to municipal discharges. Those who generally expressed support suggested that the rule should grant an outright exemption rather than create a variance process and that the variance should extend to new facilities as well as existing facilities. The commenter generally opposed to the variance indicated that the basis for establishing this variance to POTWs was not substantiated and, therefore, should not be granted, as proposed.

The comments received from USEPA urged the Department to consider the possibility of incorporating consideration of default assumed cooling through allowed chronic thermal impact zones instead of a statewide variance from water quality standards for POTWs facing cool season temperature limits. USEPA explained that what was being sought through the variance proposal was functionally an allowed zone for cooling and that is procedurally and functionally identical to the assumed dilution approach already incorporated into Wisconsin’s procedures for calculating limits and already accepted by USEPA and Wisconsin stakeholders.

The Department believes that the allowed chronic thermal impact zone provision included in the proposed rule at NR 106.59 provides a technically, scientifically, and legally defensible mechanism for evaluating effluents for cool season temperature limits. POTW effluent discharges of heat are not causing and are not known to cause an impairment to water quality including the protection and propagation of a balanced population of shellfish, fish and wildlife in and on surface waters. The final rule provides safeguards to ensure that any allowed chronic thermal impact zones will be small, will prevent lethal conditions, and will not impair the overall biological community of any water body as whole. Authorizing the Department to exercise the discretion, through the WPDES permitting process, to establish limitations where there is or could be demonstrated harm is a reasonable means to assure that temperature limits will provide this protection.

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ATTACHMENT A

COMMENTS RECEIVED IN RESPONSE TO PROPOSED RULE

In response to the proposed rule, the Department received comments from 5 parties with respect to the provisions of NR 106.59, Wis. Adm. Code. Midwest Environmental Advocates disagreed with the proposal to grant a variance to POTWs for the following reasons:

- The variance was not sufficiently justified and no categorical variance should be granted;
- Granting the variance will not assure that standards are attained;
- The variance should not extend for more than 3 years;
- Effluent temperature monitoring is not required in all cases;
- Effluent temperature limitations should reflect current effluent temperature in all cases to assure they do not increase; and
- The variance should not be extended to new facilities.

Conversely, four commenters affiliated with POTWs supported the variance and/or suggested revisions to the proposed rule. The comments included the following:

- POTWs should be exempt from temperature limitations, rather than requiring an application and granting variances;
- New POTWs should be allowed to apply for and be granted variances in the same manner as existing facilities because the costs are equivalent regardless if a new or existing facility, and there could be an effect on use of effluent reuse options;
- The environmental impacts of operating cooling technology at POTWs is greater than the thermal impact of POTW effluent;
- The rule should “guarantee” the granting of a variance to a POTW that applies for the variance.