24 November 2022

Mayor Michael Dehn
Town of Erin
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WSP Engineering
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Aziz Ahmed P. Eng.
Ministry of Environment, Conservation and Parks
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Re: Effluent Cooling System for Erin Water Resource Recovery Facility

Dear Sirs:

The Coalition for the West Credit River remains very concerned that the Erin Water Resource Recovery Facility (Erin WRRF) has the potential for high effluent temperatures impacting Brook Trout in the West Credit River.

The Environmental Compliance Approval (ECA), issued on 3 May 2022, requires effluent to be chilled during the summer months, such that the 4-day average effluent temperature remains below 19°C.

We understand that WSP has had difficulty finding an appropriate effluent cooling system model, and our inquiries to determine the status of the design have met with no response. We are seeking an update on the status of the design of the required effluent cooling system.

The Coalition submits that modern heat pumps, coupled with the shading of all outside tankage with solar panels, would offer a cost-effective and sustainable means to ensure the effluent temperature remains below 19°C.

Coalition Recommendations:

What follows are initial calculations and assumptions which indicate a heat pump cooling system, combined with tank shading by solar panels, would supply most of the additional energy required to cool the effluent down to 19°C.

Summary of the calculation steps are as follows:

1. Calculates the rate of heat to be removed from the effluent (1,400 kW)
2. Calculates the electrical energy to remove the heat from the effluent using a heat pump (350 kW)
3. Estimates the annual cost of the electrical energy to run the heat pump system ($168,000/year)
4. Estimates the annual operating cost increase of this electrical energy (17%) prior to using solar panels to reduce energy demand
5. Calculates the reduced rate of heat to be removed from the effluent if the tanks were shaded (625 kW)
6. Estimates the electrical energy generated if the tanks were shaded by solar panels (155 kW)
7. Shows that the electrical energy required to remove heat from the effluent, if the tanks are shaded is approximately the same as the electrical energy generated by the solar panels (156 kW vs 155 kW)

While not discussed below, we recommend that the cooling system has extra units for stand-by capacity and that the overall cooling system is oversized by approximately 30% as a factor of safety.

We offer the following concept and preliminary analysis in the hope that real efforts will be made by the Town of Erin to design and submit for approval a practical, cost-effective, and sustainable effluent cooling system. The Coalition is currently researching cost estimates for the necessary equipment from reliable vendors.

Our calculations and assumptions:

1. *Calculate the rate of heat to be removed from the effluent (1,400 kW)*

   Determine the amount of heat requiring removal from the effluent, assuming the effluent is 23°C and needs to be cooled by 4°C down to 19°C. As MECP is aware, we have submitted actual effluent temperature data from a number of sewage plants in the area that show effluent temperatures commonly exceed 22°C during the summer and, in some cases, approach 23°C. Unfortunately, effluent temperatures will no doubt become even warmer in the future due to climate change.

   Heat requiring removal = specific heat of water (kilo joules per kg per degree C) X effluent flow rate (flow rate in cubic meters per day) X 1,000 kg/cubic meter x 4°C temperature reduction requirement:

   = 4.180 kilojoules per kg (KJ) per degree C temp change X 7,200 cubic meters per day effluent flow X 1,000 kg/cubic meter X 4 C

   = 120,384,000 KJ per day

   = 1,393 KJ per second = 1,393 kW (round to 1,400 kW)

2. *Calculate the electrical energy to remove the heat from the effluent using a heat pump (350 kW)*

Use modern heat pumps to remove heat from the effluent and discharge such removed heat to the atmosphere – assuming there is no commercial need for heat locally, especially during the hot summer period. Assume such heat pumps have a coefficient of performance (COP) of 4

Energy draw of heat pump system = 1,400 kW / 4 = 350 kW

3. *Estimate the annual cost of electrical energy to run the heat pump ($168,000/year) without shading of the tanks with solar panels*

   Energy cost per day to run heat pump system at assumed 16.3 cents per kWh = 350 kW X 24 hours per day X $0.163 = $1,369 per day (round to $1,400 per day).

   Estimated annual power costs assuming the effluent chiller system is required to run four months per year (120 days per year) = $168,000 per year.

4. *Estimate the annual operating cost increase of this electrical energy (17%)*

   Assuming the sewage plant's "all in" operating costs are approximately $1,000,000 per year (three operators, hydro for blowers and UV etc., chemical costs and sludge disposal costs etc.), the additional power costs of the chiller system would only increase operating costs by potentially 16.8% ($168,000/$1,000,000).

5. *Calculate the reduced rate of heat to be removed from the effluent if the tanks were shaded (625 kW)*

   Reduce heat gain (and reduced effluent temperatures) by shading all outside tankage (including primary clarifiers, secondary treatment aeration and denitrification tanks and secondary clarifiers) with a solar panel roof system but with open sides for full ventilation. The shading will reduce the heat gain of the effluent, and the electricity produced by the solar panels could offset the extra (but now reduced) power requirement of the effluent cooling system.

   Heat gain without shading = Area of tanks X solar radiation level when sunny X hours per day of full sun exposure.

   = 3,100 square meters (area of all tankages as estimated from WSP drawings etc.) X full sun radiation (1,000 W per square meter) X 25% due to nighttime hours and cloudy days:

   = 775,000 W

   = 775 kW

   As per step 1, we estimated the requirement for cooling was 1,400 kW to drop the effluent temperature by 4°C. As such, assume that with full shading of outside tanks, the requirement for cooling would be reduced by about half (1,400 kW – 775 kW = 625 kW). This means that likely the effluent temperature from a fully shaded system would be 21°C instead of the originally assumed 23°C.

6. *Estimate the electrical energy generated if the tanks were shaded by solar panels (155 kW)*

   Determine energy available to run heat pumps from the solar panel system used to shade all tanks.

   Solar panels produce electricity at approximately 200 Watts per square meter. Therefore, assuming 3,100 square meters of solar panels (as per point 4), the power potential from the panels would be 620 kW. However, as per step 4, assume a 75 % reduction of power supply from the solar panels due to non-daylight hours and cloudy days.

   Net power from the solar panels = 200 W/square meter X 3,100 square meters x 25% net output reducing factor:

   = 155,000 W

   = 155 kW net power supply from solar panels

7. *Show that the electrical energy required to remove heat from the effluent if the tanks are shaded is approximately the same as the electrical energy generated by the solar panels (156 vs 155 kW)*

   Use extra power from solar panels to help power a reduced heat pump system to reduce effluent temperature to 19°C.

   As per step 1, assume a COP for the heat pump system of 4. As such, a 155 kW power supply from solar panels results in a heat pump system with a temperature reduction potential of 620 kW (4 X 155 kW). As per step 2, the reduced energy flow requirement from the effluent is only 625 kW – once the tanks are fully shaded, and the effluent temperature is already reduced prior to chilling by virtue of full shading of the tanks.

   At this point, the solar panel array appears to offset essentially 100 % of the additional power required to run the heat pump effluent cooling system during the 4-month period of its operation.

   It should be noted, however, that the solar panels will be generating electricity 12 months per year, not just the 4-month period used as the basis for all of the calculations above. This means that over the course of a year, the solar panels would produce 3 times (12 months / 4 months = 3) the electricity needed to run the heat pump system. This excess electricity could be used to offset the other electrical requirements of the Erin WRRF, or the number of solar panels required to operate the heat pump system could be reduced by two-thirds.

   Hydro One has a Net Metering program that could see them 'purchasing' the electricity from the solar panels for 12 months of the year, and then 'selling' the equivalent electricity back to the WRRF to run the heat pump system for 4 months of the year. The 'net' cost of the electricity for the heat pump system would amount to zero dollars.

If the effluent cooling system design has been submitted to MECP for review, we request access to its design, including all supporting calculations. We would submit the design to our own qualified cooling system experts for peer review at our own cost. The rationale for such a peer review is to ensure that the effluent cooling system is not undersized or vulnerable to failure.

In closing, the West Credit River coldwater ecosystem is too important to gamble on an untried and untested effluent cooling system. In our view, this extra review is warranted.

We look forward to your written response to our recommendations and to receiving the cooling system design for independent review and comment.

Respectfully,

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