SUPPLEMENTAL ANALYSIS ADDENDUM TO THERMAL ANALYSIS OF FUTURE COOLING WATER DISCHARGE

Hu Honua Bioenergy, Pepeekeo, Hawaii, dated May 1, 2018 and updated August 20, 2018

This memorandum provides additional technical information in support of a thermal analysis of planned spent cooling water discharge into a suite of underground injection control (UIC) wells on the Hu Honua Bioenergy property. The evaluation of the thermal effects of spent cooling water and its potential temperature effects on ocean water were described in the Integral report entitled *Thermal Analysis of Future Cooling Water Discharge, Hu Honua Bioenergy, Pepeekeo, Hawaii*, dated May 1, 2018 and updated August 20, 2018.

Original Analysis

The analysis utilized numerical models of the groundwater and ocean water systems to evaluate theoretical (non-empirical) thermal effects of the proposed underground injection of spent cooling water. Assumptions on spent cooling water flow rate and temperature were based on engineering calculations, consisting of a total cooling water flow rate of 21.6 mgd at a time-weighted average maximum operating temperature of 30.7°C (87.3°F). The time-weighted average maximum temperature of spent cooling water of 30.7°C (87.3°F)[1] used for modeling was based on the facility's highest anticipated use under the power purchase agreement's dispatch range, based on the temperature mass balance through the boiler and condenser when operating at high load for 14 hours per day (temperature of 32.5°C [90.5°F]) and low load for 10 hours per day (temperature of 28.2°C [82.7°F]).

Surface water modeling was conducted using output from the groundwater model under a no UIC injection scenario (ambient conditions) and an active UIC injection scenario. The no UIC injection scenario predicted ocean water temperature within 1 meter (m) of the bottom at 24.90°C (76.82°F), compared to a maximum temperature under the active UIC scenario in that same location at 25.02°C (77.04°F). The relative increase in ocean water temperature in this bottom layer between the scenario with no UIC injection (ambient conditions) and the active UIC cooling water injection scenario was 0.12°C (0.22°F).

Supplemental Analysis

At the request of the State of Hawaii Department of Health, Clean Water Branch on September 13, 2018, a supplemental analysis was performed to evaluate a "worst case"

[1] Spent cooling water injection temperature has been updated based on recent engineering analysis.

operating scenario at the highest load of 21.5 MW net (25.5 MW gross) for 24 hours/day under the power purchase agreement with the utility (even though such an operating scenario is highly unlikely since the facility is subject to dispatch limitations with the utility) consisting of a cooling water flow (injection) rate of 21.6 mgd at a constant operating temperature of 32.5°C (90.5°F). Under this active UIC scenario, the combined groundwater and surface water models predicted a maximum ocean water temperature of 25.06°C (77.11°F) within 1 meter (m) of the bottom at the same location of the original analysis, a relative increase of 0.16°C (0.29°F) above the no UIC injection scenario.

In summary, the "worst case" spent cooling water temperature of 32.5°C (90.5°F) resulted in a slightly higher relative increase in bottom ocean water temperature of 0.16°C (0.29°F) as compared to the anticipated operating scenario of 0.12°C (0.22°F). Both the anticipated operating scenario and "worst case" scenario indicate that an insignificant or *de minimis* temperature difference of less than 1.0°C would occur at the bottom of the ocean. No significant impact to the ocean is anticipated even under the "worst case" scenario.