Cornell University
January 2017

Summary: Outfall Redesign Report

Objective

Preparation of the Outfall Redesign Report was among the conditions of the 2013 SPDES permit issued to Cornell for continued operation of the Lake Source Cooling (LSC) facility. The objective of this permit condition was to evaluate potential alternative locations for the LSC outfall within the lake's Class AA segment. Three tasks were required: (1) define the mixing zone of the current LSC outfall; (2) identify alternative locations in the Class AA segment where the LSC return flow would remain below the photic zone; and (3) determine that the discharge would not contribute to an impairment of the lake's designated uses. NYSDEC approved the project workplan on May 1, 2014. Three progress reports were submitted at eight-month intervals, and the final report was submitted on November 1, 2016. Preparation of a technical publication for the peer-reviewed literature is underway. The project completion report is posted on the NYSDEC web site at http://www.dec.ny.gov/docs/water_pdf/cornelllscoutfall4.pdf

Technical appendices are also on the web site at http://www.dec.ny.gov/docs/water_pdf/cornelllscoutfall4a.pdf

Current Mixing Zone

Professor Edwin A. (Todd) Cowen and Dr. Alexandra (Allie) King of Cornell University School of Civil and Environmental Engineering's DeFrees Hydraulic Laboratory, which resides in the College of Engineering, were the project's Principal Investigators. They used the three-dimensional (3D) hydrodynamic model Si3D to complete numerical simulations of the water motion (hydrodynamics) of Cayuga Lake. Model runs predicted the LSC thermal plume under various conditions of facility performance and environmental conditions; model predictions were consistent with detailed measurements from an intensive field monitoring program. As documented in the November 2016 final report, the plume is small, in all cases less than 500m in diameter.

The Si3D model was applied to estimate residence time of water at multiple locations across the shelf, under current conditions and with an extended outfall. Residence time is short and highly influenced by the LSC return flow. Under the meteorological conditions that create the longest residence time (low wind, low streamflow), moving the LSC outfall to the Class AA segment is projected to increase residence time on the shelf from the current conditions of 1.8 days to approximately 3 days (a 67% increase).

Location in Class AA Segment

The project team analyzed years of Cayuga Lake light penetration data to characterize the depth of the photic zone within the Class AA segment, and then applied an EPA-approved mixing model (CORMIX 1) to define how high the LSC return flow would rise upward in the water column under critical conditions of lake temperature, LSC facility operation, and weather. A location 200m north of the 303(d) line was demonstrated to meet the NYSDEC criteria. Conceptual design, cost estimates, and a timeline for implementation were prepared. An outfall extension would take about seven years to design, permit, and construct at an estimated cost of $13.4M. An extended outfall would result in higher pumping heads and more energy use. Increased energy use with no offsetting benefit is in direct opposition to the University's goals for carbon neutrality as well as New York State commitments to climate action.

Relationship to Designated Uses

The project team applied the preliminary Cayuga Lake Water Quality Model to evaluate the water quality impact of relocating the outfall to the Class AA segment. The modeling indicates that concentrations of total P and chlorophyll-*a* would increase on the shelf if the LSC outfall were relocated. Water column turbidity and silt/sediment levels on the shelf would also increase without the LSC return flow. Relocating the outfall would have no beneficial effect on total P or chlorophyll-a in any region of the lake. The conclusion is that extending the outfall would exacerbate the water quality parameters for which the shelf is designated impaired, and is therefore counter-indicated.

Conclusions

Based on the detailed modeling and analysis completed to date, an outfall extension would not provide any environmental benefit. The LSC return flow reduces residence time of water on the shelf, thus diminishing the risk of algal blooms and diluting influent silts and sediment from the tributaries. The current LSC operation provides a net water quality benefit to southern Cayuga Lake and enables the University and State to advance their climate goals.