Executive Summary

In August 2010, Toronto City Council authorized the General Manager of Toronto Water to engage the professional services of a firm to undertake a peer review of the Ashbridges Bay Treatment Plant Effluent Disinfection Class Environmental Assessment Study Report prepared by AECOM, dated February 2010. Our findings are presented in this Peer Review Report.

FOCUS OF PEER REVIEW STUDY

This peer review by Associated Engineering focussed on certain elements within the Ashbridges Bay Treatment Plant Effluent Disinfection Class EA Study, dated February 2010:

- Review development of alternative disinfection strategies.
- Review the decision making process and conduct a sensitivity analysis.
- Within the decision making process, assess the assigned weights for costs, green house gas (GHG) emissions and disinfection by-products (DBPs).
- Verify costs (capital, O&M, 20 year life-cycle costs).
- Conduct a sensitivity analysis on costs.

The Ashbridges Bay Treatment Plant (ABTP), currently uses gas chlorination for effluent disinfection.

During normal flow conditions chlorine solution is added to the secondary effluent channels. When the plant receives flows at the rated capacity of 818 ML/d, the chlorine contact time does not meet the MOE Guidelines 2008. During wet weather conditions, when the flow exceeds the secondary treatment capacity, excess flow receives only primary treatment and primary effluent blends with the secondary effluent and discharges through the outfall. During these periods, chlorine is added to primary effluent bypass channels, in addition to the secondary effluent.

In October 2008, the City of Toronto initiated a Schedule B Class Environmental Assessment study for effluent disinfection for the ABTP. The Class EA Study was completed by AECOM in February 2010 and is the subject of this peer review.

The Schedule B Class EA identifies the preferred strategy for disinfection of secondary effluent and primary effluent bypass flow from the ABTP. Four alternatives were selected for detailed evaluation as possible options for effluent disinfection:

- Alternative 1 – UV disinfection for secondary effluent and primary effluent bypass.
- Alternative 2 – UV disinfection for secondary effluent and chlorination/dechlorination for primary effluent bypass.
- Alternative 3 – Ozonation of secondary effluent and primary effluent bypass.
- Alternative 4 – Chlorination/dechlorination for secondary effluent and primary effluent bypass.

Alternative 4 scored the highest in the multi-criteria analysis, and was selected as the preferred option. It should be noted that Alternative 3 was excluded from this peer review, as ozonation for effluent disinfection scored the lowest and had the highest capital and O&M costs.

KEY FINDINGS

Our findings are based on a detailed peer review of the design requirements, cost estimates and multi-criteria analysis presented in the Class EA Study.

Conceptual Design of Alternatives

The process designs used in the conceptual design of the alternative disinfection strategies are sound. Although we have identified several minor differences in the design approach, the design requirements of the Ontario Ministry of the Environment Design Guidelines for Sewage Works, (2008) have been met. The conceptual design of the alternatives provides a reasonable foundation for the development of capital and operating and maintenance costs.

Environmental Impacts

The discussions on environmental impacts of the disinfection alternatives were reviewed and found to be reasonable. The risks of release of chlorine residual and disinfection by-products (DBPs) were addressed, as were green house gas (GHG) emissions, risks of spills during transport and handling of materials and impacts during construction. Although this peer review includes minor comments, none presented a challenge to the eventual recommendation of the Class EA Study.

Social Impacts

In the discussion of social impacts, the Class EA Study used a total of eight criteria for evaluation of the alternatives. Based upon these evaluation criteria, our assessment is that the result of the ranking of alternatives within the social impacts index is correct. Minor adjustments discussed in our detailed review do not appreciably impact the order of ranking of the alternatives.

Economic Impacts

In the peer review of the cost estimate data, it was noted that the level of detail of the background information was relatively limited. This is understandable for estimates at the conceptual level.

After adjusting the cost estimates to take into account peer review findings with respect to economic factors, the relative ranking of the capital costs of the disinfection alternatives remained unchanged. For the 20 year life-cycle costs, our analysis indicates that the relative position of the disinfection alternatives remains unchanged. Alternative 4 involving effluent disinfection by chlorination remains the most cost effective alternative.

In the peer review process, we identified site specific utility, chemical and labour costs and modified the operations and maintenance costs. These operating cost adjustments tended to favour Alternative 4 over Alternative 2, because they included increased electricity rates based on 2011 actual rates and lower chemical costs (based on current City contracts).

For the 20 year life-cycle costs, our analysis indicates that the relative position of the disinfection alternatives remains unchanged. Alternative 4 involving effluent disinfection by chlorination remains the most cost effective alternative.

The results of the reassessment of the three alternatives under this peer review are summarized in Table ES-1. The costs are higher than those in the Class EA Study for a number of reasons, discussed within this report.

Table ES-1
Comparison of Disinfection Alternatives
(Revised from Table 43 of the Class EA Study)

	[illegible]		
	Alternative 1 UV disinfection for secondary effluent and primary effluent bypass	Alternative 2 UV disinfection for secondary effluent and chlorination/ dechlorination for primary effluent bypass	Alternative 4 Chlorination/ dechlorination for secondary effluent and primary effluent bypass
Secondary effluent disinfection	UV	UV	Sodium hypochlorite/ sodium bisulphite
Primary effluent bypass disinfection	UV	Sodium hypochlorite/ sodium bisulphite	Sodium hypochlorite/ sodium bisulphite
Effluent pumping requirements [1] Minimum pumping requirement Maximum pumping requirement	 4,000 ML/d 4,000 ML/d	 2,000 ML/d 4,000 ML/d	 0 ML/d 4,000 ML/d
Green House Gas Emissions [2]	3786 kg CO_2 e/d	3794 CO_2 e/d	1846 CO_2 e/d
Energy demand [3]	6.6 MW	2.9 MW	0.3 MW
Increase in ABTP energy demand [4]	45%	20%	2%
Capital Cost, 2014 dollars, (minimum pumping)	$290,100,000	$183,000,000	$134,100,000
Capital Cost, 2014 dollars, (maximum pumping)	$290,100,000	$200,500,000	$169,300,000
First Year (2015) O&M Cost (Cash Flow dollars)	$2,350,000	$2,160,000	$1,720,000
20 year Life-Cycle Cost (NPV 2011 dollars, maximum pumping requirement) [5]	$297,100,000	$213,300,000	$179,100,000.

Notes:

1. As discussed in Section 5 of the Class EA Study, minimum and maximum (conservative) pumping requirements for each alternative were developed. These requirements need further evaluation based on factors such as the feasibility of a split outfall chamber, MOE approval of primary effluent bypass discharge through one dedicated outfall during extreme peak flow events and diffuser design and overall outfall headloss based on Lake modelling and MOE approvals.
2. Based on rated average day flow (818 ML/d) operation for secondary effluent disinfection system and average annual primary effluent bypass volume of 6 ML/d (calculated based on historical flow data from 2000 – 2008).
3. Based on peak disinfection process energy demand and minimum required pumping for each Alternative (4,000 ML/d for Alternative 1, 2,000 ML/d for Alternative 2 and 0 ML/d for Alternative 4).
4. Based on existing plant energy demand of 14.7 MW.
5. Based on 3% inflation and 5% interest rates.

Costs Beyond the 20 Year Planning Horizon

The Class EA Study failed to recognize the difference in salvage value of the disinfection facilities at the end of the 20 year project life-cycle assessment period. Whereas concrete tankage can be expected to have a 50 to 60 year useful life, most mechanical, electrical and control equipment has an operational life closer to a 20 year installation life. Because the UV alternatives have a major component of equipment that would likely have to be replaced after 20 years, and chlorination/dechlorination has a much lesser equipment component, there would be significantly higher equipment replacement costs for Alternative 2 than for Alternative 4. This represents another significant economic advantage for chlorination/dechlorination that was not previously recognized.

Evaluation of Class EA and Decision Making Process

The evaluation process for the disinfection alternatives (multi-criteria analysis within a Triple-Bottom-Line (TBL) framework) was considered to be acceptable, although some findings and potential improvements were noted.

Alternative Evaluation Process Sensitivity

Based on the sensitivity analysis performed as part of the peer review, Alternative 4, chlorination/dechlorination remains the highest scoring alternative regardless of changes in the index weightings. Furthermore, if all indicators within the individual indexes are given the same weighting of importance, Alternative 4 continues to be the highest scoring alternative, although the relative difference to the scores of the other options does decrease. Finally, if the 9 indicators we have identified as risk factors are removed from the TBL evaluation, Alternative 4 continues to be the highest scoring alternative.

Green House Gas Emissions

The review of the green house gas emissions for the disinfection alternatives suggests that the general approach to the analysis was made according to current industry practice. Our findings that the green house gas emission factor for sodium hypochlorite production should be higher than that used in the Class EA Study does not impact the result that Alternative 4 generates the least quantity of green house gas emissions. The weighting of the GHG emission criterion within the 6 environmental criteria was "high" and awarded 24 percent of the available environmental weight points. This seems appropriate given the City's target to reduce GHG emissions over the long term.

Disinfection By-Products

The Class EA Study provided relatively little specific information on the subject of disinfection by-products generated by the disinfection alternatives. However, regulatory authorities in Ontario (Ministry of the Environment) and at the federal level in the United States (USEPA), recognize that properly conducted dechlorination is sufficient to minimize the toxic effects to aquatic organisms of the disinfection by-products of chlorination. The peer review finds that the weighting of the disinfection by-product criterion was suitable – "medium" – with 12 percent of the available environmental weight points.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Alternative selection — This peer review confirms that the Class EA Study has correctly selected Alternative 4 as the top ranked disinfection strategy. This alternative includes using liquid sodium hypochlorite for disinfection and liquid sodium bisulphite for dechlorination for both secondary effluent and primary effluent bypass.

Alternative evaluation process – This review has identified that the process used for the evaluation of the four disinfection strategy alternatives is basically sound. The multi-criteria analysis tool, utilized in a triple-bottom-line based comparative evaluation framework, is an appropriate approach for the Class EA Study. The review has identified a number of "procedural" items that we believe are important, and has provided suggested alternate methodologies for consideration.

The technical concept development was found to be acceptable, despite relatively minor findings. The alternative evaluation process used was acceptable (with findings) and relatively robust in that Alternative 4 remained the highest ranked effluent disinfection alternative when considering alternate scoring and weighing criteria.

Cost estimates – The sensitivity analysis performed on the cost estimates increases capital cost and O&M costs beyond those presented in the Class EA Study. However, the analysis confirms the relative position of alternatives. Alternative 4 is the most cost effective both considering initial capital cost and the life cycle cost.

DBPs and GHG – The evaluation of DBPs and GHG emissions was found to be reasonable within the multi-criteria analysis structure.

RECOMMENDATIONS

The following items are recommended for consideration by the City in the design of the proposed effluent disinfection works.

Effluent Pumping Station – The design of the proposed replacement effluent outfall system is required to finalize the plant hydraulic profile and resolve the need for final effluent pumping.

Effluent Channels – The optimum location and routing of the primary effluent bypass and secondary effluent channels needs to be determined. This should be co-ordinated with the constraints of the outfall design and also allow for maximum flexibility to include potential future facilities. The effluent channels represent a significant portion of the capital cost for all of the disinfection alternatives that were evaluated.

Chlorination/Dechlorination Process – A study of the optimum means for control of sodium hypochlorite feed and control of dechlorination reagent feed is recommended. It is also recommended that facilities for providing rapid mixing of both chemical reagents with the effluent be investigated. Further design development is recommended to determine the optimum means to achieve chlorination/dechlorination. Alternatives include the use of separate tanks as in Alternative 4, use of the effluent channels, use of the outfall pipes with simulators to provide a means of dosing control, or use of smaller tanks on shore combined with use of the outfall pipes.

The chlorination/dechlorination design concept used was based on new dedicated chlorine contact tanks. The optimum location for providing the necessary contact time for disinfection and dechlorination is subject to further design development and evaluation. There is significant potential to reduce the costs for Alternative 4 based on design concepts that have been used at other Toronto wastewater facilities and elsewhere in Ontario.

Outfall Pipes for Chlorination/Dechlorination – There is potential to use the proposed new outfall pipes for providing the necessary contact time for both chlorination and dechlorination. Further study is needed to resolve whether the decision to use the outfall pipes in this way needs to be made before starting the process of study, design and application for approval for the outfall pipes.

Availability of High Voltage Power Supply – The power demand and associated high voltage power supply requirements for each alternative were evaluated as part of the peer review, to identify potential Toronto Hydro service upgrade requirements. As the power demand for Alternative 4 is limited, an upgrade to the Toronto Hydro service would likely not be required.