Evaluation of an Innovative Technique for Augmenting Stream Baseflows and Mitigating the Thermal Impacts of Stormwater Ponds

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NOTICE

Photo credit: Photos of cooling trench construction on the front cover are by Doug McGill

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Reports conducted under the Sustainable Technologies Evaluation Program (STEP) are available at www.sustainabletechnologies.ca. For more information about this project or the STEP program, please contact:

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THE SUSTAINABLE TECHNOLOGIES EVALUATION PROGRAM

The Sustainable Technologies Evaluation Program (STEP) is a multi-agency program, led by the Toronto and Region Conservation Authority (TRCA). The program helps to provide the data and analytical tools necessary to support broader implementation of sustainable technologies and practices within a Canadian context. The main program objectives are to:

- monitor and evaluate clean water, air and energy technologies;
- assess barriers and opportunities to implementing sustainable practices;
- develop supporting tools, guidelines and policies, and
- promote broader uptake of sustainable practices through education and advocacy.

Technologies evaluated under STEP are not limited to physical products or devices; they may also include preventative measures, alternative urban site designs, and other innovative practices that help create more sustainable and liveable communities.

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EXECUTIVE SUMMARY

This project evaluates an innovative cooling trench feature installed as part of the stormwater management pond operation design in the West Cathedral Subdivision in Markham. The technology, known as the Groundwater Emulation Management System (GEMS), was designed to maintain cool stream discharge from the SWM pond catchment at a level similar to that experienced prior to development. This is accomplished by slowly draining water from the permanent pool to a cooling/infiltration trench. The cooling trench lowers the temperature of pond water through below ground heat transfer and discharges to the receiving watercourse at a rate and volume mimicking the natural discharge of groundwater. Estimated reductions in groundwater recharge caused by the conversion of land from agriculture and open space to residential use provided the basis for setting continuous flow rates released into the system.

Monitoring of the system was initiated in late August 2011, after the system was commissioned and shown to be functioning. Monitoring continued from August until late September, 2011, and again from late May 2012 to the end of September. The flow rate through the system was considerably lower than the target design flow, but sufficient to evaluate the system's cooling potential. The temperature of water discharged from the system fluctuated between 20 and 25°C during the warmest summer months, and was up to 5°C cooler than pond inlet temperatures. By comparison, the normal pond outlet had peak temperatures approximately 3 to 4°C warmer than observed from the cooling system outlet, which resulted in an increase in the average and maximum temperature of Carlton Creek by 0.6 and 1.1°C, respectively. While the cooling trench system helped mitigate the thermal impact of the pond, the outlet temperatures were warmer than groundwater discharge to streams and above the 21°C threshold for the protection of cool water fisheries.

Three grab samples at the inlet and outlet of the system after rain events indicated average total suspended solids (TSS) removal efficiency and effluent concentration of 25% and 37.5 mg/L, respectively. The outlet catchbasin and/or trench were thought to be a potential source of TSS. The inlet, which was modified from its original design, also provided limited opportunity for filtration of pond water.

A depth profile of four temperature sensors was installed at the normal outlet to characterize the thermal mitigation effects of top versus bottom (or mid) draw outlets, in comparison to the cooling effects of the trench system. These sensors were installed at approximately 0.31, 0.57, 1.10 and 1.53 meters below the normal pond water level. The pond outlet drew water from just over 0.5 m from the normal pond water level. The depth sensor data showed a peak temperature difference over 1.22 m of between 4.5 and 5.0°C, highlighting the potential thermal benefits of reverse slope outlet configurations that draw water from deep within the pond. The two temperature sensors greater than 1 m below the

normal pond water level showed less pronounced diurnal variations than sensors nearer to the water surface. The deepest sensor showed temperatures varying between 20 and 24°C during the warmest months, which is slightly below that of the cooling trench outlet. These data suggest that significant thermal benefits may be achieved by lowering the invert of the reverse slope outlet pipe to draw cooler water from deeper within the pond.

Recommendations on system design improvements and further research needs are provided for consideration.