TRANSPORTATION ASSOCIATION OF CANADA

Environmental Achievement Award

Town of Richmond Hill
Snow Storage Facility and
Performance Evaluation Study

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TOWN OF RICHMOND HILL
AN INNOVATIVE SNOW STORAGE FACILITY

The Town of Richmond Hill's Engineering and Public Works Department has actively incorporated environmental best management practices into our design, construction, operation, and maintenance of Town infrastructure for many years. With regards to winter roads maintenance, the Town disposed of snow collected from our downtown core streets at a private quarry. However, in 2002, the property owner initiated development of the quarry site leaving the municipality with the task of establishing a new snow disposal location, one that would serve the Town of Richmond Hill for years to come, be cost effective, efficient and protect the environment.

After considering various potential sites, the new snow storage facility was sited at the northerly limit of Town of Richmond Hill Operations Centre property, located north of Elgin Mills Road and west of Leslie Street. This parcel of land was considered the most advantageous as it was easily accessible to Elgin Mills Road (a centrally located arterial road); close to the source of snow collection; equipment and staff. Further, the site is relatively isolated from residential areas, having an undeveloped parcel of land to the west and Richmond Green, a regional park, to the north as its neighbours.

Despite its obvious location and operational advantages this preferred site had a major obstacle to overcome. The facility was to be located on the southerly slope of the Oak Ridges Moraine, an ecologically and environmentally significant feature in Southern Ontario. The Oak Ridges Moraine is a significant glacial deposit predominantly composed of sands and gravels. The Moraine provides critical storage of high quality drinking water and is the source of headwater streams across the Greater Toronto Area. The Town of Richmond Hill has accepted responsibility of guardianship over this prized water resource, one that is taken very seriously.

Given that the discharge from the snow storage facility would enter the headwaters of the Rouge River watershed, a significant coldwater fishery, careful design of the facility was required. This would ensure the quality and value of the ecological components of the Rouge River watershed were maintained and protection of groundwater aquifers from environmental impact was addressed.

Snowmelt Water Quality and the Snow Storage Facility

Urban drainage in cold regions is dominated by snowmelt. Furthermore, 50% to 60% of the annual load of contaminants may be produced during the winter months and stored in the snow pack created on site. Fugitive vehicle emissions, worn brake pads, road salt, grit, and wearing of asphalt and concrete surfaces from ploughs and freeze-thaw cycles cause elevated rates of chemical and material accumulation in roadside snowpacks. The trapped pollutants are released during seasonal melting, loading significant volumes of foreign material into receiving waterways.

Environment Canada's Road Salt Assessment Report indicated that increasing concentrations of road salts in the environment pose great risks to aquatic ecosystems and groundwater resources. High salt content reduces the ability of metals to adsorb onto sediments, which is the primary method of metal demobilization. Currently, alternatives to road salt, which is required to ensure road safety, is rarely applied. Despite the magnitude of this problem, there is a scarcity of treatment measures for salt-laden meltwater. The Transportation Association of Canada recognized this challenge, stating that 'there is no practical or economical way of removing the chlorides [salt] found in snow', however this facility attempts to do just that!

Built in 2003, this facility was designed to address the multiple challenges faced by local snowmelt managers and respond to salt toxicity concerns outlined in Environment Canada's 2001 Road Salt Assessment Report. The process applied in this project was so progressive that it engaged Source Water Protection initiatives two years prior to the federal governments call to address salt usage by municipalities.

The Town of Richmond Hill, already recognized as the Canadian leader in stormwater management, decided the best way to dispose of and treat snow was to use three passive stormwater management techniques in a treatment train approach (Figure 1 and Figure 2). The principles of stormwater management were applied to the site because snowmelt is similar to a low intensity long duration rainfall event, making it possible to treat snowmelt in a similar manner to stormwater.

SNOW STORAGE FACILITY DESIGN - 3-Step Treatment Train

1 Impervious Asphalt Deck

Over the winter months, snow cleared from Yonge Street, selected bridges and the Old Town areas are transported to the impervious asphalt deck for storage. The asphalt deck covers an area of approximately 4.2 acres. A concrete curb is located on the lower section of the parking lot to help direct meltwater into the two catch basin inlets, ensuring that no meltwater escapes the treatment process.

Approximately 10,245 m^3 and 18,300 m^3 of snow were collected, hauled and deposited at the facility in 2007 and 2008, respectively. As the snowpack melts, garbage, salt residue and coarser grained sediments are deposited onto the asphalt surface (Figure 3). The impervious asphalt cover protects the underlying Oak Ridges Moraine groundwater stores from contaminated meltwater infiltration. Figure 4 illustrates the growth and decline of the snowpack during the winter of 2008.

Reducing the meltwater flow velocity allows the majority of coarse materials to be deposited onto the asphalt deck surface, including a significant amount of chloride residue. In addition, slow moving water will not re-entrain sediment previously deposited along the flow path. Two conditions ensure slow water travel:

1. The snow pile is packed as high as possible to encourage slow melting.
2. The deck is sloped at a minimal grade (2% or less), angled just enough to allow downslope water flow.

At the end of the melting season, the residual debris is cleared off the asphalt surface and environmentally disposed of. It was estimated that over two tons of solids were removed from the asphalt pad in 2007 and 2008. The captured sediment is a significant amount of waste diverted from Richmond Hill's water resources.

2 Oil-Grit Separator

The meltwater that drains off the asphalt deck is collected by two sets of twin catch basins located at the low point of the asphalt deck surface. Collected flow is directed to an oil-grit separator (OGS). Upon entering the separator, the meltwater is diverted into a 'treatment chamber' where petroleum products and finer sediments are captured and separated (Figure 5). Inflowing

water is directed around the circular walls of the internal chamber, creating a non-turbulent environment that increases settling rates. Given the slow velocity of the water passing through the unit in this application the Total Suspended Solid (TSS) load captured is in the 95+% range. We note that the OGS unit is designed to allow a by-pass of excess water during high flow events to avoid scour or resuspension of the settled material, however given the slower melting rate of snow, the OGS has never exceeded its design capacity.

3 Constructed Wetland

The oil-grit separator discharges the treated water into a constructed wetland located in the southwest quadrant of the facility (Figure 6). As designed, meltwater velocity is again reduced upon entry to the wetland. This allows the remaining sediment to settle out of the water column providing additional water quality benefits for the treated meltwater. These sediments are predominantly characterized by fine grained sediments and the associated contaminants adsorbed to them. The long flowpath through the wetland provides ample time for the residual suspended solids to accumulate on the pond bottom for future removal during maintenance.

Deep rooted vegetation anchors the sediment and inhibits resuspension. Contaminants and heavy metals are also partially removed via root uptake. Wetland vegetation also provides refuge for wildlife living in an urban setting.

After this final treatment process, the treated meltwater is released back to the natural environment through a subsurface (pipe) flow route into a downstream tributary of the Rouge River. Without the wetland, water discharged directly from the asphalt deck and oil-grit separators would be several degrees warmer than the coldwater stream. This type of temperature contamination can cause altered biological community structure, excessive algae growth, and accelerated vegetative development. Once cooled by the shadow of wetland vegetation and subsurface flowpath, the temperature of the returning water is comparable to that of the native stream.

What About the Other Six Months of the Year?

Over the spring, summer and fall months, the asphalt deck doubles as an recreational amenity to the Richmond Green Park Complex. The asphalt deck is transformed into a large skateboard park, three basketball courts, in-line skating area, ball hockey rink and parking areas. The Town of Richmond Hill also takes advantage of this great space to host the annual National Public Works Week –

Public Works Challenge, where up to 300 people from the ten York Region municipalities compete for local bragging rights. (Figure 7).

Partnership with Environment Canada

The Snow Storage Facility is considered 'state-of-the-art'. This new and innovative approach to snow storage attracted the attention of Environment Canada's National Water Research Institute (NWRI) as a demonstration project for treatment of contaminated snow and as an effective tool for road salt management purposes across Canada. Since the winter of 2006/2007, an evaluation of the efficacy of the facility to remove contaminants such as chloride, sediment, oil and heavy metals in snowpack meltwater was undertaken through a partnership between NWRI and the Town of Richmond Hill.

An interim report published in December 2008 (Environment Canada - WSTD Technical Note No. AEMR-TN08-007) with a final report projected for 2010, quantifying the overall effectiveness of the facility to treat snowpack meltwater will assist in the ongoing development of the Road Salt Management Plans across Canada. "The study objectives were: (1) to monitor the release of snowmelt and common urban stormwater / snowmelt pollutants from the snow pile stored at the RHSSF [Snow Storage Facility] over the course of a snowmelt season (January-April 2007), (2) evaluate the sediment quality in the receiving (treatment) pond, and (3) evaluate the ecotoxicological status of the receiving pond and the downstream drainage ditch" (Exall et al., 2008).

To assess the operation of the Snow Storage Facility "eight types of field data were collected: (a) on-site meteorological data (Figure 8), (b) snow pile data, (c) snowmelt and rainfall runoff flow rates, (d) water quality of snowmelt and runoff leaving the storage sites, (e) water and sediment quality in the meltwater management system (OGS, stormwater pond and the downstream drainage ditch draining into the Rouge River), (f) toxicity of sediment in the stormwater pond and the drainage ditch, (g) chemical uptake by macrophytes in the stormwater pond, and (h) benthic community characterisitcs in the receiving pond and the drainage ditch" (Exall et al., 2008).

"Continuous monitoring of runoff indicated that although chloride concentrations in runoff from the storage pavement averaged 2500 mg L^{-1} over the entire melt period, chloride exhibited preferential elution (early release) from the snowpack and was not well retained by the system. The bulk of the solids remained with the snowpack until the end of the melt period, along with most of the metals" (Exall et al., 2008).

Two areas were identified where sediments may contain pollutants at levels potentially causing toxic effects: inside the OGS and by the inlet of the treatment pond. As the OGS is regularly maintained and sediment disposed of, this does not pose environmental problems. Pond sediment may require regular inspections of sediment accumulations and toxicity, which may trigger removal of polluted sediments before the reductions in the pond treatment volume would call for such an action.

"Overall, the system appears to function well with respect to the Ministry of the Environment's Guidelines for Snow Disposal and De-icing Operations in Ontario and the Transportation Association of Canada's Syntheses of Best Practice 8.0 Snow Storage and Disposal" (Exall, et al., 2008).

Municipal Engineering Perspective

From a municipal engineering perspective, the site selection was successful at keeping the operating costs low, since the facility allows meltwater to be treated passively while minimizing adverse environmental impacts. Annual facility operation and maintenance practices include cleaning of the asphalt deck and OGS, monitoring TSS effluent water quality, pond hydraulics and sediment accumulation in the pond.

At the end of each melt season, sediment on the asphalt pad is removed by a street sweeper (Figure 9). The inclusion of the OGS upstream of the pond was identified as reducing the frequency of expensive and elaborate pond dredging. By protecting the natural resource function and associated ecological diversity in the sensitive receiving water course, we were able to achieve significant economic benefits within the community.

Construction of the facility was approximately $3 million dollars (including park amenities). However, low operating costs and using the asphalt pad for recreational activities in the summer provides added value to the project and helped compensate for the initial construction costs. This practice is more cost effective than current snow disposal techniques.

The interim results show that the facility is assisting in protecting the headwater streams of the Rouge River within Richmond Hill by capturing sediment and associated pollutants either on the asphalt deck, OGS or the constructed wetland. The facility has been demonstrated to perform well with respect to both the

Ministry of the Environment's Procedure B-4-1 and the Transportation Association of Canada 'Syntheses of Best Practice 8.0 Snow Storage and Disposal', with respect to:

1. Controlling and managing snowmelt runoff from the site, by providing a paved base for the facility and curb along the perimeter, ensuring that all runoff is channelled into the treatment train;
2. Managing quality of snowmelt/runoff from the site by the treatment train comprising an OGS and a stormwater/snowmelt management pond with a sediment forebay;
3. Facilitating easy cleanup of debris and litter at the end of the snowmelt period; and,
4. Fulfilling good security standards through the site location and a protective fence.

In 2007, the Town of Richmond Hill Snow Storage Facility was presented with the Technical Innovation Award by the Ontario Public Works Association (Figure 10). The facility has also been showcased on the Discovery Channel's hit show Daily Planet and the subject of several trade journal articles.

The impact of snowmelt on the receiving environment is becoming an ever increasing issue. The introduction of Municipal Road Salt Management Plans has placed the responsibility of smart salt usage onto local and regional municipalities.

The interim report provides quantitative results from a rigorous scientific study indicating that the Snow Storage Facility reduces snowmelt pollutants including debris and sediment, which contain nutrients, heavy metals, oil and to a lesser degree, soluble contaminants such as chloride. Used in conjunction with the Town's Road Salt Management Plan will result in enhanced protection of the Town's ecological components and provide economic benefits. Information from the Snow Storage Facility can be used by Transportation Association of Canada members as a platform for designing snow storage sites, establishing expected meltwater treatment and environmental benefits, as well as assisting in the effort to keep our highways clear for travel during the winter months in Canada.

References

Exall, K., J. Marsalek, Q. Rochfort, L. Grapentine, S. Kydd, and J. Nemeth. 2008. *Assessment of Operation of the Town of Richmond Hill's Snow Storage Facility (RHSSF): Interim Report*. National Water Research Institute Technical Report.

APPENDIX

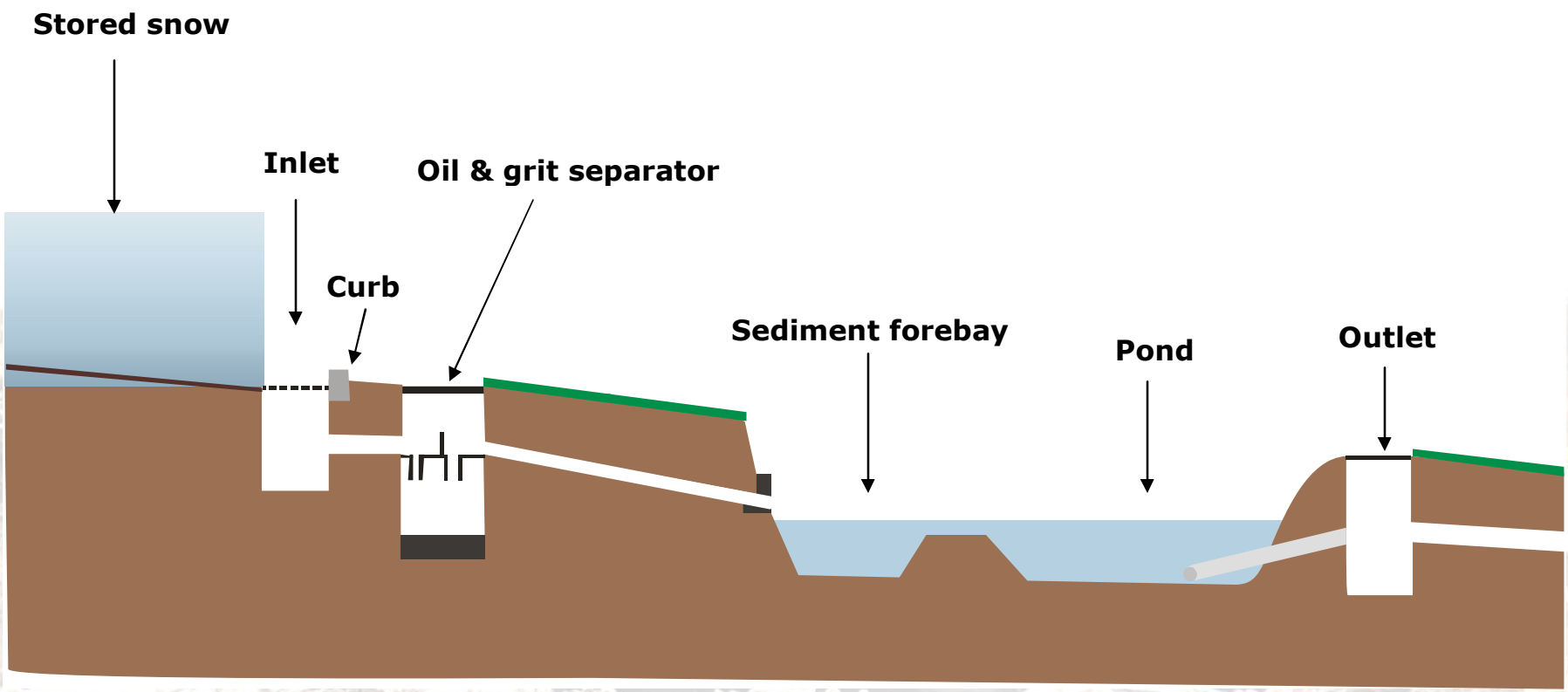

Figure 1. A cross section of the asphalt pad, oil & grit separator and wetland treatment pond at the Snow Storage Facility. Illustration is courtesy of Environment Canada (2008).

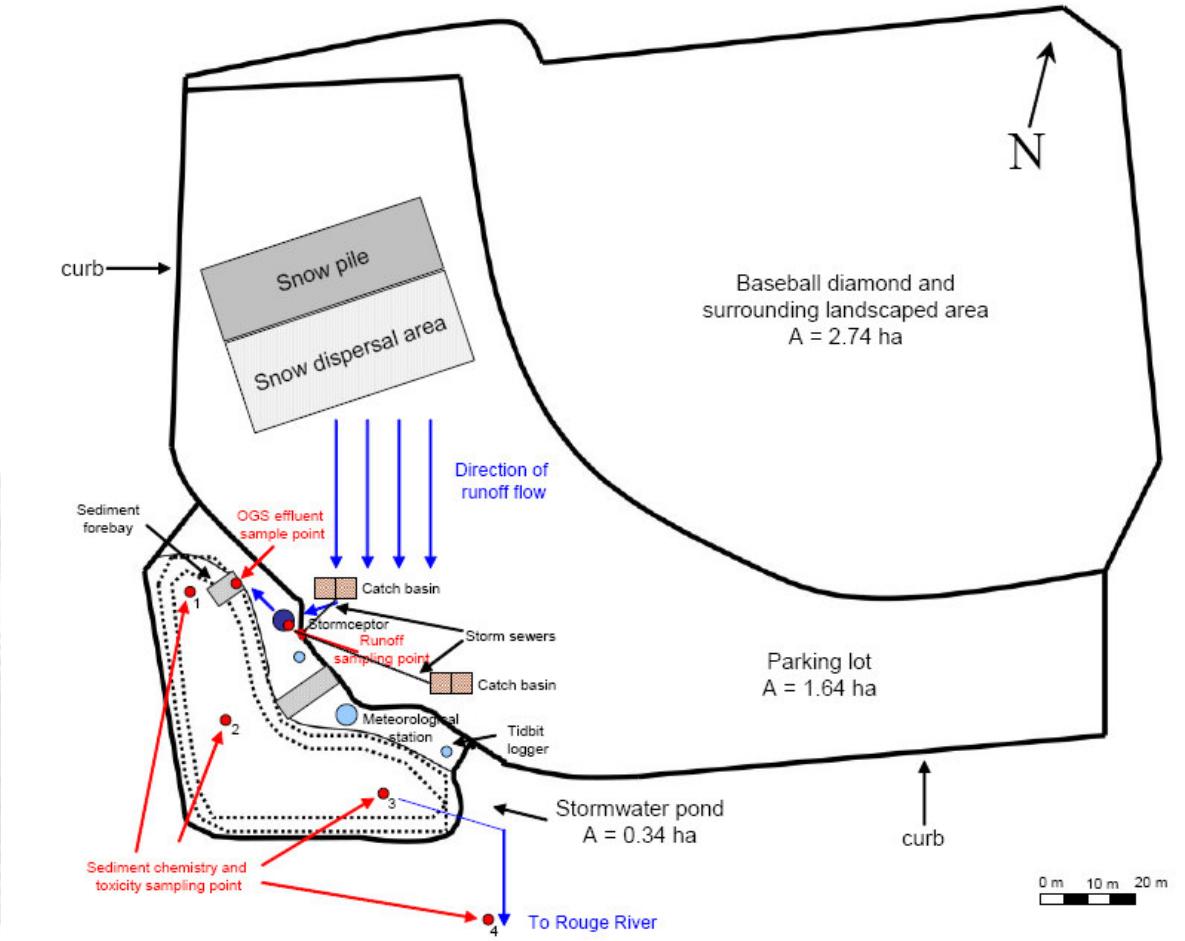

Figure 2. Site plan of the Snow Storage Facility. Red arrows indicate sampling points and blue arrows indicate the direction of meltwater flow. Illustration is courtesy of Environment Canada (2008).

Figure 3. Photographs of the snowpack that contains litter, sediment, oil and other pollutants.

Figure 4. Photographs illustrating the change in snowpack size and composition from February 15, 2008 to April 19, 2008.

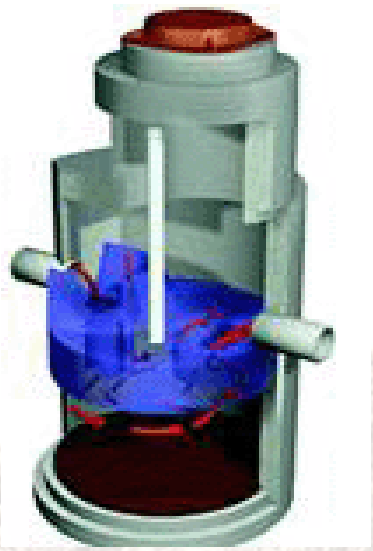

Figure 5. Oil-grit separator illustration by Stormceptor

Figure 6. Aerial photograph of the wetland treatment pond at the Snow Storage Facility.

Figure 7. Snow ploughs participating at the municipal challenge at the Snow Storage Facility for National Public Works Week

Figure 8. Environment Canada's meteorological station located at the Snow Storage Facility.

Figure 9. Removing sediment deposited on the asphalt pad after the snowpack melted.

Figure 10. Technical Innovation Award presented to the Town of Richmond Hill from Ontario Public Works Association for the Snow Storage Facility.