Urbanization, climate change and sustainability considered in retrofitting Dieppe's storm drains

Over the past several decades in the City of Dieppe, New Brunswick, the Babineau Creek watershed has been subject to urbanization with the rapid growth of developments within the watershed. The increases in peak runoff flows resulting from this rapid growth have put a strain on the culvert system (major system) within the watershed and also created adverse tailwater conditions for the storm-sewer outfalls (minor system) discharging along the watercourse. Recently, the frequency of sewer surcharging in this watershed has increased substantially from the levels of past years.

Touchie Engineering and Hydro-Com Technologies (both divisions of R.V. Anderson Associates Ltd.) were commissioned by the City to carry out a forensic investigation of the recurring sewer surcharging in the Babineau Creek watershed and recommend remedial drainage improvements. The focus of the investigation was to identify the causes of the recurring sewer surcharging, anticipate the effects of future developments, review the effects of climate change and take necessary measures to ensure a sustained high level of service of the existing storm-sewer infrastructure in the watershed.

The investigation revealed three separate issues related to culvert sizing and backwater effects at storm-sewer outfalls. The report recommended that the Babineau Creek culverts on Gauvin Rd., Champlain St. and College St. be replaced to provide adequate hydraulic capacity for the 100-year flood event with the anticipated future development. In addition, an existing storm-sewer outfall on Cousteau St. was extended from the headwater end to the tailwater end of the new Champlain St. culverts.

The report also recommended flow restriction of catch-basin outlets, using inflow control devices (ICDs) throughout the watershed to ensure that the total flow in each section of storm sewer would be capped to match the existing conveyance capacity, thus minimizing the possibility of sewer surcharging through storm-sewer system service connections. Additional surface drainage capacity would be provided at major street intersections to ensure the residual flow created by catch-basin flow restrictors would not result in excessive street flooding during a "design plus" event for the minor system (i.e. a storm event with a return period in excess of 10 years).

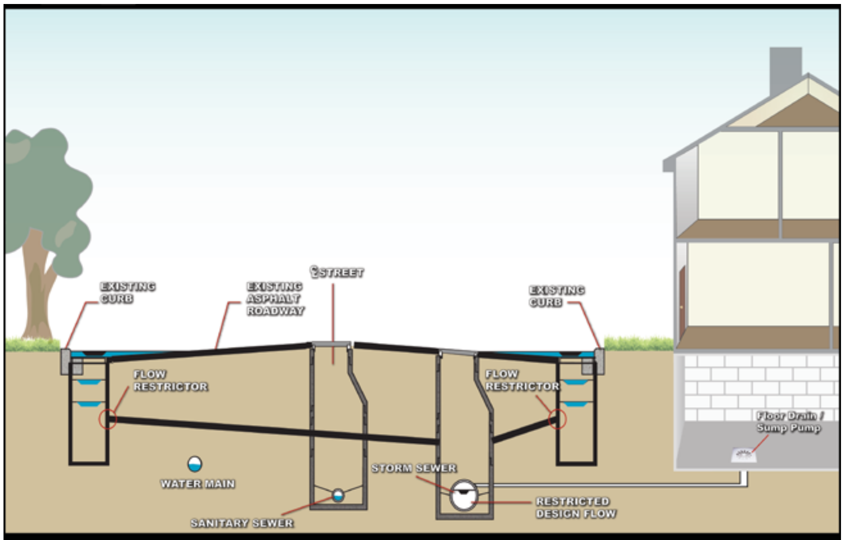
Effects of climate change

These approaches also considered the effects of climate change and the inevitability of increases in the frequency and magnitude of peak flows over the service life of the existing storm-sewer infrastructure within the watershed.

In order to quantify the effects of climate change on drainage infrastructure in Dieppe, a review of the scientific literature was performed. Relevant information on the effects of climate change for southeastern New Brunswick consisted of the results of analysis of trends in historical climate data, as well as predictions from global climate models and the results of statistical downscaling of these predictions.

Regional trends in seasonal temperatures for Atlantic Canada show an overall warming of 0.3 Celsius degrees from 1948 to 2005, with summers showing the greatest increase in temperature (+0.8 C degrees), warming characterizing springs (+0.4 C degrees) and autumns (+0.1 C degrees), but winters becoming colder (-1.0 C degrees). Precipitation increased in Atlantic Canada by approximately 10% between 1948 and 2005, a trend that continued through the 1990s (Vassuer, L. and Catto, N. 2008).

When interpreting these results, it should be noted that the trends are for average values throughout Atlantic Canada and the average values do not accurately reflect potential trends in extreme events (on which the design of drainage infrastructure is based).



TYPICAL STORM SEWER SYSTEM

Gary Lines and others performed statistical downscaling of results from the Canadian (CGCM2) and the British (HADCM3) global climate models, and found that, for the Moncton area, including Dieppe, the annual average change in precipitation is predicted to increase between 2% and 8% by 2020, between 6% and 12% by 2050, and between 8% and 19% by 2090. Preliminary results from computer model simulations that evaluate the effects of increased temperature and a less stable atmosphere on the risk of extreme precipitation events (J. Wang and X. Zhang, 2007) show that the high-risk areas in North America include the southern US, the Pacific northwest and eastern Canada.

Based on these preliminary results, the risk of an extreme precipitation event in eastern Canada is predicted to

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double, which corresponds to a halving of the return periods of existing design events (i.e. a storm event with a magnitude that historically represented a 100-year return period would in the future only represent a 50-year return period) or to an increase of the magnitude of a design storm with a given return period by approximately 20%.

In order to accommodate the predicted increases in design-flow magnitudes resulting from the expected effects of climate change, the magnitude of historical 100-year return period flows were increased by 20%.

Global climate models

Taking the effects of climate change into consideration during the retrofitting of the Dieppe storm drainage infrastructure will ensure that the hydraulic capacity of the existing storm sewers in this watershed will be sufficient to provide an acceptable level of service over the remaining service life (as defined by the structural durability).

The use of ICDs at catch-basin outlets will ensure that the flow in the downstream sewer system (the minor system) will remain within the cross-section of each pipe, regardless of the effects of climate change or the accuracy of climate-change predictions (i.e. surcharging of the minor system will be prevented regardless of the magnitude of the design storm and regardless of the increase in the precipitation intensity resulting from climate change).

The flows in excess of the minor system's hydraulic capacity will be diverted overland on the existing streets to the nearest interception point and directed into the nearest watercourse (the major system components). This approach requires that allowances be made for the additional flows resulting from climate change in the design of the major system (i.e. bridges and culverts) over the entire duration of their predicted service life, while insulating the minor system from these same effects wherever possible.

The construction work undertaken was broken out into four phases:

- Phase 1 – Gauvin Rd. culvert
- Phase 2 – Champlain St. culverts
- Phase 3 – College St. culvert extension from Highway #15 (Shediac Highway)
- Phase 4 – Additional surface drainage and flow restrictors

Each phase was substantially completed from the downstream end (Phase 1) to the upstream end (Phase 4) of the watershed. The majority of contingency money was utilized for additional infrastructure relocations, and procuring additional drainage easements to accommodate the residual overland street flows from the flow restriction in the minor system during the design plus events.

Most of the construction work was carried out near existing watercourses from June 1 to September 30, 2007, to comply with environmental regulations. The project was completed with the surface restoration and installation of flow restrictors in catch basins in October and November 2007.

The total construction cost was approximately $1.5 million and was on schedule despite pre-existing easement disputes and unknown stakeholder issues at the outset of the construction.

City Council and the taxpayers of Dieppe will reap the benefits of this sustainable approach since existing storm sewers that are still in good structural condition will not have to be replaced to address insufficient conveyance capacity, thereby alleviating high costs, public inconvenience and disruptions from construction activities. This will allow more public funds to be allocated to rehabilitating other deteriorating infrastructure within the municipality.

To this end, the City of Dieppe has implemented stormwater design criteria to mitigate the effects of urbanization and climate change while sustaining both existing and new storm-sewer infrastructure. The City is also endeavouring, in the long term, to implement watershed management plans for each of its watersheds with a potential for high-density development. This will facilitate development by addressing stormwater management requirements more economically on a regional scale rather than on individual properties.

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