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Vital need for municipal stormwater management

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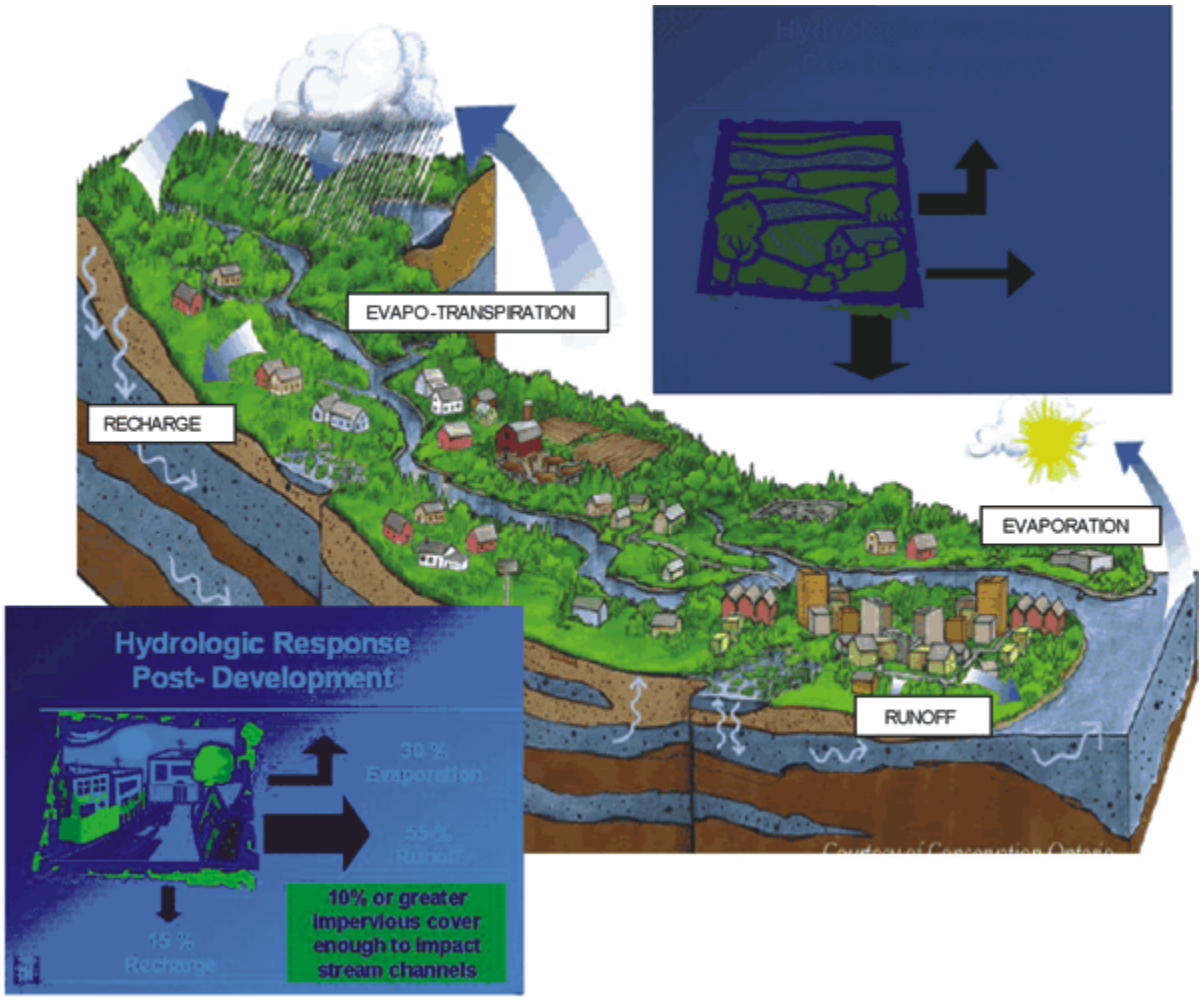

Figure 1: Hydrologic Cycle and the Effects of Urbanization Courtesy: Conservation Ontario

It has become abundantly apparent that extensive and more frequent flooding has been occurring over the past several decades not only in New Brunswick but throughout Canada. The consequences have forced many Canadian municipalities into a mode of crisis or reactive stormwater management using the *bandage approach* to control runoff.

Stormwater management can be defined as: functions associated with the planning, design, construction, maintenance and financing of both natural and constructed facilities that collect, control and convey stormwater. The objectives of stormwater management are to prevent loss of life, reduce hazards to human health and well being, minimize damage both to property and to the environment. This article is an overview of the historic approaches to municipal stormwater management, the resulting problems and the emerging needs and rationale for changes to this approach.

Historically, stormwater management in municipal settings generally has been limited to selected individual developments.

The overall large-scale management of stormwater has primarily been reactive (i.e. waiting for recurring flooding problems to manifest themselves before action is taken). It appears that this historic piecemeal and reactive approach is beginning to result in more frequent and severe flooding of streets and properties, primarily in downtown areas.

The two primary processes that influence increased flooding are urbanization and climate change. Urbanization is the often gradual conversion of previously natural or undeveloped areas into developed areas. Urbanization which impacts drainage includes: an increase in hard surfaces, such as roads, driveways, roofs, walkways and parking lots, and a reduction in natural stormwater storage provided by low-lying areas such as wetlands and floodplains. Figure 1 illustrates these effects which result in reduced evaporation and infiltration of surface water (recharge), and more runoff both as larger peak flows and larger runoff volumes.

As the magnitude of the increase in runoff is a function of the amount and the density of development in a given area, a certain critical mass of development has to be reached before its effects on drainage become severe enough to be clearly evident. Also, as new development in a watershed primarily affects existing downstream development, the cumulative effects of new development on stormwater drainage (such as flooding) are most likely to appear in the downstream areas of a watershed, rather than in the areas of new development.

Climate change, the second process that drives the increase in flooding, is expected to result in gradual changes in weather patterns, increased climate variability and increases in weather extremes. The net effect of climate change on municipal drainage infrastructure is an increase in the frequency of severe storm events that have the potential to exceed the capacity of drainage infrastructure which results in flooding.

These two processes support the conclusion that the relatively recent increases in flooding of downtown areas is a reality, rather than perception. The reasons for this type of flooding are that the effects of climate change are gradual, that flooding in many areas is caused by additional upstream development (rather than changes in the downtown areas themselves), and that upstream development had to reach a critical mass before its effects on stormwater drainage became readily apparent.

An illustration of these two processes would be the 1999 flooding events in Moncton, NB. Two very severe rainfall events (both were deemed to have a return period of 100 years), caused serious flooding in areas of Moncton that were located primarily in the lower and middle sections of the watersheds.

The following illustrates the need for a more proactive and comprehensive approach to stormwater management:

- The initial development in most Canadian municipalities occurred in low-lying areas on the banks of rivers and lakes, with new development generally radiating uphill from these older sections of town. This development pattern results in the more frequent and severe flooding occurring in downtown areas of municipalities which generally have the highest development densities and highest real estate values. These increase the damages associated with flooding and drastically increase the difficulty and costs associated with implementing stormwater management measures retroactively.
- Attempts at alleviating local flooding by increasing the capacity of the local drainage system (e.g. storm sewers, culverts and waterways) have the potential to amplify and transfer the flooding to a location further downstream.
- Increased and recurring flooding is also resulting in escalating insurance claims, expensive and cumbersome civil litigation, and an increase in public concern with regard to inconvenience and property damage related to flooding.
- Increased public awareness of the stormwater impacts of new development and the transfer of flooding to downstream locations, complicates public planning and community meetings related to the approval and zoning of new development.
- The lack of foresight with regard to stormwater management may limit or prevent new development within sections of a municipality.

The continued use of historic approaches to stormwater management may result in municipal councils becoming victims of their municipality's development success, as negative consequences of this approach only become apparent when repairs or upgrades to the drainage system are urgently needed. Often these seem economically impractical and involve high levels of public inconvenience and disruption. Proactive approach to stormwater management will result in a cost-effective way to control the impacts of development on drainage, it makes sense to implement this new approach to stormwater management for all new developments, and implement remedial upgrades to drainage systems of existing development when and where possible and practical.

The required new approach to stormwater management should include the following components:

- Integration of planning and stormwater engineering. The design of the stormwater drainage system (both the minor or traditional storm sewer system, and the major or overland drainage system) should be included as part of each new development (both residential subdivisions as well as commercial and industrial developments). These designs should assess the drainage effects on existing downstream development as well as the drainage effects from potential future upstream development.
- Development of consistent guidelines for the design of stormwater drainage infrastructure. These guidelines should include: acceptable design methods, minimum design parameters, both the minor and major drainage systems, both stormwater quantity and quality, the effects of climate change and guidance with regard to effective management measures.
- Development of a stormwater implementation plan. This type of plan would assess the drainage dynamics of all the watersheds throughout the entire municipality as well as the capacity of all drainage infrastructures. The uses of this type of plan include: the ability to determine the reserve capacity of major drainage infrastructure (culverts and bridges), the identification of potential flooding "hot spots", the assessment of the potential effects of proposed new development on existing drainage infrastructure, and the identification of areas that require additional design and construction to accommodate future development.
- Integration of potential stormwater effects from sections of natural watersheds that extend beyond municipal boundaries. These can be under the jurisdiction of another municipality or service district, which may operate under different guidelines. Consideration may be given to provincial guidelines to address these issues.

The intent of a comprehensive stormwater management plan is the ability to ensure sustainable growth by controlling changing drainage conditions. This type of approach will ensure the fair and equitable sharing of both the costs and benefits of stormwater management by both existing and future development, regardless of its relative location within a watershed. Due to the many different ways in which changing drainage conditions can be controlled at the individual development level, the stormwater management plan intends to provide large-scale watershed-based guidance for drainage. This does not eliminate the need for detailed design by a professional engineer, nor is it intended to stifle innovation in planning and design.

The new approach to stormwater management can be implemented as a capital works planning tool, by directing capital spending on stormwater infrastructure to areas most in need of upgrading, while postponing spending in other areas until the need for upgrades becomes more urgent. In many cases, upgrades to stormwater drainage infrastructure can be coordinated with improvements to traffic, sanitary sewer, and water systems as part of the capital works planning process such as upgrading a culvert under a street scheduled for improvement or repaving.

The City of Dieppe has endeavored to take this approach to capital spending related to existing storm sewer infrastructure upgrades, by monitoring the reserve capacity of the storm drainage system. To this end, the City recently completed a *Storm Water Management Implementation Plan*, and is in the process of developing *Storm Water Design Guidelines* for all new developments.

The City of Moncton has developed *Storm Water Design Guidelines* as part of its *Design Criteria Manual for Municipal Services*, and is in the process of revising these guidelines to accommodate the water quality aspects

of stormwater management. The City of Fredericton is presently completing *Storm Water Design Guidelines*, while other municipalities are following suit.

In summary, a well-prepared stormwater management plan, once implemented, can protect the natural and built environments within municipalities, and lessen potential problems that could adversely affect the sustainable growth of municipalities and wellbeing of residents. The increasing challenges faced by municipalities due to urbanization and climate change can be faced successfully with a comprehensive, integrated and pro-active stormwater management plan.

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