Chapter 27

Role of Municipal Stormwater Management Guidelines: the Markham Experience

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During the early 1990's, government agencies of the Province of Ontario published several guidelines dealing with best management practices (BMPs) for runoff *quality control* and other aspects of stormwater management. Prior to these publications, the Town of Markham, Ontario and, subsequently, many other municipalities had prepared specific guidelines, dealing mainly with runoff *quantity control*. There is now a need to update these older municipal guidelines and to harmonize them with recent provincial documents. This chapter gives an overview of this update by the Town of Markham, a municipality in the Greater Toronto Area with considerable experience in SWM implementation.

27.1 Needs

27.1.1 The Era of Quantity Control

In 1978, the Town of Markham was required to implement a very stringent reduction of peak flows on development in order to minimize downstream effects. Based on this experience, the Town of Markham developed for the first time, mandatory requirements for all new developments:

Wisner, P. and L. Arishenkoff. 1997. "Role of Municipal Stormwater Management Guidelines: the Markham Experience." *Journal of Water Management Modeling* R195-27. doi: 10.14796/JWMM.R195-27.

© CHI 1997 www.chijournal.org ISSN: 2292-6062 (Formerly in *Advances in Modeling the Management of Stormwater Impacts*. ISBN: 0-9697422-7-4)

- control of peak post-development runoff;
- utilization of storage for runoff control;
- disconnection of roof drainage; and
- use of hydrograph models.

It was only after several years of the application of these principles that an extensive municipal manual was made available by the Town of Markham to consultants undertaking work in Markham (Town of Markham, 1983). This manual described the first projects in which SWM concepts were applied in Markham. Of more importance was the introduction of the need for master drainage plans (MDPs) and recommended recreational use of SWM facilities. To facilitate project review, this manual had simplified graphs based on the OTTHYMO model, which give peak flows for small areas. Two constructed urban lakes (Mount Joy Pond, Toogood Pond) were described as examples which embody the principles of the manual.

Within two years, the Ontario Ministry of Environment and Energy (MOEE) recognized runoff quantity control principles in a manual (Brodie and Wisner, 1985), the preparation of which was co-chaired by the Town of Markham and an inter-ministerial committee. This manual was subsequently applied by other municipalities.

The Town of Markham also pursued efforts to improve local implementation of SWM techniques. In 1989, it reviewed its initial design storms based on a comparison with multi-event simulations. In the same year, the Town prepared a special on-site detention (OSD) manual which recommended:

- the use of OSDs only when their need is demonstrated in the MDP (the intent was to limit the distributed storage); and
- graphs for storage design based on modeling with OTTHYMO (Town of Markham, 1989a, 1989b);

27.1.2 The Era of Quality Control/Ecosystem Approach

In 1989, Markham sponsored an international symposium to review practical SWM experience. Over 200 participants were given the opportunity to present comments on a proposed approach for interdisciplinary MDPs including ecological considerations. Erosion control based on shear stress was also discussed at the symposium. More importantly, municipal staff and consultants had the opportunity to discuss the experiences of other Ontario municipalities, Europe, B.C. and Quebec (Town of Markham, 1989a, 1989b).

Updating the Town of Markham 1983 manual was deferred because of a succession of several provincial initiatives by the MOEE and the Ministry of Natural Resources (MNR), including:

- the MOEE/MNR (1991) interim volume runoff quality criteria based on storage of a given precipitation (similar to criteria in Washington COG);

- the 1992 MOEE SWM manual for stormwater quality best management proposing a more sophisticated ecosystem approach;
- the 1992 MOEE/MNR Subwatershed Planning Guidelines, which required runoff control studies at a larger scale than the MDPs.

Other documents were developed by the Metropolitan Toronto and Region Conservation Authority (MTRCA). A comprehensive watershed study was conducted for the Rouge River, one of the main watersheds in the Town of Markham, and the creation of the Rouge River Park was approved by the Government of Ontario.

Therefore, the Town of Markham felt the need for local guidelines to facilitate the implementation of the new provincial initiatives and account for other reports including the MNR Fish Habitat Protection Guidelines, and the MNR Natural Channel Systems Approach.

The latter phases of updating the Town of Markham manual coincided with the early preparation of MOEE's new 1994 Manual. The MOEE had numerous meetings with Markham officials to discuss the municipal position regarding the implementation of the 1994 MOEE Stormwater Management Practices Planning and Design Manual.

27.2 Organization of the Town of Markham Stormwater Management Guidelines

While a detailed description of the 1995 Markham Guidelines (Town of Markham, 1995) is beyond the scope of this chapter, its contents can be briefly summarized. An editorial effort was made so that each conceptual aspect is reviewed in a one page presentation.

- Part 1 *General Concepts* (An introduction for non-specialists is presented in eight pages): evolution of SWM concepts, ecosystem approach, subwatershed plans, types of BMP, public participation, environmental assessment, recreational aspects, safety, maintenance and need for verification of performance, and introduction to the environmental master drainage plan.
- Part 2 *Planning Aspects* (General information on SWMP/environmental BMP and selection of BMP are presented in 11 pages.) The main sections are: review of Rouge River comprehensive basin and related studies, Markham natural features, valley and corridor protection, modeling, thermal impact. A two-stage selection of BMP and economic efficiency is also included.
- Part 3 *Design Aspects* (General information on six types of municipal BMP and recommendations for SWM plans are presented in 14 pages). For SWM Plans, it reviews the dual-drainage

concept, on-site detention, bio-engineering, natural channel design, post-operational monitoring, erosion and sediment control for construction sites and content of SWM reports.

The Town of Markham Stormwater Management Guidelines also have nine appendices which deal with specific aspects, such as:

- examples of development of a short list of BMPs (in the Rouge River Watershed);
- highlights of the Rouge River Fisheries management plan;
- highlights of the Don watershed strategy; and
- fish habitat protection and stormwater management.

For consistency, some of the appendices review methods from previous Markham manuals:

- application of the rational method (RM) in Markham (the RM limitations, correction factors): the RM is still used in subdivision sewer design!
- on-site detention design graphs (needed for consistency with previous designs); and
- Markham design storms and comparison with multi-event simulations.

27.3 Review and Comparison with Provincial Guidelines

After their development, the recent Markham SWM Guidelines were submitted for review and comments to MNR, MOEE and MTRCA and several consultants, including those who prepared the provincial manuals.

The final edition accounted for comments during this review, including updates in previous agency views on some BMPs. As an example, a matrix procedure leading to an infiltration BMP was played down since MNR and MOEE expressed concerns about some of these solutions.

Some aspects of the Town of Markham Stormwater Management Guidelines are unique when compared to other manuals and include the following:

1. the synthesis of quantity, quality control and drainage design;
2. a specific Town of Markham approach to area-wide planning, called the Environmental MDP, to be used in situations where a Subwatershed Plan is not available;
3. the emphasis on economic efficiency; and
4. a careful approach to new concepts which puts greater emphasis on operational experience.

Before 1990, many new SWM concepts such as dual drainage, inlet control, etc. were mostly municipal initiatives tested by local experience and implemented gradually. The introduction of new provincial requirements between 1991 and 1993 led to concerns for municipalities such as:

- untested new recommendations;
- changes of agency emphasis (e.g. infiltration BMP) over a short period of time;
- use of “rules of thumb” instead of modeling (e.g. 25 mm storage);
- limited monitoring and maintenance experience with some BMPs;
- some attempts to propose approval of ponds without an in-depth analysis of their real need;
- proliferation of wet ponds or wetlands which are much more difficult to maintain than quantity control storage; and
- municipal review based on many documents of which some were developed by various agencies with limited municipal involvement.

The Town of Markham approach to new solutions was to combine a few experimental BMPs with the more conservative municipal SWM guidelines which reflect local practices and experience.

27.4 Discussion of Some SWM Issues

Issue 1: Phases in Planning

In the Town of Markham Stormwater Management Guidelines, the Environmental MDP (EMDP) is considered to be a compulsory step prior to the stormwater management plan (SWMP). The EMDP is an interdisciplinary, sophisticated planning study, which includes BMP selection with consideration of water quality, habitat protection, base or low flow maintenance, and other pertinent concerns. The SWMP which is the next step, uses a one-step, more straightforward conceptual design interfaced with subdivision design.

It is obvious that different types of consultants can be involved in these two steps. The SWMP does not require the same level of interdisciplinary expertise. This approach avoids duplication of environmental analysis and inventories and optimizes location and selection of BMP. Compared to other planning strategies, it also avoids review of SWMP in two phases.

The EMDP is, however, considered a temporary solution, and adequate funding should be ensured for subwatershed plans. The Markham Stormwater Management Guidelines also recommend that reviewing agencies participate in the EMDP steering committee.

Issue 2: SWM practices and regulations

SWM practices and regulations are, and will be for some time, in a state of flux. An example is the control for erosion. It is now recognized that many OSDs built for zero runoff increase, under some conditions, do not reduce downstream flooding.

Pond retrofit is an attempt to correct the situation by making better use of quantity ponds which are not considered useful anymore. We have to avoid the future retrofit of 'retrofitted' ponds.

A better understanding of the role of SWM manuals as general information is therefore necessary. Although the developers of recent provincial manuals made this aspect very clear, some consultants and reviewers interpret parts of the manuals quite literally, and therefore minimize creativity. The Markham Guidelines took a different approach.

The Markham Guidelines are a "living" document and subject to change in order to reflect the latest in stormwater management technology and it is felt this should also be valid for provincial documents.

Issue 3: Selection of BMP with Consideration of Economic Efficiency and Operation

The Markham guidelines recommend a two-stage BMP selection approach:

- *Stage I screening in sensitive projects:* the selection of a BMP from a long list is based on an ecosystem step-by-step approach, introduced in the MOEE BMP Manual (1992), and illustrated by an example;
- *Stage II selection:* a set of matrices is proposed. Such factors as capital cost, O & M cost, maintenance cost, cost per kg pollutant removed, are recognized as well as public accessibility, recreational benefits, etc.

The application of the law of diminishing returns and the economic impacts of some provincial guidelines are briefly discussed. As an example, for an increase from 60% TSS removal (Level 3) to 70% removal (Level 2) requires a wet pond volume to increase by 50% (residential areas). From 70% TSS removal to 80% TSS removal (Level 1), there is an additional increase of 75%.

More work is still necessary to refine and confirm such criteria.

Issue 4: Importance to Detailed Design Aspects

It was considered that the review of design analysis of BMPs is an essential part of municipal responsibilities. Examples are:

- Design considerations are given in concise point form for each BMP. Some additional recent information is used, compared to the MOEE 1994 manual (e.g. offline biofilters).
- A special section of the Town of Markham guidelines provides for SWM plans, detailed prescription of protection against overtopping, inlet and outlet features, including e.g. trash, back design, etc.
- The guidelines provide detailed indications of the hydraulic design of flow splitters for offline BMPs.

Issue 5: Modeling

Despite advances in modeling, there is still a trend towards simple, empirical “rules of thumb”. As an example, storage of a given rainfall amount is still used. Since the first Markham manuals were issued in 1978, Markham has promoted the use of models rather than empirical design.

The 1995 Markham guidelines briefly reviewed aspects of planning and design modeling. Examples of modeling concepts presented in the Town Guidelines include:

- A caveat is presented against some uses of m^3/ha rules for quality control, including the use of MOEE manual graphs mainly beyond their $40 \text{ m}^3/\text{ha}$ active storage criteria. These rules do not provide information on the effect of such factors as ratio of active/passive storage, rate of captured discharge, etc.;
- It is recommended that cumulative shear stress be used for erosion control;
- There is a need to consider pond monitoring results (examples are given);
- Only multi-event modeling can give an insight into quality control pond operation;
- Multi-event modeling with design storms is not encouraged;
- Simplified graphs can be used only for OSDs.

The Town of Markham Stormwater Management Guidelines do not limit the use of any well-tested models, even if not used previously in Markham. For consistency, it recommends however, that their performance be compared to previous models. Such comparisons are available for EPA-SWMM and OTTHYMO.

The Town of Markham Guidelines also indicate, as an example, that well-documented presentation of modeling assumptions and results is essential for project approval.

Issue 6: Potential Municipal Liabilities

If the public has complaints, they are addressed to the municipality. The municipality has to consider legal aspects, and the fact that post-construction rehabilitation is expensive and sometimes impossible. Municipal liabilities, such as created bio-engineering, solutions for erosion protection, which are not *equally* flood-resistant, should be minimized.

For these reasons, not all solutions discussed in other manuals are acceptable. The Town of Markham does not recommend reduced slopes for lot grading which would be contrary to current bylaws. Neither ponding areas in backyards nor sump pumping to soak-away pits is encouraged. The Town of Markham

considered that concerns for clogging and the nature of soils limit the use of perforated pipes and conveyance BMPs.

The Town of Markham agrees with the recent MNR caveats on an infiltration BMP and the guidelines discourage, in general, clogging-prone solutions, etc. While the Markham guidelines recognize the benefits for on-lot source control, use of these BMPs is only required where the municipality has access for maintenance and improvements.

Therefore, the Guidelines state that previous experience with performance and maintenance is essential in the BMP selection process. Adequate information on these aspects is also presented. Use of BMPs with short longevity is discouraged.

Finally, distributed storage (including inlet treatment) compound maintenance and liabilities. The Guidelines encourage monetary contributions to centralized facilities from small sites.

27.5 Final Remarks

It is recognized that different municipalities or agencies may have other views on some of the issues discussed, and will develop guidelines or apply the provincial manuals in other ways specific to their local conditions. The most valid part of the development of the 1995 Town of Markham Stormwater Management Guidelines was that all aspects of SWM were critically reviewed not only by the Town of Markham Engineering Department staff, but also by staff from the Planning, Parks Maintenance and Construction, and Parks & Open Space Planning Departments. This was also valid for the numerous comments received from agencies and consultants.

One of the questions raised in this process was whether these municipal guidelines duplicate provincial documents. Although the review by agencies showed that there are no contradictions between the Markham Guidelines and the provincial or MTRCA requirements, it is felt that the screening of some aspects, and the possibility to include elements otherwise dispersed in various documents, was a very useful exercise and will facilitate the future dialogue among municipalities, consultants, developers and agencies.

Acknowledgements

The active participation and support of Markham senior staff, mainly Mr. Dalo Keliar, P.Eng., Commissioner of Community Services and Mr. Alan Brown, Director of Engineering, were essential in the development of the Town of Markham Stormwater Management Guidelines. Comments from specialists

at the MOEE, MNR Maple District, MTRCA and consulting firms, such as Marshall Macklin Monaghan, and Cumming Cockburn were very useful and their assistance is gratefully acknowledged.

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