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Quinte Conservation Stormwater Management Submission Guidelines

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This guideline is a living document. It is date stamped and will be updated and posted on the Authority web site when alterations are made to reflect changes and innovations that are occurring in the engineering community. Users of this document are advised to always check our website (www.quinteconservation.ca) for the latest version.

QUINTE CONSERVATION SWM GUIDELINES FOR REVIEW OF SITE PLANS AND PLANS OF SUBDIVISION AND CONDOMINIUM

May, 2012

The Bay of Quinte Remedial Action Plan Stormwater Management Plan Guidelines, 2006, provide the basic guidelines for submission and review process for all developments within the implementation area of the BQRAP. They are relevant for all townships fronting on the Bay of Quinte within the Quinte Conservation, Lower Trent Conservation and Cataraqui Region Conservation authorities. Those guidelines include general submission requirements for SWM approval from Quinte Conservation. A copy of the guidelines is available on Quinte Conservation's website at www.quinteconservation.ca. Further, Quinte Conservation has developed Bridge and Culvert Design Guidelines, May 2010 that provide direction on design requirements for issuance of a permit under Ontario Regulation 319/09, Development, Interference with Wetlands & Alterations to Shorelines & Watercourses. These have also been posted to the website.

This document has been prepared to help designers understand the review process of Quinte Conservation for stormwater management plans in watersheds within our jurisdiction. Quinte Conservation provides this review service to the municipalities as part of their diligence under the *Planning Act* for development applications.

It is recognized that there are environmental impacts to development and the intention of stormwater management is to mitigate as much as is practicable these potential impacts.

Stormwater management submissions should provide sufficient information to understand the projected impacts on water quality and quantity and how the proposed mitigation measures will reduce those impacts. A typical submission will describe the predevelopment conditions for the property and show the proposed development along with the expected impact on the environment.

It is the responsibility of the site developer and his consultant to develop mitigating measures to reduce that impact. Impacts may also be felt by landowners or residents nearby. The site developer must not increase the risk to life and property damage for landowners and residents. Additionally, rights of Riparian landowners have been protected under common law and their right to enjoyment of their property must not be infringed upon. This is the purpose of the stormwater management submission and review.

When is stormwater management required?

Stormwater management is required for all proposed developments of 1 ha in size or larger or for those containing 0.5 ha impervious area or more. Quality and quantity control are both generally required.

What is included in a submission?

A typical submission includes a report that identifies the impacts of the proposed development and designs the mitigation measures. It will contain drawings that show how mitigation will be implemented.

When is a facility not required?

In some cases a quantity control facility may not provide any benefit. An example is a development near the mouth of a large river (i.e. Moira River) that peaks days after the storm has passed. Quantity control may be counterproductive. The designer should be able to provide justification for the decision to not implement quantity control.

Quantity control may already be provided in a central facility downstream. The designer should confirm where these facilities are in place with the municipality.

Quality control may be replaced with a cash-in-lieu contribution. In areas of redevelopment there may not be adequate room for placement of a well designed quality control facility. Belleville and Quinte West have cash-in-lieu policies that allow the municipality to construct central facilities for storm sewer systems that require remediation. In many cases it is preferable to place the investment in a single location to achieve better results.

In newly developing areas Master Drainage Plans may be in place that provide guidance on placement and contributions for a central facility. In these cases a development may be requested by the municipality to contribute to a larger facility for both quality and quantity control.

1 Submission Requirements

A complete submission will include a stormwater management report and design drawings. It is important that the designer consider that the stormwater management report contains important design information that must be shown on the drawings. It is our experience that most implementation mistakes are made due to lack of design information on the drawings. A good test is to ask, ‘Could the site contractor build the stormwater management facility based on the engineering drawings alone?’

1.1 Report

The stormwater management report should contain the following:

1) Clear statement for the purpose of the report. Is it to support a cash-in-lieu of stormwater management calculation? Is it for quantity and/or quality control?

2) What approvals will be required for the facility? What agencies are being contacted?

3) What preconsultation has been completed? Attach letters/emails in appendix.

4) What methodology will be used to develop the quantity or quality control measures? I.e. Rational Method, Modified Rational Method, single event modelling, continuous event modelling, or a unit hydrograph method. Storage developed through a modified rational method calculation is often underestimated. It is our experience that it may underestimate storage by up to 50%.

   Quinte Conservation has developed a storage volume calculation spreadsheet that uses a simple triangular inflow unit hydrograph (developed by Ed Watt for use in Ontario) and determines outflow from a simple reservoir using a storage indication method. This spreadsheet is available for reference or design assistance.

5) **Hydrology**. This section of the report will identify the predevelopment flows and post-development flows anticipated during the design storms. It will also determine the amount of storage required for both the quality and quantity control. Typically, the predevelopment flows are used as targets for the control of the post-development condition. However, there may be other site specific restrictions that would lead to different flow targets. The designer should contact both the municipality and the conservation authority to confirm target flows.

   a) *Design Storm*. The Quinte Conservation watersheds are within the 100-yr Regional storm requirement. All developments must consider the impacts for return period events from 2-yr to 100-yr frequency. The Major/Minor flow strategy is employed. Minor system must be capable of handling post development flows up to the 5-yr frequency. Major system, likewise up to the 100-yr post development flows.

   b) *IDF curves*.

      These are updated from time to time by Meteorological Services of Canada. Contact Quinte Conservation for assistance in determining applicable IDF curves.

   c) *Site Statistics*.

      i) Overall site area

      ii) Impervious areas including asphalt, roof, concrete, granular

      iii) Pervious areas

      When calculating the impervious areas consider the entire roof area of the structure, any outbuildings, sidewalks, curbs, patios that may be associated.

   d) *Runoff coefficients or curve numbers for each area*. In some situations the designer may elect to use a blended runoff coefficient. This uses an area weighted average runoff coefficient.

      Contact the municipality or Quinte Conservation for standard coefficients used.

   e) *Times of Concentration* – state methodology and show calculations. Most designers elect to refer to the MTO drainage manual for common methods.

      Consult Municipality for minimum times of concentration for 5-yr system. Use Airport Formula for rural areas where most of the flow is overland and RC<= 0.4. Use Bransby Williams formula for areas that are drained mostly by channel flow (i.e. ditches and creeks) or RC> 0.4. Other methods of determining times of concentration can also be used as appropriate.

   f) *Storm Duration*. This is the length of precipitation event to be used in the design. What duration of storm is the most appropriate to use? This is often the most difficult decision for stormwater management design. Some watersheds have Master Drainage Plans in place. These will provide the design storm and duration used for the stormwater management facility sizing.

In other areas the storm duration must be selected by the designer considering the time of concentration, drainage area and other factors. For conservatism the duration that leads to the highest storage requirement should be used.

g) *Distribution*. This is the shape of the hyetograph which can have an impact on the peak flows. Typically, designers using the Rational Method are referencing intensities provided in the IDF curves. Modellers on the other hand must select a distribution pattern to apply to the model. Common distributions are: SCS type II, AES, and Chicago. Designers should be able to explain their selection of distribution.

Watt and Chow, 1986 also recommended a 1-hr distribution hyetograph that can be approximated by a rising straight line to the peak intensity and an exponential decay curve. The intensity can be calculated by:

$$i = h \times t/a \qquad 0 < t \leq a$$
$$i = h \times e^{-K(t-a)/(t_d-a)} \qquad a < t \leq t_d$$

Where:

i = intensity in mm/hr

h = peak rainfall intensity in mm/hr

t = time in minutes

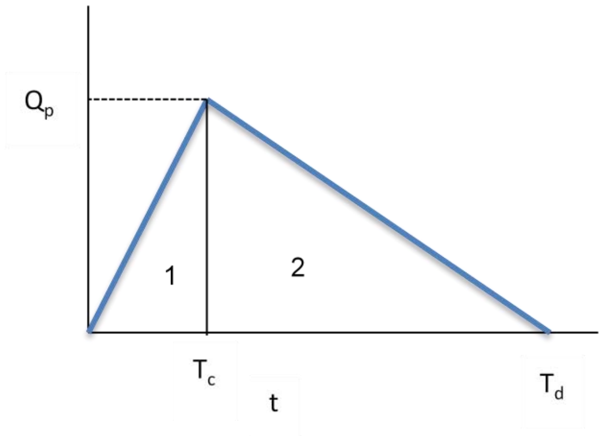
a = time of the peak in minutes = 27 (Kingston area)

K = dimensionless peak factor = 7 (Ontario)

h) *Peak flows*. Include a table showing the predevelopment and post-development uncontrolled peak flows for all return periods from 2-yr to 100-yr.

Peak flows may be calculated by one of many methods. Commonly, designers use the Rational Method for small drainage areas. Larger areas are often designed by modelling software such as: Otthymo, Midus, SWMM, HEC-HMS or other similar single event software.

i) *Inflow Hydrograph for hand calculations*. If the designer is using the Rational Method for development of the inflow hydrograph, Quinte Conservation will accept a simple triangular hydrograph for storage determination. The total depth of the event is determined from the IDF for the storm duration. Storm duration may be different than the Time of Concentration. The volume of runoff is estimated from the selected storm duration using the runoff coefficient and area of development. The peak inflow is determined using the published intensity for the Time of Concentration. The duration of the inflow hydrograph (T_d) is adjusted to match the volume of the runoff.



Volume 1 for the rising limb is found by solving the area of triangle 1:

Volume 2 for the declining limb is found by solving the area of triangle 2 which is a simple subtraction of volume 1 (V_1) from the overall volume of runoff (V).

T_d is not directly known and must be found by backing it out from the volume of triangle 2:

j) *Storage*. Determine the storage required to meet target outflows. This is the difference between the inflow and the outflow hydrographs.

Computer models have reservoir routines built in that can assist in estimating the storage required to reduce post-development peak flows. These require some iteration with a stage – discharge relationship (outflow) and a stage – storage relationship (reservoir size). Combined, these form a storage – outflow curve. A hand approximation is sometimes used following the Modified Rational Method. As discussed earlier, it has been our experience that this method often underestimates storage. Quinte Conservation has developed a spreadsheet to assist with approximating an inflow hydrograph using Watt and Chow method.

Per f) and g) the distribution and duration that produces the highest storage should be used to design the storage facility. The exception would be an area covered by a Master Drainage Plan that contributes to a central facility. Review the climate change section 1.4.1 for impact on storage.
Check on the potential for backwater effects from the outlet. It may not permit an unrestricted outflow often assumed in the design. A reduced outflow will mean an increase in the amount of storage that will be needed. A backwater elevation should be provided by examination of the outlet channel. Refer to the hydraulics section.

k) *Quality storage*. The volume of storage for quality control is approximated using the Ministry of the Environment Stormwater Management Design Manual, 2003 (as revised). This volume is comprised of both dead storage and active storage and is based on contributing area and imperviousness. Forty cubic metres per ha of the total storage is active and the remaining portion is dead storage. The dead storage is understood as the permanent pool volume. The designer must also check on the 25 mm event for erosion protection. That can affect the active storage volume.

l) *Sediment storage*. A sediment forebay should be planned to capture the large fraction of sediment. Sediment will accumulate at an assumed rate and then must be removed to ensure the function of the facility is maintained. Refer to Ministry of the Environment Stormwater Management Design Manual. The pond should function as designed when sediment storage is considered full. This means the sizing calculations for storage and velocity should consider sediment storage is at maximum. This will reduce the frequency and cost of cleanout through the main pond.

m) *Combined Quality and Quantity storage facilities*. When a combined quality/quantity control facility is proposed the designer should consider a bypass for high flows. High flows can resuspend sediments and contamination flushing these out of the facility and into the receiving water. The quantity control storage may be calculated from the top of the permanent pool.

n) *Outlet Design*. Outlets may have staged weirs and use a combination of weirs and orifice controls. Care should be taken to consider the increased flow velocity around the outlet. Also, if a rip-rap weir is proposed the designer should recognize that in-field placement of rip-rap is not precise. Rip-rap type controls should only be used for emergency spillways.

The designer should contact the municipality for restrictions they may have for types of outlets. For example, Belleville does not permit a Hickenbottom type of outlet.

7) **Hydraulics**. In some cases the depth of channel flow to and from a development or a facility must be determined. This is to ensure adequate capacity exists within the conveyance structure to safely pass design flows. Open channel flow calculations using Mannings may be used for simple channel configurations or a computer software program such as Culver Master may be employed if required.

8) **Groundwater impacts**. The development should ensure that the groundwater regime and hydrologic water balance is well understood and the development is both protected from groundwater impacts and does not cause a groundwater impact. A hydrogeologic report may be required to investigate the impacts on wells, groundwater table, dwellings, wetlands and other waterbodies. A stormwater management facility must be designed to ensure groundwater impacts result. For example, a stormwater management pond should not intercept the groundwater table and not induce dewatering of the aquifer.

9) **Sediment and Erosion Control**. All phases of the development must be protected such that offsite migration of sediment is reduced as much as possible. A strategy for mitigation must consider all stages from site clearing to completion of the site services. In addition, the plan should include the schedule and strategy for the eventual removal of the measures. A subdivision may have ongoing site works long after the initial services have been installed. The plan should also consider how sediment should be controlled after the above ground services have been accepted by the municipality.

10) **Maintenance**. This explains how the facility should be maintained and should be written in the form of a maintenance manual. A facility is designed on the principle of settling (Stokes Law). Larger sized particles will settle out in a forebay. Smaller diameter particles may be carried further through the facility. A poorly maintained facility will not function for its intended purpose and contamination will pass through into the receiving waters. The Ministry of the Environment Stormwater Management Design Manual provides good guidance on facility design and maintenance.

    The designer should consider these questions.
    - *What interval should the facility operator anticipate for cleanout?*
    - *Is there a measurement that triggers sediment cleanout?*
    - *How will the operator perform the cleanout? Access, staging, equipment.*
    - *What are the features of the facility that require maintenance?*
    - *How often should the various attributes be maintained?*
    - *What visual checks that should be made?*
    - *How should the facility appear or operate if it is functioning correctly?*
    - *What should an operator do to in the event the facility is overflowing?*

11) **Plantings**. Plantings have an important function in facility effectiveness. Certain plants can assist with uptake of nutrients and can improve particulate removal. Others help to stabilize the banks and prevent erosion. While still others provide important shading and perhaps security. An above ground facility will be exposed to wind and sun, each of which will reduce the effectiveness. Plantings can help to mitigate environmental impacts on the facility. The report should provide an explanation for the selection of various plant species and guidance on their placement.

12) **Safety**. An above ground facility will typically be partially full of water and infrequently will be full. Consider the risk to the public from this drowning hazard in the design. There is also a risk to public safety by rapidly changing water levels. Fencing, signage, and slope design may reduce this risk.

    The designer should contact the municipality for local standards for requirement of fencing at above ground facilities.

1.2 Drawings

An engineering stormwater management submission will also be accompanied by drawings. The drawings contain sufficient information to allow the facility to be constructed as designed in the SWM report. Some of the major features of the pond design include: the inlet, berms, forebay, outlet and bypass.

1.2.1 Key plan

1.2.2 Grading plan

Show the swales, lot grades, road grades, curb depressions, and external site elevations.

1.2.3 Site servicing plan

This plan shows the important underground servicing and its connection to the facility.

1.2.4 Predevelopment and Post-Development catchment area plans

These plans shows the drainage areas considered in the design. Areas should be shown in hectares to two decimal places. Ensure external areas are considered.

1.2.5 Drainage plan

This shows direction of major and minor drainage. How is the drainage going to enter the facility? What happens if the underground system is obstructed? Ensure that all first floor elevations are at least 0.3 m above the maximum expected high water level.

1.2.6 Plan view of the facility

This shows the overall grading and design features of the facility. It will also show the fencing and signage, access routes, extents of full storage. Additionally, it will provide important layout information for construction.

1.2.7 Detail plan

This drawing shows the section views of the facility, details on the inlet and outlet structure, stage-storage information, and any other views necessary to explain the facility function and construction.

1.2.8 Landscape plan

This will contain the plantings placement information and planting details.

1.2.9 Sediment and erosion control plan

This drawing shows locations of important features to control the release of sediment and prevent erosion. Notes on the drawings are necessary to explain the function of the controls to site contractors and building inspectors.

1.3 Drawings should contain:

Storage Volume. An elevation storage curve should be provided on the drawings. It should be clear what the permanent pool elevation and storage volume are. The full storage volume and elevation should also be clearly shown.

Cross section. Provide a section view through the forebay. This will show the maximum sediment storage elevation, permanent pool, maximum quality and maximum storage elevations.

Profile. This is a longitudinal view through the facility. It will allow the reviewer to see the path of the water into, through and out of the facility. It will show the invert of the inlet pipe, invert of the forebay, forebay berm elevation and side slopes, invert of the main pond, invert of the outlet (s), invert of the receiving stream. The profile will also show the freeboard of the facility.

Elevations. The important grading elevations must be provided. These include; top of pond, bottom of pond, orifice/weir controls, rip-rap protection, groundwater table, etc.

Inlet. Consider how the inlet will perform under the various hydraulic conditions of the facility. Will winter ice have an effect? Will the pond need a bypass? Typically, one inlet is recommended and it must be into the sediment forebay. There may be high velocities at the inlet. Consider the necessary erosion protection. Consider how a full supply level will propagate through the drainage system to the facility.

Outlet. This is one of the most critical components to the facility. The outlet may be a combination of several types of controls. Generally, the quality control portion has a small opening (orifice) to permit a slow drawdown over 24 hours. The larger events may be passed more quickly and weirs are often used for those events. Should a larger event than designed happen, how will that event be passed safely through the facility? At times blockages can occur to the outlet controls. An emergency spillway is usually designed for these situations.

Erosion protection. Ensure that the protection around the outlets and inlets is robust. Consider the contractor who must install the protection. If rip-rap is used, bring it past the top of the weir. Most deficiencies are found in the rip-rap protection where high water passes around the end of the rip-rap. If there is a fall, consider a plunge pool or other measures to absorb the energy.

Berms. Most above ground facilities are at grade and are formed mostly through excavation. Some have portions that are above grade and require berms to confine the water. Berms can act as small dams and should be designed following principles of dam construction. This means slopes, mass, permeability, protection from overtopping should be considered.

Planting. Show the location, species, and density of plantings. Show the protection required for the plants until they have well rooted. The municipality may require a holdback on the plantings of up to two years to ensure the plants are healthy.

Drainage around the facility. Consider the grading around the facility to ensure local drainage that is not intended to go to the facility is not impeded.

1.4 Other factors to consider in design

1.4.1 Climate Change

Precipitation patterns do not remain static. Some locations are reporting an increase in the severity and frequency of precipitation events. Stormwater management is designed for past events and presumes future events will recur at the same frequency. If predictions of increased precipitation **intensities** become reality some stormwater management infrastructure will not have capacity for increased flows or storage. Provincial websites suggest that parts of the Quinte watersheds may experience a decrease in **total depth** of precipitation of up to 10% within the next 30 years as a result of climate change (http://www.web2.mnr.gov.on.ca/mnr/ccmapbrowser/climate.html). This means watershed wide effects of climate change could be reduced stream flow. Total depth may not bear as much on urban stormwater design as much as the increase in intensity. Until further study is completed locally, it is prudent to plan for potential increase in peak flows and storage.
Facilities should be designed with additional capacity for storage and flow through at a minimum allowing for potential climate change effects. This can be addressed by **increasing the design storage capacity by 10%**.

1.4.2 Phasing

Much review and engineering time is spent on projects after they have been approved because a phasing strategy is introduced very late. Projects should be developed in consideration of potential development phases. Phasing of facility implementation can be considered, however, it is important that the facility is well protected from erosion in the early years of its use.

2 Completion of Construction

Upon completion of the facility as-constructed drawings should be prepared showing the as-constructed condition of important elevations, inverts, slopes, and other features should be prepared for review by the municipality and conservation authority. The municipality will require assurance that the facility is functioning per the design prior to release of securities. There may also be a requirement for a longer maintenance period wherein the developer is responsible for all maintenance costs. This period of time is stipulated by the municipality.