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TOWNSHIP OF THURLOW
STORMWATER MANAGEMENT STUDY FOR CANNIFTON INDUSTRIAL PARK AND ENVIRONS

August 1996

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EXECUTIVE SUMMARY

INTRODUCTION

Development has been shown to have negative impacts on the natural environment. Therefore, the Township of Thurlow, with regard to the Cannifton Secondary Plan, has commissioned this stormwater management plan to aid in the implementation of the principles of ecosystem planning, to follow the recommendations of the Bay of Quinte Remedial Action Plan.

The objectives of the study to complete this plan were:

1. An analysis of the pre- and post-development flows in channels due to various rain events.
2. Identify methods that will satisfy the requirements of the Remedial; Action Plan.
3. Analyze various combinations of methods to determine the optimum combination of stormwater management facilities and best management practices.
4. Provide preliminary design information complete with cost estimates and land requirements.
5. Recommend a strategy for the implementation of the plan, including phasing, cost sharing, and responsibilities.

The Greer Galloway Group Inc. undertook a comprehensive review of available information, detailed computer modelling, and an in-depth assessment of alternative approaches in the preparation of this stormwater management plan for the Cannifton Industrial Park Area.

STUDY AREA

This subwatershed is located immediately north of the City of Belleville, near the interchange between Highway Nos. 401 and 62, as shown on the attached figure. The total area of the subject lands is approximately 58 hectares, roughly bisected by Highway No. 62. The topography of the land is flat to gently sloped from northwest to southeast.

The primary characteristic of the subwatershed taht effects stormwater runoff is the thin soil cover and exposed bedrock. This characteristic results in high runoff flows for all rain events. Future development in the subwatershed, including low to medium residential, light industrial, and commercial uses, will further increase these runoff flows.

FORMULATION OF ALTERNATIVE APPROACHES

Alternative approaches to stormwater management were developed in consideration of location opportunities for centralized facilities, and best management practices that suit the proposed land-uses.

One flow constraint was identified; the ditch alongside Highway No. 401.

Through the use of the computer model QUALHYMO, pre- and post-development flows were simulated, and the size of centralized control facilities estimated.

Additional analysis was performed to determine the requirements for water quality control. Preliminary estimation followed the "Stormwater Management Practices Planning and Design Manual" published in 1994 by the Ministry of Environment and Energy. Final analysis included computer modelling with QUALHYMO of the treatment facilities for one certain design event.

Finally, several alternatives are presented that include on-site controls and various combinaations of centralized facilities.

EVALUATION OF ALTERNATIVE APPROACHES

The alternatives were compared in terms of performance, costs, and potential environmental impacts.

Results indicate that the most preferred alternative would likely be the easiest to implement, since property requirements do not rely on Ministry of Transportation approvals or future road alignments.

IMPLEMENTATION STRATEGY

The most preferred alternative includes on-site detention and two separate ponds; one either side of Highway No. 62. The pond to the west, will be used for both water quantity and quality control, while that to the east will be stricitly used for quality control.

During final design of the facilities and coonveyance systems, several approvals will be required. The agencies invloved will include:

- Quinte Conservation Services Alliance,
- Ministry of Environment and Energy,
- Ministry of Natural Resources,
- Ministry of Transportation, and
- Transport Canada.

Since the design and construction of the stormwater management facilities and related works will be undertaken as a municipal drain, under the Drainage Act, the requirement for an environmental assessment is waived.

On-site controls will be implemented through Site Plan Agreements for new development, and through voluntary compliance for currently developed lands.

The timing for the implementation of this plan depends on the pace of development. It is expected that the pond east of Highway No. 62 will be required first, since developement, and redevelopment, of the industrial/commercial lands is imminent.

Finally, a method for cost sharing is presented. This method lends itself to the requirements of the Drainage Act. Final cost estimates will be prepared as a component of the detailed design phase.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

1.0 INTRODUCTION

1.1 BACKGROUND

The Township of Thurlow (the Township) recognizes that development may have negative effects on the natural environment. Assessing potential environmental impacts of new development, and implementing best management practices for stormwater, is in the interest of the Township as it supports the efforts of the Ministries of Natural Resources (MNR), Environment and Energy (MOEE), and Municipal Affairs (MMA) and the Quinte Conservation Services Alliance (QCSA).

Over the past two decades, people have become aware that the natural environment has, and continues to be, degraded by human development, and are now concerned that future devlopment will continue to adversely effect our environment. Public agencies and governments have learned of the benefits of sound ecological and natural resource management, particularly in urban areas or areas undergoing intensive development, and have made commitments to reduce the impact of development on the environment.

The Township completed the Cannifton Secondary Plan (the Plan) in February 1991 addressing the land-use and development issues in the Cannifton area. One objective of the Plan is to apply the principles of ecosystems planning to implement the recommendations of the Bay of Quinte Remedial Action Plan (QRAP). The QRAP requires the integration of stormwater management into sustainable urban development through the use of natural drainage features wherever possible. Part 4, Section 3.2.1 of the Plan requires land within the drainage basins identified on Schedule 4, Stormwater Drainage Plan, have a Master Drainage Plan prepared by the developer on behalf of the Municipality prior to development.

The Township required a comprehensive Stormwater Management/Master Drainage Plan for the Cannifton Industrial Park and environs to provide the rational framework for the design and implementation of stormwater best management practices, to ensure that development proceeds in an efficient, orderly, and cost-effective manner, while meeting the regulatory requirements. In December 1994 the Township, in co-operation with QCSA, entered into an agreement with The Greer Galloway Group Inc. (Greer Galloway) to develop a comprehensive Stormwater Management Plan for a small subwatershed within the Plan area. All water emanating from this catchment discharges to the Moira River which, in turn, is a major tributary of the Bay of Quinte.

The subwatershed is located north of the Highway 62/Highway 401 interchange (see Figure 1). Stormwater drains towards the south and east and is intercepted by ditches on Cloverleaf Drive and Highway 401. The ditches and the diffuse sheet drainage in the area northeast of Cloverleaf Drive drain to the Moira River. The Moira River is, in turn, a major source for the Bay of Quinte. There is no existing or historic watercourse within the subwatershed. The total subwatershed is approximately 58 hectares.

1.2 Study Objectives

The objectives of studying stormwater management in the subwatershed, outlined in the Terms-of-Reference, are to:

1. Analyze the hydrologic response of the drainage area to determine major drainage system requirements to control post-development flows to pre-development levels.
2. Identify measures to achieve the water quality standards of the "Bay of Quinte Stormwater Implementation Strategy" under ultimate development conditions.
3. Undertake environmental and engineering analyses to determine the optimum combination of stormwater management facilities, best management practices and natural preservation to achieve objectives of 1. and 2.
4. Provide preliminary engineering for the proposed works of 3. including; cost estimates, flow targets, and land requirements to allow the document to be used as a guideline for final design.
5. Recommend an implementation strategy including; phasing, cost-sharing, if applicable, and explicit responsibilities of the Township of Thurlow and the affected land owners.

1.3 Approach

No earlier studies have examined stormwater management for developments in the subwatershed. This study uses existing information and data from studies carried out in the adjacent No Name Creek and the Nor-Belle subwatersheds. This study considers updated topographic and land use information and recommends a Stormwater Management Plan incorporating potential development (the ultimate built-out condition) meeting all relevant water management objectives. The Recommended Plan includes plans of the conceptual arrangement, land requirements, and an implementation strategy with phasing, cost-sharing and monitoring details.

Greer Galloway approached the study in five phases:

Phase 1 - Data Compilation and Preliminary Assessment

1.1 Compile and review background data such as, reports, studies and maps encompassing the study area and adjacent land.

1.2 Define the extent and significance of natural systems, including the Moira River shoreline, wooded areas and local drainage areas.

1.3 Identify factors or influences important to the integrity of the existing and desired environment, including land use planning designations and provisions.

1.4 Define goals, objectives, and targets.

1.5 Identify opportunities for protection, enhancement, rehabilitation, compensation, and development.

1.6 Conduct preliminary hydrologic modelling in consideration of other Phase 1 activities.

Phase 2 - Detailed Modelling and Conceptual Design

2.1 Determine levels of runoff control and treatment required to meet the established constraints.

2.2 Screen all Best Management Practices, with input from the Steering Committee and affected landowners, and prepare a list to achieve the goals, objectives, and targets.

2.3 Conduct computer modelling to simulate the performance of stormwater management facilities for the ultimate development scenario.

2.4 Assess the performance of the stormwater management facilities.

2.5 Develop conceptual plans and Best Management Practices for areas to be developed and for areas of compensation or to be protected, enhanced, or rehabilitated.

2.6 Complete conceptual designs for the preferred Best Management Practices.

Phase 3 - Develop an Implementation Strategy

3.1 Identify land ownership requirements and cost sharing criteria.

3.2 Prepare quantity estimates for construction.

3.3 Develop phasing and timing for Best Management Practices implementation, including construction schedules.

3.4 Develop a monitoring programme for assessing Best Management Practices performance.

3.5 Determine landowner and municipal responsibilities.

Phase 4 - Reporting and Study Conclusion

4.1 Draft Report preparation.

4.2 Review and revise the Draft Report for the Steering Committee.

Phase 5 - Public Review and Study Completion

5.1 Public Meeting and Review.

5.2 Review and revise Draft Report for the Steering Committee.

5.3 Prepare and issue Final Report and preliminary stormwater management facility design.

1.4 REPORT ORGANIZATION

This report is organized into a main body and technical appendices. All technical details in appendices are summarized in the main report. Chapter 2 is a description of the study area. Chapter 3 presents the formulation of system options. In Chapter 4 the System Options are evaluated to predict environmental, construction, operation and maintenance cost comparisons provides a review and summary of previous and ongoing studies in adjacent watersheds. Chapter 5 outlines the preferred Stormwater Management Plan with an implementation strategy.
The appendices present the supporting documentation for the Stormwater Management Plan and planning

process. Appendix A contains all figures referred to in the report. Appendix B provides an overview of all relevant studies and reports. Information on water management objectives used to develop a list of stormwater management alternatives is presented on Appendix C. The various components of a Stormwater Management Plan are described in Appendix D. Hydrologic data analyses and computer modelling are summarized in Appendix E. Results of the water quality modelling are given in Appendix F.

2.0 STUDY AREA

2.1 General Description

The subwatershed is located north of The City of Belleville, in the southwest corner of Thurlow Township, entirely within the Plan Area (see Figure 1). The total area of the catchment is approximately 58 hectares and is divided roughly in half by Highway 62 (see Figure 2).

→ The western subcatchment (28 ha) includes lands bounded by Cloverleaf Drive, to the south, Maitland Drive, to the north, Highway 62, to the east, and a north-south line approximately half way between Highway 62 and Sidney Street.

→ The eastern subcatchment (30 ha) is bounded on the east by the Moira River, the west by Highway 62, the south by the extension of Cloverleaf Drive to the river, and to the north by approximately Maitland Drive.

2.2 Existing Characteristics

2.2.1 Description of the Drainage System

There are no natural watercourses within the study area. Drainage is accomplished by overland sheet flow to roadside ditches where water is conveyed east and south to the Moira River.

Within the eastern subcatchment are two inactive, flooded quarries.

→ The first is located near the northern edge of the subwatershed immediately northeast of the Maitland Drive/Highway 62 intersection. Flooding appears to be the result of the water table elevation with little impact from surface flows.

→ The second quarry is located just west of the North Park Street/Parks Drive intersection east of Highway 62 on land owned by the construction company Tarmac. Flooding of this quarry is primarily a result of the water table elevation, but is also effected by surface water flows from the upstream subwatershed. Water originating on lands up gradient of the North Park Street/Parks Drive intersection is discharged from the roadside ditch, through a culvert, directly into the quarry. The outlet of the quarry is controlled by a long culvert discharging to the roadside ditch at the Cloverleaf Drive/North Park Street intersection.

2.2.2 Meteorological Data

Meteorological data for the subwatershed were supplied by QCSA, from the Upper No Name Creek Stormwater Management Study Draft Report to ensure continuity. A description of this data can be found in Appendix B.

2.2.3 Geology and Soils

This subwatershed is situated within the Napanee Plain physiographic region of Ontario. The region is characterized by flat to gently undulating limestone with limited overburden due to historic glacial activity in the area (Chapman and Putman, 1984).

The overburden material, or soils, is predominated by the Solmesville soil series of the Perth Family. These soils are described in "Drainage Guide for Ontario", Ontario Ministry of Agriculture and Food, 1986.

→ *Hydrologic soil group 'C',*
→ *Drainage design code 'S2Ib5'*

S — *In general, surface water gley soils are those profiles that present drainage problems related to excess water. These soils have a distinct horizon of low permeability (ie. rock) within one metre of the soil surface.*

S2 — *Overall medium texture and well structured. Soil becomes more compact with depth. Free water saturation at depths less than one metre on parent material.*

I — *Imperfectly drained - The soil moisture in excess of field capacity remains in the subsurface horizons for moderately long periods during the year.*

b — *Undulating to inclined, midslope, complex dissected landform.*

5 — *Very gentle slopes, 2-5%. Soil classification slope class 3 - moderately severe limitations that restrict the range of* *crops or require special conservation practices or both.*

2.2.4 Topography

The general slope of the land is from northwest to southeast with a gradient of approximately 0.2%.

2.2.5 Hydrologic Conditions

The subwatershed is considered 'flashy' due to the thin soil cover and exposed bedrock. Flow, sheet or channel, is strictly event driven with little, or no, base flow contribution from groundwater sources. Runoff characteristics for the subcatchments, identified in Figure 3, were classified using the United States Department of Agricultural Soil Conservation Service (SCS) Curve Number Method (see Table E1). The curve number chosen is dependant on the hydrologic soil group classification (group C) and the assumed antecedent moisture conditions of the soils (AMC II).

2.3 NATURAL FEATURES

2.3.1 Cloverleaf Drive to Maitland Drive West of Highway 62

This area consists of agricultural fields in the process of succession by eastern white cedars. Other dominant species are buckthorn saplings, raspberries, avens and herbs such as Canada goldenrod, wild carrot, orchard grass, and wild strawberry. There are also scattered pioneering trees such as poplar, cottonwood, Manitoba maple and red cedar.

2.3.2 North of Maitland Drive West of Highway 62

Most of the subwatershed north of Maitland Drive is pasture land or used for other agricultural purposes. Hedgerows in this area appear to be the source of common buckthorn saplings moving into neighbouring fields.

2.3.3 East of Highway 62

The land east of Highway 62 has been developed for commercial and light industrial use with residential use at the Highway 62/Maitland Drive intersection. There are no significant vegetation communities remaining outside of the Moira River shoreline.

2.3.4 Fish Habitat

The road drains experience intermittent flow and are unsuitable for fish habitat.

2.4 Existing and Future Land Use

The Township of Thurlow's Plan for the Cannifton area, guides development within the subwatershed and surrounding lands north of Highway 401.

The subcatchment area numbers used in Table E1 are illustrated on Figure 3 and the future land use designations are from Schedule 1, Land Use, in the Plan in the Township of Thurlow Official Plan.

Most of the subwatershed will be developed for open space, residential, light industrial, or commercial uses. A key element of the Plan's provisions regarding future development requires all development, particularly for lots greater than 0.5 hectares, to have a site specific stormwater management report and full municipal servicing. All new development, by plan of subdivision or consent, requires the completion of a Master Drainage Plan utilizing the Major-Minor stormwater management concept indicating no adverse impacts to water quality, quantity, or erosion due to the development.

To support the recommendations of the QRAP, the Plan requires appropriate stormwater quality control methods. The Plan supports the use of detention and retention facilities and, where appropriate, engineered marshes providing treatment of stormwater by settling of sediment and pollutants. The creation of permanent ponding areas for water quality improvement at outfall points is encouraged within each drainage area such as the study area. Each drainage study must address phosphorus supply into the Moira River and include an abatement plan demonstrating no net increase in loading at full development.

Ecosystem planning principles will be applied to ensure no further alteration to the aquatic plant environment results in a net loss of fish habitat and/or wetlands.

3.0 FORMULATION OF ALTERNATIVE APPROACHES

Alternative stormwater management approaches for the subwatershed have been formulated by applying the methods described in Appendices C and D, and by considering the following:

1. Location opportunities and space availability along the existing drainage ditches for construction of stormwater ponds.

2. The proposed land use in the development areas and the opportunities for rooftop and/or parking-lot storage for on-site flow attenuation.

A description of recognized stormwater management controls is presented in Appendix D.

3.1 Facility Location Opportunities and Constraints

A number of opportunities exist in the subwatershed for siting stormwater management pond(s) or wetland facilities. Constraints on siting of facilities relate primarily to the expected layout of the drainage system, topography, property ownership, perceived development opportunities, and existing land use plans. These are accounted for in defining opportunities. The following points should be noted:

1. The two existing flooded quarries may remain unchanged. Tarmac has placed fill in their quarry, and have advised they may object to its use as a SWM facility. The location of the Tarmac quarry is not optimal for stormwater management, being in the middle of the eastern catchment, therefore its retention has been discounted.

2. Most of the western subcatchment is undeveloped, including the lands most suitable for a SWM facility.

3. Existing commercial and light industrial lands will not be required to implement on-site SWM controls. Voluntary control may be solicited.

4. The Ministry of Transportation lands within the cloverleaf may be available for a quality polishing facility. If not, future realignment of the off-ramp may provide sufficient surplus property for this facility.

5. Flows in the Highway 401 ditch shall not exceed existing conditions.

3.2 METHOD OF PRELIMINARY SIZING OF SYSTEM COMPONENTS

Details of the hydrologic analyses are in Appendix E and pond size details are in Appendix F. The QUALHYMO model was used to produce 1:5 and 1:100 year return period peak flows for existing conditions. Since the SCS 6-hour storm distribution was found to produce the highest peak flows for these return periods, this distribution was used for all subsequent design storm analyses.

Existing condition peak flows at various locations in the watershed are in Appendix E (Table E1). Table E2 presents peak flows for the future developed conditions, with no new stormwater management controls. The table illustrates the need for quantity controls upstream of the Moira River.

The hydrologic analyses provide preliminary estimates of the size of the primary stormwater management, detention/retention facilities (i.e. ponds or wetlands).

1. Estimation of Active Storage Requirements

As described in Appendix E, the QUALHYMO model was used to determine the active storage requirements (ie. "detention:" volumes) needed at facility locations to control downstream peak flows to target levels presented earlier.

2. Estimation of Treatment Level Requirements

At the stormwater management facilities, treatment will primarily be by the hydraulic residence time resulting from a permanent pool volume held within the facility. The preliminary size of pool volumes (*ie.* retention volumes) has been based on the recent publication "Stormwater Management Practices Planning and Design Manual" (MOEE, 1994). These guidelines allow estimation of the permanent pool volume required per hectare of service area, to achieve any one of four levels of treatment (as indicated by solids removal). Preliminary pool size has been based on the most stringent level (Level I) intended to achieve average annual solids removal of 80%.

Once preliminary sizes were determined, modelling of pollutant delivery, transport and removal was carried out using QUALHYMO, to examine the performance of each system option in terms of:

1. Suspended Solid removal % by natural settling
2. *e. coli* removal % by natural die-off
3. Number of separate exceedances of the target suspended solids and *e. coli* levels

of 25 mg/ℓ and 100 organisms/100 mℓ respectively.

The modelling may have also suggested that the preliminary size was inadequate, or larger than necessary, to provide control to the above criteria. In either of these cases, QUALHYMO was used to resize permanent pools.

3. Design Concept for Ditches

The recommended concept is for the ditches to be designed using a 'natural channel design' method. This will help to minimize net impacts on the local environment and provide potential for local enhancement of aquatic or riparian habitats which are highly disturbed. The bed of the low-flow channel could be lined with cobbles and stones to minimize erosion potential while improving physical diversity and aquatic habitat potential. The channel banks and side slopes can be stabilized with plantings including grasses, sedges, shrubs, and aquatic species. To enable use of the channel floodways as parkland, some areas of turf grass could be incorporated within the landscape plan.

Erosion protection and channel stability must be addressed in the subsequent design of the ditches. Along the two reaches from Maitland Drive to Cloverleaf Drive, and from Cloverleaf Drive to the Moira River, existing topography dictates average channel slopes are likely to be more than 1% (depending on final alignment selected). This situation has the potential to cause flow velocities capable of causing local erosion problems unless erosion protection measures are in place. Velocity control measures (i.e. energy gradient control) could be used to assist with erosive power control. Within the context of a natural form of channel design this could possibly take the form of pool-riffle sequences along the ditch to help reduce flow velocities, dissipate flow energy and provide increased aquatic habitat potential.

3.3 Basis For Alternative Approaches

The methods used to carry out preliminary size estimates of three alternative SWM facility alternatives are outlined below. An integral part of each alternative is the inclusion of on-site controls for all future commercial and industrial development.

On-site controls are being recommended for two reasons:

1. they have become standard practice in the design of buildings and landscaping, and
2. without on-site controls, the required storage facilities will be significantly larger.

Supporting discussion is presented in Appendix E.

The alternatives consist of single or combinations of centralized stormwater management facilities, with source flow controls included in proposed commercial/industrial development areas. There are many possible combinations for stormwater management facilities but only a limited set of options has been developed for consideration. These three alternatives are based on options including a minimum number of passive facilities providing quantity or quantity/quality control.

All pond sizing is presented in Appendix F.

Mechanical treatment has not been included in the alternatives presented here. This form of water quality treatment is recognized as being very effective (Gore & Storrie, 1994), however, the initial capital cost, and ongoing operation and maintenance costs are unacceptable to the Township. Any opportunity to provide passive treatment was considered acceptable.

3.4 SWM ALT #1

This option consists of two separate stormwater management facilities for the two halves of the subwatershed. This is illustrated in Figure 4.

1. POND A:

   Purpose: Quantity and quality treatment.

   Pond Type: Wet pond.

   Location: North of Cloverleaf Drive, west of Highway 62, immediately west of the PetroCanada service centre.

   Required Land Area: 0.88 hectare.

2. POND B:

   Purpose: Quality treatment.

   Pond Type: Wet pond.

   Location: North of the Cloverleaf Drive Right-of-Way, east of North Park Street.

   Required Land Area: 0.22 hectare.

3.5 SWM ALT #2

Water quantity and quality from the western catchment is again treated separately by POND A, as above. Flow emanating from the eastern catchment will be rerouted along the Cloverleaf Drive ditch to combine with flow emanating from POND A at the Cloverleaf Drive/Highway 62 intersection. The resulting discharge will be routed through a quality polishing facility within or alongside the highway interchange. Water originating on Bell Canada's property (sub-basin 205) will continue to flow eastward to the river through overland sheet flow and the existing rock swale. This alternative is shown in Figure 5.

1. POND A: as above.

2. POND C:

Purpose: Water quality treatment.

Pond Type: Constructed wetland.

Location: The ultimate location for this facility depends on the future orientation of the highway interchange. With the current conditions a wetland facility may be located within the cloverleaf as shown in Figure 5. Alternately, since MTO has advised that their future plans are to reduce the weaving problem for the Highway 401 exit/entrance by reconstructing the cloverleaf, the location may be alongside the off-ramp, as shown in Figure 5. The timetable for this work is undetermined, but will be driven by the development of the Plan Area.

Required Land Area: 0.95 hectare.

3.6 SWM ALT #3

The final, realistic alternative to providing water quantity and quality control is to combine the flows from the two catchments at the Cloverleaf Drive/Highway 62 intersection and provide one treatment facility in or alongside the highway interchange. Water originating on Bell Canada's property (sub-basin 205) will continue to flow eastward to the river through overland sheet flow and the existing rock swale.

1. POND D:

Purpose: Water quantity and quality treatment.

Pond Type: Wet pond.

Location: See POND C and Figure 6. As this pond may include water ponded to depths (up to 2 metres) that could prove dangerous in the event of a traffic accident, MTO will not allow it to be located within the existing cloverleaf.

Required Land Area: 1.78 hectares.

4.0 EVALUATION OF ALTERNATIVE APPROACHES

Alternatives for stormwater management in the subwatershed have been developed from a wide range of possible measures, including source control and treatment facilities. This approach is consistent with fundamental principles of environmental assessment, which require consideration of all feasible solutions to a problem. Evaluation and comparison of the three alternatives has been carried out in a manner consistent with Environmental Assessment principles. This approach recognizes implementation of stormwater management facilities in the subwatershed may require compliance with the Province's *Environmental Assessment Act*, depending on the implementation mechanism.

4.1 Performance Evaluations in Terms of Pollutants Removal

The QUALHYMO model was used to simulate pollutant loadings from the subcatchments and the removal processes within the stormwater management facilities. Details of the modelling methodology are provided in Appendices E and F.

Results of each alternative are provided in Appendix F, Table F4, which includes average annual performance of the facilities in terms of pollutant removal efficiency and number of times regulatory thresholds for suspended solids (25 mg/ℓ) and coliform bacteria (100 *e. coli.* organisms/100 mℓ) are exceeded.

4.2 Approach to Comparative Evaluation

The three alternatives are compared based on capital costs (i.e. construction costs), operation and maintenance costs, and environmental costs (*ie.* impacts on the natural environment of the subwatershed, the Moira River and the Bay of Quinte). All alternatives are intended to meet the stormwater management targets of the QRAP and control peak flows rates at critical points within the subwatershed. All alternatives provide the same benefits by providing the same performance in terms of stormwater flow and quality control. It is possible evaluate each of the alternatives on the basis of their construction, operation and maintenance and environmental costs.

4.3 Cost Comparison

4.3.1 Land Acquisition

SWMALT 1 requires that the Township enter into land acquisition negotiations with two separate landowners. The lands to the west of Highway No. 62 are currently vacant and are not currently under consideration for development. The preferred location for Pond A is alongside Cloverleaf Drive at the lowest point of the catchment area. Pond B will be located in lands owned by Bell Canada, requiring the Township to negotiate a drainage easement along the southern property boundary. The property requirements have not been appraised as a part of this study, but the Township staff should be able to estimate the cost of the required lands from recent transactions.

The remaining two alternatives are dependant on the Ministry of Transportation. The Township could enter into negotiations for locating a wetland within the existing cloverleaf, but current Ministry policy does not allow the locating of such facilities within a cloverleaf. The reasons cited were:

- → potential saturation of the road foundation leading to higher maintenance costs, and
- → safety, recovery, and liability concerns over vehicle accidents within ponds.

Should the Ministry proceed with the modifications to the interchange, then the Township will be provided an opportunity to purchase the surplus lands. According to Ministry Directive QST-B-23, once the lands have been declared surplus, the local municipality will be solicited by the Ministry, and have 60 days to declare its interest in purchasing the property. An exception to this process is for small areas and narrow strips which are not viable on their own, therefore should the Township wish to pursue either of these alternatives, the Ministry of Transportation should be approached immediately concerning the future disposal and timetable for the surplus lands. If the property is deemed viable it will be sold directly by the Region, at the appraised market value, if not viable the Ministry may sell it for upto $15,000. below the appraised price.

4.3.2 Construction Costs

Table 4.1 presents estimated costs for final design and construction for the drainage works and stormwater management/treatment facilities associated with the three stormwater management alternatives.

4.3.3 Operation and Maintenance Costs

Costs for operation and maintenance of the drainage works and stormwater facilities will result from the following:

1. Routine inspection and cleaning of sediment forebays in ponds, drainage channels, and culverts.

2. Inspection of lot level controls, particularly the controlled inlets in roof drains and catch basins.

3. Landscape maintenance.

Costs for routine inspection and maintenance of drainage channels, culverts and other structures will not be substantially different between the various alternatives.

Table 4.1 Estimated Construction Costs

Alternative	Estimated Cost
SWMALT 1 POND 'A' POND 'B' includes all earthworks, inlet/outlet structures, landscaping, and fencing.	$91,000. $25,000. Total $116,000.
SWMALT 2 POND 'A' POND 'C' includes all earthworks, inlet/outlet structures, landscaping/wetland planting, and fencing.	$91,000. $130,000. Total $221,000.
SWMALT 3 POND 'D' includes all earthworks, inlet/outlet structures, landscaping/wetland planting, and fencing.	$250,000.

4.4 Environment Costs

As summarized in Appendix B, an overview survey of the natural features of the subwatershed was completed in 1995 to supplement the work carried out as part of the Upper No Name Creek Study.

The area is largely developed for industrial and commercial uses or is abandoned farmland. It is highly disturbed and there is advanced vegetation succession. Many non-native plant species such as, common buckthorn, a very invasive plant that is now ubiquitous in the region, are present.

The watercourses within the subwatershed are constructed for road drainage and are also intermittent by nature. Aquatic habitat is minimal, likely confined to the flooded Tarmac quarry and the Parks Drive ditch.

Given that the eastern catchment is highly disturbed, the western catchment is primarily abandoned farmland, and that the road ditches are unlikely to support fishery habitat, the environmental cost of the proposed facilities will likely be positive. With the creation of wet ponds or wetlands, the potential for aquatic species and waterfowl to find suitable habitat will be improved.

4.5 Overall Evaluation

By proceeding with SWMALT 1, the Township can proceed to arrange to satisfy the land requirements for the two ponds immediately within lands that are currently vacant, and without development plans. The other alternatives require the Township to wait until the Ministry of Transportation declares surplus lands for disposal. The Ministry's plans are closely linked to the development of the area and funding from the developers, while future development is closely linked to the provision of stormwater management facilities. This conundrum

When comparing the alternatives, it can be shown that the first two (SWMALT 1 and SWMALT 2) are preferable based on land requirements and construction costs. In terms of construction cost considerations alone, SMWALT 1 may be somewhat less costly than SWMALT 2.

With respect to environmental costs, all alternatives are generally the same in terms of potential impacts. However, SWMALT 2 may have the most positive impacts due to the constructed wetland.

5.0 IMPLEMENTATION STRATEGY

5.1 THE MOST PREFERRED ALTERNATIVE

The stormwater management alternative endorsed here is SWMALT 1.

This conclusion has been based on land availability and acquisition potential, and the consideration of all construction, operation, maintenance and environmental costs and benefits. Figure 4 depicts the primary elements (ditch routes and wet ponds) of the preferred management strategy. No boundaries, other than those shown in Schedule 1 of the Plan, representing constraints to development, with respect to existing natural features within the subwatershed, are required.

The stormwater strategy incorporates two stormwater ponds to provide flow control and stormwater treatment by natural settling of pollutants, and biological treatment:

Pond A: Located west of Highway 62 along the north side of Cloverleaf Drive. This facility would be constructed as a wet pond-type facility. Permanent pool volume is 2,000 m^3, and active storage is 2,700 m^3 (total storage of 4,700 m^3).

Pond B: Located along the southern portion of lands currently owned by Bell Canada. This facility would be constructed as a wet pond-type facility. Permanent pool volume is 750 m^3 with no active storage required.

This study has provided planning-level estimates of the stormwater storage volumes required at both facilities to ensure adequate stormwater treatment, to meet QRAP guidelines, and control of peak flows up to the 100-year return period. The estimated pond volumes are based on full implementation of source controls in all new residential and industrial/commercial development outlined in Appendix D.

Implementation of the stormwater strategy requires final design analysis and detailed design of the recommended stormwater ponds, ditches and culvert improvements, fulfilment of Environmental Assessment and regulatory approval requirements, determination of phasing requirements and definition of cost-sharing arrangements.

5.2 FINAL DESIGN AND ENVIRONMENTAL ASSESSMENT REQUIREMENTS

Detailed design of the various components of the stormwater strategy will be needed to obtain regulatory approvals and to allow proposed land developments to proceed.

5.2.1 Stormwater Treatment Facilities

The design process for the ponds may follow the framework of the Class Environmental Assessment for Municipal Water and Wastewater Projects (June 1993), to meet the intent and requirement of the Province's *Environmental Assessment Act*. This study will serve as a support document helping with the fulfilment of Phase I (Problem/Need Identification) and Phase II (Selection of Preferred Alternative) of the Class Environmental Assessment process.

Design of the stormwater ponds may proceed as a Schedule B project, as defined in the Class Environmental Assessment process. This requires the preparation of an Environmental Study Report justifying the need for the facility and presenting the rationale for the selected design.

Design of the stormwater ponds will include:

1. Detailed site layout and grading plans provide storage volumes.

2. Detailed design of inlet and outlet control structures to regulate storage levels and peak water levels.

3. Preparation of landscaping plans, and detailing of other design features such as access roads and fencing.

It is emphasized that further hydrologic and hydraulic analyses will likely be required, at the final design stage, to optimize the size and operation of the facilities.

5.2.2 Channels/Ditches

The preferred strategy incorporates ditches along i) existing alignments and ii) rear lot lines. These will collect runoff developed lands and provide safe conveyance to/from the ponds.

All channels should be designed to contain the 100-year flow within a designed floodway area. The benefit of this approach is a reduction in the potential of flooding on neighbouring lands.

It is recommended that the design of any channels utilize a 'natural' approach such as placement of root wads and establishment of dense vegetation to maintain channel stability, as opposed sole reliance on more traditional techniques such as gabions and imported rip-rap stone. Where velocity and erosion control is a concern, the natural design approach could include the creation of pool-riffle sequences to help control velocities and create local aquatic habitat.

As an example, the channel beds could be lined with cobbles and stones to minimize erosion potential and improved physical diversity and habitat potential. The banks and side slopes can be stabilized with plantings including grasses, sedges, shrubs, and aquatic species. To allow use of the channel floodways as parkland, some areas of turf grass could be incorporated within the overall landscape plan.

5.2.2.1 Estimation of Land Area Requirements

The land area is estimated to be 0.54 hectare for POND 'A' and 0.15 hectare for POND 'B'. This estimate includes adequate land for maintenance purposes and containment berms. Since the two ponds are located alongside a roadway, access can be directly form the road, and no land allowance will be necessary.

The following factors must be considered:

1. Maintenance access along some ditches may be needed for routine inspection, debris removal and repair of any erosion problems. Vehicle access should be possible along at least one side.

2. Energy-gradient control (i.e. velocity control) measures may be needed along some sections of the proposed ditches where the topography causes energy gradients and flow velocities which could cause erosion problems. Final design must consider flow velocities and erosion potential.

3. A vegetated buffer should be maintained along each side of the ditches to minimize direct pollutant washoff from adjacent development sites.

To allow final design of the ditches to have adequate capacity, maintenance access, and opportunities for velocity-control and erosion-control measures, a minimum ditch corridor width of 5 metres is recommended throughout the subwatershed. The proposed drainage alignments are shown on Figure 4, however, these are subject to change as land use development concepts are formulated and implemented.

5.3 REGULATORY APPROVALS

The Township believes that the most effective way to implement this plan is to proceed with the project as a municipal drain, following the requirements of the *Drainage Act*. Any projects proceeding in this way are exempt from the requirements of the *Environmental Assessment Act, R.S.O. 1990, c. E.18 as amended*, the *Environmental Protection Act, R.S.O. 1990, c E.19 as amended* (PART VIII, s 74(h)), and the *Ontario Water Resources Act, R.S.O. 1990, c. O.40 as amended* (s 53(6)(e)).

Should the project be undertaken through another process, regulatory approvals will be needed for the implementation of the stormwater management strategy including:

1. *Ontario Water Resources Act* approval will be required for the stormwater management ponds and Certificates of Approval will be issued by the Ontario Ministry of Environment & Energy based on approval of the final facility designs. The Certificates will specify stormwwater quality compliance requirement such as specific targets for bacteria and suspended solids concentration in facility effluent and will likely also specify monitoring required to demonstrate compliance.

2. Alteration to Waterway and Fill and Construction Regulations (*Conservation Authorities Act*) approval will be required for the stormwater ponds. These approvals are administered by the Quinte Conservation Services Alliance.

3. *Lakes and Rivers Improvement Act* approval of impoundment and outlet control works associated with stormwater ponds. These approvals are administered by the Ministry of Natural Resources. Approval applications require detailed design information.

4. Encroachment Permits from the Ministry of Transportation, since the works are nearby two major highways, and may impact upon Provincially owned lands.

5. Transport Canada permits for the establishment of ponds within the CFB Trenton flight control zone.

6. Negotiations with Bell Canada will be required to acquire a drainage easement along the southern boundary of their lands, and to permit the construction of a treatment facility within this easement.

5.4 Implementing Source Controls

The recommended stormwater management strategy calls for the following on-site controls within the development areas:

1. Residential source controls to ensure that roof and foundation drainage is diverted onto grassed areas, as opposed to being drained onto paved areas or directly connected to the storm sewer.

2. Industrial and commercial on-site controls to ensure roof top storage on flat-roofed buildings, along with catch basin inlet controls in parking areas, to restrict peak outflow rates.

3. Water quality can also be improved through the following actions:
   - → The Township adopt a 'Poop-and-Scoop' By-law.
   - → Regular parking lot sweeping, not cutting grass shorter than 75 millimetres, and spill response training and materials be adopted by area industrial and commercial land users.

Modelling of all alternative approaches has been based on explicit representation of these distributed control measures. They must be included in new development site plans to provide the required performance in terms of peak flow control and stormwater treatment.

5.5 PHASING

Phasing is an important aspect to implementation, since facilities must precede land development, but should be implemented only when land development will proceed. Phasing of facilities must also recognize that development within the subwatershed is likely to extend over a number of years, as individual land developers proceed.

5.5.1 Phasing of the Ponds

Construction of the east pond (POND 'B') and the west pond (POND 'A') will be needed as development begins in each respective drainage area. It is difficult to predict the timing for proposed developments in each drainage area but the most probable developments are:

1. Redevelopment of the eastern side of the Highway 62 corridor.

2. Development of the residential lands on the extreme western boundary of the subwatershed.

3. Infilling within the eastern catchment.

There appears to be potential for significant development of the eastern catchment at this time.

Design of the two stormwater ponds could occur concurrently, or the Township could proceed to design and build the eastern pond now, and require the developer of the western catchment to design and build the other pond. Further discussions are recommended between the Township, land developers, and the QCSA, to establish a schedule for design and construction of the ponds.

5.6 COST SHARING

Cost sharing for the stormwater management works is an important concern. An equitable cost-sharing arrangement for the major components is necessary. The estimated capital costs, including 20% contingency, for the major components of the two wet ponds is $116,000.

The Township is expected to own and operate the stormwater facilities however, it is important to note that POND 'B', provides peak flow control to existing levels for the entire eastern catchment and stormwater quality control through natural attenuation. The level of treatment is consistent with recent Provincial guidelines (as given in the Ministry of the Environment and Energy's Stormwater Management Practices Planning & Design Manual, June 1994). The Bell Canada lands, however, do not contribute a major portion of the flow, will not be redeveloped within the near future, and, in consideration of a drainage easement, Bell should not have an obligation to pay any portion of the costs of stormwater management.

It is recommended costs be allocated in proportion to the volume of storm-event runoff generated by the respective tributary areas and on the basis of tributary drainage area in relation to the runoff characteristics of each subcatchment. This approach has been applied to the western catchment in order to estimate cost-sharing for planning purposes and are presented in Table 5.1.

Table 5.1 Proposed Cost Apportionment

Sub-basin	Cost Apportioning per Sub-basin %	Cost Apportioned per Land-Use %		
		Residential	Industrial & Commercial	Community Facilities
100	5	5		
101	16.5		16.5	
102A	31		26.4	4.6
102B	40.8	10.2	10.2	20.4
103	4		4	
104	2.7		2.7	
Total	100.0	15.2	59.8	25.0

Since the eastern catchment is zoned for industrial and commercial uses, costs will be borne by those new and redeveloped properties.

Total cost apportionment for the entire subwatershed would be:

Residential	7.6%
Industrial/Commercial	79.9%
Community Facilities	12.5%
Total	100%

This preliminary estimate indicates that the industrial and commercial land users will contribute the largest portion of the costs. The portion assessed to community facilities should be addressed through development charges or lot levies. During subsequent planning and design of the recommended works it will be necessary to refine cost estimates and the cost-sharing calculation, based on a detailed evaluation of what proportions of facility design capacity should be allocated per lot.

5.7 OVERALL IMPLEMENTATION STRATEGY

Based on the requirements of the final design, environmental assessment, phasing and cost-sharing, an overall implementation strategy can be summarized as outlined in Table 5.2. This strategy fits the Class Environmental Assessment process for Water and Wastewater projects. Throughout design and implementation, the Class Environmental Assessment process should be used as a guide. This ensures sound decision making based on all costs.

Should the Township proceed with this project as a municipal drain, the requirements of the *Drainage Act* take precedence over the requirements of the *Environmental Asessment Act*, *Environmental Protection Act*, and the *Ontario Water Resources Act*. Therefore, this document presents the stormwater management requirements of the Cannifton Secondary Plan, and the design criteria for the municipal drain.

Table 5.2 Recommended Implementation Strategy

Phase		Tasks
1.	Preliminary Facility Design	→ Prepare designs for two stormwater management ponds and associated conveyance works following the Schedule B Class Environmental Assessment process for Municipal Water and Wastewater Projects. → Finalize timing for construction. → Design monitoring programme. → Submit Environmental Study report for public review.
2.	Finalize Design and Acquire Agency Approvals	→ Revise designs to reflect final facility layout. → Prepare final cost estimates and cost sharing. → Acquire Approvals.
3.	Construct Facilities	→ Tender project and proceed to construction.
4.	Monitoring Programme	→ Implement monitoring programme to satisfy MOEE requirements.
5.	System Improvements (if required)	→ Assess effectiveness of SWM facilities and implement modifications, if required.

6.0 REFERENCES

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APPENDICES

APPENDIX A

FIGURES

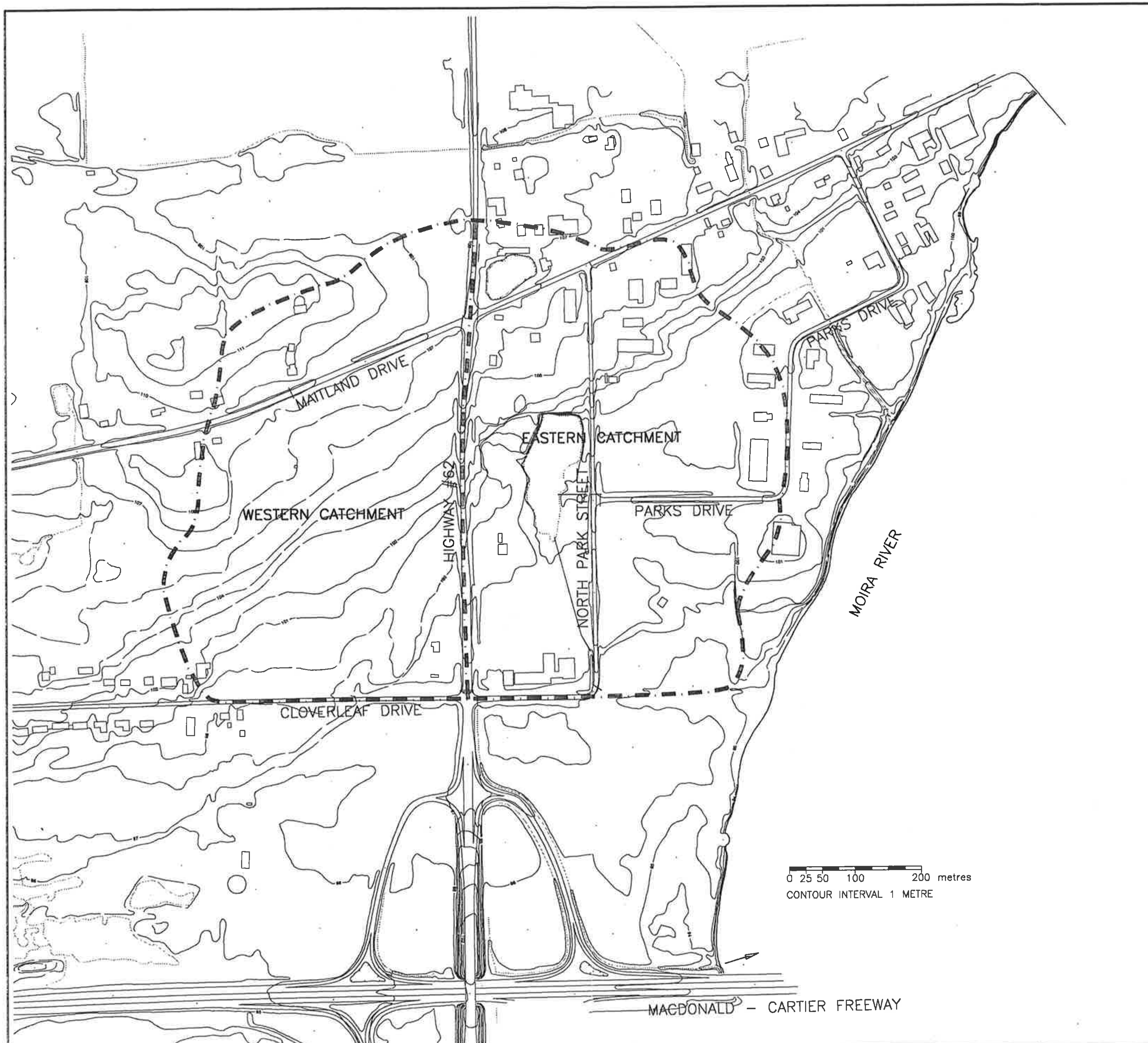
Appendix A

THE GREER GALLOWAY GROUP INC.
ENGINEERS + PLANNERS

PETERBOROUGH
BANCROFT
→ BELLEVILLE
COURTICE
PEMBROKE

PROJECT NAME	
THURLOW TOWNSHIP	
STORMWATER MANAGEMENT PLAN	
CANNIFTON INDUSTRIAL PARK AND ENVIRONS	
DRAWING NAME	
KEY MAP	
SCALE	
AS SHOWN	
DRAWN BY	DATE
RKT	08/96
CHECKED BY	DATE
–	–
PRINTED	
08/96	
PROJECT NUMBER	DRAWING NUMBER
94–B–6766	FIGURE 1

6766KEY.DWG



THE GREER GALLOWAY GROUP INC.
ENGINEERS + PLANNERS

PETERBOROUGH
BANCROFT
BELLEVILLE
COURTICE
PEMBROKE

PROJECT NAME

THURLOW TOWNSHIP

STORMWATER MANAGEMENT PLAN

CANNIFTON INDUSTRIAL PARK AND ENVIRONS

DRAWING NAME

SUBWATERSHED AREA
EXISTING CONDITIONS

note: two separate catchments

SCALE

AS SHOWN

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RKT	08/96

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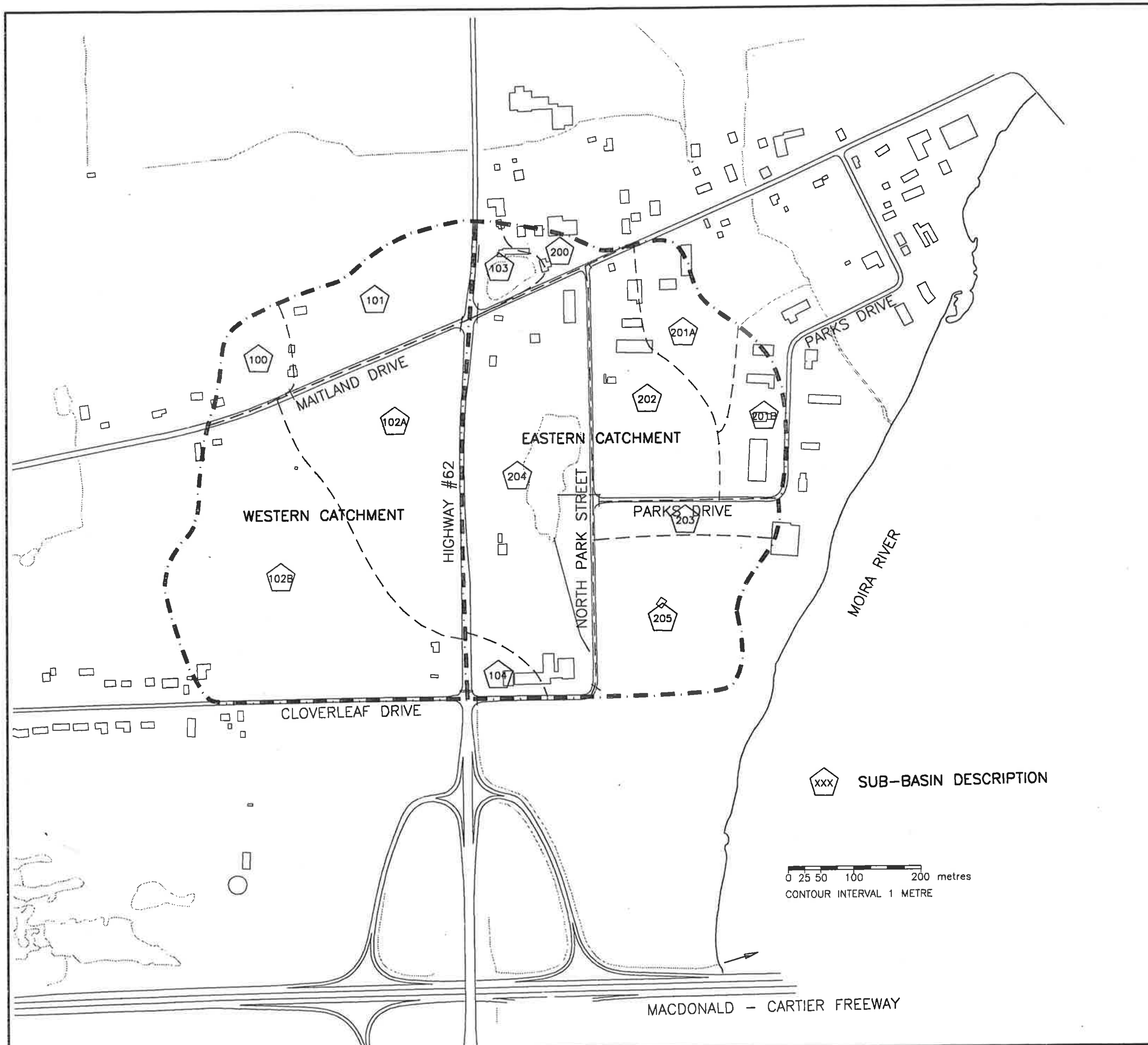
PRINTED

08/96

PROJECT NUMBER	DRAWING NUMBER
94-B-6766	FIGURE 2

6766KEY.DWG



THE GREER GALLOWAY GROUP INC.
ENGINEERS + PLANNERS

PETERBOROUGH
BANCROFT
BELLEVILLE
COURTICE
PEMBROKE

PROJECT NAME

THURLOW TOWNSHIP

STORMWATER MANAGEMENT PLAN

CANNIFTON INDUSTRIAL PARK
AND ENVIRONS

DRAWING NAME

SUB-BASINS USED FOR MODELLING
EXISTING CONDITIONS

SCALE

AS SHOWN

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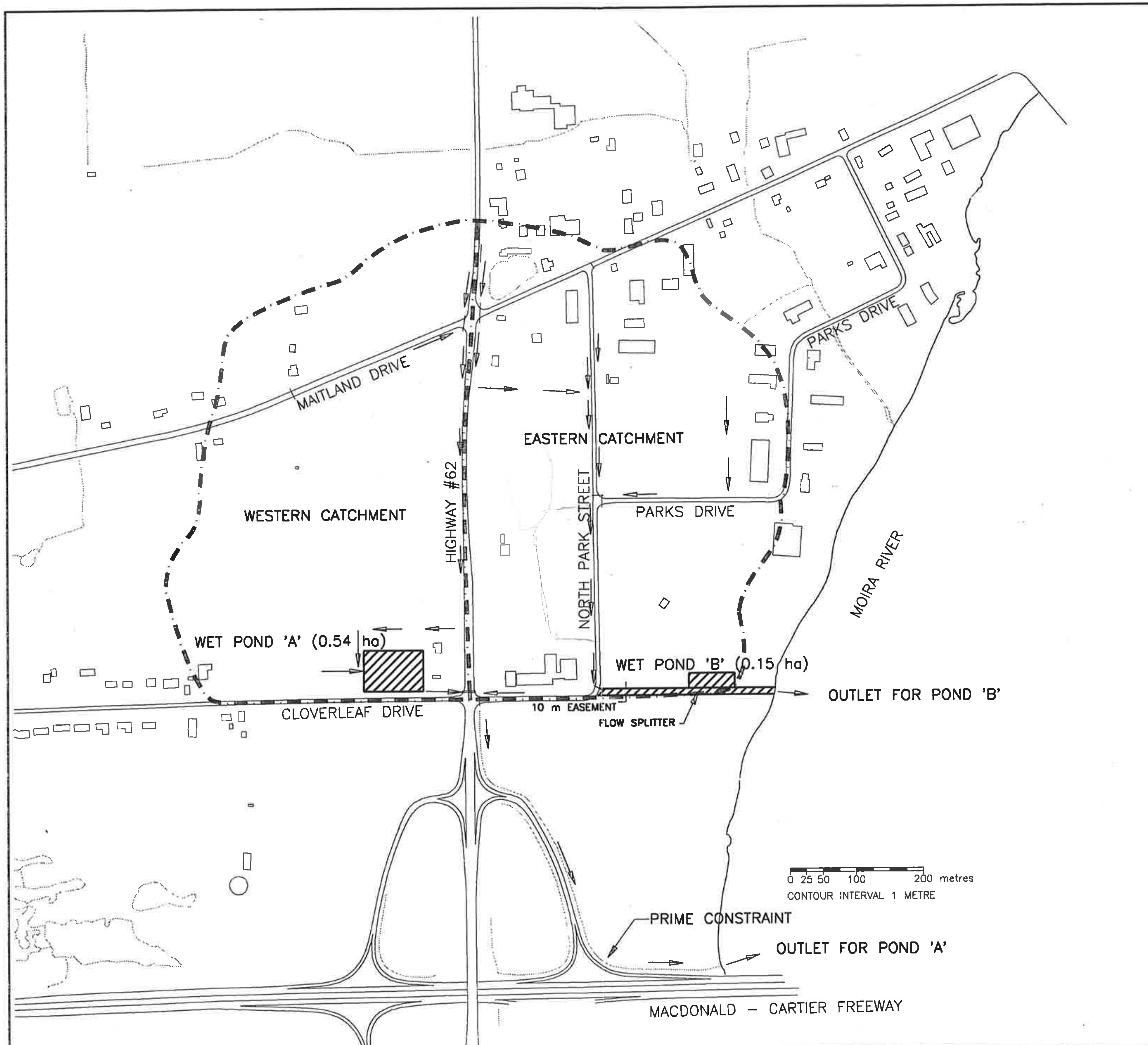
08/96

PROJECT NUMBER	DRAWING NUMBER
94-B-6766	FIGURE 3

6766KEY.DWG



THE GREER GALLOWAY GROUP INC.
ENGINEERS + PLANNERS

PETERBOROUGH
BANCROFT
BELLEVILLE
COURTICE
PEMBROKE

PROJECT NAME

THURLOW TOWNSHIP

STORMWATER MANAGEMENT PLAN

CANNIFTON INDUSTRIAL PARK AND ENVIRONS

DRAWING NAME

STORMWATER MANAGEMENT ALTERNATIVE NO. 1

SWMALT 1

note: 2 separate wet ponds

MOST PREFERRED LAYOUT

SCALE

AS SHOWN

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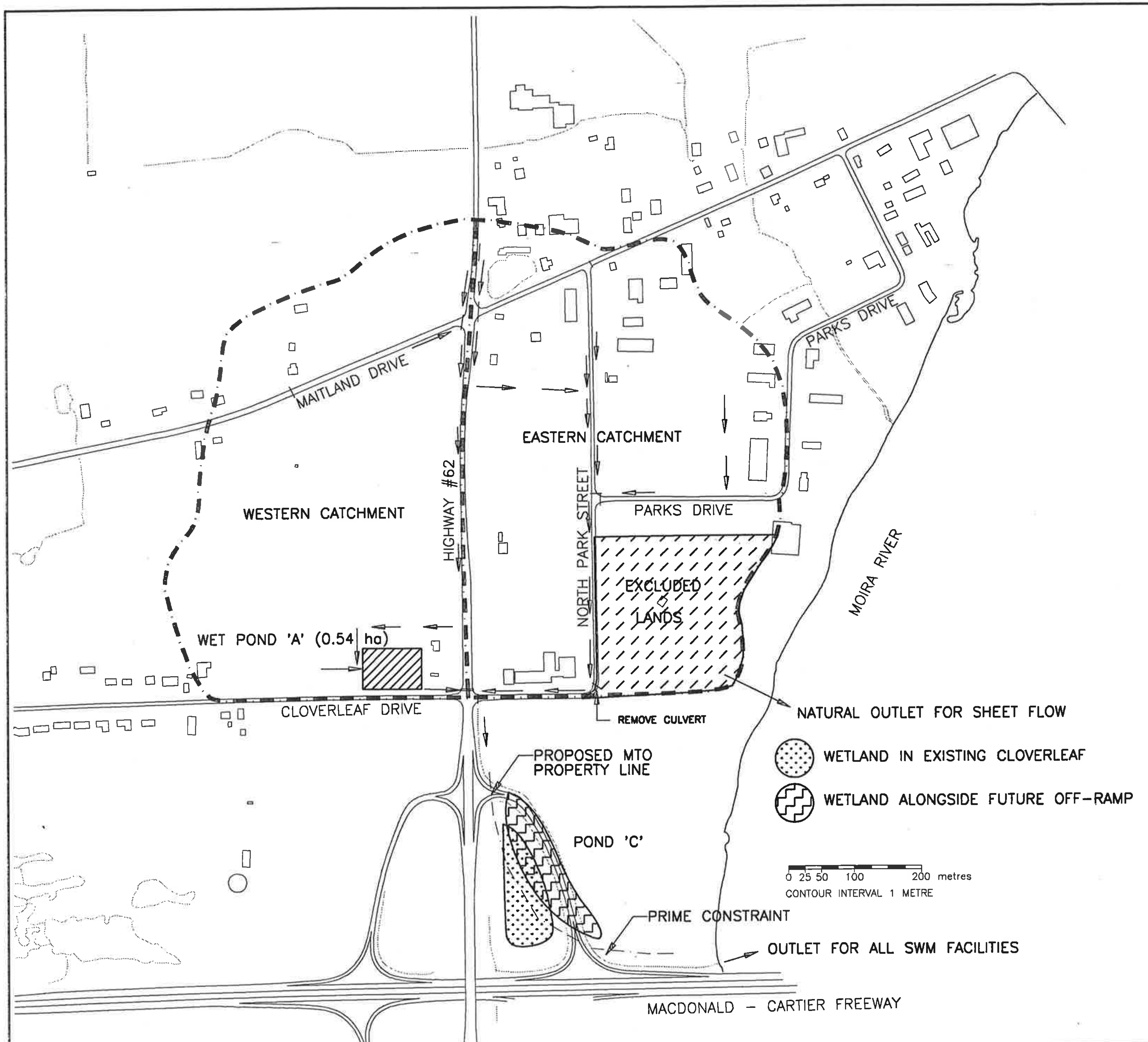
08/96

PROJECT NUMBER	DRAWING NUMBER
94-B-6766	FIGURE 4

6766KEY.DWG



THE GREER GALLOWAY GROUP INC.
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PETERBOROUGH
BANCROFT
BELLEVILLE
COURTICE
PEMBROKE

PROJECT NAME

THURLOW TOWNSHIP

STORMWATER MANAGEMENT PLAN

CANNIFTON INDUSTRIAL PARK AND ENVIRONS

DRAWING NAME

STORMWATER MANAGEMENT ALTERNATIVE NO. 2

SWMALT 2

note: wet pond plus wetland

ALTERNATE LAYOUT

SCALE	
AS SHOWN	
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RKT	08/96
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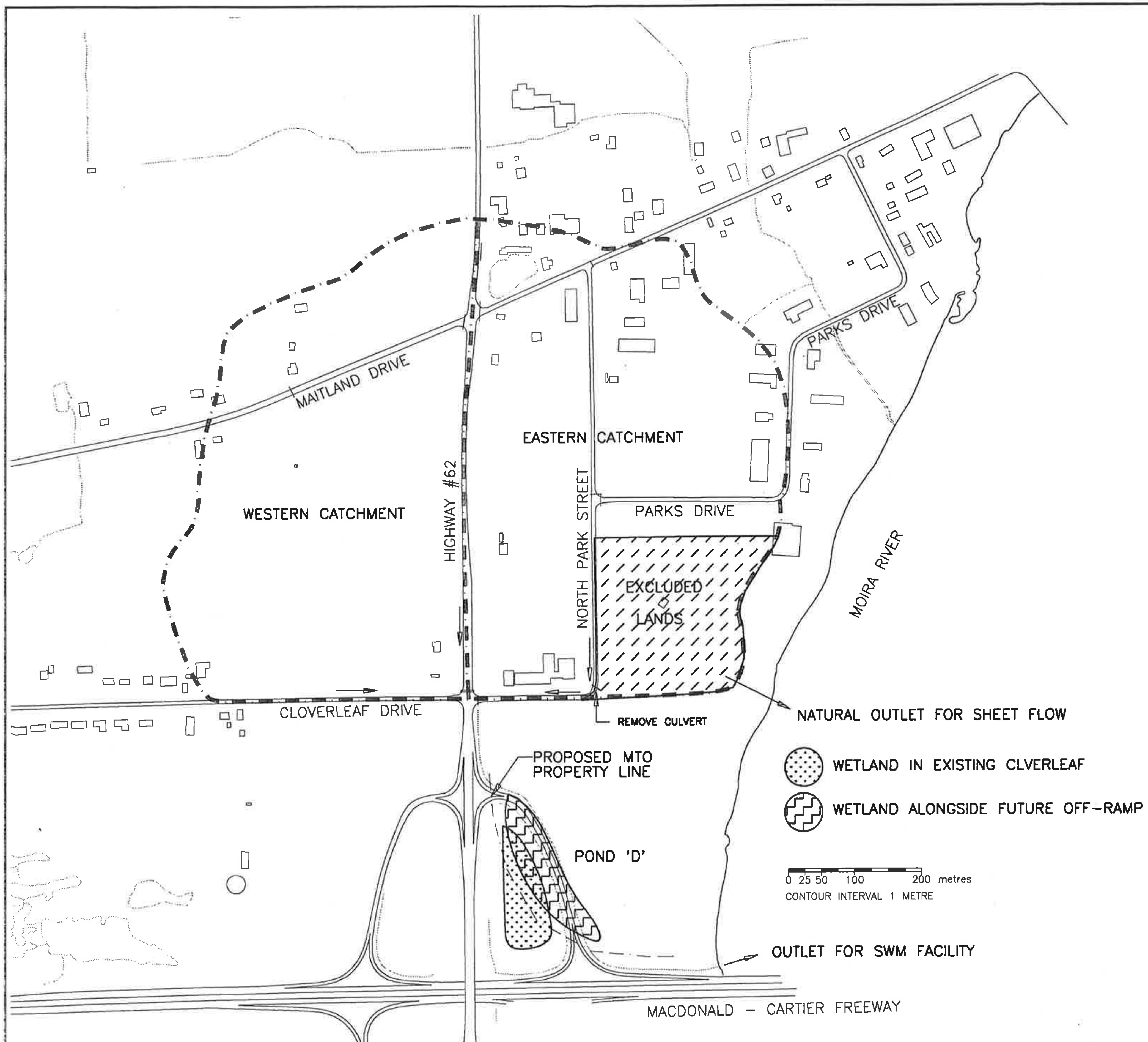
PROJECT NUMBER	DRAWING NUMBER
94-B-6766	FIGURE 5

6766KEY.DWG



THE GREER GALLOWAY GROUP INC.
ENGINEERS + PLANNERS

PETERBOROUGH
BANCROFT
BELLEVILLE
COURTICE
PEMBROKE

PROJECT NAME

THURLOW TOWNSHIP

STORMWATER MANAGEMENT PLAN

CANNIFTON INDUSTRIAL PARK
AND ENVIRONS

DRAWING NAME

STORMWATER MANAGEMENT
ALTERNATIVE NO. 3

SWMALT 3

note: single large wet pond

PREFERRED ALTERNATE LAYOUT

SCALE	
AS SHOWN	
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RKT	08/96
CHECKED BY	DATE
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08/96	
PROJECT NUMBER	DRAWING NUMBER
94-B-6766	FIGURE 6

6766KEY.DWG

APPENDIX B

OVERVIEW OF PREVIOUS STUDIES/REPORTS

APPENDIX B
OVERVIEW OF PREVIOUS STUDIES/REPORTS

Several studies of the hydrology and hydraulics of the Upper No Name Creek watershed and the catchment area subject of this study have been completed in the last 20 years. These were summarized for the Upper No Name Creek Subwatershed Study, and those summaries are repeated here with emphasis on information relevant to this study.

B.1 BELLEVILLE WATER MANAGEMENT STUDY (Crysler and Lathem, 1997)

This study identified areas prone to flooding during the 1:100 year regional storm and made recommendations to mitigate flooding. The study considered the catchment area subject of this study and the No Name Creek watershed, under the land use conditions existing at the time.

The United States Department of Agriculture, Soil Conservation Service (SCS) curve number model was used to generate peak flows, and the HEC-2 model to estimate flood prone areas. The study concluded, for the upper basin of the No Name Creek watershed (north of Tracey Street) detention basins were required to reduce regional storm flows to a level that could be accommodated in the Tracey Street storm sewer (sized for approximately the 1:5 year storm). Storage basins were recommended immediately upstream of Highway 401, and immediately downstream of Bell Boulevard on the Upper No Name Creek.

B.2 BELLEVILLE FLOODPLAIN MAPPING STUDY (Ministy of Natural Resources, 1982)

This study included HYMO and HEC-II modelling of No Name Creek to generate floodlines and to develop a plan to reduce flooding potential. Only existing land use conditions were considered.

The peak flows generated in this study were lower than the Crysler and Lathem (1977) study, which did not consider the available storage north of Highway 401. The recommended remedial work for the Upper No Name Creek basin was a variation on one of Crysler and Lathem's proposed solutions and included a detention pond upstream of Highway 401, channelization of the creek downstream of the 401 to connect with the existing channel and a swale to carry excess flow from the upper basin to Tracey Street, then into another swale to route flow back into the creek in the lower basin.

B.3 REPORT ON STORMWATER MANAGEMENT FOR THE NORTHWEST BELLEVILLE AREA (Gore & Storrie, 1986)

A stormwater management study was conducted for the City of Belleville, for the entire No Name Creek watershed. Expansion of the Quinte Mall was approved on the condition controls be enforced to control post-development peak flows to pre-development levels. This was achieved by surface detention on the parking lot and rooftop.

Required criteria to be met were flood controls for the 1:100 year regional storm, control of runoff to pre-development levels, maintenance of the existing storage north of Highway 401, and control of flows north of the 401 by developers to ensure no increase in flows from existing levels.

OTTHYMO was the hydrologic model used in this study. The Chicago distribution was used to derive a 1:5 year synthetic storm of 3 hours in duration. For analysis of flood control, the regional storm was applied, which is a 12 hour duration 1:100 year storm following the SCS Type II distribution. The model incorporated existing storage north of the 401, at the Quinte Mall, and upstream of the Tracey Street storm sewer. Storage volumes were estimated based on topographic information. The capacity of the Tracey Street storm sewer was found to be 3.5 m* at its inlet at Lemoine Street (outlet of Upper No Name Creek). With 1986 land use conditions, the modelling indicated the storm sewer had sufficient capacity for the 1:5 year flows, and would have less than 10% surcharge at 1:100 year flows, when existing storage upstream of Tracey Street is taken into consideration. Peak flows generated in this study are provided in Appendix ?. Flows were in reasonable agreement with the previous MNR (1982) study, except for outflows from the existing beaver pond north of Highway 401. The 1986 Gore and Storrie study computed available storage based on 1:2000 scale mapping, not available at the time of the MNR study.

The proposed development considered in this study included only the industrial and commercial developments south of the 401. No development north of the Highway was considered. The analysis assumed a drainage channel would be maintained through the proposed industrial development from the 401 to Bell Boulevard and the existing channel south of Bell Boulevard to the storm sewer inlet would be maintained. A detention facility was recommended at Tracey Street to control runoff from severe storms, to allow the Tracey Street Storm sewer to provide the outlet for all runoff events from the Upper No Name Creek basin. No major flows from Upper No Name Creek would therefore be routed to the southern portion of the No Name Creek watershed. The storage volume required in the detention facility, to eliminate surcharge in the storm sewer at future land use conditions for the 1:100 year storm, was estimated at 6,200 m^3.

B.4 UPDATE REPORT ON STORMWATER MANAGEMENT FOR THE NORTHWEST BELLEVILLE AREA (Gore & Storrie, 1990)

Between 1986 and 1990, parts of the No Name Creek watershed were developed, resulting in land use changes and higher imperviousness. The 1986 OTTHYMO model was modified to reflect the changes, and storage requirements adjusted. The study also considered development north of Highway 401.

At the ultimate land use conditions known at the time of the update study, it was estimated the existing storage north of the 401 would have to be increased to 16,000 m* for the 1:100 year event, an increase of 6,000 m*. South of the 401, the storage requirements at Tracey Street to maintain the storm sewer as an outlet for the 1:100 year event was increased to 10,700 m*.

B.5 NO NAME CREEK STORMWATER MANAGEMENT STUDY (Falcone Smith, 1990)

The hydrology of the Upper No Name Creek watershed, for the developers of the Belleville Home Centre and the Congress Centre, was the subject of this study. It was focussed on stormwater management strategies affecting these developments. The study area included all drainage to the Tracey Street storm sewer at Lemoine Street, as well as some analysis which was extended to include contributing areas along the length of Tracey Street to estimate the carrying capacity of the storm sewer all the way to the Moira River.

The MIDUSS model was used for the hydrologic assessment, with model discretization and input parameters used by Gore and Storrie (1986, 1990). A slightly different 1:5 year storm hydrograph was used, with 15 minute time steps, instead of 5. The same 1:100 year storm was used.

A hydraulic analysis was conducted of the entire Tracey Street storm sewer, which considered flows captured at Lemoine Street, as well as at numerous catchbasins located along Tracey Street from Lemoine Street to the Moira River. The flow from Upper No Name Creek is dominant, but the other inflows are significant, and limit the flow which can be accepted at Lemoine Street without producing surcharging. Considering the inflows all along the storm sewer as well as from Upper No Name Creek, the maximum elevation of hydraulic grade line at Lemoine Street was found to be 92.5 m, corresponding to an inflow rate of 3.5 m*/s. This implies a modest degree of surcharge, not considered to be a problem.

Analyses showed that at existing land use conditions, the Tracey Street storm sewer has sufficient capacity to prevent flooding, however any development between Tracey Street and Highway 401 will result in increased flooding potential. Stormwater management measures will therefore be required in parallel with development.

Several land use scenarios were analyzed in the study. Stormwater Management measures considered included an on-line detention pond at Tracey Street, with and without on-site detention storage. Pond sizing assumed attenuation of peak flows to pre-development levels from the future development north of the 401 would be implemented. The required pond volume for the fully developed condition was found to be 8,600 m* for the 1:100 year event.

The study considered the use of on-site detention storage as an alternative or supplement to the on-line pond. Both rooftop and parking lot storage on the commercial developments were modeled. Both of these types of storage are currently employed at the Quinte Mall, which reduces the 1:100 year peak flow by 80%. The impact of on-site storage at the Belleville Home Centre and Congress developments on the required volume in the on-line pond was assessed. The result was a significant reduction in volume of the pond to 5,400 m^3. A centralized on-line pond would still be required, however, even with on-site controls. The study recommended this be designed as a dual purpose water quantity and quality control facility.

B.6 UPPER NO NAME CREEK STORMWATER MANAGEMENT STUDY (Gore & Storrie, 1995)

Certain sections of this report are of somewhat greater significance to the current study than others. The sections which provide a more thorugh understanding of the general area are summarized below.

B.6.1 Meteorolgic Data

Data for this study was acquired from the Atmospheric Environment Service of Environment Canada. A nearly complete record, from 1960 through 1990, was available for station # 6150689 - Belleville Water Treatment Plant. This data was analyzed to prepare design storms for event modelling and, with supplementary data from neighbouring stations, was also analyzed to prepare a continuous input file.

Potential evaporation was estimated through data acquired from the AES station (# 6158733) at Pearson International Airport, Toronto.

B.6.2 Vegetation Communities

The climax forest was dominated by sugar maple. White elm, silver and red maple and cedar likely occupied the low ground. White cedar occurs where it is invading old pastures (Chapman and Putnam, 1984).

Vegetation communities, illustrated in the report, categorized the vegetation communities into Environmental Constraint Zones, from 1 to 5. Zone 1 is a Water Dominant or Related area. An objective of the Bay of Quinte Remedial Action Plan is to achieve no net loss of Zone 1 areas. The remaining four Zones are: Special Wooded Areas (Zone 2), Wooded Areas (Zone 3), Old Field Regeneration (Zone 4), and Modified Areas (Zone 5).

There were no locally or provincially significant wetlands in the catchment area.

B.6.3 Flora

The Upper No Name Creek Stormwater Management Study Draft Report reports a total of 132 species in the watershed. The terrain in the catchment area has been extensively disturbed and many non-native species such as orchard grass, awnless brome and common buckthorn are abundant. Non-native species readily colonize disturbed ground. Several uncommon species, which are species found at between 10 and 100 stations within its physiographic region, were found in the Upper No Name Creek Watershed but all were from the area around the beaver ponds.

Only one rare species, purple willow-herb, was found in the Upper No Name Creek Watershed. This species, according to Gore and Storrie Limited, is fairly common in the region occurring in many disturbed habitats. Willow-herbs can be difficult to identify, and the species has likely been overlooked (Wasylbakowsky, Natural Heritage Information Centre, Peterborough, Ontario).

B.6.4 Wildlife

All animals found in the Upper No Name Creek Watershed were common to abundant winter residents of agricultural and successional land and small woodlands in eastern Ontario. Some, such as coyote, beaver and white-tailed deer, are adaptable and continue to occupy small natural habitat areas on the edges of expanding urban areas. These species also demonstrate problems caused by wildlife in cities.

Beaver appear to have been numerous in the Upper No Name Creek study area in the past. No fresh signs of beaver were seen during the 1994 field visit in the Upper No Name Creek watershed and none were evident in the catchment area subject of this study. Beaver were observed during the field survey in December 1993, in the marshy area south of Highway 401. Trapping was also noticed.

B.6.5 Water Quality Data

In 1994 the Moira River Conservation Authority conducted a water quality data collection programme for the Upper No Name Creek. Sampling results were also available from 1993. Appendix A contains tables of all water quality data available. The data, provided in the Upper No Name Creek Stormwater Management Study Draft Report, are assumed to be representative for this study.

Water quality sampling data were collected from spring to fall, 1993. Wet or dry weather sampling conditions were not identified, but elevated bacteria levels measured on June 7, July 5 and August 4 suggest wet weather. Water quality sampling for three dry weather periods was conducted during 1994. Dry weather bacteria, suspended solids and nutrients were low.

A 2.6 mm (0.1 in.) rainfall event preceded the one wet weather event in June of 1994 but no flow information was collected at the time. The water quality data shows the bacteria levels are greater than the dry weather values. The *escherichia coliform* concentrations are elevated but are an order of magnitude less than typical wet weather stormwater concentrations.

The 1994 field program results show bacteriological contamination during wet weather in the Upper No Name Creek watershed, particularly in the more developed areas south of Highway 401. The *e. coli* concentrations in the creek, in the order of 5,000 to 7,000 no/dl, indicate a problem level of bacteriological contamination from stormwater. Bacteria levels as high as those observed in Upper No Name Creek impact on bacteria loadings to the Moira River and the Bay of Quinte and may contribute to beach pollution.

APPENDIX C

WATER MANAGEMENT OBJECTIVES

APPENDIX C
WATER MANAGEMENT OBJECTIVES

This section outlines urban runoff control requirements for the catchment area.

C.1 BASIS FOR STORMWATER MANAGEMENT TARGETS

The stormwater management targets applicable to the catchment area are based on:

1. The policies of the Ontario Ministry of the Environment and Energy, with respect to protection of surface water quality.

2. Stormwater management requirements developed for the Bay of Quinte Stormwater Management Implementation Area as part of the Bay of Quinte Remedial Action Plan.

3. Water management policies and requirements of the Moira River Conservation Authority, with respect to flood and erosion control.

4. Drainage service requirements and municipal drainage design standards of the Township of Thurlow.

C.2 SUMMARY OF CURRENT POLICIES AND REGULATIONS

The following summarize policies and regulations affecting stormwater management planning for the catchment area.

C.2.1 Land Drainage Requirements: Level of Service

The main purpose of an urban drainage system is to provide an acceptable level of service, which translates into a minimum risk to personal safety and minimum inconvenience from runoff. These level of service objectives are summarized as:

1. Protect buildings from regional storm flood damage (i.e. 100-year return period for catchment area).

2. Protect basements from regional storm flooding (i.e. 100-year return period hydraulic grade line must be below foundation drains; alternatively provide a sump pump to the foundation drain).

3. No unsafe ponding on roadway surfaces for 5-year return period runoff events and the extent and duration of ponding on residential or commercial lots must be kept to an acceptable minimum.

These land drainage objectives are best achieved through the application of the Major-Minor stormwater management concept of urban drainage design required by Section 3.2.2 of the Townships Secondary Plan. This concept is based on a drainage system composed of two interconnected sub-systems:

1. Minor or Convenience System - designed to minimize inconveniences to pedestrians and motorists by accommodating the runoff form the 5-year return period. It may consist of roof gutters, rainwater leaders, swales, street gutters, catchbasins, and storm sewers.

2. Major System For Flood Protection - the route followed by storm runoff when the minor system is inoperative or inadequate designed to provide a low risk to life and property from severe runoff events. It may consist of swales, roadways, channels, and other overland flow routes, including natural streams and valleys. This system will function whether or not it has been planned or designed and whether or not development is located wisely with respect to it. The Major and Minor systems are not necessarily separate because they may share some elements. For instance, a swale or creek may be designed to handle both flood flows.

In the catchment area the drainage system consists of a man-made ditch system. These are the primary drainage collectors, with the final outlet being the Moira River. There is no continuous or engineered major overland flow system. Major flood flow would follow existing ditches and flow to the River.

C.2.2. Erosion Control Requirements

The erosion control target is to not make existing erosion problems within the study area and downstream any worse. This is enforced by the Moira River Conservation Authority and the Ministry of Natural Resources when approvals for works under the Lakes and Rivers Improvement Act or the Fill and Alteration to Waterway Regulations are requested. Erosion control minimizes risk to adjacent properties and helps ensure the protection of downstream aquatic habitat.

C.2.3 Water Quality Protection

Requirements for controlling the impact of development on water resources stem from:

1. The policies and objectives established by the Ontario Ministry of the Environment and Energy for the protection of surface water and groundwater quantity and quality.

2. Policies and requirements of the Ontario Ministry of Natural Resources for protection of aquatic habitat under the Federal Fisheries Act.

3. Local interpretations of the Provincial policy developed from study and investigation of specific problems encountered in the area. The stormwater management guidelines developed for the Bay of Quinte is an example.

C.2.3.1. Provincial Policies

The Provincial policies and objectives are contained in the Ministry of the Environment and Energy publication Water Management: Goals, Policies, Objectives and Implementation Procedures. This so-called 'Blue Book' sets out specific water-quality objectives and policies for attaining the overall goal of ensuring the surface waters of the Province are of a quality satisfactory for aquatic life and recreation.

The Province's objectives for protecting surface water quality for aquatic habitat are consistent with the objectives of the Federal Fisheries Act, which requires discharges to water bodies not have any harmful effect on fish habitats. The Canadian Water Quality Guidelines (Canadian Council of Environmental and Resources Ministers, 1987) provides a scientific basis for establishing specific impact-control targets for protecting aquatic habitat.

C.2.3.2. The Bay of Quinte Remedial Action Plan Guidelines

Within the Bay of Quinte watershed the Provincial objectives have been interpreted in the Bay of Quinte Remedial Action Plan. The Bay of Quinte Stormwater Management Implementation Area guidelines for stormwater quality control have been developed by the Inter-Agency Storm Water Management Working Committee (Ministry of the Environment and Energy, 1993). The water quality performance objectives are that stormwater discharges to existing watercourses meet the following requirements for protecting recreational water quality in the Bay of Quinte:

> *Escherichia coli (EC) level in stormwater discharges to be 100 no/Dl or less (from May 15 to September 15). The Ministry of the Environment and Energy will allow up to four separate event exceedances of these bacteriological criteria to occur each swimming season.*
>
> *An additional guideline is total suspended solids should be below 25 mg/L (from May 15 to September 15).*

The rationale is that summertime coliform bacteria control is needed to protect the Bay for recreational use. By keeping discharge suspended solids levels to 25 mg/L, a high degree of removal will be assured. Since a wide range of pollutants are directly associated with suspended solids, it follows that a good degree of overall stormwater quality control will be assured. The Bay of Quinte Stormwater Guidelines give limits for additional parameters related to protection of aquatic life. These generally conform with the Ministry of the Environment and Energy Provincial Water Quality Objectives.

C.3 STORMWATER CONTROL TARGETS

The policies and guidelines summary can be used directly or interpreted to provide a set of targets for stormwater management in catchment area.

C.3.1 Stormwater Quality Targets

Problems become apparent when stormwater management goals and regulatory targets are compared with expected impacts of future development within the catchment area.
Recent research shows runoff from urban areas carries a number of contaminants of potential concern, including coliform bacteria (e.g. e. coli), heavy metals, hydrocarbons, chlorides, and suspended sediment. It is expected runoff from residential, commercial or industrial areas contains contaminants at concentrations and loadings with potential impact on receiving waterbodies. In particular, it is expected that without satisfactory source control and/or runoff treatment, e. coli levels will be higher than 100 no/dl at the point of discharge to the receiving water body (i.e. at the storm sewer outfall). It is also expected suspended solids levels will be above the 25 mg/L target, and a range of contaminants (including bacteria) will be associated with those sediments. Recent Ontario research on die-off and persistence of coliform bacteria in surface water systems indicates sediment resuspension may play a role in creating higher coliform levels during runoff events. Therefore, coliform bacteria control is needed not only in wet weather but also during dry weather to ensure sediment-bound bacteria levels are not maintained by dry-weather inputs. The water quality target can be stated as:

> *Drainage systems for new urban development must be designed to adequately control pollutant loads delivered to catchment area. In particular, e. coli and suspended solids concentrations in discharges to Moira River must be controlled to comply with the Bay of Quinte guidelines: e. coli must be below 100 no/dl from May 15 to September 15 (with allowance of four event exceedances), and Suspended Solids levels must be controlled to 25 mg/L.*

Meeting these targets implies adequate stormwater quality control will be provided for compliance with all existing policies and regulations for surface water quality protection.

C.3.2 Targets For Control of Peak Flows

For this study, the targets for control of peak flows have been set as outlined in Table 2. The 100-year targets are based on maintaining the predevelopment peak flow.

C.3.3 Erosion Control Targets

The objective of no increase in erosion can be achieved in two ways, control the future flow so there is no increase in the erosive power. This requires the stormwater management system be designed to not increase the duration of erosive flowrates and velocities. minimizing erosion can also be achieved by designing the conveyance system to increase resistance to erosion wherever an increase in erosive power is expected.

There are no substantial erosion concerns in the catchment area. However, as the area is developed, there may be potential for an increase in the erosive power in the ditches. The flow attenuation provided by the stormwater management system will help control this impact, by reducing peak flow during all runoff events. However, even if designed to control peak flows to present levels for all return periods from 2 to 100 years, the stormwater control system will not likely provide full control of erosive power. This reflects the fact that the *duration* of erosive flowrates is likely to increase, due to the increased volume of runoff associated with increased watershed imperviousness.

The target for stormwater management planning should be:

> *No increase in the duration with which flowrate or velocity exceeds the threshold at which erosion begins (i.e. control of excessive erosive impulse, as defined by Lorant, 1982).*

This can be achieved through additional stormwater flow attenuation (sometimes referred to as overcontrol), or through increasing the erosive threshold by increasing the resistance of the conveyance channel (i.e. through structural reinforcement or natural or bioengineering techniques). Both approaches should be considered.

C.4 SUMMARY

The stormwater control targets have been formulated during this study to guide the formulation and evaluation of specific options for the overall stormwater management system for the catchment area. The targets require:

1. Summertime control of bacteria levels in discharges to the Moira River to below 100 *e. coli* per 100 mL, with the allowances of up to four event exceedances.

2. Control of 100-year peak flowrates.

3. Consideration of flow-control or stream-channel protection measures to ensure control of erosion along the roadside ditches.

APPENDIX D

FORMULATION OF ALTERNATIVES

APPENDIX D
FORMULATION OF ALTERNATIVES

The first step in formulating alternative approaches to stormwater management was to review the literature for general alternativesand measures that mey provide controls which meet the criteria.

D.1 OVERVIEW OF APPROACH

In June, 1994, the Ministry of Environment & Energy published the "Stormwater Management Practices Planning and Design Manual" which provides technical guidance for practitioners of SWM planning, design, and review. This manual summarizes current approaches to stormwater management, from lot level controls through to the preparation of watershed plans. Any level of control, or combination of controls, may be considered as an alternative for stormwater management.

The manual suggests a hierarchy of preferred stormwater management practices:

1. Lot Level (Source) Controls
2. Conveyance Controls
3. End-of-pipe Controls

D.2 LOT LEVEL (SOURCE) CONTROLS

Lot level controls do one or more of the following:

1. Control the volume of surface runoff from a development site.
2. Control the rate of surface runoff from a development site.
3. Control the pollutants transported by runoff from a development site.

Ideally, contamination of runoff is avoided prior to 'disposal'. This is a difficult task to achieve since there is a wide variety and number of possible sources of contamination. Also, a substantial portion of urban pollutant washoff occurs from roadway surfaces.

D.2.1 Alternative Lot Level Controls

Source control measures which reduce runoff volume, rate, and contamination include:

I. Runoff rate and volume:

   A. Rooftop storage with gradual release to the drainage system.
   B. Catchbasin inlet controls such as flow restrictions, resulting in temporary ponding in parking lots, grassed areas, and roads.

The above two alternatives are commonly recommended for use in commercial/industrial zones.

C. Use of lot-by-lot infiltration measures such as:
   1. grassed swales.
   2. infiltration trenches, possibly including perforated pipe systems.
   3. diversion of rooftop runoff onto grassed areas.

D. Storage tanks or cisterns to provide temporary storage and gradual release to the drainage system.

E. Porous pavements to reduce direct runoff from paved areas

II. Source controls of runoff contamination include:

A. Intensive sweeping/vacuuming of roads and parking lots

B. Housekeeping measures in industrial areas such as:
   i. covering of chemical storage areas, garbage dumpsters, etc.,
   ii. litter control, and
   iii. spill control and containment.

C. Pet control by-laws.

D. Control or elimination of the use of fertilizers, pesticides, and herbicides

E. Public education and awareness, including measures such as signage on all stormwater inlets.

D.2.2 Evaluation of Lot Level Controls

Factors affecting the feasibility, acceptability, and practicality of source control options include:

1. Catchment Physiography and Seasonal Weather - Soil types, water table elevation, and surficial geology may render infiltration-type measures impractical within localized study areas. Seasonal weather changes (spring and fall saturation and winter frost conditions) may reduce the effectiveness of some alternatives and render them unfeasible, or to only limited, seasonal use.

2. Type of Existing and Proposed Development - The type and extent of development, development controls, and site drainage system requirements, may add constraints to the level of control achievable. For example, municipal drainage standards may discourage frequent ponding on private or public lands. If the road standards require curbs with catchbasins and storm sewers, source control of the pollutants (sediments, trace metals, hydrocarbons) wash-off will be difficult.

3. Control Objectives - The objectives for control of runoff quality and quantity will have direct impacts on the suitability of control measures. The suitability of source controls to meet the objectives will determine whether these controls are adequate in and of themselves. On their own, source controls may not be sufficient to meet site specific criteria for floe velocity,

flow rate, and/or erosive potential.

The lot level control options can be evaluated based on their known effectiveness, practicality, and feasibility. *Table D3 reviews source control measures for controlling runoff volume and rate and Table D4 evaluates methods of run-off pollution control.*

D.2.3 Performance Review

When assessing of the feasibility of lot level controls it should be recognized that:

I. Sources of bacterial pollution are numerous and widespread. Pitt (1983) provides a review of possible sources (present and active) within an urban area. The net impact of these sources is difficult to predict, therefore control, and the reason(s) for coliform bacteria persistence in the natural water environment are not fully understood. It is not reasonable to expect source controls alone can meet the current Quinte Remedial Action Plan requirement that coliform levels in summertime runoff discharge to the Moira River be below 100 **e.coli** per 100 ml.

II. Source control of bacteria, nutrients, and sediment washoff is also difficult due to the nature of the existing and expected drainage systems in the catchment area. Source control of pollutant wash-off from large commercial and industrial parking areas and from curbed roadways is difficult. Roadway washoff is difficult to control without frequent street sweeping/vacuuming. The effectiveness of street sweeping was examined by Pitt (1983) who concluded it may reduce fecal coliform discharges by up to 20%, but that 10% is more likely. Pitt (1983) notes these marginal improvements would only be associated with major increases in street cleaning expenditures.

III. Education programs in the area provide the public with an awareness of the impact of domestic sources and activities, including pet litter, landscape maintenance (use of fertilizers and herbicides, etc.), and car washing/maintenance on areas draining onto roadways. Because the impact is difficult to predict, little reliance can be placed on the effectiveness of education.

The following conclusions can be made:

I. Source controls alone may not adequately control runoff pollution. Source control measures to reduce runoff pollution are likely to be of limited effectiveness in dealing with suspended sediments, coliform bacteria, and phosphorous.

II. Rooftop storage and catchbasin inlet controls can provide substantial benefits in flow reduction (and some volume reduction) and should be continued and implemented wherever practical.

III. Centralized runoff collection or treatment facilities may be needed to provide treatment prior to discharge to the Moira River.

IV. Since on-site or source control measures may not provide the full amount of flow attenuation needed, some form of centralized runoff detention may be needed within the subwatershed to control peak flows.

The development of a conceptual stormwater management alternative focusses on providing centralized runoff detention and treatment within the catchment area. Opportunities to provide source flow control via rooftop and parking lot storage and drainage of rooftop runoff onto grassed areas are considered crucial to all alternatives developed here.

D.3 CONVEYANCE CONTROLS

The only conveyance controls likely to be effective in this subwatershed are 'naturally' designed channels. These channels can offer the ability to detain flow, reduce erosive velocities, and, with good vegetation, reduce the concentration of nutrients and bacteria to the downstream environment. The actual water quality treatment ability of these controls is intangible, but should not be disregarded. As with lot level controls, conveyance controls should be implemented as part of the overall stormwater management plan.

D.4 CENTRALIZED STORMWATER MANAGEMENT FACILITIES

Centralized stormwater management facilities are engineered detention or retention facilities located within, or alongside, the drainage system of a subwatershed. For this subwatershed they may have to be designed to provide water quality treatment as well as flow detention. The overall treatment process will have to be designed to meet the stringent *e. coli* control target.

D.4.1 Centralized Treatment Options

Table D5 lists the options for centralized treatment of runoff from developed areas and an assessment of how each of these options can be designed to accommodate runoff storage for flow control. The table also includes an assessment of the level of bacteria load reduction expected from the treatment process and its adaptability to direct effluent disinfection via a physical or chemical wastewater disinfection process.

D.4.2 Evaluation

There are a number of considerations entering into the evaluation of options besides those on Table D5 including:

D.4.2.1 Passive Systems

I. Centralized runoff treatment should occur at a minimum number of facilities; thus minimizing construction costs and the complexity of operation and maintenance.

II. Ponds and wetlands are easiest to design to include significant storage for the downstream flow control. In this subwatershed, where there are opportunities along the existing drainage system to locate ponds, the preferred approach is to use detention ponds to temporarily hold runoff and allow its gradual release. Combination retention/detention ponds or wetlands providing both water quality treatment and flow control are the most favourable options.

III. Constructed wetlands need adequate tributary area to ensure there is enough water year round. A rule-of-thumb is that a constructed wetland should be at least 1-2% of its drainage area, and that a minimum tributary area of 10 hectares is preferred (Schueler, 1992).

D.4.2.2 Active/Mechanical Systems

IV. Vortex separators are manufactured wastewater treatment devices. Their performance is dependent on the physical characteristics of the sediment (particle sizes and mass) carried by the runoff. They are best suited to small scale end-of-pipe applications, but have been tested in larger applications. Performance in a stormwater treatment system may be variable depending on flow and sediment concentration. Used alone, these devices may provide adequate solids removal to meet treatment targets, but are costly to install (particularly where sanitary sewers are not available for sediment disposal), and require routine maintenance (if syphoning at wet well is required). Since sewage treatment capacity has a finite allocation limit, which is currently committed, and stand alone systems require post-event service, vortex separators will not be considered as possible alternatives for this subwatershed.

V. Filtration systems can only be installed at the outlet of a settling pond since pre-treatment is needed to remove coarse and medium textured sediment. Filtration systems also require regular inspection and maintenance, based on sediment concentration and runoff volume and would only be viewed as an option for providing improved treatment of effluent from an initial settling facility. This alternative has also been discounted for use in this subwatershed due to initial capital costs and the requirement for routine maintenance.

Pond and/or wetland facilities are likely the most appropriate centralized runoff detention and treatment for the catchment area.

D.4.2.3 Disinfection Technology

The temporal variation in bacterial loadings and natural die-off mechanisms means that natural processes may not be adequate for bacteria removal in some cases. If passive systems cannot achieve the water quality objectives, some form of direct disinfection may be required. A number of options have been applied to effluent disinfection of municipal wastewater; these are:

1. Chlorination/Dechlorination
2. Chlorine Dioxide
3. Bromine Chloride
4. Ozone
5. Ultra Violet Light

Ultra violet disinfection has advantages in stormwater applications (Gore & Storrie, 1994). It is a relatively simple process requiring short contact time, has good bactericidal and virucidal properties, and does not create known hazardous by-products. Comparing capital and operating costs of the various disinfection options also indicates ultra violet irradiation is the most cost effective. This process, like filtration, is installed at the outlet of a detention/settling pond.

As there is adequate land available for stormwater management facilities in the subwatershed, the need for disinfection should be negligible. Ultra-violet treatment will only be considered as an alternative of last resort.

D.4.3 PREFERRED APPROACH TO CENTRALIZED STORMWATER MANAGEMENT

The preferred methods and approach to centralized stormwater management in the subwatershed are summarized as follows:

I. Centralized treatment and flow control can best be achieved through the use of wet pond/wetland facilities providing stormwater treatment by natural settling and bacteria die off. Secondary removal by biological uptake of nutrients by aquatic vegetation should also be encouraged.

II. The overall system should:

   A. Minimize the number of facilities.
   B. Facilitate phasing as upstream development proceeds.
   C. Facilitate cost sharing and implementation.

D.5 CONCLUSION

The semi-urban nature of this subwatershed, and lack of established development, allows the Township to implement a stormwater management plan that incorporates a variety control measures. To this end it is recommended that the following controls be included in the alternative approaches under consideration.

- → Lot level controls be required for all undeveloped commercial/industrial/community properties. These controls should also be encouraged for land undergoing redevelopment.
- → Foundation drains and roof leaders from residences be discharged to rear yard swales.
- → Regular parking lot sweeping, dust control, waste disposal/containment, and yard maintenance be encouraged for all properties (voluntary compliance).
- → Swales and ditches be designed to provide flow attenuation with up to 12 to 24 hours ponding.
- → Conveyance channels be designed to reduce erosive velocities, and promote contact time with vegetation.
- → Wet pond(s) and/or wetland(s) be located near the Moira River to provide flow attenuation and water quality treatment. It is likely, over the long term, that stormwater conveyance from this subwatershed will be through a piped sewer system, therefore these facilities should be sized to provide all attenuation and treatment needs.

APPENDIX E

HYDROLOGIC ANALYSIS

APPENDIX E
HYDROLOGIC ANALYSIS

E.1 HYDROLOGIC SIMULATION

The Greer Galloway Group Inc. utilized the QUALHYMO, Version 2.1, hydrologic analysis model for this study. The model supports both event driven and continuous simulations for both water quantity and quality. The model, originally developed by Rowney and Wisner (1983), with modifications by Rowney and MacRae (1991 & 1992), is utilized throughout the industry, and is accepted for providing reasonably accurate results.

It is preferrable to calibrate and verify QUALHYMO through the use of data collected during precipitation/runoff events, but the scope of this study precluded field sampling and measurements. Input parameters for QUALHYMO have been based on the recently completed Upper No Name Creek Stormwater Management Study.

In order to be conssitent with the above study, the following modelling parameters were chosen:

- → Time to peak was calculated using the SCS Curve Number formula (Singh, 1992).
- → The Nash unit hydrograph method was used for both pervious and impervious area calculations. The assumptions and parameters for this method include:
  - → 4 linear reservoirs for impervious conditions,
  - → 2 linear reservoirs for pervious conditions, and
  - → soil storage and intial abstraction are estimated through the SCS Curve Number Method.

E.2 EXISTING CONDITIONS

E.2.1 Drainage Basins

Early review of topographic maps, and field investigation, indicated that this subwatershed actually functions as two separate, equal halves divided by Highway 62 (Figure 2). The western half of the subwatershed drains south and east to a culvert under Highway 62, immediately north of Cloverleaf Drive, from whence water is conveyed southward through the Highway ditch to the Moira River. The eastern catchment drains southward, through the flooded Tarmac quarry, to the rock swale extending from the end of Cloverleaf Drive to the Moira River.

For this study the catchment area was discretized into smaller subbasins based on flow contribution at certain points (such as a culvert entrance). These subbasins are shown on Figure 3. Surface area of each basin was determined from digital topographic mapping (Northway, 1994) using AutoCAD, checked by planimeter. Details of exisitng characteristics for each subbasin are given in Table E1.

Table E1. Existing Sub-basin Characteristics

Sub-basin Number	Area (ha)	Curve Number (AMC II)	Percent Impervious (est.)
100	1.53	84	5
101	4.34	84	5
102A	8.80	81.7	negligible
102B	13.09	80.8	3.5
103	1.07	82	95
104	0.70	99	95
200	0.25	85	95
201A	2.88	84.6	35
201B	2.07	98	100
202	5.40	87.6	45
203	1.40	95	95
204	10.80	85	40
205	6.40	79	5

E.2.2 Field Investigation

Several field visits were undertaken to i) become familiar with the subwatershed and locate any areas which may act as a constraint and ii) during rainfall and snowmelt events to view the runoff characteristics.

The first visit provided some insight into the lay of the land and the general adequacy of the culverts and roadside ditches.

- → The eastern half of the subwatershed is an active industrial park with a variety of light industrial, commercial, and construction companies.
  - → Ditches are well defined alongside the roads, less well defined, or maintained, along rear property lines.
  - → All culverts appeared to be adequate for minor flow emanating from the catchment. The Parks Drive ditch was overgrown with reeds and rushes indicating that the downstream culvert was a constraint for larger events and/or the gradient of the ditch was very low.

- → All runoff flows into the Tarmac quarry at the above intersection and discharges, through a culvert, at the Cloverleaf Drive/North Park Street intersection.
- → The topography of the southern portion is very flat and bedrock is near to the surface.
- → The outlet for all runoff from this half of the subwatershed appeared to be through the ditch running from the end of Cloverleaf Drive to the Moira River.

→ The western half of the subwatershed appeared to be primarily abandonned farmland, with active farmland and a few residences along Maitland Drive, and a gas station on Highway 62. Road ditches were poorly defined, but culverts appeaered to be adequately sized for minor events. The large box culvert at the Highway 62/Cloverleaf Drive intersection appeared to be sufficient to pass a major event.

Subsequent visits confirmed that:

- → the thin soils and existing landuses promoted early runoff from precipitation events,
- → the flat topography created areas of ponding, both on yards and in ditches,
- → culverts were adequately sized for the minor events and snowmelts witnessed,
- → the culvert at North Park Street and Parks Drive created an impoundment in the road ditch, and
- → the outlet for runoff emanating from teh eastern half was through the ditch extending from the east end of Cloverleaf Drive to the Moira River.

E.2.3 Event Modelling

Event modelling was performed for the 1:5 and 1:100 year design events to simulate the minor and major events, respectively. The design storm used was an SCS Type II of 6-hours duration, with 15 minute time steps. QUALHYMO was also run with a 15 minute time step. The results of the simulations are presented for selected locations in the subwatershed in Table E2.

Table E2 Exisiting Peak Flows

Location	1:5 Year Event (m^3/s)	1:100 Year Event (m^3/s)
WEST CATCHMENT		
Southwest corner of Maitland Drive and Highway 62	0.073	0.177
Northwest corner of Cloverleaf Drive and Highway 62	0.208	0.541
Ditch south of intersection of Cloverleaf Drive and Highway 62, outlet to Moira River	0.252	0.623
EAST CATCHMENT		
Inlet to culvert under intersection of North Park Street and Parks Drive	0.360	0.630
Outlet of Tarmac quarry	0.090	0.182
Oulet of Cloverleaf Drive east ditch to Moira River	0.103	0.224

Hydrographs for both the 5 and 100 year events are shown in Figures E1 through E3.

E.3 FUTURE CONDITIONS

E.3.1 Sub-basin Characteristics

Hydrologic simulations were also performed for the planned future conditions described in Section 2.4. Table E3 shows the percent of land use type for each sub-basin. Runoff characteristics are dependant on type and density of development, effecting Curve Number and percent impervious. Several of the sub-basins are fully developed at this time, or if redevelopment occurs the sub-basin characteristics will not change appreciably (these sub-basins are identified with an asterisk). Table E4 summarizes the future characterisitics for each sub-basin.

Table E3 Percent Land Use Within Each Sub-basin

Sub-basin Number	Residential	Commercial/ Industrial	Community Facility
100	100	0	0
101	0	100	0
102A	0	85	15
102B	25	25	50
103 *	0	100	0
104 *	0	100	0
200 *	0	100	0
201A	0	100	0
201B *	0	100	0
202	0	100	0
203	0	100	0
204	0	100	0
205 *	0	100	0

Table E4 Future Sub-basin Characteristics

Sub-basin Number	Area (ha)	SCS Curve Number (AMC II)	Percent Impervious (est.)
100	1.53	82	70
101	4.34	95	95
102A	8.80	90.5	88
102B	13.09	83.8	78.2
103 *	1.07	82	95
104 *	0.70	99	95
200 *	0.25	85	95
201A	2.88	95	95
201B	2.07	95	95
202	5.40	95	95
203	1.40	95	95
204	10.80	95	95
205 *	6.40	79	5

E.3.2 Event Modelling

The major event was simulated to produce runoff hydrographs for the sub-basins under the future development scenario without any stormwater management controls. This information is presented to illustrate the effect of development on the runoff potential of a catchment area.

It is also understood that Tarmac may wish to fill in their flooded quarry completely, so Table E5 presents simulation results for both alternatives (also shown in Figures E4 to E6).

Table E5 Future Peak Flows Without SWM Controls

Location	1:100 Year Event	
	with Tarmac Quarry (m3/s)	without Tarmac Quarry (m3/s)
WEST CATCHMENT		
Southwest corner of Maitland Drive and Highway 62	0.361	no effect
Northwest corner of Cloverleaf Drive and Highway 62	1.601	no effect
Ditch, south of intersection of Cloverleaf Drive and Highway 62, outlet to Moira River	1.709	no effect
EAST CATCHMENT		
Inlet to culvert under intersection of North Park Street and Parks Drive	0.699	no effect
Outlet of Tarmac quarry	0.183	-
Outlet of Cloverleaf Drive east ditch to Moira River	0.243	1.153

E.4 FUTURE CONDITIONS INCORPORATING SWM CONTROLS

E.4.1 Assumptions

For the purposes of hydrologic analyses, the following assumptions concerning stormwater management have been made.

1. It is now common practice for commercial and industrial developers to incorporate both rooftop and parking lot detention in their site plans, therefore the simulations incorporate these.

2. Other types of development will not be allowed to discharge roof leaders or foundation drainage directly to roadside ditches or other surface drains.

3. Existing development will not be required to implement the above controls.

4. Tarmac will fill in the flooded quarry on their land to allow them to redevelop in accordance with the Secondary Plan.

5. Flow detention will not be required for the eastern catchment if a pond is located on Bell Canada's lands. The outlet for this catchment is unrestricted and since it is close to the mouth of the Moira River it does not significantly impact peak flows in the river.

E.4.1.1 On-Site Detention

The input data for QUALHYMO was modified according to the "Design of On-Site Storm Water Management" (Westlake, 1995), provided by the MRCA. This design guideline provides a set of assumptions used to estimate the runoff from the rooftops and parking lots from the remainder of the land. These assumptions are summarized below.

A. Rooftops

→ Building footprint occupies 33% gross property area. 100% of this area produces runoff to the roof storage.
→ Rooftop storage area is 75% of building footprint.
→ One roof drain is installed for every 450 m^2 roof area.
→ Roof drain discharge is 0.0004 m^3/s for each 25 mm storage depth.
→ Storage volume = storage area X depth.

B. Parking Lots

→ 67% remaining impervious property is parking, the other 33% is for circulation (no storage).
→ Storage only on parking areas.
→ One catch basin is installed for every 2,500 m^2 parking area.

→ Catch basins incorporate an inlet control device with the following characteristics:
  → $Q = 0.0175\ m^3/s$ for storage depth of 0.15 m, and
  → $Q = 0.02\ m^3/s$ for storage depth of 0.3 m.
→ Area surrounding catch basin is graded to provide 2,500 m^2 surface area for a depth of 0.3 m above the catch basin rim.

E.4.2 Event Modelling

The major event was simulated to produce runoff hydrographs for the sub-basins under the future development scenario with on-site SWM control in place.

Table E6 presents the results of this modelling and Figures E7 through E9 show the resulting hydrographs. Results from the existing conditions are included to show the storage requirements of detention ponds immediately downstream of these locations.

Table E6 Future Peak Flows With On-site SWM Controls

Location	100 Year Event (m3/s)	100 Year Existing	% Difference
WEST CATCHMENT			
Southwest corner of Maitland Drive and Highway 62	0.204	0.177	+15
Northwest corner of Cloverleaf Drive and Highway 62	0.886	0.541	+64
Ditch, south of intersection of Cloverleaf Drive and Highway 62, outlet to Moira River	0.892	0.623	+43
EAST CATCHMENT			
Inlet to culvert under intersection of North Park Street and Parks Drive	0.406	0.630	-36
Outlet of Cloverleaf Drive east ditch to Moira River	0.800	0.224	+257

Note: The Tarmac quarry is not acting as a detention facility for the post-development scenario.

E.5 WATER QUALITY MODELLING

The QUALHYMO input file was modified to include pollution modelling parameters: *e. coli* and sediment. The literature suggests typical ranges of concentration for both of these parameters for stormwater applications; in this study, the modelling has been based on similar modelling undertaken as part of the Upper No Name Creek Stormwater Management Study. For an in-depth discussion of the water quality modelling, the reader is referred to the above report (Gore & Storrie, 1994).

In a deviation from the modelling undertaken in the adjacent subwatershed, the critical rainfall event for the current modelling is taken from Westlake, 1995. To meet the QRAP criteria of no more that four water quality exceedances during the body contact season, the following design storm has been developed, and is recommended by the MRCA.

Design Storm Characteristics (single event)

- → Storm pattern - SCS Type II, 6 hour duration.
- → Rainfall depth - 14 mm total.
- → Interevent time - 48 hours.

Following this design data a theoretical precipitation record, for mid-season, was generated and programmed into QUALHYMO (see Figure E10).

The water quality response for each of the final three, alternative layouts, for stormwater management facilities, were simulated using the above parameters to ensure theri compliance with the QRAP criteria. The results are discussed in Appendix F.

APPENDIX F

POND SIZING

APPENDIX F
POND SIZING

F.1 WATER QUANTITY CONTROL

F.1.1 Design Criteria

Appendix C presents the overall water management objectives for stormwater management plans. The specific criterium for water quantity control is to limit post-development flows, emanating from the subwatershed, to pre-development levels for up to, and including, the 100 year return event.

F.1.2 Pond Alternatives

Several alternative approaches to the placement of SWM facilities were presented in the report. These required consideration of the following facilities:

SWM ALT #1

- → POND A - A dual purpose pond (quantity/quality control) north of Cloverleaf Drive, immediately west of Highway 62.
- → POND B - A single purpose pond (quality) north of the Cloverleaf Drive road allowance, east of North Park Street.

SWM ALT #2

- → POND A - A dual purpose pond north of Cloverleaf Drive, immediately west of Highway 62.
- → POND C - A quality polishing pond/wetland south of Cloverleaf Drive, alongside the Highways 62/401 interchange.

SWM ALT #3

- → POND D - A dual purpose pond south of Cloverleaf Drive, alongside the Highways 62/401 interchange.

F.1.3 Pond Sizing

Outflow hydrographs for the 100 year event were plotted for both existing and future conditions, and the area between the curves calculated to determine the active storage volume requirement. These hydrographs are shown in Figures F1 to F3. The active storage required for each pond is summarized in Table F1.

Table F1 Estimated Active Storage

POND	Volume, m^3
A	2,700
B	Not required for quantity control
C	Not Required for quantity control
D	12,600

Each of the ponds is expected to be rectangular in shape with length:width and side slope ratios of 4:1.

F.1.4 Outlet Works

After determining the active storage requirements, a preliminary stage-volume relationship was prepared for each pond to be used for sizing the outlet works. In each case, a corrugated steel culvert under inlet control, restricting peak outflow to pre-development levels, was selected.

Finally, the QUALHYMO model was used to simulate the response of the ponds and outlet works. The model utilizes the orifice flow equation for round culverts. The results are shown in Figures F1 to F3.

F.2 WATER QUALITY CONTROL

F.2.1 Design Criteria

Preliminary pond sizing, for quality control, was undertaken following the guidelines presented in "Stormwater Management Practices Planning and Design Manual" (MOEE, 1994). The effectiveness of ponds for treating water quality parameters has been determined to be primarily effected by the hydraulic residence time of water in a permanent pool.

The manual categorizes the sensitivity of the receiving waters into four levels. For this study, Level 1 protection (highest) was selected due to the potential adverse effects poor quality water emanating from this subwatershed may have on the Moira River and Bay of Quinte environments. Summary Table D2, based on percent impervious, follows.

F.2.2 Permanent Pool Sizing

For each of the alternative ponds listed above, the permanent pool requirements were determined as follows:

- → Percent impervious was calculated using an areal weighted average for each of the two catchments and the overall subwatershed.
- → Contributing watershed area for each pond was determined.
- → Permanent pool volume was calculated, based on Table F2.

The results from this task are presented in Table F3.

Table F3 Preliminary Permanent Pool Sizing

POND	Contributing Area (ha)	Percent Impervious	Permanent Pool Volume (m^3)
A (wet pond)	27.1	81	1,491
B (wet pond)	29.4	95	1,617
C (wet pond)	58.4	88.5	3,212
D (wetland)	58.4	88.5	1,168

F.3 PERFORMANCE EVALUATIONS

The pollution routing routines in QUALHYMO were implemented to assess the effectiveness of the ponds for removing pollutants during the water quality design event. Each of the alternative pond orientations have been assessed for their effectiveness in achieving the following water quality criteria:

1. Less than 100 *e. coli.* bacteria per 100 mℓ in the pond discharge, and
2. Suspended sediment concentrations of 25 mg/ℓ, or less.

All of the pond outlets were assumed to be manufactured from corrugated steel pipe with flow characteristics modelled as an orifice.

In general, QUALHYMO suggested that the preliminary sizing was inadequate to provide the necessary water quality control. Permanent pool sizes were optimized through the modelling process with the resulting sizes shown in Table F4.

Table F4 Pond Sizing Resulting from QUALHYMO Modelling

POND	PERMANENT POOL SIZE, m³	*e. coli.*		SEDIMENT Outflow Concⁿ, mg/ℓ
		Outflow Concⁿ, #/100 mℓ	% Removal	
A	2000	74	99.6	0
B	750	0	100	0
C	5000	58	99.6	0
D	4500	78	99.4	0

APPENDIX G

PUBLIC COMMENTS

Rick Tait P. Eng.
The Greer Galloway Group Inc.
River Road, Corbyville,
ON, K0K 1V0

W Waldron ,
R R #5, Belleville,
ON, K8M 4Z5
June 17, 1996

Subject: Meeting re Storm Water Control Proposals for the NW corner of Hwy 62 and Cloverleaf Drive. - your reference no. 94B6766D

Dear Mr. Tait,

Thank you for the opportunity for John Meale and myself to meet with you on the afternoon of June 13 to see your proposals concerning your drainage study for the area primarily between Maitland Drive and Cloverleaf Drive on the west side of Hwy 62. I also appreciate the opportunity to be able to review the draft report, albeit at a rather late date. As you are aware I was unable to attend the open house presentation of the plan. At first thought it is not surprising that not many people showed up as there only appear to be 2 or 3 owners who are in any way involved. However seeing the proposals involving pond A at the foot of my property I expect some residential property owners in the vicinity might also have an interest in this. The proposed pond A, which I gather is essentially a large shallow farm pond scooped out of the ground and converted to a marsh to hold the excess runoff when it occurs, will certainly not be very attractive to the neighbourhood and hence to the Township of Thurlow. The fact that my land has remained essentially undeveloped leaves a real opportunity to do it right when it is finally done. Let's try to make a favourable impression for Thurlow by making our front entrance to the City of Belleville as attractive as possible.

Although it will have to be well fenced the pond A draft concept might still be considered a hazard in the area where children will pass daily and might be tempted to enter. Your proposal involving the use of the MTO property seems to be very sensible. I would like you to more strongly stress its possibilities and not dismiss it so easily. Aside from some legitimate concerns about erosion of the highway ramps etc. the use of that enclosed area would seem to be quite compatible with the area. It is cut off completely from easy access for children and it would eliminate grass-cutting. I assume the engineering concerns can be addressed. As I mentioned in the attached commentary, I am left with the impression that the present provincial government is more amenable to cross-jurisdictional solutions. How can such an attractive solution be so easily dismissed? I think alternative 3 deserves better consideration before recommending alternative 1 as the first choice.

With respect to pond alternatives at the foot of my property the draft proposal of a **175 metre** strip 50 metre wide along Cloverleaf Drive could hardly be worse. But in any event it should be possible to arrive at a much better solution for the shape and placement of Pond A (if it is necessary) if it is done at the time a development plan for the whole property is completed. And as your report points out it will not be required until that time.

I have attached some comments with respect to the draft report. I hope that these will be helpful.

I would appreciate a copy of the final [illegible]

Yours sincerely,

W Waldron

attachment:

COMMENTS ON DRAFT REPORT
TOWNSHIP OF THURLOW STORMWATER MANAGEMENT STUDY FOR CANNIFTON INDUSTRIAL PARK AREA - GREER GALLOWAY GROUP REFERENCE NO. 94B6766D

Comments are numbered the same as in the report.

page 10-3.1.1 "Tarmac ....have advised they may object to its (existing quarry) use as a SWM facility." It is not clear why this is not considered further as it would seem to have potential to provide an economical solution as less of the quarry would have to be filled in. While this doesn't have specific relevance to the drainage on my property it does seem to indicate that Tarmac was previously consulted as to their wishes, yet I was not. Looking at the proposals might not any owner of the property on the west side of Hwy 62 also object to the proposal that would eliminate more than half the road frontage on Cloverleaf Drive? I certainly do.

page 14-3.5.2 It is difficult to comment on MTO constraints on their cloverleaf re-design but from what can be seen from this report the proposed redesign seems to be a waste of money. It would seem that their objective to reduce the interweave problem (which does seem to be needed) could simply be handled by removing the small onramp portion of the northeast "leaf" at the 401 end and redesigning the other end where it intersects with Hwy 62 North. Most of the existing loop could be retained and the interior could be used for the storm water pond D. You mentioned at our meeting that MTO officials had concerns that the depth of water in the pond would be a hazard in case of a car careening off the ramp or highway. Although it is not exactly clear what depth of water we are talking about here it seems that it is something of the order of 1 foot for everyday conditions and 3 feet for a few hours at most during a 100 year storm event. It is hard to imagine that this truly represents any significant risk to motorists. The point of this discussion is that you recognized the pond D as an alternative worth consideration but you seem to have dispelled it too readily. Based on the cost estimates of Table 4.1 Pond D alternative does show to be considerably more expensive but it is hard to understand why.

page 16-4.3 "Cost Comparisons" It is not clear if land costs are included in the comparisons. As the proposed plan involving pond A includes something like 175 metres of Cloverleaf Drive street frontage the value of the land for that proposal is significant. Also did the same person estimate all costs or were costs for the pond D site provided bt the MTO. They appear on the surface to be inconsistent.

page 17 Table 4.1 Even excluding property costs it is hard to imagine that the cost of constructing 1 pond D can cost two-thirds more than the cost of 2 ponds A and B. Landscaping and fencing costs, and berms etc. if needed are all perimeter related and so should favour a one pond alternative. It is also not evident why the larger pond D is 3 times as expensive as the pond C alternative. Admittedly the shape as shown outside of the proposed change to the ramp loop is clearly not as efficient as a pond inside the loop. Indeed if pond D were included inside the existing loop (the removal of the onramp spur would increase the enclosed area) there would appear to be room for the larger pond.

page 17-4.4 The report comments on the invasive non-native plant species such as common buckthorn in the study area. I hope this is not to be replaced with a sometimes smelly home for Purple Loosestrife.

page 21, end of section 5.2 "**a minimum ditch corridor width of 15 metres** is recommended throughout the subwatershed." This seems preposterous. The Moira

River itself must be scarcely wider at many locations. While it is not clear from figure 4 what is considered to be a ditch corridor on my land it is clear that it would not take many linear metres of ditch to equal the area removed by pond A. I am very much concerned about the area of land that this whole proposal would take. While I am sure past developments have caused problems because no provision was made for drainage, this study seems to be going over board. At any rate it is not likely that this width can be provided adjacent to the Gasoline Station at the corner of Hwy 62 and Cloverleaf Drive.

page 23-5.5 "Phasing" I am pleased to see that the report recommends not proceeding with the construction of the ponds until development is about to proceed. With the present state of my property there is no current need for the proposed facilities. At the time that development for this property is planned it would be possible to see how to best incorporate pond A if it is definitely required. Also since there appears to be no immediate need further discussions could be pursued with the MTO. The present provincial government seems to pride itself on common sense approaches and has clearly shown efforts toward elimination of red tape and enhancing cooperation amongst various jurisdictions. The SWMALT 3 would be a fine project on which to demonstrate this.

page 23-5.5.1 This seems to be somewhat at odds with the section just above. The statement that the design of the two stormwater ponds should occur concurrently so that they could be in place for concurrent development, if it occurs" does not seem to make a lot of sense as at the moment there is no indication of this happening. It is clear if pond D is not possible, which would seem to be the case without the cooperation of the MTO, a pond will be required in future somewhere on my property unless of course other alternatives to achieve the same result are available by that time. I think the options should be kept open and the detail design done in harmony with a total development plan for the property.

Appendix E Hydrographic Analysis E 4.1 "Assumptions" Point 3 seems reasonable ie that "existing development will not be required to implement above (stormwater control measures)", clearly the complete filling of the existing quarry on the east side of the highway and re-development should be considered just as new development. This report seems to defer to the wishes of the owners of that site.

Apendix F "Pond Sizing" It is not clear why a 4 to 1 length to width ratio is chosen for proposed ponds A and B although this may suffice for a worst case scenario. Allowing for side slopes, berms if necessary, landscaping, fencing etc. it would seem that a more square alternative would require less land area and should be cheaper, depending on the site and development plan specifics of course.Table E1 shows that the proposed pond drains 27.76 Hectares. The report indicates that the pond area is 0.41 Hectare. This seems to agree with the referenced study D.4.2.1 III which indicates a wet land area of from 1 to 2 percent of the drained area. However the overall site area appears to be about 40m x 175 m ie 0.7 Hectare. And, depending on what is envisaged for the drainage ditches mentioned in section 5.2 (see my comments above), the overall area taken out for drainage purposes would considerably exceed 2%.

THE CORPORATION OF THE TOWNSHIP OF THURLOW

GENERAL DELIVERY — RIVER ROAD SOUTH, R.R.#1, CORBYVILLE, ON K0K 1V0

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From the Office of:
Karen Poste, AMCT(A),
Planner.

October 22nd., 1996.

E. A. Margetson
Stormwater Management Co-Ordinator
Bay of Quinte Remedial Action Plan
Quinte Conservation Services Alliance
P.O. Box 698,
Belleville, Ontario
K8N 5B3

Dear Mr. Margetson,

Re: Cannifton Industrial Area and Environs Stormwater Management Study.

For your records, please be advised of the following Planning Committee recommendation which was recently approved by Thurlow Council:

> "THAT the final version of the Stormwater Management Study for the Cannifton Industrial Park and Environs dated August, 1996, be received;
>
> AND FURTHER THAT, the Township accept the recommendations of the report and require that the recommendations be included as conditions for all future development in the subwatershed, provided some flexibility in implementation will be permitted as long as the overall stormwater objectives can be achieved."

I trust the above is satisfactory for your purposes. If you have any questions, or if further information is required, please let me know.

Sincerely,

Karen Poste

Karen Poste, AMCT(A),
Planner.

c.c. Rick Tait, Greer Galloway.

/kmp

THE GREER
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August 29, 1996

Township of Thurlow
River Road South
Corbyville, Ontario
K0K 1V0

Attention: **Mr. Gary King, A.M.C.T.**
Clerk-Administrator

Re: **Stormwater Management Study**
Cannifton Industrial Park Area
Final Report
GGG Reference No. 94B6766D

Dear Gary;

This letter conveys into your possession two copies of our final report for the above study. We have completed the water quality modelling and have incorporated its results and the comments from stakeholders in this revision.

The following is a summary of the revisions.

→ During our last steering committee meeting Ernie noted that we need not address water quantity control for the eastern catchment. This has been redesigned to accomodate the RAP requirements only and results in less land required to accomodate the facility.

→ Water quality modelling suggested a larger facility for the western catchment. This can be seen on Figure 4, Appendix A. I realize that Ms. Waldron will not be too impressed, but this is what the modelling suggested. Maybe Karen and I should meet with her to brief her on the ramifications. She will receive a copy of this report.

→ We have clarified the selection process by elaborating on the MTO property issue and the appropriateness of using the Tarmac quarry as a SWM facility.

We hope you are satisfied with the final product and apologize for the length of time it's taken to get to this point.

Yours very truly,

THE GREER GALLOWAY GROUP INC.
ENGINEERS AND PLANNERS

R.K. Tait, P.Eng., A.P.Ag.
M.Sc.A.(Agr. Eng.)
Project Manager

encl.

cc. Ernie Margetson, P.Eng., Stormwater Management Coordinator
Bay of Quinte Remedial Action Plan