SPECIAL POLICY AREA STUDY

FOR THE

COOKSVILLE CREEK FLOODPLAIN

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1. INTRODUCTION

1.1 Overview

In October 2001, the City of Mississauga distributed Terms of Reference for the SPA Study for the Cooksville Creek Floodplain, requesting proposals from qualified consultants (ref. Appendix J). In November 2001, Philips Engineering Ltd. submitted a proposal supported by Parish Geomorphic (Stream Morphology), BGD Consulting Inc. (Land Use Planning) and Davis & Co. (Legal). This Team was subsequently retained by the City in December 2001.

The study has been undertaken in two stages; Stage I involves background data collection by the City and Consulting Team, a re-examination of structural and non-structural alternatives, development option assessment, including risk and liability; Stage II, which is contingent on Stage I results being supported by the Technical Steering Committee, involves the preparation of specific planning policies for future incorporation into the Municipal Official Plan; this report addresses Stage 1 activities only.

On January 10, 2002, a *'kick-off'* meeting was held with the Technical Steering Committee comprised of representation from various Municipal Departments, Credit Valley Conservation (CVC), Region of Peel and the Consulting Team. The primary purpose of that meeting was to review the work plan, exchange information and clarify issues and opportunities.

In the intervening period leading up to the preparation of Interim Report #1, dated May 24, 2002, the Consulting Team collected considerable background information, consulted with various municipal departments (Planning and Building, Transportation and Works), conducted field investigations, reviewed existing reports, attended the Flood Remediation Study Open House, held on March 20, 2002 and conducted hydrologic and hydraulic analyses, all in accordance with the Terms of Reference and the November 2001 proposal (ref. Appendix J).

Since the Technical Steering Committee meeting on May 24, 2002, additional meetings were held to address various salient issues related to this study as follows (ref. Appendix B):

May 28, 2002: *Meeting with Manager of GIS and CADD to review mapping check results*

June 28, 2002: *Meeting with Manager of Realty Services to examine methods of defining benefits of flood relief*

August 1, 2002: *Meeting with City staff to review comments received from City, CVC and Peel*

August 14, 2002: *Meeting with City and CVC staff to review comments from CVC and associated follow-up*

September 13, 2002: *Meeting with City to review management opportunities for parcels under consideration*

The Technical Steering Committee provided input and commentary on Interim Report #1 dated May 24, 2002 (ref. Appendix B). These comments were addressed in Interim Report #2.

Interim Report #2, which was presented to the Technical Steering Committee on October 31, 2002, provided new and updated information on the following Stage I tasks, as a result of the foregoing consultation:

- *Background Data Review*
- *Hydrologic Check*
- *Topographic Mapping Check*
- *Stream Morphology Assessment*
- *Hydraulic Modelling*
- *Feasibility Assessment of Structural Alternatives*
- *Floodplain and Erosion Management Alternative Assessment*

Since the Technical Steering Committee meeting of October 31, 2002, comments have been received from all parties (ref. Appendix B) as follows:

City of Mississauga – Transportation & Works	*November 28, 2002*
City of Mississauga – Planning & Building	*December 2, 2002*
Region of Peel	*December 6, 2002*
Credit Valley Conservation	*December 17, 2002*

Subsequent to receipt of the foregoing, the Study Team met January 14, 2003 with EWRG, who was retained by CVC to conduct a peer review of the study findings. The purpose of that meeting was to review CVC's comments and develop a process towards resolution and consensus regarding any outstanding issues.

In addition, on January 27, 2003, a meeting was held with City staff, CVC, EWRG and the Study Team to further review the consensus position reached on January 14, 2003, and establish final direction for the study (ref. Appendix B).

The Final Draft circulated February 28, 2003 accounted for the input received since the October 31, 2002 release of the Interim Report #2. Final comments were received on this document (ref. Appendix B), and discussed at the final Technical Steering Committee meeting of March 21, 2003. These comments have effectively been incorporated into this final report.

1.2 General Problem Statement

Formal floodplain management planning and design, within the Cooksville Creek watershed dates back to 1969, and even before that date in other less formal forms. The highly urbanized watershed with a flat, ill-defined floodplain valley has historically given rise to development within, or in close proximity, to flood prone areas. In addition, the watercourse flows over a highly erodible shale substrate which further complicates stream dynamics and adjacent slope stability.

The Provincial floodplain management policy for the Cooksville Creek is currently premised on the one-zone concept, whereby the Regulatory floodplain is defined by the greater of the flood produced by the Regional storm (Hurricane Hazel) or the 100 year. For the most part (in the key areas of interest), the Regional flood is considerably higher than the 100 year flood.

Portions of the currently regulated floodplain of the Cooksville Creek contains properties which are either undeveloped (but serviceable) or "ripe" for re-development (i.e. through intensification or land use conversion). In fact, the Municipal planning framework for portions of the Cooksville Creek encourages re-development, infilling and intensification. The Municipality has had numerous applications and several more are likely pending, from land owners who are interested in the development or re-development of their property in such locations.

Credit Valley Conservation and the Province of Ontario would require supporting information to approve re-designations within the Regulated floodplain that would either propose new residential uses and/or increase densities for an existing residential use, as this would increase the risk to life and property in the event of a flood, either on-site or upstream and downstream.

The issues related to the contemplated development are technical (flooding and stable flow regime), environmental (stable stream form and indirect connections to water quality), social, policy-oriented, economic and political. The problem is how best to address divergent perspectives associated with these competing issues, while doing what is best for the Public interest.

A sound integration of technical analysis and community planning, with Provincial policies is required, premised on a consensus building approach, using good planning and engineering principles. Otherwise, the issues will continue to be challenged by various stakeholders.

It should be made clear at this stage that while this study inherently considers the whole of the watershed to assess technical components such as flow rates and flood levels, the study focuses on the properties currently under consideration for an SPA (ref. Section 4.2 and Drawing 1). Evaluating technical and policy alternatives for development and redevelopment potential is the primary objective of the study; notwithstanding, depending on the ultimate management approach, there may be residual benefits (or impacts) on existing neighbourhoods, particularly in the form of flooding upstream and downstream from developing or re-developing areas. These impacts, (be they positive or negative), have required consideration in the global assessment for this study. Other studies, preceding this current initiative have examined flood and erosion mitigation alternatives for existing development within the Cooksville Creek watershed (ref. Section 1.3).

Future development proponents, not considered herein, may advance and/or request consideration for a modified flood protection standard either for new or re-developing lands. The information and analysis documented within this report is neither seen as an endorsement nor refusal of future applicants' rights in this regard. Future development proponents though must adhere to the regulations and procedures of the day.

1.3 Background Information Collected

Considerable background information exists for this study area which has been assembled by Municipal staff. The following provides a summary of information collected to date, organized by: studies, municipal policy documents and correspondence, mapping, models and other.

STUDIES

Cooksville Creek Watershed Study – (M. M. Dillon, 1970)

Cooksville Creek Study prepared by Town of Mississauga Engineering Department – September 1971

The earliest study on the Cooksville Creek available for review. Focus was on downstream portions of the watershed as development was concentrated in that area at time of Study. Study focused on creek realignment and channelization to solve flooding problems. Proposed a system of retaining walls, channelization and realignment, crossing replacements, and where permissible natural section design to improve creek hydraulics.

Cooksville Creek Watershed Study – (City of Mississauga, 1974)

Cooksville Creek Study – City of Mississauga – (Proctor & Redfern Limited, 1975)

The first significant hydrology study of the Cooksville Creek watershed made available to the Study team. Identified need for significant engineering works for flood control. Proposed a combination of storage ponds, creek relocation, channel improvements, and bridge and culvert improvements. Concluded the existing channel was unable to carry the 10 year flood for most cases, and identified 163 buildings as being within the Regulatory floodplain. Proposed a channel scheme to upgrade the capacity of the channel to carry the 25 year flood by widening and deepening the channel, employing gabion landscaped construction with a natural shale bottom and upstream storage.

Cooksville Creek Watershed Study, (M.M. Dillon, August 1979)

A review and update of the Proctor and Redfern 1975 study. Focused on flood control for 100 year and 50 year flows. Identified numerous hydraulically deficient channel sections, culverts and bridges. Investigated storage at Eglinton avenue, but concluded pond would be prohibitively big to achieve even 25 year post-to-pre on the downstream water levels. Investigated diversion of flows to the Credit River via Mary Fix tunnel, and concluded cost would be prohibitive. Proposed a system of channel and culvert works as the most economical option for mitigating downstream levels, some of which have been implemented to date.

Environmental Assessment – Cooksville Creek Flood Control Project, (Dillon Consulting Engineers & Planners, 1981)

Cooksville Creek Watershed Study Update and Water Level Sensitivity Analysis, (Dillon Consulting Engineering & Planners, 1984)

The Effect of Channelization on Cooksville Creek Flows, (M.M. Dillon, January 1985)

Investigated the effect of channelization north of Highway 403, on the downstream flows and flood levels. Found that downstream flows would increase by up to 23 %, with the increases being more significant at the regional and 100 year levels. Found that downstream levels are sensitive to the channel slope, with a 0.1% rise causing increases of 15% or more.

Mississauga Stormwater Quality Control Strategy – Final Report, November 1995 (Winter Associates/Gore & Storrie)

The Mississauga Stormwater Quality Control Strategy (1995) evaluated existing stormwater control facilities within the City of Mississauga to determine their retrofit potential to improve water quality benefits conferred by these facilities. The Cooksville Creek Bristol Road facility of direct interest to this current study was assigned a "medium" retrofit potential; an active detention volume of 30,800 m^3 (1,087,686 ft^3) as proposed for erosion control in addition to the MOE water quality requirements for permanent pool.

Cooksville Creek Floodline Mapping Study, Technical Report, (RVA, February 1996)

Cooksville Creek Rehabilitation Study – Final Report June 1997

Examined and quantified stream processes that contribute to erosion within the Cooksville Creek system, identified and mapped erosion problem areas, and proposed a long term stabilization/remediation plan. Study found watershed exhibits a flashy hydrologic response due to substantial urban component, with high creek flows and velocities. Erosion of the banks and floodplain has been documented, and channel downcutting rates were measured to be an order of magnitude greater than expected. Remediation/stabilization measures proposed include natural channel design, bed and bank armouring, riparian system enhancement, stormwater management for new development, and source control BMPs where feasible.

Of particular relevance to the current study, the Cooksville Creek Rehabilitation Study (1997) recommended certain works that may impact subject sites under consideration in this study should these works be implemented, which to date has not occurred.

An overland flow channel was recommended across the F & F Construction property. This channel would convey flows above the 5 year flood up to the 25 year flood. A weir would be constructed at the upstream end of the overland channel to provide appropriate flow diversion.

Floodway re-grading was also recommended for the Humenik site in conjunction with bioengineering of banks.

Cooksville Creek Flood Remediation Plan – Final Report (Environmental Water Resources Group, May 2002)

Investigated hydraulic conditions causing flooding along Cooksville Creek, and developed economic assessments of flood damages for 2-100 year and Regional storms. Investigated cost of complete removal of all at-risk properties from the Cooksville Creek floodplain, and concluded cost would outweigh benefits for such a program. Recommended continuation of a One-Zone Policy for Floodplain Management in the Watershed, and proposed a program of channel and culvert improvements to mitigate flood damages.

The Cooksville Creek Flood Remediation Plan, May 2002 only considered alternatives that would reduce potential flood damages. The Study did not consider alternatives that would narrow the Regulatory Floodplain across potentially developable properties. The Study only examined alternatives to remove existing buildings from the Regulatory Floodplain or significantly reduce flood damages. For example, alternatives to reduce the Regulatory Floodplain across the Inglis property were not considered, as buildings are not located in the Floodplain or no significant damages would occur for the Regulatory Flood.

POLICY DOCUMENTS AND CORRESPONDENCE

City of Mississauga – Zoning By-Laws Book I of II
City of Mississauga – Zoning By-Laws Book II of II

PDC Report Cooksville Creek – Special Policy Area Study – February 28, 2000

Official Plan Mississauga City Plan – Volume 1 of 2 - 2001
Official Plan Mississauga City Plan – Volume 2 of 2 - 2001

Region of Peel Official Plan

Floodplain Policy Statement, MNR, October 1988
Authority Policies on Floodplain Management, CVC, April 1994
Watercourse and Valley Land Protection Policies, November 1992
Adaptive Management of Stream Corridors in Ontario – Natural Channel Systems – Natural Hazards Technical Guidelines, February 2003

MAPPING

Applewood District Land Use Map – Amendment No. 5 to City Plan, City of Mississauga – February 2001

City Centre District Land Use Map Amendment No. 20 to City Plan, City of Mississauga – February 2001

Cooksville District Land Use Map Amendment No. 3 to City Plan, City of Mississauga – February 2001

Dixie District Land Use Map, City of Mississauga – February 2001

Fairview District Land Use Map Amendment No. 9 to City Plan, City of Mississauga – April 2000

Gateway District Land Use Map Amendment No. 1 to City Plan, City of Mississauga – February 2001

Hurontario District Land Use Map Amendment No. 2 to City Plan, City of Mississauga – February 2001

Lakeview District Land Use Map Amendment No. 11 to City Plan, City of Mississauga – April 2000

Mineola District Land Use Map Amendment No. 26 to City Plan, City of Mississauga – February 2001

Mississauga Valleys District Land Use Map Amendment No. 21 to City Plan, City of Mississauga – April 2000

Port Credit District Land Use Map, City of Mississauga – February 2001

Rathwood District Land Use Map Amendment No. 12 to City Plan, City of Mississauga – April 2000

Schedule 7 Planning Districts – February 2001

Plan of Existing Land Use Codes, City of Mississauga – November 2001

Flood and Fill Line Mapping 1:5000 +/-

HYDROLOGIC AND HYDRAULIC MODELS

OTTHYMO (Hydrologic Model)
- *Existing and Future land use*

HEC-2 (Hydraulic Model)
- *Existing Conditions*
- *Culvert Replacements*
- *Channel Improvement*

FLDAM
- *(Flood Damage Model)*

OTHER

Cooksville Creek (Pictures and Evaluations) 1988, 1990, 1992, 1993, 1994 and 1995

Aerial Photography, City of Mississauga – April 2001 (1 Box)

Property Owners Listing – August 2000

1.4 Discussion of Governing Policy

Within the Cooksville Creek watershed, consideration must be given to the policies regarding both floodplain management and erosion hazards. The relevant policies are set out in the following:

Provincial Policy

In 1988, the Province of Ontario adopted the *"Policy Statement on Floodplain Planning"* to provide a framework for land use planning and the regulation of development. The overall objective of this policy statement was to minimize loss of life, property damage and social disruption that can result from flooding. The principles outlined within this initial policy statement have been carried through to the current Provincial Policy Statement (PPS) adopted under Bill 20 of the Planning Act. In the implementation of these policies, the Planning Act requires that municipalities *'shall have regard for'* these policies when making planning decisions.

This PPS states in Section 3.1.1:

> *Development will generally be directed to areas outside of:*
>
> *b) hazardous lands adjacent to river and stream systems, which are impacted by flooding and/or erosion hazards*
>
> *Specifically Section 3.1.2 states:*
>
> *3.1.2 Development and site alteration will not be permitted within:*
>
> *c) a floodway (except in those exceptional situations where a Special Policy Area has been approved.)*

The PPS defines the term Special Policy Area as the following:

> *A Special Policy Area is defined as an area within a community that has historically existed in the floodplain and where site specific policies, approved by the Ministers of Natural Resources and Municipal Affairs and Housing, are intended to address the significant social and economic hardships to the community that would result from strict adherence to provincial policies concerning development.*

In addition, the PPS in Section 3.1.3 outlines the specific requirements in order to consider development within any hazardous lands including a floodplain situation such as an area designated as a Special Policy Area. The PPS defines *hazardous lands* as 'property or lands that could be unsafe for development due to naturally occurring processes. Along *river and stream systems*, this means the land, including that covered by water, to the furthest landward limit of the *flooding* or *erosion hazard* limits.'

3.1.3 *Except as provided in Policy 3.1.2 development and site alteration may be permitted in hazardous lands and hazardous sites, provided that* *all* *of the following can be achieved:*

- a) *the hazards can be safely addressed, and the development and site alteration is carried out in accordance with established standards and procedures;*
- b) *new hazards are not created and existing hazards are not aggravated;*
- c) *no adverse environmental impacts will result;*
- d) *vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies; and*
- e) *the development and site alteration does not include institutional uses or essential emergency services or the disposal, manufacture, treatment or storage of hazardous substances.*

Policy Approaches For Floodplain Management

Flood management can involve the use of both a) structural measures such as channelization, tunneling, flood storage areas, and flood proofing and b) non-structural approaches such as land use regulation to reduce risk of flooding and any potential loss of life or property damage. Policies developed for floodplain management attempt to balance the interest in development within the floodplain, against the risks caused by that development. These policies also address new uses as well as pre-existing uses within floodplain areas.

Based on the foregoing PPS policies, there are three basic planning options for addressing floodplain management:

- ***One-Zone Areas***

This approach places the entire floodplain in a one-zone category. In the one-zone policy area, no new development is permitted within the floodplain; however, it is recognized that certain buildings and structures must be located in the floodplain due to the nature of their use such as public works. In the policy document, ‘Watercourse and Valleyland Protection Policies’, Credit Valley Conservation sets out in detail the scale and type of uses permitted within the floodplain. Currently, except for a portion of Orangeville, the Authority has implemented the One-Zone Concept for floodplain planning.

- ***Two-Zone Areas***

For portions of the floodplain that could potentially be safely developed with no adverse impacts, the Municipality, with the agreement of the Conservation Authority, may designate portions of the floodplain as two-zone areas. In the designated two-zone areas, the floodplain is divided into two distinct sections- floodway and flood fringe. The floodway is typically the effective flow area designated as the area of the floodplain required to pass the flow of greatest depth and velocity. The flood fringe lies between the floodway and the edge of the floodplain. Depths and velocities of flooding in the flood fringe are typically much less than those in the floodway.

In the two-zone area, new development can occur in the flood fringe provided that the development meets certain criteria. Where new development is permitted, it will be required to be flood proofed to the level of the Regulatory Flood in order to reduce susceptibility to damage. All habitable floor space must be above the elevation of the Regulatory Flood. No development, however, is allowed with the floodway.

- ***Special Policy Areas***

Special Policy Areas (SPA) may be established in areas historically settled within the floodplain where 1) the application of one-zone or two-zone policies is not feasible, 2) a prohibition of development or redevelopment causes social and economic hardship for the community and 3) all other requirements for an SPA can be met. For an SPA, a more flexible approach in floodplain management is used. However, implicitly if adopted, a higher level of flood risk must be been accepted by the Municipality, Conservation Authority and the Province of Ontario. For each SPA, there must be Official Plan policies that address the minimum level of flood protection for new development, as well as any other site-specific issues.

- ***Flood Proofing***

The Provincial Floodplain Planning Policy Statement requires that any new development which is permitted in the floodplain be appropriately flood proofed, which also considered flood free ingress/egress during times of flooding.

The Provincial Floodplain Planning Policy Statement considers the influence of depth and Regulatory velocity of flood waters on risk and feasibility, with respect to implementing practical flood proofing measures. The following provides a practical guide:

Condition	Depth	Velocity
Stagnant Backwater	1.4 m (4.6 ft)	0.0 m/s (0.0 ft/s)
Shallow/High Velocity	0.5 m or less (1.6 ft)	1.8 m/s (6 ft/s)
Combination Product (0.4 m^2/s or 4 ft^2/s)	0.8 m (2.6 ft)	1.7 m/s (5.5 ft/s)

For ingress/egress, the conditions generally relate to access by "typical: automobiles, as well as emergency vehicles as follows:

Vehicle Type	Depth	Velocity
'Typical'	0.3 – 0.5 m (1 – 1.5 ft)	3 m/s (10 ft/s)
Emergency	0.9 – 1.2 m (3 – 4 ft)	N/A

Appendix A provides a summary of current CVC policy regarding floodproofing of access and parking for lot creation or major redevelopment as follows:

(i) Dry or flood free access and parking shall be encouraged to the extent possible
(ii) For access roads or parking, Regulatory conditions must adhere to:

Depth	Velocity
0 – 0.2 m (0 – 0.7 ft)	0 – 1.7 m/s (0 – 5.5 ft/s)
0.2 – 0.3 m (0.7 – 1.0 ft)	<1.3 m/s (<4.2 ft/s)

Table 1.1 (reproduced from the 2002 Flood Remediation Study – ref. Table 3.6) provides a summary of floodplain management options.

TABLE 1.1
FLOODPLAIN MANAGEMENT OPTION SUMMARY

	Provincial Flood Standard – One Zone	**Option – Two Zone**	**Option – Special Policy Area**	**Option – Lower Flood Standard**
Purpose	➢ To prohibit or restrict new development within the Regulatory floodplain.	➢ To allow new development within the flood fringe of the Regulatory floodplain. Prohibits or restricts new development in the floodway.	➢ To allow development within the Regulatory floodplain flood proofed to an acceptable flood level.	➢ The Regulatory floodplain will be based on a flood standard less than the Regional Storm. Probably the 100 year event.
Area of Applicability	➢ Applied to all of Cooksville Creek.	➢ Applied to all of Cooksville Creek.	➢ To portions of Cooksville Creek. The One Zone will apply to the remainder of Cooksville.	➢ To all of the Credit River watershed.
Regulatory Storm for Cooksville Creek	➢ Regional (Hurricane Hazel) in the lower reaches and 100 year in the upper reaches.	➢ Regional (Hurricane Hazel) but with a defined floodway and flood fringes in the lower reaches, 100 year in the upper reaches.	➢ Regional (Hurricane Hazel) in the lower reaches and 100 year in the upper reaches.	➢ Probably the 100 year flood, if agreed by all agencies.
Agency Agreement Required	➢ MMA, MNR, CVCA and City of Mississauga.	➢ MMA, MNR, CVCA and City of Mississauga.	➢ MMA, MNR, CVCA and City of Mississauga.	➢ MMA, MNR, CVCA and City of Mississauga.
Minor Additions	➢ Allowed with floodproofing to the Regulatory flood or highest level feasible and other factors such as flood storage and conveyance are addressed.	➢ Allowed with floodproofing to the Regulatory flood or the highest level feasible in the flood fringe.	➢ Allowed with floodproofing to an acceptable level provided with factors such as storage and conveyance are addressed.	➢ Allowed with floodproofing to the lower flood standard.
New Construction & Major Additions	➢ Allowed with floodproofing to the Regulatory flood level and other factors such as flood storage and conveyance are addressed.	➢ Allowed with floodproofing to the Regulatory level in the flood fringe. Floodproofing could consist of a fill pad beneath the building to the Regulatory flood level plus 0.3 m. Prohibited or restricted in the floodway	➢ Allowed with floodproofing to an acceptable level provided that other factors such as flood storage and conveyance are addressed.	➢ Allowed with floodproofing to the lower flood standard.

TABLE 1.1 (Cont'd)
FLOODPLAIN MANAGEMENT OPTION SUMMARY

	Provincial Flood Standard – One Zone	Option – Two Zone	Option – Special Policy Area	Option – Lower Flood Standard
Severance	➢ Prohibited or restricted.	➢ Allowed in the flood fringe.	➢ Prohibited or restricted within the Special Policy Area.	➢ Prohibited or restricted to the lower flood standard.
Subdivision	➢ Prohibited or restricted.	➢ Allowed in the flood fringe. Prohibited or restricted in the floodway.	➢ Prohibited or restricted within the Special Policy Area.	➢ Prohibited or restricted to the lower flood standard.

Policy Approaches for Erosion Hazards

None of the floodplain management options outlined in the foregoing for floodplain management reduce the requirements for addressing erosion hazards within the subject area. For each prospective development area, the erosion hazard will need to be assessed and recognized as a site constraint.

To assist in the implementation of the hazard related components of the PPS, the Ontario Ministry of Natural Resources has produced a document entitled Natural Hazards Training Manual, Provincial Policy Statement, Public Health and Safety Policies 3.1 (1997). It is expected that two new Provincial guideline documents, addressing erosion hazards will be in public circulation soon, which will provide further insight. In addition to the policies noted in the foregoing, policies of the Ontario Ministry of Natural Resources, (Lakes and Rivers Improvement Act) and the Federal Department of Fisheries and Oceans (Fisheries Act) should be considered regarding site alteration and development related to watercourse erosion hazards.

Region of Peel Official Plan

The Regional Official Plan sets out a broad strategic framework for the protection of the natural environment. Section 2.1.3.3. states:

> *It is the policy of Regional Council to identify and regulate development on lands exposed to natural hazards jointly with the area municipalities, provincial agencies and conservation authorities.*

Sections 2.4.3 and 2.4.4 set out the main policies to be considered within floodplain management. The policies are reproduced in detail in Appendix A. These policies generally prohibit development and site alteration within the one hundred year erosion limit and contain specific criteria that must be met for any development that may be considered within this erosion limit. These policies also discourage the creation of additional tableland within valley and stream corridors and generally prohibit the creation of new lots within the Creek system.

As discussed in detail later in this report, Cooksville Creek is one of the most dynamic geomorphic systems in Southern Ontario, which has been significantly exacerbated by changes to the runoff regime caused by urbanization. Erosion and slope stability requirements may, in certain locations, preclude the viability of various floodplain management alternatives, and thereby govern.

Section 2.4.4.2.2 specifically addresses the matter of floodplain management policy. It states:

> *Direct the area municipalities, in consultation with the conservation authorities, to continue to address riverine flood susceptibility through the application of the one zone approach to Floodplain planning and limited exceptions to the one zone, where appropriate, through the two-zone and special policy area concepts, as outlined in provincial policy.*

This policy allows for the consideration of alternative floodplain management techniques and the authority for establishing a two-zone or special policy area designation is based upon this policy. No amendment to the Regional Official Plan is required to implement a two-zone or special policy area designation.

City of Mississauga Official Plan

Within the City Plan, the Cooksville Creek is designated "Greenbelt" on the land use schedules for the respective district policies. Schedule 3 identifies these as part of the Natural Areas System with six Special Management Areas located along the creek corridor. A portion of the creek, located north of the Highway 403, is identified as Linkages. The Natural Area designation applies to lands containing valley lands and watercourses as well as other features. The Special Management Area designation relates to 'those areas adjacent to, or close to, existing natural areas which have the potential for restoration or which should be planned or managed specially.'

Under Section 4 of the Plan – Strategic Policies, there are numerous polices regarding floodplain management. Extracts the policies are contained in Appendix A of this report. Section 4.2.2.2 establishes the regulatory flood line as the standard for defining floodplains and states that the City generally uses a one-zone concept. Areas where two-zone or SPA have been established are set out on Schedule 3 of the Plan. To implement a two-zone concept or a SPA, an amendment to the Official Plan is required.

Valley and Watercourse Corridors within the plan are considered greenbelts and are not suited for development and, in general, development is not permitted within lands subject to flooding, erosion or slope stability. The City Plan sets out criteria for development within an identified hazard area (4.2.2.2.l) and for lands subject to flooding (4.2.2.2.t) and requirements for flood proofing. In accordance with Provincial policy, certain uses are prohibited in the floodplain.

Within the District Plans, a number of which contain portions of the Cooksville Creek, the core area of the valley system is designated as Greenbelt. Section 5 - Land Use Policies, in 5.8.4 sets out the policies for this designation stating that these lands are ‘reserved principally for flood and erosion management and conservation purposes’. 5.8.4.e states:

> *Development will not be permitted to extend within the regulatory storm floodplain or the identified slope and/or erosion hazard areas associated with a watercourse or valley corridor if there are suitable areas on the property beyond the hazard area. Reconstruction, minor additions, and maintenance of these facilities, buildings, and structures may be permitted subject to approval of the City of Mississauga and the appropriate Conservation Authority.*

There are also significant portions of the regulatory floodplain designated for a wide range of urban uses. For the majority of these lands, these designations reflect the existing established land uses. These designations though may not be realized due to other restrictions.

Zoning By-law

The channel of Cooksville Creek and the associated floodplain is not recognized within the schedules and provisions of the By-law south of Dundas Street. North of Dundas Street, the creek and associated floodplain are protected either through an Open Space Zone (O1) or Greenbelt Zone (G). Consideration should be given through a review of the zoning by-law provisions for lands associated with the Creek south of Dundas Street to create a consistent standard within the Zoning By-law for creek protection.

Credit Valley Conservation Policies

Several layers of regulatory policy apply to the consideration of erosion hazards, within the land use planning process. The Province of Ontario through the Planning Act requires implementation of the Provincial Policy Statement (PPS), 1997. To assist in implementation of the hazard related components of the Provincial Policy Statement, the OMNR has produced a document entitled Understanding Natural Hazards, 2001 (which replaces the 1997 Natural Hazards Training Manual). The Credit Valley Conservation (CVC) has been delegated the responsibility for policy implementation, with regard to hazardous areas. Through the Conservation Authorities Act, and the integrated ‘Fill, Construction, and Alteration to Waterways Regulation’, the CVC has created policies and guidelines to deal with the flooding and erosion component of the PPS. The CVC administers the Watercourse and Valleyland Protection Policies (1996) and Authority Policies on Floodplain Management (1994), along defined watercourses. The CVC also has two technical guideline documents that partly speak to erosion hazards, the CVC Stormwater Management Guidelines (1996), and Technical Guidelines for Pedestrian Bridge Crossings (1993). Table 1.2 contains the Policy definitions, factors for consideration, and method of calculation description for each of the Watercourse and Valleyland Protection Policy components. The parent document should be referenced for specific procedures and examples of setback determinations.

The CVC has been delegated authorities by the Ministry of Natural Resources. These authorities are set out in detail in the Memorandum of Understanding dated January 2001. As stated in this MOU, this delegation includes flood plain management, hazardous slopes, Great Lakes shorelines, unstable soils and erosion which are now encompassed by Section 3.1 “Natural Hazards” of the Provincial Policy Statement (1997). In this delegated role, the CA is responsible for representing the “Provincial Interest” on these matters in planning exercises where the Province is not involved. This role does not extend to other portions of the PPS unless specifically delegated or assigned in writing by the Province.

<table>
<tr><th colspan="2">TABLE 1.2
CVC WATERCOURSE AND VALLEYLAND PROTECTION POLICIES - SUMMARY
STABILITY, EROSION AND DEVELOPMENT SETBACK COMPONENTS
DEFINITION & DETERMINATION</th></tr>
<tr><td colspan="2">STABILITY COMPONENT</td></tr>
<tr><td colspan="2"><i>Definition:</i> The setback gradient line measured from the toe of the slope, or channel assuming the location of the toe remains fixed with time.</td></tr>
<tr><td colspan="2"><i>Factors for Consideration:</i></td></tr>
<tr><td>• soil strength</td><td>• changing load conditions</td></tr>
<tr><td>• groundwater conditions</td><td>• weathering of slope face</td></tr>
<tr><td>• slope geometry</td><td>• increases in surface runoff over slope</td></tr>
<tr><td>• Condition of vegetation</td><td></td></tr>
<tr><td colspan="2"><i>Method of Calculation:</i></td></tr>
<tr><td colspan="2">• There are three methods of establishing this component. Each method is progressively more involved as indicated within policy appendices.</td></tr>
<tr><td colspan="2">EROSION COMPONENT</td></tr>
<tr><td colspan="2"><i>Definition:</i> The regression of the slope toe/channel bank due to erosion over the design life of the structure at the crest of the slope and is measured as a horizontal distance.</td></tr>
<tr><td colspan="2"><i>Factors for Consideration:</i></td></tr>
<tr><td>• proximity of the slope toe to the watercourse</td><td>• sediment load carried by the watercourse</td></tr>
<tr><td>• Average and peak flow rates and velocities of the watercourse</td><td>• weathering of slope face</td></tr>
<tr><td>• susceptibility of the soils to erosion</td><td>• increases in surface runoff over slope</td></tr>
<tr><td>• type and extent of vegetation</td><td>• fluvial geomorphological processes affecting the reach within which the site is located.</td></tr>
<tr><td colspan="2"><i>Method of Calculation:</i></td></tr>
<tr><td colspan="2">• The distance from the toe of the valley wall to the watercourse channel bank as well as the design erosion allowance must be determined. The erosion is measured horizontally from the top of the channel bank or the location of the bankfull flow, whichever is lower in elevation.</td></tr>
<tr><td colspan="2">DEVELOPMENT SETBACK COMPONENT</td></tr>
<tr><td colspan="2"><i>Definition:</i> A minimum 5.0 m allowance from the identified slope hazard area to take into account external conditions which could have an adverse effect on the existing natural conditions of the slope. This setback distance may be superseded by more stringent municipal or provincial requirements.</td></tr>
<tr><td colspan="2"><i>Factors for Consideration:</i></td></tr>
<tr><td>• provide an access point along the crest of the slope</td><td>• allow for the placement of sediment control measures and limit of working easement if necessary.</td></tr>
<tr><td>• keep heavy equipment away from the slope</td><td rowspan="2">• provide tableland area for potential future revegetation and/or reforestation (e.g. Credit Valley Conservation Authority planting program)</td></tr>
<tr><td>• allow for the redirection of surface flows away form the slope hazard area</td></tr>
<tr><td colspan="2"><i>Method of Calculation:</i></td></tr>
<tr><td colspan="2">• Measured as the horizontal distance from the approved top of bank or from the combined distance derived from the Stability and Erosion Components whichever is the greater.</td></tr>
</table>

The City of Mississauga works cooperatively with the CVC to incorporate municipal consideration of hazardous areas through land use planning at the local scale. The City, through infrastructure planning guidelines of the Planning Act also requires of new development, or implements as a capital expenditure in existing development, various works that address watercourse hazards. Additional policies of the Ontario Ministry of Natural Resources (OMNR), (i.e. Lakes and Rivers Improvement Act) and the Federal Department of Fisheries and Oceans (DFO), (i.e. the Fisheries Act) can also be involved with site alteration or development issues related to watercourse erosion hazards.

A review of the current Provincial Floodplain Management Implementation Guidelines demonstrates how erosion hazards can be interpreted and integrated within the overall approach to SPA implementation. The guidelines state that it is Provincial policy for municipalities to identify "…the minimum acceptable level of protection required for new development". This is further explained in the guidelines as a recognition that the viability of historic development "…depends on a reasoned application of provincial standards" and that assessment of an SPA requires floodplain data "…in sufficient detail to graphically display and describe precisely the area and the effects". The guidelines further identify that specific technical factors must be taken into account. Given the points identified within the guidelines, it is appropriate to analyze erosion hazards from both a planning and technical perspective within the context of an SPA study. Further, the (Provincial Policy Statement) clearly identifies the importance and integration of erosion hazard assessment within the overall approach to floodplain management. As a result, neither the existing Implementation Guidelines nor the PPS suggest that floodplain planning options, or recommendations resulting from an SPA, shall supersede or nullify the requirements for erosion hazard integration within floodplain management.

2. HYDROLOGIC 'CHECK'

Section 6.2 of the Terms of Reference (ref. Appendix J), outlines the scope of work for the hydrologic 'check'. For this study, this has involved establishing a program to collect streamflow data, a technical review of the hydrologic modelling parameters, as well as an assessment of flood storage upstream of existing structures. Information on each of these initiatives is summarized in the following.

2.1 Streamflow Gauging

The current hydrologic modelling for the Cooksville Creek is uncalibrated. The model performance has not been verified based on actual stream flow and rainfall data. Rather, it has been "pseudo-calibrated" based on adjacent watershed performance which, in the absence of real data, is a standard practice. Given the timeframe for the current study, it was not possible to collect the required rainfall/streamflow data for hydrologic model calibration and meet the study timing objectives. Notwithstanding, the City of Mississauga has considered the collection of streamflow data as an appropriate approach to refine the flow prediction technique in the future. This undertaking, particularly given the considerable value of future capital works planned to address both flooding and erosion on this system, is important to ensure that the models are providing reasonable information to direct future design initiatives. Hence, it is an ultimate recommendation of this study, that the hydrologic model for this watershed be calibrated in order to confirm major flood flow response.

As part of the Cooksville Creek Rehabilitation Study completed in 1997 a gauging manhole was constructed proximate to Elaine Trail. The reason this manhole was constructed was due to equipment theft in this area. The photographs in Appendix C depict the site, as well as the orientation of the manhole itself.

The streamflow gauging system was installed on May 7, 2002 and removed at the end of November 2002. The manhole lead to the watercourse was blocked and required removal of sediment and debris. The measurement system (based on pressure transducers) tends to be ineffective during frozen conditions, hence at the end of November 2002, the gauge was removed.

There were some rating curve points collected in this location, as part of the previous 1997 study. This information is important in order to effectively allow the conversion of depth readings to runoff rates. This information though, according to Municipal staff, was not detailed enough and as its focus was on the erosion causing flow regime, additional stream current measurements were also collected as part of this study, in order to establish additional points on the rating curve. In addition, the theoretical HEC-2 rating curve for this area was used as a secondary check.

The current measurements involved the use of a portable flow meter to determine flow rates at a point near the continuous level gauge (i.e. at false manhole at Elaine Trail). There is a private bridge in close proximity and due to the high flows and velocities in the Cooksville Creek, all streamflow current metering has been from this bridge in accordance with standard protocol.

A report on the foregoing has been submitted to the City of Mississauga under separate cover.

2.2 Hydrologic Parameter Verification

The hydrologic check has involved:

- verifying previous hydrologic land use parameters
- checking hydraulic routing data
- examining model connectivity

The hydrology of the Cooksville Creek Watershed has been simulated using the OTTHYMO hydrologic model. This model uses the following input to compute the outflow from a subcatchment:

- Area
- SCS Curve Number
- Time to peak
- Slope
- Land Use

The hydrologic check has been limited to verification of land use parameters, as further verification of other modeling parameters would essentially require reconstruction of the watershed model, which is beyond the scope of this study.

Verification of land use parameters has been focused on those in the headwater catchments, as the lower reaches of the watershed south of Highway 403 are almost completely developed and the pervious land segment contribution to catchment outflows would be much smaller. Six headwater catchments have been selected, and digitally overlaid on a soil map of Peel County (Ontario Soil Report #18). The relative amounts of each soil type within each catchment have been measured, and a land use classification assigned to the catchment. A weighted CN has been calculated for each catchment, and the results shown in Table 2.1.

TABLE 2.1
VERIFICATION OF LAND USE PARAMETERS

Catchment ID	**Pervious Land Use**	**Computed CN**		**Modeled CN**	
		AMC II	**AMC III**	**AMC II**	**AMC III**
CCWT1	Agricultural	84	93	84	93
CCET1	Agricultural	85	94	83	93
CCET2	Agricultural	84	93	83	93
CC15	Agricultural	82	92	85	94
CC14	Agricultural	82	92	82	92
CC13	Agricultural	82	92	82	92

In general, the land use parameters within the hydrologic model lie within the range of values to be expected for the Cooksville Creek, based on the dominant soil types of Chinguacousy, Jeddo, Cooksville, and Oneida clays (which have high runoff potential), and agricultural land use. This would imply most SCS Curve Numbers would lie in the range of 82 – 86 for AMC II, and 92 – 94 for AMC III.

2.3 Flood Storage Assessment

One structural opportunity for floodplain management involves flood storage. The potential for flood flow attenuation upstream of man-made structures has been investigated in this study. The hydrologic modelling used in the Flood Remediation Plan Study (FRS) has correctly adopted no storage upstream of man-made structures for downstream flow prediction. The intent of exploring the influence of man-made storage for this study relates to the premise that there may be reasonable opportunities to designate certain structures as flood control systems, thereby formalizing the downstream attenuative benefit, through a reduction in peak flow. This approach may be a cost-effective means of flood control, or even a means to offset lost storage within an area considered for development.

In order to undertake the foregoing analysis, it has been necessary to determine available flood storage upstream of man-made structures. This has been accomplished using floodplain and topographic mapping to develop stage-storage-discharge relationships at the various potential sites. This information has been incorporated into the hydrologic model individually and under various combinations to determine the optimum attenuative result downstream. It should be noted that channel storage has conservatively not been discounted in this assessment, given its screening nature; as alternatives are deemed more viable additional detailed assessment would be conducted.

An examination of the potential storage available behind roadway and rail embankments and within online ponding areas has been carried out. Topographic mapping of the watershed has been examined, and a list of potential storage sites identified. The storage available at each has been estimated based on ponding to the sag elevation of the roadway, or to the limit of existing property. The sites have been ranked in order of their effectiveness in reducing downstream flows. Storage sites have been excluded where they are located within a development zone and would likely have limited effect on downstream flow reduction. Table 2.2 lists the available online storage along Cooksville Creek (ref. Drawing 2 for location).

TABLE 2.2
COOKSVILLE CREEK POTENTIAL ONLINE STORAGE FACILITIES

1	**EGLINTON AVENUE WEST**						
			STAGE		***STORAGE***		***REMARKS***
			(m)	***(ft)***	***(m^3)***	***(ft^3)***	
	HEC-2 SEC ID	10.205	159.71	523.98	0	0	
	100 YR WSEL (m)	162.83	161	528.21	1206	42588	Development Zone
	INVERT EL U/S (m)	159.71	162	531.49	5719	201957	
	TOP OF ROAD EL (m)	164.71	163	534.77	15080	532526	
	SAG ELEV (m)	164.55	164	538.05	34139	1205563	
2	**MISSISSAUGA VALLEY BOULEVARD (NORTH) to Burnhamthorpe Road**						
			STAGE		***STORAGE***		***REMARKS***
			(m)	***(ft)***	***(m^3)***	***(ft^3)***	
	HEC-2 SEC ID	7.260	123.85	406.33	0	0	
	100 YR WSEL (m)	126.29	124	406.82	34	1201	
	INVERT EL U/S (m)	123.85	125	410.10	940	33195	
	TOP OF ROAD EL (m)	129.81	126	413.38	4106	144997	
	SAG ELEV (m)	129.81	127	416.68	11662	411825	
			129	423.22	42109	1487011	
3	**Q.E.W**						
			STAGE		***STORAGE***		***REMARKS***
			(m)	***(ft)***	***(m^3)***	***(ft^3)***	
	HEC-2 SEC ID	2.724	93.5	306.75	0	0	
	100 YR WSEL (m)	99.3	95	317.68	982	34678	Development Zone
	INVERT EL U/S (m)	93.53	96	314.96	4114	145279	
	TOP OF ROAD EL (m)	98.3	97	318.24	15300	540295	
	SAG ELEV (m)	98.3	98	321.52	39214	1384779	
4	**ELAINE TRAIL**						
			STAGE		***STORAGE***		***REMARKS***
			(m)	***(ft)***	***(m^3)***	***(ft^3)***	
	HEC-2 SEC ID	8.177	98.5	323.16	0	0	
	100 YR WSEL (m)	145.24	99	324.80	675	23837	
	INVERT EL U/S (m)	141.7	100	328.08	7525	265733	
	TOP OF ROAD EL (m)	147.7	101	331.36	29275	1033799	
	SAG ELEV (m)	147.57					

There is potential for an off-line storage facility north of Bristol Road, and this has also been investigated as part of the hydrologic modeling assessment.

The sites listed in Table 2.2 have been selected based on interpretation of the topographic base mapping. Two locations at Queensway and Elaine Trail were proposed for storage in the Flood Rehabilitation Study (1997); they have been reviewed for potential impacts. Of the sites examined, the QEW and Eglinton Avenue sites were not analyzed further for peak flow attenuation, as storage in these locations would be counter to the study objectives.

In addition, there exists a large tract of land owned by the Peel Board of Education, and which is located north of Bristol Road. This is considered a suitable location for an off-line storage facility (i.e. there is an existing online water quantity facility at this location). This opportunity is discussed in further detail in Section 7.2.

3. TOPOGRAPHIC MAPPING CHECK

Some uncertainty with respect to the accuracy of the topographic mapping has been expressed by both the CVC and City (ref. Terms of Reference, Appendix J). As a result, a topographic mapping check (vertical only) was recommended.

The Study Team has checked spot elevations and contour crossings on each 1 km^2 grid in general compliance with Flood Damage Reduction Program (FDRP) specifications. A Total Station survey, based on Municipal geodetic benchmarks has been conducted to verify the accuracy of the mapping sheets using the allowable tolerances for FDRP studies.

Using benchmarks adjusted to geodetic datum from the City of Mississauga, a survey of spot elevations, at or near, primary crossings of the Cooksville Creek has been completed. The spot elevations on the City of Mississauga's digital mapping, as well as the Flood Risk mapping have been compared with the level survey information collected by Total Station.

The study area has been divided into seven, approximately one kilometre grid sheets. Two to three spot elevations have been surveyed on each map for a total of seventeen survey points. The results of the survey, as well as the difference from digital City of Mississauga mapping and the flood risk mapping, has been summarized in Table 3.1.

The Floodplain Management in Ontario Technical Guidelines, 1986, Ministry of Natural Resources, Section 7.18, Map Accuracy states that 90% of the errors of all spot heights are to be less than one-third of the contour interval. Based on the premise that the contour interval for this mapping is 1.0 m, the allowable difference would be 0.33 m.

The survey information collected as part of this study was presented to City staff on March 20, 2002 (ref. Appendix B). Municipal staff have, as a result, conducted additional investigations regarding this issue. On May 28, 2002, a meeting was held with the information management department (ref. Appendix B), at which time the details of the independent analysis was presented by City staff. Cross-sections were produced from mapping, as well as photography, and ground truthed through level survey, where the differences exceeded allowable tolerances. While some exceedances were noted, the mapping was considered suitable for use in this study. The City's mapping manager stated that the 5% exceedance criterion limit set by FDRP standards has been satisfied.

TABLE 3.1
COOKSVILLE CREEK MAPPING CHECK

Mapping ID[1]	Bench Mark Numbered Location	Elevations (m)			Difference from Mississauga Mapping (m)	Difference from Flood Risk Mapping (m)
		City of Mississauga	Flood Risk Mapping	Philips Survey 2002		
Map 1	Bristol Road East BM=#219	169.98	169.8	168.89	-0.80	-0.91
	Bristol Road and Hurontario Street	178.68	179.4	178.94	0.26	-0.46
Map 2	Eglinton Avenue East BM=#997	164.48	164.6	164.69	0.21	0.09
	Kingsbridge Garden Circle	160.98	161.1	160.81	-0.17	-0.29
Map 3	Burnhamthorpe Road BM=#365	134.08	134.2	134.38	0.3	0.18
	Mississauga Valley Boulevard BM=701	129.78	129.9	129.70	-0.08	-0.20
Map 4	Bud Gregory Boulevard BM=#953	151.48	151.6	151.69	0.21	0.09
	Rathburn Road East	143.08	143.6	143.54	0.46	-0.06
	Petersbury Crest	139.08	139.5	139.43	0.35	-0.07
Map 5	Kirwin Avenue BM=#706	113.38	113.5	113.58	0.2	0.08
	King Street East BM=#793	105.98	106.1	105.81	-0.17	-0.29
	Paisley Boulevard BM=#798	103.68	103.8	103.59	-0.09	-0.21
Map 6	Queensway East	105.28	105.4	105.21	-0.07	-0.19
	Camilla Road and Cherry Post BM=#338	103.28	103.4	103.08	-0.2	-0.32
	Camilla road and Pathfinder Drive	99038	99.5	99.26	-0.122	-0.24
Map 7	Atwater Avenue and Canterbury Road BM= #78	86.16	86.3	86.30	0.12	0.00
	Lakeshore Road East BM=#805	79.58	79.7	79.87	0.29	0.17

[1] Note: Map sheets on file with City of Mississauga.

4. STUDY AREA OVERVIEW

4.1 Study Area Description

The Cooksville Creek Watershed in the City of Mississauga was the subject of a Flood Remediation Plan Study (FRS), conducted by Environmental Water Resources Group, May 2002 (ref. Section 1.3). The following is a summary of key information, findings and recommendations contained within the FRS.

Watershed Description

Area	*33.9 km*^{2}	*13.2 sq. miles*
Length	*16.1 km*	*10.0 miles*
Width	*2.0 km*	*1.24 miles*
Total Relief	*125 m*	*410 ft*
Land Use	*Commercial/Residential*	*60%*
	Industrial	*34 %*
	Open Space	*6%*
Soil Types	*Muck*	*3%*
	Chinguacousy Clay Loam	*18%*
	Cooksville Clay	*20%*
	Fox Sandy Loam	*27%*
	Jeddo Clay Loam	*7%*
	Oneida Clay Loams	25%

Generally, resident soil types have low infiltration capacity.

The Cooksville Creek is a historically developed watershed, with extensive channelization. The Creek is channelized for 92 % of its length and exhibits significant erosion scars in places, with downcutting rates in the order of 2 to 18 cm (0.8 to 7 inches) per year. The material eroded from the upper reaches of the creek is being deposited in the channel from the CNR to Lake Ontario, which is aggrading, and has to be periodically dredged to restore waterway area.

There are poor quality aquatic habitats along the creek with small fish populations, likely of species tolerant of poor water quality. Restoring or improving aquatic habitat would require significant improvements.

Regulatory Event

The Regulatory event is defined by the 100 year or Regional storm, whichever event produces the larger hydrologic response. For Cooksville Creek, the Regulatory event is the Regional storm for the creek below Highway 403 and the Main Branch upstream of Highway 403, and the 100 year event for the East branch.

Existing Conditions

The historical development, in the absence of floodplain management, within the lower reaches of Cooksville Creek has resulted in numerous buildings being located within the Regulatory floodplain. Property owners downstream of Highway 403 currently have the greatest exposure to flood damage, with owners furthest downstream being protected only to about the 10 year level.

Upstream of Highway 403, development has been guided by Provincial/CVC policies administered by the City of Mississauga. Consequently, the level of protection offered to almost all property owners in this area is the Regulatory level.

Under current conditions, approximately 119 buildings are flooded under the 100 year and 304 under the Regional event. Most of the flooding occurs downstream of Central Parkway East, with the greatest number of buildings flooded, lying between the CNR-Atwater Avenue and QEW-King Street reaches (ref. Table 4.1). Flood depths for the Regulatory flood range from 0.2 to 1.1 m (i.e. 7.8 to 43 inches). Associated flood damages are presented in Table 4.2 and 4.3.

TABLE 4.1
BUILDING FLOODING SUMMARY[1.]

Reach	**Number of Buildings Flooded Return Period (Years)**						
	Regional	**100**	**50**	**25**	**10**	**5**	**2**
Lake Ontario to CNR	25	5	4	2	2	2	--
CNR to QEW	108	34	21	15	11	3	--
QEW to King Street East	108	46	37	21	15	9	5
King Street East to CPR	17	16	7	6	2	2	--
CPR to Mississauga Valley Boulevard (North)	31	13	13	4	--	--	--
Mississauga Valley Boulevard (North) to Highway 403	--	--	--	--	--	--	--
Highway 403 to Eglinton Avenue West	4	--	--	--	--	--	--
Eglinton Avenue West to Bristol Road West	1	--	--	--	--	--	--
Bristol Road West to Matheson Boulevard West	--	--	--	--	--	--	--
East Branch							
Burnhamthorpe Road East to Eglinton Avenue East	10	5	5	--	--	--	--
TOTAL	**305**	**119**	**87**	**48**	**30**	**16**	**5**

[1.] Reproduced from FRS May 2002

TABLE 4.2
POTENTIAL FLOOD DAMAGES[1]

Reach[3]	Damages by Return Period ($1,000's)							
	2 yr	**5 yr**	**10 yr**	**25 yr**	**50 yr**	**100 yr**	**Regional**	**EAD[2]**
1	--	--	--	--	--	--	70	0.2
2	--	--	50	50	80	240	6,040	30.1
3	--	--	50	50	100	100	200	5.7
4	--	10	20	60	250	380	1,730	14.3
5	--	10	20	210	360	2,700	6,550	60.3
6	--	--	--	110	690	860	2,750	24.0
7	--	--	--	--	--	--	--	--
8	--	--	--	--	--	--	--	--
TOTAL	**0**	**20**	**140**	**480**	**1,480**	**4,280**	**17,340**	**134.6**

[1] Reproduced from FRS May 2002

[2] Estimated Annual Damages

[3] Ref. Table 4.3 for location of reaches

TABLE 4.3
FLOOD DAMAGAE REACHES[1]

Flood Damage Reaches	**From**	**To**	**From HEC -2 Section No.**	**To HEC -2 Section No.**
1	Lake Ontario	CN Railway	0.000	0.850
2	CN Railway	Upstream of Atwater	0.850	1.520
3	Upstream of Atwater	Downstream of QEW	1.520	2,540
4	Downstream of QEW	Upstream of King Street East	2.540	4.780
5	Upstream of King Street East	CP Railway	4.780	5.920
6	CP Railway	Central Parkway East	5.920	6.690
7	Upstream of Kingsbridge Garden Circle	Upstream of Eglinton Avenue West	9.720	10.480
East Branch				
8	Burnhamthorpe Road East	Upstream of Meadows Boulevard	7.601	8.000

[1] Reproduced from FRS May 2002

Spill would occur at 5 locations on the Main branch during the Regional event as follows: (Note: A spill is defined as an area or location within the floodplain where floodwaters are not contained or confined to the floodplain. The floodwaters would either flow to an adjacent watershed or re-enter the subject watershed at some point downstream; for this study, consistent with previous investigations, all spill flow has conservatively been assumed to re-enter the Cooksville Creek).

- *CNR*
- *QEW*
- *Kirwin Avenue*
- *Hurontario Street*
- *Highway 403*

The bridge and culvert crossing capacities at these locations are insufficient to convey the Regional flood (ref Table 4.4).

TABLE 4.4
BRIDGE/CULVERT CROSSING CAPACITIES [1.]

Crossing Location	Crossing Capacity Without Overtopping				Crossing Capacity Without Building Flooding			
	Flow Rate		Water Level		Flow Rate		Water Level	
	(m^3/s)	(cfs)	(m)	(ft)	(m^3/s)	(cfs)	(m)	(ft)
Lakeshore Road East	200	7063	80.02	262.53	160	5650	79.83	261.91
Private Access	<75	<2649	80.06	262.66	210	7416	82.00	269.03
CNR	270	9535	84.75	278.05	130	4591	82.71	271.35
Atwater Avenue	120	4238	85.82	281.56	210	7416	85.96	282.02
QEW	110	3884	98.30	322.50	100	3531	97.94	321.32
Camilla Road	135	4767	99.44	326.24	135	4767	99.46	326.31
Queensway Avenue East	>290	>10241	104.90	344.16	140	4944	103.10	338.25
Paisley Boulevard	75	2649	103.40	339.23	75	2649	103.40	339.23
King Street East	>70	>2472	105.93	347.54	120	4238	107.20	351.70
Dundas Street East	160	5650	110.90	363.84	<70	<2472	108.00	354.33
Kirwin Avenue	<70	<2472	113.20	371.39	<70	<2472	113.20	371.39
CPR	>250	>8828	119.30	391.40	125	4414	115.41	378.64
Mississauga Valley Boulevard	125	4414	117.45	385.33	100	3531	116.68	382.80
Central Parkway East	195	6886	122.04	400.39	>240	>8475	>122.04	400.39
Mississauga Valley Boulevard	>220	>7769	129.81	425.88	>220	>7769	129.81	425.88
Burnhamthorpe Road East	>145	>5120	136.21	446.88	>145	>5120	136.21	446.88
Robert Speck Parkway	>145	>5120	147.57	484.15	>145	>5120	147.57	484.15
Hurontario Street On-Ramp	>145	>5120	152.70	500.98	>145	>5120	152.70	500.98
Hurontario Street	115	4061	156.02	511.87	115	4061	156.02	511.87
Highway 403	115	4061	161.40	529.52	>140	>4944	162.70	533.79
Private Access	45	1589	159.61	523.65	>120	>4238	162.70	533.79
Kingsbridge Garden Circle	70	2472	160.81	527.59	95	3355	162.08	531.75
Eglinton Avenue West	>110	>3884	154.55	507.05	95	3355	163.97	537.95
Ceremonial Drive	>110	>3884	167.58	549.80	>110	>3884	167.58	549.80
Bristol Road West	85	3002	168.93	554.23	>100	>3531	170.30	558.72
Private Access	>25	>883	169.56	556.29	>100	>3531	>171.75	563.48
East Branch								
Burnhamthorpe Road East	40	1413	134.50	441.27	>65	>2295	136.00	446.19
Meadows Boulevard	40	1413	136.19	446.81	40	1413	137.00	449.47
Rathburn Road East	45	1589	144.61	474.44	>60	>2119	>145.31	476.73
Central Parkway East	>50	>1766	150.40	493.43	>50	>1766	149.28	489.76
Bud Gregory Drive	>50	>1766	151.90	498.35	>40	>1413	152.90	501.63

[1.] Reproduced from FRS May 2002

4.2 Description of Properties Under Consideration

Throughout the Cooksville Creek watershed, there are pockets of land that have the potential for redevelopment and intensification. This potential is due in part to the policy framework established by the City of Mississauga, designating these lands for urban uses. In addition, there has been interest expressed by the development community in developing or redeveloping these sites. The following are the properties identified through this study process for consideration of alternative floodplain management options:

Lakeshore Road/Inglis Property

At the intersection of Lakeshore Road and Cooksville Creek is an older commercial/ industrial/ residential area in need of revitalization [approximately 8.94 ha +/- (22 +/- Acres)]. To the west of this area, redevelopment of older parcels has occurred; however, within the area affected by Cooksville Creek, no redevelopment has occurred due to constraints imposed by the current floodplain management policies. The existing commercial building stock has begun to deteriorate and marginal commercial uses such as reuse/pawn shops have established. Over the last decade, there has been interest in redeveloping the Inglis property, a large industrial block; however, none have proceeded due to lack of flood free access to the property.

These lands are located within the Lakeview District. The lands within the regional floodplain north of Lakeshore Road are designed as 'Business Employment' with an M1 zone. On the south side of Lakeshore Road, the lands are designated 'Auto Service Commercial' and 'Retail and Service Commercial'. Only the channel of Cooksville Creek is designated as 'Greenbelt' north of Lakeshore Road while almost the entire floodplain is so designated south of Lakeshore Road.

Consulate Property Camilla Road- North of the Queen Elizabeth Way

As shown on Schedule 2 – "Urban Form Long Term Concept" from the City Official Plan, this area is directly adjacent to the Hurontario Street Corridor. This street is a "major high density residential corridor due its transit oriented function, and several high density nodes exist at its intersections with Dundas Street, the Queensway, Sherobee Road, Hillcrest Avenue and the North Service Road" (Section 6.9.1). The District Plan identifies high-density residential uses to be centred in the Hurontario and Dundas Streets intersection and other high-density residential sites at Camilla Road and the North Service Road.

During the review of the Cooksville District policies, concerns were raised by land owners in this area, regarding the restrictions on development within the floodplain. The City of Mississauga, at the request of the Consulate Development Landowners Group, approved OPA 69 to allow 'Residential – High Density II', within the floodplain. The lands subject to OPA 69 are located on the north side of the North Service Road, west of Camilla Road and south of the Ontario Hydro right of way and are approximately 1.31 ha +/- (3.2 acres +/-). Under the previous Cooksville-Munden Park District Plan, the lands were designated as Office Commercial.

On November 18, 1999, the Region of Peel approved this OPA. Credit Valley Conservation and the Province have appealed OPA 69 to the Ontario Municipal Board. The basis for this appeal is that the amendment does not comply with the PPS and no technical studies were provided to justify the development in the floodplain. The site is currently vacant.

In addition to the lands subject to Official Plan Amendment 69, there are additional lands within the area, which are vacant or identified for potential redevelopment. Any consideration of OPA 69 lands will need to include these lands to the east.

F & F Construction Limited Property

The F & F Property [approximately 2.82 ha +/- (7.0 acres +/-)] is located on the west side of Camilla Road to the south of the Queensway. The site is designated 'Greenbelt' and 'Residential Low Density I' in the Cooksville-Munden Park Area District Plan. The landowners have indicated an interest in developing additional portions of this site although there is no current application.

Humenik Lands (Shepard Avenue)

This property [5.2 ha +/- (12.8 acres +/-)] is located on both the east and west sides of Shepard Avenue between King Street West and Paisley Boulevard East. The lands are currently developed for single detached dwellings. Although no formal development application has been submitted regarding these lands, the landowners in the area have presented to the City a site design with high-density residential uses for these lands.

The Cooksville District policies and designations for these lands are appealed to the Ontario Municipal Board. The proposed land uses are 'Residential – Medium Density I', 'Residential – Low Density I' and 'Greenbelt' designations. The approved policies for these lands date back to Amendment No. 151 to the old Township of Toronto Planning Area Official Plan. Under that Plan the lands are designated 'Residential Multiple Family' and 'Greenbelt'. The term 'Residential Multiple Family' is not defined.

In addition to the parcel described above, there are a few individual lots just south of these lands, which are vacant or have been identified for potential redevelopment. Any consideration of Shepard Avenue area will need to include these lands to the south.

Little John Lane Property

This property is located adjacent to Little John Lane. The site is currently vacant. The landowners have proposed a development for townhouse units; however, the development design requires a cut and fill with a retaining wall. No formal application has been submitted. The lands are located within an area designated as a Multi-Use Centre, which is intended to serve as a mixed commercial and residential node.

Eglinton West

The Long Acres site [11.8 ha +/- (29.1 acres +/-)] is located on the north side of Eglinton Avenue to the West of Hurontario Street. The site is designated as Residential - Medium Density 1 and Greenbelt in the Hurontario District Plan. The site is currently vacant. There is no current application for the development of these lands.

5. STREAM MORPHOLOGY ASSESSMENT

5.1 Introduction

Within the framework of an SPA planning study there is a need to integrate channel erosion issues with overall floodplain management issues. This perspective needs to be defined from a broad watershed wide assessment and then focused on reach based quantitative analysis. Channel processes should be identified and analyzed within both a technical and policy based context, to determine planning level constraints. Constraints are best identified as reach based corridors that define the limits and results of analysis.

5.2 Watershed Erosion Characterization

A systems approach has been taken to evaluate the watershed-wide perspective of erosion hazards. Previous reporting on the erosion and geomorphic dynamics of Cooksville Creek is synthesized in the Cooksville Creek Rehabilitation Study (1997). The Rehabilitation Study summarized the Cooksville Creek system as follows.

> *Cooksville Creek is a rock bed dominant system with minor sections of bedrock controlled alluvial channel. Cooksville Creek's rock bed is composed of quasi-horizontal sedimentary shale and limestone of the Georgian Bay Formation. The rock bed is easily eroded through several processes including chemical, physical, freeze-thaw, and wetting-drying weathering. The creek is generally steep and sediment starved, and lacks self-repair processes. Gradual urbanization and changes in watershed hydrology have likely accelerated the rate of channel erosion due to increased volume, duration and peak levels of frequent active channel flow.*

The Rehabilitation Study took a comprehensive hierarchical approach, with recommendations ultimately focused on cause and effect of rehabilitation options between the banks of the creek. The current study focuses on the preventative approach. Stream stability analysis and criteria are needed at the reach scale to specifically address potential SPA properties to better define the scope of development opportunities.

The system wide analysis has been based on the working hypothesis that longitudinal variance or trends in erosion diagnostics can be identified from downstream to upstream. Based on channel continuum theory, effort has been made to identify measurable increases in channel velocity, boundary shear stress, and stream power, as flow rates increase down Cooksville Creek. Trend identification can then be used to corroborate subsequent analysis of reach and site specific quantification of erosion.

Analysis of main branch diagnostics has been performed using background information available in the HEC2 hydraulic model from the previous Cooksville Creek Floodline Mapping Study (1996). The model has been modified to use the future conditions 2 year event flows, and output summary data was set to generate a selected list of erosion related criteria. The future conditions 2 year event has been chosen to reflect channel capacity hydraulics representing as much of the main branch system as possible. It should be noted that much of the analysis in the previous Rehabilitation Study used the existing conditions 2 year event for analysis. At the time of the Rehabilitation Study, approximately 10% of the Cooksville Creek watershed was available for development. In the intervening years this area has been reduced to approximately 7%. Based on this growth rate the entire watershed is approaching full build out and may be fully developed within another 5 years. As a result, the future condition hydrology has been selected as the most appropriate input data.

Approximately 300 data points have been generated for the diagnostics of channel velocity, channel boundary shear stress, and total stream power, in the modeling exercise. These results are summarized and presented as Figure G.1 (ref. Appendix G).

The plots for each variable show the longitudinal variance along the system. For reference, the longitudinal change in 2 year future event flow rate has also been presented on the channel velocity plot. Regression analysis has been performed for each plot to determine the strength of any longitudinal trend. Starting with the 2 year future event flow rate, there is a reasonable linear regression relationship, with an r^2 value of 0.78, as flows increase in the downstream direction. The best fit regression relationship for each of the erosion diagnostics is a polynomial curve showing a gradual increase in trend from upstream to down with a slight reversal or downward trend in the lowest reaches of the creek. Each of the regression values are low and the trend is weak. The identified wide scatter in data, influences the strength of the regression relationship. In turn, the longitudinal trend for each of the erosion diagnostics does not agree with the trend in discharge. A variety of reasons can provide insight to the observation; firstly and foremost, is that the creek is highly armoured and channel cross sections have been altered such that almost all natural channel tendency has been lost in the system. This has resulted in a wide spectrum of hydraulic response over and through the variety of channel features, such as fixed bends, gabion, armourstone, rip rap, and concrete linings, armoured steps, bridges, culverts, and bedrock knickpoints. Notwithstanding, a slightly increasing trend for each of the erosion related criteria, in the downstream direction, is still discernable. The slight reduction of the trend in the downstream reaches may be due to a combination of wide gabion channelization, slight drop in channel slope, and backwater effects from Lake Ontario, all of which will mute the calculation of channel velocity, shear stress, and stream power.

The next step in systems approach has been to determine measurable change within a breakdown of system reaches. This analysis has been performed using historical air photo records. Historical air photos have been used to measure plan form change. Rates of lateral migration, down valley migration, channel widening, reach lengths, and resultant sinuosity ratios have been determined. This exercise establishes overall change and rates of change from the available time steps between photos. A direct advantage of this technique is that it can be applied to specific locations of interest, such as the development properties identified in this study. Air photos were available from six historical time steps: 1954, 1977, 1986, 1990, 1993, and 2001. Ten reaches have been established based on major boundaries of fixed bridge crossing locations. These reaches agree with those used previously in the Rehabilitation Study. Detailed measurements have been taken from the available photos for each reach. Due to the level of channelization in recent decades measurable changes are not evident in all reaches. The results of this exercise are summarized in Table 5.1.

TABLE 5.1
COOKSVILLE CREEK – GEOMORPHIC REACH ANALYSIS

Reach	Year	Channel Length		Sinuosity	Average Width		Migration Rates/Notes
		(m)	(ft)		(m)	(ft)	
Lake Ontario to Atwater Avenue	1954	1498	4913	1.24	6.9	22.6	>channelized in the 1970's below Lakeshore
	1977	1318	4323	1.09	15.2	49.9	>channelized in the 1980's above Lakeshore
	1986	1303	4273	1.07	16.4	53.8	>no major planform change has occurred
	1990	1282	4204	1.06	16.4	53.8	
	1993	1271	4168	1.05	16.4	53.8	
	2001	1265	4149	1.05	16.4	53.8	
Atwater Ave. to QEW	1954	1684	5523	1.24	6.5	21.3	>hardening of banks visible in 1954
	1977	1502	4926	1.11	8.1	26.7	>no major planform change has occurred
	1986	1482	4860	1.09	10	32.8	
	1990	1480	4854	1.08	10.1	33.13	
	1993	1478	4847	1.07	10.1	33.13	
	2001	1473	4831	1.08	10.1	33.13	
QEW to Dundas St.	1954	2302	7550	1.14	5.1	16.73	>1954 - 2001 lateral migration = 0.024 m/yr
	1977	2280	7478	1.12	6.8	22.3	>1954 - 2001 down valley migration = 0.06 m/yr
	1986	2244	7360	1.09	7.3	23.9	
	1990	2236	7334	1.09	9.6	31.5	
	1993	2232	7320	1.07	8.75	28.7	
	2001	N/A		N/A	too vegetated		
Dundas St. to Central Parkway	1954	1783	5848	1.19	4.5	14.76	>1954 - 1977 lateral migration = 0.74 m/yr
	1977	1696	5563	1.13	4.6	15.1	>1954 - 2001 lateral migration = 0.12 m/yr
	1986	1624	5326	1.08	5.1	16.73	>1977 - 2001 lateral migration = 0.05 m/yr
	1990	1595	5321	1.06	5.4	17.71	
	1993	1590	5215	1.06	5.42		
	2001	N/A		N/A	too vegetated		
Central Parkway to Miss. Valley Blvd.	1954	732	2401	1.16	5.9	19.35	>channelized after 1954
	1977	583	1912	1.03	6.5	21.32	
	1986	543	1781	1.03	6.9	22.63	
	1990	526	1725	1.02	6.9	22.63	
	1993	534	1751	1.03	7.09	23.25	
	2001	531	1741	1.03	7.29	23.91	
Miss. Valley Blvd. to Mutual Rd.	1954	689	2259	1.1	1.1	3.61	>1977 - 1993 lateral migration = 0.08 m/yr
	1977	650	2132	1.09	2.2	7.21	>1977 - 2001 lateral migration = 0.34 m/yr
	1986	620	2033	1.08	3.7	12.14	>1993 - 2001 lateral migration = 0.36 m/yr
	1990	620	2033	1.08	5.5	18.04	>channelized after 1993
	1993	626	2053	1.08	5.56	18.24	
	2001	623	2043	1.08	5.55	18.20	
Mutual Rd Ped bridge to Hwy 403	1954	1050	3444	1.08	4.9	16.07	>Highway 403 built after 1977
	1977	1036	3398	1.07	5.4	17.71	
	1986	1032	3384	1.06	6.6	21.65	
	1990	1032	3384	1.06	6.6	21.65	
	1993	1035	3394	1.05	6.65	21.81	
	2001	1040	3411	1.05	6.71	22.01	
Hwy 403 to Eglinton	1954	1394	4572	1.22	6.2	20.34	>1954 -1977 minor lateral migration
	1977	1285	4214	1.12	6.23	20.43	>1954 - 1977 down valley migration = 0.23 m/yr
	1986	986	3234	1.03	7.8	25.58	>1993 - 2001 no change, channelized
	1990	986	3234	1.03	9.2	30.18	
	1993	986	3234	1.03	9.2	30.18	
	2001	986	3234	1.03	9.2	30.18	
Eglinton to Bristol	1954	1485	4870	1.13	4.75	15.58	>channelized after 1977
	1977	1469	4818	1.13	4.29	14.07	
	1993	1253	4109	1.04	3.2	10.49	
	2001	1259	4129	1.04	3.2	10.49	
Bristol to Matheson	1954	1176	3857	1.28	3.17	10.40	>1954 - 1977 lateral migration rate = 0.016 m/yr
	1977	1184	3883	1.28	3.09	10.13	>1954-1977 down valley migration = 0.22 m/yr
	1993	924	3030	1.02	2.75	9.02	>similar planform 1954 - 1977
	2001	921	3021	1.02	2.8	9.18	>channelized after 1977

General observations include the trend in decreased channel length and resultant decreased sinuosity over the available historical record. A general increase in channel width is also evident. These trends are not unexpected and are due largely to the extent of channelization that has been constructed within recent decades. Channelization has straightened the channel in many locations to maximize land use practices. Widening of the active channel has been done to increase capacity for both frequent and infrequent peak flows.

5.3 Belt Width Assessment

Belt width assessment is identified within current Provincial guidelines as a tool for constraint analysis. The intent of belt width assessment is to identify the long term limits of natural meander migration, as centred down the valley occupied by a watercourse. Belt width assessment is a technique that has widespread applicability in undeveloped areas. Unfortunately, this is not the case in urban areas that have experienced progressive increases in imperviousness with resultant changes to flow regime and channel response. Additional modifiers such as build out of roads, bridges, and other infrastructure, and implementation of capital projects for flood and erosion control, strongly modify any identifiable belt width. The historical air photo record confirms the rapid rate of urbanization in the Cooksville Creek watershed. As a result, the only area with sufficient representation of historical belt width is in the upper headwater areas that have, nonetheless, eventually been channelized. The net effect of urbanization and extensive channelization has resulted essentially in a 'structural' belt width for the system. This condition provides no predictive power to establish what would be considered an *ultimate condition natural corridor* based on belt width.

Alternatively, belt width approaches, based on empirical functions or multipliers of known bankfull width, as noted in Provincial guidelines, have been considered. The dilemma again for Cooksville Creek is that the degree of flood and erosion control channelization produces artificial bankfull widths that are not true natural channel widths. In addition, the few locations that have not been extensively channelized are in various stages of adjustment, so that stable bankfull conditions are not directly observable in the field. As a result, neither the empirical function nor multiplier approach is applicable for Cooksville Creek.

The net result for the Cooksville Creek system is that a quantitative belt width assessment is not appropriate under current or expected conditions.

5.4 Recession Rates

Beyond belt width assessment, it is considered appropriate to investigate recession rates for setback or corridor analysis. Ministry of Natural Resources guidelines suggest that a minimum of 25 years of measurable data is needed to determine accurate long term recession rates. Detailed historical air photo analysis found only eight locations with sufficient historical data to determine the recession rate for two periods of 24 years and 47 years, as noted previously in Table 5.1. These periods are within the intent of MNR guidelines. These sites are all within sections of bedrock influence. It should be noted that channelized sections above Highway 403 are not necessarily within areas of bedrock exposure and due to the history of channelization, long term recession rates were not measurable for headwater areas. Based on the available eight locations, the long term average annual recession rate, for all sites, was measured to be 0.22 m/year

(8.5 inches/year) with a range from 0.02 to 0.74 m/year (0.8 – 29 inches/year). Down valley migration rates are identified to vary from 0.06 m/yr to 0.74 m/yr (2.4 – 29 inches/year). Given this range, it is likely that the measured rates above the average are related to episodic major storm events, not the constant slow weathering of channel bedrock. Overall, it is considered fair to conclude, that rates will trend toward the average over the longer term. It should be noted, however, that the locations generally providing the highest rates of recession are reaches of channel that were in a natural condition, north of Central Parkway, prior to the headwater build out of the watershed between the 1960's and the present. Virtually all of these areas subsequently had some form of erosion control installed as of the late 1980's and early 1990's. Nonetheless the reach of channel, above Mutual Rd., with the second highest rate of historical recession had notable failure of erosion protection works within 10 years of installation. This example demonstrates how erosion continues to attack the channel despite efforts to control erosion processes.

To check the analysis of long term recession rates an updating and assessment of existing erosion monitoring stations has been completed. Parish Geomorphic Ltd. has maintained three bedrock monitoring stations on Cooksville Creek since 1998. These stations have been inventoried on an annual basis and were re-inventoried as part of this study to collect current field data. Monitoring analysis is undertaken through a comparison of scaled cross section measurements. Quantitative comparisons can be made between years and between stations. The Figures provided in Appendix G summarize the results of four years of monitoring at each of the stations.

The most significant changes are evident at stations CC01 and CC03. Station CC01 is modestly aggradational over the time series. Station CC03 is seen to be degradational with both bed lowering and bank erosion. A comparison was also done between the start and end of the monitoring periods, for each of stations CC01 and CC03, to determine the differences in active channel geometry. Table 5.2 summarizes these results.

TABLE 5.2
BEDROCK MONITORING – ACTIVE CHANNEL GEOMETRY SUMMARY

Bedrock Monitoring Site CC01 – d/s of upper Mississauga Valley Blvd.

	Nov. 98	**May 02**	**Difference**	**Monthly ?**	**Annual ?**
area (m^2)	2.127	1.870	0.256	0.009	0.106
hydraulic radius (m)	0.484	0.380	0.105	0.004	0.043
top width (m)	2.145	2.011	0.134	0.005	0.056
wetted perimeter (m)	4.390	4.924	-0.533	-0.018	-0.221
max. depth (m)	1.417	1.422	-0.005	0.000	-0.002
mean depth (m)	0.992	0.930	0.061	0.002	0.025

Bedrock Monitoring Site CC03 – west of the end of Aqua Drive

	Nov. 98	**May 02**	**Difference**	**Monthly ?**	**Annual ?**
area (m^2)	2.034	2.241	-0.206	-0.007	-0.085
hydraulic radius (m)	0.355	0.397	-0.042	-0.001	-0.017
top width (m)	1.530	1.660	-0.130	-0.004	-0.054
wetted perimeter (m)	5.651	5.734	-0.084	-0.003	-0.035
max. depth (m)	1.763	1.851	-0.088	-0.003	-0.036
mean depth (m)	1.312	1.464	-0.152	-0.005	-0.063

Station CC01 shows the effect of transient bed load accumulation in a large bed form bar on the right channel bank. In addition, this station shows a decrease in channel area but an increase in wetted perimeter due to the roughness and size of substrate. Station CC03 shows increases for all measures of channel geometry. The measured recession rate, at this station, over the four year monitoring period is 0.054 m/year (2 inches/year). This period is too short to translate into accurate long term projections, but it does demonstrate the net effect of ongoing erosion.

The results of recession rate analysis show a clear picture of the dynamics of the Cooksville Creek system. Given however that long term rates are determined by measurement only on the outside of a meander bend, they do not always lend themselves to corridor setbacks that need to be established on both sides of the creek. In addition, the artificial changes to the creek through channelization do not always allow accurate air photo measurement of natural widening rates. In turn, erosion monitoring stations can be used to show channel widening detail, but the existing period of record is too short at this time. Nonetheless, further discussion and consideration of recession rates can still be integrated into the technical and policy approaches to corridor analysis.

5.5 Technical Corridor Approach

Detailed modelling has been used to test corridor limits using stability threshold conditions. This effort determines a corridor reflecting the physical width of the ultimate stable channel under future effective flows. The detailed modelling is based on a working theory of channel evolution for Cooksville Creek.

The theoretical channel evolution model is described as follows. Comparison of Cooksville Creek to alluvial and semi-alluvial channels is not appropriate in the near term. Erosion processes will reflect bedrock control and bedrock weathering in the foreseeable future. Given enough time, however, the increase in channel capacity and sediment supply will cross a threshold, where sediment based channel rebuilding will likely occur.

The channel will progress under two mechanisms in the near to mid term. Firstly it will continue to incise and develop a gorge like morphology in response to bedrock weathering. This is clear, based on the rates of incision reported in the previous Rehabilitation Study. In turn, as the channel also widens it will attempt to meander and outflank existing erosion protection to decrease slope and energy. Sediment generation, supply, and transport will all increase in a downstream direction. Concurrently, the remaining headwater areas of the watershed will build out, and active channel flow rates would modestly increase without comprehensive stormwater management focussed at the frequent flow regime. This creates the primary consideration for model input, namely a targeted 10% increase in active channel flow above the flow rates determined in the previous Rehabilitation Study.

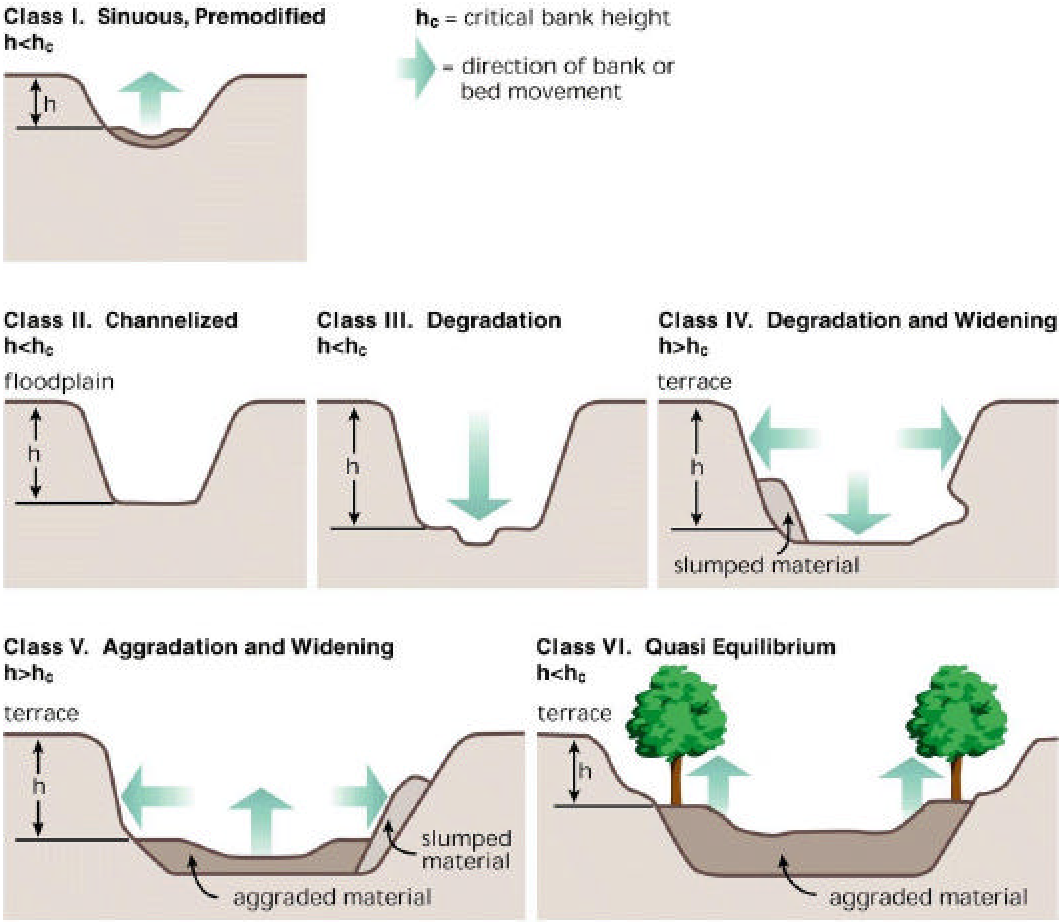
Given enough time and space, the hydraulic geometry of the creek will attempt to rebuild a stable compound cross section within a larger riparian corridor. The increased sediment supply will become aggradational as it rebuilds a nested active channel in the recovery phase. This will include both a rebuilding of the bankfull or active channel width and a rebuilding of the channel bed after stages of previous incision. The second important modelling variable assumes that the rebuilding process of the bankfull boundaries and riparian corridor will be done with finer sediment, (i.e. shale and limestone weathered into fine aggregate and parent mineral material, or catchment related sediment from urban runoff). Harder shale fragments and limestone gravel, cobble, and boulder bedload material will form a measured amount of new subpavement and bed armouring. This will be seen in imbricated bed form riffles, point bars, and in spots as a veneer over bedrock. Therefore, modelling assumes two elements in this regard. Firstly, that future in-channel substrate gradation is based on the denser material fraction of parent geology and not the dominance of soft shale as currently observed. This in turn dictates the methods for threshold tractive force and threshold velocity analysis for future stability. The added component of this assumption is that there will be an upward shift in the size of D_{50} and D_{84} material, as a lateral gradation to finer material occurs for bank and riparian rebuilding but coarser material remains in and on the channel bed. The D_{100} will remain the same because it defines the maximum size available from parent geology whether past, present, or future.

The next modelling assumption is based on channel profile. Even though the channel will attempt to lower its slope through meandering and headcutting, changes will be offset by the gradual implementation of new erosion control projects, and maintenance of past projects, that attempt to fix in place the plan form of the channel. Likewise, the creek flows through a series of fixed invert controls at hardened road bridge crossings, that also limit plan form adjustments. Notwithstanding these observations, the noted recovery of the channel through sediment transport and aggradation will attempt to rebuild the channel bed to equilibrium conditions. As a result, modelling assumes similar or slightly deeper maximum depth and similar profile conditions as existing.

Next, even though future active channel flows will likely increase, channel low flows will likely remain similar to existing. Low flow yield is dictated by baseflow contribution spread out over the existing sewershed draining to the creek, in lieu of extensive natural recharge and discharge function. As a result, the relative low flow geometry, as presently observed within the banks of the active channel, will be maintained as a surrogate for future conditions modelling.

Figure 5.1 is a schematic representation from Simon 1989, in F.I.S.R.W.G. 1998, of the channel evolution process described in the foregoing, as it might apply to a typical Cooksville Creek cross section.

Figure 5.1: Channel Evolution Model



In summary, the following key input variable assumptions have been used in the ultimate conditions setback modelling.

- 10% increase in active channel flows
- stability thresholds are based on hard shale and limestone fractions
- an upward shift in D_{50} and D_{84} substrate sizes will occur
- channel slope will be similar to existing conditions
- channel capacity maximum depth will be similar or slightly greater than existing conditions
- low flow geometry will be similar to existing conditions

Given the channel evolution scenario and modelling assumptions discussed in the foregoing, the modelling exercise proceeded as follows. Five critical locations were chosen to coincide with potential development sites, and as being representative of larger sub-reaches of the system. Existing conditions cross-sections, modified Wolman pebble counts, and channel profiles were field surveyed at a representative riffle for each location. Despite the general bedrock control conditions, riffle bed forms were observable at each site and thus selected as appropriate for analysis. Field data was input into the GEO-X model to calibrate effective channel flow rates, as determined in the previous Rehabilitation Study, against stage level. In turn, related hydraulic geometry data was generated and erosion diagnostics and stability conditions were determined for existing conditions. The results of this step showed that all inventoried locations are significantly unstable under existing conditions of effective or bankfull flow. The net result of frequent flow events will thus be a variable amount of bank and bed erosion as the channel continues to erode and adjust.

Modelling proceeded with iterative adjustments to both cross section geometry and substrate gradation, based on the input criteria discussed in the foregoing, to determine equilibrium stability for ultimate conditions. Adjustments were calibrated to equate to the respective 10% increase in active channel flow rates for each cross section. Substrate gradation was shifted down one ordinal to increase size for the D_{15}-D_{50} range, while the new D_{84} was adjusted to be the mean of the D_{50} and D_{100}. Channel capacity maximum depth was modestly increased and slope was maintained, and low flow geometry was mimicked under future conditions. A clear pattern of hydraulic geometry adjustment occurred as the exercise proceeded. Existing top of bank or channel capacity boundaries were progressively widened while riparian grade was lowered to cause an increase in the top width and wetted perimeter of the active channel. This in turn would lower the hydraulic radius and mean depth, which would then progressively reduce shear and velocity thresholds. The shape of the ultimate cross section therefore resulted in a connection of active flows to a nested riparian floodplain corridor, necessary for energy dissipation.

The detailed results of the modelling exercise, for both existing and ultimate conditions, are found in Appendix G. Table 5.3 presents a comprehensive summary of the results with final corridor width highlighted.

TABLE 5.3
TECHNICAL CORRIDOR, MODELING RESULTS SUMMARY (METRIC)

	Upstream of Lakeshore		**Upstream of QEW**		**Downstream of King St.**		**Upstream of Burnhamthorpe**		**Downstream of Matheson**	
	Existing	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**
flow (m^3/s)	28.3	32.0	26.1	29.0	26.1	29.0	19.2	22.0	12.3	14.0
area (m^2)	13.76	29.76	8.48	19.22	12.61	19.10	7.93	12.00	7.27	7.96
hydraulic radius (m)	0.72	0.37	0.59	0.37	0.67	0.53	0.66	0.59	0.62	0.66
mean depth (m)	0.73	0.37	0.61	0.37	0.69	0.54	0.72	0.59	0.64	0.68
velocity (m/s)	2.09	1.08	3.12	1.58	2.08	1.54	2.44	1.91	1.70	1.78
shear stress (kg/m^2)	7.48	3.80	25.38	15.65	9.90	7.90	15.87	14.18	3.29	3.49
stream power (watts m)	153.0	40.2	776.6	242.7	201.6	119.5	379.6	265.9	54.8	60.8
bankfull top width (m)	18.87	81.19	13.87	52.34	18.33	35.61	10.99	20.21	11.30	11.66
corridor top width (m)	24.0	85.9	15.4	58.7	23.0	39.2	12.3	29.3	15.4	15.4

TABLE 5.3(a)
TECHNICAL CORRIDOR, MODELING RESULTS SUMMARY (IMPERIAL)

	Upstream of Lakeshore		Upstream of QEW		Downstream of King St.		Upstream of Burnhamthorpe		Downstream of Matheson	
	Existing	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**
flow (ft^3/s)	999	1130	922	1024	922	1024	678	777	434	494
area (ft^2)	148.10	320.32	91.27	206.87	135.73	205.58	85.35	129.16	78.25	85.67
hydraulic radius (ft)	2.36	1.21	1.94	1.21	2.20	1.74	2.17	1.94	2.03	2.17
mean depth (ft)	2.39	1.21	2.00	1.21	2.26	1.77	2.36	1.94	2.10	2.23
velocity (ft/s)	6.86	3.54	10.24	5.18	6.82	5.05	8.01	6.27	5.58	5.84
shear stress (lb/in^2)	1.53	0.78	5.19	3.20	2.02	1.62	3.25	2.90	0.67	0.71
stream power (hp.ft)	0.67	0.18	3.41	1.07	0.89	0.53	1.67	1.17	0.24	0.27
bankfull top width (ft)	61.91	266.37	45.50	171.72	60.14	116.83	36.06	66.30	37.08	38.25
corridor top width (ft)	78.74	284.82	50.52	192.58	75.46	128.61	40.35	96.13	50.52	50.52

Modelling results show the relative decreases in mean depth and hydraulic radius. These in turn drive channel velocities, shear stress, and stream power down to threshold levels, as matched to relative substrate gradations for each sub-reach. Active channel top widths are clearly increased and the resultant overall channel capacity top widths also increase. The net result of modelling is a channel capacity or corridor top width measurement that defines the technical approach to determining corridor size for floodplain planning purposes. A qualitative comparison can be made in the upstream to downstream trend between the technical corridor results and the previously discussed watershed erosion characterization. The smaller to larger corridor widths generally match the lower to higher, upstream to downstream, regression relationship in channel velocity, shear stress, and stream power. Notwithstanding this comparison, it should be recognized that the modelling for only five specific locations does not show a sufficiently clear pattern in erosion diagnostics, however, does agree with the scatter observed in the previous trend analysis using approximately 300 data points.

It is apparent that a similar approach would provide great benefit to the design phase of future erosion control projects due to the integration between hydraulic geometry, erosion diagnostics, and stability thresholds. Likewise, analysis of existing channel size and erosion control works could also be undertaken using the same techniques. A watershed wide analysis and design program could be instituted using this consistent modelling approach.

5.6 Maintenance and Policy Corridor Approach

The maintenance corridor approach attempts to blend technical issues with the realities of future capital spending and easement requirements, and the primary intent of existing guidelines and policy. Even though modeling has suggested relatively large corridor widths are needed for natural channel evolution, it is known that the City of Mississauga will continue to implement capital projects based on the established concepts of the previous Rehabilitation Study. In this regard the focus of these projects is to deal with ongoing channel bank erosion and sediment load maintenance issues, from the City's perspective. Cumulative projects over many years of implementation will have cause and effect changes to the creek system. Net results will not be easy to predict. Nonetheless, the clear fact that projects and maintenance will continue to occur does mean that the creek system will be constantly managed within a somewhat measurable corridor. Of specific importance within this corridor will be the City's establishment of both construction easements in the short term and maintenance easements in the long term.

A review of CVC Watercourse and Valley Land Protection Policies (1992) criteria and the MNR Technical Guide, River and Stream Systems: Erosion Hazard Limit (2003) document reveals that "evidence of active erosion" for "soft rock" systems has a recommended horizontal toe erosion allowance of 5 m (16.4 ft). Conversely, the overall maximum criteria setback for toe erosion is considered to be 15 m (49.2 ft) for cohesionless soils. Based on discussion provided above, the 100 year erosion allowance using the average annual recession rate, for all measurable sites on Cooksville Creek, would be 22 m (72.2 ft). This value clearly exceeds both CVC and Provincial criteria for soft rock systems. Additional slope stability setbacks are also required where the toe erosion allowance reaches the valley wall, or when channel bank heights reach and exceed 2 m (6.6 ft). Recognizing the disparity between criteria and the reality of erosion dynamics on the creek, the CVC has implemented erosion allowances based on the criteria for cohesionless soils. The process of progressive weathering of the dominant shale material is best reflected as active erosion of cohesionless soils. As a result, a shift in policy interpretation from soft rock to cohesionless soils is considered appropriate for the geology and dynamics of the system. Additionally, the stable slope allowance should also be considered for revision from 1.4:1 for bedrock, to a conservative 3:1 reflection of highly weathered cohesionless shale. This results in a recommended shift from a 5 m (26.4 ft) erosion allowance to a 15 m (49.2 ft) erosion allowance, and a minimum 6 m stable slope allowance for 2 m (6.6 ft) high banks. The 15 m (49.2 ft) erosion allowance thus respects some consideration of measured recession rates as noted above, and will also be considered and incorporated into the maintenance corridor discussion provided below.

The technical requirements for easement creation and sizing are iterative. There is no fixed set of guidelines that the City applies to determine minimum or maximum easement widths. The process depends on landowner cooperation and negotiation, connectivity upstream and downstream, point of access issues, grades and slopes, vegetation, construction equipment sizing, and the geometry of both the existing creek channel and the designed channel for new projects. Notwithstanding these points, there is one applicable guideline from the MNR and one policy component from the CVC which both speak to maintenance corridors. The MNR Technical Guide, River and Stream Systems: Erosion Hazard Limit (2003) document suggests a minimum "erosion access allowance" of 6 m (19.7 ft) to provide a safety zone for people and vehicles to enter and exit during possible emergency situations. This allowance is in addition to the "toe erosion allowance" determination, as discussed above. Coincidentally, this allowance also equals the recommended 6 m (19.7 ft) minimum allowance for slope stability of a 2 m (6.6 ft) high bank. The CVC's Watercourse and Valley Land Protection Policies (1992) similarly speak to a 5 m (16.4 ft) "Development Setback Component". Depending on the nature of certain development types this setback is also added to the erosion and slope stability allowances. It is arguable that either of these figures may be too low for certain types of construction equipment access and activity, so additional setback distance may still be required. To partly address this, the greater of the two [i.e. the Provincial guideline of 6 m (19.7 ft)] should be used as a minimum. To more completely address this, additional criteria is required. An appropriate approach is to incorporate the recommended erosion allowance criteria of 15 m (49.2 ft), discussed above, as the additional minimum setback for channel maintenance. Doing this would recognize a combination of factors. Firstly, existing policy already has existing erosion standards written in. Secondly, 15 m (49.2 ft) is deemed adequate for both ingress and egress of construction equipment. Thirdly, given that development may be allowed to occur beyond the toe erosion allowance it is unlikely that the City would allow the entire allowance to be eroded away before they take intervening action with construction or maintenance of capital works. This is especially true if in fact the erosion allowance is a component of dedicated public lands from new development, or conversely a dedicated easement within existing development. To complete the maintenance corridor approach the Provincial 6 m (19.7 ft) erosion access allowance should be added to the 15 m (49.2 ft) as a simple factor of safety, and as an access buffer should major erosion accelerate the retreat of one side of a channel and create an emergency access issue. The maintenance corridor approach thus results in a combination of 15 m (49.2 ft) and 6 m (19.7 ft) to equal a total setback of 21 m (68.9 ft). Coincidentally, this figure is essentially the same as the system wide long term average annual recession rate times 100 years, equal to 22 m (72.2 ft). A good level of agreement in this regard adds support to the recommended setback. The resultant setback thus defines the potential City easement on either side of the creek, and two times the setback is added to the active channel width at any given location to create a total maintenance and policy corridor width.

5.7 Implementation

Based on the discussion highlighted in the foregoing, it becomes clear that a synthesis of many factors is needed to establish appropriate sub-reach setback corridors to address channel erosion along Cooksville Creek. Analysis has resulted in two primary approaches to define a comprehensive corridor. The first approach is a modeling based allowance for natural erosion. The second approach is a maintenance corridor allowance based on a combination of policy criteria and future construction, maintenance, and easement requirements. In turn, these allowances are determined on a sub-reach basis to reflect variability in the system. As a result, a simple comparative analysis of the two primary approaches can show which is more conservative and thus, based on constraint planning principles, will be deemed to govern for the respective sub-reach. Figure 5.2 presents an example comparison of the two primary corridor options as applied to the reach upstream of the QEW Highway.

Figure 5.2: Corridor Analysis Comparisons for the Reach Upstream of the QEW

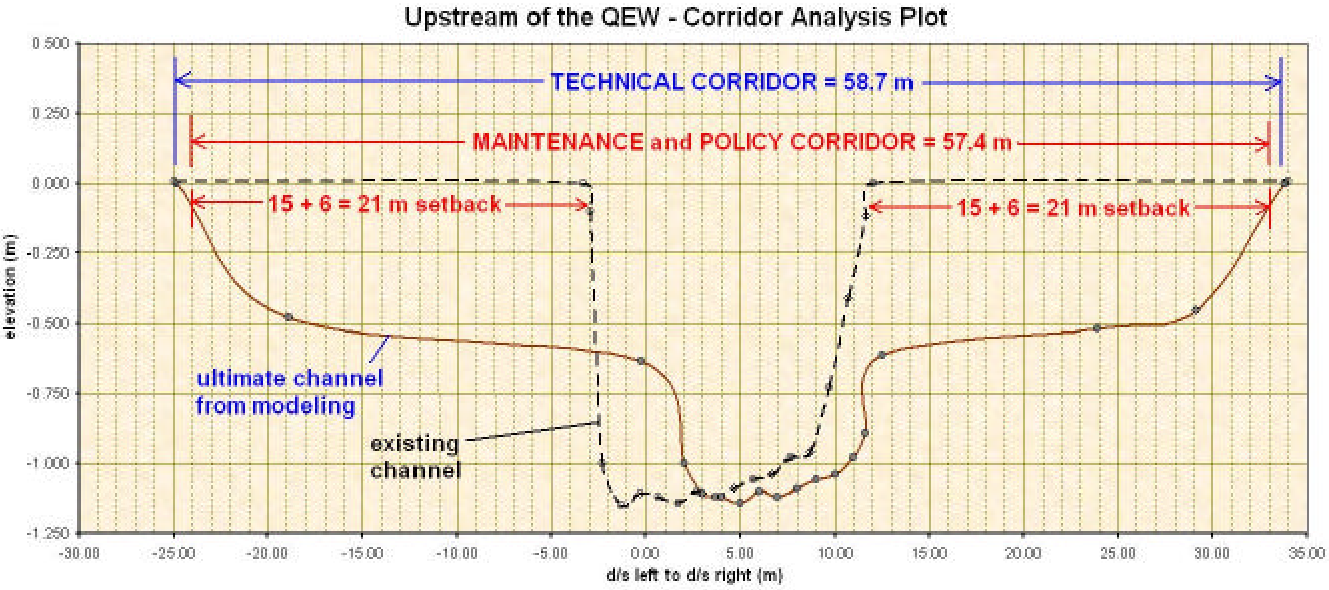


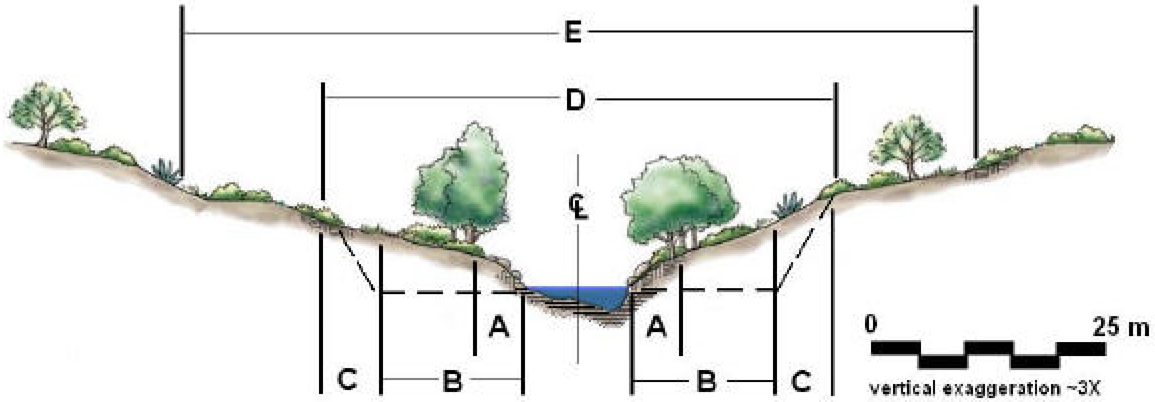
Table 5.4 provides a summary of the two primary corridor approaches and the determination of the final corridor results for each sub-reach.

TABLE 5.4
SUMMARY OF CORRIDOR ANALYSIS AND FINAL CORRIDOR RESULTS

			Sub-Reach Sites				
			u/s of Lakeshore Rd.	u/s of the QEW	d/s of King St.	u/s of Burnhamthorpe Rd.	d/s of Matheson Blvd.
OPTION 1: TECHNICAL CORRIDOR	EXISTING	existing bankfull top width (m)/ft in brackets	18.9 (61.99)	13.9 (45.59)	18.3 (60.02)	11.0 (36.08)	11.3 (37.06)
		existing top of channel corridor width (m)/ft in brackets	24.0 (78.72)	15.4 (50.51)	23.0 (75.44)	12.3 (40.34)	15.4 (50.51)
	ULTIMATE	ultimate bankfull top width (m)/ft in brackets	81.2 (266.34)	52.3 (171.54)	35.6 (116.77)	20.1 (65.93)	11.7 (38.38)
		ultimate top of channel corridor width for Option 1 (m)/ft in brackets	85.9 (281.75)	58.7 (192.54)	39.2 (128.58)	29.3 (96.10)	15.4 (50.51)
OPTION 2: MAINTENANCE AND POLICY CORRIDOR		existing top of channel capacity width (m)/ft in brackets	24.0 (78.72)	15.4 (50.51)	23.0 (75.44)	12.3 (40.34)	15.4 (50.51)
		left bank setback (m)/ft in brackets	+ 21 (68.88)	+ 21 (68.88)	+ 21 (68.88)	+ 21 (68.88)	+ 21 (68.88)
		right bank setback (m)/ft in brackets	+ 21 (68.88)	+ 21 (68.88)	+ 21 (68.88)	+ 21 (68.88)	+ 21 (68.88)
			Equals				
		ultimate top of channel corridor width for Option 2 (m)/ft in brackets	66 (216.48)	57.4 (188.27)	65 (213.20)	54.3 (178.10)	57.4 (188.27)
FINAL CORRIDOR (m)/ft in brackets = > of OPTION 1 or OPTION 2			85.9 (281.75)	58.7 (192.54)	65 (213.20)	54.3 (178.10)	57.4 (188.27)

Figure 5.3 shows a scaled comparison between the existing CVC and MNR Policy setbacks, and the proposed minimum and maximum corridor limits presented in Table 5.4.

Figure 5.3: Comparison of Policy Setbacks and Proposed Corridor Limits



A - CVC erosion allowance for shale = 5 m
B - CVC erosion allowance for cohesionless soil = 15 m
C - MNR erosion access allowance = 6 m
(note: would also reflect CVC stable slope at 3:1 for 2 m bank, as shown by dashed line)
D - proposed Cooksvile Creek corridor minimum = 54.3 m
E - proposed Cooksville Creek corridor maximum = 85.9 m

Any setback consideration for new development that falls below the recommended corridor size limits in this study could have several financial implications. Encroachment within an area identified to have ongoing erosion issues will presumably require capital spending for eventual erosion protection. This will be especially true if erosion activity also falls within dedicated public lands. The City of Mississauga will be obligated to intervene, potentially ahead of the time horizons for recommended works from the Cooksville Creek Rehabilitation Study. The nature of this erosion protection may or may not agree with the recommendations of the Rehabilitation Study. Given the nature of the new land use and the amount of encroachment, there may be a need to revise the scope of the works. If erosion is allowed to advance on to private lands, financial implications would be compounded through direct economic loss of land value and potentially due to impact on structures. There would also be a resultant decrease in the cost to benefit ratio for eventual protection works. Lands under private ownership would also be devalued in terms of market value assessment and municipal tax revenue. There would of course also be a socioeconomic loss in terms of reduced public recreational use due to the adverse loss of dedicated lands.

Given the above considerations, it is recommended that the agencies strive to proactively protect the recommended corridor limits. If these corridors are protected, and the recommendations of the Cooksville Creek Rehabilitation Study continue to be implemented, a reasonable overall management program, from a geomorphic perspective, will be provided. In turn, private development will be protected in the long term with limited additional financial risk to the City of Mississauga.

Based on the determination of the Final Corridor limits, erosion based constraint lines have been established for floodplain planning. These limits for the purpose of this assessment have been centred on the existing alignment of the watercourse, to reflect the current and future plan form, which will be relatively fixed in place due to land use constraints, capital works, and City easements. Given the analysis and results presented here, due consideration within existing CVC policy and City of Mississauga implementation of land use planning and capital works, is also recommended. Hazard land setbacks and land use designations will need to be revisited within current practices. The corridor limits identified in Table 5.4 are not currently reflected through delivery of CVC policy, nor do they have status in City of Mississauga planning documents; CVC and the City of Mississauga will have to review the foregoing in the context of current implementation procedures.

6. HYDRAULIC MODELLING

6.1 Background

The Cooksville Creek has been extensively modelled under previous study; the HEC-2 model produced for the FRS has formed the platform for all hydraulic analysis in this study, including the assessment of structural, development and policy alternatives to reflect the development constraints and opportunities for the potential development sites in Cooksville Creek. Each of the foregoing has also been assessed on the basis of various flow conditions.

Municipal Data Collection has defined the potential development locations or sites (ref. Dwg. 1).

The existing hydraulic model (HEC-2) has been updated in order to allow for the detailed assessment of each management approach for each site, individually and in combination. This has involved adding cross-sections in strategic locations, as well as introducing various hydraulic improvements as considered by the FRS.

6.2 Hydraulic model Updates and Issues

The existing hydraulic model (HEC-2) has been updated to reflect current topographic mapping compiled since the model was originally created. Modifications have been made using RiverCAD^{TM} technology; this process is described in more detail in Section 6.3.

Due to these modifications, (mostly to overbank geometry), the computed flood elevations for existing conditions using RiverCAD^{TM} differ somewhat from those generated by the FRS Cooksville Creek HEC-2 model. It should be stressed that the SPA study objectives are not to re-map the floodplain, but rather to assess flood impacts of alternative management approaches on potentially developable lands. Future applicants in these areas will need to conduct detailed floodplain mapping as set out herein (ref. Appendix I for detailed floodplain mapping standards).

A list of all cross-section locations and computed flood elevations, is reported in Appendix F. Program input data for existing conditions are attached as Appendix E and digital copies of input and output data for all conditions and options have been separately submitted on CD-ROM.

6.2.1 Spill Analysis

There are several locations within the Cooksville Creek corridor where spills would occur during the Regional flood. The RiverCAD^{TM} computer model has the capability to consider lost discharge at spill zones using several methods of describing the spill mechanics to the model. For Cooksville Creek spill analysis, the Diversion Rating Curve method has been used to define the relationship between the computed flood elevation and the amount of spill discharge at a specific water surface elevation at the spill location. The Diversion Rating Curve is developed by inspecting the local topography of the spill area, and identifying a suitably oriented cross section that is the effective control section for conveying lost discharge out of the spill zone. A table of discharge rates and corresponding water surface elevations is then computed for this control section, and this table is used by the model to determine the amount of flow leaving the main channel.

The lost flow may be returned to the system at a downstream location, or may be assumed to be lost from the watershed. In the case of Cooksville Creek, it has been assumed that the lost discharge is returned to the watershed downstream of the spill location consistent with the approach used in the FRS.

This method of spill analysis differs from that used for the Flood Remediation Study, which integrates the spill zone into the associated cross-section by orienting one extreme of the cross-section at an angle to the rest of the cross-section, in effect treating this end section as the spill zone. The current method of spill analysis is an accepted method within the framework of the HEC-2/RiverCAD hydraulic models used in this study.

6.3 RiverCAD TM Integration

Due to the extensive need to examine numerous floodplain management options, as well as the requirement to present this information to the public spatially, the Consultant Team has adopted the use of a technology (RiverCAD TM) which automatically delineates floodplains through a graphical interface between the HEC-2 (hydraulic model) and AutoCAD TM (graphics, digital terrain model). In addition, since floodplain management relates to risk, and risk is a function of both the depth and velocity of flood waters, the RiverCAD TM technology can provide a graphical image defining various gradations of flooding risk (i.e. depth and velocity).

The following procedure generally outlines how this interface has been developed and incorporated for use in this study. The three dimensional contour mapping and planimetric plans have been supplied by the City of Mississauga in MicroStation TM format (dated 2000 and 2001). These have been converted to AutoCAD TM 2002. The existing flood risk mapping for Cooksville Creek has been provided in a .tif format also supplied by the City of Mississauga, in order to co-ordinate and orient the placement of hydraulic cross-sections. This information has been used to “trace” the sections onto the current three-dimensional mapping which is ultimately used as the base map for RiverCAD TM. The existing HEC-2 model produced by EWRG as part of the FRS has subsequently been imported into RiverCAD TM and checked for errors. The mapping was then imported into RiverCAD TM and the cross-sections were “linked” to the mapping, in order to replicate the orientation within the HEC-2 modelling and current floodline mapping, as close as possible.

Once the HEC-2 model and mapping were linked, each cross-section could be viewed graphically in grid form and any necessary revisions to the sections would automatically update the hydraulic model on-line; these could include: buildings, revetments, etc. All original ground sections reflect the current digital terrain model (i.e. three-dimensional mapping) from the City. All hydraulic bridge structures were defined on the basis of the current HEC-2 model from the FRS. The FRS HEC-2 model was also used to extract channel configurations for each cross-section (i.e. below water line information). These channel points were merged through RiverCAD TM and inserted into each of the newly created cross-sections. Flow lengths between sections were generally not consistent between the FRS HEC-2 model and that which was depicted on the current floodline mapping hence flow lengths were revised using the base map and the RiverCAD TM technology.

7. FEASIBILITY ASSESSMENT OF STRUCTURAL ALTERNATIVES

7.1 FRS Structural Alternatives

In order to understand the floodplain management opportunities for the properties under consideration for development, as part of this study, the FRS has been reviewed in detail to identify what flood control/management measures have been recommended which could potentially influence structural and policy opportunities on the subject lands.

The following works have been completed to-date and have been incorporated into the HEC-2 used for the FRS and this study:

Historical Flood Control/Management Works

- Atwater Avenue – the City added a new culvert cell, lowered the existing channel, and completed 350 m of channel improvement works implemented in 1978 to 1982;
- Downstream of CPR – the City raised and extended an existing flood protection berm in 1990;
- Paisley Boulevard – the CVC widened and deepened existing culvert cell, and completed over 380 m of channel improvements works; implementation date unknown;
- Atwater Avenue to QEW – the CVC completed channel improvement works, and flood proofed several residential buildings in 1985;
- Camilla Road – the CVC flood proofed several residential buildings in 1982;
- Lakeshore Road East – the City increased the culvert capacity by adding a new cell, and completing upstream/downstream channel improvements works; implementation date unknown;
- Camilla Road – the City added a new culvert cell, and completed channel improvements works in 1982 to 1984;
- Dundas Street – the City added a new culvert cell, and the CVC completed downstream channel improvements works in 1986;
- King Street – the City added a new culvert cell works in 1989 (Kirwin Street);
- CPR – the City deepened the existing culvert works in 1988;
- CNR – the City deepened existing culvert works in 1990.

Flood Remediation Assessment

The flood remediation measures which were ultimately recommended by the FRS were selected based on functionality and property requirements; that is, only options that could be constructed on Municipally-controlled lands or easements were recommended. The approved design flow rates used in the FRS and this study are provided in Table 7.1. These flows have not been updated as part of this study; previous study has assumed future land use conditions without stormwater management.

TABLE 7.1
DESIGN PEAK FLOW RATES [1.]

Location	**Drainage Area (km^2)**		**Regional**		**100 Year**		**50 Year**		**25 Year**		**10 Year**		**5 Year**		**2 Year**	
	km^2	mi^2	m^3/s	ft^3/s	m^3/s	ft^3/s	m^3/s	ft^3/s	m^3/s	ft^3/s	m^3/s	ft^3/s	m^3/s	ft^3/s	m^3/s	ft^3/s
Lake Ontario	33.9	13.1	320	11300	210	7416	190	6710	160	5650	135	4767	120	4238	100	3531
Confluence – Cawthra Creek																
CNR	28.8	11.1	295	10417	210	7416	190	6710	165	5827	135	4767	120	4238	100	3531
QEW	27.5	10.6	295	10417	210	7416	190	6710	165	5827	135	4767	120	4238	100	3531
Queensway East	26.2	10.1	285	10064	210	7416	190	6710	165	5827	135	4767	120	4238	100	3531
Dundas Street East	25.0	9.7	280	9888	210	7416	190	6710	165	5827	135	4767	120	4238	100	3531
CPR	23.5	9.1	270	9535	210	7416	190	6710	165	5827	135	4767	120	4238	100	3531
Central Parkway East	20.6	8.0	240	8475	195	6886	175	6180	155	5474	125	4414	110	3884	90	3178
Mississauga Valley Boulevard	18.7	7.2	220	7769	180	6356	160	5650	140	4944	115	4061	100	3531	80	2825
Confluence – East Branch																
Hurontario Street	12.1	4.7	145	5120	115	4061	105	3708	90	3178	70	2472	65	2295	55	1942
Highway 403	11.9	4.6	140	4944	115	4061	105	3708	90	3178	70	2472	65	2295	55	1942
Eglinton Avenue West	8.8	3.4	110	3884	95	3355	85	3002	70	2472	6	212	50	1766	45	1589
Bristol Road West	7.6	2.9	100	3531	95	3355	85	3002	70	2472	60	2119	50	1766	45	1589
Matheson Boulevard West	6.1	2.4	80	2825	80	2825	75	2649	65	2295	55	1942	45	1589	40	1413
Cawthra Creek	4.7	1.8	55	1942	45	1589	40	1413	35	1236	30	1059	25	883	20	706
East Branch																
Mississauga Valley Boulevard	6.1	2.4	80	2825	80	2825	70	2472	60	2119	50	1766	45	1589	35	1236
Highway 403	3.8	1.5	50	1766	60	2119	50	1766	45	1589	35	1236	30	1059	25	883
Eglinton Avenue East	2.4	0.9	35	1236	40	1413	40	1413	35	1236	30	1059	25	883	20	706

Note: Design peak flow rates have been rounded

[1.] Reproduced from FRS, May 2002

The following general categories of flood remediation solutions were considered as part of the FRS:

- ***Do Nothing***

Used as a baseline condition

- ***Diversions***

These were deemed infeasible, as there are no feasible overland locations to divert sufficient floodwaters.

- ***Reservoirs (Flood Storage)***

Reservoirs were also deemed infeasible, as there were no locations identified which were considered to have sufficient available area to construct facilities of the required sizes.

- ***Flood Proofing***

Building flood proofing would reduce the flood damage to subject buildings, however, would not increase the level of protection or remove any buildings from within the floodplain. Some existing buildings have been flood proofed to varying levels of protection.

Recommended Flood Remediation Plan

The FRS recommends that the City continue to implement the current one-zone approach to floodplain management along Cooksville Creek. Furthermore, the FRS suggests the City should ensure that any redevelopment within the Cooksville Creek Watershed be accompanied by appropriate stormwater management and flood protection measures. Currently, it is estimated that only about 6% to 7% of the watershed remains undeveloped. The approved design flows from the FRS listed in Table 7.1 take this condition into account (i.e. full development – no stormwater management).

The following measures for reducing flood levels and damage were identified by the FRS to have the greatest benefit to property owners downstream of Highway 403 (ref. Table 7.2, 7.3 and 7.4 and Drawing 2).

- ***Crossing Capacity Enlargements***

Several crossings have been recommended for capacity upgrades. These are the Kirwin Avenue, CP Rail, CN Rail, QEW and Queensway crossings (ref. Table 7.2, 7.3 and 7.4). Of these, only the Kirwin Avenue culvert is owned by the City. It was recommended by the FRS that the external agencies responsible for the other crossings be encouraged to upgrade the capacity of the subject culverts to the Regulatory level. These capacity upgrades would have to be implemented in conjunction with local channel widening to ensure the hydraulic benefits are fully realized, as hydraulic/stream characteristics from the QEW to King Street East also impose constraints on the flow regime.

➢ *Watercourse Capacity Enlargements*

Channel widening has been recommended by the FRS for various sections of creek between Kirwin Avenue and Central Parkway East. When constructed in conjunction with installation of dykes/berms, these works could raise the level of protection to the 25 to 50 year level. Constructing these works may affect the Cooksville Creek recreational trail, hence ultimate mitigation design will need to account for this impact.

➢ *Dykes & Berms*

The FRS suggested that these measures could be used in certain sections of Cooksville Creek to contain the floodwaters within the channel. Locations identified for dyking are shown in Table 7.2 and Drawing 2. (Note: EAD = Estimated Annual Damages)

TABLE 7.2
RECOMMENDED REMEDIAL MEASURES ON CITY PROPERTY OR EASEMENTS

	Location	Task	Cost	Existing Level of Protection Years	Proposed Level of Protection Years	Benefits		
						No. of Buildings Removed from FP	Private Land Removed from FP	Reduced EAD $
C.1	Kirwin Avenue to CP Railway	Dyking	$0.2 M	25 yr	50 yr	0	0	$45.0 K
C.2	CP Railway to Mississauga Valley Boulevard South	Channelization	$0.7 M	25 yr	25 yr	0	0	0
C.3	Downstream Central Parkway	Dyking	$0.1M	25 yr	Regulatory	0	0.2 ha	$3.9 K
C.4	Kirwin Avenue	Enlarge Crossing Capacity	$0.7 M	25 yr	25 yr	3	0	$1.0 K

TABLE 7.3
RECOMMENDED EXTERNAL AGENCY REMEDIAL MEASURES

	Location	Task	Cost	Existing Level of Protection Years	Benefits			
					Proposed Level of protection Years	No. of Buildings Removed from FP	Private Land Removed from FP	Reduced EAD $
EA. 1	CN Railway	Enlarge Crossing Capacity	$0.3 M	10 yr	50 yr	43	4.0 ha	$24.0 K
EA. 2	CP Railway	Enlarge Crossing Capacity	$0.6 M	25 yr	25 yr	0	0	0
EA. 3	QEW	Enlarge Crossing Capacity	$1.2 M	10 yr	25 yr	2	1.0 ha	$0.2K
EA. 4	Queensway	Enlarge Crossing Capacity	$0.6 M	100 yr	100 yr	0	0	0

TABLE 7.4
PROPOSED IMPROVEMENTS

Crossing	ProposedSpan		Channel Reach	Proposed Channel Improvement
	(m)	(ft)		
Proposed Culvert Upgrades				
CNR	20	65.6		
CPR	30	98.4		
QEW	20	65.6		
Kirwin	25	82		
PROPOSED CHANNEL IMPROVEMENTS				
			Kirwin-CPR	Channel Dyking
			CPR-Miss Vall Blvd	Channel Widening
			Miss Vall Blvd-Central Parkway	Dyking

The Flood Remediation Plan Study investigated, but did not recommend any storage facilities, due to the impact on land (i.e. property and existing land uses). Specifically though, a facility located north of Bristol Road (site of an existing water quantity pond) was examined for full control, however, it was screened out as infeasible due to excessive land requirements.

7.2 Supplemental Flood Storage Assessment

For this study, major flood storage opportunities have been examined in greater detail, given that the objectives of this study relate to the potential development areas and a reduction in peak flows that would offer a net benefit on the developable area and potentially development properties may be cost effective. The peak flow reduction, that may result from the implementation of online storage, has been assessed using combinations of various storage zones. Initially, online storage was modelled at points along the entire length of Cooksville Creek. The results indicated online storage to be of marginal benefit downstream of the East and Main Branch confluence at Mississauga Valley Boulevard, which also coincides with the majority of current flood damage potential, hence subsequent modelling focussed on storage upstream of this area. Of the remaining storage locations upstream of the confluence, Eglinton Avenue is currently a potential development site, and the Highway 403 site would have to be located on MTO property. Hence, the remaining storage locations for detailed assessment included Bristol Road and Mississauga Valley Boulevard. The City of Mississauga's Master Water Quality Study also identified the possibility of having a flood control and water quality control facility at this location. Table 7.5 documents the effects of various storage options. As previously noted for this screening assessment, channel routing has conservatively not been discounted from the hydrologic assessment of on-line reservoirs, pending the results of the assessment.

Insert Table 7.5

Insert Table 7.5

The analysis of the various combinations of flood storage has indicated that the implementation of the Bristol Road site stand-alone, would result in a moderate reduction in downstream 100 year future land use flow rates (i.e. 10% to 30% +/- depending on location). Additional combinations using other sites has not resulted in a significant benefit, beyond that reported for the Bristol Road site on its own.

An optimization assessment of the Bristol Road site indicates varying levels of flow attenuation. For the purpose of this preliminary screening, the alternative which results in 125,000 m^3 (4.4 million cubic feet) of storage has been functionally laid out on the topography of the Bristol Road area for the purpose of identifying land requirements and approximate costs (ref. Appendix D, 10 ha, (24.7 acres). As shown, the stormwater management site would not intrude into the woodlot area, and it would function as an off-line system with in-stream flow splitter. This site may offer some opportunities for water quality control, as part of the City-wide strategy for same. This aspect has not been detailed nor costed at this time.

While it is recognized that a stormwater management facility at Bristol Road would not address the Regulatory flooding levels under a one-zone policy, depending on floodplain configuration and land use, there may be a benefit to potentially developable lands for application of a two-zone or SPA approach. The hydraulic impacts are discussed further in Section 7.4 and the accompanying figures.

Online storage at Bristol Rd. has the potential to control flows from the entire watershed upstream of this point. From an erosion potential perspective, frequent flows based on sub 2 year event criteria are the current standard. Typical bankfull flows have been described as occurring up to 12 times a year in Southern Ontario urban systems (Annable 1996). This would represent runoff from precipitation events in the 10 - 20 mm (.4 - .8 inches) range (Canadian Climate Normals – Toronto LBPIA 1971-2000). There is also ongoing debate that for entrenched and confined urban creeks, which are disconnected from a natural floodplain peak flow from a low frequency event may in fact cause single event catastrophic erosion, greater than long term processes.

Consideration of online storage for erosion control, at the Bristol Rd. location, would have to consider the entire spectrum of potential flows in the Cooksville Creek system. The preferred method of detailed erosion control evaluation is by development of erosion indices in the receiver and calculation of threshold exceedance values from continuous modelling of runoff response and storage-discharge relationships. Given that the receiving reach is channelized for roughly 2 km (1.25 miles) to Highway 403 downstream of the potential facility location, there are also questions of how far removed design targets would be based. This question is then compounded by the cumulative addition of subcatchment flows, both from local sewers and potentially overland. This increase in downstream flow will have a *cause and effect* influence on controlled flows from upstream. Hydrograph timing and specific discharge targets for specific reaches would need to be clearly analyzed. Concurrently, the role of future stormwater management opportunities at the infill scale level would need to be woven into the analysis.

Given the complexity of this type of analysis for a major system level facility at Bristol Road, there is an underlying assumption that storage volumes would need to be too large to feasibly control erosion potential for more than the channel immediately downstream, which is nonetheless already channelized. Also, the land owners of this property may not accept the imposition of a stormwater management facility in this location. The cumulative addition of flows from major impervious subcatchments such as Highway 403 and the City Centre may drown out any benefit of controlled flow further downstream. Previous investigation in the Rehabilitation Study (1997), of major system facilities at other watershed locations, produced similar conclusions. Within the scope of analyzing erosion based corridors, for this SPA study, it is reasonable to conclude that with or without a facility at Bristol Road the processes that define a corridor will still occur. Erosion based corridor widths would in all likelihood not be affected or reduced by a facility at Bristol Road.

7.3 Supplemental Culvert Improvements

The channelization and culvert widening recommended in the Flood Remediation Plan Study for the downstream reaches of Cooksville Creek do not benefit any upstream properties beyond the confluence at Mississauga Valley Boulevard North, due to the presence of numerous drop structures that serve to negate any backwater that would have extended beyond this point.

To date, no additional culvert improvements, beyond those recommended in the FRS have been considered for implementation, to alleviate flood concerns on the subject lands; particularly given the restriction of works on Public lands only.

One additional alternative considered in this current assessment has involved the concept of major tunnelling to convey excess flood flows. This concept would function on the premise of only conveying flows in excess of an environmental/functional minimum, assumed to be bankfull. Large diameter tunnelling operations have, in recent years with advanced in equipment and technology, become much more practical and cost effective, and as a result have been considered herein.

Based on preliminary design assessment, a 3.5 m (10 – 11 ft) diameter tunnel, extending from just upstream of Dundas Street to Lake Ontario, would likely cost in the range of $15 million. The tunnel and intakes would be constructed along the alignment of the existing creek. The estimated capacity of this system approximates some 70 m^3/s (2470 ft^3/s). With reference to Table 7.1, it is evident that the 70 m^3/s (2470 ft^3/s) value, in most cases, is just less than or equals the difference between the Regional and 100 year floodplain, which suggests that if implemented, the Regional floodplain would closely resemble the current 100 year. As noted in Section 7.4 and the floodplain mapping which follows, the difference between the Regional and 100 year for most of the properties under consideration does not effectively warrant the type of expenditure associated with a tunnelling operation, particularly when other more cost effective solutions are available.

7.4 Hydraulic Evaluation

In order to determine the benefit to the potentially developing properties of the aforementioned hydraulic improvements, the potential flood limits (Regional and 100 year), for the subject properties have been determined using River CAD^{TM}/HEC-2 for the following conditions:

(a) Future flows with Bristol Road facility in-place

(b) FRS recommended culvert and channel improvements in-place

The respective floodplain information has been illustrated on Figures 1 to 6. It should be noted that the potential flood limits on the subject properties depicted on these differs from the current regulatory floodplain (R. V. Anderson, 1996). The reason is basically three fold; firstly, the base map used in the delineation is different, secondly the ground sections used by HEC-2 are based on the current mapping and thirdly the base HEC-2 model is based on the FRS model which includes updates from the 1996 model. The Technical Steering Committee has approved the use of this model to allow for the analysis of site-specific management strategies for the subject lands only, not to replace existing floodline mapping.

Appendix F provides a summary of the potential flood levels for the future land use 100 year and Regional event for the conditions cited in the foregoing.

7.5 Summary

The following chart provides a summary of the potential benefits (in terms of flood relief) afforded by the respective measures on the specific properties considered for development. The results of this assessment (i.e. technical: hydraulic flooding – depths, velocities and coverage) are key in the subsequent assessment (ref. Section 8) of properties which takes into account: land use, erosion setbacks, flooding and other factors (i.e. environmental), in that structural alternatives need to be fully assessed and deemed technically or economically infeasible before other management approaches can be considered.

Insert Table 7.6

8. FLOODPLAIN AND EROSION MANAGEMENT ALTERNATIVES ASSESSMENT

Floodplain management may involve the use of both structural measures and non-structural approaches such as land use regulation. This report has presented the influence of the FRS and other structural options on flood potential of the subject lands (ref. Section 7).

Within Section 4.2 of this report, a number of properties were identified as potential development areas for further evaluation. This section of the report assesses these properties in terms of the possible alternative approaches for floodplain management.

As set out in Section 4.1, the Provincial, Regional and local policy framework requires that consideration be first given to possible structural solutions, which would result in the removal or reduction of the flood hazard. Any feasible structural alternatives must be discounted prior to proceeding to an alternate policy approach, such as a two –zone or special policy area.

Once this first step is completed and deemed infeasible, the next step is the evaluation of the development area for suitability for the implementation of a two-zone policy. This approach would allow development within the flood fringe (i.e. areas of slower moving and shallower depth flood waters) under certain criteria, but would tightly regulate any development within the floodway (i.e. deeper, quicker flood zone).

Only when the two-zone approach is discounted as a viable option, would a special policy area be considered. If the development area does not qualify for consideration of a special policy area, the lands would remain within their current policy framework of one zone.

An Official Plan amendment would be required to implement either a two-zone or special policy area designation within any development area.

This study has evaluated only those properties with current known development potential and interest. Over time, additional lands may be identified for development and/or intensification. A similar evaluation process to that described within this report will need to be completed for those lands on a site-specific basis. This evaluation should be based, in part, on the extensive technical base for Cooksville Creek contained within this report.

8.1 Detailed Evaluation of Site Specific Properties

For each of the development sites identified in this report, consideration of alternative flood and erosion management options has been undertaken. A summary of this evaluation and the associated recommendation for each potential development area is outlined in the following. It should be noted that the analysis and assessment has been based on the City's 2000 and 2001 mapping base; over the course of the study, this mapping base was updated (i.e. 2002). Future proponents should use the City's most current mapping base at the time of application.

8.1.1 Lakeshore Road/Inglis Property

Site Description

This development site is located on the north side of the intersection of Lakeshore Road and Cooksville Creek. Over the last decade, there has been interest in redeveloping the Inglis property, currently a large industrial block; however, nothing has been advanced, primarily due to lack of flood free access.

This site is currently designated as Business Employment and zoned as M1. Redevelopment of these lands could form an important catalyst for the revitalization of this area. Consideration of alternative uses on this site by the City to assist this process would be appropriate. The redevelopment of the westerly half the site to medium and higher density residential uses would be compatible with the surrounding area. The easterly half of the site could form a logical extension to the high density residential use and District Commercial center to the east.

Structural Management Opportunities

Structural options which address the issue of flood free access have been reviewed. Basically, two options exist: increasing the culvert capacity or modifying the roadway profile. The culvert upgrade would need to be a 20 m by 3.1 m (65.6 ft by 10.2 ft) opening to reduce Regulatory flooding to facilitate dry access. Alternatively, consideration to “building up” Lakeshore Road at points of ingress and egress for both the east and west block has also been advanced. If the road though, is built-up at the outer limits of the sites, it would need to be lowered within the center zone to replicate existing hydraulics. Any road reconstruction would need to consider existing road accesses to the south in the design of the new road profile. The costs and timing of the road reconstruction would be directly related to the development of these lands.

By raising the roadway 0.85 m +/- (33 inches +/-) at the most easterly and westerly limit of potential redevelopment and concurrently lowering the centre portion by 0.90 m +/- (35 inches +/-), would maintain upstream flood levels (ref. Appendix F and H). Table 8.1 provides a summary of on-site flood elevations with and without the existing buildings in-place, with and without revised Lakeshore Road profile (ref. Appendix F; also contains results for upgraded culvert).

TABLE 8.1
INGLIS PROPERTY STRUCTURAL ALTERNATIVE ASSESSMENT:
REGULATORY FLOOD LEVELS

Cross-Section Location No.	Condition					
	Existing Floodplain and Roadway		Existing Floodplain and Roadway Without Buildings		Existing Floodplain Without Buildings; Modified Roadway Profile	
	(m)	(ft)	(m)	(ft)	(m)	(ft)
0.44 (d/s Lakeshore Road)	78.59	257.77	78.59	257.77	78.59	257.77
0.464 (u/s Lakeshore Road)	80.80	265.02	80.80	265.02	80.40	263.71
0.54	80.55	264.20	80.56	264.24	80.04	262.53
0.64	80.67	264.59	80.70	264.69	80.31	263.42
0.70	81.02	265.75	81.03	265.78	81.03	265.78
0.78	81.19	266.30	81.20	266.34	81.24	266.47
0.79	81.37	266.89	81.34	266.79	81.34	266.79
0.795	81.45	267.16	81.38	266.93	81.40	266.99
0.85 (d/s CNR)	83.13	272.67	83.10	272.57	83.11	272.60

Potential Upstream and Downstream Impacts

Either of the structural alternatives would maintain upstream flood levels at or below existing conditions (ref. Table 8.1). Also since development would occur outside of the Regional floodplain; there would be no impact on downstream design flows due to potential 'lost' floodplain storage from development.

Downstream erosion potential is also not anticipated to be altered as a result of the contemplated structural alternatives. The existing culvert has a high capacity (i.e. between 50 and 100 years), hence general erosion causing flow events would be nominally affected by increasing the culvert/bridge geometry. The road profile modification alternative would not have any influence on erosion potential downstream.

Two-Zone

For a two-zone policy approach, the potential site access locations would be located within the flood fringe portion of the floodplain outside of the 100-year flood and in areas of less than 0.6 m (23 inches) flooding. The flood levels and velocities would need to be assessed for these locations to ensure adequacy of vehicular and emergency access in accordance with Provincial and CVC policy. Sufficient lands exist outside of the Regional flood limits to create a viable development on the property. There would be a very limited requirement for any structures to be located within the floodplain. The primary purpose of the two-zone in this location would be to address the issue of access. An Official Plan Amendment setting out these policies would be required. The portion of the site that contains the Regional flood line should be rezoned to be within a G zone with special provisions regarding access.

Ingress/Egress

Currently, the primary issue with development of this site relates to safe ingress/egress. Implementation of either of the structural alternatives would offer dry access from Lakeshore Road both east and west of the existing creek.

Zoning

Under the two-zone approach, the portion of the site that contains the 100 year flood would be rezoned to be within a G zone. The portion between the 100 year flood and Regional flood line would require specific provisions regarding flood proofing and access.

If either of the structural options are pursued, the remaining floodplain would be placed within the G zone.

Consideration of Design Alternatives

Under both policy scenarios, the amount of developable land is the same. An evaluation was completed of the development potential for these lands. The Cooksville Creek reach in this location would require an 85.9 m (281.8 ft) erosion corridor centred along the centerline of the creek using the corridor principles established in this study; this creates an additional site development constraint.

Based on the design review for this site, it is anticipated that these lands could be developed for a mix of high density, medium density and commercial uses. Due to existing low density residential area to the west, a medium density housing form would be most appropriate along the westerly limit of the site. To enhance the pedestrian activity level and the main street character of Lakeshore Road, a commercial or mixed-use building running parallel to Lakeshore Road could be proposed. On the westerly portion of the site, development options range from medium density, including townhouses and stacked townhouses, yielding approximately 113 units, to high-density apartments, yielding approximately 330 units.

On the easterly portion of the site, high density residential use is appropriate, especially to the rear of the subject lands due to the existing high density use to the east in this location. This section could be built entirely at high density residential yielding 690 units or built, in part, with commercial uses [approximately 2000 m^2 (21520 ft^2)] as an extension of the District Centre to the east. This second scenario would yield approximately 420 apartment units.

Either of these development scenarios would require Official Plan and Zoning By-law Amendments to establish these uses on these lands.

Risk

Given that all development would be outside of the Regulatory floodplain, there would be no additional risk imposed upon the subject property.

Recommendation

The structural option of reconstructing the road profile is the recommended approach for this site. Discussion should occur with the landowners regarding the potential reconstruction of road as part of the redevelopment of the subject lands or alternatively an upgrade to the existing bridge/culvert (albeit the latter is anticipated to be more costly). If the roadway reconstruction and/or culvert replacement is determined to not be feasible or cost effective due to local constraints, a two-zone approach could be implemented for these lands as a fall back.

TABLE 8.2
LAKESHORE ROAD/INGLIS PROPERTY ASSESSMENT

	Floodplain Management Options			
	Structural	**Two Zone**	**SPA**	**One Zone**
Description	Reconstruct Lakeshore Road profile to provide flood free access or upgrade culvert/bridge	Not a viable option until structural option discounted	Not a viable option as two zone option and structural measures viable	Alternative options available
Constraints	Cost of reconstruction and maintaining access to properties to south	Accesses will still be flood susceptible	N/A	Site remains undevelopable
Action Required to Proceed	Conduct detailed plan of road reconstruction and secure developer commitment to proceed with works	Official Plan/Zoning By-Law Amendment required to implement	N/A	None

8.1.2 Consulate Property Camilla Road- North of the Queen Elizabeth Way

Site Description

This development area includes lands located east and west of Camilla Road north of the QEW. The area includes the property known as the Consulate Property (west of Camilla Road), which is subject to OPA 69 and has been appealed to the Ontario Municipal Board and also includes the lands to the east of Camilla Road, which are vacant or have potential for redevelopment.

Under OPA 69, the land use proposed for the lands west of Camilla Road is high density residential. If the two-zone approach is used for this site, the flood proofing requirements would among other issues, need to address flood free underground parking on this site. This would affect site grading and could have an impact on the site design. A site specific zoning by-law would be required to address these requirements.

Structural Management Opportunities

As noted in Section 7, the primary structural option for this site is the construction of an upgraded culvert under the QEW expressway. This culvert would allow for the removal of the floodplain designation for most of the lands within this development area. Notwithstanding, the area would continue to be subject to a shallow spill potential from the Cooksville Creek upstream of Camilla Road. This potential was examined further (ref. Appendix F); generally flood depths would be less than 20 cm (7.8 inches). At the time of site design, it would be necessary to accurately establish spill flow mechanics both across the subject site and back to the creek.

The issue with culvert replacement is the high cost of construction and the need to create a partnership among the Ministry of Transportation, the City and the landowners to finance its construction (ref. Appendix H for cost estimate). Notwithstanding, QEW culvert upgrade remains the preferred option for this site, as it significantly reduces the amount of lands within the direct Regulatory floodplain.

Potential Upstream and Downstream Impacts

Replacement of the QEW culvert from a 7.9 m x 4.1 m (25.9 ft x 13.4 ft) to a 20 m x 4.1 m (65.6 ft x 13.4 ft) would remove all of the lands west of Camilla Road from the direct Regulatory floodplain and the majority of the lands east of Camilla Road from the direct Regulatory floodplain. Both properties though, (but predominantly the Consulate Site) would remain subject to a shallow spill. Development of these lands would have no discernible impact on the direct Regulatory flood limits upstream, as the lands are outside of this zone, hence no upstream impacts would result. Some local impacts may arise due to development of the subject lands, as the current spill zone would be modified; the extent of this impact is anticipated to be minor, given the current shallow nature, and any impact would likely be easily mitigated. This would need to be adequately confirmed, once a site plan depicting proposed development is submitted.

The influence on downstream design flows has been assessed by establishing the natural floodplain zone (ref. Appendix F). The Consulate Site lies entirely outside of this area hence development would have no impact on the design flows downstream. The lands east of Camilla Road are partially within the natural floodplain zone, notwithstanding development could not occur within this area hence no impact would arise downstream on design flows. Nominal ‘lost’ storage in the spill zone is not expected to result in any discernable impact; again this should be confirmed once a site plan has been prepared.

Downstream erosion potential is also not anticipated to be altered as a result of the contemplated structural alternatives. The existing culvert has a high capacity (i.e. 10 years +/-), hence general erosion causing flow events would be nominally affected by increasing the culvert/bridge geometry.

Two-Zone

Due to the cost and magnitude of the work, the culvert reconstruction may need to be considered as a long-term solution. A two-zone approach could be implemented as an interim or short term measure until such time as the structural option is built. All of the requirements of the two-zone policy, including flood proofing, securing access, as well as the amended Official Plan policies would need to be implemented under this ‘interim’ scenario. This ‘two-zone’ application on an interim basis would likely require reconstruction of access roadways to remain flood free, as well as elevating the development site, above what would ‘normally’ be done to raise buildings and lowest openings above the existing (i.e. pre QEW culvert upgrade) Regional flood elevation. This would result in additional site development costs that would likely be “throwaway” when the culvert is constructed (ref. Appendix H). It would, however, allow development to proceed on a more timely basis.

Ingress/Egress

Under interim and ultimate conditions, access to the Consulate site would be from the North Service Road. Currently, it is within the Regulatory floodplain hence it would require profile modification as part of the site development, to "remain in the dry", if advanced prior to QEW culvert replacement. The lands east of Camilla Road would generally not have the same opportunity for dry access under the interim two zone management condition; neither Camilla Road nor the North Service Road are considered to be feasibly modified to provide dry access. After culvert replacement, both Camilla road and the North Service Road would not be subject to direct Regulatory flooding, however, remain spill prone; as a result a detailed spill assessment would need to also accompany a development proposal for the lands east of Camilla Road.

Zoning

For the lands east of Camilla Road, under a two –zone approach, further changes to the zoning by-law would be required. The portion of the site that contains the 100 year flood would be rezoned to be within a G zone. The portion between the 100 year flood and Regional flood line would require specific provisions regarding flood proofing and access.

If the structural option is pursued, the remaining floodplain should be placed within the G zone, with due consideration associated with spill potential affecting ingress/egress.

The lands within the floodway would need to be placed within a G zone category. The lands directly east of Camilla Road but west of the floodway could accommodate limited low density residential intensification provided adequate flood proofing and access can be provided and there are adequate lands for a specific site outside of the erosion setback area.

Consideration of Design Alternatives

The land owners have proposed a development scenario for the Consulate lands. The developer's scenario included two high-density residential towers of 21 and 18 stories. The proposed numbers of units is 326 for a site density of 247 units/ha or an FSI of approximately 3.1. OPA 69 designated the lands Residential High Density II, which permits an FSI of approximately 1.9-2.9.

An assessment of design alternatives was completed to determine the development potential to these lands. Due to the visibility of this site from the QEW, options exist to include grade related commercial as a component of the development. In addition, this commercial space could provide additional neighbourhood services to the residents within the area. If the subject site is developed under the two-zone scenario, the placement of the residential land use on the second floor reduces the exposure of the residential units to potential flooding risks.

Based on a site development FSI of 2.9, an office commercial space of 1600 m^2 could be achieved, as well as approximately 264 units based on the original development scenario of 8 apartment units per floor.

Risk

On an interim basis, there would be some added risk, as the subject lands would be managed on a two-zone basis. This will bring Regulatory flooding in close proximity to dwelling structures, albeit dry flood proofing and ingress/egress will offer Regulatory flood protection. After the QEW culvert upgrade, the property risk would be diminished subject to the proper management of spill flow from the north.

Recommendation

It is recommended that the expansion to the culvert under the QEW be advanced and partnerships established with the MTO, City and development proponents, as benefits would be realized for all parties. As an interim measure, a two-zone approach should be implemented on the subject lands, a condition of which would be a financial contribution by the benefitting development proponent (i.e. one of three beneficiaries to a future QEW culvert upgrade). The development property west of Camilla Road would be subject to some overbank spill from Cooksville Creek upstream of Camilla Road. The extent that this spill would impact on ingress and egress, as well as on-site flood protection will need to be determined.

The interim two-zone approach is proposed to be applied to the two development areas identified on Figure 2 north of the QEW Highway to the upstream limits of development. It is important to note that, while the interim two-zone approach provides more opportunities for development within the flood fringe, it also results in a very restrictive policy framework for those lands within the floodway. As shown on the Figure 2 series, all of the lands located within the area of the 100-year flood or zones of high velocity and depth (i.e. in exceedance of CVC criteria) would be precluded from any further development opportunities, even minor expansions, if the two-zone approach were implemented, in the interim.

TABLE 8.3
QEW/CAMILLA (CONSULATE LANDS) PROPERTY ASSESSMENT

	Floodplain Management Options			
	Structural	**Two Zone**	**SPA**	**One Zone**
Description	Upgrade Culvert under QEW	Viable interim measure until works are completed Viable option if structural option discounted	Not a viable option until two zone option discounted	Alternative options available
Opportunities	Removes floodplain constraint from majority of development lands Removes some existing dwellings from floodplain Eliminates spill/flooding of QEW	Would allow for development of the majority of the lands within the development area with specific criteria i.e. flood proofing and improving ingress/egress	N/A	None
Constraints	High cost of construction and need for multi- party agreement for financing	Additional costs to development Access roads may need to be reconstructed for improved emergency and other vehicle access Will remove opportunity for any development in floodway	N/A	Site remains undevelopable
Action Required to Proceed	Advance multi-party agreement and secure financing/timing for works	Official plan/Zoning Bylaw Amendment required to implement	N/A	None

8.1.3 F & F Construction Limited Property

Site Description

The F & F Property is located on the west side of Camilla Road to the south of the Queensway. The landowners have indicated an interest in developing additional portions of this site although there is no current application.

Structural Management Opportunities

There are no identified structural options to reduce the limits of the floodplain for this site. Section 1.3 describes an overland flow channel contemplated for this area as part of the 1997 Cooksville Creek Rehabilitation Study. The design standard though only would extend to a 25 year return period, hence there would be no benefit to Regulatory flood potential.

Two-Zone

On the subject lands, the location of the Regional and 100 year Flood Level is essentially coincident. There is little difference between the generalized limits of the floodway and the entire floodplain. For this reason, a two-zone approach would have limited benefits to the property.

Special Policy Area

There is no justification for establishing a Special Policy Area on this site as the reach containing the property is contiguous with downstream and upstream lands; altering the flood standard in this isolated local area would not be warranted as nothing sets this land base apart from that upstream or downstream from it.

Recommendations

The site does have a portion of the lands that are developable under the current one zone policy with good access. It is hence recommended that the current one zone policy be maintained for this site.

TABLE 8.4
F &F CONSTRUCTION PROPERTY ASSESSMENT

	Floodplain Management Options			
	Structural Options	**Two-Zone**	**SPA**	**One-Zone**
Description	None	Not a viable option	Not a viable option	Subject lands to remain under one zone policy
Opportunities	N/A	N/A	N/A	Development on Existing lands outside of floodplain
Constraints	N/A	N/A	N/A	Lands within floodplain remain undevelopable
Action Required to Proceed	N/A	N/A	N/A	None

8.1.4 Humenik Lands (Shepard Avenue)

Site Description

This property is located on both the east and west sides of Shepard Avenue between King Street West and Paisley Boulevard East. The lands are currently developed with single detached dwellings. In addition to the Humenik lands, there are lots just north and south of these lands, which are vacant or have been identified for potential redevelopment; specifically the Meriton property south of the Humenik land assembly requires consideration of floodplain management alternatives in the context of the overall reach recommendation.

Structural Management Opportunities

There has, in the past, been structural options proposed to address the floodplain issues on these lands. The property owner has proposed channelizing the creek and constructing berming to contain the floodplain protecting the intended developable portions of the site. This option was approved by the CVC in 1997 subject to the proponent providing detailed technical documentation to satisfy specific conditions. To date, the landowner has not addressed these conditions and there is some question as to whether they can be successfully addressed. The current CVC policies direct that there can be no increase in tableland through cut/fill or channelization. The issues relating to this structural option must be resolved and this option discounted before alternative policy options can be considered.

The land owner proposal (by Humenik) for channelization was unavailable for use in this study. Hence, in the absence of the technical analysis which supported the previous submission, various channelization options have been assessed in an effort to maintain on-site and off-site flood levels. Analysis, specifically integrating the stream morphologic and hydraulic principles and criteria which would govern for this reach design, have been considered. The following describes two channelization scenarios of differing total width (i.e. 72 m versus 95 m or 236 ft versus 311 ft), each of which has implicitly different levels of stream/erosion management, focussed at stabilizing both the low flow and floodplain system.

For the purpose of this assessment, the narrower scenario [at 72 m (216 ft)] has been assumed to be centred about the existing creek alignment (i.e. implicitly a meandering floodplain), whereas the wider scenario [at 95 m (311 ft)] has been assumed to be a straight-line corridor, in which the low flow channel would be appropriately located and aligned.

The balance of the development lands [approximately 8.6 ha (21.2 acres)] would under this scenario need to be filled to the existing Regulatory flood level plus a suitable freeboard (i.e. safety factor constituting vertical difference between flood level and land level). Cost estimates associated with this proposal are detailed in Appendix H.

Potential Upstream and Downstream Impacts

In order to assess upstream and downstream impacts, an additional analysis has been conducted. Each reach has been hydraulically modelled in an effort to demonstrate no upstream or adjacent impacts (ref. Table 8.5)

TABLE 8.5
HUMENIK PROPERTY STRUCTURAL ALTERNATIVE ASSESSMENT
REGULATORY FLOOD LEVELS

Cross-Section Location No.	Existing Creek/Floodplain		Channelization Scenario		Channelization Scenario	
	(m)	(ft)	(72 m) (m)	(236.16 ft) (ft)	(95 m) (m)	(311.6 ft) (ft)
4.195	104.48	342.69	104.48	342.69	104.48	342.69
4.34	104.72	343.48	104.73	343.51	104.84	343.87
4.44	105.11	344.76	105.01	344.43	104.97	344.30
4.64	106.30	348.66	105.63	346.47	105.40	345.71
4.67	106.44	349.12	106.44	349.12	106.46	349.19
4.69	107.19	351.58	107.19	358.14	107.20	351.62

The results indicate that either scenario would adequately address the hydraulic criterion. Key issues though, given the rapid expansion and contraction of the floodplain at the upstream and downstream limit of the reach, relate to how flood flows would be transitioned. This would need to be addressed by the subject site development proponent at the time of development submission, once details of the site development are defined (i.e. roadways, grading, building areas, etc.).

The remaining test of feasibility/compliance relates to the influence of the "loss" of floodplain storage associated with channelization (cut/fill), and the impact of this loss on downstream flows and associated levels. As discussed previously with City and CVC staff, the methodology to accurately predict this impact is limited to a great extent by the modelling and its associated assumptions. For hydrologic routing through creek and floodplain sections, the Cooksville Creek Floodline Mapping

Study, 1996 (and implicitly the FRS) adopted an approach whereby flow depths, rates and travel times were calculated through a rating curve analysis developed through HEC-2 simulations. In order to compare the influence of the proposed floodplain alteration, a similar assessment has been conducted for this analysis, whereby an HEC-2 rating curve assessment has been completed for the proposed geometry and the resulting routing information has been integrated into the OTTHYMO hydrologic model to determine the influence on downstream flows. The influence of the contemplated floodplain modification is summarized as follows:

TABLE 8.6
INFLUENCE OF 'LOST STORAGE' ON FLOOD FLOWS

Floodplain Configuration	**Peak Flow at Queensway Drive**			
	Regional		**100 Year**	
	(m^3/s)	**(ft^3/s)**	**(m^3/s)**	**(ft^3/s)**
Existing Floodplain	279.48	9860.05	201.48	7108.21
Proposed Floodplain Channelization				
• 72 m	279.79	9870.99	201.37	7104.33
• 95 m	279.34	9855.12	200.36	7068.70

Clearly, the foregoing demonstrates a negligible impact associated with the cut/fill works proposed. This is not unexpected as the reach is short, its current relative storage is low, the depth of flooding is shallow and the drainage area and level of imperviousness is high.

Based on the foregoing assessment of the relative tests for feasibility, it is considered that the potential exists for a cut/fill, channelization alternative to address the respective hydraulic and morphologic criteria.

Clearly, as the planning and design process advances, additional detailed analysis will be required to ensure that the "best" technical solution is derived. There will need to be careful attention to impacts on existing infrastructure, transition to tie-in points at upstream and downstream limits, local grading, extent of stabilization (both "hard and soft" natural treatment) and other matters related to hydraulics and stream morphology.

Two-Zone

Given the widespread shallow flooding, a two-zone option is considered a possibility for these lands. While the site is subject to extensive areas of both the Regional and 100 year floodplains, of the total site area, a considerable portion of the lands are within what would constitute the flood fringe. The primary access points though to the site are currently contained within the Regulatory flood limits, hence ingress/egress issues must be addressed. Appendix F describes an analysis of the flood fringe for the existing floodplain. The definition for this assessment has been premised on flood proofing criteria of both the Province and CVC. The approximate limits have been depicted on the Figure 4 series. Depending on the details associated with the future local development plans for this area, there may be an opportunity for a two-zone management approach or alternatively a hybrid of channelization and two-zone management.

Special Policy Area

If the channelization of the creek is not considered as a feasible structural option for the contemplated development, there are three policy options available. The lands can be maintained as a one-zone area which will preclude any major redevelopment opportunities. The lands would be managed under a two-zone approach as described in the earlier section or the area can be managed through the establishment of this area as a Special Policy Area. The subject lands are in close proximity to the node or Multiple Use Center located at the intersection of Hurontario and Dundas Street. The redevelopment of this site for medium and high density residential uses would assist in supporting this node and allow for the efficient use of existing infrastructure within the community. As noted within Ministry of Natural Resources, Implementation Guidelines, October 1988, “Municipalities should note that by permitting development in the floodway or where protection is not provided to the level of the Regulatory flood, the special policy area concept places a greater level of risk upon land owners and increases the potential for loss of life and property damage”.

The Hurontario Street Corridor is a major spine in the transit network leading to City Centre, and links to major transportation networks including a number of provincial highways and two commuter rail lines. This area is fully serviced and ready for redevelopment. The current Cooksville District Policies have identified the “Cooksville Corners” as an area in transition and with potential for appropriate infill, and redevelopment. The policies also recognize the need to revitalize this area and to encourage a mix of future retail commercial and residential uses to aid in this process. Restricting development of these lands in the Cooksville Creek floodplain, although preventing the loss of life and minimize property damage, represents a potential economic loss and reduces the opportunity for community redevelopment in this area. The lack of redevelopment opportunities for lands within the Cooksville Creek floodplain represents a potential economic loss to the area as well as opportunities for community renewal.

Ingress/Egress

The structural alternatives considered herein would provide flood free access to the subject lands from King Street and Paisley Boulevard. Notwithstanding, there would need to be due consideration of the potential for impact (particularly at the upstream limit) of local spill flow mechanics at the upstream and downstream limits of this reach.

Under a two-zone or two-zone hybrid, there may need to be some modification of local roadway profiles to adequately provide protection (for access) during Regulatory flooding.

Consideration of Design Alternatives

The current landowner of the center portion of the site has proposed the development of these lands for high-density apartments (454 units), garden apartments (78 units) and townhouse units (67 units) at an overall density of 133 units per ha. The proposed development plan is considered too intense for the subject site and does not provide adequate parking or amenity space for the residential units.

This site is proximate to the node 'Cooksville Corners' at Hurontario and Dundas Street. Within this node, building heights of up to 18 storeys are permitted subject to certain policies. Combined commercial/residential buildings are permitted for an FSI between 1 and 2.9. This site is located within a transition area between this high-density node and the adjacent low-density residential area. A redevelopment scenario has been advanced for the entire development site under the channelization option and under an SPA scenario.

Under the channelization option, the total site development area would be approximately 9 ha (22.2 acres). At an FSI between 1 and 2, it could potentially accommodate approximately 712 apartment units and 104 townhouse units.

Under an SPA scenario, the developable site area would be reduced to 5.2 ha (12.8 acres). This could potentially accommodate 640 apartment units and 43 town house units. All of this development would require floodproofing and improvement to the access routes. It should be noted that these development lands contain both the Regional floodlines and the 100 year flood lines. These lands would be subject to a higher flood risk and thus proceeding with any development under this scenario would require adoption of SPA policies within the Official Plan and Zoning By-law. In addition, under this scenario, an erosion corridor of 39.2 m (128.6 ft) would remain a site development constraint.

Risk

The structural alternative contemplated herein would reduce risk to be comparable to all other one zone areas within the watershed. Should the hybrid two zone/structural alternative be advanced, there would be an increase in risk due to the proximity of shallow, slow moving flood waters.

Recommendation

It is recommended that the structural option of creek/floodplain channelization be considered and, depending on the detailed planning design information, a hybrid of channelization with two-zone be considered as an alternate management approach.

TABLE 8.7
HUMENIK LANDS PROPERTY ASSESSMENT

	Floodplain Management Options			
	Structural	**Two-Zone**	**SPA**	**One-Zone**
Description	Creek and floodplain reconstruction (cut/fill)	Flood fringe established; appropriate flood proofing required	A possible consideration if structural options discounted	SPA should be investigated prior to continuing lands in one zone
Opportunities	Provides flood free access to site and removes lands from flooding constraint	Allows development of a portion of the site; 'dry' access required; hybrid two zone/structural management approach possible	Would allow for development of the lands within the development	None
Constraints	Cost of construction and CVC approval	Dry access; impact on adjacent property owners	Implementation of a Special Policy Area requires an assessment and acceptance of the additional risk due to development in floodplain	Site remains undevelopable
Action Required to Proceed	Technical feasibility and viability of option to be determined at site design stage	Need to assess the potential of specific structural alternatives in the context of proposed development concepts, prior to initiating a two zone approach	Official Plan Amendment	None

The Meritan property, south of the Humenik land assembly will be influenced by the management approach advanced for Humenik. Floodplain/creek channelization (cut/fill) will provide a benefit to Meritan flood potential, however, the extent would need to be assessed at that time, as details become available since the Meritan lands are located at the outlet of the Humenik reach in a location of potentially rapid floodplain expansion. Regardless, the management approach (i.e. Structural, Two Zone or Hybrid) advanced for Humenik and Meritan should be common.

8.1.5 Little John Lane Property

Site Description

This property is located adjacent to Little John Lane with access from Kirwin Avenue. The site is currently vacant.

Structural Alternatives

Given the development sites' context and location within the reach between Kirwin Avenue and Dundas Street, limited viable structural alternatives are considered viable. The site context is similar to the F & F property, as measures undertaken on-site must be harmonized with upstream and downstream land uses and flooding. It is for this reason that cut/fill scenarios such as the Humenik reach are not considered appropriate in this location; the development site is too small relative to the reach length and the property does not have control of both sides of the creek/floodplain.

The site is currently subject to access constraints due to a spill along Kirwin Avenue. The City of Mississauga Capital program contemplates upgrading this culvert in 2003, thereby largely removing this site access constraint.

Recommendation

This report shows lessor flood potential than that in previous assessments. Prior to any further evaluation of policy options, verification of the flood potential is required. This should be completed based on detailed topographic survey information. Once these issues are resolved, additional policy analysis can be undertaken if required.

8.1.6 Eglinton West

Site Description

This property has frontage along Eglinton and Hurontario and borders the Cooks creek.

Structural Management Options

As noted in Table 7.6, the property is essentially affected by the local backwater from a minor tributary which crosses the site. Culvert upgrades have been deemed to be ineffective to remove this minor draw from flooding. Flood storage is effective, however, given the high cost would not be practical.

Subject to environmental confirmation regarding the sensitivity of this on-site watercourse, it would be deemed feasible to fill this tributary draw in an effort to protect it from Regulatory flooding.

Potential Upstream and Downstream Impacts

Filling the valley draw would have no impact on upstream flood elevations; this would need to be confirmed at the time of detailed site plans. ‘Lost’ floodplain storage from this tributary draw feature is also not anticipated to cause an increase in downstream flood flows; this should also be confirmed at site design stage.

Ingress/Egress

Dry access can be afforded to this property from the south and east (i.e. Eglinton Avenue and Hurontario Street).

Risk

Development as contemplated herein would place the subject lands into a one-zone setting thereby not increasing the risk to the City.

Recommendation

It is recommended that subject to supporting technical information verifying the effect of local tributary filling on upstream and downstream flood levels and flow rates respectively, that the lands be developed as contemplated herein.

9. SUMMARY

Section 8 provides specific details regarding the respective management approaches advocated for the various development areas considered in this study. The following summarizes general recommendations considered by this study

1. Floodplain management approach to be as outlined in Section 8, specifically:

Lakeshore/Inglis	*One-Zone/Structural Improvements*
Consulate/QEW	*Interim Two-Zone/Structural Improvements/One-Zone Long Term*
F & F Construction	*One-Zone*
Humenik	*Structural Improvements/Two-Zone Hybrid*
Little John Lane	*One-Zone/Structural Improvements*
Eglinton West	*One-Zone*

2. Erosion/stream corridor management to be as outlined in Section 5; the City and CVC can consider the long term maximum technical corridor as prescribed with no contribution to local creek stability works by the adjacent land owner. Alternatively, the policy corridor can be used, however, this would imply a financial contribution to future erosion protection works by the adjacent land owner.

3. Any flood delineation analyses supporting development applications must comply with the technical standards outlined herein and specifically in Appendix I.

4. Development properties not considered in this study must follow the same standards and approach as used for this study, consistent with the standards of the day.

5. The City of Mississauga's most current topographic mapping base, accompanied by detailed local field survey must accompany any application.

6. The City of Mississauga should pursue the MTO for possible cost sharing opportunities for the QEW Cooksville Creek culvert.

7. The City of Mississauga should consider the continuation of its streamflow gauging program initiated as part of this study to support future hydrologic model calibration.

TABLE OF CONTENTS

TABLE OF CONTENTS

Figures

TABLE OF CONTENTS

Figures

APPENDICES

DRAWINGS

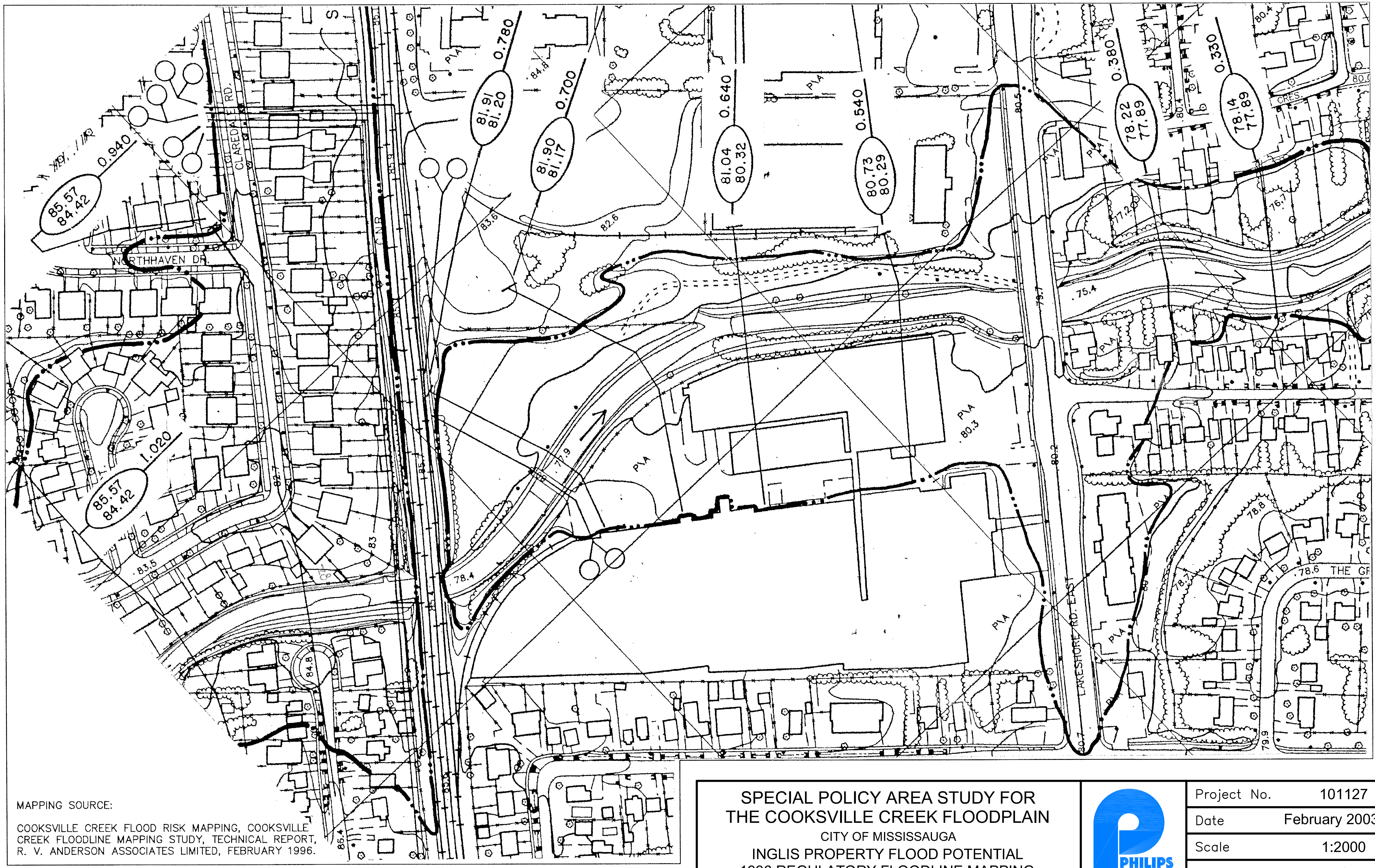
SPECIAL POLICY AREA STUDY
FOR THE
COOKSVILLE CREEK FLOODPLAIN

April 1, 2003

Philips Engineering Ltd.

In Consultation with

BGD Consulting Inc.
Parish Geomorphic
Davis & Co.



MAPPING SOURCE:

COOKSVILLE CREEK FLOOD RISK MAPPING, COOKSVILLE CREEK FLOODLINE MAPPING STUDY, TECHNICAL REPORT, R. V. ANDERSON ASSOCIATES LIMITED, FEBRUARY 1996.

SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA

INGLIS PROPERTY FLOOD POTENTIAL
1996 REGULATORY FLOODLINE MAPPING

PHILIPS ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	1

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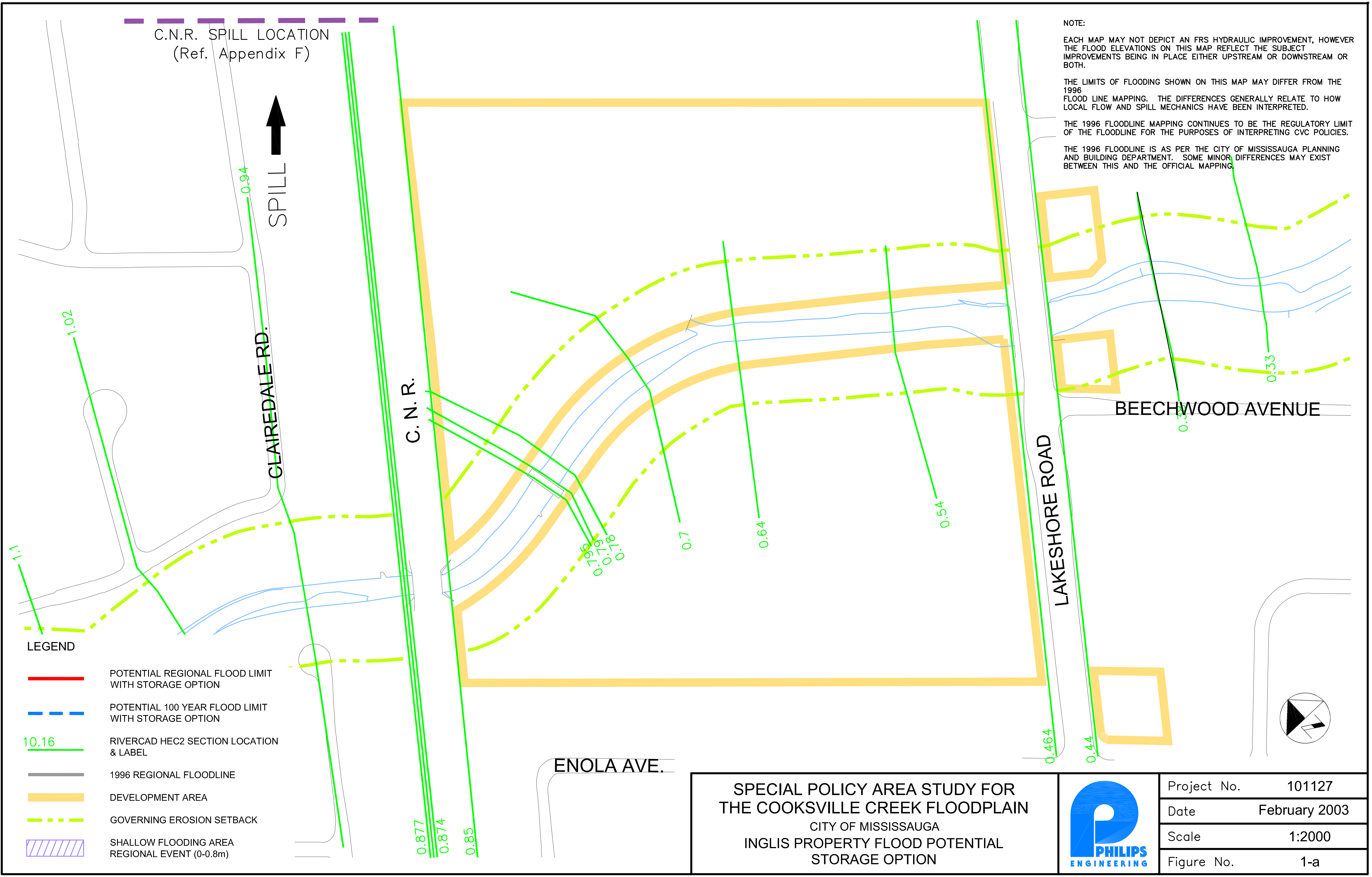

NOTE:

EACH MAP MAY NOT DEPICT AN FRS HYDRAULIC IMPROVEMENT, HOWEVER THE FLOOD ELEVATIONS ON THIS MAP REFLECT THE SUBJECT IMPROVEMENTS BEING IN PLACE EITHER UPSTREAM OR DOWNSTREAM OR BOTH.

THE LIMITS OF FLOODING SHOWN ON THIS MAP MAY DIFFER FROM THE 1996 FLOOD LINE MAPPING. THE DIFFERENCES GENERALLY RELATE TO HOW LOCAL FLOW AND SPILL MECHANICS HAVE BEEN INTERPRETED.

THE 1996 FLOODLINE MAPPING CONTINUES TO BE THE REGULATORY LIMIT OF THE FLOODLINE FOR THE PURPOSES OF INTERPRETING CVC POLICIES.

THE 1996 FLOODLINE IS AS PER THE CITY OF MISSISSAUGA PLANNING AND BUILDING DEPARTMENT. SOME MINOR DIFFERENCES MAY EXIST BETWEEN THIS AND THE OFFICIAL MAPPING.

LEGEND

🟥	POTENTIAL REGIONAL FLOOD LIMIT WITH STORAGE OPTION
🟦	POTENTIAL 100 YEAR FLOOD LIMIT WITH STORAGE OPTION
10.16	RIVERCAD HEC2 SECTION LOCATION & LABEL
⬜	1996 REGIONAL FLOODLINE
🟨	DEVELOPMENT AREA
🟩	GOVERNING EROSION SETBACK
▨	SHALLOW FLOODING AREA REGIONAL EVENT (0-0.8m)

SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA

INGLIS PROPERTY FLOOD POTENTIAL STORAGE OPTION

PHILIPS ENGINEERING

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Date	February 2003
Scale	1:2000
Figure No.	1-a

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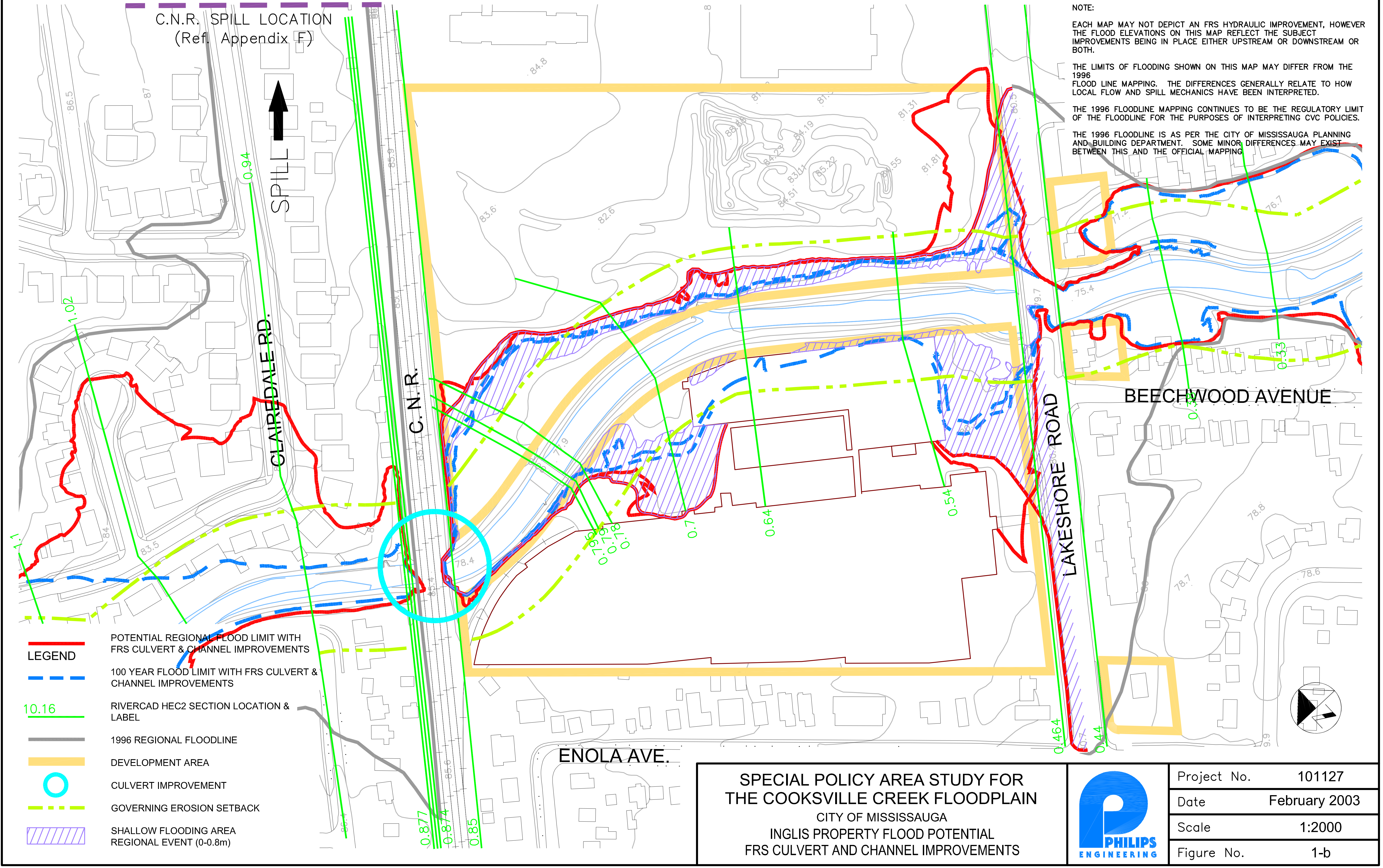

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LEGEND

🟥	POTENTIAL REGIONAL FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS
– – –	100 YEAR FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS
10.16	RIVERCAD HEC2 SECTION LOCATION & LABEL
—	1996 REGIONAL FLOODLINE
🟨	DEVELOPMENT AREA
○	CULVERT IMPROVEMENT
– · –	GOVERNING EROSION SETBACK
▨	SHALLOW FLOODING AREA REGIONAL EVENT (0-0.8m)

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
INGLIS PROPERTY FLOOD POTENTIAL
FRS CULVERT AND CHANNEL IMPROVEMENTS

PHILIPS ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	1-b

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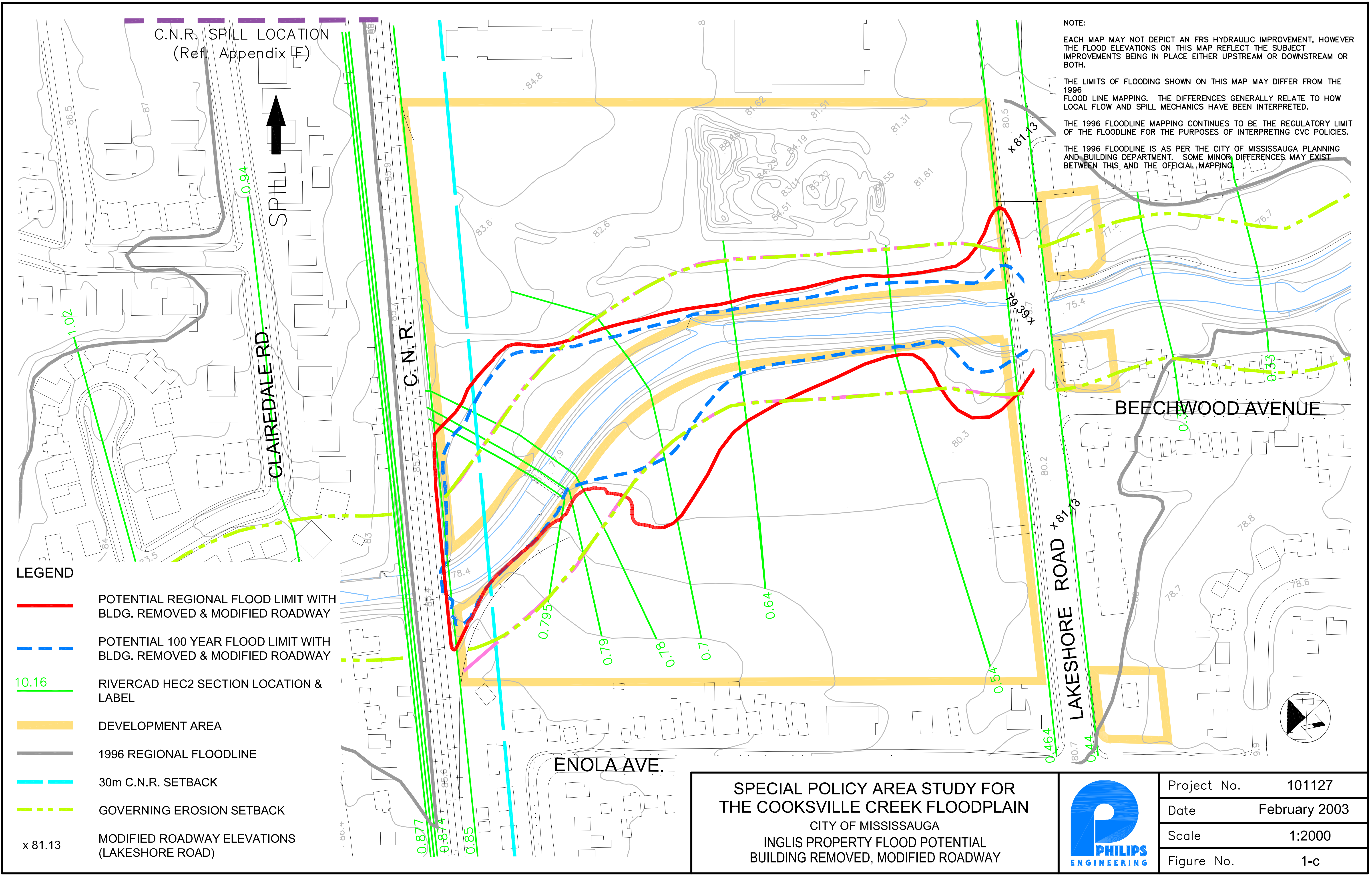

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THE 1996 FLOODLINE IS AS PER THE CITY OF MISSISSAUGA PLANNING AND BUILDING DEPARTMENT. SOME MINOR DIFFERENCES MAY EXIST BETWEEN THIS AND THE OFFICIAL MAPPING.

LEGEND

🟥	POTENTIAL REGIONAL FLOOD LIMIT WITH BLDG. REMOVED & MODIFIED ROADWAY
🟦	POTENTIAL 100 YEAR FLOOD LIMIT WITH BLDG. REMOVED & MODIFIED ROADWAY
10.16	RIVERCAD HEC2 SECTION LOCATION & LABEL
🟨	DEVELOPMENT AREA
⬜	1996 REGIONAL FLOODLINE
🟦	30m C.N.R. SETBACK
🟩	GOVERNING EROSION SETBACK
x 81.13	MODIFIED ROADWAY ELEVATIONS (LAKESHORE ROAD)

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
INGLIS PROPERTY FLOOD POTENTIAL
BUILDING REMOVED, MODIFIED ROADWAY

PHILIPS ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	1-c

Feb. 24/03 – mbk

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MAPPING SOURCE:

COOKSVILLE CREEK FLOOD RISK MAPPING, COOKSVILLE CREEK FLOODLINE MAPPING STUDY, TECHNICAL REPORT, R. V. ANDERSON ASSOCIATES LIMITED, FEBRUARY 1996.

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
CONSULATE SITE FLOOD POTENTIAL
1996 REGULATORY FLOODLINE MAPPING

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	2

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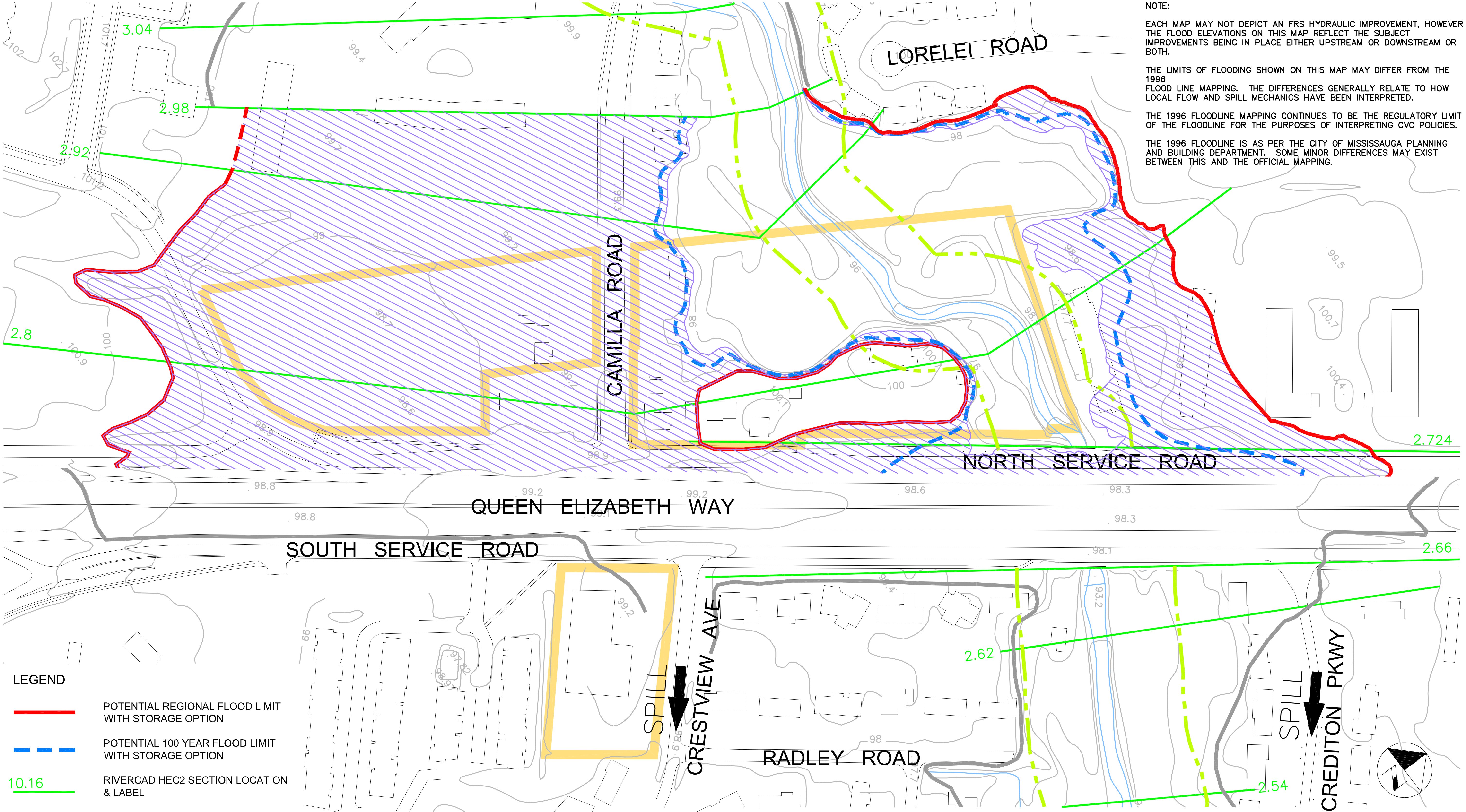

LEGEND

🟥	POTENTIAL REGIONAL FLOOD LIMIT WITH STORAGE OPTION
- - -	POTENTIAL 100 YEAR FLOOD LIMIT WITH STORAGE OPTION
10.16 ―	RIVERCAD HEC2 SECTION LOCATION & LABEL
―	1996 REGIONAL FLOODLINE
🟨	DEVELOPMENT AREA
— · —	GOVERNING EROSION SETBACK
▨	SHALLOW FLOODING AREA REGIONAL EVENT (0-0.8m)

SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA

CONSULATE SITE FLOOD POTENTIAL STORAGE OPTION

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Figure No.	2-a

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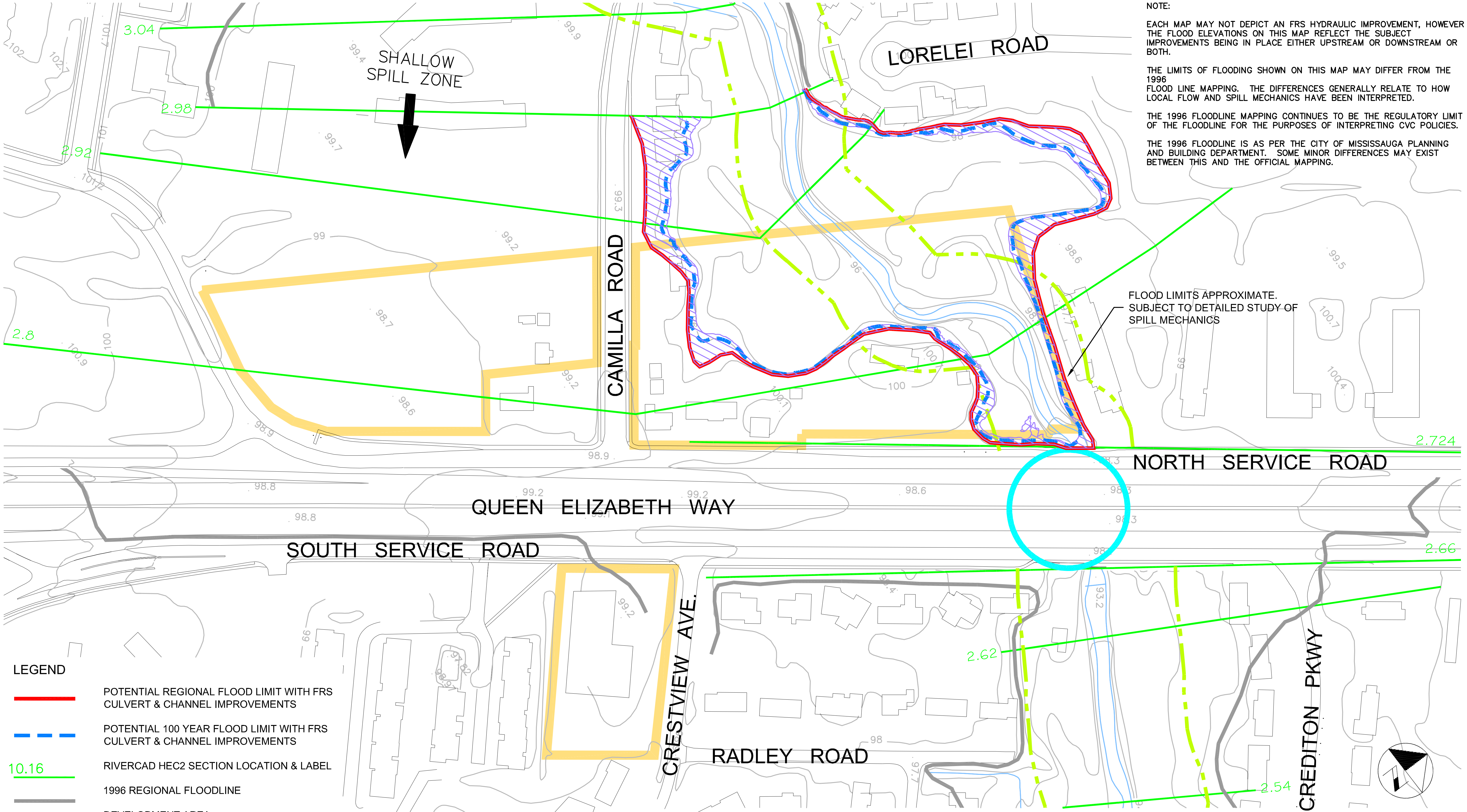

FLOOD LIMITS APPROXIMATE.
SUBJECT TO DETAILED STUDY OF
SPILL MECHANICS

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LEGEND

— POTENTIAL REGIONAL FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS
- - - POTENTIAL 100 YEAR FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS
10.16 RIVERCAD HEC2 SECTION LOCATION & LABEL
— 1996 REGIONAL FLOODLINE
▬ DEVELOPMENT AREA
○ CULVERT IMPROVEMENT
-·- GOVERNING EROSION SETBACK
▨ SHALLOW FLOODING AREA REGIONAL EVENT (0-0.6m)

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
CONSULATE SITE FLOOD POTENTIAL
FRS CULVERT AND CHANNEL IMPROVEMENTS

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Figure No.	2-b

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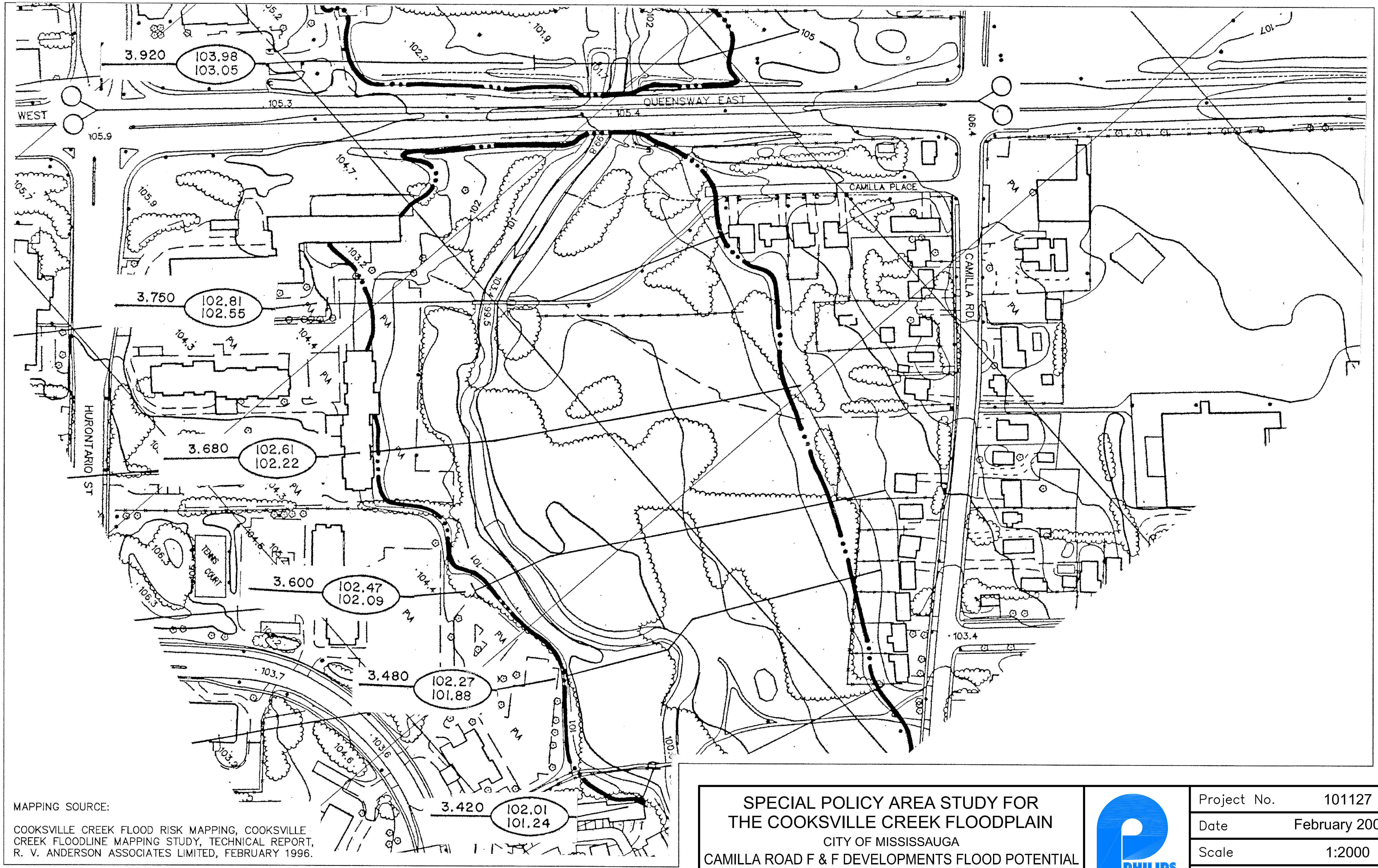

MAPPING SOURCE:

COOKSVILLE CREEK FLOOD RISK MAPPING, COOKSVILLE CREEK FLOODLINE MAPPING STUDY, TECHNICAL REPORT, R. V. ANDERSON ASSOCIATES LIMITED, FEBRUARY 1996.

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
CAMILLA ROAD F & F DEVELOPMENTS FLOOD POTENTIAL
1996 REGULATORY FLOODLINE MAPPING

PHILIPS ENGINEERING

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Figure No.	3

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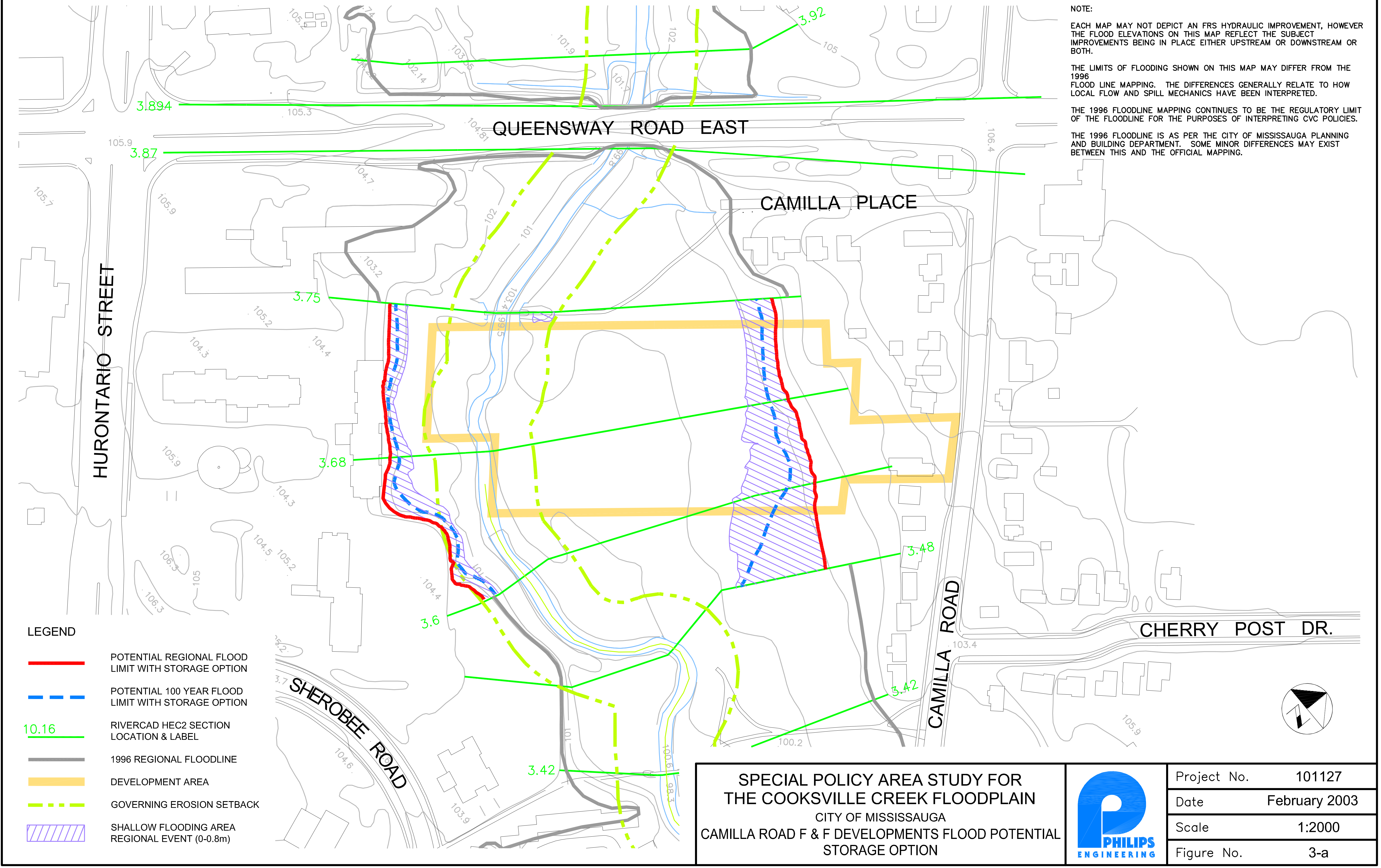

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THE 1996 FLOODLINE IS AS PER THE CITY OF MISSISSAUGA PLANNING AND BUILDING DEPARTMENT. SOME MINOR DIFFERENCES MAY EXIST BETWEEN THIS AND THE OFFICIAL MAPPING.

LEGEND

🟥	POTENTIAL REGIONAL FLOOD LIMIT WITH STORAGE OPTION
━ ━	POTENTIAL 100 YEAR FLOOD LIMIT WITH STORAGE OPTION
10.16	RIVERCAD HEC2 SECTION LOCATION & LABEL
━	1996 REGIONAL FLOODLINE
🟨	DEVELOPMENT AREA
━ · ━	GOVERNING EROSION SETBACK
▨	SHALLOW FLOODING AREA REGIONAL EVENT (0-0.8m)

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
CAMILLA ROAD F & F DEVELOPMENTS FLOOD POTENTIAL
STORAGE OPTION

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	3-a

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Feb. 21/03 – mbk

NOTE:

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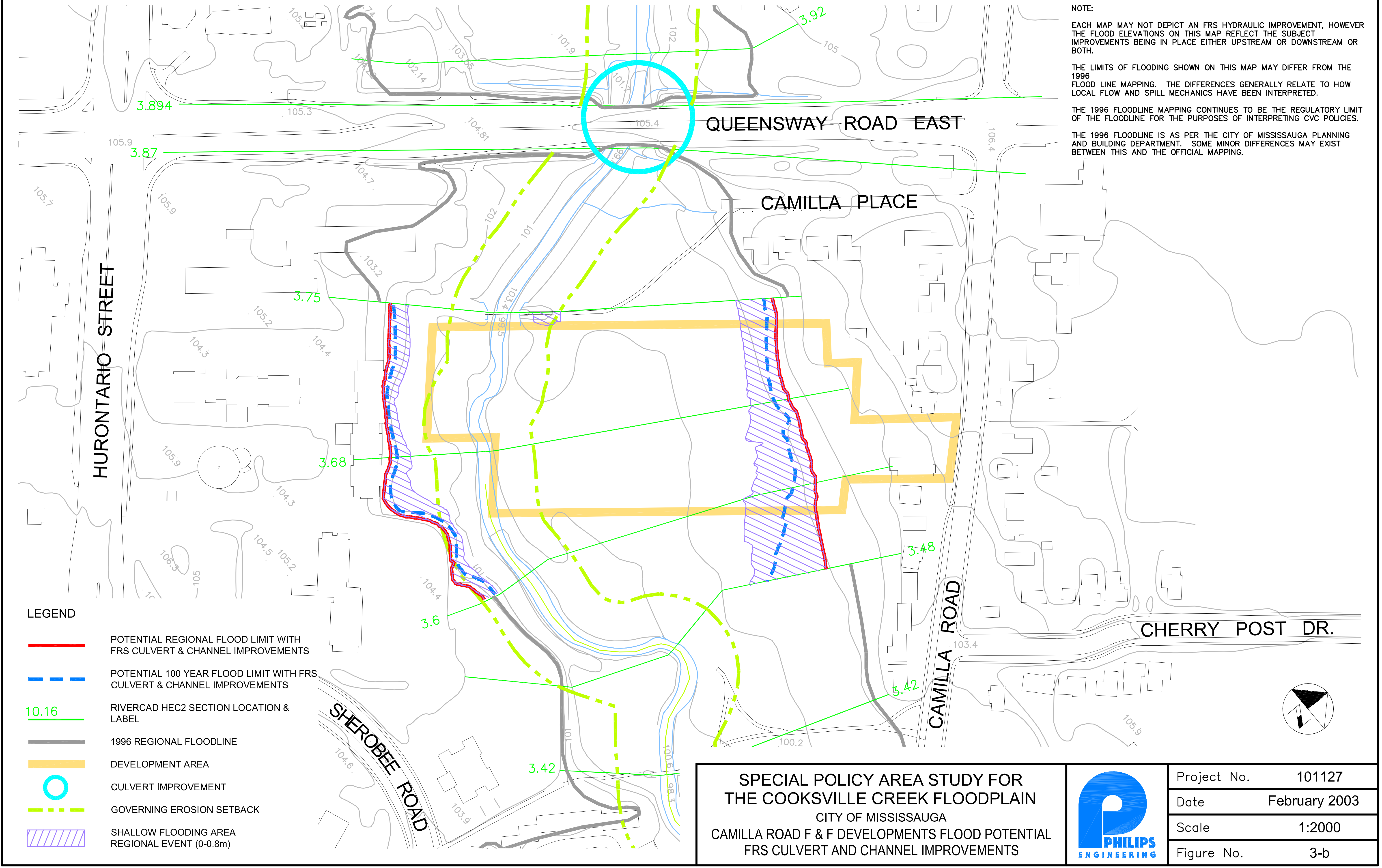
THE LIMITS OF FLOODING SHOWN ON THIS MAP MAY DIFFER FROM THE 1996 FLOOD LINE MAPPING. THE DIFFERENCES GENERALLY RELATE TO HOW LOCAL FLOW AND SPILL MECHANICS HAVE BEEN INTERPRETED.

THE 1996 FLOODLINE MAPPING CONTINUES TO BE THE REGULATORY LIMIT OF THE FLOODLINE FOR THE PURPOSES OF INTERPRETING CVC POLICIES.

THE 1996 FLOODLINE IS AS PER THE CITY OF MISSISSAUGA PLANNING AND BUILDING DEPARTMENT. SOME MINOR DIFFERENCES MAY EXIST BETWEEN THIS AND THE OFFICIAL MAPPING.



LEGEND

🟥 POTENTIAL REGIONAL FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS

▬ ▬ POTENTIAL 100 YEAR FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS

10.16 RIVERCAD HEC2 SECTION LOCATION & LABEL

▬ 1996 REGIONAL FLOODLINE

▬ DEVELOPMENT AREA

○ CULVERT IMPROVEMENT

▬ · ▬ GOVERNING EROSION SETBACK

▨ SHALLOW FLOODING AREA REGIONAL EVENT (0-0.8m)

SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA

CAMILLA ROAD F & F DEVELOPMENTS FLOOD POTENTIAL
FRS CULVERT AND CHANNEL IMPROVEMENTS

PHILIPS ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	3-b

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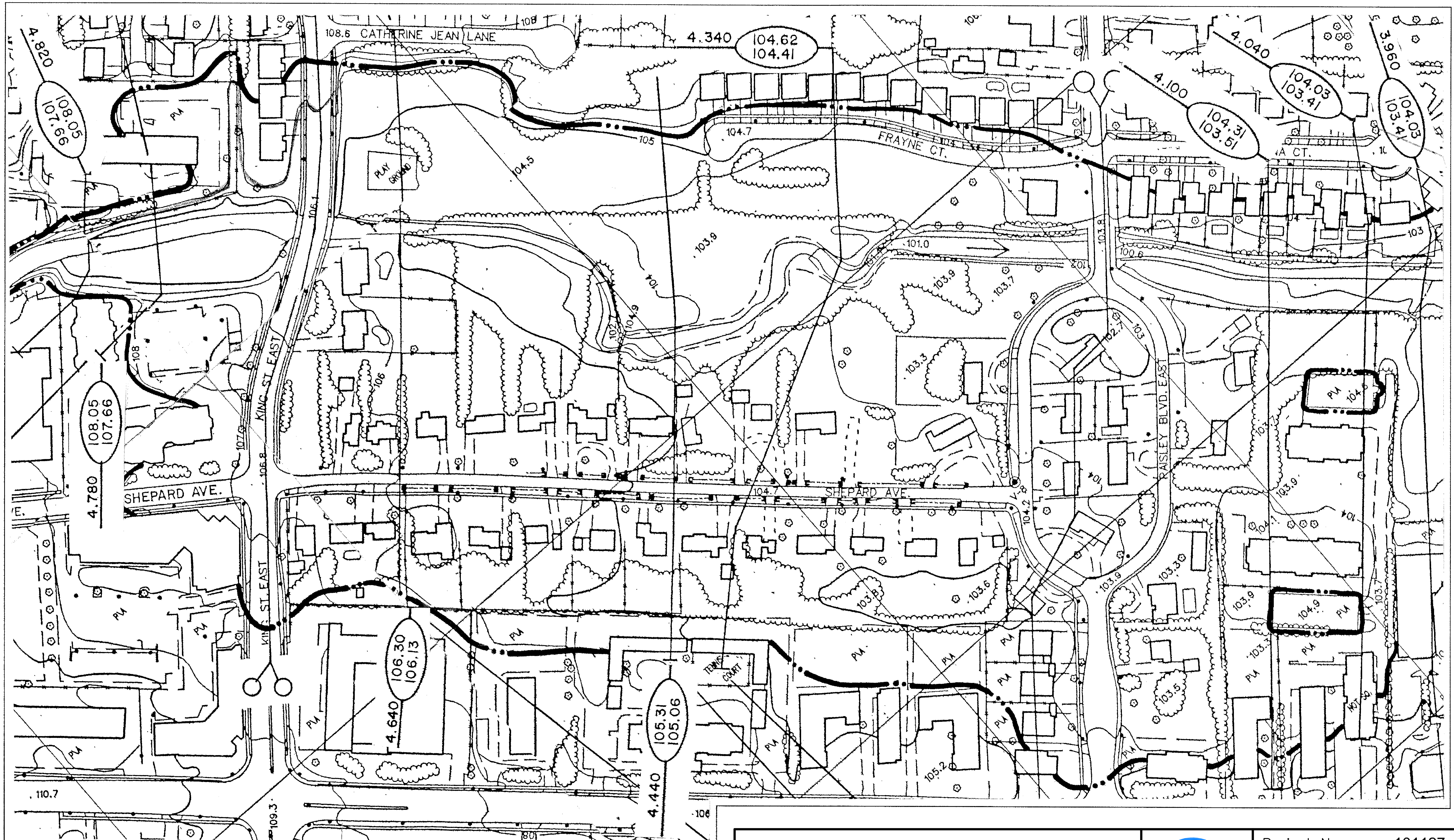
Feb. 21/03 – mbk



MAPPING SOURCE:

COOKSVILLE CREEK FLOOD RISK MAPPING, COOKSVILLE CREEK FLOODLINE MAPPING STUDY, TECHNICAL REPORT, R. V. ANDERSON ASSOCIATES LIMITED, FEBRUARY 1996.

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
HUMENIK PROPERTY FLOOD POTENTIAL
1996 REGULATORY FLOODLINE MAPPING

PHILIPS ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	4

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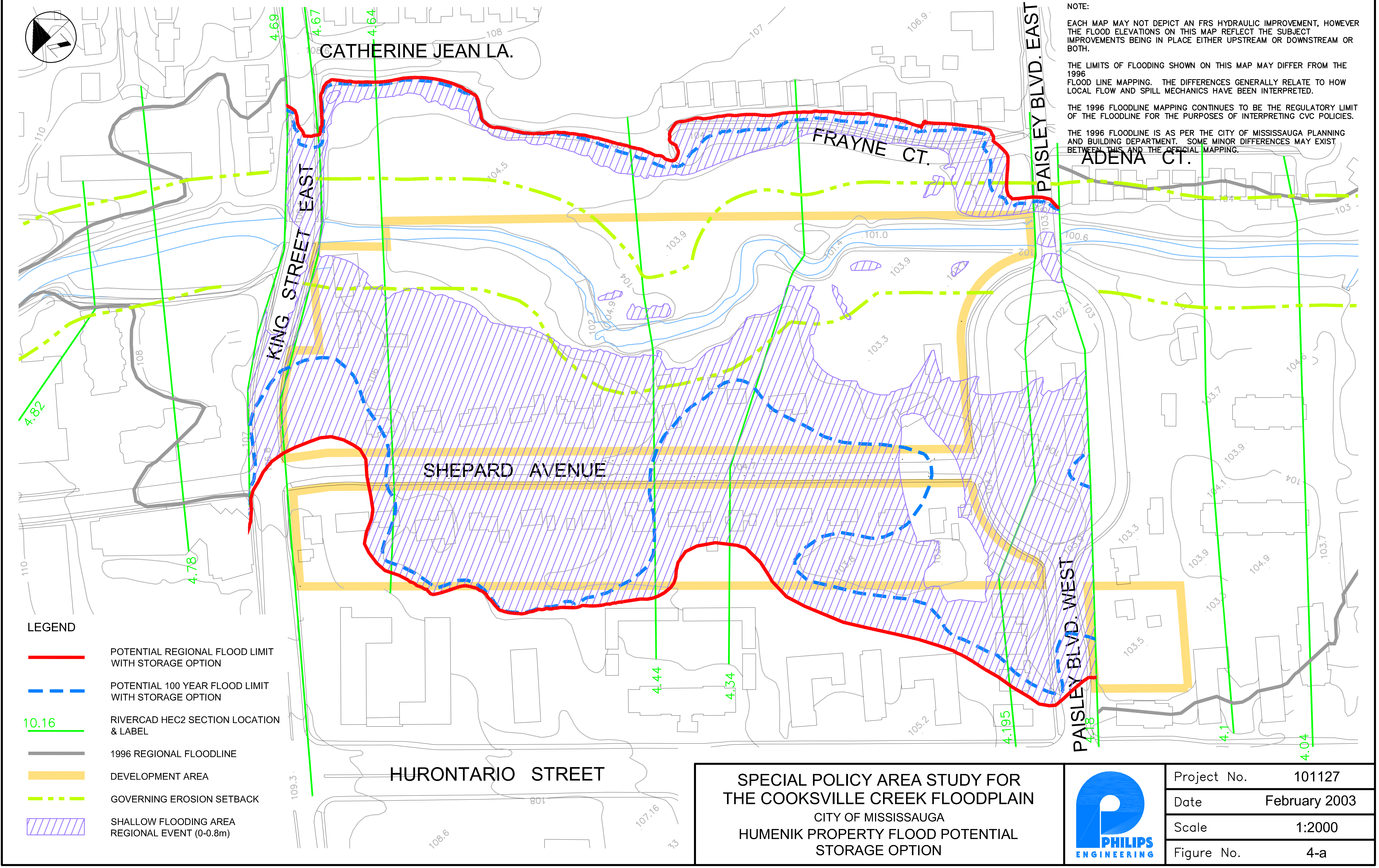
Feb. 18/03 – mbk



NOTE:

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THE 1996 FLOODLINE MAPPING CONTINUES TO BE THE REGULATORY LIMIT OF THE FLOODLINE FOR THE PURPOSES OF INTERPRETING CVC POLICIES.

THE 1996 FLOODLINE IS AS PER THE CITY OF MISSISSAUGA PLANNING AND BUILDING DEPARTMENT. SOME MINOR DIFFERENCES MAY EXIST BETWEEN THIS AND THE OFFICIAL MAPPING.

LEGEND

━	POTENTIAL REGIONAL FLOOD LIMIT WITH STORAGE OPTION
‒ ‒ ‒	POTENTIAL 100 YEAR FLOOD LIMIT WITH STORAGE OPTION
10.16 ━	RIVERCAD HEC2 SECTION LOCATION & LABEL
━	1996 REGIONAL FLOODLINE
▬	DEVELOPMENT AREA
‒ · ‒	GOVERNING EROSION SETBACK
▨	SHALLOW FLOODING AREA REGIONAL EVENT (0-0.8m)

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
HUMENIK PROPERTY FLOOD POTENTIAL
STORAGE OPTION

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	4-a

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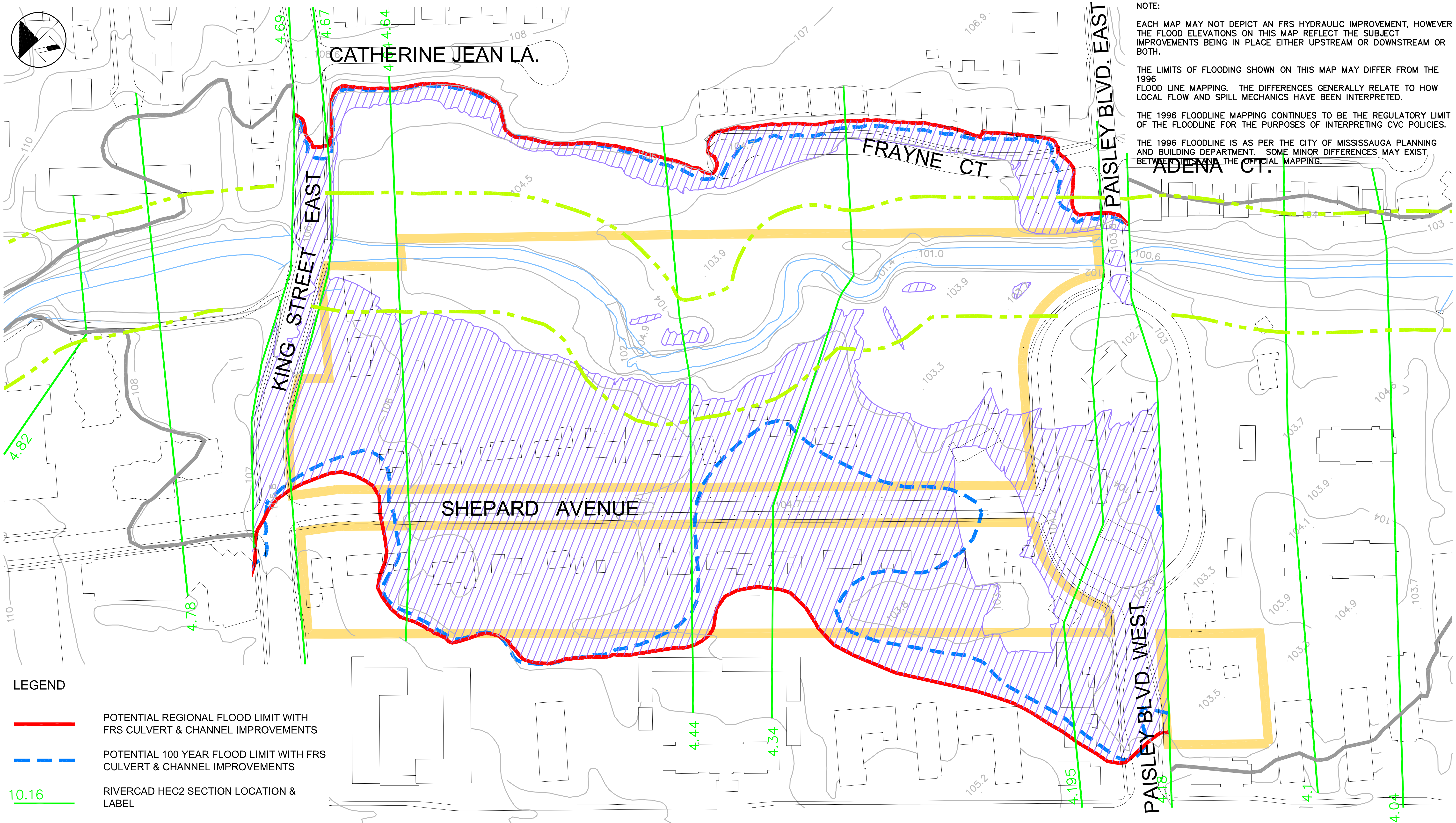
Feb. 24/03 – mbk



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LEGEND

━━	POTENTIAL REGIONAL FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS
‒ ‒ ‒	POTENTIAL 100 YEAR FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS
10.16	RIVERCAD HEC2 SECTION LOCATION & LABEL
━━	1996 REGIONAL FLOODLINE
━━	DEVELOPMENT AREA
‒ · ‒	GOVERNING EROSION SETBACK
▨	SHALLOW FLOODING AREA REGIONAL EVENT (0-0.8m)

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
HUMENIK PROPERTY FLOOD POTENTIAL
FRS CULVERT AND CHANNEL IMPROVEMENTS

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	4-b

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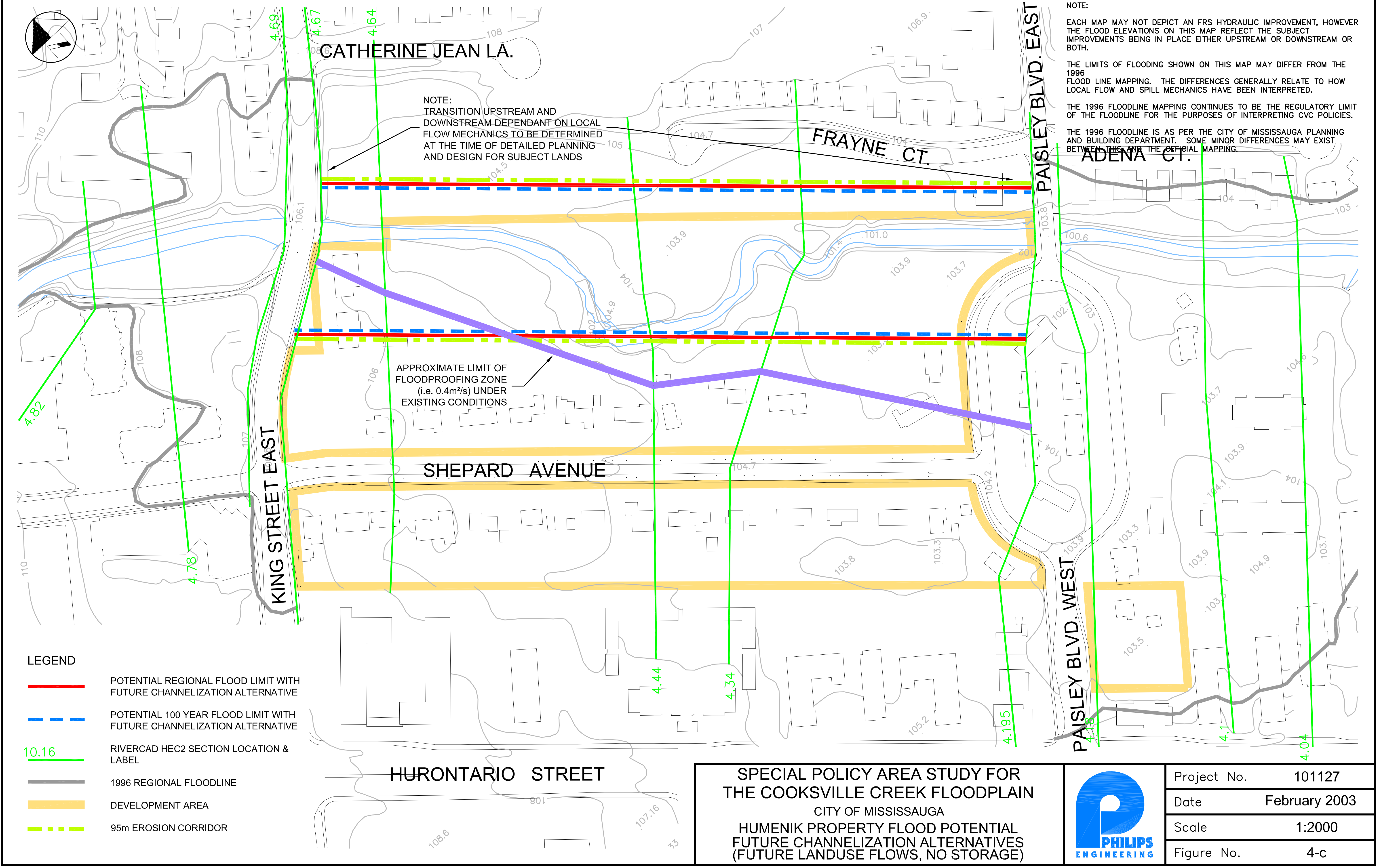
Feb. 24/03 – mbk



NOTE:
TRANSITION UPSTREAM AND
DOWNSTREAM DEPENDANT ON LOCAL
FLOW MECHANICS TO BE DETERMINED
AT THE TIME OF DETAILED PLANNING
AND DESIGN FOR SUBJECT LANDS

APPROXIMATE LIMIT OF
FLOODPROOFING ZONE
(i.e. 0.4m²/s) UNDER
EXISTING CONDITIONS

NOTE:

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THE 1996 FLOODLINE IS AS PER THE CITY OF MISSISSAUGA PLANNING AND BUILDING DEPARTMENT. SOME MINOR DIFFERENCES MAY EXIST BETWEEN THIS AND THE OFFICIAL MAPPING.

LEGEND

🟥	POTENTIAL REGIONAL FLOOD LIMIT WITH FUTURE CHANNELIZATION ALTERNATIVE
– – –	POTENTIAL 100 YEAR FLOOD LIMIT WITH FUTURE CHANNELIZATION ALTERNATIVE
10.16	RIVERCAD HEC2 SECTION LOCATION & LABEL
—	1996 REGIONAL FLOODLINE
🟧	DEVELOPMENT AREA
– · – ·	95m EROSION CORRIDOR

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
HUMENIK PROPERTY FLOOD POTENTIAL
FUTURE CHANNELIZATION ALTERNATIVES
(FUTURE LANDUSE FLOWS, NO STORAGE)

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	4-c

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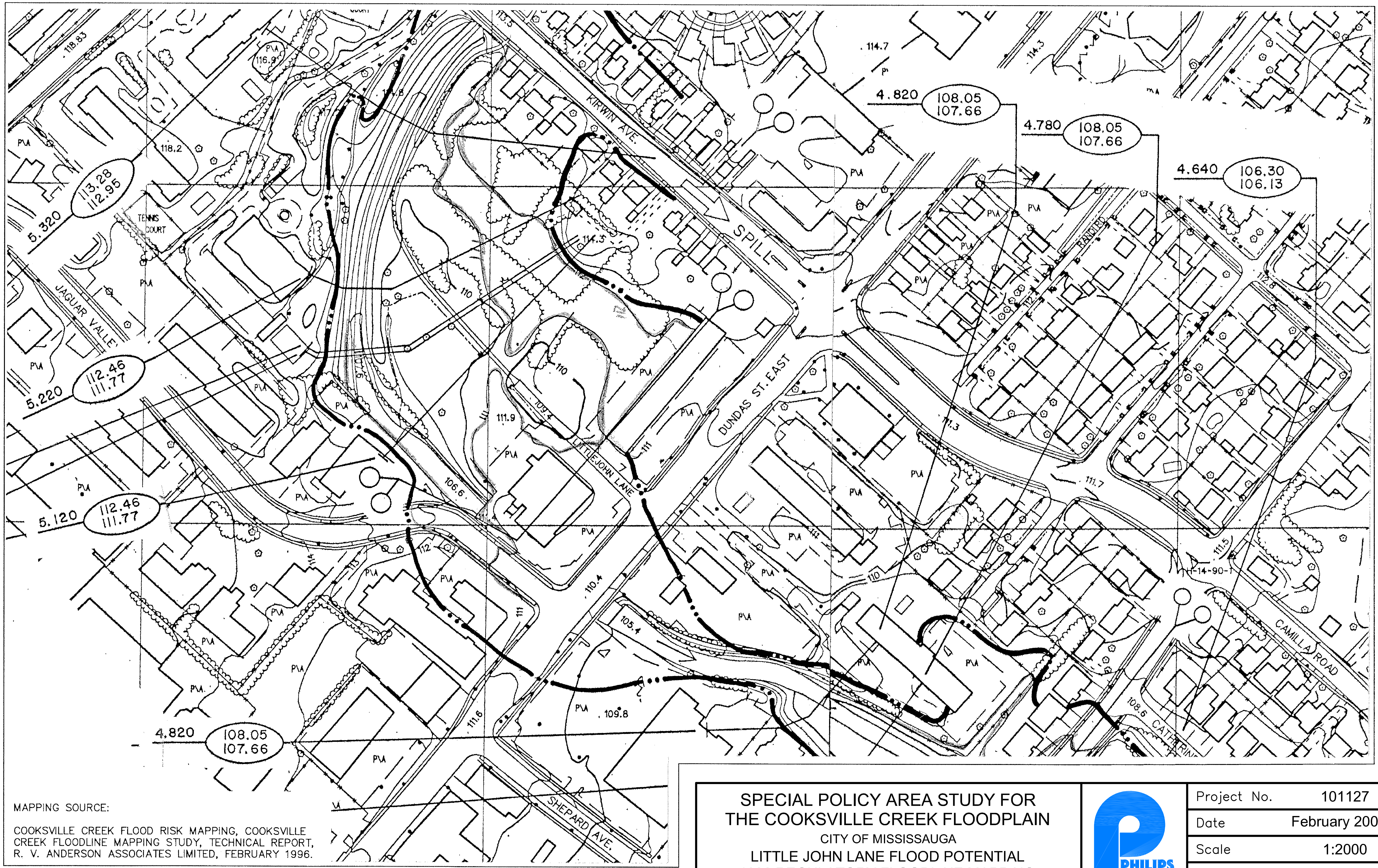
Feb. 26/03 – mbk



MAPPING SOURCE:

COOKSVILLE CREEK FLOOD RISK MAPPING, COOKSVILLE CREEK FLOODLINE MAPPING STUDY, TECHNICAL REPORT, R. V. ANDERSON ASSOCIATES LIMITED, FEBRUARY 1996.

SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA

LITTLE JOHN LANE FLOOD POTENTIAL
1996 REGULATORY FLOODLINE MAPPING

PHILIPS ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	5

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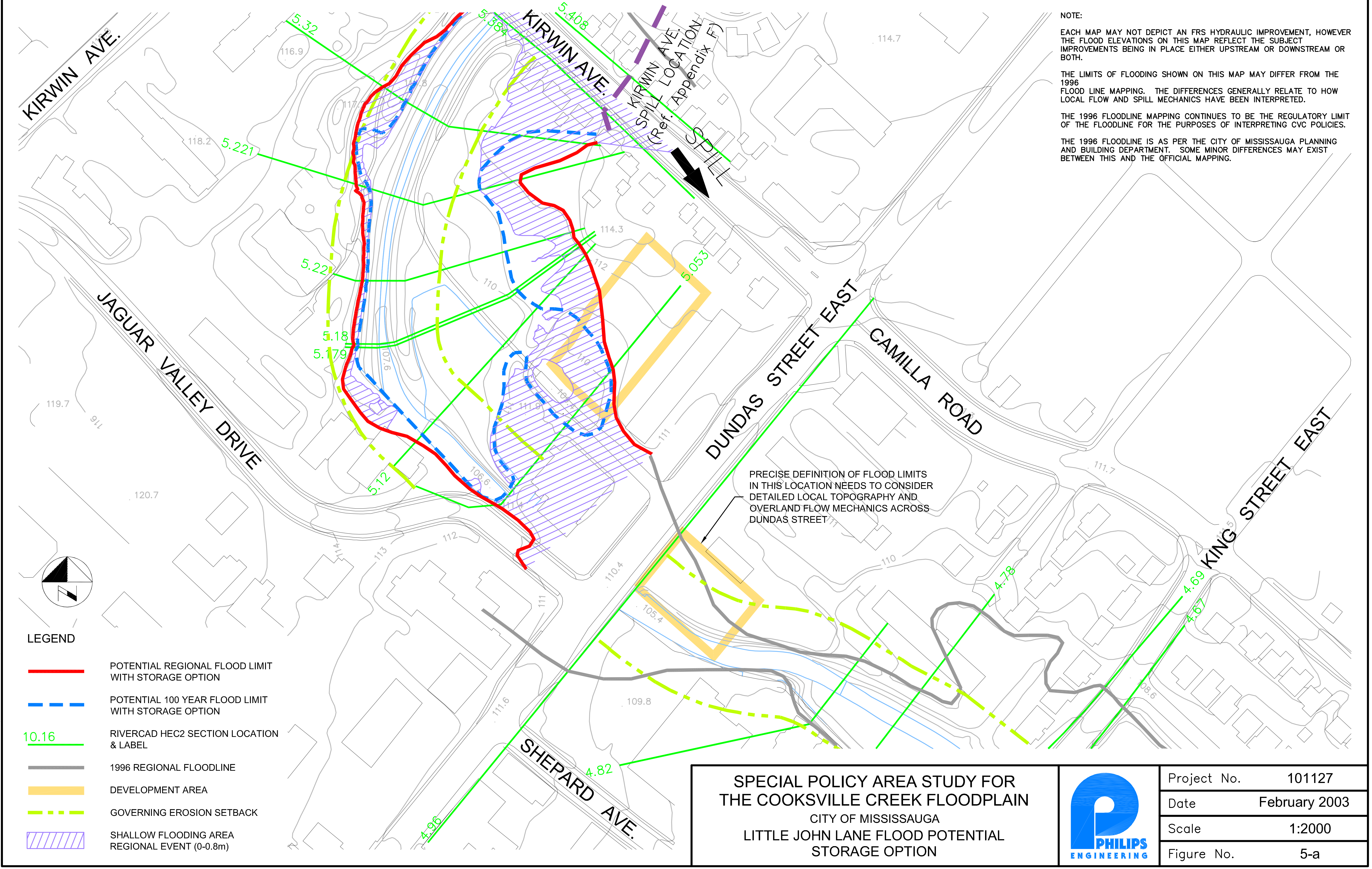
Feb. 18/03 – mbk



PRECISE DEFINITION OF FLOOD LIMITS IN THIS LOCATION NEEDS TO CONSIDER DETAILED LOCAL TOPOGRAPHY AND OVERLAND FLOW MECHANICS ACROSS DUNDAS STREET

NOTE:

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THE 1996 FLOODLINE IS AS PER THE CITY OF MISSISSAUGA PLANNING AND BUILDING DEPARTMENT. SOME MINOR DIFFERENCES MAY EXIST BETWEEN THIS AND THE OFFICIAL MAPPING.

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
LITTLE JOHN LANE FLOOD POTENTIAL
STORAGE OPTION

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	5-a

Feb. 24/03 – mbk

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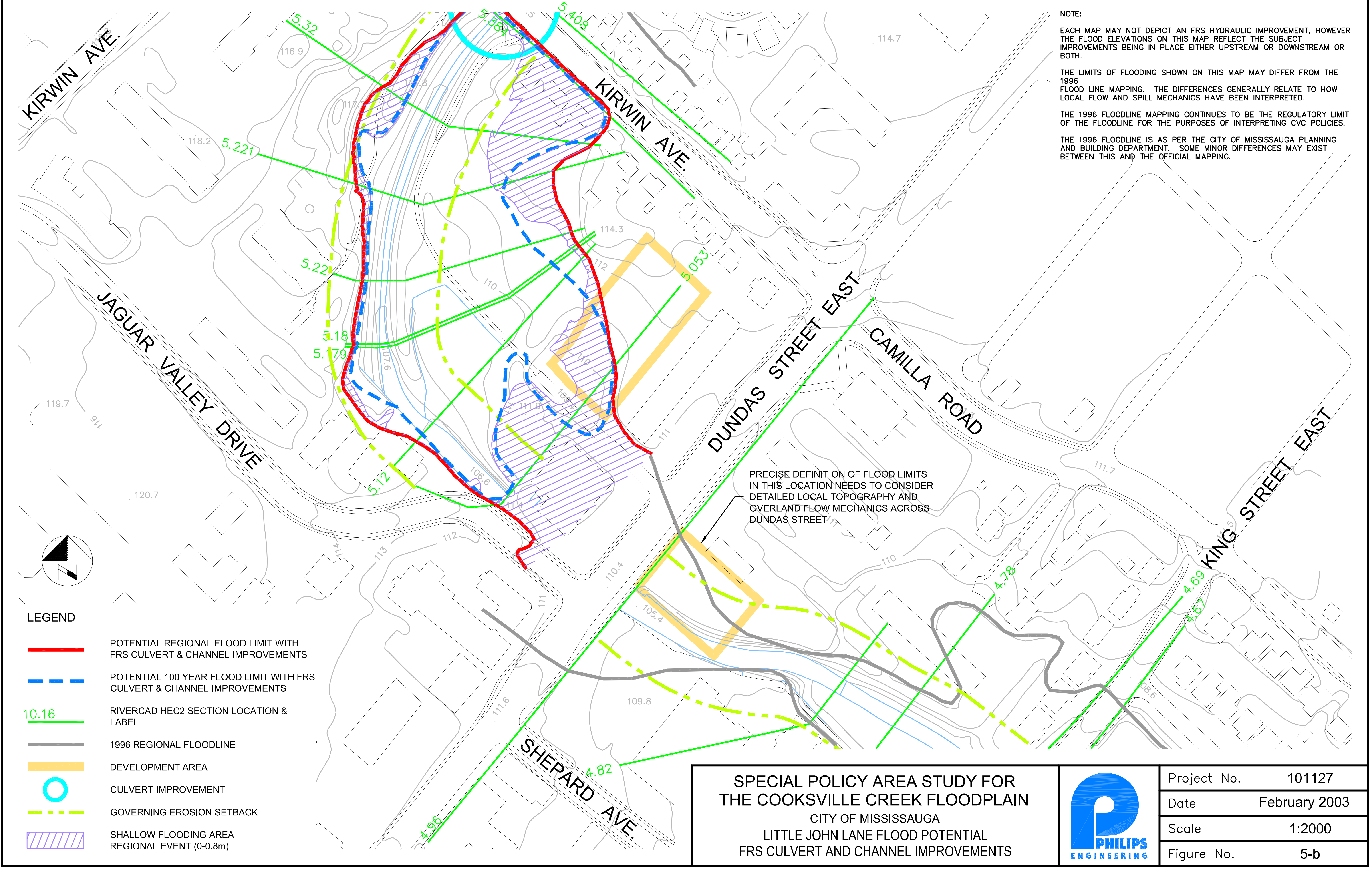

PRECISE DEFINITION OF FLOOD LIMITS IN THIS LOCATION NEEDS TO CONSIDER DETAILED LOCAL TOPOGRAPHY AND OVERLAND FLOW MECHANICS ACROSS DUNDAS STREET

NOTE:

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LEGEND

🟥	POTENTIAL REGIONAL FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS
– – –	POTENTIAL 100 YEAR FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS
10.16	RIVERCAD HEC2 SECTION LOCATION & LABEL
—	1996 REGIONAL FLOODLINE
🟧	DEVELOPMENT AREA
○	CULVERT IMPROVEMENT
– · –	GOVERNING EROSION SETBACK
▨	SHALLOW FLOODING AREA REGIONAL EVENT (0-0.8m)

SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA

LITTLE JOHN LANE FLOOD POTENTIAL

FRS CULVERT AND CHANNEL IMPROVEMENTS

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	5-b

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Feb. 26/03 – mbk

MAPPING SOURCE:

COOKSVILLE CREEK FLOOD RISK MAPPING, COOKSVILLE CREEK FLOODLINE MAPPING STUDY, TECHNICAL REPORT, R. V. ANDERSON ASSOCIATES LIMITED, FEBRUARY 1996.

SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA

EGLINTON / HWY NO. 10 FLOOD POTENTIAL
1996 REGULATORY FLOODLINE MAPPING

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	6

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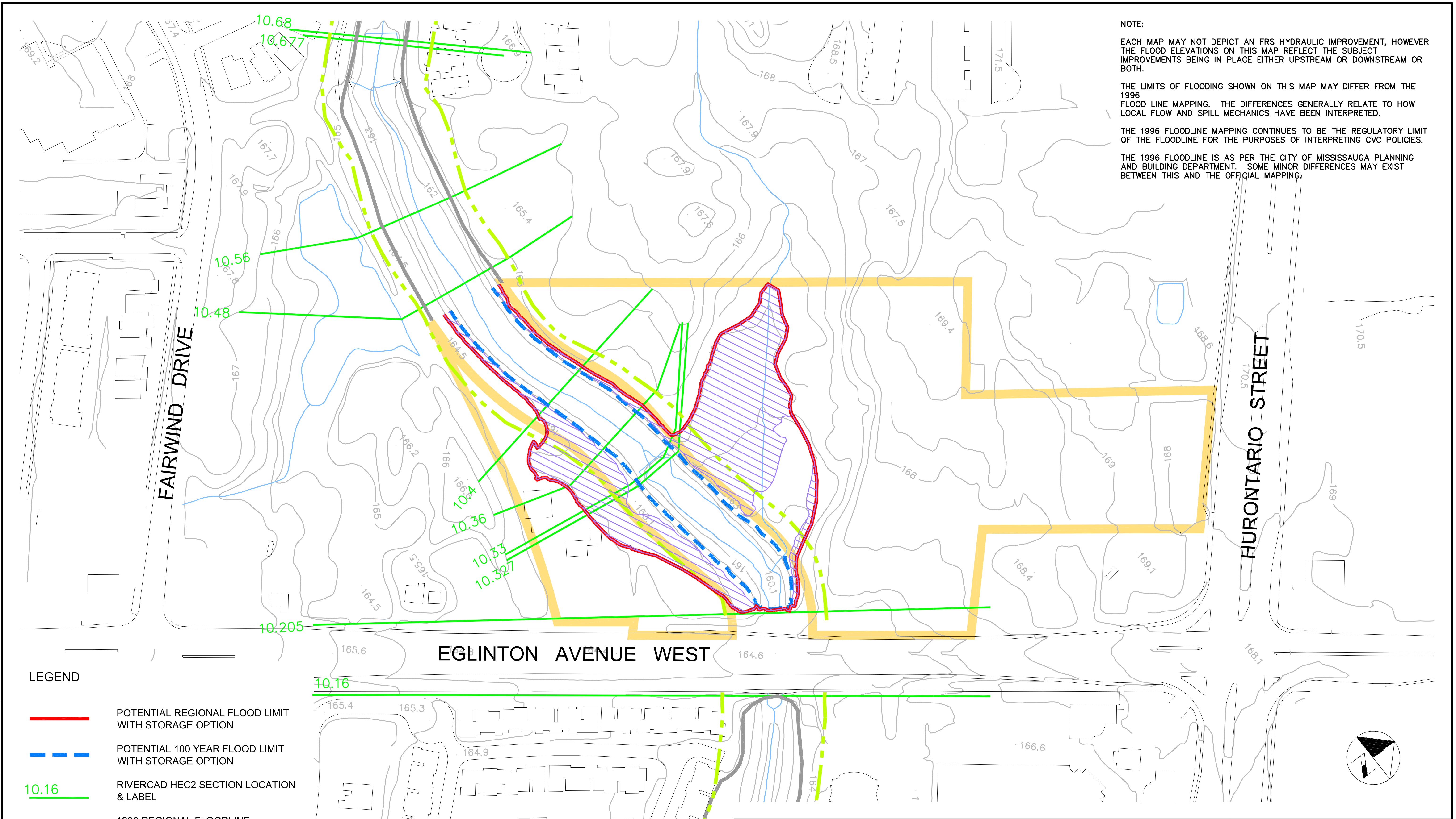
Feb. 18/03 – mbk



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LEGEND

🟥	POTENTIAL REGIONAL FLOOD LIMIT WITH STORAGE OPTION
– –	POTENTIAL 100 YEAR FLOOD LIMIT WITH STORAGE OPTION
10.16	RIVERCAD HEC2 SECTION LOCATION & LABEL
—	1996 REGIONAL FLOODLINE
🟨	DEVELOPMENT AREA
– · –	GOVERNING EROSION SETBACK
▨	SHALLOW FLOODING AREA REGIONAL EVENT (0-0.8m)

SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA
EGLINTON / HWY NO. 10 FLOOD POTENTIAL
STORAGE OPTION

PHILIPS ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	6-a

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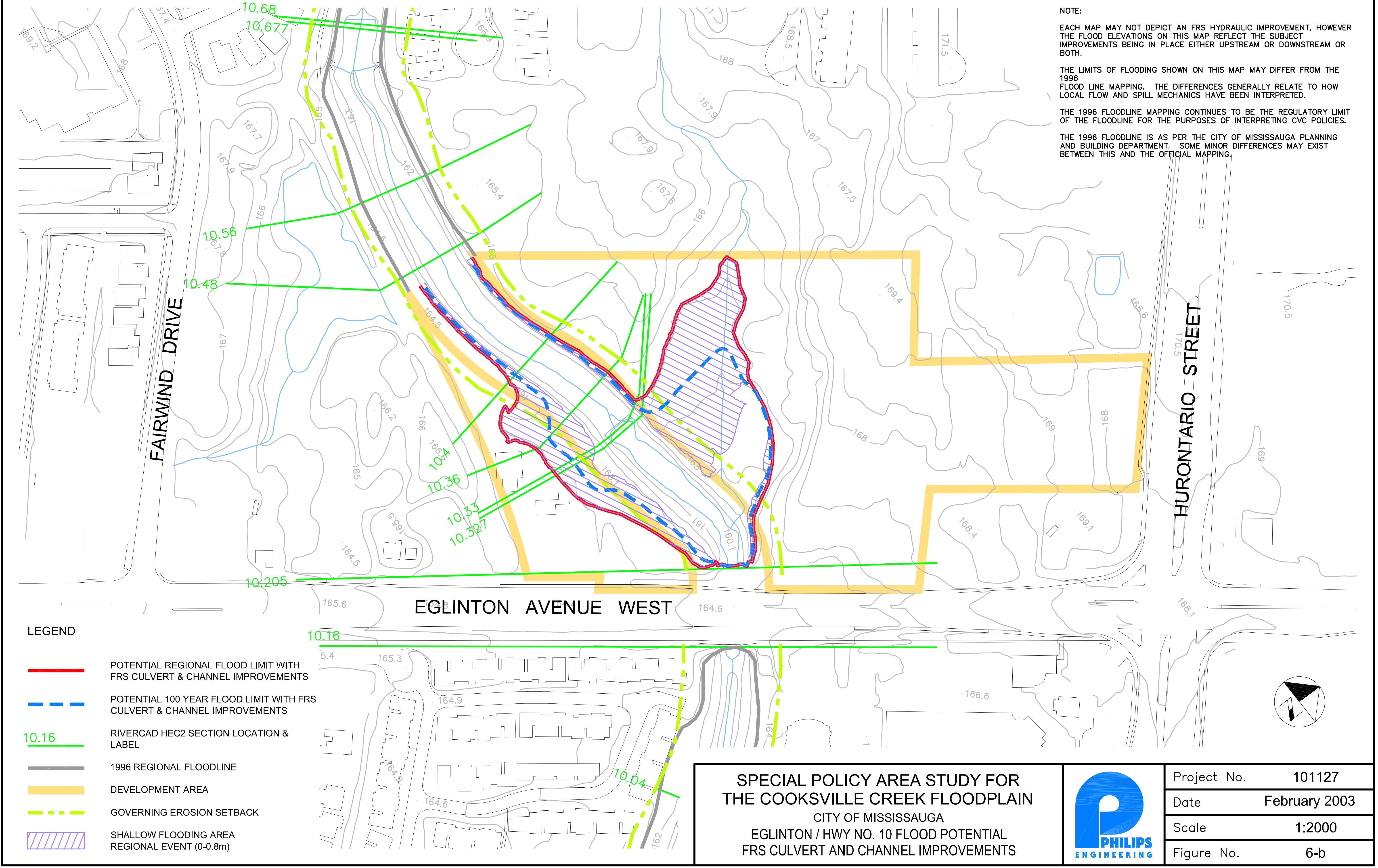
Feb. 21/03 – mbk



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LEGEND

━━	POTENTIAL REGIONAL FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS
‒ ‒ ‒	POTENTIAL 100 YEAR FLOOD LIMIT WITH FRS CULVERT & CHANNEL IMPROVEMENTS
10.16	RIVERCAD HEC2 SECTION LOCATION & LABEL
━━	1996 REGIONAL FLOODLINE
▬	DEVELOPMENT AREA
‒ · ‒	GOVERNING EROSION SETBACK
▨	SHALLOW FLOODING AREA REGIONAL EVENT (0-0.8m)

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
EGLINTON / HWY NO. 10 FLOOD POTENTIAL
FRS CULVERT AND CHANNEL IMPROVEMENTS

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:2000
Figure No.	6-b

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Feb. 21/03 – mbk

APPENDIX 'A'

POLICY EXTRACTS

r. The City may require ecologically based woodland management plans of the owner prior to municipal acquisition.

s. Where the Open Space network contains or abuts the Natural Areas System, the policies for the Natural Areas System will apply. The potential to expand or connect natural forms, functions, and linkages will be encouraged. The recreation potential of natural areas will be restricted in order to protect their viability. However, formalized passive uses may be a means of lessening the impacts of uncontrolled public access. *(CPA-78)*

t. Where lands defined as Natural Areas System by this Plan are privately owned, it is not intended that they be free and open to the general public nor that they will be acquired by the City or any other public agency. Consideration will be given, however, to public acquisition of these areas through the development approval process.

u. Environmentally Significant Area's (ESAs) classified by the Conservation Authorities are within the Natural Areas System, but not differentiated from other components of the Natural Areas System identified on Schedule 3, Environmental Areas.

v. Hazardous sites generally include sensitive marine clays, organic and peat soils, soils located in high water table areas and unstable bedrock. Development will be permitted on a hazardous site only if the site is/has been rehabilitated to remove or mitigate the hazard so that there is no remaining danger to public health or public safety or property damage.

w. Where uses may be safely located within a hazardous site, consideration of such development will need to address all of the following requirements:

   - the erosion and/or slope instability hazards can be safely addressed;
   - new or existing hazards are not created or aggravated;
   - no adverse environmental impacts would result;
   - vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies;
   - the development is carried out in accordance with established standards and procedures;
   - the development does not include institutional uses or essential emergency services or the disposal, manufacture, or treatment or storage of hazardous substances.

   Where any one or all of these requirements, cannot be fulfilled, the development will not be permitted to locate within the hazardous site.

x. Uses not permitted within any portion of a hazardous site include institutional, essential emergency services and the storage of hazardous substances.

y. In addition to the general policies for the Natural Areas System, the Greenbelt policies of this Plan will also apply to development within and adjacent to Valley and Watercourse Corridors.

z. There are a number of individual features that have special policies due to their unique attributes, these special features are addressed in the following sections.

4.2.2.2 Valley and Watercourse Corridors and the Lake Ontario Waterfront

Introduction

Valley and Watercourse Corridors and the Lake Ontario Waterfront provide ecological functions such as wildlife habitat and habitat passage, hydrological flow, connection or buffering from adjacent impacts. Of particular concern within Valley and Watercourse Corridors and the Lake Ontario Waterfront is the preservation and enhancement of fish habitat not only as an indicator of a healthy environment but also for leisure activity and tourism.

There are also hazards associated with Valley and Watercourse Corridors and the Lake Ontario Waterfront. To sustain the health of shoreline and watershed ecosystems, the local physical and ecological processes should be retained in an undisturbed state to the greatest extent possible and where feasible, enhanced. Effective natural hazards management can only occur on a comprehensive shoreline or watershed/subwatershed basis. Therefore, site-specific development activities need to be evaluated in the context of their potential impact on the overall physical and ecological processes occurring within the defined shoreline or watershed management area. Development activities that properly address the physical processes, yet threaten or pose adverse ecological impacts or vice versa are not in keeping with the Provincial Government interest of protecting the health and integrity of the shoreline and/or watershed ecosystems. The primary use will therefore, be preservation and conservation. Although physical hazards may be addressed through mitigative measures, development may still not be permitted on the basis of the ecological functions such areas may possess.

The Regulatory Floodline as defined by the appropriate Conservation Authority, will be the approved standard flood used to define the limit of floodplain lands for regulatory purposes. In recognition of Regulatory Floodplain development restrictions, the City generally uses the One Zone Concept. Schedule 3, Environmental Areas, also indicates areas where the Special Policy Area Floodplain Concept and Two Zone Floodplain Concept have been endorsed. Development within or adjacent to these areas is subject to the policies, criteria, and implementation procedures of other levels of government. *(CPA-78)*

The City will recognize the potential existence of hazardous lands outside of those areas which may exhibit unstable or organic soils, steep slopes, erosion, landslide susceptibility, or other physical hazards, and which may not come under the jurisdiction of the appropriate Conservation Authority.

Policies

a. The City acknowledges the importance of Valley and Watercourse Corridors as an integral part of the Natural Areas System. Valley and Watercourse Corridors are considered greenbelts and are not suited for development. Accordingly, through policy and programs, the City will strive to balance goals of ecological restoration and hazard protection.

b. The City, in consultation with the appropriate Conservation Authority, will consider a program for the restoration of urbanized watercourses and shorelines, including the use of native materials and buffer strips, where feasible, to improve ecological value.

c. Areas of fish habitat and potential fish habitat, listed in Appendix D: Areas of Fish Habitat and Potential Fish Habitat (Identified by Ministry of Natural Resources), will be protected from development. There are a number of options available for the protection of fish habitat such as the use of setbacks or vegetative buffers. Setbacks and buffers will be determined by the EIS.

d. Development will not be permitted within lands subject to flooding, erosion, or slope instability unless required for flood and erosion management or otherwise required by the City or other public agency and meet the requirements of the City and the appropriate Conservation Authority. *(CPA-78)*

e. Development will generally be subject to the One Zone Floodplain Concept except areas where the Special Policy Area Floodplain Concept and Two Zone Floodplain Concept have been endorsed.

f. The following uses will be permitted within the Regulatory Floodplain subject to the satisfaction of the appropriate Conservation Authority and the City:

- passive recreation activities;
- existing facilities, buildings, and structures will be recognized as legal non-conforming uses in the Zoning By-law. Reconstruction, minor additions, and maintenance of these facilities, buildings, and structures may be permitted subject to review.

g. The construction of buildings or structures permitted in or adjacent to the floodplain will be protected to the elevation of the Regulatory Flood. Additional flood protection measures to be implemented relative to individual development applications, will be determined by the appropriate Conservation Authority and the City. *(CPA-78)*

h. The following uses will not be allowed within the floodplain:

- institutional services such as hospitals, nursing homes, and schools;
- emergency services such as those provided by fire, police, and ambulance stations and electrical sub-stations;
- uses associated with the manufacture, storage, disposal, and/or consumption of hazardous substances or the treatment, collection, and disposal of sewage;
- new uses that are seen to have a detrimental impact on natural forms, functions, and linkages due to the nature of their operations, such as, golf courses, and agricultural functions;
- new transportation and utility corridors will not be contained within the floodplain, however, subject to review, may be permitted to cross floodplains; new sanitary sewers may be permitted subject to the policies of this Plan; *(CPA-78)*
- active recreational facilities.

i. Access for development adjacent to or within the floodplain will be subject to the appropriate Conservation Authority flood proofing standards and the policies of the City. *(CPA-78)*

j. Development adjacent to Valleys and Watercourse Corridors will be restricted within the identified hazard area. This limit is determined on a site by site basis and is defined by the combined influence of the stable slope allowance, erosion allowance, and the average annual recession rate. These parameters are determined through studies completed by the proponent to the satisfaction of the City and the appropriate Conservation Authority.

k. The following uses will be permitted within the identified hazard area, subject to the satisfaction of the appropriate Conservation Authority and the City:

- flood and/or erosion works;
- facilities which by their nature must locate near water or traverse watercourses (ie. bridges);
- ancillary facilities of an adjacent land use which are of a passive, non-structural nature and do not adversely affect the ability of the floodplain to pass flood waters.

l. Development may be permitted in areas within the identified hazard area where the following conditions can be met and the proposal satisfies the Natural Areas System policies of the Plan and:

- the erosion and/or slope instability hazards can be safely addressed;
- new or existing hazards are not created or aggravated;
- no adverse environmental impacts would result;
- vehicles and people have a way of safely entering and exiting the area during times of emergencies and
- development is carried out in accordance with established standards and procedures.

m. In cases where uses may be able to safely locate within the identified hazard area, all the conditions in the preceding subsection, must be addressed. Where any one or all of these conditions cannot be fulfilled, the development should be directed to areas outside the identified hazard area.

n. Uses not permitted include institutional, essential emergency services and uses associated with hazardous substances.

o. The City acknowledges the importance of the Lake Ontario shoreline as an element of the City structure and an important part of the Regional ecosystem. The Lake Ontario Shoreline is an important link between components of the Natural Areas System. Accordingly, through policy and programs, the City will strive to balance goals of ecological restoration and hazard protection.

p. Generally, the natural forms, functions, and linkages of the Lake Ontario Waterfront require restoration which will be incorporated into proposals, where possible. Modifications to the existing shoreline should contribute to healthy functioning of coastal processes and include the creation and enhancement of aquatic habitat. *(CPA-78)*

q. Lands covered by water are not suitable for development and will not be included in the calculation of density.

r. On lands adjacent to Lake Ontario, development will generally be directed to areas outside of the regulatory shoreline. The regulatory shoreline is comprised of three standards: the regulatory flood standard, the regulatory dynamic beach standard, and the regulatory erosion standard. The furthest landward limit of these three standards demarks the regulatory shoreline.

s. Development will not be permitted within the greater of:

- the regulatory dynamic beach standard;
- the regulatory flood standard;
- the regulatory erosion standard;
- the regulatory shoreline, where the area is to be used for institutional uses or essential emergency services or for the disposal, manufacture, treatment or storage of hazardous substances and/or sewage.

t. Development may be permitted in areas within the regulatory flood standard and regulatory erosion standards where the following conditions can be met and the proposal also satisfies the Natural Areas System policies of this Plan:

- the flooding and erosion hazards can safely be addressed;

- new or existing hazards are not created or aggravated;
- no adverse environmental effects will result;
- vehicles and people have a way of safely entering and exiting the area during times of flooding and erosion emergencies;
- development is carried out in accordance with established standards and procedures.

Where any one or all of these conditions and standards cannot be fulfilled, the development will be directed to areas outside the regulatory flood standard and/or the regulatory erosion standard.

u. Existing lots of record, additions and alterations to existing development will be subject to individual review at the time of application, having regard for potential environmental effects and hazards.

v. As a condition of development application approval of any lands designated Industrial, immediately adjacent lands to the shoreline of Lake Ontario, for any use other than industrial, all regulatory shoreline lands will be zoned Greenbelt and may be acquired by the City. Prior to any such acquisition, the applicant will be required to determine what shoreline protection works are required, if any, and will be encouraged to install such works to the satisfaction of the City, the appropriate Conservation Authority and other public agencies which have jurisdiction over the Lake Ontario Waterfront. *(CPA-78), (OMB Order No. 1196)*

w. *Deleted by OMB Order No. 1196. (CPA-78)*

4.2.2.3 Woodlands

a. All wooded areas are part of the Natural Areas System, and as such the general policies relating to the Natural Areas System will apply to woodlands.

b. Wherever possible, woodlands will be incorporated into the open space network. Where appropriate, these areas will be retained in a natural condition or be permitted to regenerate to assume a natural state. Public use for passive recreation will be restricted to lands which have been specifically acquired and developed for such purposes.

c. The City may require ecologically based woodlot management plans of the owner prior to municipal acquisition.

d. If a woodland is damaged or destroyed, the site will still be considered to be within the Natural Areas System, and these policies will be applied during a development proposal review. Restoration needs of the site will be determined through the review of studies required of the proponent. This policy may be superseded by a Regional or Municipal Tree By-law.

4.2.2.4 Wetlands

Introduction

A wetland may serve many functions including habitat provision, recharge and discharge of ground water, flood and erosion control, and water quality improvement. The Natural Areas System includes Provincially Significant Wetlands and Other Wetlands. Future studies may result in the identification of additional Provincially Significant Wetlands. *(CPA-6)*

Policies for Wetlands

a. No development will be permitted in a Provincially Significant Wetland or wetlands over 2 ha in size. Conservation, education, and nature appreciation activities may be allowed subject to review by the City and Provincial Government. *(CPA-78)*

b. New utilities and facilities will not be allowed within Provincially Significant Wetlands or wetlands over 2 ha in size. Maintenance of existing utilities and facilities are subject to review by the City and Provincial Government.

c. The uses permitted within the lands adjacent to a Provincially Significant Wetland, within 120 m, will include all the uses permitted within a wetland and existing agricultural activities. Consideration of development proposals requiring an approval under the *Planning Act* or new structures on vacant lots, will require the completion of a full or scoped site EIS, satisfactory to the City and the Provincial Government. *(CPA-78)*

d. The EIS must be approved before the application is dealt with by the City and will demonstrate that development will not result in any of the following: *(CPA-78)*

- loss of wetland functions;
- subsequent demand for future development which will negatively impact on existing wetland functions;
- conflict with existing site-specific

- sports parks;
- waterfront parks;
- special use parks.

d. The provision of recreational facilities within city parks will be responsive to identifiable needs and in general conformity with the guidelines contained in the *Future Direction for Recreation and Parks*.

5.8.3.3 Community Parks *(CPA-78)*

a. Community parks will be established, developed, maintained and will be designed to provide, where feasible:

- a range of recreational opportunities within walking distance of the home which could include social, cultural, educational and athletic activities of interest to the community;
- opportunities for active and passive recreation;
- opportunities for social interaction;
- multiple-purpose, year round activities.

b. Community parks will:

- be accessible for residents within 800 m of their homes;
- be as centrally located within the neighbourhood, as possible.

c. The provision of recreational facilities within community parks will be responsive to identifiable needs and in general conformity with the guidelines contained in *Future Direction for Recreation and Parks*.

5.8.3.4 Neighbourhood Parks

Deleted by Amendment No. 78. (CPA-78)

5.8.4 Greenbelt

Policies in this section address the use of greenbelt as potential areas for passive recreation. The Environment Section contains further policies dealing with flood and erosion control, drainage, and conservation of natural forms, functions, and linkages. *(CPA-78)*

Where natural areas are designated Greenbelt, they are deemed not suitable for urban development. Where a development proposal includes greenbelt lands which are required for purposes such as: lands required for conservation; lands required solely for drainage; lands susceptible to flooding; steep valley slopes; and lands below the top-of bank; such lands will be conveyed to the City or other public agency. Such lands will not be accepted as part of the parkland dedication contribution or credited against any cash-in-lieu of parkland payments or be included in the calculation of density for building coverage. Development adjacent to greenbelt lands will be subject to the delineation of the valley or watercourse corridor boundaries, buffers and setbacks by the City in consultation with the appropriate Conservation Authority.

The City may also request that proponents conduct site evaluation, site cleanup or management measures prior to conveyance of these lands. Dedication or restrictive zoning of buffers may also be required by the City in consultation with the appropriate Conservation Authority.

Although physical hazards may be addressed through mitigative measures, development may still not be permitted on the basis of the ecological functions such areas may possess.

The Greenbelt designation applies to both public and privately owned lands. Where Greenbelt land is privately owned, this Plan does not imply that it is free and open to the general public or that it will be acquired by the City or any other public agency. Consideration will be given however, to public acquisition of these areas through the development approval process.

In areas designated Greenbelt:

a. lands are reserved principally for flood and erosion management and conservation purposes; other uses which complement the principal conservation functions will be considered on their merit subject to the Environmental policies of this Plan;

b. linear, open space systems consisting primarily of bicycle and pedestrian pathways may be established, where they are compatible with the viability of the natural area, while respecting appropriate buffers from watercourses and valley slopes as determined in consultation with the appropriate Conservation Authority.

c. the construction of buildings or structures will generally not be permitted except those which are intended for flood and erosion management, or are otherwise required by the City, and meet the combined requirements of the City and the appropriate Conservation Authority. In certain instances, public facilities may be permitted where these are required for passive recreational purposes and will not cause environmental damage or affect flooding;

d. stormwater management facilities within the Greenbelt lands must have regard for the viability of natural forms, functions and linkages and may be subject to naturalization efforts as a part of development;

e. development will not be permitted to extend within the "regulatory storm" floodplain or the identified slope and/or erosion hazard areas associated with a watercourse or valley corridor if there are suitable areas on the property beyond the hazard areas. Reconstruction, minor additions, and maintenance of these facilities, buildings, and structures may be permitted subject to approval of the City of Mississauga and appropriate Conservation Authority;

f. Greenbelt lands will be subject to the additional requirements of this Plan contained in the policies relating to the Natural Areas System.

5.8.5 Cemeteries

5.8.5.1 Cemeteries are established under the jurisdiction of the Provincial Government according to the provisions of the *Cemeteries Act*. The Provincial Government air pollution controls apply to the operation of crematoria.

5.8.5.2 The City is responsible for the maintenance of a cemetery where the owner is not known, cannot be found, or is unable to maintain it. In such a case, the City is considered the owner of the cemetery.

5.8.5.3 Cemeteries and related facilities form part of the open space network. As cemeteries constitute an open space use, consideration will be given to public cemeteries being used for passive open space purposes. However, cemeteries that are privately owned are not intended to be open to the public.

5.8.5.4 The provision and operation of cemeteries and related facilities will be the primary responsibility of religious groups and other private groups. The City will operate and manage City-owned cemeteries in a cost-effective manner.

5.8.5.5 Location of Cemeteries and related facilities will be identified in this Plan and District Plans.

5.8.5.6 Cemeteries and related facilities will be located to minimize conflict with existing and future land use and transportation.

5.8.5.7 The development of new cemeteries or the enlargement of existing ones will be subject to site plan approval pursuant to the *Planning Act*. *(CPA-78)*

5.8.5.8 Crematoria, columbaria, and mausolea will be located only in cemeteries. *(CPA-78)*

2.4.3 Ravine, Valley and Stream Corridors

2.4.3.1 Objective

To prevent or minimize the risk to human life and property associated with *flooding*, erosion and/or slope instability.

2.4.3.2 Policies

It is the policy of *Regional Council* to:

2.4.3.2.1 *Support, as appropriate*, the policies and programs of the conservation authorities related to ravine, *valley and stream corridor* management and protection.

2.4.3.2.2 Direct the area municipalities, in consultation with the conservation authorities, to include in their official plans policies that *support* non-structural risk management measures and generally prohibit *development* and *site alterations* within the one hundred year erosion limit.

2.4.3.2.3 Direct the area municipalities, in consultation with the conservation authorities, to only consider *development* and *site alterations* within the one hundred year erosion limit, consistent with provincial policy if:

a) the erosion and/or slope instability hazards can safely be addressed;

b) new or existing hazards are not created or aggravated;

c) no adverse environmental effects will result;

d) vehicles and people have a way of safely entering and exiting the area during times of *flooding* and erosion emergencies; and

e) *development* and *site alterations* are carried out in accordance with *established standards and procedures.*

2.4.3.2.4 Discourage the creation of additional tableland within *valley and stream corridors*.

2.4.3.2.5 Generally prohibit the creation of new lots within *valley and stream corridors*.

2.4.4 Riverine Flood Plains

2.4.4.1 Objective

To ensure that *development* and *site alterations* do not create new or aggravate existing *Flood Plain* management problems along *flood* susceptible *riverine* environments.

2.4.4.2 Policies

It is the policy of *Regional Council* to:

2.4.4.2.1 Direct the area municipalities, in consultation with conservation authorities, to identify the lands subject to *flooding hazards*, in the appropriate planning documents, and in their official plans formulate objectives and policies for these lands.

2.4.4.2.2 Direct the area municipalities, in consultation with conservation authorities, to continue to address *riverine flood* susceptibility through the application of the one zone approach to *Flood Plain* planning and limited exceptions to the one zone, where appropriate, through the two zone and *special policy area* concepts, as outlined in provincial policy.

2.4.4.2.3 Encourage the conservation authorities to coordinate their regulations and *Flood Plain* and fill line identification regulations to ensure consistent application throughout *the region*.

2.4.4.2.4 Direct the area municipalities to include in their official plans, objectives and policies for the management of stormwater quality and quantity.

2.4.5 Other Natural Hazards

2.4.5.1 Objective

To ensure that new *development* and *site alterations* address other *natural hazards as appropriate*.

2.4.5.2 Policy

It is the policy of *Regional Council* to direct the area municipalities to include policies in their official plans which address other naturally occurring hazards, such as those created by topographic constraints, in accordance with the objectives and policies in this Plan, provincial policy and related planning documents.

2.5 RESTORATION OF THE NATURAL ENVIRONMENT

In many parts of *Peel*, settlements and land uses have diminished and in some areas, degraded the natural environment. As a result, the resilience of the *ecosystem* to cope with further change may be reduced. The quality and *integrity* of these *ecosystems*, as well as their healthy condition, may be re-established through the *restoration* of a diminished site. The degrading of the natural environment has also resulted in the fragmentation of historic *natural corridors* and linkages. Opportunities may exist to re-establish such links along existing linear features.

2.5.1 Objective

To seek opportunities to enhance the Greenlands System in *Peel* by restoring and enhancing degraded components of the *ecosystem* and by extending the network of natural areas where ecologically beneficial.

2.5.2 Policies

It is the policy of *Regional Council* to:

2.5.2.1 Promote a wide range of environmental *enhancement* and *restoration* opportunities.

2.3 The Authority shall encourage the watershed municipalities which contain formally recognized Regulatory Flood Plains, watercourses, and /or associated valleylands and related natural areas (e.g. wetlands), to initiate the process to designate and zone these areas on an appropriately restrictive land use category.

2.4 The Authority shall encourage the watershed municipalities to adopt long range plans and policies for management, use, and potential acquisition of Regulatory Flood Plains, wetlands, watercourses, and associated valleys and/or valley systems and related natural areas.

3.0 LOT CREATION

3.1 General

The Authority will discourage ownership fragmentation of valleylands, Environmentally Significant Areas, wetlands and Regulatory Flood Plains in consideration of long term management concerns related to the protection of life and property, and natural environmental integrity, including the conservation of lands.

and subdivision

3.2 Severances (Consents)

3.2.1A The Authority shall require that new lots created through consent not extend below the 'Regulatory Flood Plain', the top of bank, or within the Stability Component and/or the Erosion Component associated with a valley slope or watercourse, as defined by the CVCA, whichever is greater. (The approved procedures for establishing the Stability and Erosion Components are outlined in Appendix A to these policies). (For exceptions see 3.2.2.).

3.2.1B The Authority shall encourage the dedication of those lands defined by 3.2.1A above, to the respective municipality or other appropriate public agency for conservation purposes.

3.2.1C The Authority shall require confirmation that a suitable building envelope, as defined by the Authority, exists within the parcel to be created, while maintaining the required setback as follows:

For defined valley slopes, the setback shall be the Development Setback Component, and shall therefore be a minimum distance of 5 metres, which shall be measured from the approved top of bank or from the combined distance from the Stability and Erosion Components; or the setback shall be 5 metres measured from the 'Regulatory Flood Plain'; whichever is greater.

For undefined valley slopes, the setback is based upon the following:

-the need to protect the flood plain from disturbance, and to provide for a freeboard;
-the need to protect against potential impacts related to stream bank erosion; and
-the need to protect riparian and fish habitats and water quality.

Therefore, the minimum setback shall be represented by the greater of the following:

i) 5 metres horizontal measured from the limit of the Regulatory Flood Plain (Figure A type I) or;

ii) 15 metres measured from the channel bank for a warm water or altered fisheries stream or 30 metres measured from the channel bank for a cold water potential coldwater fisheries stream (1) (Figure A Type 11); or

iii) 5 metres measured from the **Erosion Component** for the channel bank (2) (Figure By Type 111); or

iv) 5metres measured from the combined distance of the Erosion Component and Stability Component (i.e. channel bank height is greater than 2 metres)(2) (Figure B Type iv).

(In this regard, it is recommended that the applicant also give due consideration to appropriate provincial or municipal standards and /or by-law requirements).

3.2.1D The Authority may require that the applicant provide a satisfactory site plan prior to the registration of the new lot(s).

3.2.1E The Authority shall review and approve a site and grading plan for the lot(s) or block(s) adjacent to the lands identified in 3.2.1 A) above, or containing the lands identified in 3.2.1C above prior to the issuance of building permit(s) by the respective municipality.

3.2.2 Exceptions

An exception to 3.2.1A of the aforementioned policy may be granted, provided that:

i) the respective municipality or other appropriate public agency is not willing to assume ownership of the Regulatory Flood Plain, watercourse and/or associated valleylands through dedication; and ,

ii) that Authority staff approve a detailed site and grading plan for the subject lot containing the above noted lands prior to the issuance of a building permit by the respective municipality.

Footnotes:
1. Refer to M.N.R., M.O.E., Interim Stormwater Quality Control Guidelines for New Development, May 1991
2 . This set back represents the Development Setback Component as defined in Appendix A of this document.

3.3 Subdivisions

3.3.1A The Authority shall require that new lots created through the subdivision of land, not extend below the 'Regulatory Flood Plain', the top of bank, or within the Stability Component or the Erosion Component associated with a valley slope, or watercourse as defined by the Authority, which is greater. (The approved procedures for establishing the Stability and Erosion Components are outlined in Appendix A to these policies). (For exceptions see 3.3.2)

3.3.1B All lands below this approved limit shall be maintained in a single block and zoned in an appropriately restrictive land use category. (e.g. 'Open Space', 'Hazard Land' or 'Greenbelt'). (For exceptions see 3.3.2)

3.3.1C The Authority shall encourage the dedication of those lands defined by 3.3.1A above to the respective municipality or other appropriate public agency for conservation purposes.

3.3.1D The Authority shall require, from the applicant, confirmation prior to Draft Approval, that a suitable building envelope, as defined by the Authority, exists on each of the lots and/or blocks to be created while maintaining the required setback as follows:

For defined valley slopes,

The setback shall be the Development Setback component, and shall therefore be a minimum distance of 5 metres, which shall be measured from the approved top of bank or from the combined distance derived from the Stability and Erosion Component; or the setback shall be 5 metres measured from the toe of the valley slope; or the setback shall be 5 metres measured from the 'Regulatory Flood Plain'; whichever is greater.

For undefined valley slope, the setback is based upon the following:

-the need to protect the flood plain from disturbance, and to provide for a freeboard;
-the need to protect against potential impacts related to stream bank erosion; and
-the need to protect riparian and fish habitats and water quality.

Therefore, the minimum setback shall be represented by the greater of the following:

i) 5 metres horizontal measured from the limit of the 'Regulatory Flood Plain' (figure A type I) or;

ii) 15 metres measured from the channel bank for a warmwater or altered fisheries stream or 30 metres measured from the channel bank for a cold water or potential coldwater fisheries stream (1) (Figure A type ii); or

iii) 5 metres measured from the Erosion Component for the channel bank (2) (Figure By Type 111);or

iv) 5 metres measured from the combined distance of the Erosion Component and Stability Component (i.e. channel bank height is greater than 2 metres) (2) (Figure B Type iv).

(In this regard, it is recommended that the applicant also give due consideration to appropriate provincial or municipal standards and /or by law-requirements).

Footnotes:

1. Refer to M.N.R., M.O.E., Interim Storm Quality control Guidelines for New Development, May 1991 for fisheries stream classification see Figures C1, C2 &C3.

2. This setback represents the Development Setback Component as defined in Appendix A of this document.

3.3.1E The Authority shall review site and grading plans for all lots and/or blocks adjacent to the lands identified municipality.

3.3.1F All lands located within the setback area defined by 3.3.1D above, may remain as part of the lots or blocks in the subdivision but shall be zoned in the appropriate 'Open Space' or 'Greenbelt' category.

3.3.1G In addition to the above, the Authority shall require, if appropriate, that a warning clause be included in the Agreements of Purchase and Sale and registered on the title of all affected lots and/or blocks by the applicant, indicating that those lands within the setback area defined by 3.3.1D shall be maintained in a natural condition, or enhanced, to promote the environmental integrity of the adjacent watercourse and/or valleylands. The construction of any building or structure including swimming pools, decks, patios and tennis courts shall not be permitted within the setback area.

3.3.2 Exceptions

A An exception to 3.3.1A of the aforementioned policy may be granted, provided that:

i) the respective municipality or other appropriate public agency is not willing to assume ownership for these lands through dedication.

B An exception to 3.3.1B of the aforementioned policy may be granted, where the lands defined by 3.3.1A above will not be maintained in a single block, provided that these lands are zoned in an appropriately restrictive land use category (e.g. 'Open Space' 'Hazard Land' or 'Greenbelt').

4.0 EXISTING LOTS

4.1 General Provisions

A The following policies apply to existing lots and shall be implemented by the Authority the review of applications under the Planning Act, the Niagara Escarpment planning and Development Act, the Building Code Act, and/or application made pursuant to the Regulation for construction and/or fill placement.

4.2 New Development

A New development shall be defined as the construction, erection or placement of a building or structure, or a major addition or alteration to an existing building or structure, or the construction of other works which alter surface topography, soil and drainage characteristics, and may result in the removal of stabilizing vegetation (e.g. roads and parking lots).

B New development shall not include accessory or ancillary buildings or structures or any major additions thereto.

C A major addition is defined as that which is greater that 18.6 sq. m. (200 sq. ft.)

D New development will not be permitted on lands described by Section 4.5 below that would subject life and property to significant risk.

E New development will not be permitted on lands described by Section 4.5 below, which would affect the control of pollution or the conservation of land.

F Notwithstanding D) and E) above, every reasonable attempt must be made to locate new construction outside of the lands described by Section 4.5 below.

4.3 Reconstruction and Minor Additions

A) Reconstruction shall be defined as the restoration of a building or structure to its original form (i.e. same dimensions, square footage, and footprint).

B) A minor addition shall be defined as construction of a structure which is less than or equal to 200 sq. ft.. A minor addition does not require a formal permit under Ontario Regulation 146/90, as amended, provided that it is not in the flood plain, a minimum setback of 5 metres from the top of bank or toe of a valley slope, and 15 metres from the channel bank of any watercourse is maintained.

C) Notwithstanding Section A) above, when commenting on an application for reconstruction of a building or structure under the Regulation, the Planning Act or other applicable legislation, every reasonable attempt must be made to locate the structure out of the lands described by section 4.5.1 or section 4.5.2 below.

4.4 Non-Habitable Accessory or Ancillary Buildings and Structures and Minor Landscaping

A) Non-habitable accessory or ancillary buildings and structures exceeding 500 sq. ft. (46.5 sq.m) shall be constructed outside the lands described by section 4.5.1 or 4.5.2 below.

B) Non-habitable accessory or ancillary buildings and structures of less than or equal to 500 sq. ft. shall maintain a minimum 5 metre setback from the top of bank or toe of a valley slope.

C) Non-habitable accessory or ancillary buildings and structures less than or equal to 500 sq. ft. do not require a formal permit under Ontario Regulation 146/90, as amended, provided that a minimum 5 metre setback from the top of bank or toe of a valley slope and 15 metre setback from the channel bank of any watercourse is maintained.

D) Notwithstanding Section B) above, it is recommended that any accessory structure be located outside the lands described by section 4.5.1 or section 4.5.2 below, to the extent feasible.

E) Notwithstanding 4.2), placement of fill less than or equal to 30 cubic metres within or adjacent to a valley for minor landscaping purposes does not require a formal permit under Ontario Regulation 146/90, as amended, provided that a minimum setback of 15 metres from the channel bank of any watercourse, and 5 metres from the top of bank or toe of a valley slope, is maintained, and the filled and re-graded area is immediately stabilized.

4.5 Setback Requirements

Defined Valley Slope

For existing lots within or adjacent to defined valleys, the total setback shall be the identified slope hazard area, plus a distance, if necessary, such that the total horizontal distance from the top of bank or toe of the valley slope is not less than 5 metres. Authority flood proofing policies shall also apply, as appropriate.

FYI
- no need to include in report

Ill-defined Valley Slope

For existing lots within ill-defined valleys, the total setback shall be the identified slope hazard area associated with the channel bank, plus a distance, if necessary, such that the total horizontal distance from the top of the channel bank is not less than 5 metres. Authority flood proofing policies shall also apply, as appropriate.

5.0 EROSION CONTROL

5.1 General

The Authority will not support the installation of erosion control measures, within defined valleys or on the bank watercourses, which have been designed to facilitate new development.

5.2 Exceptions

When erosion control measures are warranted to protect existing buildings and/or structures and related property, and/or to provide repairs to existing works, or to rectify documented Authority erosion hazard sites, the following criteria shall apply:

A) The erosion control measures will designed in accordance with sound engineering principles and in an environmentally compatible manner, and will also be consistent with municipal objectives and other relevant Provincial and Federal legislation.

B) The design of erosion control measures must consider the natural fluvial geomorphology of the upstream and downstream reached.

C) Stabilization through vegetative means shall be given primary consideration in the design.

D) The municipality will be responsible for the maintenance of the completed measures.

E) Satisfactory detailed site restoration and rehabilitation plans will be required from the applicant for all areas disturbed within the bed of the watercourse and riparian zone and/or valley lands.

1.0 FLOODPROOFING OF BUILDINGS AND STRUCTURES

1.1.0 NEW DEVELOPMENT

1.1.1 General Provisions

A New development shall be defined as the construction, erection or placing of a building or structure; or a major addition or alteration to an existing building or structure below, at, or above grade, that has the effect of substantially increasing the size, density, or the usability thereof.

B New development shall not include accessory or ancillary buildings or structures or any major additions thereto.

C **A major addition is defined as that which is greater than 200 sq.ft. (18.6 sq.m).**

D New development will not be permitted in defined flood plain areas that have depths greater than 0.8 metre (2.6 feet) or velocity grater than 1.7 m/s (5.5ft/s) under the "Regulatory Flood'. In this regard, the placement of fill to meet these criteria shall not be permitted.

E Notwithstanding Sub-section D) above, new development will not be permitted in defined flood plain areas that would result in a measurable reduction in the flood conveyance capability and/or storage capacity, of the subject reach of the watercourse, or cumulatively affect the control of flooding, pollution or conservation of land.

F Notwithstanding all of the above, every effort must be made to locate new development in the are of lowest risk from the flood hazard.

G Dry, passive flood-proofing to the level of the 'Regulatory Flood' is required, plus a free board of 0.3 metre (1 foot), where feasible. Reference shall be made to the current version of the Authority's Floodproofing Guidelines.

1.1.2 Habitable Buildings or Structures

A Construction of a habitable or residential building, structure or major addition shall not be permitted, unless it can be reasonably and adequately dry-flood-proofed to the level of the 'Regulatory Flood', plus, where feasible, a freeboard of 0.3 metre (1 foot).

B Notwithstanding A) above, and given concerns related to floodplain storage and the potential for structural damage to basements and foundations due to hydrostatic forces, habitable dry flood-proofed basements shall be discouraged.

C For major additions, where the existing habitable building or structure is more flood vulnerable than the addition, it is recommended that it's level of flood-proofing be enhanced through structural renovations

D The design of a major addition shall be such that it is protected against flooding through the existing building or structure to the level of the "Regulatory Flood". In addition, if the existing building will be supporting the major addition, as in the case of a second story addition, the existing building must meet the requirements under the General Provisions Section (1.1.1)

1.1.3 Industrial and Commercial Buildings and Structures

A Where dry, passive flood-proofing to the level of the "Regulatory flood is not feasible, then wet flood-proofing to the level of the "Regulatory Flood" will be required.

B Notwithstanding the General Provisions (Section 1.1.1, and A) above, the Authority recognizes that industrial or commercial buildings or structures, may by their nature, be required to be wet-flood-proofed.

1.1.4 Hazardous Substances, Institutions and Essential Services

New development of this nature is defined by Sections 1.1.1A and B), and that it is:

A Associated with the manufacture, storage, disposal and/or consumption of hazardous substances or the treatment, collection and disposal of sewage, which would pose an unacceptable threat to public safety if they were to escape their normal containment/use as a result of flooding or failure of flood-proofing measures;

B Associated with institutional services, such as hospitals, nursing homes and schools, which would pose a significant threat to the safety of the inhabitants (e.g.-the sick, the elderly, the disabled or the young), if involved in an emergency evacuation situation as a result of flooding or failure of flood-proofing measures; or

C Associated with services such as those provided by fire, police and ambulance stations and electrical substations, which would be impaired during a flood emergency as a result of flooding or failure of flood-proofing measures

1.1.4.1 Such new development shall not be permitted to locate in the "Regulatory Flood Plain"

1.1.4.2 Where new development identified above, and which by its nature may need to be located within the "Regulatory Flood Plain", and which is not considered to pose and unacceptable risk to public safety, flood proofing of the development may, due to its sensitive nature, predominate other Authority flood plain concerns.

1.1.5 Seasonal Buildings or Structures

Seasonal, habitable buildings or structures, and major or minor additions to same, shall be subject to the same level of flood-proofing as permanent habitable buildings or structures. (In this regard, refer to Sections 1.1.1 and 1.1.2 of these policies).

1.2.0 Minor Additions

1.2.1 **A minor addition shall be defined as construction, erection or placing of a habitable building or structure of any kind, which is less than or equal to 200 sq. ft. (18.6 sq.m). This is to be based upon the floor area which existed at the time these policies were first approved (1990-06-21).**

1.2.2 A minor addition to an existing building or structure in a defined flood plain area may be permitted, if it can be flood-proofed to a level consistent with the existing structure.

1.2.3 Dry, passive flood-proofing to the level of the 'Regulatory Flood' is recommended, but not required.

1.2.4 Wherever possible, consideration should be given to enhancing the level of flood-proofing for the existing building or structure.

1.2.5 A minor addition shall, to the extent feasible, be located such that it will not negatively impact on flood conveyance and/or storage.

1.3.0 Buildings and Structures Demolished or Destroyed

1.3.1 Reconstruction shall be defined as the restoration of a building or structure to its original form (i.e: same dimensions, square footage, and footprint); and it shall not be subject to the construction component of the Authority's Regulation.

1.3.2 Notwithstanding Section 1.3.1 above, when commenting on an application for the reconstruction of a building or structure in a defined floodplain area under the Planning Act or other applicable legislation, then dry, passive flood-proofing to the level of the Regulatory Flood, and relocation of the structure ti the least flood susceptible portion of the property, to the extent feasible, will be encouraged

1.3.3 Notwithstanding Section 1.3.1 above, an application under the Planning Act or other legislation to reconstruct a building or structure in the area of significant risk, which has been destroyed by flooding, and which would be subject to the equivalent level of risk, shall not be supported.

1.4.0 Non-habitable Accessory or Ancillary Buildings and Structures and Minor Landscaping

1.4.1 Non-habitable accessory or ancillary buildings or structures exceeding 500 sq. ft. (46.5 sq. m) shall be wet flood-proofed to the level of the "Regulatory Flood". Reference shall be made to the current version of the Authority's Flood-proofing Guidelines.

1.4.2 Flood-proofing is recommended, but not required, for structures of less than or equal to 500 sq. ft. (46.5 sq. m). Such new construction may be considered to be non-flood-proofed.

1.4.3 Non-habitable accessory or ancillary buildings and structures less than or equal to 500 sq. ft. (46.5 sq. m) do not require formal permit approvals under Ontario Regulation 146/90, as amended, provided that a minimum setback of 15m is maintained from the channel bank of any watercourse.

1.4.4 Pedestrian bridges in the floodplain shall be designed and constructed in accordance with the current version of the Authority's Technical Guidelines.

1.4.5 On-site sewage disposal systems shall, where feasible, be located outside of the most frequently flooded portion of the flood plain as determined by the Authority (i.e: 25 year, if known). This policy, however, may be superceded by more stringent provincial requirements.

1.4.6 Notwithstanding 1.4.2 and 1.4.3, when commenting on an application for a non-habitable structure which is less than or equal to 500 sq. ft., under the Planning Act or other applicable legislation, the structure should be located to the least flood susceptible area, and the flood-proofing of the structure, to the extent feasible, will be encouraged.

1.4.7 The placement of fill less than or equal to 30 cubic metres in volume within the Regulatory Flood Plain for minor landscaping purposes does not require formal permit approvals under Ontario Regulation 146/90, as amended, provided that a minimum setback of 15 metres from the channel bank of any watercourse, and 5m from the toe of a valley slope is maintained, and the filled and graded area is immediately stabilized.

1.5.0 Maintenance of Existing Buildings and Structures

The maintenance of an existing building or structure shall be encouraged to incorporate flood-proofing measures to the highest feasible extent.

2.0 FLOODPROOFING OF ACCESS AND PARKING

2.1.0 LOT CREATION OR MAJOR REDEVELOPMENT

2.1.1 Dry or flood free access and parking shall be encouraged to the extent feasible

2.1.2 Notwithstanding the above, access roads and/or parking facilities which are existing or proposed, related to the creation of new lots (through consent or plan of subdivision) or major redevelopment or intensification (as may be proposed through a site plan or rezoning application) shall satisfy the following depth and velocity criteria for pedestrians and automobiles:

A For depths up to and including .2 metres (0.7 feet) the velocity must be less than or equal to 1.7 m/s (5.5 ft./s) (based on the Regulatory Flood)

B For depths greater than .2 metres (0.7 feet) and less than or equal to .3 metres (1 foot), velocity must be less than or equal to 1.3 m/s (4.2. ft./s) (based on the Regulatory Flood).

2.1.3 Where such new development requires access onto an existing flooded municipal or provincial roadway, this access must have depths and velocities less than or equal to those experienced on the existing roadway. Furthermore, if these depths and velocities exceed those noted above in 2.1.2, then safe, reasonable and adequate access, alternate access for pedestrians and automobiles, to a municipal or provincial road must be available. Such alternate access must be guaranteed in perpetuity, or until additional alternate access is available.

2.2.0 EXISTING LOTS

2.2.1 Access and/or parking facilities related to development on existing lots of record must conform to the following depth and velocity criteria for pedestrians:

Maximum Depths & Velocities for Pedestrians

Acceptable Depths for Pedestrians (Maximum Depth 0.8 metres)	0.1m	0.2m	0.3m	0.4m	0.5m	0.6m	0.7m	0.8m
Acceptable Corresponding Maximum Velocities for Pedestrians (Maximum Velocity 1.7m/sec)	1.7m/s (or less)	1.7m/s (or less)	1.3m/s (or less)	1.0m/s (or less)	0.8m/s (or less)	0.7m/s (or less)	0.6m/s (or less)	0.5m/s (or less)

(Based on the Regulatory Flood)

2.2.2 Where such development requires access onto an existing flooded municipal or provincial roadway, this access must have flood depths and velocities less than or equal to those experienced on the existing roadway. Furthermore, if these depths and velocities exceed those noted in 2.2.1, then safe, reasonable and adequate, alternate access for pedestrians to flood free lands must be available.

2.2.3 Reconstruction, or additions to existing buildings or structures on existing lots, which would not increase the density or intensity of use shall not be subject to the aforementioned access and parking policies.

2.2.4 Given their relationship to valleyland uses, and their traditional day time use, parking facilities for existing and/or approved public or municipal open space uses will generally be permitted; while encouraging the highest feasible of flood level protection. Concerns related to flood conveyance capability and/or storage capacity and other Authority policies, must, however, be satisfactorily addressed.

4

2.3.0 PROVINCIAL HIGHWAYS AND MUNICIPAL ROADS

2.3.1 Primary consideration shall be given to providing safe conditions for pedestrians and automobiles.

2.3.2 The Ministry of Transportation for Ontario and member municipalities shall be encouraged by the Authority to upgrade the design of their respective roadways, located within the Regulatory Flood Plain, when feasible, in consideration of related storage and conveyance concerns, such that the flood risk is reduced or eliminated.

2.3.3 The Authority will require that:

A The design of new roads, highways and/or noise barriers, shall, to the extent feasible, prevent reductions in the flood conveyance capability and/or storage capacity of the subject watercourse reach.

B Every effort shall be made to design new roads and highways such that they are flood free. Where this cannot be reasonably achieved, the policies under Section 2.1.0 shall apply.

APPENDIX 'B'

CORRESPONDENCE – CONSULTATION

CVC
CREDIT VALLEY
CONSERVATION

RESOLUTION

Date: March 21, 2003

Resolution No.

Moved By:

Seconded By:

RESOLVED THAT *the report entitled "Cooksville Creek – Recent Studies, Cooksville Creek Flood Remediation Plan (May 2002), Special Policy Area Study for the Cooksville Creek Floodplain (February 2003) be received.*

THAT *the findings and recommendations be endorsed for future implementation to ensure the longterm protection and enhancement of Cooksville Creek as well as protection to existing residents.*

CARRIED

4

Memorandum

MISSISSAUGA

PLANNING & BUILDING
RECEIVED
MAR 14 2003

Division	Action	Info	Seen
Commissioner			
Building			
Policy Planning			Jc
Dev. & Design			
Admin. & Tech.			

EC.011.COO

LP

To: Lesley Pavan
Policy Planning Division

From: Lincoln Kan
Infrastructure & Environmental Planning

Date: March 12, 2003

Re: Special Policy Area Study For The Cooksville Creek Floodplain Final Draft - February 28, 2003

The Infrastructure & Environmental Planning Section has reviewed the above noted report and advises that we find this report satisfactory. Comments concerning clarifications and minor revisions are listed below. However, there are two issues that would require further discussions among the steering committee. First, the implementation of the corridor limits identified in this report since the procedure used in their determination is not in the CVC or the City's policies. Second, the interim two-zone approach for the Consulate Property and the financial responsibilities of the property owner with respect to the QEW culvert enlargement.

1. Under 2.3 *Flood Storage Assessment*, it is noted that the approach of flood flow attenuation upstream of man-made structures is not without precedent in the City, i.e., CNR crossing of Applewood Creek (person communication with Kealy Dedman). However, through discussions with Mr. Brian Chan and Ms. K. Dedman, it is the City's understanding that the attenuation affect of the CNR crossing was not designed as such. This issue needs to be clarified to confirm its validity.

2. Under *5.4 Recession Rates*, page 34, second line, the conversation of 0.06 m to imperial should be 2.4 inches/year and not 0.8 inches/year as stated. Also, please clarify the location of Mutual Rd. as indicated on this page.

3. Within the body of this report, references have been made to the undeveloped portions of the watershed as being 6% and 7%. This figure should be revised to reflect consistency within this document.

4. Under *8.1.1 Lakeshore Road/Inglis Property, Structural Management Opportunities*, the second paragraph stated that Table 8.1 provided a summary of on-site flood elevations including the upgraded culvert. However, this information is only provided in Appendix F and not Table 8.1. Also, under *Consideration of Design Alternatives*, an erosion corridor of 89.5 m has been specified as established in this study. However, according to Table 5.4, a corridor width of 85.9 m has been recommended.

5. Under *8.1.2 Consulate Property Camilla Road - North of the Queen Elizabeth Way, Structural Management Opportunities*, reference was made to the natural floodplain zone shown in Appendix F. This figure should be revised by removing the two spill

zones south of the QEW. Under *Ingress/Egress* of the same subsection, please provide clarification as to why, after culvert replacement, both Camilla Road and North Service Road will remain spill prone.

6. Under *8.1.4 Humenik Lands (Shepard Avenue), Special Policy Area*, it is noted that if channelization is infeasible, there are two policy options available. The lands can be maintained as a one-zone area or the establishment of this area as a Special Policy Area. Please advise as to why a two-zone area is not included as an available option. This is also reflected in Table 8.7 under Description/SPA.

c. Richard Tupholme

CVC
CREDIT VALLEY
CONSERVATION

RECEIVED
PHILIPS ENGINEERING LTD.
JAN 0[illegible] 2003
FILE No. 15112 7-10

December 17, 2002

City of Mississauga
300 City Centre Drive
Mississauga, Ontario
L5B 3C1

Attention: Ms. Lesley Pavan

Re: Comments on the Report on Special Policy Area Study for the Cooksville Creek Floodplain, Interim Report #2, October 31, 2002

Dear Lesley

We have now completed our review of the above named report and would like to offer the following comments for consideration by the City. We would like an opportunity to discuss these concerns with you at a meeting. This letter is divided into 3 major parts. The first part summarizes our major concerns, the second part provides more detailed comments, and the third part discusses an approach which will allow us to move forward.

Summary of Major Concerns

We recommend that only **one (1)** Regulatory Floodline be presented in the SPA Study. Presenting the Regional Floodline and the 1996 Floodline will lead to confusion and misinterpretation among the public and developers. We recommend that any issues related to the plotting of the floodlines and the HEC-2 model should be resolved before analyzing any of the structural alternatives. We recommend that the SPA be paused until the Regulatory Flood Plain is agreed upon.

Credit Valley Conservation 1255 Old Derry Road, Mississauga, Ontario L5N 6R4
Phone (905) 670-1615 Fax (905) 670-2210

"Conservation Through Cooperation"

A split flow analysis is the preferred method of calculating water levels upstream of a spill embankment. The split flow analysis requires significant effort given that two (2) profiles and a combined rating curve must be calculated at each crossing where spills occur. In addition, flow rates downstream of spills are not to be reduced according to Flood Damage Reduction Program standards.

If the Consultant wishes to undertake the proposed side weir approach then further documentation (i.e. discussion on the methodology, weir lengths, cross-section locations, and rating curves) is required.

7. Feasibility Assessment of Structural Alternatives

page 59, Flood Proofing - the last sentence should be changed from "Existing buildings...." to "Some existing buildings....".

page 59, Recommended Flood Remediation Plan, 1st paragraph - recommended measures from the FRS should be separated from the recommendations from the current SPA study.

page 59, Recommended Flood Remediation Plan, 1st paragraph - statements made regarding stormwater management may generate a liability for the City and the CVC. Although development may not increase the level of flooding, development will probably increase the frequency and the duration of flooding. Both may violate downstream riparian land owner rights.

page 61, 1st paragraph, last sentence - the sentence should be corrected. The 2002 Cooksville Creek FRP did not specifically look at controlling 25 year flows. For the 100 year event, there was a 25% reduction in peak flow rates at Dundas Street. This was the maximum reduction possible. Since any pond would be filled for the Regional Storm, no buildings would be removed from the Regulatory Flood Plain. No further storage alternatives were investigated.

page 61, Supplemental Flood Storage Assessment, sentence 4 - it should be noted that the majority of potential flood damages are located downstream of the confluence of the East and Main Branch and that online storage would be of marginal benefit downstream of the confluence.

C-1

Table 7.6, Eglinton Avenue North (West ??) Case (a) - we disagree with the statement "sizeable difference between 100 year and Regional floodplain. See Figure 7a.

Figures 1 through 7 - the line labelled "Registered Regional Floodline" should be relabelled "1996 Regional Floodline".

Figures 1 through 7 - the Registered Regional Floodline should be compared with the 1996 Regional Floodline and corrected where necessary. The Registered Regional Floodline is located through buildings, islands are missing, and enclosed at spill locations.

Figures 1-a through 8-d - the floodlines should be interpreted downstream of the crossings.

Figures 1-a through 1-d - the floodlines along the downstream edge of the Lakeshore Road East should be corrected. The floodlines appear to be drawn along the curb and do not appear to be physically possible. We expect the runoff to flow between the downstream buildings.

Figures 1C - the floodlines upstream of the CNR crossing are controlled by the channel and not the crossing, therefore, there should be no change in the floodlines. According to Table 7.4 it has been recommended that the channel be widened and lowered, this was not indicated in the mapping. In turn, there should be a change in the floodlines between Figures 1C and 1D.

Figure 1-e - the Regional Floodline drawn across the C.N.R. does not appear to be correct. The floodlines would indicate that there is a sag in the railway. The 1996 site survey found that the rails do not sag and slope toward the west.

Figure 2-a and Figure 2-b - the Regional Floodline has been drawn incorrectly along the South Service Road. The Floodline does not appear to have accounted for the fixed portion of the noise barrier along the downstream edge of the QEW and does not appear to have accounted for the portion of the noise barrier with swing panels.

8. Floodplain and Erosion Management Alternatives Assessment

page 69, 4th paragraph, *"Cooksville Creek requires an 89.5 m erosion setback from the centreline of the creek and creates an additional site development constraint."* This requires discussions between the City and CVC.

page 72, Recommendation, *" It is recommended .... "* - we disagree with this statement. The misinterpretation of the floodline determines whether or not this alternative is successful. We believe the Consultant has not interpreted or plotted the floodline correctly. The Camilla Road culvert has a capacity of 135 m^3/s. The Regional peak flow rate is 295 m^3/s. The upstream channel capacity is approximately 110 m^3/s. The ground elevation near cross section 3.04 is 99.4 m. The HEC-2 flood elevations are 100.6 or 100.5 m (1996 and SPA Study respectively).

page 74, Humenik Lands, Two-Zone - is not recommended. The paragraph gives reasons of the Regional and 100 year flood plains being equal. However, flood depths across the vast majority of the site is less than 0.6 m which may make flood proofing portions of the lands viable. We feel more study is required.

page 75, 2nd paragraph, *"It is recommended that the structural option of creek channelization be reviewed by the Technical Steering Committee and, if discounted, a special policy area be investigated further."* - we disagree with this statement. When Figure 4-e is compared to Figure 4-a there is no change in the Regulatory Flood Plain. The downstream Paisley Road culvert and the upstream King Street culvert overtop for the Regional Storm. All of the runoff cannot get into the channel. There is no inlet or outlet to the channel. The channel requires upstream and downstream culvert improvements to be effective.

page 75, last sentence, - *"Prior to any further evaluation of policy options, verification of the floodline map is required."* We agree with this statement. The Consultant should not show two (2) Regulatory Floodlines. If the Consultant changes the Regulatory Floodline, then the changes to the floodline maps and changes to the HEC-2 model should be documented and presented to the CVC for confirmation.

Drawings 1 and 2 - floodlines should match the 1996 Floodline maps or a note should be placed on the drawing indicating the floodlines are approximate.

Drawings 1 and 2 - floodlines should be shown along the East Branch of Cooksville Creek.

We look forwarding to further discussing these points with you.

Yours truly,

Hazel Breton

Hazel Breton, P. Eng.
Senior Water Resources Engineer
hb/cd/jp/mb

cc Richard Tupholme – City of Mississauga
Robert Gepp – Region of Peel
Rizaldo Padilla – MMAH
Ron Schekenberger – Philips Engineering

TOPOGRAPHIC MAPPING CHECK

The topographic mapping check, only looks at vertical control, there is no reference or discussion with regards to horizontal control. According to the FDRP, for the horizontal accuracy check, the user is required to select 3 well defined, identifiable and accessible features at least 20 cm from each other – maps are acceptable if the map points are within a 0.5 mm radius of their true position.

Table 3.1

UTM grid co-ordinates should be provided for each of the spot elevations in table 3.1. For some of the spot elevations surveyed, a known benchmark was used, in turn, for those that do not represent a known a benchmark UTM grid co-ordinate needs to be provided.

STREAM MORPHOLOGY ASSESSMENT

5.1 Policy Background

As stated above, the stream morphology policy discussion should be re-worded to provide a concise description of the applicable current policies and be re-located to section 1.4. The salient points relating to stream morphology should be emphasized in this section i.e. despite flood plain, there should be no development in the erosion hazard, meander belt, etc. It is touched upon on page 25 where it is concluded that there should be due regard for erosion hazard and it must be fully integrated with flood plain analysis.

For this section, as an introduction to "Stream Morphology Assessment", it should focus on the concise summary of the findings of the Cooksville Creek Rehabilitation Study (1997). We spoke at our last meeting about the fact that this system is very different from a stable system and is quite abnormal in its behaviour.

On page 22 in the 3rd paragraph, a reference is made to the 1997 Training Manual. This manual has been superseded by the 2001 "Understanding Natural Hazards" document.

5.2 Stream Stability Criterion

The first full paragraph that begins on page 24, in reading the first 2 sentences, rather than criticize the Rehabilitation study, it would be preferable to build on the work completed, as the intent was different when compared to this work. The intention of the "riparian zone definition" should be defined. Given the fact that this creek will never stabilize given the lack of a sufficient corridor, how will this approach be different? You must first establish the constraints of the system and show how you will work within these limitations. It is imperative as it be stated that we recognize the erosion issues in addition to flooding issues.

In the second to last sentence, it is questionable whether current policies can adequately deal with this system. We need this component of the study to establish the technical criteria on which the City and CVC can establish appropriate policies.

.../4

In the 3rd paragraph (after three points listed), increases in boundary shear stress are a fundamental issue but there are also other points to consider such as weathering processes etc.

Figures 5.3 to 5.6 inclusive

We understand from our meeting that figure 5.4 shows a rate of 4 to 5 cm/year of downcutting (?), while the natural rate is 1 to 2 mm/year. Can this information be provided in the text along with similar information for the remaining figures?

HYDROAULIC MODELLING

6.1 Background

In the 2nd paragraph, what does this mean to the flood line mapping currently being used?

The last paragraph on page 33 refers to "the following table". Where is the table?

The current hydraulic analysis only looks at the upstream impacts to the proposed SPAs. There needs to be a discussion, on the impacts downstream of the proposed SPAs. By allowing development within these proposed "special policy areas" we are reducing the amount of storage within the floodplain and therefore, we need to determine what impact this will have on the downstream properties.

In order, to determine the downstream impacts of the proposed SPAs, the hydrograph at Dundas Street needs to be routed through the remainder of Cooksville Creek using an unsteady State hydraulic model. Commercially available models, which have this option, include X-TRAN, DWOPER, and HEC-RAS V3.0. When running the HEC-RAS model the user must ensure that there are no pools within the channel reach. In other words, the upstream invert elevation cannot be less than the downstream invert elevation.

FEASIBILITY ASSESSMENT OF STRUCTURAL ALTERNATIVES

7.1 Summary of FRS Findings and Recommendations

Historical Flood Control/Management Works

Would it be possible to add the dates these works took place?

Table 7.1

According to table 7.1 the design flow rates south of Dundas Street East are all equal. When R.V. Anderson undertook the Cooksville Creek Floodline Mapping Study they used the OTTHYMO computer model to do the hydrologic analysis. At the time, the OTTHYMO model used the HYMO variable storage coefficient (VSC) method to route flows through channel reaches, since it is the only approach available in OTTHYMO. Recent evidence suggests that the VSC method was not thoroughly tested during its initial development, and is inadequate for routing flows through channels on flat slopes, and is not as efficient as originally claimed. In order to compensate for this R.V. Anderson made the design flow rates south of Dundas Street equal, which is a conservative estimate of the flood flows.

7.4 Hydraulic Evaluation

In reviewing conditions (a) to (d), we discussed comparing these options to existing conditions. We must be careful in that the Remediation Study has recommended that storm water management be used on all remaining development sites. We should discuss this point further. The paragraph following the 4 conditions again refers to the fact that the HEC –2 model has been modified. We need to understand what this means to the current floodline mapping.

SUMMARY

The first sentence states that flood management require both structure and non-structural approaches. CVC's approach in recent history is to use non-structural measures. Can the word "require" be changed to "may utilize"?

The 2nd sentence indicates that setbacks from the stream morphology work will be forthcoming. We would like to see this information presented prior to another report being prepared to understand the results of the assessments. This is only to ensure a timely review of the workplan.

FIGURES 1A – 1D

Floodlines do not overtop CNR embankment as shown. Floodlines between sections 0.464 and 0.38 are drawn incorrectly. The floodlines stop at Elona Avenue and overtop Lakeshore Road.

FIGURE 1C

The floodlines upstream of the CNR crossing are controlled by the channel and not the crossing, therefore, there should be no change in the floodlines. According to Table 7.4 it has been recommended that the channel be widened and lowered, this was not indicated in the mapping. In turn, there should be a change in the floodlines between Figures 1C and 1D.

…/6

FIGURES 2A – 2D

A spill occurs along Creditview Avenue and Credit on Parkway. The floodlines between sections 2.92, 2.98, and 3.04 are drawn incorrectly; the floodlines should be continuous and not leave a gap. There should be no changes in the floodlines with respect to the storage option, since there were no changes at Lakeshore Road.

FIGURES 2C – 2D

There is a barrier along QEW, in turn the floodline should be drawn along the barrier. Was the barrier taken into consideration when doing the hydraulic analysis?

FIGURES 3A – 3D

The floodlines downstream of sections 3.87 and 3.42 are drawn incorrectly. There should be no changes in the floodlines with respect to the storage option, since there were no changes at Lakeshore Road.

FIGURES 4A – 4D

The floodlines downstream of section 4.18 are drawn incorrectly. For Figures 4C and 4D, there are no recommended culvert improvements as indicated on the drawing titles.

FIGURES 5A – 5D

A spill occurs along Kirwin Avenue. The floodlines between sections 5.053 and 4.82 are drawn incorrectly. In addition, culvert improvement is to occur at Kirwin Avenue and dyking is to occur between Kirwin Avenue and CP Railway. In turn, this needs to be shown on a map upstream of Kirwin Avenue. Figures 5C and 5D illustrate the culvert improvement, but Figure 5D does not show the channel improvements.

FIGURES 6C AND 6D

There should be a change in the floodlines between Figures 6C and 6D.

FIGURES 7A – 7D

The floodlines have been interpreted incorrectly downstream of Burnamthorpe Road. There are no culvert improvements or remedial measures along Burnamthorpe Road.

FIGURES 81 – 8D

There are no culvert improvements or remedial measures along Eglinton Avenue.

.../7

C-1

PHILIPS
ENGINEERING

Meeting Minutes

January 16, 2003
Our File: 101127-75

Subject: Cooksville Creek Special Policy Area Study
Review of CVC Comments (December 17, 2002)

Date: January 14, 2003

Time: 9:30 a.m.

Location: Philips Engineering Ltd. – Burlington Offices

In Attendance:

Chris Doherty	➢	EWRG
Michael Heralall	➢	Philips Engineering Ltd.
Ron Scheckenberger	➢	Philips Engineering Ltd.

MATTERS DISCUSSED

ACTION BY:

1. Ron Scheckenberger outlined the City's objective to take the preliminary findings to an in-camera session of Council on February 3, 2003. He advised that there has been agreement amongst the City and CVC as to the format of consultation (i.e. between EWRG and PEL) prior to a more general meeting amongst all parties, to secure consensus on a plan action; this would be arranged by the City. **City**

2. The correspondence of December 17, 2002 (Breton – Pavan) was reviewed in detail as follows (Note: Numbering system introduced as per attachment):

Summary of Major Concerns

1. Chris Doherty reaffirmed of the concern with respect to the public perception of two floodlines and the confusion this may cause. Ron Scheckenberger noted that the current hydraulic analysis in support of the SPA Study and resulting depiction of flooding limits, was not intended to represent revised floodplain mapping (formally), rather, the analysis has been used as an evaluation tool to assess the developability of the subject properties.

   The following was advanced as a possible solution to address public and developer perception issues:

   (i) For City and CVC to consider removing the 1996 floodline from base mapping and restate/strengthen the text associated with qualifying caveats regarding the mapping's objective.

MATTERS DISCUSSED 2-1			ACTION BY:
		This approach is to be reviewed further by City and CVC staff.	City/CVC
2	(i)	The difference between the floodway and flood fringe will be explicitly stated in the report. This will relate to a distinction between shallow slow moving waters and deeper quicker flowing waters. A 0.8 m depth limit and the combination of velocity and depth product as per CVC policy will be used in this regard.	Philips
	(ii)	Areas that could be flood proofed as part of potential Two zone policy areas will be identified.	Philips
	(iii)	Ingress and egress paths will be explicitly stated for each development site.	Philips
	(iv)	The hydraulic and hydrologic impacts, both upstream and downstream, will be explicitly stated for each development site (as per Humenik analysis – ref. November 22, 2002 memorandum).	Philips
	(v)	Chris Doherty expressed a concern with respect to risk to life and flood damages. He noted that while flood peaks may not be impacted by development, the duration of the hydrograph may be extended causing slightly longer flooding. This is a matter related to stormwater management and associated control. This issue needs to be addressed according to the agreed upon approach for stormwater management, possible outside of the SPA Study (ref. Point 9 (ii)).	City/CVC
		Ron Scheckenberger noted that risk to life and flood damages would be explicitly stated both on-site and off-site.	Philips
	(vi)	(a) to (d)	
		The report will include reference to each of these prior initiatives. Notwithstanding, none of these influence the current recommendations of the SPA Study.	Philips
		(Note: The note at the bottom of Page 2 of the December 17, 2002 correspondence would be incorporated into the preamble of the alternative section).	Philips

E-1

3. Two technical alternatives to assess the impacts of lost floodplain storage on downstream systems were discussed. Chris Doherty indicated either a HEC-2/OTTHYMO or a DWOPER analysis could be utilized. This information is yet to be provided for the Inglis and Consulate properties pending agreement of development potential; it has been provided for Humenik as part of the November 22, 2002 memorandum — **Philips**

Detailed Comments

1. Introduction

(a) *Page 3, Paragraph 4*
Sentence has been changed to read *"Credit Valley Conservation and Province of Ontario would require supporting information to approve re-designations within Regulatory floodlines that would either propose new residential uses or increased densities for an existing residential use, …"*. — **Philips**

(b) *Page 10*
CVC policy will be added to Provincial policy for floodproofing as per Section 2 and Table 3.6 in May 2002, FRS. — **Philips**

(c) Suggested wording has been agreed to. — **Philips**

2. Hydrologic Check

Page 18 – A note will be added to the report indicating that assessment has been conducted for screening only and that storage has been accounted for twice in the hydrologic model. — **Philips**

Page 19 – The last sentence in Paragraph 2 has been changed to: *"… of the sites selected, the QEW and Eglinton sites were not analyzed further for peak flow attenuation storage as storage in these locations would be counter to the study objectives"*. — **Philips**

3. Topographic Mapping Check

The final two sentences in Paragraph 4 have been agreed to be removed. — **Philips**

Also, Chris Doherty noted that for the 1996 floodline mapping study, photogrametric cross-sections were used; these sections have two decimal places and all others (i.e. mapping derived) have one decimal place.

MATTERS DISCUSSED		ACTION BY:
4.	**Study Area Overview**	
(i)	A reference as to the source of Schedule 2 will be added.	**Philips**
(ii)	Spelling corrections will be addressed.	**Philips**
(iii)	Text will be added to describe the Eglinton Avenue West property. It was noted that Kaneff property and Peel Board of Education sites will be removed from the study as neither is influenced by its recommendations.	**B.G.D.**
5.	**Stream Morphology Assessment**	
(i)	The wording on Page 43 will be changed to reflect that the corridor limits advanced in this study will need to be reviewed by CVC in the context of its implementation framework, given the differences from current CVC and City policy.	**Philips**
(ii)	Philips/Parish also to consider addition of a generic figure depicting cross-section corridors.	**Philips/Parish**
6.	**Hydraulic Modelling**	
(i)	The model listing will be updated in Appendix E to reflect existing conditions.	**Philips**
(ii)	Reference point 1 under Major Issues.	**City/CVC/ Philips**
(iii)	Chris Doherty noted no issue with respect to the differences between the respective modelling, subject to the SPA Study floodline not being depicted as per Point 1 under Major Issues.	**City/CVC/ Philips**
(iv)	Insofar as the methodology for spill calculations, it was agreed that Philips would depict the location (in plan and cross-section) of spill sections used in the assessment, in order to support reproducibility.	**Philips**
7.	**Feasibility Assessment of Structural Alternatives**	
(i)	Agreed.	**Philips**
(ii)	Agreed.	**Philips**

(iii)	Statements with respect to stormwater management will be revised to reflect currently suggested implementation procedure (ref. Point 9(ii)).	**Philips**
(iv)	Reference to 25 year flows will be revised.	**Philips**
(v)	Agreed.	**Philips**
(vi)	Reference Page 18, Hydrologic Check.	**Philips**
(vii)	Reference Major Items Point 2 (vi).	**Philips**
(viii)	(a) Lakeshore Road culvert upgrade and channelization for Inglis property has been investigated and will be included as an alternative in Table 7.6.	**Philips**
	(b) It was agreed that the Consulate property was not subject to flooding from the Cooksville Creek floodway and rather was flood prone to some undetermined extent due to overland spill from upstream adjacent to Camilla Road. The distinction between these two flood mechanisms was considered important/significant, as this difference would provide the Consulate property with viable opportunities for flood management. This will be reflected in Table 7.6 and associated mapping.	**Philips**
	(c) It was agreed that ingress and egress will be restricted at Little John, prior to culvert replacement, based upon a spill at Kirwin Avenue. This will be reflected in Table 7.6.	**Philips**
	(d) The improvement to the Kirwin Avenue culvert (proposed for 2003) will reflect an upgrade to ingress/egress for Little John Lane property.	**Philips**
	(e) The Kaneff property has been removed from the assessment.	**Philips**
	(f) The text "sizeable difference" has been modified to indicate less significance.	**Philips**
(ix)	The labelling of the "Registered Regional Floodline" on Figures 1 through 7 will be addressed as per the resolution of Major Issue Point 1	**City/CVC/ Philips**

MATTERS DISCUSSED	ACTION BY:
(x) It was indicated that the 1996 Regional floodline is as per that provided by the City's Planning Department. It is agreed that some areas of omission and some of the accuracy is affected; a note will be added to reflect its source.	**Philips**
(xi) Ron Scheckenberger advised that, as discussed with CVC staff August 14, 2002, the differences in the floodline mapping specifically downstream of roadway cross-sections, between and 1996 and current study, relate wholly to the Engineer's interpretation of flow/spill mechanics, rather than technical calculations. It was indicated that in these "gray zones" the flow relates more to spill mechanics which have less formal definition than traditional channel and floodplain hydraulics. As such, possible development applicants in these areas could potentially undertake detailed assessments of localized flow mechanics to refine the delineation of spill and flooding. Again, pending the resolution of Major Item 1, this matter may or may not be moot.	**CVC/City/ Philips**
(xii) As per Point (xi).	**CVC/City/ Philips**
(xiii) Chris Doherty agreed that the information provided by Philips was correct.	
(xiv) Regional floodplain has been inaccurately depicted and will be updated.	**Philips**
(xv) The depiction of the floodplain adjacent to the noise barriers would be modified as it relates to the location of the swing panels and noise barriers.	**Philips**
(xvi) Philips staff generally agreed that the existing conditions modelling can incorporate the lands north of the Consulate site, west of Camilla Road to be within the floodplain. It was indicated, however, that the hydraulic improvements offered by the QEW culvert upgrade depicted on Figures 2c to 2e, would result in a significant reduction in flood levels upstream of the QEW and that the flow mechanics and associated flooding depths and velocities between Section 3.04 and the QEW would be the subject of more detailed localized assessment (related to overland flow and spill) at the time of development applications on the Consulate property and associated area.	

The floodline mapping in this location is to be shown as approximate, subject to this detailed localized study which would be a function of future development. The report will state this requirement.

Philips

(xvii) The barrier along the QEW will be used as the limit of the floodline mapping.

Philips

The barrier has not been taken into consideration when doing the hydraulic analysis as this was subject of a more detailed investigation by EWRG and not included in the base hydraulic modelling provided as part of the FRS. Notwithstanding, the differences are marginal (10 cm +/-) and of no consequence to this current initiative.

(xviii) Figure 4a through 4d – Recent topographic mapping provided by the City (Dated 2002) has corrected the topographic anomaly downstream of Paisley Avenue West; as such the floodline mapping in this location can be updated. City to advise; this would depend on the resolution of Major Point 1.

City/Philips

(xix) The limits of flooding across Dundas Street would need to be the subject of a detailed investigation, pending the provision of a detailed local topographic plan and development concept. Text would be incorporated into the report to this requirement.

Philips

It was noted that the parapet wall would affect overland flow thus locally widening the floodplain.

(xx) The low level dyking was discussed, however, it was noted that this has no Regulatory consequence for the Little John Avenue property.

It was agreed that culvert improvements on Kirwin Avenue (planned for 2003) would be shown. Dyking and channelization upstream would not be depicted on this mapping as it is beyond the study area.

Philips

(xxi) Figures 6a to 6d will be removed as Kaneff property is no longer within the study area.

Philips

(xxii) and (xxiii)

The first note accompanying each map was considered satisfactory to address this matter.

8. **Floodplain and Erosion Management Alternatives Assessment**

(i) The recommendation for an 89.5 m erosion setback will be a recommendation of the study.

(ii) Reference Point 7 (xvii).

(iii) It was discussed that the floodway could constitute a zone of lesser capacity than the 100 year and as such the shallow depth and velocity constraints could offer opportunities within a two zone context. These are to be discussed further. **Philips**

(iv) It was indicated that Figure 4e does not depict the flood limits as per the option shown. This area should be considered in the context of the November 22, 2002 memorandum. It was noted that the SPA Study is to make reference to the requirements for flood flow transition at the inlet and outlet of this reach channel along with associated upstream and downstream works. **Philips**

(v) Reference Major Point 1. **City/CVC/ Philips**

(vi) A note will be added that the 1996 floodline mapping is approximate as prepared by the City of Mississauga. **Philips**

(vii) These branches are outside the study area have not been considered. **Philips**

(viii) The title on Drawing 2 will be corrected as suggested. **Philips**

(ix) Appendix I will be removed as it does not offer additional information of use to the study objectives. **Philips**

9. **Follow-up to the SPA**

(i) It is considered that if the foregoing issues are addressed as noted, that the underlying principles will be firmly established.

(ii) Stormwater Management – Chris Doherty indicated that the wording used in the FRS referenced "appropriate" stormwater management. He cited concern with respect to potential liability and negligence on behalf of both CVC and the City of Mississauga, particularly with respect to allowing development within the floodplain and within the watershed exacerbating conditions within the floodplain, since release of the 1975 floodline mapping by Kilborn.

He cited a potential target for stormwater management related to over controlling the "100 year post-" to a "2 year pre-" flow rate. It was agreed that blanket application of this policy may, however, not satisfy the requisite objectives if no increase in peak flow within the Cooksville Creek.

It was suggested that the specific discussion of stormwater management within the SPA be removed. It was also suggested that stormwater management for future properties be dealt with in the suggested framework of an Implementation Plan. It was indicated, however, that firmly establishing the "appropriate" stormwater management would require technical assessment and would differ throughout the watershed, depending on the location of the subject site.

City/CVC

Minutes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

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c.c. All Present
Lesley Pavan, City of Mississauga
Lincoln Kan, City of Mississauga
Richard Tupholme, City of Mississauga
Hazel Breton, Credit Valley Conservation
Ruth Victor, B.G.D. Consulting Inc.
John Parish, Parish Geomorphic

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Meeting Minutes

November 7, 2002
Our File: 101127-75

Subject: Cooksville Creek SPA
Interim Report #2 Presentation to Steering Committee

Date: October 31, 2002

Time: 9:00 a.m.

Location: Mississauga Civic Centre – Committee Room B

In Attendance:
Lesley Pavan ➢ City of Mississauga
John Calvert ➢ City of Mississauga
Michael Minkowski ➢ City of Mississauga
Ruth Marland Bryan ➢ City of Mississauga
Lincoln Kan ➢ City of Mississauga
Richard Tupholme ➢ City of Mississauga
Bill Waite ➢ City of Mississauga
Robert Gepp ➢ Peel Planning
Rizaldo Padilla ➢ MMAH
Ruth Victor ➢ B.D.G. Consulting Inc.
John Perdikaris ➢ Credit Valley Conservation
Hazel Breton ➢ Credit Valley Conservation
Mary Bracken ➢ Credit Valley Conservation
John Parish ➢ Parish Geomorphic
Michael Heralall ➢ Philips Engineering Ltd.
Ron Scheckenberger ➢ Philips Engineering Ltd.

MATTERS DISCUSSED

ACTION BY:

1. Introduction

(i) Lesley Pavan introduced the meeting indicating that since the May 24, 2002 meeting, the Philips Team has been working extensively with the City and others to address respective issues and formulate a management strategy for the subject lands.

(ii) Ron Scheckenberger noted that the Team is currently at the end of the Stage 1 tasks and requires Municipal agency review, prior to proceeding with the risk assessment and bringing information to the Public, then depending on the feedback, the process would enter Stage 2 which would involve the Official Plan Amendment process and development of planning policy.

MATTERS DISCUSSED **ACTION BY:**

2. **Review of Previous Meeting Minutes**

Ron Scheckenberger undertook a review of the May 24, 2002 meeting minutes. Action arising included:

(i) Philips to provide input to the City with respect to the influence and significance of the new mapping once available. **Philips**

Lesley Pavan indicated that this is to be provided within 1 to 2 weeks. **City**

(ii) Lesley Pavan would forward new City ownership plan to Philips. Philips will incorporate into Drawing 2. **Philips/City**

(iii) Risk assessment would be completed by the Team, once the Technical Steering Committee has established a consensus under management approach for the respective properties under consideration. **Team**

(iv) Stormwater management for the Cooksville Creek watershed has been discussed at a meeting October 23, 2002 and will be further discussed at a meeting scheduled for November 6, 2002. **CVC/Miss./ Team**

3. **Overview of Work Program Since Last Meeting**

(i) Philips outlined 6 meetings held as follows:

- May 28, 2002 with GIS/Cad
- June 28, 2002 with Realty
- August 1, 2002 with City
- August 14, 2002 with City and CVC
- September 13, 2002 with City
- October 23, 2002 with City and CVC

(ii) Modelling has been updated to incorporate spills and refinements requested in review of Interim Report #1. Floodline mapping has been updated. Alternatives have been assessed for various structural measures and management strategies have developed including preliminary costing.

(iii) Ongoing stream flow data collection to be terminated sometime in the month of November 2002. **Philips**

(iv) Parish has completed the stream morphology assessment and updated the report to address commentary from the stakeholders.

(v) B.D.G. Consulting Inc. has supported and responded to respective input from agencies, prepared preliminary planning alternatives and development plans.

MATTERS DISCUSSED **ACTION BY:**

4. **Summary of Key Input and Action Arising from Agency Comments and Follow-Up Meetings**

Key items addressed included the following:

(i) CVC policies added (ref. Section 1.4, Appendix A).

(ii) Clarification of stream stability policy.

(iii) Influence of on-line storage incorporated (ref. Page 63).

(iv) Influence of watershed wide stormwater management (Page 59).

(v) Incorporation of commentary regarding mapping and an outline of differences including: spills and anomalies

(vi) Imperial notation to tables and text.

(vii) Outline of direction for future properties not considered herein (ref. Page 4 and 67).

(viii) Confirmation regarding use of current mapping by City's GIS division.

(ix) Need to secure input from City Realty regarding benefits associated with development of flood prone lands. **City**

(x) Need for incorporation on other City benefits from various revenue streams including development charges. **City**

(xi) Disclaimer notes incorporated on maps and inclusion of Regulatory flood limit.

(xii) Insofar as the foregoing, Hazel Breton requested Conservation Authority be present at any meetings where flood criteria are being discussed for the watershed. **All**

(xiii) John Calvert questioned whether or not any of the works recommended from this study can be incorporated in Development Charges. Richard Tupholme noted that if they are growth related, this would be possible. Ron Scheckenberger indicated that these works may benefit more than just development, hence this would require further review. **City**

5. Presentation of Management Strategies for Properties under Consideration

Erosion Setbacks

(i) John Parish provided an overview of the stream morphology assessment and the approach to establish a management corridor on the premise of the greater of technical versus maintenance and policy (ref. Table 5.4).

(ii) Michael Minkowski indicated that due to the technical content of this subject, he would request that the committee consider directing a Team to prepare an Executive Summary, as well as a report could be produced under multiple volumes with technical appendices and general reports. **City/Team**

(iii) Lincoln Kan questioned whether or not the objective would be to provide armouring in all areas along Cooksville Creek, since so much of it is currently armoured. John Parish indicated that the corridor approach assumes no armouring and that the watercourse would continue to evolve. This was considered to be conservative and would allow the Municipality and development proponent flexibility in proceeding through development.

(iv) The Committee was requested to review this approach as well as implications with respect future maintenance and management by the Municipality. Ron Scheckenberger indicated that the maximum erosion corridor has been placed on each of the figures, and in some instances the erosion corridor governs versus the flooding corridor. **S.C.**

Structural Assessment

(i) Ron Scheckenberger provided an overview of Table 7.6 which summarizes the initial structural assessment related to the various measure cited previously, namely: Bristol Road facility storage control, FRS culvert improvements and FRS channel improvements. From this Ron Scheckenberger indicated that each property under consideration was further reviewed in terms of structural alternatives under a one-zone context and then, depending on the results, consideration advanced to a two-zone and then special policy area, in a high archial approach.

(ii) Michael Minkowski questioned why the structural alternatives need to be exhausted and what their tests are? Ruth Victor advised that it relates to risk as two-zone and special policy area inherently assume a higher risk, as it is incumbent on the development proponent to exhaustively evaluate structural alternatives and determine whether or not they are feasible. In terms of the feasibility, the test requirements are outlined in the policy (ref. 1.4).

(iii) The currently established floodline has been defined on each map. Hazel Breton requested that this not be referenced as "registered", merely the "1996 floodline". Insofar as the differences, Ron Scheckenberger indicated that this relates largely to interpretation in "grey areas", as well as the new mapping and updated information.

Philips

(iv) Hazel Breton indicated that subject to final review, that the mapping produced from this study could be used as a premise/basis for future updating of Cooksville Creek mapping. Ron Scheckenberger indicated that it would be advisable to use the 2002 mapping base currently being prepared by the City of Mississauga in this regard. Such a recommendation should be incorporated into the final report.

Team/CVC/ City

Property Review

Each property under consideration was reviewed with respect to its existing land use, zoning, supplementary structural measures, one-zone, two-zone and SPA considerations. The following points arose during the presentation:

(i) **Inglis**

(a) Philips to provide direction on downstream impacts with respect to altering the roadway profile.

Philips

(b) Richard Tupholme advised that there would be traffic concerns for the Inglis development and that there may need to be signals provided. Additional information is required.

City

(ii) **Consulate**

(a) Hazel Breton questioned whether or not there would be any downstream impacts associated with the development. Ron Scheckenberger noted that these intuitively would be marginal, given that the development proposed is in a flood fringe and non-effective flow area. The report would need to address this issue.

Philips

(b) Lesley Pavan questioned the extent of an interim 2-zone. Ruth Victor advised this would terminate essentially terminate at the northern boundary of Consulate.

MATTERS DISCUSSED	ACTION BY:
(c) It was indicated that additional discussion would be advanced with MTO (Dean Kemper). Ron Scheckenberger advised that the current MTO planning study is being prepared and targeted for completion in June 2003 with the best case scenario for design to be initiated in fall 2003 and construction in 2004. The Ministry did indicate support for a tri-party cost sharing agreement. Discussion should begin between the City and MTO on this matter.	**City**
(iii) **Humenik**	
(a) Hazel Breton expressed concern regarding any option which reduces overall length. John Parish noted that length could likely be preserved, however, given the dynamic nature of the watercourse, this may involve a re-jigging of the erosion corridor versus the straight alignment current shown on Figure 4E. Philips and Parish are to prepare a more detailed concept in this regard for consideration by the Technical Steering Committee.	**Philips/Parish**
(b) Ron Scheckenberger indicated that the technical evaluation for hydrologic impact downstream of the Humenik site has not been completed and that it is pending consideration by this committee. All present advised that Philips should initiate this evaluation and provide technical support accordingly.	**Philips**
(c) Ron Scheckenberger noted that, subject to the results of this analysis, there may be some merit to making the development of the Humenik lands conditional or contributory to offsetting compensating storage at the Bristol Road facility site.	
(iv) **Little John Lane**	
(a) Ron Scheckenberger indicated that the existing mapping and analysis appears anomalous to that previously produced and that perhaps the new mapping available from the municipality would resolve this matter.	**City/Team**
7. **Next Steps**	
(i) It was indicated that review and input would be required from the Technical Steering Committee. Lesley Pavan requested this no later than November 29, 2002.	**All**

MATTERS DISCUSSED	ACTION BY:
(ii) John Calvert indicated that a report would be advanced through to Planning and Development Committee the second meeting in the new year (February 3, 2003). Regardless, a Corporate Report would need to be prepared for mid-December 2002. Following the advancement of this report, there would need to be public consultation.	**City**
Ultimately, once this component is completed, there would be consideration for Stage 2 of the analysis which would require policy formation directed at the Official Plan amendment, a community meeting and the final policy.	
8. **Other Business**	
(i) The matter of Cooksville Creek stormwater management was deferred to the meeting of November 6, 2002.	**CVC/City/ Philips**

Minutes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

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c.c. All Present
Chris Barnett, Davis & Co.

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Meeting Notes

September 19, 2002
Our File: 101127-75

Subject: Cooksville Creek Co-ordination Meeting

Date: September 13, 2002

Time: 9:00 a.m.

Location: Philips Engineering Ltd. – Burlington Offices

In Attendance:
Lesley Pavan ➢ City of Mississauga
Ruth Victor ➢ B.D.G. Consulting Inc.
Bill de Geus ➢ Parish Geomorphic
Ron Scheckenberger ➢ Philips Engineering Ltd.

ACTION ITEM SUMMARY **ACTION BY:**

1. Study Team (Philips) to update full report for next Technical Steering Committee meeting. **Study Team**

2. Lesley Pavan met with Assessment and Finance Departments (August 28, 2002) in order to determine the impact on taxes. These departments require the following (through BDG):

    - Number of units (i.e. bedrooms) **BDG**
    - Type of building (i.e. condominium style or otherwise)
    - Ground floor area
    - Notion of population generated
    - Location of other similar types of developments

    From the foregoing, the Assessment and Finance Department will provide information on development charges and tax revenues. **City**

3. Ron Scheckenberger requested that Julian Patteson's group provide information on the benefit from the conversion of flood lands to development lands. **City**

4. Ruth Victor to provide a paragraph on zoning for the Special Policy Areas as appropriate (pre-zoned for flood control not for use specific). **BDG**

5. Dave Marion has received the ortho-imagery and has been requested to produce the digital terrain modelling/mapping for Cooksville as a priority. Monies have been budgeted in 2003 to update the hydraulic modelling according to the new mapping. **City**

ACTION ITEM SUMMARY

ACTION BY:

6. Bill de Geus to review preliminary findings on setback for stable systems with John Parish. For the updated report, he is to provide figures depicting the evolution of this bedrock system (dimensionless) with an accompanying table depicting the setback for various reaches.

   Parish

   The issue of the influence of the setback for reaches with armouring versus no armouring relates largely to the need for future maintenance and life cycle of repairs. It was agreed that CVC policy may not be appropriate for Cooksville Creek and that in newly developing areas, if erosion protection is deemed cost beneficial, a Letter of Credit may be required to support erosion protection in perpetuity.

7. Bill de Geus suggested setting corridors and not setbacks. In this regard, he would produce the following:

   - A table depicting the natural corridor, the policy corridor under two application interpretations (conservative/less conservative) and a fourth column depicting the recommended technical corridor inclusive of space for maintenance access, safety setbacks, environmental setbacks, etc.

     Parish

8. It was requested that John Parish meet with Hazel Breton to discuss the perspective of CVC policy application to Cooksville Creek, in order to build a consensus position. Bill de Geus noted that the future MNR Technical Guidelines may also lend support thereby deflecting the onus from the CVC to the Province.

   Parish

9. The following discussion ensued regarding the various development areas:

   Inglis

   (i) Issue with ingress and egress particularly relates to emergency access. Suggestion to build-up the roadway at points of ingress, egress on both the east and the west block.

   (ii) Crossing/link between the east and west blocks was not deemed cost effective. If Lakeshore Road is built-up at the outer limits, it would likely need to be lowered within the centre zone to preserve hydraulics.

   (iii) Philips to remove the buildings and check/verify the hydraulics.

   Philips

   (iv) Request input on land use from Ruth Victor noting that it may require Official Plan Amendment. Preliminary thoughts included residential on west side of creek and commercial/employment on east side of creek.

   BDG

ACTION ITEM SUMMARY	ACTION BY:
Consulate Site	
(i) Issue regarding which condition to evaluate, with or without QEW culvert improvement in place.	
(ii) Concern that estimate from FRS of culvert replacement costs (1.2 million) is unrealistic. Information shows total required span of 20 m and an existing span of 8 m.	
(iii) Philips to speak with Chris Doherty to determine how costed.	**Philips**
(iv) In addition, Philips is to contact Michael Chiu at McCormick Rankin determining whether or not there is any immediate plans regarding the replacement.	**Philips**
(v) Concept of potential cost benefits of replacement concurrent with current interchange works. Philips to contact MTO to determine opportunity of tieing projects together.	**Philips**
(vi) Philips to update cost of culvert upgrade. A question revised regarding what is the break point related to cost benefits.	**Philips**
(vii) It was generally suggested that Consulate property can be managed under a 2-zone policy until the QEW culvert is upgraded. 2-zone policy would be applied for a reach as opposed to the whole watercourse. This would need to be verified with CVC.	**Study Team**
(viii) In order to provide access to Consulate site, adjacent roadways would need to be regraded for ingress egress.	
(ix) It was generally conceded that there would be additional cost to develop this site, prior to QEW upgrade due to roadway works and additional fill/grading.	**Philips**
(x) Possibility for 3-way agreement between City, MTO and Consulate to upgrade QEW culvert.	
(xi) Reach application of 2-zone concept may preclude redevelopment of the lands currently used for worship.	
(xii) Both options would need to be presented for the public. Need information on cost benefits from Julian Patteson for comparison.	**City**
(xiii) Benefit to City results from QEW culvert replacement due to elimination of existing dwellings on the east side of creek from floodplain.	

ACTION ITEM SUMMARY

ACTION BY:

Camilla Site F & F Properties

(i) It was generally conceded that none of the options, including those with FRS improvements, result in any meaningful alteration of the floodplain, hence status quo (1-zone would apply). **Study Team**

Huminik Property

(i) City Park and sanitary trunk lies along the eastern limit of the watercourse. This could be a constraint.

(ii) Bill de Geus advised that there is a cross-section prepared by Bill Clarke in 1996/1997. Philips to contact John Perdikaris to get a copy of the hydraulic submission. This showed the containment of the regulatory flood. It was noted that the channel option has some approval in principle at the CVC Board, however, it is inferred that the conditions could not be satisfied at a staff level (1997). **Philips**

(iii) From a review of the mapping, it was evident that 1-zone or 2-zone is unlikely to yield any further development opportunity of this reach, due to the extensive Regional and 100 year floodplains. The options essentially are as follows: **Study Team**

- Provide a hydraulic channel to satisfy flooding and stability criterion; the advantages being no flood risk, however, there is an issue with current CVC policy which states no increase in tableland through cut and fill/channelization.
- Alternatively, a Special Policy Area can be established. Notwithstanding, this raises concerns regarding flood risk.

Little John Lane

(i) Bill de Geus advised that Burnside did an analysis in this area, however, it may not be public. Philips to contact Chris Crozier to obtain a copy of the survey and analysis, if available. **Philips**

(ii) Previous development concepts included an L-shaped parcel and opportunities for a Park Land swaps, however, Philips Team is to evaluate current holding and development opportunity only. **Study Team**

(iii) It was indicated that the floodlines in the FRS versus the Philips' update are different and show significantly different developability. There would be a need to verify the floodline mapping and to determine whether cutting and filling is minor versus major.

(iv) Access to the site would be through Kirwin.

(v) It was generally concluded that the site could be managed under a 1-zone with minor edge modification. **Study Team**

Eglinton - Highway 10

(i) The only issue for this site relates to the flooding on a minor tributary draw and its impact on the site.

(ii) Mary Bracken and Bill de Geus walked this site and no watercourse was evident. Some information should be on file. Lesley Pavan to contact Mary Bracken. **City**

(iii) Management approach would suggest elimination of the on-site watercourse and 1-zone policy with updated mapping. **Study Team**

11. Schedule

(i) Philips to contact Lesley Pavan towards the end of September in order to determine potential to schedule Technical Steering Committee meeting for the end of October. **Philips**

(ii) At that time (end of October), a draft report (85% complete) would be submitted for review. Report information to be provided to Lesley Pavan at least one week prior to Technical Steering Committee meeting.

Minutes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

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c.c. All Present
John Parish, Parish Geomorphic
Chris Barnett, Davis & Co.

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Meeting Minutes

August 21, 2002
Our File: 101127-75

Subject: Cooksville Creek Special Policy Area Study
Review of Credit Valley Conservation Comments

Date: August 14, 2002

Time: 9:00 a.m.

Location: City of Mississauga
City Centre – 9th Floor Boardroom

In Attendance:

Lesley Pavan	➢	City of Mississauga
Lincoln Kan	➢	City of Mississauga
Mary Bracken	➢	Credit Valley Conservation
John Perdikaris	➢	Credit Valley Conservation
John Parish	➢	Parish Geomorphic
Mike Heralall	➢	Philips Engineering Ltd.
Ron Scheckenberger	➢	Philips Engineering Ltd.

MATTERS DISCUSSED **ACTION BY:**

1. Lesley Pavan introduced the meeting outlining that its objective was to address outstanding comments associated with CVC review of the Draft Interim Report No. 1.

2. Ron Scheckenberger undertook a review of the July 4, 2002 correspondence from CVC and action arising is summarized as follows:

   (i) Page 3 - Technical issues are to be elaborated as "flooding and stable flow regime". Environmental issues are to be described as "stable stream form and indirect connections to water quality". **Philips**

   The first paragraph final sentence is to be restated as "the problem is how best to address divergent perspectives associated with these competing issues, while doing what is best for the public interest". **Philips**

   (ii) Page 3, paragraph 2 - "Fundamental" is to be replaced by "good planning and engineering principles." **Philips**

MATTERS DISCUSSED		ACTION BY:
(iii)	Page 3, paragraph 3, third sentence – The discussion regarding upstream and downstream impacts on the associated study area will be expanded.	**Philips**
(iv)	John Perdikaris to provide R. V. Anderson 1996 study.	**CVC**
(v)	Philips to include a sentence on the intent of the respective studies. It was noted more detailed discussion is included in Appendix F.	**Philips**
(vi)	Section 1.4 – Mary Bracken is to provide text of associated CVC policies which are to be included in this section.	**CVC/Philips**
(vii)	Team is to integrate an abbreviated discussion of policy from Section 5.1 into Section 1.4.	**Parish**
(viii)	Mary Bracken is to provide a reference (i.e. letter/directive/MOU) whereby the Province has formerly delegated the responsibility for natural hazards to Conservation Authorities.	**CVC**
(ix)	Lesley Pavan is to contact Nancy Mott-Allan regarding the timing for the distribution of the new floodplain guideline document. A brief discussion followed, whereby it was suggested that the new policy would not intrinsically alter any conclusions by this study process; however, all are to review once this information is in hand.	**City** **All**
(x)	Lesley Pavan noted that the new Zoning by-law is not yet in the public form. Lesley Pavan indicated in a previous meeting that she would provide the associated text summarizing the status of zoning information.	**City**
(xi)	CVC policy will elaborate on one zone policies.	**CVC**
(xii)	Philips is to provide an input table from the FRS summarizing primary hydrologic parameters.	**Philips**
(xiii)	Insofar as offsetting lost storage, Ron Scheckenberger indicated that for the Applewood Creek watershed, the City of Mississauga introduced an on-line flood control facility. While it was suggested that on-line systems could potentially offset lost storage from SPA development, this is only an opportunity and has yet to be recommended. Further text will be provided to elaborate within Section 2.3.	**Philips**

MATTERS DISCUSSED	**ACTION BY:**
(xiv) Peel Board of Education would only be contacted if the Bristol Road stormwater management facility is advanced as a recommendation. This would be predicated on cost benefit information yet to be received from the Municipality.	
(xv) Insofar as the potential for on-line storage facilities further aggravating instability of Cooksville Creek, Ron Scheckenberger noted that a traditional analysis could involve continuous simulation and determination of cumulative excess shear, however, this would be a significant undertaking. On this premise, it was agreed that John Parish would provide a technical opinion regarding the energy and sediment balance impacts associated with potential on-line stormwater management systems.	**Parish**
(xvi) Ron Scheckenberger noted that the Terms of Reference, as well as the proposal by Philips only included a vertical control check, rather than full FDRP checking vis-à-vis horizontal control and UTM grids. All present agreed that the information provided by Philips was adequate.	
(xvii) Section 5.1 – John Parish indicated that this section would be re-authored in order to be clearer. He noted that it was not the intent to be critical of the previous 1997 study and that, in fact, the SPA study is building on those previous recommendations.	**Parish**
(xviii) Mary Bracken to provide John Parish with a CD of the 2001 "Understanding Natural Hazards" document. John Parish indicated that there are various Ministry of Natural Resources CDs to follow which provide a compendium of various documentation which will also be referenced.	**CVC** **Parish**
(xix) Figures 5.3 to 5.6 – John Parish indicated that this information will be updated based upon current data collection.	**Parish**
(xx) Section 6.1, second paragraph – It has been proposed to be changed to read "municipal data collection has defined the potential development locations or sites (ref. Drawing No. 1)."	**Philips**
(xxi) The table referred to on Page 33 will be provided by Philips.	**Philips**
(xxii) The current hydraulic analysis has only examined upstream impacts as the system is in a backwater and SPA's have not yet been proposed, hence downstream impacts on flows have not been determined. This will be a component of the subsequent reporting.	**Philips**

Insofar as the methodology for this assessment, in accordance with the Philips' proposal, a simplified technique using routing available in OTTHYMO will be used. Ron Scheckenberger commented that, based on his experience, the normal impact on downstream flows, given the size of the upstream drainage area is generally extremely nominal (less than 2%). **Philips**

(xxiii) Section 7.1 – City of Mississauga will provide the dates of historical flood control and management works. **City**

(xxiv) Table 7.1 – It was indicated that the flow rates had been based upon the approved information provided in the Flood Remediation Study dated May 2002. Those present agreed that altering these flows at this stage would be inconsistent with the Terms of Reference and also provide additional confusion to the public, hence use of the FRS flow rates would be appropriate.

(xxv) Section 7.1 – The issue of stormwater management for the balance of the development within the City of Mississauga was discussed noting that only 7% of the watershed remains undeveloped. It was indicated that the influence of distributed stormwater management and determination of same would be a significant undertaking and likely result in an extremely nominal impact (i.e. less than 7%). In order to be conservative, future land use flows have been used and will continue to be used to define flood limits as per the FRS. Philips is to provide a professional opinion describing influence of future stormwater management on in-stream flows, as well as the difference between storage provided for the 2 and 5 year events versus the 100 year and Regional. **Philips**

(xxvi) In the summary, the word "require" will be changed to "may". **Philips**

(xxvii) In the summary, the stream morphology setback information will be provided in advance of the next Technical Report. **Parish**

(xxviii) The floodline information/mapping was reviewed. Ron Scheckenberger indicated that, for the most part, the floodline mapping has been correctly "drawn" using the RiverCAD technology. Areas of difference from the currently approved floodline mapping relate primarily to the interpretation by EWRG of flood mechanics. The CVC and City expressed concern regarding the public's perception of the differences. To this end, it was

MATTERS DISCUSSED	ACTION BY:
suggested that Philips produce a general guide to the figures and as well consider an ultimate overlay (scanned image) depicting the currently approved floodplain.	**Philips**
It was also indicated that the four cases (a, b, c and d) may not specifically apply to each site, however, the influence of downstream culvert improvements and channel works may, depending on the location of the site, have an influence, hence have been included. This will be included in the guide as well.	**Philips**
Ron Scheckenberger also indicated that based on a recent conversation with EWRG staff, spills have been accounted in the previous modelling, however, in a non-traditional form and the information has yet to be rationalized as produced. It was indicated that Philips would be updating the hydraulic modelling including spills in the currently approved HEC-2 format.	**Philips**
(a) Figures 1A to 1D – It was noted that the CNR embankment does overtop and that hydraulic calculations produced by EWRG and Philips should support this	
(b) Figures 2A to 2D - The spill on Crestview and Creditview will be added. Also, it was noted that the barrier along the QEW has been modelled appropriately.	**Philips**
(c) Figures 4A to 4D – It was indicated that there may be an anomaly in the topographic mapping provided between Sections 4.04 and 4.1. The new mapping to be available in September 2002 will be used to verify this point.	**City/Philips**
(d) Figures 5A to 5D – The spill on Kerwin Avenue will be included and the Philips mapping will be updated, as there appears to be a closure problem with one of the cross-sections. Also, if possible, there will be a slight shift of the orientation of Figure 5A to include the upgraded culvert on Kerwin Avenue.	**Philips**
(e) Figures 6A to 6D – This site will be removed, as it will no longer be considered for a Special Policy Area.	**Philips**
(f) Figures 7A to 7D – Notation "End of study" will be provided for the East Branch of the Cooksville Creek.	**Philips**

MATTERS DISCUSSED	ACTION BY:
(xxix) All suggested edits to Appendices A, C, D and Drawings 1 and 2 will be introduced by Philips.	**Philips**
3. The Team will make the foregoing edits to the final document. The next work plan will involve the feasibility assessment and screening for SPA's, one zones and two zones. A meeting will be held with City of Mississauga and Philips and B.D.G. Consulting to advance this phase shortly, upon receipt of supplemental information from the Municipality.	**Team** **City/Team**

Minutes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

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c.c. All Present
Ruth Victor, B.D.G. Consulting Inc.
Chris Barnett, Davis & Co.

PHILIPS
ENGINEERING

Meeting Minutes

August 9, 2002
Our File: 101127-75

Subject: Cooksville Creek SPA Study

Date: August 1, 2002

Time: 11:00 a.m.

Location: City Centre – 8th Floor Boardroom

In Attendance:
Lesley Pavan ➢ City of Mississauga
Lincoln Kan ➢ City of Mississauga
Mike Heralall ➢ Philips Engineering Ltd.
Ron Scheckenberger ➢ Philips Engineering Ltd.

MATTERS DISCUSSED — **ACTION BY:**

1. Ron Scheckenberger introduced the meeting setting the agenda as follows:

   (i) Review of City and Agency comments.
   (ii) Mapping status update.
   (iii) Request for additional modelling from the City of Mississauga.
   (iv) Follow-up to meeting with Julian Patteson re: cost benefits.
   (v) Next phase.

2. **Review of Comments**

CVC Comments

Action arising from the review of comments dated July 4, 2002 (Bracken – Pavan) are as follows:

(i) Lesley Pavan to confirm that 1992 "Draft" R. V. Anderson Floodline Study is current. Philips to contact Bill de Gues regarding same. **City/Philips**

(ii) Lincoln Kan is to confirm the date of historical flood control works (ref. page 34). **City**

(iii) Lesley Pavan indicated that 7% of Cooksville Creek remains vacant and that stormwater management, while proposed for these areas, has been a point of concern in discussions with

CVC. It was generally concluded at the meeting that stormwater management for major storms (100 year and Regional), which are the focus of the SPA, is likely to be ineffectual, hence the conservative use of future land use flows as described in the FRS is appropriate.

(iv) Philips is to contact Chris Doherty regarding how "spills" have been addressed in the FRS. It appeared from the floodline mapping that spills have conservatively assumed not to occur, however, there does appear to be some amendments to the floodline mapping which is inconsistent. **Philips**

(v) It was suggested that Philips add a note to the maps in the legend indicating that where culvert improvements and channel improvements have not been shown on the individual maps, however, that the influence of same, off-site from these maps, has been accounted for. **Philips**

City Comments

The following action arose regarding a review of comments from the City of Mississauga dated June 11, 2002 (Pavan – Scheckenberger) and July 22, 2002 (Kan – Scheckenberger):

(i) Philips will remove the school site shown on Drawing 6a, b, c and d. **Philips**

(ii) Philips will address the "white space" shown on Drawing 1 in the mixed-use area and clarify the designations as Official Plan or City Plan. **Philips**

(iii) It was indicated that the floodplain shown on Drawing 1 reflects the current floodplain established by the City.

(iv) It was indicated that an example of flood control at an existing structure in the City of Mississauga is evident in the Applewood watershed at the CNR rail crossing.

(v) It was noted that downstream impacts from development Special Policy Areas would be addressed in the next phase. **Philips**

(vi) It was stated that the updates to the hydraulic model produced for the FRS focussed on the overbank areas (defined as per current digital mapping), as well as overbank distances, low flow channel and culvert/structure crossing common.

(vii) Some discussion ensued regarding how the study would provide direction to potential future SPA opportunities. Philips is to author a paragraph in this regard and have it reviewed by the City for its appropriateness. **Philips/City**

MATTERS DISCUSSED **ACTION BY:**

(viii) Lincoln Kan questioned the stability regime for a natural versus an armoured watercourse noting that this would relate to a development setback. Ron Scheckenberger would discuss with John Parish and provide direction accordingly. **Parish Geomorphic**

Region of Peel

Region comments outlined in correspondence dated July 17, 2002 (Hynes – Calvert) were discussed as follows:

(i) Given the context of some of the points raised, Lesley Pavan indicated that she would contact Michael Hynes to elaborate on the specific Terms of Reference for this study. **City**

3. Mapping Update

(i) Lesley Pavan indicated that according to the latest information, Dave Marion's group is still on track to produce mapping by September 2002. Once this mapping is produced, Philips will review the areas specifically identified for SPA's and then advise further whether or not there needs to be supplemental study/modelling undertaken. **City/Philips**

4. Transfer of Information from City of Mississauga

(i) Ron Scheckenberger indicated that the hydraulic modelling obtained from EWRG does not include stabilization works, constructed in the recent past and ongoing by Bob Levesque's group. It was noted, however, that the likely influence of these works on major flooding, be it 100 year or Regional, is likely to be minor. Notwithstanding, Ron Scheckenberger indicated that it is typically a requirement of consultants retained by Bob Levesque's group to demonstrate impact to the Regulatory flood from the works. Lincoln Kan is to contact Bob Levesque further regarding this issue. **City**

5. Cost Benefit Input

(i) Lesley Pavan indicated that due to vacations, she has not had a formal meeting with the finance group and that the information requested at the June 28, 2002 meeting with Julian Patteson would be forthcoming in the last week of August 2002. **City**

MATTERS DISCUSSED	**ACTION BY:**
6. **Next Phase**	
(i) Ron Scheckenberger indicated that the floodline mapping, as updated, needs to be approved by the committee before advancing to the next level of analysis which examines the appropriateness for SPA's in the various development areas cited. To this end, as the majority of the comments (technically) were forthcoming from the Conservation Authority, Lesley Pavan suggested a *"face to face"* meeting with CVC staff. She would co-ordinate accordingly.	**City**

Minutes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

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c.c. All Present
John Parish, Parish Geomorphic
Ruth Victor, BGD Consulting Inc.
Chris Barnett, Davis & Co.
Mike Heralall, Philips Engineering Ltd.
Mary Kelly, Philips Engineering Ltd.

PHILIPS
ENGINEERING

Meeting Minutes

July 4, 2002
Our File: 101127-75

Subject: Cooksville Creek SPA Study

Date: June 28, 2002

Time: 9:30 a.m.

Location: City Hall

In Attendance:
Lesley Pavan ➢ City of Mississauga
Julian Patteson ➢ City of Mississauga
Ron Scheckenberger ➢ Philips Engineering Ltd.

MATTERS DISCUSSED **ACTION BY:**

1. Lesley Pavan provided background on the Cooksville Creek and cited issues with respect to flooding, floodplain designation and the background to conflicts between a City and Conservation Authority designation.

   Lesley provided an overview of some of the subject properties, highlighting the Inglis, Consulate and Humenick lands.

   Lesley outlined the three general floodplain management strategies as follows:

   (i) One Zone
   (ii) Two Zone
   (iii) Special Policy Area

   Julian Patteson questioned the process if the respective agencies, i.e. City, Conservation Authority, MNR and Region of Peel, do not agree. Lesley Pavan indicated that each group generally has a veto ability, however the Provincial regulations generally take precedent.

2. Ron Scheckenberger provided a background with respect to the objective of determining "benefit" to a potentially developable property through various means of floodproofing. He noted that in order to define benefit: costs, cost of floodproofing works can be determined in a relatively straight forward manner, however, the benefit (i.e. floodplain land versus floodproofed land) is difficult to value.

3. Julian Patteson described various real estate principles, noting that properties are always valued on their "highest and best use" and that value is a direct function of use and utility. Julian advised that there are several techniques used to determine the value of lands, generally described as:

a. Cost of Development Approach
b. Adjacencies and Plottage Value
c. Direct Comparison Approach

Insofar as the Cost of Development method, this would require a definition of the potential development on the site, which would include the number and type/style of units. The gross sales of finished units can then be calculated for which netted out development costs and developer profit (5% - 20%) would result in the residual land value, less the discount for time (absorption) would result in the raw land value. All of these figures then would be required to be brought to present value terms.

Julian Patteson advised that current values generally across the Municipality for different types of land use are as follows:

Commercial - $30.00/sq. ft.
Townhouse Infills - $470,000/acre
Condominium/Apartment Units - $5,000 - $20,000/unit
Floodplain Land - $3,000 - $5,000/acre

The difficulty with the foregoing is how best to transcribe these to the Cooksville setting.

4. Lesley Pavan indicated that it may be necessary to bring on the finance group in order to secure input on possible revenues from new assessments. Also background on development charges which may be recovered from the development should be examined. This would ultimately relate to some benchmarks/frame work for future cost sharing between the affected development community and the municipality.

City

Ron Scheckenberger also noted that any floodproofing works would, in all likelihood, benefit existing development which would further advantage the municipality and lead to cost sharing.

5. Lesley Pavan indicated that the Study Team will develop land use concepts in consultation with the City and then advise Julian Patteson's group on requisite input necessary. Julian Patteson noted that depending on work load, this activity may need to be completed by an external party.

Study Team/ City

Minutes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

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c.c. All Present
Ruth Victor, BGD Consulting Inc.
Chris Barnett, Davis & Co.

PHILIPS
ENGINEERING

Meeting Notes

May 30, 2002
Our File: 101127-75

Subject: Special Policy Area Study Topographic Mapping Check for Cooksville Creek Floodplain

Date: May 28, 2002

Time: 1:30 p.m.

Location: Mavis Road, City of Mississauga

Meeting With:
Dave Marion ▸ City of Mississauga
Aidan Griffin ▸ City of Mississauga
Rob Cox ▸ City of Mississauga, Planning & Building
Lesley Pavan ▸ City of Mississauga, Planning & Building
Ron Scheckenberger ▸ Philips Engineering Ltd.

MATTERS DISCUSSED

ACTION BY:

1. Rob Cox was uncertain as to the vintage of the mapping provided to Philips. Philips is to return the CD to Rob Cox to verify its date. Rob Cox is to check the difference between the two mapping products – the 2001 update versus that produced for 2000 in the form of a visual scan for changes.

PEL/City

2. Dave Marion outlined the procedure undertaken to compare the mapping base used by Philips. He indicated that cross-sections were produced from the mapping and, similarly, additional cross-sections produced by separate mapping contractor from different photography (Eagle Mapping). In general, the cross-sections were taken at hard and soft points. Where the difference exceeded the 25 cm specification, field survey checks were done. They did not field verify all, only those that were outside the specified range. There was some +/- *"waggle"*. However, for the most part, the mapping proved to be quite good. Some exceedances occurred at:

   - Bristol Road
   - Mississauga Valley Boulevard
   - QEW, and
   - Rathburn

   Dave Marion indicated there could be numerous reasons, including roadway resurfacing.

MATTERS DISCUSSED	ACTION BY:
3. In conclusion, Dave Marion stated that the mapping at the points checked satisfied the 5% criterion specified by FDRP standards, hence, could be adopted for use in this study.	
4. Dave Marion advised that new mapping would be available this summer based on 2002 aerial photography through the Provincial Municipal partnership. This mapping would be to full FDRP Specifications, 1 metre contours with ½ metre interpolations.	
Dave Marion would advise week's end as to its availability.	**City**

Meeting Notes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

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c.c. All Present

PHILIPS
ENGINEERING

Meeting Minutes

May 27, 2002
Our File: 101127-75

Subject:	Cooksville Creek SPA Study Interim Report Presentation to Technical Steering Committee		
Date:	May 24, 2002		
Time:	1:30 p.m.		
Location:	Committee Room E – Mississauga City Centre		
In Attendance:	Lesley Pavan	➢	City of Mississauga
	John Calvert	➢	City of Mississauga
	Lincoln Kan	➢	City of Mississauga
	Ruth Marland Bryan	➢	City of Mississauga
	Richard Tupholme	➢	City of Mississauga
	Hazel Breton	➢	Credit Valley Conservation
	John Perdikaris	➢	Credit Valley Conservation
	Mary Bracken	➢	Credit Valley Conservation
	Ruth Victor	➢	BGD Consulting Inc.
	John Parish	➢	Parish Geomorphic
	Michael Hynes	➢	Region of Peel
	Michael Heralall	➢	Philips Engineering Ltd.
	Ron Scheckenberger	➢	Philips Engineering Ltd.

MATTERS DISCUSSED **ACTION BY:**

1. Introduction/Background

Lesley Pavan welcomed all noting that the meeting and review of Interim Report #1 by the Steering Committee was important at this stage, in order to facilitate the next phase of the study.

Ron Scheckenberger distributed the report and indicated that the report generally follows the meeting agenda, as well as the Terms of Reference. Ron Scheckenberger indicated that several meetings had been held with the City and CVC since the start-up meeting of January 10, 2002. Of the action items cited at the January 10, 2002 meeting, the following have been deferred:

(i) Hand-drawn floodlines from FRS not digitized.
(ii) Bob Sasaki not yet contacted for traffic constraints on subject properties.
(iii) Land use query not yet required by Philips.

MATTERS DISCUSSED **ACTION BY:**

Ron Scheckenberger indicated that the Team has completed a considerable portion of the tasks including: stream inventories, field survey, field reconnaissance and stream gauge installation, as well as conducted a technical analysis of various alternatives. The Team attended the March 19, 2002 Open House for the FRS.

Ron Scheckenberger noted that the study process is being completed in two stages with Stage I focussing on technical evaluation and Stage II, conditional on the findings of Stage I, involving the planning integration process leading to a possible Official Plan Amendment.

Ron Scheckenberger echoed the sentiments of Lesley Pavan in that this stage is important to receive concurrence and input from the Agencies and the City, prior to proceeding to the detailed site-specific assessment.

Ron Scheckenberger drew a distinction between the study area for the FRS and the SPA Study, noting that the FRS, included the whole of the watershed, whereas the SPA Study is focussing on properties currently under consideration for development. Notwithstanding, the whole of the watershed still needs to be considered for issues such as flows and levels.

Ron Scheckenberger requested that all the parties review the list of documentation provided in the report, in order to confirm that there is no outstanding information, which would assist this study. **All**

Lincoln Kan advised that a plan depicting where foundation drains are directly connected to local sewers is not available.

Lincoln Kan would pursue securing a plan of the Bristol Road facility. **City**

Similarly, Lincoln Kan and Michael Hynes will review the availability of geotechnical reports proximate to Cooksville Creek. **City/Region**

Ron Scheckenberger noted that Chris Doherty has advised that the current HEC-2 model used for the FRS does not have current works in-place and that this information has been requested from the City (Bob Levesque). Lincoln Kan and Lesley Pavan are to pursue. **City**

Ruth Victor undertook a review of the governing policy for floodplain management for the Cooksville Creek, as well as the background to various management strategies including a Special Policy Area initiative. Lesley Pavan questioned whether or not a zoning amendment would be required. Ruth Victor responded in the affirmative noting that it would depend on the particular approach though.

2. Status of Cooksville Creek Flood Remediation Study

Lesley Pavan questioned the status of Cooksville Creek Flood Remediation Study. Lincoln Kan indicated that the report has been completed and provided a copy dated May 2002 to Philips.

MATTERS DISCUSSED **ACTION BY:**

3. Hydrologic Check

Ron Scheckenberger indicated that a streamflow gauge has been installed (May 7, 2002) under a separate Municipal initiative (Brian Chan). In addition, current metering will be undertaken to the end of the summer in order to establish a rating curve. It was indicated that while this information would not directly benefit the SPA study, it would provide input to allow future hydrologic model calibration, which could provide a benefit to the design of future infrastructure along Cooksville Creek.

Ron Scheckenberger noted that the hydrologic parameter verification to-date has indicated that the modelling parameters are within the allowable range and are consistent with other initiatives. Ron Scheckenberger noted that Philips would undertake a more detailed comparison of land use parameters and report on same to the committee.

PEL

Ron Scheckenberger noted that Philips undertook an evaluation of the influence of man-made storage upstream of existing structures in an effort to determine whether or not there would be any benefit to reducing downstream flows. He indicated that due to the lack of substantial areas (with the exception of Bristol Road), the net benefit was marginal.

4. Topographic Mapping Check

Ron Scheckenberger indicated that Philips undertook a topographic mapping check of Cooksville Creek mapping in general accordance with FDRP protocol, noting that the mapping was outside the allowable range. This information was brought to the attention of City of Mississauga staff (Dave Marion). An additional assessment by the GIS department is being undertaken. A meeting slated for May 28, 2002 will provide further direction.

City

Lesley Pavan indicated that Dave Marion advised of new mapping (September 2002) which could be used for study. Ron Scheckenberger is to advise what the influence would be on the current initiative and whether or not there are opportunities to draw certain conclusions in the absence of having to redo floodline mapping.

PEL

5. Study Area Overview

Ron Scheckenberger provided a summary of the Flood Remediation Study conclusions with respect to the study area and its flood and erosion proneness. Ruth Victor then provided a description of the respective properties under consideration (for the SPA).

John Calvert questioned whether or not different land uses will be considered by this study. Ruth Victor indicated that, in general, the existing land use designations would be considered, however, for a site such as the Inglis property, the potential for residential will be reviewed. Ron Scheckenberger noted that the standards with respect to risk and safety differ for overnight uses versus employment uses and that these would have to be considered concurrently.

Study Team

Insofar as the Peel School Board property, John Calvert advised that the golf use was probably the closest to being approved in the past and that some quasi-community use would be the likely future for this holding. Mary Bracken questioned whether or not it would be in the School Board's jurisdiction in perpetuity. Ruth Victor believed this to be the case, however, she would confirm. **BGD**

John Calvert advised that north of Burnhamthorpe Road is not in Kaneff ownership as shown on Drawing 2. Philips to update. **PEL**

Ruth Marland Bryan questioned whether or not there would be any benefit to having mapping which depicts City ownership. It was generally agreed that this would be useful. Lesley Pavan and Ruth Marland Bryan are to follow-up. **City**

6. Stream Morphology Assessment

John Parish provided an overview of the background policy and the procedures used to establish a stability criterion setback. John Parish then provided a general overview of a channel evolution model which mimics Cooksville Creek (ref. attached).

John Parish circulated a cross-section from the guideline document (ref. attached).

John Parish indicated that the channel flows over shale bedrock over its predominant length, however, it is in an alluvial system south of Queensway. He indicated that the natural rate of degradation for shale bedrock systems is of the order of 1 mm per year, however, Cooksville Creek degrades at 4 to 5 cm per year.

Lesley Pavan questioned whether or not the changes proposed in the Provincial documentation will have any influence on the recommendations of this study. John Parish indicated that this study would be consistent with those new documents.

Lincoln Kan questioned whether or not this initiative will validate the Rehabilitation Study. John Parish noted that it would build upon the technical findings with a more focussed examination providing additional insight and more detail for the subject properties through the provision of setbacks.

John Parish noted that, by example, the Inglis property would have had its predominant change (downcutting) in the 1970's and 1980's and that currently it is roughly at its base level and it is not downcutting substantially.

Hazel Breton expressed concern with respect to the potential difference between the Provincial and CVC's criteria for Cooksville Creek, citing a need to harmonize the policy. It was indicated that CVC may require specific policy for Cooksville Creek. Lesley Pavan noted that, as part of the Terms of Reference, CVC would be required to update its policies. Lesley Pavan advised that as this initiative proceeds to an Official Plan Amendment, a report amending CVC's policies may need to be forwarded to its board. The concern related to this would be counter to Provincial policy. Lesley Pavan suggested that the Provincial policy generally establishes a minimum, notwithstanding, a legal opinion may be required. Lesley Pavan indicated that the Province was invited to this meeting but could not attend and that the Region would be providing input to the Province accordingly.

City/CVC

John Calvert questioned whether or not the City would be liable under any initiative which increases risk to existing properties. All generally conceded that the City would assume this liability ultimately. Richard Tupholme added that the current study has been advanced, in order to examine the last remaining opportunity for development potential.

Ruth Victor noted that risk and liability will ultimately be assessed and interpreted by legal counsel concurrently with the Municipal solicitors.

Study Team

John Calvert questioned whether or not new development north of Highway 401 could potentially contribute (financially) to downstream works. It was generally noted that new development would require stormwater management consistent with the FRS and that funding for off-site works could be included in a development charge.

Hazel Breton noted that there has been a general question for Cooksville Creek regarding the implications of existing flows versus future flows and that perhaps this system should be examined under existing flows to determine how much of an influence stormwater management could have. This could also include the prospect of overcontrol. PEL to examine implications.

PEL

7. Hydraulic Modelling and Feasibility Assessment of Structural Alternatives

Ron Scheckenberger indicated that the FRS hydraulic modelling has been updated, based upon existing mapping. He also noted that the hydraulic modelling would potentially require further updating, based upon the current rehabilitation initiatives by the City of Mississauga. He stated that the new HEC-2 has been premised on a different topographic base (1999) and has retained the bridges and low flow sections from the FRS and updated the top-of-bank information accordingly.

Ron Scheckenberger cited the utility of RiverCAD™ which was used as an interface between AutoCAD™ and HEC-2 to automate the floodline mapping process.

Ron Scheckenberger undertook a general review of the feasibility assessment for each of the development sites noting that the evaluation has been based upon future land use flows. Lincoln Kan will review whether the historical works cited are current. Ron Scheckenberger indicated that the various options examined by Philips included the introduction of an optimized Bristol Road stormwater management facility which he cited as reducing 100 year peak flows by 10% to 30% depending on location.

City

Ron Scheckenberger noted that four cases have been mapped:

(i) Future flows, based on existing hydraulic characteristics
(ii) Case (i) With Bristol Road facility in-place.
(iii) Case (ii) Culvert improvements as per FRS.
(iv) Case (iii) Plus channelization and dyking

Ron Scheckenberger noted that it would be necessary to integrate the FRS recommendations, as these could have a direct influence on the developability and policies to be considered for the properties under question. During the presentation of site-specific development plans, some errors were noted in the mapping. Philips is to update and redistribute maps. CD's of hydraulic modelling were distributed to City and CVC staff for review.

PEL
CVC/City

8. **Next Steps**

Once input is received from the Agencies and the Municipality, the detailed options will be examined for each development site. The stream stability assessment will be completed and setbacks established accordingly and development options will be reviewed for consideration for an SPA.

Study Team

9. **Schedule**

All present were requested to provide comments to Lesley Pavan by June 21, 2002. It was indicated that the current study is approximately 1 month behind the schedule distributed January 2002, however, this could likely be made up by conducting some of the balance of activities over the summer.

All

10. **Other Business**

Ron Scheckenberger distributed information on a legal opinion based upon the current regulations.

Ron Scheckenberger indicated that it would be necessary to secure an opinion from an appraiser regarding the value of flood relief for these properties. Lesley Pavan is to follow-up accordingly.

City

Minutes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

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c.c. All Present
Nancy Mott-Allan, Region of Peel
Chris Barnett, Davis & Co.

Attach.

Channel Evolution Model

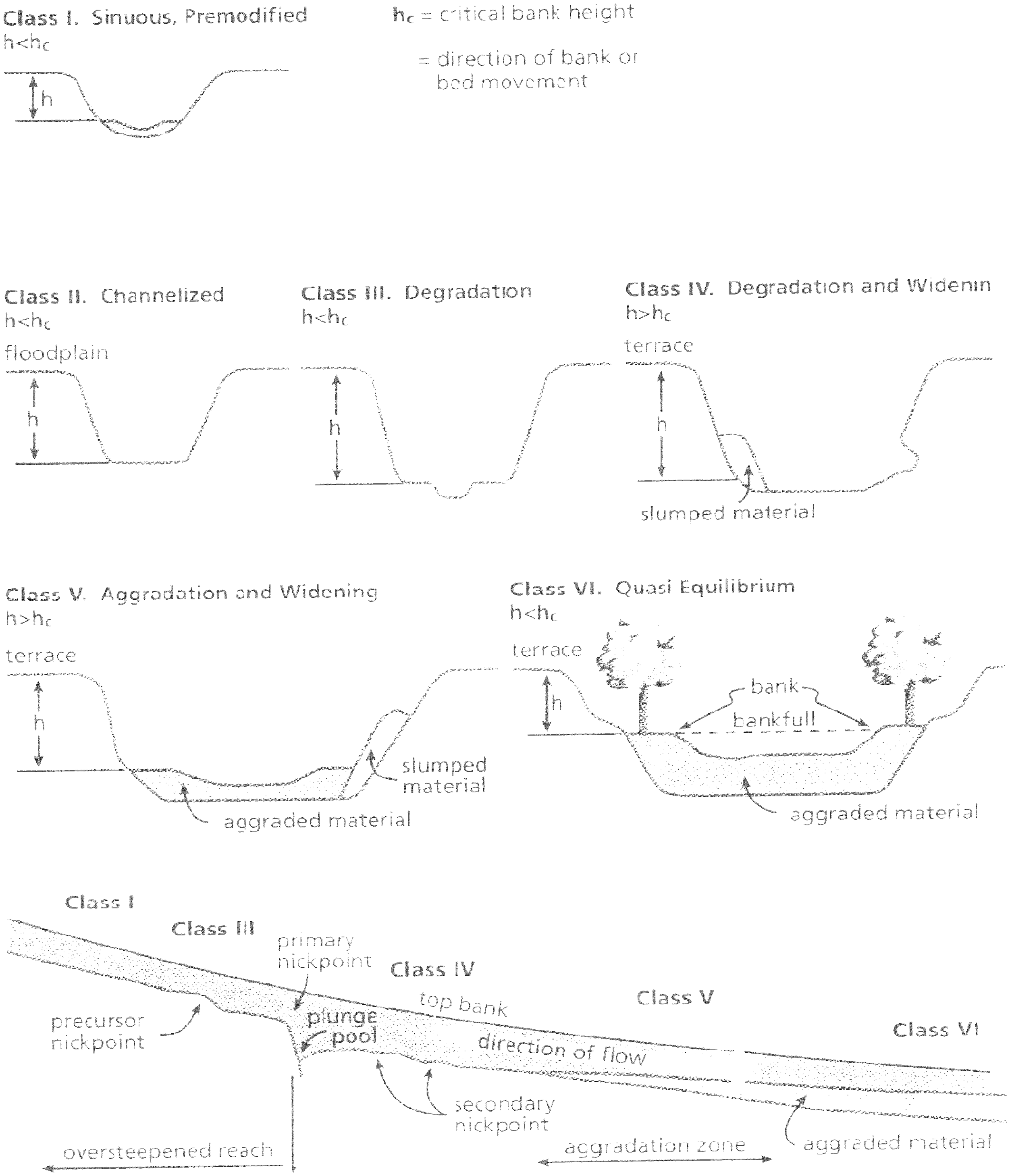
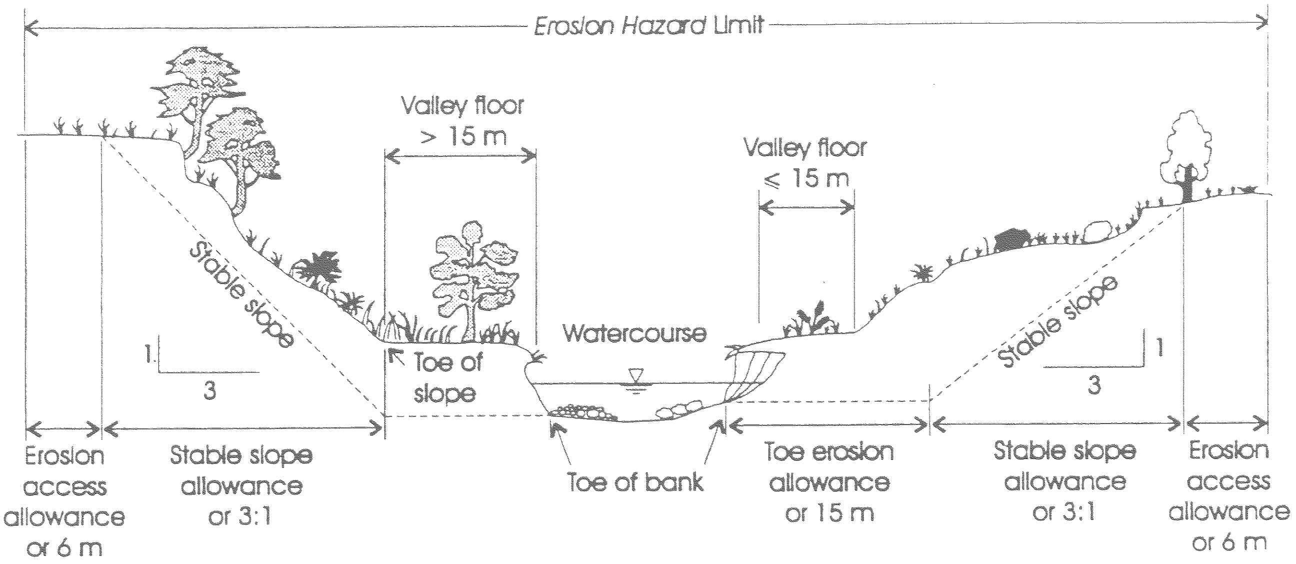
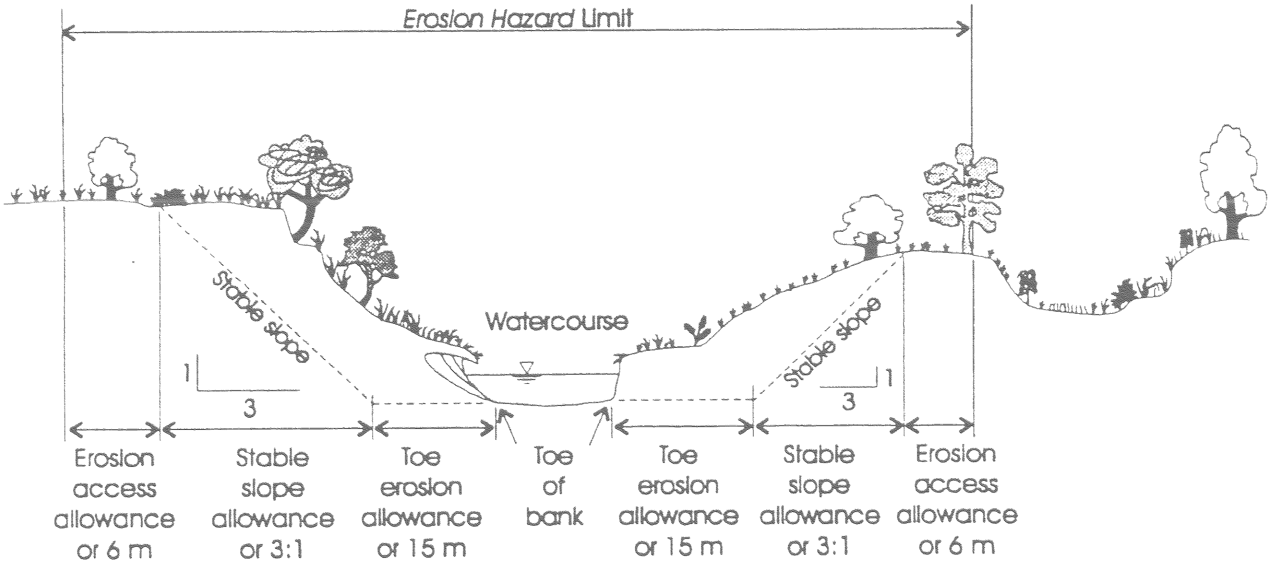


Figure 19: ***Erosion Hazard Limit*****: Confined and Terrain-Dependent (Cohesive)** ***River and Stream Systems***

a) Confined *River and Stream System*



b) Terrain-Dependent Consisting of Cohesive Materials (e.g., clay)



(not to scale)

PHILIPS
ENGINEERING

Meeting Minutes

March 19, 2002
Our File: 101127-75

Subject: Cooksville Creek Special Policy Area Study

Date: March 14, 2002

Time: 11:00 a.m.

Location: City of Mississauga – City Centre
9th Floor Board Room

In Attendance:
Lesley Pavan ➢ City of Mississauga, Planning & Building
Bob Levesque ➢ City of Mississauga, Transportation & Works
Ron Scheckenberger ➢ Philips Engineering Ltd.

Regrets:
Lincoln Kan ➢ City of Mississauga, Transportation & Works

MATTERS DISCUSSED

ACTION BY:

1. Lesley Pavan indicated the purpose of the meeting was to review proposed Municipal Capital works for flood and erosion control along Cooksville Creek.

2. Ron Scheckenberger discussed the issue with respect to mapping and its accuracy. Lesley Pavan noted that she would speak with the City Mapping Department to set-up a meeting to discuss this point further.

   City

   During the meeting, Bob Levesque contacted Municipal staff to confirm that the Municipal mapping is all set to the City of Mississauga datum which differs from geodetic. It was also confirmed that the mapping north of Burnhamthorpe is set to spring 2000 aerial photography and that the mapping south of Burnhamthorpe is set to spring 2001. Ron Scheckenberger to update elevations documented in the March 13, 2002 memo.

   Philips

3. Bob Levesque provided a handout which summarized the recommended Capital Works for Cooksville Creek (ref. attached). These works are summarized in detail within the 1997 Totten, Sims, Hubicki Report; Philips to obtain report from CVC.

   Philips

4. Ron Scheckenberger requested that any hydraulic updates to the backwater model which had been completed by any consultants since the 1996 Floodline Mapping Study be provided to Philips. Philips will also contact Chris Doherty to determine the accuracy of the existing hydraulic model.

   City
   Philips

MATTERS DISCUSSED **ACTION BY:**

5. Bob Levesque stated that a 1986 Totten, Sims Hubicki Study also provides some information on flood control initiatives. Lesley Pavan will pursue Kealy Dedman and/or Brian Chan in this regard. **City**

6. Ron Scheckenberger indicated that it appeared as if there are works for Cooksville Creek in three categories namely:

   - Completed
   - Planned
   - Future

   It will be necessary to determine the extent and scope of the works, as they will potentially affect the objectives of the Cooksville Creek Special Policy Area Study. **City/Philips**

Minutes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

RBS/mp
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Attach.

c.c. All Present
Lincoln Kan, City of Mississauga
Richard Tupholme, City of Mississauga
John Parish, Parish Geomorphic

PHILIPS
ENGINEERING

Meeting Minutes

January 18, 2002
Our File: 101127-75

Subject: Cooksville Creek Special Policy Area Study
Start-Up Meeting

Date: January 10, 2002

Time: 10:00 a.m.

Location: City of Mississauga – 10th Floor Board Room
Civic Centre

In Attendance:
Lesley Pavan ➢ City of Mississauga, Planning & Building
Richard Tupholme ➢ City of Mississauga, Transportation & Works
Kealy Dedman ➢ City of Mississauga, Transportation & Works
Lincoln Kan ➢ City of Mississauga, Transportation & Works
Katryn Detz ➢ City of Mississauga, Planning & Building
Rob Cox ➢ City of Mississauga, Planning & Building
Nancy Mott-Allen ➢ Region of Peel
Robert Gepp ➢ Region of Peel
Tracy Locke ➢ Region of Peel
Mary Bracken ➢ CVC
John Parish ➢ Parish Geomorphic
Ruth Victor ➢ B.G.D. Consulting Inc.
Ron Scheckenberger ➢ Philips Engineering Ltd.

MATTERS DISCUSSED **ACTION BY:**

1. Introduction

(i) Lesley Pavan introduced the Technical Steering Committee members as well as the Consulting Team. Ron Scheckenberger noted that Chris Barnett of Davis & Co. is also on the Consulting Team to provide input on legal aspects. Mary Bracken noted that Hazel Breton and Lisa Ainsworth will also be committee members from the Credit Valley Conservation.

2. Status of Study

(i) Lesley Pavan indicated that a preliminary data transfer meeting was held with Philips on December 7, 2001, which involved some information transfer, as well as a discussion of issues and background. The Philips Team was subsequently authorized by the Purchasing Department the week prior to Christmas and that Municipal staff had been preparing the balance of the information required for the study in the interim period.

3. **Status of Cooksville Creek Flood Remediation Study (FRS)**

(i) Kealy Dedman indicated that the study is currently in "draft" form. The report has been taken to Council this past summer, however, it is not yet in the public realm. The final submission from the consultant has been reviewed by City staff and a meeting is required to review same with Credit Valley Conservation.

(ii) Mary Bracken indicated that Hazel Breton received the report pre-Christmas and that would have comments shortly. A meeting is to be scheduled with CVC, City and the Consultant late January early February. Based on this meeting, it is expected that the final report could be prepared towards the end of February with a Public Open House pending early March. **City/CVC**

(iii) Richard Tupholme advised that Council permission for the Public Open House has already been secured.

(iv) Lesley Pavan stressed the urgency of completing this process, as it will be necessary for the Cooksville SPA to dovetail with the FRS,

(v) Ron Scheckenberger noted that it is particularly important to secure the hydraulic and hydrologic models from the FRS in order to avoid any further delays. Kealy Dedman noted that these have been essentially approved by the City and that Conservation Authority approval is pending. **CVC**

4. **Status of Floodlines**

(i) Ke[illegible]an indicated that the existing creek floodlines are essentially unaltered from the 1996 study and that these have been digitized by the Planning Department. The FRS has 'hand drawn' floodline mapping which defines the limits of reductions associated with the various alternatives. City staff will convert these to a digital format and forward to Philips. **City**

5. **Outstanding Data Needs and Required Format**

(i) Ron Scheckenberger distributed a summary of information which was provided by the City at the December 7, 2001 meeting, as well as a listing of outstanding data needs and requirements. It was indicated that Philips will be using AutoCAD ™ as the graphics platform and that .DGN files would be acceptable. Key reports and their associated timing were summarized as follows:

(a) Cooksville Creek Flood Remediation Study (end of February, Richard Tupholme) **As Noted**

- (b) Cooksville Floodline Mapping Study (provided by Lincoln Kan at meeting, Appendices to follow)
- (c) Digital Air Photos (2001), (January 18, 2002, Lincoln Kan)
- (d) Digital mapping of all hard copy products, (January 18 to 25, 2002, Rob Cox)
- (e) Hydraulic and hydrologic models, (one week +/-, Kealy Dedman)
- (f) Development proposals of subject properties (Lesley Pavan, one week +/-)
- (g) Regional Official Plan (Nancy Mott-Allen)

(ii) Other information discussed included the provision of traffic constraints to service the subject properties. Bob Sasaki is to be contacted by Lincoln Kan. **City**

(iii) Mary Bracken noted that there are no wetlands along the watercourse; she will confirm that there are no additional constraints. **CVC**

(iv) Lesley Pavan to follow-up with respect to heritage properties. **City**

(v) Lesley Pavan to contact MTO with respect to their involvement and potential constraints at the Hurontario interchange. **City**

(vi) Philips to provide a land use query one week prior to its requirement. **Philips**

6. **Discussion of Specific Properties and their Respective Issues**

(i) Lesley Pavan undertook a review of various development lands previous highlighted on a land use map. It was indicated that this map would be digitized by the City and forwarded to Philips. Matters arising included: **City**

- (a) Peel Board of Education lands in the northern limit would be included in the assessment, given their potential for redevelopment.
- (b) The Long Acres site has been previously identified as a dry basin. The Winters Water Quality Study is to be reviewed. **Philips**
- (c) The Kaneff apartment site has been the subject of various studies, however, documentation is poor. Ron Scheckenberger was encouraged to contact Chris Doherty. **Philips**
- (d) Kealy Dedman and Lincoln Kan will review the Transportation and Works file on the Humenik plans. It was indicated that while monies were collected from Humenik at one point, these have been returned. It was also noted that there is a sanitary trunk sewer constraint to this property. **City**

(e) The difficulty with the Inglis property was noted as access. A solution for these lands, however, would be important to the City interest.

(f) The F & F property is under appeal in the current City plan policies; the owner is interested in developing the property, despite a large portion being within the floodplain.

(g) The Consulate site is subject to OPA #69 which is under appeal by the CVC and Province.

7. **Schedule**

(i) Ron Scheckenberger distributed the initial schedule which indicated that the start-up meeting would be taking place the last week of November. Given the six week delay in start-up, it was indicated that the study completion for Stage 1 would need to be shifted from April to May. The attached schedule documents the amendments to the timeframes accordingly.

8. **Other Business**

(i) Ron Scheckenberger questioned the background with respect to the topographic mapping check, principally its purpose and areas of concern. It was indicated that this concern likely evolved from discussion with Conservation Authority. Both Conservation Authority and City staff are to review further and advise accordingly in order that Philips can best direct its work efforts in this regard. **CVC/City**

(ii) Ron Scheckenberger questioned whether or not the Municipality wishes to follow-up on the Philips proposal recommendation for a flow sampling program. John Parish noted that there has been a dry manhole installed which would facilitate this effort. Richard Tupholme is to review this requirement further and advise accordingly, however, general sentiment at the meeting indicated support. **City**

Minutes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

RBS/mp
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Attach.

c.c. All Present
Hazel Breton, CVC
Lisa Ainsworth, CVC
Chris Barnett, Davis & Co.

Region of Peel
Working for you

Fax Transmittal

	Date: December 6, 2002	Number of Pages including cover:
To: **Ron Scheckenberger**		Fax No.: **1-905-335-1414**
Organization: **Philips Engineering**		

From: **Michael Hynes**	Tel: **905-791-7800 Ext. 4751**	Fax No.: **905-791-7920**
Company: **Region of Peel**	Department: **Planning**	

Comments

Cooksville Creek Comments – Interim Report #2

Region of Peel
Working for you

Planning

December 6, 2002

Via Fax and Mail

Mr. Ron Scheckenberger
Philips Engineering
3215 North Service Road
P.O. Box 220
Burlington, ON L7R 3Y2

Dear Mr. Scheckenberger:

Re: **Cooksville Creek SPA**
Interim Report #2
Region File No.: P13 SPA CC

This is further to our comments of July 17, 2002 and a review of the Draft Special Policy Area - Cooksville Creek Floodplain *Interim Report #2*.

Regional Official Plan

The interpretation and wording of the Regional Official Plan and the Provincial Policy Statement appears to be accurate in the report. The process undertaken to date follows the process envisioned in the Regional Official Plan. We would highlight Regional Official Plan policy 2.4.4.2.1 as the next stage in the process.

In order to achieve what is expressed in 2.4.4.2.1, the Region looks forward to working closely with the Consultant , the City of Mississauga and the Credit Valley Conservation Authority to finalize the preferred options on potential development sites, determine associated risk and the detailed cost analysis. Regional staff will have more input during the creation of new detailed land use policy for Cooksville Creek.

Risk

The Region's concerns are primarily based on the risk associated with allowing additional development in the floodplain. What are the risks to new and existing development associated with flooding and erosion along the Creek and what is the potential liability (i.e. loss of life, property damage) for the Region and other parties as a result of allowing development to occur? We would hope that prior to the creation of new land use policies, these questions will be answered.

The Region would also note that the report did not include detailed costs associated with the proposed infrastructure improvements to the Creek. We

10 Peel Centre Dr., Brampton, ON L6T 4B9 Tel: (905) 791-7800 www.region.peel.on.ca

understand that additional work will be done in this area. However, on page 60 of the report, table 7.3 it is estimated that improvements to the Queensway crossing will cost $600,000, yet there will be no resulting benefits. Based on the final options chosen for the Creek, the Region will have to be satisfied with the benefits gained before it will expend funds to modify Regional infrastructure.

We note that the limiting impact to development in some areas of the watershed are in fact erosion, not flooding. We want to reiterate that Regional staff prefers a non-structural risk management approach to erosion situations wherever possible.

Regional staff offers the following comments on the consultants draft recommendations found in Section 8.1 of the "Detailed Evaluation of Site Specific Properties".

Inglis Property

Regional staff has no objection to the recommendations to modify the Lakeshore Road profile.

Consulate Property

Regional staff would prefer the ultimate recommendation for this site (i.e. the QEW structural option). The Regional Official Plan allows for the consideration of a two zone approach if it is deemed appropriate.

Camilla Road Property

Regional staff would support the recommendation that this site remain in a one zone concept as this site is in an active floodway.

Humenik Property

Based on the recent committee meeting, the Credit Valley Conservation Authority (CVC) and the consulting team are further looking into the structural option. The Region is not prepared to support an SPA in this area until the CVC advises that the technical approach is acceptable. As well, Regional staff request further planning analysis to address the possible social and economic hardships that may result if development does not occur in this area.

Furthermore, the Region asks the following questions related to also be addressed in the planning analysis:

1) Are there sites with similar characteristics that have been considered in such a context?
2) What are the planning objectives in the Mississauga Plan that would be promoted by allowing development of this site?

We think this additional analysis will be useful in the content from a Provincial perspective.

Little John Lane Property

We look forward to reviewing the up to date mapping and recommendations at the next Committee meeting.

Kaneff/Eglinton-Hwy 10/Peel Board of Education Properties

Our understanding is that the one zone approach will remain for these sites and the Region does not object to this.

We trust that this is of assistance and look forward to our continued participation in this study. Should you have any questions or concerns, please contact Michael Hynes at Ext. 4751.

Yours truly,

Robert Gepp
Program Manager
Development Planning Services

c. John Calvert, City of Mississauga Planning
Mary Bracken, CVC
Ophir Bar-Moshe, Regional Solicitor
Lesley Pavan, City of Mississauga Planning
Rizaldo Padilla, Ministry of Municipal Affairs and Housing

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Planning and Building Department

City of Mississauga
300 City Centre Drive
MISSISSAUGA ON L5B 3C1

FAX: 905-896-5553 (Planning)
905-896-5638 (Building)
www.city.mississauga.on.ca

MISSISSAUGA

Leading today for tomorrow

December 2, 2002

FILE: CD.04.COO
Cooksville Creek SPA Study

Mr. Ron Scheckenberger
Philips Engineering
3215 North Service Road
P.O. Box 220
Burlington, ON L7R 3Y2

Dear Mr. Scheckenberger:

RE: Cooksville Creek SPA

I have had an opportunity to review the draft Interim Report #2 for the Cooksville SPA and have a number of questions and comments which are listed below.

1. Section 1.3.pg 6. - Municipal Policy Documents. You should reference Region of Peel Official Plan. Also, under reports you should state that it was a PDC Report. The first one was for the February 28, 2000 meeting and the second was for the October 2001 meeting. Finally, you should reference the CVC policies as they are being quoted in the document and under other, please include the Provincial Documents ie. P.P.S and Hazards Manual.

2. Page 12, The Cooksville Creek is Designated "Greenbelt" on the land use schedules for the respective district policies. Schedule 3 shows areas that are identified as being part of the Natural Areas System for the City. There is a distinction between the two.

3. Section 2.1, on page 16, I note that we are still awaiting the photographs for Appendix C.

4. Not all metric conversions have been included. This will have to completed prior to finalizing the report.

5. Table 6.1- 6.8, the understanding of the table would be increased if there was a legend or footnotes.

6. Table 7.2, page 60, please define EAD.

7. Section 7.2 page 64. It should be noted that the landowners of a proposed Bristol Road facility may not accept the facility.

8. Page 71, Consideration of Design Alternatives - I would not include the comments regarding the approved density for these lands as the density has been approved by Council and is not being reviewed under this study.

9. Page 74, 1st paragraph. Freeboard should be defined.

10. Section 8.1.5. How will we verify the flood line mapping?

11. Maps - both the legend and the notes in the upper right hand corners will have to be changed to replace the reference to "registered" to "1996".

I am awaiting comments from other members of the steering committee, so these comments may be considered preliminary until everyone has commented. If you have any questions regarding these comments or require additional information, please contact the undersigned at (905) 896-5536.

Yours truly,

Lesley Pavan
Environmental Planner
Policy Planning Division
Planning and Building Department

encl.
c: L. Kan, Transportation and Works
M. Bracken, CVC
R. Marland Bryan, Community Services
R. Gepp, Region of Peel, Planning

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Transportation and Works Department

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City of Mississauga
3484 Semenyk Court
MISSISSAUGA ON L5C 4R1

FAX: (905) 896-5504
FAX: (905) 615-3173

November 28, 2002

EC.01.COO

Mr. Ron Scheckenberger, M.Eng., P.Eng
Philips Engineering Ltd.
3215 North Service Road
P.O. Box 220
Burlington, ON L7R 3Y2

RECEIVED
PHILIPS ENGINEERING LTD.
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Dear Mr. Scheckenberger:

Re: Cooksville Creek SPA Study
Interim Report #2
October 31, 2002

The Infrastructure and Environmental Planning Section has reviewed the above noted report and advises that we are in general agreement with the overall approach taken in this study. However, this section would like to offer the following comments :

1. Under '2.3 *Flood Storage Assessment*', the reference to the location of the available on-line storage sites should be Drawing No. 2 and not Drawing No. 1 as indicated. Also, please provide additional clarification on the use of the CNR crossing at Applewood Creek for flood control (i.e., Was this flood control structure designed to provide flow attenuation by the CNR since it is not on City owned lands?).

   Table 2.2 presented four potential on-line storage facilities, namely, Eglinton Avenue West, Mississauga Valley Boulevard (North), Q.E.W. and Elaine Trail. In the discussion following the table, it was mentioned that two additional locations, Queensway and Elaine Trail, have also been included for analysis. However, it is unclear as to why the Queensway location has not been included in the table while Elaine Trail has. Please also note that Drawing No. 2 only presented three of the potential on-line storage locations.

2. It is difficult to comprehend the line type corresponding to the time of data collection for Figure 5.4 - Figure 5.6.

3. Under '*5.5 Technical Corridor Approach*', at the bottom of page 39, the detailed results of the modelling exercise was noted as provided in Appendix H. This reference does not appear to be correct.

4. Under '*5.6 Maintenance and Policy Corridor Approach*', a maintenance corridor setback of 21 m was recommended based on a combination of the 15 m toe erosion allowance for cohesionless soils (CVC) and a 6 m erosion access allowance (OMNR). Please explain why a stability component has not been considered.

5. On Drawing No. 2, please differentiate the recommended remedial measures on City and external agencies' properties.

6. Please be advised that the Kirwin Avenue culvert improvement and flood protection capital works have been slated for the year 2004 in the forecast for the 2003 - 2012 Capital Budget, subject to Council approval.

7. In comparing the 100 year floodline delineation shown in the figures and that provided in Table F1, there appears to be discrepancies present. For examples, (a) for the Inglis property, the water surface elevation at section 0.790 is 81.61 m and 80.76 m for Existing A (Figure 1a) and Alternative B (Figure 1b) respectively. However, when looking at Figure 1a, the water surface elevation at this section seems to fall in around 80.8 m and not 81.61 m as indicated in the table, (b) for the Consultate site, the water surface elevation at section 2.800 is 99.02 m and 98.88 m for Existing A (Figure 2a) and Alternative B (Figure 2b) respectively. However, the water surface elevation shown in Figure 2a appears to fall well below the 99 m contour line.

   Please review the RiverCAD™ generated floodlines for discrepancies.

8. Please provide the land area requirement for the Bristol Road off-line facility as well as the level of quantity control proposed. Additionally, due to the marginal benefits the controls afforded by this facility will have on the identified properties and taking into consideration the cost of this facility, a decision should be made by the Steering Committee as to whether this option should be maintained as a viable option.

9. Please advise as to what the level of benefit will be on the proposed development / redevelopment areas outlined in this report if only the recommended remedial measures on City properties or easements were undertaken.

10. Under *'8.1.3. F & F Construction Limited Property'*, please expand as to why there is no justification for establishing a Special Policy Area.

11. Please note that discussions on the Burnhamthorpe Road (North) and Eglinton Avenue (North) properties were not presented in *'8 Floodplain and Erosion Management Alternatives Assessment'* while figures were provided for these various scenarios.

12. Please include in the body of the report the land area for each of the property under consideration.

13. Under *'8.1.2 Consulate Property Camilla Road - North of the Queen Elizabeth Way, Two-Zone'*, reference to Appendix I should be revised to Appendix H.

If you have any questions, please do not hesitate to contact the undersigned at 905-615-4086.

Sincerely,

Lincoln Kan

Lincoln Kan, P.Eng.
Storm Drainage Programming Engineer
Infrastructure and Environmental Planning

LK:lk

c: M. Bracken, CVC
L. Pavan

February 11, 2002
Our File: 101127

Ministry of Transportation
Corridor Policy Office
301 St. Paul Street
2nd Floor South
St. Catharines, ON L2R 7R4

ATTENTION: Ms. Heather Doyle
Manager

Ministry of Transportation
Central Region of Peel
Highway Engineering
Building 'D'
4th Floor
1201 Wilson Avenue
Downsview, ON M3M 1J8

ATTENTION: Mr. Joe Constantino, P. Eng.
Senior Project Manager

Dear Madam and Sir:

RE: Cooksville Creek Special Policy Area Study
City of Mississauga

The City of Mississauga has initiated a study of the Cooksville Creek. Part of the focus of the study will be to determine various means of providing flood protection to existing development, while considering the impact of future in-fill development.

The Hurontario – QEW interchange receives drainage from, and contributes drainage to, the Cooksville Creek. The study is currently at the background information collection and assessment phase. Any information on existing or planned infrastructure, or any policy issues influencing this traffic corridor would be welcomed.

If you have any questions regarding this study, please contact the undersigned or Lesley Pavan at the City of Mississauga (905) 896-5536. Thank you in advance for your assistance.

Yours very truly,

PHILIPS ENGINEERING LTD.

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

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c.c. Lesley Pavan, City of Mississauga

PHILIPS
ENGINEERING

Meeting Minutes

January 30, 2003
Our File: 101127-75

Subject: Cooksville Creek SPA Interim Report #2
CVC Comments

Date: January 27, 2003

Time: 9:30 a.m.

Location: 9th Floor Boardroom – Mississauga Civic Centre

In Attendance:

John Calvert	➢	City of Mississauga
Lesley Pavan	➢	City of Mississauga
Bill Waite	➢	City of Mississauga
Richard Tupholme	➢	City of Mississauga
Lincoln Kan	➢	City of Mississauga
Hazel Breton	➢	Credit Valley Conservation
Mary Bracken	➢	Credit Valley Conservation
John Perdikaris	➢	Credit Valley Conservation
Chris Doherty	➢	EWRG
Ron Scheckenberger	➢	Philips Engineering Ltd.

MATTERS DISCUSSED

ACTION BY:

Introduction/Process

1. Lesley Pavan introduced the meeting outlining that the objective of the City of Mississauga is to have the final draft of the Technical Report prepared by the end of February 2003. Lesley Pavan would advise on the number of copies required. **City**

Lesley Pavan noted that there has been senior staff direction to "wrap up" this process quickly and that an in-camera meeting with Council is scheduled for February 3, 2003. The final draft would then be advanced to the Technical Steering Committee and the Public at the same time (i.e. end of February 2003).

The process with respect to policy recommendations and the formal community meeting has been modified somewhat from the original plan. Lesley Pavan noted that this would be advanced on a site by site basis and that the City has delegated Official Plan Amendment approval authority from the Province. She would confirm with Region of Peel insofar as to whether or not the Province would be involved in 2-zone review. **City**

Transportation and Works Department. Also is Table 3.1 still required?

7. All references to the Flood Remediation Study should refer to the May 2002 document.

8. The document must contain imperial equivalents for all metric information.

9. There was discussion at the beginning of the project regarding the need for a overall map showing flooding depths and/or velocities. Will this map still be created for this study?

10. It is not clear what table 4.4 is telling us.

11. In section 5.1, although it is a fine point, it is my understanding that under Section 2 of the Planning Act, "Municipalities must have regard to" as opposed to "requires implementation"

12. In section 6.1, where there is a description of the RiverCAD ™ procedures, please ensure that the dates for the City maps are correct as per our meeting with representatives from Transportation and Works.

13. In Section 6.1, I was unable to locate the table that is referenced in the last paragraph.

14. In Section 7.1, there are descriptions of recommended flood remediation measures. What would the impact be on the Cooksville Creek recreational trail if through the channel widening between Kirwin Avenue and Central Parkway East? Space is limited in this area to accommodate the trail.

15. In the last paragraph of Section 7.1, it should state the land requirements for the storage facility given that was the reason stated for being screened out.

16. The legend on Drawing 1 should indicate if the land use is the Official Plan land use designation or the existing land use on the lands.

17. On Drawing 1, the flood plain on the Kaneff property should be corrected to reflect the current limit. [illegible]

18. On Drawing 1, the Shipp lands on the north east corner of Hurontario and Burnhamthorpe Road should be removed. Although the site is vacant, it does not require any special consideration, as the majority of the site is outside the floodplain.

19. It was my recollection that we were not going to identify the school site on Mississauga Valley Blvd. as a potential development site. Has this position been reconsidered?

20. There is considerable white space on Drawing 1 especially in the City Centre area. There

– graphics

is nothing in the legend to indicate why these lands are white. A land use needs to be assigned to these areas.

21. It was my understanding that the maps included as Figure1 - 8d are being reviewed as there seemed to be some concern that on some the floodlines seemed to worsen with stream improvements such as Figure 1 c & d.

22. In Figure 3d it shows the impact of widening the channel. Are there long term maintenance issues with widening the channel?

23. In Figure 4d, I was unable to locate the stream improvements shown in the legend? Are these occurring off-site?

24. In Figure 5b, the legend shows the development area as a pink/orange colour whereas development areas are indicated in yellow.

25. In Figure 6b, there seems to be a plotting error with the Regional Food Line, north of Mississauga Valley Blvd.

26. In Figure 8 b, why is the Regional Floodline worse?

I am awaiting comments from other members of the steering committee, so these comments may be considered preliminary until everyone has commented. If you have any questions regarding these comments or require additional information, please contact the undersigned at (905) 896-5536.

Yours truly

Lesley Pavan
Environmental Planner
Policy Planning Division
Planning and Building Department

encl.
cc L. Kan, Transportation and Works
M. Bracken, CVC
R. Marland, Community Services
R. Gepp, Region of Peel Planning

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APPENDIX 'A' POLICY EXTRACTS

Relevant PPS and CVC policy extracts should be included.

APPENDIX 'C' GAUGING SITE PHOTOGRAPHS

It would be helpful to have the photographs labeled i.e. location, date.

APPENDIX 'D' BRISTOL ROAD SWM FACILITY

Can another figure be added which shows the proposed pond location in relation to the entire school board lands? This would be helpful when discussions take place with the school board with respect to how much of their lands would be required for the pond.

DRAWINGS 1 AND 2

It would be helpful to add more street names to the maps, specifically, the streets referenced in the report like Kirwin, Bristol, etc.

Please call if you have any questions.

Yours very truly,

Mary Bracken
Planner

MPB/LA/HB/JP/rf

Cc: Philips Engineering Ltd.
Attention: Ron Scheckenberger

Parish Geomorphic
Attention: John Parish

BGD Consulting Inc.
Attention: Ruth Victor

Region of Peel
Attention: Rick Reitmeier
Attention: Michael Hynes

10/127-10

Planning and Building Department

City of Mississauga
300 City Centre Drive
MISSISSAUGA ON L5B 3C1

FAX: 905-896-5553 (Planning)
905-896-5638 (Building)
www.city.mississauga.on.ca

MISSISSAUGA

Leading today for tomorrow

June 11, 2002

FILE: CD.04.COO - Cooksville Creek SPA Study

Mr. Ron Scheckenberger
Philips Engineering
3215 North Service Road
P.O. Box 220
Burlington, ON L7R 3Y2

Dear Mr. Scheckenberger:

RE: Cooksville Creek SPA

I have had an opportunity to review the draft Interim Report #1 for the Cooksville SPA and have a number of questions and comments which are listed below. Any editorial comments or typographical errors have been photocopied are attached.

1. Section 1.3. I have located two additional studies for the Cooksville Creek: *Cooksville Creek Watershed Study Update and Water Level Sensitivity Analysis*, Dillion, 1984 and *Cooksville Creek Floodline Mapping - Draft Report*, R.V. Anderson Limited, 1992. These studies will be forwarded to you.

2. It should be noted that on June 17th 2002, Council will be considering the *Mississauga Plan* which will replace the current *City Plan*. While the direction of the policies will not be changing, the numbering will change. The final report will need to reference the most current document.

Check?

3. Section 2.3 Would a map help clarify the information contained in Table 2.2?

4. Section 2.3, on page 13, the middle paragraph is not clear when you reference Special Policy Areas.

5. Section 2.3, page 13, last paragraph. Discussions will have to held with the Peel Board of Education with respect to any proposed storage facility especially in light of the fact there are discussions occurring with Variety Village to locate a private community centre on this site.

6. Section 3.0 will require updating in light of the most recent meeting with staff from the

CVC
CREDIT VALLEY
CONSERVATION

RECEIVED
PHILIPS ENGINEERING LTD.
JUL 09 2002
FILE NO. 10127-10

July 4, 2002

City of Mississauga
Planning and Building Department

Attention: Lesley Pavan
Environmental Planner
Policy Planning Division

Dear Lesley:

Re: CVC comments on
Special Policy Area Study for Cooksville Creek Flood Plain
DRAFT Interim Report #1
May 24, 2002
Revised Figures dated June 20, 2002

CVC staff have reviewed the above noted draft report and figures and would like to provide the following comments.

INTRODUCTION

1.2 General Problem Statement

At the top of page 3 it is stated that the issues are technical, social, policy-oriented, economic and political and the problem is how to best address these divergent perspectives, while doing what is best for the City and its residents. It is unclear what is defined as a "technical issue. Is it not a combination of hazard (flooding and erosion) and environmental (stable stream form and indirect connections to water quality) concerns? The issues should also include 'environmental' and the solutions should achieve what is best for, not only the City and its residents (existing and future generations), but also the environment. There are certainly "competing" issues rather than "divergent perspectives".

The paragraph following this is could be better worded to lay out what the approach is towards a workable solution.

What is meant by the 3rd sentence of the 3rd paragraph?

1.3 Background Information Collected

As pointed out by Leslie Pavan, the floodline study completed by R.V. Andersen has not been referenced. It is important for the reader to understand that significant work has already been done. Could the intent of pertinent studies be included? The key findings of the previous studies are discussed in later sections. Since this study builds on the work done to date, a greater emphasis should be placed on the discussions of the previous studies.

.../2

Credit Valley Conservation 1255 Old Derry Road West, Mississauga, Ontario L5N 6R4
Phone (905) 670-1615 Fax (905) 670-2210

"Conservation Through Cooperation"

1.4 Discussion of Governing Policy

CVC policies should be included in this section.

The detailed discussion in section 5.1 could be shortened with plain language and should be incorporated into this section.

It should also be noted that the Province has formally delegated the responsibility for natural hazards to conservation authorities.

Presently, our guidance for SPAs come from the 1988 flood plain policy guidelines. The province should distribute the CDs for the new guideline document shortly. We can provide a copy once we receive it.

Would it be worthwhile to include a section on zoning? The City of Mississauga zoning by-law is presently under review. It should also be noted that rezonings may be required for some of the developments being proposed.

One Zone Areas

It is stated that no new development is permitted in the flood plain. This section should elaborate on CVC policies, which allow for some minor development, such as additions, within the flood plain, depending on specific criteria related to flood depths and velocities.

HYDROLOGIC 'CHECK'

A summary input data table should be included within the Hydrology section and should include the following parameters: subcatchment, area, SCS curve number, time to peak, slope and land use.

2.3 Flood Storage Assessment

1st paragraph, last sentence: We are not aware of instances where this approach has been used to offset lost storage within an SPA area. Our concern here is the overall watershed implications of this statement.

On page 13 and 40 reference is made to the Peel Board of Education lands on the north side of Bristol Road. When will the school board be notified of this option?

Table 2.2

There should be a comment whether these on-line storage locations have the potential of further aggravating the instability of the Cooksville Creek system. Just a note on the flow of the document (2nd paragraph, last sentence), the reader at this point is unaware of what is meant by Special Policy Areas or where they are located.

.../3

Region of Peel
Working for you

Planning

July 17, 2002

Via Fax and Mail

Mr. John Calvert
Research and Special Projects
Planning and Building Department
City of Mississauga
300 City Centre Drive, 10th Floor
Mississauga, ON L5B 3C1

Dear Mr. Calvert:

Re: **Cooksville Creek SPA**
Interim Report #1
Region File No.: P13 SPA CC

The Region of Peel has reviewed the Draft Special Policy Area - Cooksville Creek Floodplain *Interim Report #1.*

Generally speaking the Region does not have the technical expertise to comment on the technical aspects of this report.

Notwithstanding the Provincial Policy Statement (PPS), the Regional Official Plan (ROP) sets out an approach whereby a two zone approach may be considered as a part of the Special Policy Area (SPA) process. The consultant correctly concludes a two zone approach could be considered in parts of the floodplain but does not clearly state why this approach is being considered. We recommend the consultant include in the conclusion that the authority to enter into a two zone approach comes from Section 2.4.4.2.2 of the ROP.

Our concerns are based on the risk associated with allowing additional development in the floodplain. As the SPA study indicates there is a higher level of flood risk that is associated with a shift from a one-zone approach to a SPA/ two zone approach. The higher the risk of flooding, the higher the potential liability for the Region and the other parties.

The Region would support a SPA/two zone approach whereby development would only be permitted in portions of the floodplain if proposed development does not adversely affect or exasperate flooding potential and risk to human health and safety in areas of existing human activity.

We understand that the SPA/two zone approach includes a risk assessment which would include a site selection process that would show potential sites that can be developed without impacting on the current Cooksville Creek Floodplain. Regional staff recommends this level of detail be completed before Regional staff seeks Regional Council's endorsement of further development in the floodplain.

The consultant will also need to review the costs associated with the proposed infrastructure improvements to the Creek as identified in the Appendix of the report.

Regional Official Plan Amendment

Please be advised that a Regional Official Plan Amendment will not be required to enter into a SPA/ two zone approach.

Editorial Comments - Report

Our editorial comments or typographical errors are as follows:

1. Page 8, paragraph 3 refers to "Section 2.1.3.2 states:". This should read "Section 2.1.3.3 states:".
2. Page 33, last paragraph refers to a table that is not there.

We trust that this is of assistance and look forward to our continued participation in this study. Should you have any questions or concerns, please contact me at Ext. 4751.

Yours truly,

for
Robert Gepp
Program Manager
Development Planning Services

c. Mary Bracken, CVC
Ophir Bar-Moshe, Regional Solicitor
Lesley Pavan, City of Mississauga Planning
Rizaldo Padilla, Ministry of Municipal Affairs and Housing

D:\My Documents\CooksvilleCreekB

Transportation and Works Department

MISSISSAUGA

City of Mississauga
3484 Semenyk Court
MISSISSAUGA ON L5C 4R1

FAX: (905) 896-5504
FAX: (905) 615-3173

File: EC.01.COO

July 22, 2002

Mr. Ron Scheckenberger, M.Eng., P.Eng
Philips Engineering Ltd.
3215 North Service Road
P.O. Box 220
Burlington, ON L7R 3Y2

RECEIVED
PHILIPS ENGINEERING LTD.
JUL 30 2002
FILE NO.: 101127-10

Dear Mr. Scheckenberger:

Re: **Cooksville Creek SPA Study**
Draft Report of May 24, 2002

The Infrastructure and Environmental Planning Section has reviewed the above noted report and provides the following comments:

1. The draft report focussed solely on particular known properties that have been considered for potential redevelopment and/or intensification. There should be further discussions regarding how future requests for redevelopment and/or intensification, outside of the properties under consideration, will be addressed.

2. In the discussion of flood flow attenuation under Section 2.3 (first paragraph), the draft report states *"The intent of exploring the influence of manmade storage for this study is that there may be reasonable opportunities to designate certain structures as flood control systems, thereby formalizing the downstream attenuative benefit, through a reduction in peak flow. This approach is not without precedent in the City and may be a cost-effective means ..."* Please provide clarification as to where this approach has previously been used in the City of Mississauga.

3. On pages13 and 37, please note that the existing facility located north of Bristol Road is for water quantity control only and not quality control as stated.

4. In Section 5.2 of the report, it was noted that the intent of the fluvial geomorphic component of this undertaking is to establish erosion hazards which will be integrated with the floodplain analysis. Please clarify as to how the conclusions of this fluvial geomorphic assessment will compliment the *Cooksville Creek Rehabilitation Study* as well as how the impact of carrying out the recommended works outlined in the *Cooksville Creek Rehabilitation Study* will have on the erosion hazards.

5. Please provide feedback on downstream hydrologic and hydraulic impacts if the properties under consideration become Special Policy Areas.

6. The remedial measures recommended in the *Cooksville Creek Flood Remediation Plan* (*FRS*) are works on City property/easements and lands owned by external agencies as shown in Table S.3 and Table S.4 of the *FRS* respectively (Table 7.2 and Table 7.3 of the draft Cooksville Creek SPA Study). The works shown in Table 7.4 of the draft Cooksville Creek SPA Study were not recommended in the *FRS*. As such, applicable sections of the draft report, Drawing No. 2 and hydraulic modelling should be revised accordingly to only reflect the recommended remedial measures.

7. Further discussions will be required regarding the feasibility of the off-line stormwater management facility north of Bristol Road (Peel Board of Education lands). In particular, as most of the potential flooding occurs south of Mississauga Valley Blvd. (North) where the reduction in peak flow, under the 100 year future land use condition (Table 7.5), ranges between 6% and 9%, the true benefit afforded to the residents when compared to the capital cost should be looked at in further detail. A Cost/Benefit analysis of acquiring the property and constructing a facility versus the potential compensation owed by the City should be undertaken.

8. In Section 6.1, the report indicated that the hydraulic model produced for the *FRS* was updated. Please provide input as to how this update has affected the current floodline mapping.

9. The City concurs with the comments contained in CVC's letter of July 4, 2002 regarding the Revised Figures of June 20, 2002 (Hydraulic Assessment). Please review the hydraulic model and figures accordingly.

10. Please provide clarification on the first paragraph of Section 7.3.

11. The legal opinion provided by Davis & Company would need to be discussed at the next meeting.

If you have any questions, please do not hesitate to contact the undersigned at 905-615-4086.

Sincerely,

Lincoln Kan

Lincoln Kan, P.Eng.
Storm Drainage Programming Engineer
Infrastructure and Environmental Planning

LK/lk

c: L. Pavan
M. Bracken, CVC

Review of Approach in Technical Report

2. Lesley Pavan indicated that the meeting of January 14, 2003, between Philips Engineering Ltd. and EWRG involved establishing consensus on a number of items, as well as making recommendations for consideration by the City and Conservation Authority.

In this regard, there were four matters which required further discussion:

(i) **1996 Floodlines versus SPA Study projected Floodlines for Development Sites**

(a) It was suggested to remove the "A" series of drawings from the report depicting existing conditions. The registered floodline would be renamed 1996 floodline and would only be shown in areas outside of the development zones. All other study generated mapping lines, outside of the development zone, would be removed. **Philips**

(b) Within the development zones, the lines would be renamed "Potential Flood Limits" related to the Regulatory or 100 year condition and noted in the legend with the respective option in place. **Philips**

(c) It was recommended that Philips Engineering Ltd. list out the requirements for floodline mapping (as a minimum) explicitly and include this in the recommendation of the report. **Philips**

(d) There should also be emphasis on the requirement for no negative impact upstream and downstream through new development. **Philips**

(ii) **Floodplain versus Spills on Consulate Property**

(a) Ron Scheckenberger described the mechanism of flooding on this property before and after QEW culvert upgrade. He noted that a portion of the flood flow would breach north of the site and flow vis-à-vis a spill across the Consulate property and local environs.

(b) He noted that the extent of spill is highly sensitive to local grades near Camilla and that there would be a requirement, at the time of application, to undertake a detailed topographic survey, both on the Consulate property and north in the location of the spill.

MATTERS DISCUSSED	ACTION BY:
(c) It was suggested that these specific requirements for analysis be incorporated into the report as a recommendation.	**Philips**
(d) Hazel Breton indicated that it would be necessary to dry flood proof the Consulate property and that these areas would in effect be pulled out of the floodplain, subject to meeting all other criteria of ingress and egress and depth and velocity. It was indicated that the specific requirements can be made conditions of site plan approval.	**City**
(e) It was indicated that the property east of Camilla Drive would need to meet similar conditions, however, the implementation issues would be different than for the spill upstream of Consulate. This should also be outlined within the report.	**Philips**
(f) Placing this reach in a 2-zone context, either interim or long term would necessitate a Public Meeting.	**City**
(g) Mary Bracken questioned the incentive for Consulate to contribute to the QEW culvert if the developer receives consideration to develop under a 2-zone interim concept. It was concluded that a contribution would need to be made part of a condition of development for consideration of an interim 2-zone (i.e. due to increased interim risk). Further discussion would be required, particularly with MTO to establish cost sharing, as the current culvert is noted as approximately 50 years old and in reasonably good condition.	**City**
(iii) **SPA versus 2-Zone or Hybrid on Humenik Property**	
(a) Ron Scheckenberger outlined the various opportunities as discussed with Chris Doherty January 14, 2003. He specifically noted that a structural improvement to the watercourse/floodplain would allow for the management of this site under a 1-zone policy, however, there would need to be due consideration of the inlet and outlet components within this reach related to the influence on the transition system, both at Paisley and King. This may ultimately necessitate additional infrastructure and the potential purchase of additional properties.	

(b) Ron Scheckenberger described the structural works as involving natural channel design and excavation within the floodplain with likely balancing of the excavation in the floodplain with the area to be developed.

(c) Alternatively, at the meeting of January 14, 2003 it was raised that there could be a potential 2-zone application in this reach. Ron Scheckenberger noted that the initial screening for 1-zone versus 2-zone policy application was completed using the distinction between the 100 year and Regional flood limits.

At the meeting of January 14, 2003, it was outlined that the floodway, flood fringe definition could be more liberally interpreted on the basis of the depth velocity criterion established in CVC policy. Philips Engineering Ltd. is to assess the limits and provide some direction accordingly in the context of the report recommendations.

Philips

(d) Some discussion ensued with respect to the Meritan property south of Paisley and whether or not this property is intrinsically linked to the management strategy of Humenik. It was noted that depending on the solution advanced by Humenik, it may or may not have a beneficial influence on the Meritan property. Notwithstanding, it cannot make matters worse and that the 1-zone or 2-zone approach would be open for consideration in the Meritan site, as well. This is to be discussed in the final report.

Philips

(iv) Stormwater Management for Cooksville Creek

(a) Ron Scheckenberger indicated that the recommendations in the FRS of May 2002 to implement "appropriate" stormwater management requires interpretation, as specific technical support with respect to the "appropriate" management is unknown. It was agreed that the current approach is controlling the 2 to 5 year post- to pre-development levels. Notwithstanding, it was suggested that there may be factors which, depending on the location of the infill development within the watershed and relative to the watercourse would lead to an alternate management approach. Clear technical support is unavailable.

(b) Hazel Breton suggested that all parties must continue to do the "best job possible", given the available information. To this end, it was suggested that the framework for an implementation plan/study be advanced through future meetings between the senior staff at CVC and the City of Mississauga. **City/CVC**

3. **Other Business**

(i) Hazel Breton questioned whether or not there would be any confusion with respect to the alternate stream corridors which have been advocated in the report. Ron Scheckenberger noted that the basis for establishing the recommended corridors relates to technical rather than policy positions and that this information is offered for consideration of the Technical Steering Committee.

It was indicated that the narrow corridor could potentially be advocated by an applicant, subject to providing financial resources for a future repair. Philips Engineering Ltd. would incorporate an economic statement to this end through a review with Parish Geomorphic. **Philips/Parish**

(ii) Lesley Pavan requested that the blue hatching depicting shallow zones continue to be shown on the Philips Engineering Ltd. mapping. **Philips**

(iii) Philips Engineering Ltd. was requested to attempt to forward the recommendations section in the updated Technical Report to CVC and City, prior to release of the document. **Philips**

Minutes prepared by,

PHILIPS ENGINEERING LTD

Per: Ronald B. Scheckenberger, M. Eng., P. Eng.

RBS/mp
G:\WORK\101127\CORRES\MINUTES\MEETMINJAN28-03.DOC

c.c. All Present
John Parish, Parish Geomorphic
Ruth Victor, B.G.D. Consulting Inc.

Figure 1 : SCHEDULE

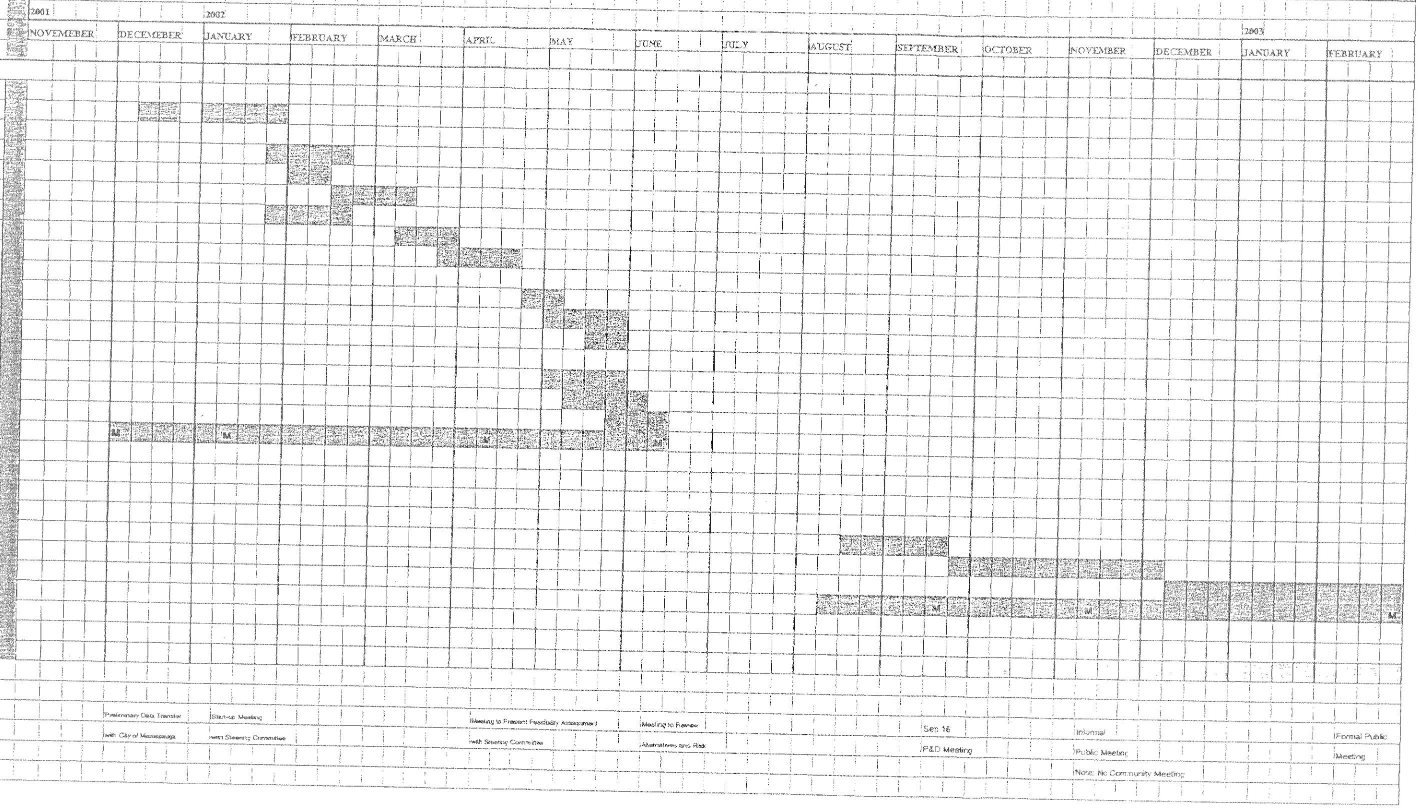
REVISED JANUARY 15TH, 2002

COOKSVILLE CREEK SPA STUDY

City of Mississauga

CVC

WORK PLAN

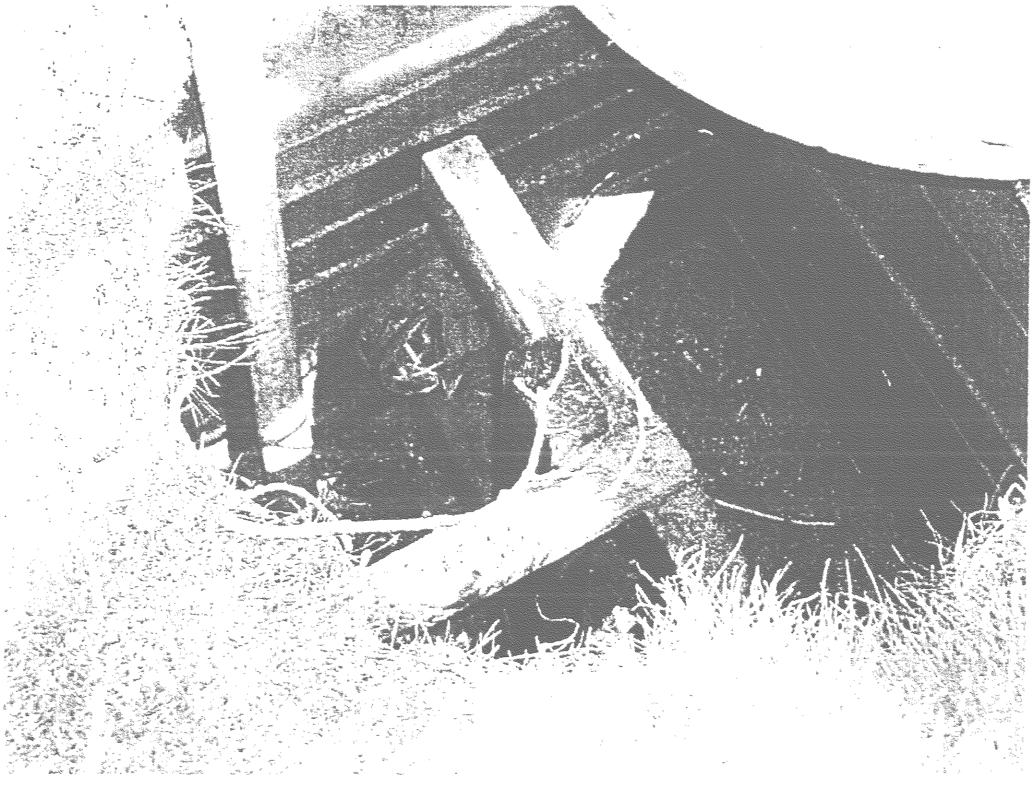


Task #	Description
	STAGE I
1	Background Data Collection and Review
2	Technical and Financial Feasibility & Requirements
	.1 Hydrologic Check
	.2 Topographic Mapping Check
	.3 Hydraulic Modelling
	.4 Stream Morphology Assessment
	.5 Feasibility Assessment
	.6 Technical Reporting and Floodline Mapping
3	Identification &Evaluation of Alternatives
	.1 Benefitting Property Definition
	.2 Examination of a range of development scenarios
	.3 Determination of Preferred Land Use
4	Risk Assessment
	.1 Review of Current Liabilities
	.2 Legal Implications of SPA Policies
	.3 Recommendations
5	Administration for Stage I
	SUBTOTAL
	STAGE II
1	Policy Formation
	.1 Draft Official Plan Amendment
	.2 Consultation
	.3 Final OPA
2	Administration for Stage II

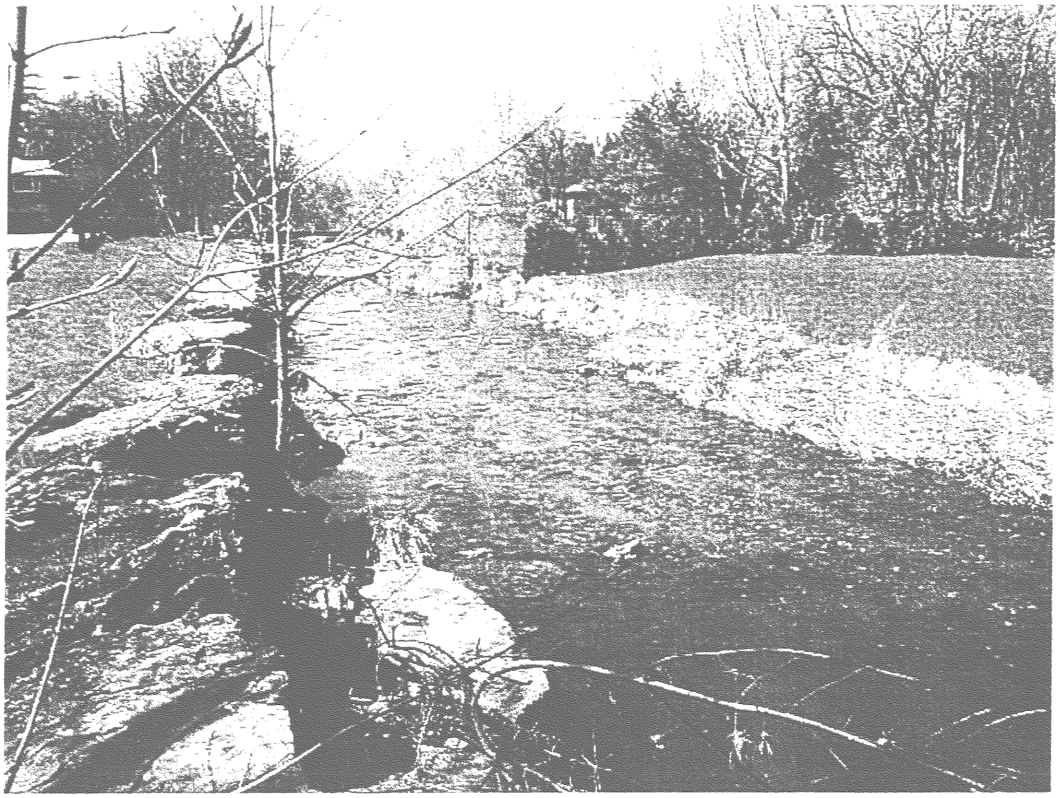
APPENDIX 'C'

GAUGING SITE PHOTOGRAPHS

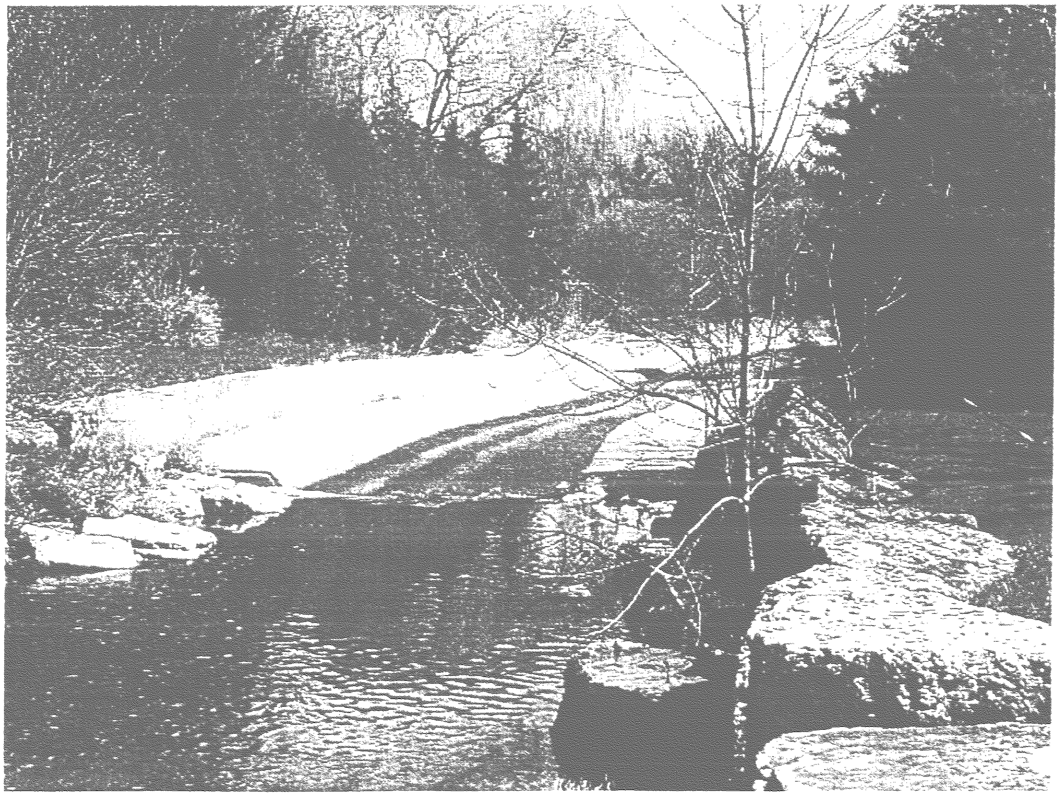
Location of shallow catchbasin used to house the stream logger, with respect to the west bank of Cooksville Creek. Picture taken looking north towards Elaine Trail cul-de-sac.



Picture of the inside of the catchbasin structure used to house the stream gauge logger



Cooksville Creek natural channel section viewed from the catchbasin looking north (upstream).



Natural creek section flowing into the concrete lined channel section. Picture taken from the catchbasin looking south (downstream).

Concrete lined trapezoidal channel section. Picture taken from the catchbasin looking south.

APPENDIX 'D'

BRISTOL ROAD SWM FACILITY

PRELIMINARY PLAN AND COST ESTIMATES

Bristol Road SWM site

Looking north from hummock adjacent to west bank of Cooksville Creek.
Natural basin form is discernible in midground of picture. Woodlot located in Natural Area HO3 is in left background.

Bristol Road SWM site

Looking north-west from hummock adjacent to west bank of Cooksville Creek. Natural depression is visible in midground of picture. Woodlot located in Natural Area HO3 is seen in background.

BRISTOL ROAD SWM FACILITY : COST ESTIMATE.

TOPSOIL STRIPPING AND REMOVAL

depth of removal = 0·15 m

area = 8·40 ha

unit cost = $\$8/m^3$

Cost = 8·40 ha × 0·15 m × \$8 = \$100,800

EXCAVATION

volume of cut/fill = 200,000 m^3

unit cost = $\$8/m^3$

Cost = 200,000 × 8 = \$1,600,000

STRUCTURES

INLET = \$100,000

OUTLET = \$100,000

SUB-TOTAL = \$1,900,000

CONTINGENCY (20%) = \$380,000

TOTAL COST (PRELIMINARY) = \$2,280,000

FILL CALCS

BOUNDING SECTION IDs	Left Filled Area (m^2)	Avg Left Filled Area	Left Distance Between (m)	Left Volume (m^3)	Right Filled Area (m^2)	Avg Right Filled Area	Right Distance Between (m)	Right Volume (m^3)	Total Section Volume (m^3)
0.00	0.00				0.00				
		0.11	81.00	8.91		5.10	133.00	677.64	686.55
1.00	0.22				10.19				
1.00	0.22				10.19				
		0.11	68.00	7.48		6.80	81.00	550.80	558.28
2.00	0.00				3.41				
2.00	0.00				3.41				
		0.00	73.40	0.00		2.46	81.00	198.86	198.86
3.00	0.00				1.50				
3.00	0.00				1.50				
		0.00	55.00	0.00		1.75	60.75	106.31	106.31
4.00	0.00				2.00				
4.00	0.00				2.00				
		0.00	48.00	0.00		1.00	66.30	66.30	66.30
5.00	0.00				0.00				
5.00	0.00				0.00				
		0.00	84.00	0.00		0.00	105.30	0.00	0.00
6.00	0.00				0.00				
6.00	0.00				0.00				
		0.00	55.50	0.00		0.00	72.70	0.00	0.00
7.00	0.00				0.00				
7.00	0.00				0.00				
		9.88	69.60	687.30		0.00	74.10	0.00	687.30
8.00	19.75				0.00				
								2303.59	m^3
		Fill along North Side of Bristol Road						1368.00	
							TOTAL FILL	3672	

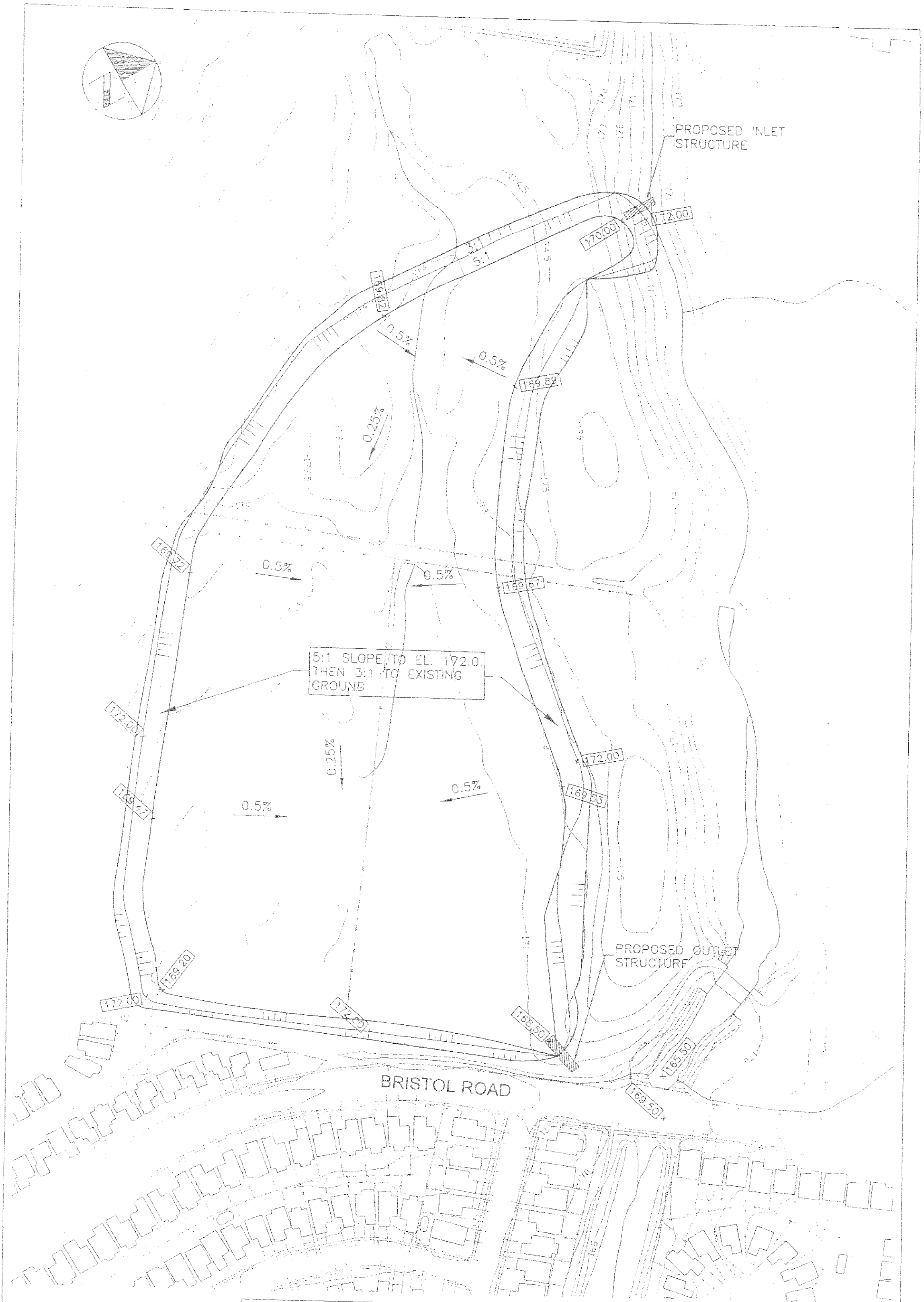
CUT CALCS

BOUNDING SECTION IDs	Left Cut Area (m2)	Avg Left Cut Area	Left Distance Between (m)	Left Volume (m^3)	Right Cut Area (m2)	Avg Right Cut Area	Right Distance Between (m)	Right Volume (m^3)	Total Section Volume (m^3)
0.00	0.00				0.00				
		88.90	81.00	7201		63.33	133.00	8422.23	15623.13
1.00	177.80				126.65				
1.00	177.80				126.65				
		212.55	68.00	14453		159.18	81.00	12893.18	27346.58
2.00	247.30				191.70				
2.00	247.30				191.70				
		230.90	73.40	16948		188.95	81.00	15304.95	32253.01
3.00	214.50				186.20				
3.00	214.50				186.20				
		209.14	55.00	11503		191.37	60.75	11625.73	23128.43
4.00	203.78				196.54				
4.00	203.78				196.54				
		223.20	48.00	10713		219.98	66.30	14584.34	25297.70
5.00	242.61				243.41				
5.00	242.61				243.41				
		223.04	84.00	18735		206.56	105.30	21750.24	40485.60
6.00	203.47				169.70				
6.00	203.47				169.70				
		180.99	55.50	10045		145.48	72.70	10576.40	20621.06
7.00	158.50				121.26				
7.00	158.50				121.26				
		82.18	69.60	5719		79.01	74.10	5854.27	11573.65
8.00	5.85				36.75				
								196329.16	m^3

POND STORAGE VOLUME CALCS

BOUNDING SECTION IDs	Left Pond Area (m2)	Avg Left Pond Area	Left Distance Between (m)	Left Volume (m^3)	Right Pond Area (m2)	Avg Right Pond Area	Right Distance Between (m)	Right Volume (m^3)	Total Section Volume (m^3)
0.00	0.00				0.00				
		100.34	81.00	8127		112.89	133.00	15013.71	23140.84
1.00	200.67				225.77				
1.00	200.67				225.77				
		216.07	68.00	14693		219.27	81.00	17760.47	32453.23
2.00	231.47				212.76				
2.00	231.47				212.76				
		203.76	73.40	14956		190.70	81.00	15446.70	30402.32
3.00	176.04				168.64				
3.00	176.04				168.64				
		154.89	55.00	8519		157.29	60.75	9555.37	18074.32
4.00	133.74				145.94				
4.00	133.74				145.94				
		122.39	48.00	5874		132.17	66.30	8762.87	14637.35
5.00	111.03				118.40				
5.00	111.03				118.40				
		87.53	84.00	7352		88.19	105.30	9286.41	16638.51
6.00	64.02				57.98				
6.00	64.02				57.98				
		47.38	55.50	2629		42.16	72.70	3064.67	5693.98
7.00	30.73				26.33				
7.00	30.73				26.33				
		22.82	69.60	1588		21.54	74.10	1596.11	3184.04
8.00	14.90				16.75				
								144224.58	m^3

POND STORAGE VOLUME @ WSEL = 171



5:1 SLOPE TO EL. 172.0, THEN 3:1 TO EXISTING GROUND

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOOD PLAIN
CITY OF MISSISSAUGA
BRISTOL ROAD SWM FACILITY

PHILIPS ENGINEERING

Project No.	101127
Date	May 2002
Scale	1:2,000
Figure	D-1

May 22/02 glee

APPENDIX 'E'

RIVERCAD^{TM} INPUT DATA

EXISTING CONDITIONS

```
SF
TC
CS     9    5.44    5.44    4.96
CR   0.5  113.34       1  113.43     1.5  113.49     2.5  113.59       5  113.76
CR   7.5  113.88      10  113.98      15  114.14      20  114.26
TC
CS    13    0.94    0.94    0.85
CR   0.5   85.09       1   85.13     1.5   85.16     2.5   85.21       5   85.31
CR   7.5   85.38      10   85.44      15   85.53      20   85.61      25   85.68
CR    35   85.79      50   85.93      75   86.10
EE
C
C     11
C   1.22

C   1.22

C   1.22

C   1.22

C   1.22

C  1.239

C  1.239

C  1.239

C  1.239

C  1.239

C  5.221section added Sept 12/02
T1      PEL PROJECT NO. 101127
T2      CITY OF MISSISSAUGA, CVCA
T3      COOKSVILLE CREEK 2002   COOKSRCAD.HEC
J1   -10       2                       0       1             320    74.8
J2     1              -1                                      -6
J3    38      43       3       1       2      40      41      33      42       8
J3    25       4
J5   -10     -10
NC 0.055   0.055   0.035     0.1     0.3
X1  0.02      17   142.8  169.55
GR    78   72.98    77.8   87.11      77  139.05      76   142.8      75  143.07
GR 74.52  146.57   74.52  152.78   74.52  160.29   74.52  167.48      76  169.55
GR  77.2  181.23    77.2  184.34      77  239.75      77  250.46   76.61  254.42
GR    77  256.26      78  273.83
NC 0.055   0.055   0.025
X1  0.12      21   59.56   88.81    75.9   66.95   98.88
X3    10
GR    82       0   78.41   21.51      78   34.91      77   59.56      76   62.67
GR    75   63.62   74.68   65.35   74.68   71.35   74.68   76.32   74.68   83.54
GR    75    83.6   77.05   88.81   77.05   91.98      75   96.02      75  115.11
GR    77  154.38   77.11   154.4      82  164.07      82  174.39   78.15  174.39
GR    78  201.72
X1  0.22      23  102.66  133.39  122.07   90.37  101.07
X3    10
GR    78   35.08   78.05   38.01      82   38.01      82   51.97   77.05      52
GR    77   55.73    76.4    77.6      77  102.66      76  107.91   75.31  110.92
GR 74.63  115.32   74.63  120.37   74.63  127.34   74.63   130.8      76  131.61
GR 77.35  133.39   77.35  136.42      78  157.05   79.08   187.7      82   187.7
GR    82  200.04   79.25  200.04      79  212.14
X1  0.33      22   26.23   53.18   83.57  100.45  101.57
X3    10
GR    79    8.49      78   22.48      77   26.23      76   28.16    75.5    33.7
GR 75.11   35.38   75.11   40.26   75.11   45.88   75.11   50.33      76   51.84
GR 77.75   53.18   77.75    56.2      77   59.86    76.7    81.6      77  103.27
GR    78  105.98      79  108.74    79.4  108.74      85  113.07      85  128.73
GR 80.15  128.75      80  135.53
NC                           0.3     0.5
X1  0.38      23   76.29  102.32    57.8   61.01   64.08
X3    10
GR    80   18.78      80    32.8      84   32.86      84   46.51      78   46.51
GR    77   76.29      76   78.41   75.36   79.28   75.36   84.86   75.36   89.91
GR 75.36   94.45   75.88   96.76      76   99.53      77  102.32      78  103.54
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GR 78.35  103.85   78.35  106.91      78  107.28      77  111.09      77  121.54
GR    78  140.43      79   143.4      80  145.83
X1  0.44      48    1008 1031.59   73.84    61.5   65.99
X3    10                                                   77.75   77.75
GR 80.76   727.8   80.59     784   80.59   784.1   80.54     798   80.54   798.1
GR 80.41     840   80.41   840.1   80.25     905   80.25   905.1    80.2     928
GR  80.2   928.1   80.14     954   80.14   954.1    78.5     980    78.5   980.1
GR  77.5   998.7    77.5   998.8    77.5 1001.34    77.5 1001.34    77.5  1005.8
GR    77  1007.8    75.9    1008   75.94    1008   75.94 1008.05   75.94 1014.65
GR 75.94  1014.7    75.7  1019.8    75.7  1019.8   75.47  1026.1   75.47 1026.15
GR 75.47 1031.54   75.47 1031.59   75.47 1031.59      78  1031.8      78    1032
GR    78    1032      78  1040.8      78  1040.9      78    1058      78  1058.1
GR    78  1067.8      80    1076   80.22    1090   80.22  1090.1   80.32    1120
GR 80.32  1120.1   80.35    1128   81.44  1247.8
SB  1.25    1.61     1.5       0    22.8    11.4    34.8       0   75.74   75.47
X1 0.464      51    1008 1031.59      24      24      24
X2                     1   78.76   80.02
X3    10                                                   80.02   80.04
BT   -51   727.8   80.76   80.76     784   80.59   80.59   784.1      82   80.59
BT           798      82   80.54   798.1   80.54   80.54     840   80.41   80.41
BT         840.1      82   80.41     905      82   80.25   905.1   80.25   80.25
BT           928    80.2    80.2   928.1      82    80.2     954      82   80.14
BT         954.1   80.14   80.14     980   80.08    78.5   980.1      82    78.5
BT         998.7      82    77.5   998.8   80.04    77.5 1001.34   80.02    77.5
BT       1001.34   81.31    77.5 1005.79   81.31    77.5  1005.8   80.33    77.5
BT        1007.8   80.33      77    1008   80.33   76.06    1008   80.33   76.06
BT       1008.05   80.33   78.76 1014.65   80.33   78.76  1014.7   80.33   76.06
BT        1019.8   80.33    75.8  1019.8   81.06    75.8  1025.6   81.06   75.74
BT        1025.6   80.63   75.74  1026.1   80.63   75.74 1026.15   80.63   78.79
BT       1031.54   80.63   78.79 1031.59   80.63   75.74 1031.59   80.63    75.7
BT        1031.8   80.63      78    1032   80.63      78    1032   80.04      78
BT        1040.8   80.08      78  1040.9      82      78    1058      82      78
BT        1058.1   80.12      78  1067.8   80.15      78    1076   80.18      80
BT          1090   80.22   80.22  1090.1      82   80.22    1120      82   80.33
BT        1120.1   80.33   80.33    1128   80.35   80.35  1247.8   81.44   81.44
GR 80.76   727.8   80.59     784   80.59   784.1   80.54     798   80.54   798.1
GR 80.41     840   80.41   840.1   80.25     905   80.25   905.1    80.2     928
GR  80.2   928.1   80.14     954   80.14   954.1    78.5     980    78.5   980.1
GR  77.5   998.7    77.5   998.8    77.5 1001.34    77.5 1001.34    77.5 1005.79
GR  77.5  1005.8      77  1007.8   76.06    1008   76.06    1008   76.06 1008.05
GR 76.06 1014.65   76.06  1014.7    75.8  1019.8    75.8  1019.8   75.74  1025.6
GR 75.74  1025.6   75.74  1026.1   75.74 1026.15   75.74 1031.54   75.74 1031.59
GR 75.74 1031.59      78  1031.8      78    1032      78    1032      78  1040.8
GR    78  1040.9      78    1058      78  1058.1      78  1067.8      80    1076
GR 80.22    1090   80.22  1090.1   80.33    1120   80.33  1120.1   80.35    1128
GR 81.44  1247.8
NC                 0.025
X1  0.54      18 1098.88 1119.74   63.21   71.91   71.27
GR    81    1000      81  1027.6      85 1027.64      85 1089.88      80  1089.9
GR    80 1091.76      79 1094.79      78 1098.88      77 1101.07   76.59 1103.41
GR 76.59 1107.08   76.59 1114.83      77  1117.5      78 1119.74      79 1123.33
GR    80 1135.15      81 1141.47      82 1154.24
NC                           0.1     0.3
X1  0.64      19  196.69  222.01   99.16   95.31   94.13
GR    85     100   80.54     100    80.1  123.61      85  123.61      85  148.26
GR    85  151.49      85  188.36    79.8  188.37      79  196.69      78   199.2
GR 77.12  205.35   77.12  207.98   77.08  211.58   77.08  214.55      78  218.83
GR    79  222.01      80  226.03      81  248.39      82  266.25
NC                           0.1     0.3
X1   0.7      15  180.76   201.1   51.77   84.58    62.9
GR    85     100   80.91     100      80  155.69   79.78   175.3   79.17  180.76
GR 77.67  185.12   77.67  188.32   77.67  192.84   77.67  197.11   79.67   201.1
GR    80  213.63      81  225.92      82  235.59      83  262.73      84  287.91
NC                           0.3     0.5
X1  0.78      15  141.91  165.97   53.98   88.11   71.54
GR    85     100   81.69     100      81  133.03      80  140.25   79.33  141.91
GR 77.91  145.72   77.91  149.62   77.88  155.19   77.88  159.33   79.81  165.97
GR    80  181.27      81  214.89      82  239.68      83  241.48      84  243.14
NC                 0.025
QT     2     295     210
X1  0.79      13  1039.9 1056.95      10      10      10
X3    10                                                    79.9    79.9
GR    87 1002.04   81.69 1002.05   80.88 1033.35   80.73  1039.9    77.8 1039.95
GR  77.8    1040   78.05  1056.9   78.05 1056.94   80.73 1056.95   80.06 1077.73
GR 81.01 1107.56   81.93 1124.59   85.67 1135.79
SB          1.58     1.5       0      17       0    30.6       0   77.89    77.8
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X1 0.795      12  1039.9 1056.95     4.9     4.9     4.9
X2                     1   79.82   80.06
X3    10                                                   80.73   80.06
BT   -11 1002.04      87      87 1002.05   81.69   81.69 1033.35   80.88   80.88
BT        1039.9   80.73   80.73 1039.95   80.73   77.89    1040   80.73   79.82
BT        1056.9   80.73   79.82 1056.94   80.73   78.14 1056.95   80.73   80.73
BT       1077.73   80.06   80.06 1107.56   81.01   81.01 1124.59   81.93   81.93
GR    87 1002.04   81.69 1002.05   80.88 1033.35   80.73  1039.9   77.89 1039.95
GR 77.89    1040   78.14  1056.9   78.14 1056.94   80.73 1056.95   80.06 1077.73
GR 81.01 1107.56   81.93 1124.59
NC                 0.015
X1  0.85      38 1194.15 1206.05  111.27    38.4   83.19
X3    10                                                    83.1    83.1
GR  85.8    1000      85    1086      84    1156      80    1192   78.37  1194.1
GR  84.6 1194.15    80.8  1194.4    80.8  1194.9    79.1  1195.2    79.1  1195.7
GR 78.37 1195.75   78.37  1198.6    80.8  1199.5    81.4  1199.9    81.4    1200
GR  81.4  1200.6    81.4  1200.7    80.8    1201   78.37    1202   78.37  1204.3
GR  78.8 1204.35    78.8    1206    84.6 1206.05   78.37  1206.1   78.37  1206.3
GR 78.37 1206.31      79    1208      80    1210      81    1282      82    1326
GR    84    1344    84.6  1406.3      85    1452   86.13  1486.3      85  1492.3
GR 84.75  1501.3      85  1511.3      86  1531.3
SB  1.25    1.57     1.5       0    10.6     0.6      62       0   78.38   78.38
X1 0.874      38 1194.15 1206.05    23.5    23.5    23.5
X2                     1    84.6   84.75
X3    10                                                    85.8   84.75
BT   -37    1000    85.8    85.8    1086    85.8    85.1    1156    85.8    84.3
BT          1192    85.8      80  1194.1    85.8   78.38 1194.15    85.8    84.6
BT        1194.4    85.8    84.6  1194.9    85.8    84.6  1195.2    85.8    84.6
BT        1195.7    85.8    84.6 1195.75    85.8    84.6  1198.6    85.8    84.6
BT        1199.5    85.8    84.6  1199.9    85.8    84.6    1200    85.8    81.4
BT        1200.6    85.8    81.4  1200.7    85.8    84.6    1201    85.8    84.6
BT          1202    85.8    84.6  1204.3    85.8    84.6 1204.35    85.8    84.6
BT          1206    85.8    84.6 1206.05    85.8    84.6  1206.1    85.8   78.38
BT        1206.3    85.8   78.38 1206.31    85.8   78.38    1208    85.8      79
BT          1210    85.8      80    1212    85.8      81    1260    85.8      82
BT          1344    85.8      83  1406.3   86.04      84    1452    86.1    84.5
BT        1486.3   86.13   84.75  1492.3      85   84.75  1501.3   84.75   84.75
BT        1511.3      85      85  1531.3      86      86
GR  85.8    1000    85.1    1086    84.3    1156      80    1192   78.38  1194.1
GR  84.6 1194.15    80.8  1194.4    80.8  1194.9    79.1  1195.2    79.1  1195.7
GR 78.38 1195.75   78.38  1198.6    80.8  1199.5    81.4  1199.9    81.4    1200
GR  81.4  1200.6    81.4  1200.7    80.8    1201   78.38    1202   78.38  1204.3
GR  78.8 1204.35    78.8    1206    84.6 1206.05   78.38  1206.1   78.38  1206.3
GR 78.38 1206.31      79    1208      80    1210      81    1212      82    1260
GR    83    1344      84  1406.3    84.5    1452   84.75  1486.3   84.75  1492.3
GR 84.75  1501.3      85  1511.3      86  1531.3
NC                 0.025
X1 0.876      38 1194.15 1206.05       2       2       2
GR  85.8    1000    85.1    1086    84.3    1156      80    1192    79.1  1194.1
GR  79.1 1194.15    79.1  1194.4    79.1  1194.9    79.1  1195.2    79.1  1195.7
GR 78.38 1195.75   78.38  1198.6   78.38  1199.5   78.38  1199.9   78.38    1200
GR 78.38  1200.6   78.38  1200.7   78.38    1201   78.38    1202   78.38  1204.3
GR  78.8 1204.35    78.8    1206    78.8 1206.05    78.8  1206.1    78.8  1206.3
GR  78.8 1206.31      79    1208      80    1210      81    1212      82    1260
GR    83    1344      84  1406.3    84.5    1452   84.75  1486.3   84.75  1492.3
GR 84.75  1501.3      85  1511.3      86  1531.3
NC                           0.1     0.3
X1 0.877      38 1194.15    1210       1       1       1
GR  85.8    1000    85.1    1086    84.3    1156      80    1192      80  1194.1
GR    80 1194.15      80  1194.4      80  1194.9    79.1  1195.2    79.1  1195.7
GR 79.02 1195.75   79.02  1198.6   79.02  1199.5   79.02  1199.9   79.02    1200
GR 79.02  1200.6   79.02  1200.7   79.02    1201   79.02    1202   79.02  1204.3
GR 79.02 1204.35   79.02    1206   79.02 1206.05   79.02  1206.1   79.02  1206.3
GR 79.02 1206.31   79.02    1208      80    1210      81    1212      82    1260
GR    83    1344      84  1406.3    84.5    1452   84.75  1486.3   84.75  1492.3
GR 84.75  1501.3      85  1511.3      86  1531.3
X1  0.94      29  241.02  260.49    55.8   63.65   58.79
GR  86.4     100      86  143.63      85  201.47    84.8  212.34   84.65  225.85
GR  84.6  227.35      84  232.82      83  235.76      82  238.86      81  241.02
GR 80.38  247.02   79.62  247.02   79.62  247.04   79.62  260.08   81.37  260.32
GR    82  260.49    82.6  267.32      87  267.32      87  274.72    83.5  274.72
GR  83.5  284.78      87  284.79      87  286.69    83.1  286.69      83  289.73
GR  82.7  317.79      83  353.98      84  402.03      85  491.86
X1  1.02      27  193.08  207.38   53.46   95.21   75.27
GR    86     100      85  172.55   84.07  189.64   82.36  193.08   80.54  193.26
GR 80.54   194.6   80.25   194.6   80.25  205.43   80.54  205.43   80.54  206.78
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GR 82.36  207.38    83.3  223.63      87  223.64      87  234.64    83.3  234.65
GR  83.3   242.8   83.35  244.43    83.5  253.03      84  330.75   84.15  361.53
GR  84.1  363.18      85  371.97      90  371.98      90  388.41    85.9  388.41
GR    86  391.56      87  394.96
X1   1.1      21  156.47   171.6   97.82   67.26   85.83
GR    87     100    86.5  113.11      89  113.11      89  121.53    86.2  121.54
GR    85  130.74      84  132.24      83  141.04      83  147.04      83  154.41
GR 83.06  156.47   81.25  156.71   81.25  158.05   80.54  159.06   80.54  170.07
GR 81.25  170.07   81.25  171.42   83.06   171.6      84  230.45      85  250.25
GR    86  281.31
X1  1.14      15  169.35  183.71   46.01   38.77   46.69
GR    87     100      86  117.27      85  133.89      84   149.7      84   168.7
GR 84.16  169.35   80.86  169.84   80.86   178.7   81.88   178.7   81.88  183.21
GR 84.56  183.71      84  220.57    84.3  224.19      85   266.1      86  286.41
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X1  1.22      18  155.09  168.54   37.12    93.2   65.35
GR    87     100    87.1   106.7      90  106.71      90  121.28    85.9  121.28
GR 85.07  149.68   84.22  155.09    81.2  156.08    81.2  157.74    81.2  167.29
GR 84.67  168.54      85  184.59    85.1  188.01      90  188.01      90  192.99
GR 85.25  192.99      86  273.59      87  300.02
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X1 1.239      17      46    60.9   29.16   27.28   25.73
GR    87       0    86.2   22.55      90   22.56      90   31.88    85.9   31.88
GR  86.5      46    82.7   46.05   81.29    48.1   81.29   60.85    86.5    60.9
GR  87.2   61.81    85.5  105.88      90  105.88      90  123.76    85.6  123.77
GR    86   163.5      87  199.33
NC                          0.3     0.5
X1  1.24      17      46    60.9       1       1       1
GR    87       0    86.2   22.55      90   22.56      90   31.88    85.9   31.88
GR  86.5      46    82.7   46.05   82.32    48.1   82.32   60.85    86.5    60.9
GR  87.2   61.81    85.5  105.86      90  105.87      90  123.74    85.6  123.74
GR    86  163.48      87  198.74
NC                0.015
X1  1.26      66    1020 1035.21      23      23      23
X3    10                                                    84.4    84.4
GR 89.61   905.5   89.57     907   89.57   907.1   89.35     914   89.35   914.1
GR 89.13     921   89.13   921.1   88.79     932   88.79   932.1   88.64     937
GR 88.64   937.1   88.08     955   88.08   955.1   87.83     963   87.83   963.1
GR 87.49     974   87.49   974.1   87.33     979   87.33   979.1   87.08     987
GR 87.08   987.1   86.93   992.4   86.93   992.5    86.8     997   86.67  1003.4
GR 86.67  1003.5    86.5    1020   85.42    1020   83.82 1020.02   83.82 1020.23
GR 82.83 1020.23   82.83 1021.45   82.38 1022.21   82.38 1025.11   82.83 1025.87
GR 82.83 1026.99   82.83 1026.99   82.41 1028.49   82.41  1028.5   82.41 1033.67
GR 82.64 1033.67   82.64 1035.19   85.38 1035.19    86.5 1035.21   86.35    1047
GR 86.19  1061.5   86.19  1061.6   86.11  1069.5   86.11  1069.6   86.06    1074
GR 86.06  1074.1    85.9    1089    85.9  1089.1   85.82    1098   85.82  1098.1
GR 86.11    1125   86.11  1125.1   86.97    1166   86.97  1166.1   87.47    1176
GR 87.47  1176.1   89.01    1207   89.01  1207.1   89.61    1219   89.61  1219.1
GR  90.7  1240.5
SB  1.25    1.64     1.5       0    15.2     1.5    39.1       0   82.55   82.58
X1 1.294      66    1020 1035.21      34      34      34
X2                       1   85.59   85.82
X3    10                                                    86.5   86.06
BT   -65   905.5   89.61   89.61     907   89.57   89.57   907.1      91   89.57
BT           914      91   89.35   914.1   89.35   89.35     921   89.13   89.13
BT         921.1      91   89.13     932      91   88.79   932.1   88.79   88.79
BT           937   88.64   88.64   937.1      91   88.64     955      91   88.08
BT         955.1   88.08   88.08     963   87.83   87.83   963.1      91   87.83
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BT              974        91     87.49     974.1     87.49     87.49       979     87.33     87.33
BT            979.1        91     87.33       987        91     87.08     987.1     87.08     87.08
BT            992.4     86.93     86.93     992.5        91     86.93       997        91      86.8
BT           1003.4        91     86.67    1003.5     86.67     86.67      1020      86.5      86.5
BT             1020      86.5     85.59   1020.02      86.5     85.59   1020.23      86.5     85.59
BT          1020.23      86.5     85.59   1021.45      86.5     85.59   1022.21      86.5     85.59
BT          1025.11      86.5     85.59   1025.87      86.5     85.59   1026.99      86.5     85.59
BT          1026.99      86.5        83   1028.49      86.5     82.65    1028.5      86.5     85.62
BT          1033.67      86.5     85.62   1033.67      86.5     85.62   1035.19      86.5     85.62
BT          1035.19      86.5     85.62   1035.21      86.5      86.5      1047     86.35     86.35
BT           1061.5     86.19     86.19    1061.6        91     86.19    1069.5        91     86.11
BT           1069.6     86.11     86.11      1074     86.06     86.06    1074.1        91     86.06
BT             1089        91      85.9    1089.1      85.9      85.9      1098     85.82     85.82
BT           1098.1        91     85.82      1125        91     86.11    1125.1     86.11     86.11
BT             1166     86.97     86.97    1166.1        91     86.97      1176        91     87.47
BT           1176.1     87.47     87.47      1207     89.01     89.01    1207.1        91     89.01
BT             1219        91     89.61    1219.1     89.61     89.61    1240.5      90.7      90.7
GR 89.61      905.5     89.57       907     89.57     907.1     89.35       914     89.35     914.1
GR 89.13        921     89.13     921.1     88.79       932     88.79     932.1     88.64       937
GR 88.64      937.1     88.08       955     88.08     955.1     87.83       963     87.83     963.1
GR 87.49        974     87.49     974.1     87.33       979     87.33     979.1     87.08       987
GR 87.08      987.1     86.93     992.4     86.93     992.5      86.8       997     86.67    1003.4
GR 86.67     1003.5      86.5      1020     85.59      1020     83.99   1020.02     83.99   1020.23
GR    83    1020.23        83   1021.45     82.55   1022.21     82.55   1025.11        83   1025.87
GR    83    1026.99        83   1026.99     82.65   1028.49     82.65    1028.5     82.65   1033.67
GR 82.88    1033.67     82.88   1035.19     85.62   1035.19      86.5   1035.21     86.35      1047
GR 86.19     1061.5     86.19    1061.6     86.11    1069.5     86.11    1069.6     86.06      1074
GR 86.06     1074.1      85.9      1089      85.9    1089.1     85.82      1098     85.82    1098.1
GR 86.11       1125     86.11    1125.1     86.97      1166     86.97    1166.1     87.47      1176
GR 87.47     1176.1     89.01      1207     89.01    1207.1     89.61      1219     89.61    1219.1
GR  90.7     1240.5
NC                      0.025
X1 1.317         36       185       199     41.56     18.99     25.34
GR    90        100      89.4    119.21        95    119.21        95    127.52      88.5    127.52
GR    88     129.67        88    131.08        88    133.97        95    133.97        95    140.11
GR    88     140.12        88    141.46      87.5    145.68        95    145.68        95    171.79
GR    87     171.79     85.27       185     84.87     185.4      84.5     185.8     83.81     186.9
GR  82.6      189.1     82.53     189.9     82.31     191.7     82.24     194.3      82.2     195.1
GR 82.16      195.7     82.46     196.7     83.66     198.2     86.63       199      86.5     223.9
GR    95     223.91        95    242.37      86.5    242.37        87    277.72        88    309.99
GR    89     333.72
NC                                  0.1       0.3
X1  1.34         28     170.8     186.7     30.88     18.97     31.96
GR    90     100.76        89    116.61        88    119.22        87    130.03     85.19     170.8
GR 83.78      171.5     82.89     172.1     82.74     174.7      82.6     177.2     82.74     178.5
GR 82.15      181.5     82.15     182.7     82.89     184.1     83.04     185.2     83.78     186.1
GR 86.75      186.7     86.75     187.4        87     235.5        88    257.62      88.2    261.66
GR    95     261.66        95     275.3        89     275.3        89    277.56        95    277.56
GR    95     305.38      90.2    305.39        91    336.33
X1  1.39         19       162     175.1     21.42     44.81     53.23
GR    90        100        89    114.46        88    119.69        87    123.33     85.75       162
GR 84.08      162.1     83.38     162.9     83.68     166.9     83.38     169.2     84.13     170.9
GR 84.49        171      86.7     175.1        87    228.41        88    229.91      88.5    243.73
GR    95     243.74        95    257.53      88.8    257.53        89    261.45
X1  1.44         12     109.4     117.7     49.06      24.3     45.94
GR    90        100        89    101.98        88    104.07        87    108.07        87     109.4
GR 84.21      110.1     84.21     113.2     85.99     117.7        87    170.53        88    181.05
GR    89     221.36        90    242.48
X1  1.48         17     124.9     135.3     31.68     19.12     33.39
GR    90        100        89    101.23        88    102.55        87    102.71     86.02     124.9
GR 85.16      125.2     84.66     126.1     84.61     134.7     85.06     134.7     86.22     135.3
GR    87     169.33        88    175.55      88.8    201.99        95    201.99        95    209.98
GR    89     209.99        90    239.71
NC             0.08
X1  1.52         19     124.8       138      33.6     32.01     33.21
GR    91        100        90    102.27        89    103.71        88    105.39        87    107.79
GR 86.32      124.8     84.65     126.9     84.91     128.3     84.85     131.4     84.74     132.8
GR 84.85      134.9     85.64     137.5      86.2       138        87    157.18        88    167.71
GR    88     184.74        88    190.75        89    196.05        90    216.51
X1  1.54         17       123     134.5     30.19     25.65     29.49
GR    91        100        90    102.38        89    103.77        88    105.48        87     107.1
GR 86.39        123     85.26     124.3     85.21     125.1     85.16     128.4     85.16     130.4
GR 85.16      131.5     85.24     132.6     86.52     134.5        87    150.95        88    157.94
GR    89     197.52        90    201.79
X1  1.56         17     122.9     136.1     28.99      34.9     27.39
GR    92        100        91     106.2        90    109.18        89    110.74     88.15     122.9
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GR 85.98   123.1    85.2   123.5    85.2   125.5   85.37   128.7   85.46     132
GR 85.37   133.1   86.59   136.1      87     144      88  156.96      89  202.57
GR    90  206.18      91  216.56
X1   1.6      22   137.5   152.1   40.11   24.87   37.06
GR    97     100    92.1     100      92  101.65      91  106.59      90   108.1
GR    89  110.03      88   113.1      87  134.06    87.1   137.5   85.86   140.5
GR 85.53   142.6   85.69   143.3   85.69   144.3   85.45   145.9   85.57   151.7
GR 86.64   151.8   87.29   152.1   87.29   153.1      88  155.05      89  201.26
GR    90  206.97      91   211.6
X1  1.64      18   157.8   173.3   18.24   26.88   30.45
GR    97     100      92     100      92  105.35      91  106.13      90  106.33
GR    89  109.85      88  111.56   87.27   157.8   86.74   158.5   86.58   160.2
GR 85.85   160.5   85.85   169.8   86.43     171    87.9   173.3      88  174.28
GR    89  188.44      90  199.05      91   207.6
X1  1.66      20   146.6   159.9   47.05   20.66   29.78
GR    92     100      91  103.75      90  103.98      89  106.19      88  111.73
GR  87.5   146.6   86.85   147.4   86.02     148   86.11   157.6    86.5   159.3
GR 87.72   159.9      88  163.06      89  167.04      90  180.83      91  190.35
GR  91.5  251.32      96  251.32      96     270    91.5     270      91  280.79
X1  1.68      19   145.7   156.2   34.62   17.17   24.32
GR    96     100      91     100      91  100.13      90  112.06      89  115.76
GR    88   135.5   87.41   145.7   87.06   146.7   86.03   147.1   86.03   153.4
GR  87.5   156.2      89  161.38      90  165.41      91  170.68    91.7  245.55
GR    96  245.56      96  263.75    91.7  263.75      91  274.82
X1 1.714      18   145.8   155.5   16.16   11.28   19.78
GR    96     100    90.8     100      90   108.9      89  114.41      88  138.07
GR 87.78   145.8   86.64   145.9    86.4   146.7   86.15   147.8   86.24   150.6
GR 86.32   155.3   87.53   155.5   88.35   156.2      89  162.96      90  164.63
GR    91  174.66    91.7  240.36      96  240.36
X1  1.73      18   167.8   177.5    20.2    8.63    13.9
GR    92     100      91  104.12      90  119.48      89   141.8      88  163.08
GR 87.86   167.8   86.72   167.9   86.48   168.7   86.23   169.8   86.32   172.6
GR  86.4   177.3   87.61   177.5      88  178.88      89  190.45      90  196.49
GR    91   208.3    91.7  259.84      96  259.85
X1 1.779      16   178.7  193.97   10.05      36   33.39
GR    91     100      90  112.88      89  144.57      89  158.64      89  168.63
GR  88.7   178.7   88.08     181  87.211     182  86.484   185.2  86.484   185.6
GR 86.52   187.1  86.702   190.8  87.647   191.9      89  193.97      91  260.84
GR    96  260.84
X1  1.78      16   178.7  193.97     0.1     0.1     0.1
GR    91     100      90  112.88      89  144.57      89  158.64      89  168.63
GR  88.7   178.7   88.08     181  87.211     182    86.9   185.2    86.9   185.6
GR  86.9   187.1    86.9   190.8  87.647   191.9      89  193.97      91  260.84
GR    96  260.84
NC          0.055
X1  1.81      17   196.8   209.7   17.32    68.6   35.19
GR    93  102.61      92  104.62      91  106.77      90  113.73      89  160.68
GR    89  164.41      89  187.69   88.44   196.8   86.82   202.4   86.82   203.9
GR  86.9   204.5    86.9   205.5   88.22   209.1   89.18   209.7      90  264.44
GR    91  280.13      96  280.15
X1 1.839      15   185.3   197.5   23.55   49.28   35.19
GR    97     100      92  100.44      91  105.61      90  130.12      89  180.45
GR 89.13   185.3   87.54   186.2   87.15   187.5   87.38     193   87.15   196.8
GR 88.97   197.5      90  247.44      91  253.69      93  258.12      94  266.25
X1  1.84      15   185.3   197.5     0.1     0.1     0.1
GR    97     100      92  100.44      91  105.61      90  130.12      89  180.45
GR 89.13   185.3    87.6   186.2    87.6   187.5    87.6     193    87.6   196.8
GR 88.97   197.5      90  247.44      91  253.69      93  258.12      94  266.25
X1  1.87      13   172.2   186.2   10.79   14.79   17.36
GR    92     100      91  114.86      90  129.21   89.33   172.2   87.78   175.4
GR 87.91   176.3   87.53   185.3   88.68   186.2      90  240.71      91  242.24
GR    92  249.79      93  263.46      97  263.47
X1   1.9      18   170.2   184.6   50.91    38.4   34.53
GR    93     100      92  121.77      91   136.3      90  157.55   89.64   170.2
GR    89   171.7      89   172.7   88.42     173   87.97   176.3   87.39   176.6
GR 87.13   179.8   87.01   182.1   89.32   184.6      90  248.52      91  254.74
GR    92  258.21      93  262.03      94   266.3
NC                 0.015
X1  1.94      19  142.52   154.1   49.88   50.09   60.96
GR    99     100      94     100      93  122.05      92  137.58      91  139.57
GR    90  140.58    89.5  142.52    89.5   142.8    88.5   143.9    88.5   146.5
GR  88.2   146.8    88.2   150.2    88.5   150.5    88.5     153    89.5   154.1
GR    90  156.18      91  226.13      92   232.4      93   240.4
X1     2      23   176.3   187.6   66.36    39.8   50.81
GR    94     100      93  130.28      99  130.29      99  142.78      92  142.79
GR    92  144.76      91  164.71      90  175.06    89.6   176.3    88.6   177.4
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GR  88.6   179.9    88.3   180.2    88.3   183.7    88.6     184    88.6   186.5
GR  89.6   187.6      90  188.45      91  225.27      92   228.5      93   231.8
GR    94  237.72    94.3  243.63      99  243.64
X1  2.04      25   174.3     186   66.69   62.08   69.96
GR    94     100      93  111.79      93  129.24    93.1  141.44      98  141.44
GR    98  150.29    92.8  150.29      92  156.09      91   168.7   90.61  172.12
GR 89.88   174.3   88.88   175.3   88.88   177.8   88.58   178.1   88.58   181.5
GR 88.88   181.9   88.88   184.3   89.88     186   90.54  187.52      91  194.51
GR    92  200.03      93  206.08      94  224.85    94.3  230.53      99  230.53
NC          0.08   0.025
X1  2.12      16  189.04  201.61   67.06   54.82   67.11
GR    95     100      94   142.4      93  155.69      92  172.86   91.19  189.04
GR 89.75  191.69   89.75  194.92   89.75  197.26   89.75   199.3   90.77  201.61
GR    91  204.94      92  241.04      93  249.98      94  262.61      95  256.99
GR    96  280.04
X1  2.16      23  175.63  184.94   26.84   62.92    38.1
GR    95     100    94.3  126.69      99  126.69      99  136.71    94.1  136.71
GR    94  137.48      93  151.49      92  173.69   91.36  174.61   91.36  175.63
GR 91.36  176.63   89.93  177.15   89.93  181.35   89.93  183.39   90.93  184.65
GR    91  184.94    91.6  248.07      92  310.29      93     313      94  314.94
GR    95  317.21      96  319.55      97  324.57
NC         0.055
X1  2.22      22  172.47  181.93    71.6   71.44   68.26
GR    99     100      99  108.41    95.5  108.41      95  118.73      94  139.93
GR    93  147.06      92  167.15   91.27  172.47   90.09  174.26   90.09  175.94
GR 90.09     178   90.09  179.79   91.11  181.93      92  193.07      92   205.5
GR    92  253.72      93  258.44      94  259.64      95  260.57      96  263.86
GR    97  269.77      98  276.12
X1  2.31      18  183.77   192.6   98.16   90.57    93.7
GR    96     100      95  109.92      94     135      99     135      99  146.15
GR    94  146.15      93  150.74   92.21  182.84   92.21  183.77   91.19  183.87
GR 91.19   192.5   92.11   192.6   92.11  193.96      93  204.65      94  234.52
GR    95  249.56      96  258.64      97  263.72
X1  2.39      22  180.85   189.6   81.28   82.87   86.66
GR    99     100      96     100      95  112.99    94.2   152.2      99   152.2
GR    99  167.32      94  167.32      94  169.65      94  172.62      93  174.85
GR 92.98  177.54   92.32  180.85   91.47   182.3   91.47  183.82   91.47  189.51
GR 93.18   189.6      94  216.37      95  228.64      95  234.62      95   238.4
GR    96  245.15      97  253.66
X1  2.46      20     165  174.75   61.49   65.33   64.99
GR    99     100      99   127.5    95.2   127.5      95  132.15      94  148.64
GR    93  163.24    92.3     165    91.8  165.56    91.8  168.06    91.8   170.6
GR  91.8  172.31   93.08  174.75      94  196.41      95  213.32     100  213.33
GR   100  227.39      96  227.39      96  245.85      96  250.79      97  267.99
NC  0.08           0.035
X1  2.54      20  211.66  222.41   99.18   84.28   98.53
GR    98     100    97.2  121.15     103  121.15     103  134.69    96.2  134.69
GR    96  137.04      95  155.91      94  183.55      93  207.13   92.85  211.66
GR 92.29  212.98   92.29  215.58   92.29  219.15   92.29  221.03   93.91  222.41
GR    95  243.29      96  258.47      97  279.12      97   287.6     102   287.6
NC                           0.3     0.5
X1  2.62      23  146.48  164.96   90.25   93.09   91.18
GR    98     100      97  104.84      96  110.46    95.2  131.25     100  131.25
GR   100   135.9    95.2   135.9      95  140.83   94.62  146.48   93.17  150.52
GR 93.17  152.87   93.17  156.04   93.17   158.1   93.84  159.94   94.66  164.96
GR    95  195.82      96  221.48    96.5   225.6     101   225.6     101  236.48
GR  97.2  236.48      99  276.52     100  341.82
NC 0.055           0.015
QT     2     295     210
X1  2.66      48 1001.55 1009.37   42.06   32.17    38.5
X3    10                                                    96.3    96.3
GR  99.3     793    99.1     806    99.1   806.1    99.1     828    99.1   828.1
GR  99.1     836    99.1   836.1    99.2     854    99.2   854.1    99.2     860
GR  99.2   860.1    99.2     886    99.2   886.1    99.2     889    99.2   889.1
GR  99.1     914    99.1   914.1    99.2     923    99.2   923.1      99     945
GR    99   945.1    98.5     951    98.5   951.1    95.5  969.45    95.5  969.55
GR  94.8  980.45    94.3  995.45    94.3  999.45      94    1000   93.86 1001.55
GR 93.86 1001.55   93.86 1002.24   92.95 1002.99   92.95 1005.46   92.95 1007.94
GR 93.86 1008.69   93.86 1009.37   93.86 1009.37      94 1009.38      94 1015.45
GR  94.5 1025.45      95 1045.45    95.9 1075.45    95.9 1075.55    98.8 1085.45
GR  98.8 1085.55    99.2 1131.45   100.4 1235.45
SB  1.25     1.7     1.5       0     5.7       0      27       0   93.53   92.95
X1 2.724      48 1001.55 1009.37      64      64      64
X2                     1   97.58    98.3
X3    10                                                    98.3    98.3
BT   -47     793    99.3    99.3     806    99.1    99.1   806.1     100    99.1
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BT             828     100    99.1   828.1    99.1    99.1     836    99.1    99.1
BT           836.1     100    99.1     854     100    99.2   854.1    99.2    99.2
BT             860    99.2    99.2   860.1     100    99.2     886     100    99.2
BT           886.1    99.2    99.2     889    99.2    99.2   889.1     100    99.2
BT             914     100    99.1   914.1    99.1    99.1     923    99.2    99.2
BT           923.1     100    99.2     945     100      99   945.1      99      99
BT             951    98.5    98.5   951.1     100    98.5  969.45     100    95.5
BT          969.55    98.4    95.5  980.45    98.4    94.8  995.45    98.3    94.3
BT          999.45    98.3    94.3    1000    98.3      94 1001.55    98.3      94
BT         1001.55    98.3   96.08 1002.24    98.3   96.75 1002.99    98.3   97.13
BT         1005.46    98.3   97.58 1007.94    98.3   97.13 1008.69    98.3   96.75
BT         1009.37    98.3   96.08 1009.37    98.3      94 1009.38    98.3      94
BT         1015.45    98.3      94 1025.45    98.4    94.5 1045.45    98.5      95
BT         1075.45    98.7    95.9 1075.55     100    95.9 1085.45     100    98.8
BT         1085.55    98.8    98.8 1131.45    99.2    99.2 1235.45   100.4   100.4
GR  99.3     793    99.1     806    99.1   806.1    99.1     828    99.1   828.1
GR  99.1     836    99.1   836.1    99.2     854    99.2   854.1    99.2     860
GR  99.2   860.1    99.2     886    99.2   886.1    99.2     889    99.2   889.1
GR  99.1     914    99.1   914.1    99.2     923    99.2   923.1      99     945
GR    99   945.1    98.5     951    98.5   951.1    95.5  969.45    95.5  969.55
GR  94.8  980.45    94.3  995.45    94.3  999.45      94    1000      94 1001.55
GR 94.44 1001.55   94.44 1002.24   93.53 1002.99   93.53 1005.46   93.53 1007.94
GR 94.44 1008.69   94.44 1009.37      94 1009.37      94 1009.38      94 1015.45
GR  94.5 1025.45      95 1045.45    95.9 1075.45    95.9 1075.55    98.8 1085.45
GR  98.8 1085.55    99.2 1131.45   100.4 1235.45
NC                 0.035
X1   2.8      39  654.78  666.96    49.9  106.61   72.17
GR   101     100     100  159.98      99   204.3      99   362.9    99.2  371.78
GR   104  371.78     104  390.16    99.2  390.16      99  424.87      99  446.02
GR  99.1  451.24     104  451.24     104  485.55    99.1  485.56     100  568.28
GR 100.1  594.22     105  594.22     105  601.72   100.1  601.72     100  615.27
GR    99  624.78      98  626.91      96  640.91   95.09  654.78   94.42  660.34
GR 94.42  661.39   94.42  662.66   94.42  663.61   96.08  666.96      97  673.88
GR    98  676.99      98   683.9      98  691.39     104  691.39     104  704.33
GR  98.6  704.33      99  749.13     100  788.07     101  801.46
NC                           0.1     0.3
X1  2.92      19  489.97  500.91  101.43  160.24  154.56
GR   101     100     100  144.92      99  404.57      98  416.72      97  461.96
GR    97  476.28      97  488.62   96.49  489.97   95.53  492.14   95.53  493.96
GR 95.53  495.67   95.53  497.33   97.23  500.91      98  541.91      99  547.76
GR   100  550.32     101   555.9   101.1   559.4     105  559.41
X1  2.98      30  418.92  428.86    72.6   41.25   54.14
GR   105     100   100.1   100.1     100  107.36    99.8  135.87     105  135.87
GR   105   150.2    99.8   150.2    99.6  198.24     105  198.24     105  279.68
GR  99.6  279.68    99.1  348.55     105  348.55     105  363.61    99.1  363.61
GR    99  365.06      98  380.95      97  413.17   96.59  418.92   95.77  420.13
GR 95.77  422.09   95.77  425.69   95.77  427.36   96.74  428.86      97  430.98
GR    98  433.42      99  434.52     100  437.09     101  450.79     105   450.8
NC                 0.025     0.3     0.5
X1  3.04      22   412.5   426.8   66.95  105.42   65.52
GR   101     100     100  150.88    99.9  228.37     105  228.37     105  305.01
GR  99.9  305.02      99  386.09    98.5   412.5      97   412.6   96.81     416
GR 95.91   416.1   95.91  420.76   95.91  423.59   95.91   426.7   98.61   426.8
GR    99  431.41     100   445.5   100.1   448.2     105   448.2     105  465.32
GR 100.2  465.33     101  502.57
NC                 0.015
X1 3.105      29    1000  1015.6   69.99   47.81   52.73
X3    10                                                    98.9    98.9
GR   101     752     100     792    99.6     860    99.6   860.1    99.9     944
GR  99.9   944.1    99.5   979.8    99.4   982.8      98   994.8   96.94    1000
GR 96.94 1000.05   96.94 1004.85   96.94  1004.9   95.94  1005.5   95.94 1005.55
GR 95.94 1010.35   95.94  1010.4      96  1010.7      96 1010.75      96 1015.55
GR    96  1015.6      97  1018.8      99  1024.8   100.1  1038.8   100.1  1038.9
GR 100.6  1052.8   100.6  1052.9   100.6  1061.2   101.1    1085
SB  1.25    1.58     1.5       0    16.3     1.2    40.9       0      96   95.94
X1  3.12      29    1000  1015.6      15       5      15
X2                     1    98.7   99.44
X3    10                                                   99.44   99.52
BT   -28     752     101     101     792     100     100     860    99.6    99.6
BT           860.1     102    99.6     944     102    99.9   944.1    99.9    99.9
BT           979.8    99.5    99.5   982.8   99.44    99.4   994.8   99.48      98
BT            1000   99.52   96.94 1000.05  100.12   99.24 1004.85  100.12   99.24
BT          1004.9  100.12   96.94  1005.5  100.12      96 1005.55  100.12      99
BT         1010.35  100.12      99  1010.4  100.12      96  1010.7  100.12   96.18
BT         1010.75  100.12   99.18 1015.55  100.12   99.18  1015.6   99.52      96
BT          1018.8   99.63      97  1024.8    99.7      99  1038.8   100.1   100.1
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BT          1061.2   100.6   100.6    1085   101.1   101.1
GR   101     752     100     792    99.6     860    99.6   860.1    99.9     944
GR  99.9   944.1    99.5   979.8    99.4   982.8      98   994.8   96.94    1000
GR 96.94 1000.05   96.94 1004.85   96.94  1004.9      96  1005.5      96 1005.55
GR    96 1010.35      96  1010.4   96.18  1010.7   96.18 1010.75   96.18 1015.55
GR 96.18  1015.6      97  1018.8      99  1024.8   100.1  1038.8   100.1  1038.9
GR 100.6  1052.8   100.6  1052.9   100.6  1061.2   101.1    1085
NC                 0.015
X1  3.18      29  279.85  290.96   58.15   24.62   59.58
GR   102     100     101   129.5   100.1  160.03     105  160.03     105  170.29
GR   105  186.05     105   231.5     105  249.85     105  262.26   100.1  262.26
GR   100   262.8      99  272.97      99  273.02   98.07  274.89    97.8  279.85
GR 97.72  279.99    96.5  282.43   96.35  285.48    96.5  288.52   97.72  290.96
GR 97.67  291.73   98.91  298.79      99  299.55     100  305.68   100.2  326.39
GR   105  326.39     105  345.22   100.2  345.22     101  381.41
NC                           0.1     0.3
X1  3.22      18  270.62  281.59   60.89   23.11    41.7
GR   102     100     101  177.56     105  177.56     105  249.46   100.1  249.46
GR   100   255.4   99.35  264.75   98.16  267.43   98.02  270.62    96.8  273.06
GR 96.65  276.11    96.8  279.15   98.02  281.59   97.99  283.67   98.71  290.27
GR    99  306.95     100  313.92     101  375.34
NC                 0.025
X1  3.28      24   290.7   299.9   48.94  100.75   81.61
GR 102.6     100     102  113.92     101  170.33     101  201.14     102  209.87
GR   106  209.87     106  256.13   100.1  256.14     100  262.66    99.3  286.29
GR 99.07  290.11   98.85   290.7   97.75   290.8   97.75   292.8   97.45   292.8
GR 97.45   297.8   97.75   297.8   97.75   299.8   98.85   299.9   99.13  303.34
GR   100  342.29     101  368.96     102  410.91     103   467.9
X1  3.42      16     158  169.75   90.29   55.46    78.4
GR   103     100     102  104.14     101  112.61     100  127.19     100  149.57
GR 99.63     158   98.19   158.1   98.19  161.25   98.19  163.56   98.19  167.01
GR 99.63  169.75     100  174.24     100  206.72     101  250.65     102   291.2
GR   103  303.01
NC  0.08
X1  3.48      15  223.66   231.8   63.65   92.53    81.1
GR   104     100     103  157.13     102  158.39     101  160.81     100  163.66
GR 99.77  223.66   98.65  228.32   98.65  229.39   98.65  230.29   98.65  231.66
GR 100.4   231.8     101  273.33     102  338.45     103  369.12     104  381.33
NC          0.08   0.035
X1   3.6      12  147.41  168.79   64.04   58.39  109.16
GR   104     100  103.89     120  101.01  133.57     100  147.41   98.91   149.6
GR 98.91  151.58   98.91  153.69   98.91  157.51     100  168.79  101.51  296.76
GR   103  358.82     104  379.85
NC 0.055   0.055
X1  3.68      17  173.63  184.34   92.56   62.13   79.02
GR   107     100     107  115.22     103  115.22     103  116.79     102  126.41
GR   101  162.91  100.98  166.45  100.21  173.63   99.18  173.93   99.18  175.62
GR 99.18  178.13   99.18  180.82  100.63  184.34     101  295.27     102  350.11
GR   103  369.64     104  395.98
NC                 0.025     0.3     0.5
X1  3.75      14  193.74  212.06   87.57   72.89   88.51
GR   105     100     104  123.27     103  133.82     102   145.8  102.25  193.74
GR100.45  193.74   99.25  199.25   99.25  206.55  100.45  212.06  102.25  212.06
GR   102   232.6     102  342.51     103  367.82     104  379.97
NC                 0.015
QT     2     285     210
X1  3.87      21  1242.3 1267.69  102.15  109.77  121.09
X3    10                                                   104.9   105.4
GR 105.9     985   105.5    1025   105.5  1025.1   104.1    1159   104.1  1159.1
GR   101    1239   100.5  1242.3  100.44  1242.3  100.43 1242.32  100.43 1245.42
GR 99.67 1247.54   99.67 1254.84  100.43 1257.88  100.43 1267.67  100.44 1267.67
GR 100.5 1267.69     101    1273     101    1273     102    1315     105    1415
GR 106.4    1495
SB  1.25    1.58     1.5       0      22       0    76.9       0    99.7   99.67
X1 3.894      21  1242.3 1267.69      24      24      24
X2                     1  103.17   104.9
X3    10                                                   104.9   105.4
BT   -20     985   105.9   105.9    1025   105.6   105.5  1025.1     107   105.5
BT          1159     107   104.1  1159.1   104.9   104.1    1239   105.4     101
BT        1242.3   105.4   100.5  1242.3   105.4  100.47 1242.32   105.4  103.17
BT       1245.42   105.4  103.17 1247.54   105.4  103.17 1254.84   105.4  103.17
BT       1257.88   105.4  103.17 1267.67   105.4  103.17 1267.67   105.4  100.47
BT       1267.69   105.4   100.5    1273   105.4     101    1273   105.4     101
BT          1315   105.7     102    1415   106.2     105    1495   106.4   106.4
GR 105.9     985   105.5    1025   105.5  1025.1   104.1    1159   104.1  1159.1
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GR   101    1239   100.5  1242.3  100.47  1242.3  100.47 1242.32  100.47 1245.42
GR  99.7 1247.54    99.7 1254.84  100.47 1257.88  100.47 1267.67  100.47 1267.67
GR 100.5 1267.69     101    1273     101    1273     102    1315     105    1415
GR 106.4    1495
NC                 0.025
X1  3.92      20   266.4   277.2   28.06   33.61   30.44
GR104.22     100     104  107.97     103   110.9  102.14  130.18     103  151.12
GR   104  153.93     104  154.16     103   169.1     102  180.71     101  249.81
GR101.97  263.63   100.6   266.4    99.7   268.3    99.7   275.3   100.6   277.2
GR101.76  278.77     102   287.2     103  310.46     104  336.81     105  367.77
NC                           0.1     0.3
X1  3.96      20   340.4   351.2   46.79   47.45   46.56
GR   105     100     104  116.92  103.74  170.04     109  170.04     109  191.64
GR 103.1  191.64     103  196.74     102  226.02     101  326.98   100.7   340.4
GR  99.8   342.3    99.8   349.3   100.7   351.2     101   351.7     102  356.73
GR   104  379.23     104  400.17   103.9  418.66     104  431.41     105  452.19
X1  4.04      30  407.85   418.6   37.39   32.53   32.47
GR   106     100     106  156.99     110  156.99     110  204.09   104.1  204.09
GR   104  231.74     104  252.14     109  252.15     109  265.66     104  265.77
GR   104  277.36   103.7  310.53     109  310.53     109  328.08   103.7  328.08
GR   102  393.41     101  401.01  101.07  407.85     101  407.86   100.1   409.7
GR 100.1   416.7     101   418.6     101  420.65     102  426.69     103  432.53
GR 103.7  440.96     109  440.97     109     460   103.7     460     104  471.73
NC                           0.3     0.5
X1   4.1      29   380.5   391.3   57.24   53.99   55.85
GR   105     100     104  135.37   105.1  138.85     109  138.85     109  151.31
GR 103.8  151.31   103.3     175     104  192.67   104.1  217.59     109  217.59
GR   109  236.69   104.1  236.69     104  262.65   103.7  302.51     103  346.66
GR   102  366.23  101.18   380.4  101.06   380.5  100.16   382.4  100.16   389.4
GR101.06   391.3     102  394.63     103  404.48     104  416.65   104.1  416.84
GR   110  416.85     110     430   104.1     430     105  466.47
NC                 0.015
X1  4.18      41    1000 1015.48   76.75   85.84   85.63
X3    10                                                   102.8   102.8
GR105.12     690   104.9     725   104.9   725.1   104.2     801   104.2   801.1
GR104.18     860  104.18   860.1   103.4     940     103     940     102  985.74
GR101.35  997.54  101.35  999.54  101.13    1000  101.13    1000  101.13 1000.02
GR101.13 1000.47  100.37 1001.23  100.37 1006.13  101.13 1006.89  101.13 1007.34
GR101.13 1007.35  101.13 1007.35  101.13 1008.12  101.13 1008.13  101.13 1008.13
GR 101.2 1008.59  100.44 1009.35  100.44 1014.25   101.2 1015.01   101.2 1015.46
GR 101.2 1015.46   101.2 1015.48     103 1017.54   103.5 1021.54   103.5 1021.64
GR 104.6    1043   104.6  1043.1   105.3    1073   105.3  1073.1   105.5 1081.04
GR 105.5 1081.04
SB  1.25    1.57     1.5       0    14.3    0.76    33.1       0  100.55  100.37
X1 4.195      41    1000 1015.48      15      15      15
X2                     1  102.99   103.4
X3    10                                                   103.4  103.71
BT   -40     690  105.12  105.12     725   104.9   104.9   725.1     107   104.9
BT           801     107   104.2   801.1   104.2   104.2     860  104.18  104.18
BT         860.1     107  104.18     940     107   103.4     940   103.4  102.99
BT        985.74  103.62     102  997.54  103.69  101.35  999.54  103.68  101.35
BT          1000  103.71  101.35    1000  104.31  101.35 1000.02  104.31  103.03
BT       1000.47  104.31  103.03 1001.23  104.31  103.03 1006.13  104.31  103.03
BT       1006.89  104.31  103.03 1007.34  104.31  103.03 1007.35  104.31  101.35
BT       1007.35  104.31  101.35 1008.12  104.31  101.31 1008.13  104.31  102.99
BT       1008.13  104.31  102.99 1008.59  104.31  102.99 1009.35  104.31  102.99
BT       1014.25  104.31  102.99 1015.01  104.31  102.99 1015.46  104.31  102.99
BT       1015.46  104.31  102.99 1015.48  103.71  101.31 1017.54  103.92  102.99
BT       1021.54     104   103.5 1021.64     107   103.5    1043     107   104.6
BT        1043.1   104.6   104.6    1073   105.3   105.3  1073.1     107   105.3
BT       1081.04     107   105.5 1081.04   105.5   105.5
GR105.12     690   104.9     725   104.9   725.1   104.2     801   104.2   801.1
GR104.18     860  104.18   860.1   103.4     940  102.99     940     102  985.74
GR101.35  997.54  101.35  999.54  101.35    1000  101.35    1000  101.35 1000.02
GR101.35 1000.47  100.59 1001.23  100.59 1006.13  101.35 1006.89  101.35 1007.34
GR101.35 1007.35  101.35 1007.35  101.31 1008.12  101.31 1008.13  101.31 1008.13
GR101.31 1008.59  100.55 1009.35  100.55 1014.25  101.31 1015.01  101.31 1015.46
GR101.31 1015.46  101.31 1015.48  102.99 1017.54   103.5 1021.54   103.5 1021.64
GR 104.6    1043   104.6  1043.1   105.3    1073   105.3  1073.1   105.5 1081.04
GR 105.5 1081.04
NC                 0.035
X1  4.34      26  333.72  354.39  153.45  137.18  149.84
GR   106     100   105.1   125.8     110   125.8     110  133.55   104.9  133.55
GR 104.8  178.96     110  178.97     110  191.21   104.8  191.21   104.7  216.23
GR   104  315.01  103.31  333.72  101.93  338.36  101.93  340.95  101.93  345.57
GR101.93  350.36   103.6  354.39     103  364.66     103  368.89     104  425.75
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GR   105  438.77     105  438.85     110  438.85     110  453.56   105.9  453.57
GR   106  454.44
NC                           0.1     0.3
X1  4.44      22  282.13  302.37   81.01  100.34  119.73
GR   106     100   105.2  122.72     110  122.72     110  130.26   105.2  130.26
GR   105  143.25     105  234.53   105.1  242.11     110  242.12     110  251.13
GR 105.1  251.14  104.54  282.13  102.87  286.36  102.87  289.86  102.87  293.42
GR102.85     297  104.21  302.37     104  316.37     104  372.97     105  402.87
GR   106  412.18     107  421.94
NC                 0.025     0.3     0.5
X1  4.64      30   309.3   316.5  157.13  161.63  186.75
GR   107     100     106  118.65     106  132.67   106.1  139.43     110  139.43
GR   110   148.9   106.1  148.91     106  159.37     106  170.35     106  175.73
GR   106  182.27   106.1  195.56     110  195.56     110  202.78   106.1  202.79
GR   106  209.27   105.9  246.07     110  246.07     110  253.58   105.9  253.58
GR105.76   309.3  103.35   309.4  103.35  311.35  103.35   314.4  103.35   316.4
GR104.71   316.5     105  377.51     106  400.86     107  405.97     108  409.75
NC                 0.015
X1  4.67      21 1212.99 1224.98   62.22   40.42   36.58
X3    10                                                   105.4   105.4
GR 108.7     905   108.5     985     106    1031   106.6    1051     106    1116
GR   106    1139   106.2    1149   106.2  1149.1   105.5    1207   105.5  1207.1
GR103.75 1212.99  103.75 1212.99  103.75 1218.84  103.75 1218.84  103.14 1219.24
GR103.14 1219.24  103.14 1224.98     104 1224.98     105    1267     106    1301
GR   108    1310
SB  1.25    1.64     1.5       0    10.4     0.4    21.1       0  103.14  103.14
X1  4.69      34  212.99  224.98      20      20      20
X2                     1  105.27  105.93
X3    10                                                  105.93  105.93
BT   -34      52   107.7   107.7    62.1   107.5   107.5      74   107.2   107.2
BT           101   107.8   107.8   101.1     110   107.8     121     110   107.8
BT         121.1   107.8   107.8     153   107.4   107.4   153.1     110   107.4
BT           173     110   107.5   173.1   107.5   107.5     182     107     107
BT         182.1     110     107     207     110   104.4   207.1  105.97   104.4
BT        212.99  105.93  103.75  212.99  106.53  105.27  218.84  106.53  105.27
BT        218.84  106.53  103.75  219.24  106.53  103.14  219.24  106.53  105.27
BT        224.98  106.53  105.27  224.98  105.93  103.14     228   106.1     105
BT           238     107     107     250   107.2   107.2   250.1     113   107.2
BT           270     113   107.8   270.1   107.8   107.8     273   107.8   107.8
BT         273.1     113   107.8     292     113   108.3   292.1   108.3   108.3
BT           295   108.4   108.4
GR 107.7      52   107.5    62.1   107.2      74   107.8     101   107.8   101.1
GR 107.8     121   107.8   121.1   107.4     153   107.4   153.1   107.5     173
GR 107.5   173.1     107     182     107   182.1   104.4     207   104.4   207.1
GR103.75  212.99  103.75  212.99  103.75  218.84  103.75  218.84  103.14  219.24
GR103.14  219.24  103.14  224.98  103.14  224.98     105     228     107     238
GR 107.2     250   107.2   250.1   107.8     270   107.8   270.1   107.8     273
GR 107.8   273.1   108.3     292   108.3   292.1   108.4     295
NC                 0.025
X1  4.78      23  293.41  310.43    47.6   87.67   77.03
GR   113  116.56     113  202.02   108.1  202.02     108  209.79     107  262.67
GR   106  267.23     105  272.44  104.77  288.34  104.66  293.41  104.31  294.44
GR104.31  297.31  104.31  300.82  104.31  303.82  105.87  310.43     106  311.21
GR   107  313.67     108   319.7     108   338.1     113   338.1     113  353.34
GR   108  353.34     108  378.98     109  393.49
NC                           0.3     0.5
X1  4.82      23   237.9  250.02   73.24    48.4   40.52
GR   110     100   109.8  107.02     115  107.02     115  215.48     108  215.49
GR   108  216.18     107  218.29     106  222.61     105  227.36  105.04  227.66
GR104.89   237.9  104.39  241.05  104.39  244.17  104.39  247.29  104.39  249.24
GR105.12  250.02     106   252.5     107  256.72     108  260.24     108  267.32
GR   108  281.53   108.2  281.54     113  291.66
NC                 0.015
QT     2     280     210
X1  4.96      19 1099.45 1112.55  102.36  131.39   139.8
X3    10                                                   108.9   108.9
GR 111.5     920     111    1011     110    1027   109.8    1053   109.1 1099.45
GR105.68  1099.5  105.68  1104.9  105.68 1104.95  105.52 1106.45  105.52  1106.5
GR105.52  1112.5  105.52 1112.55     109    1114   110.5    1122   110.8    1152
GR 110.8    1182   111.3    1227   111.3    1251     112    1339
SB  1.25    1.82     1.5       0    14.4     1.5      53       0  106.75  105.52
X1 5.053      23 1099.45 1112.55      93      93      93
X2                     1  110.85   110.9
X3    10                                                   111.6   110.9
BT   -22    1045     114     114  1045.1     114     114    1079     112     112
BT        1099.4   111.6   111.6 1099.45   111.6  106.85  1099.5   112.9  111.45
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BT          1104.9   112.9  111.45 1104.95   112.9  106.85 1106.45   112.9  106.75
BT          1106.5   112.9  111.35  1112.5   112.9  111.35 1112.55   111.4  106.75
BT            1120   111.4     111  1120.1     114     111    1162     114   111.8
BT          1162.1   111.8   111.8    1176     111     111    1180   110.9   110.9
BT            1186     111     111    1188     111     111  1188.1     115     111
BT            1268     115   112.5  1268.1   112.5   112.5
GR   114      1045     114  1045.1     112    1079   111.6  1099.4  106.85 1099.45
GR106.85    1099.5  106.85  1104.9  106.85 1104.95  106.75 1106.45  106.75  1106.5
GR106.75    1112.5  106.75 1112.55     111    1120     111  1120.1   111.8    1162
GR 111.8    1162.1     111    1176   110.9    1180     111    1186     111    1188
GR   111    1188.1   112.5    1268   112.5  1268.1
NC                    0.03
X1  5.12        20     123     136   39.87    58.7   62.31
GR   113     99.37     113    99.9     118     100     118   115.1   112.9   115.1
GR 111.9       123   107.5   123.1   107.5   124.5     107   124.6     107     134
GR   108       136     108  138.71     109   150.8     110  188.04     110  191.28
GR   110    211.58     111  222.71     112  269.12     113     275     114  278.64
NC                             0.1     0.3
X1 5.179        20     116     130   74.34   21.56   57.54
GR   114       100     113  103.75     112  104.97   111.5     116     108  119.12
GR 107.3       121   107.3     125     108     126     110     130     110  131.31
GR   110    138.58     109  140.59   108.8  141.37     109  142.65     110  203.24
GR   111    206.85     112  253.77     113  259.78     114  262.61   114.3  266.95
NC                    0.02     0.1     0.3
X1  5.18        21     116  131.31     0.1     0.1     0.1
GR   114       100     113  103.75     112  104.97   111.5     116     108     120
GR 107.6       121   107.6     125     108     126     108  126.58     109  129.68
GR   110    131.31     110  138.58     109  140.59   108.8  141.37     109  142.65
GR   110    203.24     111  206.85     112  253.77     113  259.78     114  262.61
GR 114.3    266.95
X1  5.22        18  125.07  139.34      40   28.54    39.8
GR   115       100     114  114.04     113  116.49     112  118.73     111  121.39
GR   110    122.98   109.3  125.07  108.23  127.93  108.23  129.07  108.23  130.08
GR108.23    132.09  110.43  139.34     110  143.53     110  183.23     111  203.69
GR   112    245.67     113  252.47     114  254.98
* section added Sept 12/02
X1 5.221        22  178.25  193.89   61.58   42.55   50.21
GR   117       100     116  109.01     115  128.85     115  142.78     115  154.26
GR   114    156.11     113  159.59     112   167.1     111  171.66     110  178.25
GR   109    182.83  108.56  184.83  108.56  188.83     109  191.34     110  193.89
GR   110    203.15     110  209.61     111  230.03     112  258.28     113  303.08
GR   114    314.14     114  327.19
NC                             0.3     0.5
X1  5.32        28  198.48  202.79    65.5   33.64   52.32
GR   122       100   117.2   100.1     117  138.37     116  142.01     115  145.73
GR   114    147.24     114  158.08     115  158.59     115  163.22     114  166.01
GR   113    175.76     113  183.03     113  185.02     112  187.36     111  190.68
GR110.28    194.74   108.9  198.48   108.9  199.88   108.9  201.72   108.9  202.79
GR111.34    211.32     111  215.67     111  224.84     112  233.05     113  301.96
GR   114    306.33     114  306.78     118  306.78
NC                   0.015
X1 5.384        46 1063.97 1070.04   78.38   46.99   72.45
X3    10                                                     112.5   112.5
GR 116.7       947   116.7   947.1   115.8     995   115.8   995.1   115.8    1000
GR 115.8      1001   112.5    1051     111    1058  110.03    1063  110.03 1063.97
GR110.03   1063.97  110.03 1063.99  110.03 1063.99  109.27 1066.26  109.27 1068.36
GR110.03   1070.01  110.03 1070.02  110.03 1070.02  110.03 1070.04     111    1075
GR 110.9      1082   111.5    1094   111.5  1094.1   112.2    1102   112.2  1102.1
GR 112.2      1107   112.2  1107.1   112.8    1147   112.8  1147.1   112.9    1153
GR 112.9    1153.1     113    1162     113  1162.1     114    1175     114  1175.1
GR 114.3      1183   114.3  1183.1   114.3    1187   114.3  1187.1   113.5    1197
GR 113.5    1197.1   113.5    1201   113.5  1201.1   114.5    1219   114.5  1219.1
GR   115      1227
SB  1.25      1.59     1.5       0     5.6       0    19.9       0  109.49  109.27
X1 5.408        46 1063.97 1070.04      24      24      24
X2                       1  112.99   113.2
X3    10                                                    113.47   113.2
BT   -46       947   116.7   116.7   947.1     118   116.7     995     118   115.8
BT           995.1   115.8   115.8    1000  114.69  114.69    1001  114.68  114.68
BT            1051     114     114    1058  113.63  112.99    1063   113.5  110.25
BT         1063.97  113.47  110.25 1063.97  113.47  110.25 1063.99  113.47  112.99
BT         1063.99  113.47  112.99 1066.26  113.47  112.99 1068.36  113.47  112.99
BT         1070.01  113.47  112.99 1070.02  113.47  112.99 1070.02  113.47  110.25
BT         1070.04  113.47  110.25    1075  113.58     111    1082   113.3  112.99
BT            1094  113.25   113.2  1094.1     117   113.2    1102     117   113.2
BT          1102.1   113.2   113.2    1107   113.2   113.2  1107.1     117   113.2
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BT          1153.1     117   114.2    1162     117   114.2  1162.1   114.2   114.2
BT            1175   114.2   114.2  1175.1     117   114.2    1183     117   114.3
BT          1183.1   114.3   114.3    1187   114.3   114.3  1187.1     117   114.3
BT            1197     117   114.3  1197.1   114.3   114.3    1201   114.3   114.3
BT          1201.1     117   114.3    1219     117   114.5  1219.1   114.5   114.5
BT            1227     115     115
GR 116.7       947   116.7   947.1   115.8     995   115.8   995.1  114.69    1000
GR114.68      1001     114    1051  112.99    1058  110.25    1063  110.25 1063.97
GR110.25 1063.99  112.99 1063.99  110.25 1063.99  109.49 1066.26  109.49 1068.36
GR110.25 1070.01  112.99 1070.02  110.25 1070.02  110.25 1070.04     111    1075
GR112.99      1082   113.2    1094   113.2  1094.1   113.2    1102   113.2  1102.1
GR 113.2      1107   113.2  1107.1   114.2    1147   114.2  1147.1   114.2    1153
GR 114.2    1153.1   114.2    1162   114.2  1162.1   114.2    1175   114.2  1175.1
GR 114.3      1183   114.3  1183.1   114.3    1187   114.3  1187.1   114.3    1197
GR 114.3    1197.1   114.3    1201   114.3  1201.1   114.5    1219   114.5  1219.1
GR   115      1227
NC                    0.02
X1  5.44        17  179.48   185.1   26.73   56.66   43.72
GR   121       100     116   100.1     113  167.36     112  169.45     111  171.99
GR 110.6    179.48   110.3   179.7  109.84   182.4   110.3   185.1   110.3   185.1
GR   111    187.52     112  189.83     113  192.39     114  198.87     115  204.83
GR 115.8    211.53     120  211.54
NC            0.08   0.025     0.1     0.3
X1  5.56        17   128.4  139.44   38.47  120.14  121.33
GR   121       100   116.1     100     116  103.94     113  122.04     112  125.44
GR111.97     128.4  110.67   128.5  110.67   130.6  110.67  133.23  110.67  135.21
GR111.79    139.44     112  196.29     113  203.06     114  208.58     115  212.15
GR   116    219.05     117  239.62
X1  5.62        20     142  153.43   46.35   46.49   45.89
GR   121    102.03   116.1  102.03     116  125.33     115  134.56     114  136.71
GR   113    138.44  112.18     142  111.08  142.11  111.08  143.53  111.08  146.13
GR111.08    147.76  112.19  153.43     112  178.01     112  196.63     112  208.77
GR   113    232.77     114  237.34     115  240.12     116  254.68     117  268.45
X1  5.68        20  183.15  191.62   49.79   38.95   54.46
GR   121       100   116.1   100.1     116  104.78     115  133.61     121  133.61
GR   121    143.98     115  143.98     114   153.1     113  156.99  112.14  183.15
GR111.03    184.02  111.03  185.98  111.03  188.82  111.03   190.7     112  191.62
GR   113       251     114  257.23     115  260.71     116  274.45     117  281.99
X1  5.74        18   161.5  173.23   85.68   54.09   65.39
GR   116       100   115.1  134.76     121  134.76     121  145.63   115.1  145.63
GR   115     146.6     114  157.97   112.6   161.5   111.4   161.6   111.4  164.67
GR 111.4    167.18  112.48  173.23  112.88  183.58     113  223.15     114  225.71
GR   115     227.9     116  241.26     117  265.82
X1   5.8        25  162.22  180.47   49.71   26.43   51.42
GR   116       100     116  104.65     116  111.85     121  111.85     121  119.72
GR 115.1    119.72     115   122.6   114.5  139.45     121  139.45     121  150.36
GR 114.5    150.36   114.5  162.22  112.05  167.94  111.74   168.9  111.74  170.74
GR111.74    173.29  111.74  175.37  112.89  180.47     113  188.22     113  200.93
GR   113    204.46     114  209.74     115  212.34     116  213.92     117  236.74
NC           0.055
X1  5.84        25  145.62  164.94   54.24   53.49   52.25
GR   120       100     116   100.1     116  101.02     115  104.47   115.1  121.13
GR   120    121.14     120   130.9   115.1   130.9     115  133.11     115  142.68
GR115.05    145.62  111.75  153.92  111.75  155.27  111.75  157.87  111.75  159.37
GR113.25    164.94     113  168.26     113  178.38     114  187.43     115  189.41
GR   116    193.69     117  195.54     118  197.37     119  208.42     120  232.55
NC                             0.3     0.5
QT     2       250     195
X1  5.92        28 1176.26 1207.75   53.76   92.13   71.84
X3    10                                                   122.9   119.3
GR   124      1000     115    1150     115 1176.26     122 1176.26   118.8 1177.86
GR 116.8 1184.66   121.7 1184.86   121.7 1186.46  113.09 1186.76  111.57 1188.26
GR111.57 1195.16  113.09 1195.76  113.09 1197.25   121.7 1197.55   121.7 1197.56
GR 121.7 1199.15   116.8 1199.35   118.8 1206.15     122 1207.75     116 1207.76
GR 120.6      1276     122    1360   121.9    1385     121    1401     120    1405
GR 119.3      1417   119.3    1427     121  1427.1
NC                   0.015
X15.9201        28 1176.26 1207.75     0.1     0.1     0.1
X3    10                                                   122.9   119.3
BT   -27      1000     124     124    1150     123     115 1176.26   122.9     115
BT         1176.26   122.9     122 1177.86   122.9     122 1184.66   122.9     122
BT         1184.86   122.9   121.7 1186.46   122.9   121.7 1186.76   122.9   121.7
BT         1188.26   122.9   121.7 1195.16   122.9   121.7 1195.76   122.9   121.7
BT         1197.25   122.9   121.7 1197.55   122.9   121.7 1197.56   122.9   121.7
BT         1199.15   122.9   121.7 1199.35   122.9     122 1206.15   122.9     122
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BT       1207.75   122.9     122 1207.76   122.9     116    1276   122.5   120.6
BT          1360     122     122    1385   121.9   121.9    1401     121     121
BT          1405     120     120    1417   119.3   119.3    1427   119.3   119.3
BT        1427.1     121     121
GR   124    1000     115    1150     115 1176.26     122 1176.26   118.8 1177.86
GR 116.8 1184.66   121.7 1184.86   121.7 1186.46  113.09 1186.76  111.57 1188.26
GR111.57 1195.16  113.09 1195.76  113.09 1197.25   121.7 1197.55   121.7 1197.56
GR 121.7 1199.15   116.8 1199.35   118.8 1206.15     122 1207.75     116 1207.76
GR 120.6    1276     122    1360   121.9    1385     121    1401     120    1405
GR 119.3    1417   119.3    1427     121  1427.1
X1  5.94      28 1176.26 1207.75      20      20      20
X3    10                                                   122.9   119.3
BT   -27    1000     124     124    1150     123     117 1176.26   122.9     114
BT       1176.26   122.9     122 1177.86   122.9     122 1184.66   122.9     122
BT       1184.86   122.9   121.7 1186.46   122.9   121.7 1186.76   122.9   121.7
BT       1188.26   122.9   121.7 1195.16   122.9   121.7 1195.76   122.9   121.7
BT       1197.25   122.9   121.7 1197.55   122.9   121.7 1197.56   122.9   121.7
BT       1199.15   122.9   121.7 1199.35   122.9     122 1206.15   122.9     122
BT       1207.75   122.9     122 1207.76   122.9     118    1276   122.5   119.3
BT          1360     122   119.3    1385   121.9   119.3    1401     121   119.3
BT          1405     120   119.3    1417   119.3   119.3    1427   119.3   119.3
BT        1427.1     121     121
GR   124    1000     117    1150     114 1176.26     122 1176.26   118.8 1177.86
GR 116.8 1184.66   121.7 1184.86   121.7 1186.46  113.11 1186.76  111.58 1188.26
GR111.58 1195.16  113.11 1195.76  113.11 1197.25   121.7 1197.55   121.7 1197.56
GR 121.7 1199.15   116.8 1199.35   118.8 1206.15     122 1207.75     118 1207.76
GR 119.3    1276   119.3    1360   119.3    1385   119.3    1401   119.3    1405
GR 119.3    1417   119.3    1427     121  1427.1
NC                 0.025
X15.9401      28 1176.26 1207.75     0.1     0.1     0.1
X3    10                                                   122.9   119.3
GR   124    1000     117    1150     114 1176.26     122 1176.26   118.8 1177.86
GR 116.8 1184.66   121.7 1184.86   121.7 1186.46  113.11 1186.76  111.58 1188.26
GR111.58 1195.16  113.11 1195.76  113.11 1197.25   121.7 1197.55   121.7 1197.56
GR 121.7 1199.15   116.8 1199.35   118.8 1206.15     122 1207.75     118 1207.76
GR 119.3    1276   119.3    1360   119.3    1385   119.3    1401   119.3    1405
GR 119.3    1417   119.3    1427     121  1427.1
NC                           0.1     0.3
X1 5.945      13 1176.25 1207.76       5       5       5
GR   124    1000     117    1150     114 1176.25  113.11 1186.76  111.59 1188.26
GR111.59 1195.16  113.11 1195.76  113.11 1197.25   116.8 1199.35     118 1207.76
GR 119.3    1276   119.3    1427     121  1427.1
X1 5.946      13 1186.76 1197.25       1       1       1
GR   124    1000     117    1150     114 1176.25  113.11 1186.76  112.12 1188.26
GR112.12 1195.16  113.11 1195.76  113.11 1197.25   116.8 1199.35     118 1207.76
GR 119.3    1276   119.3    1427     121  1427.1
X1  5.98      24   38.02    46.5   26.01   89.23   48.12
GR   121       0     120    3.16     119    4.98     118     8.1     117   14.42
GR   116   17.74     115   21.53     114   25.49  113.14   38.02  112.34   38.03
GR112.34   41.55  112.34    46.4   114.7    46.5     115   50.11     116   60.38
GR   117   67.84   117.1   69.59     121   69.59     121  135.94   117.1  135.94
GR   117  144.62     118  176.93   118.1  179.12     122  179.12
X1  6.04      24  203.47   212.1   48.35   32.59   41.41
GR   119       0     119    9.52     119   18.56     118  110.22     117  152.42
GR   116  185.57     115  192.24     114  196.58  113.47  203.47  112.47  203.47
GR112.47     212   114.9   212.1  115.18  217.83  115.18  223.03     116   226.6
GR   117  235.29   117.1  239.95     121  239.95     121  294.08   117.1  294.08
GR   117  300.91     118   332.8   118.2  337.73     121  337.73
NC                           0.3     0.5
X1  6.08      26  348.13  356.71   55.39   67.83    51.4
GR   119     100     118  154.93   117.1  297.55     122  297.56     122  313.02
GR 117.1  313.03     116  328.15     115  343.08   114.2  348.13  113.13   348.2
GR113.13  351.09  113.13   356.7  114.53  356.71  114.53  358.58  114.75  366.37
GR   115  368.26     116   372.3     117  375.53     117  392.88   117.1  393.45
GR   121  393.45     121   404.5   117.1   404.5     117  407.45     118  441.54
GR   119  504.93
NC                 0.015
X1 6.154      39 1167.88 1188.71  100.46   42.32    75.7
X3    10                                                   116.6   116.6
GR   121    1000     120    1000   118.2    1049   118.2  1049.1   118.1    1056
GR 118.1  1056.1   118.7    1081   118.7  1081.1   118.6    1086   118.6  1086.1
GR 118.4    1096   118.4  1096.1   118.2    1104   118.2  1104.1     118    1116
GR   118  1116.1   117.2    1132   117.3    1148   117.3  1148.1     117    1158
GR   117    1158     117  1158.1     115    1165  114.46 1167.88  114.46 1167.89
GR113.96  1171.9  113.96  1174.3  113.05  1175.5  113.05  1178.3  113.05    1181
GR113.96    1182  113.96  1186.3  114.46 1188.71  114.46 1188.71     115  1195.8
```

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GR 117.8  1228.4   118.5    1236     120  1236.1     120    1276
SB  1.25    1.63     1.5       0     6.5       0      39     1.5  113.27  113.05
X1 6.178      39 1167.88 1188.71      24      24      24
X2                     1  116.49  117.45
X3    10                                                  117.45  117.61
BT   -38    1000     121     121    1000     121     120    1049     121   118.2
BT        1049.1   118.2   118.2    1056   118.1   118.1  1056.1     121   118.1
BT          1081     121   118.7  1081.1   118.7   118.7    1086   118.6   118.6
BT        1086.1     121   118.6    1096     121   118.4  1096.1   118.4   118.4
BT          1104   118.2   118.2  1104.1     120   118.2    1116     120     118
BT        1116.1     118     118    1132  117.45   117.2    1148  117.45   117.3
BT        1148.1     120   117.3    1158     120     117    1158     120     117
BT        1158.1  117.53     117    1165  117.56     115 1167.88  117.61  114.68
BT       1167.89   118.2  115.59  1171.9   118.2  115.94  1174.3   118.2  116.14
BT        1175.5   118.2  116.25  1178.3   118.2  116.49    1181   118.2  116.25
BT          1182   118.2  116.17  1186.3   118.2   115.8 1188.71   118.2  115.59
BT       1188.71  117.61  114.68  1195.8  117.67     115  1228.4   117.8   117.8
BT          1236     119     119  1236.1     120     120    1276     120     120
GR   121    1000     120    1000   118.2    1049   118.2  1049.1   118.1    1056
GR 118.1  1056.1   118.7    1081   118.7  1081.1   118.6    1086   118.6  1086.1
GR 118.4    1096   118.4  1096.1   118.2    1104   118.2  1104.1     118    1116
GR   118  1116.1   117.2    1132   117.3    1148   117.3  1148.1     117    1158
GR   117    1158     117  1158.1     115    1165  114.68 1167.88  114.68 1167.89
GR114.18  1171.9  114.18  1174.3  113.27  1175.5  113.27  1178.3  113.27    1181
GR114.18    1182  114.18  1186.3  114.68 1188.71  114.68 1188.71     115  1195.8
GR 117.8  1228.4     119    1236     120  1236.1     120    1276
NC                  0.02
X1  6.28      21  262.06   268.7   97.01   117.9  103.91
GR   120     100     119  106.28     118  112.95     117  123.54   116.8  142.88
GR   121  142.89     121  166.64   116.8  166.64     116  251.67     115  258.81
GR114.55  262.06  113.55  263.56   113.4   265.4  113.55   267.2  114.55   268.7
GR   115  269.37     116  275.11     117  285.66     118  292.94     119  310.11
GR   122  310.12
NC                           0.1     0.3
X1  6.36      18   249.4     256   90.81   75.54   73.07
GR   121     100     120  111.46     119   123.4     118  172.65     117  211.34
GR   116  242.83     115  248.19  114.75   249.4  113.75   250.9   113.6   252.7
GR113.75   254.5  114.75     256     115  257.53     116  261.96     117  275.82
GR   118   282.6   118.9  295.33     122  295.33
X1  6.44      15   228.9   235.1   57.45   84.33   83.95
GR   120     100     119  146.57     118  189.06     117  220.43     116  225.71
GR115.15   228.9  114.15   230.4     114   232.2  114.15     234  115.15   235.1
GR   116  240.82     117  266.97     118   276.9   118.8  287.79     122  287.79
X1 6.529      17   138.4     145  126.78   76.29   93.63
GR   124     100   120.1     100     120  103.44     119  116.45     118     122
GR   117   132.2     116  136.69  115.55   138.4  114.55   139.9   114.4   141.7
GR114.55   143.5  115.55     145     116  148.35     117  149.55     118  179.81
GR 118.8  194.34     122  194.35
X1  6.53      15   138.4     145       1       1       1
GR   124     100   120.1     100     120  103.44     119  116.45     118     122
GR   117   132.2  116.35   138.4  115.35   139.9   115.2   141.7  115.35   143.5
GR116.35     145     117  149.55     118  179.81   118.8  194.34     122  194.35
X1  6.57      13  122.86  133.54   28.45   32.23   33.78
GR   123     100   119.1   100.1     119  120.23  118.45  122.86  117.23  122.86
GR 115.4  126.53   115.4  129.88  117.23  133.53  118.45  133.54     119  174.39
GR   119  185.98     119   247.7     120  299.71
X1   6.6      16   142.9   149.5   26.71   34.91   30.75
GR   121     100     120  120.43     119  128.93     118  137.88     117  141.22
GR116.65   142.9  115.65   144.4   115.5   146.2  115.65     148  116.65   149.5
GR   117  149.79     118  154.74     119  166.08     119  173.38   119.1   183.1
GR   122   183.1
X1 6.675      17  150.31  162.49   70.44   70.46   70.14
GR   121     100     121  116.24     121  132.83     120  139.87     119  143.41
GR 118.6  147.31   118.6  150.31   115.8  153.35   115.8  159.45   118.6  162.49
GR 118.6  162.49     119  163.93     120  167.73     121  177.15     122   203.4
GR 122.1  207.01     125  207.02
X1 6.676      17  118.31  130.49       1       1       1
GR   124     100     123  103.58     122  106.16     121   108.7     120  110.74
GR   119  112.66   118.6  115.31   118.6  118.31   116.7  121.35   116.7  127.45
GR 118.6  130.49   118.6  130.49     119   132.4     120  134.22     121  136.62
GR   122  138.98     123  141.55
NC                 0.015
QT     2     240     195
X1  6.69      22 1086.24 1113.56      15      15      15
X3    10                                                  124.09  122.04
GR125.51    1000     126  1000.1     126    1069   120.1  1069.1     119    1085
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GR   119 1086.23  122.26 1086.24   118.6 1092.31   118.6 1095.31  116.77 1098.35
GR116.77 1104.45   118.6 1107.49   118.6 1107.49  122.26 1113.56     120 1113.57
GR   120    1126   120.2    1138     124  1138.1     124    1270  122.04  1270.1
GR122.21  1307.3  124.79    1427
SB  1.25    1.56     1.5       0     8.3       0    92.3     1.7  116.88  116.77
X1 6.714      22 1086.24 1113.56      24      24      24
X2                     1  122.37  122.04
X3    10                                                  124.09  122.04
BT   -22    1000  125.51  125.51  1000.1     126     126    1069     126     126
BT        1069.1  124.53   120.1    1085   124.3     119 1086.23  124.09     119
BT       1086.24  124.79  122.37 1092.31  124.79  122.37 1095.31  124.79  122.37
BT       1098.35  124.79  122.37 1104.45  124.79  122.37 1107.49  124.79  122.37
BT       1107.49  124.79  122.37 1113.56  124.79  122.37 1113.57  124.09     120
BT          1126  123.72     120    1138  123.55   120.2  1138.1     124     124
BT          1270     124     124  1270.1  122.04  122.04  1307.3  122.21  122.21
BT          1427  124.79  124.79
GR125.51    1000     126  1000.1     126    1069   120.1  1069.1     119    1085
GR   119 1086.23  122.37 1086.24  118.71 1092.31  118.71 1095.31  116.88 1098.35
GR116.88 1104.45  118.71 1107.49  118.71 1107.49  122.37 1113.56     120 1113.57
GR   120    1126   120.2    1138     124  1138.1     124    1270  122.04  1270.1
GR122.21  1307.3  124.79    1427
NC                 0.025
X1 6.859      24   211.1   217.8  159.64   106.3  137.15
GR   126     100     125  110.66     124  120.28     123  125.82     122  138.71
GR   121  144.05     120     161     120  165.33     120  178.83  119.55   211.1
GR118.14  211.19  118.14  213.05  118.14  215.98  118.14  217.66  119.22   217.8
GR   120  220.87     120  226.18     120  233.53     120  243.43     120  259.43
GR   121  359.69     122  383.52     123   391.4     124  403.84
NC  0.08                     0.1     0.3
X1  6.86      24   211.1   217.8     0.1     0.1     0.1
GR   126     100     125  110.66     124  120.28     123  125.82     122  138.71
GR   121  144.05     120     161     120  165.33     120  178.83  119.55   211.1
GR118.44  211.19  118.44  213.05  118.44  215.98  118.44  217.66  119.52   217.8
GR   120  220.87     120  226.18     120  233.53     120  243.43     120  259.43
GR   121  359.69     122  383.52     123   391.4     124  403.84
X1  6.88      21   229.1   235.8   26.87    66.9   42.72
GR   126     100     125  113.26     124  122.67     123  128.77     122   145.2
GR   121   154.8   120.5  165.42     120  182.53     120  188.89     120  225.92
GR119.95   229.1  118.94  229.19  118.94  231.05  118.94  233.98  118.94  235.66
GR120.02   235.8     121  265.87     122  276.11     123     286   123.9  317.38
GR   124  341.58
X1     7      19   200.1   206.9   93.99  117.35   99.01
GR   127     100     126  101.15     125  103.31     124   108.5     123  110.26
GR   122  114.47   121.5  129.85     121  190.89  120.93   200.1  120.58  200.21
GR120.58  202.38  120.58  204.77  120.58  206.81  121.18   206.9     122   209.3
GR   123  210.44     124  211.99     125  213.73     126  217.16
NC 0.055
X1  7.08      24     202   208.2   75.62   76.19   82.06
GR   128     100     127  102.83     126  105.47     125  109.98     124  116.47
GR   123  122.48     122  143.38     122  150.84     122  190.58  122.12     202
GR120.84   202.1  120.84  204.79  120.84  206.69  122.03   208.2     122  211.43
GR   123  213.27     124  214.69     125  216.69     126  218.41     127  219.79
GR   126  222.22     128  226.61   127.5  229.99   127.5  233.64
X1  7.16      23  212.85  218.87   67.26   77.04   76.78
GR   130     100     129  101.58     128  103.78     127  106.72     126  109.12
GR   125  118.19     124  135.97     123  187.87  123.03  212.85  121.84  212.86
GR121.84  213.81  121.54  213.81  121.54     218  121.84     218  121.84  218.86
GR122.81  218.87     123   219.7     124  222.92     125  224.49     126  225.91
GR   127   228.4     128  230.11     129  231.38
X1 7.199      27  214.85  220.87   26.06   36.44   34.93
GR   131     100     130  103.52     129  105.76     128  111.51     127  114.37
GR   126  116.67     125  122.11     124  179.23     124  196.93     123  213.46
GR123.03  214.85  122.07  214.85  122.07  215.81  121.77  215.81  121.77     220
GR122.07     220  122.07  220.86  122.81  220.87     123  221.79     124  223.38
GR   125  224.48     126  225.71     127  227.11     128  228.61     129  231.24
GR   130  235.71     130  250.89
X1   7.2      26  214.85  221.79       1       1       1
GR   131     100     130  103.52     129  105.76     128  111.51     127  114.37
GR   126  116.67     125  122.11     124  179.23     124  196.93  123.03  214.85
GR122.97  214.85  122.97  215.81  122.67  215.81  122.67     220  122.97     220
GR122.97  220.86  122.97  220.87     123  221.79     124  223.38     125  224.48
GR   126  225.71     127  227.11     128  228.61     129  231.24     130  235.71
GR   130  250.89
X1  7.24      15   225.6   231.6   28.41   41.42   33.13
GR   128     100     127  108.69     126  124.33     125  142.22     124  223.11
GR123.91   225.6   122.9  225.68   122.9  227.29   122.9   231.6   124.4   231.6
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GR   125  239.34     126  240.84     127   250.8     128   256.6     129  262.41
NC                           0.3     0.5
QT     2     220     180
X1  7.26      16 1114.79 1145.21   36.46   16.55   27.43
X3    10                                                  129.81  129.81
GR131.02    1000     126    1055  125.98 1114.79  125.98 1114.79  124.76  1121.2
GR124.76  1125.2  123.85  1125.2  123.85 1139.39  124.76 1139.39  124.76 1139.41
GR125.98 1145.21  125.98 1145.21     126    1180   130.5    1195     133  1195.1
GR   133    1285
NC                 0.015
X17.2601      16 1114.79 1145.21     0.1     0.1     0.1
X3    10                                                  129.81  129.81
BT   -15    1000  131.02  131.02    1055   130.5     126 1114.79  129.81  125.98
BT       1114.79  130.41  127.81  1121.2  130.41  127.81  1125.2  130.41  127.81
BT        1125.2  130.41  127.81 1139.39  130.41  127.81 1139.39  130.41  127.81
BT       1139.41  130.41  127.81 1145.21  130.41  127.81 1145.21  129.81  125.98
BT          1180  129.81     126    1195   130.5   130.5  1195.1     133     133
BT          1285     133     133
GR131.02    1000     126    1055  125.98 1114.79  125.98 1114.79  124.76  1121.2
GR124.76  1125.2  123.85  1125.2  123.85 1139.39  124.76 1139.39  124.76 1139.41
GR125.98 1145.21  125.98 1145.21     126    1180   130.5    1195     133  1195.1
GR   133    1285
X1 7.284      16 1114.79 1145.21      24      24      24
X3    10                                                  129.81  129.81
BT   -15    1000  131.02  131.02    1055   130.5   126.2 1114.79  129.81   126.2
BT       1114.79  130.41  128.03  1121.2  130.41  128.03  1125.2  130.41  128.03
BT        1125.2  130.41  128.03 1139.39  130.41  128.03 1139.39  130.41  128.03
BT       1139.41  130.41  128.03 1145.21  130.41  128.03 1145.21  129.81   126.2
BT          1180  129.81   126.2    1195   130.5   130.5  1195.1     133     133
BT          1285     133     133
GR131.02    1000   126.2    1055   126.2 1114.79   126.2 1114.79  124.98  1121.2
GR124.98  1125.2  124.07  1125.2  124.07 1139.39  124.98 1139.39  124.98 1139.41
GR 126.2 1145.21   126.2 1145.21   126.2    1180   130.5    1195     133  1195.1
GR   133    1285
NC                 0.025
X17.2841      16 1114.79 1145.21     0.1     0.1     0.1
X3    10                                                  129.81  129.81
GR131.02    1000   126.2    1055   126.2 1114.79   126.2 1114.79  124.98  1121.2
GR124.98  1125.2  124.07  1125.2  124.07 1139.39  124.98 1139.39  124.98 1139.41
GR 126.2 1145.21   126.2 1145.21   126.2    1180   130.5    1195     133  1195.1
GR   133    1285
NC                 0.025
QT     2     145     115
X1 7.288      11   140.3     152       2       6       4
GR   130     100     129     128   127.2     135   125.5   135.3   125.5   137.3
GR 125.4   140.3   124.2   140.5     124   145.5   124.4   150.5     125     152
GR   130     168
X1  7.31      12   128.3   138.7      22      22      22
GR   130     100     129     112   127.3     123   125.6   123.3   125.6   125.3
GR 125.5   128.3   124.3   128.5   124.1   133.5   124.3   138.5   125.5   138.7
GR 125.5   142.7     130     152
X1 7.313      13   128.3   138.7       3       3       3
GR   130     100     129     102     128     110   127.3     123   125.7   123.3
GR 125.7   125.3   125.5   128.3   124.2   128.5   123.1   130.5   123.1   134.5
GR 124.3   138.5   125.5   138.7     130     152
X1  7.32      12     138     151       7       7       7
GR   129     100     128     105   127.3     132   125.8   132.3   125.8   134.3
GR 125.8     138   124.2   139.5   123.1   141.5   123.1   145.5   124.2   149.5
GR 125.8     151     130     163
X1 7.323      10     164     178       4       3       3
GR   130     129   127.3     137   127.3     159   125.9   159.2   125.9   161.2
GR 125.8     164   124.4     167   124.4     177   125.8     178     130     190
X1 7.324      10     164     178       1       1       1
GR   130     129   127.3     137   127.3     159   125.9   159.2   125.9   161.2
GR 125.8     164   124.4     167   124.4     177   125.8     178     130     190
X17.3241      10     164     178     0.1     0.1     0.1
GR   130     129   127.3     137   127.3     159   125.9   159.2   125.9   161.2
GR 125.8     164   124.1     167   124.1     177   125.8     178     130     190
X1 7.327      10     164     178     2.4     2.4     2.4
GR   130     129   127.3     137   127.3     159   125.9   159.2   125.9   161.2
GR 125.8     164   124.1     167   124.1     177   125.8     178     130     190
X17.3271       8     164     178     0.1     0.1     0.1
GR   130     129   127.3     137   127.3     159     126     164   124.5     167
GR 124.5     177     126     178     130     190
X1 7.329       8     164     178     2.4     2.4     2.4
GR   130     129   127.3     137   127.3     159     126     164   124.5     167
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GR 124.5     177     126     178     130     190
X17.3291      10     164     177     0.1     0.1     0.1
GR133.33     100  126.09  129.34   127.3     159     126     164   124.7   166.5
GR 124.7   176.5     126     177     127     181     128     186     130     190
X1  7.33      10     164     177     0.9     0.9     0.9
GR133.33     100  126.09  129.34   127.3     159     126     164   124.7   166.5
GR 124.7   176.5     126     177     127     181     128     186     130     190
X17.3301      22     164     179     0.1     0.1     0.1
GR   130     129   127.3     137   127.3     159     126     164   125.3     165
GR 125.3     166   124.9     166   124.9     167   125.3     167   125.3     169
GR 124.9     169   124.9     170   125.3     170   125.3     172   124.9     172
GR 124.9     173   125.3     173   125.3     175   125.3     179     127     181
GR   128     186     130     190
X1 7.331      22     164     179     0.9     0.9     0.9
GR   130     129   127.3     137   127.3     159     126     164   125.3     165
GR 125.3     166   124.9     166   124.9     167   125.3     167   125.3     169
GR 124.9     169   124.9     170   125.3     170   125.3     172   124.9     172
GR 124.9     173   125.3     173   125.3     175   125.3     179     127     181
GR   128     186     130     190
X17.3311      11     164     176     0.1     0.1     0.1
GR   130     122   126.2     133   126.2     154   126.2     164   125.1     166
GR   125     175   125.2     176   125.9     176     127     180     128     185
GR   130     189
X1 7.336      11     164     176       6       4       5
GR   130     122   126.2     133   126.2     154   126.2     164   125.1     166
GR   125     175   125.2     176   125.9     176     127     180     128     185
GR   130     189
NC                           0.1     0.3
X1 7.357      18     158     170      21      21      21
GR   131     100     130  103.87     129  109.63     128  113.34     127  115.39
GR126.01  125.46  126.01  128.88  126.01   157.6   126.1     158   125.1     160
GR 125.1     168   125.4     170   126.7     170     127   179.8     128  188.64
GR   129  192.33     130  196.02     131  200.12
NC  0.08    0.08
X1 7.386      17     155   168.2   25.95   31.43   28.61
GR   131     100     130  105.75     129  111.84     128  115.63  127.01  121.99
GR 126.7     155   125.1     158   125.1     166   125.4     168   127.7   168.2
GR   128  169.96     129  171.45     130  172.32     130  178.12     129  184.29
GR   129  195.79     130  202.18
NC                           0.3     0.5
X1 7.397      11     155   168.2      10      12      11
GR   131     102     130     107     127     112   126.7     118   126.7     155
GR 125.1     158   125.1     166   125.4     168   127.7   168.2     129     171
GR   130     173
X1   7.4      13     155   168.5       3       3       3
GR   133     100     132     102     131     103     130     109     127     116
GR 126.7     125   126.7     155   125.1     158   124.1     160   124.1     164
GR 125.1     168   126.7   168.5     131     176
X1 7.407      13     155   168.5       7       7       7
GR   133     100     132     102     131     103     130     109     127     116
GR 126.7     125   126.7     155   125.1     158   124.1     160   124.1     164
GR 125.1     168   126.7   168.5     131     176
X1  7.41      10     151   163.5       3       3       3
GR   133     100     131     103     130     109     127     117   126.8     151
GR 125.3     153   125.3     163   126.8   163.5   127.5     169     132     176
X1 7.411      10     150   163.5       1       1       1
GR   133     100     131     103     130     109     127     117   126.8     150
GR 125.1     153   125.1     163   126.8   163.5   127.5     169     132     176
X1 7.413      10     150   163.5     2.4     2.4     2.4
GR   133     100     131     103     130     109     127     117   126.8     150
GR 125.1     153   125.1     163   126.8   163.5   127.5     169     132     176
X17.4141      10     150   163.5     0.1     0.1     0.1
GR   133     100     131     103     130     109     127     117   126.9     150
GR 125.6     153   125.6     163   126.9   163.5   127.5     169     132     178
X1 7.415      10     150   163.5     2.4     2.4     2.4
GR   133     100     131     103     130     109     127     117   126.9     150
GR 125.6     153   125.6     163   126.9   163.5   127.5     169     132     178
X17.4151      10     150   163.5     0.1     0.1     0.1
GR   133     100     131     103     130     109     127     117     127     150
GR 126.1     153   126.1     163     127   163.5   127.5     169     132     178
X1 7.416      10     150   163.5     0.9     0.9     0.9
GR   133     100     131     103     130     109     127     117     127     150
GR 126.1     153   126.1     163     127   163.5   127.5     169     132     178
X17.4161      22     153   164.2     0.1     0.1     0.1
GR   133     100     131     103     130     109     127     117     127     153
GR 126.5     154   126.5     155   126.1     155   126.1     156   126.5     156
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GR 126.5     158   126.1     158   126.1     159   126.5     159   126.5     161
GR 126.1     161   126.1     162   126.5     162   126.5     164     127   164.2
GR 127.5     171     132     180
X1 7.417      22     153   164.2     0.9     0.9     0.9
GR   133     100     131     103     130     109     127     117     127     153
GR 126.5     154   126.5     155   126.1     155   126.1     156   126.5     156
GR 126.5     158   126.1     158   126.1     159   126.5     159   126.5     161
GR 126.1     161   126.1     162   126.5     162   126.5     164     127   164.2
GR 127.5     171     132     180
X17.4171      10     153   164.2     0.1     0.1     0.1
GR   134     100     127     117     127     153   126.1     154   126.1     164
GR   127   164.2   127.5     170     129     174     130     178     132     180
NC                           0.1     0.3
X1  7.46      17     150     164      43      43      43
GR   134     100  133.08  104.48  132.02  106.91  131.02   108.9  130.01  110.35
GR129.02  112.37  128.07  149.52   127.5     150   126.5     153   126.5     164
GR   128     164     128   164.3     129  168.54  130.01  171.43     131  173.24
GR   132  174.63     133  176.24
X1 7.518      20     118   129.2   32.94   59.44   60.37
GR135.01     100     134  102.99  133.08   108.6  132.02  111.57  131.02  113.02
GR130.01  113.92     129     118  127.55   118.2   127.6   123.2     128   128.2
GR 128.5   129.2  129.03   132.6  129.03  148.17  129.03  153.03  130.01  160.94
GR   131  166.38     132  170.24     133     172     134  173.27  135.01  175.55
X1 7.545       9     130     144      35      20      28
GR   133     100     130     111     130     113   130.3     130     128     130
GR   128     138     129     144     130     166     133     179
X17.5451       9     130     144     0.1     0.1     0.1
GR   133     100     130     111     130     113   130.3     130   128.3     130
GR 128.3     138   129.3     144     130     166     133     179
X1 7.546       9     130     144     0.9     0.9     0.9
GR   133     100     130     111     130     113   130.3     130   128.3     130
GR 128.3     138   129.3     144     130     166     133     179
X17.5461       9     130     144     0.1     0.1     0.1
GR   133     100     130     111     130     113   130.3     130     128     130
GR   128     138     129     144     130     166     133     179
X1 7.569      10     132   145.3      25      23      24
GR   134     100     131     107   130.5     112   130.4     132   128.2   132.3
GR 128.2   142.3   129.2   145.3     130     169     131     181     135     190
X1 7.614      19  133.58   148.7      45      45      45
GR   137     100     136  101.85     135  105.32     134  106.77  133.02   108.2
GR132.02  110.31  131.02  115.72  131.02  123.25  131.02  133.58   130.9     134
GR 128.8   134.2   128.8   144.2   129.5   148.5   131.5   148.7     132   151.4
GR133.08  153.58     134  155.69  135.04  158.35  136.05  160.99
NC                           0.3     0.5
X1 7.631      17 1053.38 1064.62      20      14      17
X3    10                                                  136.21  136.21
GR137.68    1000     134    1024  130.39 1053.38  130.39 1053.38  130.39  1053.4
GR130.39 1054.89  129.33 1055.95  129.33 1062.05  130.39 1063.11  130.39  1064.6
GR130.39  1064.6  130.39 1064.62     133    1069     134    1085     137    1089
GR 138.1    1100     140  1100.1
NC                 0.015
X17.6311      17 1053.38 1064.62     0.1     0.1     0.1
X3    10                                                  136.21  136.21
BT   -16    1000  137.68  137.68    1024  136.76     134 1053.38  136.21  130.39
BT       1053.38  136.21  134.73  1053.4  136.21  134.73 1054.89  136.21  134.73
BT       1055.95  136.21  134.73 1062.05  136.21  134.73 1063.11  136.21  134.73
BT        1064.6  136.21  134.73  1064.6  136.21  134.73 1064.62  136.21  130.39
BT          1069  136.21     133    1085   136.8     134    1089     137     137
BT          1100   138.1   138.1  1100.1     140     140
GR137.68    1000     134    1024  130.39 1053.38  130.39 1053.38  130.39  1053.4
GR130.39 1054.89  129.33 1055.95  129.33 1062.05  130.39 1063.11  130.39  1064.6
GR130.39  1064.6  130.39 1064.62     133    1069     134    1085     137    1089
GR 138.1    1100     140  1100.1
X1 7.655      17 1053.38 1064.62      24      24      24
X3    10                                                  136.21  136.21
BT   -16    1000  137.68  137.68    1024  136.76     134 1053.38  136.21  130.95
BT       1053.38  136.21  135.28  1053.4  136.21  135.28 1054.89  136.21  135.28
BT       1055.95  136.21  135.28 1062.05  136.21  135.28 1063.11  136.21  135.28
BT        1064.6  136.21  135.28  1064.6  136.21  135.28 1064.62  136.21  130.95
BT          1069  136.21     133    1085   136.8     134    1089     137     137
BT          1100   138.1   138.1  1100.1     140     140
GR137.68    1000     134    1024  130.95 1053.38  130.95 1053.38  130.95  1053.4
GR130.95 1054.89  129.88 1055.95  129.88 1062.05  130.95 1063.11  130.95  1064.6
GR130.95  1064.6  130.95 1064.62     133    1069     134    1085     137    1089
GR 138.1    1100     140  1100.1
NC                 0.025
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X17.6551      17 1053.38 1064.62     0.1     0.1     0.1
X3    10                                                  136.21  136.21
GR137.68    1000     134    1024  130.95 1053.38  130.95 1053.38  130.95  1053.4
GR130.95 1054.89  129.88 1055.95  129.88 1062.05  130.95 1063.11  130.95  1064.6
GR130.95  1064.6  130.95 1064.62     133    1069     134    1085     137    1089
GR 138.1    1100     140  1100.1
NC  0.08    0.08   0.025
X1 7.679      11   103.7   116.5      17      30      24
GR   136     100   133.5     100   132.5   103.7   130.4     104   130.3     110
GR 130.4   116.2   132.5   116.5   132.5     123     133     125     134     132
GR   136     135
X1 7.719       9     108   118.5      40      40      40
GR   137     100     134     106     133     108   130.8   108.3   130.7   113.3
GR 130.8   118.3     133   118.5     134     137     137     142
X1 7.723       9     106   116.5       3       3       3
GR   138     100     133     106   130.8   106.2   129.8   108.2   129.8   112.2
GR 130.8   116.2     133   116.5     134     136     137     140
X1  7.73       9     106   116.5       7       7       7
GR   138     100     133     106   130.8   106.2   129.8   108.2   129.8   112.2
GR 130.8   116.2     133   116.5     134     136     137     140
X1 7.733       8     105   115.4       3       3       3
GR   138     100   133.5     105     131   105.2     131   115.2   133.5   115.4
GR   134     125     135     137     137     140
X1 7.734       8     105   115.4       1       1       1
GR   138     100   133.5     105   130.8   105.2   130.8   115.2   133.5   115.4
GR   134     125     135     137     137     140
X1  7.74      21   105.8   116.2       6       6       6
GR   138     100   134.1     104     134   105.8   132.2     106   132.2     107
GR 131.8     107   131.8     108   132.2     108   132.2     110   131.8     110
GR 131.8     111   132.2     111   132.2     113   131.8     113   131.8     114
GR 132.2     114   132.2     116     134   116.2   134.1     120     135     139
GR   138     143
X1 7.741      21   105.8   116.2       1       1       1
GR   138     100   134.1     104     134   105.8   132.2     106   132.2     107
GR 131.8     107   131.8     108   132.2     108   132.2     110   131.8     110
GR 131.8     111   132.2     111   132.2     113   131.8     113   131.8     114
GR 132.2     114   132.2     116     134   116.2   134.1     120     135     139
GR   138     143
X17.7411       9   105.8   116.2     0.1     0.1     0.1
GR   138     100   134.1     104     134   105.8   131.8     106   131.8     116
GR   134   116.2   134.1     120     135     139     138     143
NC                           0.1     0.3
X1 7.753      15     108   118.4  0.0119  0.0119  0.0119
GR   141     100     140   101.9     139  103.02     138  103.85     137  104.92
GR   136  106.19     135  107.23     134     108   131.9   108.2   131.9   118.2
GR   134   118.4     134  127.17     135  142.42     136  143.31     137  145.48
X1 7.786      10   114.8   125.2      33      33      33
GR   139     100     136     106     135     113   134.3   114.8   132.1     115
GR 132.1     125   134.3   125.2     135     131     136     144     139     150
NC                           0.3     0.5
X1 7.799      10     123   133.5      15      10      13
GR   140     100     136     107     135     122   134.4     123   132.3   123.2
GR 132.3   133.2   134.4   133.5     135     137     136     146     140     157
X1 7.802      12     124   134.5       3       3       3
GR   140     100     136     106     135     122   134.4     124   132.3   124.2
GR 131.3   126.2   131.3   130.2   132.3   134.2   134.4   134.5     135     139
GR   136     146     140     158
X1 7.809      12     125   135.5       7       7       7
GR   140     100     136     106     135     124   134.5     125   132.3   125.2
GR 131.3   127.2   131.3   131.2   132.3   135.2   134.5   135.5     135     138
GR   136     144     140     153
X1 7.812      10     126   136.5       3       3       3
GR   140     100     136     108     135     125     135     126   132.6   126.2
GR 132.6   136.2     135   136.5     135     138     136     143     140     151
X1 7.813      10     126   136.5       1       1       1
GR   140     100     136     108     135     125     135     126   132.3   126.2
GR 132.3   136.2     135   136.5     135     138     136     143     140     151
X1  7.82      21     129   139.5       8       6       7
GR   140     100     137     105     136     122     135     129   133.8   129.2
GR 133.8   130.2   133.3   130.2   133.3   131.2   133.8   131.2   133.8   133.2
GR 133.3   133.2   133.3   134.2   133.8   134.2   133.8   136.2   133.3   136.2
GR 133.3   137.2   133.8   137.2   133.8   139.2     135   139.5     136     143
GR   140     150
X1 7.821      21     129   139.5       1       1       1
GR   140     100     137     105     136     122     135     129   133.8   129.2
GR 133.8   130.2   133.3   130.2   133.3   131.2   133.8   131.2   133.8   133.2
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GR 133.3   133.2   133.3   134.2   133.8   134.2   133.8   136.2   133.3   136.2
GR 133.3   137.2   133.8   137.2   133.8   139.2     135   139.5     136     143
GR   140     150
X17.8211       9     129   139.5     0.1     0.1     0.1
GR   140     100     137     105     136     122     135     129   133.3   129.2
GR 133.3   139.2     136   139.5     136     143     140     150
X1 7.826      18     135   145.5       6       6       6
GR   142     100     141   103.6     140  105.93     139  108.26     138  111.34
GR   137  113.85     136  129.37     135  133.42     135     135   133.4   135.2
GR 133.4   145.2     136   145.5     136  147.24     137  148.62     138  149.52
GR   139  151.67     140  153.18     141  154.69
X1 7.873       9     136     148      42      50      47
GR   141     100     138     107     137     123   136.3     136   133.8   136.3
GR 133.8   147.8   136.3     148     137     152     141     158
X1 7.876      11     135     147       3       3       3
GR   141     100     138     108     137     123   136.3     135   133.8   135.2
GR 132.8   137.2   132.8   142.7   133.8   146.7   136.3     147     137     151
GR   141     157
X1 7.883      11     132     144       7       7       7
GR   141     100     138     108     137     120   136.5     132   133.8   132.2
GR 132.8   134.2   132.8   139.7   133.8   143.7   136.5     144     137     150
GR   141     157
X1 7.886       9     130     142       3       3       3
GR   141     100     138     108     137     117   136.5 .   130   134.1   130.2
GR 134.1   141.7   136.5     142     137     149     141     155
X1 7.887       9     130     142       1       1       1
GR   141     100     138     108     137     117   136.5     130   133.8   130.2
GR 133.8   141.7   136.5     142     137     149     141     155
X1 7.893      21   128.5     141       6       6       6
GR   142     100     138     111     137     115     137   128.5   135.3     129
GR 135.3     131   134.9     131   134.9     132   135.3     132   135.3     134
GR 134.9     134   134.9     135   135.3     135   135.3     137   134.9     137
GR 134.9     138   135.3     138   135.3   140.5     137     141     137     144
GR   142     158
X1 7.894      21   128.5     141       1       1       1
GR   142     100     138     111     137     115     137   128.5   135.3     129
GR 135.3     131   134.9     131   134.9     132   135.3     132   135.3     134
GR 134.9     134   134.9     135   135.3     135   135.3     137   134.9     137
GR 134.9     138   135.3     138   135.3   140.5     137     141     137     144
GR   142     158
X17.8941       9   128.5     141     0.1     0.1     0.1
GR   142     100     138     111     137     115     137   128.5   134.9     129
GR 134.9   140.5     137     141     137     144     142     158
NC                           0.1     0.3
X1 7.911      16     119   131.5      18      15      17
GR   143     100     142  102.21     141  103.47     140  104.79     139  106.47
GR   138  108.58   137.2     119   135.4   119.2   135.4   131.2   137.2   131.5
GR   138   134.5     139  139.71     140  142.66     141  146.71     142  148.02
GR   143  149.87
X1  7.96      19  122.24  140.86   21.12    9.94   15.45
GR   144     100     143  102.84     142  107.16     141  114.71  139.24  115.22
GR138.91  122.24  136.62  122.25  136.62   125.3  135.87   126.3  135.87   136.8
GR136.62   137.8  136.62  140.86  138.91  140.86     140  147.07     141  149.45
GR   142  152.62     143  154.82     144  159.02     145  164.64
NC                 0.025
X1     8      18  122.11  129.92   29.95    30.5    29.7
GR   144     100     143  103.77     142   106.5     141  108.64     140  110.63
GR   139  119.12  137.86  122.11  136.12  122.12  136.12  129.62  137.52  129.92
GR 137.9     133     139  133.36     140  138.02     141  139.92     142  141.82
GR   143  144.16     144  149.58     145  154.25
NC                 0.025     0.3     0.5
X1 8.024      11    1025  1033.1      30      30      30
GR   145    1000     141    1013   140.2    1020   140.2    1025   137.5  1025.1
GR 137.5    1033   140.2  1033.1   140.2    1036     143    1042     143    1042
GR   145    1052
X18.0241      19    1025  1033.1     0.1     0.1     0.1
GR   145    1000     141    1013   140.2    1020   140.2    1025  138.05  1025.1
GR138.05  1028.4   137.5  1028.4   137.5  1028.8  138.05 1028.81  138.05  1029.2
GR 137.5 1029.21   137.5  1029.6  138.05  1029.6  138.05    1033   140.2  1033.1
GR 140.2    1036     143    1042     143    1042     145    1052
X18.0249      11    1025  1033.1    0.75    0.75    0.75
GR   145    1000     141    1013   140.2    1020   140.2    1025   137.5  1025.1
GR 137.5    1033   140.2  1033.1   140.2    1036     143    1042     143    1042
GR   145    1052
X1 8.036      11    1025  1033.1   11.15   11.15   11.15
GR   145    1000     141    1013   140.2    1020   140.2    1025   137.5  1025.1
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GR 137.5    1033   140.2  1033.1   140.2    1036     143    1042     143    1042
GR   145    1052
X18.0362      11    1025  1033.1     0.2     0.2     0.2
GR   145    1000     141    1013   140.2    1020   140.2    1025     139  1025.1
GR   139    1033   140.2  1033.1   140.2    1036     143    1042     143    1042
GR   145    1052
X18.0375      11    1025  1033.1     1.3     1.3     1.3
GR   145    1000     141    1013   140.2    1020   140.2    1025     139  1025.1
GR   139    1033   140.2  1033.1   140.2    1036     143    1042     143    1042
GR   145    1052
X18.0376      11    1025  1033.1     0.1     0.1     0.1
GR   145    1000     141    1013   140.2    1020   140.2    1025   137.5  1025.1
GR 137.5    1033   140.2  1033.1   140.2    1036     143    1042     143    1042
GR   145    1052
NC                           0.1     0.3
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GR   145     100     144  104.13     143  105.39     142  112.76     141  114.67
GR 140.1   117.6   140.1   117.6   137.8   117.9   137.8   124.4   140.1  124.71
GR 140.1  124.71     141  128.38     142  129.96     143  131.76     144  136.14
GR   145  144.77
X1  8.12      16     123   131.1   42.66   38.42   40.93
GR   147     100     146   103.8     145  108.65     144  111.88     143  114.62
GR   142  120.14   141.3     123     139   123.1     139     131   141.3   131.1
GR   142  134.35     143   136.3     144  140.47     145  142.08     146   149.5
GR   147  161.03
X1 8.169       9  138.93  145.13   38.68    42.2   40.31
GR   148     100     148  123.44     143  132.54     142  137.11  139.34  138.93
GR139.34  145.13     142  146.09     147  148.07     147  159.93
NC                 0.015
X1  8.17       9  138.93  145.13     0.1     0.1     0.1
GR   148     100     148  123.44     143  132.54     142  137.11   140.2  138.93
GR 140.2  145.13     142  146.09     147  148.07     147  159.93
NC                           0.3     0.5
X1 8.177      16 1119.02 1131.98       5       5       5
X3    10                                           147.7  147.57
GR149.29    1000   148.5    1037  148.13    1080     147    1110  142.12 1119.02
GR142.12 1119.07  142.12 1125.37  142.12 1125.42  140.31 1125.88  140.31 1125.93
GR140.31 1131.93  140.31 1131.98     146    1138   147.5    1145     152  1145.1
GR   152    1205
X18.1771      16 1119.02 1131.98     0.1     0.1     0.1
X3    10                                           147.7  147.57
BT   -15    1000  149.29  149.29    1037   148.5   148.5    1080  148.13  148.13
BT          1110  147.85     147 1119.02   147.7  142.12 1119.07   148.6  144.73
BT       1125.37   148.6  144.73 1125.42   148.6  142.12 1125.88   148.6  140.31
BT       1125.93   148.6  144.73 1131.93   148.6  144.73 1131.98   147.7  140.31
BT          1138  147.57     146    1145  147.63   147.5  1145.1     152     152
BT          1205     152     152
GR149.29    1000   148.5    1037  148.13    1080     147    1110  142.12 1119.02
GR142.12 1119.07  142.12 1125.37  142.12 1125.42  140.31 1125.88  140.31 1125.93
GR140.31 1131.93  140.31 1131.98     146    1138   147.5    1145     152  1145.1
GR   152    1205
X1 8.201      16 1119.02 1131.98      24      24      24
X3    10                                           147.7  147.57
BT   -15    1000  149.29  149.29    1037   148.5   148.5    1080  148.13  148.13
BT          1110  147.85     147 1119.02   147.7  142.61 1119.07   148.6  145.22
BT       1125.37   148.6  145.22 1125.42   148.6  142.61 1125.88   148.6   140.8
BT       1125.93   148.6  145.22 1131.93   148.6  145.22 1131.98   147.7   140.8
BT          1138  147.57     146    1145  147.63   147.5  1145.1     152     152
BT          1205     152     152
GR149.29    1000   148.5    1037  148.13    1080     147    1110  142.61 1119.02
GR142.61 1119.07  142.61 1125.37  142.61 1125.42   140.8 1125.88   140.8 1125.93
GR 140.8 1131.93   140.8 1131.98     146    1138   147.5    1145     152  1145.1
GR   152    1205
NC                 0.025
X18.2011      16 1119.02 1131.98     0.1     0.1     0.1
X3    10                                           147.7  147.57
GR149.29    1000   148.5    1037  148.13    1080     147    1110  142.61 1119.02
GR142.61 1119.07  142.61 1125.37  142.61 1125.42   140.8 1125.88   140.8 1125.93
GR 140.8 1131.93   140.8 1131.98     146    1138   147.5    1145     152  1145.1
GR   152    1205
NC  0.08    0.08                 0.1     0.3
X1  8.23      16   129.7   138.2      30      30      30
GR   148     100     147  114.24     146  120.96     145  125.75     144  127.57
GR 143.8   129.7   141.5     130   141.5     138   142.9   138.2     143     140
GR   144  142.04     145  144.84     146   146.3     147  154.97   147.5  163.93
GR   151  163.94
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X1  8.26      14   138.7   145.3      30      30      30
GR   148     100     147   118.6     146  129.67     145  133.17     145     134
GR 144.6   138.7   142.3     139   142.3     145   144.6   145.3     146     149
GR   146   150.5     147  153.75     148  164.81     149  170.13
NC                           0.3     0.5
X1 8.316      16   33.85   41.36      35      35      35
GR   153     4.8     153     4.9   150.9    4.98  147.52   13.11   146.6   22.99
GR 145.8   33.85   143.1   33.85   143.1   41.36   145.8   41.36  149.29   53.04
GR 149.8   60.07  150.24   79.18   150.4   90.98  151.37    97.7  152.12  105.41
GR 152.2  110.31
X18.3161      24   33.85   41.36     0.1     0.1     0.1
GR   153     4.8     153     4.9   150.9    4.98  147.52   13.11   146.6   22.99
GR 145.8   33.85  143.65   33.85  143.65      37   143.1      37   143.1    37.4
GR143.65    37.4  143.65    37.8   143.1    37.8   143.1    38.2  143.65    38.2
GR143.65   41.36   145.8   41.36  149.29   53.04   149.8   60.07  150.24   79.18
GR 150.4   90.98  151.37    97.7  152.12  105.41   152.2  110.31
X18.3169      16   33.85   41.36    0.75    0.75    0.75
GR   153     4.8     153     4.9   150.9    4.98  147.52   13.11   146.6   22.99
GR 145.8   33.85   143.1   33.85   143.1   41.36   145.8   41.36  149.29   53.04
GR 149.8   60.07  150.24   79.18   150.4   90.98  151.37    97.7  152.12  105.41
GR 152.2  110.31
X1 8.328      16   33.85   41.36   11.15   11.15   11.15
GR   153     4.8     153     4.9   150.9    4.98  147.52   13.11   146.6   22.99
GR 145.8   33.85   143.1   33.85   143.1   41.36   145.8   41.36  149.29   53.04
GR 149.8   60.07  150.24   79.18   150.4   90.98  151.37    97.7  152.12  105.41
GR 152.2  110.31
X18.3282      16   33.85   41.36     0.2     0.2     0.2
GR   153     4.8     153     4.9   150.9    4.98  147.52   13.11   146.6   22.99
GR 145.8   33.85   144.6   33.85   144.6   41.36   145.8   41.36  149.29   53.04
GR 149.8   60.07  150.24   79.18   150.4   90.98  151.37    97.7  152.12  105.41
GR 152.2  110.31
X18.3295      16   33.85   41.36     1.3     1.3     1.3
GR   153     4.8     153     4.9   150.9    4.98  147.52   13.11   146.6   22.99
GR 145.8   33.85   144.6   33.85   144.6   41.36   145.8   41.36  149.29   53.04
GR 149.8   60.07  150.24   79.18   150.4   90.98  151.37    97.7  152.12  105.41
GR 152.2  110.31
X1  8.33      15  135.85  143.36     0.1     0.1     0.1
GR   149     100     148  106.99     147  127.88     146  129.57   145.8  135.85
GR 143.1  135.85   143.1  143.36   145.8  143.36     146  146.11     147  147.29
GR   148  149.61     149  152.13     150  167.27     151  182.43     153  196.36
X1 8.368      13 1050.25 1061.45      40      40      40
GR   154    1000     153    1030     152    1038   147.6 1050.25   147.6 1051.25
GR 145.9 1051.45   145.9 1052.45   144.9 1052.45   144.9 1060.15   147.6 1060.45
GR 147.6 1061.45     149    1067     153    1117
X18.3681      21 1050.25 1061.45     0.1     0.1     0.1
GR   154    1000     153    1030     152    1038   147.6 1050.25   147.6 1051.25
GR 145.9 1051.45   145.9 1052.45  145.45 1052.45  145.45 1055.35   144.9 1055.36
GR 144.9 1055.75  145.45 1055.75  145.45 1056.15   144.9 1056.15   144.9 1056.55
GR145.45 1056.55  145.45 1060.15   147.6 1060.45   147.6 1061.45     149    1067
GR   153    1117
X18.3688      13 1050.25 1061.45    0.75    0.75    0.75
GR   154    1000     153    1030     152    1038   147.6 1050.25   147.6 1051.25
GR 145.9 1051.45   145.9 1052.45   144.9 1052.45   144.9 1060.15   147.6 1060.45
GR 147.6 1061.45     149    1067     153    1117
X1 8.379      13 1050.25 1061.45   11.15   11.15   11.15
GR   154    1000     153    1030     152    1038   147.6 1050.25   147.6 1051.25
GR 145.9 1051.45   145.9 1052.45   144.9 1052.45   144.9 1060.15   147.6 1060.45
GR 147.6 1061.45     149    1067     153    1117
X18.3792      13 1050.25 1061.45     0.2     0.2     0.2
GR   154    1000     153    1030     152    1038   147.6 1050.25   147.6 1051.25
GR 146.5 1051.45   146.5 1052.45   146.5 1052.45   146.5 1060.15   147.6 1060.45
GR 147.6 1061.45     149    1067     153    1117
X18.3795      13 1050.25 1061.45     1.3     1.3     1.3
GR   154    1000     153    1030     152    1038   147.6 1050.25   147.6 1051.25
GR 146.5 1051.45   146.5 1052.45   146.5 1052.45   146.5 1060.15   147.6 1060.45
GR 147.6 1061.45     149    1067     153    1117
X1  8.38      19  121.25  132.45     0.1     0.1     0.1
GR   152     100     151  101.84     150   105.1     149  112.93     148  117.16
GR 147.6  121.25   147.6  122.25   145.9  122.45   145.9  123.45   144.9  123.45
GR 144.9  131.15   147.6  131.45   147.6  132.45     148   139.3     149  152.35
GR   150  160.43     151  173.81     153   183.1     153  204.92
NC                           0.3     0.5
X1  8.43      15     115     128      50      50      50
GR   153     100     152  101.76     151   103.3     150  106.15     149  112.31
GR   149     114   147.9     115     147   115.1     147     126     149     128
GR   149   135.9     150   144.8     151  150.37     153  154.24     153  173.64
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NC 0.055   0.055   0.015
X1 8.456      15    1000  1012.5      25      25      25
X3    10                                                  153.22   152.7
GR154.71  930.25     153  982.25  148.46    1000  148.46 1000.05  148.46 1005.45
GR148.46  1005.5  148.59    1007  148.59 1007.05  148.59 1012.45  148.59  1012.5
GR153.33 1030.25  153.52 1060.25  153.91 1100.25  154.18 1130.25     155 1150.25
SB  1.25    1.58     1.5       0    11.6     0.6    30.1       0  148.95  148.46
X1 8.473      15    1000  1012.5      17      17      17
X2                       1  151.65   152.7
X3    10                                                  153.22   152.7
BT   -14  930.25  154.71  154.71  982.25  153.37     153    1000  153.22  149.03
BT       1000.05  153.22  151.73 1005.45  153.22  151.73  1005.5  153.22  149.03
BT          1007  153.22  148.95 1007.05  153.22  151.65 1012.45   152.7  151.65
BT        1012.5   152.7  148.95 1030.25  153.33  153.33 1060.25  153.52  153.52
BT       1100.25  153.91  153.91 1130.25  154.18  154.18 1150.25     155     155
GR154.71  930.25     153  982.25  149.03    1000  149.03 1000.05  149.03 1005.45
GR149.03  1005.5  148.95    1007  148.95 1007.05  148.95 1012.45  148.95  1012.5
GR153.33 1030.25  153.52 1060.25  153.91 1100.25  154.18 1130.25     155 1150.25
NC                 0.025
X1  8.52      16     155  166.73   54.85   28.43    40.8
GR   156     100     155  148.48     154  150.03     153   151.5     152  152.96
GR151.71  153.03   151.4     155  150.01   155.1  150.01   156.1  149.36   156.2
GR149.36   163.7  151.85  166.73     153  172.84     153  199.18     153  200.43
GR   154  206.32
NC                           0.1     0.3
X1 8.549      17     150   161.6   32.69    19.6   28.14
GR   156     100     155   129.4     154  133.63     153  136.56     152  144.92
GR151.71  148.03   151.4     150  149.46  150.05  149.46  155.45  149.46   155.5
GR149.46   156.1  149.46  156.15  149.46   161.6  151.85  166.78     154  173.12
GR   154  177.57     154  186.44
NC                 0.015     0.3     0.5
X1  8.55      17     150  166.78       1       1       1
GR   156     100     155   129.4     154  133.63     153  136.56     152  144.92
GR151.71  148.03   151.4     150     150  150.05     150  155.45     150   155.5
GR   150   156.1     150  156.15     150   161.6  151.85  166.78     154  173.12
GR   154  177.57     154  186.44
NC                 0.015
QT     2     145     115
X1 8.555      13    1000  1011.6       4       4       4
X3    10                                                  156.02  157.72
GR158.29   870.8  156.28   933.8  156.02   952.8  157.28   997.8  150.02    1000
GR150.02 1000.05  150.02 1005.45  150.02  1005.5  150.02  1006.1  150.02 1006.15
GR150.02 1011.55  150.02  1011.6  158.33  1016.8
SB  1.25    2.44     1.5       0    11.6     0.6    30.1       0  150.73  150.02
X1 8.745      13    1000  1011.6     190     190     190
X2                       1  153.47  156.02
X3    10                                                  156.02  157.72
BT   -12   870.8  158.29  158.29   933.8  156.28  156.28   952.8  156.02  156.02
BT         997.8  157.28  157.28    1000  157.72  150.77 1000.05  157.72  153.47
BT       1005.45  157.72  153.47  1005.5  157.72  150.77  1006.1  157.72  150.73
BT       1006.15  157.72  153.43 1011.55  157.72  153.43  1011.6  157.72  150.73
BT        1016.8  158.33  158.33
GR158.29   870.8  156.28   933.8  156.02   952.8  157.28   997.8  150.77    1000
GR150.77 1000.05  150.77 1005.45  150.77  1005.5  150.73  1006.1  150.73 1006.15
GR150.73 1011.55  150.73  1011.6  158.33  1016.8
X1  8.76      12  108.75  117.25      15      13      15
GR   157     100     157  104.86     156  105.84     155  107.31   154.4  108.75
GR 152.7  110.75   152.7  115.25   154.4  117.25     155  120.12     156  127.92
GR   157  137.43     158  147.67
NC                  0.03     0.1     0.3
X1 8.839      11   121.2   128.5   78.89    75.1    74.1
GR   158     100     158     116   155.2   121.2   153.7     122   153.7     128
GR 154.2   128.5     157     132     158  133.78     159  137.43   159.5  142.17
GR 159.5  143.89
NC                  0.03     0.1     0.3
X1  8.84      11   121.2   128.5       1       1       1
GR   158     100     158     116   155.2   121.2     154     122     154     128
GR 154.5   128.5     157     132     158  133.78     159  137.43   159.5  142.17
GR 159.5  143.89
NC                  0.03     0.3     0.5
X1  8.92      13   126.5   134.5   84.28    67.5   74.35
GR   159     100     159  122.21     158  123.92     157  125.11   155.7   126.5
GR 154.5     127   154.5     134     155   134.5     156  136.49     157  137.98
GR   158   139.2     159  141.18     160     144
NC                 0.015
QT     2     140     115
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X1 8.985      10    1000  1006.1      65      65      65
X3    10                                                   161.4   161.4
GR   164  653.05   161.5  919.05   161.4  993.05  154.89    1000  154.89 1000.05
GR154.89 1006.05  154.89  1006.1   161.4 1017.05     163 1073.05     164 1133.05
SB          2.04     1.5       0       6       0    22.3       0  155.38  154.89
X1 9.128      10    1000  1006.1     147     147     147
X2                     1  159.08   161.4
X3    10                                                   161.4   161.4
BT   -10  653.05     164     164  919.05   161.5   161.5  993.05   161.4   161.4
BT          1000   161.4  155.38 1000.05   161.4  159.08 1006.05   161.4  159.08
BT        1006.1   161.4  155.38 1017.05   161.4   161.4 1073.05     163     163
BT       1133.05     164     164
GR   164  653.05   161.5  919.05   161.4  993.05  155.38    1000  155.38 1000.05
GR155.38 1006.05  155.38  1006.1   161.4 1017.05     163 1073.05     164 1133.05
NC                 0.03     0.3     0.5
QT     2     120      95
X1   9.2      22  180.32  209.61   62.36   59.98   53.11
GR   164     100   163.5  132.54     163  149.22     162     167     161  180.32
GR   160   181.5     159  183.19     158  186.03     157  187.45  156.24  188.78
GR155.38  189.83  155.38   192.1  155.78  195.79  155.78   198.9  156.93  201.18
GR   158  202.95     159  204.75     160  206.24     161  209.61  160.94  211.26
GR   162     249   162.1     265
NC                0.015
X1  9.25      18    1000    1012    34.8    37.8   48.46
X3    10                                                   158.8   158.8
GR162.21     926  161.75     974  160.74     990   155.4    1000   155.4 1000.05
GR 155.4 1003.55   155.4  1003.6  155.39  1004.2  155.39 1004.25  155.39 1007.75
GR155.39  1007.8  155.48  1008.4  155.48 1008.45  155.48 1011.95  155.48    1012
GR   159    1016  160.84    1028     162  1028.1
SB  1.25    1.77     1.5       0    11.9     1.1    19.4       0  155.53  155.39
X1 9.281      18    1000    1012      31      31      31
X2                     1  157.33  159.61
X3    10                                                  159.61  159.61
BT   -17     926  162.21  162.21     974  161.75  161.75     990  160.74  160.74
BT          1000  159.61  155.53 1000.05  159.61  157.33 1003.55  159.61  157.33
BT        1003.6  159.61  155.53  1004.2  159.61  155.58 1004.25  159.61  157.38
BT       1007.75  159.61  157.38  1007.8  159.61  155.58  1008.4  159.61  155.58
BT       1008.45  159.61  157.38 1011.95  159.61  157.38    1012  159.61  155.48
BT          1016  159.86     159    1028  160.84  160.84  1028.1     162     162
GR162.21     926  161.75     974  160.74     990  155.53    1000  155.53 1000.05
GR155.53 1003.55  155.53  1003.6  155.58  1004.2  155.58 1004.25  155.58 1007.75
GR155.58  1007.8  155.58  1008.4  155.58 1008.45  155.58 1011.95  155.58    1012
GR   159    1016  160.84    1028     162  1028.1
X1 9.289      16  100.57  150.41       8       8       8
GR   166     100   162.1     100     162  100.57     161  109.85     158  113.19
GR   158  117.56  156.53  119.16  156.53  121.79  156.53   124.8  156.53  126.44
GR157.85  129.37     158  133.14     161  138.11     162  144.27   162.8  150.41
GR   166  150.41
NC                 0.03     0.1     0.3
X1  9.34      19   113.4  159.15      37      37      37
GR   166  100.76   162.5  109.43     162   113.4     161  119.77     160  122.42
GR   159  125.42     158  128.36     158  128.56   156.6  130.16   156.6  132.79
GR 156.6   135.8   156.6  137.44  157.85  140.37     159  142.66     160  144.41
GR   161  147.47     162  154.42     163  159.15   163.5  161.37
NC                 0.03     0.1     0.3
X1 9.341      19   113.4  154.42       1       1       1
GR   166  100.76   162.5  109.43     162   113.4     161  119.77     160  122.42
GR   159  125.42     158  128.36     158  128.56     157  130.16     157  132.79
GR   157   135.8     157  137.44  157.85  140.37     159  142.66     160  144.41
GR   161  147.47     162  154.42     163  159.15   163.5  161.37
X1  9.36      20  109.33  148.78      19      19      19
GR   167     100   163.1     100     163  102.11   162.5  107.19     162  109.33
GR   161  116.99     160  119.21     159   122.6  157.99  125.56   157.1  127.16
GR 157.1  129.79   157.1   132.8   157.1  134.44  157.85  137.37     159  138.32
GR   160   141.2     161  144.44     162  148.78     163  154.58   163.5  157.06
X1   9.4      20   114.8  148.64      40      40      40
GR   167     100     163  102.95   162.5  110.34     162   114.8     161   117.6
GR   160  121.08     159  123.67  158.07  126.34   157.2  128.26   157.2  129.96
GR 157.2   132.2   157.2  134.03  158.45  137.78     159  138.78     160  141.72
GR   161  145.35     162  148.64     163  154.76   163.5  157.76     164  163.23
X1 9.499      16  106.03  146.48     100     100     100
GR 162.5     100     162  106.03     161  109.67     160  112.88     159  115.17
GR   158     118   157.2     120   157.2     126     158     128     158  128.41
GR   159  131.17     160   133.8     161  137.61     162  146.48   162.5  150.24
GR   163  151.43
X1   9.5      16  106.03  146.48     0.1     0.1     0.1
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GR 162.5     100     162  106.03     161  109.67     160  112.88     159  115.17
GR   158     118   157.3     120   157.3     126     158     128     158  128.41
GR   159  131.17     160   133.8     161  137.61     162  146.48   162.5  150.24
GR   163  151.43
NC                 0.015
QT     2     110      95
X1   9.6      25   179.5   191.5   63.39   85.89   72.89
X3    10                                                   160.4   160.4
GR   164       0     164      89     164     149     164     160   162.6   160.1
GR   161     170     159     176  157.36   179.5  157.36  179.55  157.36  183.05
GR157.36   183.1  157.39   183.7  157.39  183.75  157.39  187.25  157.39   187.3
GR157.45   187.9  157.45  187.95  157.45  191.45  157.45   191.5     159     194
GR   161     200     162     207   162.5   235.5     167   235.6     167   304.5
SB  1.25    1.68     1.5       0      12     1.2    25.9       0  157.73  157.36
X1 9.627      25   179.5   191.5      27      27      27
X2                     1  160.13  160.81
X3    10                                                  160.81  160.81
BT   -25       0     164     164      89     164     164     149     164     164
BT           160     164     164   160.1   162.6   162.6     170     161     161
BT           176  160.84     159   179.5  160.81  157.73  179.55  160.81  160.13
BT        183.05  160.81  160.13   183.1  160.81  157.73   183.7  160.81  157.75
BT        183.75  160.81  160.15  187.25  160.81  160.15   187.3  160.81  157.75
BT         187.9  160.81  157.79  187.95  160.81  160.19  191.45  160.81  160.19
BT         191.5  160.81  157.45     194  160.87     159     200     161     161
BT           207     162     162   235.5   164.8   164.8   235.6     167     167
BT         304.5     167     167
GR   164       0     164      89     164     149     164     160   162.6   160.1
GR   161     170     159     176  157.73   179.5  157.73  179.55  157.73  183.05
GR157.73   183.1  157.75   183.7  157.75  183.75  157.75  187.25  157.75   187.3
GR157.79   187.9  157.79  187.95  157.79  191.45  157.79   191.5     159     194
GR   161     200     162     207   164.8   235.5     167   235.6     167   304.5
X1 9.639      15  134.75  143.34   37.23   11.03      12
GR   163     100     162  123.01     161  125.96     160  130.36  159.46  134.75
GR158.53  137.16  158.53  138.15  158.53  139.07  158.53   140.2  159.25  143.34
GR   160  149.87     161  154.52     162   162.3     163   166.5     164  169.57
NC                  0.03     0.1     0.3
X1  9.72      19  127.75  136.34    64.4   62.77   69.58
GR   167     100   163.6     100   163.5  102.77     163  108.86     162  115.02
GR   161  123.01     160  126.13  159.46  127.75  159.05  130.16  159.05  131.15
GR159.05  132.07  159.05   133.2  159.25  136.34     160  137.52     161  142.41
GR   162  150.08     163  154.35     164  158.92     165  162.84
X1   9.8      13  129.04   163.3   70.09    69.9   69.37
GR 163.5     100     163  114.84     162  129.04  161.22  134.69   159.3  144.52
GR 159.3  145.66   159.3  146.69   159.3  148.64  161.08  156.63     162   163.3
GR   163  168.62     164   172.2     165  178.43
X1  9.88      14  138.56  169.65   61.84   74.54   69.05
GR 163.5     100     163  117.87     162  138.56  161.36  143.45  159.79  149.87
GR159.39  153.03  159.39  153.59  159.39  154.17  159.39  155.09  159.67  157.33
GR161.29  163.88     162  169.65     163  179.09     164  181.32
X1  9.96      16  145.01  181.42   73.03   62.83   68.38
GR 164.5     100     164   120.7   163.5  139.56     163  145.01     162  152.26
GR161.43  156.83  159.51  163.93  159.51   164.5  159.51  165.21  159.51  166.31
GR159.88  170.45  161.61  177.21     162  181.42     163  189.01     164  194.72
GR   165   197.9
NC                           0.3     0.5
X1 10.04      14  114.68  143.07   83.56   70.88    76.9
GR   166     100   162.8     100     162  114.68   161.7  120.54     160  125.37
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GR161.58  140.61     162  143.07     163  149.74     164   158.1
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X3    10                                                  164.55  164.71
GR   167    1000     167    1231   164.1  1231.1     164    1236     161    1253
GR164.71 1254.42  161.47 1254.42     161 1255.34     161 1255.34  159.64 1255.36
GR159.64 1262.64     161 1262.64     161 1262.66  161.47 1263.58  164.71 1263.58
GR   161    1265     165    1286   166.1  1286.1   166.1    1291   166.5    1348
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SB  1.25    1.64     1.5       0     1.3       0    31.9       2  159.71  159.64
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GR   163  214.35     164     220     165  253.35     166  276.86   166.5   286.7
NC                           0.1     0.3
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GR   165  244.11     166  267.25   166.5  281.74
NC                  0.03
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GR   166     100   165.5  105.54     165  112.77   165.5  118.44     168  118.44
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GR161.02  186.03  160.93  187.64  160.63  187.64  160.63  189.75  160.93  189.75
GR161.09  197.47     162   199.2     163  201.46     164  206.06     165  218.92
GR   166  241.97   166.5  257.58
X1  10.4      19  161.12  180.39   40.25   37.81   39.57
GR   166     100   165.5  106.45     165  116.42     164  151.05     163  158.14
GR   162  160.94  161.33  161.12  161.03  165.14  161.03  167.01  160.88  167.02
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GR   164  186.89     165  190.95     166  230.72   166.5  245.68
X1 10.48      20  222.27  242.07  104.03   70.05   82.32
GR   167     100   166.5   118.2     166  125.57     165  138.62   164.4  149.75
GR 164.4  191.36   164.5     204     164     214     163   217.1     162  220.98
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GR   170     100     170  107.21     167  107.22     166  117.16     165  127.97
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GR   170     100     170  115.67     167  115.67     166  125.37     165  135.82
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GR 162.2  152.16   162.5  152.16   162.5  155.08   162.5  162.64     164     164
GR   165  166.56     166  172.38   166.5  178.66     171  178.67     171  198.78
GR   167  198.78     167  208.15     167  236.08
X1 10.72      20  119.82  149.46      30      30      30
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GR   165  149.46     166  152.76     167  163.25   167.1  166.73     171  166.74
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GR   168     100     167  129.07     166   137.9     165  145.53     164  148.84
GR163.11   149.1   162.9  153.75  162.74  154.21  162.44  154.21  162.44  156.32
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X3    10                                                  167.58  167.58
GR   171     770     171     970   169.1   970.1     168     979     165     989
GR162.81    1000  162.81 1000.05  162.81 1004.55  162.81  1004.6  162.88  1006.1
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GR   170  1021.1     170    1209
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BT           979     168     168     989  167.58     165    1000  167.58  162.81
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BT        1021.1     170     170    1209     170     170
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BT        1006.1  168.28  163.09 1006.15  168.28  166.49 1010.65  168.28  166.49
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BT        1021.1     170     170    1209     170     170
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GR   170  1021.1     170    1209
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X3    10                                                  167.58  167.58
GR   171     770     171     970   169.1   970.1     168     979     165     989
GR163.09    1000  163.09 1000.05  163.09 1004.55  163.09  1004.6  163.09  1006.1
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GR   170  1021.1     170    1209
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GR   169     100     168  109.09     167  116.08     166  117.97     165  122.24
GR164.89  127.76  163.83  128.56   163.5  128.57   163.5  130.77  163.83  130.77
GR164.83  132.33     167  139.91     167  144.53     168  148.06     169  153.84
NC                           0.1     0.3
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GR 170.2  165.73     174  165.73
X1 11.24      13  114.61   145.2   65.36   72.84   69.68
GR   170     100     169  103.69     168  114.61   165.7  123.02  165.46   132.4
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GR   168   145.2     169  149.56     170   158.1
X1 11.32      18  119.71  151.29    68.3   71.55   71.35
GR   174     100   170.1   100.1     170  101.23     169   103.3     168  119.71
GR   167  122.48   165.7  126.19   165.7  136.68  165.39  136.68  165.39  138.99
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GR   170     167   170.1  169.92     174  169.92
X1 11.37      18  133.69  137.27   46.68   51.45   48.83
GR   170     100     169  110.04     168  115.28     167   122.2     166  126.57
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GR164.86   135.9  165.16   135.9  165.86  137.27  166.27  140.99     167  148.74
GR   168  152.02     169  157.69     170     166
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BT         1023.85     173     173 1108.75     173     173
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GR   172  214.57
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GR   175     100     174  118.35     173  128.08     172  132.56     171  135.37
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NC                 0.015
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GR169.63     148  169.63  155.31  168.41  155.31  168.41  158.99  169.63  158.99
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GR   174   199.1     175  217.94
NC                           0.3     0.5
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GR 174.8     100     174  118.15     173  139.22     172   148.7     171  156.22
GR170.02  161.68  168.89  170.59  168.89  172.36  168.89  174.73  168.89  177.15
GR169.36  182.32     170  188.68     171  201.45     172  214.43     173  228.48
GR   174  241.36     175  253.89
NC                 0.015
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X3    10                                                  169.56  169.56
GR174.62       0  174.62       0  173.67   19.38  172.64   38.35  170.02   62.68
GR168.07    69.8  168.07    69.8  168.07    72.8  168.07    72.8  168.05    73.2
GR168.05    73.2  168.05   76.21  168.05   76.21  168.89   78.15  169.59      82
GR169.59   83.32  171.82   116.1  175.01  156.15
SB  1.25    1.68     1.5       0     7.4    0.41    5.46       0  168.12  168.05
X112.065      18    69.8   76.21      10      10      10
X2                     1  168.96  169.56
X3    10                                                  169.56  169.56
```

```
BT   -17       0  174.62  174.62       0  174.62  174.62   19.38  173.67  173.67
BT         38.35  172.64  172.64   62.68  170.02  170.02    69.8  169.56  168.14
BT          69.8  169.56  168.98    72.8  169.56  168.98    72.8  169.56  168.14
BT          73.2  169.56  168.12    73.2  169.56  168.96   76.21  169.56  168.96
BT         76.21  169.56  168.12   78.15  169.57  168.89      82  169.59  169.59
BT         83.32  169.59  169.59   116.1  171.82  171.82  156.15  175.01  175.01
GR174.62       0  174.62       0  173.67   19.38  172.64   38.35  170.02   62.68
GR168.14    69.8  168.14    69.8  168.14    72.8  168.14    72.8  168.12    73.2
GR168.12    73.2  168.12   76.21  168.12   76.21  168.89   78.15  169.59      82
GR169.59   83.32  171.82   116.1  175.01  156.15
NC                0.03
X1 12.12      15  154.24  160.36   40.95   45.78   43.89
GR   175     100     174  115.27     173  124.63     172  133.14     171  139.51
GR   170     145   169.1  154.24  168.84  157.43  169.15  160.36     170  163.61
GR   171  167.94     172  173.64     173   185.1     174  211.11     175  223.29
NC                         0.1     0.3
X1  12.2      13  130.71  149.57   59.55   87.22   75.45
GR   175     100     174  107.69     173  114.61     172  119.72     171  125.24
GR170.13  130.71  168.89   138.8  169.97  149.57     171  150.79     172  159.17
GR   173  175.43     174  208.21     175  223.18
X1 12.28      12  131.35  156.78   78.41   67.07   74.09
GR   175     100     174  110.98     173  119.17     172  124.45  170.72  131.35
GR168.96  146.59  170.11  155.63     171  156.78     172  164.89     173  180.89
GR   174  208.41     175  250.48
X1 12.36      14  129.54  142.29   69.23   57.79   66.17
GR 174.5     100     174  101.84     173  108.92     172  116.08     171  123.95
GR   170  129.48  169.67  129.54  168.95  135.11  169.49  142.29     171  147.88
GR   172  156.25     173  171.31     174  204.97     175  247.68
QT     2      80      80
X1 12.44      17  122.75  136.15   73.22   75.63    70.4
GR   176     100     175  102.57     174  106.48     173  111.91     172  115.33
GR   171  119.12  169.67  122.75  169.24  127.85  169.24  128.94  169.24  129.76
GR169.24  130.59  169.62  136.15     171  141.02     172  143.59     173  149.86
GR   174  155.84     175  160.45
X1 12.52      20  142.43  153.49   64.35   62.03   63.47
GR   180     100   176.6   100.1     176  120.43     175   126.7     174  128.83
GR   173  130.98     172  135.06  170.83   136.3  169.44  142.43  169.29  147.98
GR169.67  153.49     171  155.42     172  158.33     173  162.36     174  168.75
GR   175  172.27     176   175.2   176.5  176.93   176.5  178.57   176.5  185.29
X1  12.6      19   143.9  155.16   70.59   80.85   73.25
GR   180     100   176.6   100.1     176  120.73     175  127.99     174  130.49
GR   173  134.24     172  136.48     171  140.99  169.71   143.9  169.39  149.86
GR169.64  155.16     171  156.71     172  158.51     173  161.52     174  164.48
GR   175  170.78     176  173.69   176.5  175.92     177  232.79
X1 12.68      22  153.73  166.66   69.55   56.74   60.28
GR   181     100   177.1   100.1     177   111.7     176   114.5     176  122.51
GR   176  131.49     175  137.25     174  142.08     173  144.94     172  147.73
GR   171  151.82  169.99  153.73  169.58  160.41  169.65  166.16  169.99  166.66
GR   171  168.24     172  170.74     173  173.15     174  176.02     175  179.11
GR   176  186.51     177  195.86
X1 12.76      22  136.55  148.49   65.72   45.43   53.78
GR   179     100   175.7   100.1     175  120.97     174  125.75     173  128.37
GR   172  131.76     171  133.23  169.83  136.55  169.45   142.4  169.45  143.18
GR169.45  143.59  169.45  144.42  169.75  148.49     171  152.83     172  155.41
GR   173  157.85     174  159.14     175  162.08     176  199.82     177   205.6
GR 177.1  211.38     181  211.38
EJ
T1      PEL PROJECT NO. 101127
T2      CITY OF MISSISSAUGA, CVCA
T3      COOKSVILLE CREEK 2002   COOKSRCAD.HEC
J1   -10       3                       0       1             210    74.8
J2    15              -1                                      -6



ER
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APPENDIX 'F'

HYDRAULIC SUMMARIES

HYDRAULIC SUMMARIES
FOR DEVELOPMENT PROPERTIES

TABLE F.1. COOKSVILLE CREEK FLOOD REDUCTION ALTERNATIVES

Alternative A: Storage at Bristol Road
Alternative B: FRS Culvert and Channel Improvements

HEC-2 SEC ID	Q_{REG} (EXISTING) (m^3/s)	REGIONAL FLOOD ELEVATION (m)	Q_{100} EXISTING (m^3/s)	100 YEAR WATER SURFACE ELEVATIONS (m)	
				ALTERNATIVE A	ALTERNATIVE B
INGLIS PROPERTY					
0.464	320.00	80.80	210	80.21	80.34
0.540	320.00	80.55	210	80.10	80.21
0.640	320.00	80.67	210	80.15	80.27
0.700	320.00	81.02	210	80.32	80.45
0.780	320.00	81.19	210	80.88	80.97
0.790	295.00	81.37	210	80.71	80.76
0.795	295.00	81.45	210	80.54	80.85
0.850	295.00	83.13	210	82.19	81.12
CONSULATE SITE					
2.540	295.00	96.13	210	95.58	95.69
2.620	295.00	96.29	210	95.72	95.84
2.660	295.00	96.38	210	96.33	95.90
2.724	295.00	99.23	210	98.83	96.41
2.800	295.00	99.18	210	98.79	97.40
2.920	295.00	99.43	210	98.97	98.73

The Regional and 100 year elevations are updated elevations based on new 2000 mapping base.

TABLE F.1. COOKSVILLE CREEK FLOOD REDUCTION ALTERNATIVES

Alternative A: Storage at Bristol Road
Alternative B: FRS Culvert and Channel Improvements

HEC-2 SEC ID	Q_{REG} (EXISTING) (m^3/s)	REGIONAL FLOOD ELEVATION (m)	Q_{100} EXISTING (m^3/s)	100 YEAR WATER SURFACE ELEVATIONS (m)	
				ALTERNATIVE A	ALTERNATIVE B
HUMENIK PROPERTY					
3.600	295.00	102.22	210	101.78	101.85
3.680	295.00	102.42	210	101.95	102.04
3.750	295.00	102.74	210	102.42	102.54
CAMILLA ROAD F & F					
4.100	285.00	103.83	210	103.19	103.34
4.180	285.00	103.95	210	103.76	103.86
4.195	285.00	104.48	210	104.27	104.34
4.340	285.00	104.72	210	104.34	104.42
4.440	285.00	105.11	210	104.79	104.86
4.640	285.00	106.30	210	106.08	106.13
4.670	285.00	106.44	210	106.07	106.09
LITTLE JOHN LANE					
4.820	285.00	108.02	210	107.57	107.64
4.960	280.00	109.24	210	108.37	108.78
5.053	252.64	110.23	210	110.24	110.38
5.120	252.64	112.29	210	111.19	111.66

The Regional and 100 year elevations are updated elevations based on new 2000 mapping base.

TABLE F.1. COOKSVILLE CREEK FLOOD REDUCTION ALTERNATIVES

Alternative A: Storage at Bristol Road
Alternative B: FRS Culvert and Channel Improvements

HEC-2 SEC ID	Q_{REG} (EXISTING) (m^3/s)	REGIONAL FLOOD ELEVATION (m)	Q_{100} EXISTING (m^3/s)	100 YEAR WATER SURFACE ELEVATIONS (m)	
				ALTERNATIVE A	ALTERNATIVE B
			KANEFF PROPERTY		
7.357	145.00	128.39	115	127.51	128.01
7.386	145.00	128.22	115	127.31	127.84
7.397	145.00	128.41	115	127.60	128.05
7.400	145.00	128.44	115	127.68	128.09
7.407	145.00	128.44	115	127.69	128.10
7.410	145.00	128.38	115	127.61	128.03
7.411	145.00	128.47	115	127.75	128.13
7.413	145.00	128.47	115	127.75	128.13
7.414	145.00	128.43	115	127.69	128.09
7.415	145.00	128.44	115	127.74	128.11
7.415	145.00	128.40	115	127.70	128.05
7.416	145.00	128.40	115	127.71	128.06
7.416	145.00	128.47	115	127.81	128.03
7.417	145.00	128.47	115	127.83	128.03
7.417	145.00	128.44	115	127.97	128.02
7.460	145.00	129.03	115	128.17	128.61
7.518	145.00	130.16	115	129.61	129.90
7.545	145.00	130.47	115	129.80	130.20
7.545	145.00	130.69	115	130.15	130.45
7.546	145.00	130.70	115	130.16	130.47
7.546	145.00	131.06	115	130.53	130.82
7.569	145.00	131.05	115	130.52	130.81
7.614	145.00	131.21	115	130.43	130.77

The Regional and 100 year elevations are updated elevations based on new 2000 mapping base.

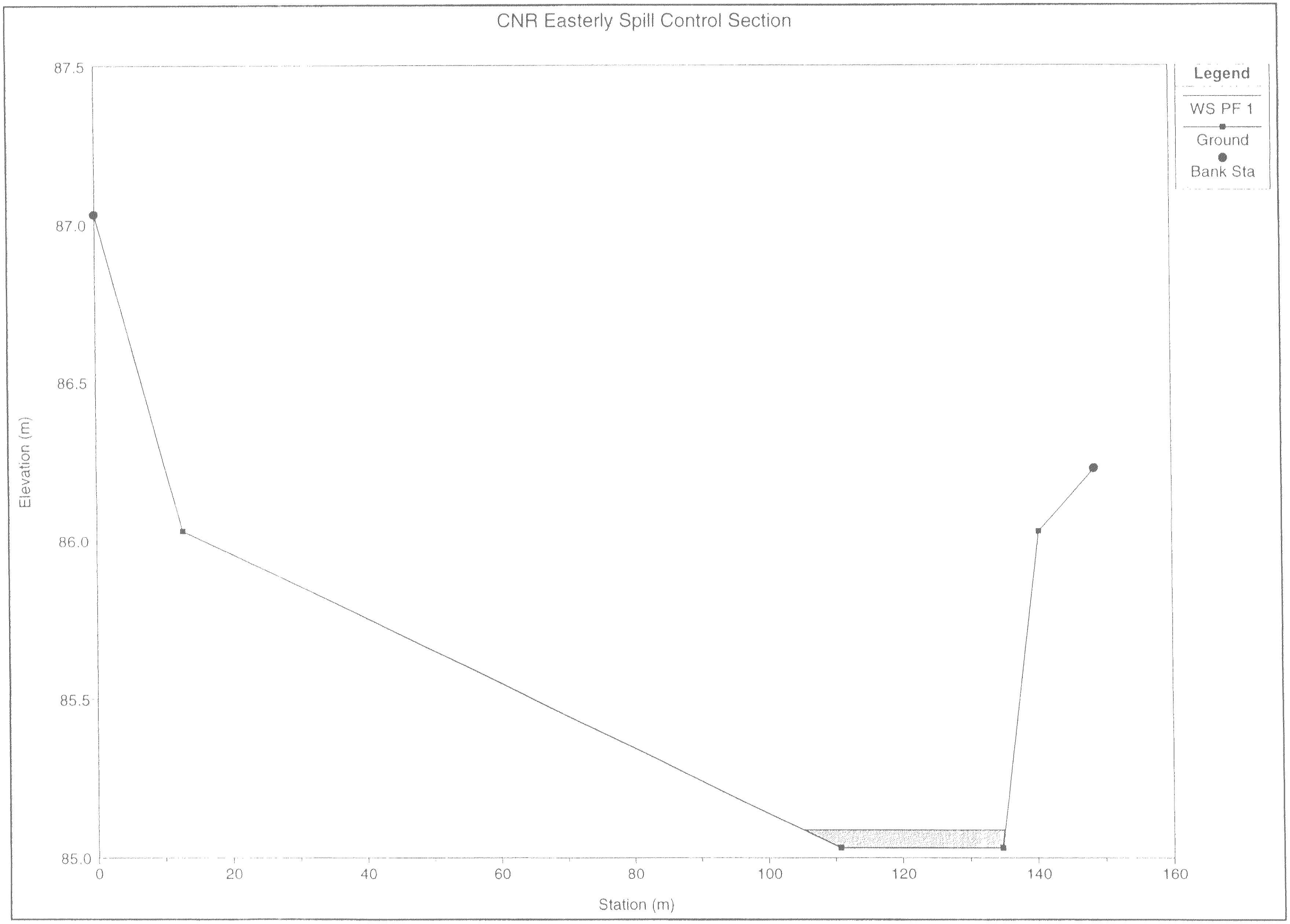
TABLE F.1. COOKSVILLE CREEK FLOOD REDUCTION ALTERNATIVES

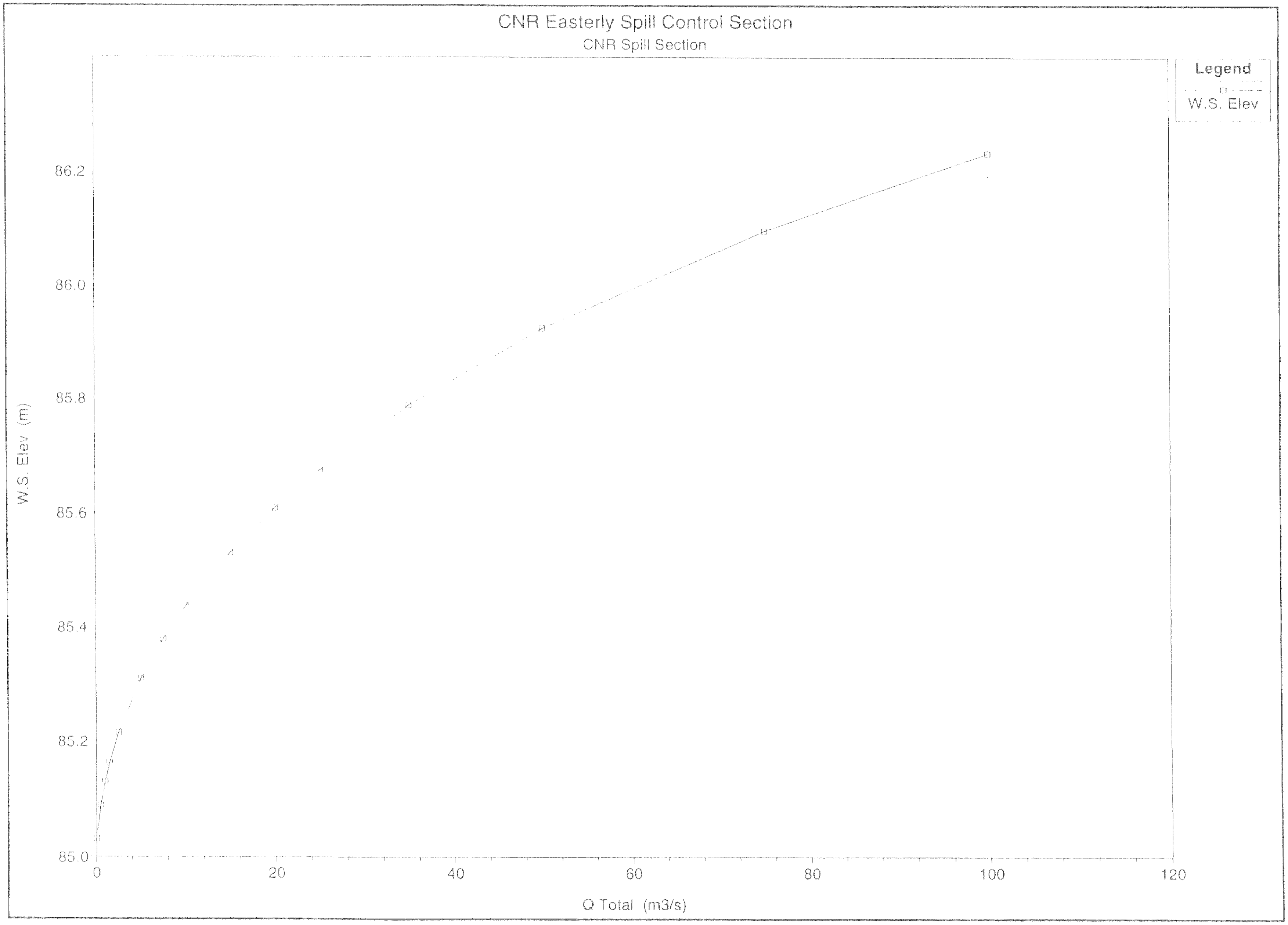
Alternative A: Storage at Bristol Road
Alternative B: FRS Culvert and Channel Improvements

HEC-2 SEC ID	Q_{REG} (EXISTING) (m^3/s)	REGIONAL FLOOD ELEVATION (m)	Q_{100} EXISTING (m^3/s)	100 YEAR WATER SURFACE ELEVATIONS (m)	
				ALTERNATIVE A	ALTERNATIVE B
EGLINTON / HIGHWAY 10					
10.205	110.00	163.04	95	162.03	162.65
10.327	110.00	164.08	95	162.63	163.68
10.330	110.00	164.03	95	162.56	163.59
10.360	110.00	164.05	95	162.98	163.66
10.400	110.00	164.05	95	163.00	163.67
10.480	110.00	164.11	95	163.07	163.75
PEEL BOARD OF EDUCATION					
11.705	100.00	168.95	95	167.66	168.26
11.760	100.00	169.13	95	168.03	169.03
11.790	100.00	169.11	95	168.07	169.03
11.800	100.00	170.78	95	170.33	170.77
11.880	100.00	171.61	95	170.90	171.53
11.960	100.00	171.65	95	170.93	171.57
12.040	100.00	171.64	95	170.92	171.56
12.055	100.00	171.54	95	170.87	171.47
12.065	100.00	171.54	95	170.86	171.46
12.120	100.00	171.56	95	170.85	171.48
12.200	100.00	171.82	95	171.15	171.15
12.280	100.00	171.96	95	171.27	171.27
12.360	100.00	171.98	95	171.31	171.31
12.440	80.00	172.14	80	171.31	171.31

The Regional and 100 year elevations are updated elevations based on new 2000 mapping base.

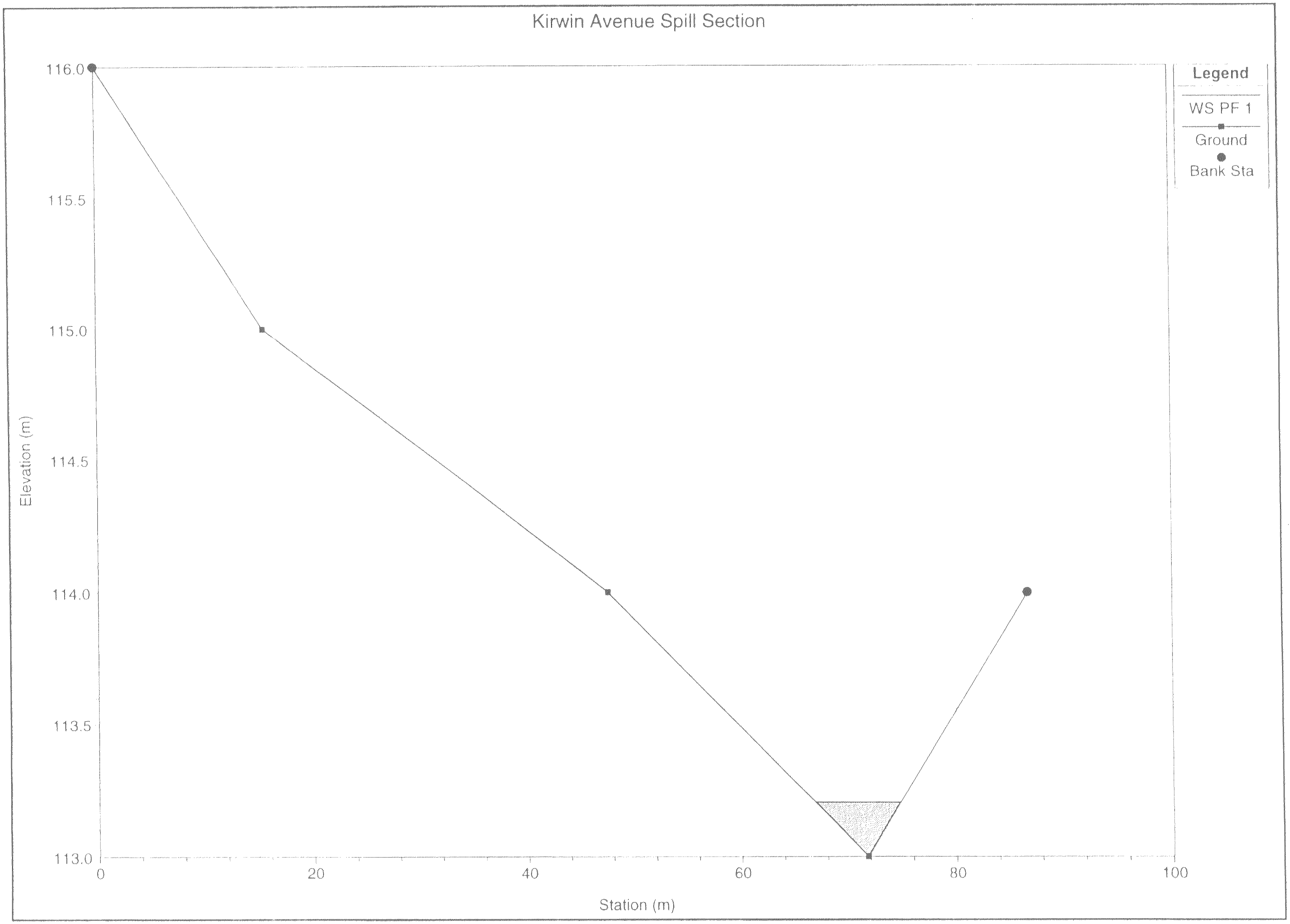
SPILL MECHANICS:
CONTROL SECTIONS AND RATING CURVES

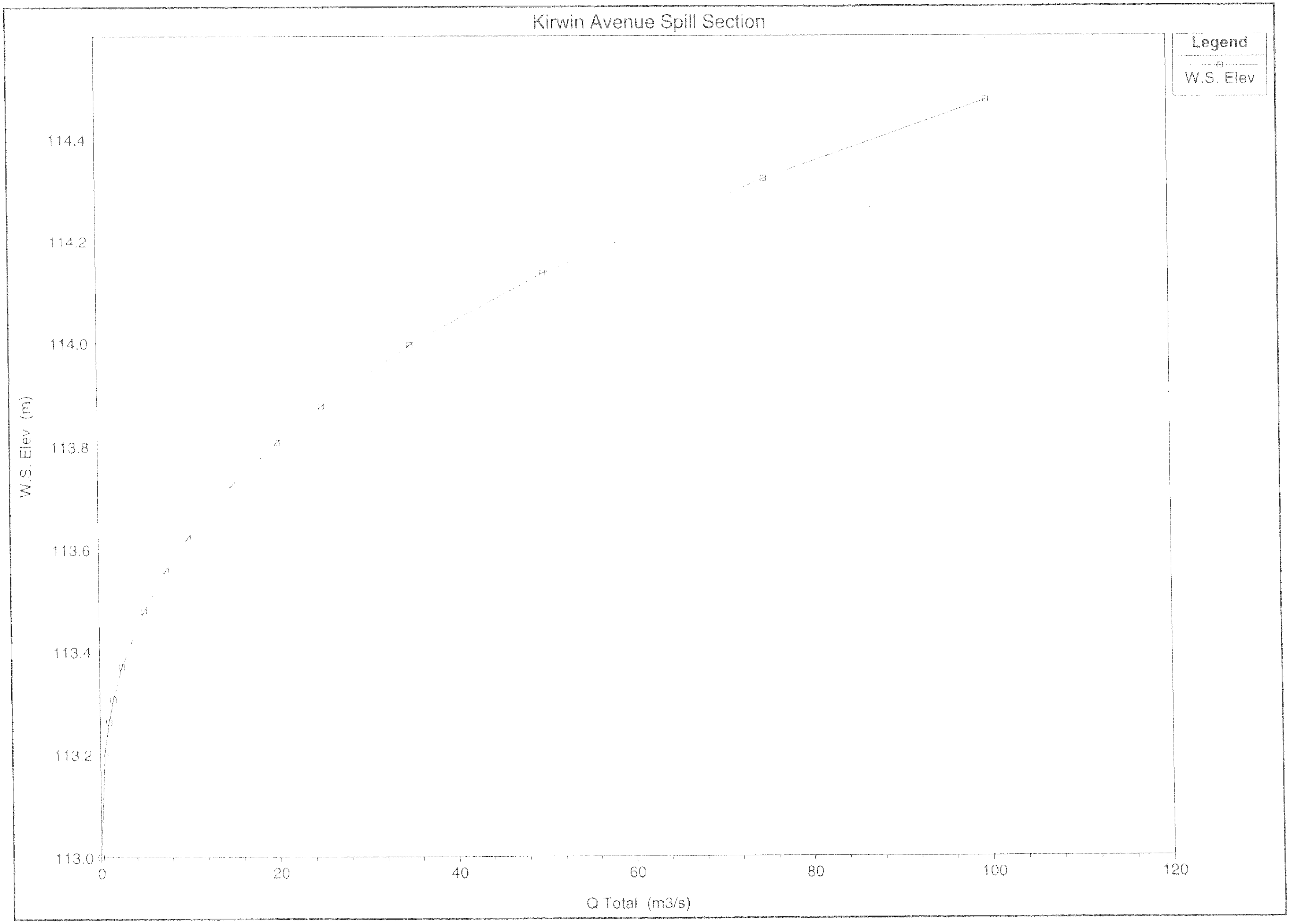

CNR Easterly Spill Control Section
Legend
WS PF 1
Ground
Bank Sta
87.5
87.0
86.5
86.0
85.5
85.0
Elevation (m)
0
20
40
60
80
100
120
140
160
Station (m)



CNR Easterly Spill Control Section

CNR Spill Section


Kirwin Avenue Spill Section
Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
116.0
115.5
115.0
114.5
114.0
113.5
113.0
Station (m)
0
20
40
60
80
100


Kirwin Avenue Spill Section
Legend
W.S. Elev
W.S. Elev (m)
114.4
114.2
114.0
113.8
113.6
113.4
113.2
113.0
0
20
40
60
80
100
120
Q Total (m3/s)

INGLIS PROPERTY STRUCTURAL ALTERNATIVE: LAKESHORE ROAD CULVERT REPLACEMENT

OBJECTIVE:

To determine culvert size resulting in upstream water surface elevations equal or less than flood elevations under the Lakeshore Road reconstruction option.

TABLE 8.1
INGLIS PROPERTY STRUCTURAL OPTION ASSESSMENT: REGULATORY FLOOD LEVELS

Cross-Section	Condition		
	Existing Floodplain and Roadway	Existing Floodplain without Buildings; Modified Roadway	Existing Floodplain and upgraded culvert (20 m x 3.05 m)
0.44 (d/s Lakeshore Road)	78.59	78.59	78.59
0.464 (u/s Lakeshore Road)	80.80	80.40	80.32
0.54	80.55	80.04	79.91
0.64	80.67	80.31	80.29
0.70	81.02	81.03	81.02
0.78	81.19	81.24	81.19
0.79	81.37	81.34	81.37
0.795	81.45	81.40	81.45
0.85 (d/s CNR)	83.13	83.11	83.13

```
LAKESHORE ROAD EAST CULVERT REPLACEMENT
20 m SPAN, EXISTING ROAD PROFILE AND SPAN MAINTAINED


X1 0.440    48.0 1008.00 1031.59   73.84    61.5   65.99
X3  10.0                                                   77.75   77.75
GR80.76 727.8   80.59   784.    80.59   784.1   80.54   798.0   80.54   798.1
GR80.41 840.0   80.41   840.1   80.25   905.0   80.25   905.1   80.2    928.
GR80.2  928.1   80.14   954.0   80.14   954.1   78.50   980.0   78.50   980.1
GR77.5  998.7   77.5    998.8   77.5    1001.34 77.5    1001.35 77.5    1005.8
GR77.0  1007.8  75.90   1008.00 75.94   1008.01 75.94   1008.05 75.94   1014.65
GR75.94 1014.70 75.7    1019.8  75.7    1019.81 75.47   1026.10 75.47   1026.15
GR75.47 1031.54 75.47   1031.58 75.47   1031.59 78.0    1031.8  78.0    1032.0
GR78.0  1032.01 78.0    1040.8  78.0    1040.9  78.0    1058.0  78.0    1058.1
GR78.0  1067.8  80.0    1076.0  80.22   1090.0  80.22   1090.1  80.32   1120.0
GR80.32 1120.1  80.35   1128.0  81.44   1247.8


SB  1.25    1.61    1.50     0.0   22.80     2.8    61.0     0.0   75.74   75.47

X1 0.464    43.0 1008.00 1031.59    24.0    24.0    24.0
X2                   1.0   78.76   80.02
X310.0                                                     80.02   80.04
BT -43.0  727.8    80.76   80.76  784.0    80.59   80.59 784.1     82.0    80.59
BT        798.0    82.0    80.54  798.1    80.54   80.54  840.0    80.41   80.41
BT        840.1    82.0    80.41  905.0    82.0    80.25  905.1    80.25   80.25
BT        928.0    80.2    80.2   928.1    82.0    80.2   954.0    82.0    80.14
BT        954.1    80.14   80.14  980.0    80.08   78.50  980.1    82.0    78.50
BT        998.7    82.0    77.5   998.8    80.04   77.5  1001.34   80.02   77.5
BT       1001.35   81.31   77.5  1005.79   81.31   77.5  1005.8    80.33   77.5
BT       1007.8    80.33   77.0  1008.00   80.33   76.06 1008.01   80.33   76.06
BT       1008.05   80.33   78.76 1031.54   80.63   78.79 1031.58   80.63   75.74
BT       1031.59   80.63   75.7  1031.8    80.63   78.0  1032.0    80.63   78.0
BT       1032.01   80.04   78.0  1040.8    80.07   78.0  1040.9    82.0    78.0
BT       1058.0    82.0    78.0  1058.1    80.12   78.0  1067.8    80.15   78.0
BT       1076.0    80.18   80.0  1090.0    80.22   80.22 1090.1    82.0    80.22
BT       1120.0    82.0    80.32 1120.1    80.32   80.32 1128.0    80.35   80.35
BT       1247.8    81.44   81.44
GR80.76 727.8   80.59   784.    80.59   784.1   80.54   798.0   80.54   798.1
GR80.41 840.0   80.41   840.1   80.25   905.0   80.25   905.1   80.2    928.
GR80.2  928.1   80.14   954.0   80.14   954.1   78.50   980.0   78.5    980.1
GR77.5  998.7   77.5    998.8   77.5    1001.34 77.5    1001.35 77.5    1005.79
GR77.5  1005.8  77.0    1007.8  76.06   1008.00 76.06   1008.01 76.06   1008.05
GR75.74 1031.54 75.74   1031.58 75.74   1031.59 78.0    1031.8  78.0    1032.0
GR78.0  1032.01 78.0    1040.8  78.0    1040.9  78.0    1058.0  78.0    1058.1
GR78.0  1067.8  80.0    1076.0  80.22   1090.0  80.22   1090.1  80.32   1120.0
GR80.32 1120.1  80.35   1128.0
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LAKESHORE ROAD ALTERNATIVE ASSESSMENT
CULVERT REPLACEMENT 20 m SPAN x 3.05 RISE

        SECNO       Q        EG      CWSEL     CRIWS     ELTRD     ELLC    K*CHSL     ELMIN     DEPTH      AREA     TOPWID

*        .020    320.00    78.08     77.49     77.49       .00       .00      .00     74.52      2.97    131.78    157.23
*        .020    210.00    77.37     76.49     76.49       .00       .00      .00     74.52      1.97     51.80     33.40

*        .120    320.00    78.25     78.10       .00       .00       .00     1.62     74.68      3.42    257.56    144.52
*        .120    210.00    77.61     77.50       .00       .00       .00     1.62     74.68      2.82    185.75    107.87

*        .220    320.00    78.42     78.04       .00       .00       .00     -.49     74.63      3.41    163.23    109.07
*        .220    210.00    77.79     77.44       .00       .00       .00     -.49     74.63      2.81    105.13     87.53

         .330    320.00    78.66     78.10       .00       .00       .00     4.73     75.11      2.99    133.48     85.29
*        .330    210.00    78.14     77.78     77.78       .00       .00     4.73     75.11      2.67    106.61     82.11

*        .380    320.00    78.97     78.21     78.21       .00       .00     3.90     75.36      2.85    116.83     91.20
         .380    210.00    78.38     77.83     77.65       .00       .00     3.90     75.36      2.47     83.41     81.07

*        .440    320.00    79.41     78.59     78.59       .00       .00     1.67     75.47      3.12    111.74     91.55
         .440    210.00    78.70     77.91     77.77       .00       .00     1.67     75.47      2.44     58.16     40.68

*        .464    320.00    80.46     80.32       .00     80.02     78.76    11.25     75.74      4.58    306.31    241.30
*        .464    210.00    79.28     78.81       .00     80.02     78.76    11.25     75.74      3.07     68.58     23.59

*        .540    320.00    80.98     79.91     79.75       .00       .00    11.93     76.59      3.32     81.12     42.03
*        .540    210.00    80.05     79.05     79.05       .00       .00    11.93     76.59      2.46     50.42     29.24

         .640    320.00    81.30     80.29     80.20       .00       .00     5.21     77.08      3.21     80.67     54.45
         .640    210.00    80.46     79.67     79.53       .00       .00     5.21     77.08      2.59     55.84     35.06

*        .700    320.00    81.69     81.02     81.02       .00       .00     9.38     77.67      3.35    143.75    126.08
*        .700    210.00    81.13     80.45     80.45       .00       .00     9.38     77.67      2.78     80.81     91.07

         .780    320.00    81.87     81.19     81.03       .00       .00     2.94     77.88      3.31    122.01     95.75
*        .780    210.00    81.36     80.97       .00       .00       .00     2.94     77.88      3.09    101.76     80.21

*        .790    295.00    82.14     81.37     81.37       .00       .00    -8.00     77.80      3.57    113.81    100.07
*        .790    210.00    81.61     80.77     80.72       .00       .00    -8.00     77.80      2.97     64.03     61.71

*        .795    295.00    82.16     81.45     81.40     80.06     79.82    18.37     77.89      3.56    120.04    104.40
*        .795    210.00    81.66     80.85     80.80     80.06     79.82    18.37     77.89      2.96     67.71     67.75
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COMPUTED FLOOD ELEVATION CHECK

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	**Peak Discharge**		**Computed Water Surface Elevations**					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
0.020	320	11300	77.49	254.23	77.34	253.74	0.15	0.49
0.020	210	7416	76.49	250.95	76.52	251.05	-0.03	-0.10
0.120	320	11300	78.10	256.23	77.92	255.64	0.18	0.59
0.120	210	7416	77.50	254.26	77.50	254.26	0.00	0.00
0.220	320	11300	78.04	256.03	77.99	255.87	0.05	0.16
0.220	210	7416	77.44	254.07	77.58	254.52	-0.14	-0.46
0.330	320	11300	78.10	256.23	78.14	256.36	-0.04	-0.13
0.330	210	7416	77.78	255.18	77.89	255.54	-0.11	-0.36
0.380	320	11300	78.21	256.59	78.22	256.62	-0.01	-0.03
0.380	210	7416	77.83	255.34	77.76	255.12	0.07	0.23
0.440	320	11300	78.59	257.84	78.58	257.81	0.01	0.03
0.440	210	7416	77.91	255.61	78.18	256.49	-0.27	-0.89
0.464	320	11300	80.80	265.09	80.80	265.09	0.00	0.00
0.464	210	7416	80.34	263.58	80.41	263.81	-0.07	-0.23
0.540	320	11300	80.55	264.27	80.46	263.97	0.09	0.30
0.540	210	7416	80.21	263.15	80.25	263.28	-0.04	-0.13
0.640	320	11300	80.67	264.66	81.05	265.91	-0.38	-1.25
0.640	210	7416	80.27	263.35	80.31	263.48	-0.04	-0.13
0.700	320	11300	81.02	265.81	81.90	268.70	-0.88	-2.89
0.700	210	7416	80.45	263.94	81.17	266.30	-0.72	-2.36

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	**Peak Discharge**		**Computed Water Surface Elevations**					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
0.780	320	11300	81.19	266.37	81.90	268.70	-0.71	-2.33
0.780	210	7416	80.97	265.65	81.20	266.40	-0.23	-0.75
0.790	295	10417	81.37	266.96	81.89	268.66	-0.52	-1.71
0.790	210	7416	80.76	264.96	81.08	266.01	-0.32	-1.05
0.795	295	10417	81.45	267.22	81.88	268.63	-0.43	-1.41
0.795	210	7416	80.84	265.22	80.94	265.55	-0.10	-0.33
0.874	284.94	10062	85.46	280.38	83.11	272.67	0.02	0.07
0.874	210	7416	82.85	271.81	82.39	270.31	0.00	0.00
0.876	284.94	10062	85.46	280.38	85.56	280.71	-0.13	-0.43
0.876	210	7416	84.42	276.97	82.85	271.81	0.00	0.00
0.877	284.94	10062	85.46	280.38	85.57	280.74	-0.13	-0.43
0.877	210	7416	84.42	276.97	84.42	276.97	0.00	0.00
0.940	295	10417	85.44	280.31	85.57	280.74	-0.13	-0.43
0.940	210	7416	84.38	276.83	84.42	276.97	0.00	0.00
0.940	295	10417	85.42	280.25	85.30	279.85	0.12	0.39
0.940	210	7416	84.38	276.83	84.19	276.21	0.19	0.62
1.020	295	10417	85.41	280.21	85.21	279.56	0.18	0.59
1.020	210	7416	84.24	276.37	84.05	275.75	0.19	0.62
1.100	295	10417	85.41	280.21	85.59	280.80	-0.20	-0.66
1.100	210	7416	84.38	276.83	84.49	277.19	-0.11	-0.36

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
1.140	295	10417	85.20	279.52	85.38	280.11	-0.17	-0.56
1.140	210	7416	84.72	277.95	84.14	276.05	0.58	1.90
1.220	295	10417	86.01	282.18	85.69	281.13	0.32	1.05
1.220	210	7416	84.45	277.06	84.87	278.44	-0.42	-1.38
1.239	295	10417	85.87	281.72	85.82	281.56	0.05	0.16
1.239	210	7416	85.36	280.05	85.37	280.08	-0.01	-0.03
1.240	295	10417	86.55	283.95	85.78	281.43	0.77	2.53
1.240	210	7416	85.08	279.13	85.08	279.13	0.00	0.00
1.260	295	10417	86.65	284.28	87.72	287.79	-1.07	-3.51
1.260	210	7416	85.23	279.62	85.23	279.62	0.00	0.00
1.294	295	10417	86.87	285.00	87.71	287.76	-0.84	-2.76
1.294	210	7416	85.45	280.34	85.45	280.34	0.00	0.00
1.317	295	10417	87.24	286.22	87.57	287.30	-0.33	-1.08
1.317	210	7416	85.85	281.66	85.89	281.79	-0.04	-0.13
1.340	295	10417	87.95	288.55	88.03	288.81	-0.08	-0.26
1.340	210	7416	87.04	285.56	87.19	286.05	-0.15	-0.49
1.390	295	10417	87.80	288.05	87.83	288.15	-0.03	-0.10
1.390	210	7416	87.44	286.87	87.42	286.81	0.02	0.07
1.440	295	10417	88.17	289.27	88.20	289.37	-0.03	-0.10
1.440	210	7416	87.81	288.09	87.84	288.19	-0.03	-0.10

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
1.480	295	10417	88.43	290.12	88.73	291.11	-0.30	-0.98
1.480	210	7416	88.10	289.04	88.33	289.79	-0.23	-0.75
1.520	295	10417	88.34	289.83	88.38	289.96	-0.04	-0.13
1.520	210	7416	87.93	288.48	88.12	289.10	-0.19	-0.62
1.540	295	10417	88.64	290.81	88.79	291.30	-0.15	-0.49
1.540	210	7416	88.16	289.24	88.21	289.40	-0.05	-0.16
1.560	295	10417	89.20	292.65	89.11	292.35	0.09	0.30
1.560	210	7416	88.51	290.38	88.49	290.32	0.02	0.07
1.600	295	10417	89.81	294.65	89.98	295.21	-0.17	-0.56
1.600	210	7416	89.25	292.81	89.37	293.21	-0.12	-0.39
1.640	295	10417	89.93	295.04	89.99	295.24	-0.06	-0.20
1.640	210	7416	89.38	293.24	89.37	293.21	0.01	0.03
1.660	295	10417	89.84	294.75	89.82	294.68	0.02	0.07
1.660	210	7416	89.29	292.94	89.21	292.68	0.08	0.26
1.680	295	10417	89.96	295.14	89.87	294.85	0.09	0.30
1.680	210	7416	89.49	293.60	89.39	293.27	0.10	0.33
1.714	295	10417	90.11	295.63	90.68	297.50	-0.57	-1.87
1.714	210	7416	89.65	294.12	89.99	295.24	-0.34	-1.12
1.730	295	10417	90.68	297.50	90.69	297.54	-0.01	-0.03
1.730	210	7416	90.00	295.27	89.98	295.21	0.02	0.07

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
1.779	295	10417	90.88	298.16	90.89	298.19	-0.01	-0.03
1.779	210	7416	90.15	295.76	90.27	296.16	-0.12	-0.39
1.780	295	10417	90.88	298.16	90.89	298.19	-0.01	-0.03
1.780	210	7416	90.12	295.67	90.27	296.16	-0.15	-0.49
1.810	295	10417	91.08	298.82	90.97	298.45	0.11	0.36
1.810	210	7416	90.48	296.85	90.38	296.52	0.10	0.33
1.839	295	10417	91.04	298.68	90.96	298.42	0.08	0.26
1.839	210	7416	90.39	296.55	90.36	296.45	0.03	0.10
1.840	295	10417	91.05	298.72	90.96	298.42	0.09	0.30
1.840	210	7416	90.35	296.42	90.37	296.49	-0.02	-0.07
1.870	295	10417	91.04	298.68	90.99	298.52	0.05	0.16
1.870	210	7416	90.53	297.01	90.38	296.52	0.15	0.49
1.900	295	10417	90.93	298.32	90.78	297.83	0.15	0.49
1.900	210	7416	90.55	297.08	90.45	296.75	0.10	0.33
1.940	295	10417	91.97	301.74	91.38	299.80	0.59	1.94
1.940	210	7416	91.56	300.39	91.06	298.75	0.50	1.64
2.000	295	10417	92.22	302.56	92.25	302.65	-0.03	-0.10
2.000	210	7416	91.72	300.91	91.76	301.05	-0.04	-0.13
2.040	295	10417	92.73	304.23	92.87	304.69	-0.14	-0.46
2.040	210	7416	92.15	302.33	92.12	302.23	0.03	0.10

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
2.120	295	10417	93.92	308.13	94.05	308.56	-0.13	-0.43
2.120	210	7416	92.94	304.92	93.22	305.84	-0.28	-0.92
2.160	295	10417	94.18	308.99	94.25	309.22	-0.07	-0.23
2.160	210	7416	93.41	306.46	93.47	306.66	-0.06	-0.20
2.220	295	10417	94.17	308.95	94.23	309.15	-0.06	-0.20
2.220	210	7416	93.38	306.36	93.45	306.59	-0.07	-0.23
2.310	295	10417	94.27	309.28	94.39	309.67	-0.12	-0.39
2.310	210	7416	93.96	308.26	94.04	308.53	-0.08	-0.26
2.390	295	10417	95.29	312.63	95.52	313.38	-0.23	-0.75
2.390	210	7416	94.92	311.41	95.04	311.81	-0.12	-0.39
2.460	295	10417	95.65	313.81	96.32	316.01	-0.67	-2.20
2.460	210	7416	95.35	312.82	95.78	314.24	-0.43	-1.41
2.540	295	10417	96.13	315.38	96.44	316.40	-0.31	-1.02
2.540	210	7416	95.69	313.94	95.87	314.53	-0.18	-0.59
2.620	295	10417	96.29	315.91	96.57	316.83	-0.28	-0.92
2.620	210	7416	95.84	314.43	96.02	315.02	-0.18	-0.59
2.660	295	10417	96.38	316.20	96.54	316.73	-0.16	-0.52
2.660	210	7416	96.34	316.07	96.32	316.01	0.02	0.07
2.724	295	10417	99.23	325.55	99.24	325.59	-0.01	-0.03
2.724	210	7416	98.92	324.54	98.92	324.54	0.00	0.00

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	**Peak Discharge**		**Computed Water Surface Elevations**					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
2.800	295	10417	99.18	325.39	99.20	325.46	-0.02	-0.07
2.800	210	7416	98.88	324.41	98.87	324.37	0.01	0.03
2.920	295	10417	99.43	326.21	99.40	326.11	0.03	0.10
2.920	210	7416	99.08	325.06	99.06	325.00	0.02	0.07
2.980	295	10417	99.28	325.72	99.32	325.85	-0.04	-0.13
2.980	210	7416	98.98	324.73	99.02	324.86	-0.04	-0.13
3.040	295	10417	100.10	328.41	100.09	328.38	0.01	0.03
3.040	210	7416	99.47	326.34	99.33	325.88	0.14	0.46
3.105	295	10417	100.10	328.41	100.09	328.38	0.01	0.03
3.105	210	7416	99.95	327.92	99.97	327.98	-0.02	-0.07
3.120	295	10417	99.84	327.56	99.67	327.00	0.17	0.56
3.120	210	7416	99.97	327.98	99.98	328.01	-0.01	-0.03
3.180	295	10417	100.79	330.67	100.62	330.11	0.17	0.56
3.180	210	7416	99.95	327.92	99.93	327.85	0.02	0.07
3.220	295	10417	101.46	332.87	101.56	333.20	-0.10	-0.33
3.220	210	7416	100.66	330.25	100.61	330.08	0.05	0.16
3.280	295	10417	101.86	334.18	101.99	334.61	-0.13	-0.43
3.280	210	7416	101.06	331.56	100.97	331.26	0.09	0.30
3.420	295	10417	101.89	334.28	102.01	334.67	-0.12	-0.39
3.420	210	7416	101.13	331.79	101.24	332.15	-0.11	-0.36

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
3.480	295	10417	101.95	334.48	102.27	335.53	-0.32	-1.05
3.480	210	7416	101.29	332.31	101.88	334.25	-0.59	-1.94
3.600	295	10417	102.22	335.36	102.47	336.18	-0.25	-0.82
3.600	210	7416	101.88	334.25	102.09	334.94	-0.21	-0.69
3.680	295	10417	102.42	336.02	102.61	336.64	-0.19	-0.62
3.680	210	7416	102.06	334.84	102.22	335.36	-0.16	-0.52
3.750	295	10417	102.74	337.07	102.81	337.30	-0.07	-0.23
3.750	210	7416	102.54	336.41	102.55	336.45	-0.01	-0.03
3.870	285	10064	102.68	336.87	102.81	337.30	-0.13	-0.43
3.870	210	7416	102.58	336.54	102.64	336.74	-0.06	-0.20
3.894	285	10064	102.96	337.79	103.23	338.68	-0.27	-0.89
3.894	210	7416	102.59	336.58	102.71	336.97	-0.12	-0.39
3.920	285	10064	103.96	341.07	103.98	341.14	-0.02	-0.07
3.920	210	7416	103.24	338.71	103.05	338.09	0.19	0.62
3.960	285	10064	103.99	341.17	104.03	341.30	-0.04	-0.13
3.960	210	7416	103.32	338.97	103.41	339.27	-0.09	-0.30
4.040	285	10064	103.71	340.25	103.62	339.96	0.09	0.30
4.040	210	7416	103.02	337.99	103.30	338.91	-0.28	-0.92
4.100	285	10064	103.83	340.65	104.31	342.22	-0.48	-1.57
4.100	210	7416	103.34	339.04	103.51	339.60	-0.17	-0.56

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
4.180	285	10064	103.95	341.04	104.34	342.32	-0.39	-1.28
4.180	210	7416	103.86	340.74	104.08	341.47	-0.22	-0.72
4.195	285	10064	104.48	342.78	104.60	343.17	-0.12	-0.39
4.195	210	7416	104.34	342.32	104.41	342.55	-0.07	-0.23
4.340	285	10064	104.72	343.57	104.62	343.24	0.10	0.33
4.340	210	7416	104.42	342.58	104.38	342.45	0.04	0.13
4.440	285	10064	105.11	344.84	105.31	345.50	-0.20	-0.66
4.440	210	7416	104.86	344.02	105.06	344.68	-0.20	-0.66
4.640	285	10064	106.30	348.75	106.30	348.75	0.00	0.00
4.640	210	7416	106.13	348.19	106.13	348.19	0.00	0.00
4.670	285	10064	106.44	349.21	106.44	349.21	0.00	0.00
4.670	210	7416	106.09	348.06	106.09	348.06	0.00	0.00
4.690	285	10064	107.19	351.67	107.16	351.57	0.03	0.10
4.690	210	7416	107.38	352.29	107.38	352.29	0.00	0.00
4.780	285	10064	108.17	354.88	108.05	354.49	0.12	0.39
4.780	210	7416	107.72	353.41	107.66	353.21	0.06	0.20
4.820	285	10064	108.02	354.39	107.93	354.10	0.09	0.30
4.820	210	7416	107.64	353.15	107.58	352.95	0.06	0.20
4.960	280	9888	109.24	358.39	109.19	358.23	0.05	0.16
4.960	210	7416	108.78	356.89	108.56	356.16	0.22	0.72

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
5.053	252.64	8922	110.23	361.64	111.01	364.20	-0.78	-2.56
5.053	195.48	6903	110.03	360.99	110.70	363.18	-0.67	-2.20
5.120	252.64	8922	112.29	368.40	112.46	368.96	-0.17	-0.56
5.120	195.48	6903	111.39	365.45	111.77	366.70	-0.38	-1.25
5.179	252.64	8922	112.30	368.43	112.46	368.96	-0.16	-0.52
5.179	195.48	6903	111.40	365.48	111.75	366.63	-0.35	-1.15
5.180	252.64	8922	112.27	368.34	112.40	368.76	-0.13	-0.43
5.180	195.48	6903	111.35	365.32	111.68	366.40	-0.33	-1.08
5.220	252.64	8922	112.19	368.07	112.39	368.73	-0.20	-0.66
5.220	195.48	6903	111.15	364.66	111.67	366.37	-0.52	-1.71
5.320	252.64	8922	113.10	371.06	113.28	371.65	-0.18	-0.59
5.320	195.48	6903	112.71	369.78	112.95	370.57	-0.24	-0.79
5.384	252.64	8922	113.37	371.94	113.46	372.24	-0.09	-0.30
5.384	195.48	6903	113.04	370.86	113.13	371.16	-0.09	-0.30
5.408	252.64	8922	114.58	375.91	114.66	376.18	-0.08	-0.26
5.408	195.48	6903	114.34	375.13	114.40	375.32	-0.06	-0.20
5.440	280	9888	114.44	375.45	114.82	376.70	-0.38	-1.25
5.440	210	7416	114.12	374.40	114.35	375.16	-0.23	-0.75
5.560	280	9888	115.59	379.23	115.61	379.29	-0.02	-0.07
5.560	210	7416	115.00	377.29	115.20	377.95	-0.20	-0.66

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
5.620	280	9888	115.62	379.33	115.62	379.33	0.00	0.00
5.620	210	7416	115.03	377.39	115.21	377.98	-0.18	-0.59
5.680	280	9888	115.64	379.39	115.69	379.56	-0.05	-0.16
5.680	210	7416	115.05	377.46	115.26	378.15	-0.21	-0.69
5.740	280	9888	115.55	379.10	115.62	379.33	-0.07	-0.23
5.740	210	7416	114.95	377.13	115.21	377.98	-0.26	-0.85
5.800	280	9888	115.51	378.97	115.63	379.36	-0.12	-0.39
5.800	210	7416	114.92	377.03	115.22	378.01	-0.30	-0.98
5.840	280	9888	115.60	379.26	115.52	379.00	0.08	0.26
5.840	210	7416	115.05	377.46	115.14	377.75	-0.09	-0.30
5.920	250	8828	115.79	379.88	115.79	379.88	0.00	0.00
5.920	195	6886	115.20	377.95	115.20	377.95	0.00	0.00
5.920	250	8828	115.79	379.88	115.80	379.92	-0.01	-0.03
5.920	195	6886	115.21	377.98	115.20	377.95	0.01	0.03
5.940	250	8828	116.69	382.84	116.67	382.77	0.02	0.07
5.940	195	6886	115.98	380.51	115.97	380.47	0.01	0.03
5.940	250	8828	116.69	382.84	116.68	382.80	0.01	0.03
5.940	195	6886	115.98	380.51	115.97	380.47	0.01	0.03
5.945	250	8828	117.94	386.94	117.94	386.94	0.00	0.00
5.945	195	6886	116.98	383.79	116.98	383.79	0.00	0.00

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
5.946	250	8828	117.88	386.74	117.93	386.90	-0.05	-0.16
5.946	195	6886	116.90	383.53	116.97	383.76	-0.07	-0.23
5.980	250	8828	117.96	387.00	117.80	386.48	0.16	0.52
5.980	195	6886	116.98	383.79	116.74	383.00	0.24	0.79
6.040	250	8828	118.03	387.23	118.05	387.30	-0.02	-0.07
6.040	195	6886	117.00	383.85	117.11	384.21	-0.11	-0.36
6.080	250	8828	118.06	387.33	118.06	387.33	0.00	0.00
6.080	195	6886	117.03	383.95	117.14	384.31	-0.11	-0.36
6.154	250	8828	118.04	387.27	118.09	387.43	-0.05	-0.16
6.154	195	6886	117.20	384.51	117.30	384.84	-0.10	-0.33
6.178	250	8828	118.50	388.77	118.52	388.84	-0.02	-0.07
6.178	195	6886	118.10	387.46	118.14	387.59	-0.04	-0.13
6.280	250	8828	118.60	389.10	118.50	388.77	0.10	0.33
6.280	195	6886	118.15	387.63	118.11	387.50	0.04	0.13
6.360	250	8828	118.49	388.74	118.54	388.91	-0.05	-0.16
6.360	195	6886	118.01	387.17	118.11	387.50	-0.10	-0.33
6.440	250	8828	118.36	388.32	118.48	388.71	-0.12	-0.39
6.440	195	6886	117.97	387.04	118.02	387.20	-0.05	-0.16
6.529	250	8828	118.90	390.09	118.61	389.14	0.29	0.95
6.529	195	6886	118.56	388.97	118.25	387.95	0.31	1.02

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
6.530	250	8828	119.10	390.74	118.72	389.50	0.38	1.25
6.530	195	6886	118.80	389.76	118.44	388.58	0.36	1.18
6.570	250	8828	119.86	393.24	120.03	393.79	-0.17	-0.56
6.570	195	6886	119.59	392.35	119.62	392.45	-0.03	-0.10
6.600	250	8828	120.12	394.09	120.10	394.02	0.02	0.07
6.600	195	6886	119.76	392.91	119.70	392.71	0.06	0.20
6.675	250	8828	120.11	394.06	120.26	394.55	-0.15	-0.49
6.675	195	6886	119.76	392.91	119.81	393.07	-0.05	-0.16
6.676	250	8828	120.58	395.60	120.53	395.43	0.05	0.16
6.676	195	6886	120.12	394.09	120.20	394.35	-0.08	-0.26
6.690	240	8475	121.56	398.81	120.41	395.04	1.15	3.77
6.690	195	6886	120.87	396.55	120.13	394.12	0.74	2.43
6.714	240	8475	121.54	398.75	120.52	395.40	1.02	3.35
6.714	195	6886	120.85	396.48	120.17	394.25	0.68	2.23
6.859	240	8475	122.17	400.82	122.13	400.68	0.04	0.13
6.859	195	6886	121.55	398.78	121.63	399.04	-0.08	-0.26
6.860	240	8475	122.17	400.82	122.10	400.59	0.07	0.23
6.860	195	6886	121.55	398.78	121.57	398.85	-0.02	-0.07
6.880	240	8475	122.12	400.65	122.14	400.72	-0.02	-0.07
6.880	195	6886	121.42	398.35	121.64	399.08	-0.22	-0.72

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
7.000	240	8475	122.62	402.29	122.97	403.44	-0.35	-1.15
7.000	195	6886	122.46	401.77	122.82	402.95	-0.36	-1.18
7.080	240	8475	123.31	404.56	123.56	405.38	-0.25	-0.82
7.080	195	6886	123.15	404.03	123.42	404.92	-0.27	-0.89
7.160	240	8475	124.52	408.53	124.47	408.36	0.05	0.16
7.160	195	6886	124.38	408.07	124.34	407.93	0.04	0.13
7.199	240	8475	125.26	410.95	124.94	409.90	0.32	1.05
7.199	195	6886	125.10	410.43	124.76	409.31	0.34	1.12
7.200	240	8475	125.33	411.18	124.97	410.00	0.36	1.18
7.200	195	6886	125.21	410.79	124.80	409.44	0.41	1.35
7.240	240	8475	125.63	412.17	125.57	411.97	0.06	0.20
7.240	195	6886	125.49	411.71	125.45	411.58	0.04	0.13
7.260	220	7769	126.32	414.43	126.31	414.40	0.01	0.03
7.260	180	6356	126.10	413.71	126.10	413.71	0.00	0.00
7.260	220	7769	126.32	414.43	126.31	414.40	0.01	0.03
7.260	180	6356	126.10	413.71	126.10	413.71	0.00	0.00
7.284	220	7769	126.53	415.12	126.53	415.12	0.00	0.00
7.284	180	6356	126.32	414.43	126.32	414.43	0.00	0.00
7.284	220	7769	126.54	415.15	126.54	415.15	0.00	0.00
7.284	180	6356	126.33	414.46	126.33	414.46	0.00	0.00

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
7.288	145	5120	126.67	415.58	126.67	415.58	0.00	0.00
7.288	115	4061	126.36	414.56	126.36	414.56	0.00	0.00
7.310	145	5120	126.83	416.10	126.83	416.10	0.00	0.00
7.310	115	4061	126.52	415.09	126.52	415.09	0.00	0.00
7.313	145	5120	127.48	418.24	127.48	418.24	0.00	0.00
7.313	115	4061	127.16	417.19	127.16	417.19	0.00	0.00
7.320	145	5120	127.68	418.89	127.68	418.89	0.00	0.00
7.320	115	4061	127.30	417.65	127.30	417.65	0.00	0.00
7.323	145	5120	127.63	418.73	127.63	418.73	0.00	0.00
7.323	115	4061	127.24	417.45	127.24	417.45	0.00	0.00
7.324	145	5120	127.63	418.73	127.63	418.73	0.00	0.00
7.324	115	4061	127.24	417.45	127.24	417.45	0.00	0.00
7.324	145	5120	127.76	419.16	127.76	419.16	0.00	0.00
7.324	115	4061	127.37	417.88	127.36	417.84	0.01	0.03
7.327	145	5120	127.77	419.19	127.76	419.16	0.01	0.03
7.327	115	4061	127.37	417.88	127.37	417.88	0.00	0.00
7.327	145	5120	127.69	418.93	127.68	418.89	0.01	0.03
7.327	115	4061	127.28	417.58	127.28	417.58	0.00	0.00
7.329	145	5120	127.69	418.93	127.69	418.93	0.00	0.00
7.329	115	4061	127.29	417.61	127.29	417.61	0.00	0.00

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	**Peak Discharge**		**Computed Water Surface Elevations**					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
7.329	145	5120	128.04	420.07	128.03	420.04	0.01	0.03
7.329	115	4061	127.53	418.40	127.52	418.37	0.01	0.03
7.330	145	5120	128.04	420.07	128.03	420.04	0.01	0.03
7.330	115	4061	127.53	418.40	127.52	418.37	0.01	0.03
7.330	145	5120	127.94	419.75	127.93	419.71	0.01	0.03
7.330	115	4061	127.41	418.01	127.40	417.97	0.01	0.03
7.331	145	5120	127.94	419.75	127.93	419.71	0.01	0.03
7.331	115	4061	127.41	418.01	127.40	417.97	0.01	0.03
7.331	145	5120	128.30	420.93	128.30	420.93	0.00	0.00
7.331	115	4061	127.93	419.71	127.92	419.68	0.01	0.03
7.336	145	5120	128.31	420.96	128.30	420.93	0.01	0.03
7.336	115	4061	127.93	419.71	127.93	419.71	0.00	0.00
7.357	145	5120	128.39	421.22	128.39	421.22	0.00	0.00
7.357	115	4061	128.01	419.98	128.01	419.98	0.00	0.00
7.386	145	5120	128.22	420.66	128.29	420.89	-0.07	-0.23
7.386	115	4061	127.84	419.42	127.91	419.65	-0.07	-0.23
7.397	145	5120	128.41	421.29	128.31	420.96	0.10	0.33
7.397	115	4061	128.05	420.11	127.93	419.71	0.12	0.39
7.400	145	5120	128.44	421.39	128.35	421.09	0.09	0.30
7.400	115	4061	128.09	420.24	128.00	419.94	0.09	0.30

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
7.407	145	5120	128.44	421.39	128.36	421.12	0.08	0.26
7.407	115	4061	128.10	420.27	128.01	419.98	0.09	0.30
7.410	145	5120	128.38	421.19	128.28	420.86	0.10	0.33
7.410	115	4061	128.03	420.04	127.93	419.71	0.10	0.33
7.411	145	5120	128.47	421.48	128.39	421.22	0.08	0.26
7.411	115	4061	128.13	420.37	128.07	420.17	0.06	0.20
7.413	145	5120	128.47	421.48	128.39	421.22	0.08	0.26
7.413	115	4061	128.13	420.37	128.07	420.17	0.06	0.20
7.414	145	5120	128.43	421.35	128.36	421.12	0.07	0.23
7.414	115	4061	128.09	420.24	128.02	420.01	0.07	0.23
7.415	145	5120	128.44	421.39	128.36	421.12	0.08	0.26
7.415	115	4061	128.11	420.30	128.03	420.04	0.08	0.26
7.415	145	5120	128.40	421.25	128.31	420.96	0.09	0.30
7.415	115	4061	128.05	420.11	127.94	419.75	0.11	0.36
7.416	145	5120	128.40	421.25	128.31	420.96	0.09	0.30
7.416	115	4061	128.05	420.11	127.94	419.75	0.11	0.36
7.416	145	5120	128.47	421.48	128.32	420.99	0.15	0.49
7.416	115	4061	128.03	420.04	128.01	419.98	0.02	0.07
7.417	145	5120	128.47	421.48	128.37	421.16	0.10	0.33
7.417	115	4061	128.03	420.04	128.02	420.01	0.01	0.03

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
7.417	145	5120	128.44	421.39	128.34	421.06	0.10	0.33
7.417	115	4061	128.02	420.01	128.02	420.01	0.00	0.00
7.460	145	5120	129.03	423.32	128.74	422.37	0.29	0.95
7.460	115	4061	128.61	421.94	128.48	421.52	0.13	0.43
7.518	145	5120	130.16	427.03	130.25	427.32	-0.09	-0.30
7.518	115	4061	129.90	426.18	129.99	426.47	-0.09	-0.30
7.545	145	5120	130.47	428.05	130.47	428.05	0.00	0.00
7.545	115	4061	130.20	427.16	130.19	427.13	0.01	0.03
7.545	145	5120	130.69	428.77	130.69	428.77	0.00	0.00
7.545	115	4061	130.45	427.98	130.45	427.98	0.00	0.00
7.546	145	5120	130.70	428.80	130.70	428.80	0.00	0.00
7.546	115	4061	130.47	428.05	130.47	428.05	0.00	0.00
7.546	145	5120	131.06	429.98	131.06	429.98	0.00	0.00
7.546	115	4061	130.82	429.19	130.82	429.19	0.00	0.00
7.569	145	5120	131.05	429.95	131.05	429.95	0.00	0.00
7.569	115	4061	130.81	429.16	130.81	429.16	0.00	0.00
7.614	145	5120	131.21	430.47	131.24	430.57	-0.03	-0.10
7.614	115	4061	130.77	429.03	130.77	429.03	0.00	0.00
7.631	145	5120	132.27	433.95	132.27	433.95	0.00	0.00
7.631	115	4061	131.91	432.77	131.91	432.77	0.00	0.00

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
7.631	145	5120	132.27	433.95	132.27	433.95	0.00	0.00
7.631	115	4061	131.91	432.77	131.91	432.77	0.00	0.00
7.655	145	5120	132.82	435.76	132.82	435.76	0.00	0.00
7.655	115	4061	132.46	434.57	132.46	434.57	0.00	0.00
7.655	145	5120	132.83	435.79	132.83	435.79	0.00	0.00
7.655	115	4061	132.47	434.61	132.47	434.61	0.00	0.00
7.679	145	5120	134.05	439.79	134.05	439.79	0.00	0.00
7.679	115	4061	133.45	437.82	133.45	437.82	0.00	0.00
7.719	145	5120	133.85	439.14	133.85	439.14	0.00	0.00
7.719	115	4061	133.25	437.17	133.25	437.17	0.00	0.00
7.723	145	5120	134.60	441.60	134.59	441.56	0.01	0.03
7.723	115	4061	134.11	439.99	134.11	439.99	0.00	0.00
7.730	145	5120	134.61	441.63	134.61	441.63	0.00	0.00
7.730	115	4061	134.12	440.02	134.13	440.05	-0.01	-0.03
7.733	145	5120	134.41	440.97	134.41	440.97	0.00	0.00
7.733	115	4061	133.93	439.40	133.95	439.46	-0.02	-0.07
7.734	145	5120	134.71	441.96	134.69	441.89	0.02	0.07
7.734	115	4061	134.21	440.32	134.22	440.35	-0.01	-0.03
7.740	145	5120	135.06	443.10	135.06	443.10	0.00	0.00
7.740	115	4061	134.58	441.53	134.58	441.53	0.00	0.00

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
7.741	145	5120	135.06	443.10	135.07	443.14	-0.01	-0.03
7.741	115	4061	134.59	441.56	134.60	441.60	-0.01	-0.03
7.741	145	5120	135.66	445.07	135.66	445.07	0.00	0.00
7.741	115	4061	135.32	443.96	135.32	443.96	0.00	0.00
7.753	145	5120	135.67	445.11	135.67	445.11	0.00	0.00
7.753	115	4061	135.32	443.96	135.33	443.99	-0.01	-0.03
7.786	145	5120	135.49	444.52	135.53	444.65	-0.04	-0.13
7.786	115	4061	135.22	443.63	135.25	443.73	-0.03	-0.10
7.799	145	5120	135.47	444.45	135.50	444.55	-0.03	-0.10
7.799	115	4061	135.21	443.60	135.24	443.70	-0.03	-0.10
7.802	145	5120	136.19	446.81	136.19	446.81	0.00	0.00
7.802	115	4061	135.72	445.27	135.73	445.30	-0.01	-0.03
7.809	145	5120	136.19	446.81	136.19	446.81	0.00	0.00
7.809	115	4061	135.73	445.30	135.73	445.30	0.00	0.00
7.812	145	5120	136.03	446.29	136.03	446.29	0.00	0.00
7.812	115	4061	135.56	444.75	135.56	444.75	0.00	0.00
7.813	145	5120	136.36	447.37	136.36	447.37	0.00	0.00
7.813	115	4061	135.88	445.80	135.88	445.80	0.00	0.00
7.820	145	5120	136.49	447.80	136.49	447.80	0.00	0.00
7.820	115	4061	136.09	446.48	136.09	446.48	0.00	0.00

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
7.821	145	5120	136.49	447.80	136.50	447.83	-0.01	-0.03
7.821	115	4061	136.10	446.52	136.10	446.52	0.00	0.00
7.821	145	5120	137.17	450.03	137.17	450.03	0.00	0.00
7.821	115	4061	136.78	448.75	136.78	448.75	0.00	0.00
7.826	145	5120	137.16	449.99	137.16	449.99	0.00	0.00
7.826	115	4061	136.77	448.72	136.77	448.72	0.00	0.00
7.873	145	5120	137.21	450.16	137.21	450.16	0.00	0.00
7.873	115	4061	136.84	448.94	136.84	448.94	0.00	0.00
7.876	145	5120	137.56	451.31	137.57	451.34	-0.01	-0.03
7.876	115	4061	137.15	449.96	137.14	449.93	0.01	0.03
7.883	145	5120	137.57	451.34	137.58	451.37	-0.01	-0.03
7.883	115	4061	137.15	449.96	137.15	449.96	0.00	0.00
7.886	145	5120	137.45	450.95	137.45	450.95	0.00	0.00
7.886	115	4061	137.02	449.54	137.02	449.54	0.00	0.00
7.887	145	5120	137.66	451.63	137.68	451.70	-0.02	-0.07
7.887	115	4061	137.25	450.29	137.25	450.29	0.00	0.00
7.893	145	5120	137.77	452.00	137.76	451.96	0.01	0.03
7.893	115	4061	137.46	450.98	137.46	450.98	0.00	0.00
7.894	145	5120	137.77	452.00	137.78	452.03	-0.01	-0.03
7.894	115	4061	137.46	450.98	137.47	451.01	-0.01	-0.03

Appendix F: **COMPUTED FLOOD LEVEL ELEVATION CHECK**

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
7.894	145	5120	138.37	453.96	138.37	453.96	0.00	0.00
7.894	115	4061	138.05	452.91	138.04	452.88	0.01	0.03
7.911	145	5120	138.04	452.88	138.06	452.95	-0.02	-0.07
7.911	115	4061	137.82	452.16	137.82	452.16	0.00	0.00
7.960	145	5120	138.54	454.52	138.52	454.46	0.02	0.07
7.960	115	4061	138.13	453.18	138.12	453.14	0.01	0.03
8.000	145	5120	139.46	457.54	139.48	457.61	-0.02	-0.07
8.000	115	4061	138.97	455.93	139.01	456.06	-0.04	-0.13
8.024	145	5120	141.01	462.63	141.01	462.63	0.00	0.00
8.024	115	4061	140.42	460.69	140.43	460.72	-0.01	-0.03
8.024	145	5120	141.37	463.81	141.37	463.81	0.00	0.00
8.024	115	4061	140.98	462.53	140.98	462.53	0.00	0.00
8.025	145	5120	142.10	466.20	142.10	466.20	0.00	0.00
8.025	115	4061	141.72	464.95	141.72	464.95	0.00	0.00
8.036	145	5120	142.13	466.30	142.14	466.33	-0.01	-0.03
8.036	115	4061	141.75	465.05	141.76	465.09	-0.01	-0.03
8.036	145	5120	141.92	465.61	141.92	465.61	0.00	0.00
8.036	115	4061	141.60	464.56	141.60	464.56	0.00	0.00
8.038	145	5120	141.93	465.64	141.93	465.64	0.00	0.00
8.038	115	4061	141.62	464.63	141.62	464.63	0.00	0.00

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
8.038	145	5120	142.82	468.56	142.82	468.56	0.00	0.00
8.038	115	4061	142.43	467.28	142.43	467.28	0.00	0.00
8.080	145	5120	142.57	467.74	142.63	467.94	-0.06	-0.20
8.080	115	4061	142.26	466.73	142.29	466.83	-0.03	-0.10
8.120	145	5120	142.38	467.12	142.34	466.99	0.04	0.13
8.120	115	4061	141.92	465.61	141.89	465.51	0.03	0.10
8.169	145	5120	143.18	469.74	142.93	468.92	0.25	0.82
8.169	115	4061	142.60	467.84	142.43	467.28	0.17	0.56
8.170	145	5120	143.94	472.24	143.86	471.98	0.08	0.26
8.170	115	4061	143.43	470.57	143.36	470.34	0.07	0.23
8.177	145	5120	145.63	477.78	145.34	476.83	0.29	0.95
8.177	115	4061	144.91	475.42	144.68	474.67	0.23	0.75
8.177	145	5120	145.63	477.78	145.24	476.50	0.39	1.28
8.177	115	4061	144.91	475.42	144.67	474.63	0.24	0.79
8.201	145	5120	145.59	477.65	145.29	476.67	0.30	0.98
8.201	115	4061	144.87	475.29	144.62	474.47	0.25	0.82
8.201	145	5120	145.59	477.65	145.43	477.13	0.16	0.52
8.201	115	4061	144.87	475.29	144.71	474.76	0.16	0.52
8.230	145	5120	145.42	477.09	145.15	476.21	0.27	0.89
8.230	115	4061	144.63	474.50	144.35	473.58	0.28	0.92

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	**Peak Discharge**		**Computed Water Surface Elevations**					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
8.260	145	5120	146.29	479.95	146.25	479.82	0.04	0.13
8.260	115	4061	145.72	478.08	145.72	478.08	0.00	0.00
8.316	145	5120	146.80	481.62	146.80	481.62	0.00	0.00
8.316	115	4061	146.02	479.06	146.03	479.10	-0.01	-0.03
8.316	145	5120	147.21	482.97	147.22	483.00	-0.01	-0.03
8.316	115	4061	146.75	481.46	146.75	481.46	0.00	0.00
8.317	145	5120	148.00	485.56	148.01	485.59	-0.01	-0.03
8.317	115	4061	147.58	484.18	147.58	484.18	0.00	0.00
8.328	145	5120	148.02	485.62	148.04	485.69	-0.02	-0.07
8.328	115	4061	147.61	484.28	147.62	484.31	-0.01	-0.03
8.328	145	5120	147.80	484.90	147.80	484.90	0.00	0.00
8.328	115	4061	147.47	483.82	147.47	483.82	0.00	0.00
8.330	145	5120	147.82	484.97	147.82	484.97	0.00	0.00
8.330	115	4061	147.47	483.82	147.48	483.85	-0.01	-0.03
8.330	145	5120	148.65	487.69	148.65	487.69	0.00	0.00
8.330	115	4061	148.28	486.48	148.28	486.48	0.00	0.00
8.368	145	5120	148.33	486.64	148.33	486.64	0.00	0.00
8.368	115	4061	148.04	485.69	148.05	485.72	-0.01	-0.03
8.368	145	5120	148.50	487.20	148.50	487.20	0.00	0.00
8.368	115	4061	148.11	485.92	148.12	485.95	-0.01	-0.03

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
8.369	145	5120	149.42	490.22	149.42	490.22	0.00	0.00
8.369	115	4061	148.95	488.68	148.93	488.61	0.02	0.07
8.379	145	5120	149.45	490.32	149.45	490.32	0.00	0.00
8.379	115	4061	148.98	488.77	148.97	488.74	0.01	0.03
8.379	145	5120	149.32	489.89	149.32	489.89	0.00	0.00
8.379	115	4061	148.95	488.68	148.95	488.68	0.00	0.00
8.380	145	5120	149.33	489.92	149.33	489.92	0.00	0.00
8.380	115	4061	148.96	488.71	148.96	488.71	0.00	0.00
8.380	145	5120	150.51	493.79	150.35	493.27	0.16	0.52
8.380	115	4061	150.03	492.22	149.92	491.86	0.11	0.36
8.430	145	5120	150.41	493.47	150.27	493.01	0.14	0.46
8.430	115	4061	149.93	491.89	149.83	491.56	0.10	0.33
8.456	145	5120	150.92	495.14	150.91	495.11	0.01	0.03
8.456	115	4061	150.57	493.99	150.57	493.99	0.00	0.00
8.473	145	5120	150.91	495.11	150.91	495.11	0.00	0.00
8.473	115	4061	151.74	497.83	151.74	497.83	0.00	0.00
8.520	145	5120	152.29	499.63	152.34	499.80	-0.05	-0.16
8.520	115	4061	151.91	498.39	151.92	498.42	-0.01	-0.03
8.549	145	5120	153.26	502.82	153.22	502.68	0.04	0.13
8.549	115	4061	152.77	501.21	152.76	501.18	0.01	0.03

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
8.550	145	5120	153.24	502.75	153.09	502.26	0.15	0.49
8.550	115	4061	152.74	501.11	152.64	500.78	0.10	0.33
8.555	145	5120	152.97	501.86	152.93	501.73	0.04	0.13
8.555	115	4061	152.53	500.42	152.53	500.42	0.00	0.00
8.745	145	5120	155.51	510.20	155.46	510.03	0.05	0.16
8.745	115	4061	153.81	504.62	153.81	504.62	0.00	0.00
8.760	145	5120	156.27	512.69	156.36	512.99	-0.09	-0.30
8.760	115	4061	155.81	511.18	155.83	511.25	-0.02	-0.07
8.839	145	5120	157.19	515.71	157.20	515.74	-0.01	-0.03
8.839	115	4061	156.70	514.10	156.76	514.30	-0.06	-0.20
8.840	145	5120	157.42	516.46	157.42	516.46	0.00	0.00
8.840	115	4061	157.00	515.09	156.99	515.05	0.01	0.03
8.920	145	5120	158.41	519.71	158.17	518.92	0.24	0.79
8.920	115	4061	157.95	518.20	157.80	517.71	0.15	0.49
8.985	140	4944	158.66	520.53	158.65	520.50	0.01	0.03
8.985	115	4061	158.20	519.02	158.19	518.99	0.01	0.03
9.128	140	4944	160.76	527.42	160.76	527.42	0.00	0.00
9.128	115	4061	160.17	525.49	160.16	525.45	0.01	0.03
9.200	120	4238	161.92	531.23	161.94	531.29	-0.02	-0.07
9.200	95	3355	161.15	528.70	161.16	528.73	-0.01	-0.03

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
9.250	120	4238	161.91	531.19	161.92	531.23	-0.01	-0.03
9.250	95	3355	161.15	528.70	161.15	528.70	0.00	0.00
9.281	120	4238	161.91	531.19	161.91	531.19	0.00	0.00
9.281	95	3355	161.19	528.83	161.19	528.83	0.00	0.00
9.289	120	4238	161.94	531.29	161.94	531.29	0.00	0.00
9.289	95	3355	161.21	528.90	161.20	528.86	0.01	0.03
9.340	120	4238	161.94	531.29	161.95	531.33	-0.01	-0.03
9.340	95	3355	161.20	528.86	161.21	528.90	-0.01	-0.03
9.341	120	4238	161.93	531.26	161.95	531.33	-0.02	-0.07
9.341	95	3355	161.19	528.83	161.20	528.86	-0.01	-0.03
9.360	120	4238	161.94	531.29	161.95	531.33	-0.01	-0.03
9.360	95	3355	161.20	528.86	161.21	528.90	-0.01	-0.03
9.400	120	4238	161.94	531.29	161.96	531.36	-0.02	-0.07
9.400	95	3355	161.21	528.90	161.22	528.93	-0.01	-0.03
9.499	120	4238	162.00	531.49	161.99	531.46	0.01	0.03
9.499	95	3355	161.28	529.13	161.27	529.09	0.01	0.03
9.500	120	4238	162.00	531.49	161.99	531.46	0.01	0.03
9.500	95	3355	161.28	529.13	161.26	529.06	0.02	0.07
9.600	110	3884	161.98	531.42	161.98	531.42	0.00	0.00
9.600	95	3355	161.26	529.06	161.25	529.03	0.01	0.03

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
9.627	110	3884	162.00	531.49	162.00	531.49	0.00	0.00
9.627	95	3355	161.55	530.01	161.54	529.98	0.01	0.03
9.639	110	3884	161.80	530.83	161.78	530.77	0.02	0.07
9.639	95	3355	161.24	529.00	161.22	528.93	0.02	0.07
9.720	110	3884	161.80	530.83	162.23	532.24	-0.43	-1.41
9.720	95	3355	161.33	529.29	161.90	531.16	-0.57	-1.87
9.800	110	3884	162.37	532.70	162.47	533.03	-0.10	-0.33
9.800	95	3355	162.17	532.05	162.18	532.08	-0.01	-0.03
9.880	110	3884	162.46	533.00	162.58	533.39	-0.12	-0.39
9.880	95	3355	162.27	532.38	162.32	532.54	-0.05	-0.16
9.960	110	3884	162.57	533.36	162.69	533.75	-0.12	-0.39
9.960	95	3355	162.40	532.80	162.46	533.00	-0.06	-0.20
10.040	110	3884	162.70	533.79	162.81	534.15	-0.11	-0.36
10.040	95	3355	162.54	533.26	162.61	533.49	-0.07	-0.23
10.160	110	3884	162.41	532.83	162.50	533.13	-0.09	-0.30
10.160	95	3355	162.35	532.64	162.40	532.80	-0.05	-0.16
10.205	110	3884	163.04	534.90	162.98	534.70	0.06	0.20
10.205	95	3355	162.63	533.56	162.64	533.59	-0.01	-0.03
10.327	110	3884	164.08	538.31	164.11	538.41	-0.03	-0.10
10.327	95	3355	163.68	537.00	163.73	537.17	-0.05	-0.16

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
10.330	110	3884	164.03	538.15	164.07	538.28	-0.04	-0.13
10.330	95	3355	163.59	536.71	163.67	536.97	-0.08	-0.26
10.360	110	3884	164.05	538.22	164.09	538.35	-0.04	-0.13
10.360	95	3355	163.66	536.94	163.73	537.17	-0.07	-0.23
10.400	110	3884	164.05	538.22	164.09	538.35	-0.04	-0.13
10.400	95	3355	163.67	536.97	163.73	537.17	-0.06	-0.20
10.480	110	3884	164.11	538.41	164.13	538.48	-0.02	-0.07
10.480	95	3355	163.75	537.23	163.78	537.33	-0.03	-0.10
10.560	110	3884	164.13	538.48	164.17	538.61	-0.04	-0.13
10.560	95	3355	163.77	537.30	163.83	537.49	-0.06	-0.20
10.677	110	3884	164.20	538.71	164.25	538.87	-0.05	-0.16
10.677	95	3355	163.88	537.66	163.94	537.85	-0.06	-0.20
10.680	110	3884	163.92	537.79	164.14	538.51	-0.22	-0.72
10.680	95	3355	163.78	537.33	163.72	537.13	0.06	0.20
10.720	110	3884	164.24	538.84	164.16	538.58	0.08	0.26
10.720	95	3355	164.10	538.38	164.04	538.18	0.06	0.20
10.800	110	3884	164.96	541.20	164.89	540.97	0.07	0.23
10.800	95	3355	164.81	540.71	164.75	540.51	0.06	0.20
10.854	110	3884	165.28	542.25	165.28	542.25	0.00	0.00
10.854	95	3355	165.06	541.53	165.06	541.53	0.00	0.00

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
10.877	110	3884	165.53	543.07	165.53	543.07	0.00	0.00
10.877	95	3355	165.31	542.35	165.31	542.35	0.00	0.00
10.878	110	3884	166.56	546.45	166.56	546.45	0.00	0.00
10.878	95	3355	166.23	545.37	166.23	545.37	0.00	0.00
10.938	110	3884	166.65	546.75	166.94	547.70	-0.29	-0.95
10.938	95	3355	166.33	545.70	166.52	546.32	-0.19	-0.62
10.940	110	3884	166.60	546.58	166.93	547.66	-0.33	-1.08
10.940	95	3355	166.40	545.93	166.51	546.29	-0.11	-0.36
10.999	110	3884	167.15	548.39	167.08	548.16	0.07	0.23
10.999	95	3355	166.99	547.86	166.78	547.17	0.21	0.69
11.000	110	3884	167.14	548.35	167.08	548.16	0.06	0.20
11.000	95	3355	166.99	547.86	166.77	547.14	0.22	0.72
11.080	110	3884	167.27	548.78	167.22	548.62	0.05	0.16
11.080	95	3355	167.12	548.29	166.97	547.80	0.15	0.49
11.160	110	3884	167.65	550.03	167.50	549.53	0.15	0.49
11.160	95	3355	167.48	549.47	167.31	548.91	0.17	0.56
11.240	110	3884	167.78	550.45	167.66	550.06	0.12	0.39
11.240	95	3355	167.61	549.89	167.48	549.47	0.13	0.43
11.320	110	3884	167.95	551.01	167.84	550.65	0.11	0.36
11.320	95	3355	167.78	550.45	167.67	550.09	0.11	0.36

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
11.370	110	3884	168.05	551.34	167.96	551.04	0.09	0.30
11.370	95	3355	167.87	550.75	167.79	550.49	0.08	0.26
11.400	110	3884	168.21	551.86	168.01	551.21	0.20	0.66
11.400	95	3355	168.04	551.31	167.84	550.65	0.20	0.66
11.520	110	3884	168.36	552.36	168.22	551.90	0.14	0.46
11.520	95	3355	168.19	551.80	168.04	551.31	0.15	0.49
11.600	110	3884	168.42	552.55	168.29	552.13	0.13	0.43
11.600	95	3355	168.25	551.99	168.12	551.57	0.13	0.43
11.675	100	3531	168.16	551.70	168.00	551.17	0.16	0.52
11.675	95	3355	167.97	551.08	167.81	550.55	0.16	0.52
11.705	100	3531	168.95	554.29	168.31	552.19	0.64	2.10
11.705	95	3355	168.26	552.03	168.18	551.76	0.08	0.26
11.760	100	3531	169.13	554.88	169.17	555.01	-0.04	-0.13
11.760	95	3355	169.03	554.55	169.03	554.55	0.00	0.00
11.790	100	3531	169.11	554.82	169.16	554.98	-0.05	-0.16
11.790	95	3355	169.03	554.55	169.02	554.52	0.01	0.03
11.800	100	3531	170.78	560.30	170.85	560.52	-0.07	-0.23
11.800	95	3355	170.77	560.26	170.77	560.26	0.00	0.00
11.880	100	3531	171.61	563.02	171.60	562.99	0.01	0.03
11.880	95	3355	171.53	562.76	171.53	562.76	0.00	0.00

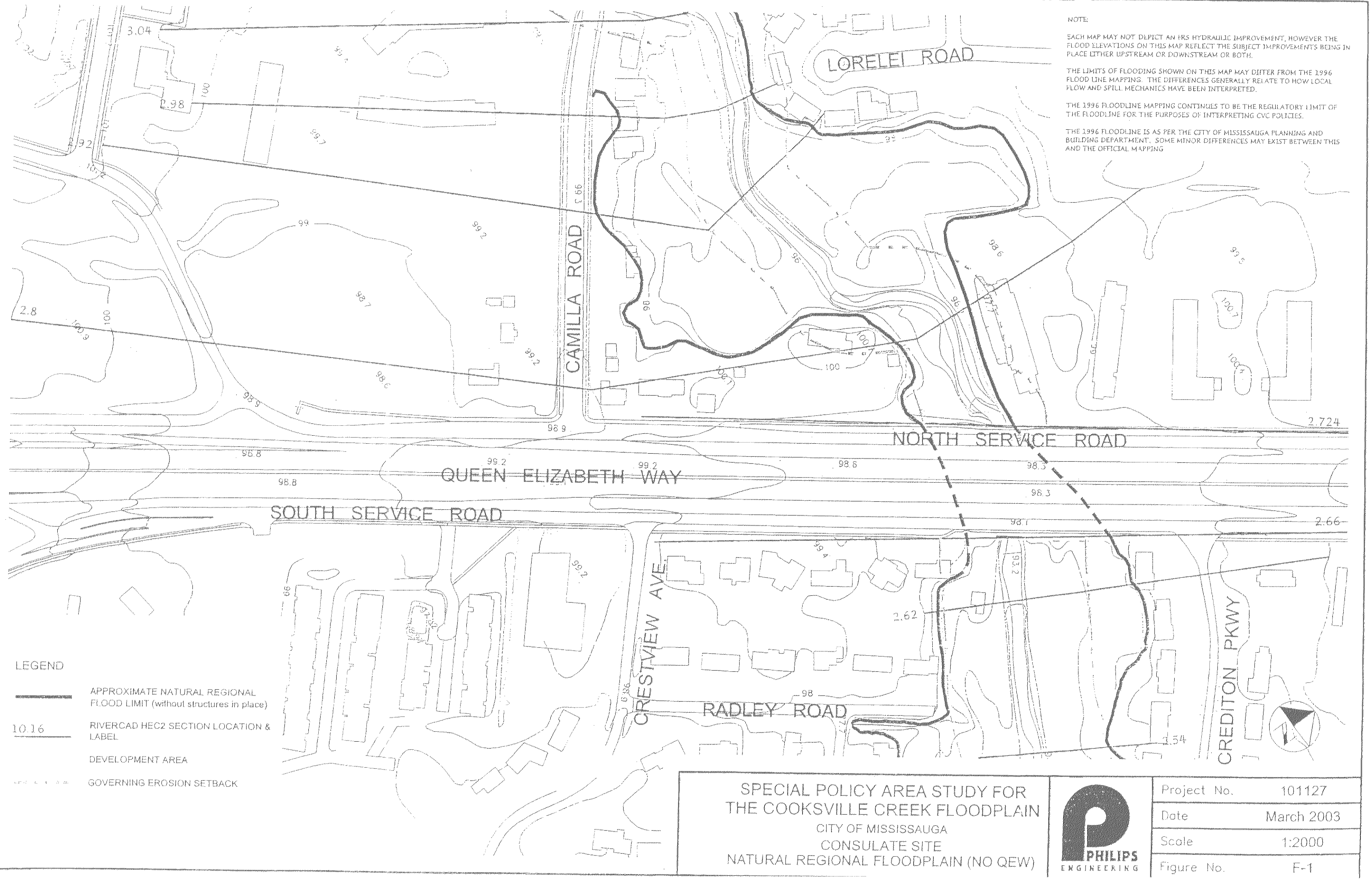
Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	Peak Discharge		Computed Water Surface Elevations					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
11.960	100	3531	171.65	563.15	171.64	563.12	0.01	0.03
11.960	95	3355	171.57	562.89	171.57	562.89	0.00	0.00
12.040	100	3531	171.64	563.12	171.63	563.08	0.01	0.03
12.040	95	3355	171.56	562.85	171.56	562.85	0.00	0.00
12.055	100	3531	171.54	562.79	171.54	562.79	0.00	0.00
12.055	95	3355	171.47	562.56	171.48	562.59	-0.01	-0.03
12.065	100	3531	171.54	562.79	171.54	562.79	0.00	0.00
12.065	95	3355	171.46	562.53	171.47	562.56	-0.01	-0.03
12.120	100	3531	171.56	562.85	171.67	563.21	-0.11	-0.36
12.120	95	3355	171.48	562.59	171.59	562.95	-0.11	-0.36
12.200	100	3531	171.82	563.71	171.84	563.77	-0.02	-0.07
12.200	95	3355	171.75	563.48	171.77	563.54	-0.02	-0.07
12.280	100	3531	171.96	564.17	171.96	564.17	0.00	0.00
12.280	95	3355	171.89	563.94	171.89	563.94	0.00	0.00
12.360	100	3531	171.98	564.23	172.01	564.33	-0.03	-0.10
12.360	95	3355	171.91	564.00	171.94	564.10	-0.03	-0.10
12.440	80	2825	172.14	564.76	172.14	564.76	0.00	0.00
12.440	80	2825	172.06	564.49	172.06	564.49	0.00	0.00
12.520	80	2825	172.17	564.86	172.18	564.89	-0.01	-0.03
12.520	80	2825	172.09	564.59	172.10	564.63	-0.01	-0.03

Appendix F: COMPUTED FLOOD LEVEL ELEVATION CHECK

Cross-Section Number	**Peak Discharge**		**Computed Water Surface Elevations**					
			RIVERCAD		HEC-2		CHANGE	
	(m^3/s)	(ft^3/s)	(m MSL)	(feet MSL)	(m MSL)	(feet MSL)	(m)	(feet)
12.600	80	2825	172.22	565.02	172.25	565.12	-0.03	-0.10
12.600	80	2825	172.14	564.76	172.18	564.89	-0.04	-0.13
12.680	80	2825	172.33	565.38	172.34	565.41	-0.01	-0.03
12.680	80	2825	172.27	565.18	172.29	565.25	-0.02	-0.07
12.760	80	2825	172.44	565.74	172.41	565.64	0.03	0.10
12.760	80	2825	172.39	565.58	172.36	565.48	0.03	0.10

CONSULTATE PROPERTY
NATURAL FLOODPLAIN ASSESSMENT



NOTE:

EACH MAP MAY NOT DEPICT AN FRS HYDRAULIC IMPROVEMENT, HOWEVER THE FLOOD ELEVATIONS ON THIS MAP REFLECT THE SUBJECT IMPROVEMENTS BEING IN PLACE EITHER UPSTREAM OR DOWNSTREAM OR BOTH.

THE LIMITS OF FLOODING SHOWN ON THIS MAP MAY DIFFER FROM THE 1996 FLOOD LINE MAPPING. THE DIFFERENCES GENERALLY RELATE TO HOW LOCAL FLOW AND SPILL MECHANICS HAVE BEEN INTERPRETED.

THE 1996 FLOODLINE MAPPING CONTINUES TO BE THE REGULATORY LIMIT OF THE FLOODLINE FOR THE PURPOSES OF INTERPRETING CVC POLICIES.

THE 1996 FLOODLINE IS AS PER THE CITY OF MISSISSAUGA PLANNING AND BUILDING DEPARTMENT. SOME MINOR DIFFERENCES MAY EXIST BETWEEN THIS AND THE OFFICIAL MAPPING

LEGEND

▬	APPROXIMATE NATURAL REGIONAL FLOOD LIMIT (without structures in place)
10.16	RIVERCAD HEC2 SECTION LOCATION & LABEL
	DEVELOPMENT AREA
- - -	GOVERNING EROSION SETBACK

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
CONSULATE SITE
NATURAL REGIONAL FLOODPLAIN (NO QEW)

PHILIPS
ENGINEERING

Project No.	101127
Date	March 2003
Scale	1:2000
Figure No.	F-1

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          CONSULATE NATURAL FLOOD LIMITS ASSESSMENT

          Note: QEW and associated culvert have been removed from HEC-2 model.

SUMMARY PRINTOUT

         SECNO        Q        EG       CWSEL     CRIWS     ELTRD     ELLC    K*CHSL     ELMIN     DEPTH      AREA     TOPWID

*        2.460    295.00     96.57     96.32       .00       .00       .00      4.71     91.80      4.52    210.04      86.55
*        2.460    210.00     96.01     95.78       .00       .00       .00      4.71     91.80      3.98    163.87      86.28

*        2.540    295.00     96.68     96.44       .00       .00       .00      6.12     92.29      4.15    215.96     114.85
*        2.540    210.00     96.13     95.87       .00       .00       .00      6.12     92.29      3.58    152.43     106.09

         2.620    295.00     96.95     96.57       .00       .00       .00     11.00     93.17      3.40    152.42     105.43
*        2.620    210.00     96.48     96.02       .00       .00       .00     11.00     93.17      2.85     97.74      96.75

*        2.800    295.00     98.81     97.88     97.88       .00       .00     16.45     94.42      3.46     86.54      48.14
*        2.800    210.00     98.23     97.42     97.42       .00       .00     16.45     94.42      3.00     66.32      41.66

*        2.920    295.00     99.33     99.14       .00       .00       .00      9.25     95.53      3.61    205.69     147.91
*        2.920    210.00     98.87     98.61       .00       .00       .00      9.25     95.53      3.08    135.06     122.96

*        2.980    295.00     99.70     99.04       .00       .00       .00      4.00     95.77      3.27    112.50      77.47
*        2.980    210.00     99.29     98.69     98.69       .00       .00      4.00     95.77      2.92     85.84      70.63

*        3.040    295.00    100.60    100.04    100.04       .00       .00      2.33     95.91      4.13    162.24     190.52
*        3.040    210.00    100.17     99.31     99.31       .00       .00      2.33     95.91      3.40     68.88      58.39
```

CONSULATE PROPERTY
PRELIMINARY SPILL ANALYSIS

CAMILLA / CONSULATE SITE

SEC 3.04 : FLOOD EL = 100.15

SEC 2.98 FLOOD EL = 99.28 (contained to east of Camilla Road)

- water will spill from SEC 3.04 as shown on Drawing 2-C.

- Area of flow thru spill sections = 42.7 m²
  Area of main channel flow = 134.6 m²

  Ratio of flows of spill to main = $\frac{42.7}{182.3} = .23$

- Q_{spill} = 69.03 m³/s.

- flow will spread out to cover d/s area to section extent west of Camilla Road.

- TW of flow @ 2.98' = 200 + m.

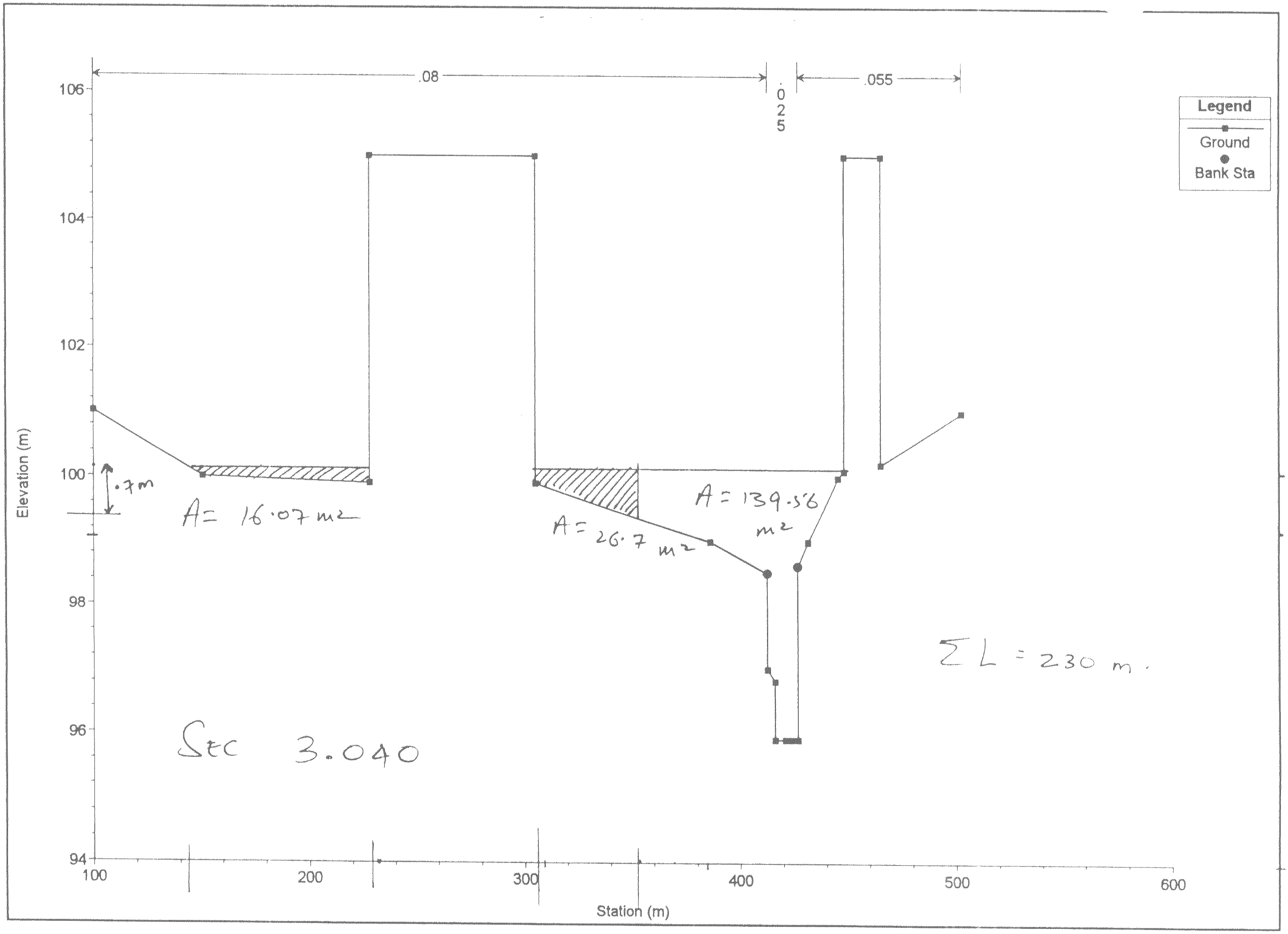
- assuming uniform depth and same velocity (conservati
  applying the continuity eqn:

  $$\text{depth @ } 2.98' = \frac{42.7\,m^2}{200\,m} = .21\,m$$

2.98' refers to section between 3.04 and 2.98.

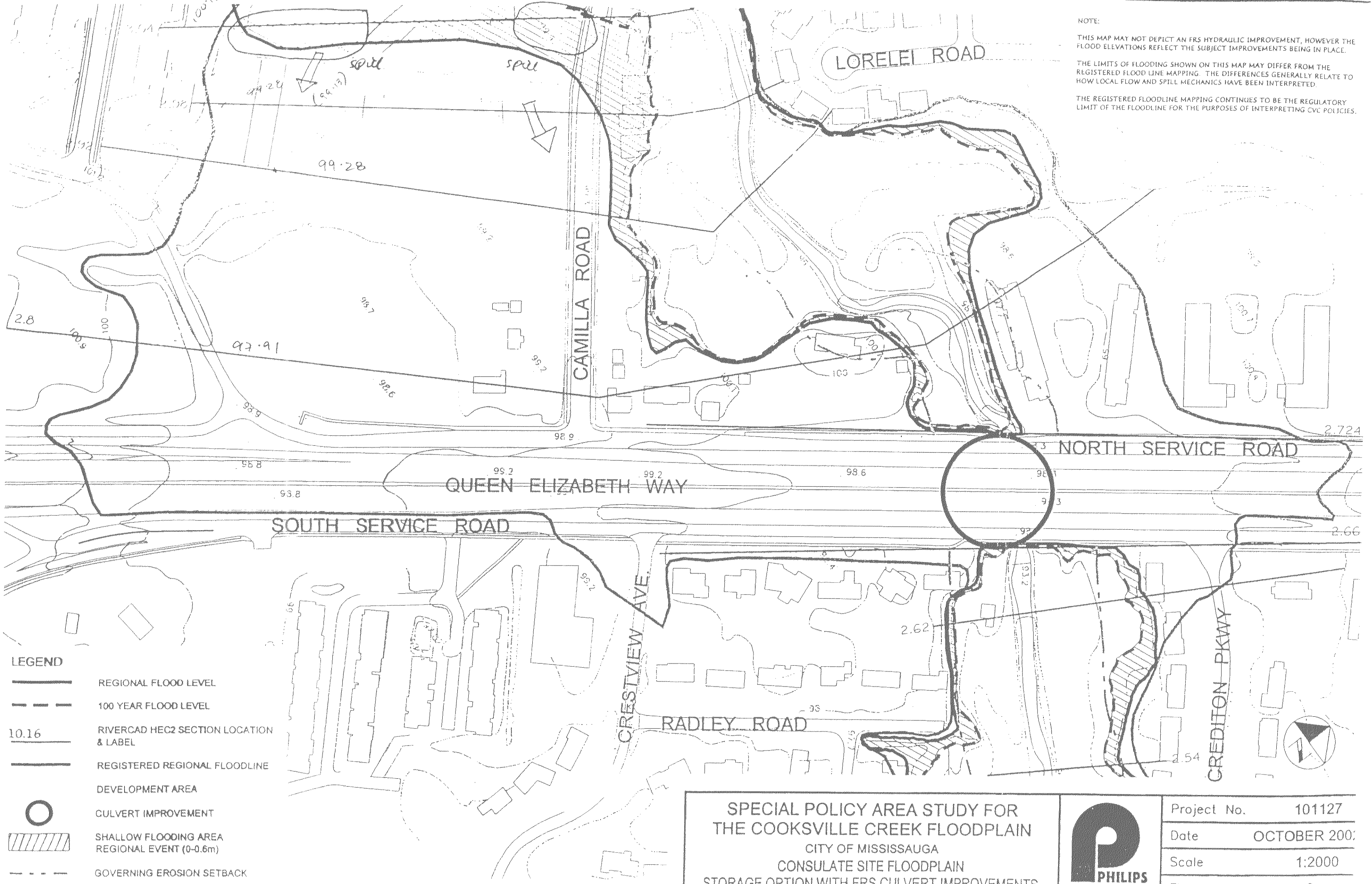
West spill
21 cms

east spill
57 cms.



Sec 3.040

ΣL = 230 m.



NOTE:

THIS MAP MAY NOT DEPICT AN FRS HYDRAULIC IMPROVEMENT, HOWEVER THE FLOOD ELEVATIONS REFLECT THE SUBJECT IMPROVEMENTS BEING IN PLACE.

THE LIMITS OF FLOODING SHOWN ON THIS MAP MAY DIFFER FROM THE REGISTERED FLOOD LINE MAPPING. THE DIFFERENCES GENERALLY RELATE TO HOW LOCAL FLOW AND SPILL MECHANICS HAVE BEEN INTERPRETED.

THE REGISTERED FLOODLINE MAPPING CONTINUES TO BE THE REGULATORY LIMIT OF THE FLOODLINE FOR THE PURPOSES OF INTERPRETING CVC POLICIES.

SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN
CITY OF MISSISSAUGA
CONSULATE SITE FLOODPLAIN
STORAGE OPTION WITH FRS CULVERT IMPROVEMENTS

PHILIPS
ENGINEERING

Project No.	101127
Date	OCTOBER 200
Scale	1:2000
Figure No.	2-c

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Oct. 30/02 - plee

HUMENIK PROPERTY
FLOOD FRINGE INVESTIGATION

HUMENIK PROPERTY FLOOD FRINGE INVESTIGATION

The HEC-2 Flow Distribution reporting function (field 10 on X2 and J2 cards) is used to obtain the flow and depth based on horizontal stationing across the flow section. Linear interpolation is applied to derive a limiting station beyond which the product of depth and velocity is greater than 0.4.

HEC-2 SECTION ID	FLOOD FRINGE LIMITS
4.195	194 m
4.340	176 m
4.440	162 m
4.640	177 m
4.670	234 m

APPENDIX 'G'

STREAM MORPHOLOGY ANALYSIS

Figure G.1: Longitudinal Variance in 2 Year Future Discharge and Channel Velocity

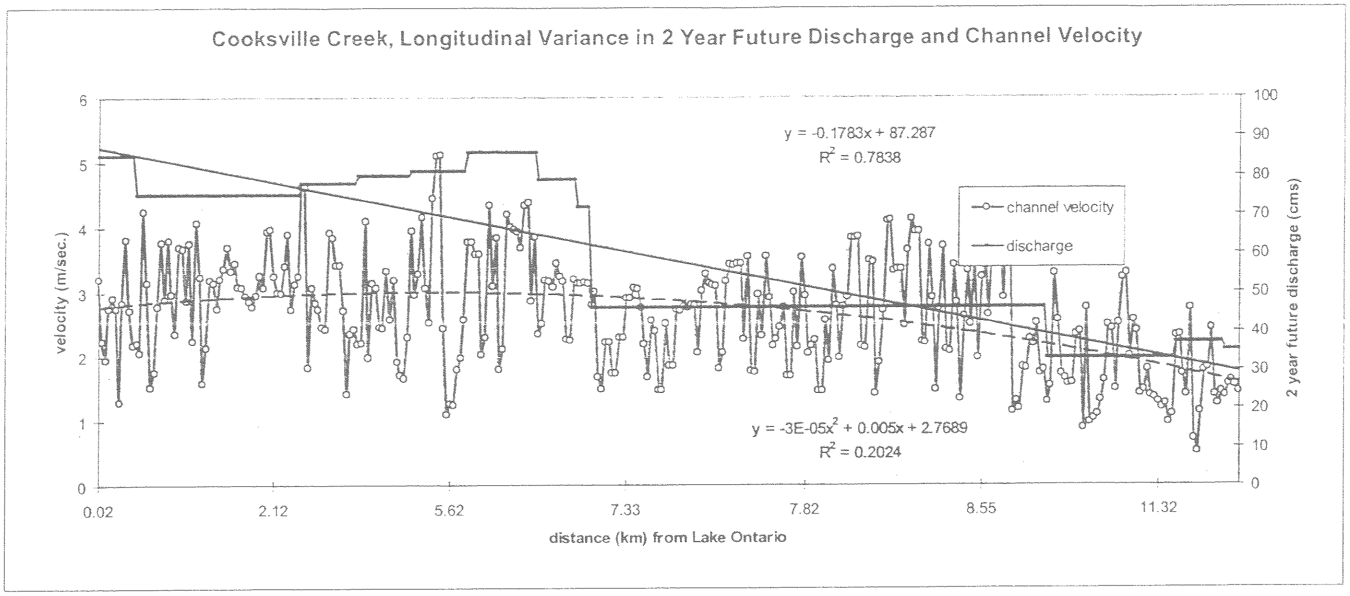


Figure G.2: Longitudinal Variance in Channel Boundary Shear Stress

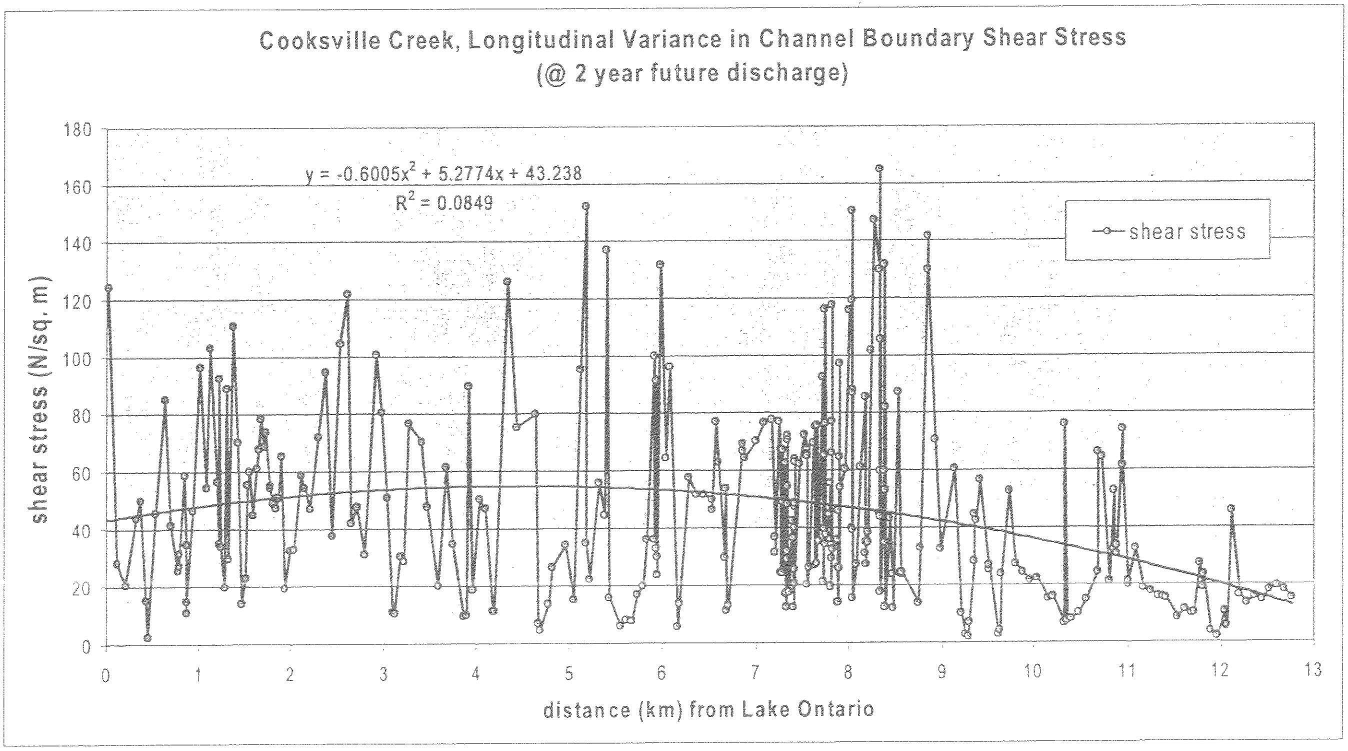


Figure G.3: Longitudinal Variance in Channel Stream Power

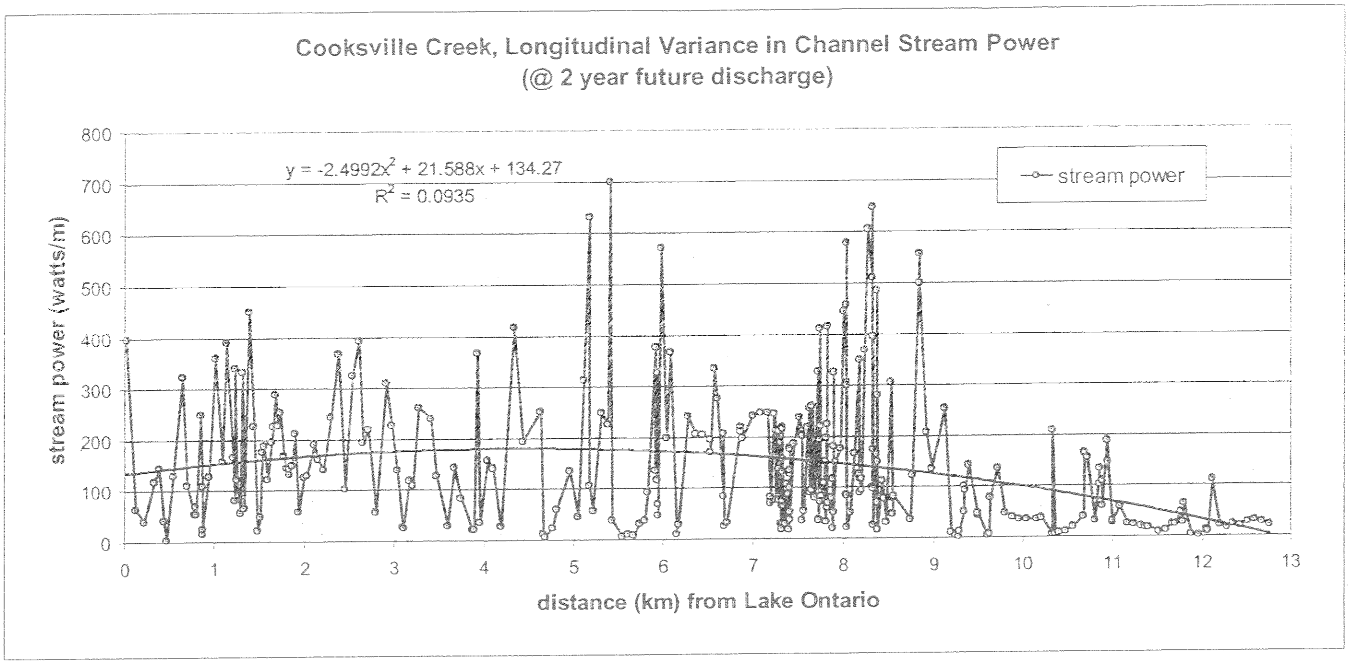


Figure G.4: Bedrock Monitoring, CC02 Downstream of Upper Mississauga Valley Boulevard

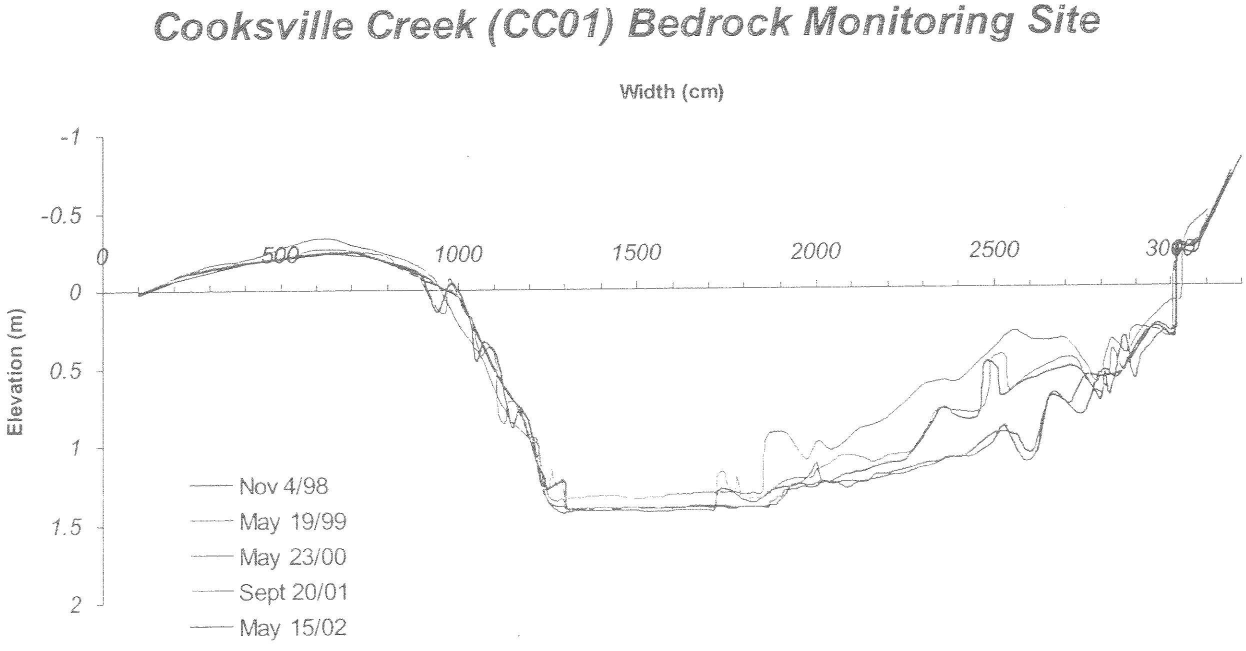


Figure G.5: Bedrock Monitoring, CC02 West of the West End of Orano Road

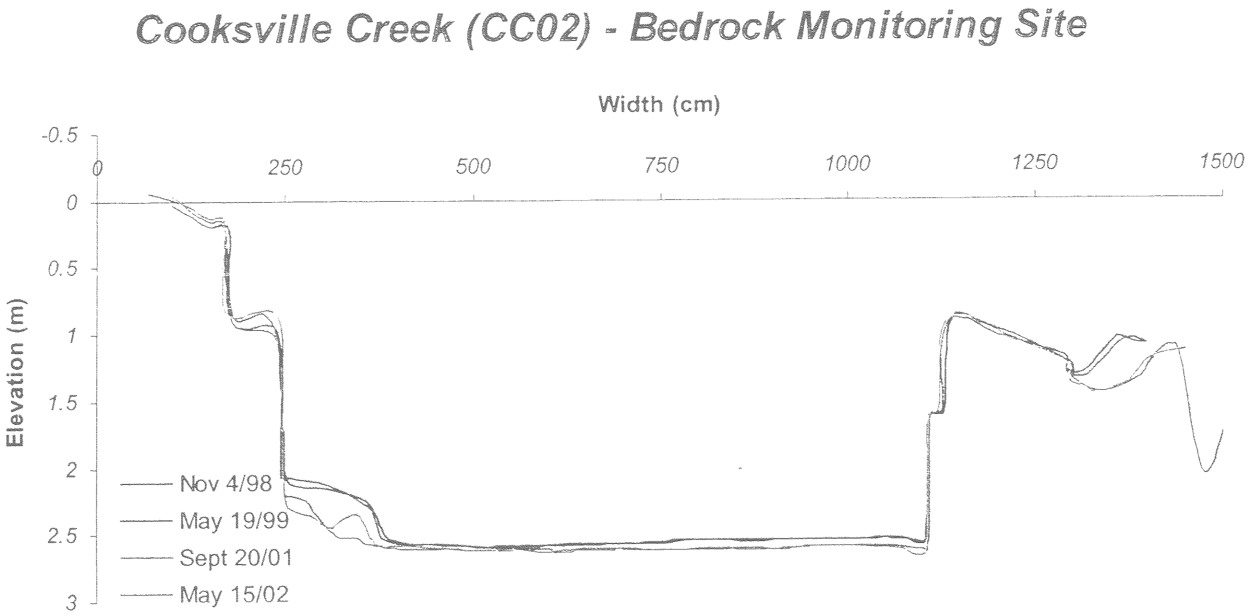
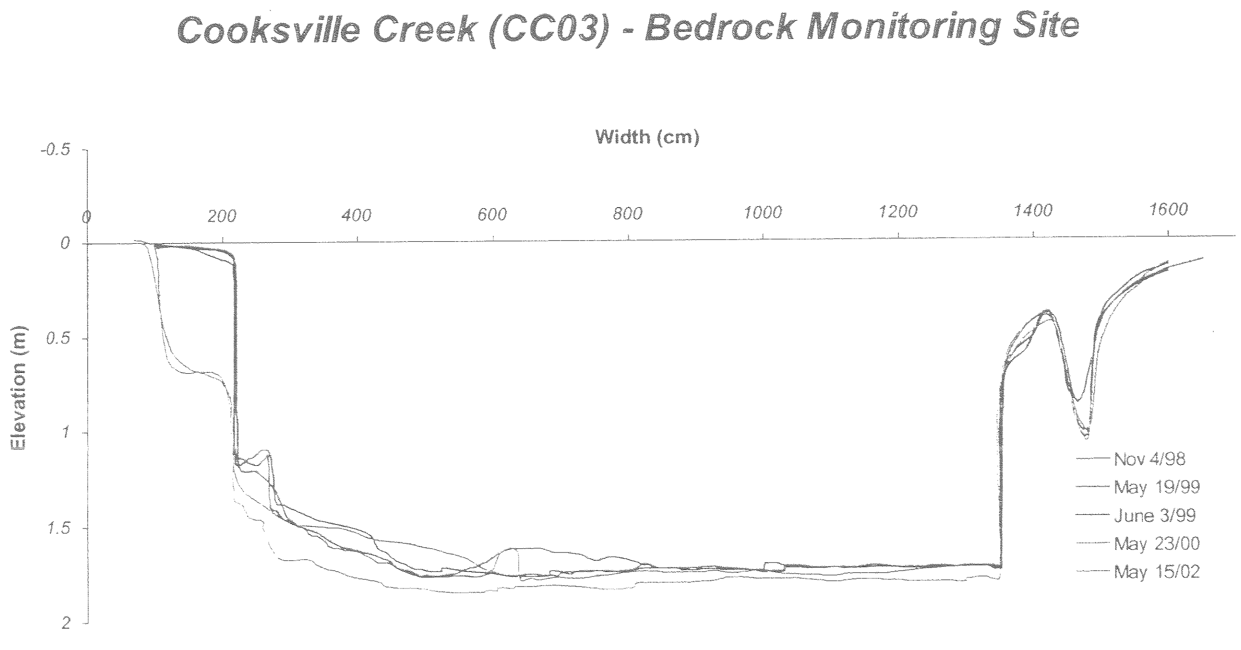
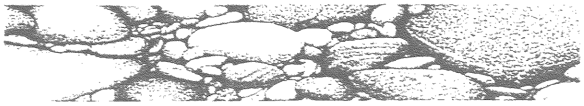


Figure G.6: Bedrock Monitoring, CC03 West of the West End of Aqua Drive



GEO-X v.1.4(2002) Geomorphic Cross Section Analysis Model
PARISH Geomorphic Ltd. Author/Programmer: B. de Geus



Project: **COOKSVILLE CREEK SPECIAL POLICY AREA STUDY**
GEOMORPHOLOGY COMPONENT

Material	Range (mm)		#	# sum	# %	% sum
silt/clay	0	0.062		0	0.0	0.0
very fine sand	0.062	0.13		0	0.0	0.0
fine sand	0.13	0.25		0	0.0	0.0
medium sand	0.25	0.5		0	0.0	0.0
coarse sand	0.5	1		0	0.0	0.0
very coarse sand	1	2	1	1	2.6	2.6
very fine gravel	3	4	1	2	2.6	5.1
fine gravel	5	6	2	4	5.1	10.3
	7	8	1	5	2.6	12.8
medium gravel	9	10		5	0.0	12.8
	11	15	1	6	2.6	15.4
	16	20		6	0.0	15.4
	21	25		6	0.0	15.4
coarse gravel	26	30	3	9	7.7	23.1
very coarse gravel	31	40	3	12	7.7	30.8
	41	50	3	15	7.7	38.5
	51	60	1	16	2.6	41.0
small cobble	61	70		16	0.0	41.0
	71	80	4	20	10.3	51.3
medium cobble	81	90		20	0.0	51.3
	91	100	4	24	10.3	61.5
	101	110	4	28	10.3	71.8
large cobble	111	120	5	33	12.8	84.6
	121	130	2	35	5.1	89.7
	131	140		35	0.0	89.7
	141	150	2	37	5.1	94.9
	151	160	2	39	5.1	100.0
	161	170		39	0.0	100.0
very large cobble	171	180		39	0.0	100.0
	181	190		39	0.0	100.0
	191	200		39	0.0	100.0
	201	210		39	0.0	100.0
	211	220		39	0.0	100.0
	221	230		39	0.0	100.0
	231	240		39	0.0	100.0
	241	250		39	0.0	100.0
small boulder	251	260		39	0.0	100.0
	261	270		39	0.0	100.0
	271	280		39	0.0	100.0
	281	290		39	0.0	100.0
	291	300		39	0.0	100.0
	301	310		39	0.0	100.0
	311	320		39	0.0	100.0
	321	330		39	0.0	100.0
	331	340		39	0.0	100.0
	341	350		39	0.0	100.0
	351	360		39	0.0	100.0
	361	370		39	0.0	100.0
	371	380		39	0.0	100.0
	381	391		39	0.0	100.0
		bdrk		39	0.0	100.0
		TOTAL	39		100.0	

Description:

U/S of LAKESHORE - TECHNICAL CORRIDOR ANALYSIS

EXISTING CONDITIONS

Substrate Type Count

silt/clay	sand	gravel	cobble	boulder	bedrock
0	1	15	23	0	0

Substrate Type Percent

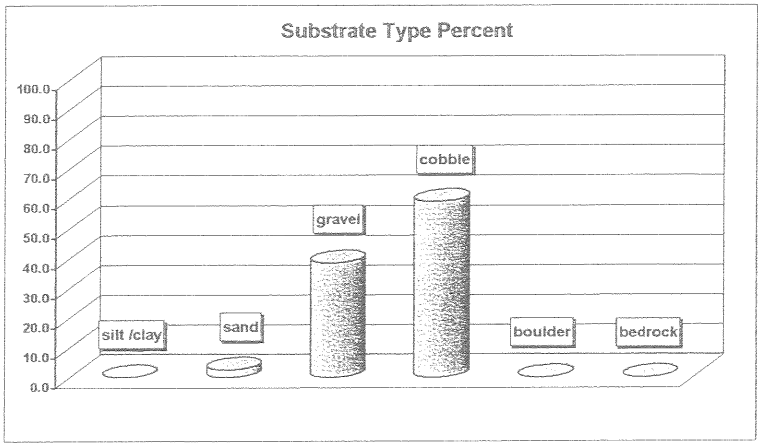
silt/clay	sand	gravel	cobble	boulder	bedrock
0.0	2.6	38.5	59.0	0.0	0.0

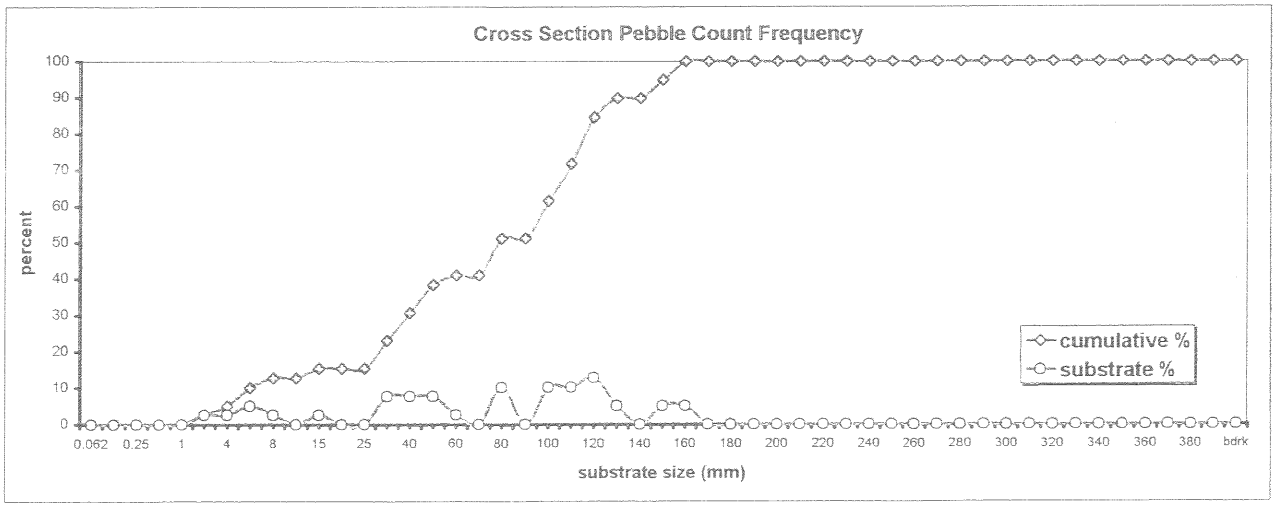
Hydraulic Roughness

rr R/D_{84}	6.10
ff V mean/V*	7.82
ff D_{84}	7.34
ff mean	7.58
	ROUGH BED

Gradation Summary (mm)

D_{15}	D_{30}	D_{50}	D_{84}	D_{100}	
12.00	38.00	75.00	118.00	160.00	Stability Design Targets
22.5	31.5	67.5	81.0	90.0	high turbulence angular
25.0	35.0	75.0	90.0	100.0	high turbulence riverstone
13.5	27.0	45.0	58.5	67.5	low turbulence angular
15.0	30.0	50.0	65.0	75.0	low turbulence riverstone





Section Survey			A (m^2)			WP (m)			TW (m)		
Sta.	Elev. (m)	Subm.	Part d	d	Total	Part	Full	Total	Part	Full	Total
-3	1	0	0.029	0.000	0.029	0.443	0.000	0.443	0.420	0.000	0.420
0	0	1	0.000	0.250	0.250	0.000	1.024	1.024	0.000	1.000	1.000
1	-0.22	1	0.000	0.495	0.495	0.000	1.036	1.036	0.000	1.000	1.000
2	-0.49	1	0.000	0.620	0.620	0.000	1.000	1.000	0.000	1.000	1.000
3	-0.47	1	0.000	0.670	0.670	0.000	1.007	1.007	0.000	1.000	1.000
4	-0.59	1	0.000	0.760	0.760	0.000	1.002	1.002	0.000	1.000	1.000
5	-0.65	1	0.000	0.825	0.825	0.000	1.002	1.002	0.000	1.000	1.000
6	-0.72	1	0.000	0.870	0.870	0.000	1.000	1.000	0.000	1.000	1.000
7	-0.74	1	0.000	0.875	0.875	0.000	1.000	1.000	0.000	1.000	1.000
8	-0.73	1	0.000	0.890	0.890	0.000	1.001	1.001	0.000	1.000	1.000
9	-0.77	1	0.000	0.895	0.895	0.000	1.000	1.000	0.000	1.000	1.000
10	-0.74	1	0.000	0.895	0.895	0.000	1.000	1.000	0.000	1.000	1.000
11	-0.77	1	0.000	0.905	0.905	0.000	1.000	1.000	0.000	1.000	1.000
12	-0.76	1	0.000	0.910	0.910	0.000	1.000	1.000	0.000	1.000	1.000
13	-0.78	1	0.000	0.900	0.900	0.000	1.001	1.001	0.000	1.000	1.000
14	-0.74	1	0.000	0.895	0.895	0.000	1.000	1.000	0.000	1.000	1.000
15	-0.77	1	0.000	0.895	0.895	0.000	1.000	1.000	0.000	1.000	1.000
16	-0.74	1	0.000	0.755	0.755	0.000	1.031	1.031	0.000	1.000	1.000
17	-0.49	1	0.000	0.390	0.390	0.000	1.109	1.109	0.000	1.000	1.000
18	-0.01	0	0.033	0.000	0.033	0.470	0.000	0.470	0.446	0.000	0.446
21.00	1										
				TOTAL	13.758			19.128			18.866

Section Metrics							
Bf_{elev} (m)		Bf stations L / R			W_{fpa} (m)	ER_{elev} (m)	
0.140		-0.450	18.450		0.00	1.060	
E_s	r_c		z	h bank L / R (m)		ER stations L / R	
0.0104	100.00		3.0	1.75	1.75		

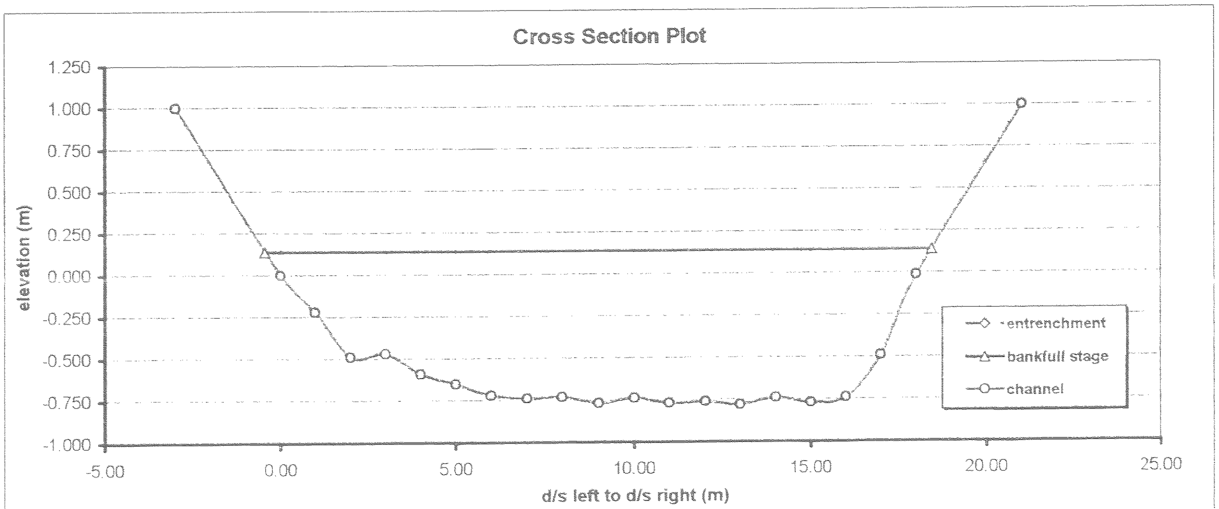
Hydraulic Geometry	
A (m^2)	13.758
R (m)	0.719
TW (m)	18.866
WP (m)	19.128
max. d (m)	0.920
mean d (m)	0.729
$E_{super (Limer.)}$ (m)	0.13
$E_{super (Strick.)}$ (m)	0.13

Hydraulic Ratios	
ER max. d	0.00
BHR L	1.90
BHR R	1.90
TW/max d	20.5
TW/mean d	25.9

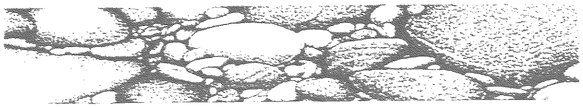
Flow Regime (Limerinos)	
Q (cms)	28.71
V (m s-1)	2.09
n	0.039
Fr	0.78
D_c rectangular	0.62
D_c trapezoidal	1.22
D_c triangular	1.80
D_c parabolic	1.24
D_c mean	1.22
Ω (watts m^{-1})	298.63
ω_a (watts m^{-2})	153.00
ω_a/TW (watts m^{-1})	8.11
*Re**	97.9
turbulence	HIGH

Flow Regime (Strickler)	
Q (cms)	29.54
V (m s^{-1})	2.15
n	0.038
Fr	0.80
D_c rectangular	0.63
D_c trapezoidal	1.23
D_c triangular	1.82
D_c parabolic	1.26
D_c mean	1.23
Ω (watts m^{-1})	307.18
ω_a (watts m^{-2})	157.38
ω_a/TW (watts m^{-1})	8.34
*Re**	95.2
turbulence	HIGH

Erosion Diagnostics						
τ_{calc} (kg m^{-2})	7.48					
τ_{calc} (N m^{-2})	73.31	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
τ D_{crit} (mm)	75.57	UNSTABLE	UNSTABLE	UNSTABLE	STABLE	STABLE
V D_{crit} (mm) L.	227.50	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE
V D_{crit} (mm) S.	234.01	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE
EP (N m^{-1} s^{-1}) L.	1365.40					
EP (N m^{-1} s^{-1}) S.	1404.47					
V*	0.27	Limerinos	Strickler			
V_{comp} (m s^{-1})	5.12	STABLE	STABLE			



GEO-X v.1.4(2002) Geomorphic Cross Section Analysis Model
PARISH Geomorphic Ltd. Author/Programmer: B. de Geus



Project: **COOKSVILLE CREEK SPECIAL POLICY AREA STUDY**
GEOMORPHOLOGY COMPONENT

Material	Range (mm)		#	# sum	# %	% sum
silt/clay	0	0.062		0		
very fine sand	0.062	0.13		0		
fine sand	0.13	0.25		0		
medium sand	0.25	0.5		0		
coarse sand	0.5	1		0		
very coarse sand	1	2		0		
very fine gravel	3	4		0		
fine gravel	5	6		0		
	7	8		0		
medium gravel	9	10		0		
	11	15		0		
	16	20		0		
	21	25		0		
coarse gravel	26	30		0		
very coarse gravel	31	40		0		
	41	50		0		
	51	60		0		
small cobble	61	70		0		
	71	80		0		
medium cobble	81	90		0		
	91	100		0		
	101	110		0		
large cobble	111	120		0		
	121	130		0		
	131	140		0		
	141	150		0		
	151	160		0		
	161	170		0		
very large cobble	171	180		0		
	181	190		0		
	191	200		0		
	201	210		0		
	211	220		0		
	221	230		0		
	231	240		0		
	241	250		0		
small boulder	251	260		0		
	261	270		0		
	271	280		0		
	281	290		0		
	291	300		0		
	301	310		0		
	311	320		0		
	321	330		0		
	331	340		0		
	341	350		0		
	351	360		0		
	361	370		0		
	371	380		0		
	381	391		0		
		bdrk		0		
		TOTAL	0			

Description:

U/S of LAKESHORE - TECHNICAL CORRIDOR ANALYSIS

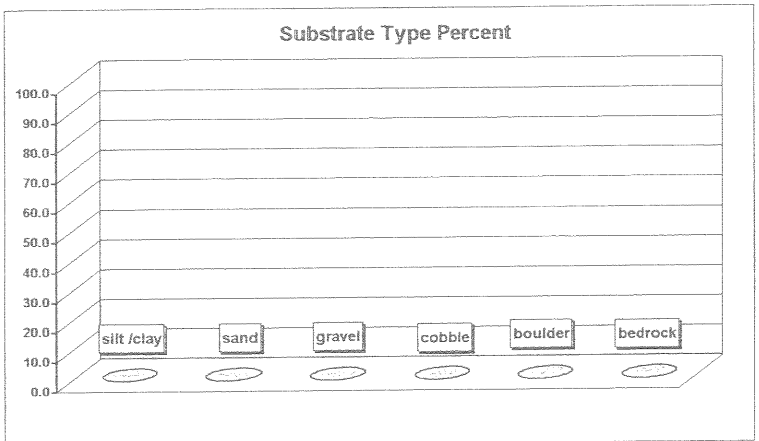
ULTIMATE STABLE CONDITIONS

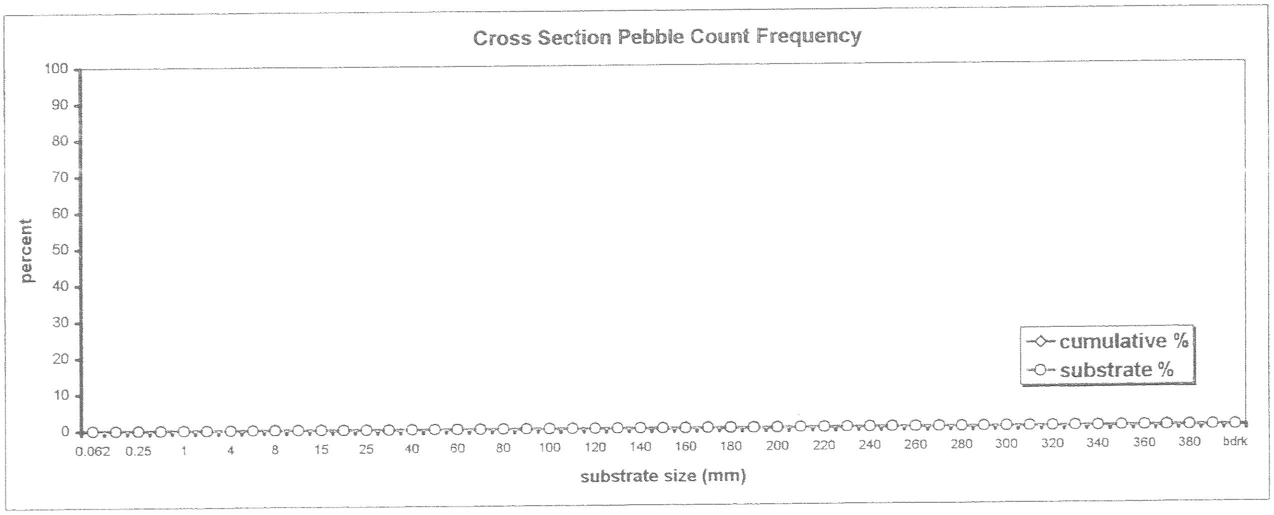
Substrate Type Count					
silt/clay	sand	gravel	cobble	boulder	bedrock
0	0	0	0	0	0

Substrate Type Percent					
silt/clay	sand	gravel	cobble	boulder	bedrock

Hydraulic Roughness	
rr R/D_{84}	2.63
ff V mean/V*	6.07
ff D_{84}	5.23
ff mean	5.65
	ROUGH BED

Gradation Summary (mm)					
D_{15}	D_{30}	D_{50}	D_{84}	D_{100}	
38.00	75.00	118.00	139.00	160.00	Stability Design Targets
35.4	49.6	106.2	127.4	141.6	high turbulence angular
39.3	55.1	118.0	141.6	157.3	high turbulence riverstone
21.2	42.5	70.8	92.0	106.2	low turbulence angular
23.6	47.2	78.7	102.3	118.0	low turbulence riverstone





Section Survey			A (m^2)			WP (m)			TW (m)		
Sta.	Elev. (m)	Subm.	Part d	d	Total	Part	Full	Total	Part	Full	Total
-34.81	1	0	0.072	0.000	0.072	0.795	0.000	0.795	0.773	0.000	0.773
-31.57	0.225	1	0.000	7.812	7.812	0.000	32.280	32.280	0.000	32.280	32.280
0.71	0.111	1	0.000	0.739	0.739	0.000	1.928	1.928	0.000	1.920	1.920
2.63	-0.061	1	0.000	0.340	0.340	0.000	0.645	0.645	0.000	0.630	0.630
3.26	-0.198	1	0.000	0.595	0.595	0.000	0.837	0.837	0.000	0.740	0.740
4	-0.59	1	0.000	1.030	1.030	0.000	1.002	1.002	0.000	1.000	1.000
5	-0.65	1	0.000	1.095	1.095	0.000	1.002	1.002	0.000	1.000	1.000
6	-0.72	1	0.000	1.140	1.140	0.000	1.000	1.000	0.000	1.000	1.000
7	-0.74	1	0.000	1.145	1.145	0.000	1.000	1.000	0.000	1.000	1.000
8	-0.73	1	0.000	1.160	1.160	0.000	1.001	1.001	0.000	1.000	1.000
9	-0.77	1	0.000	1.165	1.165	0.000	1.000	1.000	0.000	1.000	1.000
10	-0.74	1	0.000	1.165	1.165	0.000	1.000	1.000	0.000	1.000	1.000
11	-0.77	1	0.000	1.175	1.175	0.000	1.000	1.000	0.000	1.000	1.000
12	-0.76	1	0.000	1.180	1.180	0.000	1.000	1.000	0.000	1.000	1.000
13	-0.78	1	0.000	0.945	0.945	0.000	1.114	1.114	0.000	1.000	1.000
14	-0.29	1	0.000	0.191	0.191	0.000	0.301	0.301	0.000	0.290	0.290
14.29	-0.21	1	0.000	0.383	0.383	0.000	0.728	0.728	0.000	0.710	0.710
15	-0.05	1	0.000	0.742	0.742	0.000	2.008	2.008	0.000	2.000	2.000
17	0.128	1	0.000	7.607	7.607	0.000	31.050	31.050	0.000	31.050	31.050
48.05	0.202	0	0.083	0.000	0.083	0.824	0.000	0.824	0.798	0.000	0.798
51.11	1										
				TOTAL	29.764			81.516			81.191

Section Metrics

Bf_{elev} (m)		Bf stations L / R		W_{fpa} (m)		ER_{elev} (m)	
0.410		-32.200	49.000	0.00		1.600	
E_s	r_c	z	h bank L / R (m)			ER stations L / R	
0.0104	100.00	3.0	1.75	1.75			

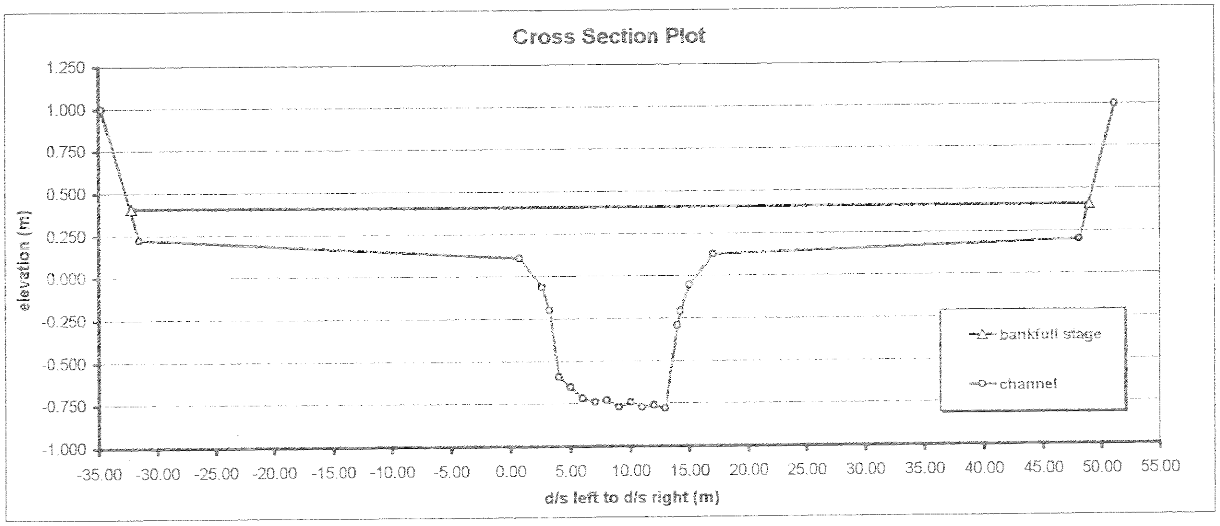
Hydraulic Geometry	
A (m^2)	29.764
R (m)	0.365
TW (m)	81.191
WP (m)	81.516
max. d (m)	1.190
mean d (m)	0.367
$E_{super (Limer.)}$ (m)	0.15
$E_{super (Strick.)}$ (m)	0.20

Hydraulic Ratios	
ER max. d	0.00
BHR L	1.47
BHR R	1.47
TW/max d	68.2
TW/mean d	221.5

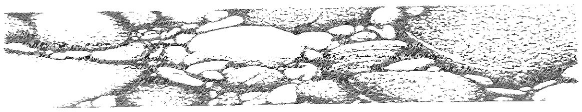
Flow Regime (Limerinos)	
Q (cms)	32.15
V (m s-1)	1.08
n	0.048
Fr	0.57
D_c rectangular	0.26
D_c trapezoidal	1.23
D_c triangular	1.88
D_c parabolic	1.56
D_c mean	1.23
Ω (watts m^{-1})	334.41
ω_a (watts m^{-2})	40.20
ω_a/TW (watts m^{-1})	0.50
*Re**	211.0
turbulence	HIGH

Flow Regime (Strickler)	
Q (cms)	37.56
V (m s^{-1})	1.26
n	0.041
Fr	0.67
D_c rectangular	0.28
D_c trapezoidal	1.32
D_c triangular	2.00
D_c parabolic	1.68
D_c mean	1.32
Ω (watts m^{-1})	390.67
ω_a (watts m^{-2})	46.97
ω_a/TW (watts m^{-1})	0.58
*Re**	180.6
turbulence	HIGH

Erosion Diagnostics						
τ_{calc} (kg m^{-2})	3.80					
τ_{calc} (N m^{-2})	37.21	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
τ D_{crit} (mm)	38.37	REGIME	STABLE	STABLE	STABLE	STABLE
V D_{crit} (mm) L.	117.75	REGIME	REGIME	STABLE	STABLE	STABLE
V D_{crit} (mm) S.	137.56	UNSTABLE	UNSTABLE	UNSTABLE	STABLE	STABLE
EP (N m^{-1} s^{-1}) L.	1196.33					
EP (N m^{-1} s^{-1}) S.	1397.59					
V*	0.19	Limerinos	Strickler			
V_{comp} (m s^{-1})	5.52	STABLE	STABLE			



GEO-X v.1.4(2002) Geomorphic Cross Section Analysis Model
PARISH Geomorphic Ltd. Author/Programmer: B. de Geus



Project: **COOKSVILLE CREEK SPECIAL POLICY AREA STUDY**
GEOMORPHOLOGY COMPONENT

Material	Range (mm)		#	# sum	# %	% sum
silt/clay	0	0.062		0	0.0	0.0
very fine sand	0.062	0.13		0	0.0	0.0
fine sand	0.13	0.25		0	0.0	0.0
medium sand	0.25	0.5		0	0.0	0.0
coarse sand	0.5	1		0	0.0	0.0
very coarse sand	1	2	1	1	2.9	2.9
very fine gravel	3	4		1	0.0	2.9
fine gravel	5	6		1	0.0	2.9
	7	8		1	0.0	2.9
medium gravel	9	10		1	0.0	2.9
	11	15		1	0.0	2.9
	16	20	1	2	2.9	5.9
	21	25	1	3	2.9	8.8
coarse gravel	26	30	1	4	2.9	11.8
very coarse gravel	31	40	4	8	11.8	23.5
	41	50	3	11	8.8	32.4
	51	60	2	13	5.9	38.2
small cobble	61	70	3	16	8.8	47.1
	71	80	1	17	2.9	50.0
medium cobble	81	90		17	0.0	50.0
	91	100	2	19	5.9	55.9
	101	110	2	21	5.9	61.8
large cobble	111	120	3	24	8.8	70.6
	121	130		24	0.0	70.6
	131	140		24	0.0	70.6
	141	150	1	25	2.9	73.5
	151	160	1	26	2.9	76.5
	161	170	2	28	5.9	82.4
very large cobble	171	180	1	29	2.9	85.3
	181	190	1	30	2.9	88.2
	191	200		30	0.0	88.2
	201	210	1	31	2.9	91.2
	211	220		31	0.0	91.2
	221	230		31	0.0	91.2
	231	240		31	0.0	91.2
	241	250	1	32	2.9	94.1
small boulder	251	260		32	0.0	94.1
	261	270		32	0.0	94.1
	271	280		32	0.0	94.1
	281	290		32	0.0	94.1
	291	300		32	0.0	94.1
	301	310	1	33	2.9	97.1
	311	320		33	0.0	97.1
	321	330		33	0.0	97.1
	331	340		33	0.0	97.1
	341	350	1	34	2.9	100.0
	351	360		34	0.0	100.0
	361	370		34	0.0	100.0
	371	380		34	0.0	100.0
	381	391		34	0.0	100.0
		bdrk		34	0.0	100.0
		TOTAL	34		100.0	

Description:

U/S of QEW - TECHNICAL CORRIDOR ANALYSIS

EXISTING CONDITIONS

Substrate Type Count

silt/clay	sand	gravel	cobble	boulder	bedrock
0	1	12	19	2	0

Substrate Type Percent

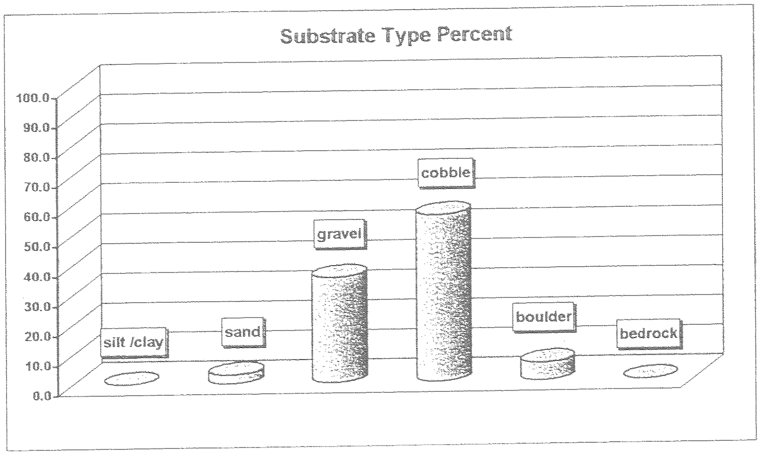
silt/clay	sand	gravel	cobble	boulder	bedrock
0.0	2.9	35.3	55.9	5.9	0.0

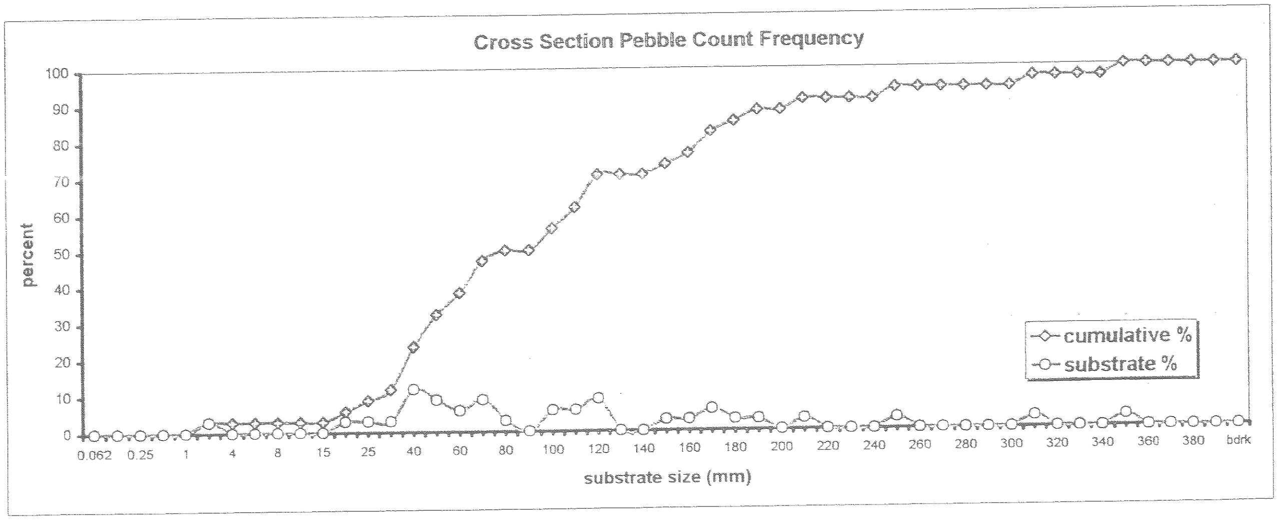
Hydraulic Roughness

ff R/D_{84}	3.36
ff V mean/V*	6.92
ff D_{84}	5.90
ff mean	6.41
	ROUGH BED

Gradation Summary (mm)

D_{15}	D_{30}	D_{50}	D_{84}	D_{100}	
32.00	47.00	80.00	177.00	350.00	Stability Design Targets
24.0	33.6	72.0	86.4	96.0	high turbulence angular
26.7	37.3	80.0	96.0	106.7	high turbulence riverstone
14.4	28.8	48.0	62.4	72.0	low turbulence angular
16.0	32.0	53.3	69.3	80.0	low turbulence riverstone





Section Survey			A (m^2)			WP (m)			TW (m)		
Sta.	Elev. (m)	Subm.	Part d	d	Total	Part	Full	Total	Part	Full	Total
0	0	0	0.038	0.000	0.038	0.465	0.000	0.465	0.176	0.000	0.176
0.34	-0.83	1	0.000	0.340	0.340	0.000	0.682	0.682	0.000	0.660	0.660
1	-1	1	0.000	0.675	0.675	0.000	1.011	1.011	0.000	1.000	1.000
2	-1.15	1	0.000	0.730	0.730	0.000	1.001	1.001	0.000	1.000	1.000
3	-1.11	1	0.000	0.715	0.715	0.000	1.000	1.000	0.000	1.000	1.000
4	-1.12	1	0.000	0.730	0.730	0.000	1.000	1.000	0.000	1.000	1.000
5	-1.14	1	0.000	0.720	0.720	0.000	1.001	1.001	0.000	1.000	1.000
6	-1.1	1	0.000	0.710	0.710	0.000	1.000	1.000	0.000	1.000	1.000
7	-1.12	1	0.000	0.705	0.705	0.000	1.000	1.000	0.000	1.000	1.000
8	-1.09	1	0.000	0.675	0.675	0.000	1.000	1.000	0.000	1.000	1.000
9	-1.06	1	0.000	0.650	0.650	0.000	1.000	1.000	0.000	1.000	1.000
10	-1.04	1	0.000	0.610	0.610	0.000	1.002	1.002	0.000	1.000	1.000
11	-0.98	1	0.000	0.570	0.570	0.000	1.000	1.000	0.000	1.000	1.000
12	-0.96	1	0.000	0.445	0.445	0.000	1.026	1.026	0.000	1.000	1.000
13	-0.73	1	0.000	0.170	0.170	0.000	1.050	1.050	0.000	1.000	1.000
14	-0.41	0	0.000	0.000	0.000	0.036	0.000	0.036	0.034	0.000	0.034
15	-0.12	-1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.37	0										
				TOTAL	8.483			14.275			13.871

Section Metrics

Bf$_{elev}$ (m)	Bf stations L / R		W$_{ba}$ (m)	ER$_{elev}$ (m)		
-0.400	0.100	14.000	0.00	0.350		
E_a	r_c	z	h bank L / R (m)		ER stations L / R	
0.0427	100.00	2.0	1.00	1.00		

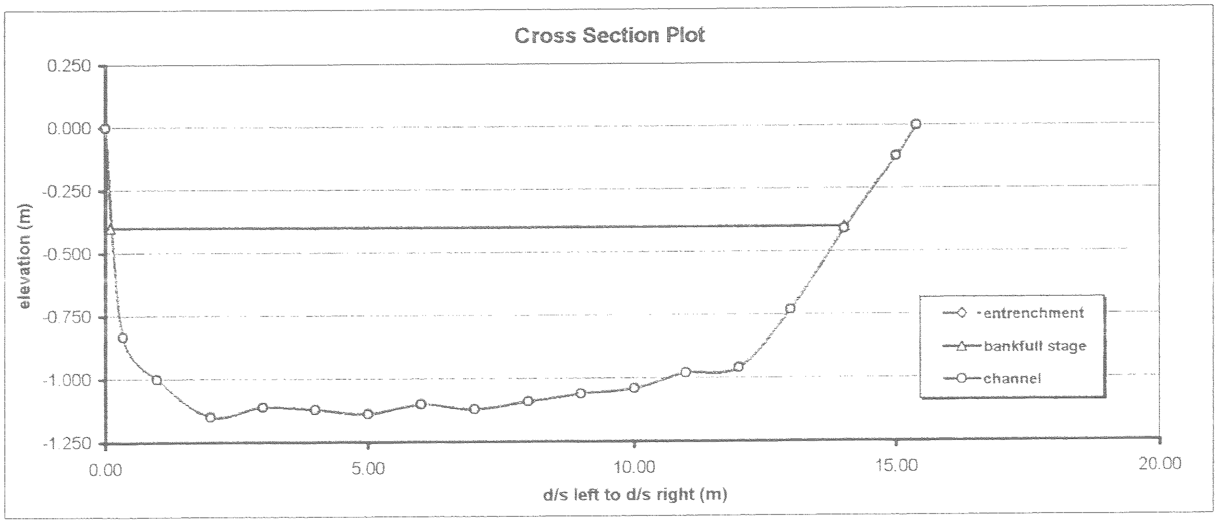
Hydraulic Geometry	
A (m^2)	8.483
R (m)	0.594
TW (m)	13.871
WP (m)	14.275
max. d (m)	0.750
mean d (m)	0.612
$E_{super\ (Limer.)}$ (m)	0.21
$E_{super\ (Strick.)}$ (m)	0.30

Hydraulic Ratios	
ER max. d	0.00
BHR L	1.33
BHR R	1.33
TW/max d	18.5
TW/mean d	22.7

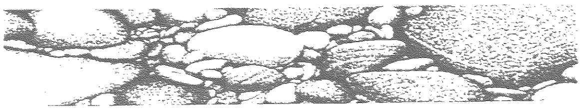
Flow Regime (Limerinos)	
Q (cms)	26.49
V (m s-1)	3.12
n	0.047
Fr	1.28
D_c rectangular	0.72
D_c trapezoidal	1.34
D_c triangular	2.04
D_c parabolic	1.24
D_c mean	1.34
Ω (watts m^{-1})	1131.11
ω_a (watts m^{-2})	776.55
ω_a/TW (watts m^{-1})	55.99
Re^*	129.5
turbulence	HIGH

Flow Regime (Strickler)	
Q (cms)	32.12
V (m s^{-1})	3.79
n	0.039
Fr	1.55
D_c rectangular	0.82
D_c trapezoidal	1.47
D_c triangular	2.21
D_c parabolic	1.37
D_c mean	1.47
Ω (watts m^{-1})	1371.43
ω_a (watts m^{-2})	941.54
ω_a/TW (watts m^{-1})	67.88
Re^*	106.8
turbulence	HIGH

Erosion Diagnostics						
τ_{calc} (kg m^{-2})	25.38					
τ_{calc} (N m^{-2})	248.68	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
τ D_{cnt} (mm)	256.37	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE	STABLE
V D_{cnt} (mm) L.	340.37	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE	STABLE
V D_{cnt} (mm) S.	412.69	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE
EP (N m^{-1} s^{-1}) L.	1646.67					
EP (N m^{-1} s^{-1}) S.	1996.52					
V*	0.50	Limerinos	Strickler			
V_{comp} (m s^{-1})	6.17	STABLE	STABLE			



GEO-X v.1.4(2002) Geomorphic Cross Section Analysis Model
PARISH Geomorphic Ltd. Author/Programmer: B. de Geus



Project: **COOKSVILLE CREEK SPECIAL POLICY AREA STUDY**
GEOMORPHOLOGY COMPONENT

Material	Range (mm)		#	# sum	# %	% sum
silt/clay	0	0.062		0		
very fine sand	0.062	0.13		0		
fine sand	0.13	0.25		0		
medium sand	0.25	0.5		0		
coarse sand	0.5	1		0		
very coarse sand	1	2		0		
very fine gravel	3	4		0		
fine gravel	5	6		0		
	7	8		0		
medium gravel	9	10		0		
	11	15		0		
	16	20		0		
	21	25		0		
coarse gravel	26	30		0		
very coarse gravel	31	40		0		
	41	50		0		
	51	60		0		
small cobble	61	70		0		
	71	80		0		
medium cobble	81	90		0		
	91	100		0		
	101	110		0		
large cobble	111	120		0		
	121	130		0		
	131	140		0		
	141	150		0		
	151	160		0		
	161	170		0		
very large cobble	171	180		0		
	181	190		0		
	191	200		0		
	201	210		0		
	211	220		0		
	221	230		0		
	231	240		0		
	241	250		0		
small boulder	251	260		0		
	261	270		0		
	271	280		0		
	281	290		0		
	291	300		0		
	301	310		0		
	311	320		0		
	321	330		0		
	331	340		0		
	341	350		0		
	351	360		0		
	361	370		0		
	371	380		0		
	381	391		0		
		bdrk		0		
		TOTAL	0			

Description:

U/S of QEW - TECHNICAL CORRIDOR ANALYSIS

ULTIMATE STABLE CONDITIONS

Substrate Type Count

silt/clay	sand	gravel	cobble	boulder	bedrock
0	0	0	0	0	0

Substrate Type Percent

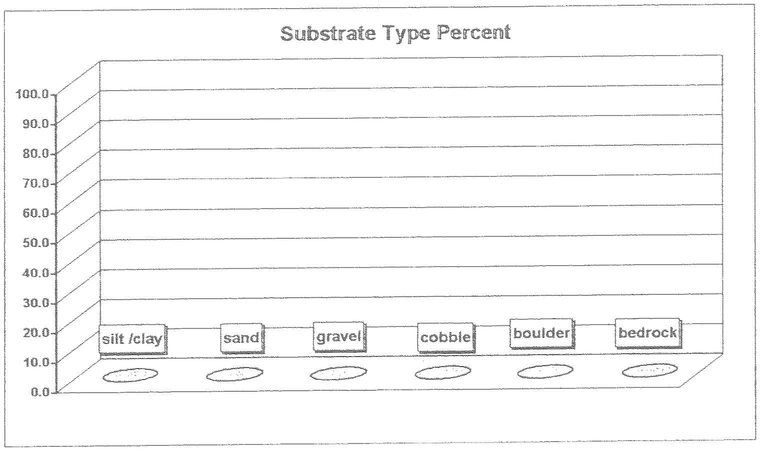
silt/clay	sand	gravel	cobble	boulder	bedrock

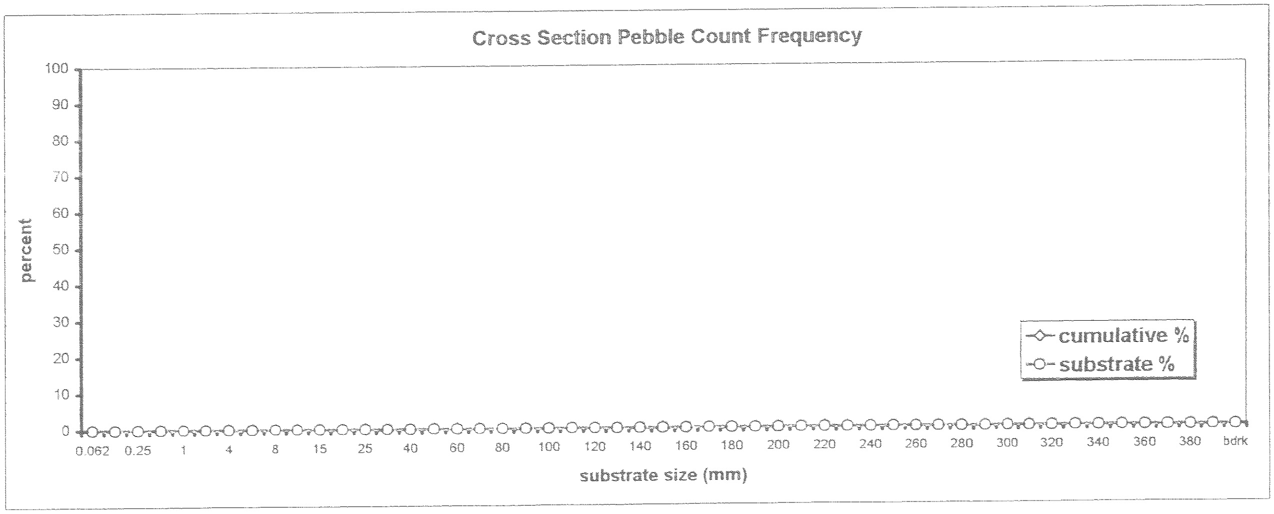
Hydraulic Roughness

rr R/D_{84}	1.38
ff V mean/V*	5.07
ff D_{84}	3.64
ff mean	4.36
	ROUGH BED

Gradation Summary (mm)

D_{15}	D_{30}	D_{50}	D_{84}	D_{100}	
47.00	80.00	177.00	265.00	350.00	Stability Design Targets
53.1	74.3	159.3	191.2	212.4	high turbulence angular
59.0	82.6	177.0	212.4	236.0	high turbulence riverstone
31.9	63.7	106.2	138.1	159.3	low turbulence angular
35.4	70.8	118.0	153.4	177.0	low turbulence riverstone





Section Survey			A (m^2)			WP (m)			TW (m)		
Sta.	Elev. (m)	Subm.	Part d	d	Total	Part	Full	Total	Part	Full	Total
-24 89	0	0	0.252	0.000	0.252	2.511	0.000	2.511	2.503	0.000	2.503
-18 9	-0 481	1	0.000	5.193	5.193	0.000	18.681	18.681	0.000	18.680	18.680
-0 22	-0 635	1	0.000	1.193	1.193	0.000	2.250	2.250	0.000	2.220	2.220
2	-1	1	0.000	0.775	0.775	0.000	1.006	1.006	0.000	1.000	1.000
3	-1.11	1	0.000	0.835	0.835	0.000	1.000	1.000	0.000	1.000	1.000
4	-1.12	1	0.000	0.850	0.850	0.000	1.000	1.000	0.000	1.000	1.000
5	-1 14	1	0.000	0.840	0.840	0.000	1.001	1.001	0.000	1.000	1.000
6	-1 1	1	0.000	0.830	0.830	0.000	1.000	1.000	0.000	1.000	1.000
7	-1.12	1	0.000	0.825	0.825	0.000	1.000	1.000	0.000	1.000	1.000
8	-1.09	1	0.000	0.795	0.795	0.000	1.000	1.000	0.000	1.000	1.000
9	-1.06	1	0.000	0.770	0.770	0.000	1.000	1.000	0.000	1.000	1.000
10	-1.04	1	0.000	0.730	0.730	0.000	1.002	1.002	0.000	1.000	1.000
11	-0.98	1	0.000	0.393	0.393	0.000	0.607	0.607	0.000	0.600	0.600
11.6	-0 891	1	0.000	0.445	0.445	0.000	0.980	0.980	0.000	0.940	0.940
12 54	-0 615	1	0.000	3.260	3.260	0.000	11.360	11.360	0.000	11.360	11.360
23.9	-0.519	1	0.000	1.078	1.078	0.000	5.210	5.210	0.000	5.210	5.210
29.11	-0.455	0	0.160	0.000	0.160	1.831	0.000	1.831	1.823	0.000	1.823
33.85	0										
				TOTAL	19.224			52.440			52.336

Section Metrics

Bf_{elev} (m)	Bf stations L / R		W_{fsa} (m)	ER_{elev} (m)	
-0.280	-22.500	31.000	0.00	0.580	
E_s	r_c	z	h bank L / R (m)		ER stations L / R
0.0427	100.00	2.0	1.00	1.00	

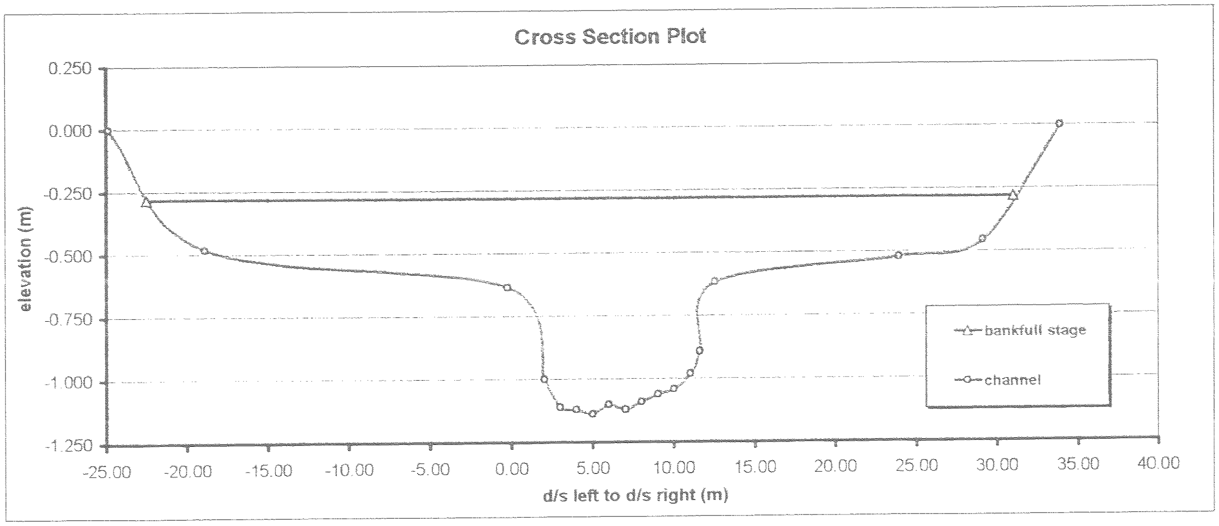
Hydraulic Geometry	
A (m^2)	19.224
R (m)	0.367
TW (m)	52.336
WP (m)	52.440
max. d (m)	0.860
mean d (m)	0.367
$E_{super (Limer.)}$ (m)	0.20
$E_{super (Strick.)}$ (m)	0.46

Hydraulic Ratios	
ER max. d	0.00
BHR L	1.16
BHR R	1.16
TW/max d	60.9
TW/mean d	142.5

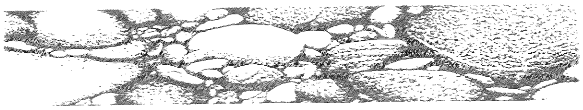
Flow Regime (Limerinos)	
Q (cms)	30.41
V (m s-1)	1.58
n	0.067
Fr	0.83
D_c rectangular	0.33
D_c trapezoidal	1.33
D_c triangular	2.16
D_c parabolic	1.51
D_c mean	1.33
Ω (watts m^{-1})	1298.52
ω_a (watts m^{-2})	242.67
ω_a/TW (watts m^{-1})	4.64
*Re**	438.5
turbulence	HIGH

Flow Regime (Strickler)	
Q (cms)	46.01
V (m s^{-1})	2.39
n	0.044
Fr	1.26
D_c rectangular	0.43
D_c trapezoidal	1.61
D_c triangular	2.55
D_c parabolic	1.86
D_c mean	1.61
Ω (watts m^{-1})	1964.59
ω_a (watts m^{-2})	367.14
ω_a/TW (watts m^{-1})	7.02
*Re**	289.8
turbulence	HIGH

Erosion Diagnostics						
τ_{calc} (kg m^{-2})	15.65					
τ_{calc} (N m^{-2})	153.40	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
τ D_{crit} (mm)	158.15	REGIME	REGIME	STABLE	STABLE	STABLE
V D_{crit} (mm) L.	172.43	REGIME	REGIME	STABLE	STABLE	STABLE
V D_{crit} (mm) S.	260.87	UNSTABLE	UNSTABLE	UNSTABLE	STABLE	STABLE
EP (N m^{-1} s^{-1}) L.	2473.27					
EP (N m^{-1} s^{-1}) S.	3741.94					
V*	0.39	Limerinos	Strickler			
V_{comp} (m s^{-1})	7.42	STABLE	STABLE			



GEO-X v.1.4(2002) Geomorphic Cross Section Analysis Model
PARISH Geomorphic Ltd. Author/Programmer: B. de Geus



Project: **COOKSVILLE CREEK SPECIAL POLICY AREA STUDY**
GEOMORPHOLOGY COMPONENT

Material	Range (mm)		#	# sum	# %	% sum
silt/clay	0	0.062		0	0.0	0.0
very fine sand	0.062	0.13		0	0.0	0.0
fine sand	0.13	0.25		0	0.0	0.0
medium sand	0.25	0.5	1	1	2.6	2.6
coarse sand	0.5	1		1	0.0	2.6
very coarse sand	1	2	2	3	5.1	7.7
very fine gravel	3	4	1	4	2.6	10.3
fine gravel	5	6		4	0.0	10.3
	7	8	1	5	2.6	12.8
medium gravel	9	10		5	0.0	12.8
	11	15	1	6	2.6	15.4
	16	20		6	0.0	15.4
	21	25	1	7	2.6	17.9
coarse gravel	26	30		7	0.0	17.9
very coarse gravel	31	40	5	12	12.8	30.8
	41	50		12	0.0	30.8
	51	60	2	14	5.1	35.9
small cobble	61	70	2	16	5.1	41.0
	71	80	2	18	5.1	46.2
medium cobble	81	90		18	0.0	46.2
	91	100		18	0.0	46.2
	101	110	2	20	5.1	51.3
large cobble	111	120	3	23	7.7	59.0
	121	130	2	25	5.1	64.1
	131	140	4	29	10.3	74.4
	141	150	3	32	7.7	82.1
	151	160		32	0.0	82.1
	161	170	1	33	2.6	84.6
very large cobble	171	180	1	34	2.6	87.2
	181	190	1	35	2.6	89.7
	191	200	2	37	5.1	94.9
	201	210	1	38	2.6	97.4
	211	220		38	0.0	97.4
	221	230		38	0.0	97.4
	231	240		38	0.0	97.4
	241	250	1	39	2.6	100.0
small boulder	251	260		39	0.0	100.0
	261	270		39	0.0	100.0
	271	280		39	0.0	100.0
	281	290		39	0.0	100.0
	291	300		39	0.0	100.0
	301	310		39	0.0	100.0
	311	320		39	0.0	100.0
	321	330		39	0.0	100.0
	331	340		39	0.0	100.0
	341	350		39	0.0	100.0
	351	360		39	0.0	100.0
	361	370		39	0.0	100.0
	371	380		39	0.0	100.0
	381	391		39	0.0	100.0
		bdrk		39	0.0	100.0
		TOTAL	39		100.0	

Description:

D/S of KING ST. - TECHNICAL CORRIDOR ANALYSIS

EXISTING CONDITIONS

Substrate Type Count

silt/clay	sand	gravel	cobble	boulder	bedrock
0	3	11	25	0	0

Substrate Type Percent

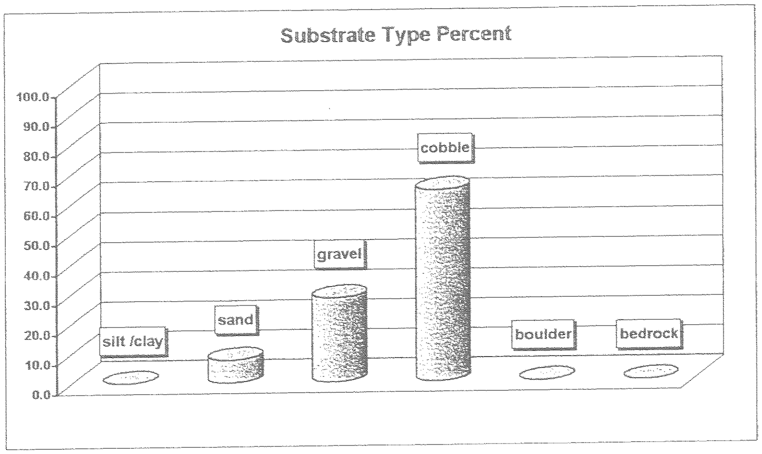
silt/clay	sand	gravel	cobble	boulder	bedrock
0.0	7.7	28.2	64.1	0.0	0.0

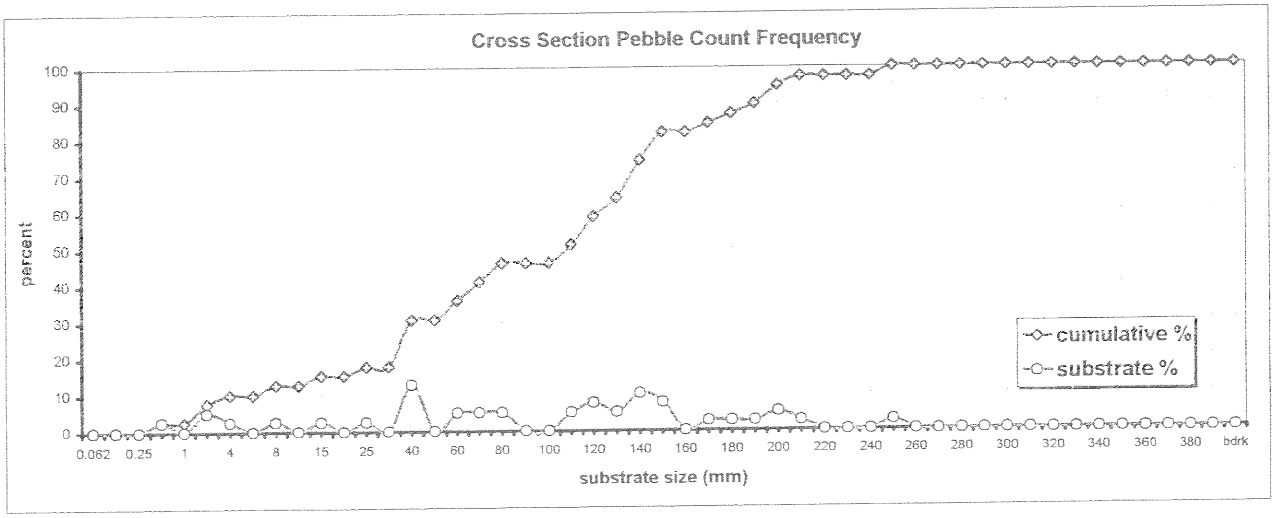
Hydraulic Roughness

rr R/D_{84}	3.96
ff V mean/V*	7.02
ff D_{84}	6.30
ff mean	6.66
	ROUGH BED

Gradation Summary (mm)

D_{15}	D_{30}	D_{50}	D_{84}	D_{100}	
14.00	39.00	107.00	169.00	250.00	Stability Design Targets
32.1	44.9	96.3	115.6	128.4	high turbulence angular
35.7	49.9	107.0	128.4	142.7	high turbulence riverstone
19.3	38.5	64.2	83.5	96.3	low turbulence angular
21.4	42.8	71.3	92.7	107.0	low turbulence riverstone





Section Survey			A (m^2)			WP (m)			TW (m)		
Sta.	Elev. (m)	Subm.	Part d	d	Total	Part	Full	Total	Part	Full	Total
0	0.5	0	0.000	0.000	0.000	0.010	0.000	0.010	0.000	0.000	0.000
0	0	1	0.000	0.505	0.505	0.000	1.407	1.407	0.000	1.000	1.000
1	-0.99	1	0.000	1.005	1.005	0.000	1.000	1.000	0.000	1.000	1.000
2	-1	1	0.000	0.995	0.995	0.000	1.000	1.000	0.000	1.000	1.000
3	-0.97	1	0.000	1.015	1.015	0.000	1.002	1.002	0.000	1.000	1.000
4	-1.04	1	0.000	1.015	1.015	0.000	1.002	1.002	0.000	1.000	1.000
5	-0.97	1	0.000	1.005	1.005	0.000	1.001	1.001	0.000	1.000	1.000
6	-1.02	1	0.000	1.010	1.010	0.000	1.001	1.001	0.000	1.000	1.000
7	-0.98	1	0.000	0.960	0.960	0.000	1.002	1.002	0.000	1.000	1.000
8	-0.92	1	0.000	0.930	0.930	0.000	1.000	1.000	0.000	1.000	1.000
9	-0.92	1	0.000	0.930	0.930	0.000	1.000	1.000	0.000	1.000	1.000
10	-0.92	1	0.000	0.895	0.895	0.000	1.002	1.002	0.000	1.000	1.000
11	-0.85	1	0.000	0.685	0.685	0.000	1.059	1.059	0.000	1.000	1.000
12	-0.5	1	0.000	0.460	0.460	0.000	1.005	1.005	0.000	1.000	1.000
13	-0.4	1	0.000	0.395	0.395	0.000	1.000	1.000	0.000	1.000	1.000
14	-0.37	1	0.000	0.320	0.320	0.000	1.007	1.007	0.000	1.000	1.000
15	-0.25	1	0.000	0.240	0.240	0.000	1.001	1.001	0.000	1.000	1.000
16	-0.21	1	0.000	0.165	0.165	0.000	1.006	1.006	0.000	1.000	1.000
17	-0.1	1	0.000	0.070	0.070	0.000	1.003	1.003	0.000	1.000	1.000
18	-0.02	1	0.000	0.005	0.005	0.000	0.231	0.231	0.000	0.230	0.230
18.23	0	0	0.000	0.000	0.000	0.096	0.000	0.096	0.095	0.000	0.095
23.00	0.5										
				TOTAL	12.605			18.838			18.325

Section Metrics							
Bf_{elev} (m)		Bf stations L / R		W_{ba} (m)		ER_{elev} (m)	
0.010		0.000	18.300	0.00		1.060	
E_a	r_c	z	h bank L / R (m)			ER stations L / R	
0.0148	100.00	4.0	1.50	1.50			

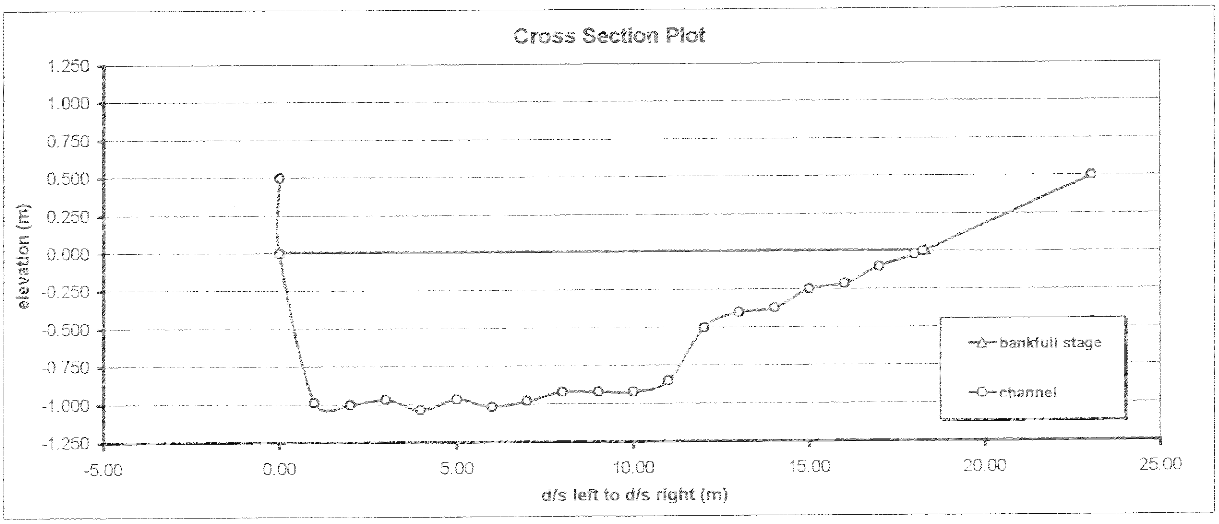
Hydraulic Geometry	
A (m^2)	12.605
R (m)	0.669
TW (m)	18.325
WP (m)	18.838
max. d (m)	1.050
mean d (m)	0.688
$E_{super (Limer.)}$ (m)	0.12
$E_{super (Strick.)}$ (m)	0.15

Hydraulic Ratios	
ER max. d	0.00
BHR L	1.43
BHR R	1.43
TW/max d	17.5
TW/mean d	26.6

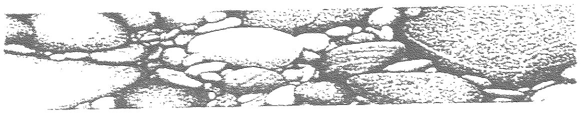
Flow Regime (Limerinos)	
Q (cms)	26.19
V (m s-1)	2.08
n	0.045
Fr	0.80
D_c rectangular	0.60
D_c trapezoidal	1.11
D_c triangular	1.54
D_c parabolic	1.20
D_c mean	1.11
Ω (watts m^{-1})	387.61
$ω_a$ (watts m^{-2})	201.64
$ω_a$/TW (watts m^{-1})	11.00
*Re**	162.6
turbulence	HIGH

Flow Regime (Strickler)	
Q (cms)	28.95
V (m s^{-1})	2.30
n	0.040
Fr	0.88
D_c rectangular	0.64
D_c trapezoidal	1.17
D_c triangular	1.61
D_c parabolic	1.26
D_c mean	1.17
Ω (watts m^{-1})	428.53
$ω_a$ (watts m^{-2})	222.93
$ω_a$/TW (watts m^{-1})	12.17
*Re**	147.1
turbulence	HIGH

Erosion Diagnostics						
$τ_{calc}$ (kg m^{-2})	9.90					
$τ_{calc}$ (N m^{-2})	97.05	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
τ D_{crit} (mm)	100.05	REGIME	REGIME	STABLE	STABLE	STABLE
V D_{crit} (mm) L.	226.47	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE	STABLE
V D_{crit} (mm) S.	250.38	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE
EP (N m^{-1} s^{-1}) L.	1954.80					
EP (N m^{-1} s^{-1}) S.	2161.18					
V*	0.31	Limerinos	Strickler			
V_{comp} (m s^{-1})	6.04	STABLE	STABLE			



GEO-X v.1.4(2002) Geomorphic Cross Section Analysis Model
PARISH Geomorphic Ltd. Author/Programmer: B. de Geus



Project: **COOKSVILLE CREEK SPECIAL POLICY AREA STUDY**
GEOMORPHOLOGY COMPONENT

Material	Range (mm)		#	# sum	# %	% sum
silt/clay	0	0.062		0		
very fine sand	0.062	0.13		0		
fine sand	0.13	0.25		0		
medium sand	0.25	0.5		0		
coarse sand	0.5	1		0		
very coarse sand	1	2		0		
very fine gravel	3	4		0		
fine gravel	5	6		0		
	7	8		0		
medium gravel	9	10		0		
	11	15		0		
	16	20		0		
	21	25		0		
coarse gravel	26	30		0		
very coarse gravel	31	40		0		
	41	50		0		
	51	60		0		
small cobble	61	70		0		
	71	80		0		
medium cobble	81	90		0		
	91	100		0		
	101	110		0		
large cobble	111	120		0		
	121	130		0		
	131	140		0		
	141	150		0		
	151	160		0		
	161	170		0		
very large cobble	171	180		0		
	181	190		0		
	191	200		0		
	201	210		0		
	211	220		0		
	221	230		0		
	231	240		0		
	241	250		0		
small boulder	251	260		0		
	261	270		0		
	271	280		0		
	281	290		0		
	291	300		0		
	301	310		0		
	311	320		0		
	321	330		0		
	331	340		0		
	341	350		0		
	351	360		0		
	361	370		0		
	371	380		0		
	381	391		0		
		bdrk		0		
		TOTAL	0			

Description:

D/S of KING ST. - TECHNICAL CORRIDOR ANALYSIS

ULTIMATE STABLE CONDITIONS

Substrate Type Count

silt/clay	sand	gravel	cobble	boulder	bedrock
0	0	0	0	0	0

Substrate Type Percent

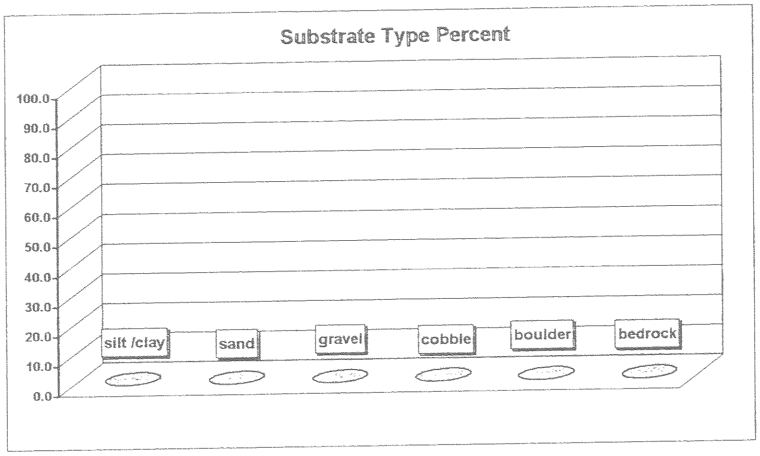
silt/clay	sand	gravel	cobble	boulder	bedrock

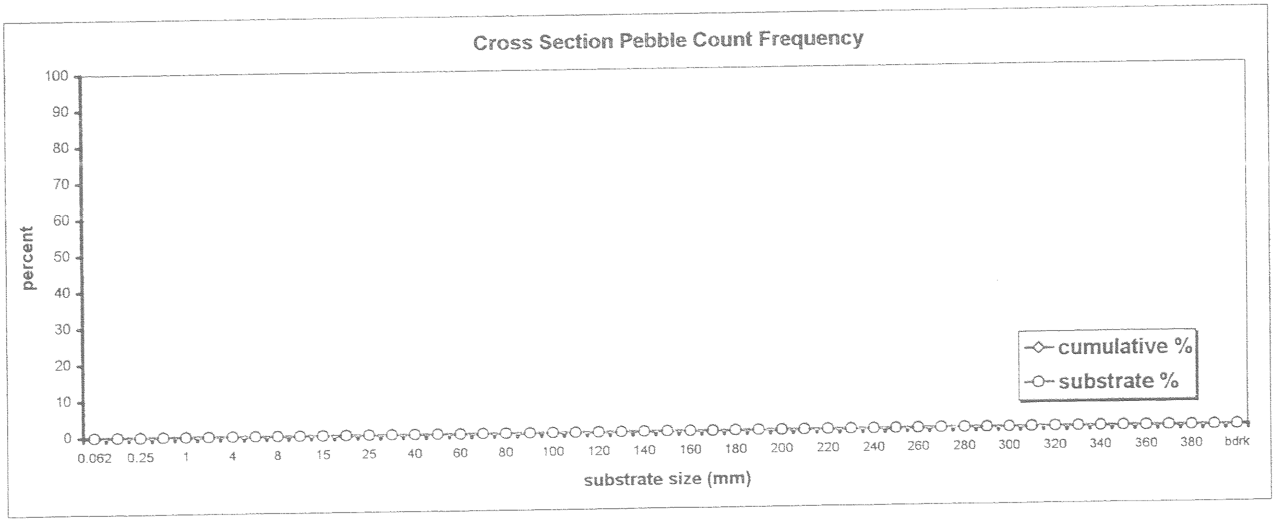
Hydraulic Roughness

rr R/D_{84}	2.54
ff V mean/V*	6.05
ff D_{84}	5.15
ff mean	5.60
	ROUGH BED

Gradation Summary (mm)

D_{15}	D_{30}	D_{50}	D_{84}	D_{100}	
39.00	107.00	169.00	210.00	250.00	Stability Design Targets
50.7	71.0	152.1	182.5	202.8	high turbulence angular
56.3	78.9	169.0	202.8	225.3	high turbulence riverstone
30.4	60.8	101.4	131.8	152.1	low turbulence angular
33.8	67.6	112.7	146.5	169.0	low turbulence riverstone





Section Survey			A (m^2)			WP (m)			TW (m)		
Sta.	Elev. (m)	Subm.	Part d	d	Total	Part	Full	Total	Part	Full	Total
-9.21	0.5	0	0.003	0.000	0.003	0.140	0.000	0.140	0.131	0.000	0.131
-7.9	0	1	0.000	4.851	4.851	0.000	8.955	8.955	0.000	8.900	8.900
1	-0.99	1	0.000	1.045	1.045	0.000	1.000	1.000	0.000	1.000	1.000
2	-1	1	0.000	1.035	1.035	0.000	1.000	1.000	0.000	1.000	1.000
3	-0.97	1	0.000	1.055	1.055	0.000	1.002	1.002	0.000	1.000	1.000
4	-1.04	1	0.000	1.055	1.055	0.000	1.002	1.002	0.000	1.000	1.000
5	-0.97	1	0.000	1.045	1.045	0.000	1.001	1.001	0.000	1.000	1.000
6	-1.02	1	0.000	1.050	1.050	0.000	1.001	1.001	0.000	1.000	1.000
7	-0.98	1	0.000	1.000	1.000	0.000	1.002	1.002	0.000	1.000	1.000
8	-0.92	1	0.000	0.970	0.970	0.000	1.000	1.000	0.000	1.000	1.000
9	-0.92	1	0.000	0.970	0.970	0.000	1.000	1.000	0.000	1.000	1.000
10	-0.92	1	0.000	0.935	0.935	0.000	1.002	1.002	0.000	1.000	1.000
11	-0.85	1	0.000	0.725	0.725	0.000	1.059	1.059	0.000	1.000	1.000
12	-0.5	1	0.000	0.500	0.500	0.000	1.005	1.005	0.000	1.000	1.000
13	-0.4	1	0.000	0.401	0.401	0.000	1.005	1.005	0.000	1.000	1.000
14	-0.301	1	0.000	0.326	0.326	0.000	1.001	1.001	0.000	1.000	1.000
15	-0.25	1	0.000	0.673	0.673	0.000	2.451	2.451	0.000	2.450	2.450
17.45	-0.199	1	0.000	0.781	0.781	0.000	3.500	3.500	0.000	3.500	3.500
20.95	-0.147	1	0.000	0.678	0.678	0.000	6.493	6.493	0.000	6.490	6.490
27.44	0.038	0	0.001	0.000	0.001	0.144	0.000	0.144	0.144	0.000	0.144
28.6	0.135	-1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30.00	0.5										
				TOTAL	19.097			35.765			35.615

Section Metrics							
Bf_{elev} (m)		Bf stations L / R		W_{fpa} (m)		ER_{elev} (m)	
0.050		-8.100	27.500	0.00		1.140	
E_d	r_c	z	h bank L / R (m)			ER stations L / R	
0.0148	100.00	4.0	1.50	1.50			

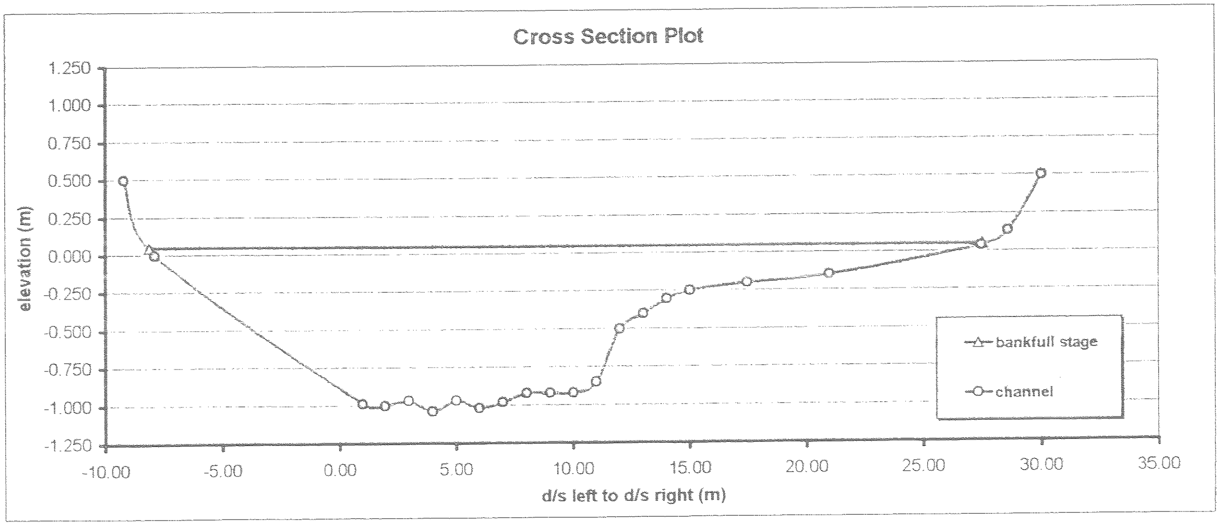
Hydraulic Geometry	
A (m^2)	19.097
R (m)	0.534
TW (m)	35.615
WP (m)	35.765
max. d (m)	1.090
mean d (m)	0.536
$E_{super\,(Limer.)}$ (m)	0.13
$E_{super\,(Strick.)}$ (m)	0.18

Hydraulic Ratios	
ER max. d	0.00
BHR L	1.38
BHR R	1.38
TW/max d	32.7
TW/mean d	66.4

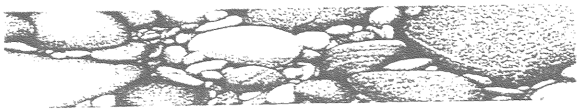
Flow Regime (Limerinos)	
Q (cms)	29.45
V (m s-1)	1.54
n	0.052
Fr	0.67
D_c rectangular	0.42
D_c trapezoidal	1.13
D_c triangular	1.62
D_c parabolic	1.35
D_c mean	1.13
Ω (watts m^{-1})	435.92
ω_a (watts m^{-2})	119.45
ω_a/TW (watts m^{-1})	3.35
*Re**	305.4
turbulence	HIGH

Flow Regime (Strickler)	
Q (cms)	34.89
V (m s^{-1})	1.83
n	0.044
Fr	0.80
D_c rectangular	0.46
D_c trapezoidal	1.22
D_c triangular	1.73
D_c parabolic	1.47
D_c mean	1.22
Ω (watts m^{-1})	516.39
ω_a (watts m^{-2})	141.50
ω_a/TW (watts m^{-1})	3.97
*Re**	257.8
turbulence	HIGH

Erosion Diagnostics						
τ_{calc} (kg m^{-2})	7.90					
τ_{calc} (N m^{-2})	77.44	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
τ D_{cnt} (mm)	79.84	REGIME	STABLE	STABLE	STABLE	STABLE
V D_{cnt} (mm) L.	168.12	REGIME	REGIME	STABLE	STABLE	STABLE
V D_{cnt} (mm) S.	199.15	UNSTABLE	UNSTABLE	UNSTABLE	STABLE	STABLE
EP (N m^{-1} s^{-1}) L.	2408.94					
EP (N m^{-1} s^{-1}) S.	2853.63					
V*	0.28	Limerinos	Strickler			
V_{comp} (m s^{-1})	6.67	STABLE	STABLE			



GEO-X v.1.4(2002) Geomorphic Cross Section Analysis Model
PARISH Geomorphic Ltd. Author/Programmer: B. de Geus



Project: **COOKSVILLE CREEK SPECIAL POLICY AREA STUDY**
GEOMORPHOLOGY COMPONENT

Material	Range (mm)		#	# sum	# %	% sum
silt/clay	0	0.062		0	0.0	0.0
very fine sand	0.062	0.13		0	0.0	0.0
fine sand	0.13	0.25		0	0.0	0.0
medium sand	0.25	0.5		0	0.0	0.0
coarse sand	0.5	1		0	0.0	0.0
very coarse sand	1	2	1	1	2.6	2.6
very fine gravel	3	4	1	2	2.6	5.1
fine gravel	5	6	2	4	5.1	10.3
	7	8	1	5	2.6	12.8
medium gravel	9	10		5	0.0	12.8
	11	15	3	8	7.7	20.5
	16	20		8	0.0	20.5
	21	25	1	9	2.6	23.1
coarse gravel	26	30	2	11	5.1	28.2
very coarse gravel	31	40	1	12	2.6	30.8
	41	50	2	14	5.1	35.9
	51	60	4	18	10.3	46.2
small cobble	61	70	2	20	5.1	51.3
	71	80		20	0.0	51.3
medium cobble	81	90	1	21	2.6	53.8
	91	100	3	24	7.7	61.5
	101	110		24	0.0	61.5
large cobble	111	120		24	0.0	61.5
	121	130	1	25	2.6	64.1
	131	140	1	26	2.6	66.7
	141	150	2	28	5.1	71.8
	151	160	1	29	2.6	74.4
	161	170		29	0.0	74.4
very large cobble	171	180	1	30	2.6	76.9
	181	190		30	0.0	76.9
	191	200	2	32	5.1	82.1
	201	210	1	33	2.6	84.6
	211	220	1	34	2.6	87.2
	221	230	1	35	2.6	89.7
	231	240		35	0.0	89.7
	241	250		35	0.0	89.7
small boulder	251	260	1	36	2.6	92.3
	261	270	1	37	2.6	94.9
	271	280		37	0.0	94.9
	281	290		37	0.0	94.9
	291	300	1	38	2.6	97.4
	301	310		38	0.0	97.4
	311	320		38	0.0	97.4
	321	330		38	0.0	97.4
	331	340	1	39	2.6	100.0
	341	350		39	0.0	100.0
	351	360		39	0.0	100.0
	361	370		39	0.0	100.0
	371	380		39	0.0	100.0
	381	391		39	0.0	100.0
		bdrk		39	0.0	100.0
		TOTAL	39		100.0	

Description:

U/S of BURNHAMTHORPE - TECHNICAL CORRIDOR ANALYSIS

EXISTING CONDITIONS

Substrate Type Count

silt/clay	sand	gravel	cobble	boulder	bedrock
0	1	17	17	4	0

Substrate Type Percent

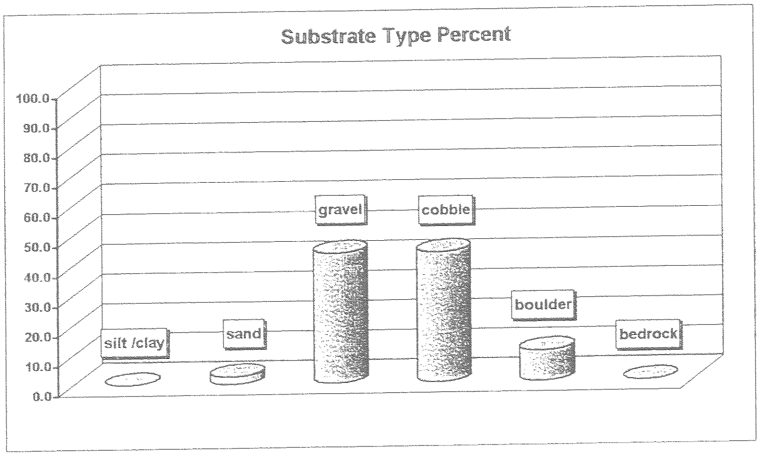
silt/clay	sand	gravel	cobble	boulder	bedrock
0.0	2.6	43.6	43.6	10.3	0.0

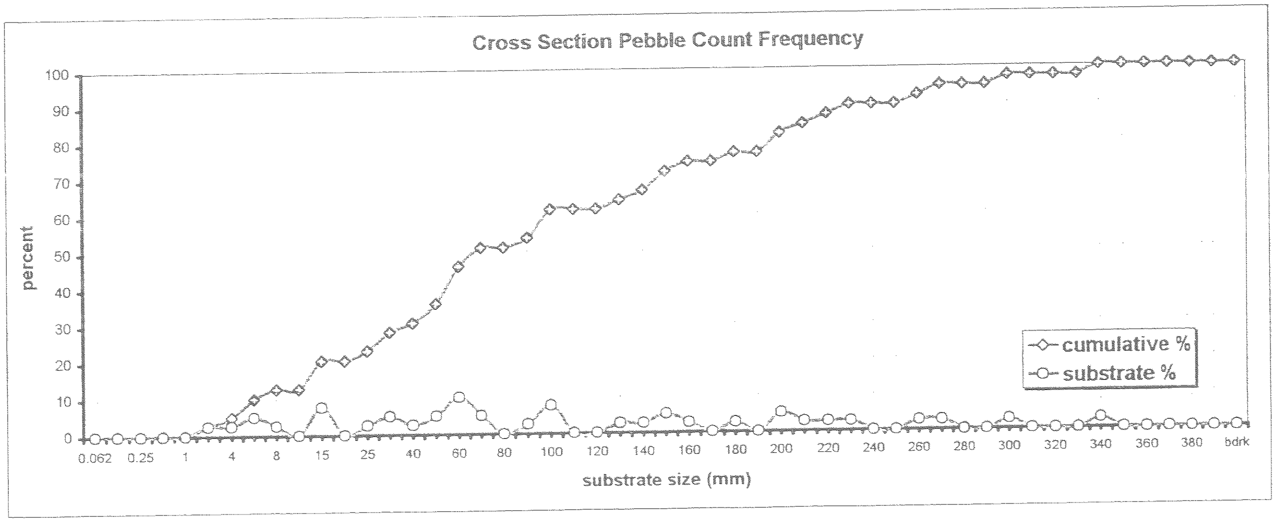
Hydraulic Roughness

ff R/D_{84}	3.12
ff V mean/V^*	7.06
ff D_{84}	5.88
ff mean	6.47
	ROUGH BED

Gradation Summary (mm)

D_{15}	D_{30}	D_{50}	D_{84}	D_{100}	
13.00	39.00	68.00	210.00	340.00	Stability Design Targets
20.4	28.6	61.2	73.4	81.6	high turbulence angular
22.7	31.7	68.0	81.6	90.7	high turbulence riverstone
12.2	24.5	40.8	53.0	61.2	low turbulence angular
13.6	27.2	45.3	58.9	68.0	low turbulence riverstone





Section Survey			A (m^2)			WP (m)			TW (m)		
Sta.	Elev. (m)	Subm.	Part d	d	Total	Part	Full	Total	Part	Full	Total
0	0	-1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	-0.78	0	0.061	0.000	0.061	0.659	0.000	0.659	0.195	0.000	0.195
1.3	-1.75	1	0.000	0.441	0.441	0.000	0.700	0.700	0.000	0.700	0.700
2	-1.75	1	0.000	0.575	0.575	0.000	1.006	1.006	0.000	1.000	1.000
3	-1.64	1	0.000	0.560	0.560	0.000	1.003	1.003	0.000	1.000	1.000
4	-1.72	1	0.000	0.590	0.590	0.000	1.000	1.000	0.000	1.000	1.000
5	-1.7	1	0.000	0.605	0.605	0.000	1.001	1.001	0.000	1.000	1.000
6	-1.75	1	0.000	0.715	0.715	0.000	1.014	1.014	0.000	1.000	1.000
7	-1.92	1	0.000	0.810	0.810	0.000	1.000	1.000	0.000	1.000	1.000
8	-1.94	1	0.000	0.870	0.870	0.000	1.005	1.005	0.000	1.000	1.000
9	-2.04	1	0.000	0.955	0.955	0.000	1.002	1.002	0.000	1.000	1.000
10	-2.11	1	0.000	0.915	0.915	0.000	1.011	1.011	0.000	1.000	1.000
11	-1.96	1	0.000	0.556	0.556	0.000	0.651	0.651	0.000	0.650	0.650
11.65	-1.99	1	0.000	0.247	0.247	0.000	0.481	0.481	0.000	0.350	0.350
12	-1.66	0	0.026	0.000	0.026	0.549	0.000	0.549	0.098	0.000	0.098
12.3	0										
				TOTAL	7.926			12.084			10.992

Section Metrics

Bf_{elev} (m)	Bf stations L / R		W_{fsa} (m)	ER_{elev} (m)
-1.120	1.100	12.100	0.00	-0.130

E_d	r_c	z	h bank L / R (m)		ER stations L / R	
0.0242	100.00	0.5	1.75	1.75		

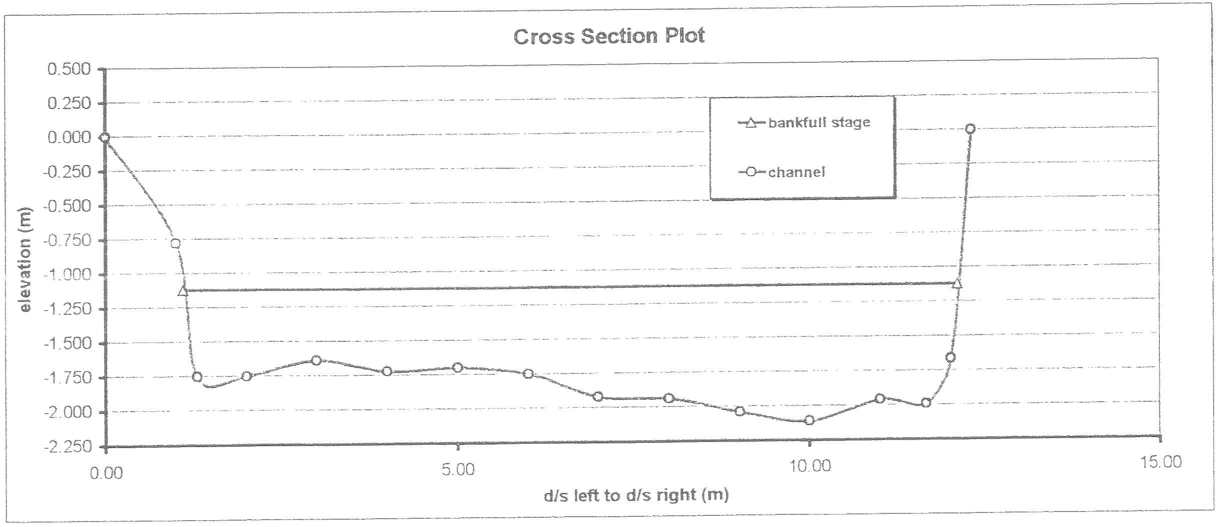
Hydraulic Geometry	
A (m^2)	7.926
R (m)	0.656
TW (m)	10.992
WP (m)	12.084
max. d (m)	0.990
mean d (m)	0.721
$E_{super (Limer.)}$ (m)	0.10
$E_{super (Strick.)}$ (m)	0.16

Hydraulic Ratios	
ER max. d	0.00
BHR L	1.77
BHR R	1.77
TW/max d	11.1
TW/mean d	15.2

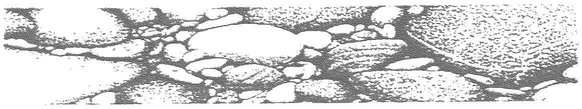
Flow Regime (Limerinos)	
Q (cms)	19.34
V (m s-1)	2.44
n	0.048
Fr	0.92
D_c rectangular	0.68
D_c trapezoidal	1.61
D_c triangular	3.14
D_c parabolic	1.02
D_c mean	1.61
Ω (watts m^{-1})	468.09
ω_a (watts m^{-2})	379.63
ω_a/TW (watts m^{-1})	34.54
*Re**	115.2
turbulence	HIGH

Flow Regime (Strickler)	
Q (cms)	24.81
V (m s^{-1})	3.13
n	0.037
Fr	1.18
D_c rectangular	0.81
D_c trapezoidal	1.81
D_c triangular	3.47
D_c parabolic	1.15
D_c mean	1.81
Ω (watts m^{-1})	600.48
ω_a (watts m^{-2})	487.00
ω_a/TW (watts m^{-1})	44.30
*Re**	89.8
turbulence	HIGH

Erosion Diagnostics						
τ_{calc} (kg m^{-2})	15.87					
τ_{calc} (N m^{-2})	155.56	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
τ D_{cnt} (mm)	160.37	UNSTABLE	UNSTABLE	UNSTABLE	STABLE	STABLE
V D_{cnt} (mm) L.	266.00	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE	STABLE
V D_{cnt} (mm) S.	341.23	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE
EP (N m^{-1} s^{-1}) L.	1230.02					
EP (N m^{-1} s^{-1}) S.	1577.91					
V*	0.39	Limerinos	Strickler			
V_{comp} (m s^{-1})	6.67	STABLE	STABLE			



GEO-X v.1.4(2002) Geomorphic Cross Section Analysis Model
PARISH Geomorphic Ltd. Author/Programmer: B. de Geus



Project: **COOKSVILLE CREEK SPECIAL POLICY AREA STUDY**
GEOMORPHOLOGY COMPONENT

Material	Range (mm)		#	# sum	# %	% sum
silt/clay	0	0.062		0		
very fine sand	0.062	0.13		0		
fine sand	0.13	0.25		0		
medium sand	0.25	0.5		0		
coarse sand	0.5	1		0		
very coarse sand	1	2		0		
very fine gravel	3	4		0		
fine gravel	5	6		0		
	7	8		0		
medium gravel	9	10		0		
	11	15		0		
	16	20		0		
	21	25		0		
coarse gravel	26	30		0		
very coarse gravel	31	40		0		
	41	50		0		
	51	60		0		
small cobble	61	70		0		
	71	80		0		
medium cobble	81	90		0		
	91	100		0		
	101	110		0		
large cobble	111	120		0		
	121	130		0		
	131	140		0		
	141	150		0		
	151	160		0		
	161	170		0		
very large cobble	171	180		0		
	181	190		0		
	191	200		0		
	201	210		0		
	211	220		0		
	221	230		0		
	231	240		0		
	241	250		0		
small boulder	251	260		0		
	261	270		0		
	271	280		0		
	281	290		0		
	291	300		0		
	301	310		0		
	311	320		0		
	321	330		0		
	331	340		0		
	341	350		0		
	351	360		0		
	361	370		0		
	371	380		0		
	381	391		0		
		bdrk		0		
		TOTAL	0			

Description:

U/S of BURNHAMTHORPE - CROSS SECTION AND SETBACK ANALYSIS

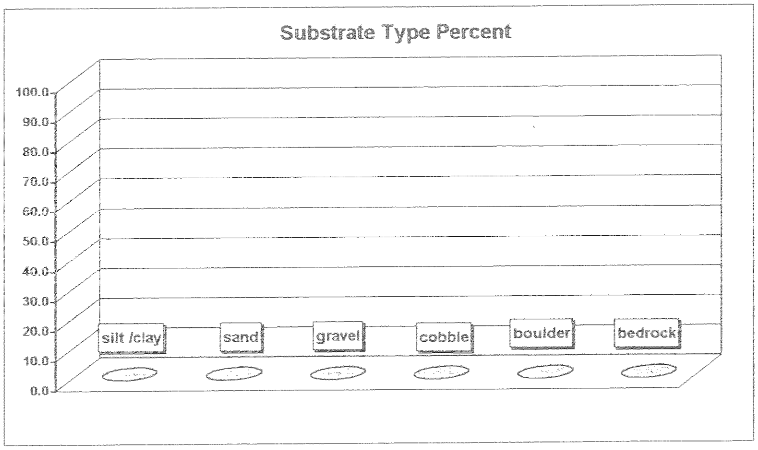
ULTIMATE STABLE CONDITIONS

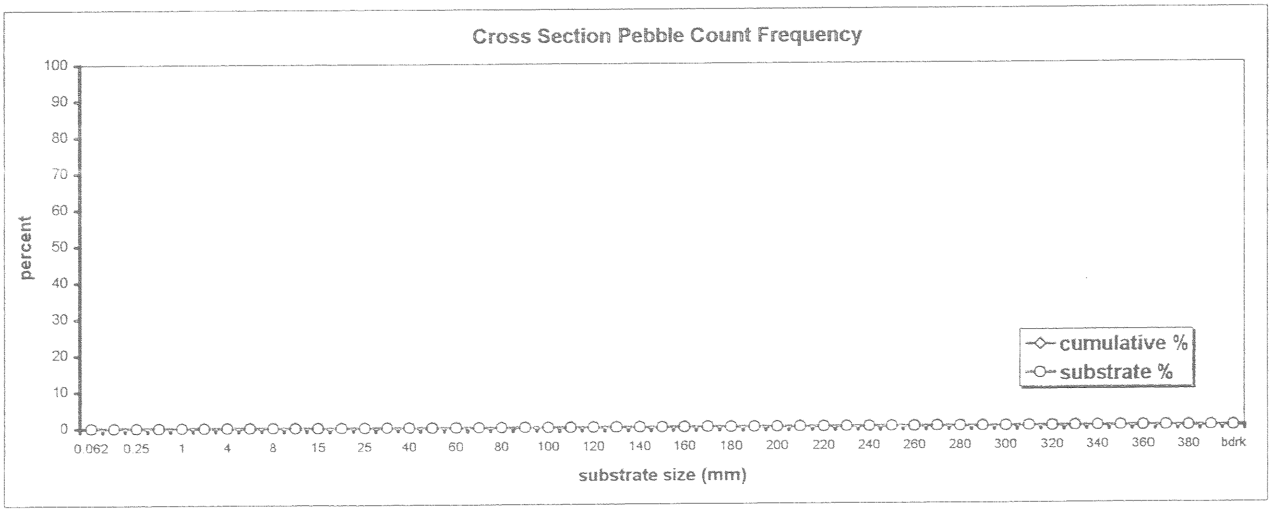
Substrate Type Count					
silt/clay	sand	gravel	cobble	boulder	bedrock
0	0	0	0	0	0

Substrate Type Percent					
silt/clay	sand	gravel	cobble	boulder	bedrock

Hydraulic Roughness	
rr R/D84	2.13
ff V mean/V*	5.78
ff D84	4.74
ff mean	5.26
	ROUGH BED

Gradation Summary (mm)					
D_{15}	D_{30}	D_{50}	D_{84}	D_{100}	
39.00	68.00	210.00	275.00	340.00	Stability Design Targets
63.0	88.2	189.0	226.8	252.0	high turbulence angular
70.0	98.0	210.0	252.0	280.0	high turbulence riverstone
37.8	75.6	126.0	163.8	189.0	low turbulence angular
42.0	84.0	140.0	182.0	210.0	low turbulence riverstone





Section Survey			A (m^2)			WP (m)			TW (m)		
Sta.	Elev. (m)	Subm.	Part d	d	Total	Part	Full	Total	Part	Full	Total
-9.09	0	0	0.020	0.000	0.020	0.441	0.000	0.441	0.431	0.000	0.431
-4.3	-1.044	1	0.000	1.088	1.088	0.000	4.440	4.440	0.000	4.430	4.430
0.13	-1.347	1	0.000	1.119	1.119	0.000	1.913	1.913	0.000	1.870	1.870
2	-1.75	1	0.000	0.745	0.745	0.000	1.006	1.006	0.000	1.000	1.000
3	-1.64	1	0.000	0.730	0.730	0.000	1.003	1.003	0.000	1.000	1.000
4	-1.72	1	0.000	0.760	0.760	0.000	1.000	1.000	0.000	1.000	1.000
5	-1.7	1	0.000	0.775	0.775	0.000	1.001	1.001	0.000	1.000	1.000
6	-1.75	1	0.000	0.885	0.885	0.000	1.014	1.014	0.000	1.000	1.000
7	-1.92	1	0.000	0.980	0.980	0.000	1.000	1.000	0.000	1.000	1.000
8	-1.94	1	0.000	1.040	1.040	0.000	1.005	1.005	0.000	1.000	1.000
9	-2.04	1	0.000	1.125	1.125	0.000	1.002	1.002	0.000	1.000	1.000
10	-2.11	1	0.000	1.085	1.085	0.000	1.011	1.011	0.000	1.000	1.000
11	-1.96	1	0.000	0.885	0.885	0.000	1.347	1.347	0.000	1.220	1.220
12.22	-1.39	1	0.000	0.746	0.746	0.000	2.852	2.852	0.000	2.830	2.830
15.05	-1.037	0	0.019	0.000	0.019	0.438	0.000	0.438	0.430	0.000	0.430
20.17	0										
				TOTAL	12.001			20.475			20.211

Section Metrics						
Bf_{elev} (m)		Bf stations L / R		W_{fpa} (m)	ER_{elev} (m)	
-0.950		-4.900	15.400	0.00	0.210	
E_s	r_c	z	h bank L / R (m)		ER stations L / R	
0.0242	100.00	0.5	1.75	1.75		

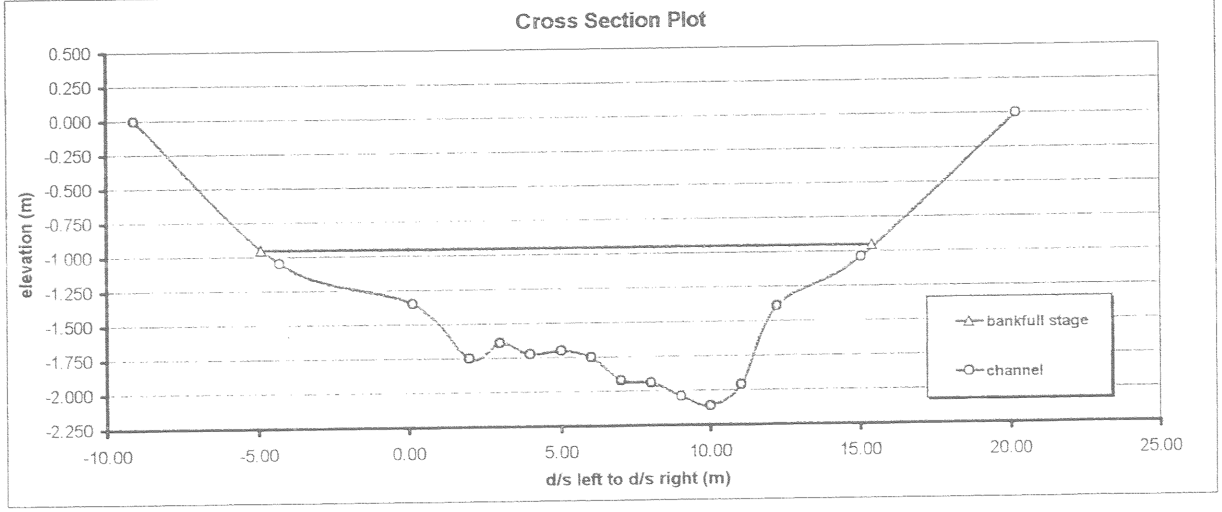
Hydraulic Geometry	
A (m^2)	12.001
R (m)	0.586
TW (m)	20.211
WP (m)	20.475
max. d (m)	1.160
mean d (m)	0.594
$E_{super\ (Limer.)}$ (m)	0.11
$E_{super\ (Strick.)}$ (m)	0.18

Hydraulic Ratios	
ER max. d	0.00
BHR L	1.51
BHR R	1.51
TW/max d	17.4
TW/mean d	34.0

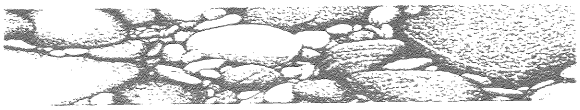
Flow Regime (Limerinos)	
Q (cms)	22.96
V (m s-1)	1.91
n	0.057
Fr	0.79
D_c rectangular	0.51
D_c trapezoidal	1.68
D_c triangular	3.36
D_c parabolic	1.17
D_c mean	1.68
Ω (watts m^{-1})	555.58
ω_a (watts m^{-2})	265.91
ω_a/TW (watts m^{-1})	13.16
*Re**	411.7
turbulence	HIGH

Flow Regime (Strickler)	
Q (cms)	28.76
V (m s^{-1})	2.40
n	0.045
Fr	0.99
D_c rectangular	0.59
D_c trapezoidal	1.86
D_c triangular	3.68
D_c parabolic	1.30
D_c mean	1.86
Ω (watts m^{-1})	696.06
ω_a (watts m^{-2})	333.15
ω_a/TW (watts m^{-1})	16.48
*Re**	328.6
turbulence	HIGH

Erosion Diagnostics						
τ_{calc} (kg m^{-2})	14.18					
τ_{calc} (N m^{-2})	139.00	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
τ D_{cnt} (mm)	143.30	REGIME	REGIME	STABLE	STABLE	STABLE
V D_{cnt} (mm) L.	208.52	REGIME	REGIME	STABLE	STABLE	STABLE
V D_{crit} (mm) S.	261.24	UNSTABLE	UNSTABLE	UNSTABLE	STABLE	STABLE
EP (N m^{-1} s^{-1}) L.	3630.87					
EP (N m^{-1} s^{-1}) S.	4548.99					
V*	0.37	Limerinos	Strickler			
V_{comp} (m s^{-1})	7.55	STABLE	STABLE			



GEO-X v.1.4(2002) Geomorphic Cross Section Analysis Model
PARISH Geomorphic Ltd. Author/Programmer: B. de Geus



Project: **COOKSVILLE CREEK SPECIAL POLICY AREA STUDY**
GEOMORPHOLOGY COMPONENT

Material	Range (mm)		#	# sum	# %	% sum
silt/clay	0	0.062		0		
very fine sand	0.062	0.13		0		
fine sand	0.13	0.25		0		
medium sand	0.25	0.5		0		
coarse sand	0.5	1		0		
very coarse sand	1	2		0		
very fine gravel	3	4		0		
fine gravel	5	6		0		
	7	8		0		
medium gravel	9	10		0		
	11	15		0		
	16	20		0		
	21	25		0		
coarse gravel	26	30		0		
very coarse gravel	31	40		0		
	41	50		0		
	51	60		0		
small cobble	61	70		0		
	71	80		0		
medium cobble	81	90		0		
	91	100		0		
	101	110		0		
large cobble	111	120		0		
	121	130		0		
	131	140		0		
	141	150		0		
	151	160		0		
	161	170		0		
very large cobble	171	180		0		
	181	190		0		
	191	200		0		
	201	210		0		
	211	220		0		
	221	230		0		
	231	240		0		
	241	250		0		
small boulder	251	260		0		
	261	270		0		
	271	280		0		
	281	290		0		
	291	300		0		
	301	310		0		
	311	320		0		
	321	330		0		
	331	340		0		
	341	350		0		
	351	360		0		
	361	370		0		
	371	380		0		
	381	391		0		
		bdrk		0		
		TOTAL	0			

Description:

D/S of MATHESON BLVD. - TECHNICAL CORRIDOR

EXISTING CONDITIONS

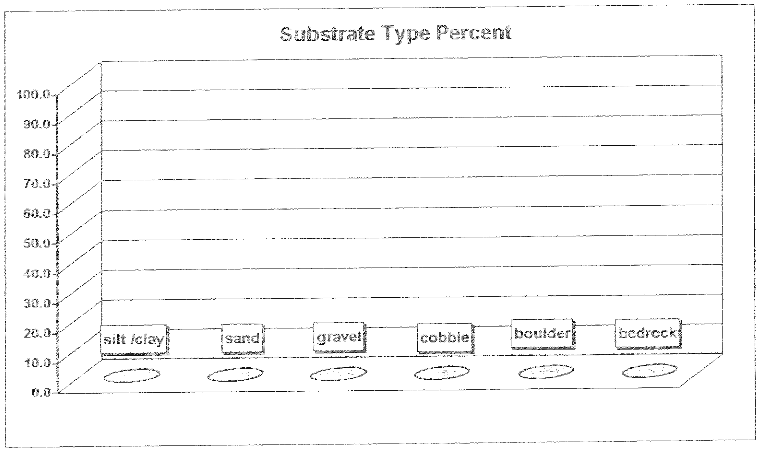
Note: i) stable gabion channel - D50 and D84 values calibrated to recommended Mannings n

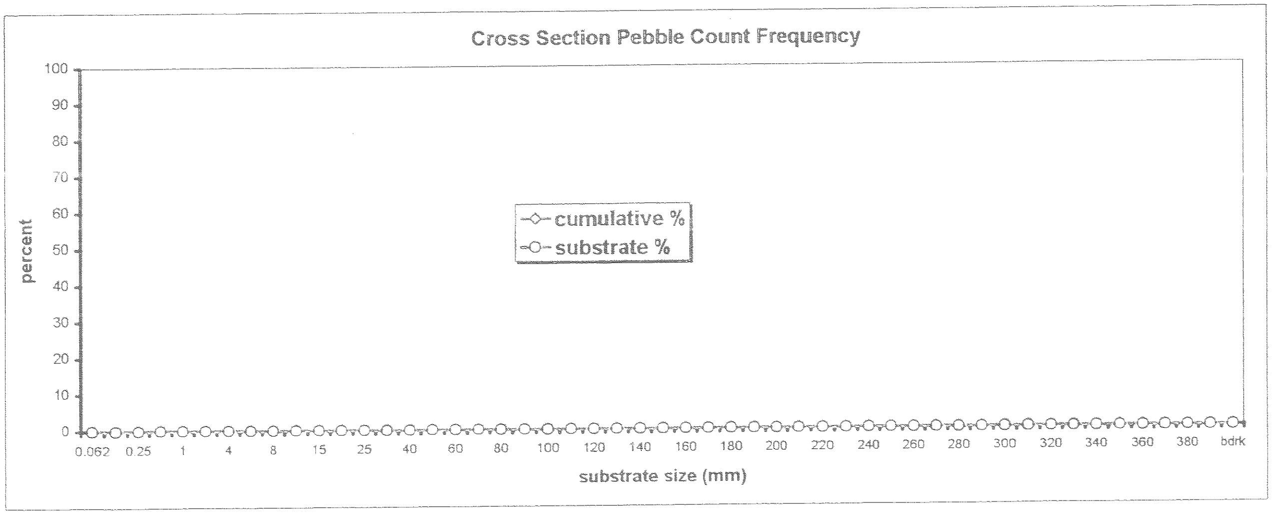
Substrate Type Count					
silt/clay	sand	gravel	cobble	boulder	bedrock
0	0	0	0	0	0

Hydraulic Roughness	
rr R/D_{84}	12.43
ff V mean/V*	9.24
ff D_{84}	9.15
ff mean	9.20
	SMOOTH BED

Substrate Type Percent					
silt/clay	sand	gravel	cobble	boulder	bedrock

Gradation Summary (mm)					
D_{15}	D_{30}	D_{50}	D_{84}	D_{100}	
		30.00	50.00		Stability Design Targets
9.0	12.6	27.0	32.4	36.0	high turbulence angular
10.0	14.0	30.0	36.0	40.0	high turbulence riverstone
5.4	10.8	18.0	23.4	27.0	low turbulence angular
6.0	12.0	20.0	26.0	30.0	low turbulence riverstone





Section Survey			A (m^2)			WP (m)			TW (m)		
Sta.	Elev. (m)	Subm.	Part d	d	Total	Part	Full	Total	Part	Full	Total
-3	1	0	0.144	0.000	0.144	0.980	0.000	0.980	0.930	0.000	0.930
0	0	1	0.000	0.430	0.430	0.000	1.028	1.028	0.000	1.000	1.000
1	-0.24	1	0.000	0.575	0.575	0.000	1.001	1.001	0.000	1.000	1.000
2	-0.29	1	0.000	0.630	0.630	0.000	1.002	1.002	0.000	1.000	1.000
3	-0.35	1	0.000	0.950	0.950	0.000	1.156	1.156	0.000	1.000	1.000
4	-0.93	1	0.000	1.210	1.210	0.000	1.002	1.002	0.000	1.000	1.000
5	-0.87	1	0.000	1.110	1.110	0.000	1.010	1.010	0.000	1.000	1.000
6	-0.73	1	0.000	0.850	0.850	0.000	1.070	1.070	0.000	1.000	1.000
7	-0.35	1	0.000	0.615	0.615	0.000	1.004	1.004	0.000	1.000	1.000
8	-0.26	1	0.000	0.465	0.465	0.000	1.022	1.022	0.000	1.000	1.000
9	-0.05	1	0.000	0.147	0.147	0.000	0.443	0.443	0.000	0.440	0.440
9.44	0	0	0.144	0.000	0.144	0.980	0.000	0.980	0.930	0.000	0.930
12.44	1										
				TOTAL	7.271			11.698			11.300

Section Metrics

Bf_{elev} (m)		Bf stations L / R			W_{ba} (m)	ER_{elev} (m)	
0.310		-0.900	10.400		0.00	1.550	
E_s	r_c		z	h bank L / R (m)		ER stations L / R	
0.0053	100.00		3.0	0.75	0.75		

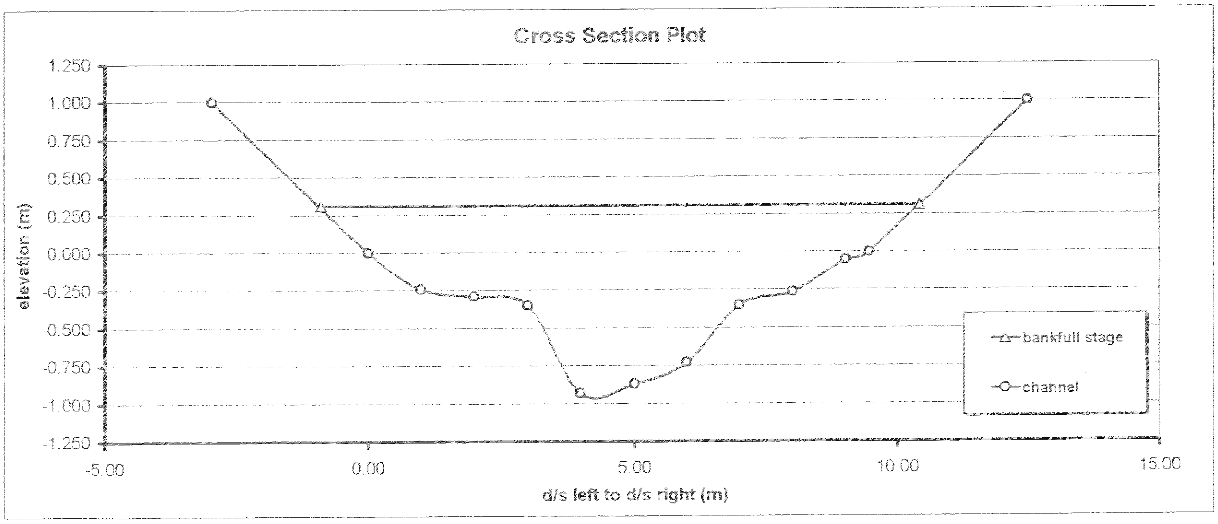
Hydraulic Geometry	
A (m^2)	7.271
R (m)	0.622
TW (m)	11.300
WP (m)	11.698
max. d (m)	1.240
mean d (m)	0.643
$E_{super (Limer.)}$ (m)	0.05
$E_{super (Strick.)}$ (m)	0.05

Hydraulic Ratios	
ER max. d	0.00
BHR L	0.60
BHR R	0.60
TW/max d	9.1
TW/mean d	17.6

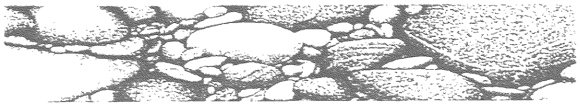
Flow Regime (Limerinos)	
Q (cms)	12.35
V (m s-1)	1.70
n	0.031
Fr	0.68
D_c rectangular	0.50
D_c trapezoidal	0.87
D_c triangular	1.28
D_c parabolic	0.84
D_c mean	0.87
Ω (watts m^{-1})	65.46
ω_a (watts m^{-2})	54.84
ω_a/TW (watts m^{-1})	4.85
*Re**	32.3
turbulence	HIGH

Flow Regime (Strickler)	
Q (cms)	11.81
V (m s^{-1})	1.62
n	0.033
Fr	0.65
D_c rectangular	0.48
D_c trapezoidal	0.85
D_c triangular	1.26
D_c parabolic	0.82
D_c mean	0.85
Ω (watts m^{-1})	62.58
ω_a (watts m^{-2})	52.43
ω_a/TW (watts m^{-1})	4.64
*Re**	33.8
turbulence	HIGH

Erosion Diagnostics						
τ_{crit} (kg m^{-2})	3.29					
τ_{crit} (N m^{-2})	32.28	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
τ D_{crit} (mm)	33.28					
V D_{crit} (mm) L.	185.16					
V D_{crit} (mm) S.	177.02					
EP (N m^{-1} s^{-1}) L.	439.48					
EP (N m^{-1} s^{-1}) S.	420.16					
V*	0.18	Limerinos	Strickler			
V_{comp} (m s^{-1})	3.45	STABLE	STABLE			



GEO-X v.1.4(2002) Geomorphic Cross Section Analysis Model
PARISH Geomorphic Ltd. Author/Programmer: B. de Geus



Project: **COOKSVILLE CREEK SPECIAL POLICY AREA STUDY**
GEOMORPHOLOGY COMPONENT

Material	Range (mm)		#	# sum	# %	% sum
silt/clay	0	0.062		0		
very fine sand	0.062	0.13		0		
fine sand	0.13	0.25		0		
medium sand	0.25	0.5		0		
coarse sand	0.5	1		0		
very coarse sand	1	2		0		
very fine gravel	3	4		0		
fine gravel	5	6		0		
	7	8		0		
medium gravel	9	10		0		
	11	15		0		
	16	20		0		
	21	25		0		
coarse gravel	26	30		0		
very coarse gravel	31	40		0		
	41	50		0		
	51	60		0		
small cobble	61	70		0		
	71	80		0		
medium cobble	81	90		0		
	91	100		0		
	101	110		0		
large cobble	111	120		0		
	121	130		0		
	131	140		0		
	141	150		0		
	151	160		0		
	161	170		0		
very large cobble	171	180		0		
	181	190		0		
	191	200		0		
	201	210		0		
	211	220		0		
	221	230		0		
	231	240		0		
	241	250		0		
small boulder	251	260		0		
	261	270		0		
	271	280		0		
	281	290		0		
	291	300		0		
	301	310		0		
	311	320		0		
	321	330		0		
	331	340		0		
	341	350		0		
	351	360		0		
	361	370		0		
	371	380		0		
	381	391		0		
		bdrk		0		
		TOTAL	0			

Description:

D/S of MATHESON BLVD. - TECHNICAL CORRIDOR

ULTIMATE CONDITIONS

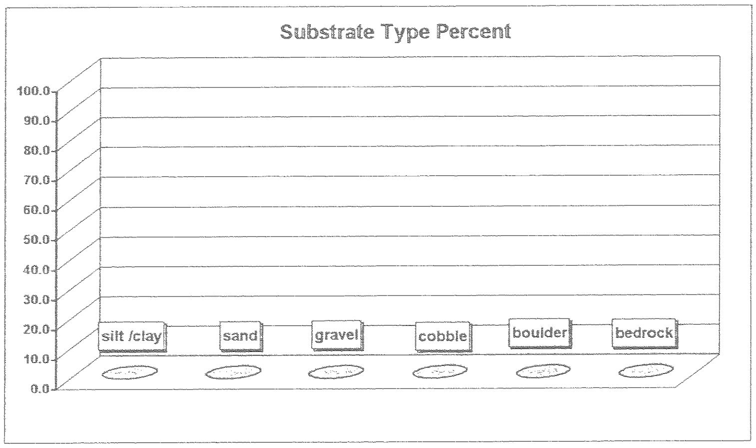
Note: i) stable gabion channel - D50 and D84 values calibrated to recommended Mannings n

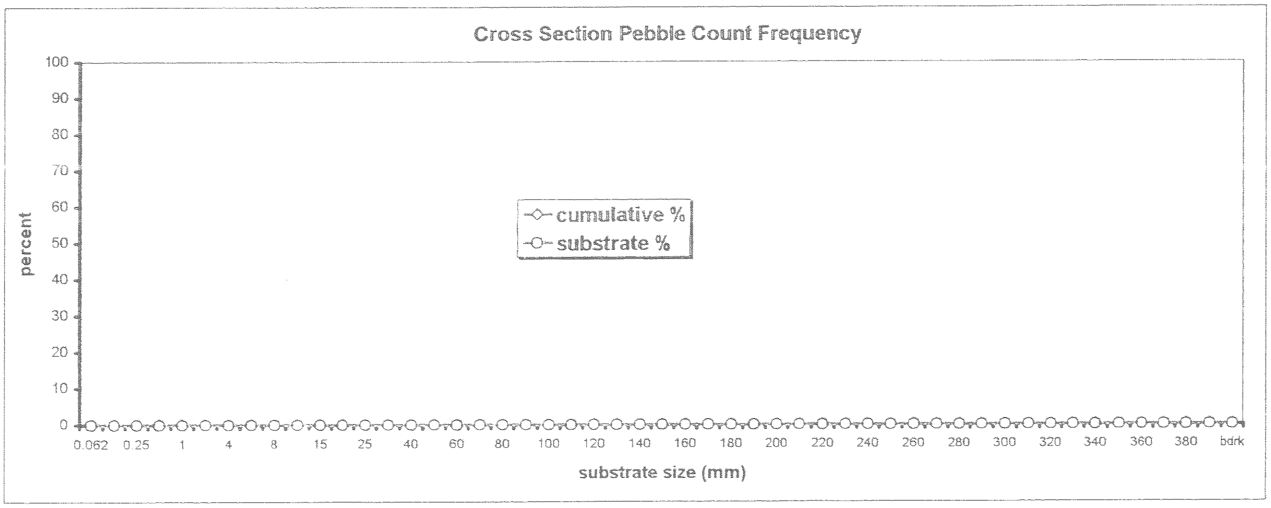
Substrate Type Count					
silt/clay	sand	gravel	cobble	boulder	bedrock
0	0	0	0	0	0

Substrate Type Percent					
silt/clay	sand	gravel	cobble	boulder	bedrock

Hydraulic Roughness	
rr R/D_{84}	13.18
ff V mean/V*	9.36
ff D_{84}	9.30
ff mean	9.33
	SMOOTH BED

Gradation Summary (mm)					
D_{15}	D_{30}	D_{50}	D_{84}	D_{100}	
		30.00	50.00		Stability Design Targets
9.0	12.6	27.0	32.4	36.0	high turbulence angular
10.0	14.0	30.0	36.0	40.0	high turbulence riverstone
5.4	10.8	18.0	23.4	27.0	low turbulence angular
6.0	12.0	20.0	26.0	30.0	low turbulence riverstone





Section Survey			A (m^2)			WP (m)			TW (m)		
Sta.	Elev. (m)	Subm.	Part d	d	Total	Part	Full	Total	Part	Full	Total
-3	1	0	0.205	0.000	0.205	1.170	0.000	1.170	1.110	0.000	1.110
0	0	1	0.000	0.490	0.490	0.000	1.028	1.028	0.000	1.000	1.000
1	-0.24	1	0.000	0.635	0.635	0.000	1.001	1.001	0.000	1.000	1.000
2	-0.29	1	0.000	0.690	0.690	0.000	1.002	1.002	0.000	1.000	1.000
3	-0.35	1	0.000	1.010	1.010	0.000	1.156	1.156	0.000	1.000	1.000
4	-0.93	1	0.000	1.270	1.270	0.000	1.002	1.002	0.000	1.000	1.000
5	-0.87	1	0.000	1.170	1.170	0.000	1.010	1.010	0.000	1.000	1.000
6	-0.73	1	0.000	0.910	0.910	0.000	1.070	1.070	0.000	1.000	1.000
7	-0.35	1	0.000	0.675	0.675	0.000	1.004	1.004	0.000	1.000	1.000
8	-0.26	1	0.000	0.525	0.525	0.000	1.022	1.022	0.000	1.000	1.000
9	-0.05	1	0.000	0.174	0.174	0.000	0.443	0.443	0.000	0.440	0.440
9.44	0	0	0.205	0.000	0.205	1.170	0.000	1.170	1.110	0.000	1.110
12.44	1										
				TOTAL	7.960			12.078			11.660

Section Metrics

Bf_{elev} (m)		Bf stations L / R			W_{fpa} (m)	ER_{elev} (m)	
0.370		-1.100	10.600		0.00	1.670	
E_q	r_c		z	h bank L / R (m)		ER stations L / R	
0.0053	100.00		3.0	0.75	0.75		

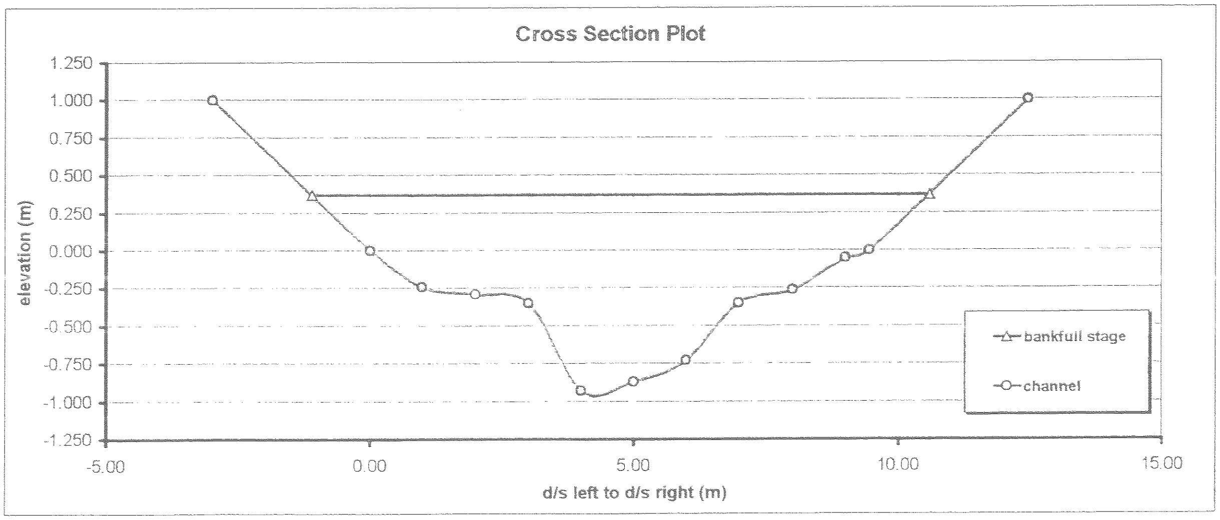
Hydraulic Geometry	
A (m^2)	7.960
R (m)	0.659
TW (m)	11.660
WP (m)	12.078
max. d (m)	1.300
mean d (m)	0.683
$E_{super (Limer.)}$ (m)	0.06
$E_{super (Strick.)}$ (m)	0.05

Hydraulic Ratios	
ER max. d	0.00
BHR L	0.58
BHR R	0.58
TW/max d	9.0
TW/mean d	17.1

Flow Regime (Limerinos)	
Q (cms)	14.14
V (m s-1)	1.78
n	0.031
Fr	0.69
D_c rectangular	0.53
D_c trapezoidal	0.92
D_c triangular	1.35
D_c parabolic	0.88
D_c mean	0.92
Ω (watts m^{-1})	74.95
ω_a (watts m^{-2})	60.82
ω_a/TW (watts m^{-1})	5.22
*Re**	31.8
turbulence	HIGH

Flow Regime (Strickler)	
Q (cms)	13.44
V (m s^{-1})	1.69
n	0.033
Fr	0.65
D_c rectangular	0.52
D_c trapezoidal	0.90
D_c triangular	1.33
D_c parabolic	0.86
D_c mean	0.90
Ω (watts m^{-1})	71.25
ω_a (watts m^{-2})	57.82
ω_a/TW (watts m^{-1})	4.96
*Re**	33.4
turbulence	HIGH

Erosion Diagnostics						
τ_{calc} (kg m^{-2})	3.49					
τ_{calc} (N m^{-2})	34.23	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
τ D_{crit} (mm)	35.29					
V D_{crit} (mm) L.	193.66					
V D_{crit} (mm) S.	184.10					
EP (N m^{-1} s^{-1}) L.	456.19					
EP (N m^{-1} s^{-1}) S.	433.69					
V*	0.19	Limerinos	Strickler			
V_{comp} (m s^{-1})	3.45	STABLE	STABLE			



1.2 Floodline Map Copies

☐ 2 sets of the final cronaflex maps.

☐ 4 sets of white prints.

☐ 2 sets of all digital maps.

2.0 MAPPING CHECK and SURVEY WORK

☐ **Map Selection** - map sheets selected by the Technical Sub Committee, not more than 10% of the map sheets are to be selected, not less than 1 map sheet per project.

☐ **Vertical Accuracy** - select 10 spot elevations and 10 contours, that are evenly distributed throughout the map - maps are acceptable if 90% of the spot elevations are within 1/3 of the contour interval - maps are acceptable if 90% of the contour crossings are within ½ the contour interval.

☐ **Horizontal Accuracy** - select 3 well defined, identifiable and accessible features at least 20 cm from each other - maps are acceptable if the map points are within a 0.5 mm radius of there true position.

☐ **Surveyed Coordinates** – all coordinates surveyed in the field shall be reported to Geodetic elevations and to the UTM referencing system.

☐ **Benchmarks and Monuments** – all benchmarks and monuments used in the survey work shall be described and located on the floodline maps.

☐ **Total Station** – all total station field book electronic files shall become part of the deliverables to the client. Both electronic and hard copy ASCII files shall compose the deliverables.

☐ **Field Books** – copies of the field books shall become part of the deliverables to the client.

3.0 HYDROLOGY

3.1 Points of Interest

Provide a check on the accuracy of the following, including how checked:

- Discretization Schematic

☐ Carefully consider discretization of the watershed separating major tributary areas.

☐ Figure - Schematic diagram of the watershed model.

3.2 Drainage Boundaries

Provide a check on the accuracy of the following including how checked:

- Drainage Area
- Impervious Area
- Pervious Area

☐ Determine the watershed contributing drainage area through field reconnaissance supplemented through the use of topographic maps and air photo interpretation.

☐ N/A Ineffective areas such as large gravel pits, which do not contribute to surface runoff, shall be excluded in the evaluation of flood flows.

3.3 Rainfall IDF Values

Provide a check on the accuracy of the following including how checked:

- Design Storm Time Step
- Design Storm Duration
- Design Storm Pattern

☐ The model shall be based on precipitation frequency or, where snowmelt floods are significant, a combination of snowmelt and precipitation.

☐ The equivalent circular area method shall be used to compute the area rainfall reduction factors for Regional storm for all watersheds except those having an extremely elongated shape, for which the isoheytal method shall be used.

Appendix A

Floodline Mapping Checklist

0. INTRODUCTION

Our detailed review is based upon the Canada / Ontario Terms of Reference for Floodline Mapping Studies. Our review includes the following sections:

- 1.0 General
- 2.0 Mapping Check
- 3.0 Hydrology
  - 3.1 Points of Interest
  - 3.2 Drainage Boundaries
  - 3.3 Rainfall IDF Values
  - 3.4 Hydrograph Computation Method
  - 3.5 Channel Routing
  - 3.6 Reservoir Routing
  - 3.7 Precipitation / Streamflow Data
  - 3.8 Calibration
  - 3.9 Verification
  - 3.10 Sensitivity Analysis
  - 3.11 Site Frequency Analysis
  - 3.12 Regional Frequency Analysis
  - 3.13 Results

- 4.0 Hydraulics
  - 4.1 Modelling Methodology
  - 4.2 Channel Cross Sections
  - 4.3 Crossing Analysis
  - 4.4 Boundary Conditions
  - 4.5 Calibration
  - 4.6 Sensitivity Analysis
  - 4.7 Results

- 5.0 Floodline Maps

Requirements of the Canada/Ontario Terms of reference are shown in small print. All requirements that have been met in our opinion are shown with a check mark. Outstanding requirements are shown with an open rectangular shaded box. Requirements that are not applicable are shown with N/A.

1.0 GENERAL

☐ The technical reports for hydrology, hydraulics, and maps are to be prepared in such a manner that the entire work can be recreated by any qualified persons without the need to refer to any other material. Further, qualified persons are to be able to recognize and understand all the methods, approaches, basic data, and rationale used for these methods.

☐ All existing studies, reports, plans, maps, hydrologic and hydraulic data related to the watershed will be reviewed and documented. All proposed development in the watershed will be investigated through the use of official plans, zoning bylaws, draft plans of subdivisions, engineering drawings, and other pertinent documents or information, to determine the effect of such changes in land use on floodlines.

☐ The most current version of the computer model programs will be used.

☐ If the consultant proposes any modifications to the program or proposes to use an existing modified program, the consultant must submit to the Authority input test data, output, and complete listing of the modified computer program, user's manual and an explanation in detail as to the nature of and reasons for modifications for review and approval prior to its use.

☐ List of technical persons with qualifications that worked on the project.

☐ A.P.E.O. stamp and signature of the Project Manager / Project Engineer.

1.1 Report Copies

☐ Background Information Report: 1 copy.

☐ Tender Document for Topographic Mapping: Number of copies will be specified by the Authority.

☐ Map Coordination and Monitoring Report: 3 copies.

☐ All Field Survey Notes: 2 copies.

☐ Topographic Mapping Inspection Report: 2 copies.

☐ Technical Report: 5 copies.

APPENDIX 'H'

ECONOMIC ASSESSMENT OF STRUCTURAL ALTERNATIVES

☐ Design Storm Pattern

☐ Design Storm Time Step

☐ Design Storm Duration

3.4 Hydrograph Computation Method

Provide a check on the accuracy of the following including how checked:

- Pervious Hydrologic Parameters
- Impervious Hydrologic Parameters
- Model Connectivity
- Model Input Data

☐ Watersheds for which the required parameters of the regional frequency relationships fall outside the range of applicability of the regression equations, (i.e. for small or urban watersheds) the 100, 50, 20, 10, 5, and 2 year floods shall be determined using a calibrated hydrologic model.

☐ The Regional Storm flood flow must be determined using a hydrologic model approved by the Authority. (HYMO, HYMO-VUH, OTTHYMO, FLOOD 2, HEC-1, SWMM, and ILLUDAS are some of the approved hydrologic models). Other models may be acceptable, provided they comply with criteria established by the Conservation Authorities and Water Management Branch and receive written approval from the Authority prior to the execution of the engineering agreement.

☐ One complete listing of the computer program source and executable modules, input data and the detailed output for the hydrological model on IBM PC format.

☐ Methodology used in determining watershed parameters.

☐ Impervious areas shall be determined by sampling a representative area in each subcatchment.

☐ Methodology used in determining design flows for existing and future conditions.

☐ In order to determine future flows, the calibrated model parameters must be adjusted accordingly.

☐ The soils and land use data shall be reviewed to understand the influence on runoff.

☐ Future proposals for culvert replacement shall also be considered. For points downstream of such structures, the design flows shall not exhibit the retardation provided by the structures, i.e. only non-routed flows should be used.

☐ Discussion on the justification for the selected watershed parameters used in the study.

☐ Discussion on the specific criteria used in determining the design flood flows.

☐ An assessment of the impact of the future land use on the return period flows must be carried out using a calibrated hydrologic model and fully documented in the hydrology report.

☐ The proposed method for adjustment to account for future land use should be thoroughly discussed in the proposal.

☐ Table - Input data and summary output of hydrologic analysis.

☐ Table - Hydrologic data used in the determination of Regional Storm flood flows.

☐ Table - Calculations of various watershed parameters (weighted slope, time of concentration, time to peak, recession constant, curve numbers etc.), rainfall reduction factors, storage-outflow relationships.

☐ Figure - Plots of the stream(s) watershed / subwatersheds profiles and valley cross-sections.

☐ Figure - Land use plans (existing and future conditions) and soil maps.

☐ Figure - A small scale topographic map showing the watershed subwatershed boundaries, and hydrometric stations.

☐ Figure - A large scale topographic map of the watershed showing the subwatersheds, overland flow and channel lengths used in time of concentration calculations, location of valley cross-sections, structures with significant storage.

3.5 Channel Routing

Provide a check on the accuracy of the following including how checked:

- Cross Section Location
- Cross Section Points
- Channel Slope
- Manning Parameters
- Time Step

☐ Dynamic wave routing shall be undertaken for channel reaches with mild slope where the diffusive wave model criterion cannot be satisfied. U.S. National Weather Service Dynamic Wave Operational Model (DWOPER) is acceptable to carry out this analysis.

☐ Cross-sections required for the hydrologic model routing procedure must be obtained from 1:5,000 or 1:2,000 topographic mapping or from field surveys. Cross-sections shall be extended sufficiently to ensure that the flows shall not exceed the range of the travel timetable.

☐ Rating curves and travel times used in channel routing shall be determined by preliminary hydraulic calculations of the backwater profile or by procedures available in the approved hydrologic model.

☐ The length of the reaches and routing time increment shall be in accordance with criteria as outlined in the publication entitled 'Flood Routing Sensitivity Study' published by the Conservation Authorities and Water Management Branch.

☐ Discussion on the hydrologic routing procedure.

3.6 Reservoir Routing

Provide a check on the accuracy of the following including how checked:

- Discharge Elevation
- Storage Elevation
- Tailwater Elevation

☐ Reservoir routing shall be undertaken for instream lakes and swamps, dam and embankments, such as railway embankments and road fills that have significant storage effect.

☐ Discussion on the method used and assumptions made in the calculation of the effects of lakes, reservoirs, embankments and land use on flows.

☐ The Authority shall be consulted where this storage, or alternatively, failure of the dam or embankment, will have a significant effect on downstream flows and / or upstream flood levels. If failure may occur under flood conditions, consideration will be given to the effect on increasing the downstream peak flows.

3.7 Precipitation / Streamflow Data

☐ Source, availability and location of hydrometric data.

☐ Inspection of the stream flow and rainfall gauges records.

☐ A detailed inspection report on the station including equipment, site rating curve, vulnerability to backwater, ice influence or flanking with conclusions regarding its reliability shall be prepared as part of the hydrology report.

☐ Table - Precipitation and snowmelt data used in the determination of return period flows.

☐ Table - Available hydrometric data.

3.8 Calibration

☐ The calibrated hydrologic model or other acceptable procedure should be used to determine flows at ungauged locations and must be discussed in detail in the hydrology report.

☐ If there are no suitable records, parameters used in the model must be supported by calibration and testing on a similar adjacent watershed.

☐ At least three significant events (minimum runoff 25mm) shall be used at the calibration stage. The consultant must carefully examine the records and gauges in order to determine their accuracy and suitability for calibration and subsequent validation.

☐ Calibration and validation of the hydrologic model shall be undertaken using all available streamflow records.

☐ Calibrated watershed parameters shall not be adjusted beyond published ranges.

☐ Discussion on the data used in calibration work including the reasons for the choice of data used in the work.

☐ Discussion on the information, other than the most current, used in the calibration work.

☐ Justification of the values of the calibrated parameters.

☐ Report any calibration problems to the Authority.

☐ Data (observed hydrographs, rainfall amounts, spatial and temporal distributions of rainfall, antecedent moisture conditions, etc.) used in calibration.

☐ Table - Input data and output of the calibration and validation analysis.

☐ Table - Hydrologic and hydrometric data used in the calibration and validation works.

☐ Table - Calibration and validation results.

☐ Table - Calculated and calibrated watershed parameters for existing and future conditions.

☐ Figure - Observed and simulated hydrographs in the calibration and validation analysis.

☐ Figure - Observed precipitation (rainfall, snowmelt).

3.9 Verification

☐ The flows generated by the calibrated model must be substantiated through comparison with other analyses such as regional frequency analysis, MTC Modified Index Flood Method or other approved methods deemed suitable and approved by the Authority.

☐ Table - Comparison of flows by different methods for various return period flood events.

3.10 Sensitivity Analysis

☐ Carry out sensitivity analyses to determine the impact of changing model parameters and degree of discretization of the watershed on calculated flows.

☐ Table - Input data and output for sensitivity analyses.

3.11 Site Frequency Analysis

☐ The 100, 50, 20, 10, 5, and 2-year floods shall be determined by single station flood frequency analysis or by regional flood frequency analysis.

☐ Frequency analysis shall be undertaken where suitable streamflow records exist for the study watershed.

☐ The suitability of the records for frequency analysis will be evaluated through discussion with the operating agency, field inspection and review of the records.

☐ Single station analysis shall be carried out when the length of record is equal to or greater than 20 years.

☐ For the length of record between 10 years and 19 years, single station analysis shall be substantiated through comparison with regional frequency analysis. If the length of record is less than 10 years, only regional frequency analysis shall be undertaken.

☐ Factors that must be considered in using existing streamflow records are the conversion and reconversion of regulated and natural flows; non-stationary records; the extension of the streamflow records; single site versus regional flood frequency analysis; and transfer of location of record.

☐ Frequency analysis should be carried out using the Consolidated Frequency Analysis computer program (CFA1), developed by Environment Canada. Other models may be substituted only when prior written approval is received from the Conservation Authorities and Water Management Branch and Environment Canada. The 95% confidence limits and expected probability adjustments must be provided.

☐ Discussion on the criteria used in the flood frequency analysis; reasons for choosing a particular distribution.

☐ Table - Input data and computer printouts of flood frequency analysis.

☐ Table - Streamflow data used in the frequency analysis.

☐ Table - Results of the frequency analysis.

☐ Figure - Flood frequency curves.

☐ Figure - Confidence limits.

☐ Figure - Expected probability adjustments.

3.12 Regional Frequency Analysis

☐ Figure - Regional analysis.

3.13 Results

☐ Determine flood flows for the 100, 50, 20, 10, 5, and 2-year return period floods and the Regional Flood, where applicable, for existing and future conditions unless otherwise specified.

☐ Design peak flow rates should remain constant or increase with increasing drainage area. The values shown in the HEC-RAS model decrease with increasing drainage area.

☐ Identify potential spill areas in the hydrologic phase.

☐ N/A Detailed analysis of spills quantities.

☐ Table - Magnitude of design floods for existing and future conditions at various points of interest along the watercourse.

4.0 HYDRAULICS

4.1 Modelling Methodology

Provide a check on the accuracy of the following including how checked:

- Subcritical / Supercritical

☐ Water surface profiles shall be computed using the most current version of HEC-2 / HEC-RAS.

☐ Collection and processing of data, computational procedure and analysis of computed profiles must meet criteria and guidelines published by the Hydrologic Engineering Center in the User's Manual and Training Documents.

☐ One complete listing of the HEC-2 / HEC-RAS and HEC-2 EDIT source and executable modules, input data, HEC-2 EDIT output and the detailed and summary output for the hydraulic model on diskettes in IBM PC format (or in a form acceptable to the Conservation Authority / Municipality).

☐ A hydraulic model other than HEC-2 / HEC-RAS may be used, provided the consultant is able to demonstrate its necessity and benefits to the Authority.

☐ The consultant should justify the use of "non-standard" model options.

☐ The HEC-2 / HEC-RAS model should be continuous from the upstream study limit to the downstream study limit.

4.2 Channel Cross Sections

Provide a check on the accuracy of the following including how checked:

- Cross Section Location
- Cross Section Points
- Channel Slope
- Roughness Parameters
- Expansion / Contraction Parameters
- Distance Parameters

☐ Cross-sections shall be located and spaced in accordance with the criteria and guidelines published by the Hydrologic Engineering Center in the HEC-2 / HEC-RAS User's Manual and Training Documents.

☐ All cross sections should be coded looking downstream.

☐ Maximum spacing between successive cross-sections shall be dictated by the analytical requirements of the model and in no case shall result in more than one-half metre difference in successive water surface elevations, unless approved by the Authority.

☐ Cross-sections shall be extended across the entire floodplain, should be perpendicular to the anticipated flow lines (approximately perpendicular to contour lines) and only positive chainages are to be utilized. Computer generated vertically extended or interpolated cross-sections are not acceptable.

☐ Cross-sections of the channel above and below the waterline must be taken by field survey at all representative locations throughout the channel reach. This data will supplement the photogrammetrically generated cross-sections above the waterline.

☐ Chainages shall be used to identify the cross-sections. The same numbering system for the cross-sections must be used in the HEC-2 / HEC-RAS model, as on the floodline maps and field survey notes and plots.

☐ Discussion on the criteria used in locating and defining the cross-sections on a reach-by-reach basis used in hydrologic routing and backwater analysis.

4.3 Crossing Analysis

Provide a check on the accuracy of the following including how checked:

- Crossing Dimensions - Shape, Length, Width, Road Profile
- Roughness Parameters
- Inlet Control Calculations
- Outlet Control Calculations
- Weir Calculations

☐ A bridge data sheet shall be prepared for each structure.

☐ Copies of all bridge / culvert drawings used to develop the HEC-2 / HEC-RAS model shall be submitted to the CVC.

☐ All existing structures, such as bridges, dams and embankments are to be photographed and those, which will affect the floodline, are to be surveyed.

☐ An explanation must be provided for other structures, which are not surveyed.

☐ Survey information of dimensions and elevations must be referenced to geodetic datum.

☐ The top of road profile must be obtained by field survey and extend across the entire width of the flood plain.

☐ Selection of bridge routines.

☐ Floodlines upstream of structures with significant upstream storage will be based upon reservoir routing.

☐ A dam break analysis shall be undertaken to determine flood levels downstream of high embankments where failure under flood conditions may occur.

☐ Input data and output of the dynamic modelling analysis.

☐ Discussion on the method used and assumptions made in the calculation of the effects of the bridges, culverts crossings and embankments on water surface profiles; selection of bridge routine and reasons for each crossing.

4.4 Boundary Conditions

☐ Starting water surface elevations must be established based on the guidelines published by the Hydrologic Engineering Center in the HEC-2 / HEC-RAS User's Manual and Training Documents.

☐ Where a control starting elevation (such as a weir) is not possible, the starting section shall be located sufficiently downstream that the reach under consideration is not significantly affected by starting elevations.

☐ Where a lake is the control point, the starting water surface elevation shall be based on the long-term mean lake level.

☐ Discussion on the method used and assumptions made in the determination of the starting water surface elevations for backwater computations.

☐ Table - Starting water surface elevations.

4.5 Calibration

☐ The consultant must calibrate the hydraulic model where data such as high water marks are available.

☐ AND' values for various recorded floods 'n' values for design flood.

☐ Discussion on the data used in calibration work including the reasons for the choice of data used in the work.

☐ Discussion on the information, other than the most current, used in the calibration work.

☐ Input data and output of the final calibration run.

☐ Table - Results of calibration.

☐ Table - Observed flow hydrographs and water level profiles.

4.6 Sensitivity Analysis

☐ The consultant must carry out sensitivity analysis in accordance with Section F8 of the Technical Guidelines to determine the effects of changing model parameters on the resulting flood levels.

☐ An assessment of the sensitivity of culvert blockages on upstream flood levels must also be carried out for high embankments.

☐ Input data and output for the sensitivity analyses.

☐ Table - Results of sensitivity analysis.

4.7 Results

☐ Water surface profiles must be determined for the Regional Flood and the 100, 50, 20, 10, 5 and 2-year floods for future land use conditions.

☐ The 1:100 year lake levels are to be superimposed on the resultant water surface profile to establish the Regulatory level.

☐ Each spill area must be separately discussed in the technical report.

☐ The consultant must determine the extent and depth of flooding due to the spill.

☐ The consultant must determine the volume of spill flow going out of the channel and its impact on downstream peak flows and flood levels.

☐ The consultant must investigate whether the spill is natural or as a result of manmade structures and discuss this with the Authority.

☐ Spill areas may be identified as such only when the flow going out of the channel is not significant in terms of downstream flows.

☐ If the spill is due to manmade structures, downstream flood levels are to be determined for both total flows and reduced flows.

☐ In case of a significant natural spill, downstream flood levels will be based upon reduced peak flows.

☐ All calculations for spill area analysis including computer printouts and input data and the output on diskettes in IBM PC format or in a form acceptable to the Authority.

☐ Discussion on the assumptions made and methods used, with respect to parameter estimation, at various stages of hydraulic analysis.

☐ Discussion on the specific criteria used to determine where the effective flow limits are located.

☐ Discussion on the reasons for using the selected Manning's roughness and other bridge coefficients in determining the design flood water surface profiles.

☐ Discussion of all hydraulic control points.

☐ All calculations for spill area analysis.

☐ Discussion on the methods used and assumptions made in the determination of spill flows; effects on downstream flows and floodlines, areas affected due to the spill.

☐ Table - Design flows and flood levels at critical locations.

☐ Table - Parameters, coefficients.

☐ Figure - A large-scale topographic map showing the watershed and subwatershed boundaries and floodline mapping study limits.

☐ Figure - Water surface profile(s) of design flood(s).

☐ Plots of all cross-sections and road profiles with structures.

☐ Photographs of channel and floodplain are to be taken at several representative locations.

5.0 FLOODLINE MAPS

☐ Insufficient mapping must be reported immediately to the Authority.

☐ The location of each cross-section used in the HEC-2 / HEC-RAS model will be shown with a light line.

☐ The chainages of each cross-section shall correspond to the HEC-2 / HEC-RAS model.

☐ There shall be a spot elevation on each section giving the water surface elevation to the nearest centimeter for each floodline to be plotted.

☐ Chainages shall be given where the watercourse enters and leaves each sheet, and at confluences.

☐ The Regional Storm and the 100-year floodlines are to be plotted on the final floodline maps. The floodlines are to be plotted in ink in a format specified by the Authority.

☐ Each map shall bear the A.P.E.O. stamp and signature of the consultant's engineer adjacent to the stamp / signature of a senior officer of the mapping firm.

☐ Mapping Contents

Contours - 1:2,000 scale - 1 metre with 0.5 auxiliary contours.

Projection System - 6^o Universal Transverse Mercator.

Sheet Layout - 1:50,000 map depicting layout.

Legend, Bar Scale, Standards Notes.

Edges Ties - misalignment of map features is unacceptable.

Language - interior English, surround details in French and English.

Nomenclature - communities, streets, highways, railways, national and provincial parks, significant water features, and islands will be named - names will conform with those used by local administrative authorities.

Boundaries - international, provincial, territorial district, geographic township, Indian reserve, and national / provincial park boundaries.

Township Fabric - all lots, concession lines and applicable numbers.

HEC-RAS / HEC-2 Models

Manning Roughness Coefficients

Overbank	Woods	0.080
	Meadows	0.055
	Lawns	0.045
Channel	Natural	0.035
	Grass	0.030
	Natural Rock	0.030
	Armour Stone	0.025
	Concrete	0.013
	Articulated Block i.e. Terrafix	0.020
	Gabions	0.025
	Wood	0.015
	Corrugated Steel Pipe - 3"x1"	0.024
	Structural Plate Corrugated Steel Pipe - 6"x2"	0.032

Expansion and Contraction Coefficients

Natural sections	0.1 contraction 0.3 expansion
Abrupt changes (e.g. road / rail crossings)	0.3 contraction 0.5 expansion

Weir Coefficient

Weir Coefficient	1.5

Starting Water Surface Elevations - Lake Ontario at Mississauga

Return Period Years	Flood Elevation Metres
100	76.0
50	75.9
25	75.8
10	75.7
5	75.6
2	75.4
Mean annual	74.8

Values for Lake Ontario at Toronto includes +0.08 m conversion from Great Lakes Datum to Geodetic Datum 100 year Lake Ontario Level at Mississauga is 75.91.

HEC-RAS Options

Output Options

Critical Always Calculated	No

Conveyance Calculations

At breaks in Manning N values	Yes
Between every coordinate point	No

Friction Slope Methods

Average conveyance	No
Average Friction Slope	No
Geometric Mean Friction Slope	No
Harmonic Mean Friction Slope	No
Program Selects Appropriate Method	Yes

Calculation Tolerances

Water Surface	0.003
Critical Depth	0.003
Maximum Iterations	40
Maximum Difference Tolerance	0.1
Flow Tolerance Factor	0.001

Critical Depth

Multiple Critical Depth Search	Yes
Parabolic Method	No

Cross Sections

Maximum Points on Cross Section	500

Bridges Coding Procedure

Culvert	No
Bridge	Yes

Momentum Equation

- Add Friction Component	Yes
- Add Weight Component	Yes

Momentum Class B Defaults

- Inside U/S End	Yes
- Inside D/S End	No

HEC - RAS Options .... continued

Pressure Flow Criteria

- U/S Energy Grade Line	Yes
- U/S Water Surface Elevation	No

Bridges / Culverts - Deck / Roadway

- Maximum Allowance	95%
- Submergence Broad Crested Weir	Yes
- Submergence Ogee Crested Weir	No

Low Flow

- Energy (Standard Step)	Yes
- Momentum	Yes
- Yarnell	Yes
- Highest Energy Answer	Yes

High Flow Methods

- Energy Only (Standard Step)	
- Pressure and / or Weir	
Submerged Inlet Cd	Blank
Submerged Inlet and Outlet	0.8
Maximum Low Chord	Blank

Flow Regime

Subcritical	No
Supercritical	No
Mixed	Yes

APPENDIX 'I'

FLOODPLAIN MAPPING STANDARDS

PRELIMINARY COST ESTIMATE FOR INTERIM MEASURES TO FLOODPROOF HUMENIK LANDS:

SITE SIZE: 8.65 ha +/- filling component only

FILLING:

FLOOD ELV. = 105.2m FREEBOARD = 0.3m

AVE SITE GRADE = 104.0m AVE FILL DEPTH = 1.5 m

FILL VOLUME = 129750m3COST FOR FILLING @ 8/m3 = $1,040,000

SUBTOTAL **$1,040,000**

CHANNEL WORKS:

ASSUME 400m OF CHANNEL REQUIRED FOR FLOODPROOFING

REQUIRED GEOMETRY – 60 M TOPWIDTH

NO UTILITIES TO BE RELOCATED

$1000 PER METRE $ 400,000

SUBTOTAL **$ 400,000**
TOTAL **$1,440,000**

ALLOWANCE (25%) $360,000

GRAND TOTAL $ 1,800,000

PRELIMINARY COST ESTIMATE FOR INTERIM MEASURES TO FLOODPROOF INGLIS LANDS:

ROAD WORKS:

ASSUME 250m OF ROADWAY REQUIRED FOR UPGRADE

FOUR LANE 1.0m AVE GRADE CHANGE

NO SERVICES TO BE RELOCATED

$1000 PER METRE		$250,000
	SUBTOTAL	**$250,000**
ALLOWANCE (30%)		$75,000
	GRAND TOTAL	**$ 325,000**

QEW CULVERT COST ESTIMATE:

The structural cost to construct the culvert 20m x 64m = 1280 sq.m. @ $1,200.per sq. m approx. would be $1,500,000+/-

The Culvert would be constructed in 3 stages on QEW and would require MTO Approval as traffic at the Hwy 10 interchange would be disrupted and possibly ramps closed. Staging the construction would require the removal of the High Mast Lighting, centre barriers, and may require reconstruction of the shoulders, if they are not adequate for the traffic that would need to be placed on the shoulders. Noise barrier walls would also be required to be relocated for the installation of the culvert. In order to do refine the estimate further, it would be necessary to have more information on the geometry of the crossing. Lane width, shoulders, median etc. For a preliminary estimate, traffic control and management measures would be in the $3 million dollar range, if MTO would accept this proposal.

The total under this scenario would be $4.5 million

An other method of construction would be to jack the culvert section in. Aspects to consider would include the location of High mast lighting foundations which are typically in the 9m depth range, the noise barrier foundations typically in the 1.5 metre range. Excavating across the Service roads could be carried out by conventional methods and 45-50m would be left for the jacking method. Jacking methods may required more space above the culvert in order to get MTO approval. This would change the geometry (ie hydraulic capacity) of the culvert.

The costs at this stage are expected to be equivalent but may in fact be somewhat less – this has yet to be confirmed.

PRELIMINARY COST ESTIMATE FOR INTERIM MEASURES TO FLOODPROOF CONSULATE LANDS:

SITE SIZE: 1.2 ha +/-

FILLING:

FLOOD ELV. = 99.5-99.7m FREEBOARD = 0.3m

AVE SITE GRADE = 98.65m AVE FILL DEPTH = 1.35 m

FILL VOLUME = 16200 m3 COST FOR FILLING @ 10/m3 = $162,000

SITE PREPARATION 12000 m2 @ $4/m2 $48,000

SUBTOTAL **$210,000**

ROAD WORKS:

ASSUME 100m OF ROADWAY REQUIRED FOR UPGRADE

TWO LANE 1.0m AVE GRADE CHANGE

NO SERVICES TO BE RELOCATED

$600 PER METRE $60,000

SUBTOTAL **$60,000**

TOTAL $270,000

ALLOWANCE (30%) $81,000

GRAND TOTAL $ 351,000

APPENDIX 'J'

TERMS OF REFERENCE

A Terms of Reference
for a Consultant Bid for a

SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOOD PLAIN

City of Mississauga
Planning and Building Department
September, 2001

Closing Time: November 1, 2001, 4:00 pm
Deliver to: Manager, Material Management
Corporate Services Department
The Corporation of the City of Mississauga
300 City Centre Drive, 4th Floor, Facade
Mississauga, Ontario
L5B 3C1

Planning and Building Department Contact:
Lesley Pavan, (905) 896-5536 or Mark Chicoine, (905) 896-5753

TERMS OF REFERENCE
SPECIAL POLICY AREA STUDY
FOR THE
COOKSVILLE CREEK FLOOD PLAIN

September, 2001

1.0 Introduction

The City of Mississauga (herein after referred to as the "City") is undertaking a study to determine the feasibility of implementing a Special Policy Area within portions of the Cooksville Creek, and invites qualified consultants to submit proposals.

2.0 Background

The use of the One-Zone Flood Plain Concept for Cooksville Creek places restrictions on development (and redevelopment) on a number of properties, especially within the Cooksville Planning District. Notwithstanding the flooding issues, a number of landowners wish to pursue development of their lands. On November 18, 1999, Regional Council approved the following recommendation:

> RECOMMENDATION GC-311-1999
> That the Region of Peel request the Credit Valley Conservation (CVC) to undertake a special policy area study of the Cooksville Creek, and assist the CVC and the City of Mississauga in this regard.

This recommendation was approved in conjunction with the approval of Official Plan Amendment 69 which designated the lands on the west side of Camilla Road and north of the North Service Road as Residential High Density II. OPA 69 has been appealed by the CVC and the Ministry of Municipal Affairs and Housing (MMAH) to the Ontario Municipal Board.

Notwithstanding the Region's resolution, it has been determined that the City of Mississauga Planning and Building Department should take the lead for the study and that representatives from Mississauga Transportation and Works Department, CVC, Ministry of Natural Resources (MNR), MMAH and the Region of Peel will provide technical support. Although the Planning and Building Department is capable of completing portions of the work required for an SPA study, technical assistance is required to complete the study.

3.0 Project Scope

Attached is a copy of the complete Terms of Reference for the SPA study. Consultants are being asked to only bid on a portion of the overall study. Specifically, the consultants will be completing the tasks outlined in Sections 6.2, 6.3.,6.4 and 6.5.

4.0 Task List

The project may be completed in two stages. Items 6.2, 6.3, 6.4 of the attached Terms of Reference will be completed as part of Stage I. Depending on the outcome of the study, the Consultants will be asked to also complete item 6.5 as Stage II. Bids should reflect this two stage process and estimate the costs for each stage separately.

5.0 Items to be Supplied by the City

- relevant studies completed to date for the Cooksville Creek;
- planning and existing land use information as required.

6.0 Work Schedule and Meetings:

The project would be initiated by the successful consultant on or about November 26, 2001 and be completed by April 1, 2002. The following meetings will be required;

- project start-up meeting
- one progress meeting with the technical committee (consultant proposal to establish the most appropriate junction);
- meeting with the technical committee to present draft findings;
- attendance at Planning and Development Committee meeting where preliminary findings and draft Official Plan options will be presented;
- Community meeting on draft policies; and
- Public meeting on SPA draft policies.

7.0 Final Products to be Delivered to the City

- minutes of meetings;
- 15 copies of draft report;
- 15 copies of final written report which describes the study purpose, background research and documentation methodology. A copy of the final report will also be supplied on diskette in WordPerfect Version 6.0 or higher
- digital mapping project files in Bentley's MicroStation GeoGraphics software.

8.0 Submission Requirements

The proposal should demonstrate the consultant's understanding of the study requirements and qualifications of all project staff including references. Consultants are asked to comment on their ability to complete the proposed work within the allotted time frame. This should be outlined in a proposed work plan. A budget and schedule breakdown is required detailing project personnel, cost and timing by study components including all taxes and disbursements.

9.0 Evaluation Criteria

The City in its sole and absolute discretion reserves the right to select the consultant or consultants it deems most appropriate for the project, and to reject any or all proposals, in whole or in part. Proposals will be evaluated against a number of criteria, including but not limited to:

Cost:	Total cost effectiveness to the City.
Timing:	Ability to complete the desired work in the established time frame.
Experience:	Experience of staff members to be made available to the City for the performance of this project including familiarity with SPA studies.

The City reserves the right to request additional information. The lowest cost or any proposal will not necessarily be accepted.

10.0 Schedule and Communications

Ten copies of the proposal are to be received by 4:00 p.m. September 21, 2001. It should be delivered to: Manager, Material Management, Corporate Services Department, The Corporation of the City of Mississauga, 300 City Centre Drive, 4th Floor, Facade, Mississauga, ON L5B 3C1. If you have any further questions, please contact Lesley Pavan at (905) 896-5536 or Mark Chicoine at (905) 896-5753 of the Policy Planning Division, Planning and Building Department. Although there will be a technical steering committee to guide the project, once the project is awarded, all communications will be co-ordinated through the Policy Planning Division of the Planning and Building Department.

11.0 Contract

The contract resulting from the acceptance by the City of a proposal will be in a form satisfactory to the City. In the event of any changes to the original contract, the consultant shall secure a duly authorized "Change to Contract" prior to commencing any new or additional work.

12.0 Assignment and Use of Sub-Consultants

No work or portions of work, may be assigned or sub-contracted without the prior written approval of the City.

13.0 Confidentiality

The consultant shall not at anytime before, during or after the completion of the work divulge any confidential information communicated to or acquired by the consultant or disclosed by the City in the course of carrying out the work provided for herein. No such information shall be used by the consultant before, during or after the completion of the work on any other project without the prior written approval of the City.

14.0 Proposal Submission Costs

Any and all costs incurred in responding to this invitation including the preparation and submission of a proposal, the supply of products or service information, the conduct of demonstrations, interviews or negotiations, or any other activities connect with this request, shall be born entirely by the consultant.

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Terms of Reference

Cooksville Creek Special Policy Area Study

25 September 2001

City of Mississauga
Planning and Building Department

1.0 Introduction

The City of Mississauga (herein after referred to as the "City") is undertaking a review of the Cooksville Creek flood plain to determine the feasibility of adopting Special Policy Area (SPA) policies in accordance with the Natural Hazards section of the Provincial Policy Statement.

2.0 Background

The Cooksville Creek originates within the City and its 3,300 ha (8,154 ac) watershed bisects nine planning districts before outletting into Lake Ontario. Portions of the Cooksville Creek have been modified by channelization associated with flood and erosion control and stormwater management. The majority of these works have been undertaken by the City and Credit Valley Conservation (CVC), in part to address impacts of urbanization including, "flashy" flood waters within an extensive flood plain, high erosion rates and degraded water quality. There are approximately 309 structures in the flood plain as outlined in the 1996 Cooksville Creek Flood Line Mapping Study prepared by the City and CVC.

There have been development and re-development interests expressed by a number of landowners with holdings adjacent to Cooksville Creek that are impacted by its regulatory storm flood plain. Some of these parcels have had no decision made under the recently approved Cooksville District Policies as a result of on going discussions with respect to the appropriate designation of their lands given the floodplain constraints. City Council, in response to a request raised by one of the landowners, approved OPA 69 to allow high-density residential development on a parcel within the flood plain. On November 18, 1999, Regional Council approved OPA 69 and required "That the Region of Peel request the CVC to undertake a special policy area study of the Cooksville Creek, and assist the CVC and the City of Mississauga in this regard." A meeting was subsequently held with representatives from the City, CVC, Ministry of Natural Resources (MNR), Ministry of Municipal Affairs & Housing (MMAH) and the Region of Peel, wherein it was determined that the City is required to take the lead for the study, with other agencies providing technical support.

An integral component of the Special Policy Area (SPA) study will involve the assessment of risks to life, property, and potential public liability associated with approving development in flood-prone areas.

Findings, recommendations and if applicable, proposed SPA policies, must receive provincial approval from the Ministers of Municipal Affairs & Housing and Natural Resources prior to their implementation.

3.0 Technical Committee

In order to ensure that all partners are in agreement with the SPA and to ensure that proper procedures are followed, a Technical Committee has been established. Members of this Committee include:

City of Mississauga
Lesley Pavan, Planning and Building
Richard Tupolme, Transportation and Works
Storm Programming Engineer, Transportation and Works
Michal Minkowski, Office of the City Solicitor
Tony Rossi, Corporate Services

Region of Peel
Nancy Mott-Allen, Planning
Robert Gepp, Planning

Credit Valley Conservation
Mary Bracken,
Hazel Breton
Lisa Ainsworth

Ministry of Municipal Affairs and Housing
Rizaldo Padilla

Ministry of Natural Resources
John Cottrill

4.0 Project Scope

The City of Mississauga will review the entire Cooksville Creek watershed in its consideration of appropriate sites for SPA consideration. It is anticipated that only a few sites within the floodplain will be considered for SPA. Specific criteria based on flooding and erosion constraints and feasibility for technical remedies will be used to further evaluate these selected sites. Various reductions in the standard will be examined along with the benefits and liabilities of reducing the regulatory flood standard in order to determine the feasibility of implementing an SPA. Those areas not identified as feasible for Special Policy Area status will remain subject to current floodplain management policies.

5.0 Goals

The goals of the project are:

- to define potential areas and to determine technical criteria for development and re-development within the Cooksville Creek flood plain, and to assess the risks and cumulative impacts associated with permitting such development;

- to make a recommendation to City Council as to whether or not to proceed with SPA policies based upon initial findings; and

- should it be determined that SPA polices in accordance with the Provincial Policy Statement for Public Health and Safety are worth pursuing, then a further goal would be to develop draft SPA policies for City Plan amendments.

6.0 Task List

The implementation guidelines for Special Policy Area Studies provide for a three phase study process. These phases and their specific tasks are outlined below.

6.1 Municipal Data Collection

Before policies are developed, the City will collect data and demonstrate adequate consideration of alternatives. Specifically, the City will:

6.1.1 compile summaries of conclusions and recommendations from appropriate studies that have addressed flooding and erosion in the Cooksville Creek;

6.1.2 determine the existing land uses within the flood plain;

6.1.3 plot the location of existing buildings;

6.1.4 identify all vacant parcels;

6.1.5 determine what can be built under existing zoning provisions, including current applications;

6.1.6 determine what is proposed under the existing land use policies, including current applications;

6.1.7 determine any additional non-natural hazard related constraints to development such as servicing capabilities, parcel ownership, natural areas, and traffic issues;

6.1.8 determine which properties can redevelop under existing Provincial, Regional, City and CVC policies; and

6.1.9 prepare justification for SPA which addresses community issues and technical criteria as outlined in the implementation guidelines.

6.2 Technical Feasibility & Requirements

Technical and financial feasibility will be explored for both standard approaches and non-standard policy and guideline deviations towards floodplain development. Previous studies will be referenced, specifically to the Cooksville Creek Flood Remediation Study (EWRG 2001) (which addresses 6.2.1 and 6.2.2) and the Cooksville Creek Rehabilitation Study (1997). The following issues will need to be addressed:

6.2.1 confirmation of the findings of the Cooksville Creek Flood Remediation Study with respect to the feasibility of structural flood relief, e.g. bridge opening improvements;

6.2.2 the feasibility of Regulatory level structural floodproofing for individual sites, irrespective of depth, loss of storage and conveyance criteria, including consideration of cumulative effects, in current CVC policy and guidelines;

6.2.3 the feasibility of Regulatory level cut and fill (balanced or net fill) for individual sites, irrespective of depth, loss of storage, and conveyance criteria, including consideration of cumulative effects, in current CVC policy and guidelines;

6.2.4 the feasibility of a Two-Zone approach; and

6.2.5 the feasibility of a reduced Regulatory Standard;

6.2.6 a description of the sediment and erosion processes occurring within Cooksville Creek and a description of the long term stability of the creek banks.

A hydrologic check followed by a detailed hydraulic analysis will be required to confirm technical feasibility for any of 6.2.1 to 6.2.5. An iterative approach is required to determine feasibility thresholds. Hydraulic analysis will compare existing to proposed future development conditions. Off-site hydraulic impacts (depth and velocity) on existing development will be unacceptable. Items 6.2.1 and 6.2.2 are system-wide applications. Items 6.2.3 to 6.2.5 may be combined for as many sites as applicable, where off-site impacts are mitigated. Detailed reporting and deliverables for any hydraulic analysis will be required to follow CVC's Floodline Mapping Study Checklist guidelines. A topographic mapping check is required to confirm that the mapping produced is accurate.

The results of the Technical Feasibility analysis are to be summarized in a set of flood plain maps, with supporting documentation describing the threshold technical criteria to be met by future development.

6.3. Identification and Evaluation of Alternatives

Alternative approaches will be considered with respect to handling the problems of the flood prone area including upstream and downstream effects of the alternatives. This consideration will include:

6.3.1 ensuring that all alternatives to development outside the flood plain and within CVC policies are reviewed and considered;

6.3.2 determining which properties would benefit from a relaxation of current floodplain policy standards;

6.3.3 examining a range of development scenarios of various floodproofing standards; and

6.3.4 determining desired land use for those properties.

6.4 Risk Assessment

A risk assessment will be prepared that will include:

6.4.1 a review of current liabilities for all parties, the City, the Region, CVC and the Province and anticipated ones where SPA policies are proposed;*

6.4.2 a determination of legal implications of proceeding with SPA policies;*

6.4.3 preparation of recommendations for Council with respect to proceeding with SPA policies.

* These potions of the study will require consultation with the technical committee and due to concerns regarding confidentiality will be required to be submitted under separate cover from the study report

6.5 Policy Formation

Should the initial findings of the SPA warrant policy formulation, as supported by the Province, Region, CVC and Council, City Plan policies will have to be developed which contain the following information:

6.5.1 an introductory statement containing an explanation of provincial policy, a brief description of the area proposed for a SPA, and a justification for the proposal (including an evaluation of risk factors involved in permitting development in the flood plain);

6.5.2 the boundaries of the SPA shall extend to the regulatory flood lines on each side of the watercourse (if appropriate). The policies will then address all land uses, additions, renovations, replacements and site alteration within these boundaries;

6.5.3 the minimum acceptable level of protection (flood proofing) for development within the SPA;

6.5.4 detailed implementation policies identifying the mechanisms (i.e. zoning, site plan control) and a means to be applied to ensure flood susceptibility and flood proofing are addressed by new development;

6.5.5 policies for new buildings, additions, renovations, infilling, replacements and site alterations within the proposed SPA;

6.5.6 the roles of Council, the CVC, the Region of Peel, the Ministries of Municipal Affairs, Natural Resources with respect to circulation and review of development proposals including subdivision plans, consents, minor variances, building permits and site alterations;

6.5.7 the delineation of the boundaries of the special policy area as an overlay on the land use schedule; and

6.5.8 an appendix which includes background reports and studies supporting the policies proposed.

*[Note that CVC's *Authority Policies on Floodplain Management* will also require amendment if the SPA policy is approved]

7.0 Work Schedule and Meetings

See attached work schedule.

8.0 Public Process

The adoption of SPA policies could affect landowners upstream and downstream of the SPA areas. Therefore, public participation will be crucial to the process. Public meetings will be as follows.

8.1 Community Meeting

Following the determination by Council as to whether or not to pursue SPA policies and endorsement by Council a meeting will be held for all landowners within and adjacent to the flood plain to obtain preliminary comments regarding the OPA. Following this meeting the draft OPA policies can be finalized.

8.2 Informal Public Meeting

Prior to holding a public meeting on the SPA policies, preliminary approval must be granted by the Province to ensure that unrealistic expectations are not raised. Once this is received an informal meeting on the draft OPA will be held to receive public comments.

8.3 Formal Public Meeting

A formal public meeting will be held in accordance with the Planning Act requirements. All landowners within and abutting the flood plain will be notified as well by a newspaper notice.

9.0 Final Products

A final written report and accompanying map which describes the study purpose, background research and documentation methodology, and identifies the site location of potential areas for SPA and a cost and benefit analysis of proceeding with SPA policies will be completed.

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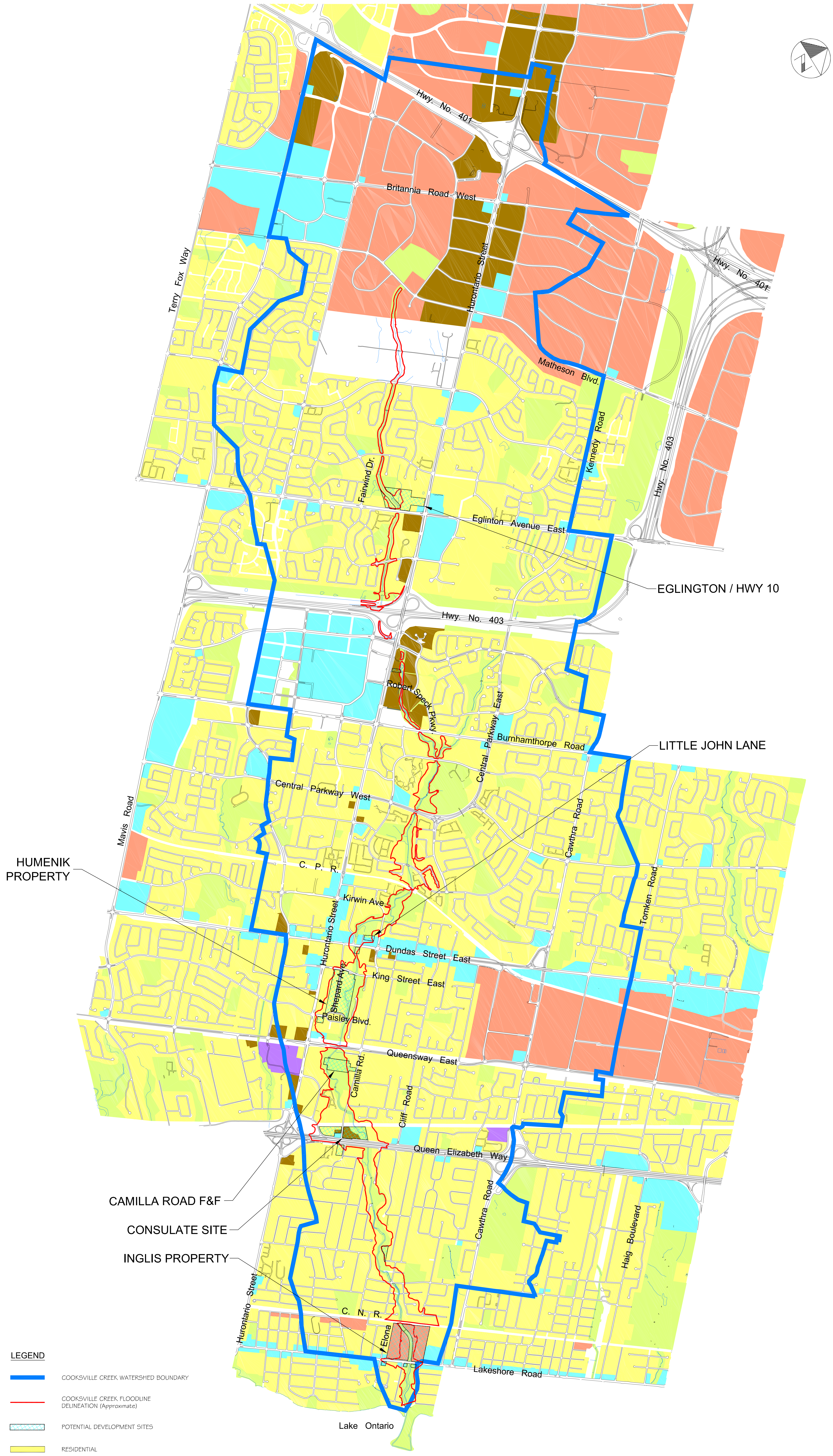
Proposed Work Schedule - Cooksville Creek SPA

Date	Activity Completed	Comments
November26, 2001	Consultants commence study	
November 2001 - April 2002	Consultant to undertake items 6.2 - 6.4	
April 20, 2002	Submission of Report by Consultants	
June 2002	Report to Planning and Development Committee (PDC) on preliminary findings and draft Official Plan options	Will require council endorsement to take draft policies to the public for initial comment similar to district plan open house #2
Summer 2002	Draft City Plan Policies for submission to Province	We require provincial approval prior to City adopting policies
Sept 2002	Community meeting on draft policies	Purpose is to obtain initial community feedback for input into policies prior to formal public meeting
Sept 2002	Formal agency comments due on draft OPA	
October 2002	Blue paper on draft SPA policies to PDC	
December 2002	Public Meeting on SPA draft OP Polices Adopt policies	



LEGEND

🟦	COOKSVILLE CREEK WATERSHED BOUNDARY
🟥	COOKSVILLE CREEK FLOODLINE DELINEATION (Approximate)
▨	POTENTIAL DEVELOPMENT SITES
🟨	RESIDENTIAL
🟧	BUSINESS EMPLOYMENT
🟫	OFFICE
🟦	COMMERCIAL (MIXED USE)
🟩	OPEN SPACE
🟪	OTHER

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SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA

GENERALIZED EXISTING & PROPOSED LAND USE PLAN

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:20,000
Drawing No.	1

Feb. 14/03 mbk

LEGEND

🟦	COOKSVILLE CREEK WATERSHED BOUNDARY
🟥	COOKSVILLE CREEK FLOODLINE DELINEATION (Approximate)
▨	POTENTIAL DEVELOPMENT SITES
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SPECIAL POLICY AREA STUDY FOR
THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA

GENERALIZED EXISTING & PROPOSED
LAND USE PLAN

PHILIPS
ENGINEERING

Project No.	101127
Date	February 2003
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Feb. 14/03 mbk

LEGEND

▬	COOKSVILLE CREEK WATERSHED BOUNDARY
―	REGULATORY FLOODPLAIN (APPROXIMATE)
―	100 YEAR FLOODPLAIN (APPROXIMATE)
▨	POTENTIAL DEVELOPMENT SITES
▬	WIDENING CHANNEL
▬	DYKING
●	CULVERT IMPROVEMENTS
●	POTENTIAL ON-LINE STORAGE LOCATION

SPECIAL POLICY AREA STUDY FOR THE COOKSVILLE CREEK FLOODPLAIN

CITY OF MISSISSAUGA

OPTIONAL FLOOD REMEDIATION WORKS

PHILIPS ENGINEERING

Project No.	101127
Date	February 2003
Scale	1:20,000
Drawing No.	2

Feb. 24/03 mbk

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