City of Vaughan

The City Above Toronto

City of Vaughan

Thornhill Storm Drainage Improvements Study
Final Report
February 2008

GENIVAR

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6101

February 8, 2008

Mr. Pat Marcantonio, C.E.T.
City of Vaughan
2141 Major Mackenize Drive
Vaughan, ON L6A 1T1

Re: Thornhill Storm Drainage Improvement Study
Final Report

Dear Mr. Marcantonio:

It is our pleasure to submit our Final Report for the above referenced project.

This report summarizes our findings resulting from the preliminary field investigations and the assessment of existing drainage infrastructure. The analysis reveals that the Brooke Street trunk storm sewer becomes severely surcharged during major rainfall events and this poses a flood risk to the surrounding properties. In addition, some components of the existing local drainage infrastructure (i.e. municipal and private driveway culverts, ditch inlets, road side ditches) were found to be deficient.

Information obtained through the public consultation process revealed that indiscriminate grading on private property has resulted in localized flooding and damages to private property. These are private property issues and the City of Vaughan is not in a position to intervene.

The recommended alternative involves construction of a new stormwater management facility within Gallanough Park. The SWM facility is necessary in order to reduce the flow rates in the Brooke Street trunk storm sewer and to reduce the flooding risk. The recommended alternative also involves repairing or replacing deficient drainage infrastructure (i.e. culverts, etc.).

Should you have any questions, please contact the undersigned.

Yours truly,
GENIVAR Ontario Inc.

Alan E. Winter, P.Eng.

/aew

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Executive Summary

The City of Vaughan is planning to reconstruct some of the local roads in this neighbourhood. Prior to commencing road design work the city requires that a study be undertaken to assess the effectiveness and/or performance of the existing storm drainage system in the area.

The Thornhill Storm Drainage Improvements Study was initiated and followed the planning and design process outlined in the MEA June 2000 Municipal Class Environmental Assessment document (Schedule B).

This Report summarizes the investigations and assessment of the existing drainage infrastructure (both major and minor systems) and identifies drainage system deficiencies that pose a flooding risk.

Existing background data for the Study Area was collected and reviewed. Preliminary field investigations were undertaken by GENIVAR.

There are three drainage catchments within the Study Area. Each catchment area drains to a separate drainage course. Generally, each Drainage Course flows in an eastward direction. The catchment area for each drainage course was delineated and used in calculating flow values for the various design storm events.

Field investigations were conducted for the drainage elements within the study area. Also, preliminary hydrologic and hydraulic analysis of the drainage system was undertaken. The preliminary hydraulic analysis concluded that municipal road crossing culverts of Drainage Course #1 have adequate capacity to convey the 100-year flow, while some of the crossing culverts of Drainage Course #2 do not have adequate capacities and need to be replaced. A number of problem areas were identified. The most significant deficiency is the Brooke Street trunk storm sewer which surcharges during major rainfall events. Alternatives solutions were developed and evaluated. A Preliminary Preferred Alternative was selected.

Two Public Information Centres (PIC) were held, one on February 20, 2007 and a second on December 11, 2007. Members of the consultant team, the local councillor and City staff attended these meetings to discuss the project with the residents, to answer their questions and obtain their input regarding the flooding problems.

A meeting was convened with the Toronto and Region Conservation Authority to discuss the Preliminary Preferred Alternative. TRCA indicated that a permit would be required replacement of municipal culverts along Drainage Courses #1 and #2.

The Recommended Solution involves:

- Construction of a new stormwater management facility in Gallanough Park.
- Constructing a new storm sewer along Thornridge Drive, just west of Brooke Street;
- Replacement of undersized ditch inlets and catch basins;
- Replacement of deficient culverts;
- Improvement of road side ditch conveyance capacity.

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1. Introduction

1.1 General

The residential streets and properties located in the Thornhill neighbourhood located south-west of Yonge Street and Centre Street experienced flooding as a result of the August 19, 2005 rainfall event. The adjoining municipalities of City of Toronto and Town of Markham also experienced flooding complaints from residents as a result of that storm event. That event was severe and it is known to have exceeded the 1 in 100 year recurrence interval. Over 150 mm of rainfall occurred in a 3-hour period. Flooding in the area has been previously reported during heavy rain storms and local residents have requested that the City of Vaughan review the flooding problems.

The Thornhill neighbourhood that was affected is an older well-established community. It is part of the Thornhill Heritage Conservation District. That designation was made in 1983 and recognizes the area for both its natural and built heritage features. Properties in the neighbourhood are typically older single-family residential homes, constructed in the 1950's and 1960's. A number of these older residential homes were recently redeveloped and replaced with a large size houses.

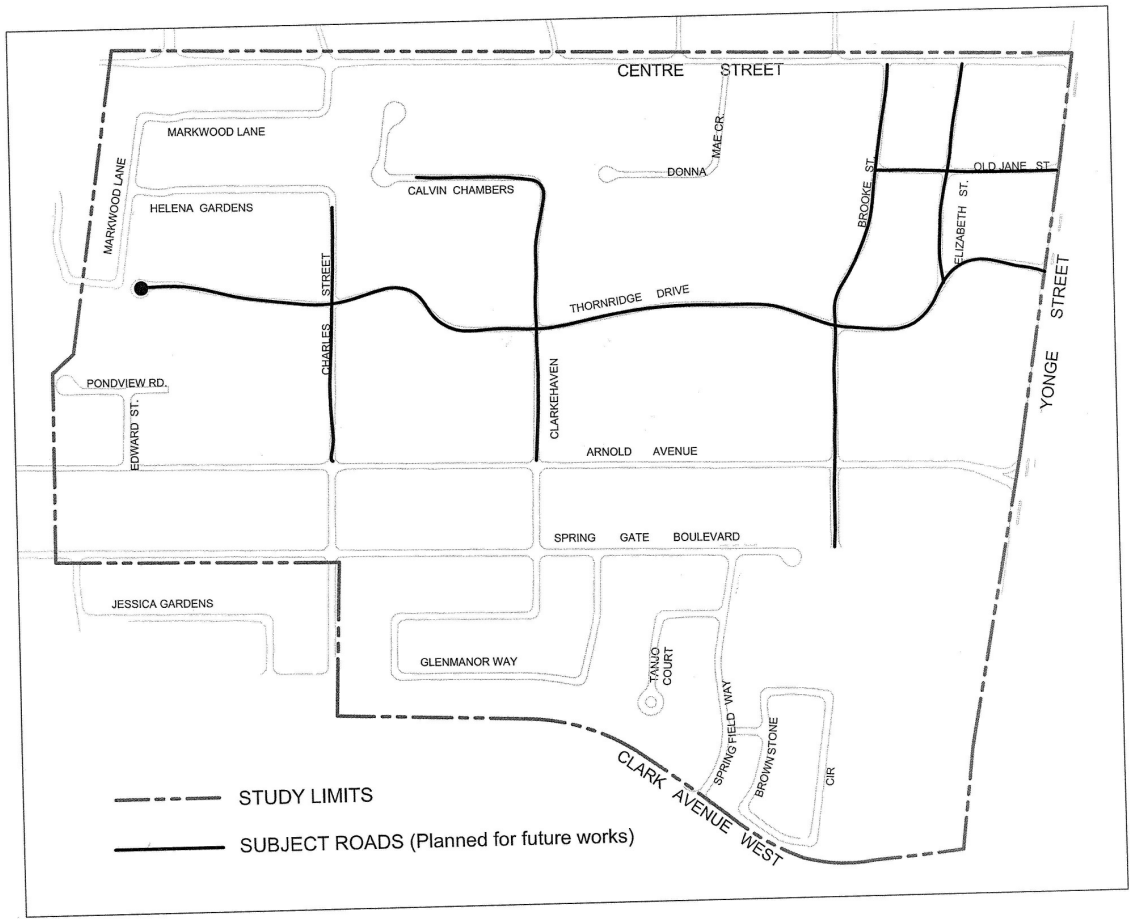
The City of Vaughan is planning to reconstruct some of the local roads in this neighbourhood and prior to commencing road design work requires that a study be undertaken to assess the effectiveness and/or performance of the existing storm drainage system in the area.

In December 2006, GENIVAR was retained by the City of Vaughan to conduct a Storm Drainage Improvements Study of the area.

1.2 Study Area

The Study Area, as shown in Figure 1, is bounded by Centre Street to the north, Yonge Street to the east, Clarke Avenue West to Charles, north to and along Spring Gate Boulevard to the south, and approximately Edward Street to the west. The Study Area was amended during the course of the study, with the initial Study Area being somewhat smaller as shown in the letter to external agencies dated February 12, 2007 (Appendix A-1). The expanded Study Area resulted from the quest for suitable remedial alternatives.

Figure 1 Study Area



Specific roads planned for improvement include: Thornridge Drive, Elizabeth Street, Old Jane Street, Brooke Street, Clarkhaven Street, Calvin Chambers Road, Raymond Drive and Charles Street. The identification of drainage deficiencies is an important consideration to the reconstruction of these roads.

Some re-development and in-filling has occurred in this area during recent years; taking advantage of the mature, quiet character of the local streets and large lot sizes. At the east periphery of the Study Area along Yonge Street, commercial areas are established. Some of the more recently constructed roads in the area have curb and gutter, catch basins and storm sewers. However, for the most part, the neighbourhood still retains a rural character with most local roads having narrow pavement width, gravel shoulders and roadside ditches.

1.3 Study Purpose

The purpose of this study is to undertake a detailed investigation and assessment of the existing drainage infrastructure (both major and minor systems) and to identify drainage system deficiencies that may cause flooding.

It is important to identify portions of the drainage system that are deficient according to current municipal standards. Once the storm sewer system reaches its capacity and surcharging is severe

enough to cause overland flow, it is important to know that the overland flow system has sufficient capacity to ensure safe conveyance of peak flows.

This project is being conducted in three distinct phases as follows:

Phase 1: Preliminary Study and Determination of Relationship to Municipal Class Environmental Assessment

- Preliminary site investigation of minor and major storm drainage system
- Determination of appropriate Class EA schedule and initiation of project file
- Public information centre to inform public and receive information
- Identify elements of existing drainage system and investigate problem areas which are performing in deficient manner
- Preparation of interim report suitable for presentation to Vaughan Council

Phase 2: Detailed Study/Project File

- Develop alternative strategies for correcting localized drainage problems
- Prepare preliminary cost estimates for budgeting purposes for each alternative
- Public information centre to present alternatives and preferred solution

Phase 3: Engineering Report Based on Preferred Alternative

- Identify preferred alternative for improving effectiveness/performance of storm drainage system
- Prepare preliminary cost estimates for budgeting purposes

2. Study Approach

2.1 Class Environmental Assessment Planning Process

The Municipal Class Environmental Assessment, June 2000 prepared by the Municipal Engineers Association (MEA) details a procedure for decision-making and problem solving to resolve concerns identified during these types of projects. The Class EA identifies three categories of projects, listed as Schedules A, B, and C of the document, and specifies the study process to be followed for each category. The Thornhill Storm Drainage Improvements Study falls into a Schedule B category. Schedule B projects essentially require completion of Phases 1 and 2 of the planning process, Problem Identification and Evaluation of Alternative Solutions. At the end of Phase 2, the EA category was reviewed with the City of Vaughan to confirm the appropriate Class EA Schedule.

This report documents the planning process, its conclusions and their rationale. This report is structured to reflect the requirements of the Environmental Assessment Act, while at the same time providing ease of understanding of the decision-making process.

It contains the following:

- the purpose of the project;
- the environmental assessment process followed;
- the current environmental conditions in the Study Area;
- the alternatives considered;
- the environmental effects associated with the project and all reasonable alternatives;
- the rationale and description of the recommended alternative; and
- the commitment for further work to be undertaken relative to identified “environmentally significant areas/issues”.

2.2 General Approach

The approach used to develop the drainage and stormwater management plan is as follows:

i) Background Information and Data Collection

- Review available background studies and engineering reports
- Review available information for existing drainage systems
- Review previous drainage design drawings

ii) Field Investigations

- Examine existing drainage conditions
- Verify size and condition of existing drainage infrastructure
- Complete a photographic inventory of existing drainage infrastructure, drainage ditches and culverts

iii) Drainage System Assessment

- Generate peak flow rates for design storms at critical locations
- Assess hydraulic capacity of all culvert crossing structures with respect to City of Vaughan design criteria
- Identify potential deficiencies associated with storm drainage system

iv) Develop Strategies for Drainage Alternatives

- Identify drainage improvement alternatives
- Evaluate and finalize recommended strategy and drainage system
- Provide recommendations for improvements to drainage system

v) Complete Documentation

- Prepare overall plan of recommended improvements to drainage system
- Prepare Drainage and Storm Drainage Report

2.3 Notice of Study Commencement

A Notice of Study Commencement was issued and appeared in the local City of Vaughan newspaper and the City of Vaughan web site (Appendix A-1). Letters announcing commencement of the project were distributed to external agencies, mandatory public contacts, special interest groups and utility companies. The City of Vaughan staff hand delivered notices to all residents within the initial Study Area advising the commencement of the Study.

2.4 First Public Information Centre

A Public Information Centre (PIC) was held at Garnet A. Williams Community Centre (501 Clark Avenue West) on February 20, 2007 between 7:00 p.m. and 9:00 p.m. to present the purpose and objectives of the study and to solicit input for the Study. Over 20 residents from the Study Area attended the PIC. Members of the consultant team, the local councillor and City staff attended to discuss the project with the residents, to answer their questions and obtain their input regarding the flooding problems.

The City of Vaughan received letters from local residents that provided documentation regarding the flooding that occurred as a result of the August 19, 2005 rainstorm event.

2.5 Residents Survey

A questionnaire was distributed at PIC # 1 asking for input regarding existing flooding problems. A copy of the questionnaire is given in Appendix A-1. A total of 6 responses were received.

All residents who responded to the survey reported flooding on their property.

Reasons for the flooding included lack of capacity in drainage courses and culverts being blocked with leaves and debris, as well as overflowing ditches. Some more specific problems were also reported.

2.6 Part II Order

Under the provisions of the EA Act, members of the public, interest groups, and review agencies may request the Minister of the Environment to require the proponent to comply with Part II of the EA Act before proceeding with the proposed undertaking. The Minister's decision on a Part II Order is final. If a person or party has a concern, it should be brought to the attention of the proponent during the planning process. If the concern is not resolved, the person or party with the concern may ask the proponent to voluntarily elevate a Schedule B project to an individual EA. If the proponent declines, and if that person or party with the concern wishes, they may write to the Minister of the Environment and request a Part II Order.

Once the request for a Part II Order has been received, the Minister of the Environment has 45 days to review the information and prepare a report. The 45 day period starts after the 30 day public review has ended.

If there are critical deficiencies in the documentation submitted by the proponent, the Director of the Environmental Assessment and Approvals Branch may require the proponent to submit additional information in order to assist in the decision. If this occurs, the 45 day period is no longer applicable; however, within 21 days of the receipt of the additional, appropriate information, the Environmental Assessment and Approvals Branch will make a recommendation to the Minister of the Environment.

Acceptance of the Study Report and EA file and approval of the project by the Minister of the Environment will allow the City of Vaughan to:

- acquire property necessary for project implementation;
- construct the proposed infrastructure;
- operate and maintain the completed infrastructure.

3. Review of Background Information and Field Reconnaissance

Existing background data for the Study Area was collected and reviewed. The City of Vaughan provided the following information:

- City of Vaughan design criteria and standards
- Digital topographic plans and maps of the Study Area.
- Orthographic drawings for the Study Area.
- Correspondence on flooding event of August 19, 2005.
- Soils reports.
- Property data from the City, including legal survey plans showing easements.
- As-built drawings for local roads, which included information regarding storm sewers and sanitary sewers
- A number of subdivision development plans
- Existing culvert data record sheets
- Previous reports relating to stormwater management pond A4 located south of the Thornridge Drive west end

The topographic mapping assisted in identifying catchment area boundaries and drainage courses that traverse the Study Area. Unfortunately, there is very limited data or reports available that specify the criteria used to design the existing drainage infrastructure. Therefore, any special design assumptions or considerations that may have been used to design the existing drainage infrastructure are not known.

Correspondence from local residents reveal that flooding in the Study Area has occurred on several occasions and that the City of Vaughan has attempted to address the problems.

3.1 Field Reconnaissance Work

Preliminary field investigations undertaken by GENIVAR were initiated on December 21, 2006 and have continued commensurate with the Study needs. The purpose of the investigations was to confirm the status of drainage patterns as identified from the review of background information and to assess the overall condition of the existing drainage infrastructure.

Municipal culvert crossings were inspected and the inlets and outlets of these structures were photographed. Field investigations also involved examination of private residential driveway culverts, catch basins, ditch inlets and roadside ditches. The entire Study Area was visually inspected to identify hydraulic capacity problems at existing structures and determine any deficiencies that would need to be addressed in conjunction with future local road improvements. Field investigation photographs are provided in Appendix B.

Most of the roads in the Study Area have a rural section with roadside ditches. A number of streets, mainly on the west and south sides of the Study Area (i.e. Markwood Lane, Pondview Road, Edward Street, Spring Gate Boulevard and a portion of Helena Gardens, Charles Street, Calvin Chambers Road, Clarkhaven Street, Arnold Avenue, as well as roads south of Spring Gate Boulevard) have a standard urban section with concrete curbs and storm sewers.

There are three drainage courses that traverse the Study Area, from west to east. Water does not flow perennially to these drainage courses, but only during rainstorm events. In May 2006

Toronto and Region Conservation Authority (TRCA) designated 2 of the 3 drainage courses as watercourses - Drainage Course #1 and Drainage Course #2. Therefore, these watercourses fall under TRCA Regulation 166/06. The third drainage course is essentially the south side ditch of Arnold Avenue.

The two watercourses flow across private properties and several landowners have incorporated the watercourses into their property's landscaping. The watercourses cross roadways via culverts. For the most part the watercourses are not contained with any easements.

3.2 Existing Drainage Conditions

The following description of existing drainage conditions presents an overview of the Study Area within the context of the larger drainage basin and receiving watercourse. Then a more detailed description of the various catchment areas within the Study Area is provided. Finally, a detailed description of the drainage conditions associated with each individual road is presented.

3.2.1 Study Area in Context

The Study Area is located within the Don River watershed, which is under the jurisdiction of Toronto and Region Conservation Authority. There are no major watercourses within the Study Area, but there are 3 minor drainage courses, which will be discussed below.

Generally speaking, the portion of the Study Area north of Arnold Avenue and east of Charles Street was developed some time ago, while the development of the remainder of the Study Area is more recent (post 1980's). However, some redevelopment of individual properties is occurring within the northerly portion of the Study Area.

Most of the roadways within the Study Area have a rural cross section with ditches on both sides. Those roadways were not designed using a dual drainage concept (major overland flows conveyed along roadways and minor flows conveyed in sewers). More recently constructed roads have curbs, gutters and storm sewers which meet City of Vaughan municipal road standards and apply the dual drainage concept.

3.2.2 Main Drainage Courses within the Study Area

The existing drainage patterns within the Study Area have been established through an examination of background information, topographic maps provided by the City of Vaughan, and field investigations. There are three drainage catchments within the Study Area. Each catchment area drains to a separate drainage course. Generally, each Drainage Course flows in an eastward direction. Each Drainage Course has a separate outlet. Figure 2 delineates the catchment areas and Drainage Courses.

Figure 3 shows the existing drainage systems for the Study Area, overlaid on an orthophoto base. The reader is encouraged to refer to Figures 2 and 3 and also Appendix B while reading the following sections of the report, which contains photos taken during the field investigations.

3.2.2.1 Catchment Area (Drainage Course) 1

Catchment Area #1 approximately covers the northern half of the Study Area. Figure 2 delineates the catchment area and shows a large external sub-catchment area north of Centre Street that contributes drainage to Catchment Area #1.

The land use within this catchment area is almost entirely residential. Referring to Figure 3, it is easily seen that the typical lot size associated with properties within the Study Area is much larger than for properties outside the Study Area. Some properties within the area have re-developed and larger homes have been built, taking advantage of the larger lot size. Information gathered through the public consultation process suggested that changes in lot grading have resulted in changes in drainage patterns. More specifically, some properties are receiving drainage from adjacent properties as a result of indiscriminate re-grading. This problem was echoed by many attendees of both Public Information Centre #1 and #2.

With only a few exceptions, all drainage that is generated within Catchment Area #1 is collected and discharged to Drainage Course #1. The few exceptions are small areas along the northern fringe of the Study Area, where storm water collected by local storm sewers is discharged to the Centre Street trunk storm sewer, thus leaving the Study Area. Note that drainage conveyed in the Centre Street trunk sewer discharges to the Brooke Street trunk, which discharges to the East Don River.

Within the Study Area, Drainage Course #1 essentially begins at the outlet from the stormwater management facility (dry type detention A4) located in the park area immediately adjacent to the westerly end of Thornridge Drive from the south side. The stormwater management facility A4 is one of four detention facilities in series located west of the study area and controls runoff from a number of subdivisions with a total approximate drainage area of 38.5 ha that is outside of the Study Area.

Although the field staff did not undertake investigations on private property, they were able to observe small wooden bridges constructed across Drainage Course #1 in the backyards of private residences.

Drainage Course #1 mostly traverses private property, although a short portion of this drainage course is coincident with the Centre Street north side ditch. In some locations where the drainage course passes through private property, homeowners have incorporated it into the landscaping of their property. It crosses several municipal roads before discharging to a 1.8 m x 1.5 m concrete box culvert in the vicinity of Old Jane Street and Yonge Street. The culvert crosses Yonge Street into the Town of Markham. Ultimately the runoff must outlet to the Don River, however, the information provided by the Town of Markham regarding the sewer infrastructure that conveys this drainage to its outlet was not sufficient to assess the capacity of the drainage infrastructure elements.

Drainage Course # 1 flows through various culvert crossings under Charles Street, Thornridge Drive, Clarkhaven Street, Centre Street, Brooke Street, Elizabeth Street and Old Jane Street. Table 3.1 identifies photos (Appendix B) that show the various municipal crossing culverts.

Table 3.1 List of Photos for the Crossing Culverts of Drainage Course #1

Culvert #	Road	Photo #
C11	Charles Street	1

Table 3.1 List of Photos for the Crossing Culverts of Drainage Course #1

Culvert #	Road	Photo #
C12	Thornridge Drive	2
C13	Clarkhaven Street	3
C14	Centre Street	4 and 11
C15	Oakbank Road	9 and 10
C16	Centre Street	22
C17	Brooke Street	13 and 14
C18	Elizabeth Street	17 and 18
C19	Old Jane Street	19 and 20

3.2.2.2 Catchment Area (Drainage Course) 2

Catchment Area #2 covers the middle and southwestern portions of the Study Area. Figure 2 delineates the catchment area and shows a small external sub-catchment area west of the Study Area.

Similar to Catchment Area #1, the land use within this catchment area is almost entirely residential, with typically large sized lots. Likewise, some properties within this catchment area have re-developed and larger homes have been built.

All drainage generated within Catchment Area #2 is collected and discharged to Drainage Course #2. However, Drainage Course #2 is not entirely continuous and has more than one outlet.

For the purpose of this Study, Drainage Course #2 begins at the westerly Study Area limit, coincident with the roadside ditches associated with Arnold Avenue (Photos 23, 24 and 25), then it crosses Charles Street and traverses private property until it crosses Clarkhaven Street and joins the south side road ditch of Thornridge Drive.

In some locations where the drainage course passes through private property, homeowners have incorporated it into the landscaping of their property (Photos 29 and 30).

About 120 metres west of Brooke St, Drainage Course #2 departs from flowing in the Thornridge Drive south side ditch and flows south easterly, traversing private property until it reaches the west side road ditch associated with Brooke Street, just north of Arnold Avenue (Photo 38). At this point storm drainage can enter the large ditch inlet that connects to the 3000 mm diameter trunk storm sewer under Brooke Street. When the water level increases and the capture capacity associated with the ditch inlet is exceeded, storm water will flow through twin 800 mm diameter CSP culverts under Brooke Street (Photos 36, 37, 38 and 39).

Downstream of the twin 800 mm diameter culverts, the overland flow route passes between 105 and 107 Brooke Street, but becomes poorly defined and discontinuous in the backyard of 26 Arnold Avenue. This is a result of filling-in of the drainage course and re-grading of private property by previous landowners in order to construct a swimming pool. This area has experienced repeated flooding and is a known problem area. It is understood that the ditch inlet on the west side of Brooke Street was constructed by the City of Vaughan to alleviate some of the flooding. However, the overland flow route traverses private property and the City of

Vaughan does not have any easements that cover this flow route. The overland flow route has not been reinstated.

Storm drainage from the south road ditch of Thornridge Drive flows through a swale between 51 and 53 Thornridge Drive and enters Drainage Course #2 in the backyards of various private properties.

The outlet for this drainage course is located north of Arnold Ave, west of Yonge Street (Photo 51). The outlet is a 1200 mm storm sewer inlet structure that conveys drainage to a trunk storm sewer under Yonge Street. Ultimately the runoff must outlet to the Don River, however, the information provided by the Town of Markham regarding the sewer infrastructure that conveys this drainage to its outlet was not sufficient to assess the capacity of the drainage infrastructure elements.

Table 3.2 identifies photos (Appendix B) that show the various municipal crossing culverts.

Table 3.2 List of Photos for the Crossing Culverts of Drainage Course #2

Culvert #	Road	Photo #
C1	Arnold Avenue	23, 24, and 25
C2	Charles Street	26
C3	Clarkhaven Street	27 and 28
C6	Brooke Street	36, 37, 38, and 39

3.2.2.3 Catchment Area (Drainage Course) 3

Catchment Area #3 is a very small area located at the southerly portion the Study Area between Charles Street and Brooke Street, south of Arnold Avenue. Figure 2 delineates the catchment area.

The land use within this catchment area is residential and similar in nature to other parts of the Study Area.

All drainage generated within Catchment Area #3 is collected and discharged to Drainage Course #3, which is essentially the south roadside ditch of Arnold Avenue. It begins at Charles Street and flows eastward through a culvert crossing under Clarkhaven Street (Photo 52) and enters a twin ditch inlet (catch basins) located at the southwest corner of Brooke Street and Arnold Avenue intersection (Photo 53). Drainage is then conveyed through an existing 375 mm diameter connection to the 3000 mm diameter trunk storm sewer within the Brooke Street road allowance.

3.2.3 Drainage Pattern of Each Road within the Study Area

3.2.3.1 Centre Street (re-constructed in 2000)

From the western end of the study area to Markwood Lane: This portion of Centre Street has an urban cross section complete with curbs and gutter and catch basins on both sides of the roadway. There are also roadside ditches behind the curbs that capture external runoff and convey it eastward. The south side ditch drains to a ditch inlet catch basin located at the southwest corner of Centre Street and Markwood Lane (Photo 5), which is connected to the 1800

mm diameter trunk storm sewer within the Centre Street road allowance. The north side ditch drains eastward to a 675 mm diameter municipal CSP culvert (Photo 6).

From Markwood Lane to Oakbank Road: This portion of Centre Street has an urban cross section complete with mountable curbs and gutter and catch basins on both sides of the roadway. Ditches are located on both sides to convey major overland flow and the external runoff. Flow direction is eastward. The north side ditch drains into the Oakbank Natural Pond (Photo 8), which overflows back into the north side ditch through a 600mm diameter CSP culvert (C15) located under Oakbank Road (Photos 9 and 10). The available information regarding the Oakbank Natural Pond was not sufficient to assess the pond outflow rates, however, discharging rates from the natural pond to the north side ditch were estimated based on the capacity of the 600mm diameter CSP culvert (C15). The south side ditch drains to a 400 mm diameter private CSP driveway culvert located opposite Oakbank Road (Photos 4 and 7), then enters municipal culvert C14, which conveys drainage flow under Centre Street to the north side ditch of Centre Street (Photo 11).

From Oakbank Road to Yonge Street: This portion of Centre Street has an urban cross section complete with mountable curbs and gutter and catch basins on both sides of the roadway. Ditches, municipal road culverts and private driveway entrance culverts are located on both sides to convey major overland flow and the external runoff. Flow direction is eastward. The north side ditch is considered part of Drainage Course #1. The drainage flow is then conveyed from north side ditch to the south side ditch through culvert C16, located west of Thornbank Road (Photo 22).

3.2.3.2 Old Jane Street

From Brooke Street to Elizabeth Street (rural cross section): Storm drainage flows eastward and is conveyed by ditches on both sides of the paved roadway. It is conveyed through a 300 mm diameter CSP culvert and directed northward to outlet into Drainage Course #1, north of Old Jane Street and downstream of Elizabeth Street.

From Elizabeth Street to Yonge Street (rural cross section): Storm drainage from the north side of the roadway drains by ditch to crossing culvert inlet C19 (Photo 19), while storm drainage from the south side of the road drains by ditch to a ditch inlet catch basin that is connected to culvert C19 (Photo 20). Ditches are not well defined on the south side of Old Jane Street; hence drainage is conveyed via sheet flow. Also, the ditch inlet catch basin is surrounded by high-elevation ground and it was observed to be clogged with leaves and debris at the time of field investigation, thus obstructing the capture of runoff by the ditch inlet. There is a sag point in the middle of this stretch of roadway.

3.2.3.3 Elizabeth Street (rural cross section)

Storm drainage originating from the west side of the roadway is conveyed by roadside ditches and a municipal road culvert. Drainage is conveyed from both road ends to crossing culvert C18 (Photos 17 and 18).

Storm drainage from the east side of Elizabeth Street and north of Old Jane Street drains by ditches and private driveway culverts. It is conveyed from both road ends to crossing culvert C18. Runoff from the east side of Elizabeth Street and south of Old Jane Street drains north via sheet flow, then flows east along the south side of Old Jane Street to culvert C19.

3.2.3.4 Brooke Street

From Centre Street to Old Jane Street (rural cross section): Storm drainage is conveyed through roadside ditches and private driveway culverts on both sides of Brooke Street and is directed to crossing culvert C17 (Photos 13 and 14). There is a sag point in the middle of the road at culvert C17.

From Old Jane Street to Arnold Avenue (rural cross section): Storm drainage originating from the west side of Brooke Street is conveyed southward via roadside ditches, municipal culverts and private driveway culverts to the ditch inlet catch basin (DICB #1) located on the west side of Brooke Street just north of Arnold Avenue (Photos 38 and 39). The west roadside ditch is lined with asphalt between the church located at 140 Brooke Street and north entrance of the parking lot located south of the church. The municipal road culvert C5 conveys drainage under Thornridge Drive. That culvert was found deformed and in poor condition (Photos 34 and 35).

DICB #1 is connected via 600 mm diameter concrete pipe to the 3000 mm diameter trunk storm sewer located within the Brooke Street road allowance. At the time of the field inspections, DICB #1 was clogged with leaves and sediment (Photo 39). Under major storm conditions, or when ditch inlet DICB #1 becomes clogged, flow will partially be conveyed from the west side of Brooke Street to the east side of the road through twin 800 mm diameter CSP culverts C6 (Photos 36 and 37). When the peak flow rate exceeds the capacity of the ditch inlet and the twin CSPs, it will overtop Brooke Street and flow eastward; re-connecting with Drainage Course #2 downstream of Brooke Street.

Storm drainage from the east side of Brooke Street drains via roadside ditches and through private driveway culverts southward to Thornridge Drive, then eastward through the north side road ditch of Thornridge Drive to a municipal road culvert that conveys the flow southward to Drainage Course #2.

Drainage from the east side of Brooke Street and south of Thornridge Drive drains via ditches and private driveway culverts southward to Drainage Course #2.

From Arnold Avenue to Spring Gate Boulevard (rural cross section): Drainage from the west side of Brooke Street drains northward via roadside ditches and through private driveway culverts to the twin ditch inlet catch basins (DICB #2) at the southwest corner of Brooke Street and Arnold Avenue. DICB #2 connects via a 375 mm diameter concrete pipe to the 3000 mm diameter Brooke Street trunk storm sewer. Under major storm conditions, or if DICB #2 is plugged, flow would overtop Brooke Street and/or Arnold Avenue from the southwest corner to northeast corner of the intersection and re-connect to Drainage Course #2.

Drainage from the east side of Brooke Street drains northward via roadside ditches and through private driveway culverts to catch basins located at the southeast corner of Brooke Street and Arnold Avenue.

3.2.3.5 Donna Mae Crescent (rural cross section)

Storm drainage is conveyed via roadside ditches and through private driveway culverts within the road right-of-way from the western end of the Donna Mae to its intersection at Centre Street. Flow from the southwest side of Donna Mae and Centre Street is conveyed through a 400 mm diameter municipal CSP culvert to the north side road ditch of Centre Street. Flow from the

southeast side of Donna Mae and Centre Street is conveyed through a 375 mm diameter concrete culvert to an existing catch basin and then to the 2100 mm diameter Centre Street trunk storm sewer.

3.2.3.6 Calvin Chambers Road

The western portion of Calvin Chambers (from the west end to house #103) consists of an urban road cross section that has curbs, gutter and a storm sewer. The Calvin Chambers storm sewer is connected to the 1800 mm diameter Centre Street trunk storm sewer. The eastern portion of the roadway (from house #103 to the east end) is serviced by roadside ditches and private driveway culverts on both sides of the road. Storm drainage is conveyed eastward and outlets to Drainage Course #1.

3.2.3.7 Thornridge Drive

From the western end to 50 m west of Clarkhaven Street: The most westerly end (about 50 m) of Thornridge Drive has an urban road cross section, complete with curbs, gutter and catch basins. The portion of Thornridge Drive between this urban section and to about 50 m west of Clarkhaven Street, is serviced by roadside ditches, municipal road culverts and private driveway culverts on both sides of Thornridge Drive. Drainage conveyed in the roadside ditches discharges into Drainage Course #1, just east of Raymond Drive. An 1800 mm diameter municipal CSP culvert (C12) is used to convey Drainage course #1 under Thornridge Drive (Photo 2).

From 50 m west of Clarkhaven Street to Brooke Street (rural cross section): Runoff from the north side of Thornridge Drive is conveyed by ditches and through private driveway culverts to municipal culvert C4, located about 120 m west of Brooke Street (Photos 31 and 32). Storm water runoff from the south side of Thornridge Drive is conveyed by Drainage Course #2, which parallels the roadway alignment. Private driveway culverts facilitate the conveyance of Drainage Course #2. Drainage conveyed in the north side road ditch discharges to Drainage Course #2 via culvert C4, which was found to be in poor condition. There is a sag point in the roadway at crossing culvert C4.

From Brooke Street to Elizabeth Street (rural cross section): Storm water from both sides of the roadway is conveyed to the mid-point between Brooke Street and Elizabeth Street by roadside ditches and through private driveway culverts. It is conveyed to Drainage Course #2 through a 600 x 200 mm elliptical CSP culvert and a swale located between 27 and 23 Thornridge Drive (Photo 50). The municipal CSP culvert was found deformed and in poor condition (Photos 46 and 47). Drainage in the vicinity of Elizabeth Street should be conveyed westward by a municipal culvert under the north side of the intersection, but it is completely blocked (Photos 44 and 45).

From Elizabeth Street to Yonge Street (rural cross section): Except for the immediate vicinity of the intersection, drainage from both sides of Thornridge Drive is conveyed eastward by roadside ditches and through driveway culverts. It is conveyed to ditch inlets located on both sides of Thornridge Drive at Yonge Street. The ditch inlets are connected to the Yonge Street storm sewer system. Drainage water ponds in the northeast corner of Thornridge and Elizabeth due to the poor condition of the municipal culvert.

3.2.3.8 Raymond Drive

Storm water collected in the roadside ditches is conveyed southward through private driveway culverts and outlets to Drainage Course #2.

3.2.3.9 Helena Gardens

The western portion of the road has an urban cross section with curbs, catch basins and a storm sewer. The southerly portion of the roadway has roadside ditches with private driveway culverts on both sides of the road used to convey drainage. Drainage is directed southward to the roadside ditches of Thornridge Drive.

3.2.3.10 Markwood Lane

Markwood Lane has an urban road cross section and is serviced by a storm sewer. The storm sewer is connected to the 1800 mm diameter Centre Street storm sewer.

3.2.3.11 Arnold Avenue

From the western study limit to Charles Street (rural cross section): Drainage is conveyed eastward by roadside ditches and private driveway culverts on both sides of the roadway. Drainage Course #2 is coincident with the roadside ditch system of Arnold Avenue. Approximately 120 m west of Charles Street there are twin 800 mm diameter municipal CSP culverts (C1) that convey drainage from the south side ditch to the north side ditch (Photos 23 and 24). The twin CSP culverts were found in acceptable condition. Immediately downstream of the outlet of the twin municipal culverts is a single 600 m diameter driveway culvert (Photo 25). There is a sag point in the road approximately 100 m west of Charles Street.

From Charles Street to Brooke Street (rural cross section): Runoff from the north side of Arnold Avenue is conveyed eastward by roadside ditches, municipal road culverts, and private driveway culverts. It eventually discharges to ditch inlet catch basin DICB #1, located at Brooke Street just north of Arnold Avenue. The west end of the municipal road culvert at Clarkhaven Street is buried and the east end of the culvert is deformed (Photos 41, 42 and 43). Therefore, drainage flow would overtop Arnold Avenue from north to south and drain to the catch basins located at Clarkhaven Street south of Arnold Avenue and then conveyed to the storm sewer along Spring Gate Boulevard.

Runoff from the south side of Arnold Avenue is conveyed eastward by roadside ditches, municipal road culverts, and private driveway culverts. The municipal road culvert under the south side of the intersection with Clarkhaven is deformed and in poor condition (Photo 52). It is conveyed to DICB #2 located at the southwest corner of Brooke Street and Arnold Avenue (Photo 53). DICB #2 is connected through a 375 mm diameter concrete pipe to the 3000 mm diameter Brooke Street trunk storm sewer. The municipal road culvert at Clarkhaven Street is deformed at both ends and would only allow flow under light storm events to be conveyed to the east, which means that flow under heavy storm events will drain to the catch basins located at Clarkhaven Street south of Arnold Avenue and then conveyed to the storm sewer along Spring Gate Boulevard.

From Brooke Street to Yonge Street (urban cross section): This section of Arnold Avenue is serviced by curbs, gutter, catch basins and a storm sewer. The storm sewer flows westward and connects to the 3000 mm diameter Brooke Street trunk storm sewer.

3.2.3.12 Spring Gate Boulevard

The Spring Gate Boulevard is entirely serviced by curbs, gutter, catch basins and a storm sewer. The storm sewer flows eastward and connects to the 3000 mm diameter Brooke Street trunk storm sewer. There is a sag point in the roadway approximately 180 m west of Charles Street with large size catch basins on both sides of the road to capture major flow at this location.

3.2.3.13 Clarkhaven Street

From Spring Gate Boulevard to Arnold Avenue: This portion of Clarkhaven Street has an urban cross section, complete with curbs and gutter on both sides. There is a sag point in the road approximately 50 m south of Arnold Avenue. Twin catchbasins are located on each side of the road at the sag point that drain to a storm sewer connected to the Spring Gate Boulevard storm sewer.

From Arnold Avenue to 20 m north of Thornridge Drive: Storm drainage is conveyed by roadside ditches and private driveway culverts on both sides of the roadway. It is conveyed to Drainage Course #2 through crossing culvert C3 located approximately 20 m south of Thornridge Drive (Photos 27 and 28).

From 20 m north of Thornridge Drive to Calvin Chambers Road: Drainage is conveyed northward by roadside ditches and private driveway culverts. The roadside ditches outlet to Drainage Course #1 at municipal culvert C13, located approximately 40 m south of Calvin Chambers Road (Photo 3).

3.2.3.14 Charles Street

From Clark Avenue West to Arnold Avenue: This portion of Charles Street has an urban cross section complete with curbs and gutter on both sides of the roadway. Catchbasins drain to a storm sewer, which is connected to the Spring Gate Boulevard storm sewer.

From Arnold Avenue to 80 m south of Thornridge Drive: Drainage is conveyed by roadside ditches and private driveway culverts. Drainage Course # 2 traverses this section of roadway through municipal culvert C2 located approximately 50 m north of Arnold Avenue (Photo 26). The roadside ditches outlet into Drainage Course # 2.

From 80 m south of Thornridge Drive to Thornridge Drive: Drainage is conveyed by roadside ditches and private driveway culverts on both sides of the roadway. Drainage Course #1 traverses this section of roadway through municipal culvert C11 located approximately 45 m south of Thornridge Drive (Photo 1). Culvert C11 coincides with a sag point in the road.

3.2.3.15 Edward Street

Edward Street has an urban cross section complete with curbs, catch basins are located on both sides of the road at the north end of Edward Street. These catch basins collect runoff from the north section of Edward Street as well as the east and middle sections of Pondview Road and connect to the 375 mm diameter PVC storm pipe located along Pondview Road.

3.2.3.16 Pondview Road

Pondview Road has an urban cross section complete with curbs, twin catch basins are located on both sides of the road at the west end of Pondview Road. The catch basins is connected to a

375 mm diameter PVC storm sewer that discharges runoff to the east end of Pondview Road and then connects to a 450 mm diameter PVC storm pipe that discharge the flow north to Drainage Course #1 just downstream of Pond A4.

3.2.3.17 Glenmanor Way

Glenmanor Way has an urban road cross section and is serviced by a storm sewer. The storm sewer is connected to the 1200 mm diameter Spring Gate Boulevard storm sewer.

3.2.3.18 Tanjo Court

Tanjo Court has an urban road cross section and is serviced by a storm sewer. The storm sewer is connected to the1950 mm diameter Springfield Way storm sewer.

3.2.3.19 Springfield Way

Springfield Way has an urban road cross section and is serviced by the 1950 mm diameter Springfield Way storm sewer.

3.2.3.20 Brownstone Circle

Brownstone Circle has an urban road cross section and is serviced by a storm sewer. The storm sewer is connected to the 1500 mm diameter storm sewer located south of the Gallanough Library and connected to the 3000mm diameter storm trunk along Brooke Street.

4. Preliminary hydrologic and hydraulic analysis

4.1 City of Vaughan Drainage Design Criteria

City of Vaughan Design Criteria outlines the standards for the design of storm drainage works and other facilities. The minor system (storm sewers and road ditches) is to be designed to convey the 5-year design storm event without surcharging. Runoff rates in excess of the design capacity of the minor system shall be conveyed by the major system (streets, ditches, and swales) to a safe outlet. The combination of minor and major systems shall be designed to prevent flooding of private property.

4.2 Hydrologic Analysis

Peak flow rates were calculated using the Rational Method. Design flow rates were generated for the 5 and 100 year-design storm events. The peak flow intensities were calculated using the City of Vaughan IDF Curve Parameters. Other hydrologic parameters for individual sub-catchment areas were determined using the topographic maps obtained from the City of Vaughan. An average runoff coefficient value of 0.6 was selected as a representative value for the Study Area that includes residential houses, roads, institutional buildings and some open areas.

4.3 Hydraulic Analysis

A preliminary hydraulic analysis using Culvert Master Hydraulic Model was undertaken to identify whether the existing system satisfies current City of Vaughan Drainage Design Criteria. The hydraulic analysis was intended to identify problem areas. The following sections describe the hydraulic analysis for each of the three drainage courses.

4.3.1 Drainage Course # 1

From the preliminary analysis, it appears that the municipal road culverts associated with Drainage Course #1 have adequate hydraulic capacity to convey the 100-year design storm. This preliminary analysis did not investigate every driveway culvert and every section of the drainage course within the Study Area to ensure that the 100-year flow could be conveyed safely without flooding or ponding on private properties. The detailed design work associated with the proposed road re-construction will establish the road geometry parameters, which will establish the need to replace driveway culverts and re-shape road-side ditches.

Although the hydraulic analysis has shown that the municipal road culverts have adequate capacity, it is expected that the culverts may be replaced at the time of road reconstruction. This is due to their present poor condition. Table 4.1 presents the results of the hydraulic analysis for the municipal road culverts, while the hydraulic model (CulvertMaster) output is presented in Appendix C.

Table 4.1 Hydraulic Analysis Results of Drainage Course #1

Culvert ID	Culvert Size (mm)	100 Year Peak Flow (m^3/sec)	Top of Road Elevation (m)	Calculated Headwater Elevation (m)	Remarks
C11	1800 CSP	1.09	181.90	181.00	Culvert has adequate capacity
C12	1800 CSP	1.42	180.80	179.66	Culvert has adequate capacity
C13	1600x2200 CSPA	1.47	178.50	177.42	Culvert has adequate capacity
C14	1200x1200 Concrete Box	1.71	175.90	175.46	Culvert has adequate capacity
C16	1200x2500 Concrete Box	4.03	175.40	174.74	Culvert has adequate capacity
C19	1000x2500 Concrete Box w/open bottom	4.36	172.60	172.54	Culvert has adequate capacity

Analysis was conducted for the north side ditch of Centre Street and it was found that the peak flow associated with the 100 year storm event is 4.03 m^3/sec, while the ditch capacity was calculated to be over 20 m^3/sec.

4.3.2 Drainage Course # 2

It is concluded that some of the key drainage elements associated with Drainage Course #2 do not have adequate capacity to convey the 100-year flow, without overtopping the road. This is shown in Table 4.2, while the hydraulic model (CulvertMaster) output is presented in Appendix C. This preliminary analysis did not cover all drainage elements within the Study Area. As mentioned previously, detailed design work associated with the proposed road re-construction will establish the road geometry parameters, which will establish the need to replace driveway culverts and re-shape road-side ditches.

Table 4.2 presents the results of the hydraulic analysis of the municipal road culverts.

Table 4.2 Hydraulic Analysis Results of Drainage Course #2

Culvert ID	Culvert Size (mm)	100 Year Peak Flow (m^3/sec)	Top of Road Elevation (m)	Calculated Headwater Elevation (m)	Remarks
D1	600 CSP	2.49	183.00	183.36	Driveway culvert does not have adequate capacity to convey the 5-year storm without overtopping the road
		1.41 (5 Year Flow)		183.20	
C2	1000x1700 CSPA	2.51	182.90	182.67	Culvert has adequate capacity
C3	800x1300 CSPA	2.51	179.90	179.98	Culvert does not have adequate capacity
C4	400x750 Elliptical CSP	0.77	175.80	175.82	Culvert does not have adequate capacity
C5	400 CSP	0.62	176.00	176.08	Culvert does not have adequate capacity

Crossing culvert C6 and the ditch inlet DICB #1 were analyzed separately. The maximum capacity of the twin crossing culverts along with the ditch inlet was calculated, assuming the water level to be at the same elevation as the edge of the road pavement (just before overtopping the road). The drainage capacity of the twin culverts and the ditch inlet together was calculated as 3.21 m^3/sec, while the peak flows were found to be 2.04 and 3.83 m^3/sec for the 5 and 100-year storms, respectively. This means that the twin crossing culverts along with the ditch inlet have the capacity to convey the 5-year storm flow, but cannot convey the 100 year storm flow without overtopping Brooke Street.

Analysis was conducted for the side road ditch just downstream of the private driveway culvert D1 and it was found that peak flow associated with the 100-year storm event is 2.49 m^3/sec, while the ditch capacity was calculated as 2.67 m^3/sec. Also, analysis was conducted for Drainage Course #2 just downstream of the crossing culvert C1 and it was found that the peak flow associated with the 100-year storm event is 2.51 m^3/sec, while the drainage course capacity was calculated as 3.0 m^3/sec.

4.3.3 Drainage Course # 3

Peak flow rates for the twin ditch inlet catch basins located at the southwest corner of Brooke Street and Arnold Avenue (DICB #2) were calculated to be 0.48 and 0.85 m^3/s for the 5 and 100-year design storm events respectively. To assess the maximum capacity of the ditch inlets, the headwater was assumed to be at the edge of road pavement. The ditch inlets and the 375 mm diameter connecting pipe to the 3000 mm diameter Brooke Street trunk storm sewer were analysed as orifices to assess their capacities. The analysis indicated that the maximum capacity of the twin ditch inlets is 0.58 m^3/sec, while that of the connecting pipe is 0.35 m^3/s. This means that the connecting pipe capacity governs the overall capacity.

This preliminary analysis did not cover all drainage elements (ditches, catch basins, driveway culverts).

5. Problem Areas

5.1 Problem Areas within Drainage Course #1

According to the preliminary hydraulic analysis and field investigations, it is concluded that the components of drainage infrastructure along Drainage Course #1 have adequate capacities to convey the design peak flows without overtopping the roads.

According to verbal communications from residents attending the Public Information Centres there appears to have been some indiscriminate grading of private property that has caused localized flooding.

Attendees at the PICs also noted that the August 19, 2005 rainfall event caused the outlet structure of the stormwater management detention facility (pond A4) at the westerly end of Thornridge Drive to fail, thus causing downstream flooding.

5.2 Problem Areas within Drainage Course #2

The following problem areas were identified within Drainage Course #2 catchment area as shown in Figure 3:

- Area 1 – existing driveway culvert D1 at 132 Arnold Street is undersized (600 mm diameter CSP).
- Area 2 – ditch inlet DICB 1 (1338 mm x 768 mm) and 600 mm diameter connecting pipe at 36 Brooke Street has inadequate capacity to convey major storm events.
- Area 3 – a discontinuity in the overland flow route exists in the backyards of 105 Brooke Street and 26 Arnold Avenue, 27 and 26, 27 and 22, 23 and 18, 23 and 14 on Thornridge Drive and Arnold Avenue.
- Area 4 – a discontinuity in the overland flow route exists between 23 and 27 Thornridge Drive.
- Area 5 – the existing 450 mm diameter CSP culvert at the intersection of Elizabeth Street and Thornridge Drive is in poor condition and deformed, which constricts the flow capacity and causes road overtopping.
- Area 6- the existing crossing culvert (600 mm x 200 mm CSP) in front of 28 Thornridge Drive is in poor condition and constricts the flow. As noted in the field, the 300 mm diameter CSP driveway culvert just downstream of the crossing culvert is undersized.
- Area 8 – the existing crossing culvert C3 (1300 mm x 800 mm CSPA) south of the intersection of Clarkhaven Street and Thornridge Drive is in acceptable condition, however, it does not have sufficient hydraulic capacity.
- Area 9 – the existing crossing culvert C4 (750 x 400 mm CSPA) on Thornridge Drive west of Brooke Street is in poor condition, deformed, and does not have sufficient hydraulic capacity.

- Area 10 – the existing 400 mm diameter CSP municipal culvert C5, at the intersection of Brooke Street and Thornridge Drive is in poor condition, deformed, and does not have sufficient hydraulic capacity.
- Area 11 – the 400 mm diameter municipal road CSP culvert located at the north side of Arnold Avenue and Clarkhaven Street intersection is buried at the upstream side and deformed at the downstream side. This means that the flow along the upstream ditch will overtop one of the intersecting roads.

5.3 Problem Areas within Drainage Course #3

The following problem areas were identified within the Drainage Course #3 catchment area:

- Area 7 – the existing twin ditch inlet catch basin (twin 500 x 500 mm) and 375 mm diameter storm sewer connection at the southwest corner of Brooke Street and Arnold Avenue intersection have inadequate hydraulic capacity to convey major storm events.
- Area 12 – the 400 mm diameter municipal CSP culvert located at the south side of Arnold Avenue and Clarkhaven Street intersection is deformed at both ends and the upstream ditch flow will be conveyed south to the catch basins located on Clarkhaven Street, about 50 m south of Arnold Avenue.

5.4 3000 mm Diameter Brooke Street Storm Sewer

There is a 3000 mm diameter trunk storm sewer located under Brooke Street. It flows northward through the Study area and discharges to the East Don River. It has an extensive catchment area that extends south to the CN Rail line and potentially west to Bathurst Street (refer to Figure 2). It appears that only a small amount of drainage generated from within the Study Area enters this trunk storm sewer. As-built engineering design drawings were provided by the City of Vaughan, but unfortunately, no design report for the trunk storm sewer has been found and therefore the design criteria and assumptions used for its design are unknown. The drawings include a detail that shows a 750 mm diameter sanitary sewer constructed inside the 3000 mm diameter storm sewer.

A hydraulic analysis of the trunk sewer was undertaken. The XP-SWMM model was used for the analysis. The catchment area contributing to the 3000 mm diameter trunk sewer is bounded by Yonge Street on the east, CNR on the south, Bathurst Street on the west, and Spring Gate Blvd on the north. The drainage area was measured as 164.4 ha. The Rational Method was used to calculate peak flow values discharged to the 3000 mm diameter storm trunk sewer. It was assumed that the storm sewer network was designed to convey the 5-year storm event (minor system) to the 3000 mm diameter storm sewer trunk. According to the topography of the catchment area, the overland flow (major system) is also directed to the Brooke Street trunk storm sewer.

The 5-year peak flow was calculated using the Rational Method as 13 m^3/sec., while the total peak flow that would be conveyed to the trunk under the 100 year storm event was estimated as 16 m^3/sec.

The capacity of the Centre Street trunk sewer was calculated using the storm sewer plans and profiles that was provided by the City of Vaughan and was calculated as 14 m^3/sec.

The XP-SWMM model was used for the analysis of the trunk sewer and it was found that under existing conditions, the trunk would surcharge at Arnold Avenue and flooding would occur as shown in Figure 4, while under the preliminary preferred alternative (with a detention facility at the upstream end of the Brooke Street trunk), flooding could be eliminated as shown in Figure 5.

5.5 Problem Statement

From the review of background information, field investigations and the preliminary hydrologic and hydraulic analysis of the Study Area, the drainage deficiencies are presented in Figure 3 and summarized below.

- Surcharging of Brooke Street trunk storm sewer
- Undersized or damaged culverts under driveways
- Inadequately sized roadside ditches
- Inadequate or unknown outlet capacity
- Discontinuous overland flow routes
- Sags or low points in roadways or ditches where water may pond
- Inadequate number of catch basins or drainage inlets
- Blockage or constrictions in conveyance system
- Indiscriminate grading on private property that causes drainage to spill onto adjacent private property

Figure 4 Brooke Street Trunk Sewer Analysis under Existing Condtions

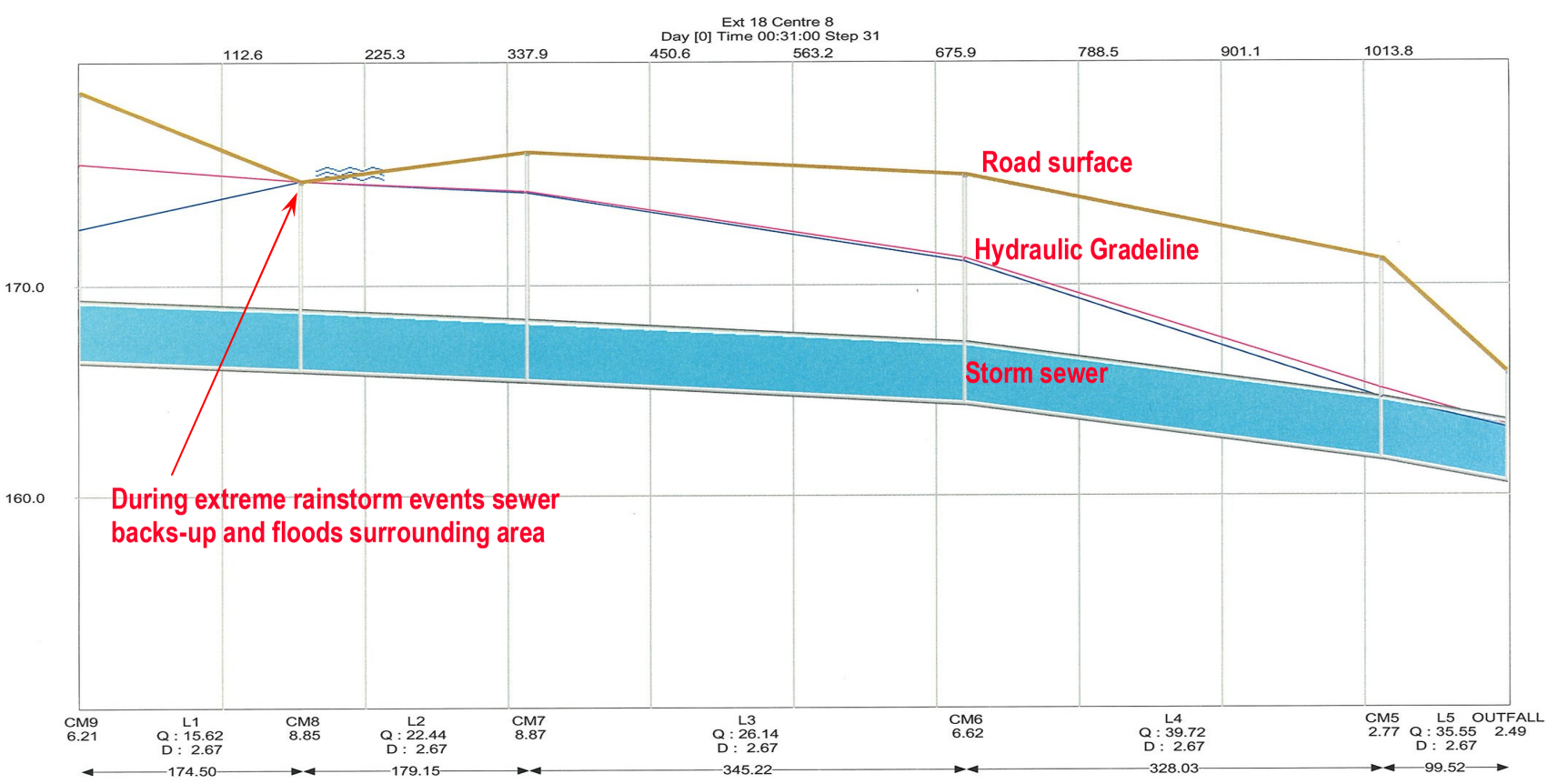
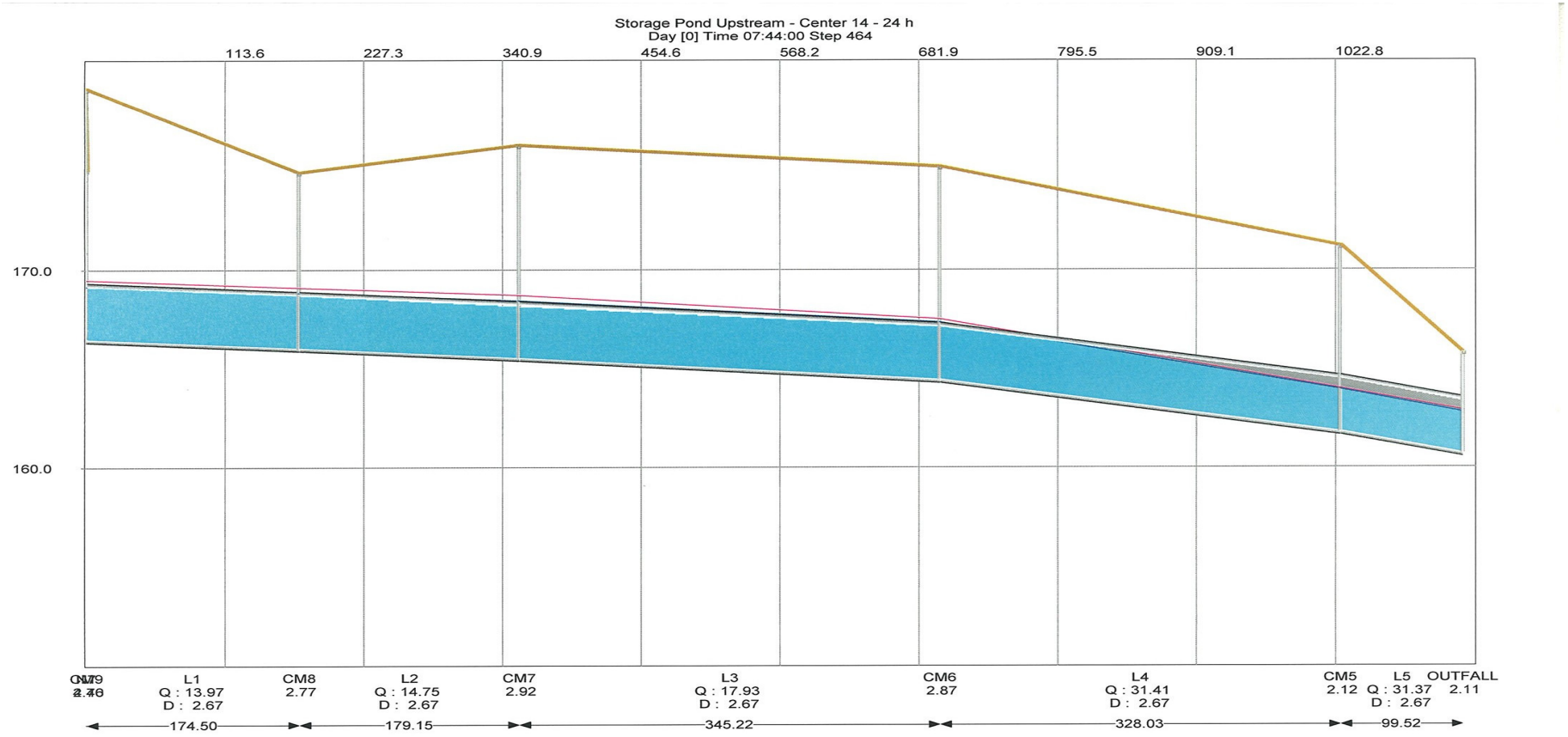


Figure 5 Brooke Street Trunk Sewer Analysis under Preliminary Preferred Solution



6. Alternative Solutions

The purpose of this study is to produce a solution which will reduce or eliminate the flooding risks in the Study Area. With this purpose in mind, the Class EA planning process requires that alternative solutions be considered. This must include the alternative to make no improvements (Do-Nothing).

A number of alternatives were identified. Each of these alternatives is briefly outlined below:

1. New storm sewer system. This would involve constructing new storm sewers (or ditches) on certain roadways Most of the drainage within the Study Area is conveyed by open roadside ditches; there are very few storm sewers. The conveyance capacity of the existing roadside ditches is contingent on the conveyance capacity of private driveway and municipal culverts. Where driveway culverts are undersized or damaged, there is a high risk of ditches over-flowing. Construction of storm sewers would reduce the flooding risk for minor storm events. Large size storm sewers (relief sewers) could be constructed to convey larger magnitude storm events.

2. Rehabilitate or upgrade existing storm drainage system. This would involve replacing or upgrading deficient portions of the storm drainage system. It could also involve modifying the existing drainage system to improve system capacity. Deficient culverts and under-sized ditch inlets and catch basins would be replaced, where appropriate. In some areas where roadways are proposed for reconstruction, curbs and gutters could be installed. In some situations it may be possible to divert one drainage course into adjoining drainage course. This could be considered where capacity improvements would be accomplished.

3. Expansion of existing storm drainage system. This alternative would increase the extent of the existing storm drainage system (sewers or ditches) or change management practices to existing drainage system to improve the capacity of existing system. It may be possible to improve the conveyance capacity of drainage courses or road side ditches.

4. Implement stormwater management measures. This would involve constructing stormwater storage facilities. Stormwater management facilities would detain runoff and regulate the discharge rates to receiving storm sewers or drainage courses.

5. Do Nothing. This alternative would not involve any improvements or changes to the storm drainage system. It does not necessarily mean that no further re-development in the community would occur.

Each alternative solution also has various options for consideration. In considering the range of alternatives, it turns out that some of the candidate solutions may be reasonable or feasible than other alternatives.

6.1 Evaluation of Alternative Solutions

The evaluation criteria used for determining the suitability of various alternative solutions in the Study Area include the following factors:

- Alternative accomplishments

- Advantages/Disadvantages
- Potential effects
- Feasibility and cost estimate

For each alternative (and option) the above factors were applied, considering the local conditions and design targets, to determine its suitability in this area.

The results of the evaluation are presented in Table 6.1. Those alternative solutions and options deemed feasible for the Study Area were used to develop the Preliminary Preferred Solution.

Thornhill Storm Drainage Improvements Study

Table 6.1 Alternative Solutions Evaluation Matrix

Alternative	What would this alternative accomplish?	Advantages	Disadvantages	Potential Effects	Comment
New storm sewer system					
Arnold Ave	• Collect road drainage and convey it within road right-of-way. Possibly intercept drainage courses #2 & #3	• pickup drainage from Arnold Ave including drainage from outside Study Area • may eliminate driveway culverts if curbs & gutters are constructed with storm sewers	• No plans to re-construct Arnold Ave that would facilitate construction of storm sewers • Existing trunk sewer along Brooke Street does not have adequate capacity to enable connection of Arnold St storm sewer	• Typical impacts during construction • Potentially some utility conflicts • Would need to locate suitable outlet for Arnold Ave storm sewer (presumably Brooke St sewer) • Need ditch inlets if no curb and gutter	• Not favourable
Thornridge Drive	• Collect road drainage and convey it within road right-of-way. Possibly intercept drainage courses #1 & #2	• Could coincide with re-construction of Thornridge Dr • may eliminate driveway culverts if curbs & gutters are constructed with storm sewers	• Existing trunk sewer along Brooke Street does not have adequate capacity to enable connection of Thornridge Drive storm sewer	• Typical impacts during construction • Potentially some utility conflicts • Would need to locate suitable outlet for Thornridge Drive storm sewer (presumably Brooke St sewer) • Need ditch inlets if no curb and gutter	• Not favourable, except for short section just west of Brooke St.
Clarkhaven St	• Collect road drainage and convey it within road right-of-way. Possibly intercept additional runoff	• Could coincide with re-construction of Clarkhaven • Could pickup drainage from Arnold Ave • may eliminate driveway culverts if curbs & gutters are constructed with storm sewers	• Existing trunk sewer along Brooke Street does not have adequate capacity to enable connection of Clarkhaven St storm sewer • Require the construction of Thornridge Drive storm sewer.	• Typical impacts during construction • Potentially some utility conflicts • Would need to locate suitable outlet for Clarkhaven St storm sewer • Need ditch inlets if no curb and gutter	• Not favourable, except for short sections
Brooke St	• Reduce peak flow rate and surcharging in existing Brooke St trunk sewer • Would provide a relief sewer for existing trunk sewer	• Would reduce surcharging in existing Brooke St trunk sewer and eliminate potential flooding in vicinity of Brooke & Arnold	• Relief sewer would be very deep (>10 m) • The sewer construction would be extremely costly and need a new outfall at East Don River. Would increase discharge rates and erosion potential in river	• Construction would employ tunneling techniques and dewatering • Construction impacts would be significant • Utility conflicts • Would need new outfall structure at river • Would increase discharge rates and erosion potential in river	• extremely expensive • very disruptive with significant impacts within Study Area and downstream • not recommended for any further consideration
Rehabilitate or upgrade existing storm sewage system (including diverting drainage courses)					

Alternative	What would this alternative accomplish?	Advantages	Disadvantages	Potential Effects	Comment
Replace deficient culverts	• Provide proper conveyance capacity	• Would reduce localized flooding	• Make require grading onto private property	• Minor impacts during replacement	• Recommended where needed
Construct urban road sections with curbs, gutter and storm sewers	• Create dual drainage system - minor drainage conveyed in storm sewers & major drainage overland along roadways • Would meet City of Vaughan design standards for roads	• Driveway culverts and cross culverts at intersections would be eliminated • Road drainage would be conveyed within road right-of-way.	• May meet municipal standards, but won't solve all flooding problems • May require extensive re-grading to provide positive drainage along roadways • Grading on private property • May need rear lot catch basins • Urban road section is controversial with some landowners – not everyone wants it • Sewers need outlets with adequate capacity • Overland flow needs proper outlet capacity	• Would change character of neighborhood • Typical impacts during construction • Grading and earthworks on private property • Potentially some utility conflicts	• There are certain sections of roadway that would benefit from curb and gutter, but would depend on road reconstruction design work
Replace undersized ditch inlets and catch basins	• Increase capture capacity of storm sewer system	• Reduce localized flooding	• Storm sewer system needs sufficient conveyance and outlet capacity	• Minor impacts from construction • Potential to worsen flooding if sewer capacity is already insufficient	• Recommended for implementation
Divert Drainage Course #2 to Drainage Course #3 at Charles St (either partially or complete diversion)	• Reduce peak discharge rates in drainage course #2	• Reduce peak discharge rates in drainage course #2	• Not possible to divert surface flow without constructing extremely deep ditch since the depth of Drainage Course #2 is quite deep compared to that of Drainage Course #3. Would need a sewer in order to achieve diversion	• Insufficient outlet capacity • Cross section of Drainage Course #3 to be upgraded. • Potential utility conflicts.	• Not recommended for any further consideration
Divert Drainage Course #2 to Drainage Course #1 at Charles St	• Reduce peak discharge rates in drainage course #2	• Re-grade ditch from C2 to C11 and replace driveway culverts.	• Unknown outlet capacity • Would be Schedule C, Class EA	• Potentially insufficient outlet capacity • Potential utility conflicts.	• Not recommended for any further consideration
Divert Drainage Course #2 to Drainage Course #1 at Clarkhaven	• Reduce peak discharge rates in drainage course #2	• Re-grade ditch from C3 to C13 and replace driveway culverts.	• Unknown outlet capacity • Would be Schedule C, Class EA	• Potentially insufficient outlet capacity • Potential utility conflicts.	• Not recommended for any further consideration
Divert (short-cut) Drainage Course #2 from Brooke St to existing 1500 mm diameter sewer	• Avoid flooding of property in vicinity of Brooke St& Arnold Ave	• Avoid flooding of property in vicinity of Brooke St& Arnold Ave	• Only possible by pipe • Expensive solution	• Potential utility conflicts.	• Not recommended for any further consideration
Expansion of existing storm drainage system					
Improve conveyance capacity of drainage courses to convey 100 yr	• Increase conveyance capacity and reduce flooding on private property and over municipal roads	• Would reduce localized flooding • Municipal road culverts in poor condition would be replaced at time of drainage course improvements	• Minimal existing easements for drainage courses on private property. City does not have jurisdiction on private property. Would require co-operation of all landowners and would be very difficult to completely implement • No control of drainage courses on private property unless easements for construction and maintenance purposes are negotiated with private landowners • Can not implement this alternative without properly sized outlets	• Private landowners have incorporated drainage courses into their landscaping • Tree & vegetation removal • Potentially insufficient outlet capacity and unknown d/s impact • Driveway culverts would need to be replaced • Grading and earthworks on private property • Potentially some utility conflicts	• Not recommended for any further consideration

Alternative	What would this alternative accomplish?	Advantages	Disadvantages	Potential Effects	Comment
Improve road ditch conveyance capacity	• Would meet City of Vaughan design standards for road drainage and eliminate overflow from roads	• May meet municipal standards, but won't solve all flooding problems	• Considerable existing encroachment into road right-of-way by private landowners will cause controversy when road ditch capacity needs to be increased • Need properly sized outlets • Need positive overland flow route or large dia sewers to complete drainage scheme	• May result in large roadside ditches • Encroachment works would be removed • Driveway culverts would need to be replaced • Potential grading on private property • Potentially some utility conflicts	• Recommended where beneficial
Require stormwater management (storage pond alternatives)					
Increase storage capacity of existing SWM facilities (existing A4 pond)	• Reduce peak discharge rates and reduce flooding along Drainage Course #1.	• Would reduce peak discharge rates and reduce flooding along Drainage Course #1.	• Pond A4 already provides 100 year design storage • No benefit to other drainage courses where flooding is a serious issue	• Flooding areas associated with drainage Course #2 still an issue.	• Not recommended
New SWM facility in Gallanough Park, south of Spring Gate Blvd. and west of Yonge St.	• Reduce peak flows discharged to the Brooke Street trunk sewer and reduce flooding.	• property is owned by the City of Vaughan. • Would resolve majority of flooding risk • Could excavate and re-grade park area. • Relieve peak flows from the Brooke Street trunk sewer and allow for connecting some of the study area drainage courses to the trunk. • Opportunity to redevelop park area.	• Will not solve all drainage issues since some issues are related to private property' re-grading and landscaping. • Converting community park for SWM purposes is controversial	• A number of trees and public facilities would be relocated and/or compensated. • Impacts during construction • Change the current use of the park area, but still maintain passive park facilities	• Recommended.
Do Nothing	• Would not address existing flooding problems	• No advantage	• Flooding risk would remain and flooding problems would continue to cause damage	• Potential flooding risks would remain	• Not recommended

7. Preliminary Preferred Solution

It is seen from Table 6.1, that many of the alternative solutions are either not favourable or not recommended for further consideration. Indeed, as shown in Figure 6, the only alternatives that are recommended are:

- Construction of a new stormwater management facility in Gallanough Park.
- Possible new storm sewer along Thornridge Drive, just west of Brooke Street;
- Replacement of undersized ditch inlets and catch basins;
- Replacement of deficient culverts;
- Improvement of ditch conveyance capacity.

Essentially, all of the above forms the preliminary preferred solution. The preliminary preferred solution does combine various individual alternative solutions. For example, it includes replacing undersized ditch inlets (rehab or upgrade) and increasing road ditch conveyance capacity (expansion).

The construction of a new stormwater management facility in Gallanough Park as shown in Figure 6 and Figure 7 would address the serious Brooke Street storm sewer surcharging problem, which is the major cause of the significant flooding problems. The other alternatives only address localized problems and do not address the more serious sewer surcharging problem.

A rigorous economic analysis was not undertaken. benefit-to-cost ratio method of analysis was not completed because of the difficulty of properly quantifying the values. However, cost estimates were prepared and it was considered whether the City of Vaughan would have the capacity to finance the solution.

It is the City's intention to maintain a passive park setting, while protecting the environment through proper stormwater management controls. It would be the City's desires to create an amenity for the community. Figure 7 depicts a concept for the integration of the proposed stormwater management facility into the park.

7.1 Cost Estimates of the Preliminary Preferred Solution

Capital cost estimates were derived for the preliminary preferred solution based on unit costs for comparable work in other areas. Engineering design costs were not included. The detailed cost estimates are given in Appendix D.

The total construction cost estimate of the preliminary preferred solution is $3.0 million. This includes a 30% contingency on construction cost estimates but does not include engineering design costs.

7.2 Second Public Information Centre

The Public Information Centre held on December 11, 2007 presented the alternative solutions, and the Preliminary Preferred Alternative Solution along with their advantages, disadvantages and potential effects. Table 6.1 presents the current version of the evaluation of alternative solutions. Input from the public was requested and responses received are found in Appendix A-4.

Figure 7: Proposed Stormwater Management Detention Facility in Gallanough Park

GENIVAR

7.3 Agency Consultation

A meeting was convened with staff of the Toronto and Region Conservation Authority on January 15, 2008 to discuss the Preliminary Preferred Solution. TRCA noted that Drainage Courses #1 and #2 were designated as watercourses in may 2006. Therefore, these watercourses fall under TRCA Regulation 166/06.

TRCA noted that any for municipal culvert proposed to be replaced along either Drainage Course #1 or #2, would require a hydraulic analysis to be undertaken to confirm that water surface elevations would not change and that any replacement culvert would not pose a flood risk to adjoining properties. TRCA indicated their desire for the preparation of floodline mapping of the two watercourses.

TRCA enquired whether the proposed SWM facility could incorporate any water quality considerations. It was indicated to TRCA that available space in Gallanough Park is very limited and it is unlikely there would be sufficient capacity in the proposed SWM facility for water quality control.

8. Recommended Solution

This section describes the components of the Recommended Solution and potential environmental effects and mitigating measures. It also identifies recommendations for further work. The recommended solution is shown in Figure 6.

8.1 Construct Stormwater Management Facility in Gallanough Park

The construction of a stormwater management facility in Gallanough Park would detain runoff and regulate the discharge rates to the Brooke Street trunk storm sewer and eliminate flooding occurrence during heavy storm events.

Preliminary analysis found that a detention facility with a storage capacity of about 22,000 m^3 is required to detain sufficient runoff generated from storm events (up to the 100 year storm) in order to reduce the surcharging effect in the Brooke Street trunk sewer. In addition, this would allow drainage from Drainage Course #2 and #3 to be connected the Brooke Street trunk sewer without causing surcharging or risk of flooding. Detailed hydrologic and hydraulic modeling of the external drainage area contributing to the Brooke Street trunk should be completed to better size the detention facility.

The SWM facility will require a Certificate of Approval (C of A) from MOE, but no permits are required from TRCA.

8.2 Replace Deficient Culverts

It has been determined that a number of culverts should be replaced. This is due to insufficient capacity, and/or poor culvert condition. The culverts recommended for replacement are D1,C3, C4, C5, C11, C12. Also, the following side road culverts need to be replaced:

- At the intersection of Clarkhaven Street and Thornridge Drive
- At the intersection of Elizabeth Street and Thornridge Drive
- At the intersection of Clarkhaven Street and Arnold Avenue

Also, the crossing culvert and the driveway culvert on Thornridge Drive east of Brooke Street should be replaced as shown in Figure 6.

Permits would be required from TRCA for culverts to be replaced on Drainage Course #1 and #2.

8.3 Construct New Storm Sewer along Thornridge Drive, just West of Brooke Street

It is recommended to construct a new storm sewer along Thornridge Drive, just west of Brooke Street. The new storm sewer would connect to the Brooke Street trunk storm sewer. The purpose of this storm sewer is to remove the flow from Drainage Course #2 that meanders through private property after it departs the south side ditch in front of 53 Thornridge Drive, enroute to the west side ditch of Brooke Street. The existing ditch inlet in the west side ditch of Brooke Street would remain to pick-up local drainage from the area.

8.4 Replace Deficient Catchbasins and Ditch Inlets

The capacity of the twin ditch inlets located at the southwest quadrant of Brooke Street and Arnold Avenue is inadequate. Also, the size of the pipe connecting the twin ditch inlets with the Brooke Street trunk is inadequate. It is recommended to improve the capacity of the twin ditch inlets and the connecting pipe.

8.5 Remove Crossing Twin Culverts North of Brooke Street and Arnold Avenue Intersection

Since a new storm sewer along Thornridge Drive will be constructed just west of Brooke Street, the twin culverts crossing Brooke Street north of Arnold Avenue intersection are recommended for removal. This would eliminate flooding at the downstream side of the twin culverts, as the Drainage Course #2 is blocked at this area.

8.6 Improve Ditch Conveyance Capacity

During the detail design stage for the proposed road reconstruction, the conveyance capacity of the road side ditches needs to be reviewed to confirm adequacy for storm major flow, without overtopping the roads.

The design flow rates should be reviewed at the detailed design stage for each individual roadway and drainage element (i.e. driveway culverts, ditches, inlets, etc.) based on the drainage catchments for each drainage element.

8.7 Community Effects

The Recommended Solution will require construction within an existing residential community. Community facilities will be affected. There will be minimal disruption to residents expected during construction. There will be disruption to the park, but no loss of use to the park is expected. Standard construction safety practices will be implemented to ensure that the construction site is secure and that the public are safeguarded against unnecessary risk. After construction, the area will be fully restored.

Construction activities will have the potential to result in temporary noise level increases and vibration. Control measures, if required, will be applied to reduce the noise and vibration generated by construction operations.

Detailed hydrologic and hydraulic modelling should be conducted to confirm the sizing of the proposed stormwater management facility and refine the concept of constructing a SWM facility with partial underground storage to accommodate the more frequent storm events.

8.8 Heritage Resources

Archaeological Resources

No archaeological resources are affected by the construction.

Historical Resources

The construction of the SWM facility will be adjacent to one heritage structure. However, it is not expected that the structure will be affected by the construction.

8.9 Vegetation

The Recommended Alternative avoids woodlands.

8.10 Wetlands

The proposed infrastructure construction will not result in a loss of wetland area or function.

8.11 Wildlife

The effect on wildlife is considered to be minor because the area of wildlife habitat removed or disturbed is small.

8.12 Fisheries

The streams within the Study Area do not have permanent flow and do not support fish habitat. Therefore, the only potential impact would be from construction operations in the vicinity of the streams. Implementation of site specific erosion and sediment control measures will minimize impacts during and after construction.

8.13 Water Resources

Ground Water

It is not anticipated that there will be any significant change in ground water quality or quantity as a result of construction or operation of the proposed SWM facility.

Surface Water

There is a potential to change the water quality of the receiving watercourses through increased turbidity levels and suspended solids concentrations during construction. During construction, the following mitigation measures will be followed:

- The exposed areas should be kept to a minimum at all times to minimize the potential for erosion;
- Exposed surfaces should be re-stabilized and re-vegetated as soon as possible;
- Appropriate sediment control devices or structures should be used during construction to retain sediment on the site. If necessary, temporary sediment ponds should be used to provide the detention time required for sufficient dewatering.

8.14 Traffic

The construction of the proposed infrastructure will result in traffic disruption. The magnitude of disruption will depend on a number of factors. Construction requires that materials be brought to the site and earth that is excavated be hauled away from the site. Other factors that contribute to

traffic disruption include lane reductions, the time of day, and weather conditions. Some of these factors can be mitigated more successfully than others.

In some situations, the lane reductions may only be necessary during the actual hours of construction operations. In which case the hours of construction operation may be restricted to minimize traffic disruption.

9. Conclusion and Recommendations

9.1 Conclusions

The Study Area is subject to frequent flooding problems during heavy storm events. The City of Vaughan required that a drainage assessment be undertaken for the study area prior to commencing reconstruction of certain roads in the Study Area.

The Study Area receives flows from a large external urban area. This has resulted in sewer surcharging of the Brooke Street trunk storm sewer and flooding at some locations, especially at the low ground elevation areas such as the area just north of the Brooke Street and Arnold Avenue intersection. Other deficient drainage issues identified include:

- Undersized or damaged culverts under driveways
- Inadequately sized roadside ditches
- Inadequate or unknown outlet capacity
- Discontinuous overland flow routes
- Sags or low points in roadways or ditches where water may pond
- Inadequate number of catch basins or drainage inlets
- Blockage or constrictions in conveyance system
- Indiscriminate grading on private property that causes drainage to spill onto adjacent private property

Alternative solutions were identified and evaluated. Essentially the Recommended Solution involves:

- Construction of a new stormwater management facility in Gallanough Park;
- Constructing a new storm sewer along Thornridge Drive, just west of Brooke Street;
- Replacement of undersized ditch inlets and catch basins;
- Replacement of deficient culverts;
- Improvement of ditch conveyance capacity.

9.2 Recommendations

It is recommended that the Recommended Solution be implemented.

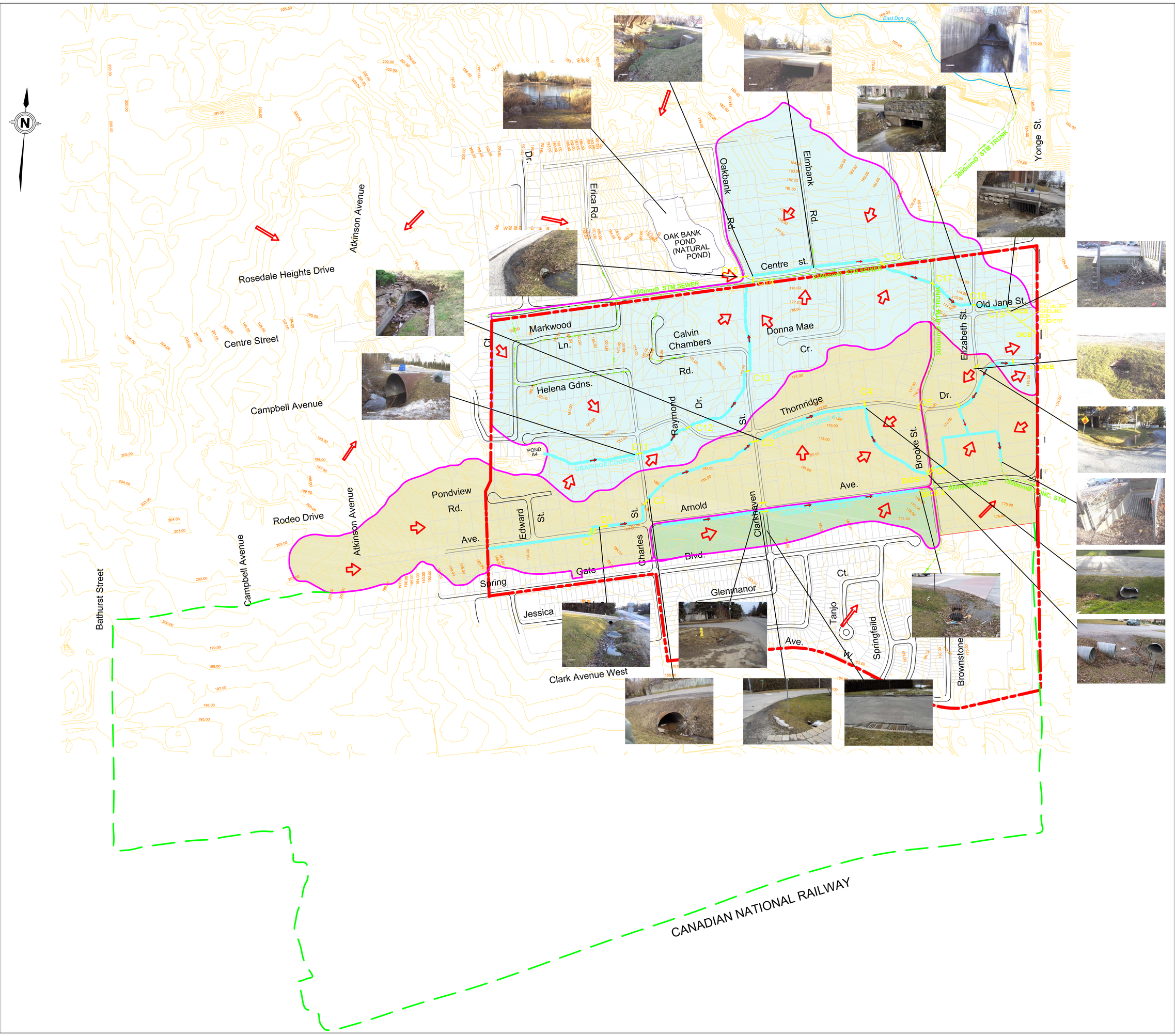
Detailed hydrologic and hydraulic modeling of the drainage area contributing to the Brooke Street trunk should be completed as part of the work associated with the detailed design of the stormwater management facility. This is required to better size the detention facility and determine whether the SWM facility could incorporate any water quality control.

APPENDIX A

CLASS EA FILE DOCUMENTATIONS

APPENDIX A-1

CLASS EA NOTICES AT DIFFERENT STUDY STAGES



LEGEND

- STUDY AREA
- CATCHMENT BOUNDARY
- DRAINAGE COURSE / DITCH LINE
- OVERLAND FLOW DIRECTION
- EXTERNAL FLOW DIRECTION
- C4 — CROSSING CULVERT
- STORM TRUNK
- STORM SEWER
- CATCHMENT AREA FOR DRAINAGE COURSE #1
- CATCHMENT AREA FOR DRAINAGE COURSE #2
- CATCHMENT AREA FOR DRAINAGE COURSE #3
- DRAINAGE AREA TO BROOKE ST. TRUNK SEWER

NO.	DESCRIPTION	BY	DATE
5			
4			
3			
2			
1			

REVISIONS

CONSULTANT:

GENIVAR

600 Cochrane Drive, Suite 500, Markham, ON, L3R 5K3
Telephone: (905) 475-7270 / Fax: (905) 475-5994

ENGINEER'S STAMP:

APPROVED AS TO FORM IN RELIANCE UPON THE PROFESSIONAL SKILL AND ABILITY OF MACVIRO CONSULTANTS INC., AS TO DESIGN AND SPECIFICATION.

DATE: _____

CATCHMENT BOUNDARIES AND DRAINAGE COURSES

THORNHILL STORM
DRAINAGE IMPROVEMENTS STUDY

City of Vaughan
The City Above Toronto

ENGINEERING DEPARTMENT

DESIGNED BY:	DATE: FEB. 2008	CHECKED BY:	
DRAWN BY:	SURVEYED BY:	APPROVED BY:	
SCALE : 1:3500	PROJ. No. 6101	DWG. No. FIGURE 2	SHEET No.

H:\6101\Drawings\Catchment Areas and Drainage Courses_Feb14_2008.dwg (Nov 26, 2008)

KEY PLAN
N.T.S.

LEGEND

- STUDY AREA
- CATCHMENT BOUNDARY
- DRAINAGE COURSE / DITCH LINE
- OVERLAND FLOW DIRECTION
- EXTERNAL FLOW DIRECTION
- C4 — CROSSING CULVERT
- STORM TRUNK
- STORM SEWER
- AREA 1 — PROBLEM AREA

NO.	DESCRIPTION	BY	DATE
5			
4			
3			
2			
1			

REVISIONS

CONSULTANT:

GENIVAR
600 Cochrane Drive, Suite 500, Markham, ON, L3R 5K3
Telephone: (905) 475-7270 / Fax: (905) 475-5994

ENGINEER'S STAMP:

APPROVED AS TO FORM IN RELIANCE UPON THE PROFESSIONAL SKILL AND ABILITY OF MACVIRO CONSULTANTS INC., AS TO DESIGN AND SPECIFICATION.

DATE: _____

DRAINAGE ISSUES AND PROBLEM AREAS

THORNHILL STORM
DRAINAGE IMPROVEMENTS STUDY

City of Vaughan
The City Above Toronto

ENGINEERING DEPARTMENT

DESIGNED BY:	DATE: FEB. 2008	CHECKED BY:	
DRAWN BY:	SURVEYED BY:	APPROVED BY:	
SCALE : 1:2500	PROJ. No. 6101	DWG. No. FIGURE 3	SHEET No.

P:\6101\Drawings\Catchment Areas and Drainage Courses\6101-07.dwg (Feb 14, 2008)

CENTRE STREET

MARKWOOD LANE

MARKWOOD LANE

HELENA GARDENS

CALVIN CHAMBERS

DONNA

MAE CR.

STREET

CHARLES

THORNRIDGE DRIVE

BROOKE ST.

ELIZABETH ST.

OLD JANE ST.

3000mmØ STM TRUNK

3000mmØ STM TRUNK

CONSTRUCT STORM SEWER & CONNECT TO BROOKE ST. TRUNK SEWER

REPLACE CULVERT

REPLACE DEFICIENT CULVERTS

REPLACE DEFICIENT CULVERTS

REPLACE CULVERTS

PONDVIEW RD.

EDWARD ST.

REPLACE DEFICIENT CULVERTS

CLARKEHAVEN

IMPROVE DITCH INLET CAPTURE

REMOVE CULVERTS

DICB

DICB

DICB

STREET

YONGE

ARNOLD AVENUE

DICB 1

DICB 2

1500mmØ CONC STM

REPLACE CULVERTS

SPRING GATE BOULEVARD

PROPOSED STORMWATER DETENTION FACILITY

175.00

JESSICA GARDENS

HALLMARK COURT

GLENMANOR WAY

TANJO COURT

SPRING FIELD WAY

BROWNSTONE CIR

CLARK AVENUE WEST

CLARK AVENUE WEST

KEY PLAN
N.T.S.

LEGEND

- STUDY LIMITS
- DRAINAGE COURSES
- STORM TRUNK

NO.	DESCRIPTION	BY	DATE
5			
4			
3			
2			
1			

REVISIONS

CONSULTANT:

GENIVAR

600 Cochrane Drive, Suite 500, Markham, ON, L3R 5K3
Telephone: (905) 475-7270 / Fax: (905) 475-5994

ENGINEER'S STAMP:

APPROVED AS TO FORM IN RELIANCE UPON THE PROFESSIONAL SKILL AND ABILITY OF MACVIRO CONSULTANTS INC., AS TO DESIGN AND SPECIFICATION.

DATE: _____

PRELIMINARY PREFERRED SOLUTION

THORNHILL STORM
DRAINAGE IMPROVEMENTS STUDY

City of Vaughan
The City Above Toronto

ENGINEERING DEPARTMENT

DESIGNED BY:	DATE: FEB. 2008	CHECKED BY:
DRAWN BY: BP	SURVEYED BY:	APPROVED BY:
SCALE : 1:600	PROJ. No. 6101	DWG. No. / SHEET No. FIGURE 6

NOTICES

NOTICE OF STUDY COMMENCEMENT

THORNHILL STORM DRAINAGE IMPROVEMENTS STUDY

The City of Vaughan has initiated a study to investigate and assess the existing drainage infrastructure and to identify drainage system deficiencies in the Thornhill neighbourhood, located on the southeast corner of Yonge Street and Centre Street. For a detailed map of the study area, please visit www.vaughan.ca, Engineering Department/Projects. The study will also identify and recommend an appropriate course of action for any necessary improvements.

The project is being planned under Schedule B of the Municipal Class Environmental Assessment. The study will entail a background review and assessment of existing conditions, a detailed study and evaluation of alternative solutions and preparation of a stormwater management plan.

Public input and comments are invited for incorporation into the planning of this project. A public meeting will be held at a later date under the Class Environmental Assessment process. There will be a minimum of two public meetings during the study to solicit input, inform the residents of progress and to receive feedback.

For further information of this project, please contact:

Alan E. Winter, P. Eng.
MacViro Consultants Inc.
A Division of Genivar Ontario Inc.
600 Cochrane Drive, Suite 500
Markham, ON L3R 5K3
Tel: 905-475-7270 ext. 323
Fax: 905-475-5994
Email: awinter@macviro.com

Pat Marcantonio, C.E.T.
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, ON L6A 1T1
Tel: 905-832-8525 ext. 3111
Fax: 905-303-2045
Email: pat.marcantonio@vaughan.ca

This notice first issued January 11, 2007

NOTICES

NOTICE OF STUDY COMMENCEMENT

THORNHILL STORM DRAINAGE IMPROVEMENTS STUDY

***** Please note that the location was previously advertised incorrectly as the southeast corner of Yonge Street and Centre Street. The correct location is the "southwest corner".***

The City of Vaughan has initiated a study to investigate and assess the existing drainage infrastructure and to identify drainage system deficiencies in the Thornhill neighbourhood, located on the *****southwest corner*** of Yonge Street and Centre Street. For complete information and a detailed map of the study area, please visit www.vaughan.ca, Engineering Department/ Projects. The study will also identify and recommend an appropriate course of action for any necessary improvements.

City of Vaughan
The City Above Toronto

The City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario
Canada L6A 1T1
Tel [905] 832-2281

December 15, 2006

NOTICE TO PROPERTY OWNERS

RE: THORNHILL STORM DRAINAGE IMPROVEMENTS STUDY

The City of Vaughan has initiated preliminary engineering investigations including topographic surveys and other field reconnaissance work for a Drainage Improvements Study in the Thornhill area. (See map on back).

Field staff will be examining the drainage infrastructure in the area. Surveyors are required to determine ground elevations and the locations of topographic features within the road right-of-way and about the area of your property as deemed necessary for this study. There may be a need to enter upon your property to take measurements, gather building details and locate property lines, utilities and such. There will be no need to enter your home.

This project continuance is subject to Council Approval as part of the Capital Works Budget. Work will be carried out by either City approved engineering staff or a City approved consultant under the direction of the Engineering Department.

Should you have any questions or suggestions regarding this project, please contact the undersigned at (905) 832-8525, ext. 3111.

Yours truly,

Pat Marcantonio, C.E.T.
Senior Engineering Assistant

PM:mc

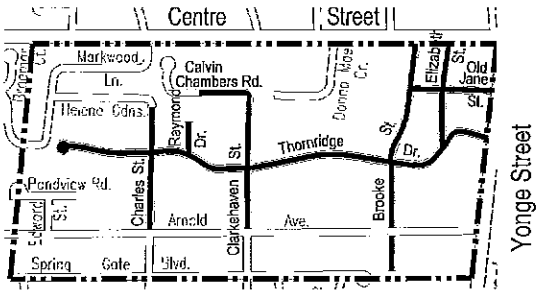
GENIVAR

MacViro
A division of GENIVAR Ontario Inc.

February 12, 2007

«Salutation» «First_Name» «Last_Name»
«Title»
«BranchDivisionDepartment»
«Organization»
«Address_1» «Address_2»
«City», «Prov» «PC»

Re: THORNHILL STORM DRAINAGE IMPROVEMENTS STUDY
CITY OF VAUGHAN
THE REGIONAL MUNICIPALITY OF YORK



Dear «Salutation» «Last_Name»:

The City of Vaughan has initiated a study to investigate and assess the existing drainage infrastructure and to identify drainage system deficiencies in the Thornhill neighborhood, located on the southwest corner of Yonge Street and Centre Street (see map).

The City is following the Municipal Class Environmental Assessment for this study. Attached is the notice of Study Commencement as well as the notice of the first Public Information Centre (PIC).

The first PIC will be held on February 20, 2007, between 7:00 p.m. and 9:00 p.m., at Garnet A. Williams Community Centre (501 Clark Avenue West), Meeting Room #3.

An information package has been prepared and will be available during the PIC to describe the drainage issues, and to solicit input from review agencies and the public to assist in selecting the preferred remedial alternatives during the second phase of the study.

We would appreciate a reply to confirm that your organization is interested in this undertaking and wants to be added to the mailing list and kept informed of project progress. Please confirm that you are the appropriate contact for this matter.

Mr. Alan E. Winter, P. Eng.
MacViro Consultants –
A division of GENIVAR Ontario Inc.
600 Cochrane Drive, Suite 500
Markham, Ontario
L3R 5K3
Tel: (905) 475-7270 (ext. 323)
Fax: (905) 475-5994
Email: awinter@macviro.com

cc: Pat Marcantonio, City of Vaughan

Attachments: Notice of Study Commencement
Notice of Public Information Centre

City of Vaughan
The City Above Toronto

NOTICE OF PUBLIC INFORMATION CENTRE

Thornhill Storm Drainage Improvements Study

The City of Vaughan is carrying out a study to investigate and assess the existing drainage infrastructure and to identify drainage system deficiencies in the Thornhill neighbourhood, located on the southwest corner of Yonge Street and Centre Street. For a detailed map of the study area, please visit www.vaughan.ca, Engineering Department/Projects.

The project is being planned in compliance with Schedule "B" of the Municipal Class Environmental Assessment (June 2000) process. The first Public Information Centre was held on February 20, 2007 to introduce the study and solicit input from the public. At that time, the Study Area was somewhat smaller and focused on the flood susceptible areas.

The causes of the existing drainage problems have been identified and alternative solutions have been examined. A preliminary preferred solution has also been identified. The Study Area boundaries have been amended to include additional areas that may be affected by the implementation of remedial measures. Area residents are invited to attend the second Public Information Centre to provide further input and comments for incorporation into the planning of this project.

An information package will be available during the Public Information Centre to describe the drainage issues, and to solicit input from the public in selecting the final preferred remedial alternative solution. Details are as follows:

Date:	Tuesday, December 11, 2007
Time:	7:00 p.m. to 9:00 p.m.
Location:	Garnet A. Williams Community Centre 501 Clark Avenue West Meeting Room No. 3.

If you are unable to attend this meeting, but would like further information or to provide your input, please contact:

Mr. Alan E. Winter, P. Eng.
GENIVAR Ontario Inc.
600 Cochrane Drive, Suite 500
Markham, Ontario
L3R 5K3
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Gary P. Carroll, P. Eng.
Director of Engineering Services
Email: gary.carroll@vaughan.ca

City of Vaughan
The City Above Toronto

November 21, 2007

INVITATION TO PUBLIC INFORMATION CENTRE NO. 2

Thornhill Storm Drainage Improvements Study

The City of Vaughan is carrying out a study to investigate and assess the existing drainage infrastructure and to identify drainage system deficiencies in the Thornhill neighbourhood, located on the southwest corner of Yonge Street and Centre Street. (See Map on back).

The project is being planned in compliance with Schedule "B" of the Municipal Class Environmental Assessment (June 2000) process. The first Public Information Centre was held on February 20, 2007 to introduce the study and solicit input from the public. At that time, the Study Area was somewhat smaller and focused on the flood susceptible areas.

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If you are unable to attend this meeting, but would like further information or to provide your input, please contact:

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GENIVAR Ontario Inc.
600 Cochrane Drive, Suite 500
Markham, Ontario
L3R 5K3
Tel: (905) 475-7270 (ext. 323)
Fax: (905) 475-5994
Email: alan.winter@genivar.com

Mr. Pat Marcantonio, C.E.T.
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario
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Tel: (905) 832-8525 (ext. 3111)
Fax: (905) 303-2045
Email: pat.marcantonio@vaughan.ca

Gary P. Carroll, P. Eng.
Director of Engineering Services
Email: gary.carroll@vaughan.ca

Ward (5) Sub-Committee

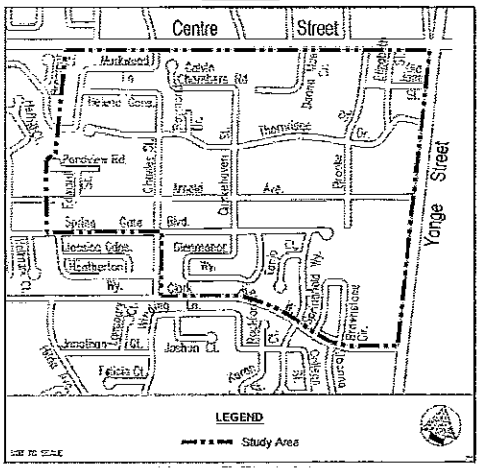
Linda D. Jackson Mayor Ext. 8836	Joyce Frustaglio Regional Councillor Ext. 8341	Mario Ferri Regional Councillor Ext. 8350	Gino Rosati Regional Councillor Ext. 8441	Alan Shefman Local Councillor Ext. 8349

NOTICES MAILED ON - NOV. 26/07

GENIVAR

December 6, 2007

KEY MAP



«Salutation» «First_Name» «Last_Name»
«Title»
«BranchDivisionDepartment»
«Organization»
«Address_1» «Address_2»
«City», «Prov» «PC»

Re: THORNHILL STORM DRAINAGE IMPROVEMENTS STUDY
CITY OF VAUGHAN
THE REGIONAL MUNICIPALITY OF YORK

Dear «Salutation» «Last_Name»:

The City of Vaughan is carrying out a study to investigate and assess the existing drainage infrastructure and to identify drainage system deficiencies in the Thornhill neighbourhood, located on the southwest corner of Yonge Street and Centre Street (see map).

The project is being planned in compliance with Schedule "B" of the Municipal Class Environmental Assessment (June 2000) process. The first Public Information Centre was held on February 20, 2007 to introduce the study and solicit input from the public.

The causes of the existing drainage problems have been identified and alternative solutions have been examined. A preliminary preferred solution has also been identified. The Study Area boundaries have been amended to include additional areas that may be affected by the implementation of remedial measures. Area residents are invited to attend the second Public Information Centre to provide further input and comments.

An information package will be available during the Public Information Centre to describe the drainage issues, and to solicit input from the public in selecting the final preferred remedial alternative solution. Details are as follows:

Date:	Tuesday, December 11, 2007
Time:	7:00 p.m. to 9:00 p.m.
Location:	Garnet A. Williams Community Centre 501 Clark Avenue West – Meeting Room No. 3

If you are unable to attend this meeting, but would like further information or to provide your input, please contact:

Mr. Alan E. Winter, P.Eng.
GENIVAR Ontario Inc.
600 Cochrane Drive, Suite 500
Markham, Ontario L3R 5K3
Tel: (905) 475-7270 (ext. 323)
Fax: (905) 475-5994
Email: alan.winter@genivar.com

Mr. Pat Marcantonio, C.E.T.
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario L6A 1T1
Tel: (905) 832-8525 (ext. 3111)
Fax: (905) 303-2045
Email: pat.marcantonio@vaughan.ca

Att.: Notice of Public Information Centre

Ontario

MINISTRY OF CULTURE
Ministère de la Culture
FACSIMILE COVER PAGE
Formule d'envoi par télécopie

Alan Winter

To/*Destinataire*	*Date* March 8, 2007	Time *Heure*
PLEASE FORWARD TO: **Alan Winter**		Tel No. 905-475-7270 x323
Office MacViro Consultants		Fax No. 905-475-5994
Location Markham		

From/*Expéditeur*

Name *Nom*	Malcolm Horne	Tel No. *N° de tél.* *(416) 314-7146*
Office *Bureau*	Heritage Operations Unit Programs and Services Branch	Fax No. *N° de télécopieur* *(416) 314-7175*
Location *Endroit*	400 University Avenue, 4th Floor Toronto, Ontario, M7A 2R9 *400, rue University, 4e étage* *Toronto (Ontario) M7A 2R9*	No. of pages Plus this page 3 *N° de pages* *- incluant cette page*

Municipal Class Environmental Assessment, Thornhill Storm Drainage Improvements Study, City of Vaughan, MCL File 19WT070

Any questions/problems with this transmission, please contact the sender.
Si vous avez des questions ou des difficultés en ce qui concerne les documents transmis, veuillez communiquer avec l'expéditeur.

Ministère de la Culture

Programs and Services Branch
400 University Avenue
Toronto ON M7A 2R9

Direction des programmes et des services
400, avenue University
Toronto ON M7A 2R9

Ontario

Heritage Operations Unit, 4th Floor
Tel:(416)314-7146 Fax:(416)314-7175
email: malcolm.horne@ontario.ca

March 8, 2007

Alan E. Winter
MacViro Consultants
600 Cochrane Drive, Suite 500
Markham ON L3R 5K3

RE: Municipal Class Environmental Assessment, Thornhill Storm Drainage Improvements Study, City of Vaughan, MCL File 19WT070

Dear Mr. Winter:

A principal concern of this Ministry is the adverse effects that undertakings such as the above mentioned may have on cultural heritage resources. If a preferred alternative is determined to have the potential to have an impact on cultural heritage resources, then this Ministry would recommend that a cultural heritage resource assessment be prepared. If any features of cultural heritage value or interest are identified, then any negative impacts would have to be mitigated by either avoidance or documentation.

Using the available heritage databases and mapping in this office, and based on the information received, it has been determined that this project may have the potential to impact archaeological sites. This determination is based the study area being within the former historic village of Thornhill.

It is recommended that a licensed consultant archaeologist be retained to prepare an assessment of the potential for impacts to archaeological sites and the need for further archaeological assessment of alternatives. This evaluation should inform the selection of alternatives. If the preferred alternative is determined to have the potential for impacts to archaeological sites, then archaeological fieldwork should be undertaken by a licensed consultant archaeologist to identify any archaeological sites and mitigate impacts. The archaeological assesment should include not only the proposed right-of-way and proposed direct construction impacts from this project but also such impacts as detours, access roads, storage and staging areas, and any other areas to be impacted by this project.

No demolition, grading, filling, or any form of soil disturbances, should take place in the areas proposed to be impacted prior to the issuance of a letter from the Ministry of Culture indicating that all concerns for archaeological sites have met licensing and conservation requirements.

Cultural heritage resources include all built heritage and cultural heritage landscape resources or features of historical, architectural, or archaeological interest. The Cultural Heritage Coordinator for

the City of Vaughan should be consulted concerning the historical background of the areas to be impacted and any concerns that they may have for impacts to cultural heritage features.

Please also contact the Heritage Policy and Program Development Unit of this Ministry for advice regarding built heritage and cultural heritage landscape features that may be impacted by this project.

For further purposes related to the archaeological assessment, please contact the undersigned.

Should you wish to discuss this matter further, please do not hesitate to contact me.

Sincerely,

Malcolm Horne
Heritage Planner/Archaeologist

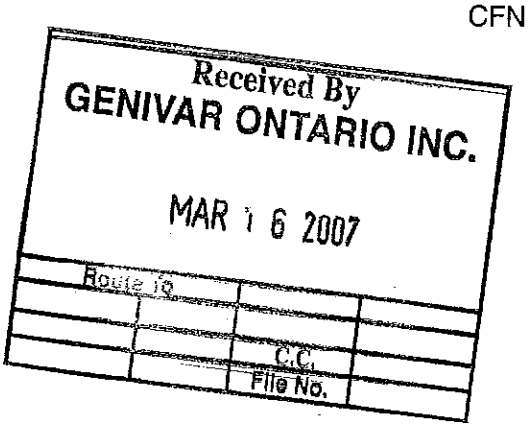
cc. Paul Marcantonio, Senior Engineering Assistant, City of Vaughan
Stephen Robinson, Cultural Heritage Coordinator, City of Vaughan
Tamara Anson-Cartwright, Heritage Policy & Program Development, Ministry of Culture

Salutation	First Name	Last Name	Title	Branch/Division/Department	Organization	Address 1	Address 2	City	Prov	PC
Ms.	Tracy	Smith	District Manager, Aurora District		Ministry of Natural Resources (MNR)	50 Bloomington Road West		Aurora	Ontario	L4G 3G8
Mr.	Keith	West	Director	Central Region	Ministry of the Environment (MOE)	5775 Yonge Street	8th Floor	North York	Ontario	M2M 4J1
Mr.	John	Leach	Clerk	Clerks Department	City of Vaughan	2141 Major Mackenzie Dr.		Vaughan	Ontario	L6A 1T1
Mr.	Malcolm	Horne	Heritage Planner	Heritage and Libraries Branch	Ministry of Citizenship, Culture & Recreation	400 University Avenue	4th Floor	Toronto	Ontario	M7A 2R9
Mr.	Paul	May	Director	Infrastructure Planning	Regional Municipality of York	17250 Yonge Street		Newmarket	Ontario	L3Y 6Z1
Mr.	Jeremy	Collinson			Ontario Heritage Foundation	10 Adelaide Street East		Toronto	Ontario	M5C 1J3
Ms.	Sara	Fayle	Assistant Curator		York Region District School Board	2 Valleywood Drive		Markham	Ontario	L3R 8H3
Mr.	Peter	Oliver			German Mills Ratepayers Association	14 German Mills Road		Thornhill	Ontario	L3T 4H5
Ms.	Laura	James	Planner II - Environmental Assessment Review	Planning and Development	Toronto and Region Conservation Authority	5 Shoreham Drive		Downsview	Ontario	M3N 1S4
Ms.	Sharmila	Krishna-Kumar		Municipal Operations Centre	c/o Plantec Consulting Engineers	200 Town Centre Blvd.	Suite 300	Markham	Ontario	L3R 8G5
Mr.	Joe	Marozzo	Mark-up Coordinator		Enbridge Gas	500 Consumers Rd.	4th Floor	North York	Ontario	M2J 1P8
Mr.	Gord	Barclay	Service Provisioning Manager		FCI Broadband	280 Hillmount Rd.	Unit 9	Markham	Ontario	L6C 3A1
Mr.	Lorne	McHoul	CAD Technician	Records Department	Power Stream Inc.	8100 Warden Ave.	Box 4100	Markham	Ontario	L3R 8H7
Mr.	Doug	Washburn	Planning Team Member		Rogers Cable	244 Newkirk Rd.		Richmond Hill	Ontario	L4C 3S5

TORONTO AND REGION Conservation
for The Living City

March 12, 2007

CFN 38913



VIA MAIL & EMAIL (awinter@macviro.com)

Mr. Alan Winter
MacViro Consultants
600 Cochrane Drive, Suite 500
Markham, ON
L3R 5K3

Dear Mr. Winter:

Re: Response to Notice of Commencement and Public Information Centre
Thornhill Storm Drainage Improvements Study
Municipal Class Environmental Assessment (EA) - Schedule B
Don River Watershed; City of Vaughan; Regional Municipality of York

Toronto and Region Conservation Authority (TRCA) staff received the Notice of Commencement and Pubic Information Centre for the above-noted Environmental Assessment (EA) application on February 15, 2007. It is the understanding of TRCA staff that this undertaking will involve the assessment of existing drainage infrastructure conditions, identification of the drainage system deficiencies, evaluation of alternative solutions, and preparation of a stormwater management plan. While staff is unable to attend the Public Information Centre, please forward one copy of any handouts or display materials from this meeting for our files.

Developing the EA

Staff conducted a review of the background mapping and has identified environmental concerns within the study area. These environmental concerns should be identified in the EA document in both the text and on an overlay map, as appropriate. Digital versions of the mapping and available TRCA data will follow under separate cover.

Site and building design should avoid impacts and support sustainable solutions as related to the natural, socio-economic and cultural environment. TRCA staff's environmental concerns in this undertaking are:

Natural Environment

- Regulation Limit
- Terrestrial Natural Heritage System (draft)

For your reference, we are providing *Appendix 1: TRCA Environmental Concerns and EA Document Requirements* and *Appendix 2: Preliminary Technical Study Requirements*.

This information should be used in developing the alternatives. Staff will confirm if additional studies are required as the EA progresses.

Selecting the Preferred Alternative

TRCA staff requires that the preferred alternative meets the following criteria:

Criteria 1: prevents the risk associated with flooding, erosion or slope instability;
Criteria 2: protects and rehabilitates existing landforms, features and functions;
Criteria 3: provides for aquatic, terrestrial, human access;
Criteria 4: minimizes water/energy consumption and pollution; and,
Criteria 5: addresses TRCA property and archaeology concerns.

Please book a meeting through the TRCA Project Manager prior to selecting the preferred alternative solution and design. At the meeting, TRCA staff will discuss issues related to our environmental concerns, as outlined in Appendices 1 and 2.

TRCA Project Management Details

1. The TRCA Project Manager for your file is Laura James, Planner II, Environmental Assessments, and can be reached at 416-661-6600, extension 5723 or by email at ljames@trca.on.ca.

2. To assist our review of the undertaking, please quote Central File Number (CFN) 38913 on any correspondence, or with any telephone or e-mail inquiries.

3. Please include Laura James on the mailing list and ensure that this Project Manager receives the following:

   A. A response to this letter that identifies how TRCA's environmental concerns will be addressed in the EA document

   B. Notice(s) of Public Information Centres (PICs) and handouts

   C. 4 copies of the double-sided Phase 1 and 2 Report identifying problems and alternative solutions

   D. Copies of the Phase 3 Report as per the attached Service Delivery Standards

      i) Four (4) copies of the draft EA document 15 days prior to filing if the Phase 1, 2 and 3 Reports **have been submitted** previously, or;

      ii) Five (5) copies of the draft EA document 30 days prior to filing if the Phase 1, 2 and 3 Reports **have not been submitted** previously.

E. Notice of Study Completion

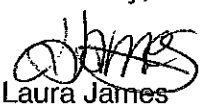
F. One (1) hard copy of the final EA document

G. One (1) digital copy of the final EA document and appendices in .pdf form

5. Please include TRCA's Don River Watershed Specialist, Adele Freeman on the undertaking's mailing list and ensure that she receives all notices of Public Information Centres (PICs). Adele's information should be sent to TRCA's Head Office at 5 Shoreham Drive, Downsview, M3N 1S4.

Should you have any questions or require any additional information please contact me at 416-661-6600 extension 5723 or by email at ljames@trca.on.ca.

Yours truly,



Laura James
Planner II, Environmental Assessment Review
Planning and Development

/DR

Encl.
1. Appendix 1 - TRCA Environmental Concerns and EA Document Requirements
2. Appendix 2 - TRCA Preliminary Technical Study Requirements

SENT VIA EMAIL ONLY

cc: Pat Marcantonio, Senior Engineering Assistant, The City of Vaughan (pat.marcantonio@vaughan.ca)
Adele Freeman, TRCA, Director, Watershed Management
Beth Williston, TRCA, Manager, Environmental Assessment Review
Bill Kiru, TRCA, Manager, Planning and Development Regulation

APPENDIX 1 - TRCA ENVIRONMENTAL CONCERNS AND EA DOCUMENT REQUIREMENTS

Environmental Concerns	TRCA Programs, Policies and Guidelines	EA Document Requirements
NATURAL ENVIRONMENT		
Regulation Limit	TRCA's *Valley and Stream Corridor Management Program (VSCMP),* Section 4.3 - Infrastructure and Servicing should be followed There are Regulation Limits within the study area. In accordance with Ontario Regulation 166/06 (Development, Interference with Wetlands and Alterations to Shorelines and Watercourses), a permit is required from the TRCA prior to any of the following works taking place: a) straightening, changing, diverting or interfering in any way with the existing channel of a river, creek, stream or watercourse, or for changing or interfering in any way with a wetland; b) development, if in the opinion of the authority, the control of flooding, erosion, dynamic beaches or pollution or the conservation of land may be affected by the development. Development is defined as: i) the construction, reconstruction, erection or placing of a building or structure of any kind, ii) any change to a building or structure that would have the effect of altering the use or potential use of the building or structure, increasing the size of the building or structure or increasing the number of dwelling units in the building or structure, iii) site grading, iv) the temporary or permanent placing, dumping or removal of any material, originating on the site or elsewhere.	1. Indicate in the text and mapping what areas are within the Regulation Limits 2. Discuss in detail how the alternative design will reflect the relevant portions of the VSCMP in order that impacts to the regulated areas and areas of concern will be minimized 3. Note which portions of the project will potentially require permits for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses through TRCA 4. Include a copy of the Regulation Limits in the EA Appendices and reference the information in the text of the EA Document.
Terrestrial Natural Heritage System (draft)	The study area is located within the draft Terrestrial Natural Heritage System. TRCA has prepared a draft Terrestrial Natural Heritage System Strategy (TNHSS) for TRCA's jurisdiction. This system recognizes the need to improve both the quantity and quality of the terrestrial habitats. A model has been used to delineate an improved or "targeted" system to meet these objectives as outlined on the maps included in the draft TNHSS. A copy of our draft Terrestrial Natural Heritage Strategy (TNHS) can be obtained from our website www.trca.on.ca\land_protection\terrestrial\default.asp?load=approach. TRCA's *Valley and Stream Corridor Management Program (VSCMP),* Section 4.3 - Infrastructure and Servicing Items 14, 16 and 19 should be followed.	3. Indicate in the text and mapping what portions of the study area are within the TNHS. 4. Please provide a discussion in detail how the EA document undertaking will conform to the requirements of TRCA's Valley and Stream Corridor Management Program (VSCMP) and TNHSS. 5. If applicable, please include a statement in the EA document on the Migratory Bird Convention Act, which is enforced by Environment Canada. Under this legislation tree cutting should not occur during the nesting phase of on-site migratory birds. 6. If applicable please include a statement in the EA document on the Species at Risk Act (SARA). The purpose of this legislation is to prevent wildlife species from being extirpated or extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened, as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened.

APPENDIX 2

Preliminary Technical Study Requirements

TRCA requires that the preferred alternative meet the following criteria:

Criteria 1: Prevent risk associated with flooding, erosion or slope instability;
Criteria 2: Protect and rehabilitate existing landforms and features and functions;
Criteria 3: Provide for aquatic, terrestrial and human access; and,
Criteria 4: Minimize water and energy consumption
Criteria 5: Minimize water and air pollution and thermal variation

In relation to this project, the following studies may be required, as a minimum. Staff will confirm additional study requirements as the EA progresses, if additional issues or impacts are identified.

Type of Study or Report	Guidelines Available Yes/No
Hydraulic and hydrologic studies to delineate floodlines and flow rates, including detailed topographic mapping and modelling	Yes
Fluvial Geomorphology Studies ☐ 100-year toe erosion limit for slope stability ☐ Meander belt and erosion limit delineation studies ☐ Watercourse characterization study	Yes
Geotechnical studies ☐ slope stability (valley and shoreline) ☐ construction feasibility (tunnelling, footings etc.)	Yes
Hydrogeological studies ☐ report for determining dewatering requirements for watercourse crossings, or impacts on watercourses and natural features ☐ groundwater upwellings ☐ Geotechnical report for determining groundwater potential (upwelling and dewatering needs), including slug tests ☐ Local aquifer conditions study to be confirmed through step and pump tests ☐ Predicted zone of influence map using measured coefficients ☐ Hydrogeologic study which includes surficial geology; identification of shallow, deep and perched aquifers; cross-sectional drawings of identified aquifer/aquitard systems, assessment of hydrogeologic coefficients, especially hydraulic conductivity (K) based on slug pump tests or aquifer pumping tests	Yes
Legal survey of field verified natural features, including top-of- bank (staked with TRCA)	No
Stormwater management study including water quality (including temperature), quantity, stream bank erosion and water budget.	Yes MOE SWM and Planning Design Manual
Channel Crossings Assessment including terrestrial passage trails, fish	No
Natural Heritage Study, including ☐ inventory and mapping of landforms, aquatic and terrestrial resources including areas that are part of the TRCA TNHS ☐ baseline conditions report within all natural features and functions within the hydrogeological zone of influence ☐ mitigation, compensation and monitoring strategies for impacted terrestrial and aquatic resources ☐ assessment and identification of linkages and barriers for aquatic and terrestrial resources	No
Atmospheric Deposition Study	No
Assessment and identification of local, regional and national trail systems	Yes

Type of Study or Report	Guidelines Available
	Yes/No
Assessment and identification of archaeological and built heritage resources	No
Assessment of TRCA property/programming interests	No
Erosion and sediment control assessment	Yes
Sustainability assessment ☐ that emphasizes site development, water savings, energy efficiency, materials selection, waste management and indoor environmental quality, as defined by the Canada Green Building Council.	Yes
Other _____	

Enbridge Gas Distribution Inc.
500 Consumers Rd.
North York, ON, M2J 1P8
Canada
www.enbridge.com/gas

Jamie Delaney
Tel 416-495-6321
Fax 416-758-4374
jamie.delaney@enbridge.com
mark-ups@enbridge.com

ENBRIDGE

EGD File Number: 46526

To Whom It May Concern,

Re: STORM DRAINAGE IMPROVEMENT STUDY AT SW CORNER OF YONGE & CENTRE ST

Please find attached a copy of your drawing(s) on which we have marked our existing/proposed underground plant and have made the following determinations:

☒ **GENERAL LOCATION**

- Please refer to the attached drawings for information on our existing or proposed gas plant. The information provided is for **GENERAL LOCATION ONLY.** You must re-submit your detailed drawings for sign off by Enbridge Gas Distribution.

☐ **NO-CONFLICT**

- We have **NO OBJECTION** to your proposed plant as indicated. Please refer to the attached drawings for information on our existing or proposed gas plant. GAS MAINS MUST BE FIELD LOCATED. Before digging, please call ONTARIO ONE CALL. 48 hours in advance at 1-800-400-2255 for free gas locates service.
- See **"Third Party Requirements"** booklet for definitions, requirements & contact information.
- Test Holes are required to determine actual depth where infrastructure crosses gas plant.

☐ **CONFLICT**

- We have an **OBJECTION** to your proposed plant as indicated. Please refer to the attached drawings for information on our existing or proposed gas plant. Review your proposal and make changes to your plant to satisfy these requirements.
- See **"Third Party Requirements"** booklet for definitions, requirements & contact information.
- If relocation of our plant is required, contact Manager of Special Projects:
  - ☐ Central Region: Carmelo Tancioco 416-758-7956
  - ☐ Eastern Region: Ian Taylor 613-742-4637
  - ☐ Niagara Region: Martin Goddard 905-641-4815

☐ **NEB PERMIT REQUIRED**

- An application form needs to be filed when crossing or working within 30 m of the right-off-way of the NEB regulated natural gas pipeline.
- Find enclosed booklet containing information and permit application form.
- If you want to discuss NEB permit process contact the Enbridge Gas Distribution Land Dept.:
  Chuck Reaney: 416-753-6929

☐ **VITAL MAIN**

- You are working within 3 m of a Vital Main Pipeline. A representative of the company must be contacted three (3) days prior to commencement of work. A member of our field force must be present while excavation of the main takes place and prior to backfilling. Alternatively please contact the Enbridge Gas Distribution Damage Prevention Dept: 1(866) 922-3622.
- See **"Third Party Requirements"** booklet for definitions, requirements & contact information.

For Enbridge Internal Use:

☐ **PILING & SHORING - SPECIAL PROJECTS REVIEW REQUIRED**

☐ **EXCAVATION, REPAVING OR GRADING - SPECIAL PROJECTS REVIEW REQUIRED**

Yours,

Jamie Delaney

February 28, 2007

City of Vaughan

The City Above Toronto

City of Vaughan
Thornhill Storm Drainage Improvements Study

Public Information Centre No. 1

February 20, 2007

MacViro

A division of GENIVAR Ontario Inc.

Welcome

Today is an opportunity for you to hear about and offer input on the Thornhill Storm Drainage Improvements Study that is currently being conducted by the City of Vaughan.
This Public Open House Notebook will help you to navigate the evening's activities. This notebook contains:

- The agenda
- Key contacts
- Questionnaire
- A brief evaluation form

What are we going to do?
Our goals for this evening are:

- Present the background and need for the study
- Describe the Class EA process
- Describe the work done to date on the project
- To hear and document various perspectives from all participating stakeholders

Input that is received tonight will be carefully considered during the project as we will develop a recommended course of action for consideration by City Council.

Why is this important?
The recommendations of this study will affect property owners including residents, organizations and institutions within the study area. Our hope is to work with the community to build an understanding of the drainage issues. The solutions ultimately suggested from this study should enjoy broad public support. This meeting is the critical beginning to this important dialogue.

A final comment …
Each participant brings valuable opinions, experiences and suggestions. You are not expected to be an expert on drainage or municipal infrastructure. The project team will guide the discussions. We are interested in your perspective. We would like to hear from everyone. We hope this notebook will help you to participate fully today.

Project Team

City of Vaughan

Mr. Pat Marcantonio, C.E.T.
Senior Engineering Assistant

Mr. Thomas Ungar, P. Eng.
Manager, Design Services

Mr. Gary P. Carroll, M. Eng., P. Eng.
Director of Engineering Services

Engineering Consulting Firm:

Mr. Alan E. Winter, P.Eng.
MacViro Consultants – A Division of GENIVAR Ontario Inc.

Agenda for February 20, 2007

City of Vaughan Thornhill Storm Drainage Improvements Study
Public Information Centre #1, February 20, 2007
Garnet A. Williams Community Centre, Meeting Room #3
501 Clark Avenue West

7:00-7:30 pm	Open House
7:30-8:15 pm	Formal Presentation by Consultant Team
8:15-9:00 pm	Individual Discussion

Thank you for your time and input!

Please take time to fill in a meeting evaluation so we know what you like and where we can improve for next time.

Project Background ...

Why?

A number of residents of the Brooke Street areas have been experiencing periodic flooding of their properties due to storm water runoff. A significant major flooding occurred on August 19, 2005. The residents requested the City of Vaughan to review the drainage problem.

Decision-Making Criteria:

The study will examine various alternatives for solving the flooding problems within the study limits. A number of criteria will be used to select a preferred solution to recommend to City Council:

- Maximize the benefit-to-cost ratio.
- Consider initial capital costs as well as long-term operational and maintenance costs. The solution needs to be affordable and sustainable.
- Minimize environmental impacts.

Who is being consulted?

The public (including businesses, residents, homeowners, local schools and churches) are being consulted through two public information centres (PICs). The first PIC summarizes initial findings of the project. The second PIC will present the study recommendations.

Next Steps ...

If you have any questions, comments or outstanding concerns as we move forward, please contact:

City of Vaughan
Mr. Pat Marcantonio, CET
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario
L6A 1T1
Phone: (905) 832-8525 Ext. 3111
Fax: (905) 303-2045
Email: pat.marcantonio@vaughan.ca

Mr. Gary P. Carroll, M. Eng., P. Eng.
Director of Engineering Services
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario
L6A 1T1
Phone:(905) 832-8525 Ext. 3101
Fax: (905) 303-2045
Email: gary.carroll@vaughan.ca

Engineering Consulting Firm
Mr. Alan E. Winter, P.Eng.
MacViro Consultants
A Division of GENIVAR Ontario Inc.
600 Cochrane Drive, Suite 500
Markham, Ontario
L3R 5K3
Phone: (905) 475-7270 Ext. 323
Fax: (905) 475-5994
Email: awinter@macviro.com

Any additional comments should be forwarded by March 2, 2007. Comments received will be compiled and summarized in the project documentation. Copies of the presentation and posterboards from tonight's meeting will soon be available on the City's website at: http://www.city.vaughan.on.ca.

Thank you for your participation today! We hope that you will continue to contribute as this project progresses and we look forward to seeing you again at Public Information Centre No. 2.

Questionnaire

Please return this questionnaire to a project team member before you leave, or you can mail it in later if you prefer …

Please provide your name and/or street address

Name	
Street Address	
Phone Number	
Email	

Please note that with the exception of personal information, all comments will become part of the public record.

Question #1 – Why are you attending this meeting?

Interested Resident ☐ Land Owner ☐

Other ☐

(Please Specify) _____

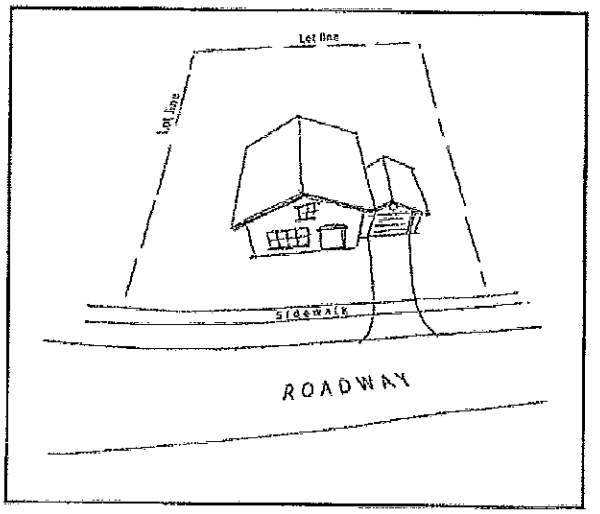
_____

_____

Question #2 – your experience …

We are hoping to get information from property owners regarding flooding impacts. In your experience, what was the impact on your property?
Was there flooding on your property?
Was there any damage to your house or other buildings?
Was there any damage to building contents? If so, how did water enter the building?
If flooding was limited to outdoor areas (back yard or front yard), where did the flow come from? Where did it go?

You can use this diagram to indicate conditions on your property and the road in front of your house.



Question #3 – Do you have any concerns regarding the quantity of water in a specific drainage course?

Yes ☐ No ☐

Which drainage course? _____

_____

What are your concerns? Flooding ☐ Erosion ☐ Other ☐

Please describe them: _____

_____

Question #4 – Is there any additional information that the project team should be considering in the development of the Thornhill Storm Drainage Improvements Study?

Question #5 – Other Comments …

Do you have any other comments? Do you need any additional information to assist you to participate in this process?

Question #6 – Do you wish to be added to the mailing list for this study?

Name: _____

Address: _____

Postal Code: _____

Telephone: _____ Fax: _____

Please fill out and leave at registration desk or send, before March 2, 2007 to:

City of Vaughan
Mr. Pat Marcantonio, CET
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario
L6A 1T1
Phone: (905) 832-8525 Ext. 3111
Fax: (905) 303-2045
Email: pat.marcantonio@vaughan.ca

Engineering Consulting Firm
Mr. Alan E. Winter, P.Eng.
MacViro Consultants
A Division of GENIVAR Ontario Inc.
600 Cochrane Drive, Suite 500
Markham, Ontario
L3R 5K3
Phone: (905) 475-7270 Ext. 323
Fax: (905) 475-5994
Email: awinter@macviro.com

Evaluation Form

(Please return this form to a project team member)

Today's event was the first of two public information centres for the Thornhill Storm Drainage Improvement Study. We would appreciate any comments you have that could help to improve this meeting to help ensure productive public dialogue.

What did you like most about today?

What should we improve?

Do you have other ideas about this process?

Thank you for your thoughts!

Vaughan
The City Above Toronto

MacViro

THORNHILL STORM DRAINAGE IMPROVEMENT STUDY

Municipal Class Environmental Assessment

WELCOME TO THE PUBLIC INFORMATION CENTRE #1

FEBRUARY 20TH, 2007

Agenda

7:00 – 7:30 PM	Open House	Overview of the Study purpose, objectives, background info, Class EA process and work completed to date.
7:30 – 8:15 PM	Formal Presentation by Consultant Team	Overview of the Study purpose, objectives, background info, Class EA process and work completed to date.
8:15 – 9:00 PM	Open Forum and Individual Discussion	Please circulate around the room, view the displays and speak to City staff & members of Consultant Team.

Vaughan
The City Above Toronto

We Need Your Input

MacViro

The purpose of this Public Information Center is to:

- Introduce you to the study team
- Outline how the study is being carried out

We need your input on:

- Flooding problems in your area
- Drainage and/or environmental issues within the study area

Please…

- Review the display panels and listen to the presentation

Thank you!

Presentation Overview

- PROBLEM STATEMENT
- STUDY OBJECTIVES
- CLASS ENVIRONMENTAL ASSESSMENT PROCESS
- BACKGROUND
- TASKS COMPLETED TO DATE
- PROBLEM AREAS
- NEXT STEPS
- QUESTIONS

Study Area


N
Centre Street
Markwood Ln.
Calvin Chambers Rd.
Donna Mae Cr.
Elizabeth St.
Old Jane St.
Yonge Street
Helena Gdns.
Raymond Dr.
Thornridge Dr.
Pondview Rd.
Charles St.
Clarkehaven St.
Brooke St.
Edward St.
Arnold Ave.
Spring Gate Blvd.
Study Limits
Subject Roads (planned for future works)

Problem Statement

Recurring Surface Flooding and Road Overtopping within the Study Area during Heavy Storm Conditions.

City of Vaughan plans to reconstruct some of the local roads and needs a drainage and stormwater management plan to enable road reconstruction.

Study Objectives

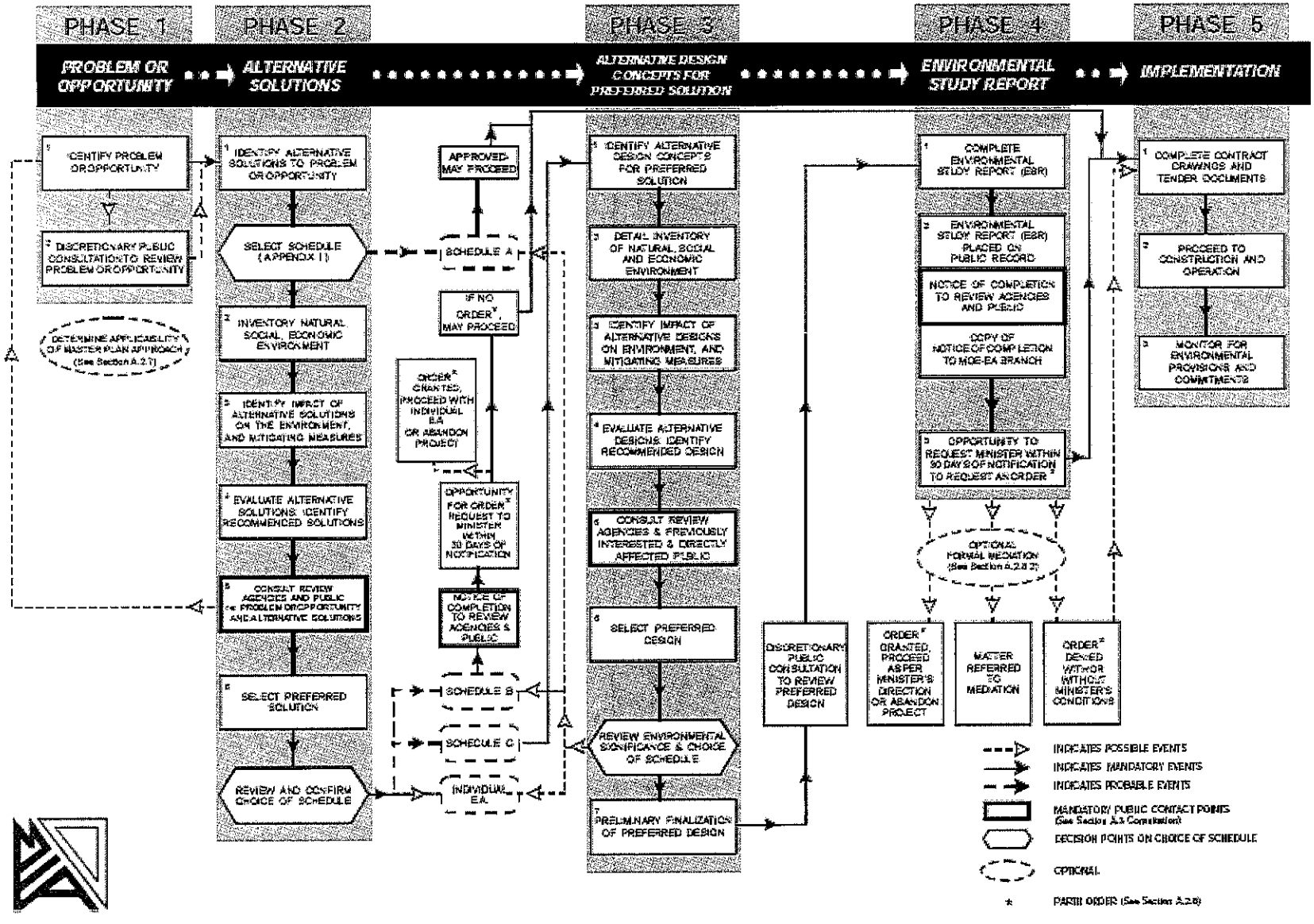
The primary objectives of the Study are to:

- **Identify historical and potential surface flooding and road overtopping problems**
- **Assess adequacy of existing drainage system**
- **Determine causes of surface flooding and road overtopping**
- **Evaluate alternatives and develop a Stormwater Management Plan**

Overview – Class Environmental Assessment Process

- The *Municipal Class EA process* enables the planning of municipal infrastructure projects in accordance with a proven procedure for the protection of the environment.
- The Study is being undertaken in accordance with the planning and design process for a Schedule 'B' project (see flow chart).
- The Schedule 'B' Class EA process includes public and review agency consultation, an evaluation of alternatives, an assessment of the effects on the environment and identification of reasonable measures to mitigate any adverse effects.

Municipal Class EA Planning & Design Process



Drainage Pattern

There are 3 main drainage courses within the study area:

➢ ***Drainage Course #1:*** Serves the north portion of the study area.

- starts at stormwater management pond at westerly end of Thornridge Dr.
- flows easterly, then northerly through private property and conveyed under City roads through culverts
- flows through culvert under Centre Street just east of Oakbank Rd, then flows easterly within north side Centre St road ditch
- crosses under Centre St and flows easterly through private property to an existing underground box culvert near Old Jane St and Yonge St.

Drainage Pattern

➢ ***Drainage Course #2:*** **Serves south west and middle portions of study area.**

- **starts from south side Arnold Ave road ditch and crosses through culvert to north side road ditch (west of Charles St) then flows easterly within north side road ditch**
- **easterly through private property, conveyed under City roads through culverts, then flows south east through private property towards Brooke St north of Arnold Ave.**
- **ditch inlet catch basin located on west side of Brooke St partially captures flow and conveys it in a large trunk storm sewer under Brooke St.**
- **major storm flows overtop Brooke St and flood area east of Brooke St.**
- **overland flows eventually drain to a storm sewer that crosses Yonge St.**

Drainage Pattern

Drainage Course #3: **Serves the south portion of the study area.**

- **starts from south side road ditch of Arnold Ave. near Charles St.**
- **flows easterly within south side ditch of Arnold Ave.**
- **ditch inlet catch basins located at south west corner of Brooke St and Arnold Ave. intersection receives ditch flow and discharges to trunk sewer under Brooke St.**

Tasks Completed To Date

The following tasks have been completed:

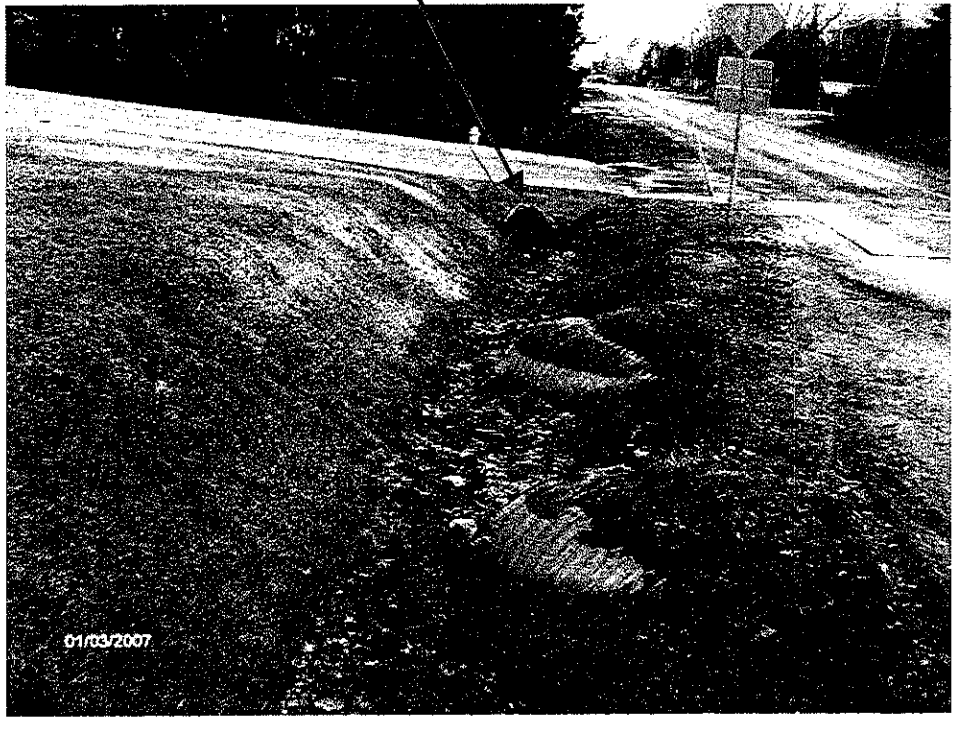
- Notice of Study Commencement
- Background information collected and reviewed
- Preliminary field investigations
- Preliminary hydrologic analysis to calculate flows at key locations for various design storm events
- Preliminary hydraulic analysis to assess adequacy of key drainage elements
- Identified "Problem Areas "

Drainage Course #1:

No drainage deficiencies were identified along Drainage Course #1.

Drainage Course #2:

Problem Area 1: **Existing driveway culvert at 132 Arnold Street is undersized (600mm CSP).**



Problem Areas

Drainage Course #2 (cont.):

Problem Area 2: **Ditch inlet and storm sewer connection in front of 36 Brooke St have inadequate capacity to capture and convey major storm events.**

Drainage Course #2 (cont.):

Problem Area 3: **discontinuous overland flow route downstream from Brooke St.**

Problem Area 4: **discontinuous overland flow route between 23 and 27 Thornridge Dr.**

Drainage Course #2 (cont.):

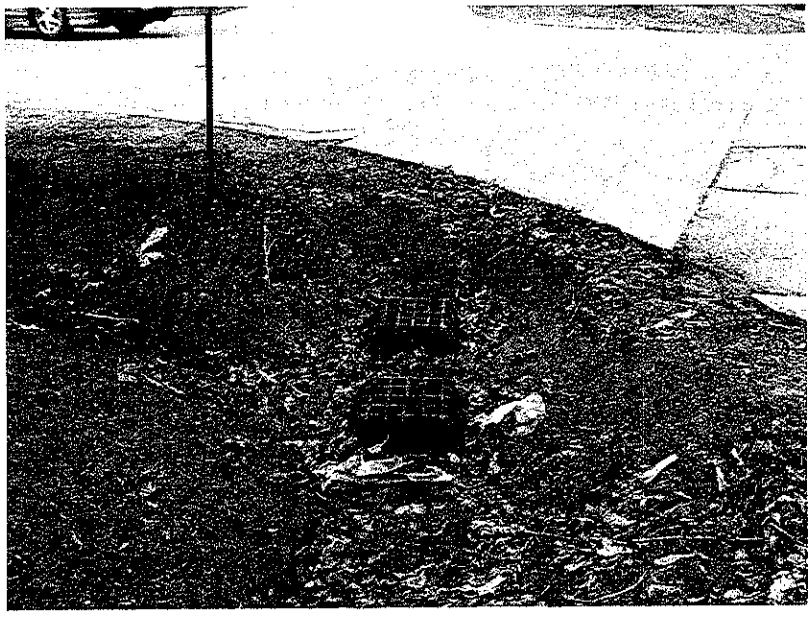
Problem Area 5: **Existing culvert (450mm CSP) at the north side of Elizabeth St. and Thornridge Dr. intersection in poor condition and completely deformed.**

Drainage Course #2 (cont.):

Problem Area 6: **Existing culvert crossing Thornridge Dr. in poor condition and restricts flow. Entrance culvert just downstream of crossing culvert is undersized (300mm CSP).**

Drainage Course #3:

Problem Area 7: **Existing ditch inlet catch basins and storm sewer connection to the trunk storm sewer do not have adequate capacity to convey major storm events (SW corner of Brooke St. and Arnold Ave.)**



Problem Areas

In addition to these problem areas, there are a number of other drainage deficiencies in the study area generally related to ditch inlets and culverts that are either silted or clogged with leaves and debris. Some localized sections of road side ditches have inadequate capacity.

Next Steps – To Study Completion

- Develop alternatives to address flooding problems
- Evaluate alternatives and select preferred
- Prepare conceptual design and implementation plan.
- Receive input from public and agencies and continue consultation process with:
  - Public through second PIC meeting.
  - Review Agencies (TRCA, MOE, MNR, DFO,… etc.).

Public Participation

Your Input is Valued and Needed

We encourage you to provide us with your comments and suggestions

Please complete and return the attached Questionnaire and Evaluation Form.

Please inform us of any information you may have that would benefit our Study. Submit your comments to us at any time throughout the Study (phone, fax, e-mail).

For additional information, please contact:

Mr. Pat Marcantonio, CET
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario L6A 1T1

Phone: (905) 832-8525 Ext. 3111
Fax: (905) 303-2045
Email: pat.marcantonio@vaughan.ca

Mr. Gary P. Carroll, M. Eng., P. Eng.
Director of Engineering Services
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario L6A 1T1

Phone: (905) 832-8525 Ext. 3101
Fax: (905) 303-2045
Email: gary.carroll@vaughan.ca

THANK YOU

Questionnaire

Please return this questionnaire to a project team member before you leave, or you can mail it in later if you prefer ...

Please provide your name and/or street address

Name	
Street Address	
Phone Number	
Email	

Please note that with the exception of personal information, all comments will become part of the public record.

Question #1 – Why are you attending this meeting?

Interested Resident ☐ Land Owner ☑

Other ☐

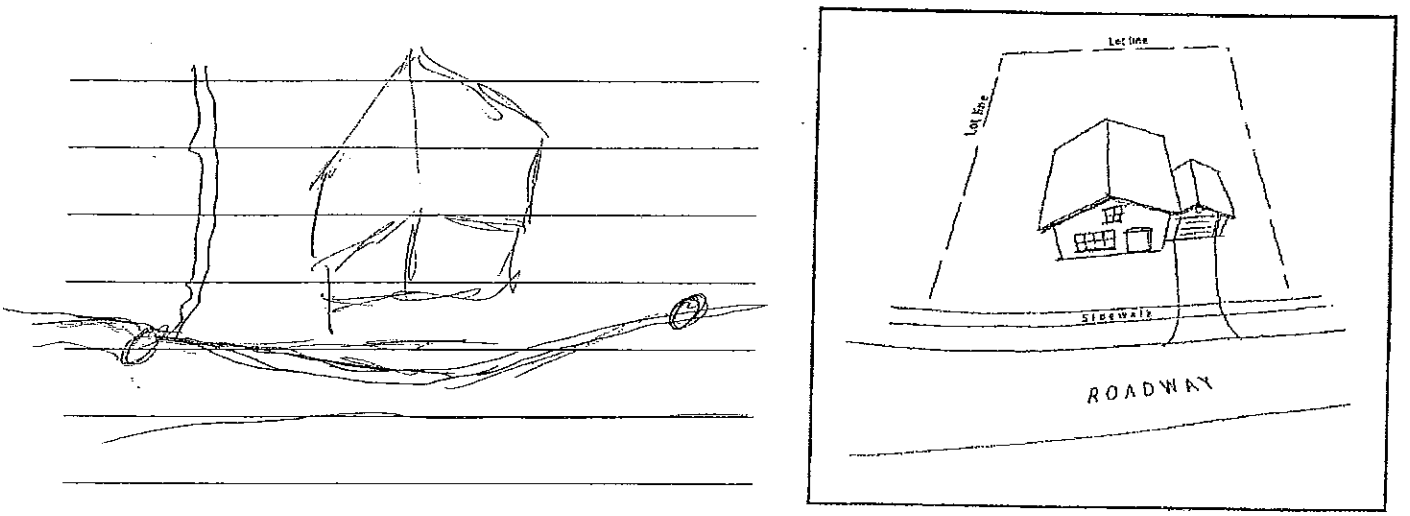
(Please Specify)

DRAINAGE PROBLEM

Question #2 – your experience ...

We are hoping to get information from property owners regarding flooding impacts. In your experience, what was the impact on your property?
Was there flooding on your property? YES
Was there any damage to your house or other buildings? YES
Was there any damage to building contents? If so, how did water enter the building? YES
If flooding was limited to outdoor areas (back yard or front yard), where did the flow come from? Where did it go? BASEMENT

You can use this diagram to indicate conditions on your property and the road in front of your house.



Question #3 – Do you have any concerns regarding the quantity of water in a specific drainage course?

Yes ☑ No ☐

Which drainage course?

What are your concerns? Flooding ☑ Erosion ☐ Other ☐

Please describe them:

Question #4 – Is there any additional information that the project team should be considering in the development of the Thornhill Storm Drainage Improvements Study?

CLEAN DRAINAGE, SEWERS

Question #5 – Other Comments …

Do you have any other comments? Do you need any additional information to assist you to participate in this process?

Question #6 – Do you wish to be added to the mailing list for this study?

Name: _____

Address: _____

Postal Code: _____

Telephone: _____ Fax: _____

Please fill out and leave at registration desk or send, before March 2, 2007 to:

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Question #1 – Why are you attending this meeting?

Interested Resident ☑ Land Owner ☑

Other ☐

(Please Specify) _____

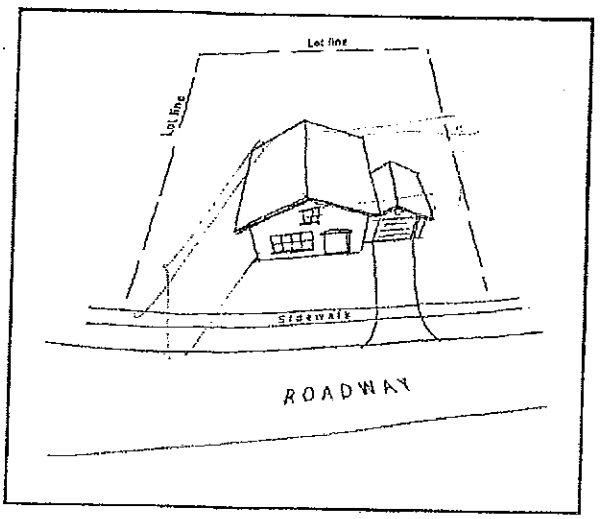
Question #2 – your experience ...

We are hoping to get information from property owners regarding flooding impacts. In your experience, what was the impact on your property?

- Was there flooding on your property?
- Was there any damage to your house or other buildings?
- Was there any damage to building contents? If so, how did water enter the building?

If flooding was limited to outdoor areas (back yard or front yard), where did the flow come from? Where did it go?

You can use this diagram to indicate conditions on your property and the road in front of your house.



Question #3 – Do you have any concerns regarding the quantity of water in a specific drainage course?

Yes ☑ No ☐

Which drainage course? Both front & back

What are your concerns? Flooding ☑ Erosion ☐ Other ☐

Please describe them:

Question #4 – Is there any additional information that the project team should be considering in the development of the Thornhill Storm Drainage Improvements Study?

Private property easement not consistant in all backyards / sideyards causing water flow problems & flooding

Question #5 – Other Comments …

Do you have any other comments? Do you need any additional information to assist you to participate in this process?

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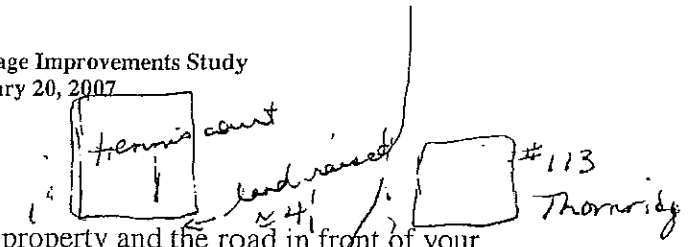
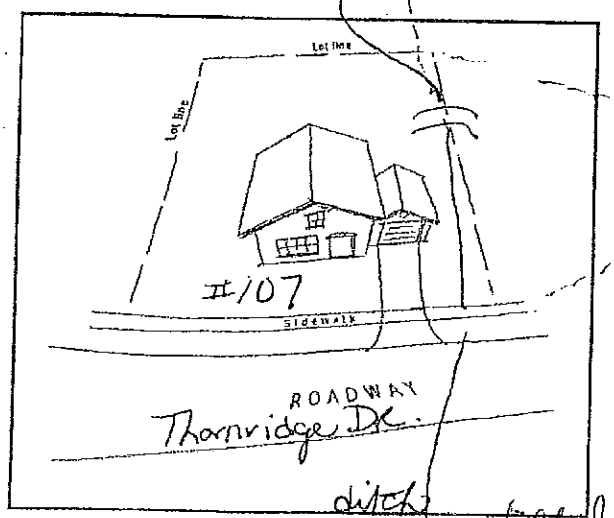


You can use this diagram to indicate conditions on your property and the road in front of your house.



#98

- ditch filled in by owner when home rebuilt - water sits at edge of roadway - drainage from prior ditches ~~culverts~~ is absent

Question #3 – Do you have any concerns regarding the quantity of water in a specific drainage course?

Yes ☑ No ☐

Which drainage course? Creek running from south to north through our property over time the creek seems to have filled w sediment + does not hold the same volume of water - I clean the creek every spring + often fall to facilitate water flow - we feel the creek needs to be redug to make it wider + deeper

What are your concerns? Flooding ☑ Erosion ☑ Other ☑

Please describe them: -as above-

#113 moved the creek further east when they rebuilt + we are experiencing land erosion

#113 also raised their land at the east end of their lot and built a retaining wall. Wherever it rains our property receives all the run off from their tennis court - They did not

#98 - no culverts - west side risk

Question #4 – Is there any additional information that the project team should be considering in the development of the Thornhill Storm Drainage Improvements Study?

Question #5 – Other Comments …

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Questionnaire

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Please provide your name and/or street address

Name	
Street Address	
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Question #1 – Why are you attending this meeting?

Interested Resident [X] Land Owner [ ]

Other [ ]

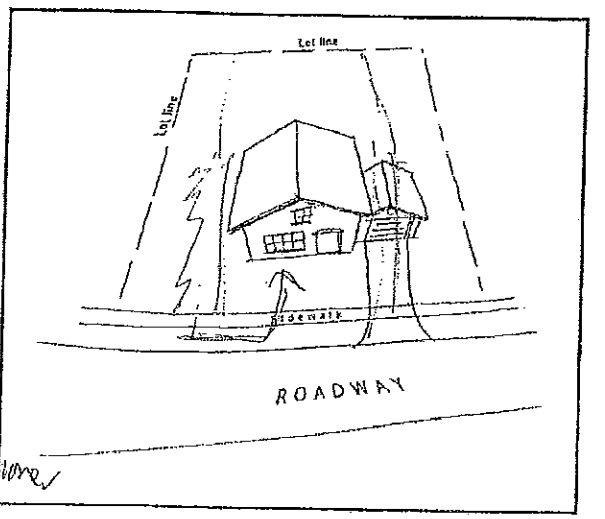
(Please Specify) GOT FLOODED IN 1986 WAS ON CHANEL 7 NEWS, and on Aug. 19. 2005 again with Damage outside Bakyard Front Sides, Air Conditioner swept away + FLOODED

– OVER –

Question #2 – your experience …

We are hoping to get information from property owners regarding flooding impacts. In your experience, what was the impact on your property?
Was there flooding on your property? YES
Was there any damage to your house or other buildings? YES
Was there any damage to building contents? If so, how did water enter the building? YES
If flooding was limited to outdoor areas (back yard or front yard), where did the flow come from? Where did it go?

You can use this diagram to indicate conditions on your property and the road in front of your house.



The Flooding of my House is the Lowest on the Street did MAJOR Damage. went into Garage FLOODED 2 CARS, Railroad Ties lifted To Backyard all Gravel GRASS + Earth on Left Side of House went to Back yard, Ruined Air Conditioner + FLOODED my Basement 18000- Damage insurance did not pay. Lost old Family Heirloom Pictures Etc. We Need more (Catch Basins) Storm Sewers on Spring gate Blvd.

Question #3 – Do you have any concerns regarding the quantity of water in a specific drainage course?

Yes [X] No [ ]

Which drainage course? Spring Gate Blvd 252, 256, 260 and 6 Houses on the South Side of the Street.

What are your concerns? Flooding [X] Erosion [ ] Other [ ]

Please describe them:

(overland) OVERNIGHT FLOW also Need Drainage (COVERTS) Courses between my Backyard To 137 ARNOLD ST in the Back.

Question #4 – Is there any additional information that the project team should be considering in the development of the Thornhill Storm Drainage Improvements Study?

Question #5 – Other Comments …

Do you have any other comments? Do you need any additional information to assist you to participate in this process?

Question #6 – Do you wish to be added to the mailing list for this study? Yes

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Question #1 – Why are you attending this meeting?

Interested Resident ☐ Land Owner ☑

Other ☐

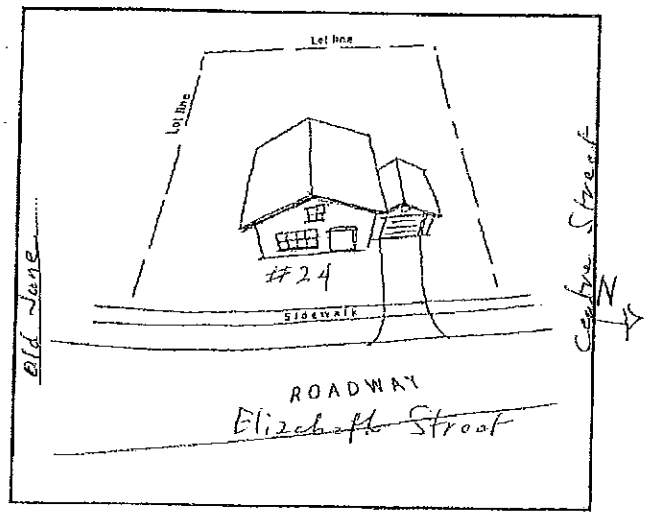
(Please Specify) _____

Question #2 – your experience …

We are hoping to get information from property owners regarding flooding impacts. In your experience, what was the impact on your property? some shrub damage
Was there flooding on your property? yes
Was there any damage to your house or other buildings? no
Was there any damage to building contents? If so, how did water enter the building? no, no
If flooding was limited to outdoor areas (back yard or front yard), where did the flow come from? Where did it go? flood came along # / walkway - went eastward to under old Jane Street at old Jane drainage stopped by litter at grid.

You can use this diagram to indicate conditions on your property and the road in front of your house.

Water from the West goes under Brodie Street & crosses Sowden's & (prior) Secord property, past Kimber's (on 23 Elizabeth St.) to the drain that goes underground at Yonge St. Here, at that drain, there is often a back-up of water that floods the whole watershed area.



Question #3 – Do you have any concerns regarding the quantity of water in a specific drainage course?

Yes ☑ No ☐

Which drainage course? #1

What are your concerns? Flooding ☑ Erosion ☑ Other ☑

Please describe them: other - Backup of water drainage or water courses under Old Jane Street just East of Elizabeth Street. Here, there is a back/up. Garbage left by those who litter poses a problem to drainage of the water way.

Question #4 – Is there any additional information that the project team should be considering in the development of the Thornhill Storm Drainage Improvements Study?

Question #5 – Other Comments …

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Question #1 – Why are you attending this meeting?

Interested Resident ☐ Land Owner ☒

Other ☐

(Please Specify) To learn about plans for storm drainage as it affects my place and what lies in the future to address the problem of flooding, namely the culvert on Cachalover St. which has been unable to handle flooding causing water to flow over the Street and endangering my home. Precedent appears to be becoming overloaded / overflow

Question #2 – your experience …

We are hoping to get information from property owners regarding flooding impacts. In your experience, what was the impact on your property?
Was there flooding on your property?
Was there any damage to your house or other buildings?
Was there any damage to building contents? If so, how did water enter the building?
If flooding was limited to outdoor areas (back yard or front yard), where did the flow come from? Where did it go?

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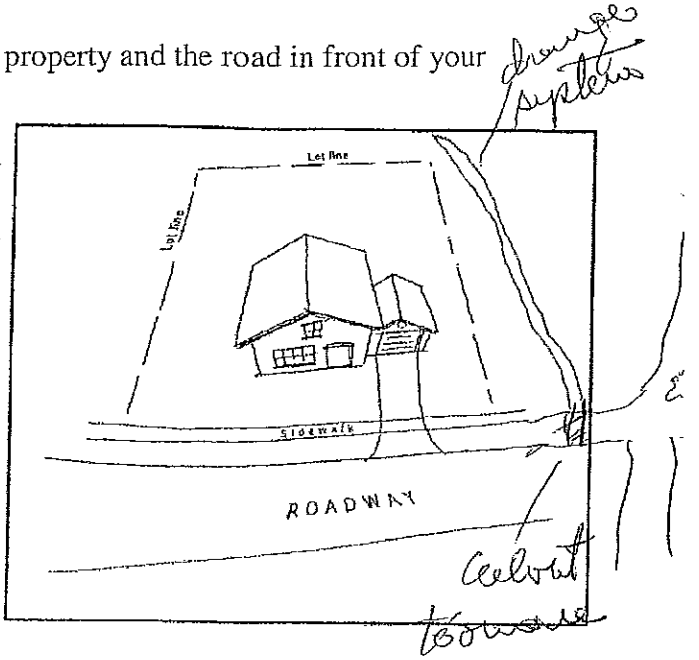


Question #3 – Do you have any concerns regarding the quantity of water in a specific drainage course?

Yes [X] No [ ]

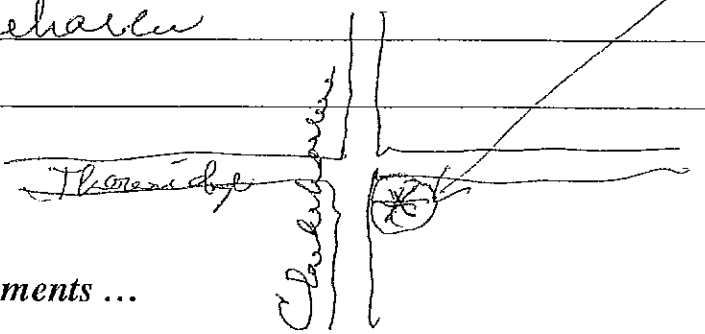
Which drainage course? #7

What are your concerns? Flooding [X] Erosion [ ] Other [ ]

Please describe them: The build up of water and the inability of the culvert under my street to handle the flow during flooding

Question #4 – Is there any additional information that the project team should be considering in the development of the Thornhill Storm Drainage Improvements Study?

Some culverts along Thornridge that are too small and can't handle the flow in particular the property at the corner of Thornridge Dr. & Clarkehaven



Question #5 – Other Comments …

Do you have any other comments? Do you need any additional information to assist you to participate in this process?

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Evaluation Form

(Please return this form to a project team member)

Today's event was the first of two public information centres for the Thornhill Storm Drainage Improvement Study. We would appreciate any comments you have that could help to improve this meeting to help ensure productive public dialogue.

What did you like most about today?

The presentation which clarified in my mind the area believed to flood, and hopefully the end result being relief of unnecessary flooding.

What should we improve?

Do you have other ideas about this process?

make sure that notification of meetings and any other information is delivered to all homes.
I found out about this meeting from one of my neighbours since I guess the person delivering info missed my home.

Thank you for your thoughts!

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What did you like most about today?

know what is the city doing for us.

What should we improve?

should be done earlier.
and be effective.

Do you have other ideas about this process?

Notice of meeting should be left ~~in~~ in Mail Box instead of plug ~~between~~ the doors. between

Thank you for your thoughts!

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(Please return this form to a project team member)

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What did you like most about today?

Being informed

What should we improve?

- Drainage
- Curb development in residential area - more building, more problems
- Improve existing system

Do you have other ideas about this process?

Curb Letting

Thank you for your thoughts!

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Today's event was the first of two public information centres for the Thornhill Storm Drainage Improvement Study. We would appreciate any comments you have that could help to improve this meeting to help ensure productive public dialogue.

What did you like most about today?

openess to inform + discuss options with residents

What should we improve?

Presentation could be more succinct

Do you have other ideas about this process?

the quicker the action the better

Thank you for your thoughts!

City of Vaughan

The City Above Toronto

City of Vaughan
Thornhill Storm Drainage Improvements Study

Public Information Centre No. 2

December 11, 2007

GENIVAR

Welcome

Today is an opportunity for you to hear about and offer input on the Thornhill Storm Drainage Improvements Study that is currently being conducted by the City of Vaughan.
This Public Open House Notebook will help you to navigate the evening's activities. This notebook contains:

- The agenda
- Key contacts
- Questionnaire
- A brief evaluation form

What are we going to do?
Our goals for this evening are:

- Present the background and need for the study
- Describe the Class EA process
- Describe different alternative solutions
- Present the Preliminary Preferred Solution
- To hear and document various perspectives from all participating stakeholders

Input that is received tonight will be carefully considered and addressed as part of the Class EA Process.

Why is this important?
The recommendations of this study will affect property owners including residents, organizations and institutions within the study area. Our hope is to work with the community to build an understanding of the drainage issues. The Preliminary Preferred Solution suggested from this study should enjoy broad public support.

A final comment …
Each participant brings valuable opinions, experiences and suggestions. You are not expected to be an expert on drainage or municipal infrastructure. The project team will guide the discussions. We are interested in your perspective. We would like to hear from everyone. We hope this notebook will help you to participate fully today.

Project Team

City of Vaughan
Mr. Pat Marcantonio, C.E.T.
Senior Engineering Assistant

Mr. Thomas Ungar, P. Eng.
Manager, Design Services

Engineering Consulting Firm:
Mr. Alan E. Winter, P.Eng.
GENIVAR Ontario Inc.

Agenda for December 11, 2007

City of Vaughan Thornhill Storm Drainage Improvements Study
Public Information Centre #2, December 11, 2007
Garnet A. Williams Community Centre, Meeting Room #3
501 Clark Avenue West

7:00-8:15 pm	Open House and Formal Presentation by Consultant Team
8:15-9:00 pm	Individual Discussion

Thank you for your time and input!

Please take time to fill in a meeting evaluation so we know what you like and where we can improve for next time.

Project Background ...

Why?

A number of residents of the Brooke Street areas have been experiencing periodic flooding of their properties due to storm water runoff. A significant major flooding occurred on August 19, 2005. The residents requested the City of Vaughan to review the drainage problem.

Decision-Making Criteria:

The study examined various alternatives for solving the flooding problems within the study limits. A number of criteria were used to select the Preliminary Preferred Solution to recommend to City Council:

- Maximize the benefit-to-cost ratio.
- Consider initial capital costs as well as long-term operational and maintenance costs. The solution needs to be affordable and sustainable.
- Minimize environmental impacts.

Who is being consulted?

The public (including businesses, residents, homeowners, local schools and churches) are being consulted through two public information centres (PICs). The first PIC summarized initial findings of the project. The second PIC presents the Preliminary Preferred Solution.

Next Steps ...

If you have any questions, comments or outstanding concerns as we move forward, please contact:

City of Vaughan
Mr. Pat Marcantonio, CET
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario
L6A 1T1
Phone: (905) 832-8525 Ext. 3111
Fax: (905) 303-2045
Email: pat.marcantonio@vaughan.ca

Mr. Tom Ungar, P. Eng.
Manager, Design Services
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario L6A 1T1

Phone:(905) 832-8525 Ext. 3110
Fax: (905) 303-2045
Email: tom.ungar@vaughan.ca

Engineering Consulting Firm
Mr. Alan E. Winter, P.Eng.
GENIVAR Ontario Inc.
600 Cochrane Drive, Suite 500
Markham, Ontario
L3R 5K3
Phone: (905) 475-7270 Ext. 323
Fax: (905) 475-5994
Email: awinter@macviro.com

Any additional comments should be forwarded by December 21, 2007. Comments received will be compiled and summarized in the project documentation. Copies of the presentation and posterboards from tonight's meeting will soon be available on the City's website at: http://www.city.vaughan.on.ca.

Thank you for your participation today at Public Information Centre No. 2 and for your valued input.

Questionnaire

Please return this questionnaire to a project team member before you leave, or you can mail it in later if you prefer …

Please provide your name and/or street address

Name	
Street Address	
Phone Number	
Email	

Please note that with the exception of personal information, all comments will become part of the public record.

Question #1 – Why are you attending this meeting?

Interested Resident ☐ Land Owner ☐

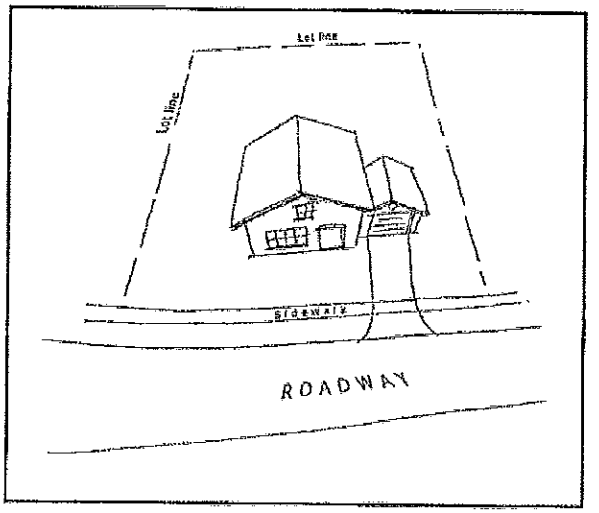
Other ☐

(Please Specify) _____

Question #2 – your experience …

We are hoping to get information from property owners regarding flooding impacts. In your experience, what was the impact on your property?
Was there flooding on your property?
Was there any damage to your house or other buildings?
Was there any damage to building contents? If so, how did water enter the building?
If flooding was limited to outdoor areas (back yard or front yard), where did the flow come from? Where did it go?

You can use this diagram to indicate conditions on your property and the road in front of your house.



Question #3 – Do you have any concerns regarding the Preliminary Preferred Solution?

Yes ☐ No ☐

What are your concerns? Flooding ☐ Erosion ☐ Other ☐

Please describe them: _____

_____

Question #4 – Is there any additional information that the project team should be considering in selecting the Preferred Solution?

Question #5 – Other Comments …

Do you have any other comments? Do you need any additional information to assist you to participate in this process?

Question #6 – Do you wish to be added to the mailing list for this study?

Name: _____

Address: _____

Postal Code: _____

Telephone: _____ Fax: _____

Please fill out and leave at registration desk or send, before December 21, 2007 to:

City of Vaughan
Mr. Pat Marcantonio, CET
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario
L6A 1T1
Phone: (905) 832-8525 Ext. 3111
Fax: (905) 303-2045
Email: pat.marcantonio@vaughan.ca

Engineering Consulting Firm
Mr. Alan E. Winter, P.Eng.
GENIVAR Ontario Inc.
600 Cochrane Drive, Suite 500
Markham, Ontario
L3R 5K3
Phone: (905) 475-7270 Ext. 323
Fax: (905) 475-5994
Email: awinter@macviro.com

Evaluation Form

(Please return this form to a project team member)

Today's event was the second of two public information centres for the Thornhill Storm Drainage Improvement Study. We would appreciate any comments you have that could help to improve this meeting to help ensure productive public dialogue.

What did you like most about today?

What should we improve?

Do you have other ideas about this process?

Thank you for your thoughts!

THORNHILL STORM DRAINAGE IMPROVEMENT STUDY

Municipal Class Environmental Assessment

WELCOME TO THE PUBLIC INFORMATION CENTRE #2

Tuesday, December 11TH, 2007

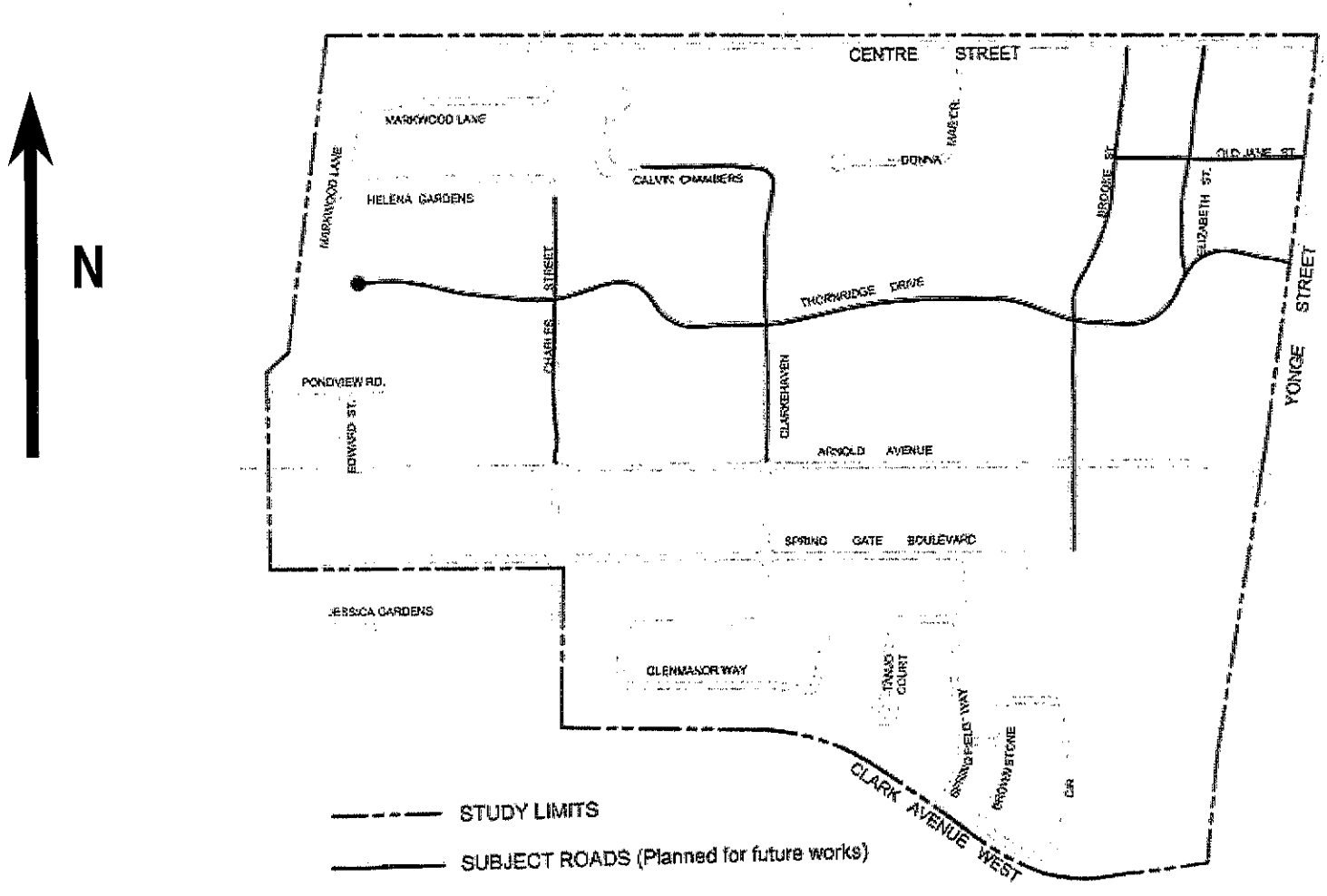
Agenda

7:00 – 8:15 PM	Open House and Formal Presentation by Consultant Team	Overview of the Study purpose, objectives, background info, Class EA process and work completed including presentation of the Preliminary Preferred Solution.
8:15 – 9:00 PM	Open Forum and Individual Discussion	Please circulate around the room, view the displays and speak to City staff & members of Consultant Team.

Presentation Overview

- PROBLEM STATEMENT
- STUDY OBJECTIVES
- CLASS ENVIRONMENTAL ASSESSMENT PROCESS
- BACKGROUND
- PUBLIC INFORMATION CENTRE #1
- PROBLEM AREAS
- DEVELOP AND EVALUATE ALTERNATIVE SOLUTIONS
- PRELIMINARY PREFERRED SOLUTION
- QUESTIONS

Study Area


N
CENTRE STREET
MARKWOOD LANE
HELENA GARDENS
CALVIN CHAMBERS
DONNA
OLD JANE ST.
ELIZABETH ST.
THORNRIDGE DRIVE
PONDVIEW RD.
EDWARD ST.
CHARLES STREET
CLARKEHAVEN
ARNOLD AVENUE
YONGE STREET
SPRING GATE BOULEVARD
JESSICA GARDENS
GLENMANOR WAY
TRANS COURT
BROOMSTONE
CLARK AVENUE WEST
STUDY LIMITS
SUBJECT ROADS (Planned for future works)

Problem Statement

Recurring Surface Flooding and Road Overtopping within the Study Area during Heavy Storm Conditions.

City of Vaughan plans to reconstruct some of the local roads and needs a drainage and stormwater management plan to enable road reconstruction.

Study Objectives

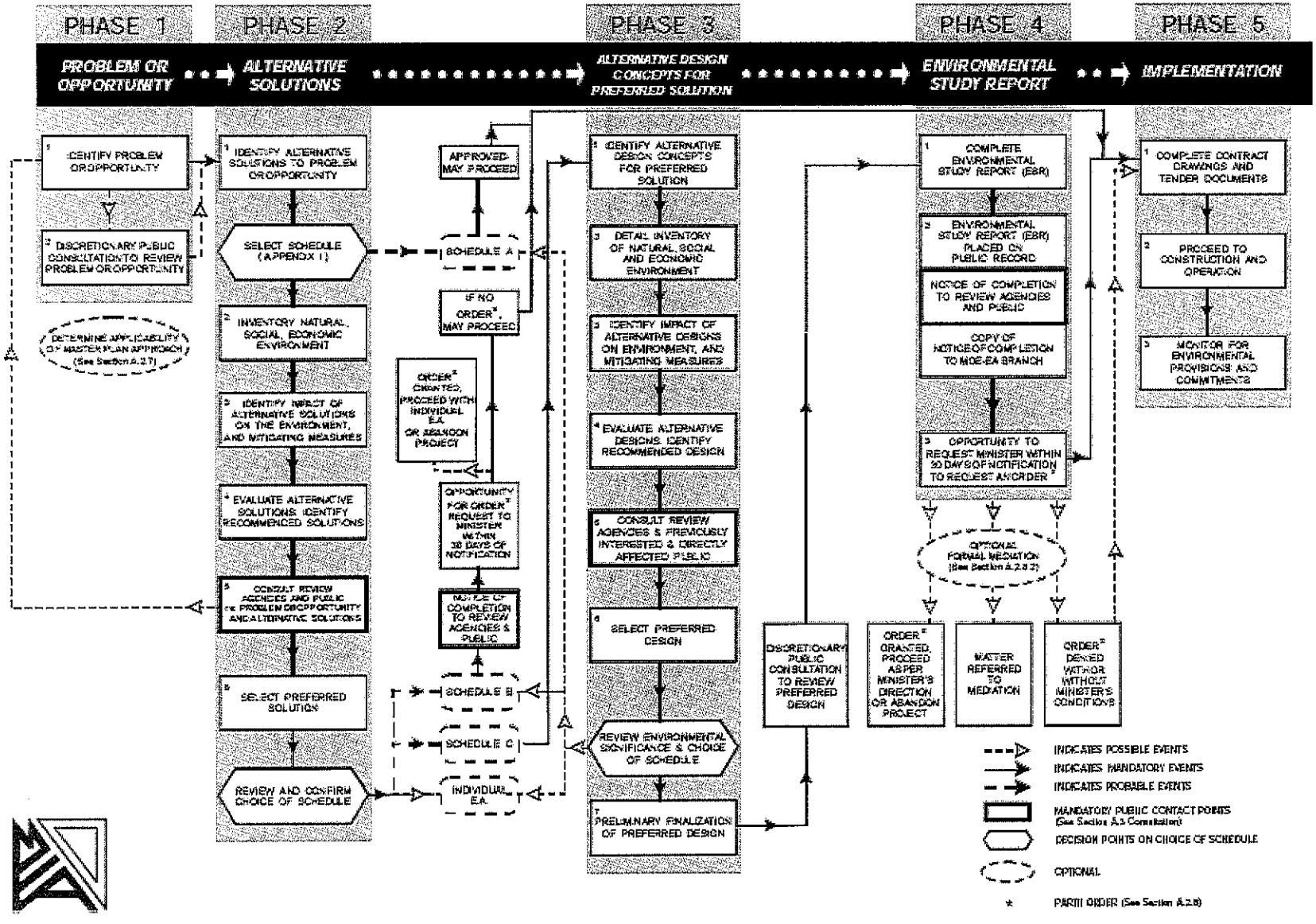
The primary objectives of the Study are to:

- Identify historical and potential surface flooding and road overtopping problems
- Assess adequacy of existing drainage system
- Determine causes of surface flooding and road overtopping
- Evaluate and develop Stormwater Management Plan alternatives
- Select Preliminary Preferred Stormwater Management Plan

Overview – Class Environmental Assessment Process

- The *Municipal Class EA process* enables the planning of municipal infrastructure projects in accordance with a proven procedure for the protection of the environment.
- The Study is being undertaken in accordance with the planning and design process for a Schedule 'B' project (see flow chart).
- The Schedule 'B' Class EA process includes public and review agency consultation, an evaluation of alternatives, an assessment of the effects on the environment and identification of reasonable measures to mitigate any adverse effects.

Municipal Class EA Planning & Design Process



Drainage Patterns

There are 3 main drainage courses within the study area:

➢ ***Drainage Course #1:*** Serves the north portion of the study area.

- starts at stormwater management pond at westerly end of Thornridge Dr.
- flows easterly, then northerly through private property and conveyed under City roads through culverts
- flows through culvert under Centre Street just east of Oakbank Rd, then flows easterly within north side Centre St road ditch
- crosses under Centre St and flows easterly through private property to an existing underground box culvert near Old Jane St and Yonge St.

Drainage Pattern

➢ ***Drainage Course #2:*** **Serves south west and middle portions of study area.**

- **starts from south side Arnold Ave road ditch and crosses through culvert to north side road ditch (west of Charles St) then flows easterly within north side road ditch**
- **easterly through private property, conveyed under City roads through culverts, then flows south east through private property towards Brooke St north of Arnold Ave.**
- **ditch inlet catch basin located on west side of Brooke St partially captures flow and conveys it in a large trunk storm sewer under Brooke St.**
- **major storm flows overtop Brooke St and flood area east of Brooke St.**
- **overland flows eventually drain to a storm sewer that crosses Yonge St.**

Drainage Pattern

Drainage Course #3: **Serves the south portion of the study area.**

- **starts from south side road ditch of Arnold Ave. near Charles St.**
- **flows easterly within south side ditch of Arnold Ave.**
- **ditch inlet catch basins located at south west corner of Brooke St and Arnold Ave. intersection receives ditch flow and discharges to trunk sewer under Brooke St.**

Tasks Completed To Date

The following tasks have been completed:

- Notice of Study Commencement
- Background information collected and reviewed
- Preliminary field investigations
- Preliminary hydrologic analysis to calculate flows at key locations for various design storm events
- Preliminary hydraulic analysis to assess adequacy of key drainage elements
- Identified "Problem Areas "
- Developed/evaluated alternative solutions
- Selected preliminary preferred solution

Problem Areas

Drainage Course #1:

No deficiencies in drainage capacity associated with City of Vaughan municipal infrastructure were identified along Drainage Course #1.

Some municipal road culverts should be replaced at time of road reconstruction due to poor condition.

Some complaints from individual property owners regarding re-development and re-grading on private properties that directs runoff onto adjacent properties

Drainage Course #2:

Problem Area 1: **Existing driveway culvert at 132 Arnold Street is undersized (600mm CSP).**

Drainage Course #2 (cont.):

Problem Area 2: **Ditch inlet and storm sewer connection in front of 36 Brooke St have inadequate capacity to capture and convey major storm events.**

Ditch inlet is connected to Brooke St. trunk storm sewer, which becomes severely surcharged during major storm events

Problem Areas

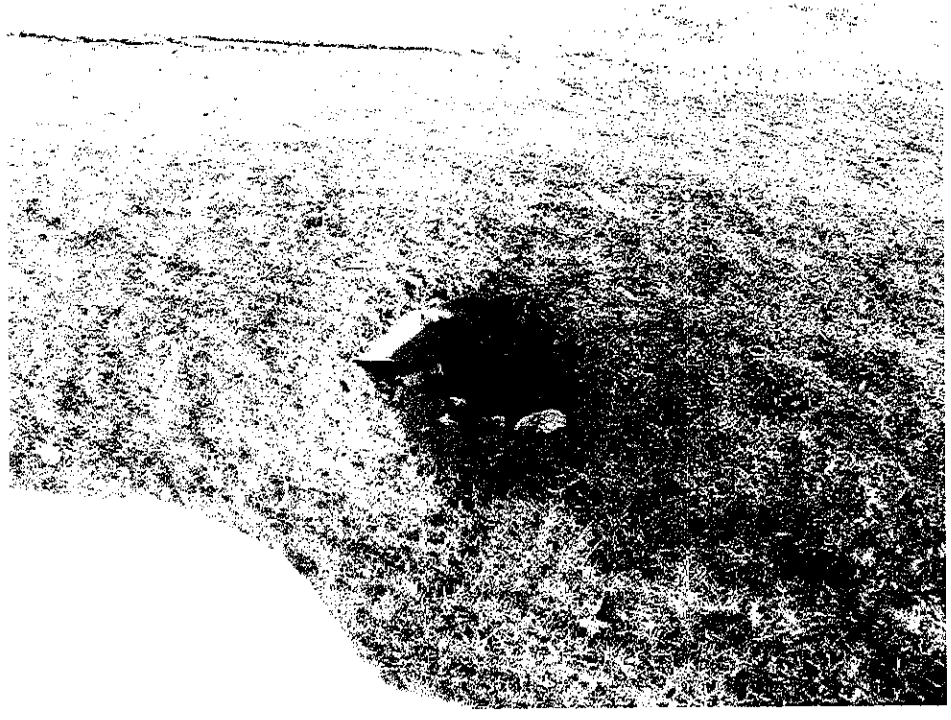
Drainage Course #2 (cont.):

Problem Area 3: **discontinuous overland flow route downstream from Brooke St.**

Problem Area 4: **discontinuous overland flow route between 23 and 27 Thornridge Dr.**

Drainage Course #2 (cont.):

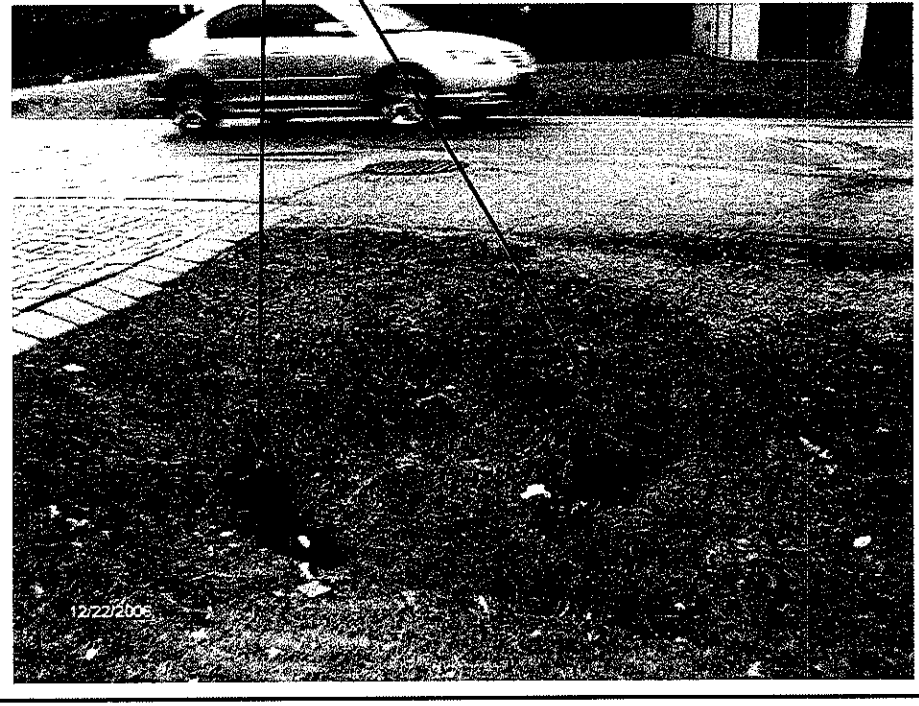
Problem Area 5: **Existing culvert (450mm CSP) at the north side of Elizabeth St. and Thornridge Dr. intersection in poor condition and completely deformed.**



Problem Areas

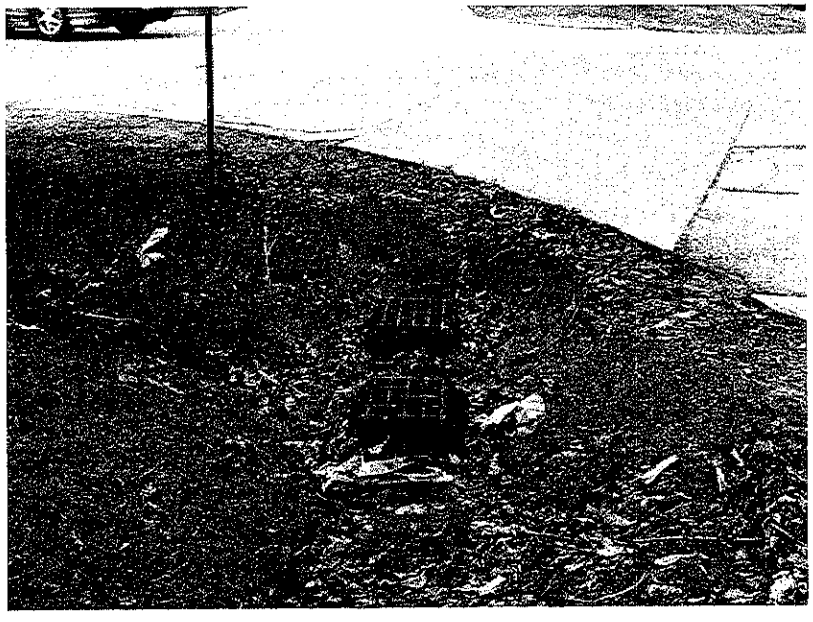
Drainage Course #2 (cont.):

Problem Area 6: **Existing culvert crossing Thornridge Dr. in poor condition and restricts flow. Entrance culvert just downstream of crossing culvert is undersized (300mm CSP).**



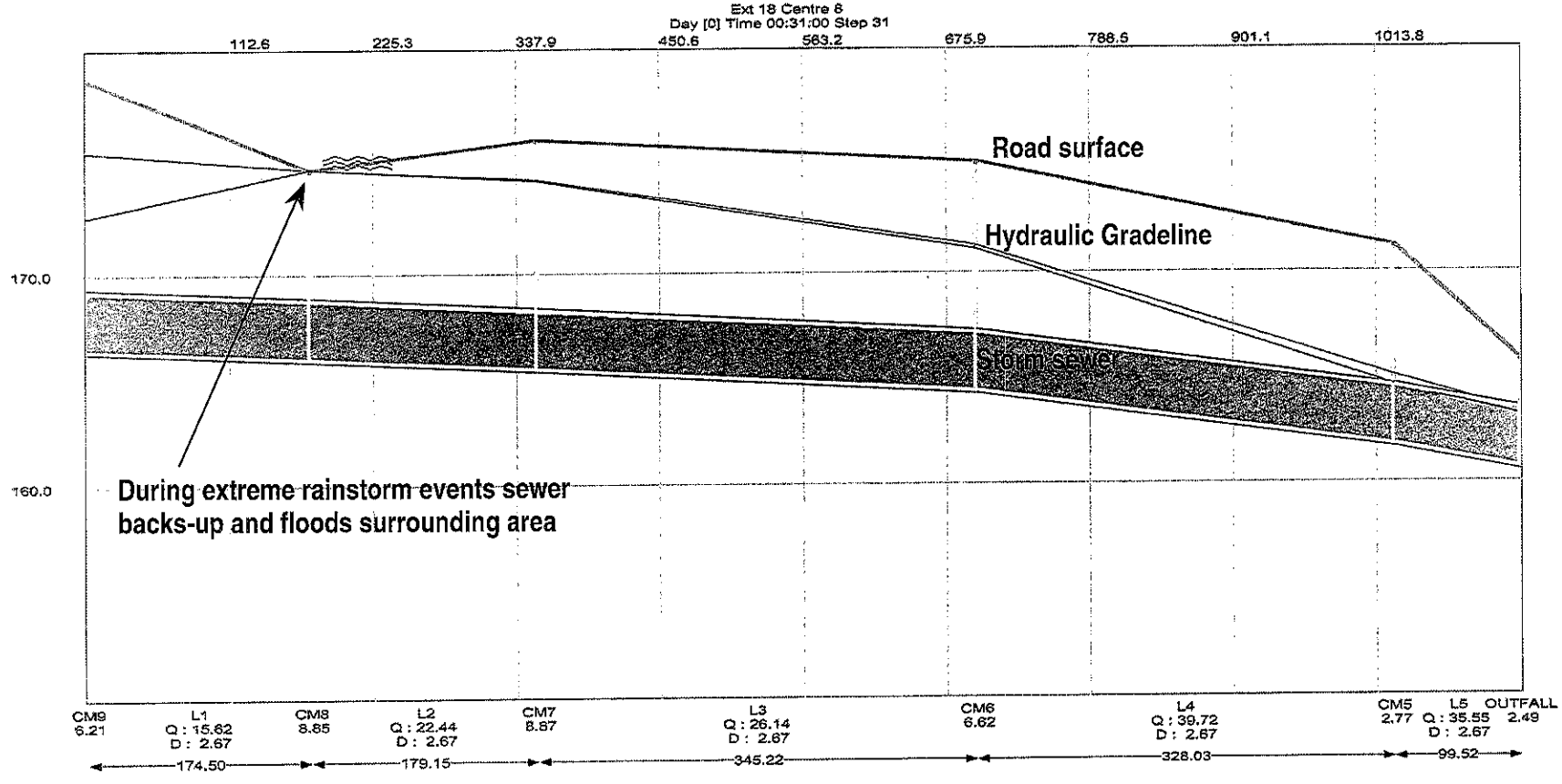
Drainage Course #3:

Problem Area 7: **Existing ditch inlet catch basins and storm sewer connection to the trunk storm sewer do not have adequate capacity to convey major storm events (SW corner of Brooke St. and Arnold Ave.)**



Brooke St. Trunk Sewer Analysis

Under Existing Conditions:



Problem Areas

In addition to these problem areas, there are a number of other drainage deficiencies in the study area generally related to:

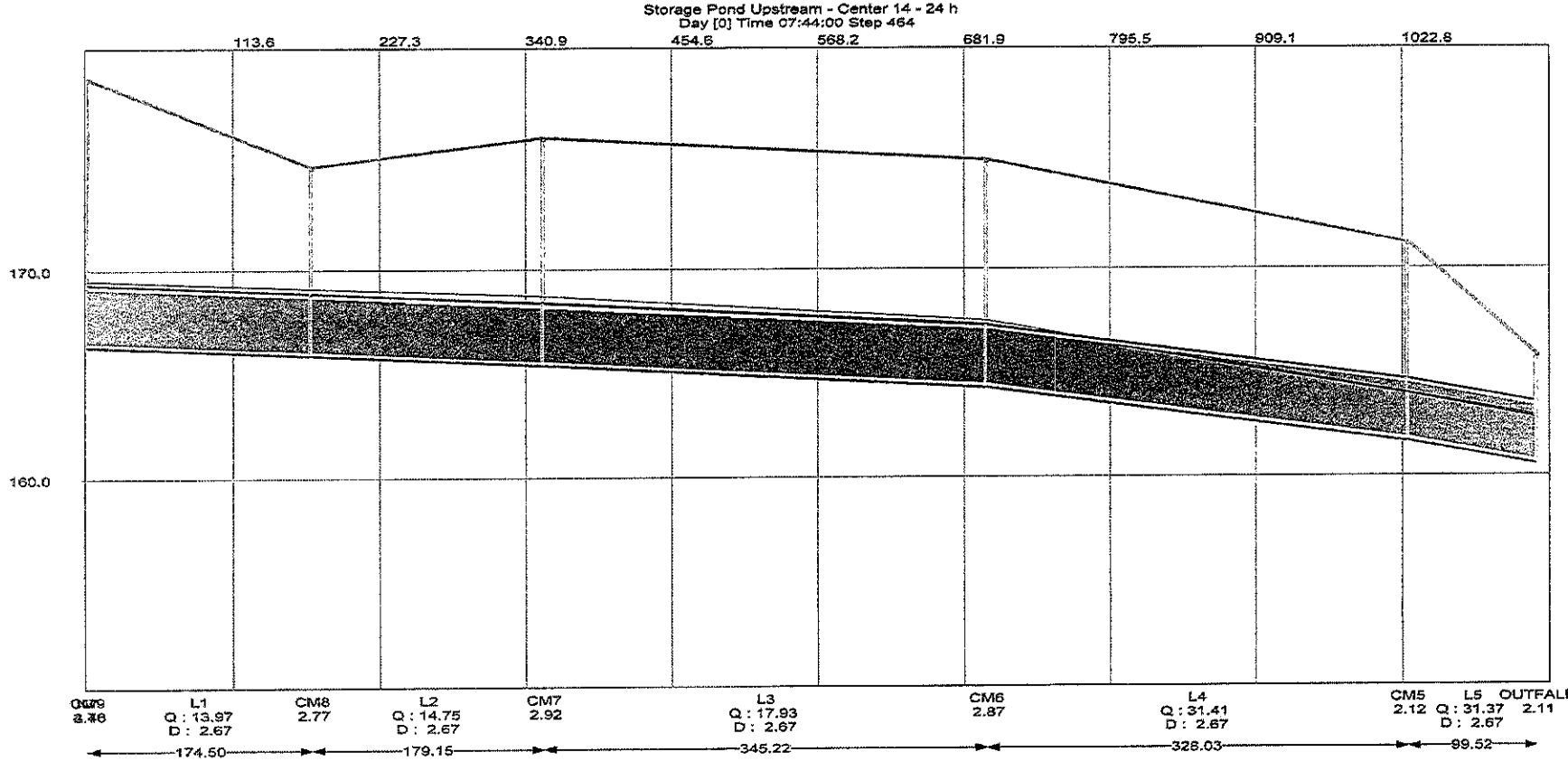
- Ditch inlets and culverts that are either silted or clogged with leaves and debris.
- Some localized sections of road side ditches have inadequate capacity.
- Re-development and re-grading on private properties – directing runoff onto adjacent properties.
- Insufficient (or unknown) outlet capacity of major drainage system

Alternative Solutions

A number of alternative solutions were investigated, which included the following:

- **New storm sewer system**
- **Expansion or upgrading of existing storm drainage system.**
- **Rehabilitate existing storm drainage system.**
- **Implement Stormwater Management Controls.**
- **Do Nothing**

After Constructing SWM Pond:



Preliminary Preferred Solution

- Replace deficient culverts at various locations
- Improve ditch inlet capture capacity
- Construct storm sewer along Thornridge Drive from house # 53 to Brooke St. and connect to Brooke St. trunk sewer.
- Construct a Stormwater Management Facility in G Park
  - ✓ Option 1: All the above + Open SWM pond (5m deep)
  - ✓ Option 2: All the above + Open SWM pond (2m deep) + underground storage (3m deep)

Preliminary cost estimate is:

Option 1	$1.2M - $1.5M
Option 2	$3.0M - $3.2M

Next Steps – To Study Completion

- Receive input from public and agencies with regard to the Preliminary Preferred Solution and continue consultation process with:
  - Public
  - Review Agencies (TRCA, MOE, MNR, DFO, etc.).
- File Environmental Assessment Screening Document
- Allow 30 days for Public review

Public Participation

Your Input is Valued and Needed

We encourage you to provide us with your comments and suggestions

Please complete and return the Questionnaire and Evaluation Form.

Please inform us of any information you may have that would benefit our Study. Submit your comments to us (phone, fax, e-mail).

For additional information, please contact:

Mr. Pat Marcantonio, CET
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario L6A 1T1

Phone: (905) 832-8525 Ext. 3111
Fax: (905) 303-2045
Email: pat.marcantonio@vaughan.ca

Mr. Tom Ungar, P. Eng.
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Vaughan, Ontario L6A 1T1

Phone: (905) 832-8525 Ext. 3110
Fax: (905) 303-2045
Email: tom.ungar@vaughan.ca

THANK YOU

Alan Winter

From:
Sent: Thursday, January 10, 2008 11:53 PM
To: tom.ungar@vaughan.ca; pat.marcantonio@vaughan.ca; Alan Winter
Subject: Thornhill Storm Drainage Improvements Study, PIC No 2, Dec 11, 2007

On Dec 11, 2007, staff from Genivar came to Thornhill to notify the community of the study captioned above and its findings. Very quickly, it became clear that the Consultant Genivar's formulation of the alternatives and the criteria for choosing between those alternatives were full of large holes and lack clarity and completeness.

The 5 alternatives investigated are not good enough. The alternative of "New Storm Sewer System" is ridiculous to say the least.

The alternative "Expansion or upgrading the system" is not satisfactory either.

Where is the alternative of Rehabilitating AND Expanding the System?

The criteria were:
. Maximize the benefit-to-cost ratio
. Affordability
. Minimize environmental impacts

Genivar didn't discuss the "measures" of the criteria; e.g. what is the measure of affordability? The measures of the environmental impacts? The measures of the benefits and costs?

The Consultants seemed to be unaware of the fact that in the evaluation process, knowledgeable engineers don't use the out-dated benefit-to-cost ratio any more, as most of the elements of the cost and benefits are not quantifiable. While one may be able to put a dollar value to the decrease in the property values of the houses near the "proposed pond" (and I doubt that the Consultant did that), one can't put a monetary value to the suffering of people because of the smell coming out of the "pond" or the dampness that will fill the area or the mosquito bites that will increase significantly, or the potential danger of implanting a pond in the middle of a fully developed area, or the danger of the pond over-flowing, or the health costs and implications of all of the above.

The Consultant was unable to give a satisfactory answer to my questions regarding the evaluation method used. Did they use reliable simulation techniques to measure the impacts of each alternative? Or simply they chose the cheapest alternative, irrespective of its impacts on the community.

Putting a pond like this in the middle of our community is a serious undertaking that most of the area residents would reject if they were clearly informed about its full impacts.

I strongly oppose the "pond" idea and urge the Vaughan Municipality to instruct the Consultants to re-study the issue and come up with a better solution.

I stated my opposition during the meeting mentioned above. I hope it was entered in the meeting document.

Best regards.

I'd like to officially

GENIVAR

Proj. No. 6101

February 11, 2008

Re: Thornhill Storm Drainage Improvements Study

Dear

Thank you for your email of January 10, 2008. The following clarifies the alternative solutions that were considered and the evaluation of same.

The Thornhill Storm Drainage Improvements Study is following the planning and design process outlined in the MEA June 2000 Municipal Class Environmental Assessment document. The project is considered a Schedule B and as such involves completing Phase 1 (Identification and Description of Problem) and Phase 2 (Alternative Solutions) of the Class EA process. The process is subject to screening criteria.

The problems identified include:

- Brooke Street trunk storm sewer becomes surcharged during significant storm events. Essentially, the trunk sewer does not have sufficient capacity to convey major storm events, without the potential of backing-up and causing flooding.
- Ditch inlets and culverts have become either silted or clogged with leaves and debris.
- Some localized sections of road side ditches lack adequate conveyance capacity.
- Re-development and re-grading that has occurred on private properties has re-directed runoff onto adjacent properties, which causes flooding of adjacent properties.
- Insufficient (or unknown) outlet capacity of major drainage system.

A range of alternative solutions was developed. The alternative solutions are as follows:

1. New storm sewer system. This would involve constructing new storm sewers (or ditches).
2. Rehabilitate or upgrade existing storm drainage system. This would involve replacing or upgrading deficient portions of the storm drainage system. It could also involve modifying the existing drainage system to improve system capacity.
3. Expansion of existing storm sewer system. This alternative would add new storm sewers (or ditches) or change management practices to existing drainage system to improve the capacity of existing system.

600 Cochrane Drive, 5th Floor, Markham, Ontario L3R 5K3
Telephone: 905.475.7270 • Fax: 905.475.5994 • www.genivar.com

4. Implement stormwater management measures. This would involve constructing stormwater storage facilities.
5. Do Nothing. This alternative would not involve any improvements or changes to the storm drainage system. It does not necessarily mean that no further re-development in the community would occur.

Each alternative solution also had various options for consideration. In considering the range of alternatives, it turns out that some of the candidate solutions are more reasonable or feasible than other alternatives.

The Public Information Centre held on December 11, 2007 presented the alternative solutions, along with their advantages, disadvantages and potential effects. The attached table presents the current version of the evaluation of alternative solutions.

It is seen from the attached table, that not many of the alternative solutions are either not favourable or not recommended for further consideration. Indeed, the only alternatives that are recommended are:

- Possible new storm sewer along Thornridge Drive, just west of Brooke St;
- Replacement of undersized ditch inlets and catch basins;
- Replacement of deficient culverts;
- Improvement of ditch conveyance capacity; and
- Construction of a new stormwater management facility in Gallenough Park.

Essentially, all of the above forms the preliminary preferred solution. The preliminary preferred solution does combine various individual alternative solutions. For example, it includes replacing undersized ditch inlets (rehab or upgrade) and increasing road ditch conveyance capacity (expansion).

A rigorous economic analysis was not undertaken. You are correct that benefit-to-cost ratio method of analysis was not completed because of the difficulty of properly quantifying the values. However, we did prepare cost estimates and considered whether the City of Vaughan would have the capacity to finance the solution.

All of the issues that you raise regarding the construction of a stormwater management facility can be mitigated by proper design of the SWM facility. It is the City's intention to maintain a passive park setting, while protecting the environment through proper stormwater management controls. It would be the City's desires to create an amenity for the community.

The construction of a new stormwater management facility in Gallenough Park would address the serious Brooke St storm sewer surcharging problem, which is the major cause of the significant flooding problems. The other alternatives only address localized problems and do not address the more serious sewer surcharging problem.

We trust this information helps clarify the alternative solutions considered and their evaluation.

Yours truly,
GENIVAR Ontario Inc.

Alan E. Winter, P.Eng.

cc: Pat Marcantonio, C.E.T., Senior Engineering Assistant, City of Vaughan
Tom Ungar, P.Eng., Manager Design, City of Vaughan
Bill Robinson, P.Eng, Commissioner Engineering & Public Works, City of Vaughan
Mayor Linda Jackson, City of Vaughan
Councillor Alan Shefman, City of Vaughan
Regional Councillor Joyce Frustaglio, City of Vaughan
Regional Councillor Mario Ferri, City of Vaughan
Regional Councillor Gino Rosati, City of Vaughan

Questionnaire

Please return this questionnaire to a project team member before you leave, or you can mail it in later if you prefer …

Please provide your name and/or street address

Name	
Street Address	
Phone Number	
Email	

Please note that with the exception of personal information, all comments will become part of the public record.

Question #1 – Why are you attending this meeting?

Interested Resident ☐ Land Owner ☑

Other ☐

(Please Specify) _____

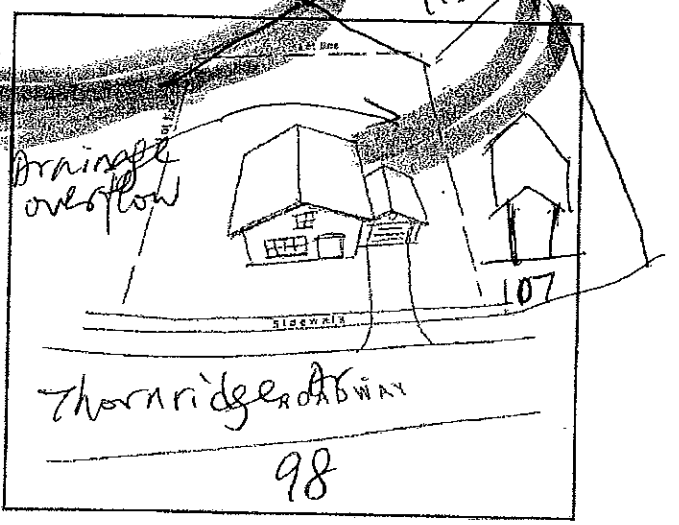
_____

_____

Question #2 – your experience …

We are hoping to get information from property owners regarding flooding impacts. In your experience, what was the impact on your property?
Was there flooding on your property?
Was there any damage to your house or other buildings?
Was there any damage to building contents? If so, how did water enter the building?
If flooding was limited to outdoor areas (back yard or front yard), where did the flow come from? Where did it go?

You can use this diagram to indicate conditions on your property and the road in front of your house.



Water of Drainage route #1 between Charles street and Clarkhaven did not follow the turn of route #1, on Thornridge Dr. and did not handle water flow properly because of huge rainfall and hence flooded most houses along Thornridge Dr. (See attached photos taken the following week of Aug 19, 2005

Drainage overflow

← original drain water flow

Question #3 – Do you have any concerns regarding the Preliminary Preferred Solution?

Yes ☑ No ☐ not enough help. We need to build a bigger reservoir at west end of Thornridge Drive.

What are your concerns? Flooding ☑ Erosion ☐ Other ☐

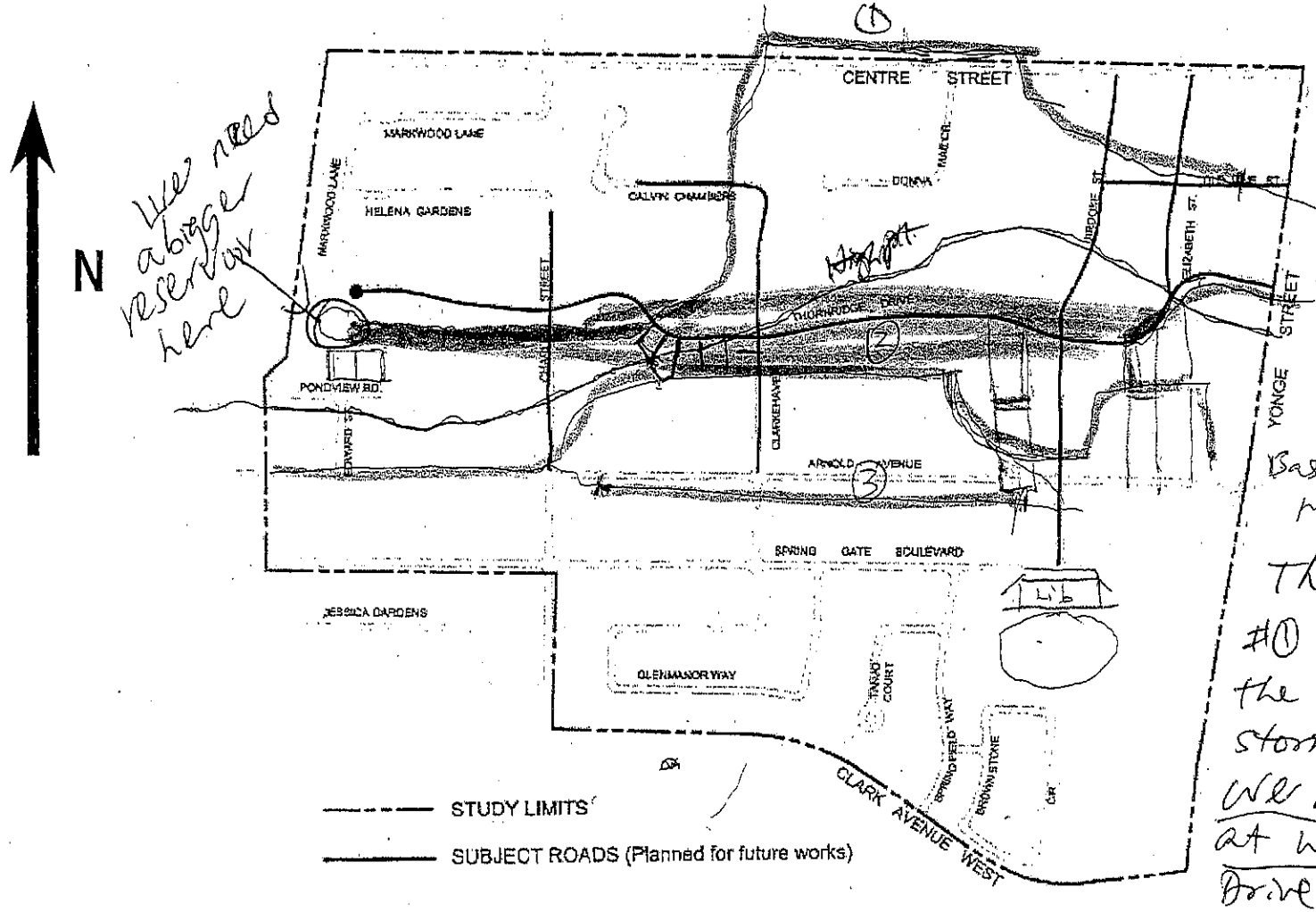
Please describe them: #98 Thornridge Drive took away their culverts when they rebuild new house several years ago. Water stay in front yard and on the road, drainage water can not go through. Lots of mosquitos grown up there.

the preliminary solution of Stormwater Management facility in G park is great idea!! We fully support this idea! GOOD WORK DONE! THANK YOU! please build it asap!

Question #4 – Is there any additional information that the project team should be considering in selecting the Preferred Solution?

Question #5 – Other Comments ...

Do you have any other comments? Do you need any additional information to assist you to participate in this process?



We need a bigger reservoir here

① ② ③

Original drainage paths.

Aug 19, 2005 Expanded drainage paths, see all photos taken in Muffler's week of Aug 19.05

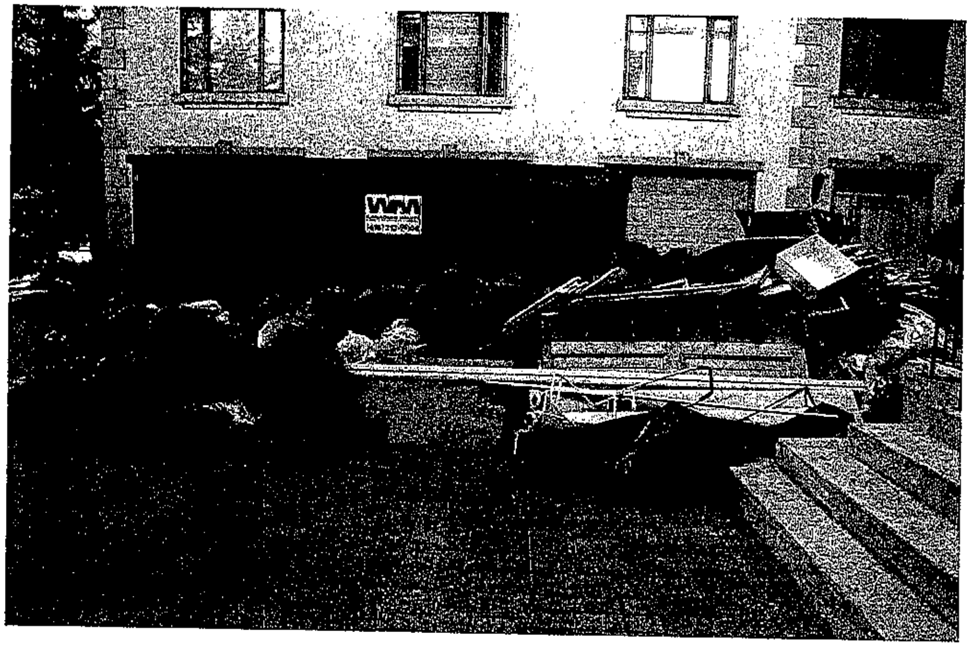
Basin behind

That means drainage #① cannot handle the volumne at storm peak. on Aug 19,05

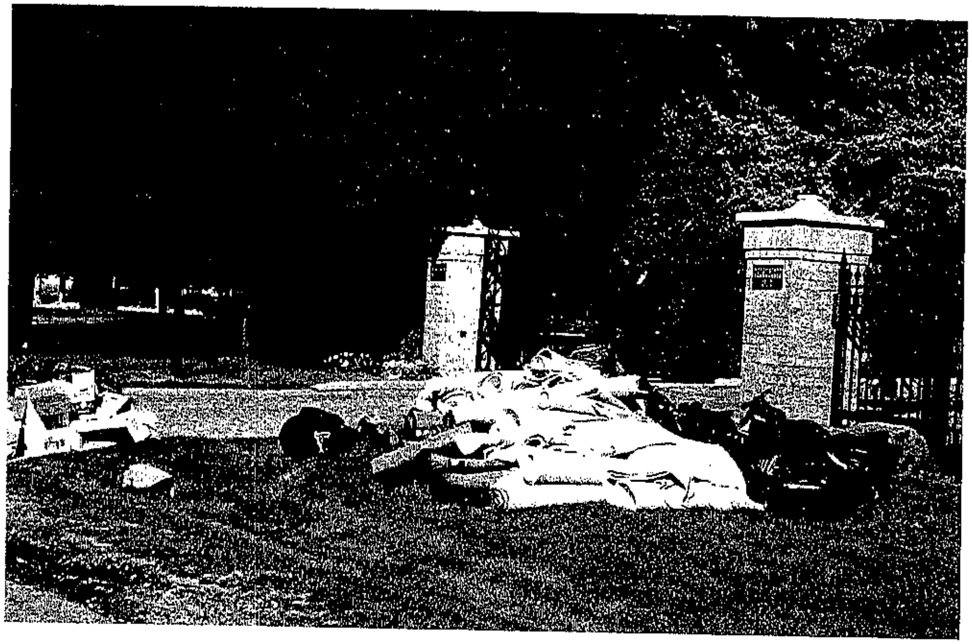
We need bigger reservoir at West end of Thornridge Drive near pondview Rd

THORNHILL STORM DRAINAGE IMPROVEMENT STUDY
MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

PUBLIC INFORMATION CENTRE #2

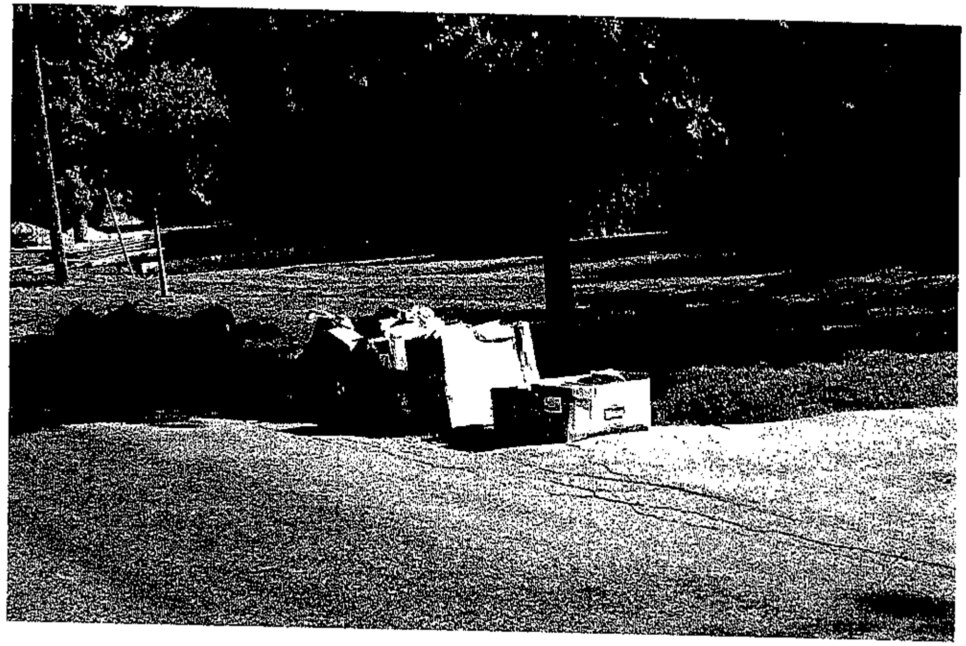


#80 - #107. Thornridge Dr   Aug 2005



40-70.

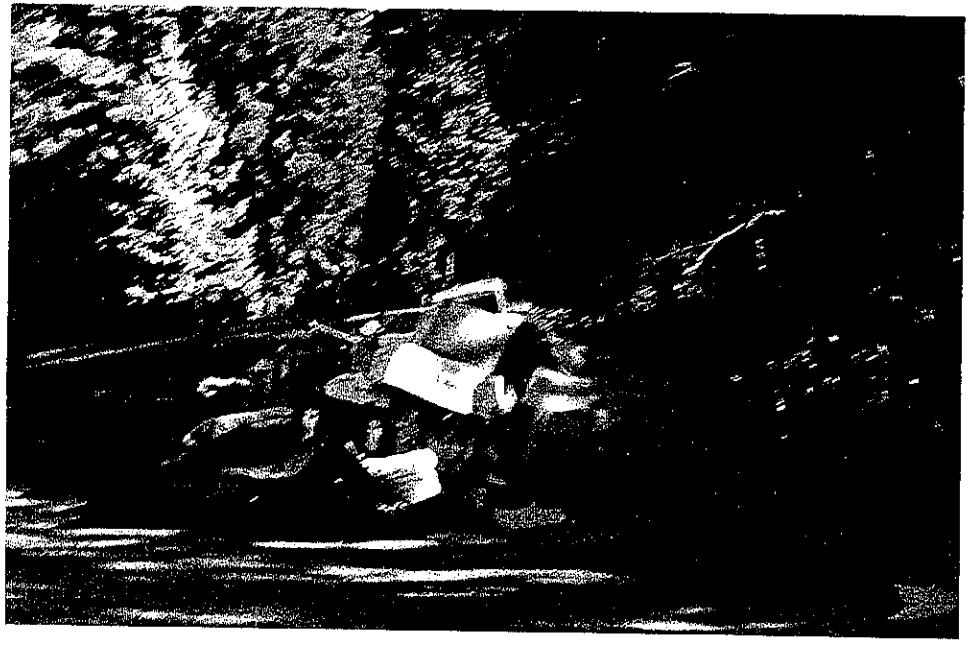
Thornridge Dr. Aug 2005

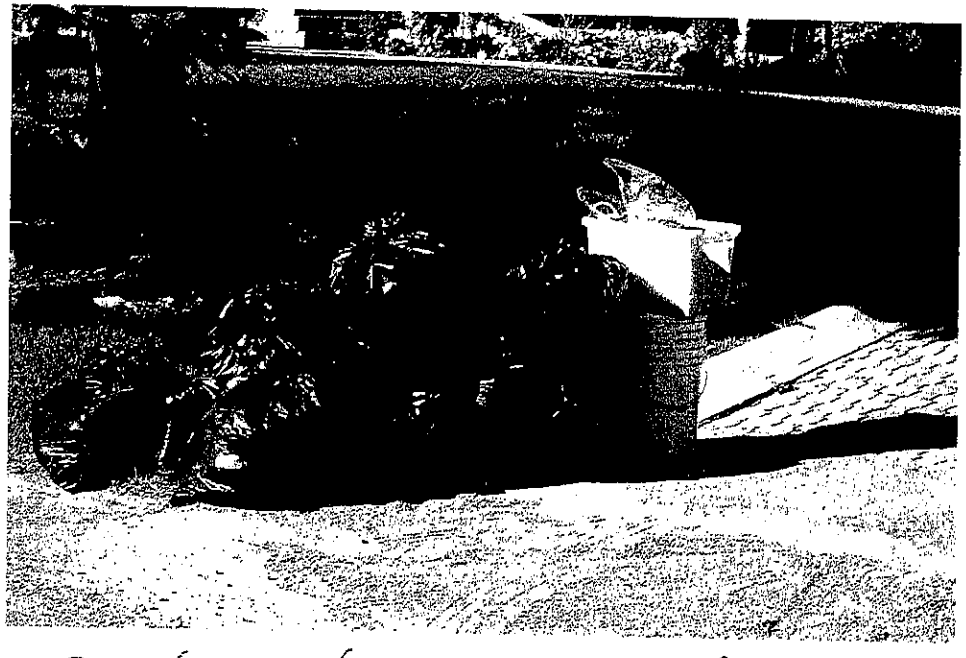


#98 — #117 Thornridge Dr. Aug 2005

Brooke street.
Between Arnold and Thornridge Dr.

Aug 2005





Aug 2005 Charles street (section between Arnold and Thornridge Dr.)

City of Vaughan
The City Above Toronto

ENGINEERING DEPARTMENT

FAX TRANSMISSION

10401 Dufferin Street
R.R. 2
Vaughan, Ontario
L6A 1S2
Tel. (905) 832-8525
Fax (905) 832-2045

ORIGINAL TO FOLLOW BY MAIL: ____ YES ✓ NO

DATE JAN. 10/08

Attention BRIAN E. WINTER

Company: GENIVAR

Fax #: 1-905-475-7270

Pages: 5 (including cover page)

From: Marie Cassata, Administrative Assistant, Ext. 3102

Subject: QUESTIONNAIRE

REPLY NOT REQUESTED ☐ REQUEST REPLY ☐ REQUEST RUSH REPLY ☐

COMMENTS:

PLEASE SEE ATTACHED INFORMATION.
FOR YOUR REVIEW & COMMENTS

THANK YOU.

PAT MARCANTONIO

Questionnaire

Please return this questionnaire to a project team member before you leave, or you can mail it in later if you prefer ...

Please provide your name and/or street address PM

Name	
Street Address	
Phone Number	
Email	

Please note that with the exception of personal information, all comments will become part of the public record.

Question #1 – Why are you attending this meeting?

Interested Resident [✓] Land Owner [ ]

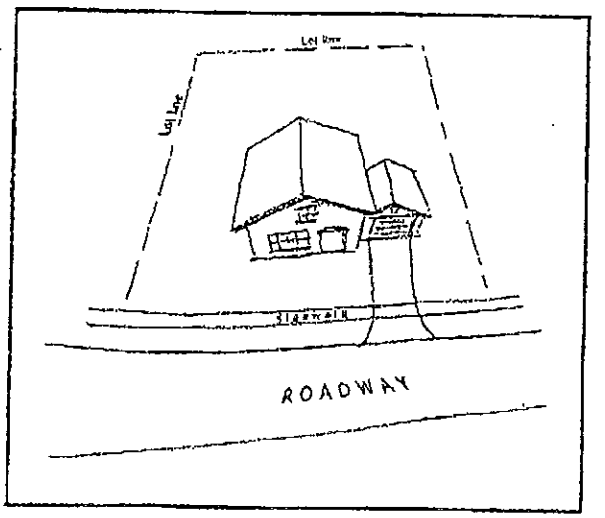
Other [ ]

(Please Specify) _____

Question #2 – your experience ...

We are hoping to get information from property owners regarding flooding impacts. In your experience, what was the impact on your property? MINIMAL
Was there flooding on your property? A BIT
Was there any damage to your house or other buildings? NO
Was there any damage to building contents? If so, how did water enter the building? NO
If flooding was limited to outdoor areas (back yard or front yard), where did the flow come from? Where did it go? LOCAL RUNOFF DRAINED OFF PROPERTY

You can use this diagram to indicate conditions on your property and the road in front of your house.



Question #3 – Do you have any concerns regarding the Preliminary Preferred Solution?

Yes ☑ No ☐

What are your concerns? Flooding ☐ Erosion ☐ Other ☑

Please describe them: ALTERATIONS TO GALLANOGH PARK

Question #4 – Is there any additional information that the project team should be considering in selecting the Preferred Solution?

IMPACT OF USAGE OF GALLANOUGH PARK

Question #5 – Other Comments ...

Do you have any other comments? Do you need any additional information to assist you to participate in this process?

NEED TO HAVE DETAILED INFORMATION ON CHANGES TO GALLANOUGH PARK IF SWM POND IS CONSTRUCTED

Question #6 – Do you wish to be added to the mailing list for this study? YES

Name: A D STAUFFER

Address: 53 SPRING GATE BLVD

THORNHILL Postal Code: L4J 8C9

Telephone: Fax:

Please fill out and leave at registration desk or send, before December 21, 2007 to:

City of Vaughan
Mr. Pat Marcantonio, CET
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario
L6A 1T1
Phone: (905) 832-8525 Ext. 3111
Fax: (905) 303-2045
Email: pat.marcantonio@vaughan.ca

Engineering Consulting Firm
Mr. Alan E. Winter, P.Eng.
GENIVAR Ontario Inc.
600 Cochrane Drive, Suite 500
Markham, Ontario
L3R 5K3
Phone: (905) 475-7270 Ext. 323
Fax: (905) 475-5994
Email: awinter@macviro.com

Questionnaire

Please return this questionnaire to a project team member before you leave, or you can mail it in later if you prefer ...

Please provide your name and/or street address

Name	
Street Address	
Phone Number	
Email	

Please note that with the exception of personal information, all comments will become part of the public record.

Question #1 – Why are you attending this meeting?

Interested Resident ☐ Land Owner ☒

Other ☐

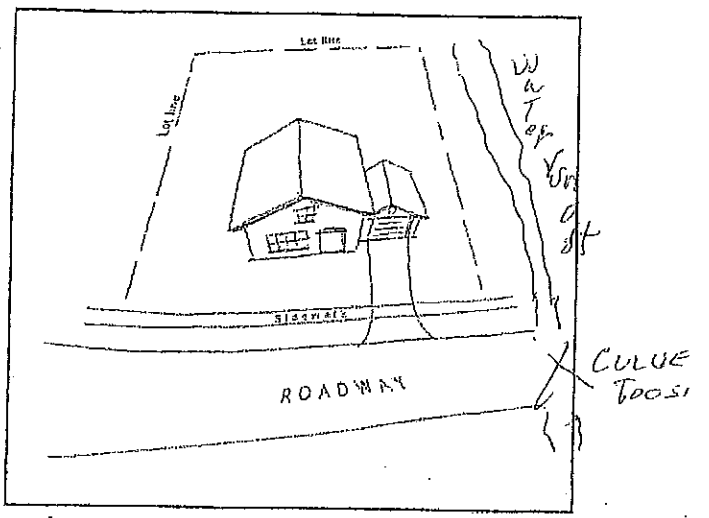
(Please Specify) _____

Question #2 – your experience ...

We are hoping to get information from property owners regarding flooding impacts. In your experience, what was the impact on your property?
Was there flooding on your property?
Was there any damage to your house or other buildings?
Was there any damage to building contents? If so, how did water enter the building?
If flooding was limited to outdoor areas (back yard or front yard), where did the flow come from? Where did it go?

You can use this diagram to indicate conditions on your property and the road in front of your house.

The culvert under Clarkehaven St is in bad shape and cannot carry increased run off. I have lived here for 50 years and there has been flooding every year due to the inadequacy of the culvert notably the flood of 2 years ago each year the run off eventually built up to the point of flowing over the road



Question #3 – Do you have any concerns regarding the Preliminary Preferred Solution?

Yes ☐ No ☒

What are your concerns? Flooding ☐ Erosion ☐ Other ☐

Please describe them: _____

_____

Question #4 – Is there any additional information that the project team should be considering in selecting the Preferred Solution?

looks OK to me

Question #5 – Other Comments ...

Do you have any other comments? Do you need any additional information to assist you to participate in this process?

good jobs so far

Question #6 – Do you wish to be added to the mailing list for this study?

Name: _____

Address: _____

Postal Code: _____

Telephone: _____ Fax: _____

Please fill out and leave at registration desk or send, before ~~December 21, 2007~~ Jan. 4th, 2008 to:

City of Vaughan
Mr. Pat Marcantonio, CET
Senior Engineering Assistant
City of Vaughan
2141 Major Mackenzie Drive
Vaughan, Ontario
L6A 1T1
Phone: (905) 832-8525 Ext. 3111
Fax: (905) 303-2045
Email: pat.marcantonio@vaughan.ca

Engineering Consulting Firm
Mr. Alan E. Winter, P.Eng.
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Phone: (905) 475-7270 Ext. 323
Fax: (905) 475-5994
Email: awinter@macviro.com

Thornhill Storm Drainage Improvement Study
Drainage Course #1

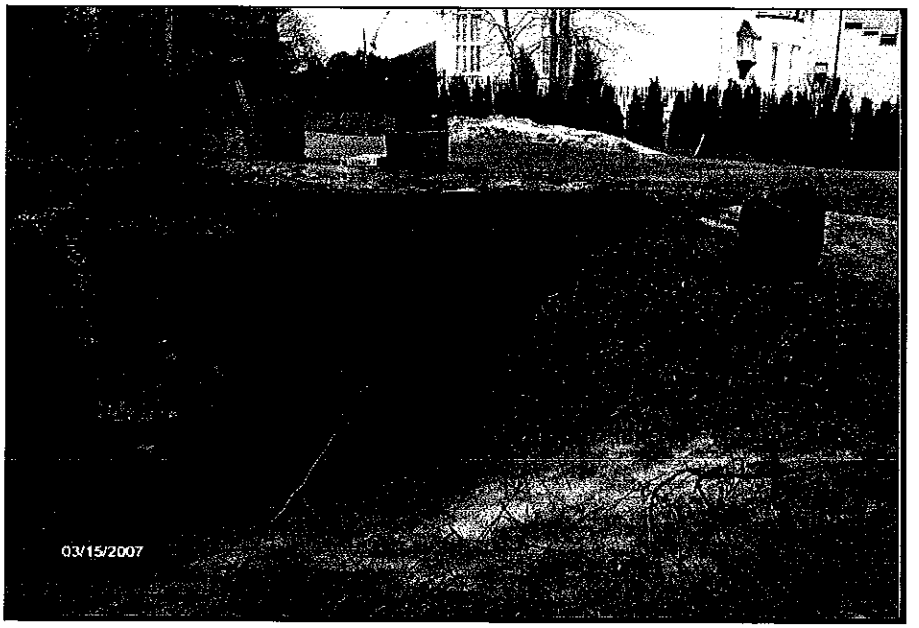

Photo 1 C11 - 1800 mm CSP crossing culvert on Charles St., south of Thornridge Dr.

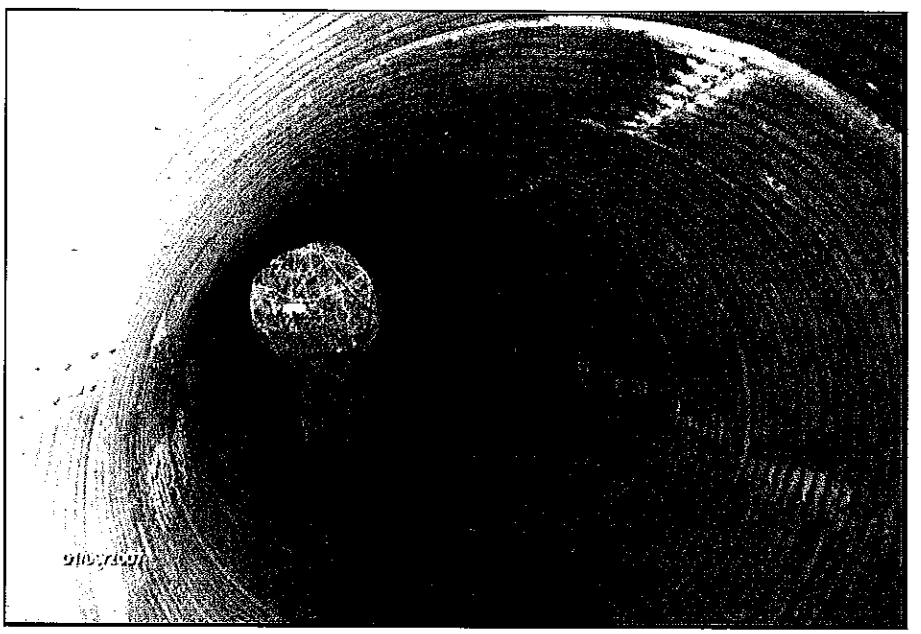

Photo 2 C12 - 1800 mm CSP crossing culvert on Thornridge Dr., east of Raymond Dr.
Middle section deformed and bottom broken

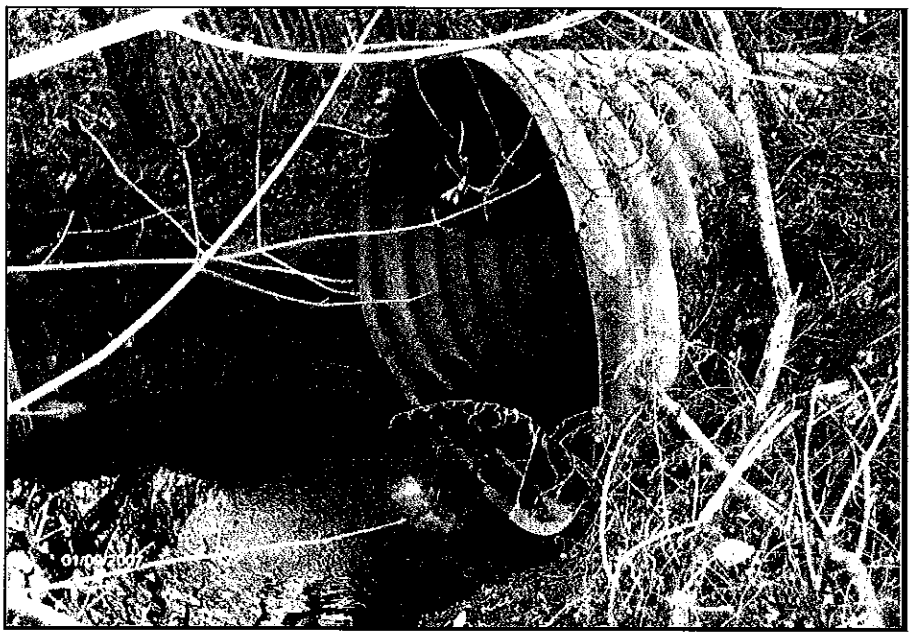

Photo 3 C13 - 1600x2200 mm CSPA crossing culvert on Clarkhaven St., south of Calvin Chamber Rd. Downstream side eroded

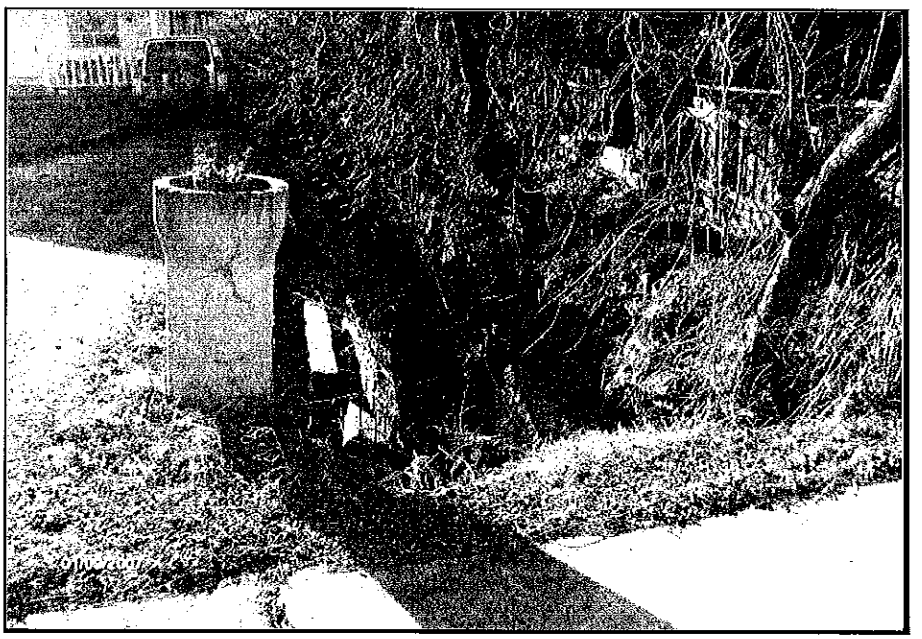

Photo 4 Upstream of Culvert C14 just south of Centre St. Drainage Couse is not well defined

Photo 5 Ditch inlet at the south west corner of Centre St. and Markwood Ln.
capture runoff from the west side ditch and convey it to the 1800 mm storm sewer under Centre St.

Photo 6 675 mm CSP side road culvert under Erica Rd. north of Centre St.
capture runoff from the west side ditch and convey it to the Oakbank Pond

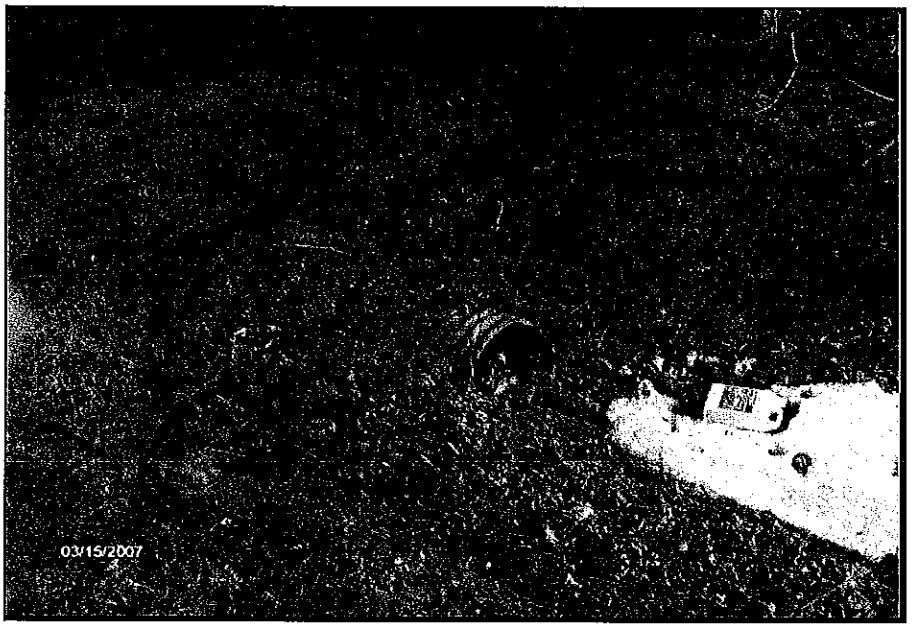

Photo 7 400 mm CSP driveway culvert west of C14, south of centre St. convey flow from ditch to Drainage Course #1 - culvert is in good condition

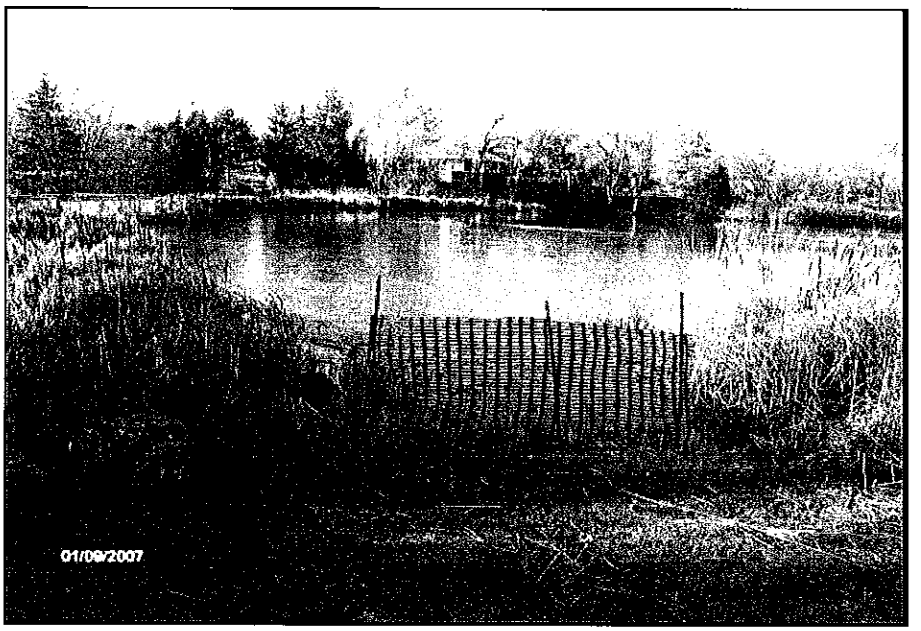

Photo 8 Oakbank Natural Pond north of Centre St. contribute to Drainage Course #1 through 600 mm CSP side road culvert C15

Photo 9 600 mm CSP side road culvert C15 (inlet)
convey discharged overflow from Oakbank pond to the north side ditch of Centre St.

Photo 10 600 mm CSP side road culvert C15 (outet)
convey discharged overflow from Oakbank pond to the north side ditch of Centre St. - outlet deformed

Thornhill Storm Drainage Improvement Study
Drainage Course #1

Photo 11 Outlet of 1200x1200 mm culvert C14.
Convey flow from drainage Course #1to north side ditch of Centre st.
Relief ditch inlet to convey flows from heavy storm events to the 2100 mm storm sewer along Centre St.

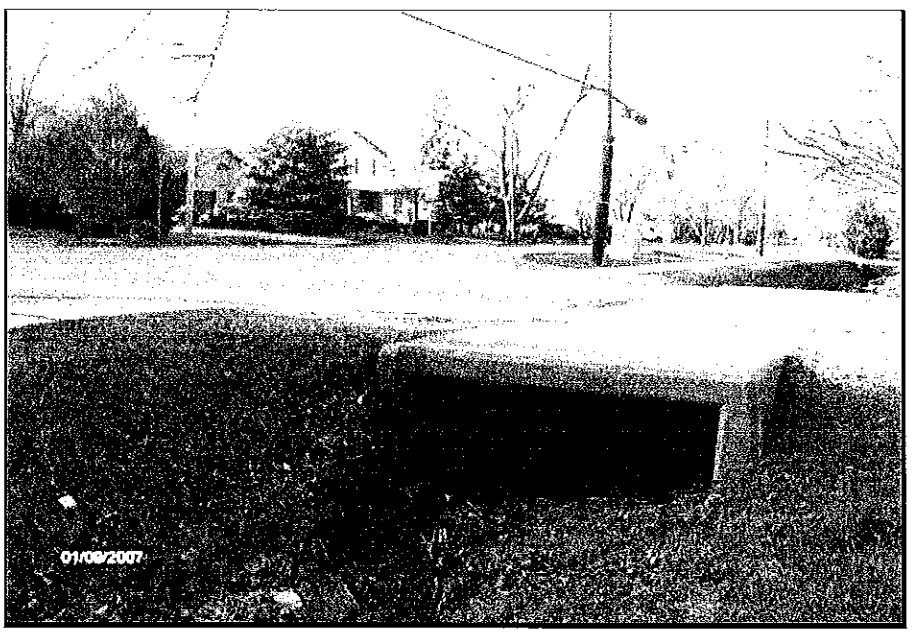

Photo 12 900x2400 mm side road culvert under Elmbank Rd. north of Centre St.

Photo 13 Upstream of Culvert C17 - cracked

Photo 14 Downstream of Culvert C17

Photo 15 Drainage Course #1, upstream of Culvert C17

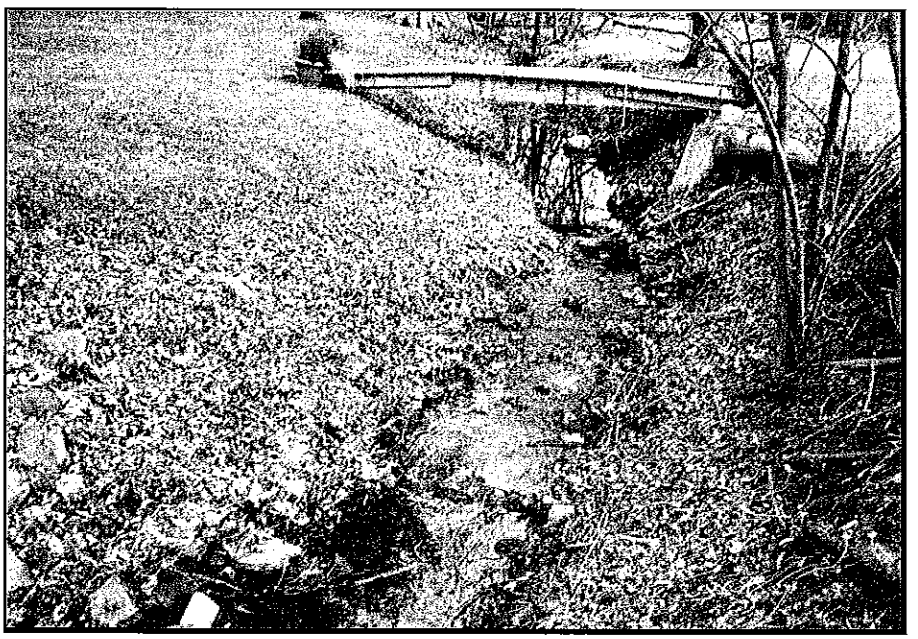

Photo 16 Drainage Course #1, downstream of Culvert C17

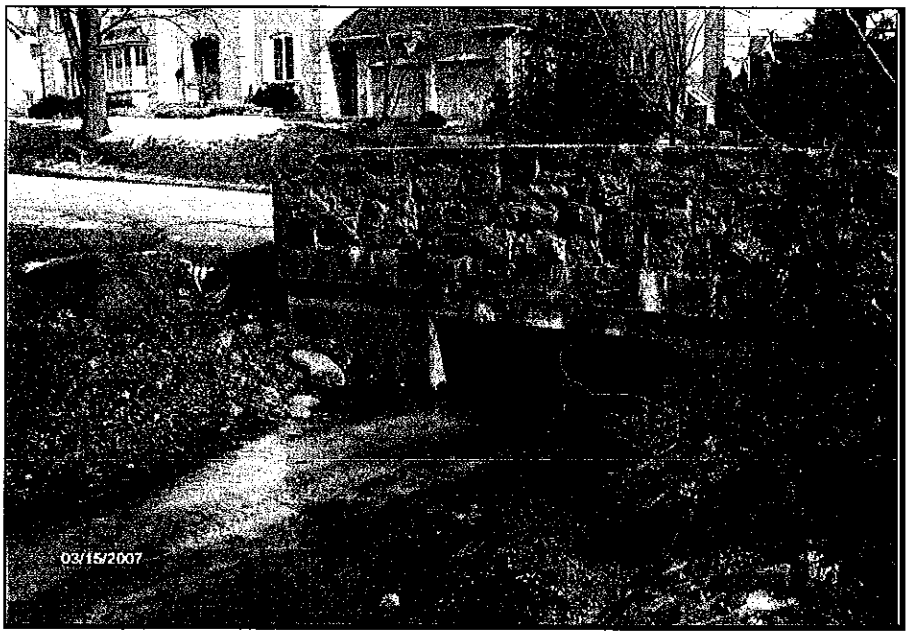

Photo 17 Upstream of Culvert C18

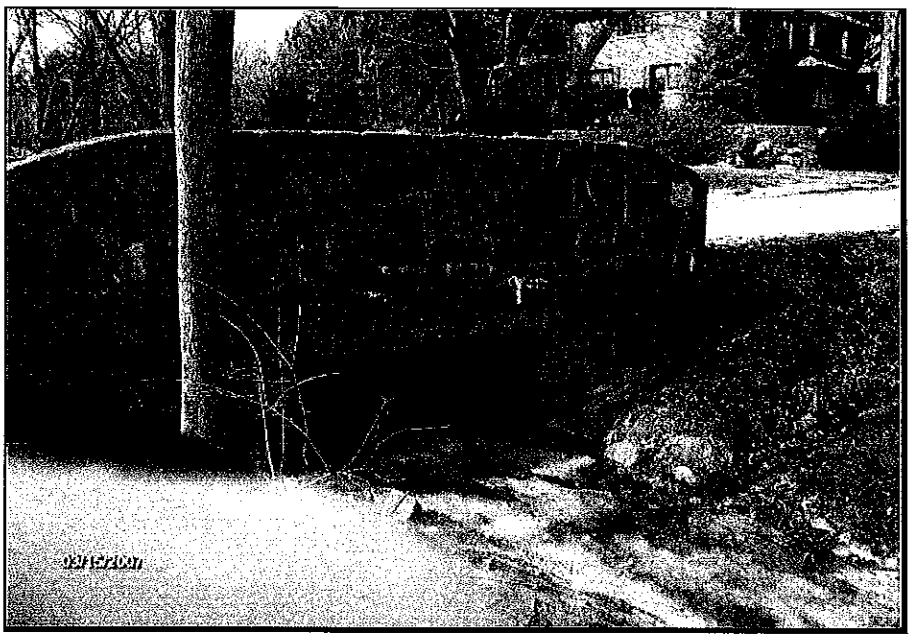

Photo 18 Downstream of Culvert C18

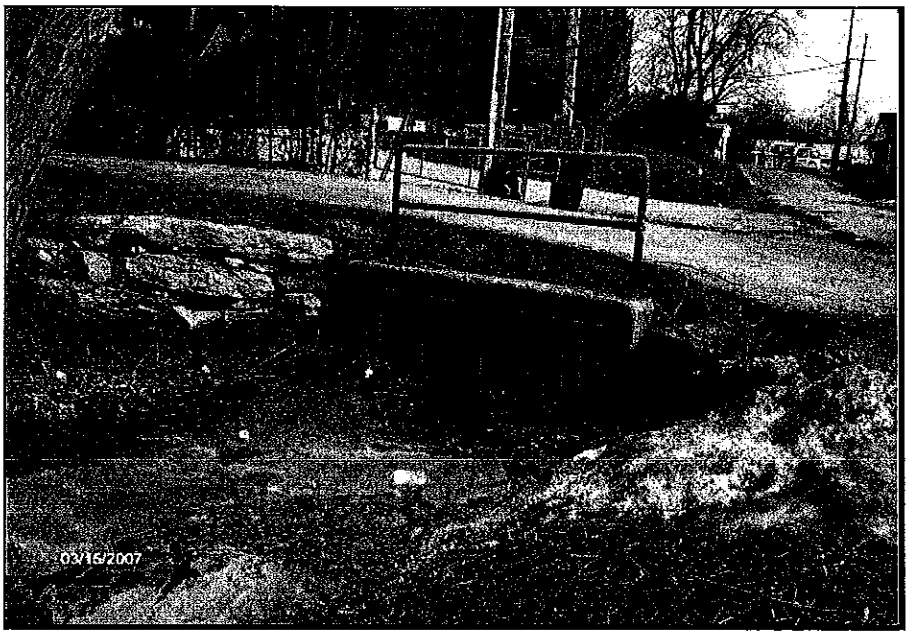

Photo 19 Upstream of Culvert C19

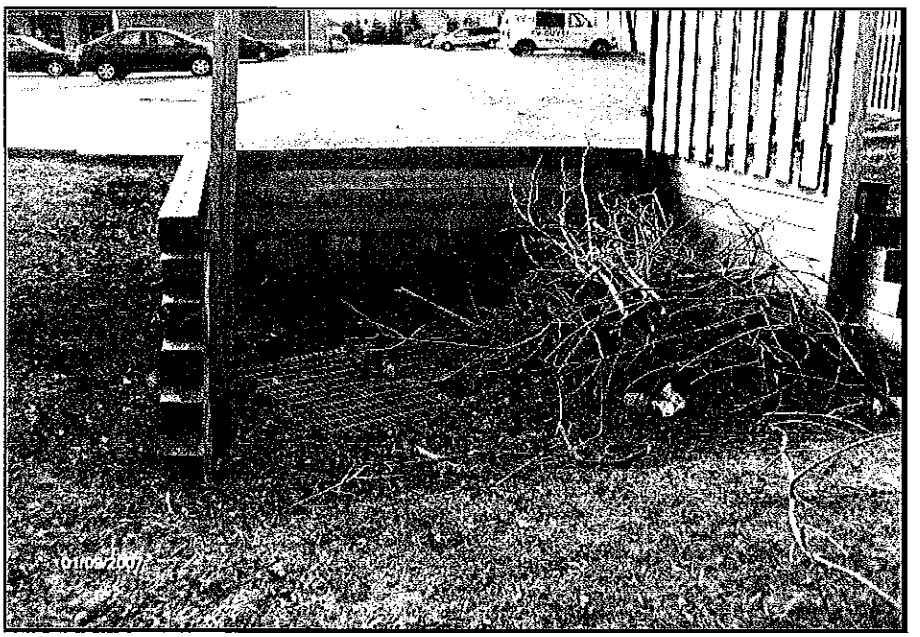

Photo 20 1200x2400 mm ditch inlet on the south side of Old Jane St. connected to culvert C19

Photo 21 1200x2400 mm ditch inlet on the west side of Yonge St. connected to culvert C19

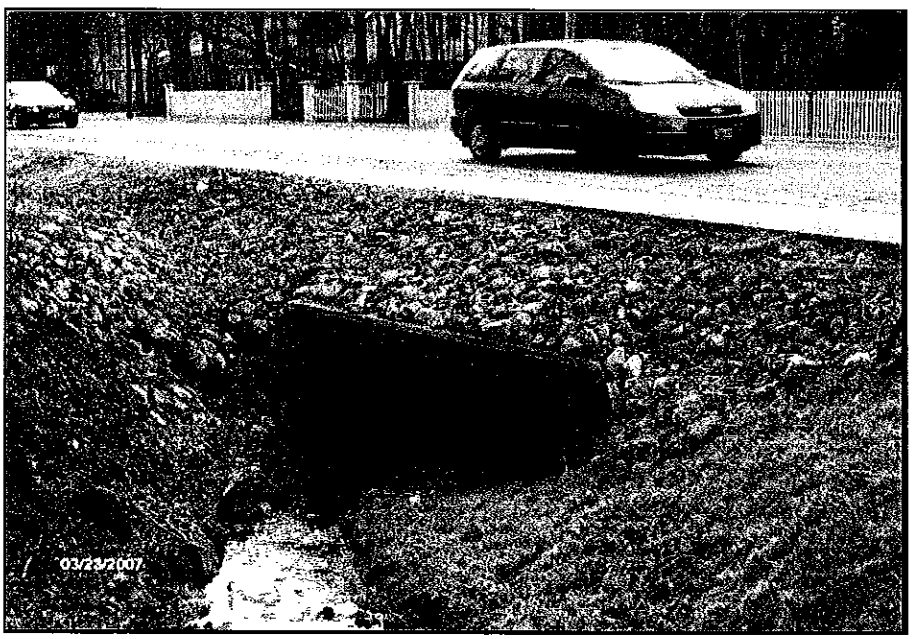

Photo 22 1200x2500 mm crossing culvert C16 under Centre st. east of Donna Mae Cr.

Photo 23 Inlet of 700x1100 mm CSPA crossing culvert C1`on Arnold Ave., west of Charles St. minor deformation

Photo 24 Outlet of 700x1100 mm CSPA crossing culvert C1`on Arnold Ave., west of Charles St. minor deformation

Photo 25 600 mm CSP driveway culvert D1 at the driveway of 132 Arnold Ave.
Culvert is undersized

Photo 26 1000x1700 mm CSPA crossing culvert C2 on Charles St. north of Arnold Ave.
Culvert is rusted

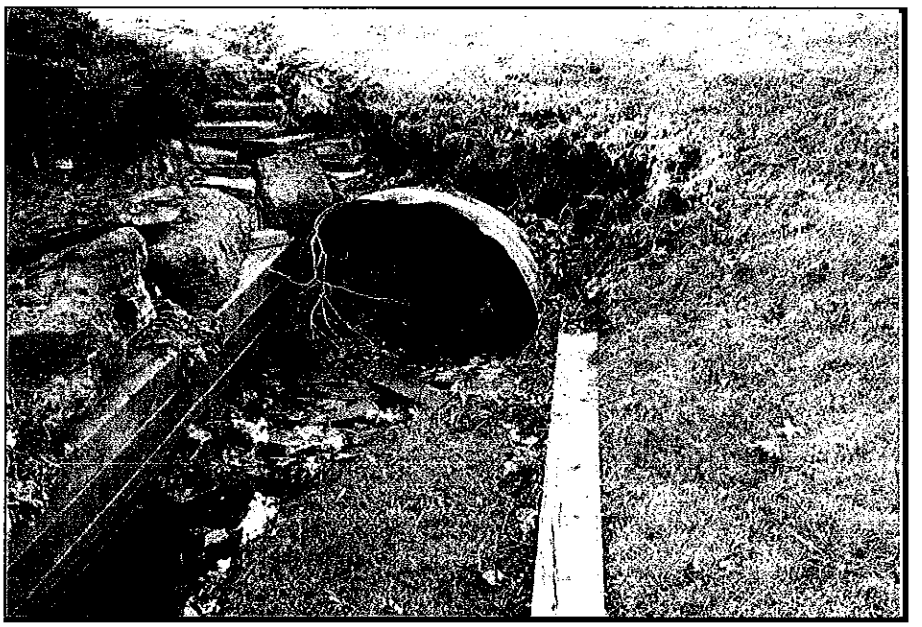

Photo 27 Inlet of 800x1300 CSPA crossing culvert C3 on Clarkhaven St. south of Thornridge Dr. Culvert condition is acceptable

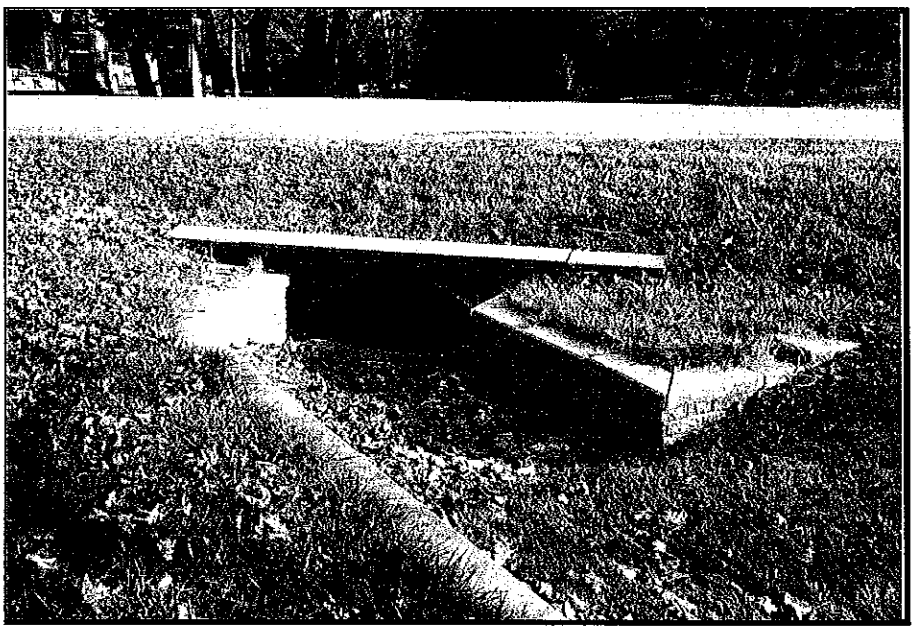

Photo 28 Outlet of 800x1300 CSPA crossing culvert C3 on Clarkhaven St. south of Thornridge Dr. Culvert condition is acceptable

Thornhill Storm Drainage Improvement Study
Drainage Course #2

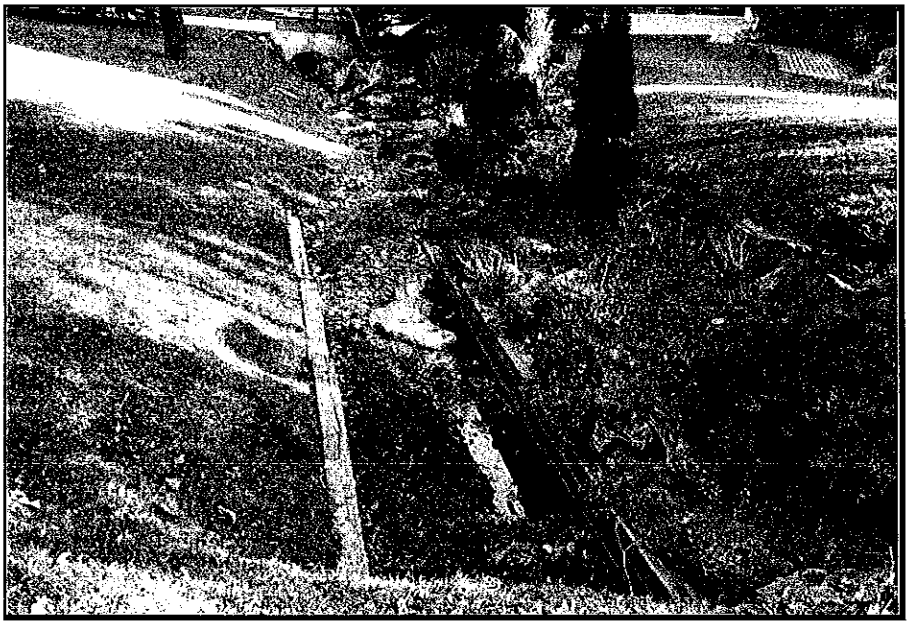

Photo 29 Drainage Course #2 downstream of culvert C3

Photo 30 Drainage Course #2 upstream of culvert C3

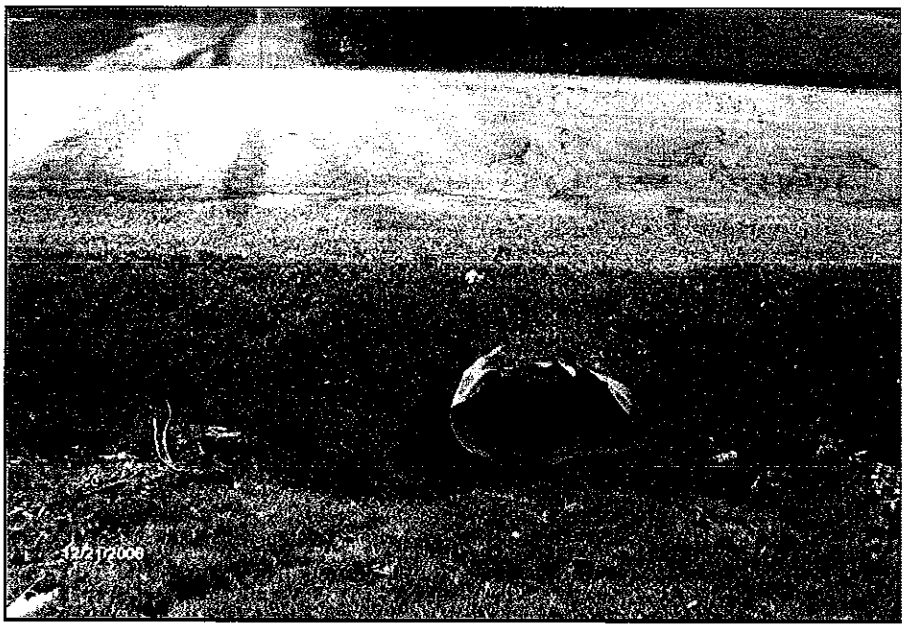

Photo 31 Inlet of 400x750 mm CSPA crossing culvert C4 on Thornridge Dr. west of Brooke St.
Inlet is deformed and in poor condition

Photo 32 Outlet of 400x750 mm CSPA crossing culvert C4 on Thornridge Dr. west of Brooke St.
Outlet is deformed and in poor condition

Photo 33 Drainage Course #2, downstream of Culvert C4

Photo 34 Inlet of 400 CSP crossing culvert C5 at the intersection of Thornridge Dr. and Brooke St.
Culvert is deformed and in poor condition

Photo 35 Outlet of 400 CSP crossing culvert C5 at the intersection of Thornridge Dr. and Brooke St.
Culvert is deformed and in poor condition

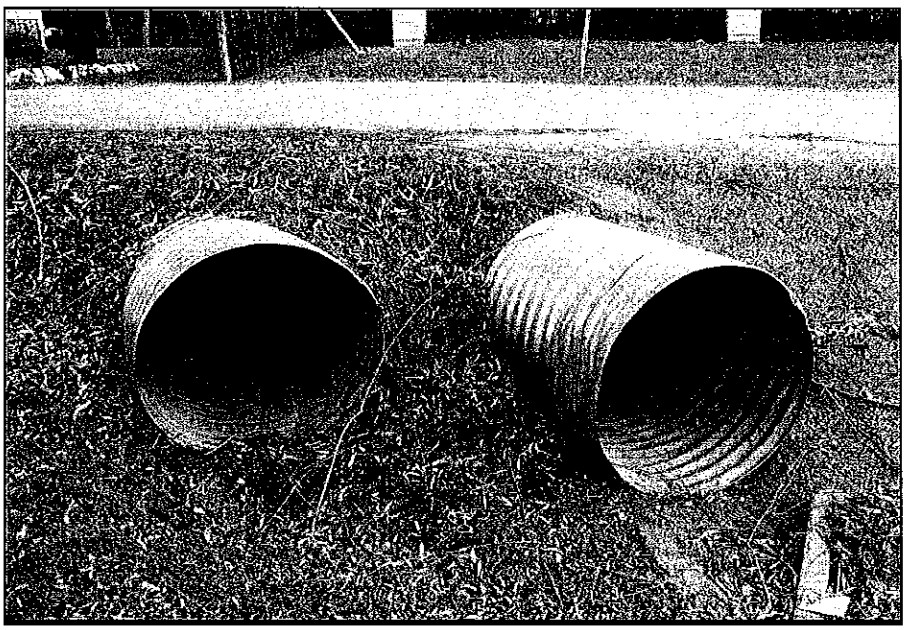

Photo 36 Inlet of 2 x 800 mm CSP crossing culvert C6 on Brooke St. north of Arnold Ave.
Culvert is in good condition

Photo 37 Outlet of 2 x 800 mm CSP crossing culvert C6 on Brooke St. north of Arnold Ave.
Culvert is in good condition

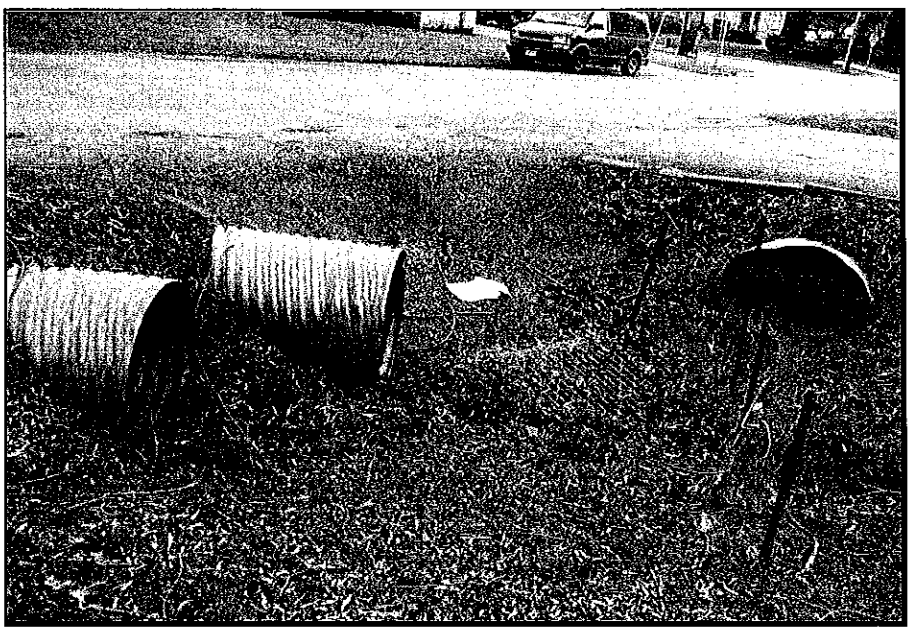

Photo 38 800x1350 mm DICB 1 with 2 x800 CSP crossing culverts on Brooke St. north of Arnold Ave.

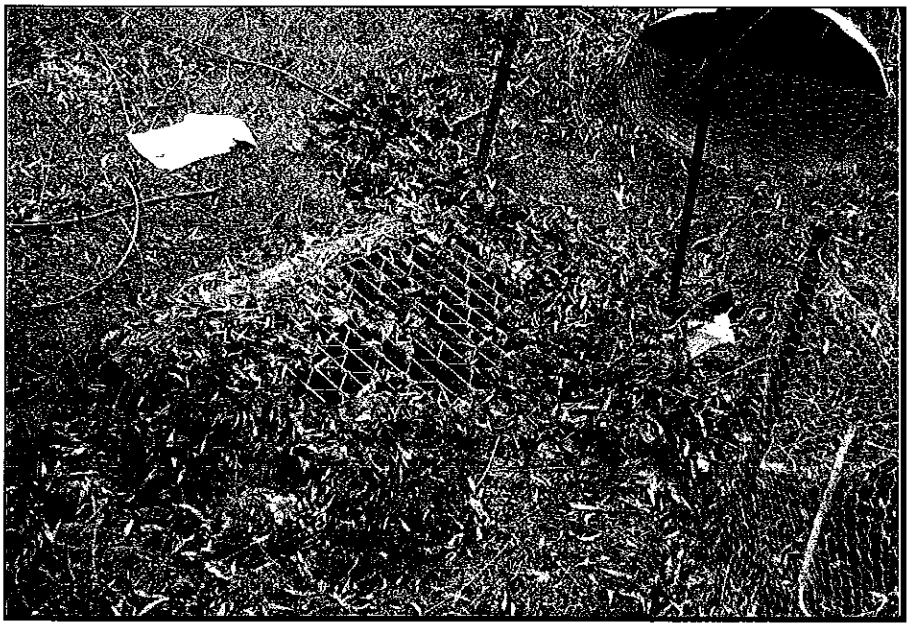

Photo 39 800x1350 mm DICB 1 on Brooke St. north of Arnold Ave.

Photo 40 Drainage Course #2, downstream of Culvert C6

Photo 41 Inlet of side road culvert on the north side of Arnold Ave. at Clarkhaven St.
Culvert inlet is buried due to construction activity

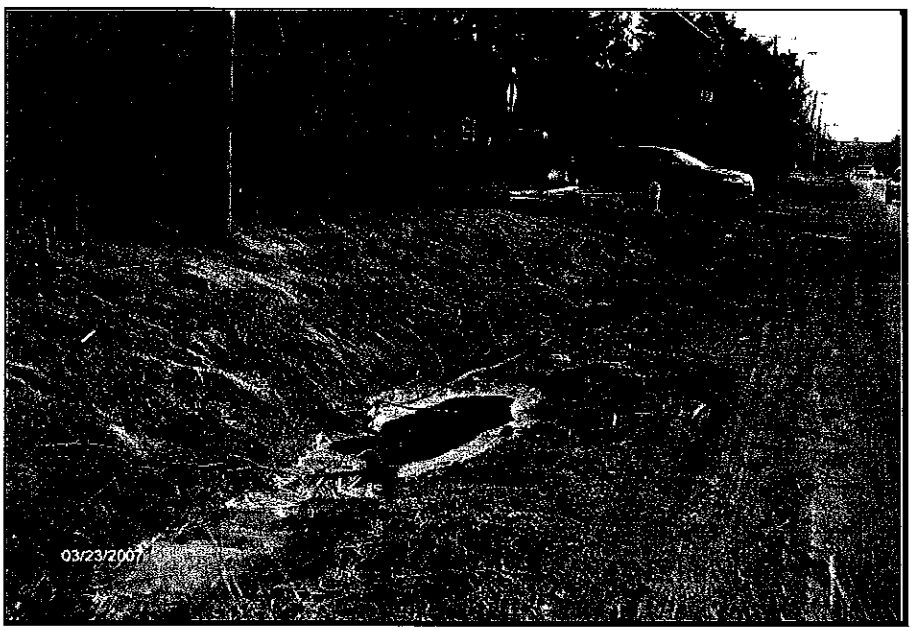

Photo 42 Ditch upstream of side road culvert on the north side of Arnold Ave. at Clarkhaven St.
Culvert inlet is buried and ditch is ponding

Photo 43 Outlet of 400 mm CSP side road culvert on the north side of Arnold Ave. at Clarkhaven St.
Culvert outlet is deformed

Photo 44 Flow is ponding in the ditch located on the north east corner of Thornridge Dr. and Elizabeth St.

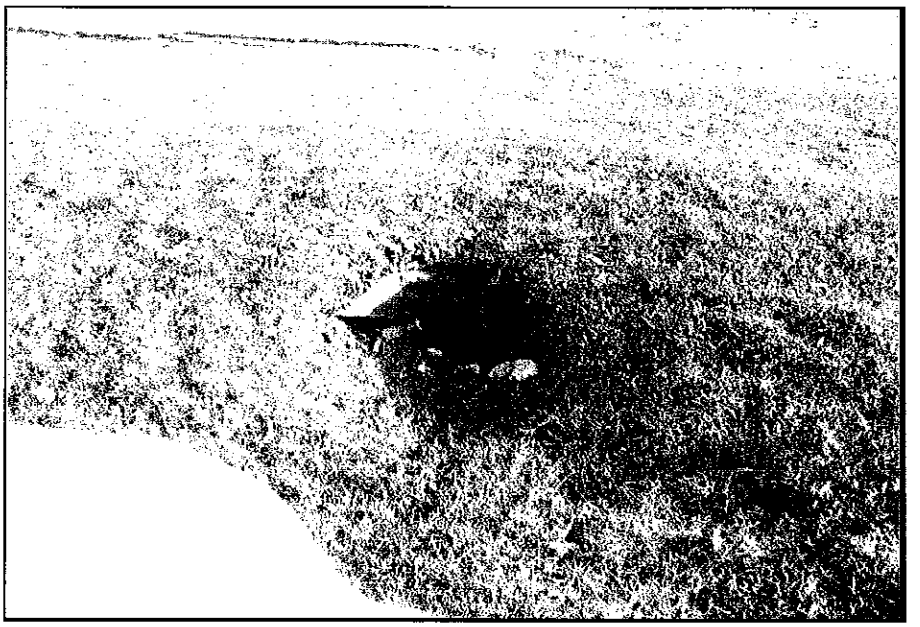

Photo 45 Side road culvert on the north side of Thornridge Dr. and Elizabeth St. intersection is completely blocked.

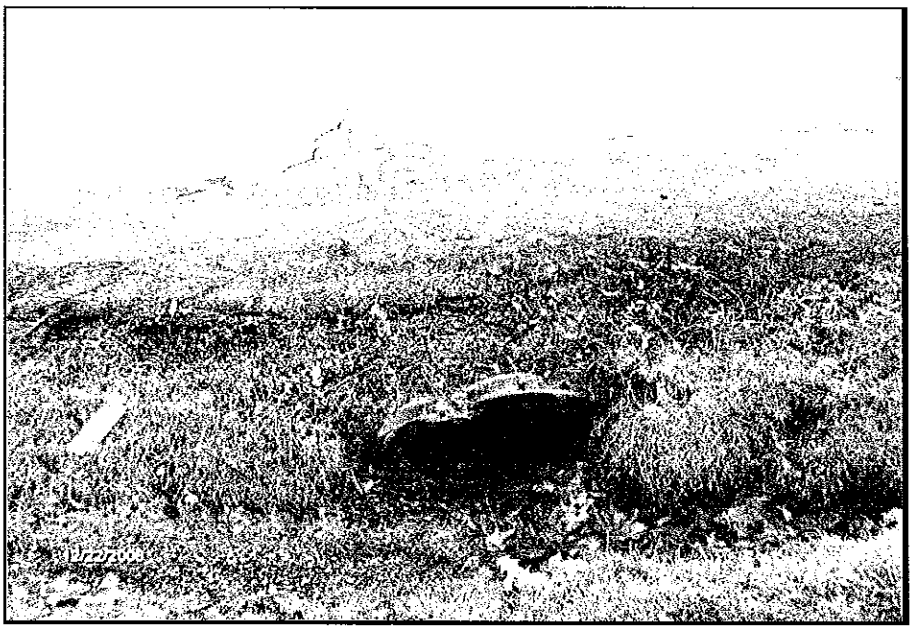

Photo 46 Inlet of 200x600 mm CSPA crossing culvert on Thornridge Dr. east of Brooke st.
Culvert is deformed, rusted, and in poor condition

Photo 47 Outlet of 200x600 mm CSPA crossing culvert on Thornridge Dr. east of Brooke st.
Culvert is deformed, rusted, and in poor condition

Photo 48 Inlet of 300 mm CSP driveway culvert at house no. 23 Thornridge Dr.
Culvert is undersized.

Photo 49 Outlet of 300 mm CSP driveway culvert at house no. 23 Thornridge Dr.
Culvert is undersized.

Photo 50 Drainage course between houses 23 and 27 Thornridge Dr.

Thornhill Storm Drainage Improvement Study
Drainage Course #2

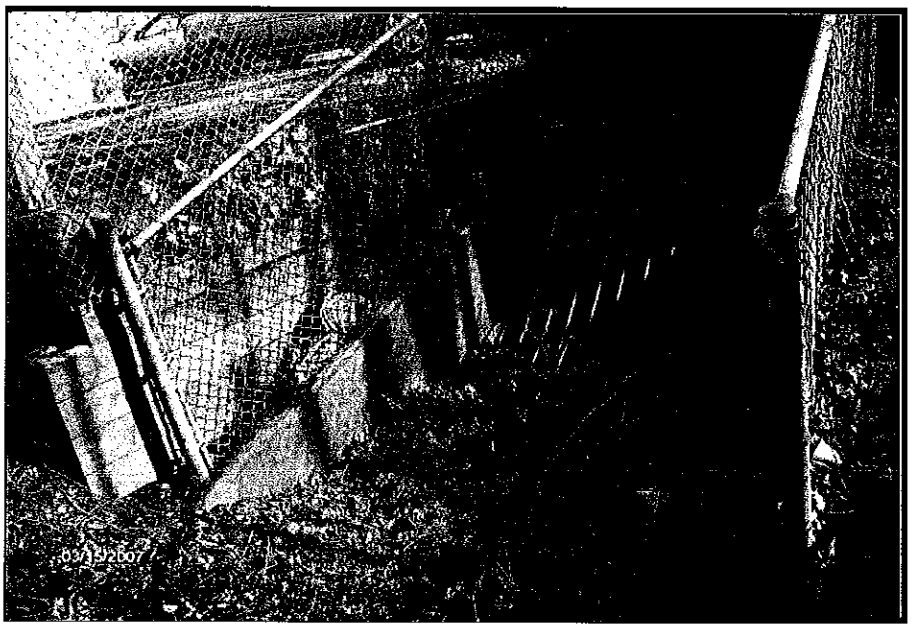

Photo 51 1200 mm Concrete storm sewer inlet at the downstream end of Drainage Course #2 located west of Yonge St. and north of Arnold Ave.

Photo 52 400 mm CSP side road culvert at the south side of Arnold Ave. at Clarkhaven St.
Culvert is deformed and in poor condition

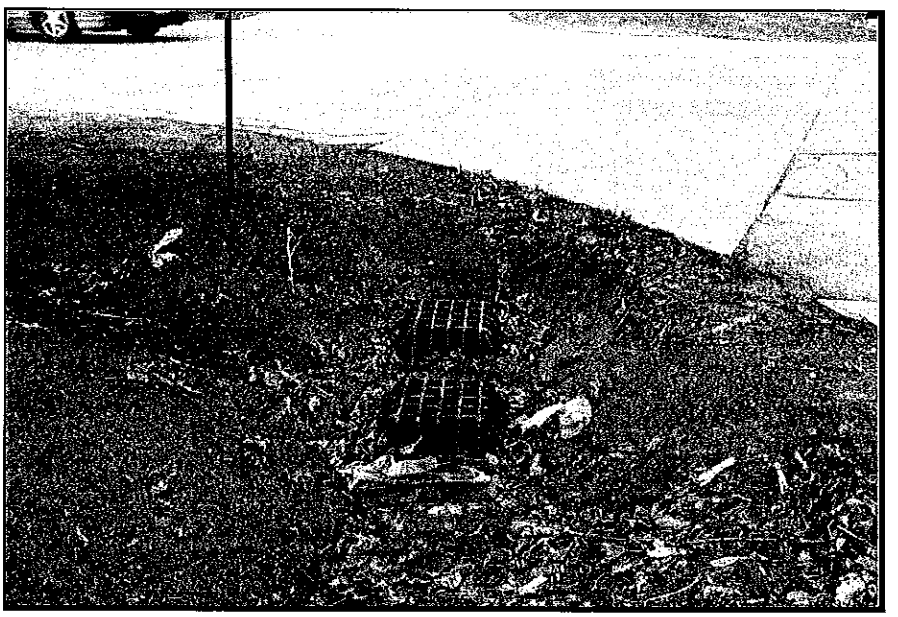

Photo 53 Twin Ditch Inlet DICB 2 at the south west corner of Brooke St. and Arnold Ave.
Twin ditch inlets and the connecting 375 mm pipe is undersized.

Culvert Designer/Analyzer Report
D1 - 100 Year

Analysis Component			
Storm Event	Check	Discharge	1.4100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.4900 m³/s	Check Discharge	1.4100 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	182.30 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-600 mm Circular	0.6419 m³/s	183.20 m	2.43 m/s
Weir	Roadway	0.7690 m³/s	183.20 m	N/A
Total	----------	1.4109 m³/s	183.20 m	N/A

Culvert Designer/Analyzer Report
D1 - 100 Year

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	183.20 m	Discharge	0.6419 m³/s
Inlet Control HW Elev	183.20 m	Tailwater Elevation	182.30 m
Outlet Control HW Elev	183.20 m	Control Type	Outlet Control
Headwater Depth/ Height	1.98		

Grades			
Upstream Invert	182.00 m	Downstream Invert	181.93 m
Length	7.00 m	Constructed Slope	0.010000 m/m

Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	0.52 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.52 m
Velocity Downstream	2.43 m/s	Critical Slope	0.032340 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CSP	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	183.20 m	Upstream Velocity Head	0.25 m
Ke	0.90	Entrance Loss	0.22 m

Inlet Control Properties			
Inlet Control HW Elev	183.20 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.3 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
D1 - 100 Year

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.7690 m³/s	Allowable HW Elevation	183.20 m
Roadway Width	7.00 m	Overtopping Coefficient	1.67 SI
Low Point	183.00 m	Headwater Elevation	183.20 m
Discharge Coefficient (Cr)	3.02	Submergence Factor (Kt)	1.00
Tailwater Elevation	182.30 m		

Sta (m)	Elev (m)
0.00	183.00
5.00	183.00

Culvert Designer/Analyzer Report
C2 - 100 Year

Analysis Component			
Storm Event	Design	Discharge	2.5100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.5100 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	181.83 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-1650 x 1020 mm Arch	2.5096 m³/s	182.67 m	2.60 m/s
Weir	Roadway	0.0000 m³/s	182.67 m	N/A
Total	----------	2.5096 m³/s	182.67 m	N/A

Culvert Designer/Analyzer Report
C2 - 100 Year

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	182.67 m	Discharge	2.5096 m³/s
Inlet Control HW Elev	182.62 m	Tailwater Elevation	181.83 m
Outlet Control HW Elev	182.67 m	Control Type	Outlet Control
Headwater Depth/ Height	1.25		

Grades			
Upstream Invert	181.40 m	Downstream Invert	181.33 m
Length	7.00 m	Constructed Slope	0.010000 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.66 m
Slope Type	Mild	Normal Depth	0.86 m
Flow Regime	Subcritical	Critical Depth	0.66 m
Velocity Downstream	2.60 m/s	Critical Slope	0.016234 m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.025
Section Material	Steel and Aluminum Var CR Historic	Span	1.65 m
Section Size	1650 x 1020 mm	Rise	1.02 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	182.67 m	Upstream Velocity Head	0.27 m
Ke	0.90	Entrance Loss	0.24 m

Inlet Control Properties			
Inlet Control HW Elev	182.62 m	Flow Control	N/A
Inlet Type	Thin wall projecting	Area Full	1.3 m²
K	0.03400	HDS 5 Chart	40
M	1.50000	HDS 5 Scale	3
C	0.04960	Equation Form	1
Y	0.57000		

Culvert Designer/Analyzer Report
C2 - 100 Year

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000 m³/s	Allowable HW Elevation	182.67 m
Roadway Width	7.00 m	Overtopping Coefficient	1.60 SI
Low Point	182.90 m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	181.83 m		

Sta (m)	Elev (m)
0.00	182.90
10.00	182.90

Culvert Designer/Analyzer Report
C3 - 100 Year

Analysis Component			
Storm Event	Design	Discharge	2.5100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.5100 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	178.70 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-1270 x 790 mm Arch	2.1510 m³/s	179.98 m	3.01 m/s
Weir	Roadway	0.3593 m³/s	179.98 m	N/A
Total	----------	2.5103 m³/s	179.98 m	N/A

Culvert Designer/Analyzer Report
C3 - 100 Year

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	179.98	m	Discharge	2.1510	m³/s
Inlet Control HW Elev	179.98	m	Tailwater Elevation	178.70	m
Outlet Control HW Elev	179.92	m	Control Type	Inlet Control	
Headwater Depth/ Height	2.13				

Grades					
Upstream Invert	178.30	m	Downstream Invert	178.23	m
Length	7.00	m	Constructed Slope	0.010000	m/m

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	0.66	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.66	m
Velocity Downstream	3.01	m/s	Critical Slope	0.029464	m/m

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR Historic		Span	1.27	m
Section Size	1270 x 790 mm		Rise	0.79	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	179.92	m	Upstream Velocity Head	0.39	m
Ke	0.90		Entrance Loss	0.35	m

Inlet Control Properties					
Inlet Control HW Elev	179.98	m	Flow Control	N/A	
Inlet Type	Thin wall projecting		Area Full	0.8	m²
K	0.03400		HDS 5 Chart	40	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

Culvert Designer/Analyzer Report
C3 - 100 Year

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.3593 m³/s	Allowable HW Elevation	179.98 m
Roadway Width	7.00 m	Overtopping Coefficient	1.64 SI
Low Point	179.90 m	Headwater Elevation	179.98 m
Discharge Coefficient (Cr)	2.97	Submergence Factor (Kt)	1.00
Tailwater Elevation	178.70 m		

Sta (m)	Elev (m)
0.00	179.90
10.00	179.90

Culvert Designer/Analyzer Report
C4 - 100 Year

Analysis Component			
Storm Event	Design	Discharge	0.7700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.7700 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	175.10 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-490 x 770 mm Horiz Ellipse	0.7398 m³/s	175.82 m	2.53 m/s
Weir	Roadway	0.0305 m³/s	175.82 m	N/A
Total	----------	0.7703 m³/s	175.82 m	N/A

Culvert Designer/Analyzer Report
C4 - 100 Year

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	175.82	m	Discharge	0.7398	m³/s
Inlet Control HW Elev	175.74	m	Tailwater Elevation	175.10	m
Outlet Control HW Elev	175.82	m	Control Type	Outlet Control	
Headwater Depth/ Height	2.08				

Grades					
Upstream Invert	174.80	m	Downstream Invert	174.73	m
Length	7.00	m	Constructed Slope	0.010000	m/m

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	0.44	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.44	m
Velocity Downstream	2.53	m/s	Critical Slope	0.034560	m/m

Section					
Section Shape	Horizontal Ellipse		Mannings Coefficient	0.024	
Section Material	Concrete		Span	0.77	m
Section Size	490 x 770 mm		Rise	0.49	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	175.82	m	Upstream Velocity Head	0.30	m
Ke	0.20		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev	175.74	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	29	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C4 - 100 Year

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.0305 m³/s	Allowable HW Elevation	175.82 m
Roadway Width	7.00 m	Overtopping Coefficient	1.61 SI
Low Point	175.80 m	Headwater Elevation	175.82 m
Discharge Coefficient (Cr)	2.92	Submergence Factor (Kt)	1.00
Tailwater Elevation	175.10 m		

Sta (m)	Elev (m)
0.00	175.80
10.00	175.80

Culvert Designer/Analyzer Report
C5 - 100 Year

Analysis Component			
Storm Event	Design	Discharge	0.6200 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.6200 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	175.40 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-400 mm Circular	0.2223 m³/s	176.08 m	1.97 m/s
Weir	Roadway	0.3988 m³/s	176.08 m	N/A
Total	----------	0.6211 m³/s	176.08 m	N/A

Culvert Designer/Analyzer Report
C5 - 100 Year

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	176.08	m	Discharge	0.2223	m³/s
Inlet Control HW Elev	175.99	m	Tailwater Elevation	175.40	m
Outlet Control HW Elev	176.08	m	Control Type	Outlet Control	
Headwater Depth/ Height	2.22				

Grades					
Upstream Invert	175.20	m	Downstream Invert	175.13	m
Length	7.00	m	Constructed Slope	0.010000	m/m

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	0.34	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.34	m
Velocity Downstream	1.97	m/s	Critical Slope	0.037287	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CSP		Span	0.40	m
Section Size	400 mm		Rise	0.40	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	176.08	m	Upstream Velocity Head	0.16	m
Ke	0.90		Entrance Loss	0.15	m

Inlet Control Properties					
Inlet Control HW Elev	175.99	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.1	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C5 - 100 Year

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.3988 m³/s	Allowable HW Elevation	176.08 m
Roadway Width	7.00 m	Overtopping Coefficient	1.64 SI
Low Point	176.00 m	Headwater Elevation	176.08 m
Discharge Coefficient (Cr)	2.97	Submergence Factor (Kt)	1.00
Tailwater Elevation	175.40 m		

Sta (m)	Elev (m)
0.00	176.00
10.00	176.00

Culvert Designer/Analyzer Report
C11- 100 Year

Analysis Component			
Storm Event	Design	Discharge	1.0900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.0900 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	180.90 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-1800 mm Circular	1.0886 m³/s	181.00 m	0.85 m/s
Weir	Roadway	0.0000 m³/s	181.00 m	N/A
Total	----------	1.0886 m³/s	181.00 m	N/A

Culvert Designer/Analyzer Report
C11- 100 Year

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	181.00 m	Discharge	1.0886 m³/s
Inlet Control HW Elev	180.90 m	Tailwater Elevation	180.90 m
Outlet Control HW Elev	181.00 m	Control Type	Outlet Control
Headwater Depth/ Height	0.49		

Grades			
Upstream Invert	180.10 m	Downstream Invert	180.00 m
Length	10.00 m	Constructed Slope	0.010000 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.90 m
Slope Type	Mild	Normal Depth	0.51 m
Flow Regime	Subcritical	Critical Depth	0.50 m
Velocity Downstream	0.85 m/s	Critical Slope	0.010544 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CSP	Span	1.83 m
Section Size	1800 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	181.00 m	Upstream Velocity Head	0.05 m
Ke	0.90	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev	180.90 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	2.6 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
C11- 100 Year

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000 m³/s	Allowable HW Elevation	181.00 m
Roadway Width	10.00 m	Overtopping Coefficient	1.60 SI
Low Point	181.90 m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	180.90 m		

Sta (m)	Elev (m)
0.00	181.90
20.00	181.90

Culvert Designer/Analyzer Report
C12 - 100 Year

Analysis Component			
Storm Event	Design	Discharge	1.4200 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.4200 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	179.50 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-1800 mm Circular	1.4192 m³/s	179.66 m	1.10 m/s
Weir	Roadway	0.0000 m³/s	179.66 m	N/A
Total	----------	1.4192 m³/s	179.66 m	N/A

Culvert Designer/Analyzer Report
C12 - 100 Year

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	179.66 m	Discharge	1.4192 m³/s
Inlet Control HW Elev	179.51 m	Tailwater Elevation	179.50 m
Outlet Control HW Elev	179.66 m	Control Type	Outlet Control
Headwater Depth/ Height	0.53		

Grades			
Upstream Invert	178.70 m	Downstream Invert	178.60 m
Length	10.00 m	Constructed Slope	0.010000 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.90 m
Slope Type	Mild	Normal Depth	0.58 m
Flow Regime	Subcritical	Critical Depth	0.57 m
Velocity Downstream	1.10 m/s	Critical Slope	0.010535 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CSP	Span	1.83 m
Section Size	1800 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	179.66 m	Upstream Velocity Head	0.08 m
Ke	0.90	Entrance Loss	0.07 m

Inlet Control Properties			
Inlet Control HW Elev	179.51 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	2.6 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
C12 - 100 Year

Component:Weir

Hydraulic Component(s): Roadway				
Discharge	0.0000	m³/s	Allowable HW Elevation	179.66 m
Roadway Width	10.00	m	Overtopping Coefficient	1.60 SI
Low Point	180.80	m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt)	1.00
Tailwater Elevation	179.50	m		

Sta (m)	Elev (m)
0.00	180.80
20.00	180.80

Culvert Designer/Analyzer Report
C13 - 100 Year

Analysis Component			
Storm Event	Design	Discharge	1.4700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.4700 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	177.30 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-2210 x 1600 mm Arch	1.4686 m³/s	177.42 m	0.95 m/s
Weir	Roadway	0.0000 m³/s	177.42 m	N/A
Total	----------	1.4686 m³/s	177.42 m	N/A

Culvert Designer/Analyzer Report
C13 - 100 Year

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	177.42 m	Discharge	1.4686 m³/s
Inlet Control HW Elev	177.30 m	Tailwater Elevation	177.30 m
Outlet Control HW Elev	177.42 m	Control Type	Outlet Control
Headwater Depth/ Height	0.51		

Grades			
Upstream Invert	176.60 m	Downstream Invert	176.50 m
Length	10.00 m	Constructed Slope	0.010000 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.80 m
Slope Type	Mild	Normal Depth	0.46 m
Flow Regime	Subcritical	Critical Depth	0.45 m
Velocity Downstream	0.95 m/s	Critical Slope	0.010502 m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.025
Section Material	Steel and Aluminum Var CR Historic	Span	2.21 m
Section Size	2210 x 1600 mm	Rise	1.60 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	177.42 m	Upstream Velocity Head	0.06 m
Ke	0.90	Entrance Loss	0.06 m

Inlet Control Properties			
Inlet Control HW Elev	177.30 m	Flow Control	N/A
Inlet Type	Thin wall projecting	Area Full	2.8 m²
K	0.03400	HDS 5 Chart	40
M	1.50000	HDS 5 Scale	3
C	0.04960	Equation Form	1
Y	0.57000		

Culvert Designer/Analyzer Report
C13 - 100 Year

Component:Weir

Hydraulic Component(s): Roadway				
Discharge	0.0000	m^3/s	Allowable HW Elevation	177.42 m
Roadway Width	10.00	m	Overtopping Coefficient	1.60 SI
Low Point	178.50	m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt)	1.00
Tailwater Elevation	177.30	m		

Sta (m)	Elev (m)
0.00	178.50
20.00	178.50

Culvert Designer/Analyzer Report
C14 - 100 Year

Analysis Component			
Storm Event	Design	Discharge	1.7100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.7100 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	174.90 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-1220 x 1220 mm Box	1.7093 m³/s	175.46 m	2.34 m/s
Weir	Roadway	0.0000 m³/s	175.46 m	N/A
Total	----------	1.7093 m³/s	175.46 m	N/A

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Culvert Designer/Analyzer Report
C14 - 100 Year

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	175.46 m	Discharge	1.7093 m³/s
Inlet Control HW Elev	175.39 m	Tailwater Elevation	174.90 m
Outlet Control HW Elev	175.46 m	Control Type	Outlet Control
Headwater Depth/ Height	0.87		

Grades			
Upstream Invert	174.40 m	Downstream Invert	174.30 m
Length	10.00 m	Constructed Slope	0.010000 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.60 m
Slope Type	Mild	Normal Depth	0.62 m
Flow Regime	Subcritical	Critical Depth	0.59 m
Velocity Downstream	2.34 m/s	Critical Slope	0.011503 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.020
Section Material	Concrete	Span	1.22 m
Section Size	1220 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	175.46 m	Upstream Velocity Head	0.26 m
Ke	0.70	Entrance Loss	0.18 m

Inlet Control Properties			
Inlet Control HW Elev	175.39 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.5 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Designer/Analyzer Report
C14 - 100 Year

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000 m³/s	Allowable HW Elevation	175.46 m
Roadway Width	10.00 m	Overtopping Coefficient	1.60 SI
Low Point	175.90 m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	174.90 m		

Sta (m)	Elev (m)
0.00	175.90
20.00	175.90

Culvert Designer/Analyzer Report
C16 - 100 Year

Analysis Component			
Storm Event	Design	Discharge	4.2100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	4.2100 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	173.85 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-2440 x 1220 mm Box	4.2105 m³/s	174.74 m	2.77 m/s
Weir	Roadway	0.0000 m³/s	174.74 m	N/A
Total	----------	4.2105 m³/s	174.74 m	N/A

Culvert Designer/Analyzer Report
C16 - 100 Year

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	174.74 m	Discharge	4.2105 m³/s
Inlet Control HW Elev	174.64 m	Tailwater Elevation	173.85 m
Outlet Control HW Elev	174.74 m	Control Type	Outlet Control
Headwater Depth/ Height	1.02		

Grades			
Upstream Invert	173.50 m	Downstream Invert	173.26 m
Length	24.00 m	Constructed Slope	0.010000 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.62 m
Slope Type	Steep	Normal Depth	0.62 m
Flow Regime	Supercritical	Critical Depth	0.67 m
Velocity Downstream	2.77 m/s	Critical Slope	0.008042 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.020
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	174.74 m	Upstream Velocity Head	0.34 m
Ke	0.70	Entrance Loss	0.24 m

Inlet Control Properties			
Inlet Control HW Elev	174.64 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.0 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Designer/Analyzer Report
C16 - 100 Year

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000 m³/s	Allowable HW Elevation	174.74 m
Roadway Width	7.00 m	Overtopping Coefficient	1.60 SI
Low Point	175.40 m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	173.85 m		

Sta (m)	Elev (m)
0.00	175.40
10.00	175.40

Culvert Designer/Analyzer Report
C19 - 100 Year

Analysis Component			
Storm Event	Design	Discharge	4.3600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	4.3600 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	171.75 m

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-2440 x 1220 mm Box	4.2108 m³/s	172.54 m	2.77 m/s
Weir	Roadway	0.1503 m³/s	172.54 m	N/A
Total	----------	4.3611 m³/s	172.54 m	N/A

Culvert Designer/Analyzer Report
C19 - 100 Year

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	172.54 m	Discharge	4.2108 m³/s
Inlet Control HW Elev	172.44 m	Tailwater Elevation	171.75 m
Outlet Control HW Elev	172.54 m	Control Type	Outlet Control
Headwater Depth/ Height	1.02		

Grades			
Upstream Invert	171.30 m	Downstream Invert	171.15 m
Length	15.00 m	Constructed Slope	0.010000 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.62 m
Slope Type	Steep	Normal Depth	0.62 m
Flow Regime	Supercritical	Critical Depth	0.67 m
Velocity Downstream	2.77 m/s	Critical Slope	0.008042 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.020
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	172.54 m	Upstream Velocity Head	0.34 m
Ke	0.70	Entrance Loss	0.24 m

Inlet Control Properties			
Inlet Control HW Elev	172.44 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.0 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

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Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.1503 m^3/s	Allowable HW Elevation	172.54 m
Roadway Width	7.00 m	Overtopping Coefficient	1.63 SI
Low Point	172.50 m	Headwater Elevation	172.54 m
Discharge Coefficient (Cr)	2.94	Submergence Factor (Kt)	1.00
Tailwater Elevation	171.75 m		

Sta (m)	Elev (m)
0.00	172.60
10.00	172.60