COMMITTEE OF THE WHOLE – WORKING SESSION - NOVEMBER 25, 2008

SUMMER 2008 RAINSTORM UPDATE

Recommendations

The Commissioner of Engineering and Public Works recommends that:

1. Staff participate in the Toronto Region Conservation Authority climate change study and contribute $5,000 towards the study for the development of a specific Intensity Duration and Frequency Curve (IDF) for the City that reflects the changing local climate and storm event intensity. Funding for this contribution to come from the operating budget;

2. Should the IDF curves noted above vary significantly from those presently used by the City, staff amend the engineering design standards, policies and practices to reflect these new curves and the impact of climate change;

3. Staff develop a roof leader disconnection program to mitigate the amount of rain water entering into the City's storm drainage systems, together with an implementing by-law and an education program to assist homeowners with this work;

4. Staff report back to Council by June 30, 2009 regarding a potential backflow valve installation rebate program with proposed details of this program and potential funding sources.

5. Zoning By-Law 1-88 be amended to prohibit the construction of back-slope residential driveways in the City due to the high potential for flooding and property damage during a major storm event; and

6. Staff work with homeowners to re-establish designated major overland flow routes within easements on private property.

Economic Impact

There are sufficient funds in the approved Water and Wastewater budget to cover the $5,000 cost to participate in the TRCA Climate Change Study.

Purpose

This report provides Council with an update on the actions that staff has taken as a result of the major rain storm events that occurred on August 19, 2005 and in June and July 2008.

Background – Analysis and Options

Executive Summary

- In August 2005, the City experienced a major rainstorm, where numerous areas of the City experienced flooding and sewer back-ups. In June and July of 2008, specific areas of the City, mostly the Thornhill area, experienced similar flooding conditions.

- The storm of June 22, 2008 was approximately 100 minutes in duration. The maximum intensity of this storm was 180 mm/hr and lasted for 15 minutes. This resulted in an intensity of greater than a 100 year storm. Approx. 65 mm of rain was received on Thornhill.

- The storm of June 23, 2008 reached a maximum intensity of 160 mm/hr for 15 minutes. Due to the saturated soil from the previous day's storm, the amount of absorption was severely limited, resulting in increased run-off, and discharge to the City's sewer network. The range of rainfall City-wide was 0-50mm, with the Thornhill area receiving 42mm.

- The storm of July 19, 2008 produced rainfall of 8 – 55 mm City-wide, with Thornhill receiving between 20 and 53mm of rain.

- The storm of July 22, 2008 produced a range of 16 – 82 mm across the City, with Thornhill receiving between 23 and 40 mm of rain.

- Due to the high intensity and durations of some of these events, the capacity of the minor storm sewer system was exceeded.

- Closed circuit television inspection of the sewers in the most impacted areas found no defects or blockages in the storm, or sanitary sewer systems.

- Smoke testing in areas where it was suspected that roof leaders may be contributing extraneous flows to the City's sewerage system, found no improper connections.

- The City's sewerage systems are designed properly and in accordance with accepted Engineering standards.

- Due to the changing climate, staff recommends working with the TRCA to develop Intensity, Duration, and Frequency (IDF) curves, specific to Vaughan. Should these curves differ significantly from what is currently used to design the storm sewers in the City, these new curves be used for all future projects.

- To mitigate future flooding and surcharging of the City's sewer system, a roof leader disconnect program and education program is recommended. Although testing in the Chelwood Drive and Carl Tennen Street showed this was not an issue, the extent of the roof leader connections in the rest of the City is not known. It is prudent to have all roof leaders' discharge to the ground surface in accordance with current best practices.

- While residents may expect the City to replace and update the sewer network to prevent sewer back-ups during severe storms, it is not feasible to do so due to the enormous cost, lack of space in built-up areas, downstream impacts and disruption involved.

- Due to the changing climate, it is expected that extreme rainfall events will continue to occur in the future leading to flooding and sewer surcharging. Staff is taking the necessary steps and actions to mitigate the affects of climate change. As noted by Mr. Gord Miller, the Environmental Commissioner for the Province of Ontario has indicated in general that: *"We have an infrastructure that was built for a climate we no longer have."*

- There are steps homeowners can take to isolate themselves from sewer back-ups. One such step is the installation of a backflow device. For those residents who have been impacted by repeated sewer back-ups, it is recommended that a backflow valve installation rebate program be developed, and a follow-up report be presented to Council by June 30, 2009, outlining the details of such a rebate program, including how it would be funded and administered.

- There are a number of overland flow routes where the City has an easement over the homeowners' property. Over the years, when properties have been sold, easement rights have not been maintained, resulting in landscaping and grade alterations that adversely

impact overland flow routes. In some cases, these works have impacted the overland flow routes such that they do not function as efficiently as they should. As such, it is recommended that staff work with these homeowners to re-establish these flow routes.

- One point of entry for storm water into the sanitary sewer system is through the pick holes in the tops of the manhole covers. In the low lying areas, a significant amount of water can potentially enter the sanitary system through these holes. This could create surcharged conditions, which may contribute to sewer back-ups into basements. To help mitigate the amount of storm water entering the sanitary system, staff is installing water tight manhole lids in the low lying areas where basement back-ups have been identified, and where road resurfacing/reconstruction works are taking place.

- A storm water study is currently underway to identify flood prone areas in the City, which will be completed Q1-2009. Staff has requested additional funding through the draft 2009 Capital Budget to build on this initial work.

Background

On June 21, 2008 and July 21, 2008, the City of Vaughan, as well as surrounding municipalities, experienced rainstorm events that caused localized flooding and some property damage. This report outlines what took place and the actions associated with the storms.

This report is divided into 5 sections:

Section “A” outlines the history and theory of storm drainage and how the City’s storm drainage system is designed to operate.
Section “B” gives specific data related to the storms experienced during the summer of 2008.
Section “C” outlines the actions taken by the City to date and the results.
Section “D” outlines a direction on moving forward.
Section “E” provides an update on other ongoing works.

SECTION “A” – THE HISTORY AND THEORY OF STORM WATER MANAGEMENT

The Need For Storm Water Management

Urbanization of land significantly alters the hydrology of a watershed as residential, commercial and industrial development leads to an increase in impervious surfaces in the drainage area. As a result, the response of an urbanized watershed to precipitation is significantly different from the response of a natural watershed. Post development peak runoff is expected to exceed pre development runoff from a similar storm event. The most common effects are reduced infiltration and more rapid run-off, which significantly increase the peak discharge rates and runoff volumes. To accommodate the higher rates and volumes of storm water runoff in urban areas, storm sewer conveyance systems are installed to provide efficient drainage of the area. Additional protection is provided through detention and storage structures to control release rates to downstream systems.

In 1954, Hurricane Hazel caused the most severe flooding in the Southern Ontario area in recorded history, where approximately 212 millimeters of rain fell in the Toronto Region within 36 hours. Storm water management was borne out of the detrimental effects of this storm that left thousands of people homeless and caused extensive damage to municipal and private infrastructure including roads, buildings and houses. This storm also jump-started the Conservation Authorities’ Flood Control Program. The intent of the program was to transfer the liability of low lying flood susceptible or flood plain land from private hands to the Authorities’ and to acquire lands necessary for the construction of flood protection works. In addition, a province-wide flood plain planning policy was initiated through the Conservation Authorities Act. Regulations were implemented to restrict future development and land use in flood prone areas.

Since the 1980's, the Toronto Region Conservation Authority (TRCA) and many area municipalities within the Region of York, including the City of Vaughan, have addressed the impact of urbanization on the environment through the use of storm water management.

When land is converted from agricultural use to residential/employment use, it often results in increased water levels in ditches, sewers, streams, and creeks and ultimately the Don and Humber Rivers (the receiving rivers to the City of Vaughan), during periods of rainfall and snow melt. As water is unable to flow freely into the ground (due to concrete, asphalt pavements and buildings), the new sewers and roads move the water to our streams more quickly. Storm water management involves storing a portion of the "additional" water (referred to as storm water runoff) in designated holding areas or ponds, and releasing this water at a reduced rate, typically equal to the rate prior to development. Storm water management has since evolved to improve water quality and mitigate the impacts of erosion and temperature. In addition, existing facilities are being retrofitted to optimize their effectiveness to manage storm water.

Storm water management controls consist of source controls, pre-development conveyance controls and end of pipe controls. The intent of these controls is to maintain the condition of the watershed with respect to water quantity, water quality and erosion control. Storm water management controls provide the following benefits:

- Enhanced community safety by minimizing flooding
- Less property damage during major storm events
- Minimized pollution to watercourse during storm events
- Less erosion of stream banks during flooding
- Minimized impacts to aquatic habitats

How The Municipal Storm Drainage System Works

The City storm drainage system consists of a **minor system** and a **major system.** The **minor system** includes all below ground storm sewer piping and appurtenances such as catch basins. It is generally designed to accommodate runoff generated by a 5-Year Storm event. The minor system is intended to take runoff from typical, less intense, storm events and drain roadways quickly. More intense storm events use overland flow routes to convey runoff to water courses. The **major system** component includes the aboveground overland flow of water within the roadway and boulevards of a municipal right-of-way. The major system design also includes storm water management ponds and other overland flow routes through municipal property or easements. The overland flow route is designed to accommodate runoff that isn't captured by the minor system up to a 100-Year Storm event. Most, if not all, municipalities design their storm drainage system in this way.

Storm Water Engineering Design Standards and Criteria

One of the key engineering design parameters used in the determination of post-development urban runoff from precipitation or rainfall, and the subsequent design of municipal storm sewer systems, is the development of synthetic design rainstorm events.

The three key parameters required to establish a specific synthetic design storm event include intensity, duration and frequency. These parameters are typically referred to as the **IDF curve** for a specific rainfall event. **Intensity** is the rate of rainfall as referenced to a time unit. The normal unit of measurement is millimeters per hour (mm/hr). **Duration** is the length of time in which the rainfall event occurred, usually measured in seconds, minutes and hours. **Frequency** refers to the probability of reoccurrence or return period of a specific rainfall event of a specified depth, intensity and duration. Frequency is normally reported in years (i.e., the rainfall event is expected to occur at least once in a certain number of years).

Frequency or return period estimates are based on a long term statistical analysis and there is absolutely no guarantee that a 10-Year Return Period Storm Event (10-Year Storm) cannot happen in two consecutive years, weeks or even days. It is only a statistical estimate.

In accordance with the Engineering Department's Design Criteria and Standard Drawings Manual, a comprehensive Storm Water Management (SWM) plan including a drainage report must be submitted to the City for review in conjunction with any development application. This provides an integrated means of dealing with the many impacts of urban development on water quantity and quality, erosion and sedimentation and the hydrologic cycle (preservation of groundwater resources). The preparation of a storm water management plan is based on an approved Master Drainage Plan and TRCA initiatives where the criteria is established by the City and the TRCA. The guidelines for the design of storm water management facilities in the City are considered supplemental to the latest version of the Ministry of Environment Storm Water Management Practices, Planning and Design Manual. These criteria represent commonly accepted municipal engineering design standards and practices by all jurisdictions within the Province of Ontario.

SECTION "B" - JUNE / JULY 2008 Storms

Characteristics of the June-July 2008 Rainstorm Events - Radar Weather Information

Due to the amount of flooding, and the number of complaints received regarding water damage, the City retained Kije Sipi Ltd - RadHyPS Inc. to do a statistical analysis of the significant storm events that occurred over the summer of 2008. The storm events in the City of Vaughan during the periods of June 21 to 24 and July 19 to 24, 2008 were characterized and described in terms of their total rainfall, maximum intensity and duration using graphs and thematic maps in order to delineate the spatial variation of the rainfall in the City. Attachments No.1 and No. 2 show the radar data thematically for both storm events. The Thornhill sector was given special consideration. The City experienced multiple storms during June 21 to 24 and July 19 to 24, 2008. The King City Environment Canada radar data was used in the analysis and was calibrated with the rain gauge data from several meteorological stations in the GTA that was also acquired from Environment Canada. The nearest gauge to Thornhill area is the Toronto North York rain gauge.

Storm Periods of June 21 to 24, 2008: There was a great spatial variation in total precipitation varying from approximately 2 to 140mm of rain over the City for the 4 day period. Generally 6 to 20mm fell across most of the municipality; however, the larger total rainfall accumulations fell in the Thornhill area, which received a total of 60 to 140mm of rainfall during this 4 day period.

The total duration of the June 22nd storm was approximately 100 minutes and the total rainfall accumulation for this storm event in Thornhill sector was about 65mm with a maximum intensity of 180mm /hr at 15 minutes. The urban storm water management infrastructure is designed on City of Vaughan Design Criteria using the IDF data up to 1971. Based on the City's IDF data, the July 22 storm was a 50 year storm event (50 year storm=66.24mm); however, the intensity of the storm after first 15 minutes reached surpassed the intensity of a 100 year design storm event (180mm /hr Vs. 158mm/hr for 100 year design storm).

A 50 year design storm event would normally generate 66.24mm of rainfall over a three hour event. The storm accumulated the same amount of water in half the time. In other words, the observed June 22nd storm was a 50 year storm but of shorter duration and more intense, which contributed to the flooding problems in Thornhill. Short duration and intense storms like the June 22, 2008 storm event require positive overland flow drainage to avoid surcharging of pipes that are designed based on a 5 year storm event. Grading changes on some drainage easements by private land owners may have obstructed exiting major overland flow routes. This situation was evident during a site visit to the Thornhill area.

The June 23rd storm event varied between 0 and 50mm within the entire City boundary. The Thornhill area received approximately 42mm of rainfall. The duration of the storm event was 40 minutes and the intensity reached 160mm/hr within the first 15 minutes of the storm. The minor flow system is designed for a 5 year storm event and total accumulated rainfall was 43.45mm for 180 minutes. Similar to June 22, the June 23rd storm was also of short duration and very intense; however, the accumulated volume of rainfall was almost equal to a 5 year storm event. It is likely that the June 22nd storm event created wet soil conditions and there was very little chance of further infiltration during the June 23rd storm event. These multiple short duration and intense storms can contribute to flooding problems.

Storm Periods of July 19 to 24, 2008: The total precipitation across the entire City was 32 to 100mm for the 5 day period and the Thornhill sector received approximately 50 to 85 mm of rainfall. There were two significant storms noted during this period on July 19th and July 22nd. The first storm on July 19th lasted 24 hours and the second storm on July 22nd consisted of rainfall events of different durations.

The total rainfall received during July 19th storm varied from 8 to 55mm for the entire City and the Thornhill area was subjected to a total of 20 to 53mm of rainfall. The duration of the storm was 18.2 hours with a maximum intensity of about 63mm/hr after 10 minutes and it generated a total rainfall of approximately 30mm. This storm event would have created saturated soil conditions in the area thus providing more likelihood of higher runoff during the subsequent storm event.

As mentioned above, the soil conditions were wet when the July 22nd storm event occurred. The total accumulated precipitation for this particular storm event varied from 16 to 82mm. The Thornhill area received a total rainfall accumulation between 23 and 40mm.

Both observed storms appear to be of short duration and very intense that exceeded the minor system flow capacity which resulted in overland flow.

Summary of Flooding Damage

Based on the analysis of the 2008 summer rainstorms, it has been noted that most of the high intensities and volumes of precipitation occurred centered around the east end of the City. The majority of flooding complaints received were in the older residential neighbourhoods of Thornhill and Woodbridge.

Engineering Services staff compiled the records from Public Works dispatch and from the Clerk's Department. The records were categorized and then mapped to determine where the majority of complaints occurred. In all, 174 complaints were received by the City. Of these 174, 19 were related to a back up of the sanitary sewer into the basement, and the remainder were either general street flooding complaints or the caller did not specify the nature of the complaint. To date, a total of 16 claims for damages have been filed with the Clerk's Department. Of the 19 basement flooding complaints, 12 are from residences that were also flooded during August 19th 2005 storm.

Table 1 below summarizes the complaints received during the June and July 2008 storm events.

Ward	**Total No. Complaints**	**Confirmed Basement Back up**	**Other or Non-Specific Complaint**	**Claim**
1	10	0	10	0
2	9	1	8	0
3	1	0	1	0
4	125	16	109	15
5	29	2	27	1

174 19 155 16

Potential Sources of Basement Flooding

In understanding the sources of basement flooding, it is important to keep in mind the fundamental difference between a sanitary and storm sewer system. The sanitary sewer carries wastewater (sewage) from all plumbing fixtures and basement floor drains (i.e. toilets, sinks, laundry, etc.) and eventually leads to a sewage treatment plant. Storm sewers collect storm runoff or storm water from catch basins located in roads, parking lots and rear yards, and weeping tiles where feasible (foundation drains) and carry these flows into nearby storm water management facilities which eventually outlet to natural watercourses.

Water can enter a residential basement for a number of reasons. Basement flooding is most likely to occur during a heavy rainfall event. The potential causes of basement flooding include the following:

- leaks in basement walls, windows or doors
- poor lot drainage
- failure of the foundation drain system
- overflowing of eaves troughs
- blocked storm sewer lateral connections between the house and the main storm sewer in the street
- a back-up of water in the storm sewer system or a combination of wastewater and rainwater from the sanitary sewer system
- cross connections (a sanitary lateral connected to a storm sewer or vice versa)
- illegal basement walkouts with improper grading
- illegal basement bathrooms / kitchens connected to the storm sewer instead of the sanitary sewer system
- failure of sump pumps in areas where they are required to pump foundation drain water
- connection of eaves trough downspouts to the sanitary or storm sewer connection
- basement windows or below grade doors in a flood-prone area
- back sloped driveways

Attachment No. 3 schematically illustrates the potential sources of basement flooding as described above. It is important to note that a number of the above noted sources of basement flooding are due to situations and/or alterations made directly by individual homeowners on private property. Further, mitigating these sources may only reduce the risk of basement flooding and not necessarily eliminate it altogether.

SECTION "C" – RESPONSE TO FLOODING

Sewer Inspection and Testing – Wards 4 and 5

As part of the City's ongoing investigation into the flooding events from the June 22 and July 22 2008 rain storms, the Public Works Department undertook an inspection of the sewers on those streets most affected by the recent flooding. The storm sewers on Clark Avenue from York Hill Blvd. to Hilda Avenue, as well as the sewers on Thornbury Circle, Bevshire Circle, and Tangreen Circle and the outlets to the Clark Avenue storm sewer were flushed and inspected with a closed circuit camera. As well, the storm and sanitary sewers on Carl Tennen Street, Samuel Oster Avenue from Chelwood Drive to Judith Avenue and Chelwood Drive from Judith Avenue to Zahavy Drive were also flushed and inspected in the same manner.

Public Works has compiled video recordings of the sewer systems on these streets. Staff reviewed the findings, looking for evidence of clogged or damaged pipe and infrastructure, or other conditions that may have contributed to the flooding conditions. All the sewer systems that

were inspected were found to be in good condition and free of any blockages.

Staff's observations of houses in the area did note that a number of homes have roof downspouts leading into the ground rather than discharging onto the ground surface in accordance with City standards. As these downspouts may be tied into the sewer systems, causing the sewers to overload and backup into basements, the Public Works Department conducted smoke testing to determine where these roof leaders were connected.

Smoke testing involves blowing a non-hazardous smoke into the sewers at manholes. The smoke is pushed though the sewer systems and appurtenances and will appear at openings such as catch basins, roof leaders connected to the system, sewer vents and other points of access.

This testing took place in October 2008, and involved the streets surrounding and including Carl Tennen Street, Zahavy Drive, Westcroft Avenue, Samuel Oster Avenue from Chelwood Drive to Judith Avenue, Bayhampton Crescent, Briarcliffe Crescent, Judith Avenue, and Chelwood Drive. There were some locations that were suspected of having improper connections on Chelwood and Zahavy; however, all were subsequently dye tested and no direct roof leader connections were found.

Storm Inlet Grate Inspection/Changeover

Public Works staff undertook a review of the storm inlet grates with the intent on replacing a number of older flat inlet structures with those that allow free flow when significant amounts of debris accumulate on the grate. The newer parabolic design grates allow for the debris to float to the top of the grate, allowing water to flow freely underneath. The inlet grates at William Street and James Street in Woodbridge and at Brooke Street and Arnold Avenue in Thornhill have been replaced with the new grate design.

At Memorial Hill in Woodbridge, the ditch was badly eroded with uprooted trees and undermined soil banks. The trees were cleared, the ditch re-shaped, and then lined with stone to protect the slopes from erosion. Several large concrete blocks were installed to dissipate and slow the velocity of the water flows. A berm was also created around the sides and back of the inlet grate to prevent the storm water from jumping the inlet as it previously did in heavy storm events.

Capital Works

In addition to the ongoing routine maintenance performed by Public Works staff, there have been a number of capital works undertaken to clean-up and re-shape the open watercourses to improve flow characteristics and improve aesthetics. To date, there has been work performed on the watercourse that runs south to the William and James Streets grate, re-shaping and lining the Cloverleaf and Jersey Creek swales, the Fiori Drive drainage channel and the Charlton Avenue overland flow swale. In addition, design work has already begun on the Hillside Creek watercourse, and is in the review stages.

Following the August 2005 flooding incident, the City retained Genivar Consultants in December 2006 to do a study of the Thornridge drainage area at a cost of approximately $50,000. The purpose of the study was to determine what remedial works should be done to minimize the risk of flooding in future. The study recommended that a storm drainage facility, in the form of either a pond or an underground storage tank, should be constructed in the vicinity of Gallanough Park. An Environmental Assessment for the facility is proposed in the 2009 capital budget.

SECTION "D" – "MOVING FORWARD"

Climate Change and What It Will Mean To The City And Storm Water Management

The climate of a region can have a significant impact on the quantity and quality of storm water

runoff. Factors such as pre-existing soil moisture, the average rainfall intensity, the storm duration, and the amount of the snowmelt present can have significant impacts on the characteristics of runoff from an area. The high intensity, short duration rainfall events can also generate significant loadings of suspended solids in storm water runoff.

Updated IDF Curves

The City's storm water infrastructure design is based on IDF data from 1971. There is current need to update the IDF data to accommodate changes in weather patterns that have occurred since 1971. TRCA is currently working with Environment Canada and other partners on updating the IDF data for the Golden Horseshoe municipalities of Southern Ontario. It is recommended that the City of Vaughan participate in this study and contribute financially in the amount of $5,000.

Studies have shown that there is a linear relationship between the increase in rainfall intensity and volume, and the number of pipes capable of successfully conveying the resulting flows. Updated design standards may require larger pipe sizing for minor flows than typically used in the past. Other best management practices may be adopted to minimize the consequences of climate change on urban infrastructure.

Preventive Measures to Mitigate Future Impacts of Severe Storms and Basement Flooding

i) Backflow Valve Installation and Subsidy Program

There are numerous things a homeowner can do to reduce the potential of property damage during a severe rainfall event. However, one of the most significant and cost effective things that can be done is the installation of a backflow prevention device on the sanitary house connection. Such a device significantly reduces the risk of basement flooding from sewer back-ups.

In the City of Toronto, a subsidy exists to homeowners who install sewer backflow valves. This subsidy is up to 80% of the total invoiced cost, to a maximum of $1,250.00, including all eligible labour, materials, permits, and taxes. The City of Vaughan could create a Basement Flooding Protection Subsidy, similar to that of the City of Toronto's. Such a subsidy could be developed whereby those homeowners who have documented proof of a sewer back-up could be eligible for a subsidy. Potential conditions for such a subsidy could be based on:

- An annual maximum funding cap for the program.
- A Plumbing Permit must be taken out with the City for the installation of such a device.
- Residents must submit a completed and compliant application form, together with all invoices and other documentation substantiating the completion of the work.
- All necessary paperwork and documentation must be submitted to the City within 90 days of the work being completed.
- The property owner assumes all responsibility for the work, including installation, performance, maintenance, repair and use, and any other financial responsibility.
- The City inspects the completed work to ensure it is compliant with City requirements.

For discussion purposes, at a funding level of $100,000, there would be sufficient funding to subsidize over 100 applications, based on a maximum subsidy of $1,000. Should the subsidy rate be increased to $1,250, similar to the City of Toronto's, the number of applications that could be approved under that funding would be reduced to 80.

Once the annual funding amount had been exhausted, those homeowners approved to receive a subsidy would have to wait until the following year to receive their subsidy, based on available funding.

Should Council wish to implement such a Basement Flooding Protection Subsidy, additional work would be required by staff to review and identify the annual funding requirements and any administrative issues and staff and other resource requirements needed. In addition, a release agreement would have to be developed in conjunction with Legal Services staff to ensure the City incurs no additional liability as a result of the rebate and work related to the installation of the backflow valves.

ii) Downspout Disconnection Program

The disconnection of downspouts (roof leaders) from the sewer system, can help prevent surcharging of the storm sewer system by reducing the amount of water entering the system in the first place. The discharged water would then go onto lawns and other porous surfaces so that the water does not reach the storm sewer system.

In order to ensure that this is being done, it is recommended that the City develop a Mandatory Downspout Disconnection By-law that requires all homeowners to disconnect any roof leaders from entering into the City's storm water sewers. Such a by-law would allow homeowners a period of 2 years after its approval to complete the necessary works.

Along with the by-law, a communications strategy would need to be developed that outlines in a clear and pictorial format how homeowners can do this work themselves. Summer students could be hired to conduct a door-to-door inventory of homes in severely flooded areas. If they find homes where the roof leaders do not discharge onto the ground, as required, they would leave an educational brochure concerning the impact this has on the City's sewer system, as well as the impact it may have on their own property such as basement flooding. A detailed list of locations would be compiled, and those houses would be re-visited the following year to determine if any action had been taken to disconnect these roof leaders from the City's sewer system. This program could be developed and implemented, subject to availability of funding.

It is not recommended that the City subsidize such a program, or get become involved in doing the work for residents. This is a low cost change that homeowners can do for themselves.

iii) Soft Landscaping/Rain Barrels

One of the contributing factors to the amount of run-off generated from a property is the amount of hard surfacing on the property. Homeowners need to be reminded about the environmental benefits of installing landscaping that allows storm water to soak into the ground, rather than run-off directly into the storm sewer system. Impervious surfaces, such as asphalt, concrete, and interlocking stones, should be minimized, and/or replaced with alternatives whereby water can soak into the ground.

Rain barrels can be effective in storing rain water as well. This stored water can be released onto gardens at a later date. Not only does this help prevent the water from going into the storm sewer, but it also promotes water conservation. In 2008, the Region of York held rain barrel sales in areas across the region, including Vaughan. Staff has had preliminary discussions with Region staff to see if these could be sold during the 2009 Public Works Day in May. Staff will continue to work with the Region to see if this can be made possible.

iv) Prohibition of Reverse Slope Driveways

Homeowners with reverse slope driveways have the potential to suffer more damage than the

average homeowner when severe storms occur. This is because storm water may top over the overland flow heights, and run down into the below grade garage. As such, it is recommended that the construction of any new reverse slope driveways or below grade driveways in the City, be prohibited.

v) Annual Catch Basin and SWM Pond Cleaning Program

Currently, the Public Works Department has an annual catch basin cleaning program. The current level of funding does not allow the City to clean every catch basin on an annual basis. Accordingly, additional funding would need to be allocated in future Operating Budgets to provide a higher level of catch basin maintenance.

There are currently 72 assumed storm water management ponds throughout the City, with an estimated additional 50 ponds that will be constructed and assumed in the near future. In 2003, a study was implemented to assess the current conditions and prioritize the on-going maintenance of these ponds. The City of Vaughan was one of the first municipalities within the TRCA's jurisdictional watersheds to implement such a study.

The cleaning and maintenance budget requirements for a limited number of existing SWM facilities have been included in previous and current Capital Budgets. Increased sustainable funding for an enhanced level of cleaning and maintenance of the City's storm water management pond facilities and catch basins will be required in the future.

vi) Illegal Sewer Connections Information Brochure

Basement flooding can also be the result of illegal connections being made to the City's sewer system. In cases where the homeowner takes it upon himself/herself to construct a bathroom and/or kitchen in the basement of a house that does not have approved roughed-in connections, there is a danger that the homeowner may connect these fixtures to the wrong sewer. Toilets, sinks, showers etc. must all be connected to the sanitary sewer system. An improper connection made to a storm sewer will not only lead to raw sewage entering the storm drainage system, but it may also result in storm water entering the house in heavy rainfalls through these illegal connections. A smoke or dye-testing program would help identify illegal connections of this type. However, an educational/information brochure could be prepared and circulated to all residents. This may be a more effective means to correct and mitigate this concern.

vii) Flood Emergency Response Plan

As a follow-up to the City-Wide Drainage and Storm Water Management Criteria Study currently underway, the development of a flood emergency response plan identifying areas susceptible to severe flooding and defining concrete steps to mitigate the risk for property damage and/or public safety would be appropriate. Input from the City's Manager of Emergency Planning would be included as part of this plan development.

SECTION "E" – ONGOING WORKS

It is anticipated that the City-Wide Drainage and Storm Water Management Criteria Update Study will be completed by the first quarter of 2009. Preliminary findings on flood vulnerable roads and structures throughout the City have been provided to staff for review and input. In addition, recommendations with regards to revisions to applicable storm drainage and storm water management design criteria have also been provided for review. A component of this study will also include a detailed micro drainage analysis of site flooded during the August 19th, 2005 rainstorm.

The Thornhill Drainage Improvement Study was recently completed by the City which recommended:

- constructing a SWM facility in the Gallanough Park area,
- constructing storm sewers along several locations,
- replacing deficient culverts, catch basins and ditch inlets, and
- improving ditch conveyance capacity at various locations.

In addition, the Engineering Department independently completed a preliminary analysis of two problem areas in Thornhill, specifically within Blocks 1 and 8. The analysis identified potential deficiencies with respect to existing positive drainage routes for major storm events. Altered drainage easements by private landowners appear to have impacted positive drainage capabilities within the system. Additional detailed investigation will be required for the study area. A capital budget request has been submitted for a 2009 Phase 2 Drainage Study to continue this analysis in more detail. As a result, it is recommended that staff work with homeowner's to re-establish designated overland flow routes within easements on private property.

Engineering and Public Works Initiatives

On-going and future studies related to storm water management engineering design standards, and policies and procedures review, will allow for future flooding mitigation from events such as the August 19th, 2005 and the June/July 2008 rainstorms, by establishing improved City-wide policies related to:

- storm water management facility retrofit requirements,
- updated storm water management design criteria,
- sedimentation and erosion control, and
- infiltration and inflow reductions, based on sewage flow monitoring.

Staff is currently implementing the recommendations and maintenance priorities of the Storm Water Management Inventory and Maintenance Study completed by Clarifica Consulting in 2004. As a result, the required maintenance of assumed SWM facilities is being prioritized and included in yearly Capital Budget deliberations.

In addition, Engineering Services has completed a comprehensive piped infrastructure data capture exercise. This has provided a detailed Geographic Information System (GIS) database of the City's existing sewer and water main infrastructure. This database will become an essential tool to improve the City's capabilities to store and analyze critical flooding related data and to develop a comprehensive Flood Emergency Response Plan.

What Other Municipalities Are Doing

City of Toronto

The City of Toronto has also experienced extreme weather events and the resulting flooding and basement back-ups of the sewerage systems. On August 19, 2005, Toronto received over 4,200 basement flooding complaints.

In the older parts of Toronto, the storm and sanitary sewers are not separated. As such, during periods of intense storms and sewer surcharging, sanitary sewage can back up into basements. They undertook a study and divided the City into 31 areas prone to basement flooding. As a result of the study, they have made sanitary sewer improvements a priority in the areas prone to basement flooding. It is important to note that Vaughan has separated storm and sanitary sewer systems.

Storm water projects in Toronto are also implemented on a priority system, based on the number of benefitting properties involved and the cost of the works apportioned to each benefitting property.

Toronto has also introduced a mandatory downspout disconnection program, and as previously noted, have a backflow valve installation rebate program, as well as a rebate for the installation of sump pumps, where necessary. Along with this, an educational component was developed.

In order to deal with the issues related to basement flooding, and the work resulting from the associated programs, a total of 21 new Full Time Employee (FTEs) were requested. The breakdown was 5 professional / technical staff for the basement flooding remediation work, 11 FTEs for the inspection aspect of the downspout disconnection program, and 5 additional FTEs to deal with the subsidy/rebate programs.

Toronto staff also recommended that Council require any applicant of a Plumbing Permit related to the sewer drain, where there is a below grade living area anywhere in the City, to install a backflow valve on their sanitary sewer lateral. Similar to what is recommended in this report, Toronto staff are also recommending that zoning regulations be changed to restrict the construction of below grade and reverse sloped driveways.

City of Peterborough

In July 2004, the City of Peterborough was hit by a severe rainfall event that caused significant flood damage. The flood damage was reported in excess of $100 million in direct physical damages to private and public property. In addition, the City of Peterborough suffered indirect damages such as disruption in residential living conditions, loss of business and loss of wages or income.

The City of Peterborough initiated a flood reduction master plan study to investigate the causes and determine remedial measures to improve the operation of the drainage system and reduce the risk of damage from future flooding. The causes for the flood damage were unprecedented heavy rainfall on largely impervious downtown core resulting in high runoff, insufficient storm sewer capacity, poorly defined overland flow routes and unwanted water getting into the sanitary sewer system. The flood reduction master plan study identified several catchment based flood reduction studies in future. The important steps for the City of Peterborough were to prepare a detailed implementation plan, including dollar amounts / sources of funding and to prepare detailed terms of reference for the most urgent action steps.

Vaughan is also proceeding in a similar way. The Thornhill Storm Drainage Improvements Study was recently completed. The City-Wide Drainage and Storm Water Management Criteria Update is near completion. In addition, the Black Creek Optimization Study has commenced in cooperation with the TRCA. This study will identify mitigation and optimization works required to minimize flooding risks throughout the Black Creed watershed.

Relationship to Vaughan Vision 2020

This report and its recommendations are consistent with the priorities previously set by Council, and relate to the following Vaughan Vision Goals and Objectives:

Goal:	Service Excellence
Objective:	Pursue Excellence in Service Delivery
Objective:	Lead and Promote Environmental Sustainability
Objective:	Enhance and Ensure Community Safety, Health and Wellness Maintain Assets and Infrastructure

Conclusion

The intensity, duration and frequency analysis of the June/July 2008 rainstorms exceeded the 5-Year storm sewer design criteria. As a result of the high rainfall intensities over a short duration, flooding damage did occur at various locations throughout the City. Since the City uses the 5-Year Storm design criteria for the minor system drainage design (a commonly accepted design standard within the Province of Ontario), a significant amount of overland flow within city streets and overall system flooding would be expected.

The on-going and future initiatives identified herein will allow the City to remain proactive and more effectively manage future natural occurrences such as the June/July 2008 rainstorms. Any mitigating measures implemented within the City will serve to reduce the potential risk and associated damage resulting from natural occurrences; however, they will not eliminate the risk completely.

As was noted at a recent climate change presentation by Mr. Gord Miller – Environmental Commissioner for the Province of Ontario: ***"We have an infrastructure that was built for a climate we no longer have."***

Attachments

1. June '08 Storm Radar Image
2. July '08 Storm Radar Image
3. Potential Sources of Basement Flooding

Report prepared by

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Rob Meek, Manager of Environmental & Technical Services, ext. 6100
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Respectfully submitted,

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Commissioner of Engineering & Public Works

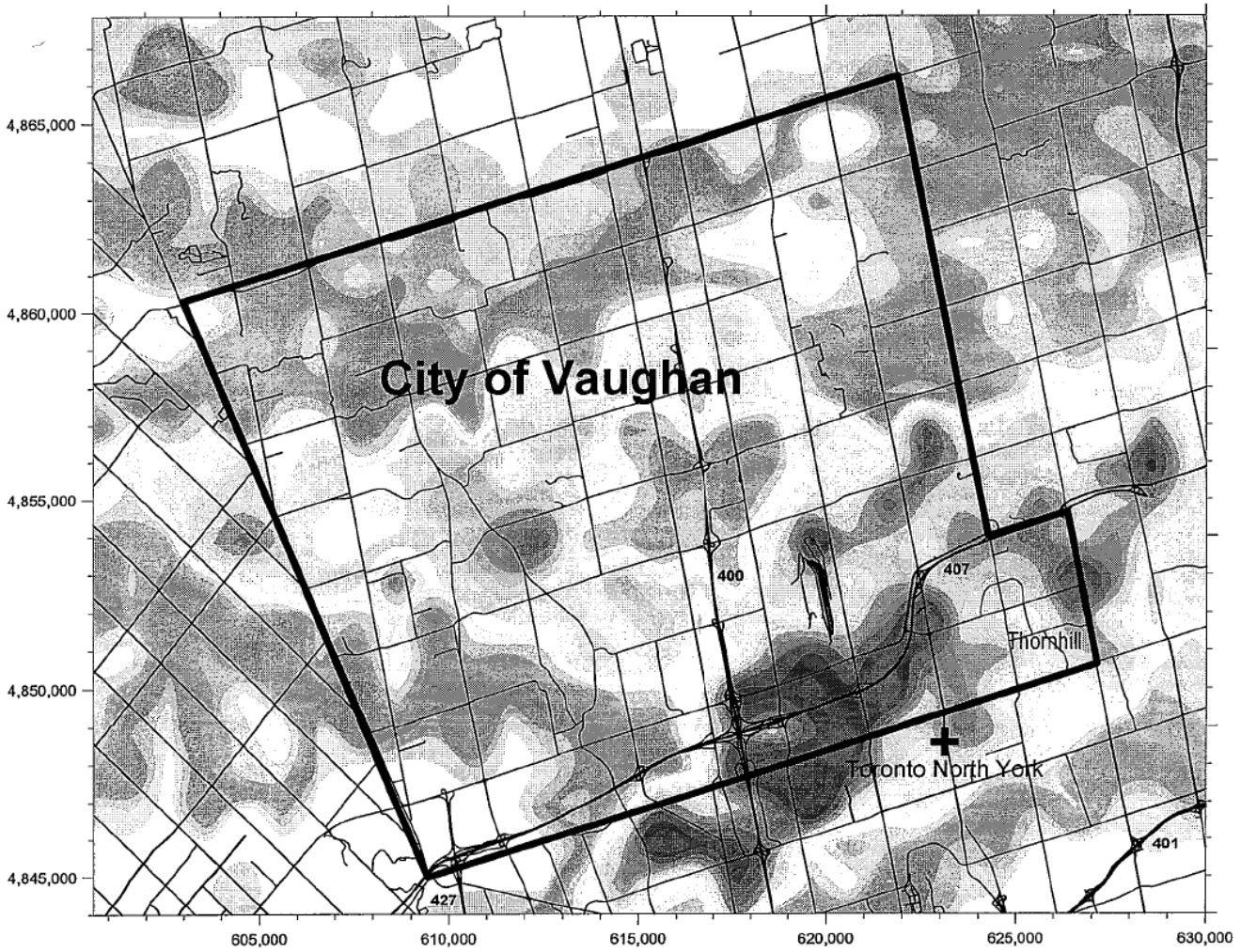
Brian T. Anthony, CRS-S, C. Tech
Director of Public Works

Andrew Pearce, C.E.T.
Director of Development/Transportation Engineering

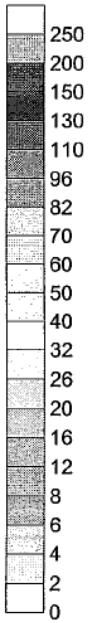
Attachment No. 1 – June '08 Storm Radar Image

Kije Sipi Ltd
WATER RESOURCES AND GEOMATICS CONSULTANTS

RadHyPS
Radar Hydrological Products and Services



Maximum 5-Minute Intensity (mm/hr)



Maximum 5-Minute Intensities for June 22 2008 period 12:00 to 21:55 EST

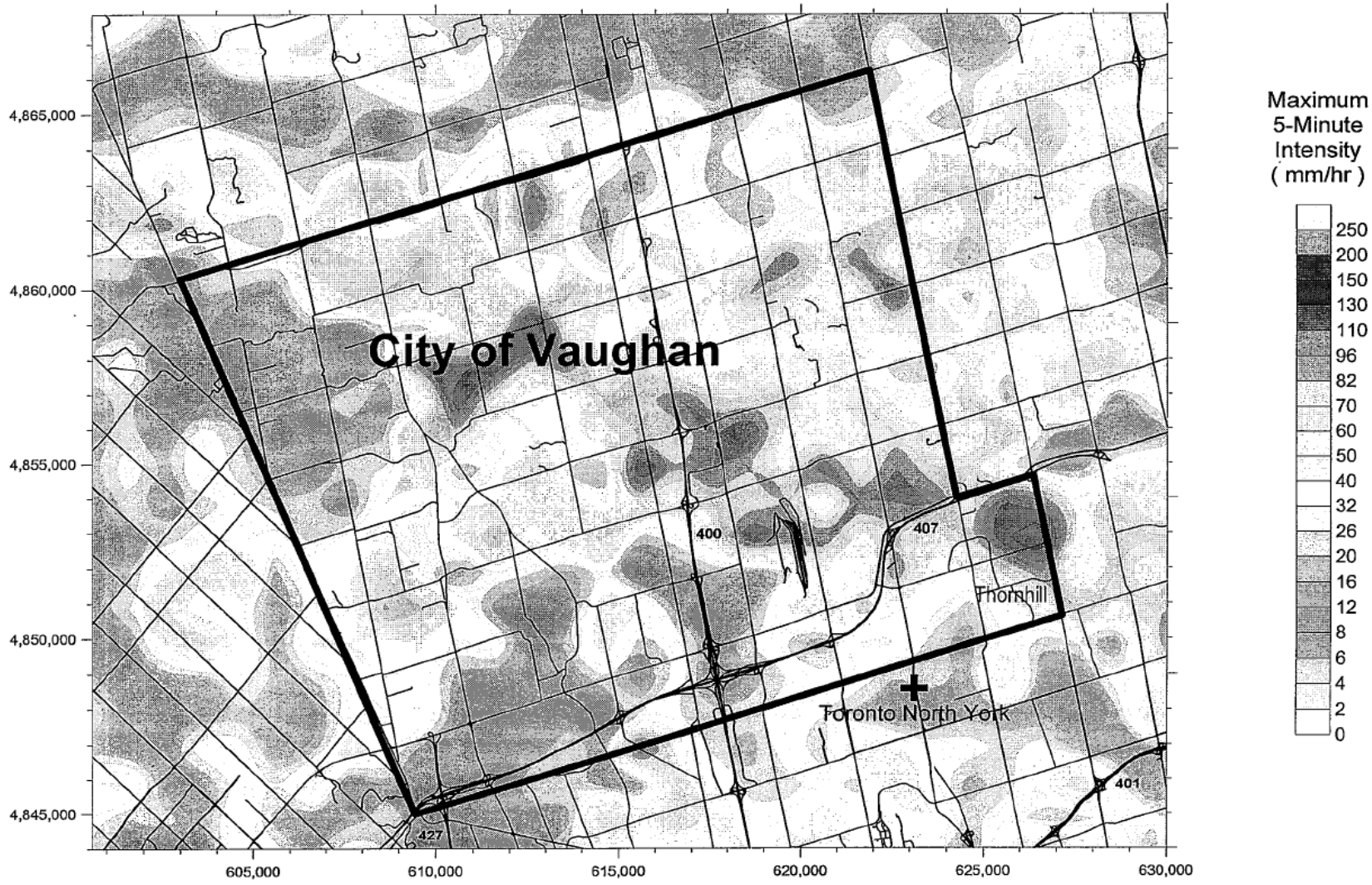
Maximum Precipitation Intensities Based on FF3 GCF Calibration of King City Radar Data

Features mapped using the UTM Projection (NAD83) and expressed in meters.

Attachment No. 2 – July '08 Storm Radar Image

Kije Sipi Ltd
WATER RESOURCES AND GEOMATICS CONSULTANTS

RadHyPS
Radar Hydrological Products and Services



Maximum 5-Minute Intensity (mm/hr)

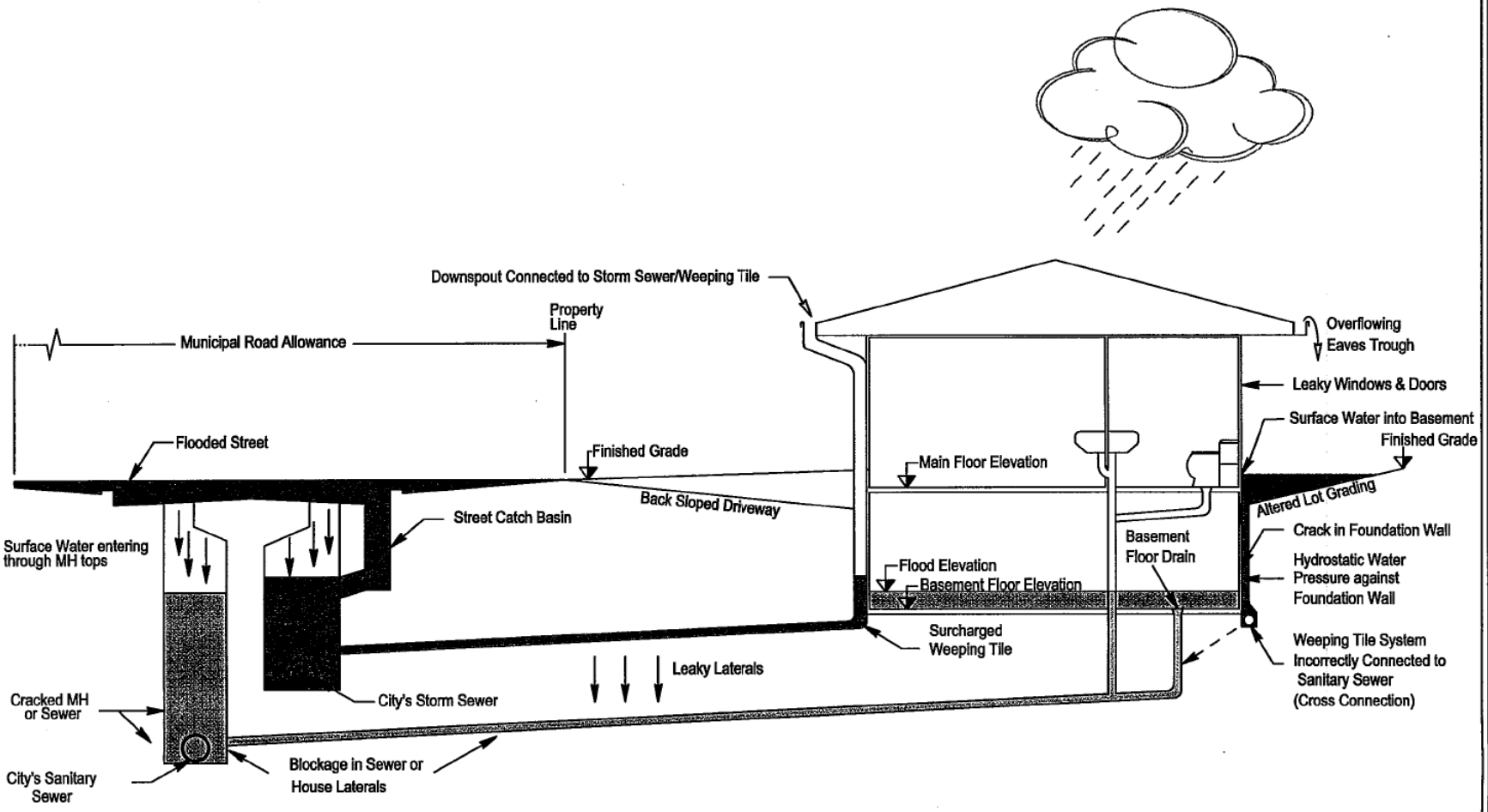
250
200
150
130
110
96
82
70
60
50
40
32
26
20
16
12
8
6
4
2
0

Maximum 5-Minute Intensities for July 22-23 2008 period 03:00 to 19:55 EST

Maximum Precipitation Intensities Based on FF3 GCF Calibration of King City Radar Data

Features mapped using the UTM Projection (NAD83) and expressed in meters.

ATTACHMENT No. 3



POTENTIAL SOURCES OF BASEMENT FLOODING

LEGEND

Storm Sewer

Sanitary Sewer

N.T.S.

CITY OF VAUGHAN - ENGINEERING PLANNING & STUDIES