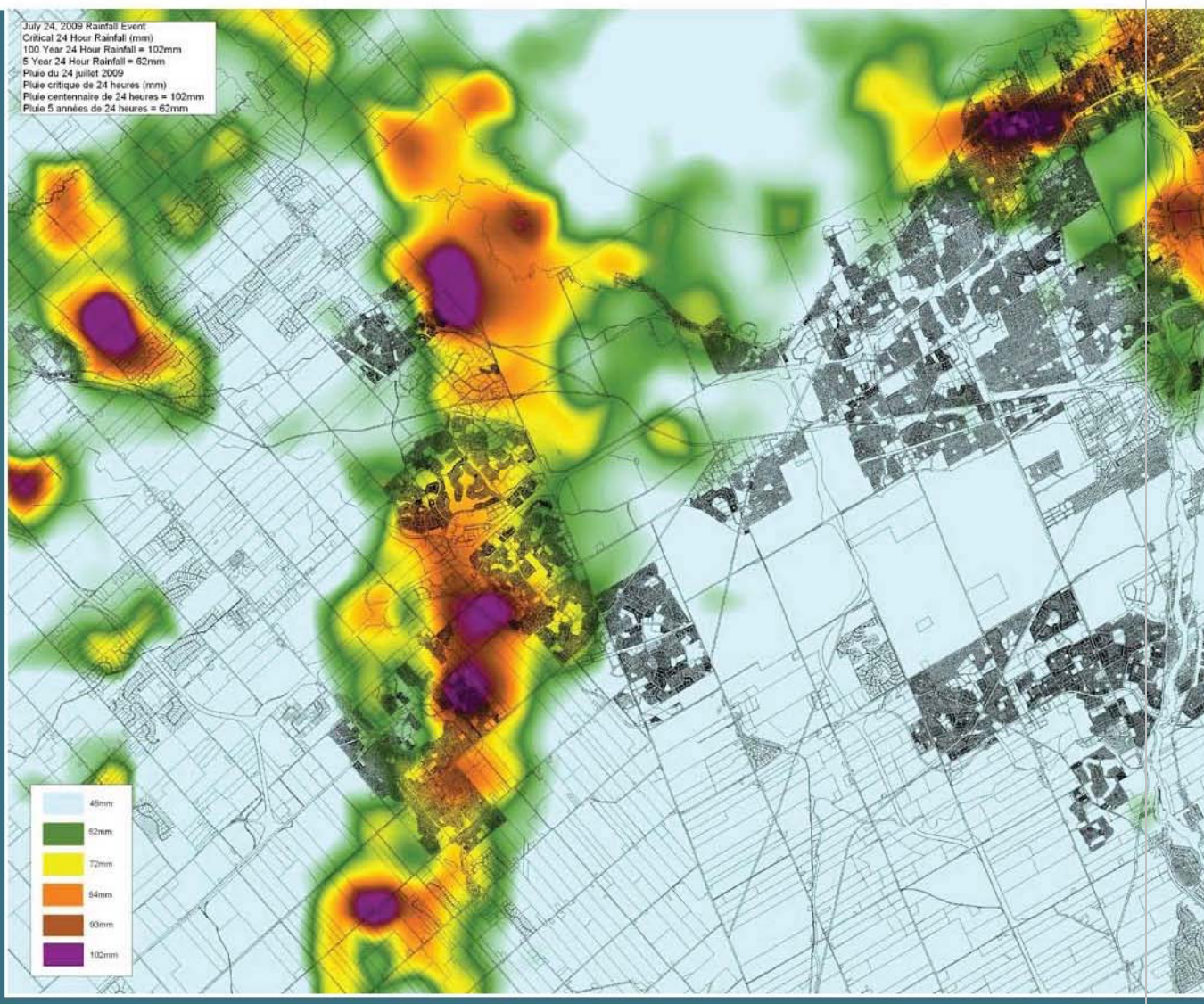


WEST-END FLOODING INVESTIGATION
24 JULY 2009 RAINSTORM EVENT

PHASES 1 AND 2 – SUMMARY REPORT

JANUARY 2010

Summary Report

Background

On July 24, 2009, parts of the City of Ottawa experienced a significant rainstorm (over 100 mm of rain in a 24-hour period in some areas) resulting in nearly 1,500 flooded basements, overflows at two sewage pumping stations, and seven culvert failures. These occurred primarily in the City's west end, mainly in Ward 4 - Kanata North (Beaverbrook), Ward 5 - West Carleton-March (Carp Village), Ward 6 - Stittsville, and Ward 23 - Kanata South (Katimavik and Glen Cairn). An investigation, led by the Infrastructure Services Department (ISD) and supported by several City departments, is underway to understand why flooding occurred, what can be done to reduce the risk of future occurrences, and to implement solutions.

Scope of Investigation

The investigation is being undertaken in five phases: Phase 1 - Background data collection; Phase 2 - Assessment and problem definition; Phase 3 - Identification and evaluation of alternative solutions; Phase 4 - Development and approval of action plan; and Phase 5 - Implementation of approved action plan.

The scope of the investigation includes all west end locations that experienced flooding. The focus is on affected areas where flooding resulted in damage to private properties or to City infrastructure. While heavy rainfall and flooding also occurred in other parts of the City, flooding in other areas appears to be isolated and dispersed. These isolated cases will be subject to a separate investigation on an individual basis.

This summary report provides a summary of the results of Phases1 and 2 of the investigation. The main report provides more technical details. Phase 3 has been initiated and is ongoing. It is noted that this investigation is subject to a peer review and will be made available to the public. The only difference between the main technical reports submitted to the peer review and the version available to the public is references that could identify specific properties have been removed from the version available to the public. This does not change the findings available in both reports.

Public Input

Public input has been key to the investigation. A number of residents have submitted comments and photos that were very helpful in understanding what took place on July 24, 2009. In addition, how water entered basements is based on information provided by residents as part of the City's First Response when the event took place.

Public meetings were organized by affected Ward Councillors and held in the following west end locations:

- Stittsville and District Community Centre, July 30, 2009 (evening)
- Kanata Recreation Complex, September 12, 2009 (all day with three sessions)

- Earl of March School, October 1, 2009 (evening)

A presentation was also made to Council on September 2, 2009. The presentation provided an overview of the extent of flooding, general causes of flooding and a work plan focusing on finding solutions that will reduce the risk of future flooding occurrences.

Opportunities for public input will be available throughout the various phases of the investigation process. For example, the Glen Cairn Flooding Investigation Study has been initiated and is following the Class Environmental Assessment process. A Community Committee has been established for Kanata South and this group has provided beneficial input.

Design Standards

As with most built goods, standards evolve over time. This also applies to design standards for municipal infrastructure. The area that has seen the greatest change is related to storm water management.

Pre 1960's
Sewers first constructed in Ottawa, over 100 years ago, were comprised of combined pipes that conveyed storms and sanitary flows directly to the river. In the late 1950's and early 1960's, flows from those combined sewers were intercepted and a high percentage was redirected to the wastewater treatment plant. In addition, in the 1950's the industry practice moved from building combined sewers to partially separated sewers; separate sanitary and storm pipes but with perimeter foundation drains connected to the sanitary sewer.

1960's to 1990's
In the early to mid 1960's the industry practice moved to fully separated sewers; perimeter foundation drains connected to storm sewers. Storm sewers were designed based on capturing frequent rainfall events but little to no provisions were made for large events. It is only in the mid 80's and 90's that consideration started to be given to incorporating into the overall community design plans overland drainage as part of the design of storm drainage systems to deal with larger/infrequent rainfall events. It is also in the 90's that new developments started to include stormwater ponds to store rain water during large rainfall events. These ponds later evolved to provide stormwater quality benefits to protect receiving streams.

Current Standards
Current urban storm drainage systems consist of two separate and distinct systems (also referred to as dual drainage): 1) the minor system and 2) the major system. The minor system consists of the underground storm sewer system that conveys flows from the more frequent, lower intensity rainstorms. The major system, which consists of the overland flow routes (street network, swales, watercourses, etc.), is designed to convey runoff from the less frequent, high intensity storm events that are in excess of the minor system design capacity. Dual drainage often features the use of inlet restrictors that limit inflow to the minor system. Flow to the minor system is restricted to the capacity of the storm sewer pipes. During events that exceed the capacity of the minor system, excess flow is conveyed overland or stored on site. Minor systems are therefore protected from surcharge during rare events and with proper major system drainage the risk of

basement flooding is minimized. The use of backwater valves can also provide a second level of protection during rare events.

Current City of Ottawa sewer design standards are based on current recognized industry practices and these have been applied on a city-wide basis since 2004. The majority of the west end areas affected by the July 24, 2009 event were built in the 1960's to 1980's, before implementation of dual drainage standards. Therefore, increasing the resiliency to large rainfall events in these communities requires working within the constraints of how these were built.

Key Findings (Basement Flooding)

The root cause of the basement flooding on July 24, 2009 is the rainfall exceeded what the sewer systems were designed to handle (note: this includes provisions for overland drainage as sewer pipes alone are not designed to handle these types of large rainfall events). Sewer cleaning has not been identified as a cause of flooding.

Several factors contributed to widespread occurrences of flooding and sewer backups in the City's west-end. The following is intended to highlight key findings. The extent to which these contributed to basement flooding is being analyzed in more detail as part of Phase 3 of the investigation.

Overtaxed storm sewers and overland drainage:
The July 24, 2009 rainfall event exceeded the design capacity of the storm drainage system. This led to water entering basements through window wells, improperly sealed backwater valves or cleanouts, and floor joint around foundations. Water in these basements evacuated through basement floor drains contributing high extraneous flows to the sanitary sewer system.

During Phase 3 of the investigation, measures to increase the ability of the existing drainage systems to handle large rainfall events will be analyzed. These included capacity of the existing storm sewers, installation of inlet control devices (ICDs), and improvements to overland drainage.

Failure of backwater valves:
Due to the significant rainfall, storm sewers were overtaxed causing water to backup in lateral connection and creating pressure on backwater valves (BWVs). Approximately 125 homes, mainly located in the Stittsville area, experienced failure of BWVs exacerbating extraneous flows to the sanitary sewer system. The investigation carried out to date indicates that BWVs were installed in the correct position but water entered basement through caps that did not provide a proper seal.

Phase 3 of the investigation is looking into BWV standards and opportunities to increase public awareness of what measures residents can take to confirm that BWV caps are closed properly.

High extraneous flows in sanitary sewers:
Sanitary sewers experienced extraneous flows significantly greater than what they were designed to handle leading to many occurrences of sewer backups in basements. These high extraneous

flows were caused by basements flooded by storm water (as discussed above), water entering through holes in maintenance covers that would have been submerged during the large rainfall event and through sump pumps discharging illegally to the sanitary system. High extraneous flows could also be from foundation drains or storm catch basins that are cross-connected. Fog testing is being undertaken in Glen Cairn, Katimavik and Beaverbrook to confirm if any of these are present that would require them to be redirected to the storm system.

During Phase 3 of the investigation, staff will examine the results of the fog testing, and analyze the capacity of the sanitary sewer system to identify potential flow restrictions and capacity upgrades to allow the sewer system to handle larger extraneous flows. They will also look at opportunities to increase public awareness on measures residents can take to reduce extraneous flow to the sanitary system, such as not discharging sump pumps into the sanitary sewer via connections to the laundry tub or floor drain, and the importance of not opening maintenance hole covers to drain water accumulated on the road surface. There is no confirmation that the latter has occurred, but photos of the July 24, 2009 event posted on Facebook shows an individual (in the south eastern part of Glen Cairn) trying to open a maintenance hole cover in the middle of the road and comments suggest that he was not successful. Opening maintenance hole covers under those conditions could cause extensive sewer backups in basements.

Overtaxed sewage pumping stations:
Under normal operating conditions, pumping stations have adequate capacity to handle sewage flows. The conditions experienced on July 24, 2009 resulted in higher than usual levels of extraneous flows in the sanitary sewers causing most of the pumping stations to operate at or above their design capacity. Overflows occurred at two pumping station locations: Fringewood and Acres Road. Both occurrences were reported to the Ministry of the Environment. The high operating levels at some of the stations caused water levels to rise in major trunk sewers further exacerbating sanitary sewer backups. This was particularly the case at the Hazeldean pumping station causing flows to backup in the Sittsville and Glamorgan collectors.

Phase 3 of the investigation will look into the inlet and overflow performances at the Hazeldean pumping station and opportunities for improvements as warranted. This is being coordinated with other operational upgrades and improvements. Further review is also required at the Acres Road pumping station to see what improvements are required to reduce the risk of future overflows occurring the way they took place on July 24, 2009.

Overwhelmed drainage along Monahan Drain at Terry Fox Drive:
The TransCanada Trail (TCT), that intersects Terry Fox Drive, is the watershed boundary between the Carp and Monahan drainage systems. The area to the north of the TCT drains towards the Carp River and the area to the south drains towards the Monahan drain and on to the Jock River.

There is a culvert where the Monahan Drain crosses Terry Fox Drive. This culvert is designed to convey flow from a relatively small area. During the July 24, 2009 rainfall event, a large pool of water accumulated on the west side of Terry Fox Drive. This issue is still subject to more detailed investigation, but it appears the significant rainfall overwhelmed the Monahan Municipal Drain system and some flows were directed north towards the TCT instead of

outleting to the south as intended under normal conditions. As noted, the TCT is the dividing boundary between the Carp and the Monahan systems, but there is a culvert located just east of the Hazeldean pumping station. This culvert is intended to drain rear yards from homes along Rothesay and the eastern portion of Glamorgan to the Monahan Drain. This culvert permitted flows from the Monahan Drain to reverse and move northward into the rear yards of the homes along Glamorgan and Castleglen and could have contributed flows to the Glen Cairn pond.

Phase 3 of the investigation is looking into analyzing the Monahan Drain system to assess its performance during the July 24, 2009 storm event and identify measures to reduce the risk of water flowing north towards the TCT.

<u>High water level in Glen Cairn Stormwater Pond and Carp River:</u>
Storm water in the Glen Cairn and Bridlewood North communities flows through the Glen Cairn Stormwater Pond, located on the west side of Terry Fox, before outleting into the Carp River. The pond provides both water quality and quantity control benefits.

The reach of the Carp River that flows through the Glen Cairn community also flows through the pond. During large rainfall events, water accumulates in the pond, and this affects the water level in the reach of the Carp River located in the Glen Cairn community. This section of the Carp River was subject of previous channel improvements following the 2002 event. Based on the available data, there are no indications to suggest that the Carp River overtopped its banks. The channel improvements were effective in reducing the impact of surface flooding in the community.

Since the pond and the Carp River serve as the outlet for all storm sewers, the capacity of the storm sewers are impacted by the outlet levels during large/infrequent rainfall events. This would have exacerbated the overtaxing of the storm sewers. As a result, sump pumps are being recommended as part of the Residential Protective Plumbing Program for homes in Glen Cairn located in the area influenced by the levels in the Glen Cairn pond and Carp River.

Phase 3 of the investigation is looking into analyzing the impact of the water levels in the Glen Cairn pond and Carp River on the outlet conditions for the storm sewer systems. This is being undertaken as part of the ongoing Glen Cairn Flooding Investigation Study.

<u>High water level in Cattail Creek at Katimavik Road:</u>
On July 24, 2009, high water levels were reported in Cattail Creek at Katimavik Drive. Debris had partially clogged the grate of the culvert crossing Katimavik Road, causing water to back into the yards of properties along Peary Way and entering basements through window wells and joints around basement floors resulting in high extraneous flows causing sewer backups in other homes in the immediate area. The partial clogging of the grate is expected to have occurred as a result of debris (i.e. branches, leaves) along the creek being transported. The grate has since been removed until the situation is reviewed in more detail.

Phase 3 of the investigation is looking into analyzing the culvert and drainage systems in more detail to ensure there is sufficient capacity to provide an appropriate level of protection. The design for the grate at this location is also being reviewed.

Other Findings (Culvert Failures)

The significant rainfall also contributed to failure of seven road culverts (all less than 3 m in size). This does not include the culvert crossing Katimavik Road discussed above. None of these seven culverts contributed to basement flooding and did not result in injuries or damage to private properties.

The extent of failure varied by location, but extension joint failures on corrugated steel pipe culverts caused most failures and invert rust-out contributed to others. Corrective action has been taken for all culverts. Options are also being investigated to reduce the risk of future failures resulting from significant rainfall events.

Summary of Findings by Clusters

Clusters are defined as groupings of homes in the same general area that experienced basement flooding. Clusters are identified by community name or by a major street in the affected area. The limits of the clusters are shown in Figure 1. A summary of findings by clusters is provided in Table 1.

As noted in Table 1, several factors contributed to widespread occurrences of flooding and sewer backups. The extent to which these may have contributed to basement flooding is being analyzed in more detail as part of Phase 3 of the investigation.

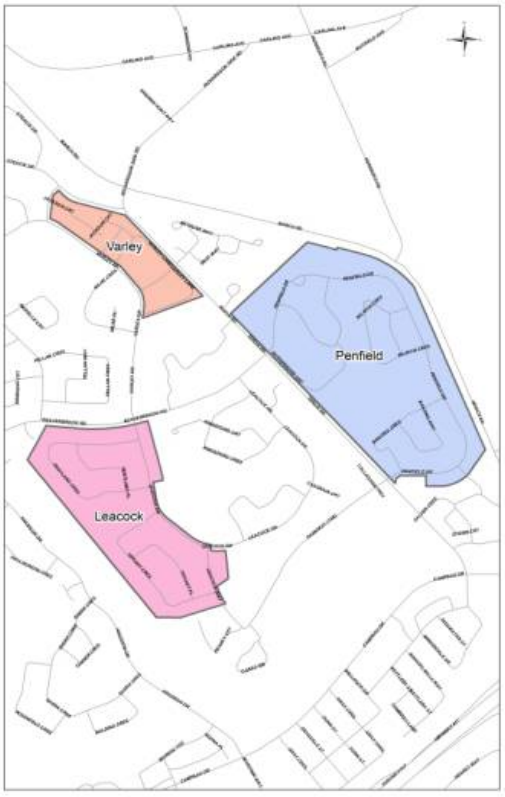
Next Steps

The next steps are focussed on completing the review of alternatives and the selection of solutions that will assist in reducing the risk of future basement flooding in the affected areas. As noted in the key findings, the focus will be to:

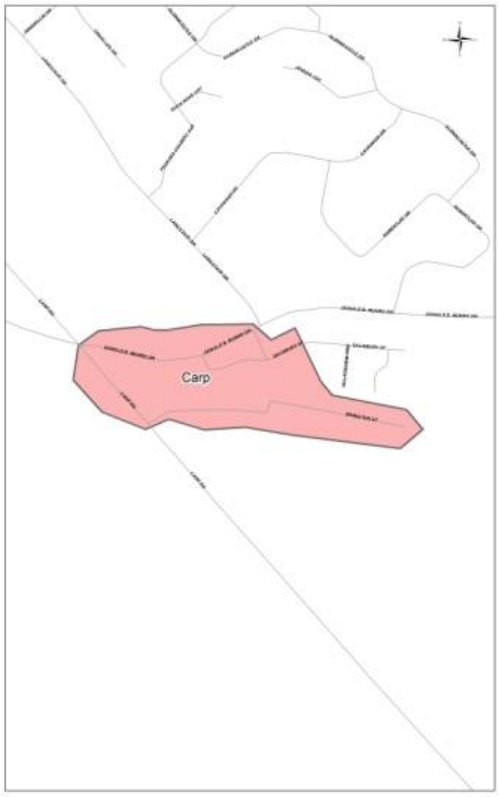
- Reduce storm water inflow into sanitary sewer;
- Review and improve overland drainage, where required;
- Install inlet control devices (ICDs) on storm sewer;
- Increase awareness of backflow valve and sump pump maintenance requirements; and
- Promote Residential Protective Plumbing Program.

Given the difference in scope for the various areas, some will be identified and implemented sooner than others. To ensure that delays don't occur in the implementation, funding is being identified as part of the 2010 Draft Rate Supported Capital Budget. A memo to Council will be issued in January 2010 providing an update on the status of the investigation and an outline of the funding requirements being included in the 2010 Draft Rate Supported Capital Budget to allow implementation of solutions to begin in 2010.

Figure 1 – Limits of Flooding Clusters



Ward 4 – Kanata North



Ward 5 – West Carleton-March

Ward 6 – Stittsville - Kanata-West

Ward 23 – Kanata South

Table 1 – Summary of Findings by Clusters

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
Ward 4 – Kanata North			
Leacock (constructed in 1964)	32	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. Sewers were not designed, nor are they intended to handle the extraneous flows experienced during the July 24, 2009 rainfall event.	Phase 3 is underway and will be analyzing in more details the hydraulic capacity of the sanitary and storm sewer systems to identify improvements. Fog testing is also being conducted to identify sources of extraneous flows in the sanitary sewer system.
Penfield (constructed in 1969)	7	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. The sanitary sewer outlet for this area is the March Ridge Trunk sewer. High extraneous flows caused the Acres Road pumping station to overflow and it is suspected that March Ridge Trunk was surcharged. Basements that were impacted are the lowest in the area and would be the first to be impacted.	Phase 3 is underway and will be analyzing the trunk sewers, up to and including the Acres Road pumping station, to determine if this was in fact the cause of flooding. The analysis will also extend to the local system, as necessary, to identify if there are local constraints that could have aggravated the sewer backups.
Ward 5 – West Carleton-March			
Carp Village – Rivington St. (constructed in 2001)	11	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. This condition occurred as a result of high extraneous flows into the sanitary sewer system from water entering through maintenance hole covers or sump pumps directed to the sanitary sewer. Only the lowest basements on the north side experienced sewer backups.	Phase 3 is underway and will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices (ICDs) and improvements to overland drainage.

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
Ward 6 – Stittsville-Kanata-West			
Old Stittsville (constructed in 1979)	29	Based on information reported, the source of basement flooding appears to be equally divided between storm water entering through window wells and sump pits, and sanitary sewer backups. In areas with no storm sewers, water entered through sump pits and foundations. Design reports for this cluster noted groundwater to be high, which could have further aggravated the situation. It is not uncommon for residents to connect sump pumps to the sanitary system when there is an inadequate outlet or drainage outside of the house. This can aggravate already serious extraneous flow problems in the sanitary sewer system. Storm drainage infrastructure was constructed in the late 1970s. At that time, storm drainage systems were not designed to handle large-infrequent rainfall events.	Phase 3 is underway and will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage.
West Wood (constructed in 2004)	102	Based on information reported, most of the West Wood cluster flooded when the storm sewer system surcharged and entered basements through failed backwater valves (BWVs). Water exited from basements through floor drains into the sanitary sewer, which sent a significant amount of extraneous flow into the system. This led to local sanitary sewer system surcharges that caused water to enter homes through floor drains. The lowest basements were flooded due to excess flow in the sanitary sewer system.	Phase 3 is underway and will be reviewing overland flow routes and sizing of ICDs to reduce the risk of future flooding occurrences. Given the high incidence of failed BWVs, a review has been initiated and should be available towards the end of Q1 of 2010.

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
West Wind (constructed in 1984-2004)	54	Based on information reported, most homes flooded when the storm sewer system surcharged and entered basements through failed BWVs and through sump pits. Water exited from basements through floor drains into the sanitary sewer, which sent a significant amount of extraneous flow into the system. This led to local sanitary sewer system surcharges that caused water to enter homes through floor drains. The lowest basements were flooded due to excess flow in the sanitary sewer system.	Phase 3 is underway and will be reviewing overland flow routes and sizing of ICDs to reduce the risk of future flooding occurrences. Given the high incidence of failed backwater valves, a review has been initiated and should be available towards the end of Q1 of 2010.
Jackson Trails (constructed in 2005-2007)	11	Based on information reported, most homes flooded when the storm sewer system surcharged and entered basements through failed BWVs and through sump pits. Water exited from basements through floor drains into the sanitary sewer, which sent a significant amount of extraneous flow into the system. This led to local sanitary sewer system surcharges that caused water to enter homes through floor drains. The lowest basements were flooded due to excess flow in the sanitary sewer system.	Jackson Trails is a new development under construction. It was designed to current sewer design standards, but it appears that a number of ICDs had yet to be installed. Direction has been given to proceed immediately with the installation of the missing ICDs. This has also generated a motion from Council for future projects that a confirmation by a Professional Engineer be provided confirming that ICDs have been installed before the system being put into service.
Granite Ridge (constructed in 2000-2006)	42	Based on information reported, most homes flooded when the storm sewer system surcharged and entered basements through failed BWVs, cleanouts and foundation cracks. Water exited from basements through floor drains into the sanitary sewer, which sent a significant amount of extraneous flow into the system. This led to local sanitary sewer system surcharges that caused water to enter homes through floor drains. The lowest basements were flooded due to excess flow in the sanitary sewer system.	Phase 3 is underway and will be reviewing overland flow routes and sizing of ICDs to reduce the risk of future flooding occurrences. Given the high incidence of failed backwater valves, a review has been initiated and should be available towards the end of Q1 of 2010.

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
Eileen (constructed in 1992)	9	Based on information reported, most homes flooded when the storm sewer system surcharged and entered basements through failed BWVs. Water exited from basements through floor drains into the sanitary sewer, which sent a significant amount of extraneous flow into the system.	Phase 3 is underway and will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage. Given the high incidence of failed backwater valves, a review has been initiated and should be available towards the end of Q1 of 2010.
Amberwood (constructed in 1984)	52	Based on information reported, most homes flooded when the storm sewer system surcharged and entered basements through failed BWVs, cleanouts, window wells and joints around basement floors. Water exited from basements through floor drains into the sanitary sewer, which sent a significant amount of extraneous flow into the system. This led to local sanitary sewer system surcharges that caused water to enter homes through floor drains. The lowest basements were flooded due to excess flow in the sanitary sewer system.	Phase 3 is underway and will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage. Given the high incidence of failed backwater valves, a review has been initiated and should be available towards the end of Q1 of 2010.
Wyldewood (constructed in 1983)	13	Based on information reported, most homes flooded when the storm sewer system surcharged and entered basements through failed BWVs, cleanouts, window wells and joints around basement floors. Water exited from basements through floor drains into the sanitary sewer, which sent a significant amount of extraneous flow into the system.	Phase 3 is underway and will be reviewing overland flow routes and sizing of ICDs to reduce the risk of future flooding occurrences.

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
Ward 23 – Kanata South			
Naismith (constructed in 1978)	16	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. This condition occurred as a result of high extraneous flows into the sanitary sewer system. Some properties also experienced flooding through backwater valves, window wells and joints around basement floors as a result of storm drainage systems (sewers and overland drainage) not designed to handle large-infrequent rainfall events.	Phase 3 is underway and will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. Fog testing is being conducted to identify sources of extraneous flows in the sanitary sewer system. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage.
Vanstone (constructed in 1978)	39	Based on information reported, the source of basement flooding appears to be equally divided between storm water entering through window wells and sump pits, and sanitary sewer backups. This area is predominantly serviced by open ditches. There have been several infills, which may have impacted floodings through the elimination of stormwater outlets and conveyance capacity. Homes in this area have sump pits and pumps that provide foundation drainage. Field findings highlighted several eaves trough downspouts directed into the ground. During large rainfall events this could introduce more water than the sump pumps are able to handle resulting in basement flooding. Stormwater from these flooded basements introduced significant extraneous flow into the sanitary sewer system. It is also suspected that some homes have their sump pump outleting into the sanitary sewer (i.e. outleting into the laundry tub). The sources of extraneous flows in the sanitary sewer system would have caused other homes to experience sewer backups.	Phase 3 is underway and will be analyzing in more details the hydraulic capacity of both sanitary and storm drainage systems, including the impact of infilled ditches. Fog testing is being conducted to identify sources of extraneous flows in the sanitary sewer system. Communication will also take place with residents of homes serviced by sump pumps and/or with downspouts outleting along the foundation to reduce potential extraneous sources into the sanitary sewer system.

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
Peary (constructed in 1975)	14	Based on information reported, the source of basement flooding appears to be equally divided between storm water entering through window wells and joints around basement floors, and sanitary sewer backups. On July 24, 2009, high water levels were reported in Cattail Creek at Katimavik Drive. Debris had clogged the grate of the culvert crossing Katimavik Road, causing water to back into the yards of properties along Peary Way and entering basements through window wells and joints around basement floors resulting in high extraneous flows causing sewer backups in other homes in the immediate area. The partial clogging of the grate is expected to have occurred as a result of broken tree branches and debris along the creek being transported.	The culvert grate has been removed to minimize the risk of future blockages. A culvert capacity analysis will be completed to ensure the culvert has sufficient capacity to provide the appropriate level of protection against flooding.
Glamorgan (constructed in 1973-1974)	392	This area was the most severely affected by the July 24, 2009 rainfall. Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. This condition occurred as a result of high extraneous flows into the sanitary sewer system. It is suspected that a number of properties also experienced flooding through window wells and joints around basement floors as a result of storm drainage systems (sewers and overland drainage) not designed to handle large-infrequent rainfall events. There are a number of factors that appear to have contributed to flooding and sewer backups in this area. • Due to the excessive extraneous flows, the Hazeldean pumping station operated beyond its rated capacity and the high water level at the station caused flows to backup in the Sittsville and	Phase 3 is underway and given the many contributing factors, a consultant is being retained for the Glen Cairn Flooding Investigation Study. This study will follow the Class Environmental Assessment process. This study will be analyzing the capacity of the existing storm sewers and considering the installation of ICDs and improvements to overland drainage as measures to increase the resiliency of the existing drainage systems to handle large rainfall events. The analysis will consider in greater detail the impact of the water levels in the Glen Cairn pond and Carp River on the outlet conditions for the storm sewer system as this will affect the design of the ICDs and provisions for overland drainage.

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
Glamorgan (continued)		Glamorgan collectors. This would have exacerbated the sewer backups in the Glamorgan area. • The storm sewers for the Glamorgan area outlet in the Glen Cairn pond and the high water level in the pond resulting from the July 24, 2009 rainfall would have impacted the capacity of the storm sewer system. • The perimeter foundation drains for all homes in this area were constructed without the protection of a backwater valve. Without inlet restrictions (ICDs), the storm sewers will impact the foundation drainage systems that could cause basement flooding. • The TransCanada Trail (TCT) is the watershed boundary between the Carp and Monahan drainage systems. The area to the north of the TCT drains towards the Carp River and the area to the south drains towards the Monahan Drain and on to the Jock River. Due to the significant rainfall, flows from the Monahan Municipal Drain system were directed towards the TCT instead of outleting to the south as intended. A culvert located just east of the Hazeldean pumping station is intended to drain rear yards from homes along Rothesay and the eastern portion of Glamorgan to the Monahan Drain. This culvert permitted flows from the Monahan Drain to reverse and move northward into the rearyards of the homes along Glamorgan and Castleglen and could have contributed flows to the Glen Cairn pond.	The study will also be reviewing the results of the fog testing, and analyzing the capacity of the sanitary sewer system to identify potential flow restrictions and capacity upgrades to allow the sewer system to handle larger extraneous flows. A key element of the study will be an evaluation of the Hazeldean pumping station, including but not limited to the inlet structure and the overflow performance to define improvements as warranted. This is being coordinated with operational improvements and capacity needs to accommodate future growth. Phase 3 of the investigation is also looking into analyzing the Monahan Drain system in more detail to assess its performance during the July 24, 2009 storm implement mitigation measures as warranted.

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
Abbey Hill (constructed in 1965-1968)	91	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. This condition occurred as a result of high extraneous flows into the sanitary sewer system. It is suspected that a number of properties also experienced flooding through window wells and joints around basement floors as a result of storm drainage systems (sewers and overland drainage) not designed to handle large-infrequent rainfall events. The perimeter foundation drains for all homes in this area were constructed without the protection of a backwater valve.	Phase 3 is underway and given the many contributing factors, a consultant is being retained for the Glen Cairn Flooding Investigation Study. This study will follow the Class Environmental Assessment process. This study will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. Fog testing is being conducted to identify sources of extraneous flows in the sanitary sewer system. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage.
Oriole (constructed in 1974)	31	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. This condition occurred as a result of high extraneous flows into the sanitary sewer system. It is suspected that a number of properties also experienced flooding through window wells and joints around basement floors as a result of storm drainage systems (sewers and overland drainage) not designed to handle large-infrequent rainfall events. The perimeter foundation drains for all homes in this area were constructed without the protection of a backwater valve.	Phase 3 is underway and given the many contributing factors, a consultant is being retained for the Glen Cairn Flooding Investigation Study. This study will follow the Class Environmental Assessment process. This study will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. Fog testing is being conducted to identify sources of extraneous flows in the sanitary sewer system. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage.

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
Banning (constructed in 1964)	30	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. This condition occurred as a result of high extraneous flows into the sanitary sewer system. It is suspected that a number of properties also experienced flooding through window wells and joints around basement floors as a result of storm drainage systems (sewers and overland drainage) not designed to handle large-infrequent rainfall events. The perimeter foundation drains for all homes in this area were constructed without the protection of a backwater valve.	Phase 3 is underway and given the many contributing factors, a consultant is being retained for the Glen Cairn Flooding Investigation Study. This study will follow the Class Environmental Assessment process. This study will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. Fog testing is being conducted to identify sources of extraneous flows in the sanitary sewer system. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage.
McKitrick (constructed in 1974-1979)	28	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. This condition occurred as a result of high extraneous flows into the sanitary sewer system. It is suspected that a number of properties also experienced flooding through window wells and joints around basement floors as a result of storm drainage systems (sewers and overland drainage) not designed to handle large-infrequent rainfall events.	Phase 3 is underway and given the many contributing factors, a consultant is being retained for the Glen Cairn Flooding Investigation Study. This study will follow the Class Environmental Assessment process. This study will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. Fog testing is being conducted to identify sources of extraneous flows in the sanitary sewer system. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage.

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
Gowrie (constructed in 1982)	59	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. This condition occurred as a result of high extraneous flows into the sanitary sewer system. It is suspected that a number of properties also experienced flooding through window wells and joints around basement floors as a result of storm drainage systems (sewers and overland drainage) not designed to handle large-infrequent rainfall events.	Phase 3 is underway and given the many contributing factors, a consultant is being retained for the Glen Cairn Flooding Investigation Study. This study will follow the Class Environmental Assessment process. This study will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. Fog testing is being conducted to identify sources of extraneous flows in the sanitary sewer system. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage.
McElroy (constructed in 1975)	32	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. This condition occurred as a result of high extraneous flows into the sanitary sewer system and could have been influenced by the surcharged levels in the Glamorgan system. It is suspected that a number of properties also experienced flooding through window wells and joints around basement floors as a result of storm drainage systems (sewers and overland drainage) not designed to handle large-infrequent rainfall events. The perimeter foundation drains for all homes in this area were constructed without the protection of a backwater valve.	Phase 3 is underway and given the many contributing factors, a consultant is being retained for the Glen Cairn Flooding Investigation Study. This study will follow the Class Environmental Assessment process. This study will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. Fog testing is being conducted to identify sources of extraneous flows in the sanitary sewer system. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage.

Cluster Name	# of Reported Flooding Locations	Probable Source of Flooding	Status of Investigation
Halkirk (constructed in 1996)	21	Based on information reported, the majority of basement flooding resulted from sanitary sewer backups. This condition occurred as a result of high extraneous flows into the sanitary sewer system. It is suspected that a number of properties also experienced flooding through window wells and joints around basement floors as a result of storm drainage systems (sewers and overland drainage) not designed to handle large-infrequent rainfall events.	Phase 3 is underway and given the many contributing factors, a consultant is being retained for the Glen Cairn Flooding Investigation Study. This study will follow the Class Environmental Assessment process. This study will be analyzing in more details the hydraulic capacity of both sanitary and storm sewer systems. Fog testing is being conducted to identify sources of extraneous flows in the sanitary sewer system. The hydraulic analysis will also look at improving the ability of the storm drainage system to handle large-infrequent rainfall events, such as installation of inlet control devices and improvements to overland drainage.