AUGUST 10, 2023 FLOOD INVESTIGATION REPORT

DRAFT SUMMARY REPORT WARD 16

Asset Management (Water Resources)
Infrastructure and Water Services
December 14, 2023

INTRODUCTION

The event that occurred on August 10th, 2023, produced an average of 60 mm of rain throughout the city over a period of 5 hours, with a peak recorded volume of 107 mm at the Colonnade Road gauge. Furthermore, the intensity of the storm reached a peak of 190 mm/hr at the Colonnade rain gauge. The storm followed a West to East band in the south portion of the City Core with a return frequency of approximately 100 years (1% change of occurring in any given year). Other parts of the city experienced a lesser event, in the range of a 10 year to 50 year storm. Due to the nature of the storm (high peak intensity and high volume), sanitary sewers, storm sewers and overland drainage systems were all affected.

To date there are 474 reports of flooding related to the August 10th, 2023 rainfall event. For those reported through 311, the property that flooded was recorded but no further information was provided such as the entry point of the water. In the past, first response would visit flooded properties but once water had receded, the entry source was difficult to determine. As such First response chose to discontinue physical responding to calls following a flood event and simply recorded the property that flooded. Many of the reports are therefore via AMB questionnaire distributed to residents by councilors or individual calls/emails forwarded to AMB or through public meeting(s) at community level.

Preliminary analysis of the flood reports shows that the source of flooding varied by neighbourhood depending on the age and configuration of the sewer system. For many, flooding occurred via floor drains and basement plumbing, indicating that the sanitary sewer system was overwhelmed due to high extraneous flows from weeping tiles connected to the sanitary system (homes constructed before the mid-1960s). In other cases, flooding was caused by surcharging of the storm sewer system, which backed up water into the weeping tiles (homes constructed after the mid-1960s). There were also many instances of overland flooding due to the lack of a well-defined overland flow system that caused property damage, closed roads and in some cases, entered basements via windows, reverse slope driveways and other openings. When a basement is flooded, the water drains back into the sanitary system via the floor drain, which further exacerbates surcharging of the sanitary sewer system.

To provide a preliminary understanding of the flooding that was experienced, flood reports are grouped into clusters where a cluster is defined as a grouping of homes that have flooded in a particular area. Two clusters accounting for approximately 24 flood reports were identified. The remaining flooding reports (13) did not fall into a specific cluster and at the time of writing this report, they are suspected as being a local issue most likely related to the private property, however infrastructure issues are not ruled out.

1.0 DIFFERENT TYPES OF SEWER SYSTEMS

The City of Ottawa is serviced by various types of sewer systems. Prior to 1948, the City constructed combined sewers in urban areas, in which both domestic sewage and surface runoff were conveyed in the same piped system. Such systems were prone to surcharging during large rainfall events and overflows to surface water bodies often occurred. The surcharging of these systems also caused sewage to backup into some basements.

From 1948 to 1961 the City constructed sanitary sewers and surface runoff was conveyed using ditches and shallow storm sewers. The practice at the time was to use the deeper sanitary sewer pipes to capture foundation drain flow, thereby eliminating the need for sump pumps in homes. This practice unfortunately led to excess flow in the sanitary system during large rainfall events.

In 1961 the City of Ottawa passed a bylaw that required that all new sewer systems be fully separated. In other words, a sanitary sewer system would be designed for domestic flow only and a deeper storm system would capture surface runoff and foundation drain flow. The City even proceeded to separate sewers in some of the combined areas, however due to outlet restrictions, the storm sewers were shallow and foundation drains remained connected to the sanitary sewers. Also, in many areas where ditch drainage existed, the City constructed storm sewers, but again due to various drainage conditions or limitations the sewers were shallow and foundation drains remained connected to the sanitary system. ***All areas that have foundation drains connected to the sanitary sewers are referred to as partially separated. Figure 1.0 below, shows an approximate outline of the partially separated systems (in yellow) and fully separated systems (in red) in the southern portion of the City core, which was most affected by the storm.***

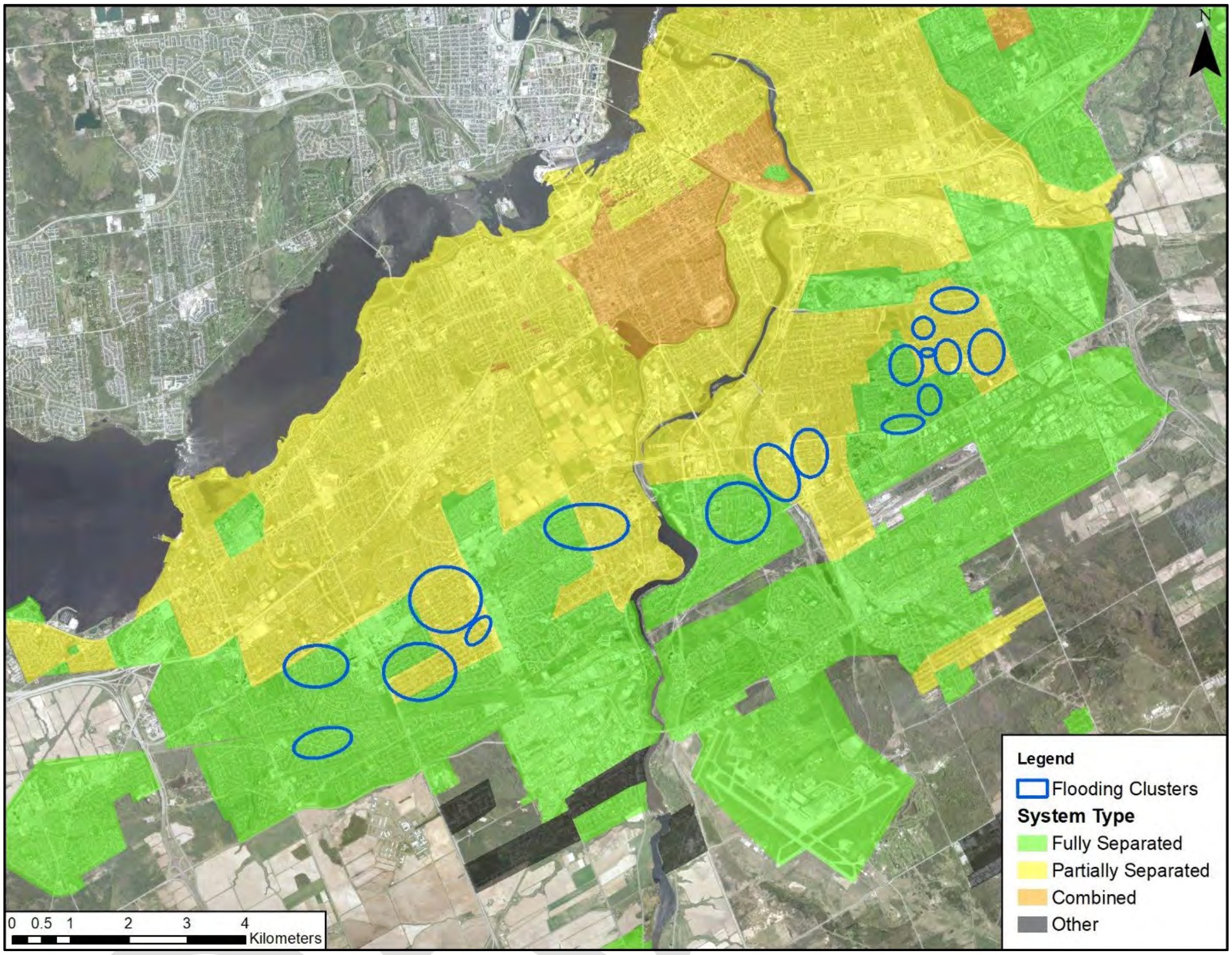

Figure 1 – System Type and Flooding Clusters

2.0 CHARACTERISTICS OF RAINFALL EVENT

The average rainfall in the partially separated area was 60 mm with a peak recorded volume of 107 mm. The peak intensity of the event reached 190 mm/hr at the Colonnade rain gauge. Although the event did not reach the peak 100 year peak intensity of 243 mm/hr, it lasted longer than a typical storm, therefore the sustained intensity created an effect similar to a 100 year storm. Figures 2 and 3 below show the Intensity Duration Frequency (IDF) curves for the event at the Colonnade and Mooney's Bay rain gauges. It is apparent from the graphs that as the storm progressed, the curve moved into the 100 year range due to the sustained intensity over a long period of time.

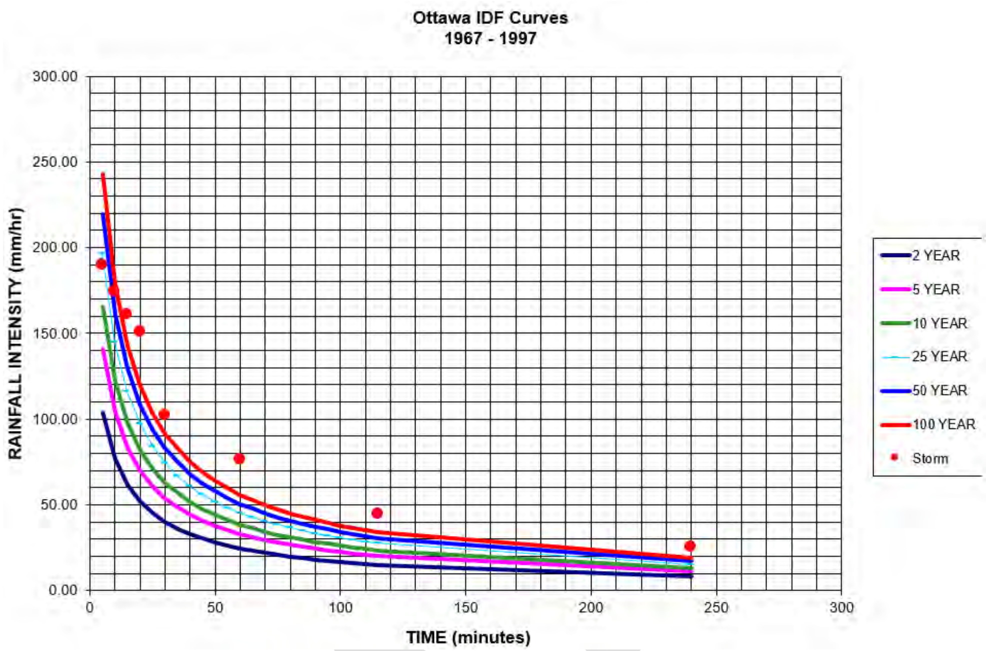

Figure 2 - Colonnade Road Rain Gauge

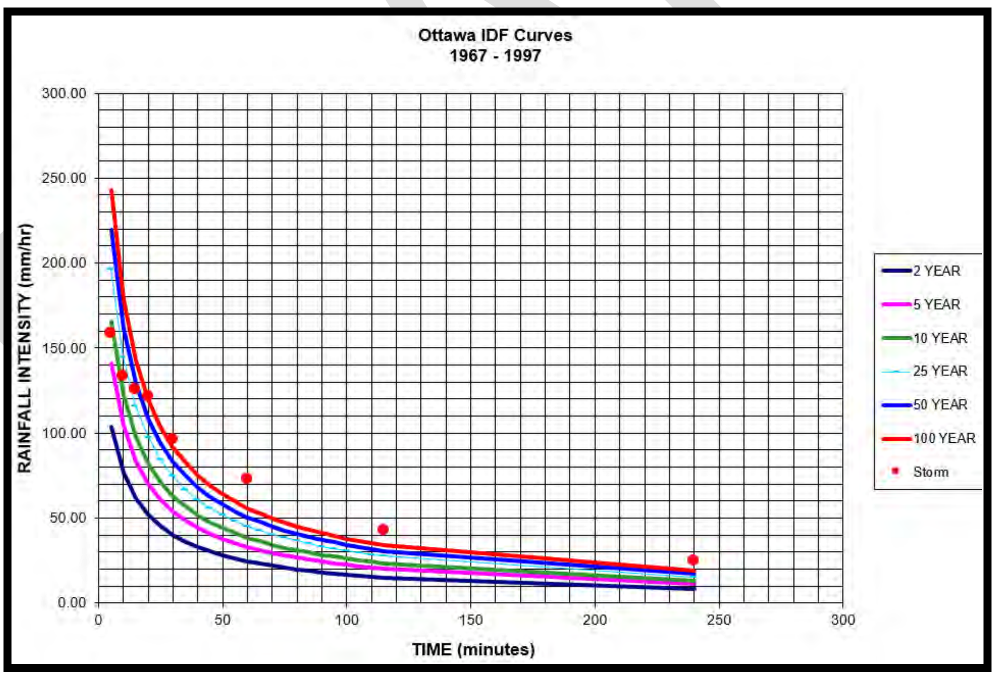

Figure 3 – Mooney's Bay Rain Gauge

Although the storm of August 10th affected the entire city, the peak of the storm followed a band near the south end of the City core. The rain gauges along that band showed the greatest rainfall volume and intensity. Figure 4.0 shows the approximate path where the highest rainfall was experienced.

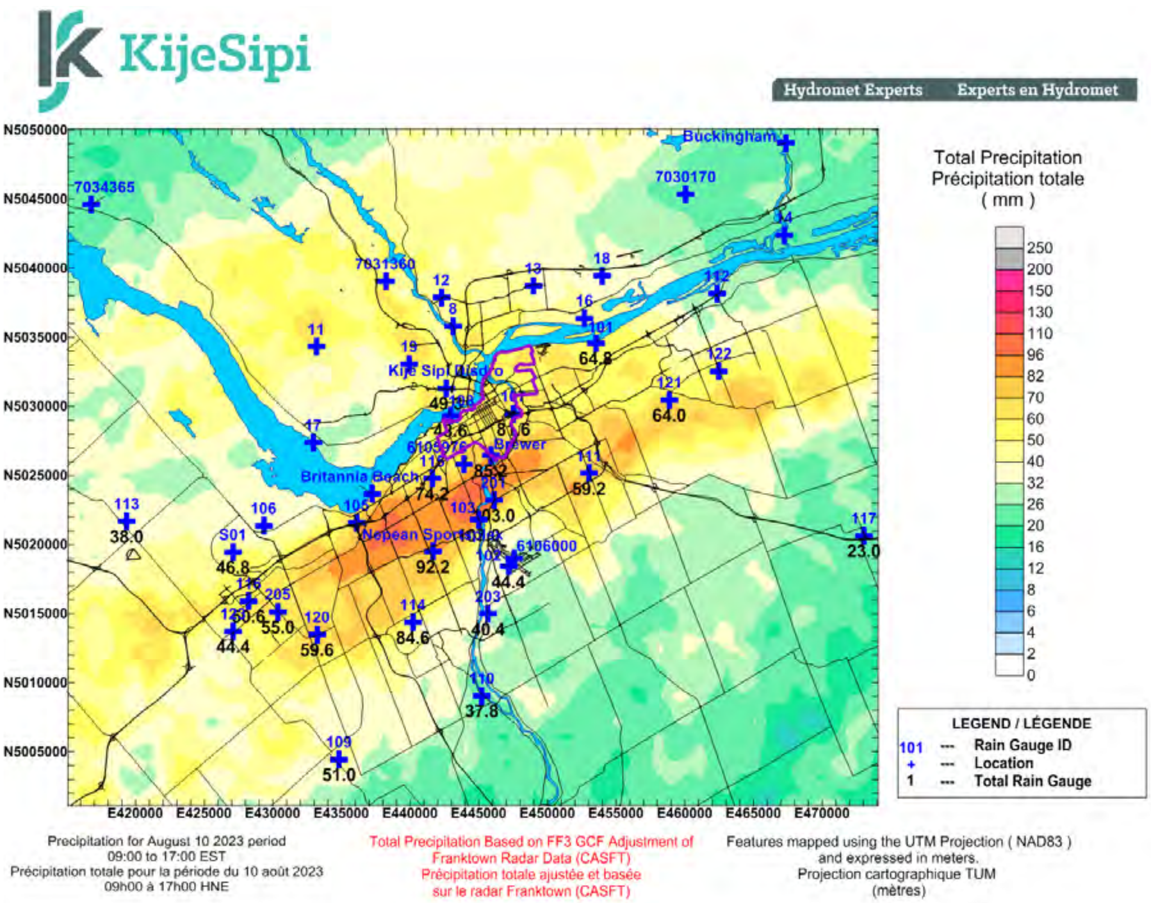

Figure 4 – Path of Storm Peak

In contrast, the event of September 9th, 2004 that caused over 1700 occurrences of basement flooding in the City, produced approximately 140 mm of rain over a 24 hour period. That event did not have a high peak intensity, but the volume saturated the ground and surcharged the sanitary system in the partially separated area due to flow from foundation drains. A similar event occurred in October 2017. The event of this year was both high volume/long duration and high intensity, thus impacting the sanitary system, the storm sewer system and the overland system, as explained in the next section.

3.0 GENERAL OVERVIEW OF FLOODING:

The rainfall of August 10th had both high volume and high intensity, thus impacting the sanitary sewers, the storm sewers and the overland drainage system. Various areas were impacted differently depending on the type of sewer system.

Partially Separated Systems: These systems were constructed prior to the early-mid 1960s and have weeping tiles connected to the sanitary sewers. When a high volume of rain falls over an extended period of time, much of the rainfall infiltrates into the ground and reaches the weeping tiles. This flow then enters the sanitary system causing surcharge since the flow contribution from weeping tiles is much greater than the domestic flow and can exceed the capacity of the sanitary sewers during an extreme storm. This surcharged water then flows back into basements via floor drains and basement plumbing. Many of the flooded areas on August 10th, flooded due to surcharging from the sanitary sewer system.

Fully Separated Systems: In fully separated systems, foundation drains (weeping tiles) are connected to the storm sewer and not the sanitary sewer. However, these systems are also prone to surcharge when too much surface water enters the storm sewer via catch basins. Storm sewers are design to capture frequent rainfall events, so when a critical event occurs, these systems can surcharge. In newer subdivisions, the flow entering the system is restricted and excess runoff is managed on the surface, but most older areas do not have these types of controls as to not exacerbate surface flooding. When the storm sewer surcharges, water can backup around the weeping tiles and enter the basement via foundation joints and cracks. We suspect that this occurred in some of the flooding clusters.

Ditch Systems: Ditch systems are often like Partially Separated system in that weeping tiles can be connected to the sanitary sewers (prior to mid 1960's). In many instances, residents may redirect their sump pumps to the house's internal pluming if there is no adequate outlet outside the building. Like storm sewers, ditches are designed to convey runoff from smaller frequent events with excess flow being directed to the street or even onto private property.

Surface drainage: In newer subdivisions, roadways and easement are designed to convey overland flow to an outlet, consisting usually of a ditch system or watercourse. Old neighbourhoods, however, have no clearly defined overland flow system and water can accumulate at low points and spill through private property. If the depth of ponding or flow is excessive, water can enter homes via windows, reverse slope driveways or other openings, and can also damage yards. This flow can also impede traffic and damage vehicles. This was the case in many of the flooding clusters.

Combined impact: If a home floods due to storm sewer surcharge or surface water entering via a window, water will accumulate in the basement and drain back out via the floor drain. This drain is connected to the sanitary sewer and can lead to surcharging of the sanitary sewer if many flooded homes are all draining at once. This can then impact homes further downstream as the sanitary system becomes surcharged. We suspect some area flooded due to this combined impact.

Information collected following the event of August 10th indicated that in many of the incidents, water entered homes either through the basement floor drain or via basement plumbing. This is indicative of a potential sanitary sewer backup or a sanitary sewer service connection malfunction. The information also noted that many other the incidents were attributed to storm sewer backup, windows and foundation cracks.

It is to note that some homes on a particular street flooded when other adjacent homes did not. It is possible that the homes that were flooded have lower basement elevations than adjacent homes or that adjacent homes have protective plumbing.

A summary of the flooding investigation to date is provided in the following section.

4.0 FLOODING CLUSTERS:

The following section describes the flooding that occurred on August 10th, 2023 on a cluster by cluster basis and provides a possible explanation as to the causes in each flooding cluster.

Note that a cluster is defined as a group of homes that have flooded in a general area. There are also isolated locations that reported basement flooding. Some of them may be the result of sewer system backup (as noted below), however due to the randomness of these locations, it is considered that many of these flooding occurrences are related to service connection problems, internal plumbing deficiencies or local grading deficiencies, and not as a result of a backup of the City's sewer system (See Section 5.0).

To provide a quick assessment of capacity constraints of the sewer system, where applicable, the models developed over recent years and calibrated for the September 2004 event, were updated using the August 10th event and used to better understand system performance accounting for operational constraints during the event.

4.1 Deer Park / Dynes Cluster – Ward 9 & 16:

- **Location and System Characteristics:** Eighteen homes (19) reported flooding in this cluster, 13 in the Deer Park area in Ward 9, and 6 in the Dynes Road area in Ward 16. The Deer Park area is fully separated meaning that weeping tiles are connected to the storm sewer system and more prone to flooding from storm sewer surcharging. The Dynes Road area is partially separated and thus more prone to basement flooding from sanitary sewer surcharge. There was also a report of deep roadway flooding on Arnot Road by St. Augustine School and excessive roadway flow on Meadowlands from Fisher to Orton.

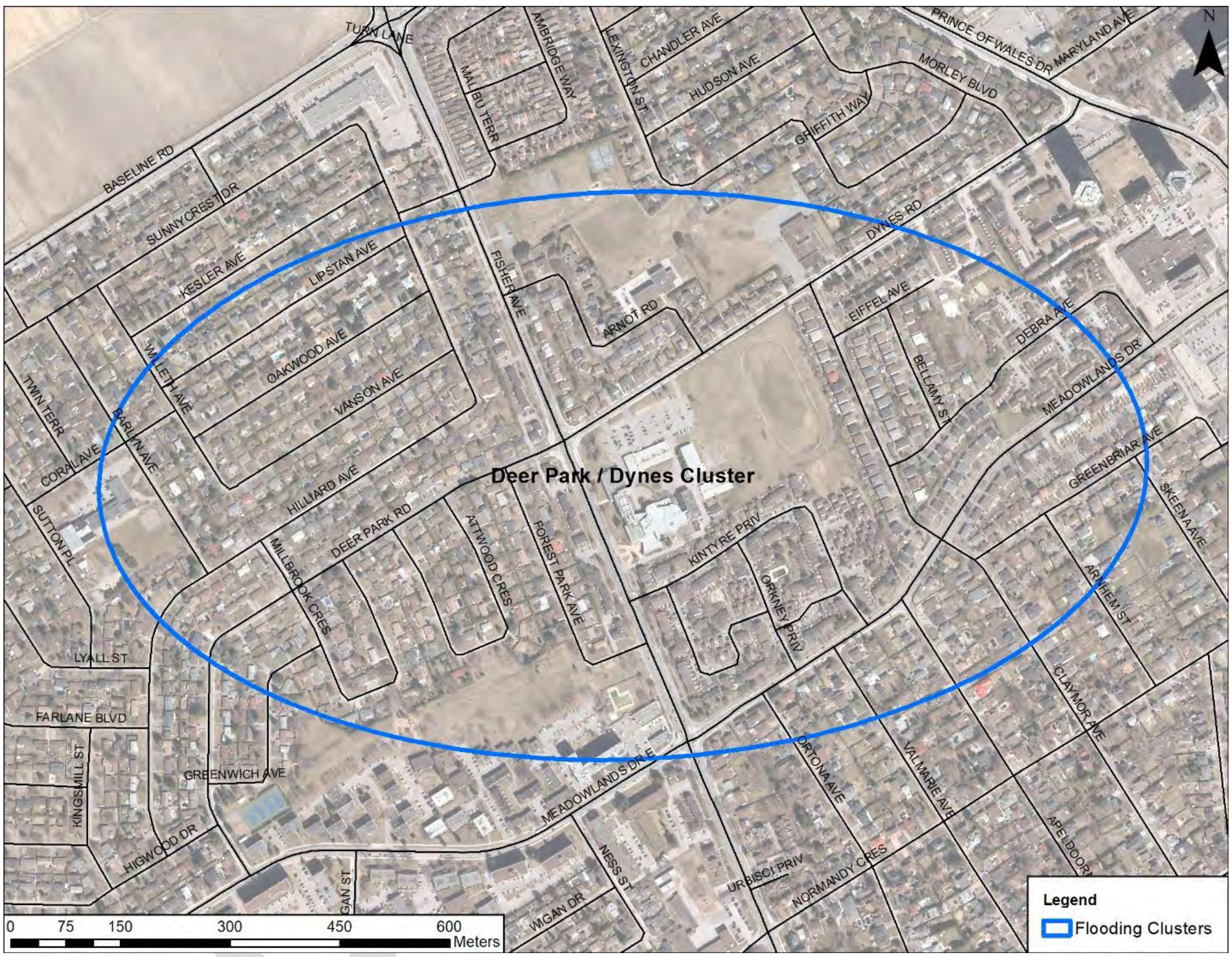

Figure 5 – Deer Park / Dynes Cluster, August 10 Flooding

- **Type of Flooding:** First response data does not provide any indication as to how the properties flooded.

- **Previous Flooding:** The Deer Park and Dynes area have experienced historical flooding since 1979 with over 50 reports of basement flooding. Approximately half the flooding occurred in 2004 when Hurricane Frances caused sanitary sewer systems throughout the city to surcharge leading to basement flooding. The remainder occurred during severe thunderstorm events such as 1996, 1998, 2000 when the storm sewer was surcharged.

- **Previous Investigations and Remedial Measures:** Following the 2004 event, the City embarked on a long-term program of upgrading the sewer systems in Parkwood Hills and the Dynes Roads areas. Both storm and sanitary sewers were upgraded on portions of Wallford, Farlane, Hilliard, Millbrook, Higwood and Deer Park and on Dynes and Prince of Wales. In addition, inlet control devices have been installed throughout the storm sewer system to reduce the risk of surcharging.

- **Current Investigation:** The computer models that were developed as part of the sewer upgrade projects were re-visited using the August 10th event. The sanitary sewer models indicate that the Dynes Road system could have been subject to sanitary sewer surcharge up to basement elevations.

  The roadway flooding on Arnot Road is due to a low point in the road. Water must pond to a depth of approximately 0.8 m before spilling to Dynes Road. This is only problematic during extreme rainfall events. There were also reports of deep water on Meadowlands from Fisher to Ortona, however there are no ponding low points in that area and the depth of flow is simply the depth of the overland drainage system during critical events.

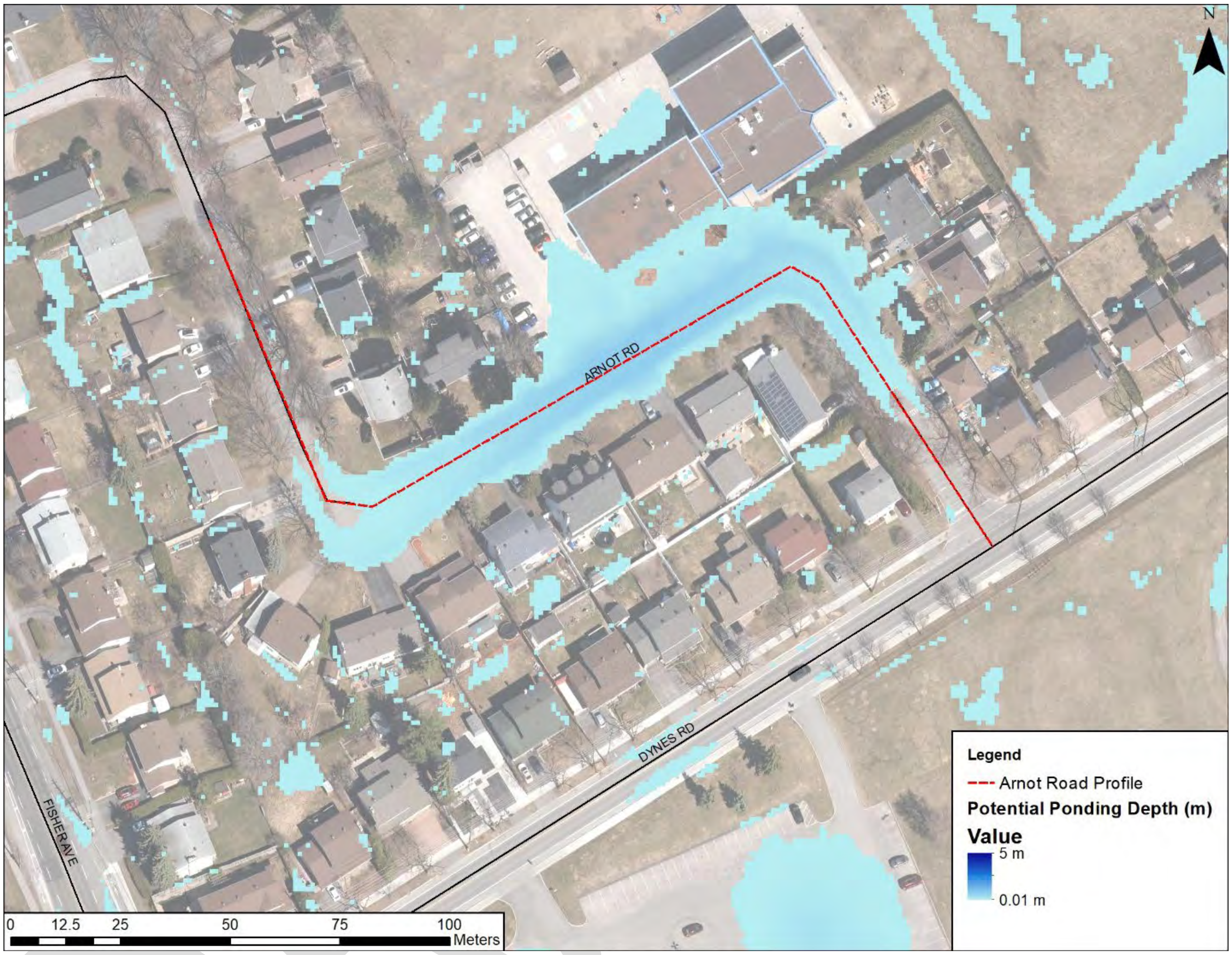

Figure 6.1 –Ponding Depth on Arnot Road before spilling to Dynes Road

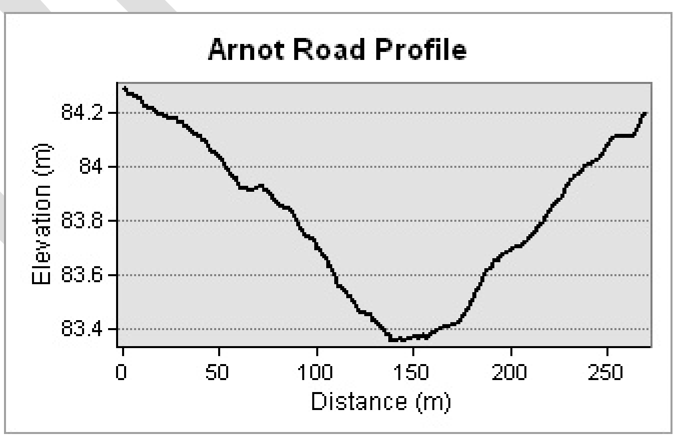

Figure 6.2 – Arnot Road Profile (extent shown in Figure 6.1)

- **Probable Cause of Flooding:** It is difficult to determine if flooding was due to a surcharged sanitary system or surcharged storm system without confirmation of the water entry point to the homes. Computer simulations show that the Dynes Road area would have been more at risk from sanitary sewer surcharge. We are still soliciting and receiving flood questionnaire and will have a better understanding of the cause of flooding in the near future.

- **Next Steps:** Communication with residents will be required to explain the benefits of installing backwater valves and how to protect homes from flooding. The local storm and sanitary sewer system will also be reviewed using the computer models built for the previous sewer upgrade projects to see if any additional improvements can be done to reduce the surcharge level during critical events. The overland flow system on Arnot will also be looked at to see if there are way of minimizing the accumulation of water at the low point. It must be noted however, that grading limitations may greatly hinder such an undertaking and that affected homeowners may need to take additional measures to protect their properties if the ponding poses a risk to their building.

4.2 Riverside Park Cluster:

- **Location and System Characteristics:** Eighteen (18) properties reported flooding in the August 10th, 2023 event. The Riverside Park area was developed in the mid-1960s and is fully separated, which means that weeping tiles are connected to the storm sewer system. This area is therefore more at risk of flooding due to storm sewer surcharge than from sanitary sewer surcharge.

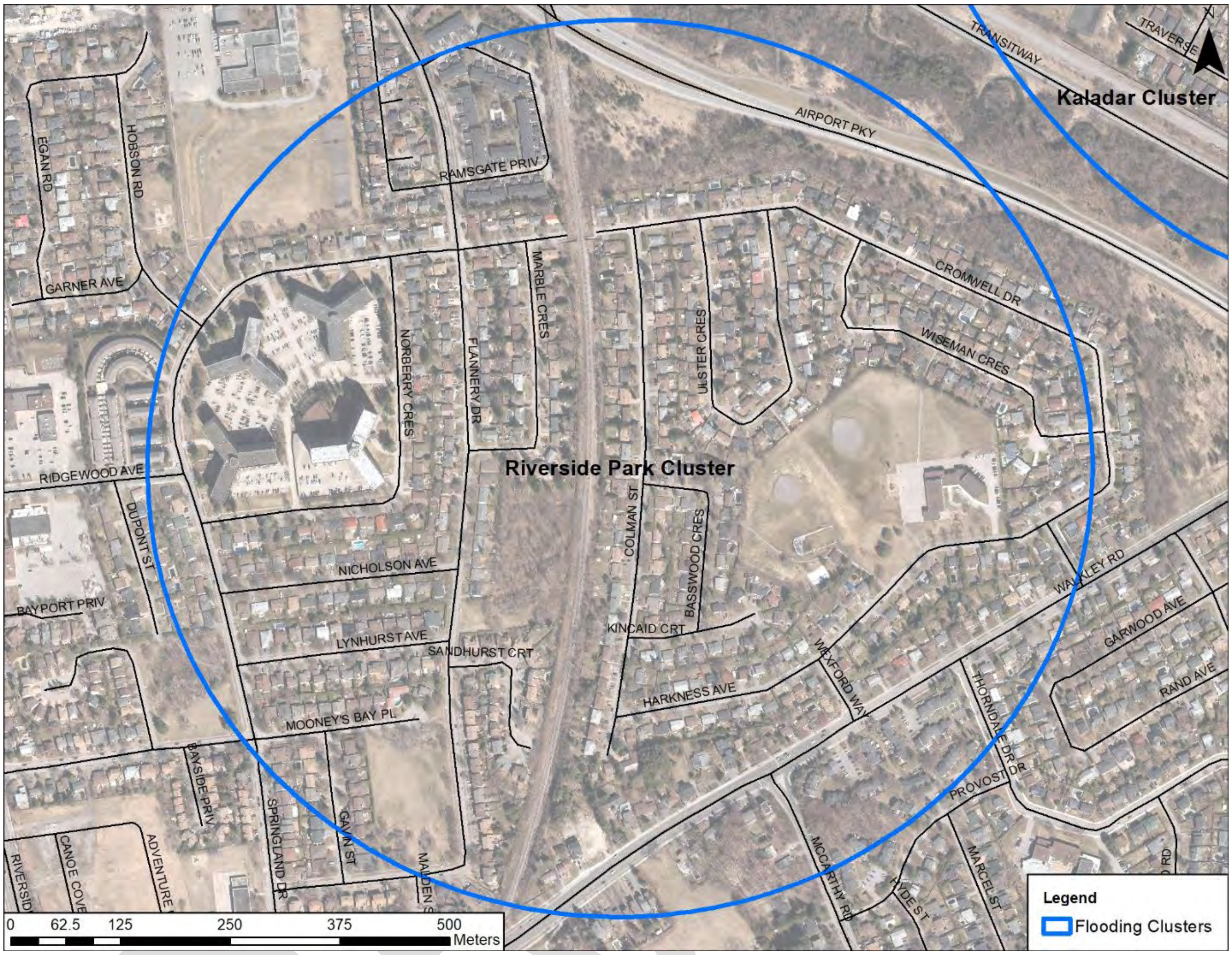

Figure 7 – Riverside Park Cluster, August 10 Flooding

- **Type of Flooding**. First response data does not provide any indication as the how the properties flooded. Resident flood questionnaires reported flooding of reverse driveways due to overland flow and flooding from the floor drain in at least one case. There were also reports of street flooding on Harkness, Lynhurst, Nicholson, Springland, Norberry and Ulster.

- **Previous Flooding:** There are approximately 30 reports of basement flooding in this area from previous years. Most of the flooding occurred during high intensity thunderstorm events, such as the ones in 1996, 2009 and 2011. The flooding reports were interspersed throughout the area for each event, which did not create specific clusters. A review of all flooding events, though, show that this area does in fact form a cluster due to flooding from storm sewer surcharge.

- **Previous Investigations and Remedial Measures**. As noted earlier, previous flooding events did not identify clusters in each individual events, which would have indicated that the problem was related to the private property. As such, no system wide remedial measures were investigated and/or implemented.

- **Current Investigation:** A review of the sanitary sewer model shows that it would not have surcharged to reach basement elevations during the event of August 10th, thus making it unlikely that sanitary sewer surcharge was the main cause of flooding. The storm sewer model however, showed significant surcharge during such a critical event, up to street level, meaning storm sewer surcharge most likely backed up around weeping tiles and entered homes through foundation cracks and joints.

  In addition, there were numerous reports of overland flooding on various streets. An analysis of the overland drainage system shows a significant amount of overland flow coming from Pauline Vanier Park. This runoff would have flowed behind the homes along Colman Street flooding rear yards and a reverse driveway on Colman as water flowed from the rear yard to the street (see image below). The resident on Colman also noted water coming out of the basement plumbing. This would indicate that the sanitary system was most likely impacted due to flooded basements as water drains back to the sewer via the floor drains.

Figure 8 – Flood on Colman Street

The image below shows the overland flow paths and low points in this area, which clearly shows the flow from Pauline Vanier Park into the rear yards on Colman.

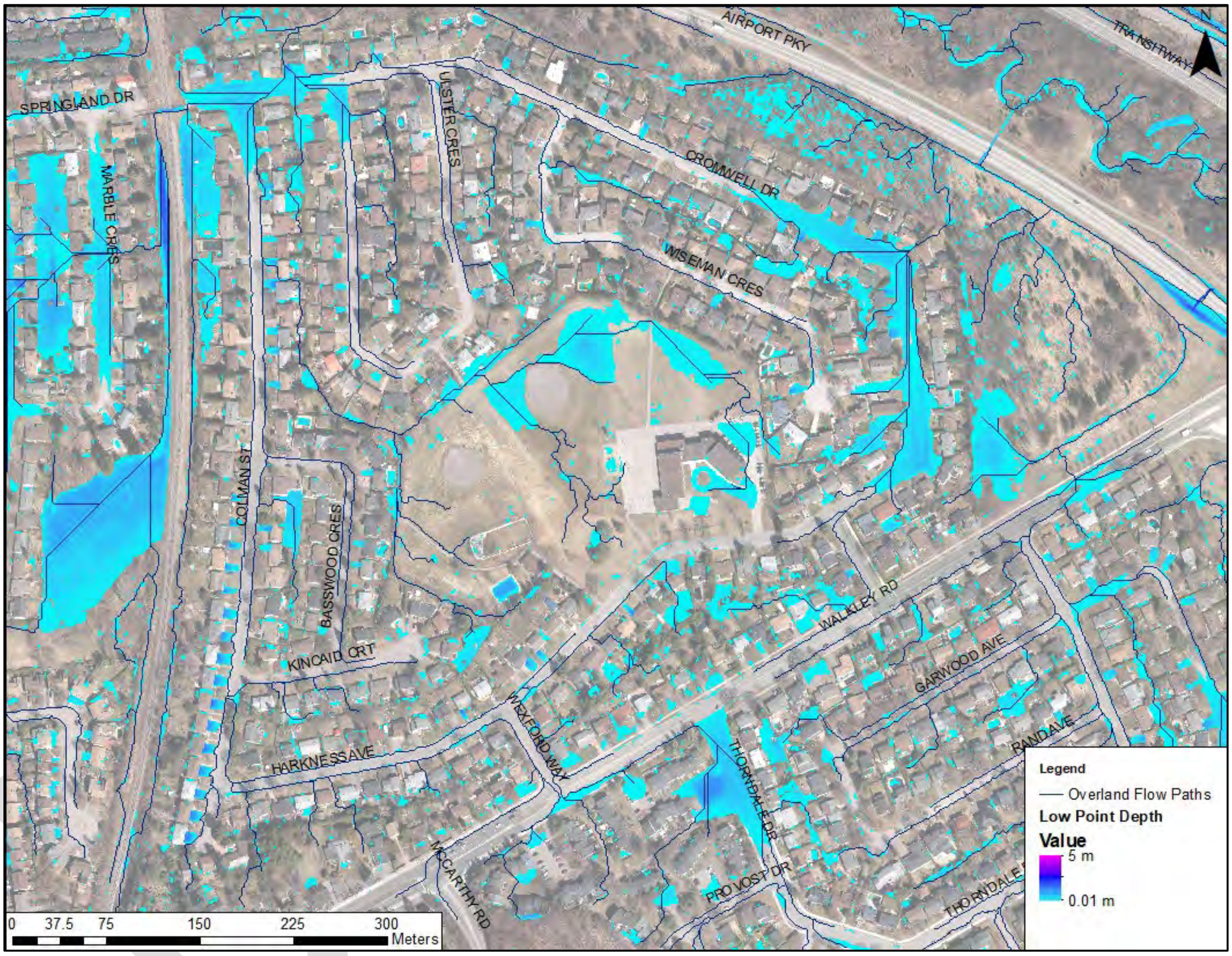

Figure 9 – Riverside Park Cluster, Overland Flow Paths and Low Points

Streets that report flooding include Harkness, Lynhurst, Nicholson, Springland, Norberry and Ulster. In many of these instances, reverse slope driveways were impacted, and basements flooded as a result. Low points have been observed on Lynhurst, Nicholson, Springland and Norberry and unfortunately these low points were part of the original design and cannot be removed without re-grading the neighbouhood.

- **Probable Cause of Flooding**: Surcharged storm sewers led to basement flooding in this cluster area as well as excess overland flow in the rear yard system along Colman Street.

Furthermore, sanitary sewers may have been indirectly impacted due to flooded basements draining back to the sanitary system via floor drains. Further investigation into the storm sewer and overland system will be required.

- **Next Steps:** The flooding situation in Riverside Park is complex in that the overland system is creating much of the problems. Excess flow from Pauline Vanier School and park is spilling into rear yards and flooding homes. The City will study this area in greater detail to see if storage in the park can be implemented to reduce the overland flow. Streets with low points are another issue. This area was designed and built in the early to mid-60s using the standard of the time. Overland drainage was not taken into consideration as it is today, and as such water accumulates in low points and spills through private properties. This is especially problematic if there are reverse slope driveways on the street. In many instances, a hump can be added to reduce spillage into the driveway, but that is often not enough protection for critical events. Communication with residents will be needed to explain the flooding risk so that they can find ways to further protect their properties. The City will also look at ways of reducing flow accumulation at low points if feasible. Note that any option that includes storage in parks or other locations, will most likely require an EA study, which will add one or two years to the study period.

  The storm sewer system will also be looked at in greater detail to see if the level of surcharge can be reduced by restricting catch basin inflow. This will be problematic though, because in new subdivisions this is done by restricting flow into the sewers and managing excess water on the streets. In our case, street drainage is already a major problem, and we would be exacerbating it by adding more surface drainage.

5.0 FLOODING IN NON-CLUSTER GROUPS:

As noted in Section 4, clusters are defined as a group of nearby homes that have flooded. Approximately 37 reports were submitted to the city regarding basement flooding in Ward 16. Twenty-four (24) of those are within cluster groups while the remaining 13 are assumed being due to property issues. Although some of these may have flooded due to a localized sewer surcharge, it unlikely since other nearby homes would have also reported basement flooding. It is very likely these individual locations flooded due to a private property issue such as tree roots in the sewer lateral, roof leader connected to the foundation drain or damage to the sewer lateral pipe. This does not mean however, that the sanitary did system did not surcharge since neighbours may have simply not reported flooding or they may have had installed a backwater valve.

Given the sporadic nature of these occurrences, it is recommended that these homes have their sewer lateral inspected or that they apply to the Protective Plumbing Program since the inspection will identify issues on the property. Should there be no issues with the private connection, the City will then look at the individual location in greater detail.

6.0 ROADWAY FLOODING

There were many reports of flooded streets during the August 10th event impeding vehicles and the flow of traffic. If a flooded roadway does not impact buildings, it should be left to drain on its own if possible. If leaves are blocking catch basins, residents can remove the blockage if it is safe to do so, but in no case should maintenance hole covers be lifted to drain the street. A sudden surge or water into the sewers, especially the sanitary sewers, will lead to basement flooding. The design standard of these older neighborhoods never accounted for this amount of excess surface runoff. Older subdivisions are not designed like newer ones, where water spills from street to street until it reaches an outlet. In many instances water drains between properties. The City cannot change this flow path and residents are encouraged to flood proof their foundations and any building openings. The City can however share our overland flow information with residents and help them by identifying way they can protect themselves. This is especially critical when reverse slope driveways are located at a low spot on a street.

7.0 LEVEL OF SERVICE AND PUBLIC EXPECTATIONS:

Most of the homes in the hardest hit areas of the City were constructed in the early to mid-1960s when the design standard was quite different than today's standard. As we noted earlier in the report, prior to the mid-1960s, weeping tiles were connected to the sanitary sewer system, which can cause surcharging of sanitary sewer during critical events. Disconnecting all of these weeping tiles would be a significant undertaking that would take a significant amount of time with massive disruption to any given community, and it would also require changes to private property plumbing at the homeowner's expense. Given the rare occurrence of these events in the past, protective plumbing offered a good solution that provided additional protection. As these events increase in frequency in the future, residents may need to look to additional measures, over and above what the city can do on the sewer system, to protect their properties.

Storm sewers in the 1960s were designed to capture runoff from events that are much smaller than what they are designed for today. This means that excess runoff must be managed on the surface, which is challenging due to overland flow systems that also lack modern design. Roads in new subdivisions are designed to run like rivers during critical events, where water cascades from one street to another until it reaches an outlet. In older areas however, water can accumulate in low-lying areas, cut through private property and pond in rear yards, which occurred during the August 10th event. Creating a well-defined overland flow system in topographically challenged areas can be very difficult to achieve. Upgrading sewer systems can help with frequent storm events, but such infrastructure upgrades will take decades to achieve since upgrading a local system would only push the problem to the downstream system. Storm sewer are only designed to capture runoff from frequent events, so even if all the sewers are upgraded, the overland flow system during critical events would still be problematic. The City will look at ways of improving the overland system as sewers are upgraded, but the topographical constraints of these older areas will make it near impossible to provide a level of service equivalent to what is provided today in new subdivisions.

The City is working diligently at upgrading its infrastructure to provide the best level of service feasible, but such changes can take decades to implement. Given the increase in flooding events due to climate change, future works will need to include private property measures. The City cannot implement work on private property, but City engineers can use their knowledge and expertise to help residents find the best way of protecting themselves until the infrastructure is upgraded.

8.0 PROTECTIVE PLUMBING PROGRAM:

Since the inception of the program in 2004, more than 3,000 homes have had backwater valves installed. This program has been active for almost twenty years and is open to all residents of the city. Information on sewer backups and flooding can be found on the City's website at:

https://ottawa.ca/en/residents/water-and-environment/wastewater-and-sewers/sewer-backups-and-flooding.

Furthermore, information on the City's Protective Plumbing program can be found at:

https://ottawa.ca/en/residents/water-and-environment/wastewater-and-sewers/sewer-backups-and-flooding#residential-protective-plumbing-program

It is important to note that the City strives to minimize sewer surcharge and thus provide adequate basement protection to all homes in the City, however due to the age of the sewer system in some areas as well as the design standard at the time of construction, it is impossible to provide the same level of service throughout the City. This is why backwater valves are important as a second line of defense. Even new subdivisions that have the most up to date standard have sanitary and storm backwater valves installed because there are often unknowns that can occur in complex collection systems that can cause water to backup to basement levels.

9.0 PROTECTIVE PLUMBING FAILURE:

In some instances, it appears that homes with existing protective plumbing reported basement flooding following this event. This could have occurred for four reasons: 1) the valve malfunctioned, 2) improper maintenance of the valve, 3) the storm valve functioned properly and while closed, groundwater overwhelmed the foundation drainage system and water entered through cracks and openings, or 4) the sanitary valve functioned properly and while closed, all internal drainage (toilets, tubs, showers, sinks) bubbled out through the floor drain. It is to note that backwater valves are the responsibility of the owner and any inspection, maintenance or repairs should be undertaken by the owner.

10.0 311/FIRST RESPONSE:

Residents are typically encouraged to call 311 to report flooding, however many residents complained that their calls to 311 were not getting through or that they never heard back after leaving a message. The sheer number of calls overwhelmed the 311 system and left many residents in the dark. Furthermore, the lack of site visits following flood reports meant that information indicating how a home flooded was not recorded. This information is critical when doing a post flood analysis to determine if the cause of flooding was related to the storm sewer, sanitary sewer or overland drainage. As a results, Infrastructure and Water services sent out questionnaires with the help of Councillor's staff asking residents to explain how they flooded. This created a delay in assessing the impact of the flood since questionnaires needed to be returned before any analysis could be finalized. In the future, the City should include this questionnaire on their Sewer Backup and Basement flooding website page asking residents to fill in it and forward to the City. In addition, 311 and First Response should provide callers with the questionnaire or direct them to the city website.

11.0 Next Steps:

The information presented herein is based on a cursory analysis of the sewer system using existing computer models and/or historical information. The next steps will consist of further simulating the actual event to determine if additional causes to the ones described above were responsible for the flooding and determine if infrastructure improvements are warranted and feasible to reduce the risk of future flooding.

It is to note, that infrastructure solutions are long term solutions that can take up to decades to implement, however residents are looking for faster solutions to their problem. Residents are encouraged to look at ways of flood proofing the individual properties in addition to what the City will be undertaking with respect to infrastructure work. We are currently looking a way in which City staff can share information with homeowners to assist them in finding solutions to floodproof their homes while long term infrastructure work is undertaken. Any flood proofing work within the City Right of Way will be done by City staff, but any work on private property will be the responsibility of the owner.

As recommended in a Council motion, a website should be created outlining the challenges identified in this memo, outlining areas of the city most at risk and providing homeowners with information that will allow them to better understand their own situation and find ways of improving their level of protection. Finally, good information is critical when trying to understand how a system flooded. Residents should call 311 to report a flood and a survey should be sent to them so that they can relay to City staff how they flooded. In addition, it is recommended that 311operators be provided with an information flooding package that they can quickly relay to the callers during flooding events.

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