Adapting to Changing Flood Patterns in the City of Hamilton
Acknowledgements

Executive Director:
Eva Ligeti, Clean Air Partnership

Authors:
David Sol, Ryerson University
Michelle Sawka

Advisors, Reviewers & Editors:
Caroline Rodgers, Clean Air Partnership
Kevin Behan, Clean Air Partnership
Eva Ligeti, Clean Air Partnership

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For more information, contact:
Clean Air Partnership
75 Elizabeth Street
Toronto, Ontario. M5G 1P4, Canada
416-392-6672
www.cleanairpartnership.org

About the Clean Air Partnership
Clean Air Partnership (CAP) is a registered charity that works in partnership to promote and coordinate actions to improve local air quality and reduce greenhouse gases for healthy communities. Our applied research on municipal policies strives to broaden and improve access to public policy debate on air pollution and climate change issues. Our social marketing programs focus on energy conservation activities that motivate individuals, government, schools, utilities, businesses and communities to take action to clean the air.

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Forward – Community Adaptation Initiative Case Studies

This case study is one of five produced by Clean Air Partnership for the Community Adaptation Initiative, a provincially funded program through the Ontario Ministry of the Environment that delivers climate change adaptation resources for municipalities. The case studies provide detailed examples of climate change adaptation in Ontario communities. Tailored for municipal audiences, each study examines a program, plan or action with a view to encouraging replication in other municipalities confronting similar challenges. To this end, important data relating to regional background, planning process, challenges and lessons learned have been highlighted.

Climate change is expected to place increased stress on natural, social and built environments. It will also create challenges for municipalities as they work to minimize the impacts of climate change through the development and implementation of climate change adaptation plans. Municipalities must be prepared for increasing variability in temperature and precipitation patterns and increasing occurrences of extreme events such as droughts, extreme heat, storms and other expected impacts. Climate change will place additional stress on infrastructure, planning and social services, environmental conditions and buildings.

Existing municipal efforts primarily focus on mitigating climate change. However, through adaptation, municipalities can implement plans or take action to reduce the more immediate impacts of climate change. This process may involve altering existing policies, or creating new ones that address observed or expected climate changes. Ultimately, adaptive action at this juncture will prepare municipalities for future climate change impacts that threaten their populations, infrastructure and daily operations.
Executive Summary

Like many Ontario municipalities, the City of Hamilton has recently experienced extensive flooding as a result of several severe storms. More frequent and intense storm activity is expected in this region as a result of climate change. To protect its communities, businesses and infrastructure from damage related to flooding or storm events, it was necessary to recognize their increasing presence in the city, and develop a comprehensive stormwater management strategy that addressed such impacts.

This case study outlines Hamilton’s iterative and progressive approach to addressing flooding issues that arise from climate change. The strategy includes development of comprehensive Master Plans, creation of a Storm Event Response Group (SERG), and development of an Independent Community Panel (ICP) composed of experts in the community.

This case study concludes with the lessons learned from this process, which may assist other Ontario communities facing similar flooding challenges resulting from increased storm activity.

Figure 1    Redhill Creek Expressway flooding July 26, 2009

Source: (Brown, 2009)
1 Introduction

The City of Hamilton is one of several southern Ontario municipalities to experience major rainstorms resulting in extensive property damage since 2005. With unprecedented frequency, these intense storms have overwhelmed existing infrastructure and caused major flooding of roadways, businesses, and residential basements. The majority of the damage has been attributed to backed up sewers. This damage has served as a catalyst for three related developments: a more detailed analysis of municipal stormwater plans, a shift away from design standards that only consider historical weather data, and a review of the City programs in place to help alleviate the impacts of severe storms.

Hamilton is an expanding city with a wide range of infrastructure and natural features that are facing increasingly diverse pressures from climate change. Additionally, the municipal government is wrestling with the complexity of flooding issues and the uncertainty related to the intensity and location of climate impacts. To cope, Hamilton is approaching stormwater management from multiple levels through an iterative process that incorporates community members’ expertise, policy development, resident behavioural change, community consultation, modeling and infrastructure upgrades. This approach is conducive to addressing climate change impacts because it enables the municipality to provide dynamic protection for its residents, businesses and infrastructure by sharing ideas and best practices and coordinating efforts across all the potentially affected parties.

Hamilton’s integrative approach involved the development of three comprehensive infrastructure Master Plans that prioritized consultation: Transportation, Water and Wastewater, and Stormwater. These plans were simultaneously undertaken in order to both integrate stormwater management measures into site planning, and to ensure consistency and support between Plans (City of Hamilton, 2009). While the Master Plans were being developed, the City of Hamilton was struck with major storm activity and flooding. These events prompted the creation of two new groups. The first, Storm Event Response Group (SERG), is a working group comprised of City staff that functions to coordinate actions to respond to flooding issues across various departments and relevant organizations. It was also heavily involved in the creation of the second group, the Independent Community Panel (ICP). This group was composed of experts from the community, and was tasked with providing recommendations for action based on analysis of recent stormwater issues and a review of the Stormwater Master Plan.

This case study outlines Hamilton’s approach to addressing flooding issues that arise from climate change, with the goal of providing guidance to other municipalities facing similar challenges.
1.1 Geographic Context

Hamilton is a port city located at the western end of Lake Ontario, roughly in the center of the Golden Horseshoe region, between Niagara Falls and Toronto. The area’s unique geography features the naturally protected Hamilton Harbour and the Niagara Escarpment, which bisects the city into ‘upper’ and ‘lower’ parts (Figure 3). The majority of the urbanized area is below the escarpment, where erosion and flooding problems are the worst. The natural drainage area of the municipality includes 15 watersheds over 131,000 ha. In 2001 the six municipalities forming the Regional Municipality of Hamilton Wentworth were amalgamated into the new City of Hamilton. The newly amalgamated single tier municipality has a population of 519,949 (Statistics Canada, 2012) and is comprised of both rural and urban communities. Jurisdiction over its watershed is split between four conservation authorities (Hamilton, Halton, Grand River, and Niagara). The
Government of Ontario’s Growth Plan for the Greater Golden Horseshoe predicts the City of Hamilton’s population will increase to 660,000 by 2031 (Government of Ontario, 2006).

Figure 3 Hamilton Elevations (Green line indicates boundary of Niagara Escarpment)

![Map of Hamilton Elevations](map.hamilton.ca)

Source: map.hamilton.ca

### 1.2 Stormwater Management in Hamilton

Prior to amalgamation, each individual municipality was in charge of its own stormwater management. Regional government’s role in storm drainage applied only to regional roads. Historically, most of the municipal stormwater systems were built with the primary goal of managing the quantity of stormwater, though newer subwatershed management practices are much more comprehensive and consider water quality, erosion, fisheries, groundwater and protection of natural features as well. There is also considerable variation in the water quantity design standards used in older infrastructure; ranging from two to seventeen year storm return periods (City of Hamilton, 2010a).
The amalgamated city operates one of the largest, oldest and most complex stormwater drainage systems within the Great Lakes basin; a system that contains both separated and combined sewers (City of Hamilton, 2010d). Within the former City of Hamilton there are over 600 kilometres of combined sewers where both storm and sanitary sewers drain into a single trunk sewer to be treated. After periods of heavy rain, the storage capacity of combined systems can be overwhelmed, forcing the mixed waste to backup into homes or be discharged without treatment. Additionally, this older area of combined sewer service does not have an engineered overland system of drainage. Overland systems are designed to manage heavy rainfall that exceeds the capacity of the sewer system and may include roadways, ditches, and ponds. The challenges posed by Hamilton’s geography, population growth and aging infrastructure are especially formidable when combined with the increasing risks from future weather variability.

Although Hamilton is not alone in having experienced major flooding, within a four year period it endured two rainfall storm events that far exceeded historical patterns. During the first event, on August 19th, 2005, 60 millimeters of rain fell in one hour. By comparison, 95 percent of storm events yield 25 millimeters of rain or less, over a three hour period (City of Hamilton, 2006). The second event, on July 26 2009, saw 109 millimeters fall in only two hours and its impact was exacerbated by the fact that the ground was already saturated as a result of a storm that occurred two days earlier. This latter event flooded streets and homes, and caused millions of dollars of damage (Environment Canada, 2009).

Damage that resulted from the two storm events was extensive (Figure 4). It is estimated that over 1,700 homes were flooded throughout the summer of 2005 (Citizens at City Hall, 2010). The runoff was so powerful on August 19, that 64 truckloads carrying over 1000 tonnes of debris needed to be cleared from the Chedoke Golf Course (McGillivray and Sandink, 2007). The City declared the storm a disaster, and Hamilton has since established a compassionate grant payment system for flood-affected homeowners that has paid out nearly five million dollars (City of Hamilton, 2005; City of Hamilton, 2010c).

Though these two storms were the largest, between 2005 and 2009 there were four other storms that also caused significant flooding in parts of the city1. The sheer volume of rain associated with the storms, and the spatial variability in storm intensity resulted in heavy rains often unexpectedly concentrated in small areas of the city (City of Hamilton, 2006). This spatial and intensity variation is widely seen as a characteristic of climate change, making it more difficult to predict the number or locations of intense storms in the region. Models also indicate that climate change could lead to an increased risk of tropical storms in the North Atlantic that could potentially pass over the Great Lakes area. Therefore the City of Hamilton is preparing for more frequent intense, highly variable storms in the region (City of Hamilton, 2006).

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1 Storms of June 1, 2004; July 26, 2005; July 10, 2006; and August 29, 2009

2 Other examples include the ‘Citizen’s Forum’ comprising of members from each ward to make recommendations on area rating of property taxes; the Waste Reduction Task Force that features members from the general public, education, business, and environmental sectors to assist in solid waste management, and the Youth Advisory Committee on youth issues with 20 members between the ages of 14 and 24
2 Adapting to Changing Flood Patterns in Hamilton

2.1 Stormwater Planning in the City

To provide a set of consistent directions, in 2003 the City integrated the planning activities of the former municipalities under a process called “Building A Strong Foundation” (BASF). The BASF consultation process created a growth guide related to infrastructure development, transportation, and environmental protection (Figure 5). The guide was adopted by City Council and formed the basis of the Growth Related Integrated Development Strategy (GRIDS). The purpose of GRIDS was to identify a preferred growth scenario for the next thirty years that prioritized the directions outlined in the guide and conformed to provincial plans.

GRIDS proposed five different growth strategies for the city that each considered a projected population of 660,000 and 80,000 additional households by 2031, but differed in the focused development areas and expansion of the City of Hamilton’s urban boundary. Each proposed growth option was considered in terms of how it would affect community, economic, and ecological well-being. Taking into consideration comments received at Public Information Centres, City staff eventually recommended the ‘Downtown Focus and

Figure 4 July 26, 2009 Flooding

Source: (Brown, 2009)
Nodes and Corridor’ option which accommodates about 78% growth within the existing City urban area and added 1040ha of land to the urban area with growth focused around key mixed use areas and corridors (City of Hamilton, 2005).

The GRIDS process promoted coordination among infrastructure plans for transportation, stormwater management, water and wastewater in support of growth strategy decisions. For each of the three Master Plans a 3-staged study process was followed (outlined in Figure 4). An important component of each Master Plan was consultation with affected parties. Extensive consultation was undertaken early on and throughout the master planning process so as to foster a cooperative process (City of Hamilton, 2007). The intent of undertaking GRIDS and the Master Plans development as an integrated process was to ensure that the end product of each Plan would support the others and be consistent with the vision for the City (City of Hamilton, 2007).

**Stormwater Master Plan**

The development of the Stormwater Master Plan started in 2004 and included Public Information Centres (associated with the GRIDS growth plan decisions) and Stakeholder Workshops specific to stormwater, water and wastewater, and transportation (City of Hamilton, 2007). Throughout the process, individual meetings were held with each of the four Conservation Authorities to discuss the opportunities, constraints, and to receive input. The final draft of the Plan was circulated for review by twenty-two City staff from various departments and the four Conservation Authorities. The comments received in this final review process were addressed and incorporated in the final Master Plan, which was made public on May 18, 2007 (City of Hamilton, 2007).

The guiding principle of the Stormwater Master Plan is to “Treat rainwater as a resource to be protected and managed rather than a waste product to be quickly moved from where it falls.”

Goals:

1. To develop management guidelines for the maintenance/replacement of the City’s existing separated storm sewer systems and for design of proposed systems.

2. To develop and implement appropriate strategies in order to protect, enhance and restore the natural resources of the watersheds located within the City under present conditions and as land use changes occur in the future (City of Hamilton, 2007).
As specified in its goals, the Stormwater Master Plan addresses issues that relate directly to storm sewer infrastructure and capacity for areas that are serviced by separate storm sewer systems. The areas serviced by combined sewer systems are addressed under the Integrated Water and Wastewater Master Plan (City of Hamilton 2007). Consistent with the focus on an integrated and consistent approach, the two plans were prepared simultaneously and public consultation events were conducted jointly. This ensured that any stormwater issues, regardless of which of the pre-amalgamation sewer system they occur in, could be addressed in a consistent manner.

Consultation and communication within the City departments and council was a key part of the development of the Stormwater Master Plan. Ponds are major components of the Plan, appearing often as End-of-Pipe controls. During the consultation process, concerns were raised regarding the appearance and maintenance of proposed ponds. The main consideration was the City of Hamilton’s lack of landscape guidelines, operations manual and maintenance fee structure for the new ponds. In response to the concerns, the Plan development team arranged half day informational tours of some of the existing facilities in
the surrounding communities, and held an open house session for City Councillors to drop by and ask questions. They also accelerated the preparation of appropriate regulations and manuals to ensure the facilities would be designed and operated in accordance with the most current standards, and that they would be an amenity to the community. The Class Environmental Assessment requirements for public consultation for the proposed pond projects had been met, but the City staff committed to providing additional consultation opportunities prior to starting construction on any stormwater ponds included in the Master Plan (City of Hamilton, 2007).

![Figure 6 Example of a Stormwater Management Pond in Hamilton](source)

The development of the Stormwater Master Plan was an iterative process that integrated considerable consultation with various city departments, external agencies, and the public. Overall, public input primarily dealt with specific issues on a localized basis, and input from Conservation Authorities was particularly valuable with respect to identification of existing programs and the need for improving coordination and funding of existing and proposed programs (Hamilton, 2007a).

While the Water/Wastewater and Stormwater Master Plans are key components of Hamilton’s long-term flood prevention strategies, they are not a direct or complete response to increased storm activity and flooding. In hindsight, City staff has acknowledged that in light of the current issues, the Master Plan process may have been too focused on new facilities and future development, not giving enough attention to the holistic performance of the current system with potential retrofit and source control and damage mitigation practices in extreme events. It needs to be recognized that severe storms can frequently exceed design standards and cannot be addressed with capacity improvements alone. The rainfalls in the summer of 2005 were a strong reminder of this. The City responded by creating two groups that were tasked with specifically analyzing flooding issues in Hamilton.
2.2 Engaging Multiple Stakeholders in Storm Event Response

2.2.1 Storm Event Response Group (SERG)

In response to the summer of 2005 storm events, the general manager of the public works department established the SERG. This multi-departmental and multi-disciplinary group is comprised of city staff from the following divisions: Water and Wastewater, Capital Planning and Implementation, Operations and Maintenance, and Risk Management. They are tasked with leading the City’s efforts to examine the causes and effects of severe storm events (City of Hamilton, 2009). Issues related to storms often require attention of several different divisions, so the group was created to have representation from decision makers across these divisions in order to improve its effectiveness in offering coordinated responses and planning.

In September 2005, City Council directed the City staff, and specifically SERG, to establish an Independent Community Panel (ICP) to identify the impacts of storm events and to make recommendations to Council (City of Hamilton, 2010a). The panel consisted of five professionals from the community with expertise related to watershed planning, wastewater engineering, flood prevention, stormwater management, landscape architecture and insurance. They completed a final report recommending 26 initiatives that was presented to SERG and City Council in September 2006. To evaluate the City’s progress on the recommendation, in December 2008, City staff initiated a voluntary ICP review. The review found that the City had achieved all 26 recommendations from the original report, and submitted another 23 recommendations to consider in future planning. SERG meets regularly to ensure that the ICP recommendations are being implemented.

Figure 7 Flooding in Greenhill Ave. area

Source: Hamilton, 2007
2.2.2 The Independent Community Panel (ICP)

On September 1, 2005 Hamilton City Council passed a motion to establish the ICP on Flooding Issues. The city of Hamilton has a history of using citizens on volunteer advisory committees. On November 23, 2005, a second City Council resolution provided a timeline for the implementation of the panel. The facilitator was to be selected and terms of reference developed by the end of that year, panel members selected by March 2006, and the final report submitted by July 2006. The City hired an independent consultant to facilitate the entire process, including the selection of members. The consultant and City staff worked together to review Council’s directions and develop a short list of potential members based on specific expertise and experience. The consultant interviewed candidates to discuss interest, availability, and potential conflict of interest. From this, a final five individuals were recommended for membership and appointed as volunteers.

The consultant facilitated the meetings and coordination of the ICP throughout the spring and summer of 2006 and wrote the final report. Specific ICP activities included:

- Receiving background information and meeting with SERG members
- Tours of flood-affected neighbourhoods and meetings with residents
- Independent research and consultation with stakeholder groups
- Attended GRIDS information sessions and Hamilton public meeting on flood issues
- Examining experiences of other Canadian municipalities
- Meeting with agencies and insurance industry groups
- Reviewing the materials available on the Stormwater and Wastewater Master Plans.

2.2.3 Independent Community Panel Recommendations

Although the ICP mandate did not specify research on climate change, due to its relevancy when examining issues of flooding, the panel members chose to dedicate a section of their report to the issue. The panel was unanimous in recognizing that changes to the weather will be an ongoing concern. They cited the growing concern that the effects of climate change will be felt through the region as more frequent intense, highly variable storms. The panel found that the intense storm events of 2005 had a considerable and costly effect on the community’s homeowners, built infrastructure, and natural environment. In addition, it was estimated that homeowner damages are likely even higher than reported due to a lack of insurance coverage for overland and infiltration flooding (City of Hamilton, 2010b).

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2 Other examples include the ‘Citizen’s Forum’ comprising of members from each ward to make recommendations on area rating of property taxes; the Waste Reduction Task Force that features members from the general public, education, business, and environmental sectors to assist in solid waste management, and the Youth Advisory Committee on youth issues with 20 members between the ages of 14 and 24 (Hamilton, 2005).
Upon completing their required activities, the ICP made a number of observations in a final report to the City. Analysis of the major storms confirmed that they were of an intensity that would have exceeded the capacity of any previous design standard utilized in Hamilton. They noted however, that Hamilton is not unique in this regard, citing extensive flooding in many other Canadian cities including Peterborough in 2004 and damage done in Toronto by the same August 19 2005 storm that hit Hamilton.

The ICP found residents generally believed that municipal failures were responsible for flooding, particularly sewer backup. However, the panel found that the primary source of the problem was the sheer magnitude of the storms exceeding reasonable design specifications. In fact, it appeared that the stormwater system functioned generally well and to specification in most areas of the city. When the sewer system is overwhelmed and water begins to move overland, factors other than the sewer pipe system become problems: obstructions, homeowner alteration of grading and landscaping, or soil saturation from previous wet weather. Basement flooding damage is exacerbated by poor design of existing houses with garages sloping towards them, basements lower than the sewer mains, or the absence of back-flow preventers.

The ICP noted the amount of water that fell during the August 2005 storm would have exceeded even the highest standards of sewer design that could be reasonably implemented and that Hamilton had made good progress in consolidating the different systems of the former municipalities and implementing new city-wide stormwater
guidelines. The large, severe storms potentially associated with climate change would most likely still exceed sewer design upgrade, thus after reviewing the potential for adopting higher standards, the panel concluded that this would be a large cost for uncertain gains that may be beyond a responsible level of risk relative to other concerns. However, additional gains can more effectively and economically be achieved through non-structural measures such as the disconnection of downspouts that discharge into the sewers.

Figure 9  ICP Panel Background

<table>
<thead>
<tr>
<th>Independent Community Panel Members</th>
</tr>
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<tbody>
<tr>
<td>Carl Bodimeade, P.Eng (ICP Chair)</td>
</tr>
<tr>
<td>Professional Engineer with more than 25 years of experience related to water and wastewater collection and treatment, site remediation and hydrogeological investigations. Carl is Vice President of Hatch Mott MacDonald’s water and wastewater infrastructure services branch in Ontario.</td>
</tr>
<tr>
<td>Dr. Yiping Guo, B.Sc., M.A.Sc., Ph.D, P.Eng</td>
</tr>
<tr>
<td>Associate Professor in the Civil Engineering Department at McMaster University. Dr. Guo’s research interests include uncertainty analysis, watershed planning and stormwater management. He has more than 15 years of experience related to teaching, research and engineering design. The development of analytical probabilistic stormwater models is currently the focus of Dr. Guo’s research.</td>
</tr>
<tr>
<td>Dr. Paul Kay, B.Sc., M.S., Ph.D</td>
</tr>
<tr>
<td>Associate Professor in, and Chair of, the Department of Environment and Resource Studies at the University of Waterloo. His research interests include climate change and water resource management. He is a member of the Canadian Water Resources Association and the International Water Resource Association.</td>
</tr>
<tr>
<td>Paul Kovacs</td>
</tr>
<tr>
<td>Insurance specialist with more than 25 years of public policy formation experience. Paul is Executive Director of the Institute for Catastrophic Loss Reduction, President of the Property and Casualty Insurance Compensation Corporation, and is an Adjunct Professor in the Economics Department at the University of Western Ontario.</td>
</tr>
<tr>
<td>Mark Schollen, B.L.Arch., O.A.L.A., C.S.I.A., A.S.L.A</td>
</tr>
<tr>
<td>Landscape architect and Principal of Schollen and Company Inc. With more than 20 years of experience, Mark is a recognized expert in the fields of natural channel design, non-structural stormwater management, environmental restorations, habitat creation and enhancement, and landscape management. Mark is also a Sessional Lecturer at the John H. Daniels Faculty of Architecture, Landscape and Design at the University of Toronto.</td>
</tr>
</tbody>
</table>

Source: ICP, 2009
The panel commended the SERG’s efforts to better understand the characteristics of the problem areas with accurate data and analysis. The review of the Stormwater Master Plan found it to be progressive and comprehensive in addressing long term growth and environmental quality. Additionally, the ICP was impressed with the GRIDS process, noting that it is a successful initiative that has become a model for other municipalities. Nonetheless, with specific regard to flooding issues, the panel was able to make 26 recommendations for further action.

The ICP recommendations in 2006 were generally supportive of the ongoing actions, noting that the major issues were already being addressed, and stressed opportunities that would provide the greatest returns.

In terms of technology and engineering, the panel’s main recommendation was that, while unfeasible to rebuild infrastructure to handle the most severe storms, the increasing intensity of storms as a result of climate change needs to be considered. This would require higher design standards for future projects; creating an emergency response plan for severe storms; a more area-specific approach prioritizing problem zones; and using more detailed data for meteorological analysis of past events in specific areas rather than regional data. The panel pointed out some specific improvements that could be made to the conveyance system but cautioned against focusing too much on built infrastructure solutions and recommended a more comprehensive cost-benefit analysis that considered the social and economic impacts of infrastructure construction. In addition, they supported the non-structural solutions being considered such as ponds, landscaping, and watercourse restoration, pointing out further opportunities in the City to improve natural functions of watercourses and greenspaces.

The ICP stressed that urban design and planning play an important role in stormwater management both at the level of new large-scale developments and individual existing properties. Many of these source-control strategies are present in the Stormwater Master Plan but the panel recommended a more aggressive approach to involving property owners in mitigation efforts, including a pilot project for sump pumps and backflow preventers in problem neighbourhoods.

Since 2005, SERG and the City of Hamilton Public Works department have been responding to the flooding issues and acting on the recommendations of the 2006 ICP report.

2.3 Initiatives and Programs

2.3.1 Modeling

Following the 2005 flooding, the city undertook a thorough sewer inspection program. A camera inspection of existing pipes, prioritizing flood prone areas, revealed that the system was in generally good condition, and that the few blockages or other maintenance issues that existed could not have been the primary cause of flooding.
Enhanced computer modeling is being used to evaluate the capacity and flow performance of the system under different loads. Currently, the City has completed models for the citywide combined sewer system and the citywide sanitary sewer system. In the future, models will also include citywide separated storm sewer and overland flow models, as well as improved climate data. As recommended by the ICP, the network of rainfall gauges has been expanded and integrated with radar data. SERG also hired a rainfall analysis consultant to quantify the previous storms. Once integrated, and combined with new rainfall data systems, this modeling could be one of the most effective measures to improve storm preparedness by correlating the flood pattern with weather.

Another modeling method being employed involves receiving feedback on the actual performance of the system. This pipe flow monitoring provides real time control and is being developed to optimize the capacity by limiting the flow in vulnerable areas, thus minimizing the chances of downstream overflow.

### 2.3.2 Area Specific Studies

Another recommendation of the ICP was a prioritized and more area-specific approach to studies and planning. SERG has initiated several stormwater studies in affected areas to provide further detail on the causes of flooding and make recommendations for structural improvements or management techniques. Sub-watershed studies have also been conducted to investigate environmental conditions to make recommendations for lower impact from new developments.

Six small area studies have been conducted in the Neighbourhoods of Ainslie Wood / Westdale, Garner, Greenhill, Mountview, Sanatorium, and Fessenden as well as the larger area studies of Stoney Creek Urvan Boundary Expansion, Lower East End Drainage Study, and the Stormwater Master Plan study area. Sub-watershed studies include Upper and Lower Davis Creek, Nannon Creek, and South Waterdown (City of Hamilton, 2010a). These studies have contributed to a richer understanding of the specific causes of localized flooding which has led to an improved prioritization of capital.

As a result of the modeling, and studies recommended by the ICP and implemented by SERG and the Public Works department, a number of capital projects have been undertaken to reduce flood risks. Work completed between 2005 and 2010 totaled over $171 million, including pipe upgrades, replacements, and rehabilitation projects. Planned capital works to 2015 are estimated at over $472 million. The increased awareness of problem areas has also enhanced operations and maintenance measures. Priority storm inlet, catch basins, culverts, and outfalls are ranked according to risk, history, and condition. Prior to a forecasted storm and after a storm, maintenance staff inspects for and clears any blockages (City of Hamilton 2010e).
2.3.3 Community Communication and Programs

One of the tasks of the ICP was to make recommendations for a communications plan. The panel recommended closer cooperation with insurance companies, as they are also interested in reducing risk of flood damages; are experts at risk management; and have information systems that could be shared with the City. Additionally, the ICP commented that City response to flooding complaints, and homeowner education and engagement were key factors in better stormwater management and needed improvement to reduce flood risk.

To address these issues, several initiatives were launched to increase awareness and behavioural change in building owners. Details of two programs, the Protective Plumbing Program and Flood Aware campaign, which were a direct result of the ICP report are outlined below.

Lateral inspection and repairs, downspout disconnections, and backwater valves are three examples of homeowner improvements that can reduce the risk of flooding.

- In Hamilton, the lateral sewer connection from the house all the way to the main is the property of the landowner. Leaking laterals are believed to contribute more than half of the unintended infiltration into the system and blocked laterals increase the risk of backup.
• In older neighbourhoods, the downspouts from the house were connected directly into the sewer, greatly increasing the source-water that enters the system. While improper disconnections can increase risks of downstream surface flooding, appropriate disconnections that allow for collection or infiltration can result in significant volume reductions in the sewers.

• One of the most costly, and certainly most distressing types of flood damage a homeowner can experience is basement flooding from sewer surcharging, causing sewage and water to enter the house. A backwater valve that prevents reverse flow can protect a home from this type of flooding. While every new home is required to have a backwater valve in many Canadian cities, including Toronto, Edmonton, and Winnipeg, its use is not as common in Hamilton.

In December 2008 public works staff selected 75 previously flooded properties to participate in a pilot program to subsidize the installation of a backwater valve to prevent sewer backup into the residence (value up to $2000) and to perform a lateral drain inspection (value up to $1000). Thirty homes participated and twenty installed a backwater valve. Despite the severe flooding that occurred the following summer, there have been no reports of flooding from these residents.

In 2009, the pilot project was replaced by the city-wide Protective Plumbing Program (3P). Initially, property owners who had experienced sewer related flooding from an eligible storm could receive subsidy under the 3P for:

• Installation of a backwater valve
• Installation of a sump pump in conjunction with a backwater valve
• Free inspection of sewer lateral
• Sewer lateral repairs
• Disconnection of downspouts

As of July 2011, eligibility for the 3P program was extended to all owner-occupied properties connected to the City of Hamilton system.

The Protective Plumbing Program was recently featured as a key component of a showcase house in Hamilton that was retrofitted with flood protection measures by the Institute for Catastrophic Loss Reduction. A bungalow in the Rosedale neighbourhood that had experienced extensive flooding in the July 26, 2009 storm was equipped with a backwater valve, sump pumps, and other preventative retrofits (TheSpec.com, July 26 2011).

**Flood Aware**

In addition to promoting the Protective Plumbing Program, the SERG committee initiated a communication and engagement plan, as recommended by the ICP, called “Flood Aware”. Several key products of this program were:
• A four-page brochure and advertisement that provided information about flood prevention in the home and actions the City was taking. Tips included protection measures, insurance recommendations, and how to file a claim with the City. The brochure was made available throughout the City, delivered to residences, and appeared in the local paper.

• Four seasonal Flood Aware advertisements were published throughout the year with season-specific tips.

• A Flood Aware webpage containing all the related information, or links to it, was added to the Hamilton website.

Additional communication and participation strategies being implemented include SERG reports to City Council, discounted rain barrels for homeowners, media information updates during storms, and the establishment of a flood claims hotline for affected residents. Finally, upon ICP recommendation, post-flooding health and safety information for residents was posted on the website.

2.4 Reconvening the Independent Community Panel

The ICP was reconvened in December of 2008. SERG staff initiated the second panel review (rather than Council as in 2006) and the members were hired as professional consultants. SERG staff indicated a desire to have a third party peer review to comment on the actions taken to reduce oversights. Using the original ICP panel also allowed for opinions on progress made on the original recommendations. This sentiment was shared by an ICP member, noting that it also allows each group to confirm understandings of the previous observations and recommendations.

The intent of this review was to evaluate the City’s stormwater management practices since 2006, comment on the previous recommendations, and to make new recommendations as needed. The following activities were undertaken:

• Review of background material provided by the City;

• Meetings with Water and Wastewater staff, SERG members, Capital Planning and Implementation, Public Health, Development Engineering, Operation and Maintenance, Budgets and Finance, and consultants working on stormwater projects;

• Meet with SERG to discuss observations and recommendations;

• Provided input on the draft and final reports prepared by Hardy Stevenson and Associates Limited (City of Hamilton, 2009).

The panel noted that Hamilton has been very successful in creating interdepartmental and interdisciplinary cooperation in its approach to the issue of flooding, as evident in the SERG activities and the use of the ICP. Hamilton has also utilized expert consultants to assist in projects and is using quality data in its studies. It was observed that though the City had
made some progress on prior recommendations, more could be done to strengthen integration, partnerships, and communication.

Within the City, cooperation with local conservation authorities and other staff sections such as Parks Maintenance and Open Space Development could be increased. These groups have considerable knowledge and operations that affect large areas of the watershed or that could also be used as space to incorporate water management retrofits such as holding ponds or infiltration systems. For example, the Forestry and Horticulture Section maintains over 131,000 trees in the municipality and are monitoring for insect and disease issues that could create debris contributing to stormwater blockages but this information is not being shared with appropriate stormwater management teams.

Improved communications is recommended as essential to better integrating the management practices, both among interdepartmental groups and externally with the public, the insurance industry, and other institutions that could offer valuable assistance such as universities.

A major observation from the ICP in this review was that Hamilton, although working hard at the major issues it faces, has fallen behind the level of proactive and innovative responses to climate change being initiated in other municipalities. In particular, the panel stresses the need to incorporate more Low Impact Design standards for developments, expand or strengthen the source control programs such as downspout disconnection, and be more explicit about the managing the risks associated with climate change and incorporating climate change modeling.

Many important aspects of overall stormwater management are found in separate Master Plans and studies. For example, the Stormwater Master Plan covers separated sewer systems and environmental impacts, while the Water and Wastewater Master Plan covers the combined sewers. An overall, integrated wet weather flow plan should be considered.

The panel found that responses to the 2006 recommendations tended to focus on physical infrastructure and recommends the inclusion of other socioeconomic factors such as age or education that might relate to risk levels and participation in mitigation programs such as P3.

Hamilton staff has accepted the recommendations and indicated that the majority of the above recommendations can be accommodated. However, the major challenge at this time appears to be finding resources to implement the programs. The City is currently studying funding options, but a recent attempt to implement an additional stormwater rate was quashed by Council.
3 Challenges

There were several challenges that the City of Hamilton faced while adapting their stormwater management strategy to climate change. These included challenges related to motivation and behavioural change; public perception and flooding characteristics; and securing ongoing funding.

Maintaining Motivation

Flooding is unpredictable and it is difficult to maintain proactive mitigation efforts when there is no constant or immediate threat. Between its initial review and 2009 when it reconvened, the ICP observed that at the sense of urgency that was present in the aftermath of the 2005 and 2006 storms had subsided. The follow-up ICP comments were made before the storms of 2009, but their point underscores the challenge of maintaining efforts between periods of severe storms.

Public Perception

The ICP found that public perceptions of floods tend towards blaming the city government for a lack of adequate infrastructure. While there are a number of measures that can be taken to mitigate damage from flooding, it is not possible to prevent overloading of sewer systems during very severe and concentrated rainfalls. Through the ICP review it became apparent to those community members involved that the storms experienced by Hamilton would have overwhelmed even the most modern system. Despite these findings, the perception that municipality is at fault indicates a lack of understanding about the roles of the sewer system and responsibilities of property owner in the face of major storm events. No amount of hard work by Hamilton staff and recommendations from the ICP can eliminate the risk from unprecedented storm events.

Long-term Funding

One of the most fundamental challenges that the City of Hamilton faces is finding long-term funds to commit to ongoing groups (like the SERG) and programs (3P and Flood Aware). Currently, SERG is funded in the City’s capital budget, but programs are not. Funding for the programs comes from the Water and Wastewater Rate added to residential, commercial, institutional, and industrial water bills. This arrangement is dynamic, where the municipal contribution and the rate paid by water consumers is reassessed every year. The City of Hamilton is currently evaluating adding a proposed Stormwater Rate to water bills in order to support the City’s current and future anticipated Stormwater Management Services program expenditures. This new Rate would be administered in a similar fashion as the City’s current Water and Wastewater Rate (City of Hamilton, 2011). This type of funding structure poses an issue for long-term programs in that public control over a portion of the funding could lead to struggles over the continuation of programs, particularly if public opinion views these programs as being solely part of the municipality’s responsibility.
4 Lessons Learned

Lesson 1: A key component of communication strategies targeting participation in specific programs is a focus on mutual understanding about risk and responsibility. When soliciting the general public’s participation in flood prevention programs, communicate not only the risks of flooding but also the liabilities and responsibility associated with each party (including the City, the homeowner, and the insurance companies). The Flood Aware program brochures include prevention tips for homeowners, information on actions taken by the City, and insurance recommendations.

Lesson 2: Don’t wait for the perfect model or all the answers before taking action. We may be uncertain about the specific effects of climate change, but we can be certain that adaption requires support and cooperation.
Conspicuously absent from the public communication material is discussion of climate change and the need for adaptation strategies by all citizens. When stormwater efforts are presented to the public, they seem to be very focused on identifying and addressing the problem technically at the expense of taking critical, if uncertain, steps towards adaptation. The City has acknowledged the wide range of mitigation strategies, particularly source-control methods, which have high return on effort with the cooperation of the public. Dealing with the effects of climate change together will first and foremost require some agreement, even if it is agreement about uncertainty. Without this, political support for appropriate infrastructure projects will be difficult, especially when facing increasing financial constraints.

Lesson 3: Establish an interdisciplinary team to coordinate stormwater management, ensure the team has time and resources to commit at regular intervals, and if possible, have a dedicated staff member for this purpose.
The multiple causes of flooding mean that mitigation strategies often involve different sectors or divisions within the municipality. Establishing the Storm Event Response Group has allowed improved coordination of efforts and provided an appropriate entity for effective consultation with other groups such as City Council and the Independent Community Panel. However, staff has expressed that it is difficult to maintain focus and progress during periods without flooding. Recently Hamilton has dedicated a staff member full time to stormwater and flooding issues.

Lesson 4: Be open to the resources of local experts and consider establishing an independent panel.
Our daily weather has always been unpredictable, now there is added uncertainty in the future due to climate change. Likewise, stormwater management is inherently complex and the effects of climate change further complicate today’s more comprehensive approach and flood prevention measures. City staff has expressed that this makes stormwater
management a very frustrating job, made more stressful because it is also an emotional issue for residents facing personal losses or increased taxes. The willingness to recruit experts to review stormwater management issues has provided staff with a much higher level of confidence in their approach by both validating challenges and revealing new opportunities.

**Lesson 5: Solicit community experts effectively and respectfully by recognizing their experience and providing clear but not constraining Terms of Reference.**

One of the ICP members recalls being motivated to participate in the innovative use of an expert panel for flood issues because damage from flooding is a serious national issue that requires a variety of local solutions. Involvement with the ICP was a chance to be involved at that level. This member also found that the terms of reference were attractive because they were clear in defining the problem and goals but not too narrow or constraining in the approach, indicating that Hamilton recognized the complexities of flooding and were open to advice from a broad range of experts.

**Lesson 6: Use care when bringing together individual experts from different fields and consider using an external facilitator.**

The City hired an independent consultant to facilitate meetings and an objective participant in the ICP members selection process. The high level of expertise and experience on the panel illustrates the success in recruiting community members to assist the city. One risk in bringing together a small group of specialists is the need to trust each individual in their area of expertise, stressing the importance of a properly constituted panel in providing effective recommendations.

**Lesson 7: Consider reconvening a successful panel for a review of progress. The second review can provide much greater returns with less effort.**

After a successful experience with the Independent Community Panel in 2006, SERG staff members requested a second review of their progress. One of the panel members related that it was very encouraging to be asked back, stating that it illustrated both the effectiveness of the process and that the City is genuinely committed to finding improvements. A second review was also thought to be very productive because it allowed for deeper understanding of progress made and previous recommendations can be reevaluated and compared to actions; it recognizes that these issues do take time and that one report of recommendations is not going solve the problems; and it has the potential to reinvigorate action on the issue.
References

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City of Hamilton. (2010a) Staff Report, SERG Update July 9 2010
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