

Urban flood resilience in Ontario



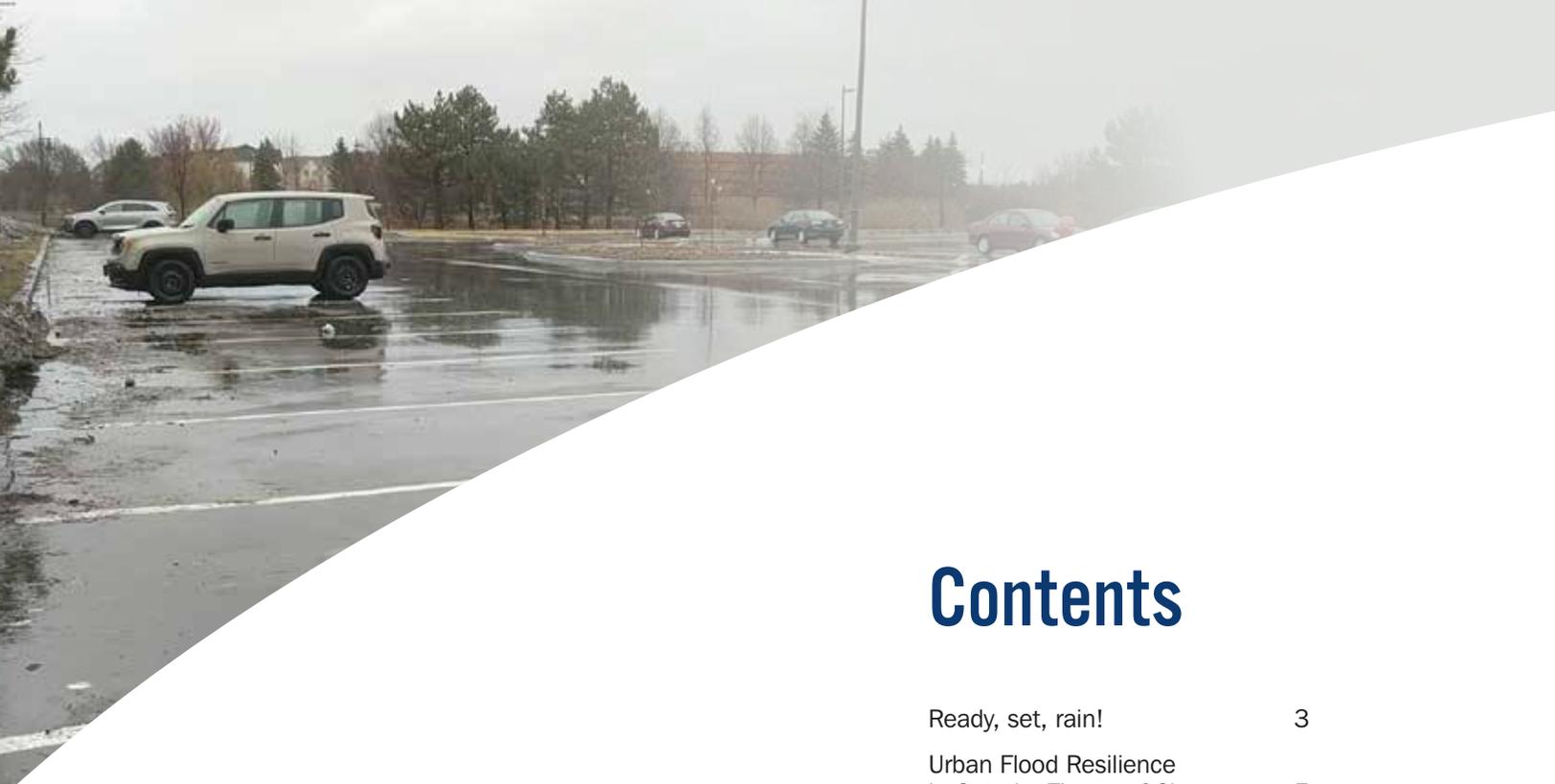
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Prepared by Clara Blakelock,
Green Communities Canada
with contributions from participants
in the Ontario Urban Flooding
Collaborative.

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Ready, set, rain!

A collaborative action plan for urban flooding in Ontario

Toronto. Mississauga. Windsor. Burlington. Thunder Bay. Markham. In the last several years, all of these cities have experienced major flood events, causing damage totalling billions of dollars. Most of the damage was caused by urban flooding, occurring outside of riverine flood plains. Urban flooding occurs when the volume of runoff overwhelms stormwater and wastewater systems. It's a serious and growing problem, not limited to large rainfall events – every city and town in Ontario has neighbourhoods where basement flooding is a common occurrence, not making headlines, but nevertheless devastating to those affected.

Flooding is a complex issue with many different manifestations. To most people, flooding brings to mind images of rivers overflowing their banks. But the majority of flood damage in Ontario occurs due to urban flooding, which includes:

- Storm sewer backup due to undersized or blocked pipes.
- Uncontrolled overland flooding due to a lack of designated overland flow routes.
- Self-flooding or flooding of neighbours because of poor property-level drainage.
- Sanitary sewer backups that occur when rain inundates combined or partially separated sewers, or when pipes are blocked or pumping capacity is inadequate.

Rainfall volumes can also overwhelm the capacity of sewage treatment plants. As a result, thousands of cubic metres of untreated or undertreated sewage are released into fresh water bodies, resulting in bacterial contamination.

Do you have a flooding story?

Sump pump stopped working and had two inches of water in the basement. – Booky

Water came up through the basement floor during an extreme heavy downpour – the downspout was not directed away from the foundation. – Ken

Sewer backup one month after buying a home. We didn't have or know what a backwater valve was, but we have one now. – Blake

We had a sewer backup in our basement three years ago. The whole street had the same experience. – Rose

We had a renter that got out of bed and realized there was a foot of water on their floor. We saw some of our things floating down the street. Our house insurance went up after that. – Wendy

In the 2004 flood I had four feet of sewage in my basement; \$32,000 damages, but insurance covered it all. - Anonymous

Stories were collected through public outreach in Brantford, Thunder Bay and Peterborough, as well as online.

Causes

Storm water infrastructure in older neighbourhoods was not designed to control flooding or prevent pollution. Lack of maintenance of aging infrastructure adds to the problem by reducing capacity.

Urbanization has resulted in a large increase in impervious surfaces – roads, parking lots, buildings – and the corresponding loss of vegetation. As a result of the way we have built our communities, very little rainfall is infiltrated into the ground, captured by vegetation, or returned to the atmosphere through evapotranspiration. Instead, most rainfall becomes runoff, resulting in large volumes that infrastructure was never designed to accommodate. This increase in runoff contributes to riverine flooding in communities downstream. As climate change brings more frequent and more extreme precipitation events, the problem is getting worse.

Urban flooding can be devastating to the economy, our health, and the environment. For more on the causes and impacts, see [Urban Flooding in Ontario: Towards Collective Impact Solutions](#).

Who is responsible?

Urban flooding is not an easy problem to solve. Most people never consider the risk of flooding until it happens to them, and then they want solutions enacted immediately. But fixing the mistakes of the past can be long, involved, and expensive. It requires proactive investment, before disasters occur.

Responsibility is a complicated question. A wide range of actors need to work together. Depending on the municipality, different tiers of government or wastewater utilities may be responsible for wastewater systems and stormwater systems (which in combination often contribute to urban flooding). In Ontario, Conservation Authorities are responsible for floodplain management and watershed issues, but don't own and manage stormwater infrastructure. The Ontario government guides stormwater policy and land use planning, and the Federal government administers disaster relief following flood events.

Beyond governments, others are necessarily involved. The insurance industry is paying out more, as flooding becomes more and more frequent. Academic researchers are studying everything from the performance of flood protection devices to the projected impacts of climate change.

Private companies sell services to prevent flooding directly to property owners, from backwater valves, to basement waterproofing, to landscaping. Consulting firms work with municipalities to create and implement plans to address flooding. Non-profits work to protect the public and the environment from floods. And residents and business owners are cleaning up after floods and looking for ways to protect themselves in the future.

No single entity - government, organization, or industry - can solve this problem alone. Coordinated action is needed in order to make real progress in advancing urban flood resilience in Ontario.

Ready, set, rain!

What would it mean for a community to be resilient to urban flooding? No one can control the weather or the intensity of storms, and stop flooding altogether. But there is much that we can do to make sure communities are ready for rain, and that damaging impacts are minimized instead of continuing to grow more severe. This action strategy maps out four areas where communities can take concrete action to increase resilience.



No progress can be made while the problem is not well-understood. Communities need to understand and map their urban flood risk, have an open conversation with citizens about the state of infrastructure, and determine how to move forward, ensuring that the most vulnerable neighbourhoods will be addressed first.



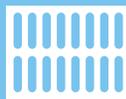
Private properties can contribute to flood risk, as well as being part of the solution. Citizens need help to prepare for floods, by doing everything possible to reduce risk on their own properties, as well as being ready for emergencies that may occur.

Protect and Restore



One of the root causes of urban flooding is the large increase in runoff volumes due to urbanization. Communities can work to reverse the negative trends of urbanization by protecting existing natural infrastructure (wetlands, forests) and retrofitting the built up landscape with green infrastructure which minimizes runoff.

Improve



Infrastructure in older neighbourhoods needs to be upgraded. Each neighbourhood will need different solutions, depending on its characteristics. Communities must also ensure that new development and retrofits are built to be resilient to flooding.

The work of the urban flooding collaborative will be to support communities to move closer to this vision of flood resilience. We have identified a range of projects that are needed to fill in the gaps. These include developing and testing tools and strategies for communicating flood risk to the public, providing training to service providers in flood resilience, supporting municipalities to incorporate green infrastructure, and educating children about flood risk, among others.

To get involved in implementing or supporting these or other projects to increase urban flood resilience in Ontario, visit <http://www.raincommunitysolutions.ca/en/urban-flooding/>

Acknowledgements

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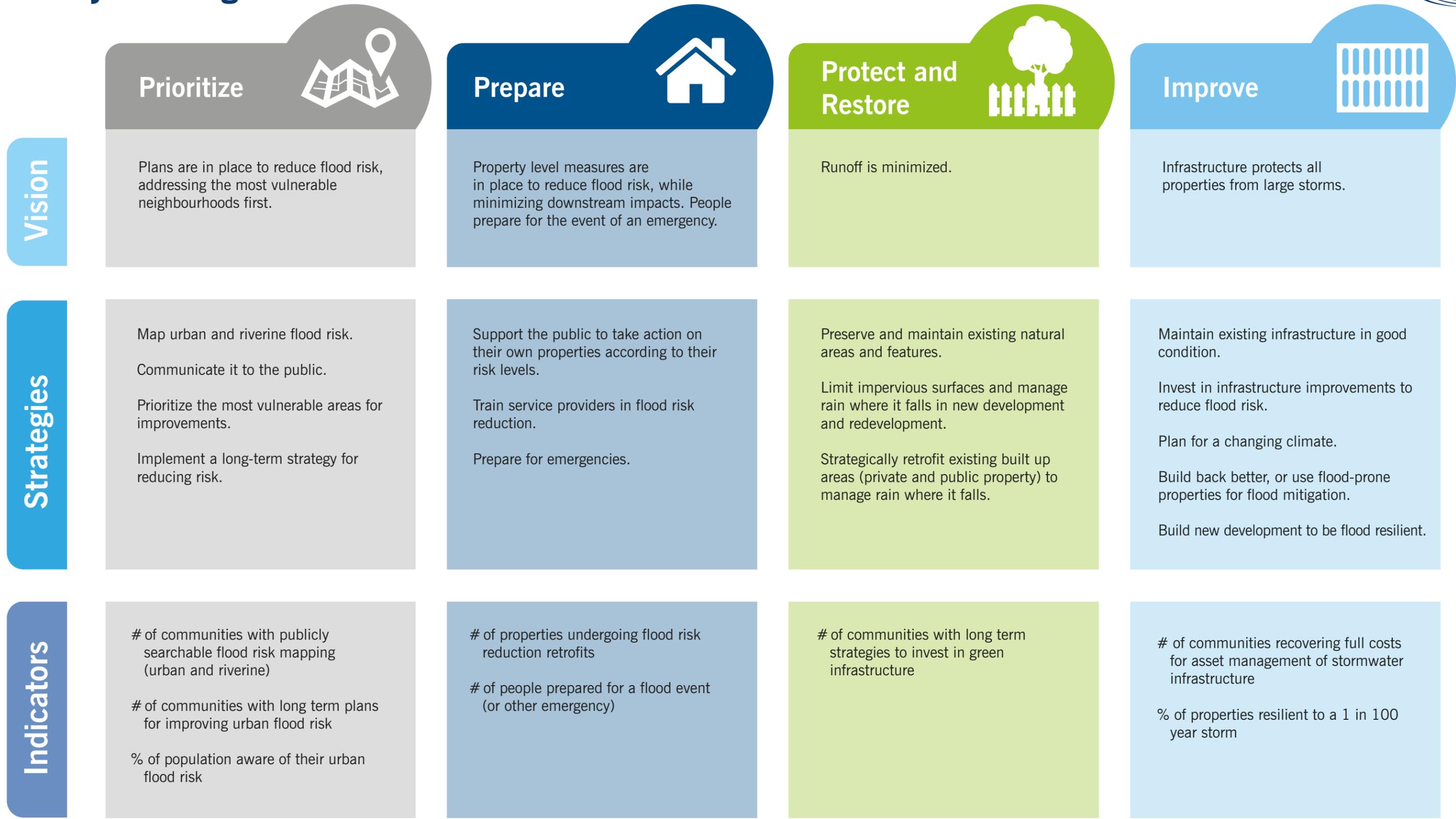
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Acknowledgement here does not imply agreement with the strategy. All errors and omissions are the responsibility of Green Communities Canada.

Urban Flood Resilience in Ontario: Theory of Change





Vision

Plans are in place to reduce flood risk, addressing the most vulnerable neighbourhoods first.

Strategies

- Map urban and riverine flood risk.
- Communicate it to the public.
- Prioritize the most vulnerable areas for improvements.
- Implement a long-term strategy for reducing risk.

Indicators

- # of communities with publicly searchable flood risk mapping (urban and riverine)
- # of communities with long term plans for improving urban flood risk
- % of population aware of their urban flood risk

Urban flood risk is not determined by riverine flood plains. Much of the flooding that occurs in cities happens outside of floodplains, away from rivers and lakes. Sometimes riverine and urban flooding are related, and sometimes urban flooding occurs when high water levels are not an issue.

Mapping of urban flood risk is a new concept in many communities, while riverine floodplains have been mapped for decades, although those maps may also require updating.

Factors that impact urban flood risk are the age, design, and condition of municipal infrastructure, topography and overland flow routes, and drainage practices at the property level.

Some high risk areas are well known, because they experience repeated flooding even during average sized rain events. However, it is important to base risk mapping on more than just where flooding has already occurred. The very high-intensity short-duration events that have caused flooding in recent years (for example, in Burlington in 2014, and Windsor area in 2016 and 2017) can be extremely localized –

the areas that were flooded may not necessarily have higher risk profiles than other areas, but they just happened to be located where the storm touched down.

In taking a holistic approach to flood risk mapping (including riverine), it is important to involve all the relevant players – this might include upper and lower tier municipalities, water utilities, and Conservation Authorities.

While there isn't a standard approach to mapping urban flood risk that will work for all municipalities, a combination of the following information can begin to provide a picture:

- Data on flooding complaints to the City;
- Age, design, and condition of infrastructure;
- Areas of combined or partially separated sewers;
- Areas of greatest uptake of basement flood-proofing subsidies;
- Flow monitoring;
- Hydraulic modelling;
- Data from insurance companies (in particular, a city's own insurance company may be able to provide their codes for determining insurance premiums for sewer backup and/or overland flooding risk);
- Oral histories and community consultations.



Stormwater infrastructure in older neighbourhoods is often out of date.

If you were flooded today, what would you lose?

I live in a basement apartment – I would lose pets, valuables video games. – Samantha

A lot of sentimental things and pictures of my grandkids. Also gifts from my kids and grandkids. – Rose

My daughter's bedroom, furniture and television, items of sentimental value. – Meredith

Everything in our basement – furnace, hot water heater, furniture. - Anonymous

The goal is to create a map that paints a picture of the level of urban flood risk across a sewershed. This will include areas that have already been flooded (or are flooded repeatedly) as well as areas that are at risk, but just haven't been hit yet with a big enough storm.

Once risk has been assessed, neighbourhoods can then be prioritized for infrastructure improvements. It is more than likely that a municipality will not be able to fix all infrastructure issues that lead to increased flood risk within current budgets – or even begin to study all of the neighbourhoods at risk immediately.

However, by making this information public, a conversation can be started with citizens about current infrastructure conditions, who is at risk, what investments are needed and what citizens can do on their own properties to protect themselves.

Asset management, which will be required in order to access provincial infrastructure funding from senior levels of government, provides an opportunity to begin this analysis of current infrastructure conditions and future targets, provides an opportunity to begin this analysis of current infrastructure conditions and future targets. These plans will ensure that adequate funding, which may include a dedicated stormwater fee or another funding mechanism, such as local improvement charges (LICs) or development charges, is provided to achieve set targets.

It may be possible to prioritize high risk areas without extensive risk analysis (for example, areas that experience repeated basement flooding even during average storm events). Depending on the municipality and its available budget, these areas may be the only ones that can be addressed in the short term.

The long term strategy for improving levels of service requires a framework for determining where work should be done first. There may be many areas with similar levels of risk that cannot all be addressed at once. Such a framework should consider the social and demographic factors that might make some neighbourhoods more vulnerable than others. Lower income residents are more likely to live in basements and to be devastated in the event of a flood. It can also take into account the public's priorities for what is most important to protect. Simple models based only on the dollar value of potential losses will not capture these vulnerabilities.

When risks are well understood, budgets, policies, procedures, bylaws, and standards can be adjusted to ensure that potential liabilities are adequately addressed. This might include investing additional funds in flood mitigation infrastructure, limiting building permits and redevelopment in areas with inadequate infrastructure, as well as mandating flood protection measures in new and redevelopment.



Alleyways often lack proper pathways for drainage which can result in flooding.





Case study: City of Edmonton flood mitigation

The City of Edmonton is undergoing a [city-wide flood mitigation study](#), analysing flood risk across 160 neighbourhoods built before 1981 in order to prioritize infrastructure improvements. As part of this process, the City and EPCOR, which manages drainage for the City, have released flood risk maps to the public, showing risk levels by sub-basin. The public

was engaged to determine which types of flooding impacts were most important to them to address first. The public prioritized minimizing flooding impacts to essential services (hospitals, EMS, fire etc.) and social agencies. This input, along with the risk mapping, will guide the long term strategy.

Additional tools and resources

[Urban Flood Risk Evaluation to Guide Best Practices and Projects - Tiered Vulnerability Assessment and Risk Mapping for Storm, Wastewater and River Systems from Flood Plain to Floor Drain](#) - Robert Muir, P. Eng.

City-wide flood risk profile, City of Ottawa (to be released in 2019)

[Weathering the storm: developing a Canadian standard for existing flood-resilient communities](#) – N. Moudrak and B. Feltmate, Intact Centre on Climate Adaptation (2019)



Prepare



Vision

Property level measures are in place to reduce flood risk, while minimizing downstream impacts. People prepare for the event of an emergency.

Strategies

- Support the public to take action on their own properties according to their risk levels.
- Train service providers in flood risk reduction.
- Prepare for emergencies.

Indicators

- # of properties undergoing flood risk reduction retrofits
- # of people prepared for a flood event (or other emergency)

No one is completely safe from flooding. However, as risk mapping will show, some neighbourhoods are at significantly higher risk than others. Even with infrastructure improvements, flood risk will never be reduced to zero. And many infrastructure improvements will take years to complete.

Communicating flood risk to the public has two important purposes: to gain their support for investments in infrastructure improvements, and to encourage them to take action on their properties to reduce their individual and community-wide flood risk.

Recommended actions will vary depending on the type of flood risk being faced by property owners (not all will apply to every property). Some actions include:

- Direct downspouts away from building foundations.
- Grade so ground slopes away from foundations.
- Keep drains and sewers unclogged (avoid putting fats, oils, grease and flushable wipes down drains).
- Ensure sewer laterals are in good condition.
- Disconnect foundation drains from sanitary sewers and install sump pumps with backup power supply.
- Install and regularly maintain backwater valves.
- Reduce runoff and manage rain where it falls.
- Ensure adequate insurance coverage.
- Create family emergency plans and keep an emergency kit in the home.
- In higher risk areas, furnish basements with the understanding that they may be flooded (non-absorbent materials, waterproof bins, all valuables elevated off the floor, and not relying on basements for living space).





Getting people to spend time and money on implementing these recommended actions is a challenge. Many municipalities offer subsidy programs for some of the more costly measures, but uptake is generally quite low (around 7% of eligible properties), and survey data shows a large majority of people are not taking any action to protect their homes from flooding. In a survey of Toronto Hydro customers, only 9% had a full emergency kit at home¹. Approximately 12,000 households, or 0.2% of Ontario households, have created family emergency plans through Emergency Management Ontario's online system².

One key reason may be that flood risk is perceived as low, and so other household priorities take precedence, and people don't think about the need to be prepared for an emergency. The structure of subsidy programs (complex applications, up front investments, minimal community outreach) may also contribute to low uptake.

Property owners who decide to take recommended actions, and need to engage with professional help, continue to face barriers. Determining which action to take in order to have the greatest impact is no easy task. Foundation specialists will fix foundations, landscape professionals will landscape, eavestroughers will adjust eavestroughs, plumbers will work with the plumbing – depending on which type of professional the property owner engages with, they may get a completely different solution, with no guarantee that it will actually solve their problems.

When work is done on properties, there is a lack of accountability and quality control, in both installation and maintenance. It has been estimated that 25% of backwater valves installed in homes are not functional, and most have never been maintained after installation³.

Renters, especially those in basement apartments, are particularly vulnerable to flooding while having little agency to reduce their risk, given that most investments need to be made by the property owner, who has little incentive to do so.

As of yet, there is no silver bullet for getting uptake of flood protection measures on private property. A number of case studies are highlighted below, and initiatives of the Urban Flooding Collaborative aim to address some of the barriers being faced.

Have you done anything to protect your home from flooding?

No, we haven't needed to in our new home so far. – Amber

No. I know about backwater valves but it's too expensive. Might still do it. – Anonymous

Installed a sump pump as well as make sure our drain isn't plugged. The pump is connected to the waste water line. – Vincent

House is built into a hill, because of landscaping shouldn't experience flooding ever. – Greg

We run a de-humidifier to get moisture out of the basement. – Benny

We banked away from the house and put in rain barrels – Sharon

Nothing – the landlord put up drywall which will be ruined again if it floods. – Matt

We live on a low area so a sump pump is necessary, we should have a battery backup. – Booky

1. New survey shows Toronto Hydro customers aren't prepared for emergencies. <http://www.newsroom.torontohydro.com/2017-05-08-New-survey-shows-Toronto-Hydro-customers-arent-prepared-for-emergencies>

2. Emergency preparedness action plan. https://beprepared.emergencymanagementontario.ca/myplan/?language=en-CA&_ga=2.55887522.880737030.1541962395.236214407.1541962395

3. Binns A., McBean E. 2017. Lot-level approaches to control urban flood risk and mitigate basement flooding. Available at: <https://www.slideshare.net/glennmcgillivray/iclr-friday-forum-lotlevel-approaches-to-control-urban-flood-risk-april-21-2017>



Reverse slope driveways make homes more prone to flooding.

Case Studies

RAIN Home Visit and other site-specific advice programs

In many cases, there is no other way to diagnose flood risk and water issues on a property except with a property level assessment. The RAIN Home Visit, developed by Green Communities Canada and later adapted by the Intact Centre on Climate Adaptation into the Home Flood Protection Program, are two such services. In these programs, trained guides work through a standardized checklist with a property owner to provide property-specific flood risk reduction recommendations (including pollution prevention, in the case of the RAIN Home Visit).

Some municipalities also offer this service, formally or informally, by providing municipal staff, often in the engineering department, to visit with property owners and help them diagnose flooding issues. These types of assessments, from knowledgeable, impartial third parties (not trying to sell anything) can help property owners determine which measures to invest in to get the most value for their money. However, because each appointment can take up to two hours, they are costly to administer. The detail of the recommendations will also vary depending on the training and knowledge of the assessor – from basic, standardized recommendations to site-specific flood risk reduction plans.

The Intact Centre is partnering with Seneca and Fleming Colleges to deliver training on delivering site-specific flood risk reduction advice to future home inspectors.



Homes can be at elevated risk of flooding from downspouts discharging at the foundation, something which can be easily fixed.

Contact: info@raincommunitysolutions.ca



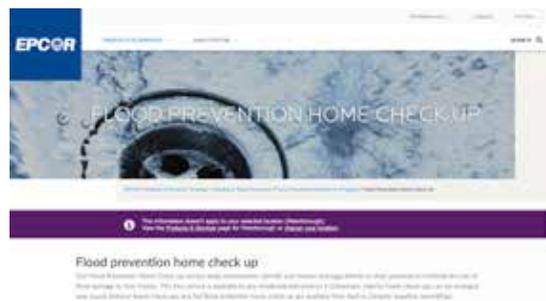
www.raincommunitysolutions.ca/en/rain-home-visit/



www.intactcentreclimateadaptation.ca/programs/home_flood_protect/



<https://flemingcollege.ca/news/home-flood-risk-assessment-training-course-now-offered-online-across-canada/>



www.epcor.com/products-services/drainage/flooding-flood-prevention/flood-prevention-homeowner-programs/Pages/flood-prevention-home-check-up.aspx





Training and certification

York Region and the Region of Peel partnered with Landscape Ontario to develop and implement the Fusion Landscape Professional training and certification program for the Landscape Horticulture industry. Fusion landscapes are water-efficient landscapes which manage rain where it falls. Rather than focusing on the environmental benefits of the Fusion landscape, promotional materials feature beautiful images of Fusion gardens, along with words that evoke an emotional response in people. This approach was supported by market research. Certified Fusion landscape professionals work directly with property owners to create beautiful, water-efficient landscapes. The Regions also help promote these certified professionals through the advertising of the Fusion brand and by providing a list of certified contractors to the public. The program is a partnership between the public sector, trade organizations and private companies. This is a model that could potentially be expanded to other forms of flood protection measures on private property.

Other related training programs that could serve as models include Green Plumbers (about water efficiency), and the U.S. National Green Infrastructure Certification Program.



<https://horttrades.com/fusion>



www.york.ca/wps/portal/yorkhome/environment



<http://www.peelregion.ca/watersmartpeel/residents/fusion-landscaping/>



www.greenplumberstraining.org/Pages/default.aspx

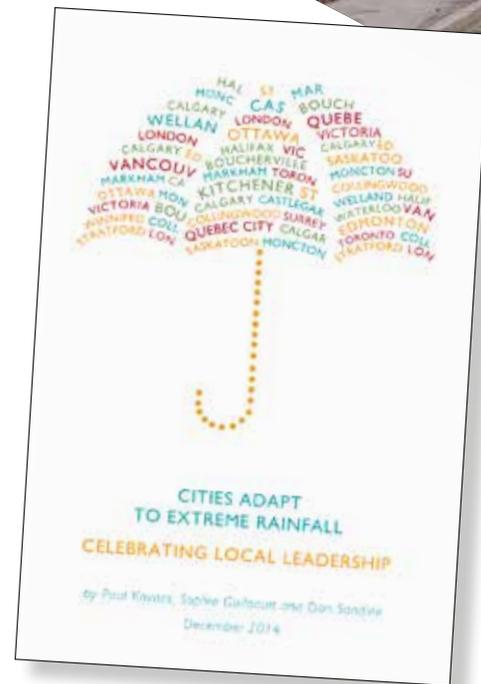


<https://ngicp.org/>



Incentivizing flood protection

The City of Saskatoon succeeded in getting 50% of targeted homeowners to take advantage of a subsidy program to install backwater valves. Key elements of the program included targeted outreach to high risk properties, engagement with plumbing contractors, and giving people the option of having the City pay the contractor directly.



Read the full case study in Cities Adapt to Extreme Rainfall⁴

Additional tools and resources

[Assessing local mandatory measures to reduce flood risk and inflow and infiltration in existing homes](#) (2017). Kyriasis, J., Zizzo, L., Sandink, D. Institute for Catastrophic Loss Reduction.

Other resources from the Institute for Catastrophic Loss Reduction are available at <http://basementfloodreduction.com/>

4. Kovacs, P., Guibault, S., Sandink, D. 2014. Cities Adapt to Extreme Rainfall. Institute for Catastrophic Loss Reduction Available at: https://www.iclr.org/wp-content/uploads/PDFs/CITIES_ADAPT_DIGITAL_VERSION.compressed.pdf





Vision

Runoff is minimized.

Strategies

- Preserve and maintain existing natural areas and features.
- Limit impervious surfaces and manage rain where it falls in new development and redevelopment.
- Strategically retrofit existing built up areas (private and public property) to manage rain where it falls.

Indicators

of communities with long term strategies to invest in green infrastructure

The way we have built up our cities, paving over surfaces and channeling water away as quickly as possible, has contributed to flooding (urban and riverine) as well as water quality and aquatic habitat impairment. A newer approach to managing stormwater, being adopted by many municipalities and supported by the provincial government, is to manage rain close to where it falls with green infrastructure. This approach mimics the natural water balance by infiltrating or using as much rainfall as possible, so that only a minimal amount runs off untreated into waterbodies.



Urban green infrastructure, like this roadside rain garden, absorbs runoff from nearby hard surfaces during smaller rainfall events.

Green infrastructure can reduce flood risk in several ways:

- Preserving and/or enhancing existing wetlands, forests, and meadows can ensure that communities downstream are at reduced risk of flooding.
- In areas with undersized sewers, reducing runoff volumes can take pressure off and reduce the risk of surcharging.
- Retrofitting existing built up areas to manage rain where it falls and reduce impervious surface can reverse the negative trends of urbanization, ultimately reducing flood risk downstream (when done at scale).

Green infrastructure can also address localized ponding issues that cause hazards, especially for pedestrians, cyclists, and wheelchair-users.

Within urban areas, green stormwater infrastructure is generally designed and built to handle smaller rain events (e.g. 25mm), and not the extreme events which cause flooding. It is not a replacement for grey infrastructure improvements. However, green infrastructure is part of an integrated approach to managing urban runoff, from the smallest events to the largest.

When implemented at a broad scale, there are many co-benefits to green infrastructure implementation:

- Increased groundwater recharge, important for stream, wetland, and forest health, as well as when used as a drinking water source or for irrigation;
- Improved air quality;
- More walkable communities;
- Carbon sequestration;
- Improved water quality (beaches, aquatic habitats, drinking water downstream);
- Increased property values and economic activity;
- Pollinator habitats.

Local conditions will determine which types of green infrastructure will be most relevant, and which types of policies and programs will work best.

Some examples include:

- Protect and enhance the urban forest by setting targets for canopy cover, ensuring adequate soil volume for newly planted trees, and limiting tree removals on public and private property.
- Use green redevelopment planning to drive reductions in impervious cover, especially in areas that do not have adequate levels of service for stormwater management.
- Incentivize managing rain where it falls and reducing impervious areas on private and institutional property (e.g. schools).
- Incorporate green infrastructure into municipal rights of way during road reconstruction work, where possible.
- Reduce impervious cover and manage rain where it falls where possible in municipal operations, including during flood mitigation infrastructure work.
- Limit the upsizing of single family/detached housing to curtail the loss of previous area.
- Minimize parking requirements.
- Preserve existing green space, minimize the footprint of new development, and set strong targets for managing rain where it falls.
- Maximize the use of parkland dedication bylaws.

Green infrastructure can be applied strategically in areas where the most benefits will be achieved. A plan for investing in green infrastructure (whether through a stand-alone strategy or as part of another plan) can identify which types of policies and which areas of the city would be most appropriate for green infrastructure implementation locally.

Case study: Southdown Grid aggregation project

Credit Valley Conservation, in partnership with the Region of Peel, private landowners, and the Mississauga Board of Trade is piloting an innovative approach to retrofitting existing built up areas with green infrastructure. In partnership with 13 small and medium sized businesses whose properties drain into Rattray Marsh, the Drainage Act, a very old piece of legislation traditionally used in agricultural areas, is being applied to facilitate a neighbourhood-wide application of low impact development.



[Economic instruments to facilitate stormwater management on private property](#) (2018). Fortin, F., Gauley, B., Patterson, T. Credit Valley Conservation



[The Drainage Act as a tool to facilitate the implementation of green, low impact drainage infrastructure on private property](#) (2018). Trenouth, B. Credit Valley Conservation.

Case studies:

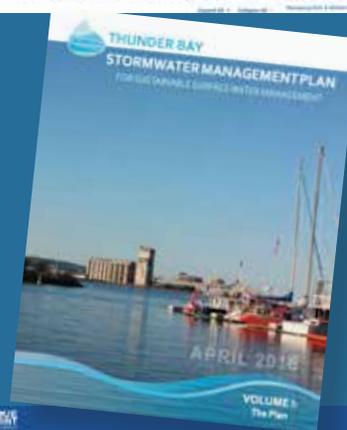
Green Streets

After implementing successful pilot projects, municipalities are now beginning to explore how to institutionalize the inclusion of green infrastructure, when it makes sense, into regular road reconstruction. The City of Toronto has developed [Green Streets Design Guidelines](#), and is in the process of developing an implementation strategy. The City of Ottawa is developing a screening tool to help determine which right of way projects would be most suitable for the inclusion of low impact development, and to narrow down which types should be included (to be completed in 2019).



Thunder Bay

Thunder Bay's 2016 [Stormwater Management plan](#) identified 600 potential sites for green stormwater infrastructure. As of the end of 2018, 30 green infrastructure projects have been built, draining 45 acres through these facilities. A financing study is currently underway to determine how to fill the funding gap for stormwater infrastructure.



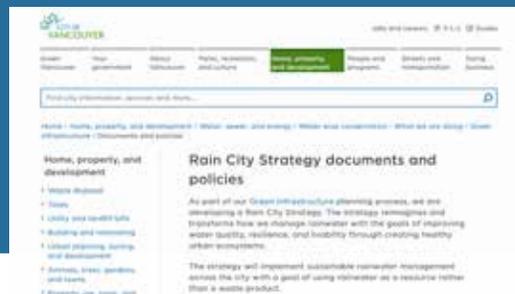
Blueprint Columbus

[Blueprint Columbus](#) in Columbus, Ohio, is an integrated approach to reducing inflow and infiltration into the sanitary system (sewer backups and sewer overflows), without increasing flows to the storm sewer system. The four pillars are lateral lining, downspout disconnection, sump pumps, and green infrastructure. Runoff from downspouts and foundation drains is redirected to streets, which is then managed with green infrastructure in rights of way. Because the benefits of these private property improvements accrue to the public, there is no cost to individual homeowners for these projects.



Vancouver Rain City Strategy

In 2016, Vancouver City Council approved a target to capture and clean 90% of rainfall in the city with green infrastructure. A green infrastructure team was created, and the [Rain City Strategy](#) is currently in development, which will determine how this target will be met.



Additional tools and resources

[Soak it up toolkit! 16 actions your municipality can take to reduce runoff and runoff pollution](#)

(2017). Blakelock, C., Maynes, C. Green Communities Canada

[Resources from Credit Valley Conservation](#)

[Resources from Sustainable Technologies Evaluation Programme](#)



Vision

Infrastructure protects all properties from flooding

Strategies

- Maintain existing infrastructure in good condition.
- Invest in infrastructure improvements to reduce flood risk.
- Plan for a changing climate.
- Build back better, or use flood-prone properties for flood mitigation.
- Build new development to be flood resilient.

Indicators

of communities recovering full costs for asset management of stormwater infrastructure
 % of properties resilient to a 1 in 100 year storm

Reducing flooding in existing built up areas will require major, long term, infrastructure investments. The Municipal Class Environmental Assessment process is designed to analyse problems and evaluate alternative solutions. Every neighbourhood will face different issues and require different solutions.

Some common infrastructure improvements for reducing flood risk are:

- Increasing storm sewer size;
- Separating combined sewers;
- Building above-ground or underground stormwater detention;
- Acquiring land on overland flow routes;
- Daylighting creeks and reclaiming flood plains.

While large scale infrastructure improvements can take years to plan and implement, there are measures that can be taken in the meantime to ensure that existing infrastructure is prepared for large storms. These include preventive maintenance like cleaning catch basins, dredging stormwater ponds, sweeping streets, and checking and repairing culverts.

Inflow and infiltration into the sanitary sewer system can be reduced by replacing manhole covers (as well as with measures on the private side). Installing inlet control devices in stormwater catch basins can also help with overloaded storm sewers in some cases (though they can also contribute to flooding in others).

Municipalities must also consider the impacts of a changing climate in their infrastructure decisions. These investments are designed to last decades, and so must be planned with forethought. Modelling can be used to determine how infrastructure will perform during events even larger than the “design storm”. Many municipalities are adjusting their Intensity-Duration-Frequency curves to account for a changing climate (although by nature the impacts of climate change are uncertain).

In areas where additional detention capacity is needed, parks may be the only public open space with potential. However, parks staff and the public are very sensitive to disruption and changes to parks. There are, however, many examples where these challenges have been successfully navigated, by breaking down silos and engaging with the public.





Some communities are also beginning to bridge the line between public and private property and invest in infrastructure that is located on the private side. This may be the only option in some areas, or it may be a more efficient option. Municipalities tend to be wary of this approach, fearing that infrastructure will not be preserved as built or that there will be issues with access for maintenance. See Southdown Grid Aggregation Project (page 17) for an example of how this is being done in one pilot neighbourhood in Mississauga.

Building new development to be resilient to flooding is much easier than addressing urban flooding in older neighbourhoods. Green infrastructure can be planned from the beginning (rather than retrofitted), and grey infrastructure is designed and built to modern standards. Private side flood risk reduction measures are also included in the Ontario Building Code, although this is a minimum standard that is being exceeded by some municipalities ([see Durham Region Climate Resilience Standard for New Houses](#)). There have been some issues identified in some areas with code enforcement, and ensuring that flood risk reduction measures are built and installed as designed. This can be addressed by additional training and collaboration between municipal departments.

It may always be the case that some areas are more prone to flooding than others, and infrastructure improvements will not be able to completely solve the problem. Land use planning and infrastructure designs have changed over the years, and it is not always possible to retroactively fix these problems – or the investment required would not be acceptable to the public. In these cases, the public must be engaged to understand the different options and the trade-offs that will be required. In some cases, the investments to improve infrastructure may not be deemed worth it, and adaptation measures on the private side, or relocation, may be preferable.



Culverts need to be adequately sized to convey water underneath roads.

Case studies: City of Toronto



The City of Toronto has completed environmental assessments for [reducing basement flooding](#) in 32 study areas. While grey infrastructure improvements are the main mechanisms identified for reducing flood risk, the studies still recommend that green infrastructure be used in order to meet water quality goals.

Cooksville Creek flood remediation



A major project in the city of Mississauga to mitigate riverine flooding in the urbanized [Cooksville creek](#) neighbourhood will involve the installation of detention ponds (8 out of 9 of which are underground) in existing parks. This was made possible through coordination and partnership between the stormwater and parks departments within the city.

Markham flood control program



The City of Markham conducted an environmental assessment in West Thornhill to address flooding experienced in storms in 2005 and 2009. The first phase of construction is complete, and consists of increasing pipe size to accommodate 1 in 100 year storms, re-lining sanitary sewers to prevent seepage, replacing manholes and catchbasins (including “super” catch basins) and an end of pipe water quality treatment tank. This is just one part of a larger [flood control program](#) which is funded by a dedicated stormwater fee.



Copenhagen, Denmark

The Copenhagen 2012 [Cloudburst Management Plan](#) is an ambitious, 20 year plan to make the City of Copenhagen resilient to extreme rainfall events. It is a grey-green approach, which acknowledges that flood-control measures should also be effective for smaller rainfall events, and that rain should be absorbed where possible, but there are some areas of the city where existing development makes this unfeasible. “Ideally, pluvial flooding adaptive measures in Copenhagen must combine solutions which make the city more green and blue by draining off rainwater at ground level. Tunnel solutions will be used in those parts of the city where no opportunities exist for drainage solely at ground level.”

Additional tools and resources

[Preventing disaster before it strikes: Developing a Canadian standard for flood-resilient residential communities.](#) (2017). Moudrak, N., Feltmate, B. Intact Centre on Climate Adaptation.

[Durham Region Climate Resilience Standard for New Homes.](#) (2018). Durham Region and the Institute for Catastrophic Loss Reduction.

[Considering climate change in the environmental assessment process.](#) Resource from the former Ministry of Environment and Climate Change.

[Computerized tool for the development of intensity-duration-frequency curves under climate change.](#) Institute for Catastrophic Loss Reduction, University of Western Ontario.



Stormwater ponds provide flood control, but can suffer from lack of maintenance.



Proposed projects

The Ontario Urban Flooding Collaborative is formed around the principle that urban flooding is not a problem that can be solved by any one group or entity. The following projects have been identified in consultation with stakeholders as initiatives that would help communities move towards flood resilience. They are meant to be starting points for discussion and collaboration, and could be implemented in many different ways, with many different partners. Members of the collaborative are working together to implement these and other projects.

1. Map flood risk and communicate it to the public

Create and test tools for communicating city-wide flood risk mapping with the public. Engagement strategies could include:

- Online tools (websites, apps, videos);
- Workshops for information providers, including real estate agents, home inspectors, contractors, insurance representatives etc;
- Site-specific advice for property owners;
- Hands on, do it yourself, flood risk reduction workshops and activities for the public;
- Outreach through neighbourhood associations, business improvement associations, faith communities, schools, and other community-based organizations and at community events.

While strategies and messaging will vary depending on the community, efficiencies can be found by sharing materials and results between communities. The result will be a toolbox of engagement materials and strategies that can be used in other communities.

Indicators

- # of communities with publicly searchable flood risk mapping (urban and riverine)
- # of communities with long term plans for improving urban flood risk
- % of population aware of their urban flood risk

Partners

Municipalities, Conservation Authorities, consulting firms, communication experts, community engagement experts.

2. Train service providers in flood resilience

Develop a training program for tradespeople (landscape professionals, foundation repair specialists, general contractors, plumbers, eavestroughers etc.) to educate them about the principles of flood resilience and holistic water management, and the correct application of flood protection measures. The training will include:

- Overview of different types of flooding;
- Municipal systems and how they contribute to flood risk;
- Private-side factors contributing to flood risk;
- Overview of measures to reduce flood risk;
- Prioritizing flood risk reduction measures;
- Conducting flood risk assessments;
- Details specific to each profession on installing flood protection measures;
- Ensuring maintenance of flood risk reduction measures;
- Minimizing downstream impact.

Municipalities will then be able to use this designation to direct incentive programs, and property owners and insurers can have more trust in the work done by these professionals.

Indicators

- # of properties undergoing flood risk reduction retrofits

Partners

Municipalities, trade associations, colleges, flood risk reduction experts, insurance industry

3. Neighbourhood-based resilience

Support existing community-based organizations (nonprofits, faith groups, neighbourhood and business associations etc.) to prepare for emergencies, including flooding. Activities might include:

- Mapping and communicating existing community resources that can be called on in times of emergency;
- Identifying gaps that need to be filled;
- Communicating preparedness information to the public.

Indicators

- # of people prepared for a flood event (or other emergency)
- # of properties undergoing flood risk reduction retrofits

Partners

Municipalities, faith communities, community and business associations, non-profits

4. Assess green infrastructure barriers and opportunities

Municipalities work to:

- Assess existing green infrastructure conditions and relevant policies;
- Set targets for managing rain where it falls;
- Identify priority areas for green infrastructure;
- Review and address barriers to green infrastructure implementation;
- Identify policies and programs for implementing green infrastructure.

This process could generate a stand-alone green infrastructure strategy, or contribute to the development of existing plans, such as stormwater master plans or watershed plans.

Indicators

- # of communities with long term strategies to invest in green infrastructure

Partners

Municipalities, conservation authorities, green infrastructure experts



5. Retrofit neighbourhoods for flood resilience

Demonstrate the potential for green infrastructure to reduce runoff volumes by retrofitting neighbourhoods at a concentrated scale, on private and public property, to manage 90% of annual runoff close to where it falls. At the same time, encourage and facilitate other flood risk reduction retrofits at the property level, in conjunction with municipal infrastructure improvements. The goal is to create, at the micro scale, neighbourhoods that encompass all the principles of flood resilience – property owners understand flood risk, take action to reduce risk on their own properties, while reducing runoff volumes from their properties. At the same time, the municipality undertakes infrastructure improvements. This project could also be combined with a neighbourhood resilience project to facilitate emergency preparedness.

Indicators

- # of communities with long term strategies to invest in green infrastructure
- % of properties resilient to the 1 in 100 year storm

Partners

Municipalities, conservation authorities, non-profits, community and business associations

6. Educate children about flood risk and preparedness

Create and disseminate content for schools, day camps, and after school programs to educate children about:

- The urban and natural water cycles;
- Traditional stormwater infrastructure and green infrastructure;
- How and why floods occur;
- What people can do to protect themselves from flooding;
- How to prepare in the event of an emergency.

Indicators

- % of the population aware of their urban flood risk
- # of people prepared for a flood event (or other emergency)

Partners

Municipalities, conservation authorities, non-profits (education and environment), school boards

7. Test innovative strategies for promoting flood risk reduction

Test innovative approaches to encourage or require action for flood risk reduction. Strategies might include:

- Improved communications and engagement around existing basement flood protection subsidies;
- Improved program design for incentive programs;
- Contractor engagement and/or incentives, possibly in conjunction with a training program;
- Inclusion and enforcement of flood protection measures in local building codes;
- Flood resilience report cards for buildings, tied with insurance rates or shared at time of sale.

Indicators

- # of properties undergoing flood risk reduction retrofits

Partners

Municipalities, faith communities, community and business associations, non-profits



Moving Forward

Urban flooding is already a reality here in Ontario, across Canada and throughout the world – and without concerted effort, the problem will only get worse. This action strategy is intended to provide guidance to communities looking to increase urban flood resilience on what can and should be done. However, the strategy itself is only a starting point.

Since the first draft of this action strategy was shared, in November 2018, conversations have been ongoing with many different stakeholders about what precisely is needed to address some of the gaps identified, and implement the projects sketched out above. If you would like to get involved in any of the projects identified above, or other collaborative projects that address urban flood resilience in Ontario, [get in touch](#).

Some key themes have emerged from these discussions that cut across the different projects and the different pillars of the strategy.

Improve public understanding. Much more needs to be done to engage the public in understanding the watersheds they live in, and how their homes, and the infrastructure around their homes, fit into these watersheds. This lack of understanding is a key source of underpreparedness. It's not a simple thing to increase this public understanding – merely creating educational materials is not enough (although the information needs to be readily and easily available when people seek it out). We need to be reaching people through many different channels in order to communicate with a broad segment of the population.

Focus on thriving communities. Investments in flood resilience, both at a property level and municipal level, can be a tough sell – extreme rain events may not happen frequently, or for many years. It can be difficult to make the case for urgency. Resilience measures that have benefits during times of non-emergency (most of the time) are easier to justify, because they serve multiple purposes. This applies equally to physical measures to prevent flood damages, as well as projects to increase emergency preparedness and change behaviour.

Instead of focusing only on times of emergency, communities should derive value from investments in resilience at all times.

Benefit from partnerships. When floods occur, blaming and finger pointing are often the first reaction – most often at the municipality. But municipal infrastructure will never be able to protect from all floods. Private property owners need to see themselves as partners in flood protection, together with their local governments. This requires a change in attitude not just on the part of private property owners, but by municipalities, who will need to be open with the public about the state of their municipal infrastructure and what it can and can't accomplish. Water flows across public and private property without regard, and bridging the divide between public municipal infrastructure and private infrastructure provides many opportunities to increase resilience.

Institutionalize resilience. As long as measures to increase resilience are voluntary, they will have limited uptake. We need to design systems that require increases in resilience, at key moments of opportunity – for example, during regularly scheduled municipal construction, during home renovations, and when properties are bought or sold.

Through collaborative efforts, we can make progress on increasing flood resilience in Ontario's cities and towns – and at the same time create vibrant, thriving places to live.