Letter from our Executive Director

Buffalo Niagara RIVERKEEPER is a leading water advocacy not for profit organization dedicated to protecting the quality and quantity of water, while connecting people to water. We do this by implementing and advancing solutions that clean pollution from our waterways, restore fish and wildlife habitat, and enhance public access through greenways and eco-tours. Healthy water is essential to the health and well being of this community. For over twenty years we have developed a world class team of water restoration experts and have made critical progress towards revitalizing parts of the 900,000 acres of our watershed. We have launched a major *Rust to Blue* Initiative that leverages WNY's Blue Economy by restoring the health and integrity of our watershed.

Sewage pollution is the greatest on-going threat to the Great Lakes and our regional waterways. Storm water pollution causes a multitude of water quality problems including bacteria, algae blooms, foul odors, and aesthetic impacts. These issues will be exacerbated by climate change.

Riverkeeper's *Know Your Sewershed Campaign* is an opportunity for homeowners and property owners to take immediate cost efficient action to combat storm water pollution threats. Please join us today by installing a rain barrel, creating a rain garden and/or joining our Citizen Action Team to monitor water quality. If we collectively join forces, we will have safer drinking water, more places to swim and fewer beach closings.

On behalf of our entire team at Riverkeeper, we hope you find this manual informative and that it inspires you to become part of our Region's water quality solution! This project was made possible by support from Freshwater Future through its Climate grant program. We also want to thank the Margaret L. Wendt Foundation, the Joy Family Foundation, the WNY Foundation and the Goodyear Foundation for support for our *Rust to Blue* Green Infrastructure work. For more information, please see our website at bnriverkeeper.org.

Yours for Clean Water,

Jill Jedlicka,
Executive Director
Buffalo Niagara RIVERKEEPER

Table of Contents

Source: Prof. Andrew Davidhazy, RIT

What is the Know Your Sewershed Campaign?

The Know Your Sewershed Campaign is an educational outreach initiative to help people understand how valuable our fresh water resource is. This Campaign focuses on understanding where your storm water drains, the impacts it has on the local environment and how individual property owners can make a positive impact by taking a few actions steps. The goal of this campaign is to present sustainable solutions that can be a tool for you to transform your property to become more sustainable, which will ultimately improve your local environment and quality of life.

With more intense and more frequent storm events expected to occur due to climate change, it is important to understand the impacts these storms will have on our communities and our local environment.

"Pollution conveyed by stormwater degrades the quality of drinking water, damages fisheries and habitat of plants and animals that depend on clean water for survival". - US Environmental Protection Agency

Water is the source of life and it is also the most valuable resource on the planet. The Know Your Sewershed Campaign is a tool designed both to help you understand the impacts of stormwater and, to provide you with the education that will enable you to lead and live by example.

Source: www.klemencov.com

FRESHWATER™ FUTURE

BUFFALO NIAGARA RIVERKEEPER®

How does land development affect our water cycle?

Natural water cycle vs. water cycle in developed land:

The water cycle is the constant movement of water above, on, and below the earth's surface. It is an important cycle that replenishes ground water supply, which helps to maintain levels in our lakes and rivers. It begins as water evaporates into the atmosphere from vegetation, soil, lakes, rivers, snowfields and oceans- a process called evapotranspiration. (See appendix 'F': Glossary)

As water vapor rises it condenses to form clouds that return water to the land through precipitation: rain, snow, or hail. Precipitation falls on the earth, where it both flows across the surface and is absorbed into the ground. Ultimately, due to topography, water that flows across the surface typically makes its way into water bodies nearby. When water is absorbed into the soil, it is called infiltration, and it causes ground water recharge to occur.

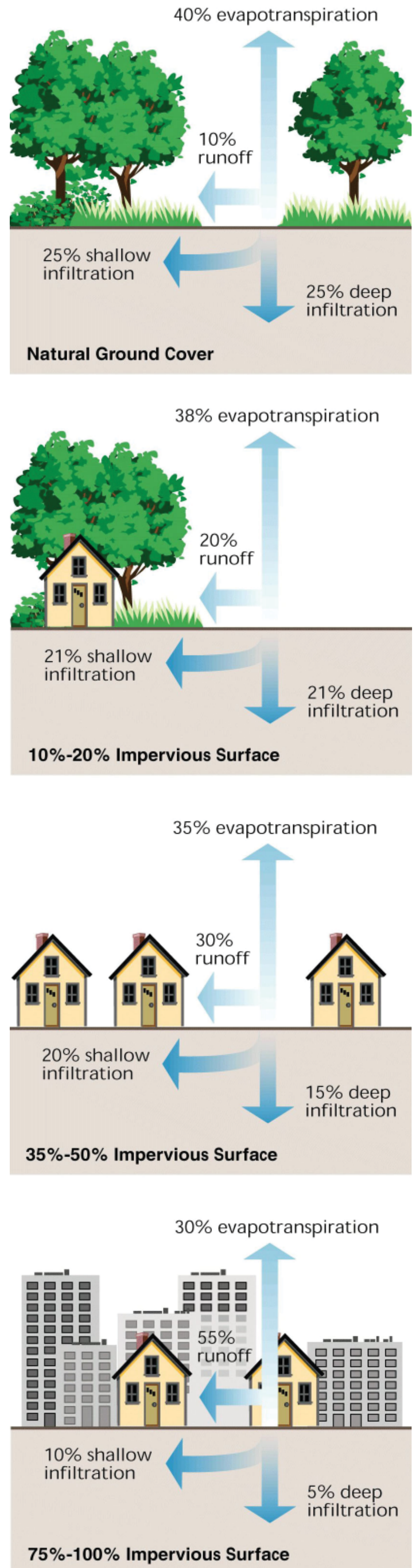
As we develop our land, we increase impervious surfaces, altering the natural water cycle.

When wet weather events, such as rain fall or snow melt occur in undeveloped settings, most water infiltrates into the ground. As land is developed, impervious cover increases, causing stormwater to flow rapidly over the land and into our sewer systems.

During extreme rain fall and/or snow melt, wastewater treatment plants typically cannot handle the high volume of stormwater, causing overflow events to occur. This causes untreated water to flow directly into our water bodies resulting in flooding, erosion, and pollution. (See appendix 'B': Combined Sewer System, for more detailed explanation of this process)

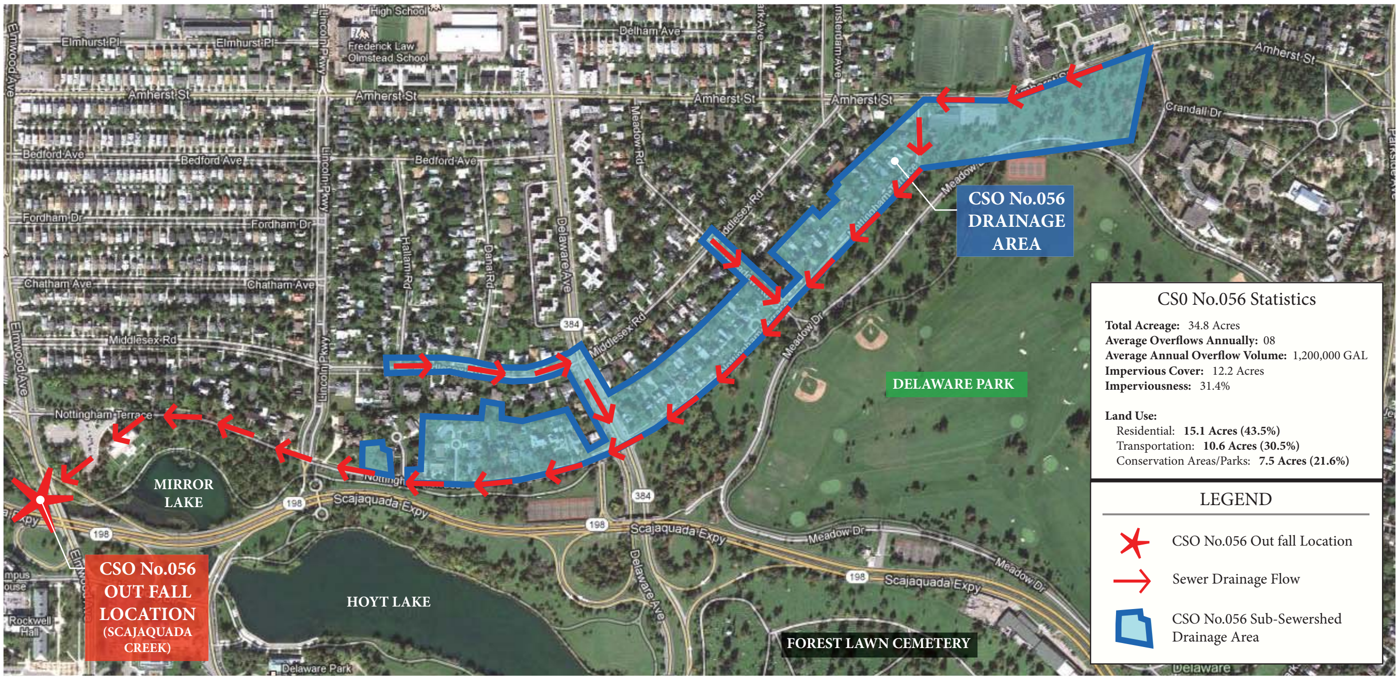
Stormwater can contain pollutants such as sediments, bacteria, fertilizers, nitrogen, phosphorous and other chemicals that can threaten aquatic health and contribute to the loss of water dependant recreational activities.

According to the EPA, untreated stormwater is the leading cause of water pollution today.



Source: US Environmental Protection Agency

Where does my stormwater go?



Source: Buffalo Niagara Riverkeeper

A sewershed is a drainage area from which all stormwater and sanitary waste is collected. There are various types of conveyance systems, the two most common being combined sewer systems and separated storm and sewer systems, each of which are further explained in Appendix 'B'. Both of these systems have outfall pipes that discharge into nearby water bodies.

The City of Buffalo, like many other older communities, relies upon a combined sewer system that uses the same network of pipes to convey both stormwater and sanitary sewage to a waste water treatment facility. When an intense storm event occurs, the sewer system is overwhelmed. This results in a portion of the combined storm and sanitary water bypassing the treatment facility and discharging into local water bodies. It is important to note that these systems were designed this way in order to prevent sewage back-ups into homes and businesses.

Combined sewer overflows (CSO) are important to locate because they often discharge highly-polluted runoff that can be dangerous for human contact. Raw sewage and other pollutants such as animal waste, litter, motor oil, yard clippings, fertilizers and pesticides also drain into the local waterways, harming the environment.

Every overflow pipe is associated with a specific discreet drainage area. CSO No.056, shown on the map above, discharges into Scajaquada Creek, just downstream from Hoyt Lake. Scajaquada Creek is a major source of pollution for the Black Rock Canal, the Niagara River, and Lake Ontario. So controlling discharges into Scjaquada Creek can have positive benefits for the entire watershed.

Image below: CSO No.056 outfall location in Scajaquada Creek.

Source: Buffalo Niagara Riverkeeper

How will climate change affect precipitation in the Great Lakes region?

Climate change is a significant and lasting change in weather patterns. While climate change happens as a result of natural phenomena and processes, it is also affected by human impacts. While the most significant causes of climate change can be debated, there is no denying that climate change is occurring, and will continue to occur.

Scientists use computer-generated models, based on math and physics, to attempt to predict future impacts of climate change. Some components are more-easily understood than others, but regardless, it is imperative to consider the effects climate change will have on our environments and our everyday lives.

In their recent publication, "Improve Your Project's Success: Consider Climate Change and Adaptation", Freshwater Future and EcoAdapt share a table summarizing Great Lakes climate variability trends. The table identifies twelve different climate factors, a projected trend of those factors, and the certainty of those projections. Nearly all of the factors and their purported trends have impacts on water quality and/or to how people interact with the water.

Three components related to stormwater and drainage: rainfall, extreme rains, and runoff are expected to increase. Coupled with antiquated drainage systems, an increase in any of these factors could have detrimental effects on water quality and public health. An increase in rainfall, extreme rainfall events, and runoff will result in an increase of CSO events. In addition, as air and lake temperatures are expected to rise, an increase in warm runoff entering our natural water bodies has a significant probability of lowering, or eliminating, dissolved oxygen in the water, which could result in compromised aquatic habitat and ecological health.

While we may not be able to completely reverse or undo climate change, it is important to understand its projected effects, and make changes to our lifestyles and approaches to our natural systems, to adapt to and be prepared for it. By understanding our sewersheds, and how we can reduce and alleviate our contributions to our drainage systems, we will be better prepared for climate change and a step closer to protecting our water.

Source: www.wgrz.com/weather

Precipitation trends are increasing:

- Summers getting drier, winters and springs are getting wetter;
- Rainfall likely to be more intense
- The southeastern Great Lakes region may see overall decrease in precipitation;
- Changes in lake-effect snow are not well predicted.

Ecosystems and habitats will be impacted:

- Greater risk of both flood and drought;
- Altered runoff patterns;
- Increase risk of invasive species establishment;
- Fire risk may increase due to drier weather.

The economy, infrastructure and human health will also experience some change:

- Increase in sewer overflow events, releasing more untreated sewer into lakes and rivers;
- Increased damage to infrastructure from extreme weather events.
- Greater conflict over water use and management;

Learn more about climate change at: www.freshwaterfuture.org

Source: www.wildflower.org/plants

Source: cityofportland.gov

Source: University of New Hampshire

What is green stormwater infrastructure and how is it part of the solution?

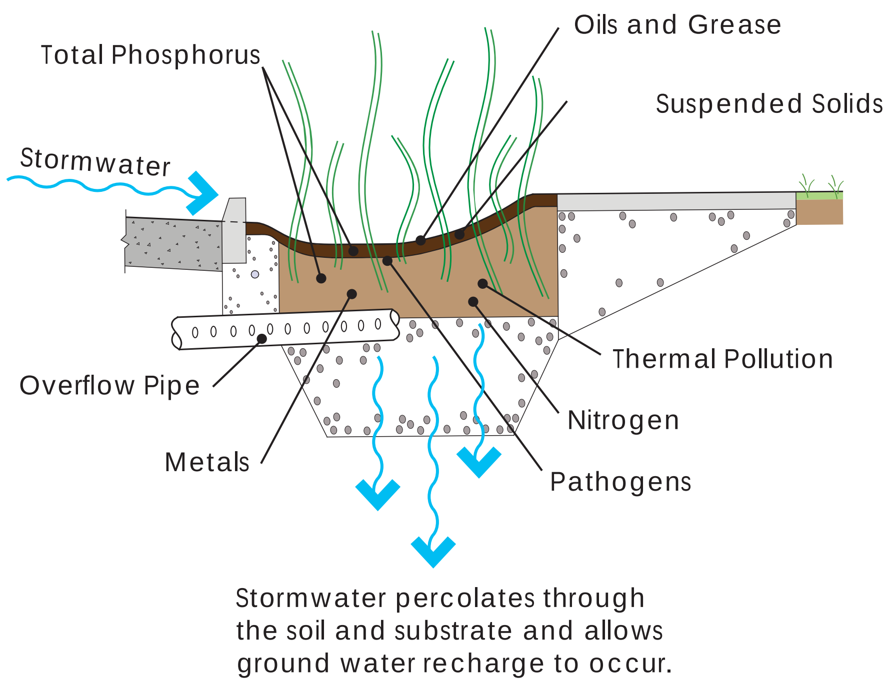
Green Stormwater Infrastructure and Best Management Practices (BMP's):

The term 'green stormwater infrastructure' includes a wide variety of practices, at multiple scales, used to: manage and treat stormwater; maintain and restore natural hydrology and ecological function by infiltration and evapotranspiration; and capture/harvest and reuse of stormwater. These practices, when designed correctly, can be considered a Best Manage Practice, also known as, 'BMP'.

Rain gardens (referred to technically as Bio-remediation), uses plants and soil medias to trap and uptake pollutants. It is a component of green stormwater infrastructure not offered by conventional piping systems that plays a major role in helping filter and clean stormwater before it leaves a site. The graphic below shows locations within the rain garden space where several toxins are absorbed, captured and removed from stormwater.

Implementation of green stormwater infrastructure and BMPs will contribute to reducing the amount of stormwater entering the existing sewer system and to water quality improvements.

Rain Garden Benefits:



Source: Buffalo Niagara Riverkeeper

How can I reduce my impact on the sewer system and help my local environment?

Source: www.greeninfrastructurefoundation.org

There are many ways to make your property more sustainable. Every drop counts and you can do simple things that will make a big impact. First, it is important to understand your sewer system and how you can reduce your stormwater footprint. Below is a list that will help guide you to determine how you can be part of the solution:

1. Understand your sewer system. Do you have a Combined Sewer System or a Separated Sewer System? (See appendix ‘C’)

2. Understand your impact on your sewer system and your local environment. You can calculate the impervious cover of your property to better understand your current impact. (See page No.09)

3. Understand what green alternatives are and what types are most suitable for you and your lifestyle. Here are some green alternatives that may work for you:

   - **Downspout disconnection;**
   - **Rain water harvesting (rain barrels and cisterns);**
   - **Replacing impervious surfaces (concrete and asphalt) with permeable pavers or porous asphalt;**
   - **Naturalization of your property (install more landscaped areas on your property and let plants help absorb your stormwater runoff);**
   - **Installing rain gardens and bio-swales;**
   - **Elimination or reduce the use of fertilizers or pesticides.**

4. Once you identify which green alternatives you are interested in, you can calculate your potential impact with a green reduction calculator. The calculator will help you understand how much stormwater you can relieve from your sewershed. (See page No.10)

5. Next, implement your green practices to improve your stormwater impact and lead by example, showing your environmental stewardship!

6. Spread the word, get your neighbors to participate, creating even more change and a bigger impact!

Source: Buffalo Niagara Riverkeeper

Source: www.wildflower.org/plants

Lead by example and live more sustainably. Remember, every drop counts!

How much stormwater is my property generating?

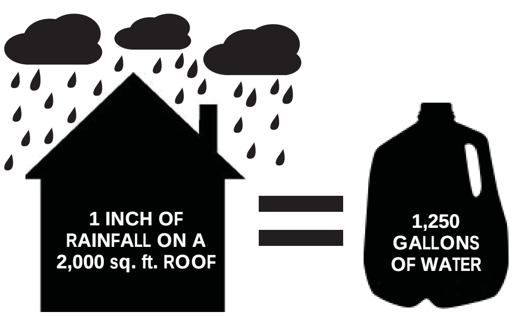
To figure out how much stormwater your property is contributing to the sewer system, use the step-by-step guide below. To begin, calculate your property's impervious surface. **Impervious surfaces are any surface In the landscape that cannot effectively absorb or infiltrate rainfall or snowmelt.** This includes rooftops and traditional driveways, roads, parking lots, and sidewalks: If you decrease your impervious surfaces and increase your natural systems, you can reduce your stormwater footprint.

Stormwater Generator Calculator:

Step 1: Using formulas **A, B and C below,** calculate your property's impervious surfaces. Add **A, B and C** to determine your total impervious surface (square footage). (Total square feet = ___________)

Step 2: Convert (multiply) total square footage to square inches, using the formula:
(Total square feet **X** 144 = ___________ square inches)

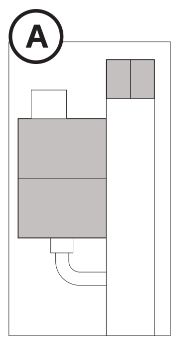
Step 3: Convert (multiply) cubic inches to gallons, using the formula:
(Cubic inches **X** .004329 = ___________ Gallons)



DID YOU KNOW?

Source: Buffalo Niagara Riverkeeper

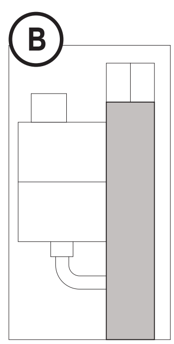
****In the City of Buffalo, overflow events typically occur during wet weather events measuring 1-inch of precipitation or greater.***



ROOFTOPS

Calculate the square footage of your roof.
Use the formula:
Length of roof x Width of roof.

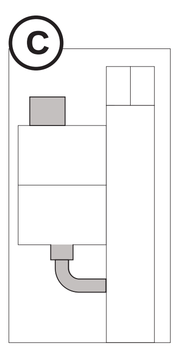
L x W = ________________ **square feet**



DRIVEWAY

Calculate the square footage of your driveway. Use the formula:
Length x Width.

L x W = ________________ **square feet**



OTHER IMPERVIOUS COVER

Calculate the square footage of other impervious surfaces, you might have more than one (your patios, decks, walkways, and pools). Use the formula: Length x Width.

L x W = ________________ **square feet**

How much stormwater can I eliminate by using green stormwater practices?

By using green stormwater practices, you can be part of a solution that mimics the natural process and has multiple environmental benefits.

Unlike single-purpose 'grey' stormwater infrastructure, which uses pipes to dispose of rainwater, green infrastructure uses rain water harvesting, vegetation and soil to manage stormwater. **Green infrastructure is an effective and cost-efficient solution that makes a positive impact.** Use the step-by-step guide below to help you calculate the impact you have by implementing green infrastructure alternatives.

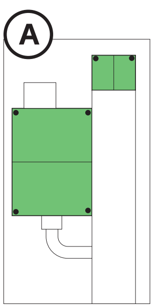
Green Infrastructure Calculator:

Step 1: Using **A, B and C** below, calculate the square footage of the impervious surfaces that you could modify to reduce stormwater from entering the sewer system.

Step 2: By implementing green stormwater infrastructure I can reduce ___________ square footage of impervious surfaces.

Step 3: Subtract the square footage identified above (Step 2) from square footage on Page No.09, Step 1. (Page No.09, Step 1 square footage – Page No.10 Step 2 square footage = ___________ square footage of impervious surface)

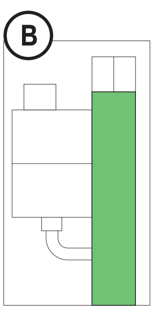
Step 4: Using the same method described in Steps 2 through Steps 4 on Page No.9, convert (multiply) square footage in Step 3, above into Gallons. Use formula:
(Cubic inches **X** .004329 = ___________ Gallons)



DOWNSPOUTS

Locate your roof downspouts and see if they are connected to the sewer system. If they are, you can disconnect them and use the roof calculations as your reduction.

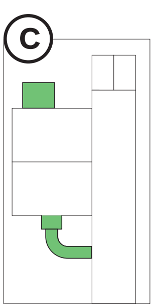
L x W = _______________ square feet



DRIVWAYS

Permeable pavements are an option to allow infiltration of stormwater back into the groundwater table.

L x W = _______________ square feet



OTHER PAVED SURFACES

Look to see how the patios and sidewalk drains. Natural infiltration systems such as rain gardens or bio-swales might be suitable to capture runoff. Permeable pavers are another option as they will infiltrate stormwater back into the ground.

L x W = _______________ square feet

By implementing green stormwater infrastructure, I can reduce my property's stormwater contribution by _______________ Gallons. (Insert step 4)

Naturalize your site!

Your GREEN REMODEL will help your local environment and you can lead by example. With careful planning, you can create a home that combines beauty, efficiency, and convenience with sustainability and conservation.

Implementation of a GREEN REMODEL includes installing permeable paving, rain gardens, green roofs, rain water harvesting and more.

Green stormwater infrastructure can be an effective tool for adapting to climate change, creating healthy built environments, and improving quality of life.

How can I be part of the solution?

One easy way to make a big difference is to disconnect your downspouts from your sewer system. Here are some facts:

- Rooftops contribute to thousands of gallons of water during each rain event, are typically connected directly into the sewer system.

- Disconnecting your downspouts will give you the opportunity to harvest the stormwater, if you choose to using a rain barrel or cistern. Your harvested rain water can be used for many purposes such as, washing your car or irrigating your gardens. Rain gardens can also accept any overflows from the rain barrels or cisterns which will keep the stormwater away from your house foundation.

- rather than install a rain barrel, your downspouts are disconnected, you can redirect your stormwater runoff into a rain garden and your landscape will function as a sustainable system to manage your stormwater and help keep it out of the sewer system with out having to manage or maintain a rain barrel.

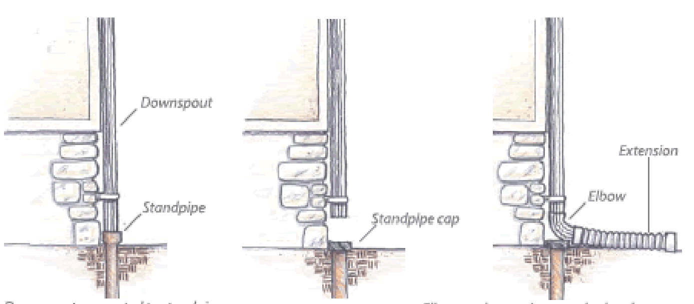
- It is an easy way to make a positive impact on your local environment and lead by example to showcase environmental stewardship.

- **Getting a rain barrel is easy, call Buffalo Niagara Riverkeeper at (716)852-7483. You can learn more about rain barrels by visiting: www.bnriverkeeper.org**

Rain barrel for stormwater harvesting:

Source: https://bnriverkeeper.org

Downspout Disconnection:

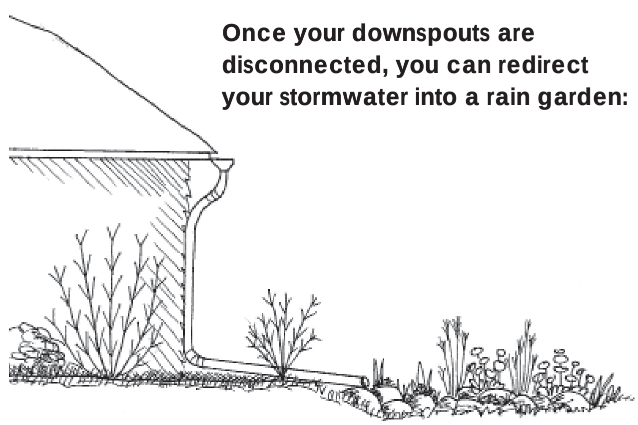


Downspout connected to standpipe.

Elbow and extension attached to downspout.

Source: http://marc.org/environment/Water/downspout.htm

Once your downspouts are disconnected, you can redirect your stormwater into a rain garden:



Source: Buffalo Niagara Riverkeeper

Source: www.allvoices.com

Source: https://onlyraindownthedrain.com

Call To Action: Five Things You Can Do

FIVE THINGS YOU CAN DO!

- **Stop, reduce and slow down the stormwater runoff** from your property by implementing any of the green stormwater infrastructure solutions identified in this publication.
- **Naturalize your property** with gardens, lawns, trees, and porous pavements to help reduce your stormwater runoff.
- **Go toxic free** on your property. Limit or stop the use of fertilizers and pesticides.
- **Use less piped water** and be more cautious of the amount of water used for washing your car, taking showers, landscape irrigation etc.
- **Get involved** in your local environmental organizations. Buffalo Niagara Riverkeeper is a science-based, community focused, advocacy organization in Western New York dedicated to protecting and restoring the quality and quantity of our most valuable natural asset, our fresh water. (See page No.13 to learn how you can get involved in Buffalo Niagara Riverkeeper)

BUFFALO NIAGARA RIVERKEEPER®

Other ways to engage in region wide healthy water activities !

Spring & Fall Shoreline Cleanup

Join Buffalo Niagara RIVERKEEPER every Spring and Fall for its annual shoreline sweeps. Thousands of volunteers remove tons of trash from Buffalo Niagara's shorelines to help protect and improve water quality.

bnriverkeeper.org/get-involved/cleanups

River Paddling & Cycling Tours

Learn about history, culture, and wildlife, or listen to music while experiencing the beauty of our local waterways. Riverkeeper offers a variety of River Tours throughout the summer. Join us for a paddle or cycling tour and enjoy newly revised waterfronts of WNY!

bnriverkeeper.org/get-involved/rivertours

Plant for Nature

Look no farther than your own backyard or neighborhood! Planting native trees and plant species on your property contributes to a healthy watershed. Join or organize a local community group for a planting event in your neighborhood. Please contact Buffalo Niagara Riverkeeper if you would like a copy of our native plant guide.

For more information about how to get involved visit:

bnriverkeeper.org/get-involved

Appendix Table of Contents

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Appendix A: Clean Water Act and background information

The Environmental Protection Agency Proposed National Rule-making to Strengthen Stormwater Programs:
The Environmental Protection Agency has initiated national rule-making to establish a comprehensive program to reduce stormwater discharges from new development and redevelopment, while also making other improvements to strengthen its stormwater programs.

Source: Don Bousquet

The Green Infrastructure for Clean Water Act:
Stormwater runoff is a serious threat to the nation's waterways and public health. It is costing Americans hundreds of millions of dollars each year in pollution cleanup and increased treatment costs. Fortunately, the U.S. Congress is beginning to recognize that green stormwater infrastructure provides an effective, cost-efficient and environmentally sound approach to reducing stormwater and combined sewer overflow pollution.

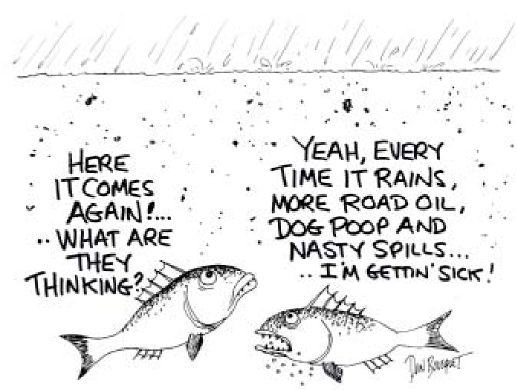
With the introduction of H.R. 2030/S. 1115, the Green Infrastructure for Clean Water Act, Congress would encourage states and municipalities to utilize green stormwater infrastructure techniques to address water quality and quantity and stormwater management issues.

Source: Don Bousquet

Background Information:
In 2006, EPA requested the National Research Council (NRC) to conduct a review of its stormwater program. In October 2008, The NRC released its report, Urban Stormwater Management in the United States (The National Academies Press, 2009) finding, among other things such as:

"The rapid conversion of land to urban and suburban areas has profoundly altered how water flows during and following storm events, putting higher volumes of water and more pollutants into the nation's rivers, lakes and estuaries. These changes have degraded water quality and habitat in virtually every urban stream."

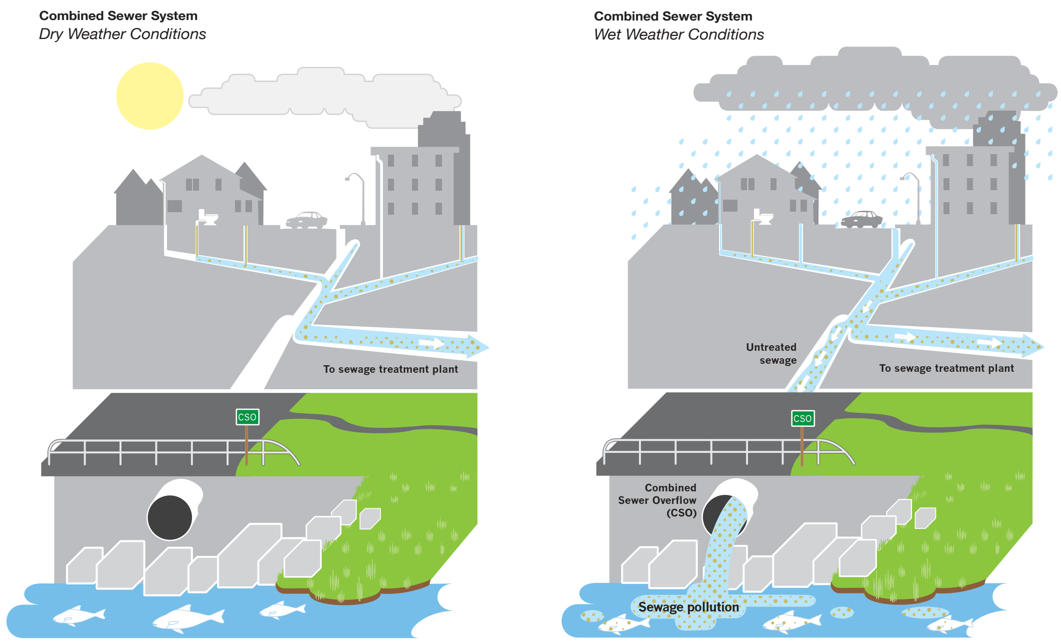
The report recommends a number of actions, including conserving natural areas, reducing hard surface cover (roads, parking lots, roof tops and other impervious surfaces), and retrofitting urban areas with features that hold and treat stormwater.



Source: Don Bousquet

Because of the strong need to reduce impervious surfaces in many communities, the EPA announced that during this rule-making process, it will examine, analyze and evaluate sustainable green stormwater infrastructure design techniques that mimic natural water processes that infiltrate and recharge, evapotranspire and/or harvest and reuse precipitation.
(www.asla.org/federalgovernmentaffairs)

Appendix B: Combined Sewer System



Source: Illustration by Joel Brenden

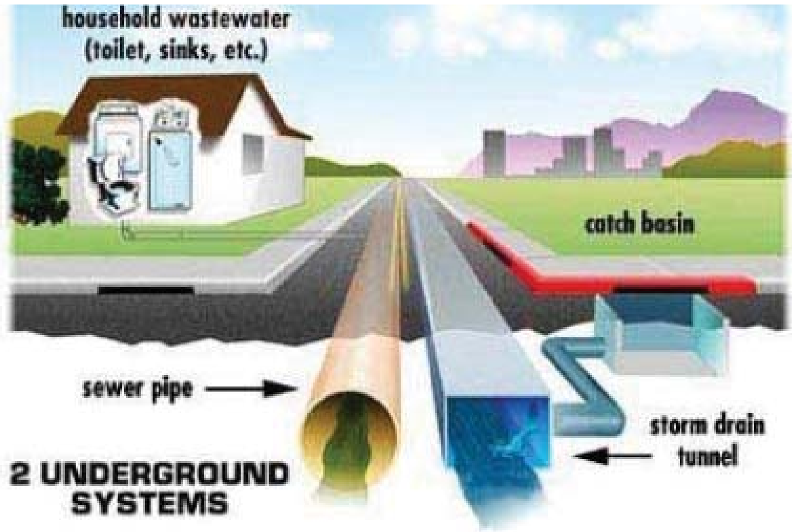
Combined Sewer Systems (CSO) are conveyance systems that are designed to collect stormwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a water body.

However, during periods of heavy rainfall or snowmelt, the total water volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to occasionally overflow and discharge excess untreated water directly into nearby streams, rivers, or other water bodies in order to prevent basement back-ups and flooding. This is commonly referred to as a combined sewer overflow event.

Combined sewer systems contribute to water quality issues when they overflow, harming local waterways. Types of pollutants that can empty into the local water bodies from combined sewer system overflow events are:

- **Untreated human waste, which can host E.coli and Botulism (Type C) bacteria;**
- **Industrial waste;**
- **Litter and trash;**
- **Sediment and debris;**
- **Toxic pollutants (fertilizers and pesticides).**

Appendix B: Municipal Sewer Separated Storm System



Source: EPA, stormwater

Municipal Sewer Separated Systems (MS4) are those that are designed to keep stormwater and sanitry sewer systems separated, with two separate piping systems (shown above).
It is common for newer cities and suburban areas to have a MS4 system. To find out which sewer system you have, see Appendix 'C'.

MS4 systems work well to keep polluted stormwater runoff separate from sanitary waste water. The sanitary waste water is transported to the waste water treatment plant, while the polluted stormwater is emptied into local waterways without any treatment of the potential pollutants it collects along the way.

These separated systems are commonly known to contribute to water quality issues and often harm the waterways. Pollutants that can empty into the local waterways from MS4 communities include:

- **Litter and trash;**
- **Sediment;**
- **Higher water temperature;**
- **Toxic pollutants (fertilizers and pesticides);**
- **Animal waste;**
- **Automobile toxins (motor oil, break dust and fluids).**

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Appendix C: Sewer system types by community in the Buffalo and Niagara River watershed

Erie County:

City of Buffalo (CSO)
City of Lackawanna (MS4)
City of Tonawanda (MS4)
Town of Alden (MS4)
Town of Amherst (MS4)
Town of Aurora (MS4)
Town of Boston (MS4)
Town of Brant (MS4)
Town of Cheektowaga (MS4)
Town of Clarence (MS4)
Town of Colden (MS4)
Town of Collins (MS4)
Town of Concord (MS4)
Town of Eden (MS4)
Town of Elma (MS4)
Town of Evans (MS4)
Town of Grand Island (MS4)
Town of Hamburg (MS4)
Town of Holland (MS4)
Town of Lancaster (MS4)
Town of Marilla (MS4)
Town of Newstead (MS4)
Town of North Collins (MS4)
Town of Orchard Park (MS4)
Town of Sardinia (MS4)
Town of Tonawanda (MS4)
Town of Wales (MS4)
Town of West Seneca (MS4)
Village of Akron (MS4)
Village of Alden (MS4)
Village of Angola (MS4)
Village of Blasdell (MS4)
Village of Depew (MS4)
Village of East Aurora (MS4)
Village of Gowanda (MS4)
Village of Hamburg (MS4)
Village of Kenmore (MS4)
Village of Lancaster (MS4)
Village of North Collins (MS4)
Village of Orchard Park (MS4)
Village of Sloan (MS4)
Village of Springville (MS4)
Village of Williamsville (MS4)

Genesee County:

City of Batavia (MS4)
Town of Alabama (MS4)
Town of Alexander (MS4)
Town of Batavia (MS4)
Town of Bethany (MS4)
Town of Darien (MS4)
Town of Pembroke (MS4)
Town of Stafford (MS4)
Village of Alexander (MS4)
Village of Corfu (MS4)

Niagara County:

City of Lockport (CSO/MS4)
City of Niagara Falls (CSO/MS4)
City of North Tonawanda (MS4)
Town of Cambria (MS4)
Town of Lewiston (MS4)
Town of Lockport (MS4)
Town of Niagara (MS4)
Town of Pendleton (MS4)
Town of Porter (MS4)
Town of Royalton (MS4)
Town of Wheatfield (MS4)
Village of Youngstown (MS4)

Wyoming County:

Town of Arcade (MS4)
Town of Attica (MS4)
Town of Bennington (MS4)
Town of Java (MS4)
Town of Middlebury (MS4)
Town of Orangeville (MS4)
Town of Sheldon (MS4)
Town of Warsaw (MS4)
Town of Wethersfield (MS4)
Village of Attica (MS4)

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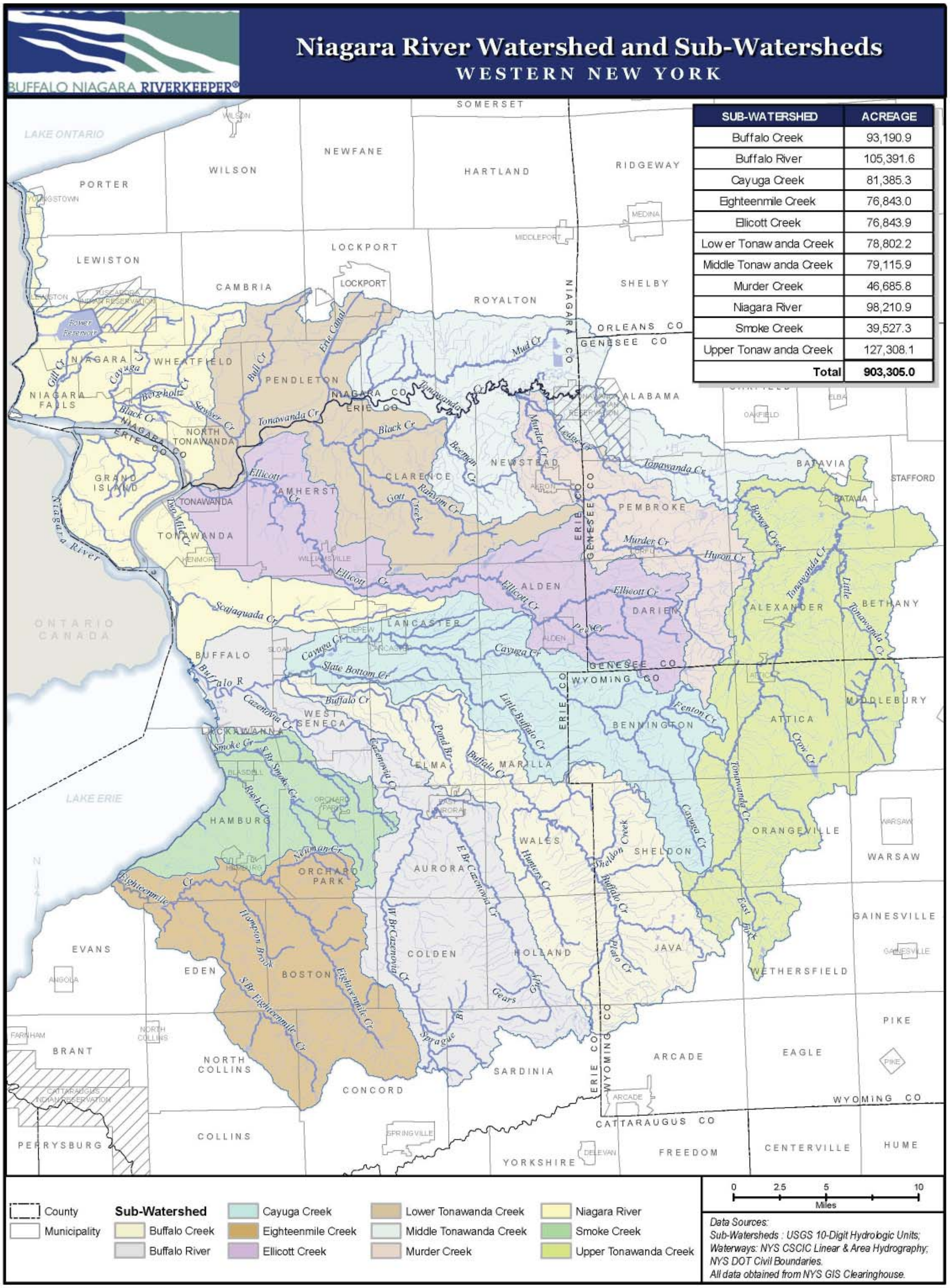
Appendix D: Buffalo and Niagara River watershed map



Prepared by Lisa Matthies-Wiza, Sept 2010.

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Appendix E: Case studies

Other cities are implementing green stormwater practices to help manage their sewer overflow problem. These practices will reduce the amount of stormwater entering the combined systems, and also serve to clean stormwater and reduce pollutants entering our local environments. Some progressive cities are already combining green stormwater infrastructure with transportation, public safety projects and public art.

Toronto has incorporated public art into some of their green stormwater infrastructure projects, such as in example one below. Aside from being aesthetically pleasing, the art work functions with the stormwater feature to circulate and aerate the water. Chicago is a good example of a city looking to implement progressive techniques to reduce their stormwater footprint. In addition to their Green Ally program, they have installed a green roof on their City Hall. Portland, Oregon is another good example of how these design practices can be combined. Using “bump-outs”, Portland is shortening pedestrian crosswalks while simultaneously implementing green stormwater practices, see number three. Finally, the City of Buffalo has recently implemented some green street pilot projects in an effort to better understand how green stormwater infrastructure will function in our local climate.

1 Public Art and Waterfront Design
Toronto, Ontario (Canada)

2 Green Roof (City Hall)
Chicago, Illinois

3 Green Streets
Portland, Oregon

4 Bio-remediation
Buffalo, New York

Source: City of Toronto

Source: City of Chicago

Source: cityofportland.gov

Source: Buffalo Niagara Riverkeeper

① Case Study: Toronto, Canada

According to the City of Toronto's Planning and Environment department, Toronto's City Council adopted the Wet Weather Flow Master Plan (WWFMP) and a 25-year implementation plan in 2003. The goal of the WWFMP is to reduce, and ultimately eliminate, impacts of wet weather events. The goal of this document is to protect their environment, and improve the ecological health of the watersheds.

Source: City of Toronto

The plan was developed with the recognition that wet weather events will be managed on a watershed basis. Also, stormwater will need to be managed at the property or site for the first 1-inch of storm event.

Green infrastructure can also support the urban planning process by offering creative ways to blend planning and design with public art and innovative and attractive projects. Toronto's waterfront is a great example of how international collaboration can be a stage for such innovative designs. Toronto is a cold weather climate city that can lead by example in sustainable design solutions.

Source: City of Toronto

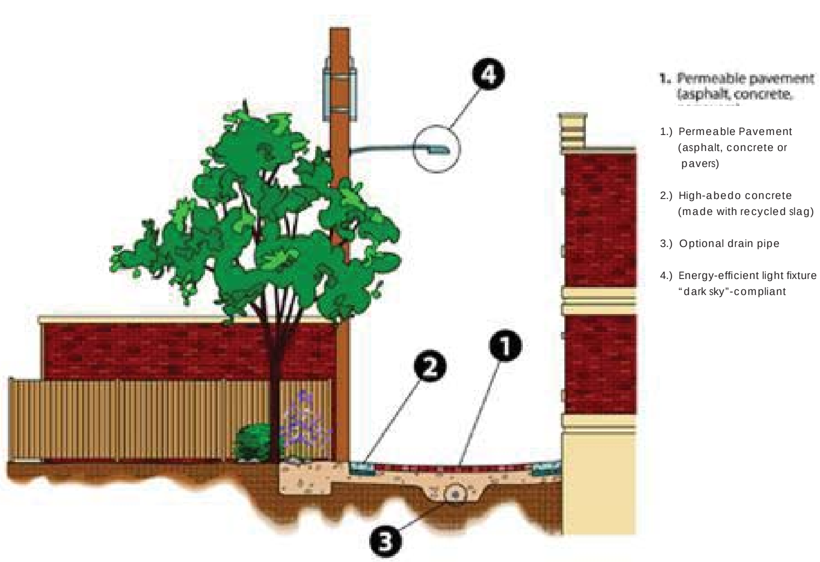
The City of Toronto has also produced a plan called, "Design Guidelines for 'Greening' Surface Parking Lots". This document provides specific strategies and measures which developers and designers of surface parking lots use to meet environmental performance targets of the Toronto Green Development Standard.

The Guidelines are designed to deal with common urban design and environmental challenges, especially regarding surface parking lots. **'Greening' surface parking lots to improve water quality can include these approaches:**

- **Planting trees;**
- **Providing good quality soil and generous landscaped areas;**
- **Enhancing pedestrian and cycling infrastructure;**
- **Managing stormwater on-site;**
- **Reducing the urban heat island effect; and using sustainable materials and technologies.**

② Case Study: Chicago, Illinois

http//cityofchicago.org/dam/city/depts/cdot/green_alley_handbook_2010.pdf



http//cityofchicago.org/dam/city/depts/cdot/green_alley_handbook_2010.pdf

Chicago's Green Alley program is one of many environmentally friendly initiatives put forth by Chicago Department of Transportation (CDOT). Green alleys incorporate a variety of best management practices:

- Permeable pavements (asphalt, concrete or pavers) that allow stormwater to filter through the pavement and drain into the ground, instead of collecting on hard surfaces or draining into the sewer system. The pavement can be used on the full width of an alley, or simply in a center trench.
- Open bottom catch basins--installed in alleys to capture water and funnel it into the ground
- High-albedo pavement, a lighter-colored surface that reflects sunlight instead of absorbing it, helping reduce the urban heat island effect
- Recycled materials, such as concrete aggregate, slag and recycled tire rubber

The Green Alley program began as a pilot in 2006, and through 2010, more than 100 Green Alleys have been installed. **To learn more about Chicago's Green Alley program, please visit:**

www.cityofchicago.org/city/en/depts/cdot/provdrs/street/svcs/green_alleys.html

③ Case Study: Portland, Oregon

Source: cityofportland.gov

Source: cityofportland.gov

Portland, Oregon is a great example of a city that has embraced green infrastructure, and is considered one of the leaders of implementing sustainable design in the United States of America.

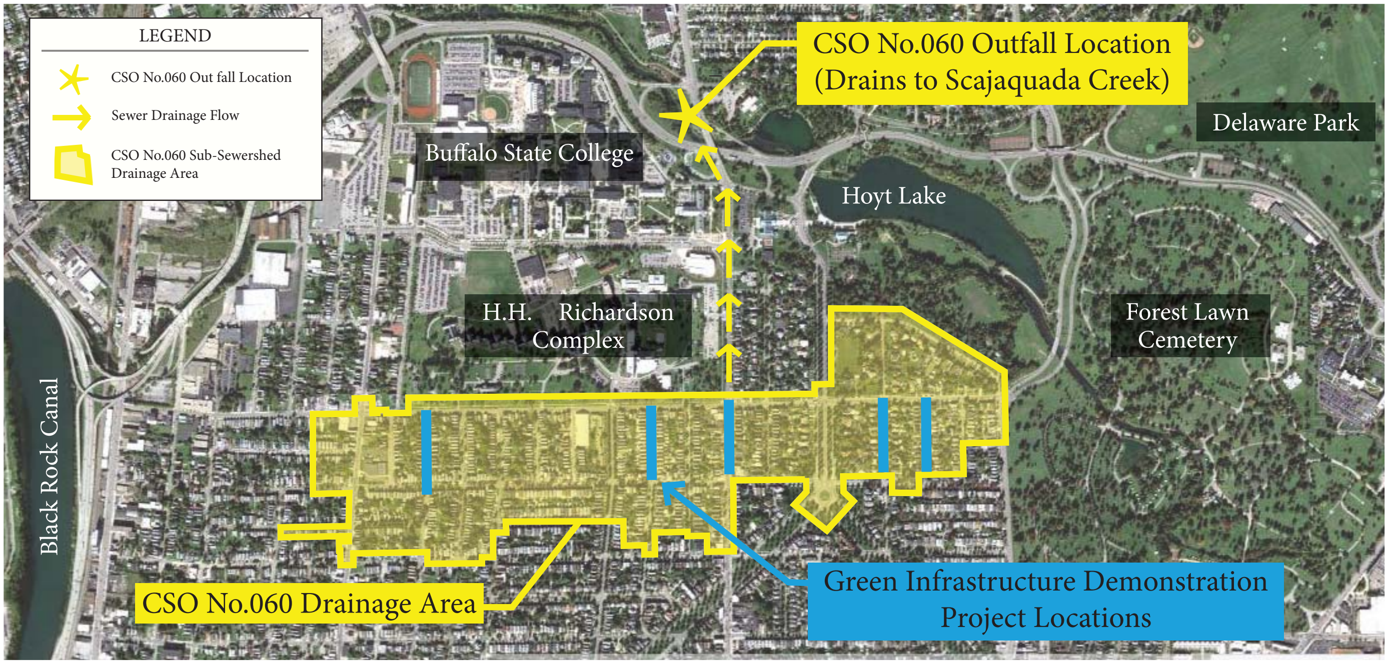
The City is using green stormwater infrastructure for stormwater management as an alternative to conventional grey infrastructure which is traditional drain and pipes. The City is reducing the amount of stormwater that enters into their combined system by mandating the disconnect of roof drains and requiring new developments to include green infrastructure installations.

Green stormwater infrastructure can also play a role in making streets safer. Roadway intersections can be safer when there is a 'bump-out' installed, which shortens the crosswalk distance for pedestrians (see the image above). A 'bump-out' design allows for stormwater to flow into a bio-remediation planter where it can treat and infiltrate stormwater runoff, an example of a multi benefit design.

The image on the left is a good example of creating new bio-swales (rain gardens) that allow stormwater to flow into designated spaces, rather than directly into the combined system. These vegetated areas not only help reduce the amount of overflow events each year, but they also provide a beautiful aesthetic component that can raise property value.

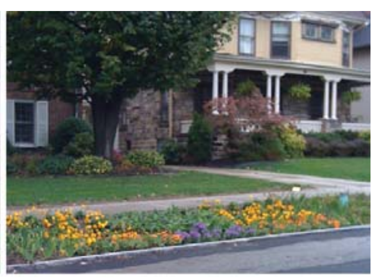
Portland is a prime example of how a municipality can utilize sustainable design, including green stormwater infrastructure to improve the quality of life of the people and the local environment. (www.portlandoregon.gov/bes/31892)

④ Case Study: Buffalo, New York



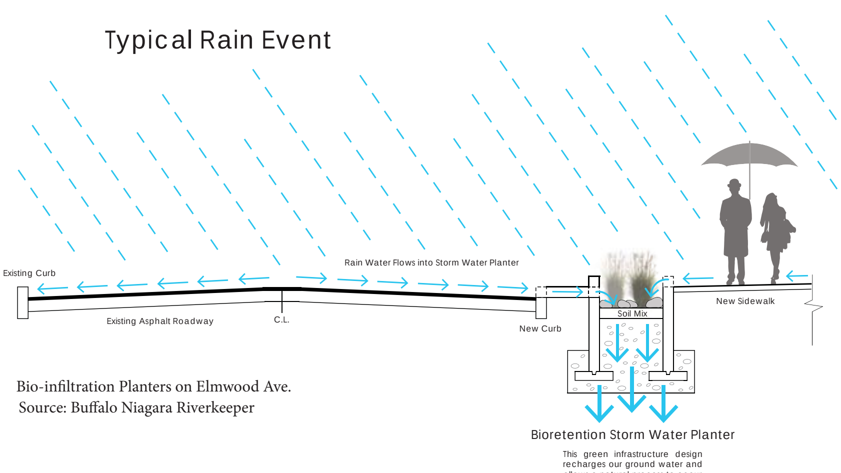
Source: Buffalo Niagara Riverkeeper

Source: Buffalo Niagara Riverkeeper



Rain Garden on Windsor Ave.

Source: Buffalo Niagara Riverkeeper



Bio-infiltration Planters on Elmwood Ave.
Source: Buffalo Niagara Riverkeeper

In Western New York, Buffalo is also testing green stormwater management and weaving it into the urban fabric through a project called Green Streets Demonstration Project (CSO No.060). This project was originally scheduled for a sewer separation (also known as grey infrastructure). During the design process, the project was transformed into a green streets demonstration project. The Buffalo Sewer Authority has led by example in testing different types of green stormwater infrastructure solutions to measure performance in cold weather and poor draining soils.

Types of green stormwater technologies that are being tested include: Porous asphalt, rain gardens and bio-infiltration planters. For all residential properties and businesses in the project area, this project also includes a downspout disconnection opportunity.

To learn more about this project,visit: http://bnriverkeeper.org/cso-60-demon-stration-project/

Appendix F: Green Infrastructure Glossary

Bio-infiltration swale: A natural linear vegetated system designed to filter pollutants from stormwater. Typically gentle in slope, swales usually direct stormwater water to a receiving facility while also allowing for infiltration. Infiltration further treats water quality via the passage of water through the soil matrix, to replenish groundwater.

Bio-infiltration trench: A mixed media stone (gravel, or gravel and sand) trench topped with porous soil and vegetation used to treat stormwater using biofiltration, filtration and infiltration. Bio-infiltration utilizes the flow of water through vegetation, soil and then filter material (such as gravel and sand) to provide contaminant capture and filtration. Filtered water is then allowed to infiltrate into the ground which further treats water quality via the passage of water through the soil matrix.

Bio-remediation: Any process that uses biological organisms such as plants, microbes or enzymes to solve (remediate) an environmental problem such as contaminated water or soil. Bio-remediation processes may be entirely natural or enhanced through alteration that better the conditions for organisms to work including modifying temperature, amount of air, and the type of nutrients in the soil or water being remediated.

Bio-retention: The slowing down of stormwater by capturing it in shallow landscaped beds, usually called rain gardens, which allows stormwater to be absorbed by the plants and filtered through the soil matrix.

Blue roof: A blue roof is a roof that is deliberately designed to store or detain water from rainfall or snow melt. Blue roofs can be designed as roof-top ponds or as systems that store water in porous materials or as usable spaces that hold water under a raised modular surface or decking. A blue roof is utilized for temporary detention of stormwater and can also be used to store water for irrigation.

Bump-outs/Bulb-outs: Typically utilized in streetscape design at intersections as a curb modification that narrows the street width in order to better enable pedestrian crossings, new applications are designed to allow stormwater to enter the curb and flow into retention/filtration/infiltration/ facilities underground. These underground filtration systems are used to slow down and help filter stormwater runoff. Although generally the bump-out surface is paved at intersections, some may include landscaping, particularly bump outs that are specifically designed as stormwater planters.

Cistern: A large receptacle placed either above ground or below and used for capturing and storing stormwater from roof drains or downspouts.

Combined sewer overflow (CSO): Combined sewer systems convey both sewage and stormwater in the same pipe network to the municipal treatment facility. Sometimes, especially during heavy storm events, combined sewer systems receive higher than normal flows of stormwater which exceed the systems designed capacity. In order to prevent backups of the system, discharge pipes are located along the network to relieve surcharging flows. These discharge pipes (or outfalls) usually empty into nearby waterways. The discharge is called a combined sewer overflow (CSO).

Contained planter: A variation of a stormwater planter that is fully contained, without drainage, designed to filter stormwater through a soil mixture and allow for uptake by the potted plants. Overflow piping must be directed to an acceptable discharge point.

Curb extensions: Typically utilized in streetscape design at intersections as a curb modification that narrows the street width in order to better enable pedestrian crossings. Also called bump-out or bulb-outs, curb extensions are usually paved at intersections, however with green street applications, these areas are specifically designed to receive stormwater.

Detention: Temporary storage of an indefinite amount of stormwater typically held within the drainage facility system in order to slow down stormwater flow. A detention facility will release water back into the system at a slower rate than it is collected and can be designed to allow for gravity settling of pollutants or for infiltration and/or evaporation of the water stored.

Downspout disconnection: The practice of redirecting collected roof or elevated highway drainage to any green infrastructure system that encourages detention, filtration and infiltration of stormwater. Downspouts can be directed to a rain barrel or cistern for storage or diverted directly to a lawn, raingarden, swale, or stormwater planter.

Dry swale: A linear drainage channel typically constructed of soil and/or stone filter material utilized for both detention and filtration.

Dry well: A deep storage pit filled with filter stone to allow for filtration and storage of stormwater allowing it to slowly infiltrate in the subgrade.

Appendix F: Green Infrastructure Glossary

Flow-through planter: A variation of a stormwater planter that contains an underdrain and is located adjacent to a structure, typically requiring waterproofing or separation form the structure. The flow-through stormwater planter is filled with stone (gravel), a soil mixture and planted with vegetation. Underdrains that collect the filtered water and overflow piping must be directed to an acceptable discharge point.

Green roof: Green roofs are designed systems built upon flat or shallowly sloping roofs that are capable of absorbing and retaining large amounts of stormwater. Vegetation is grown in the special soil layer where stormwater is utilized by plant uptake which also allows for evapotranspiration and evaporation. Excess water released from the soil layer runs into a drainage layer, usually in the form of a drainage mat, which then conveys the filtered water to an acceptable discharge point. Green roofs provide additional sustainability benefits as they also absorb noise and air pollution, provide for rooftop cooling, extend the life of a roofing system and create habitat for insects and birds.

Green Infrastructure: As it applies to stormwater runoff management, green infrastructure refers to designed systems that mimic nature to capture, detain and filter stormwater runoff. These green systems absorb stormwater and allow for plant uptake, evapotranspiration, controlled release, and infiltration into the ground where filtered flows can replenish groundwater stores. As a source control in combined sewer system management, green infrastructure reduces the amount of stormwater that enters the network and therefore reduces the number of combined sewer overflow discharges as well as the need for end-of-pipe stormwater treatment. On a regional planning scale, green infrastructure refers to all of the practices that reduce run-off and encourage the restoration and preservation of natural pervious and absorptive landscapes.

Green streets: Street designs that serve all modes of travel and environmental sustainability. Green streets optimize stormwater management by utilizing green infrastructure in efforts that more closely mimic natural hydrology while accommodating safe and efficient use of the public right of way.
Impervious surface: A surface area which does not allow stormwater to penetrate so it causes run off at a rapid rate of flow. Impervious surfaces include solid pavements, roofs and compacted soils.

Infiltration: A practice that captures and holds water while allowing for percolation of the water into the soil. Infiltration treats water quality via the passage of water through the soil matrix, ultimately, in order to replenish groundwater.
Infiltration planter- A stormwater planter variation that has on open or pervious bottom that allows filtered water to infiltrate into the ground.

Infiltration trench: A mixed media stone (gravel, or gravel and sand) trench used to treat stormwater using filtration and infiltration. Infiltration utilizes the flow of water through a system of filter materials to provide contaminant capture and filtration. Filtered water is then allowed to infiltrate into the ground which further treats water quality via the passage of water through the underlying soil matrix.

Pervious surface: Any permeable surface that supports the infiltration of water. Pervious surfaces include structurally intact soils that allow for the free movement of water and porous pavements which are designed to have void spaces that allow water to penetrate the structural substrate beneath.

Porous (pervious) asphalt: Coarse stone and asphalt binder containing only a minimum of fine aggregate in the mixture in order to allow for water to percolate through small voids created between larger aggregates. Underlain by a layer of uniformly graded stone (gravel) filter material, porous asphalt allows water to drain through quickly.

Porous (pervious) concrete: A concrete mixture of cement, uniform (or open-graded) coarse aggregate, and water that resembles exposed aggregate concrete when cured. Void spaces in the mixture allow for rapid percolation of water into the stone (gravel) filter material below.

Porous pavement: Pavement systems that are designed to allow for the percolation of stormwater through the permeable surface and into structural stone filter media below.

Porous (permeable) pavers: Pavement units made of brick, cut stone, cobbles or pre-cast concrete set atop a system of sand and filter stone materials. Sand or pea gravel mixtures fill the gaps between pavers allowing for water to pass into the underlying substrate where it can then infiltrate into the ground. Engineered precast concrete unit pavers are often designed to interlock to provide a very stable surface.

Rain barrel: A small receptacle placed above ground and used to capture and store rainwater harvested from roof scuppers or downspouts. Stored water is generally used for irrigation and the rain barrel can be modified to include overflow piping that drains into a raingarden or lawn.

Appendix F: Green Infrastructure Glossary

Rain garden: A landscape feature that collects rainfall and snow melt into a porous soil media that supports plants. Rain garden plants are typically hardy native or naturalized species that tolerate both inundation and drought. The rain garden functions within the full range of the hydrologic cycle as the plants, soil, water, microbes and other organisms contribute to ecological remediation.

Retention: Permanent storage of a definite amount of stormwater typically held within the drainage facility system as an open water body such as a pond.

Riparian buffer: A designated conservation zone established along a water body where development and landscape disturbance is prohibited. Buffer zones protect water bodies, provide stormwater filtration and infiltration, promote ecosystem function, encourage habitat connectivity and preserve natural hydrologic integrity of the shoreline.

Sewershed: A sewer shed is the delineated wastewater collection area in which all flows are conveyed to a single outlet such as a major trunk line, pump station or the wastewater treatment facility.

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Soil compaction: Soil structure that has been destroyed by decreasing void spaces thereby reducing permeability. Compacted soils inhibit or prevent air and water flow.

Stormwater: Stormwater is the flow of water generated from either rain or melting snow which is not absorbed into the ground but rather, is conveyed over impervious surfaces into drains that flow into the sewers. Excess stormwater can cause flooding and combined sewer overflows.

Stormwater hotspot: Land uses that harbor significant toxicants require stormwater management that treats potentially contaminated runoff effectively before it is allowed to infiltrate into groundwater resources.

Stormwater planters: Contained planting areas filled with soil mix and gravel typically used in urban environments. Planters are designed to allow for filtration and plant uptake of stormwater before allowing filtered water to either infiltrate into underlying soil or be redirected into an acceptable discharge point. Stormwater planters can be designed as contained planters, flow-through planters or infiltration planters.

Stormwater wetlands: Preservation or reestablishment of natural marshlands, pocket wetlands, vernal pools and shoreline buffers which also include the implementation of engineered treatment wetland facilities.

Stream daylighting: Restoring culverted and tunneled streams to reestablish habitats, create runoff buffers, encourage infiltration, provide public access to water features and restore natural stream functions.

Sub-sewershed: The sub-sewershed is the wastewater drainage area associated with an individual CSO outfall.

Vermiculture (vermicomposting): The cultivation of worms in composting and for soil remediation. South American researchers recently studied the viability of using earthworms to process high concentrations of heavy metal for the bioremediation of old industrial sites.

From Rust to Blue: Buffalo Niagara RIVERKEEPER's Vision for a New Economy

Clean water is a vital asset and one whose value will increase as global climates change. On any given day, our local water resources support recreation, eco-tourism, fish and wildlife, manufacturing, waste processing, power generation, trans-shipment, and provide drinking water to nearly one million people. With the anticipated increase use and desirability of our local water resources, Riverkeeper is working with local residents and community leaders to establish plans to invite sustainable and non-polluting industries into our community.

Advocating for WNY's Blue Economy is simple, and Riverkeeper has established Five Guiding Principles:

1) Water is a driver of regional economic revitalization.
2) Prioritize increased public access and open space protection.
3) Green Infrastructure is part of the solution to our sewage problem.
4) Establish the Niagara River Greenway as an international spotlight.
5) Utilize the power of public, private and non-profit partnerships.

Economic investments wax and wane, but the water will always be here. Let's work to ensure a sustainable blue economy for the next generation of Western New Yorkers.

RIVERKEEPER is dedicated to protecting and restoring the quality and quantity of our most valuable natural asset -- our water. We are committed to improving the legacy we leave for future generations. Our goal is for everyone to have access to fishable, swimmable and drinkable water throughout the Buffalo Niagara Region.

For more information visit:
bnriverkeeper.org, facebook/bnriverkeeper, and twitter/bnriverkeeper

If you would like to donate visit: bnriverkeeper.org/support-and-donations