Green Infrastructure Application Best Management Practices

A Guideline for Stormwater Management

Geneva South Main Street Historic District

FINGER LAKES INSTITUTE

HOBART AND WILLIAM SMITH COLLEGES

Acknowledgements

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About the FLI-Community Design Center (FLI-CDC)

The Finger Lakes Institute, in partnership with Hobart & William Smith Colleges has created a community design center that strives to provide Finger Lakes communities with innovative, creative, and sustainable design solutions that improve the built environment and quality of life, while protecting the natural environment.

Communities throughout the Finger Lakes region share similar economic, environmental, and social characteristics mainly as a result of the natural assets and history of the region. The current and future state of communities relies on improving quality of life for all citizens, being good stewards of natural resources, and fostering the responsible growth of the built environment. To support these efforts, we offer comprehensive sustainable community development planning and design services to communities throughout the Finger Lakes region.

It is our mission to:

- Raise awareness of the benefits and potential of sustainable community development and design for small towns, villages, cities and other entities;
- Encourage preservation and protection of natural resources and the built environment;
- Facilitate regional planning and collaboration among communities, businesses, non-profits, higher education institutions, and other entities;
- Foster community resilience by providing an active resource center for holistic community planning and design and disseminating our expertise nationally.

About this Project

Genesee/Finger Lakes Regional Planning Council (G/FLRPC) has received partial funding through the Ontario County Water Resources Council's 2013 Special Projects Fund to work on a project entitled, Green Infrastructure for Historic Districts. G/FLRPC, in cooperation with the Ontario County Soil and Water Conservation District (OC SWCD), will identify sites suitable for green infrastructure practices and techniques in the seven National Register Historic Districts in Ontario County. These districts have been identified using New York State Department of Parks, Recreation and Historic Preservation data. Soil maps prepared by the Ontario County GIS Program will assist in these recommendations. Students from the Finger Lakes Institute – Community Design Center (FLI-CDC) will then create visual representations of the recommended green infrastructure practices and techniques.

Green infrastructure uses vegetation and soil to manage rainwater where it falls instead of using pipes to dispose of it in New York State waters. As a watershed develops, more impervious cover is created. Roads, buildings, parking, sidewalks, and driveways all increase runoff from rain events and snow melt. Stormwater runoff contains pollutants such as nutrients, pathogens, sediment, toxic contaminants, and oil and grease. Water quality problems generated by these pollutants have resulted with water bodies such as lakes and streams having impaired or stressed uses. Green infrastructure reduces stormwater discharges and lowers pollutant loads.

Green and sustainable design has become increasingly popular in both the preservation and new construction industries due to public interest in energy conservation, water efficiency, and source reduction and waste management. Preservation and green goals overlap, and reconciling their differences is possible—provided that both sides strive to be as creative and flexible as possible. Preservation of natural features; permeable paving materials for parking lots, walkways, and driveways; driveway reduction; vegetated swales; rain gardens; green roofs; stormwater planters; rain barrels and cisterns; native vegetation; and downspout disconnection or extensions have been identified as green infrastructure practices and techniques that could easily be incorporated into historic districts with some guidance.

The primary goal of Green Infrastructure for Historic Districts is to provide assistance to municipalities and residents who wish to incorporate the concepts and practices of green infrastructure into their structures while maintaining the historic integrity of the individual buildings and the overall character of their community.

Introduction

Due to its close proximately to multiple bodies of freshwater, the Finger Lakes region reaps the visual aesthetic and the environmental diversity benefits of the lake ecosystem. However, like many other water bodies, there are assorted threats to the health and vitality of the Finger Lakes. One of the main sources of pollution that contributes to the Finger Lakes is stormwater run-off. Stormwater is the water from rain and melted snow that runs off into nearby water bodies, instead of soaking into the ground. The runoff collects pollutions, such as chemicals, sediments, debris, and other pollutants that flow over impervious surfaces.

One of the ways to prevent the stormwater from reaching the water bodies is through green infrastructure. In the context of stormwater management, the term green infrastructure includes a wide array of practices at multiple scales to manage and treat stormwater, maintain and restore natural hydrology and ecological function by infiltration, evapotranspiration, capture and reuse of stormwater, and establishment of natural vegetative features. Unlike traditional grey infrastructure, green infrastructure is a practice that mimics the system of the natural environment to have a sustainable method of controlling pollution. Green infrastructure can be used to treat the polluted runoff to mitigate those pollutants from running into water bodies, like the Finger Lakes.

Green Infrastructure in Historic Districts

Ontario County is made up of many different towns and villages all with their own unique histories and cultures. Within the county, there are currently six National Historic Districts, soon to be seven as Downtown Geneva is in the process of applying for designation.

1. Farmington Quaker Crossroad Historic District
2. East Bloomfield Historic District
3. Canandaigua Historic District
4. South Main Street Historic District (Geneva)

5. Genesee Park Historic District (Geneva)
6. Clifton Springs Sanitarium Historic District
7. Downtown Geneva Historic District (TBD)

Historic research conducted as part of this project found that green infrastructure practices actually existed within each of these districts in the past, as it wasn't until 20th century industrialization that modern stormwater infrastructure practices were introduced and impervious paving became commonplace. Thus, it is hoped that by re-introducing green infrastructure into each of these historic districts, not only can their historic accuracy and integrity be improved, but protection of existing structures, regional water bodies and local habitats can be improved as well as decrease the need for traditional water management infrastructure practices.

A historic photograph of Geneva's South Main Street shoes permeable pavers, street trees and a bio-swale.

Methods

On May 8, 2013, Jayme Breschard Thomann, Senior Planner at the Genesee/Finger Lakes Regional Planning Council and P.J. Emerick, Sr. , District Manager for the Ontario County Soil and Water Conservation District visited each of the seven historic districts, evaluated soils and made recommendations about appropriate green infrastructure techniques for each district.

From those findings, for each district, the green infrastructure application guidelines were created. Recommendations are based off the research from the New York State Stormwater Management Design Manual – Chapter 5. The research that was conducted also utilized historical background from the various Ontario County historical societies and online research.

EPA National Stormwater Calculator

The EPA's National Stormwater Calculator can also be used to help enhance planning and application of green infrastructure techniques. The calculator is a desktop application that estimates the annual amount of rainwater and frequency of runoff from a specific site anywhere in the United States. Estimates are based on local soil conditions, land cover, and historic rainfall records. It is designed to be used by anyone interested in reducing runoff from a property, including:

- Site developers
- Landscape architects
- Urban planners
- Homeowners

The Calculator accesses several national databases that provide soil, topography, rainfall, and evaporation information for the chosen site. The user supplies information about the site's land cover and selects the types of low impact development (LID) controls they would like to use, such as:

- Rain harvesting (cisterns, rain barrels)
- Rain gardens
- Green roofs
- Stormwater planters
- Porous pavement
- Infiltration basins (planters, swales, filter strips, rain gardens, porous pavement are all various forms of green infrastructure techniques that utilize an infiltration basin)

To better inform decisions, it is recommended that the user develop a range of results with various assumptions about model inputs such as percent of impervious surface, soil type, and sizing of green infrastructure.

Clean water is essential to keeping our families and the environment healthy. The Calculator helps protect and restore the environmental integrity of our waterways. The link to calculator can be found below.
http://www.epa.gov/nrmrl/wswrd/wq/models/swc/

About this Document

This document serves as a guide to the application of green infrastructure practices and techniques for each of the seven historic districts in Ontario County. Application details include descriptions of typical preferred locations of each practice, recommendations of the appropriate sizes and/or models of each practice, relevant products and costs, as well as any necessary site preparation and maintenance necessary.

The City of Geneva is comprised of two official historic districts, soon to be a third. The district of South Main encompasses 140 structures, including Pulteney Park, and stretches a mile long. The north end of the district is closer to the center of downtown Geneva, and is characterized by the brick row houses built in the 1820's and 1830's. The south end of the district includes Hobart College campus and modern Hobart and William Smith Colleges have expanded and absorbed many of the historic houses along South Main. The largest growth period was between 1825 and 1850, when over half of the structures included in the district were built. Historically, the east side

plots of land were not for sale or to be developed and were meant to keep free so as not to obstruct the view of the lake.

Green infrastructure practices recommended for South Main Street are:

1. Porous pavement
2. Ribbon driveways
3. Shared driveways
4. Rain gardens
5. Rain barrels
6. Tree pits
7. Stormwater planters
8. Storm drain Markings

The predominately-urbanized area of Geneva South Main is made up mainly of impermeable spaces. Being located along side of Seneca Lake, the importance of preventing and cleaning up stormwater pollution run-off is very great. The Geneva South Main District consists of South and North Main Street, which frequently encounters interstate truck travel, as well as increased travel during the tourist season. This increased rate of car and truck traffic have led to an increase in pollutants being exposed to stormwater run-off, like road salts.

It is anticipated that this information will be utilized by property owners or municipal officials to incorporate the green infrastructure practices into each district, as appropriate.

Green Innovation Grant Program (GIGP)

A grant for various entities in New York State looking to incorporate green infrastructure exists, and could be applied for. The Green Innovation Grant Program (GIGP) provides grants on a competitive basis to projects that improve water quality and demonstrate green stormwater infrastructure in New York. GIGP is administered by NYS Environmental Facilities Corporation (EFC) through the Clean Water State Revolving Fund (CWSRF) and is funded through a grant from the US Environmental Protection Agency (EPA).

Projects selected for funding go beyond providing a greener solution, they maximize opportunities to leverage the multiple benefits of green infrastructure, which include restoring habitat, protecting against flooding, providing cleaner air, and spurring economic development and community revitalization. At a time when so much of our infrastructure is in need of replacement or repair and communities are struggling to meet competing needs, we need resilient and affordable solutions like green infrastructure that can meet many objectives at once.

EFC seeks highly visible demonstration projects which:

- Create and maintain green, wet-weather infrastructure
- Spur innovation in the field of stormwater management
- Build capacity locally and beyond, to construct and maintain green infrastructure
- Facilitate the transfer of new technologies and practices to other areas of the State

GIGP 5 applicants are strongly encouraged to work with their Regional Council to align their project with regional goals and priorities. EFC reserves the right to fund all, or a portion of, an eligible proposed project. Funding will be provided to selected projects to the extent that funds are available.

ELIGIBLE TYPES OF APPLICANTS:

- Municipalities

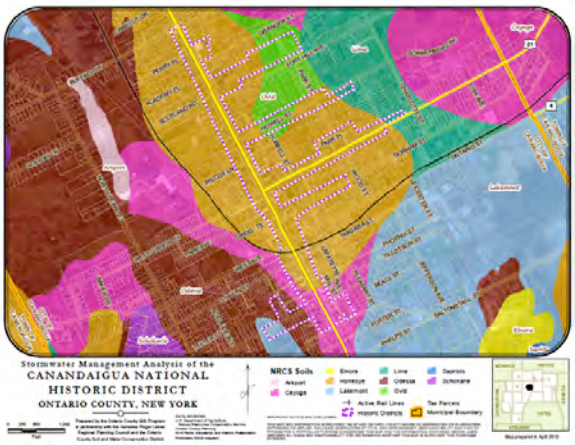
- State Agencies
- Public Benefit Corporations
- Public Authorities
- Not-for-profit Corporations
- For-profit Corporations
- Individuals
- Firms
- Partnerships
- Associations
- Soil and Water Conservation Districts

For more information about this funding opportunity, please see:

http://regionalcouncils.ny.gov/sites/default/files/documents/2013/resources_available_2013.pdf.

Soil Maps

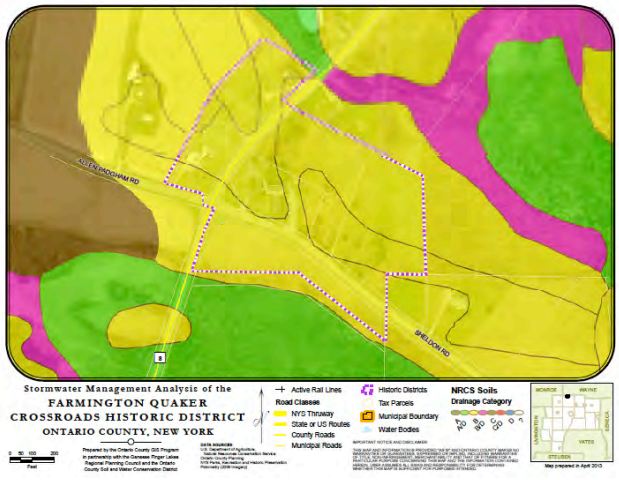
There are two types of soil maps provided within this report. The first illustrates the specific soil type present in the Historic Districts and the second shows its drainage classification. Data from these two maps was used in developing the following best management practices and if relevant, specific recommendations for dealing with the relevant soil type and drainage category for each Historic District are described for each stormwater management technique.



These maps were created by the Ontario County GIS Program in partnership with the Genesee/Finger Lakes Regional Planning Council and the Ontario County Soil and Water Conservation District.

Drainage Categories

The key provided on the Drainage Classification maps provides information about the drainage capabilities of the underlying soils in each Historic District. Definitions and descriptions of each drainage group are provided below.



Group A—Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

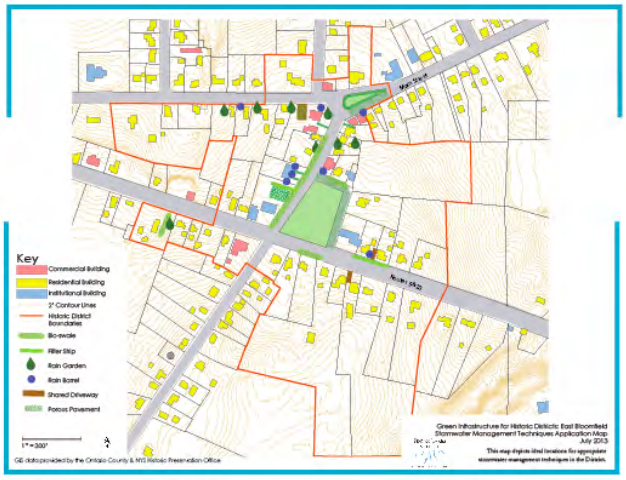
Group B—Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

Group C—Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

Group D—Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 50 centimeters [20 inches] and all soils with a water table within 60 centimeters [24 inches] of the surface are in this group, although some may have a dual classification, as described in the next section, if they can be adequately drained.

Dual hydrologic soil groups—Certain wet soils are placed in group D based solely on the presence of a water table within 60 centimeters [24 inches] of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 60 centimeters [24 inches] below the surface in a soil where it would be higher in a natural state.

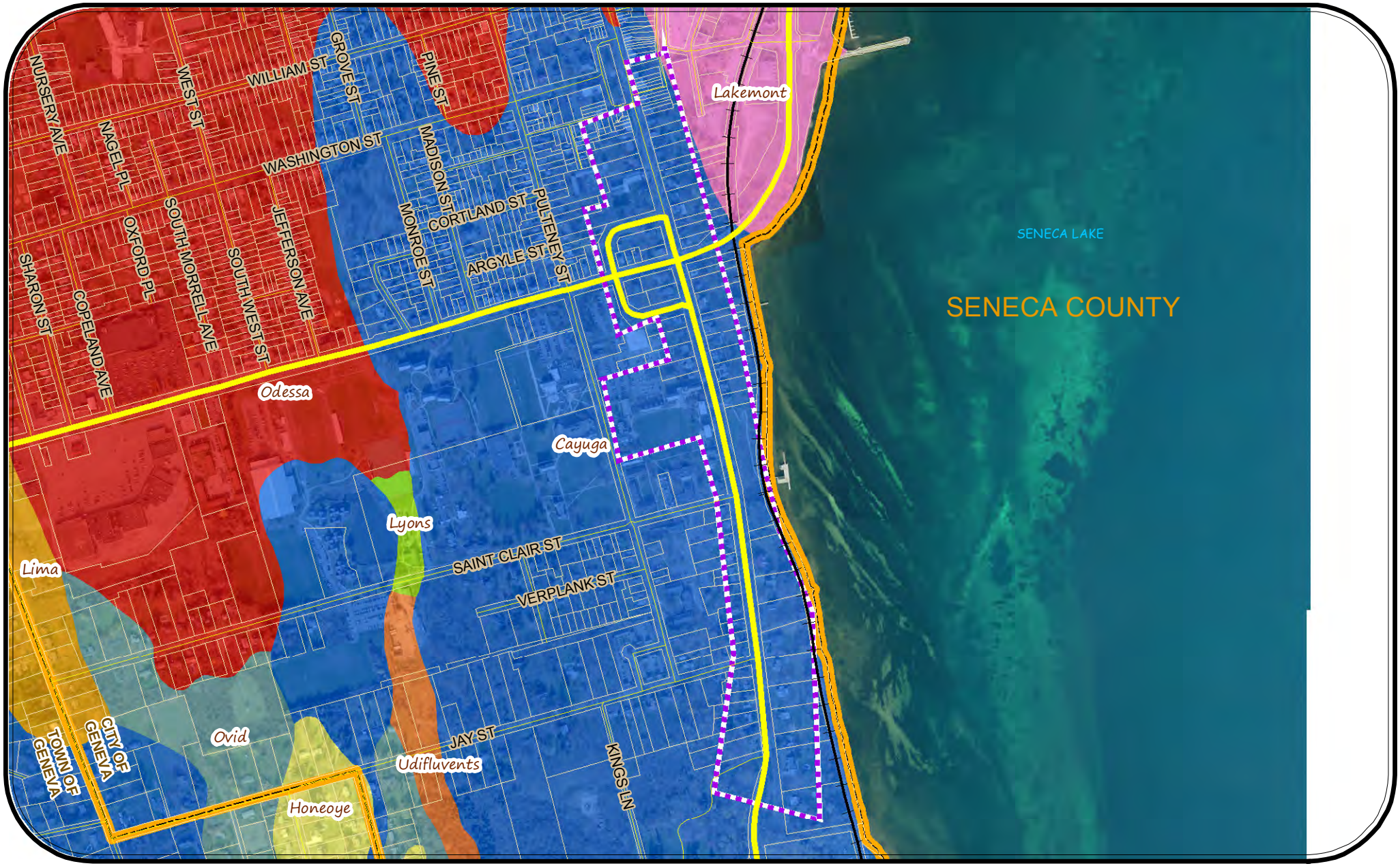
For more information about soil classification, see Part 630: Hydrology, Chapter 7 of the *National Engineering Handbook* by the United States Department of Agriculture.



Stormwater Management Techniques Map

Also included in the following pages is a map which details the ideal locations for the application of relevant stormwater management techniques for the Historic District. It is anticipated that these maps can be used by property owners and municipal officials to guide decisions regarding the location and need of green infrastructure techniques and methods within the Historic District. For further details regarding the installation of each technique, please see the following report.

These maps were created by the Finger Lakes Institute – Community Design Center using GIS data provided by Ontario County and the New York State Historic Preservation Office. Each Historic District was visited and appropriate places for green infrastructure were identified and recorded using physical observation and recommendations made by the Genesee/Finger Lakes Regional Planning Council. It should be noted that in most instances, all possible applications of the green infrastructure techniques were recorded, but each property owner should be careful to consider the specific needs and conditions of their property.



Stormwater Management Analysis of the GENEVA SOUTH MAIN STREET HISTORIC DISTRICT

ONTARIO COUNTY, NEW YORK

0 200 400 800

Feet

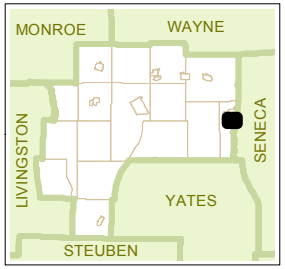
Prepared by the Ontario County GIS Program in partnership with the Genesse Finger Lakes Regional Planning Council and the Ontario County Soil and Water Conservation District

DATA SOURCES:
U.S. Department of Agriculture, Natural Resources Conservation Service
Ontario County Planning
NYS Parks, Recreation and Historic Preservation
Pictometry (2009 Imagery)

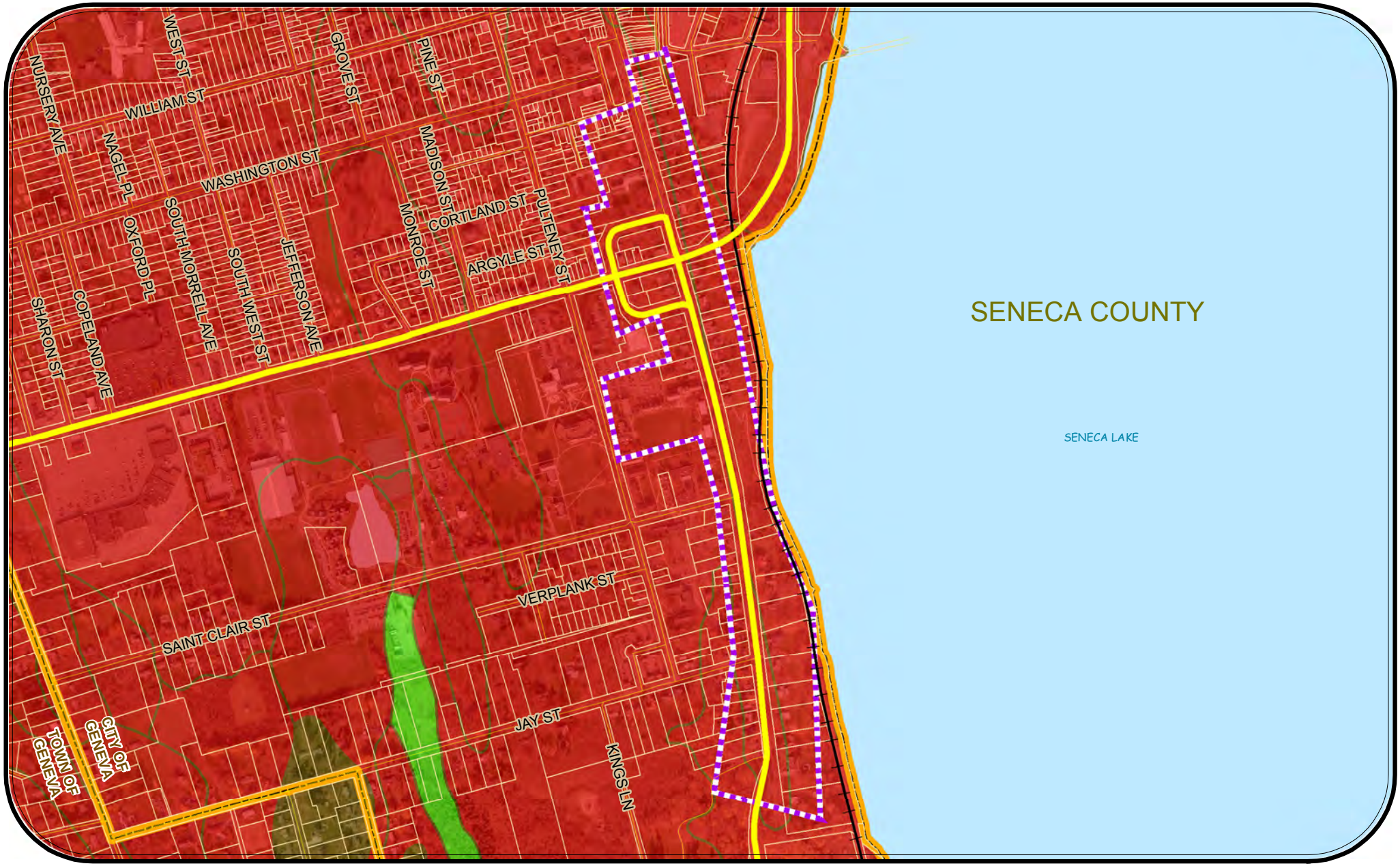
NRCS Soils

- Cayuga
- Honeoye
- Lakemont
- Lima
- Lyons
- Odessa
- Ovid
- Udifluvents

- Historic Districts
- Tax Parcels
- Municipal Boundary
- Active Rail Lines



Map prepared in April 2013



Stormwater Management Analysis of the
GENEVA SOUTH MAIN STREET HISTORIC DISTRICT
ONTARIO COUNTY, NEW YORK

0 200 400 800
Feet

Prepared by the Ontario County GIS Program in partnership with the Genesse Finger Lakes Regional Planning Council and the Ontario County Soil and Water Conservation District

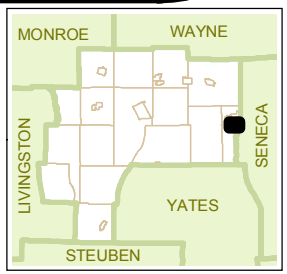
DATA SOURCES:
U.S. Department of Agriculture, Natural Resources Conservation Service
Ontario County Planning
NYS Parks, Recreation and Historic Preservation
Pictometry (2009 Imagery)

- Active Rail Lines

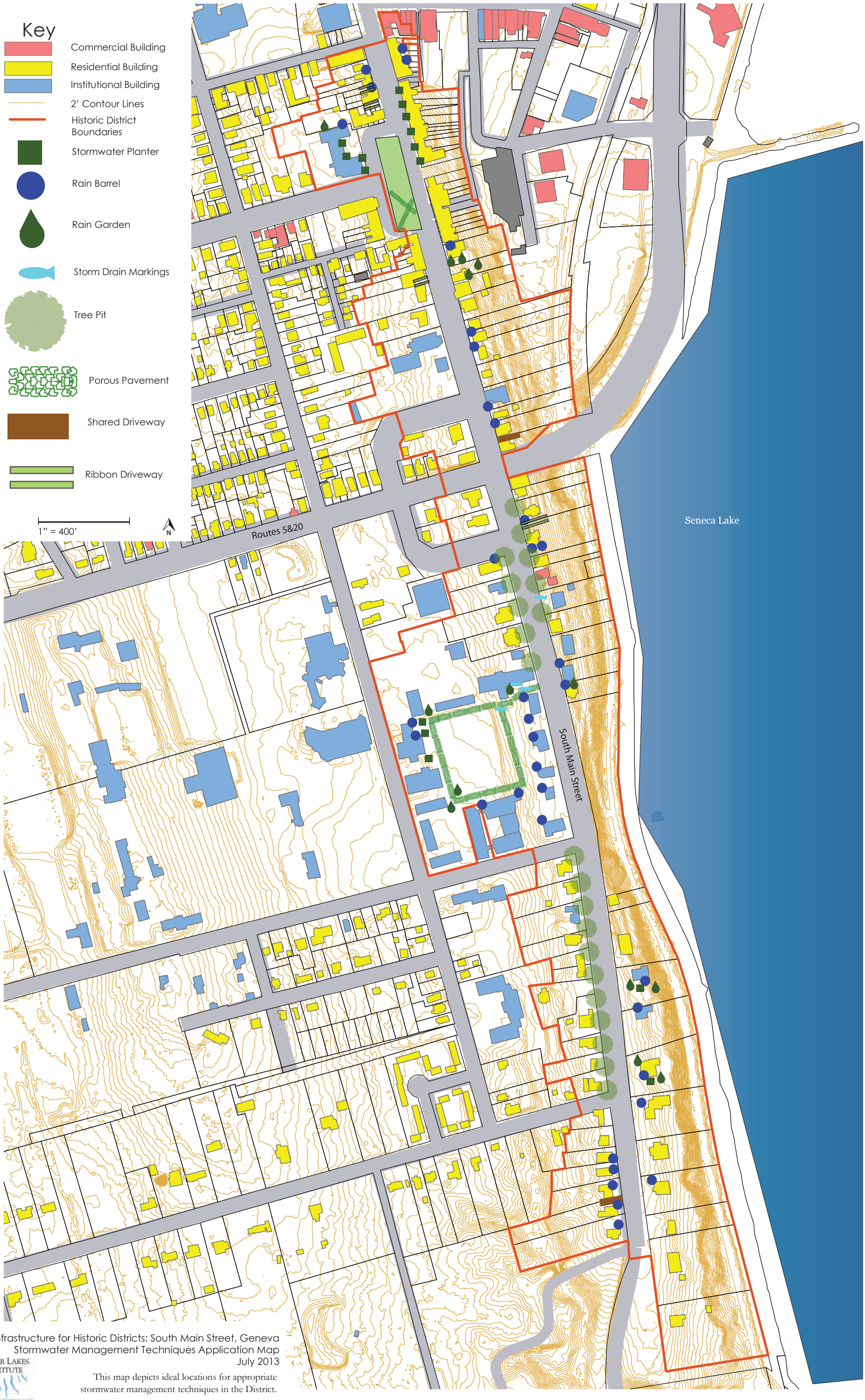
Road Classes
- NYS Thruway
- State or US Routes
- County Roads
- Municipal Roads

- Historic Districts
- Tax Parcels
- Municipal Boundary
- Water Bodies

NRCS Soils
Drainage Category
A A/D B B/D C C/D D ?



Map prepared in April 2013



Green Infrastructure for Historic Districts: South Main Street, Geneva
Stormwater Management Techniques Application Map
July 2013

This map depicts ideal locations for appropriate stormwater management techniques in the District.

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GIS data provided by Ontario County & NYS Historic Preservation Office

Porous Pavement

Porous, or permeable, pavement is material that allows stormwater to move through the surface and be absorbed rather than flow over the surface. Currently, most development uses impervious materials, such as asphalt and concrete. Rainwater cannot penetrate these materials and is directed into a storm drain off of impervious material, where it then continues to flow untreated into a waterway. Because of this during heavy rainfall sewer systems can also get overwhelmed and flood. Porous pavement is a development technique that can mutually reduce run-off and flooding, as well as minimize the spread of pollution.

Pervious pavement is widely available and can bear frequent traffic, as well as is universally accessible. Porous paving functions like a stormwater infiltration basin and allows the stormwater to infiltrate the soil over a large area, thus facilitating recharge of precious groundwater supplies locally.

Figure 1: Pebbled Path in Pulteney Park

Source: Geneva Historical Society.

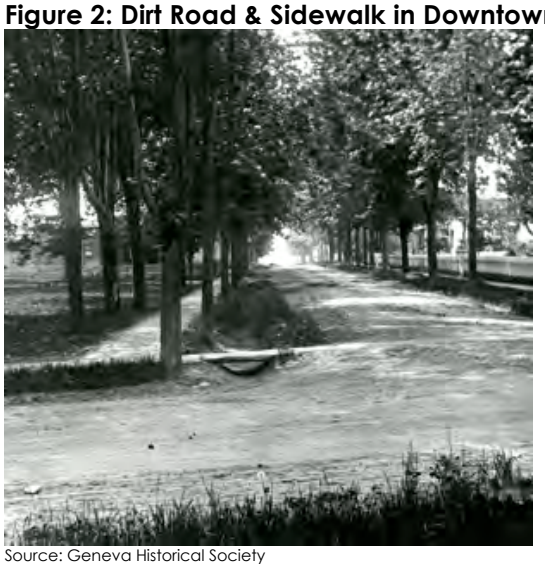
Some examples of places that can utilize porous pavement include: roads, paths, lawns and lots that are subject to light vehicular traffic, such as car/parking lots, cycle-paths, service or emergency access lanes, road and airport shoulders, and residential sidewalks and driveways.

Application in a Historic District

Historic photos from Ontario County show pebble and gravel sidewalks, dirt roads and driveways, and then later cobblestone and brick pathways before being paved over with impervious materials. Many home exteriors in Historic districts had descriptions of pathways with spaced out stones framed by grass, where water could easily run off the surface and be absorbed by it's surrounding environment. Figures 1 and 2 are pictures from Geneva, Figure 1 is a pebbled pathway in Pulteney Park, and Figure 2 shows a dirt road and sidewalk in downtown Geneva. The first porous pavement to be widely used however after the industrial revolution was pervious concrete. Pervious concrete was first used in the 1800s in Europe as pavement surfacing. Cost efficiency was the main motivator due to a decreased amount of cement. Then during WWII pervious cement became popular again due to a decrease in availability of cement. Below are some further porous pavement options.

By implementing porous paving in a historic district, it is likely that this will improve the historic character and integrity of the district, as well as mitigate stormwater run-off. However, historic photographs and records should be consulted first, so that the porous pavement application is as accurate to past conditions of the site as possible. The Ontario County Historical Society and Museum has detailed records and photographs which can be consulted.

Figure 2: Dirt Road & Sidewalk in Downtown Geneva



Source: Geneva Historical Society

Types of Porous Pavement

Concrete & Brick Pervious Pavers

Concrete and brick pervious pavers are commonly used materials that qualify as low impact development and allow the absorption of water. Concrete or brick pavers are manufactured in many sizes and shapes and are laid with a drainage base and permeable joint material, allowing water to slowly seep into the ground. Homeowners can use them for parking areas, patios, sidewalks, and pool decks. Driveways can be paved with these, however, snow removal equipment may catch edges.

Plastic Grids

Plastic Grids allow for a 100% porous system using structural grid systems for containing and stabilizing either gravel or turf. These grids come in a variety of shapes and sizes depending on use; from pathways to commercial parking lots. These systems can be used to meet LEED requirements as well. The ideal design for this type of grid system is a closed cell system, which prevents gravel/sand/turf from migrating laterally.

Figure 3: Loose Gravel

Source: http://www.englishgardenco.co.uk/driveways.html

Porous asphalt

Porous asphalt is conventional asphalt with large, single-sized aggregate particles that leave open voids and give the material porosity and permeability. Under the porous asphalt surface is a base course of further single-sized aggregate that acts as a reservoir where water can be allowed to evaporate and/or be absorbed by underlying soils. Porous asphalt surfaces, called *open-graded friction courses* (OGFC), are being used on highways to improve driving safety by removing water from the surface. OGFCs are not full-depth porous pavements, but a porous surface course usually 3/4 to 1.5 inches thick that allows for the lateral flow of water through the pavement, improving the friction characteristics of the road and reducing road spray.

Loose Gravel

Loose gravel may be used or stone-chippings are another alternative. This form of porous paving should only be used in very low-speed, low-traffic settings like car parks and drives.

Permeable Interlocking Concrete Pavements

Permeable interlocking concrete pavements are concrete (or stone) units with open, permeable spaces between the units. They give an architectural appearance, and can bear both light and heavy traffic, particularly interlocking concrete pavers, excepting high-volume or high-speed roads.

Figure 4: Porous Turf

Source: http://www.100khouse.com/2010/12/08/permeable-pavement-options-for-leed-projects/

Porous Turf

Porous turf, as seen in Figure 4, if properly constructed, can be used for occasional parking like that at churches and stadia. Plastic turf reinforcing grids can be used to support the increased load. Living turf transpires water, actively counteracting the "heat island" with what appears to be a green open lawn.

Figure 5: Permeable Clay Brick Pavements

Source: http://www.stixnstones.com/blog/bid/96524/Garden-Stone-Path-Ideas-and-Gallery

Permeable Clay Brick Pavements

Permeable clay brick pavements are fired clay brick units with open, permeable spaces between the units. Clay pavers provide a durable surface that allows stormwater runoff to permeate through the joints. These are ideal for incorporating porous pavement in historic districts.

Resin Bound Paving

Resin bound paving is a mixture of resin binder and aggregate. Enough resin is used to allow each particle to adhere to one another and to the base yet leave voids for water to permeate through. Resin bound paving provides a strong and durable surface that is suitable for pedestrian and vehicular traffic in applications such as pathways, driveways, car parks and access roads.

Elastomerically Bound Recycled Glass Porous Pavement

Elastomerically bound recycled glass porous pavement is made out of processed post consumer glass with a mixture of resins, pigments, and binding agents. The product trademarked as FilterPave provides a permeable paving material that also reuses materials that would otherwise be disposed in landfills. Approximately 75 % of glass in the U.S. is disposed in landfills, so increasing the use of this form of porous pavement helps reuse material and reduce waste.

Benefits

Although some porous paving materials appear nearly indistinguishable from non-porous materials, their environmental effects are qualitatively different. Whether pervious concrete, porous asphalt, paving stones or concrete or plastic-based pavers, all these pervious materials allow stormwater to percolate and infiltrate the surface areas that currently do not utilize the soil below. The goal is to control stormwater at the source, reduce runoff and improve water quality by filtering pollutants in the substrata layers.

Figure 6: An Example of Porous Paving

Source: http://www.wycokck.org/InternetDept.aspx?id=23020&menu_id=1444&banner=15284

Benefits of permeable paving include:

- Recharging ground water
- Run-off reduction
- decrease in capacity restraints in stormwater networks
- effective pollutant treatment for solids, metals, nutrients, and hydrocarbons, as well as aesthetic improvement to otherwise hard urban surfaces.

Controlling Pollutants

Perhaps one of the most important benefits of porous pavement is the reduction of pollutants. Impervious pavement amplifies and spreads non-point source pollution. Non-point source pollution is caused by rainfall or snowmelt moving over the ground. As run-off moves it picks up human made pollutants and deposits them into streams, creeks, and lakes. Common examples of pollutants that fall into this category and spoil our waterways are: fertilizers, herbicides, insecticides, oil, and grease.

Porous pavement slows the velocity and momentum in which water moves over the surface, allowing sediment to drop out of the water, resulting in less erosion; and this means the water picks up less pollutants and allows the pollutants to filter into the ground. Studies have shown that porous pavements capture the heavy metals that fall on them, preventing them from washing downstream and accumulating inadvertently in the environment. In the void spaces, naturally occurring micro-organisms digest car oils, leaving little but carbon dioxide and water.

Examples

A study done in Rockville, MD reported high removal rates for zinc (99%), lead (98%), and chemical oxygen demand (82%). The University of New Hampshire Stormwater center found typical performance efficiencies for TSS, total zinc, and total phosphorous to exceed 95%, 97%, and 42% respectively. The EPA estimates that porous pavement has the ability to remove 65% of total phosphorous, 80-85% of nitrogen, and 82%-95% of suspended solids.

Site Specific Considerations

Soils

The soil should have a minimum infiltration rate of 0.5 inches per hour. Soil testing is required to maintain and ensure effective pollutant removal is taking place in the soils. South Main Street is developed over Cayuga soil. Cayuga soils are undulating, rolling, and hilly soils on till plains where a thin fine-textured deposit from pro-glacial lakes overlies the till. The underlying till is derived from limestone, dolomite, sandstone or shale. This kind of soil is moderately well drained. The potential for surface runoff ranges from low to very high depending on slope and the area.

Cayuga soils have the potential to be highly productive, however they require skilled management for control of run-off an erosion. Porous pavement would be able to help mitigate this and help reduce erosion and run-off.

Siting

Permeable pavement cannot be used in areas where there are risks for foundation damage, basement flooding, interference with subsurface sewage disposal systems, or detrimental impacts to other underground structures. Permeable pavement, like any other stormwater infiltration practice, bears the possibility of groundwater contamination. Therefore, permeable paving infiltration systems should not be used to treat stormwater hot spots. Stormwater hot spots are areas where land uses or activities have the potential to generate highly contaminated run-off. Examples of this are commercial nurseries, auto recycling and repair facilities, fleet washing, fueling stations, high use commercial parking lots, and marinas.

The recommended applications of permeable paving are for low-traffic roads, single-family residential driveways, overflow parking areas, sidewalks, plazas, tennis and or basketball courts, and courtyard areas, as well as backyard patios. Many opportunities exist in larger parking lots, schools, municipal facilities, and urban hardscapes as well. Permeable paving is easily applicable to redevelopment areas as well as new development.

Figure 7:

Source: http://homeklondike.com/2010/09/29/garden-path-design-ideas/

As mentioned, porous pavement is recommended for mostly light traffic areas, however, given the variability of products available the range of accepted applications is expanding. Some concrete paver companies have developed products specifically for industrial applications.

Zoning

The City of Geneva does not have any regulations specifically pertaining to porous pavement restrictions or recommendations. However, chapter 350 article X historic zoning outlines specific regulations and procedures that must be followed when altering the appearance of any historic structure. Changing the appearance of driveways or walks may require approval from the Historic Overlay commission.

Slopes

Permeable paving can only be used on gentle slopes (<5%), ideal surfaces should be completely flat. For all permeable paving, base course is a reservoir layer of 1"-2" crushed stone; depth to be determined by storage required and frost penetration. Thus, permeable paving is not recommended for many of the driveways on the west side of South Main Street, because of the steep grade of many of them.

Figure 8: A Terraced Application of Porous Pavement

Source: http://realestate.msn.com/garden-paths-12-easy-to-imitate-stone-walkways-1

The introduction of dirt or sand onto the paving surface, whether transported by runoff from elsewhere or carried by vehicles, will contribute to premature clogging and failure of the paving. Consequently, permeable paving should be constructed as one of the last items to be built on a development site and flat or very minimal slope. A terraced system may be used on slopes and perforated pipes can be used to help distribute run-off through the reservoir evenly. An example of a terraced system can be seen in Figure 8 above.

Drainage

Not all water will be absorbed by porous pavement, therefore drainage must be taken into consideration. Run-off should flow through and exit permeable pavements in a safe and non-erosive manner. Systems should be designed to ensure that the water surface evaluations for the 10- year 24-hour design storm do not rise into the pavement to prevent freeze/thaw damage. As a back up measure to help mitigate clogging, permeable paving practices can be designed with a perimeter trench to provide some overflow treatment.

Climate

Concerns over the resistance to the freeze-thaw cycle have limited the use of pervious concrete in cold weather environments. The rate of freezing in most applications is dictated by the local climate. Avoiding saturation during the freeze cycle is the key to the longevity of the concrete. Having a well-prepared 8 to 24 inch (200 to 600 mm) sub-base and drainage will reduce the possibility of freeze-thaw damage. The use of salt or sand during the winter should be minimized. Road salt contains chlorides that could migrate through the porous pavement into groundwater. Snow plow blades could catch block edges and damage surfaces. Sand cannot be used for snow and ice control on pervious asphalt or concrete because it will plug the pores and reduce permeability.

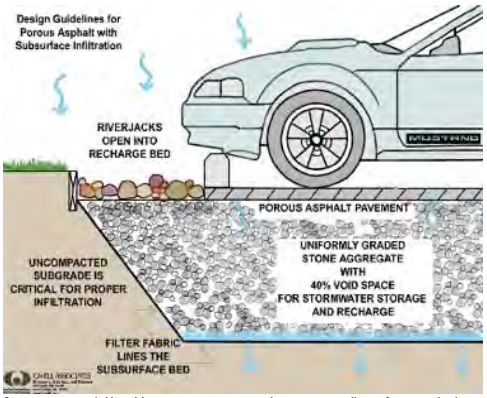
These potential problems do not mean that porous pavement cannot be used here in the Finger Lakes though. Porous pavement designed to reduce frost heave and clogging have been used successfully in Norway. Furthermore, experience suggests that rapid drainage below porous surfaces increases the rate of snow melt above. So, salting and plowing may become less necessary and severe. Sidewalks, patios, and tennis courts are a few examples of places that are not greatly affected by snow and could still easily be paved with a form of porous pavement.

Site Preparation & Design

Construction Guidelines

When installing pervious pavement projects certain precautions should be taken. Prior to installation areas for the porous pavement should be clearly marked in order to avoid compaction or disturbance of the soil. Weather conditions at the time of installation can affect the final product, as well. Extremely low or high temperatures should be avoided during construction. The pervious pavement and other infiltration practices should be installed towards the end of construction-to ensure securement and stability of upstream construction. It is recommended that filter fabric overlap a minimum of 16 inches and should be secured at least 4 feet outside of the bed to help drainage. The strip of fabric should remain in place until all bare soils contiguous to the beds are stabilized and vegetated.

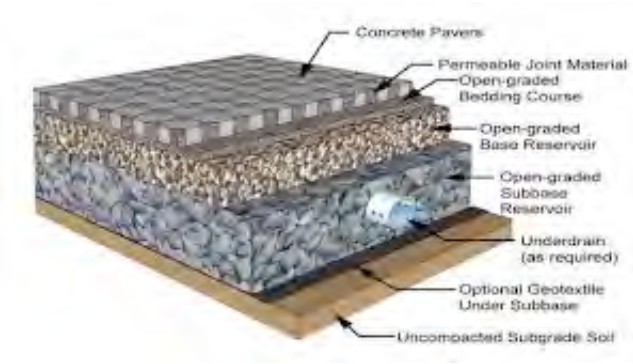
Figure 9: Layers of Porous Paving



Source: http://www.mapc.org/resources/low-impact-dev-toolkit/permeable-paving

Figure 10: Layers of Porous Paving

More specifically, there a few layers that should be incorporated into porous paving to ensure proper and efficient absorption and filtration. There should be a "choker course"—a single ½ inch layer of crushed granules and functions as a stabilizer for the open-graded asphalt surface for paving. A drainage layer is used to separate the underlying native soils from the filter layer with a three inch layer or gravel over a reservoir course. An underdrain is required to meet storage/release criteria and overflow piping is necessary to minimize the chance of clogging. It is recommended that a 4"-6" perforated PVC pipe with 3/8 inch perforations at 6 inches on center, solid connectors should be used. Each pipe should have a minimum 0.5% slope and be placed 20 feet apart. An observation well is also required-in order to observe any changes in groundwater levels that may occur over a period of time. Examples of these layers can be more clearly demonstrated in Figures 9 and 10.



Source: http://www.dot.ca.gov/hq/LandArch/ec/lid/lid-permeable-paving-new.htm

Maintenance

If maintenance is not carried out on a regular basis, the porous pavements can begin to function more like impervious surfaces due to clogging. However, with more advanced paving systems the levels of maintenance needed can be greatly decreased. An example of this is plastic grid systems. Plastic grid systems are becoming more and more popular with local government maintenance personnel because they result in reduced gravel migration and increased weed suppression in public park settings.

Some permeable paving products are prone to damage from misuse, such as drivers who tear up patches of plastic & gravel grid systems by "joy riding" on remote parking lots at night. The damage is not difficult to repair but can look unsightly in the meantime. Grass pavers require supplemental watering in the first year to establish the vegetation, otherwise they may need to

be re-seeded.

A maintenance checklist for permeable paving would include:

- Posting signs that identify porous pavement areas
- Keeping landscape areas well-maintained to help prevent soil transportation and erosion onto the pavement
- Regular cleaning with a vacuum sweeping machine, or high pressure hosing
- Regular monitoring to ensure the surface is draining properly after storms
- It should not be resealed or repaved with impermeable materials
- An annual inspection for deterioration is recommended

Basic quick fixes for each type are available and fairly easy to do. Potholes and cracks can be filled with patching mixes, as long as less than ~10% of the surface needs repairing. Spot clogging can be fixed by drilling 0.5 holes through the pavement every few feet. Displaced gavel in open celled pavers can be refilled as needed.

Feasibility & Limitations

Major limitations to this practice are suitability of the site grades, subsoils, drainage characteristics, and groundwater conditions. Proper site selection is an important criterion in reducing the failure rate of using porous paving. Ownership and maintenance also heavily influence the success of a permeable pavement. Soil should be permeable and able to support adequate infiltration. Sandy and silty soils are critical to successful application of permeable pavements. Chlorides can easily migrate into ground water, so heavily salted pavement is not ideal. The surface material must be able to tolerate undulations from frost movements, and be able to bear frost. Since the Finger Lakes experience a colder climate porous material may require more in-depth consideration.

Cost

Some estimates put the cost of permeable paving at two to three times that of conventional asphalt paving. Using permeable paving, however, can reduce the cost of providing larger or more stormwater BMPs on site, and these savings should be factored into any cost analysis. In addition, the off-site environmental impact costs of not reducing on-site stormwater volumes and pollution have historically been ignored or assigned to other groups (local government parks, public works and environmental restoration budgets, fisheries losses, etc.) The City of Olympia, Washington is studying the use of pervious concrete quite closely and finding that new stormwater regulations are making it a viable alternative to stormwater ponds. The table below shows cost estimates below for various different kinds of porous pavement options.

Table 1

	Paved Area (sq ft)	Quote ($) Highest	Quote ($) Lowest	Quote ($ sq yd) Highest	Quote ($ sq yd) Lowest
Hot Mix Asphalt	36,225	98,600	92,620	24.50	23.01
Porous Asphalt	5,328	28,650	18,352	48,40	31.00
Porous Pavers	5,328	67,960	61,755	114.80	104.32
Porous Concrete	7,988	63,200	53,919	71.21	60.75

Conclusion

The proper utilization of pervious paving is recognized by Best Management Practice by the U.S. Environmental Protection Agency (EPA) for providing first flush pollution control and stormwater management. As regulations further limit stormwater runoff, it is becoming more expensive for property owners to develop real estate, due to the size and expense of the necessary drainage systems. Pervious concrete reduces the runoff from paved areas, which reduces the need for separate stormwater retention ponds and allows the use of smaller capacity storm sewers. This allows property owners to develop a larger area of available property at a lower cost. Pervious concrete also naturally filters stormwater and can reduce pollutant loads entering into streams, ponds and rivers; protecting our ecosystems and unique glacially made region.

Ribbon Driveways

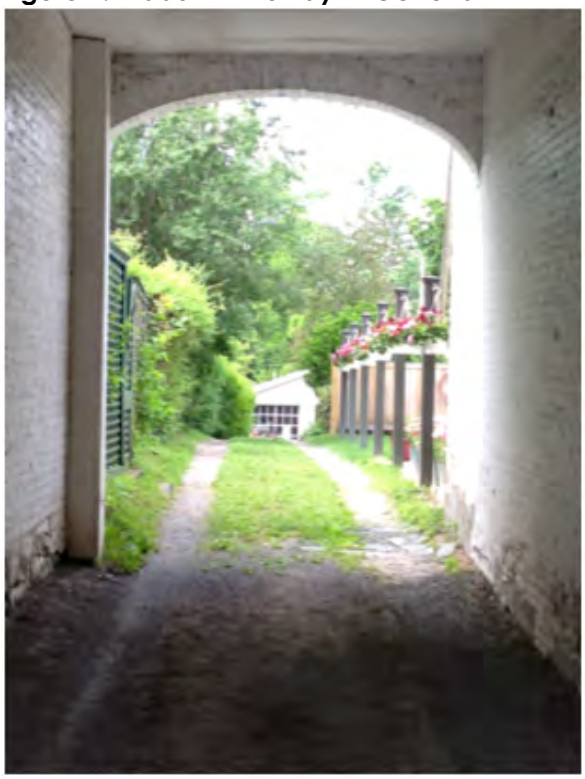
Ribbon driveways, (sometimes called Hollywood driveways), were popular in the 1920s to 1940s. Before driveways were paved ruts would form where the soil had been compacted down from the wheels continuously driving over particular areas. These ruts were then paved over with concrete, leaving the grass in the center, and the ribbon driveway was born.

Today, too many landscapes are dominated by impervious pavement. Ribbon driveways are an old school alternative to development that helps restore some green into our environments. Figure 1 to the left is an example of a ribbon driveway in the historic district of Geneva, NY on South Main Street.

Application in a Historic District

Ribbon driveways are actually already quite common in many of the historic districts in Ontario County, such as East Bloomfield, Canandaigua and South Main Street in Geneva. Many of these ribbon driveways actually also incorporate porous pavement, as the driving surface is often small pebbles or compacted dirt. In the past, ribbon driveways were also quite common in the region. Before the days of paving, people would pull their cars into their driveways and the tires would form ruts on the grass leaving only the patch in the middle. Once paving began (originally with concrete), the ruts were filled and the grass was left to grow. Therefore, incorporating ribbon driveways into individual properties is a low-cost green infrastructure technique, which can contribute to the historic character of any district.

Figure 1: Ribbon Driveway in Geneva



Source: Cari Varner, 2013.

Benefits

Because the entire surface of the driveway is not paved with a pervious material, ribbon driveways help prevent rainwater from immediately running off into stormwater sewers which runs into waterways untreated. This helps keep waterways clear of things like motor oil, fertilizers, and pesticides that often sit on driveways and contribute to non-point source pollution. Non-point source pollution is caused by rainfall or snowmelt moving over and through the ground. As run-off moves it picks up human made pollutants and deposits them into streams, creeks, and lakes. Impervious surface increases the momentum and velocity run-off has which allows the water to pick up and carry even more pollutants. A ribbon driveway would help slow the water causing sediment and pollutants to drop out or be caught by plants and soil and slowly filtered out.

Some further benefits of ribbon driveways include that they are often cheaper to install due to less surface area that needs to be paved over, and they are cooler in the summer to walk and play on due to less surface area absorbing the hot summer sun. Increased vegetation and less surface area also helps reduce the heat island affect. Ribbon driveways are now being encouraged and recommended in many historic communities and often help increase property values and the appeal of a neighborhood.

Types

There are many different styles and techniques of ribbon driveways that can be employed. The pavement surface can be traditional asphalt, but there are permeable pavement possibilities as well ranging from very inexpensive small stones to pavers and even driveways and carports made of grass that provide a greater reduction in stormwater run-off, while providing the same level of functionality for the driveway.

Small Stone Ribbon Driveways

These are the least expensive, and allow water to penetrate, but require more frequent maintenance because little stones are easily displaced. By "stones," it is imperative to use smooth stones, not crushed gravel, which lets water run off instead of down in the ground. Figure 2 is an example of how a gravel driveway can be transformed into a ribbon driveway using small stones, stone slabs, and paved strips.

Figure 2: Small Stone Driveway

Source: http://www.houzz.com/photos/exterior/ribbon-rug-/ls=4

Grass

Yes, it's possible to turn the asphalt or concrete of driveways into lawns. This is achieved by sinking a durable plastic grid into the ground and letting the grass grow in it. Vehicles can be driven on it, just like on a driveway, but if they are parked for extended periods of time, the grass won't grow. This can also be accomplished with products like PermaTURF, which are manufactured in New Hampshire and snow removal tested, and safe.

Figure 3: Pavers

Source: http://www.houzz.com/grass-driveway

Pavers

There are good-looking interlocking pavers that fit together like puzzle pieces but that have sufficient gaps between them to allow water to seep down into the ground. It is important to research what types of pavers you would like, as some have awkward and clunky spacing. Pavers are available in permeable and impervious materials, and the spacing between them allows run-off to be absorbed rather than running into a sewer.

Pervious (permeable) Concrete

Pervious (permeable) concrete is made by using less fine material in the concrete mix, allowing bigger particles to bind together and leaving more void space between them. Pervious concrete is very durable and local contractors are recommended for installation.

Porous Asphalt

This type of asphalt works on the same principle as the pervious concrete described above. It, too, is durable, but should be installed by an experienced contractor. These pavements, used mostly for parking lots, allow water to drain through the pavement surface into a stone recharge bed and infiltrate into the soils below the pavement

Site Specific Considerations

Zoning and Recommendations

Check your local building codes to see what is permissible in your location. The City of Geneva does not have any regulations specifically pertaining to ribbon driveways and many districts across the nation are starting to recommend the use of ribbon driveways, especially in historic areas. In fact, there are quite a few instances of ribbon driveways that already exist in the South Main Historic District.

Historic Overlay

Chapter 350, Article X Historic Zoning has specific procedures and regulations concerning the alteration of any historic structure. Many towns are now recommending a return to ribbon driveways in historic districts to help restore historic feel and may provide incentives.

Unless you have a very high skill level, hire a contractor, especially for permeable asphalt or concrete.

Siting and Soils

It is important that the subsurface is properly prepared and that there is a solid yet porous layer underneath. Building on heavy clay is not ideal because clay is very impermeable, therefore it's suggested to place a permeable surface on top of it to help. Consulting a local engineering firm or reliable contractor in this case is recommended. Genesee park is made up of soil classified as "Odessa". This type of soil is classified as being "somewhat poorly drained" and the potential for runoff ranges from medium to very high. Permeability is moderately slow in the surface layer and slow or very slow in the subsoil and substratum. Impervious surfaces enhance run-off and further inhibit water from being absorbed. Extra vegetation or an added layer of porous material may be recommended or helpful in slowing and minimizing erosion and run-off in this area.

Finally, make sure ribbon driveways aren't placed too close to a well. Water that is allowed to seep deep into the ground is purified as it trickles down through layers of soil, sand, and porous rock. However, if your well is close by, you may have no choice but to allow water to drain off to avoid contamination.

Site Preparation & Design

Construction

Usually, running strips around 18 inches wide is sufficient and the extreme outer width of the two 'tracks' of concrete or asphalt would need to be the width of a typical passenger automobile. If your driveway will need to accommodate big trucks then obviously the dimensions will have to be sized up accordingly. But this can easily be done by measuring the width of your own vehicles.

In some ways and in some cases, ground preparation is a little easier compared to traditional paving of driveways because it is often quicker and less expensive because the leveling isn't as critical and you might not need to dig as deep either.

Maintenance and Weather Conditions

In the winter a ribbon driveway may seem like a hassle, but the most modern way of laying a ribbon driveway is with plastic honey-comb like bases that can be shoveled, the makers of these are based in New Hampshire, so surely they're no strangers to snow either. Figures 4 and 7 show how these pavers can be used.

Other maintenance issues that should be considered before installing or converting to a ribbon driveway that are often overlooked include taking care of the strip in the middle of the "ribbons". This can be planted, returned to grass, or filled with gravel. However, most times this needs mowing, and weeding. Pavers are not suggested for plowing because the plow can catch edges. Ribbon driveways are admittedly slightly more difficult to maintain in the Finger Lakes region due to winter conditions, however; by paving with a porous material or planting along the edges of the drive run-off and pollutant loads can still be minimized.

Costs and Considerations

The following is a rough guide to the per-square-foot costs of materials when installed professionally:

- Pervious concrete: $4 to $8
- Porous asphalt: $4.60
- Grid systems for grass: $5 to $6.50
- Pavers: $12 to $15

A traditional dark black asphalt driveway costs around $1 to $5 per square foot. So for a 12x50 foot driveway, it would cost between $600 and $3,000. A quarter mile driveway is estimated to average between $21,000 and $52000.

Stamped and colored asphalt that looks like bricks costs approximately between $1800 to $6,000 for a 12x50 foot driveway.

For a typical concrete driveway it can be expected to pay the high end of the $3.73 - $4.21 per square foot range for a licensed, bonded and insured contractor and for complex or rush projects.

Other tips to keep in mind are that concrete lasts longer than asphalt in warmer climates, but asphalt lasts longer were the weather is cold. A rougher surface, such as small stones, can make snow removal more difficult, so you may have to consider a tradeoff between cost and convenience. It should also be considered if anyone in your household uses a wheelchair, a rougher surface obviously hinders accessibility and strips of pavement may need to be closer together, or with a set of wide set and then more narrow strips.

Conclusion

Ribbon driveways are an out of the box way to restore some creativity to property as well as an attractive way to benefit yourself, your community, and the environment. This type of project produces a myriad of benefits from helping reduce the heat island effect to increasing property values. By harnessing this technique as green infrastructure stormwater and pollution can be drastically reduced, as well as minimize the risk of flooding.

Shared Parking

Shared parking refers to areas or spaces that are used to serve two or more individual land-uses. This is when individual land-uses, either on the same site or from nearby sites form an agreement to share available parking space and/or land developable for parking.

Shared parking may be applied when land uses have different parking demand patterns and are able to use the same parking spaces/areas throughout the day. Shared parking is most effective when these land uses have significantly different peak parking characteristics that vary by time of day, day of week, and/or season of the year. In these situations, shared parking strategies will result in fewer total parking spaces needed when compared to the total number of spaces needed for each land use or business separately. Figure 1 shows how shared parking and driveways can be utilized in residential neighborhoods such as the South Main Historic District.

Application in a Historic District

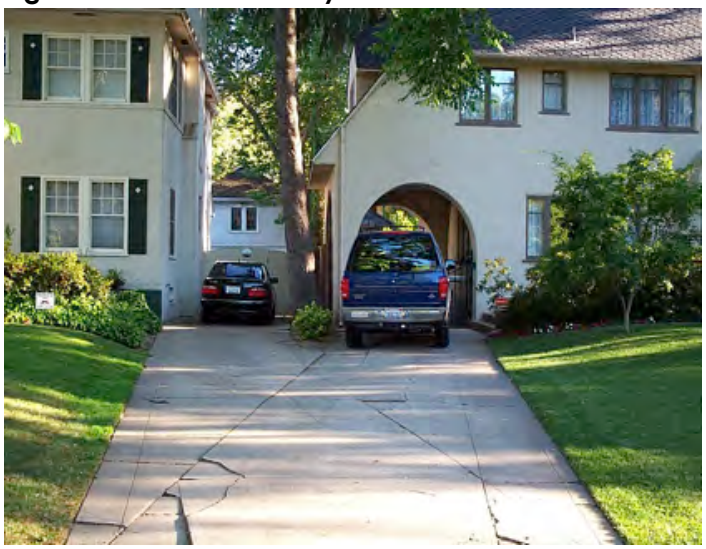
Shared driveways were actually quite common historically. In the past, prior to Zoning Codes which provided strict guidelines about the amount of parking required, many properties would share an access route, especially in downtown and urban areas where land area was limited. The benefits of shared driveways such as a lower installation price per property and the shared cost (and labor) of maintenance led to their popularity, which is apparent in historic districts such as Canandaigua. Shared driveways have no more visual impact than a traditional driveway, but the diminished paved space introduces the opportunity to increase green space, yards and gardens and of course, provide greater opportunity for stormwater to be filtered and reabsorbed into the ground. Shared driveways can even be combined with ribbon driveways and porous pavement to increase the amount of permeable surface.

Benefits & Objectives

The direct benefits associated with this type of green infrastructure include:

- Fewer watercourse or wetland crossings
- Fewer curb cuts, especially on State Highways
- Improved sight lines
- Less re-grading
- Preservation of significant trees, or other preservation or resource protection benefits.
- Reduce total impervious surface.
- Reduce road/parking construction costs.
- Provide safe access and adequate parking.
- Minimize disturbance to natural site hydrology.
- Improve site appearance
- Create opportunities for stormwater treatment and infiltration.

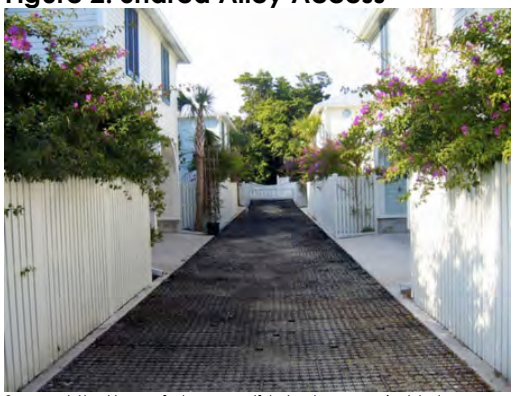
Figure 1: Shared Driveway



Source: http://home.comcast.net/~dempseys3/mpark/mpindex.html

The principal purpose of promoting shared parking is to reduce land devoted to parking, thereby allowing increased densities in urban areas or providing space for open spaces, walkways or other amenities. This will help communities develop better potential for transit and encourage pedestrian and bike commutes, reducing dependence on private vehicles. The overall goal of this and other growth management projects is to create a sense of community in every neighborhood and area of the region, helping individuals feel connected and establishing a sense of place.

Figure 2: Shared Alley Access



Source: http://www.forbes.com/fdc/welcome_mjx.shtml

Shared parking has the ability to not only reduce impervious landscapes, but have economic incentives such as reducing costs of developing and maintaining parking areas for businesses that agree to share parking between themselves. Shared parking increases communication and coordination between individual businesses, among business districts and neighborhood residents, and within large urban districts. By necessity, shared parking brings people together to consider how they can meet mutual needs.

Environmentally speaking, reductions in the amount of surface parking provided for each land use also means less impermeable surface. This means that there is more room for swales, vegetation, and other features that help prevent stormwater run-off from reaching storm sewers, slows the velocity in which water travels over the surfaces, and helps filter out pollutants that get picked up by stormwater such as oil, grease, pesticides, and fertilizers from lawns, driveways, and parking lots.

Residential Shared Drives

Shared driveways residentially offer shared plowing costs, and often extra parking for guests. The typical snow removal service could be between $25-$55, sharing with at least one neighbor would cut costs in half which could save a lot of money during the long winter months. The same principle applies with re-paving and re-surfacing. Some people are hesitant to share a driveway but most likely there will be no issues if you know your neighbors well. And if not, shared driveways are a way to connect to your neighbors and create more of a community feel in neighborhoods. Of course, it would be prudent to look at the deed to spell out restrictions in driveway use and maintenance, or write out a contract. It may also be useful to ask shared driveway owners how it is maintained, or when it was last paved, etc.

Site Specific Considerations & Criteria

Siting & Location

Here, in the Finger Lakes Region when tourism kicks up in the summer season this often results in busier streets, more crowded parking lots, and increased street parking. The Finger Lakes also host many different historic districts with shop lined downtown districts, and residential areas with unique architecture like row houses. Shared parking and shared driveways would help alleviate parking stress during these times without expanding existing parking areas and retaining historical integrity.

Land uses often involved in specific shared parking arrangements include:

- Offices
- Restaurants
- Retail
- Colleges
- Churches, Mosques, Temples etc.
- Cinemas
- Special event situations
- Private drives
- Public parks

Shared parking is often inherent in mixed-use developments that house one or more businesses that are complementary, ancillary, or support other activities, such as a small convenience store located in the lobby of an office building. General parking lots and/or on-street parking that is available for patrons of nearby businesses/commercial districts are other forms of shared parking. When applied at the district-wide level, it can produce appreciable results.

Figure 3: Parking

Source:
http://www.wbdg.org/ccb/AF/AFSUSTTOOLKIT/Strategies/Site/Strategies_SharedParking.shtml

Example

An example of how the application of shared parking as a growth management strategy produces results is further explained and demonstrated by Figure 4 below. By reducing the number of parking spaces needed by 0.5 spaces per 1000 square feet of gross leasable area built, based on each parking stall being 350 square feet (including the stall and associated circulation area), one acre of land can be saved for purposes other than surface parking for every 249,000 square feet of grass leasable area built.

Figure 4: Shared Parking Between Different Uses

Source: http://mashable.com/2012/04/20/parking-panda/

Narrower roadways, smaller parking areas, and smaller stormwater management systems often result in lower site development costs. Areas that have implemented more shared drives and parking lots have experienced lower average speeds, documented more room opened up for trees and landscaping, improved aesthetics, and reduced the heat island effect by reducing total impervious surface. This is all done by designs that reduce the amount of parking in big over-sized lots and break it up into multiple smaller lots separated by vegetation create more attractive developments.

Zoning & Historic Overlay

Alternative roadway and parking designs may conflict with local codes, which often have strict requirements for road widths and drainage systems, as well as the minimum amount of parking required. The City of Geneva does not have any regulations specifically pertaining to shared drives. However, the City of Geneva does have strict guidelines for the amount of minimum parking by use in each zone. These regulations basically do not allow shared parking systems within the City. However, it is still recommended to contact the proper personnel; many boards may be willing to adjust their standards if developers, advocates, and neighbors support the alternative design. Chapter 350, article X Historic Zoning also outlines different recommendations and regulations concerning the alteration of any historic structure.

Overflow Parking

Respondents who are not involved in shared parking arrangements expressed concern that lack of available space will send overflow parking into adjacent neighborhoods and parking areas. People who have experience with shared parking did not typically raise this issue. Good signage and routine enforcement can address any overflow concerns, as well as providing additional assistance for special seasonal or event parking arrangements.

Safety (and Perception of Safety)

Experience has shown that patrons will only use a parking facility if they feel safe. They need to feel that their car is safe from vandalism and theft, and that they can walk freely through an area without encountering danger to themselves. Shared parking will be most successful in areas that are perceived as safe by potential patrons. If the area does not promote a high user confidence level, additional security measures ranging from lighting to security patrols, may assist the signage. Shared parking also reduces crowded street parking-often making it difficult to see pedestrians and oncoming traffic.

Signage

Since many parking facilities are designed to minimize street frontages, thereby reducing visibility, participants in shared parking agreements should provide good signage. For a shared parking area or a shared driveway to be successful, signage must be visible and understandable to people using the area. Signs should indicate clearly where parking is available for each land-use. The signs should be placed at the business, at the street access point, and inside the lot. These signs should be aesthetically pleasing, informative and conform to all appropriate municipal codes.

Maintenance

For shared projects to be a success, maintenance must be on going and thorough. Aesthetics are important. Not only should the facilities have landscaping in good condition, the facilities should be relatively free from litter. Beyond standard upkeep and appearance, the facilities need to be without serious defect (i.e. pavement in good repair, no potholes, and striping and directional arrows should be clearly visible). Maintenance concerns should be addressed though a shared parking agreement between participants. This is particularly important in Historic Districts.

Concerns & Limitations

Many interviews, surveys, and studies have revealed a number of concerns about site design and operation, though none appear to be barriers to shared parking development. Often mentioned issues are:

- Liability
- Location
- Maintenance
- Parking Overflow
- Safety (and perception of safety)
- Enforcement
- Signage

Emergency service access is a common concern with reduced street widths. Where possible, these concerns can be addressed through education or multiple points of access to a site.

Cost

Narrower streets and smaller parking lots cost less than conventional streets because less grading, base material, and pavement is required. Open section roadways cost considerably less than standard designs due to the elimination of curbs and gutters. By increasing shared parking and opening up private or previously designated spots this increases the availability and ease of certain areas making it more convenient to visit and customers more likely to stop and browse.

Conclusion

Shared parking lots and driveways are easy ways to cut down on land used for impervious surface, and ugly lots. By increasing shared parking urban areas become not only less cluttered and often times more safe, due to increased visibility, but also much more appealing to the eye, encouraging more people to visit and make use of urban areas. The Finger Lakes region has pristine waterways and forests, with plenty of historic downtowns for visitors and tourists to enjoy, as well as year –round residents. Shared drives help ensure that this doesn't change, and offers a new way to cut-back on increased urban development that disturbs the beautiful nature and landscapes in the surrounding area.

Rain Garden

A rain garden is a shallow depression in the landscape that is planted with deep-rooted native plants and grasses. It is a green infrastructure technique that allows rainwater and stormwater runoff from urban areas and impervious surfaces, such as roofs, driveways and sidewalks to be absorbed back into the ground and reduces the potential for runoff pollution.

Introduction

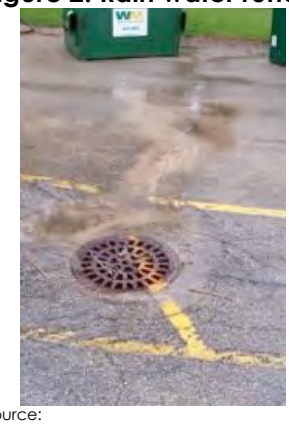
"A common problem for homeowners is what to do wet and soggy areas of their yard. Rain gardens help address both of these issues. A rain garden is a designated zone where water accumulates during storms and wet spells. Instead of grass, this area is planted with plants that are tolerant of standing water, and can also withstand the dry periods between storms." (See Figure 1)
(http://ferncreekdesign.org/raingarden.html)

Figure 1: Residential Rain Garden

Source: http://articles.washingtonpost.com/2011-07-20/lifestyle/35238427_1_ rain-garden-rain-forests-storm-water

Redirected stormwater is often warmer than the groundwater normally feeding a stream, which has resulted in some negative outcomes. The increase of warmer water flowing into waterways, where normally ground water flows in, can upset in some aquatic ecosystems primarily through the reduction of dissolved oxygen. Stormwater runoff is also a source where pollutants washed off hard or compacted surfaces during rain events. These pollutants can derive from both human and natural causes. Some examples of pollutants that can be carried by stormwater runoff are fertilizers, pesticides, bacteria from pet waste, eroded soil, road salt, grass clippings and litter.

Figure 2: Rain water runoff



Source:
http://www.uwgb.edu/facilities/stormwater/

The purpose of a rain garden is to improve water quality in nearby bodies of water. Rain gardens filter up to 99% of water pollutants through natural processes, making ground water safer and cleaner.

Rain gardens are a great technique to decrease the amount of stormwater that enters into sewer systems. Rain gardens are also a less costly alternative to traditional sewer treatment. Living in an ever-increasing urbanized society, the majority of land cover is made up of impervious surfaces. Some examples of impervious surfaces that contribute greatly to stormwater runoff are roofs, sidewalks, roads, and driveways. When it rains these surfaces cannot absorb the water, so the rainwater becomes run-off (See Figure 2). It is high-speed run-off and has high potential for infrastructure destruction. It can cause flooding, erode property and soils, and carry pollutants into streams, wetlands and lakes.

The purpose of rain gardens is to recall nature's natural filtration and retention process, while improving the visual aesthetics of the community. They also mitigate the potential for costly infrastructure, like pipes, drains and treatment facilities.

Application in a Historic District

The first rain gardens were in our native ecosystems. Before humans settled and began constructing the built environment with impervious surfaces, rain was filtered naturally through soil, roots, and plants in nature. Rain gardens were created as a result of trying to recreate the natural water filtration system. Stormwater specialists created the first conceived green infrastructure rain garden in Maryland in 1990. However, many conventional gardens were created not with stormwater runoff in mind, but worked as tool of filtration. In the Finger Lakes region, many of the historic districts before the twentieth century had gardens.

To the outside observer, rain gardens look much like any other garden. For this reason, they have a minimal impact on a historic district, and with any well-maintained garden, can actually contribute beauty and interest to the area. Gardens in general and rain gardens were very common in Ontario County, as the glacial soils here are very rich. Rain gardens, like other gardens, are entirely compatible with the aesthetics and character of a historic district.

Site Specific Consideration

Location

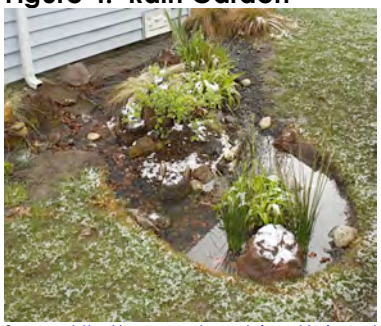
Although rain gardens look like a typical flower garden, they are designed specifically to capture and absorb rainwater from impervious surfaces. Since they have a distinct purpose, they need to be strategically placed. When constructing rain gardens, their location is very important to optimize the potential absorption of stormwater runoff. Therefore it is necessary for homeowners to observe their property and base the rain garden location on the specific characteristic of rain flow to determine the best location.

Figure 3: Rain Garden

Source: http://ferncreekdesign.org/raingarden.html

When it rains, a rain garden can fill a few inches of water and it allows water to slowly filter into the ground and soil. Compared to a patch of lawn, a rain garden allows up to 30% more water to soak into the ground. To successfully optimize the runoff absorption of a rain garden, it should be located between a water source (roof down spout, a paved surface, or a hill in your lawn) and where the water usually runs to, examples are a storm drain or a gutter. (See Figure 3 & Figure 4& Figure 5)

Figure 4: Rain Garden



Source: http://www.mychamplain.net/raingardens

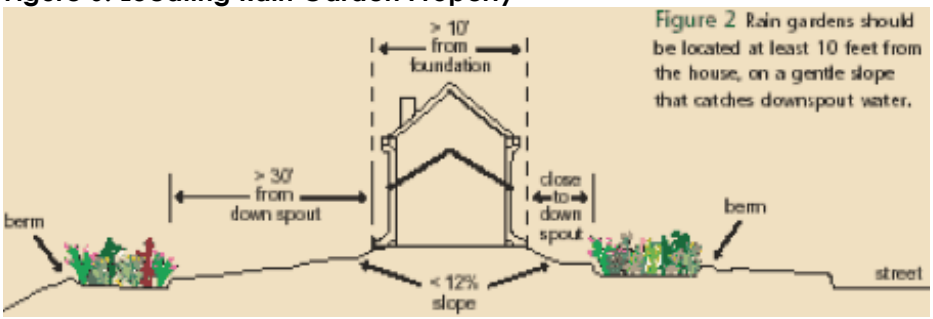
Figure 5: Rain Garden

Source: http://mtwatercourse.org/media/photos/LIDRainBarrel01.jpg

When locating where to place the rain garden on your property there are several different conditions that should be considered: (See Figure 6)

- Rain Gardens should be built at least 10 feet from a house or building.
- Think about the direction of flow from building downspouts/ sump pumps outlets, so that the rain garden is built on a low point in the lawn.
- Place the garden to take advantage of the natural drainage patterns that will direct garden overflow from the buildings.
- Locate the garden so it received full or partial sunlight.
- It should avoid areas over a septic system.

Figure 6: Locating Rain Garden Property



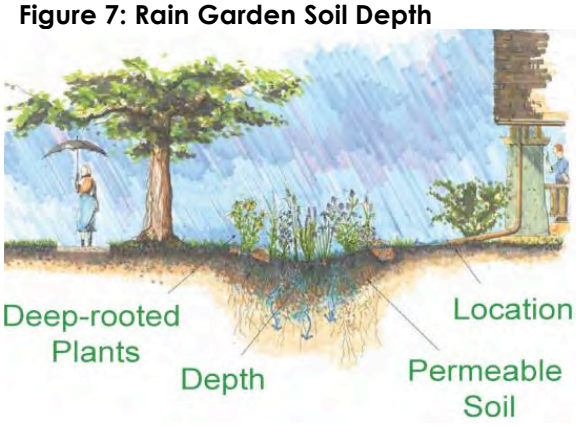
Source: (http://www.lakesuperiorstreams.org/stormwater/toolkit/raingarden.html)

Zoning & Historic Districts

The city of Geneva does not have any regulations specifically pertaining to the usage of rain gardens, however poisonous and noxious plants are prohibited from being planted. Chapter 350, article X Historic Zoning should also be looked at. This section outlines the procedures and regulations involving the alteration of any historic structure.

Soil

Figure 7: Rain Garden Soil Depth



Source: http://www.thecoves.ca/projects/pollution-solutions

Whenever it rains, water-flow from impervious surfaces is diverted into the garden, where there is maximum potential for water to infiltrate the ground and nourish the plants in the garden. The size and depth of the rain garden are based off of different environmental factor of the landscape.

Some of the dependent factors are soil type, slope and the size of the area that will be drained into the garden. Rain gardens must have good drainage location so it can soak in water within 24 hours after rainfall.

When an area's soils are not permeable enough to allow water to drain and filter properly, the soil should be replaced and an under-drain installed, which is a concealed drain with an opening that water can enter when it reaches drainage levels. The depth of the soils should be about 4 inches below the bottom of the plants roots. This bio retention mixture should typically contain 60% sand, 20% compost, and 20% topsoil. Bio-retention is the process that contaminants and sedimentation are removed from stormwater runoff through natural means. Existing soil must be removed and replaced. Do not combine the sandy soil (bio-retention) mixture with a surrounding, existing soil that does not have high sand content. Otherwise, the clay particles will settle in between the sand particles and form a concrete-like substance. Since most of the soils used in urbanized areas are reliant on chemical materials such as fertilizers it has a lowered rate of absorption, therefore it is necessary to test out the condition of your rain garden soil and if necessary, take the measures to build around the conditions of your soil. Preferred soil mixtures are discussed in the Cost & Products section below.

South Main Street is developed over Cayuga soil. Cayuga soils are undulating, rolling, and hilly soils on till plains where a thin fine-textured deposit from pro-glacial lakes overlies the till. The underlying till is derived from limestone, dolomite, sandstone or shale. This kind of soil is moderately well drained and the potential for surface runoff ranges from low to very high. Most areas with this type of soil are used for growing hay, pasture, small grains, and corn. Some areas are idle. Woodlots contain sugar maple, red oak, white ash, hickory, yellow birch and associated hardwoods.

To test for the condition of your soil, take a handful of soil from your future garden site and squeeze firmly. If your soil holds shape, poke it slightly. If it gently crumbles then it is in proper condition for being a rain garden. If after poking it the soil remains in the same shape then the soil has too much clay. If the soil immediately falls apart then it is too sandy. As described above, there is much variability in the drainage quality of Cayuga soils, so proper testing is imperative.

Soil Depth

For rain gardens, it is most beneficial to have the soil deep enough so that it can accept large roots, which initially should be about 24 inches deep. Deep plant roots also create additional channels for stormwater to filter into the ground (See Figure 7). Microbial populations feed off plant root secretions and break down carbon (such as in mulch or desiccated plant roots) to aggregate soil particles. This increases infiltration rates.

Slope and Depth

When you have determined what type of soil you have you can determine the size of the garden. This is based on of the soil type and the area you are going to drain, and example of this is by using the size of your roof. To generally measure the size of your rain garden you can multiply the drainage area by the appropriate value according to the slope of your property. The rain gardens surface is dependent on the storage volume of runoff water. The storage volume requirements but should not exceed a loading ratio of 5:1 (drainage area to infiltration area, where drainage area is assumed to be 100% impervious; to the extent that the drainage area is not 100% impervious, the loading ratio may be modified).

Another way to determine the slope of land where the garden is being built for the depth of the rain garden is by the rule of thumb:

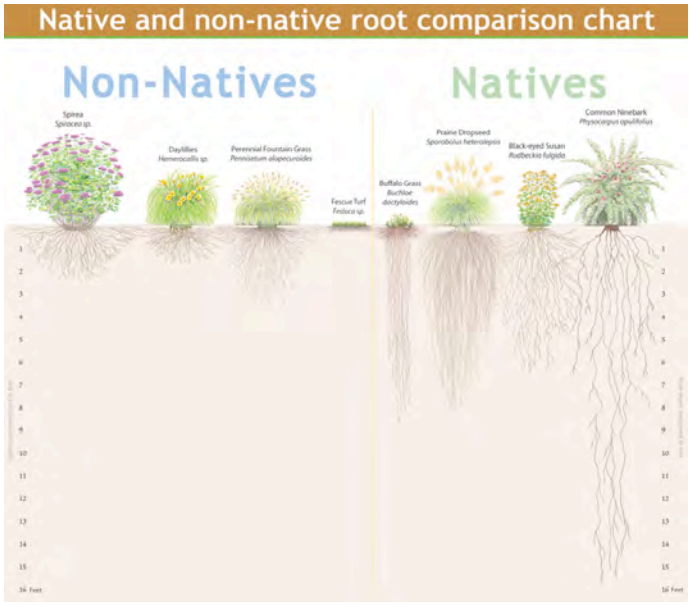
- Less than 4% slope: Dig garden 3-5 inches deep
- Between 5-7% slope: Dig garden 6-7 inches deep
- Between 8-12% slope: Dig garden 8 inches deep

Native Plants

Unlike natural gardens, rain gardens are made with the purpose of reducing water runoff; therefore it is essential for rain gardens to be constructed with the environment in mind. The plants in the rain garden play an essential role in the functionality and performance of the garden. Therefore, builders need to be conscious of the plants that are placed into the rain gardens. Planters must be conscious of species of plants that are in the rain garden, so there are a variety of plants, be sure it is a native species to ensure durability and that the plant can survive in ranging weather conditions.

It is preferred when installing a rain garden that native plants should be used. Native plants are the plants that originated in the area, it is the vegetation that grow and thrive in the environment since it originated there and is best suited for the environmental conditions. This is because native plants are best adapted to soil and temperature conditions of your neighborhood, tolerable to both saturated and dry soil. Using native plants is ideal because they can have a greater survival rate when tolerating the soil conditions. The roots of the native plants are able to flourish with the native soil. (See Figure 8). Native plants also work as a positive contribution to urban habitats for native spices and insects.

Figure 8: Native Plants Thrive in their native environment



Source: http://water-festival.org/2013/635/where-water-falls-rain-gardens-as-a-clean-solution-to-spring-stormwater-pollution/

Often, simply adjusting the landscape so that downspouts and paved surfaces drain into existing gardens may be all that is needed because the soil has been well loosened and plants are well established. However, many plants do not tolerate saturated roots for long and often more water runs off one's roof than people realize. Often the required location and storage capacity of the garden area must be determined first. Rain garden plants are then selected to match the situation, not the other way around.

Some native plants that are in the Finger Lakes region as advised in the NYS Stormwater Management Design Manual in Chapter 5, can be seen in Figure 9.

Trees

Well-planned plantings require minimal maintenance to survive, and are compatible with adjacent land use. Trees under power lines, or that up-heave sidewalk when soils become moist, or whose roots seek out and clog drainage tiles can cause expensive damage.

Trees generally contribute most to the functionality of rain gardens when located close enough to tap moisture in the rain garden depression, yet do not excessively shade the garden. Also, the shading open surface waters can reduce excessive heating of habitat. Plants tolerate inundation by warm water for less time because heat drives out dissolved oxygen, thus a plant tolerant of early spring flooding may not survive summer inundation.

Figure 9: Finger Lakes Region Ideal Native Plants

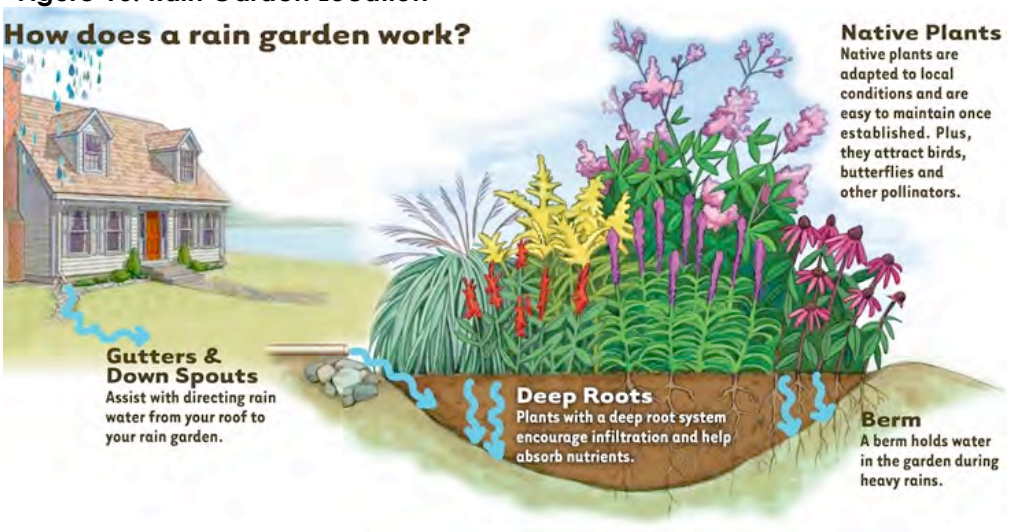
Table 5.11 Suggested Rain Garden Plant List	
Shrubs	**Herbaceous Plants**
Witch Hazel *Hamemelis virginiana*	Cinnamon Fern *Osmunda cinnamomea*
Winterberry *Ilex verticillata*	Cutleaf Coneflower *Rudbeckia laciniata*
Arrowwood *Viburnum dentatum*	Woolgrass *Scirpus cyperinus*
Brook-side Alder *Alnus serrulata*	New England Aster *Aster novae-angliae*
Red-Osier Dogwood *Cornus stolonifera*	Fox Sedge *Carex vulpinoidea*
Sweet Pepperbush *Clethra alnifolia*	Spotted Joe-Pye Weed *Eupatorium maculatum*
	Switch Grass *Panicum virgatum*
	Great Blue Lobelia *Lobelia siphatica*
	Wild Bergamot *Monarda fistulosa*
	Red Milkweed *Asclepias incarnate*
Adapted from NYSDM Bioretention Specifications, Bannerman, Brooklyn Botanic Garden.	

Source: http://www.dec.ny.gov/docs/water_pdf/swdm2010chptr5.pdf

Site Prep Design
Installation and Maintenance

1. Choose Garden Location: Walk your property while it's raining and find out where the water runoff lies (See Figure 10).
2. Check for underground pipes: Make sure before you dig to make the rain garden to have a utility mark the location of underground lines.
3. Select the Plants: Choose native plants that bloom at different times of the season and have a variety of heights, shapes and textures. Variety is Key!
4. Start Digging: A rain garden is usually one to two feet deep with a flat bottom and angled sides. Most are between 100 and 300 square feet in size.
5. Add the soil that is best for the environmental conditions.
6. Plant, water, and tend: After building the rain garden the job is not done. You need to water your rain garden, especially when it's first planted and during dry weather. Rain gardens also need to be regularly weeded and mulched.

Figure 10: Rain Garden Location



Source: http://www.watershedcouncil.org/learn/rain-gardens/

Cost

One of the most important factors involved with the rain garden project is the budget. According to the Watershed Activities to Encourage Restoration website, the cost associated with installation of the rain garden is about $3-$4 per square foot, depending on the soil conditions and the type of plants used. Although the cost is a little more than a typical landscaping job, it is because of the increased number of plants that are being used. However, it is also this initial expensive investment that will pay off in the near future, both environmentally and homeowner costs. Below is a chart from the Chesapeake Bay Foundation and their materials budget (See Figure 11).

As far as choosing which kind of soils to place in for your rain garden, the ideal soil mix to use is 50-60% sand, 20-30% topsoil (no clay) and 20-30% compost. The reason sandy soil is the most ideal is because unlike regular gardens, sand and loamy soil drains better than clay soil that can be waterlogged or compacted soil, which is normally found on developed land and sand will not mix well with it. Sand and loamy soils drain water well. Unfortunately most of the Finger Lakes region is filled with soil with a high clay content, so will be necessary to purchase soil that has a low clay level.

Figure 11: Example of Rain Garden Cost

Build Your Own Rain Garden
Sample Materials Budget

Material	Quantity	Price Each	Total Price	Source
2 x 12 #1 treated pine board	3	$15.00	$45.00	Hardware store
2 foot steel rebar	10	$ .96	$9.60	Hardware store
Stainless steel elbow brackets w/screws	2	$7.00	$14.00	Hardware store
40 lb. Bag topsoil	4	$3.00	$12.00	Donated by Nice Guy Landscaping Co.
20 lb. Bag sand	1	$5.00	$5.00	Donated by Nice Guy Landscaping
40 lb. Bag mulch	1	$3.00	$3.00	Donated by Nice Guy Landscaping
Straw bale	1	$5.00	$5.00	Donated by Sally's Dad
Screwdriver	1	$4.00	$4.00	Borrow from Janitor
Hammer	1	$12.00	$12.00	Borrow from Janitor
Shovels	3	$20.00	$60.00	Borrow from home
Rakes	2	$10.00	$20.00	Borrow from home
Total			**$189.60 + costs of plants and flowers**	

These prices are just estimates and will vary, depending on where you buy them. You may not need to **buy** everything on this list, and you may decide that you need items not included here. Your budget will also depend on the kinds of plants you decide to use, how many, and what size garden you design! And remember, if you are able to borrow materials, or have them donated, you can subtract them from the actual cost of the project. In other words, the total in this sample budget is $189.00, but the group only needs to raise $68.60 because many of the items have been donated or borrowed!

One more thing: don't forget to include the costs of your plants and flowers!

Source:
http://www.lowimpactdevelopment.org/raingarden_design/downloads/BaysaversRainGardenGuide.pdf

Conclusions

Environmental Benefits

There are many benefits of installing a rain garden. The first is the environmental benefits. Rain gardens improves water quality. Rain gardens filter contaminates from run-off, improving quality of water and recharging ground water.

Rain gardens also reduce stormwater pollution, by collecting and using rain water that would otherwise be drained into the sewer system. Rain gardens divert this water and decrease the flow of pollution to sewers and instead flow to waste water treatment plants (See Figure 12).

Rain garden reduce sewer flooding and overflow. If adopted on a community or neighborhood scale, rain gardens can reduce combined sewer overflows and localized flooding. Most importantly, by creating a holding zone for water that would typically end up in the gutter, the total volume of runoff from a storm is reduced. Rain gardens ultimately protect rivers, streams and greater bodies of water, and in particular the Finger Lakes, which are treasured bodies of waters in this area. Polluted stormwater that enters rivers and creeks untreated can hurt both water quality and the wildlife that inhabit them. Excessive runoff can also erode banks and increase downstream flooding as well. Rain gardens can help minimize both.

This has an important positive benefit to rivers, streams, and lakes where high runoff volumes cause many devastating effects. Instead, water is able to slowly seep back into the ground and replenish the water table. In a related way, storm runoff also picks up phosphorous and nitrogen from lawn fertilizers and street debris, as well as pollutants like gas, oil, antifreeze, and other chemicals which can also cause major problems for the streams and lakes that it drains into.

When this water is allowed to slowly seep into the ground, most pollutants will become attached to the soil, and removed from the water (See Figure 13). As a benefit to the homeowner, rain gardens provide a solution to existing wet spots where water naturally accumulates, or a beautiful and environmentally-friendly garden to replace an area of lawn.

Figure 12: Displaced rain water runoff

Source: http://www.watershedactivities.com/projects/fall/raingrdn.html

Benefits for Homeowners

Rain gardens reduce the potential for basement flooding. A rain garden gives runoff a beneficial, safe place to go, helping to keep it away from your home's foundation.

Rain gardens reduce garden maintenance. A rain garden essentially "waters itself," requiring little or no additional irrigation. In fact, rain gardens are more likely than other gardens to survive droughts. Periodic weeding, mulching and pruning are all the maintenance they need. Because you don't need to fertilize or spray them, they make your yard a healthier place for your children and pets as well.

Figure 13: Water Filtration

Source: http://www.watershedactivities.com/projects/fall/raingrdn.html

Rain gardens enhance curb appeal. Because are more tolerant of the local climate, soil, and water conditions, native plants are recommended for rain gardens. These plants also provide interesting planting opportunities, and are an attractive and creative alternative to traditional lawn landscapes

Rain gardens increase garden enjoyment. Rain gardens are not only pleasing to look it, they are an ideal habitat for birds, butterflies, and other wildlife.

Rain gardens reduce mosquitoes. In a properly designed rain garden, water will soak into the ground within a day or two, long before mosquitoes have the opportunity to breed. They can also be designed to attract the kinds of insects that eliminate pest insects.

With just a little effort, a rain garden can be a beautiful, low-maintenance addition to your lawn. Its contribution to our region's water quality may seem small. But if we all do our part, the total impact can be environment-changing.

Figure 14: Rain Garden

Source:
http://www.watershedactivities.com/projects/fall/raingrdn.html

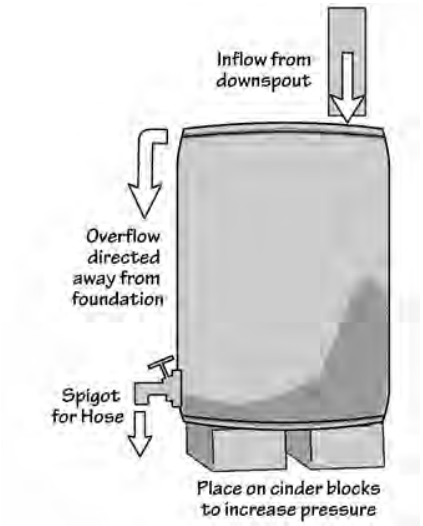
Rain Barrels

A rain barrel is a water tank used to collect and store rain water runoff, typically from rooftops via rain gutters. Barrels usually range from 50 to 80 gallons and have a spigot for filling watering cans and a connection for a soaker hose. Stormwater run-off can then be used later for lawn and landscaping irrigation or filtered and used for non-potable water activities and other uses that have a routine demand for water when in service.

Today, typically, 55 gallon plastic barrels are used for water collection and storage, although their size may vary from a few gallons to hundreds. These types of containers are very economical and affordable as well as extremely durable and weather hardy and may be constructed of any water-retaining material. Rain barrels consist of:

- a watertight storage container
- secure cover
- a debris/mosquito screen
- a coarse inlet filter with clean-out valve
- an overflow pipe
- a drain for cleaning
- and an extraction system (tap or pump).

Figure 1: Rain Barrel Parts



Source: http://www.lmvp.org/Waterline/2008number1/misc.html

Figure 1 demonstrates how a typical rain barrel functions. Additional features might include a water level indicator, a sediment trap or a connector pipe to an additional tank for extra storage volume. The storage containers are usually placed on riser blocks or a gravel pad to aid in gravity drainage of collected runoff and to prevent the accumulation of overflow water around the system.

A collection system can yield 623 gallons of water from 1 inch of rain on a 1,000 square foot roof. In arid climates, rain barrels are often used to store water during the rainy season for use during dryer periods. Harvesting rain water through the use of rain barrels often reduces mains water and the amount of water that runs into storm drains which has economic and environmental benefits, and aids in self-sufficiency. Some of the most common uses of harvested rainwater include:

- watering gardens
- agriculture/irrigation
- flushing toilets and can be used for washing machines
- washing cars
- toping off, or filling pools

- drinking, especially when other water supplies are unavailable, expensive, or of poor quality, and that adequate care is taken that the water is not contaminated or the water is adequately filtered.

Application in a Historic District

In recorded history, the use of rainwater collection can be traced as far back as ancient times some 3,000 years ago (850 BC). In the days of the Roman Empire, atrium fed rainwater collection cisterns were common place and to this day an important part of history. Although not documented photographically, it is known that many settlers in this region used rain barrels and catchment systems for washing clothes, bathing, cooking, and other uses. In today's modern world we have the ability to use a myriad of different catchment systems designed for specific collection and uses.

There are a wide variety of types of rain barrels made from diverse materials available today. Care should be taken to select rain barrels, which are compatible with the aesthetics and character of a historic district. Natural materials such as wood, or incorporating plantings on the top of the barrel, and using landscaping can help obscure the barrel and allow it to blend in with it's surrounding environment. Additionally, barrels can be sited on the backs of buildings, or painted the same color of the adjacent building. Examples of the successful integration of rain barrels into a historic district can be seen throughout the South Main Historic District in Geneva.

Benefits

Rain barrels have various different economic and environmental benefits associated with them; the following passages explain the most prominent. Since the rainwater is usually collected from the roofs of houses, it picks up little contamination when it falls.

Therefore, it is important to keep your roof clean of debris and potential contaminants to maximize purity. The material your roof is made of is also important in how much contamination the water will carry. The chemicals and hard water from many of our municipal water systems can produce an imbalance in the soil of your garden. Chemical fertilizers, fungicides, pesticides, and drought can also disrupt the balance and harmony of the soil. This imbalance causes trees and plants to weaken and makes them more susceptible to disease.

Figure 2: Rain Barrel with Planter

Source: http://bungalowclub.org/newsletter/summer-2009/rain-gardens-and-rain-barrels/

Healthy Plants and Soil

Trees and plants have an efficient immune system that allows them to fend off diseases and other invaders as long as they have a healthy soil environment and aren't stressed by other factors such as drought. Trees and plants rely on fungus, bacteria, and nematodes to help them absorb the minerals and nutrients they need. When you look at your garden, visualize it as a vast interconnected community of trees, plants and tiny critters that live in the soil, all interacting and affecting each other. Thus, the type of water you use in your garden will affect the health of this intricate community. Tap water contains inorganic ions and fluoride compounds that accumulate in the soil over time and potentially harm plant roots and microorganisms in the soil.

Rainwater does not contain the same additives found in tap water. It benefits plants in your garden by cleaning the soil of salt buildup, thereby promoting an environment conducive to root development.

Money Saver

Rain barrels save homeowners money on their water bills. Garden and lawn irrigation accounts for 40% of residential water use during the summer, according to the U.S. Environmental Protection Agency. By using rain barrels, homeowners can save 1,300 gallons of water during the growing season. Connecting multiple barrels maximizes rain capture which can provide a free water source for irrigation and ease reliance on the city's water supply.

Reduction of Run-off

Rain barrels help reduce the flow of storm run-off. When it rains, run-off picks up soil, fertilizer, oil, pesticides and other contaminants from hard surfaces and landscapes. Storm run-off is not treated and flows directly into streams, lakes and other bodies of water nearby. Run-off fertilizers increase algae growth in lakes, and excess soil alters the habitat for fish. Bacteria can even make lakes and oceans dangerous for recreational activities. Rain barrels capture water that would have swept over a paved surface or lawn, thereby minimizing run-off pollutants.

Types of Barrels

Figure 3: Plastic Barrel

Source: http://www.cleanairgardening.com/rain-collection-barrel.html

Figure 4: Disguised Rain Barrel

Source: http://www.organicgardening.com/learn-and-grow/rain-barrels?page=0,5

Figure 5: Clay Barrel

Source: http://www.rainwatersolutions.com/pages/moby-faq

Rainwater tanks may be constructed from materials such as plastic (polyethylene), wood, concrete, galvanized steel, as well as fiberglass and stainless steel which are rust and chemical-resistant. Tanks are usually installed above ground, and are usually opaque to prevent the exposure of stored water to sunlight, to decrease algal bloom. Rain barrels may be covered and have screen inlets to prevent insects, debris, animals and bird droppings from entering into the water.

Figure 6: Wood Rain Barrel on South Main Street, Geneva

Source: Photograph by Cari Varner, 2013.

There are a myriad of different types of rain barrels today, which Figures 3 - 5 demonstrate. The most common materials rain barrels are made out of are plastic, wood, galvanized metal, and ceramic clay or stone rain barrels. Wooden rain barrels are particularly complementary to historic areas, and have the ability to add to landscaping. Figure 6, is of a wooden rain barrel that can be seen in the historic district of Geneva, NY on South Main Street. Rain barrels that double as planters add some aesthetic value to your rain barrel and help it blend in as well, as seen in Figure 2. Many historic photos show elaborate vegetable and flower gardens in front of homes in Ontario County. Rain barrels help create a more historically accurate and aesthetically pleasing environment by encouraging more gardens, as seen, can even be planted themselves.

Climate

A full 55-gallon barrel represents a significant quantity of water. When filled, it weighs almost 500 lbs. If it's permitted to freeze, a number of unfortunate things might happen. For one, your drain spout might become plugged with ice and prevent drainage until the next thaw. The water contained in your hoses might freeze, splitting the hoses and releasing the barrel's overflow. In extreme cases, the barrel might split or crack from the pressure of the expanding ice. Below are a couple ways to help prevent this from happening this winter.

Taking Down the Barrel

Since, the Finger Lakes experience quite a bit of snow and cold weather, the most prudent course of action is to drain your barrel and store it for the winter. Open the bottom faucet and drain the barrel through a hose into your garden area, then drain and coil the hose. Do the same with the overflow, if it has a hose attached. Wash out the barrel with a gentle soap, and rinse it with vinegar and water. Store the barrel upside down in a sheltered location such as a shed or garage so it doesn't blow away during the winter.

Overwintering

If taking down the barrel is a nuisance, you might be able to safely overwinter your barrel while keeping it in use. You can do this by purchasing a dark-colored barrel or paint it a dark color to maximize solar warming. You should site the barrel on the south-facing side of your house, where it will receive the most sun, and when cold weather is in the forecast, insulate your barrel with an old blanket or with bags filled with dry autumn leaves. There are also now rain barrels made specifically to protect against freezing, for colder climates such as the Finger Lakes.

The links below provide helpful guides and reviews for different products and display the diversity that exists for rain barrel products.

http://www.organicgardening.com/learn-and-grow/rain-barrels?page=0,6
http://www.rainbarrelresource.com/

Site Design Criteria

Below is a DIY step by step guide to help walk you through the process of creating your own rain barrel and show you what you may need to expect and prepare for:

1. Start with a large, food-quality, plastic barrel and drill a hole in the cap of the barrel with

a large, 3/4-inch drill bit. While plastic is preferred because it won't rust, any large, waterproof container will work well.
2. Drill a second hole nearby along the side of the container about 1 or 2 inches from the top.
3. Flip the barrel over and drill a third hole into the base.
4. Determine the number of pipe adaptors (male) and couplings (female) needed to span the distance from the hole at the barrel base to the outer edge of the barrel.
5. Wrap each threaded adaptor end of piping with plumber's tape for a watertight seal.
6. Screw the sections together, making sure they're secure and tight.
7. Attach a curved coupling to the hole on the barrel base and connect the additional adaptors to the curved section. Join a spigot to the end of the attached pipe section. This will allow you to control the release of the collected water.
8. The hole on the side of the barrel is for the spigot. Secure a small piece of PVC pipe through the hole to connect the spigot.
9. Join the spigot to the pipe.
10. Attach a garden hose to the spigot.
11. To make a water collection funnel, cut a piece of window screening a little bigger than the PVC coupling and secure it with a hose clamp.
12. Slide the pipe into the large hole in the barrel.
13. To attach the rain collector to your house, find a location that is level. Remember that when the rain collector is full, it can weigh more than 400 pounds, so it's important to place it in a level location to keep the barrel stable.
14. Place the rain barrel on stacked cinderblocks to raise it off the ground. This provides room underneath the barrel for the release spigot and a watering can to access the rainwater. Make sure the cinderblocks are stable.
15. About 1 or 2 inches above the barrel along the gutter, cut out and hinge an elbow section.
16. Fit the base of the section with a metal screen.
17. Place a pad on the metal screen to soften the sound of rain hitting the metal.
18. When the barrel is full, the downspout can be hinged closed to stop the flow of water to the barrel.
19. Because most rain barrels hold only 55 gallons of water, you can stretch the garden's water supply even further for those dry summer months by adding additional barrels. Just make sure to redirect the surplus water.
20. When you install your rain barrel, add an overflow pipe, so that excess water can escape. Make sure that the overflow pipe is pointed away from your home's foundation.
21. Always keep a lid on your rain barrel to prevent any curious children or animals from toppling in, as well as preventing any potential mosquito populations from exploding.
22. If you treat your roof for pests or wood, be sure to unhook your rain barrel for at least two weeks.

Zoning & Historic Zoning

The City of Geneva does not have any regulations specifically pertaining to the use or placement of rain barrels, however, it is important that they are stabilized and on sturdy ground or surfaces to prevent spillage and/or harm. Chapter 350, article X Historic Zoning outlines procedures necessary concerning any alteration to a historic structure, so it is recommended to overview that section first.

For historic districts, maintaining the integrity of the built environment is of utmost importance. There are many rain barrel designs which can be utilized that minimize the visual impact, or are compatible with historic detailing. For example, rain barrels which are made of wooden materials (such as old wine barrels or similar), are obscured by vegetation, are painted to match

the color of the house, are placed in the back of the house etc. are all recommended so that the historic feel is maintained. In fact, there are already many instances of rain barrels that have been used by residents in the South Main Historic District.

Figure 7: A Typical Residential Roof

Source: http://www.rainbarrelresource.com

Site Preparation and Design

If you're wondering how many rain barrels you may want to purchase, or make, the following equation allows you to calculate an estimate of how much rainwater can be harvested from your roof.
First the catchment area must be determined, or the area of roof.
(L + gutters) x (W + gutters) = Catchment

It's important to know that for every single inch of rainfall on a 1,000 square foot roof, there are 623 gallons of rainwater that will be available.

Now to calculate the amount of rain you will be able to capture, use the following formula:
A = (catchment area of building)
R = (inches of rain)
G = (total amount of collected rainwater)

(A) x (R) x (600 gallons) / 1000 = (G)

For example, the average monthly rainfall in the Finger Lakes region between April and October is approximately 3 inches. The cost of water in Geneva is currently $4.28/1,000 gallons. That means about 1,869 gallons of water will run off a 1,000 square foot roof during that 6 month period, which means if captured homeowners could save about $100 dollars on their water bill each year. Especially considering that water usage increases during peak summer months.
Table 1 below shows average monthly rainfall in Geneva, New York. The link below the table allows you to look up more rainfall averages for the Finger Lakes Region so you can calculate your own potential savings and figure out how big a rain barrel, or how many, you may want.

Table 2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. High	30°	31°	41°	54°	66°	75°	80°	78°	71°	58°	47°	35°
Avg. Low	14°	15°	24°	35°	45°	55°	60°	58°	51°	40°	32°	21°
Mean	22°	24°	34°	45°	56°	65°	70°	68°	61°	50°	40°	28°
Avg. Precip.	1.8 in	1.8 in	2.1 in	2.9 in	3.0 in	3.7 in	3.0 in	3.1 in	3.3 in	2.9 in	3.1 in	2.5 in

Contamination and Maintenance

If rainwater is used for drinking, it is often filtered first. Filtration may remove pathogens. While rain water is pure it may become contaminated during collection or by collection of particulate matter in the air as it falls. While rain water does not contain chlorine, contamination from

airborne pollutants, which settles onto rooftops, may be a risk in urban or industrial areas. Many water suppliers and health authorities, such as the not advise using rainwater for drinking when there is an alternative mains water supply available. However, reports of illness associated with rainwater tanks are relatively infrequent, and public health studies have not identified a correlation. Rainwater is generally considered fit to drink if it smells, tastes and looks fine. However some pathogens, chemical contamination and sub-micrometre suspended metal may produce neither smell, taste and not be visible.

To keep a clean water supply, the rain barrels must be kept clean. It is recommended to inspect them regularly, keep them well-enclosed, and to occasionally empty them and clean them with an appropriate dilution of chlorine and to rinse them well. They can be cleaned by using a stiff brush to scrub all inside surfaces. A good disinfecting solution is 1/4 cup 5.25% liquid chlorine bleach in 10 gallons of water. Flush the barrel thoroughly with clean water to remove sediment after construction, cleaning or maintenance. Keeping gutters, gutter guards, downspouts, and roof washers free of foreign materials, clean, and uncluttered also helps keep water clean and free of pollutants. If still worried about pollution-it is recommended to apply the water to the soil around plants, rather than directly on the plants themselves. By doing this you allow soil to perform it's role as a filter and help recharge your soil with compost, as well as tramps heavy metals so they are not taken up by your plants.

Pests

Mosquitos can quickly become a problem because larvae thrive in stagnant water. This can be prevented by ensuring you have a sealed water tight cover, or by adding a small amount of cooking oil to the surface. Cooking oil suffocates the larvae, but does not compromise sanitation. Bleach can also help prevent mosquitoes. Finally, by placing a screen a top of the downspout leaves and debris that washes down into the storage tank is minimized. If a screen is unsightly, exposed openings can also be screened with shrubs or other landscaped features.

Drainage & Irrigation

If present, a rain barrel's continuous discharge outlet should be placed so that the tank does not empty completely, ensuring water availability at all times, while also providing at least some storage capacity for every storm. A diverter at the cistern inlet can redirect the "first flush" of runoff which is more likely to have particulates, leaves, and air-deposited contaminants washed off the roof. A first flush feature captures the first 5-10 gallons of water that comes off your roof and holds it separately from subsequent water that goes into the main storage tank. These first flush gallons contain the majority of dust, pollen, bird waste etc. that builds up between rains and can still be used on ornamentals or lawn away from vegetable gardens.

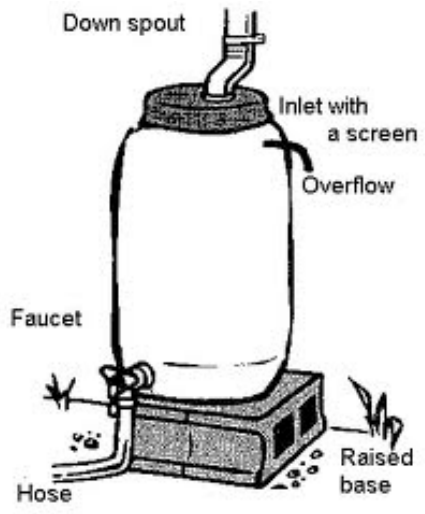
Keep your rain barrel reasonably clean. Rinse it thoroughly at the end of each growing season and as you have the opportunity throughout the summer. If you notice that its contents seem particularly mucky or smelly, drain the barrel, rinse it out, and start afresh with the next rainfall. In summary, maintenance includes checking roofs and rain gutters for vegetation and debris, maintaining screens around the tank, and occasionally desludging (removing sediment by draining and cleaning the tank of algae and other contaminants).

Rain Barrels and Roofing

Certain paints and roofing materials may cause contamination. In particular, it is advised that lead-based paints never be used. Tar-based coatings are also not recommended, as they affect the taste of the water. Zinc can also be a source of contamination in some paints, as well as galvanized iron or zincalume roofs, particularly when new, should not collect water for potable use. Roofs painted with acrylic paints may have detergents and other chemicals

dissolve in the runoff. Runoff from fibrous cement roofs should be discarded for an entire winter, due to leaching of lime. Chemically treated timbers and lead flashing should not be used in roof catchments. Likewise, rainwater should not be collected from parts of the roof incorporating flues from wood burners. Overflows or discharge pipes from roof-mounted appliances such as air-conditioners or hot-water systems should not have their discharge feed into a rainwater tank.

Figure 8: A Typical Rain Barrel



Source: http://www.stepbystep.com/how-to-build-a-rain-barrel-108267/

Considerations

Initial sizes typically range in capacity from around 100 to 25,000 gallons for larger commercial or residential uses. The most common rain barrels are usually plastic and hold about 55 gallons. Depending on predicted rainfall, and intended use, the consumer has the ability to choose from a diverse range of sizes. Some considerations before opting for bare minimum, or a more expensive larger barrel is the supply desired. The area of roof draining into the barrel, and intended use and typical consumption of water for certain activities such as washing a car, irrigation, garden use, watering a lawn, or topping off a pool are a few further considerations that should be made.

Concerning safety- Your rain barrel must be secured on a firm, level surface. A full 55-gallon rain barrel weighs over 400 lbs. and tipping is a risk if it's unsecured or on uneven ground. The barrel must be structurally sound and should be a food-grade container made to hold liquid. Containers such as trash cans are not designed to withstand the pressure of the water.

Cost

Rainwater tanks may have a high (perceived) initial cost. However, many homes use small scale rain barrels to harvest minute quantities of water for landscaping/gardening applications rather than as a potable water surrogate. These small rain barrels, bought new or can be recycled from food storage and transport barrels or, in some cases, whiskey and wine aging barrels, are often inexpensive. There are also many low cost designs that use locally available materials and village level technologies for applications in developing countries where there are limited alternatives for potable drinking water.

Although costs vary somewhat between manufacturers, in general, the cost of a single, rain barrel roof top water catchment system, minus the down spout and other accessories, averages about $120. Costs to a homeowner can be reduced still further by constructing his or her own barrel, which can be done with basic supplies for as low as $20.

While rain barrel installation costs are relatively easy to quantify, the costs savings, both to the individual and the local utility system are not as easy to measure. Nevertheless, it is reasonable to expect that widespread use of rain barrels or cisterns will decrease the hydraulic loads and hence the costs required for the construction and maintenance of off-site storm drain systems. The reduction in volume on the local water distribution system can extend the overall life of it.

Below, in Table 2, is a sample cost estimate for a single rain barrel, minus the downspout, in a residential area for use in small-scale irrigation and gardening purposes only. The estimate assumes that the homeowner, garden group, or volunteers provide the labor, including

assembly of rain barrel if necessary. The disturbed area is considered to be minimal and small enough to avoid any permits and fees. The following are average costs for a typical, newly manufactured rain barrel plus optional accessories.

Table 3

ITEM	***COST***
Rain Barrel with sealed top	$120
Overflow Kit/Runoff pipe	$35
Rain Diverter	$18
Soaker Hose	$21
Linking Kit	$12
Spigot, if not supplied	$5
Additional Guttering	$5
TOTAL ESTIMATED COST:	**$216**

Conclusion

As stated before, in Geneva, water costs $4.28 per 1,000 gallons. The average person uses 50 gallons per day just for household utilities. In the U.S. approximately 7.8 billion gallons of the 26 billion gallons consumed daily are devoted to outdoor uses. In the summer this amount of water can exceed the amount used for all other purposes in the entire year. The typical suburban lawn consumed 10,000 gallons above and beyond rainwater each year. The EPA estimates that about 40% of total household water use in the peak summer months could be saved by using rain barrels to capture rainwater. This season in particular has exceeded average monthly rainfalls and harvesting even a fraction of that water can help save homeowners money, reduce stormwater run-off and flooding, help decrease demand and stress on local water systems, and reduce the amount of non-point source pollution that flows untreated into our precious waterways during storms.

For further tips and guides about cleaning, maintenance, and/or environmental impacts visit the link below, or see the attached link to the EPA guide about harvesting rainwater.
http://www.rainbarrelman.com/faq.htm
http://water.epa.gov/polwaste/nps/upload/rainharvesting.pdf

Tree Plantings & Pits

Tree planting usually refers to concentrated groupings of trees planted in landscaped areas while tree pits, also called tree boxes, generally refer to individually planted trees in contained areas such as sidewalk cut-outs or curbed islands. Tree planting can be used for landscaping, stormwater management practice areas, conservation areas and erosion and sediment control. Conserving existing trees or planting new trees at new or redevelopment sites can reduce stormwater run-off, promote evapotranspiration, increase nutrient uptake, provide shading and thermal reductions, and encourage wildlife habitat.

Tree plots and planting trees are not only aesthetically pleasing, they also raise property values, and lend to a historic neighborhood feel. Streets and walkways are vastly improved by an increased number of trees also because the leaves, branches and trunks of street trees can capture up to 30% of a typical rainfall event through absorption and evaporation. Tree root systems can absorb up to another 30%, resulting in reduced stormwater runoff and potential flooding. This also results in less man-made drainage infrastructure. Furthermore, leaves absorb many pollutants, like CO^2, and provide shading which can lower temperatures up to 15 degrees Fahrenheit, reduce traffic noise levels, and help prevent ground level ozone-which often contributes to smog and other harmful pollution that caused respiratory problems in many elderly people and children.

Figure 1: Street Trees in Canandaigua

Source: Ontario County Historic Museum

Figure 2: Street Trees in Geneva

Source: Geneva Historic Society

Application in a Historic District

In the past, many downtowns such as Canandaigua featured wide, tree-lined streets. Figures 1 and 2 are old photos of Wilber Street in Canandaigua, and South Main Street in Geneva from the early 1900's. These trees provided shading for pedestrians, introduced greenery into urban areas and of course, mitigated stormwater run-off. As downtowns developed, street trees were often removed to allow motorists easy views of the storefronts or

removed due to maintenance concerns. Today, street trees and tree pits are experiencing a revival. Tree pits built with materials like wrought-iron fencing or low brick walls are especially compatible with historic districts, and enhance the historic feel. For example, downtown Canandaigua is currently undergoing a major renovation of its sidewalks and adding tree pits with the specific intention of introducing green infrastructure. Trees and tree pits are a welcome addition to any historic district, and do not infringe on the historic integrity of the area, but rather contribute to it.

Benefits

The benefits of tree plots and general planting of trees include, but are not limited to:

- Increased property value
- Increase in aesthetics
- Reduced stormwater run-off and velocity of water moving over impervious surface
- Decrease in air, water, and soil pollution through aided and addition filtration methods
- Provide microhabitats
- Increase in shading provided
- Buffer traffic noise
- Reduce heat island effect

Figure 3: Street Trees

Source: http://actrees.org/news/trees-in-the-news/research/mature-trees-significantly-reduce-energy-use-in-urban-areas/

Recommended Application of the Practice

Conservation of existing trees is recommended where stands of existing trees are non-invasive, healthy and likely to continue to flourish in the proposed site conditions. Planting of new trees is recommended for areas that will remain or become pervious in the proposed condition and are large enough to sustain multiple trees. Planting of trees in tree pits is recommended in street rights-of-way or other small-scale pervious areas in highly impervious redevelopment sites that can support limited tree development.

Tree plots can also be used in more creative ways to help break up impervious structures in unconventional places, or areas that are typically hostile environments. A couple examples of this can be seen below in Figures 4 and 5.

Figure 4: A Creative Use of Street Trees

Source: "Trees as Green Infrastructure" By David Elkin.

Figure 5: An Unusual Vessel for Street Trees

Source: "Trees as Green Infrastructure" By David Elkin.

Figure 4 shows tree plots in an open plaza, trees could be planted like this in parking lots --sloping the pavement towards the base of the trees. This would help drain stormwater, decrease run-off, and filter the water of pollutants; while providing shading and helping cool the temperature of the asphalt and surrounding area. Figure 5 shows how abandoned train cars can be repurposed by planting trees, a creative way to make otherwise barren sites more appealing to the eye.

Site Specific Considerations

Environmental & Landscaping Elements

Before construction begins the following should be considered and standards met.

- Adequate space must be provided for each tree to grow.
- Trees should be selected for diversity and to promote native, non-invasive species.
- Soil quality and volume may be poor. Soil amendments and de-compaction may be required prior to planting. Heavy equipment traffic should be limited in the vicinity of both existing and proposed tree planting areas.

Soil

In pursuit of soil volumes required to grow environmentally productive urban trees techniques can be used that rely on the inventive use of space and augmented construction methods. Space permitting, the easiest way to achieve target volumes is an open planting area (10 feet by 34 feet by 3 feet tree pit). Since this is usually not possible in heavily paved areas, augmented techniques using covered soil in combination with open soil can be used. These include the use of root paths (narrow trenches of un-compacted soil under pavement to connect the planting area to nearby volumes of soil), structural soils and suspended-pavement systems.

Professor Nina Bassuk and colleagues at Cornell University, solved the compaction problem by mixing angular one-inch crushed stone with planting soil, at a stone-to-soil ratio of 4:1. The stone pieces form a load-bearing "rigid lattice" leaves space for un-compacted soil.

Figure 6: A Street Tree in an Urban Area

Source: http://erbology.com/2011/04/15/classy-upper-east-side-street-tree-pits/

Suspended-pavement systems offer the best combination of structural strength and large volumes of quality soil. A suspended-pavement system consists of an underground post-and-beam structure and a deck with pavement on top. The structure supports the weight of the pavement and additional loading by pedestrians and vehicles, leaving the space for large volumes of un-compacted soil for root growth and storm-water treatment. This approach also protects pavement and curbs from the rogue roots of cornered trees.

South Main Street Historic District is developed over Cayuga soil. Cayuga soils are undulating, rolling, and hilly soils on till plains where a thin fine-textured deposit from pro-glacial lakes overlies the till. The underlying till is derived from limestone, dolomite, sandstone or shale. This kind of soil is moderately well drained and the potential for surface runoff ranges from low to very high. Most areas with this type of soil are used for growing hay, pasture, small grains, and corn. Some areas are idle. Woodlots contain sugar maple, red oak, white ash, hickory, yellow birch and associated hardwoods.

Zoning

Zoning codes for the city of Geneva state that it is prohibited to allow hedges, shrubs, or trees to encroach onto public sidewalks and lines of sight of public roadways. It also states that trees must be spaced according to the species size class (small trees must be spaced 15 ft, medium 25 ft, and large trees 35 ft) and that tree lawns (the grassy area between the curb and sidewalk) must be at least 4 feet wide for small tree planting, and at least 6 feet wide for medium to large trees. Further regulations that may affect the planting of trees include:

- No street tree shall be planted within 35 feet of a street corner
- No street tree shall be planted within 10 feet of a fire plug or utility pole
- No street tree other than those species listed as small shall be planted under or within 10 horizontal feet of an overhead utility wire

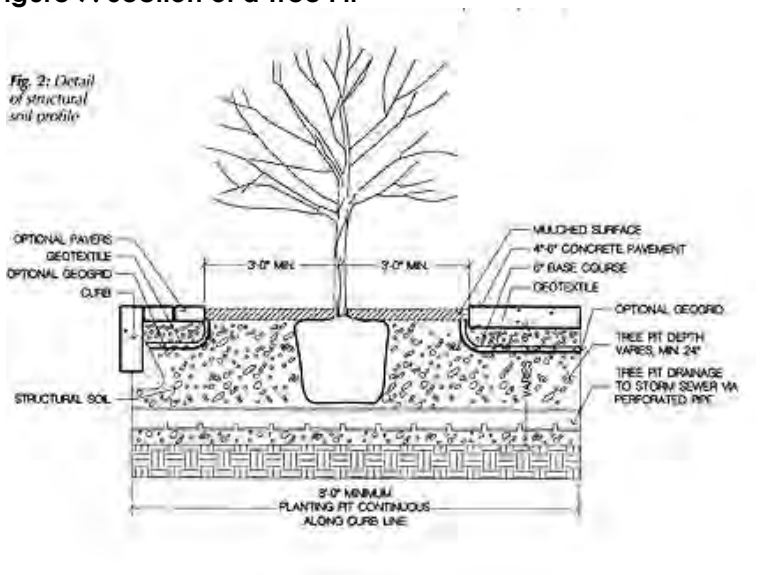
It is asked that owners of any tree overhanging any street or right-of-way within the City of Geneva shall prune the branches so that such branches shall not severely obstruct the light from street lamps or obstruct the view of any intersection, and so that the lowest branches are at least 13 feet above the street surface and at least 8 feet above the sidewalk surface.

If for some reason a tree on your property is dead, or diseased, it is the owners responsibility to remove any broken or decayed limbs, which are considered a menace to public safety. Because of this you may need to first consult with local officials to discuss waivers for alternative designs.

There are also specific procedures that must be adhered to concerning the alteration of the appearance of any historic structure, so it is recommended to review this which can be found in chapter 350, article X Historic Zoning.

Sizing and Design Criteria

Figure 7: Section of a Tree Pit



http://www.state.nj.us/dep/parksandforests/forest/community/tree_planting_specs.html

For tree planting, the area considered for runoff reduction is limited to the pervious area in which trees are planted. In an urban setting where trees are contained by impervious structures such as curbs and sidewalks, the area is calculated as follows: For up to a 16-foot diameter canopy of a mature tree, the area considered for reduction shall be the area of the tree canopy. For larger trees, the area credited is 100 square feet per tree. A typical planting detail specifies a 4 foot by 10 foot tree pit carved out of highly compacted soil and surrounded by pavement.

An alternative sizing for run-off reduction in urban settings may follow the bio-retention or stormwater planters design and sizing. In these cases, the sizing of the practice relies on the storage capacity of the soil in the cavity created for the root ball of the tree and ponding area. The infiltration rate for this type of planter must be a minimum of 2 inches per hour.

Retooling underground infrastructure to accommodate high quality, un-compacted soil enables the growth of large-canopy trees and the absorption of large volumes of stormwater.

Required Elements

Conservation of existing native trees during the development process should be managed in a systematic manner using the following steps:

1. Inventory existing trees on-site.
2. Identify trees to be protected.
3. Design the development with conservation of these trees in mind.
4. Protect the trees and surrounding soils during construction by limiting clearing, grading and compaction.
5. Protect and maintain trees post construction.

Figure 7 is a cross section showing how a tree planter can be implemented.

New Trees

For planting of new trees, maximize the use of pervious areas on the site that are good locations for tree planting. For example: road rights-of-way, landscaped islands in cul-de-sacs or traffic circles, parking lots, and private lawns. These urban planting sites may have harsh soil and environmental conditions that must be addressed through appropriate species selection or proper site preparation prior to planting. However, as Figures 8 & 9 below show—it's more than possible to overcome these issues.

Figure 8: A Street Tree with Parking

Source: "Trees as Green Infrastructure" By David Elkin.

Figure 9: Street Trees with Sidewalks

Source: "Trees as Green Infrastructure" By David Elkin.

Where the new trees will be planted:

- The tree species must be chosen from an approved list of local native species
- New trees planted must be planted within 10 feet of ground-level, directly connected impervious areas.
- New deciduous trees must be at least 2-inch caliper and new evergreen trees must be at least 6 feet tall to be eligible for the reduction.
- A 100 square-foot directly connected impervious area reduction is permitted for each new tree. This credit may only be applied to the impervious area adjacent to the tree.
- Recommend minimum 1,000 cubic feet soil media available per tree.

For new trees, the average slope for the contributing area, including the area under the canopy must not be greater than 5%. The maximum slope can be increased where existing trees are being preserved. Slope specifications for filter strips and buffers should be followed as guidelines. The maximum reduction permitted, for both new and existing trees, is 25% of directly connected ground level impervious area.

Figure 10: New Trees in a Plaza

Source: "Trees as Green Infrastructure" By David Elkin.

Figure 11: Trees in Parking Lot

Source: "Trees as Green Infrastructure" By David Elkin.

Information about native trees, shrubs, and plant species as well as guides for transplanting, tips, and directions can be found on the Finger Lakes Native Plant Species website, and there are guides provided by Cornell online as well.

Some suggested trees that are native to the Finger Lakes region are listed below. They are characterized by having the ability to thrive in full to partial sun and shade, and moist to well-drained soil to periods of dry soil with hardiness levels that span 4-9, lower numbers are associated with more moist soils and higher numbers with dry soil.

Large Trees

Common Name: Katsura Tree, Scientific Name: Cercidiphyllum japonicum
Hardiness Zone: 5a, prefers full sun, tolerates partial shade, pH: < 8.2
Height: 40'-60' (can reach 100' in the wild), Width: quite variable, 25'-60', grows medium to fast relatively pest free, resistant to Verticillium Wilt
Transplant Issues: easy to transplant B&B or < 2" caliper bare root, and is suggested for wide street tree lawns/pits and parks due to size and drought sensitivity

Common Name: Whitespire Sr. Gray Birch Scientific Name: Betula populifolia 'Whitespire Sr.'
Hardiness Zone: 4a (consistently moist-occasional periods of dry soil), full sun is preferred, pH: <7.5
Height: 40', Width: 25', grows medium (possibly fast)
Insect/Disease Factors: shows some resistance to bronze birch borer, reportedly leafhopper resistant
there are no known management issues of significance, and are suggested for narrow or wide street tree lawns/pits (preferably wide lawns/pits for multi-stem form), parks

Figure 12: Sugar Maple

Source: Recommended Urban Trees: Site Assessment and Tree Selection for Stress Tolerance, Urban Horticulture Institute at Cornell University

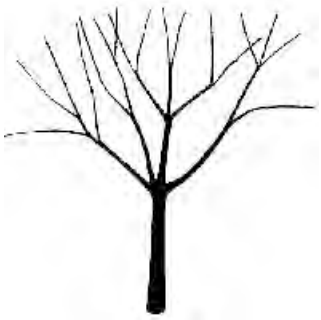
Common Name: Sugar Maple, Scientific Name: Acer saccharum
Hardiness Zone: 4 (consistently moist, well drained soil-occasional periods of dry soil), full sun is

preferred, pH: < 7.5
Height: 45'-50' typical, 60'-75' possible (can grow 100'+ in wild), Width: 35'-40' typical, 55'-70' possible, grows slow to medium
Transplant Issues: easy to transplant B&B or < 2" caliper bare root, has no significant management issues and is suggested for wide street tree/pits due to drought sensitivity, parks

Small Trees

Common Name: Trident Maple, Scientific Name: Acer buergerianum
Hardiness Zone: 6a (consistently moist, well drained soil, occasional periods of dry soil, prolonged periods of dry soil), prefers full sun, pH: < 7.5
Height: 20' - 25', Width: 20'-25', grows slow to medium, but typically slow
difficult to transplant B&B, may require pruning for low branching, is suggested for wide street tree lawns/pits, narrow tree lawns/pits with pruning, and parks. There are no insect or disease factors that are serious or limiting

Figure 13: Trident Maple



Source: Recommended Urban Trees: Site Assessment and Tree Selection for Stress Tolerance, Urban Horticulture Institute at Cornell University

Common Name: Goldenraintree, Scientific Name: Koelreuteria paniculata
Hardiness Zone: 5b (consistently moist, well drained-occasional dry periods-prolonged periods of dry soil), prefers full sun and tolerates heat well, pH: < 8.2
Height: 30' (can reach 40'), Width: 30', grows medium to fast
easy to transplant B&B or < 2" caliper bare root, has no significant management issues and is suggested for narrow or wide street tree lawns/pits, parks, suitable for CU-Structural Soil™, and is relatively pest free.

Common Name: Corneliancherry Dogwood, Scientific Name: Cornus mas
Hardiness Zone: 5a (4) (consistently moist, well drained soil, occasional periods of dry soil), prefers full sun and tolerates partial shade, pH: < 8.2
Growth Characteristics: Height: 20', Width: 20', grows slow to medium
easy to transplant B&B and < 2" caliper bare root, and is suggested for wide street tree lawns/pits, narrow street tree lawns/pits with pruning or single-leader form, parks, suitable for CU-Structural Soil™, and is relatively pest and disease resistant.

Some suggested flower plants and shrubs that are also native to the area and known to attract butterflies and birds include: Columbine, New England Aster, Spiked Gay-Feather, Cardinal Flower, and Purple Coneflower. Red Chokeberry and Summer Sweet Bush are also options.

By using other green infrastructure techniques such as permeable pavements, drainage slots, curb-cut inlets, and sheet flow stormwater can be allowed to infiltrate the soil in several ways.

Examples

Figure 14: Silva Cell

http://riles-files.blogspot.com/2012/09/silva-cells-infrastructure-concerns.html

An installation in downtown Minneapolis intercepts stormwater for 6.6 acres with 179 trees planted in Silva Cells. A Silva Cell is a modular suspended pavement system that uses soil volumes to support large tree growth and provide powerful on-site stormwater management through. Each Silva Cell is composed of a frame and a deck. Frames are 48" (1200 mm) long x 24" (600 mm) wide x 16" (400 mm) high, and each one holds 10 cubic feet (.28 cubic meters) of soil. They can be stacked one, two, or three high before they are topped with a deck to create a maximum containment area for lightly compacted loam soil. Silva Cells can be spread laterally as wide as necessary. Each unit is about 92% void space, making it easy to accommodate utilities. Suspended-pavement systems are not new, and one of the best case studies is in Charlotte, North Carolina, where, in 1985, 170 trees were planted using custom suspended pavement along a 10-block stretch in the downtown business district. A 2009 survey found that the trees (167 of the 170 survived) have thrived, reaching an average height of 44 feet and 16 inches.

Maintenance

During the first three years, mulching, watering and protection of young trees may be necessary and should be included in the inspection list. Inspections should be performed every three months and within one week of ice storms, within one week of high wind events that reach speeds of 20 mph until trees have reached maturity.

As a minimum, the following items should be included in the regular inspection list:

- Assess tree health
- Determine survival rate; replace any dead trees.
- Inspect tree for evidence of insect and disease damage; treat as necessary
- Inspect tree for damages or dead limbs; prune as necessary

Feasibility & Limitations

While tree planting can enhance stormwater management goals, it is not a "stand alone" treatment or management practice and should be used with other green infrastructure techniques. Overhead and underground utilities may also limit the types of trees that can be planted and their location. Trees sometimes do not survive through construction or in certain urban environments unless proper tree selection, landscape design, protection and maintenance are incorporated in the technique. Inadequate soil rooting volumes and compacted soils are the largest factors in tree decline, and can lead to cracked and lifted pavements, curbs and retaining walls.

Native vegetation may be perceived to harbor undesirable wildlife and insects. However, most people enjoy viewing wildlife, and native vegetation does not provide a food source for most vermin. Continued education is necessary to show that humans and wildlife can co-exist, even at the neighborhood level.

Cost

Depending on the scale and method of development for tree plots price can range quite a bit. If doing a home project, tree plots can be fairly economical with individual medium sized trees costing between $16.00-$20.00 for a sapling about 2-3 ft. tall at purchase. Below are some

examples of larger, city-wide projects.

Cost estimates based on the street tree plan for the Wilkinsburg Business District along Penn Avenue, PA:
Site Preparation, Materials, and Planting Costs per Tree:
Increasing or creating a new tree pit* $300.00
New tree* $250.00
Soil amendments (mulch, compost, etc.) $75.00
Accessory planting's $100.00
Stakes and guy materials $25.00
Maintenance and warrantees (2 year) $150.00
Total Estimated Cost $900.00
*Includes labor costs

Cost Estimates for Implementation of Plan
This includes the removal of approximately 50 existing trees, and the introduction of approximately 67 new trees.
Removal and Planting Estimates
Removal of approx. 50 existing trees $15,000.00
Planning of approx. 67 new trees $60,300.00
Total Estimated Cost $75,300.00

Another estimation based on the Tree-Eco plan in Georgia can be seen below:

Number of Plots: 200
Number of personnel per crew: 3
Cost per crew day: $800 ($100/hr x 8 hours/day)
Number of plots per day: 3-4 (as few as one and as many as seven per day)
Total number of days for project with 200 plots: 50-67 days
Total cost based on 200 plots, 3 plots/day avg., and $800/day: $40,000 - $50,000

The Achilles heel of tree plots is the initial cost, adding as much as $10,000 per tree to install compared with conventional methods. A life-cycle cost calculation goes a long way toward justifying this investment, and, in some cases, savings in up-front costs for traditional infrastructure can pay for it many times over. For instance, the City of Minneapolis chose a $1.5 million Silva Cell installation over a $7.5 million storm-sewer upgrade to meet the city's storm-water goals.

Stormwater Planters

Stormwater planters are small landscaped stormwater treatment devices that can be placed above or below ground and can be designed as infiltration or filtering practices. Stormwater planters use soil infiltration and biogeochemical processes to decrease stormwater quantity and improve water quality, similar to rain gardens and green roofs. Three versions of stormwater planters include contained planters, infiltration planters, and flow-through planters.

Historically, many more trees can be seen lining streets and parks. In Canandaigua and Geneva specifically there were freshwater wetlands that extended the lakes but these were drained and developed over. Stormwater planters can be an aesthetically pleasing way to help restore some natural integrity to more urban environments.

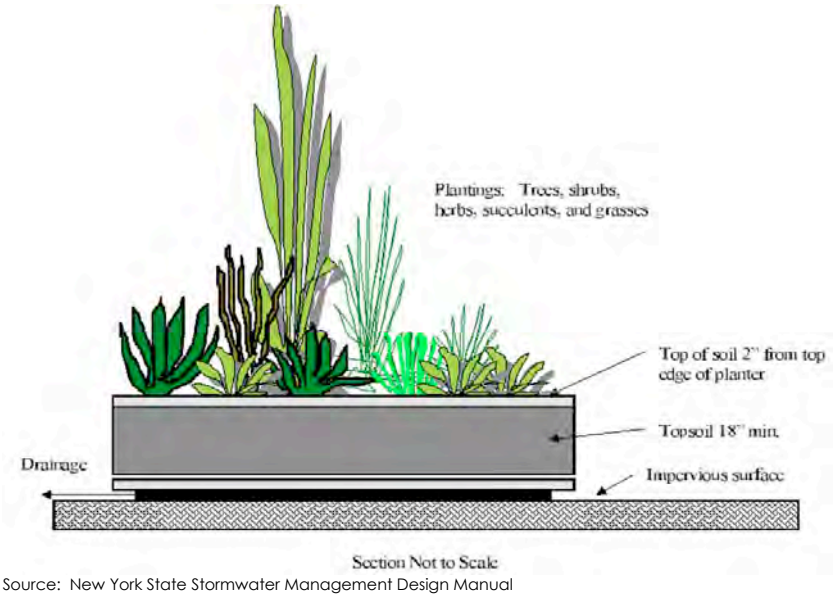
Application in a Historic District

Stormwater planters are a very common application in urban, downtown areas as a way to introduce greenery and flowers and can be seen in Downtown Geneva, Canandaigua and Clifton Springs. There are many different ways to design stormwater planters, and a variety of materials to use. When incorporating stormwater planters into a historic district, it is important to use historic details relevant to the district and containers such as natural or wire baskets, terra cotta pots, and brick planters. When the planters are selected with the aesthetics of the district in mind, they are likely to contribute the historic character of the area, as well as collect stormwater.

Contained Planters

A contained planter is essentially a potted plant placed above an impervious surface (Figure 1). Rainwater infiltrates through the soil media (which can be mulch, soil, or gravel) within the container, and overflows when the void space or infiltration capacity of the container is exceeded. Contained planters do not receive stormwater run-off or treat it directly, however they do capture more rainwater, which decreases the amount of run-off from impervious surfaces during storm events.

Figure 1: Stormwater Planter Section



Source: New York State Stormwater Management Design Manual

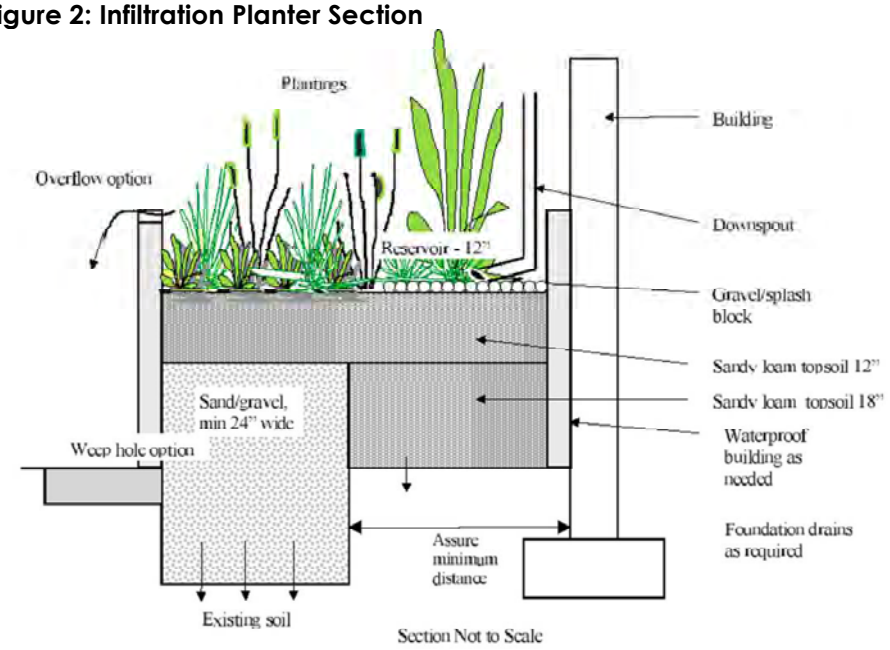
Benefits associated with contained planters include:

- Reduced impervious surface
- Decrease in stormwater run-off
- Visually appealing
- Versatile-can be placed on many types of impervious surfaces e.g. sidewalks, plazas, and rooftops

Contained planters can be planted with shrubs, flowers, bulbs, ground cover, herbs, and even small trees. Trees are especially recommended because they provide canopy cover for impervious surfaces that are not covered by the planter. Planting native species are beneficial and important to development because they are largely self-sustaining and do not require much extra maintenance like watering or pesticides.

Infiltration Planter

Figure 2: Infiltration Planter Section



Source: New York State Stormwater Management Design Manual

An infiltration planter (Figure 2) is a contained planter with a pervious, or open, bottom that allows stormwater to infiltrate through the soil within the planter and pass into the underlying soil They usually contain a layer of gravel, soil, and vegetation. Stormwater run-off temporarily pools on top of the soil, then slowly infiltrates through the planter into the ground. These types of planters are not recommended for use if the soil does not drain well already.

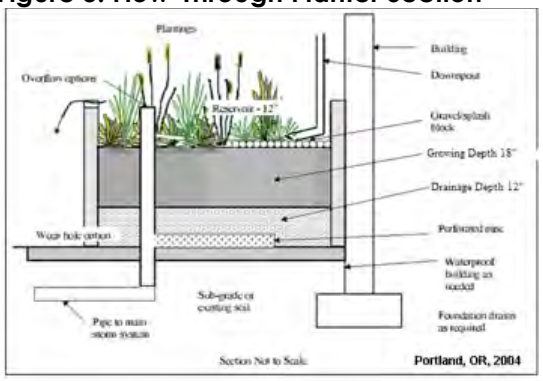
Some benefits of infiltration planters are:

- Ideal for space-limited sites
- Reduce stormwater run-off flow rate, volume, and temperature
- Reduce pollutants entering into storm drains
- Recharge ground water
- Provide energy benefits when planted near building walls

Infiltration planters can contain the same types of plants a contained planter can

Flow-Through Planters

Figure 3: Flow-Through Planter Section



Source: New York State Stormwater Management Design Manual

A flow-through planter (Figure 3) is a contained planter with an under drain system that conducts filtered stormwater to the storm drain system or downstream waterway (Figure 3). Flow through planters do not infiltrate into the ground, and can be placed above or in the ground. They are filled with gravel, soil, and vegetation and are typically waterproofed. They are used to temporarily store stormwater run-off on top of the soil and then filter sediment and pollutants as the water slowly infiltrates down through the planter. Excess water collects in a perforated pipe at the bottom of the planter and drains to a destination point or conveyance system.

Benefits associated with flow-through planters include, but are not limited too:

- Ideal for constrained sites because they can be built directly next to buildings
- Useful on slopes that are too steep for other green infrastructure techniques
- Can be built and placed on poorly draining soils
- Used in contaminated areas
- Reduce stormwater flow rates, volume, and temperature
- Improve water quality
- Provide shading, and energy benefits when sited against building walls
- Aesthetically pleasing

Vegetation can include a variety of shrubs, small plants, and other plants that are appropriate seasonally. Summer irrigation and weeding may be required-this can be minimized though by planting native and well-adapted species. Some examples of native plants that could be used in any three of these stormwater planters include: columbine, new England aster, spiked gay-feather, and cardinal flower. And some suggested shrubs are red chokeberry, and summer sweet bush.

All three types of stormwater planters include three common elements: planter "box" material (e.g., wood or concrete); growing medium consisting of organic soil media; and vegetation. Infiltration and flow-through planters may also include splash rock, filter fabric, gravel drainage layer, and perforated pipe. All three types come in various different sizes and shapes, and can be made out of stone, concrete, brick, plastic, lumber, or wood.

Figure 4: Example of Stormwater Planter

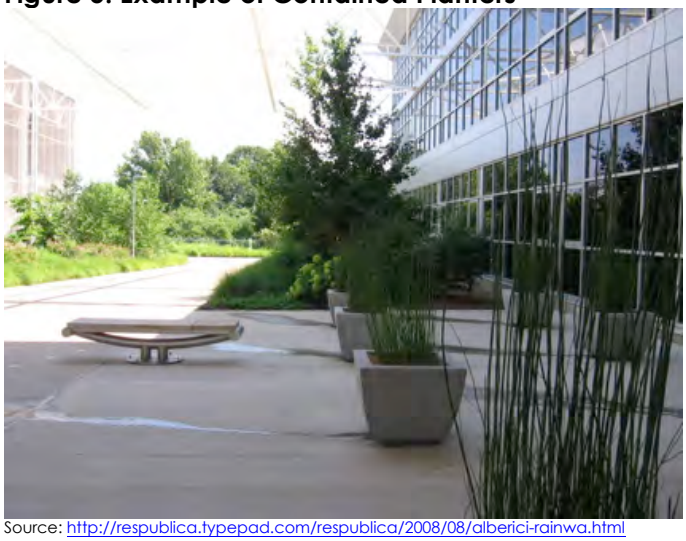
Source: http://www.portlandoregon.gov/bes/article/68716

In general, stormwater planters make filtration treatment of groundwater and soils possible. They also slow the velocity stormwater moves over impervious areas, as well as reduces the volume of stormwater. Planters also create an aesthetic landscape and provide microhabitats within urban environments.

Location

The versatility of stormwater planters makes them uniquely suited for urban redevelopment sites. Depending on the type, they can be placed adjacent to buildings, on terraces or rooftops. Building downspouts can be placed directly into infiltration or flow-through planters; whereas contained planters are designed to capture rainwater, essentially decreasing the site impervious area. The infiltration and adsorption properties of stormwater planters make them well suited to treat common pollutants found in rooftop runoff, such as nutrients, sediment and dust, and bacteria found in bird feces. Stormwater planters are most effective at treating small storm events because of their comparatively small individual treatment capacity.

Figure 5: Example of Contained Planters



Source: http://respublica.typepad.com/respublica/2008/08/alberici-rainwa.html

Currently, in Canandaigua bio-retention centers, rain gardens, and stormwater planters are being installed to help improve the appearance of the district whilst also helping mitigate

stormwater. In many of the surrounding areas extensive gardens were a major characteristic of historic homes and properties, as well as wide tree-lined streets. Nowadays, telephone wires and underground pipes and systems can inhibit our ability to replant areas. Stormwater planters offer a compromise to this problem by providing specific designated areas and containers for plants and by using them as an economic agent to help clean our streets, air, and water and reduce pressures on stormwater sewers and drains during storms.

Site Specific Considerations

Required Elements

There are a number of siting, sizing, and material specification guidelines that should be considered during stormwater planter design. Specifically, vegetation selected for planters should be native species that are relatively self-sustaining and adapt well. Pesticides and fertilizers should be avoided whenever possible.

Siting

- Flow-through and infiltration stormwater planters should not receive drainage from impervious areas greater than 15,000 square feet.
- Infiltration planters should be located a minimum distance of ten feet from structures.
- To prevent erosion, splash rocks should be placed below downspouts or where stormwater enters the planter.

Soil

- Soil specifications for the stormwater planter growing medium should allow an infiltration rate of 2 inches per hour, and 5 inches an hour for the drainage layer.
- Soil compaction must be no greater than 85% in the planter.
- The growing medium depth for all three stormwater planter types should be at least 18 inches.
- Growing media should be a uniform mixture of 70% sand (100% passing the 1-inch sieve and 5% passing the No. 200 sieve) and 30% topsoil with an average of 5% organic material, such as compost or peat, free of stones, roots and woody debris and animal waste.
- For infiltration and flow-through planters the drainage layer should have a minimum depth of 12 inches. Drainage layer should be clean sand with 100% passing the 1-inch sieve and 5% passing the No. 200 sieve.

Sizing

- Stormwater planters should be designed to pond water for less than 12 hours, with a maximum ponding depth of 12 inches.
- An overflow control should redirect high flows to the storm drain system or an alternative treatment facility.
- Generally, flow-though and infiltration planters should have a minimum width of 1.5 and 2.5 feet, respectively.

Zoning

The City of Geneva does not have any regulations specifically pertaining to stormwater planters of any type, however, if planting trees it is recommended to see the zoning regulations lined out in the Tree Plot section above. Chapter 350 article X Historic Zoning should also be visited regarding the change in appearance of any historic structure or district.

Figure 6: Planters in a Public Plaza

Source: New York State Stormwater Management Design Manual

Site Preparation & Design of Infiltration Planters

The infiltration rate of the native soil should be a minimum of 2 inches per hour. A minimum infiltration depth of 3 feet should be provided between the bottom of the infiltration practice and any impermeable boundaries, such as the seasonal high groundwater level or rock. Infiltration planters should also be designed and constructed with no longitudinal or lateral slope.

Materials suitable for planter wall construction include stone, concrete, brick, clay, plastic, wood, or other durable material.

Treated wood may leach toxic chemicals and contaminate stormwater, and should not be used. Flow-through planter walls can be incorporated into a building foundation, with detailed specifications for planter waterproofing.

Sizing and Design Criteria

Stormwater planters should initially be sized to satisfy the WQv requirements for the impervious surface area draining to the practice. This does not apply to contained planters because they are designed to decrease impervious area, not receive additional runoff from adjacent surfaces. The basis for the sizing guidance is the same as that for bio-retention (see Chapter 6 of the New York Stormwater Management Design Manual) and relies on the principles of Darcy's Law, where water is passed through porous media with a given head, a given hydraulic conductivity, over a given timeframe. The equation for sizing an infiltration or flow-through stormwater planter based upon the contributing area is as follows:

Figure 7: Stormwater Planter with Roof Spout

Source: New York State Stormwater Management Design Manual

$$Af = WQv \times (df) / [k \times (hf + df)(tf)]$$

where:

Af = the required surface area [square feet]
WQv = water quality volume [cubic feet]
df = depth of the soil medium [feet]
k = the hydraulic conductivity [ft/day], usually set at 4 ft/day when soil is loosely placed in the planter, but can be varied depending on the properties of the soil media. Some

other reported conductivity values are:
Sand: 3.5 ft/day
Peat: 2.0 ft/day
Leaf compost: 8.7 ft/day
Bioretention Soil: 0.5 ft/day
Hf = average height of water above the planter bed [≤6 inches for a maximum ponding depth of 12 inches]
tf = the design time to filter the treatment volume through the filter media [usually set at 3 to 4 hours]

Example

A simple example for sizing a stormwater planter using WQv is presented below. The ultimate size of a stormwater planter is a function of either the impervious area or the infiltration capacity of the media. Determine the required surface area of a stormwater planter that will be installed to treat stormwater run-off from an impervious area of 3,000 square feet, given the depth of the soil medium is 1.5 feet.

Step 1: calculate the WQv
WQv = (P) (Rv) (A) / 12
Where: P = 90% rainfall number =0.9 in
Rv = 0.05 + 0.009 (I) = 0.05 + 0.009(100) = 0.95
I = percentage impervious area draining to planter = 100%
A = area draining to practice = 3,000 ft2
WQv = (0.9)(0.95)(3000)/12
WQv = 213.75 ft3
Step 2: Calculate required surface area:
Af = WQv*(df) / [k*(hf +df) (tf)]
where: WQv = 213.75 ft3
df = depth of soil medium = 1.5 ft
k = hydraulic conductivity = 4 ft/day
hf = Average height of water above planter bed = 0.5 ft
tf = filter time = 0.17 days
Af = (213.75)(1.5) / [(4)(0.5+1.5)(0.17)]
Af = 235.75 ft2

Therefore, a 240 square-foot stormwater planter with a soil medium depth of 1.5 feet will be needed to treat stormwater from a 3,000 square foot area. The calculated WQv of 213.75 ft3 is added to the Runoff Reduction Volume for the site (if the site soils are suitable for infiltration). If the planter is designed as a flow-through planter on C soils, then 96 ft3 (45% of the WQv for the area draining to the planter) is added to the Runoff Reduction Volume. 64 ft3 (30% of the WQv) is added towards the Runoff Reduction Volume for a flow through planter on D soils.

Maintenance

A regular and thorough inspection regime is vital to the proper and efficient function of stormwater planters. Debris and trash removal should be conducted on a weekly or monthly basis, depending on likelihood of accumulation. Following construction, planters should be inspected after each storm event greater than 0.5 inches, and at least twice in the first six months. Subsequently, inspections should be conducted seasonally and after storm events equal to or greater than the 1-year storm event. Routine maintenance activities include pruning and replacing dead or dying vegetation, plant thinning, and erosion repair. Since stormwater planters are not typically preceded by pre-treatment practices, the soil surface should be inspected for evidence of sediment build-up from the connected impervious surface and for

surface ponding. Attention should be paid to additional seasonal maintenance needs as well as the first growing season.

Feasibility and Limitations

The primary limitation to the use of stormwater planters is their size. They are by definition small-scale stormwater treatment cells that are not well suited to treat runoff from large storm events, or large surface areas. They can, however, be used in series or to augment other stormwater management practices. Other limitations include:

- Stormwater planters are not designed to treat runoff from roadways or parking lots but are ideally suited for treating rooftop or courtyard/plaza runoff.
- Flow-through and infiltration stormwater planters should not receive drainage from impervious areas greater than 15,000 square feet.
- For all three types of stormwater planters, if the infiltration capacity of the soil is exceeded, the planter will overflow. Excess stormwater needs to be directed to a secondary treatment system or released untreated to the storm drain system.

Cost

Cost of installation is approximately $8/square foot, however, cost will vary depending on the size and material of the planter. Each planter is estimated to cost about $400-$500 per year for a 500 square foot planter. Maintenance costs will vary depending on the size and material of the planter as well, plus the types of plants utilized.

Conclusion

Stormwater planters offer a wide variety of ways to implement more nature into urban environments. Historically, trees and residencies were rich with vegetation and largely contributed to the aesthetics and visual appeal of these areas. This heavy vegetation also helped mitigate stormwater and prevent flooding during these times, which meant there was less of a need for man-made infrastructure and impervious surface. Installing planters in historic downtown areas will help improve the functionality of current water management systems and aesthetics, while also returning that historic small town feel to the area.

Storm Drain Marking

Storm drain marking is labeling a storm drain inlet with a pre-printed marker, title, sticker, or stencil that has a message to prevent pollution into storm drains. The message can read "Dump No Waste", or a similar written message that specifies the water body to which the storm drain inlet drains.

Introduction

When rainfall carries pollutants from a wide variety of sources into surface water or ground water, this creates nonpoint source pollution. Nonpoint source pollutants can be chemicals, such as pesticides and fertilizers. They can also be gasoline, motor oil, anti freeze and road salt (see Figure 1). The pollutants can also be natural, like soils, animal wastes, grass clippings and fallen leaves (see Figure 2). In urban areas, most nonpoint source pollutants get swept from rainfall flow, into drains and then into the waterways, leading to larger bodies of water.

Figure 1: Storm drain pollution

Source: hhttp://www.wilmingtonnc.gov/public_services/stormwater/report_stormwater_pollution

The polluted runoff flows through the storm sewer underground and is released untreated into local waterways. Many people do not know that storm drain inlets empty out directly into bodies of water. The lack of knowledge and care enables people to pollute. This contributes to the disconnect of action and outcome. Storm drain marking is a method used to maximize citizens' consciousness of what polluting storm drain results in for the environment.

Storm drain marking involves labeling storm drain inlets with plaques, tiles, and painted or pre-cast messages warning citizens not to dump pollutants into the drain. The messages are generally a simple phrase or graphic to remind those passing by that the storm drains connect to local water bodies and that dumping will pollute those waters (See Figure 3 & 4 & 5). Some storm drain markers specify which water body the inlet drains to or name a particular river, lake, or bay. For this area, we would use the Finger Lakes.

Figure 3: Storm drain marking

Source: hhttp://www.ennisflint.com/Products/Preformed-Thermoplastic/PreMark/PreMark-Galleries/Two-Layer-Stencils-Gallery

Figure 4: Storm drain marking

Source: http://www.clflwd.org/resources_news.php

Figure 5: Storm drain marking

Source: http://www.watershedactivities.com/projects/summer/stormdrn.html

Storm Drain Marking provides a visible reminder of the consequences of improper waste disposal in storm drains. The focus is on storm drains because they are direct conduits that can carry pollution into area rivers and streams. Storm drain marking is one way to remind the public that storm sewers are for water and not trash.

Application in a Historic District

Storm drain markings are a relatively new technique designed to educate the public about where material that is dumped into storm drains, sewer grates and other gutters ends up – local water bodies. One of the first cities to undertake a storm drain-marking project successfully was in Austin, Texas in 1995. After experiencing an increased amount of storm drain pollution, the water protection department of Texas implemented this project. The Finger Lakes does not have a history of storm drain marking projects historically, but has many storm drains in the historic districts, especially Geneva and Canandaigua, where there is a higher population.

Because storm drain markings did not exist historically, there are no precedents to guide their incorporation into a historic district. But, like any signage in a historic district, they can be designed as such to be compatible with the overall aesthetic of the district. It is recommended that permanent sign type marking be used. These can be designed to even indicate that they are in a historic district, or can use serif fonts or historic color schemes so that they have a low visual profile. Because storm drain markings are so small and occur on the sidewalk or storm drain it is not anticipated that they would have a negative impact on the character of a historic district.

Site Prep Design

Applicability

The entire community, in particular those areas that are more susceptible to where water or where trash, nutrients or biological oxygen demand has been a pollutant can participate in storm drain marking projects. And despite the condition of the body of water, these storm drain signs can raise awareness about storm drains and where it flows.

The drains should be carefully selected to send the message to the maximum number of citizens (for example, in areas of high pedestrian traffic) and to target drains leading to water bodies where illegal dumping has been identified as a source of pollution.

Implementation & Zoning

To successfully implement storm drain marking projects, it needs to be approved by local governmental regulations. This is because storm drains are public property and any unapproved art around it would be considered vandalism. The city of Geneva does not have any specific regulations pertaining to storm drain marking, but it cannot be implemented without permission first.

Figure 6: Paste Storm drain marking

Source: http://www.ccia-net.com/solid_waste/cleancommunities.aspx

If municipalities are the ones establishing storm drain markings, then there should be a prioritization of which storm drains are most passed by or have the potential to be dumped into. The drains should be carefully selected to send the message to the maximum number of citizens (for example, in areas of high pedestrian traffic) and to target drains leading to water-bodies where non-point source pollution has been identified.

Municipal crews or volunteers can paste or stencil messages on storm drains (See Figure 6 & Figure 7). Some municipalities may have their own workers to produce a message, to eliminate liability and safety concerns.

Figure 7: Stencil storm drain marking

Source: https://www.facebook.com/savebuzzardsbay?rf=171214736266070

On the other hand, volunteer groups could conduct marking projects in cooperation with a municipality. If this arrangement between municipalities and volunteers were to happen, usually volunteer groups provide the labor and the municipality provides supplies, safety equipment, and a map or directions to the drains to be marked. Using volunteers lowers costs and increases public awareness of stormwater pollutants and their path to water bodies. A municipality can establish a program to comprehensively address storm drain marking, actively recruit volunteer groups to help, or facilitate volunteer groups that take the initiative to undertake a marking project.

Organizers Role

Whoever initiates the storm drain marking project, the municipality or volunteer group should assign a person to be the leader of the project. The one responsible should coordinate volunteers and the process of the project. The best candidate for the project leader is someone who has background in public works or water quality department. Since this program is heavily dependent on the labor of volunteers, those who organize and coordinator the project should possess skills in recruiting, training, managing, and recognizing volunteers. Organizers and coordinators should provide the following:

- Marking kits containing all materials and tools needed to carry out a marking project,

- A map of the storm drains to be marked,
- Training for volunteers on safety procedures and on the technique for using stencils or affixing signs,
- Safety equipment (traffic cones, safety vests, masks or goggles for spray paint, and gloves if glue is used), and
- Incentives and rewards for volunteers (e.g. badges, T-shirts, certificates).

Another recommendation is for organizers to keep track of which storm drains are polluted, so that serious instances of dumping may be recorded and action taken. Participants in storm drain marking projects can also note storm drains that are clogged with debris. This way the city can organize future clean up efforts.

Organizers should organize and instruct volunteers on the signs of dumping and explain how to fill out data cards. In addition, volunteers should record the locations of all storm drains labeled during the project for the city to track. It would also be beneficial to get feedback from volunteers for organizers can improve future marking projects.

Organizers should utilize all advertisements opportunities as possible. This will not only make people more aware of the project, but it will potentially get more volunteers. Contact newspapers to provide advanced notice of a planned storm drain marking event. Public service announcements made before the event also will help to reinforce the message. Additionally, in targeted neighborhoods, volunteers can distribute door hangers that notify residents that storm drain marking is taking place, explain the purpose of the project, and offer tips on how citizens can reduce urban runoff.

Figure 8: Permanent Sign

Source:
http://www.wilmingtonnc.gov/public_services/stormwater/education_outreach/storm_drain_marking

Since marking projects take place on city streets, volunteer safety is of utmost importance. The city might wish to designate lower-traffic residential areas as targets for volunteer marking and provide safety equipment and training. Most programs require that marking be done in teams, with at least one person designated to watch for traffic. Adult supervision is needed when volunteers are school children or members of youth groups. Most cities also require participating volunteers (or their parents, in the case of minors) to sign a waiver of liability. An attorney for the municipality should be consulted to determine what liability exists and how to handle this issue.

Types of Markings

With many different crafts and materials out there being produced. When implementing stormwater marking signs, the materials that are chosen are very important. Depending on the materials, it can determine how long the marking will last and the amount of maintenance that will be needed for it.

Permanent Signs

One option that can be used is permanent signs. This marking can be made form aluminum, ceramic, plastic, or other durable materials (See Figure 8 & Figure 9). These signs can be affixed with adhesive applied to the street or sidewalk surface. These markers last longer than stenciled messages and need only glue to affix them to storm drain inlets. It is important to use non-toxic, double stick adhesive pads. These are available from sign manufacturers as an alternative to

glue, which may not be appropriate for use by children. When creating the sign it can be done by the municipality or volunteer, but it is best to localize it so people can recognize the place affected by the pollution. These permanent signs are beneficial because they can be neater and easier to read from a distance. However, tiles or plaques can be broken by pedestrian traffic if they are disturbed before the glue dries. If you choose to use tiles or plaques it would best to block off the affixed area to ensure the glue dried properly.

Figure 9: Permanent Sign

Source: http://www.almetek.com/sdmenvironmental.html

Figure 10: Stencil Sign

Source: http://www.clark.wa.gov/water-resources/education/stenciling.html

Stencils

Another type of marking is stencils and paint to label their storm drains. Communities can stencil directly onto the curb, street, or sidewalk. They can also paint a white background and then stencil over it. The most commonly used stencils are made of Mylar, a flexible plastic material that can be cleaned and reused many times. (See figure 10) However, stencils can also be made from cardboard, aluminum, or other material. Because painted stencils are not as durable as other types of markers, the message might need to be retouched or reapplied every few years.

Paint or ink can be sprayed on or applied by brush and roller. Spray paint is the quickest and probably the easiest to apply neatly (See Figure 11 & Figure 12). However, regions that do not meet federal air-quality standards should avoid using spray paints, since many contain air-polluting propellants. To prevent any materials from entering the storm drain, the use of "environmentally friendly" paints free of heavy metals and low in volatile organic compounds is recommended.

Figure 11: Spray Paint Marking

Source: ttp://www.estacadaeagle.com/EACTeamsUpWithPublicWorksToPromoteCleanWaterToTheClackamasRiver.html

Figure 12: Spray Paint Marking

Source: http://www.estacadaeagle.com/EACTeamsUpWithPublicWorksToPromoteCleanWaterToTheClackamasRiver.html

When using any of the storm drain marking techniques it is imperative to make sure that the materials: glue, paints, etc. is safely not going down sewers or the storm drains (See Figure 13).

Figure 13: Environmental Safety with markings

Source: http://blog.baybackpack.com/?m=201008

Freehand Painting

There are many opportunities to bring outreach to the community through storm drain painting (See Figure 14).

Costs

Plastic stencils, which can last for 25 to 500 stencilings, depending on whether paint is sprayed or applied with a brush or roller, can be purchased for $10-$15.50 depending on the size, materials, quantity purchased, and manufacturer. Metal stencils, which last longer, can cost $100 or more.

Storm drain markers vary in cost depending on materials, design requirements, and the quantity purchased. It is important to contact the manufacturer when pricing storm drain markers because custom sizes, shapes, and designs, such as those that specify a local water body, can increase the unit cost. For stock messages, however, ceramic tile markers cost approximately $7, whereas plastic markers of 4-inch diameter range in cost from $1 and $2.95, depending on material composition and quantity purchased. Glue for affixing the marker costs approximately $.025 per application.

Figure 14: Hand painted design by LaSheria Bailey

Source: http://baltimorecommunitygroup.wordpress.com/901-arts/

Door hangers and other educational materials that complement the markers can also be purchased from some manufacturers, and often a "starter kit" is offered that includes a variety of materials to conduct a public outreach campaign.

Conclusions

Benefits

If a municipality chooses to initiate a storm drain marking program and solicit the help of volunteer organizations, they can advertise through a variety of channels. They can distribute pamphlets and brochures to area service organizations, place articles in local magazines, take out newspaper ads, place an environmental insert in the local newspaper, make presentations at community meetings, develop public service announcements for radio, and create a website with background and contact information as well as photographs and stories from past marking events.

Storm drain marking projects offer an excellent opportunity to educate the public about the link between storm drain systems, water quality, and their watershed. It increases public awareness of stormwater issues. Volunteer groups can provide additional benefits by picking up trash near the marked storm drains and by noting where maintenance is needed. Storm drain marking projects can become a community effort. Children or local artists can get involved. (See figure 14 & 15) It improves the aesthetic of the community and creates a connection between the citizens.

Limitations

A storm drain marking project is for the most part effective and inexpensive. The limitation comes with larger communities that have many storm drain inlets. The only limitation is getting enough volunteers to put in work to go through with the program. So volunteer coordinators need to be skilled at recruiting and organizing the efforts of volunteers to provide adequate coverage over large areas. Safety considerations might also limit marking programs in areas where traffic congestion is high. Other environmental considerations, such as the use of propellants in spray paint in areas that do not meet air quality standards, should be taken into account. Finally, stenciled messages will require repainting after years of weather and traffic, and tiles and permanent signs might need replacement if they are improperly installed or subject to heavy traffic or vandalism.

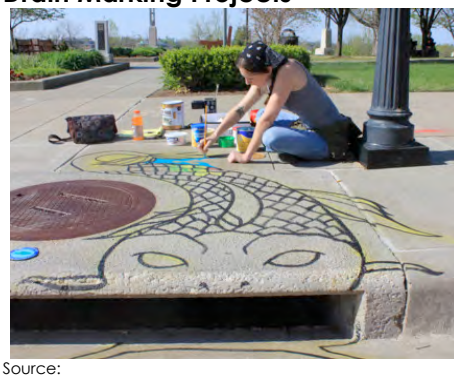
Figure 15: Community Efforts for Drain Marking Projects

Source: https://www.facebook.com/TAPPWater

Effectiveness

By raising public awareness of urban runoff, storm drain marking programs should discourage practices that generate stormwater pollutants. As with any public education project, however, it is difficult to precisely measure the effect that storm drain marking programs have on human behavior. Surveys of public recognition of the storm drain message, or surveys that capture changes in behavior, can indicate whether a storm drain marking program is effective. Some municipalities attempt to assess the effectiveness of storm drain marking programs by periodically examining water samples from targeted storm drain outfalls (places where storm drains empty into a water body). If the storm drains leading to a particular outfall have been labeled, and if the levels of pollutants from that outfall decline after the labels were put in place, one can assume the labeling has been effective.

Figure 17: Community Efforts for Drain Marking Projects



Source: http://ilove.springfieldmo.org/post/5219235280/storm-drain-murals-designed-to-educate-inspire