# Storm Water Management in the City of Chicago

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## Abstract

The City of Chicago owes its very existence to its location at the confluence of the Chicago River and Lake Michigan. Lake Michigan provides the City with an abundant water supply while the Chicago River serves as a highway to move goods and services critical to the City's growth. Chicago has built a historic legacy in protecting these valuable water resources. To protect its water supply, engineers in the 1900s constructed the Chicago Sanitary and Ship Canal to reverse the Chicago River's natural flow from eastward to westward, steering human and industrial waste away from Lake Michigan. In 1972, Chicago pioneered the use of deep tunnels to capture, convey, and store combined sewage during storms for later treatment.

Today, Chicago is taking a new comprehensive approach toward further improving the quality of its surface waters. Rather than through large scale engineering projects, the approach centers on simple storm water Best Management Practices (BMPs) at the source level to reduce the negative impacts of storm water runoff. Through various model projects, the City aims to demonstrate the efficacy of various BMP approaches, promote public acceptance and usage, and encourage modification of local ordinances to allow wide-spread usage of BMPs.

## History of Storm Water Management

In 1885 a severe rainstorm caused sewage-contaminated river water to flow into Lake Michigan, contaminating the City's drinking water. This disaster led to a cholera and typhoid outbreak that killed over 90,000 people. Repeated outbreaks of epidemic diseases compelled the City to find a way to stop the flow of polluted water into Lake Michigan. The Metropolitan Sanitary District of Greater Chicago was created in 1889 to safeguard the city's drinking water and determine an acceptable way to dispose of waste.

In 1900, the sewer overflow problem was solved by a massive engineering effort. Engineers constructed the Chicago Sanitary and Ship Canal to reverse the Chicago River's natural flow from eastward to westward, thereby steering human and industrial waste away from Lake Michigan. Now the river flows into the DesPlaines River, the Mississippi River and, eventually, the Gulf of Mexico. Locks regulate the elevation of the river and prevent Lake Michigan from draining freely (City of Chicago, 2000).

While this solution protected the Lake, it did not reduce the pollution level in the Chicago River. Rainfalls of as little as 1/3 inch overloaded local sewer systems and caused combined sewer overflows (CSOs) - a mixture of storm water runoff and raw sewage, into the waterway. Hundreds of CSOs are located along the waterway. CSOs still polluted the waterways and, with the heaviest rainstorms, raised flood stages to levels resulting in river backflows into Lake Michigan, causing beach closures. Major underlying causes of the problem were lack of an adequate floodwater outlet and increasing urban growth.
In 1972, the Metropolitan Water Reclamation District of Greater Chicago (formerly Metropolitan Sanitary

District of Greater Chicago) started construction of a large scale, multi-purpose Tunnel and Reservoir Program (TARP), comprised of deep rock tunnels and surface reservoirs that capture, convey, and store combined sewage during storms until it can be transferred to existing treatment plants when capacity becomes available.

In 1974, prior to TARP, only 10 fish species were found in the Calumet and Chicago River systems. With improvements in wastewater treatment technology, the species count rose to 33 by the early 1980s. In 1984, the first TARP tunnel projects came online, reducing the frequency and volume of combined sewer overflows. Subsequently, the species count rose gradually to 54 by 1990, and had reached 63 by 2000. This steady climb over the years is due in part to additional segments of the TARP tunnels coming online, further improvements in treatment plant performance, and supplemental aeration of the waterways (EPA Region V, 2002).

Today, increased residential and commercial development is ocurring along the banks of Chicago waterways. The waterways are no longer considered just navigational canals, but are seen to be amenities or center pieces of urban life. The public's interest in the river has grown, as evidenced by the increasing numbers of paddlers, walkers, bikers, and even jet skiers on the river. Fishing on the river has also grown in popularity. Fish consumption advisories still remain in place, however, and large portions of the rivers are not safe for full body contact. Additional work remains to be done.

## Current Storm Water Management Approach

The City is taking a new comprehensive approach toward further improving the quality of its surface waters. Rather than through large scale engineering projects, the approach centers on implementing and promoting demonstration projects that utilize simple storm water Best Management Practices (BMPs) at the source level. The goals of these BMPs are to reduce the quantity and improve the quality of urban storm water runoff.

### ***Common Storm Water BMP Techniques***

Storm water pollutants includes such substances as solids, metals, oil and greases, and road salt. BMPs commonly employed in Chicago's model projects to treat storm water runoff include vegetated swales, infiltration trenches or basins, detention basins, mechanical filtration/sediment and oil grease traps, roof top gardens, and cisterns that capture runoff for gray water use. A brief description of some of these BMPs are described below.

*Vegetated Swales* - In vegetated swale designs, storm water is conveyed through a vegetated swale instead of a storm sewer. Swales increase storm water infiltration potential and storage. Swales also remove pollutants via settling, vegetative filtering, and to some extent infiltration through the soil. Sediments need to be periodically removed from vegetated swales, and the vegetation mowed and replanted as needed (NIPC 1995).

*Infiltration Trench or Basin* - In an infiltration trench or basin, storm water runs through a swale or into a basin that has a porous bottom (sand or gravel), causing storm water to infiltrate into the ground. As the storm water percolates through the ground, contaminated particles are trapped within the soil and the resulting treated water migrates to the groundwater. Water quality benefits are derived from the removal of contaminants that are sorbed onto soil particles and decreased flows into the river. Sediment will tend to clog systems unless the systems are routinely maintained. The condition of the trench should be periodically checked and the accumulated sediment removed. After years of operation, the stone in the trench may need to be removed and cleaned and the filter fabric replaced (NIPC 1995).

*Detention Basin* - In a detention basin, storm water enters a basin that has a structure to control outflow. The water quality benefits result from attenuation of flows by slowing the velocity of water and removal of solids by settling due to lower water velocities. Effectiveness is greatest for suspended sediments such as heavy metals. Lower effectiveness is expected for soluble constituents and nutrients. Oil and grease typically pass through, unless the detention basin is planted with vegetation in a manner that leaves no open water flow paths from one end to the other. Sediments need to be removed periodically, and vegetation should be mowed and replanted periodically (NIPC 1995).

*Sediment and Oil and Grease Traps* - In sediment and oil and grease traps, storm water runs through a structural device that has a chamber that traps oil, grease, and sediment. The solids need to be removed periodically. The advantage of this design is that oil, grease, and sediment are trapped at a location that is easily accessible to maintenance crews. Water entering the chamber could pass over and under a series of baffles. Baffles at the bottom of the chamber could trap sediment, and baffles at the top could trap oil and grease.

*Rain Gardens (bioretention cells)* - Rain gardens have native plant amenity features and provide for the infiltration of excess rain water from impervious surfaces. Native plants have root systems that are deeper than typical turf grasses, and provide greater absorptive capacity not only into the plant but also into the soil. Rain gardens are not meant to treat heavily polluted runoff, nor are they designed to absorb maximum rainfall. Instead, they are designed to mitigate local and downstream flooding problems by providing space for excess runoff to be absorbed into the soil or to slow the velocity of the runoff as it passes through the remainder of the storm sewer infrastructure.

## Model Projects

Working together, City departments have conducted specific model projects at the municipal, residential, commercial/industrial, and public infrastructure levels. Each project utilizes one or more of the aforementioned BMP techniques. Through these model projects, the City aims to demonstrate the efficacy of various BMP approaches, promote public acceptance and usage, and encourage modification of local ordinances to allow wide-spread usage. Some examples of model projects conducted by Chicago are described below.

***Municipal Facility Projects***

*City Hall Rooftop Garden* - The City Hall rooftop garden encompasses 20,000 square feet of planted area and includes more than 150 species of native plants. The roof system was designed to carry 1-inch of precipitation. Aside from the storm water benefits, green roofs lower ambient air temperatures in the summer, provide better insulation which reduces energy demands, and provides animal or insect habitat. The project was selected for a pilot to study the benefits of green roof systems. The project also includes the development of prototypical guidelines and specifications that can be used elsewhere, and conduction of a study quantifying the environmental benefits of green roof systems. Lessons learned from the project were incorporated into the City's A Guide to Rooftop Gardens booklet. The booklet is targeted to the general public to promote construction of green roofs in the City.

*Chicago Center for Green Technology* - This city building was renovated to serve as a model for an energy-efficient and environmentally friendly design. The City expects to receive a Platinum Certification under the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Program. Storm water BMPs employed at the site include a functional green roof system, cisterns (capturing up to 12,000 gallons of roof runoff), sheetflow of parking lot runoff to vegetated swales, and a storm water detention area.

***Residential Projects***

*Downspout Disconnection Campaign* - Individual residents are being encouraged to disconnect their downspouts, blocking their sewer connection and redirecting the rainwater from their roofs to adjacent landscaped areas. This reduces runoff flow to the combined sewer system, promote groundwater recharge while supporting local green spaces. During summer 2002, the City canvassed flood prone areas of the city, distributing door hangers and brochures to houses which were considered appropriate for downspout disconnection. The City will be promoting the use of rain barrels in conjunction with the downspout disconnection campaign. Gutters could be drained into rain barrels, storing rain water for later irrigation use.

*Model Rain Gardens* - Model rain gardens are being built in City parkways to absorb additional rainwater during heavy rain periods. Including French drains installed below ground level and plants that can withstand extreme wet and dry conditions, twelve such gardens have been installed in a flood-prone area. These rain gardens were installed to receive runoff from sidewalks and roof areas. Large rain gardens are being planned for the future that will be connected to curb cuts to absorb additional capacity from roads.

***Commercial/Industrial Projects***

*Ford Centerpoint Supplier Park* - Ford Motor Company operates a car-manufacturing plant in the Calumet area. Ford is currently finalizing plans to build a supplier park adjacent to their existing facility. This development, which will eventually consist of 1.7 million square feet on 150 acres of land, has the potential to exemplify how industry and environment can co-exist. The purpose of the development is to reduce transportation costs and pollution from long ground delivery distances, and provide a just-in-time manufacturing source of materials for the plant.

A range of innovative, conservation-minded options will be implemented to improve water quality, decrease heavy runoff to the creek, and prevent pollution. First, the development will utilize a separate storm water and sanitary sewer system. All storm water runoff from rooftops and parking lots will be routed into vegetated swales. Swales will contain native vegetation that filters the water as it is conveyed. Storm water runoff from public streets that will be constructed to accommodate the development will drain into roadside swales through curb cuts. Although the swales will be privately owned, a drainage easement will be granted to the City.

The swales will empty into vegetated detention basins for treatment, then be conveyed to a wetlands area and finally into Indian Creek. This design will slow the pace of movement of water into the creek, removing harmful contaminants and decreasing the erosion often caused by major storm events. The entire campus will be planted with shortgrass prairie, tallgrass prairie, and native trees.

## ***Public Infrastructure Projects***

*130th and Torrence Intersection* - The City is reconstructing the intersection of 130th and Torrence Avenue. As part of this project, both streets will be depressed. Storm water from a rain event will be collected in an underground chamber and then pumped to the Calumet River. The City is considering a variety of treatment options for the storm water before its discharge to the river. These options involve selecting the right combination of BMPs in series that will treat the runoff most effectively and at the least cost. The options include a treatment train of sediment, oil, and grease traps, followed by vegetated swales, infiltration trenches, and a wetland detention basin. The most efficient system is expected to remove 98% of total solids, 88 % of oils and greases, and 40% of the road salt from the runoff (Tetra Tech 2002).

*South Lake Shore Drive Project* - South Lake Shore Drive is an important part of the City's transportation system. It is an essential commuter link between the downtown area and the City's south side. Heavy traffic and seasonal weather contrasts have led to crumbling road conditions on the drive. The City of Chicago, Illinois Department of Transportation, and the Federal Highway Administration are investing $162 million to reconstruct more than 6 miles of the roadway. More than 14 acres of green space enhancements will be included in the reconstruction efforts, including new median landscaping, trees, shrubs, perennials, and ornamental grasses.

City engineers also looked at better management of storm water runoff from the drive to protect the water quality in Lake Michigan. Prior to the reconstruction, storm water from the road was directly discharged to the lake. In contrast, all the storm water runoff in the newer North Lake Shore Drive is directed to the City's sewer system. Unfortunately, this sometimes overwhelms the system, causing sewage to backup onto the drive.

As an alternative, City engineers are utilizing a system that directs only the first flush of the South Lake Shore Drive runoff to the sewers. Remaining flow, which will be generally cleaner, will be discharged to the lake. Diversion of the first flush helps reduce the flow into the City's combined sewer system and thereby improve the quality of the runoff discharged into the lake. Once the reconstruction is completed, the City will monitor water quality in the outfalls to see if modifications to the system are needed.

*Infiltration Alley* - In the Fall of 2001, the City reconstructed an asphalt alley using a permeable system. The new alley has eliminated formerly chronic local flooding without using the sewer system and reduced the "heat island" effect by eliminating dark, heat-absorbing surfaces.

The City used Gravelpave2™, a porous gravel structure, manufactured by Invisible Structures, that contains gravel and provides heavy load bearing support, unlimited traffic volume, and indefinite parking duration. In one 40 in. x 40 in. section of the structure, there are 144 rings made of highly durable plastic, each 2 inches in diameter and 1 inch high and held together underneath by a geo-fabric layer. The section below is a 10-inch thick, compacted aggregate base course consisting of a 2/3 stone and 1/3 sand mixture. The new system can handle up to 3" of rainfall per hour, allowing rainwater to soak into the ground and thereby reducing polluted run-off and flooding. The system is suitable for traffic, including residential and service vehicles.

*Rain Blocker Program* - Rain Blocker is Chicago's program of installing "vortex" type restrictors in sewer inlets to regulate the rate of storm water runoff entering the sewer system. The system is designed to keep sewers flowing at capacity without backing up. The excess water remains on the street longer instead of backing up in basements or causing CSOs.

**Summary**

Of course, no one project provides all of the answers. Rather, a combination of the above model projects, implemented on a City-wide and case by case basis, could reverse current trends of urban infrastructure, and thereby dramatically improve water quality.

## Next Steps

In the coming year, the City will continue to implement model projects that demonstrate effective management of storm water without requiring additional cost over more traditional methods. The City is also working with the Northeastern Illinois Planning Commission in preparing an urban BMP booklet designed specifically to educate and engage landowners in thoughtful, proactive storm water management approaches. A variety of educational and regulatory programs are also being considered, in addition to monitoring programs to assess the efficiency and replicability of our model projects.

## References

City of Chicago website “http://www.cityofchicago.org/Environment/Rivertour/”

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