

Keys to Green Streets: Collaboration and Sound Engineering

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Abstract

The Plainfield Avenue Bioretention Islands project in Grand Rapids, Michigan is an example of how public agencies and the private sector can effectively work together to accomplish green initiatives. This project utilized federal, local and private funds to finance street improvements that included innovative storm water management techniques. Michigan’s Complete Streets legislation, the Michigan Department of Transportation’s Context Sensitive Solutions process and the City of Grand Rapids’ Complete Streets Resolution are public policies driving awareness of sustainable infrastructure practices, but they do not provide best practices or funding mechanisms. However, the collaborative efforts between stakeholders involved in the Plainfield Avenue project creatively generated sufficient funding to implement this multifaceted pilot project.

Introduction

Plainfield Avenue is a major transportation artery running through a potential historic district. The Creston Neighborhood Association and the Creston Business Association proposed combining their financial resources to create a boulevard streetscape on Plainfield Avenue as part of a master plan for the area. During this time, local concerns for the water quality of the Grand River were growing. The City of Grand Rapids collaborated with community leaders to implement low impact development techniques in the road design to manage storm water. A city engineer created a unique “bioretention island” concept that would improve both area water quality and aesthetics. The Michigan Department of Transportation took interest in financially partnering with the city on the place-making idea in order to use it as a pilot project for treating storm water within a roadway, instead of outside. The MDOT grant was used by the city to leverage funds from local foundations, while community leaders used it to leverage funding from the rest of the community. The city engaged the consulting firm Fishbeck, Thompson, Carr & Huber, Inc. to redesign the street and integrate the water quality improvements. The resulting design included seven bioretention islands constructed within the roadway median.



“Vital business districts are critical components of a livable city and a strong economy. Great neighborhoods and vital business districts go hand-in-hand; one cannot succeed without the success of the other. The choices that are made in locating and designing business districts are also important factors in creating a walkable city and supporting transit.” ~ City of Grand Rapids Master Plan 2002

Public Policy

The Plainfield Avenue Bioretention Islands project in Grand Rapids, Michigan is an example of how public agencies and the private sector can effectively work together to accomplish green initiatives. A number of events set the stage for the successful funding and implementation of this pilot project at the state and local levels. Beginning in 2003, the State of Michigan defined Context Sensitive Design as “a collaborative, interdisciplinary approach involving stakeholders for the development of a transportation facility that fits its physical setting and preserves scenic, aesthetic, cultural, and environmental resources, while maintaining safety and mobility.” 1. (*Michigan Department of Transportation Commission, 2005, Page 1*) In 2005 the Michigan Department of Transportation (MDOT) determined to “...pursue a proactive, consistent and Context Sensitive Solutions (CSS) process in keeping with its mission to provide the highest quality integrated transportation services for economic benefit and improved quality of life.” 1. (*Michigan Department of Transportation Commission, 2005, Page 1*) CSS principles include: early and continuous public involvement, effective decision-making, reflecting community values, achieving environmental sensitivity and stewardship, ensuring safe and feasible integrated solutions, protecting scenic resources and achieving aesthetically pleasing solutions. MDOT also decided that “A successful CSS program will require mutual commitment on the part of both transportation agencies and stakeholders to identify appropriate opportunities to plan, develop, construct, operate and maintain infrastructure in accordance with CSS principles...” 1. (*Michigan Department of Transportation Commission, 2005, Page 1*) MDOT uses CSS as a planning, development and implementation process used for the whole life cycle of a project, and CSS is used on every project, regardless of type or size. In 2010 the Michigan Legislature passed legislation calling for Complete Streets, which are roadways designed with all users in mind, including motorists, bicyclists, public transportation riders and pedestrians of all ages and abilities. 2. (*Michigan Legislature, 2010*) The law established a Complete Streets Advisory Council and charged it with educating and advising all levels of government, interest groups and the public on the development, implementation and coordination of Complete Streets policies.

The City of Grand Rapids has a tradition of working to support multiple transportation modes, thereby creating a street environment that accommodates motorists, pedestrians and cyclists. To demonstrate its continued commitment to the work of creating Complete Streets, the city passed a Complete Streets resolution in March 2011. The city committed to “design and construct Complete Streets wherever feasible, and staff will conduct a review of pertinent policies, ordinances and design specifications that affect the public right-of-way to ensure cohesive Complete Streets implementation.” 3. (*City of Grand Rapids City Clerk’s Office, 2011, page 118*) The 2002 Grand Rapids Master Plan was updated in 2012. The update, called Green Grand Rapids, made recommendations for balanced, safe transportation and green

corridors. This served as a foundation for support of the Plainfield Avenue Bioretention Islands project. 4. (*City of Grand Rapids, Planning Department, 2012*)

Collaboration

The Creston neighborhood is located in the northeast quadrant of Grand Rapids, and is home to the Creston Neighborhood Association (CNA). Beginning in 2003, the CNA began to focus its neighborhood improvement work on its commercial corridor of Plainfield Avenue. Business owners in this low-to-moderate income area felt the general decline in commercial property conditions and the high number of vacancies needed the attention of the wider community. The resident members of CNA, in collaboration with the Creston Business Association (CBA), the City of Grand Rapids and other community stakeholders, began a formal process of evaluation of the neighborhood's socioeconomic profile and land use. In 2006 and 2007, over 100 individuals engaged in a design charette, the creation of the Creston Neighborhood Master Plan and the Creston Corridor Work Plan. Since 2006, CNA's Creston Corridor Initiative program has raised funds for façade improvements, public art murals and the placement of mosaic benches in public spaces. The Creston Car Show has become an annual marketing event for the neighborhood. These were all helpful toward positive place-making. However, with the 2008 financial downturn and a change in CNA leadership, the plans were shelved. In 2011, CNA's executive director and area business owners began work on the creation of a state-authorized Corridor Improvement District (CID), now named the North Quarter. The intent was to capture taxes which could be used to improve the three area commercial districts. All these planning efforts would soon become vital.

Plainfield Avenue was scheduled to be resurfaced in 2012 by the City of Grand Rapids with funding provided by the federal Surface Transportation Program and City of Grand Rapids capital improvement funds. Early in the design process, the city sent a data-gathering letter to homeowners and businesses along Plainfield Avenue, and to the CBA and the CNA, notifying them of the proposed work effort. The letter requested information related to the condition of the street and site observations (i.e. inadequate water pressure, road flooding, basement back-ups, etc.) During this initial stage, a local business owner expressed interest in a boulevard concept for the street, with trees and plantings, as noted in the Creston Master Plan. He cited this place-making vision as one incentive for his investment in the district.

The approaching project prompted the neighborhood and business associations to request a meeting with city engineers and their city commissioner to explore plans to enhance the road project with some type of planted boulevard. While the city agreed to review some areas where boulevards might fit, it was made clear that there was not sufficient funding available for the proposed place-making enhancements. It became obvious that while state and local public policy was leading to better projects, there were still two challenges: to identify best practices for these types of enhancements and to identify funding mechanisms.

Undaunted, the group asked the City Manager to attend one of the monthly CBA meetings. In front of a large group of stakeholders, he explained the city's unfortunate funding situation, but promised to search for any money left over from the previous year's construction contracts. The city found \$30,000 and estimated that, if coupled with fundraising from the businesses, it might be enough to cover the cost of one or two traditional landscape islands.

The Second Ward Commissioner for the City of Grand Rapids had previously been involved in the design charette for Plainfield Avenue, as well as the meetings to form the tax increment finance district. The commissioner attended a Healing Our Waters Conference on the Great Lakes, which focused on the need to capture storm water on-site. Storm water is the number one cause of pollution in the nearby Grand River, which empties into Lake Michigan. Contaminants range from fine sediment, heavy metals and oils to debris, such as cigarette butts and soda bottles. The Grand River is only a few blocks away from the Plainfield Avenue business corridor.

Postponement of the resurfacing project to allow time to raise money was rejected because it could set the project back by years. However, the group was excited to learn that one of the city engineers had drawn up innovative plans for boulevard islands that would direct storm water beneath the road's surface toward concave planting areas in the roadway median. The water would surface in the "bioretention island" and flow by gravity along its length, irrigating the plants inside. The city engineer was reluctant to show the group his plans because he was not sure the idea could leverage a federal grant. However, the group immediately recognized that this design could capture the imagination of potential funders.

While this was happening, the local environmental action council launched a campaign to educate the Grand Rapids community about the need to capture storm water to prevent it from flowing into the Grand River. A newly-revised city master plan, Green Grand Rapids, included green initiatives similar to those reflected in the Creston Neighborhood's plans, setting the stage for a fundraising campaign.

The Second Ward Commissioner asked the City Manager to consider allowing donors to contribute over a 10-year period of time to make it feasible to raise more substantial amounts of money. The request was granted and the group immediately began going from business to business, reaching out to residents and contacting local foundations.

By November 2011, the city was working on a grant request to MDOT. City staff believed they had an operational design for bioretention islands that was worth consideration of a federal Transportation Enhancement (TE) grant. They defended the unique engineering design and convinced MDOT engineers and water quality experts that it would be effective and safe. The total project cost was expected to be about \$330,000 for seven islands, enough to make a real difference in the local watershed. The city's place-making efforts were recognized as a good local example

of MDOT's Context Sensitive Solutions process. The addition of bike lanes would support both the city's and the state's Complete Streets policies. MDOT determined the following components comprised an excellent place-making effort:

- The water quality improvements to the Grand River
- The calming effect and aesthetic value of the plantings
- The safety improvements with the addition of a left turn lane and bike lanes
- The increased exposure for the local businesses by narrowing the through lanes to slow traffic

In December, the MDOT Office of Economic Development agreed to identify the venture as a pilot project in Michigan, and committed TE grant funds that would cover about half of the overall project costs.

Grant applicants do not need to have local match funding secured before applying to MDOT. Instead, the department uses an innovative initial funding commitment, called a Conditional Commitment, for a future grant award. Conditions include such items as certifying the project right-of-way, designing the project to meet federal standards and obtaining all necessary permits. The most important condition is obtaining the matching funds, because that confirms the applicant does not need to have already secured the matching funds to apply. The applicant must also provide evidence that the project will be maintained for its design life. Once all the federal aid requirements are met, and the local match has been secured, MDOT issues the actual grant award. With the MDOT Conditional Commitment now in hand, the local stakeholders could use it to leverage other funds.

The next big problem was the timeline. In order to keep the road resurfacing project in the 2012 construction season, all of funds for the bioretention islands would have to be raised by December 28, 2011. Being the holiday season, foundations were not holding board meetings. Residents and business owners were busy with the season's activities. But the project still needed \$150,000 to become a reality. This amount included both the match money and \$30,000 to establish a fund for future maintenance. The challenge seemed insurmountable. However, the pre-planning efforts of the Creston Neighborhood residents and businesses, along with the pre-planning efforts of city leaders and staff, together created a strong collaboration, resulting in a synergy that propelled the project past these obstacles. Moving with a sense of urgency and determination, a city grant writer, the CNA and the CBA began their appeals for the remaining needed funds. One effort was directed at local foundations and another effort at local residents and businesses.

They discovered the local foundations were acutely aware of the detrimental effects of storm water on local rivers and lakes, and were supportive of requests to "green up" neighborhood corridors. Eager to facilitate the creation of vibrant business districts, several gave discretionary funds in lieu of a normal grant. The Dyer-Ives Foundation, a champion of neighborhoods, gave an early gift, strengthening the project's position with all of the other potential donors. Ultimately, a total of \$70,000

was secured from seven foundations including the Dyer-Ives Foundation, the Grand Rapids Community Foundation, the Frey Foundation, the Meijer Foundation, the Kiwanis Foundation, the Morrison Family Foundation and the James and Shirley Balk Foundation. Additional individual private donations comprised an astounding \$84,000, exceeding the total funding goal.

In a period of just a few weeks, at the busiest time of year, the Plainfield Avenue Bioretention Islands project was conceived and funded. Design of the islands was completed over the next two months and construction was completed in the summer of 2012. A ribbon-cutting ceremony in September featured a bus tour of the seven islands to explain how they work and highlight the drought resistant plants used to beautify the streetscape. Educational signage and a bronze plaque honoring donors will be installed in the corridor in 2013.

Sound Engineering

Plainfield Avenue from Leonard Street to Ann Street is a principal arterial route approximately 0.90 miles long and located in the northeast quadrant of Grand Rapids, Michigan, as shown in Figure 1.

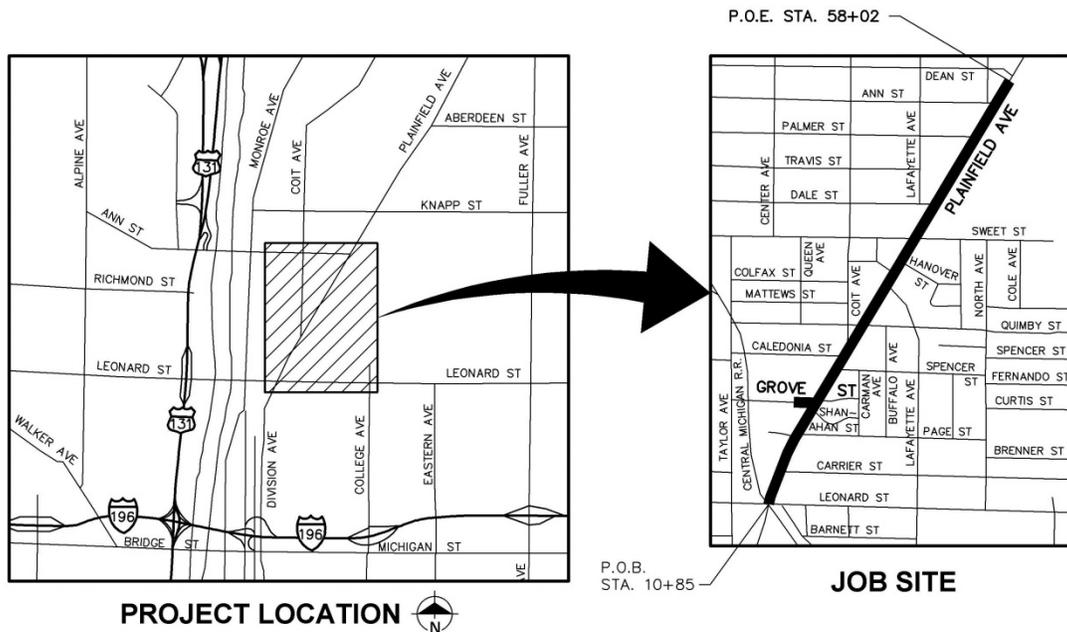


Figure 1: Plainfield Avenue Project Location

During the initial scoping stages of the project in September 2011, various stakeholders and city departments reviewed the private and public utility improvements needed within the project limits and discussed the impacts of these changes. City departments represented at these meetings included: Traffic Safety, Planning, Environmental Services, Water, Street Lighting, Parks and Recreation,

Parking Services, Fire, Police and others. Combined sewer overflow (CSO) work along Plainfield Avenue between Grove Street and Spencer Street was required to complete one of the final contracts for a 20-year phased infrastructure project. The CSO project has eliminated 99.9 percent of the combined sewer overflows to the Grand River. Water main replacement and roadway reconstruction was also proposed in the affected section of Plainfield Avenue.

Green Grand Rapids is a planning document created in October 2011, which inventories and targets the implementation of green infrastructure throughout the city. Targets include balancing automobile transportation and bikeway networks with the greening of priority streets. The document outlines goals to create a community that enriches people and is balanced with nature. In Green Grand Rapids, Plainfield Avenue was identified as a “major street” with a limited tree canopy. Its canopy cover ranged between 3 and 11 percent, which is low in comparison to targeted goals.

The Grand Rapids Sustainability Plan identified several targets to provide services to the community while promoting economic prosperity, ensuring social equity and protecting the integrity of the natural environment for all citizens. 5. (*City of Grand Rapids, Office of Energy and Sustainability, 2011*) This triple bottom line approach using city leadership, partnership with others and commitment to citizens is integral to all functions of the city.

The first target is to reduce greenhouse gas emissions (carbon footprint) and its impact on climate change by increasing the number of miles of on-street bike lanes. Plainfield Avenue was identified as a corridor in which to increase the use of bicycles and promote a north-south connection into and out of downtown Grand Rapids. Bike lanes had already been established along portions of Plainfield Avenue north of Sweet Street to Three Mile Road as part of a “roadway diet” completed in 2006. This effort reduced four travel lanes to two ten-foot through lanes, two five-foot bike lanes and a center turn lane. The impact did not reduce the capacity of the roadway, but it did reduce average travel speeds by several miles per hour.

A second target is to protect and maintain healthy ecosystems and natural habitat by increasing tree canopy in the city, increasing the use of low-maintenance grasses and native plants used in landscaping, and increasing the diversity of tree species planted. The addition of trees and other vegetation along the Plainfield Avenue corridor would help to achieve this goal.

Finally, it is the city’s goal to improve water quality in the Grand River and its tributaries by reducing storm water discharge and pollutants. The city’s National Pollutant Discharge Elimination System storm water permit requires the city to prepare a Watershed Master Plan that addresses problem areas and the Total Daily Maximum Load for established parameters that may affect storm water discharging to waters of the state (i.e. the Grand River). The city developed the plan and implemented this demonstration project as part of the effort.

The CBA and the CNA hosted a design open house to solicit input from the Creston community regarding the proposed road modifications. Designers from the city and Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) presented the preliminary designs for the bioretention islands, solicited input and discussed concerns. During interviews and surveys of local residents and businesses, several themes emerged, including the need to revitalize the local business community. Business owners wanted to create an environment which was inviting for retail customers. They wanted to see vacant stores occupied with vibrant new businesses. They wanted to establish the community with place-making in mind, where destinations are created, sociable and transformative.

A theme that developed was to beautify a highly urban neighborhood by providing green space. The impacted Plainfield corridor contained few shade trees and sparse landscaping, especially at the southern end. The overall area is characterized by older businesses and homes, many of which are located within close proximity to the roadway. The islands provided an opportunity to integrate the beneficial functions of plant material into this highly developed environment, including: interception and uptake of rainwater, microclimate cooling (thus combating the heat island effect), and providing an aesthetically pleasing asset to the neighborhood. These impacts may have secondary effects of increasing property value, improving the general perception of the neighborhood as a desirable destination, and attracting new businesses and residents.

Another theme that emerged was the problem of the fast pace of traffic through the center of the community. Although the volume of traffic on Plainfield Avenue was high (estimated to be over 16,000 vehicles per day), businesses wanted to allow these levels in order to maintain retail exposure. A three year traffic analysis from 2008 through 2010 was conducted along the corridor by the city's Traffic Safety Department. This study did not elucidate any significant trends or patterns for any specific type of crash. Parking was important and therefore its removal to provide additional green space was not supported. Removal of parking was also not feasible given the already narrow sidewalk areas along store fronts. What emerged was a goal to use a context sensitive design which could maintain or improve the current level of traffic service at all of the intersections while reducing average traffic speeds.

Leonard Street is just south of the Plainfield Avenue project area, with a small section under the jurisdiction of MDOT (Business Loop U.S.-131). Plainfield Avenue north of Leonard Street has five lanes of traffic, including four through lanes and a left turn lane. Protection of this geometric configuration was required to maintain the current level of service for the roadway. Introduction of bike lanes in this section would not be possible without significant right-of-way acquisition and roadway widening. However, to the north, from Carrier Street to Grove Street, a "road diet" was proposed with 5-foot bike lanes, a 10-foot left turn lane and the elimination of two parking spaces just north of Page Street. From Grove Street to Sweet Street the roadway was generally 46 feet wide, and the road diet was continued with the addition of a 10-foot left turn lane and the reduction of the through lane widths from

15 feet to 10 feet, along with two 8-foot parking lanes. The section north, from Sweet Street to Ann Street, remained the same with a 10-foot center turn lane, two 11-foot travel lanes and two 5-foot bike lanes. Adjusting 125 feet of curb just north of Ann Street on the east side of the roadway was necessary to provide the 11-foot travel lanes, a northbound 5-foot bike lane, a center turn lane and 8-foot parking on the west side.

Although the American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets 2011, 6th edition, specifies that 10-foot lanes may be used where truck volumes are low and speeds are less than 35 miles per hour, MDOT guidelines require minimum travel lanes of 11 feet. 6. (*American Association of State Highway and Transportation Officials, 2011*) Therefore, it was necessary to secure a design exception for the use of 10-foot travel lanes through this corridor. The city's Traffic Safety and Engineering Departments met with MDOT to provide information necessary to receive a design exception to allow the 10-foot travel lane widths.

While preliminary design concepts and cost estimates were developed through the fall of 2011, the design of the seven bioretention islands did not begin in earnest until December, after MDOT provided the Conditional Commitment for a TE grant. However, the scope of the project still could not be identified in full until there was commitment from local foundations, as well as the local business and neighborhood associations, for the necessary local match funding and maintenance funding. The design of the bioretention islands along Plainfield Avenue was a joint effort between the city's Engineering Department and FTC&H.

The islands vary in length from 60 to 220 feet and span approximately one mile. The available width of the islands was determined by the roadway design, which included 10-foot left turn lanes. MDOT Local Agency Programs Guidelines for Geometrics require a minimum of one foot of separation between the edge of the travel lane and any curbing. 7. (*Michigan Department of Transportation, 2008*) Therefore, a 1-foot inverted gutter pan with a 6-inch wide curb head was selected. The inside island width was limited to a maximum of seven feet. An initial concept for draining storm water runoff from the sides of the road into the island was to discharge the storm water through a shallow gravity pipe system. However, the final vetted concept was modified with a siphon type system connecting the new catch basin connections to an inlet structure at the center of the islands (see Figures 2 and 3).

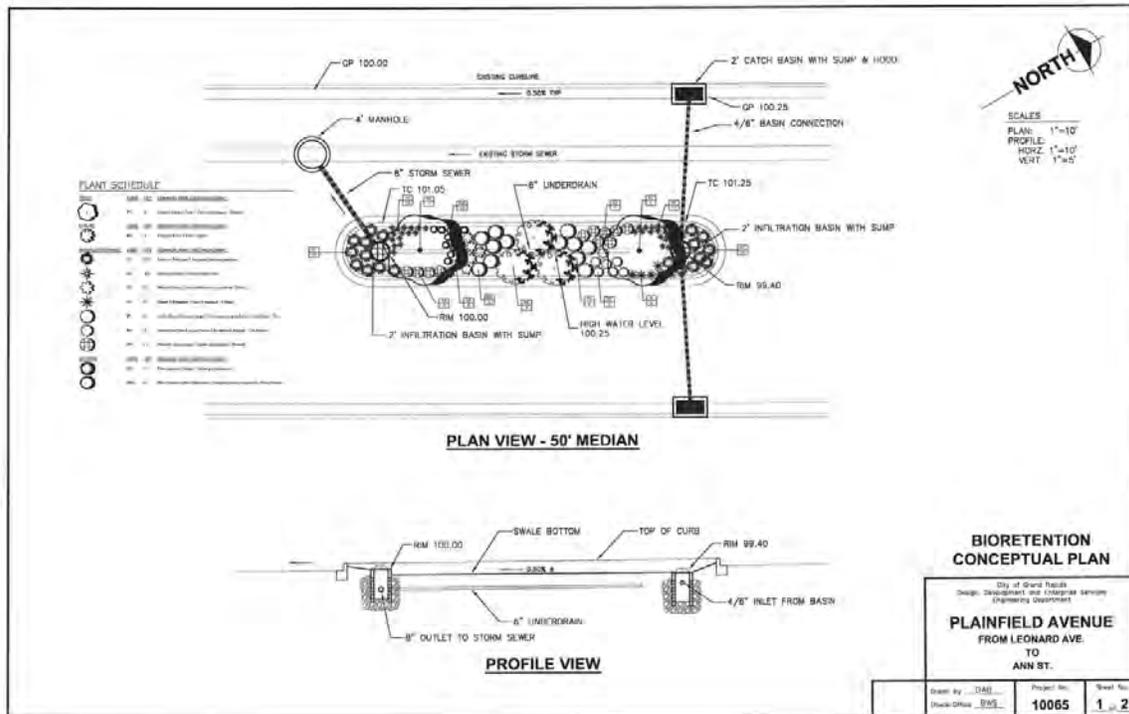


Figure 2: Plan View - Bioretention Conceptual Plan

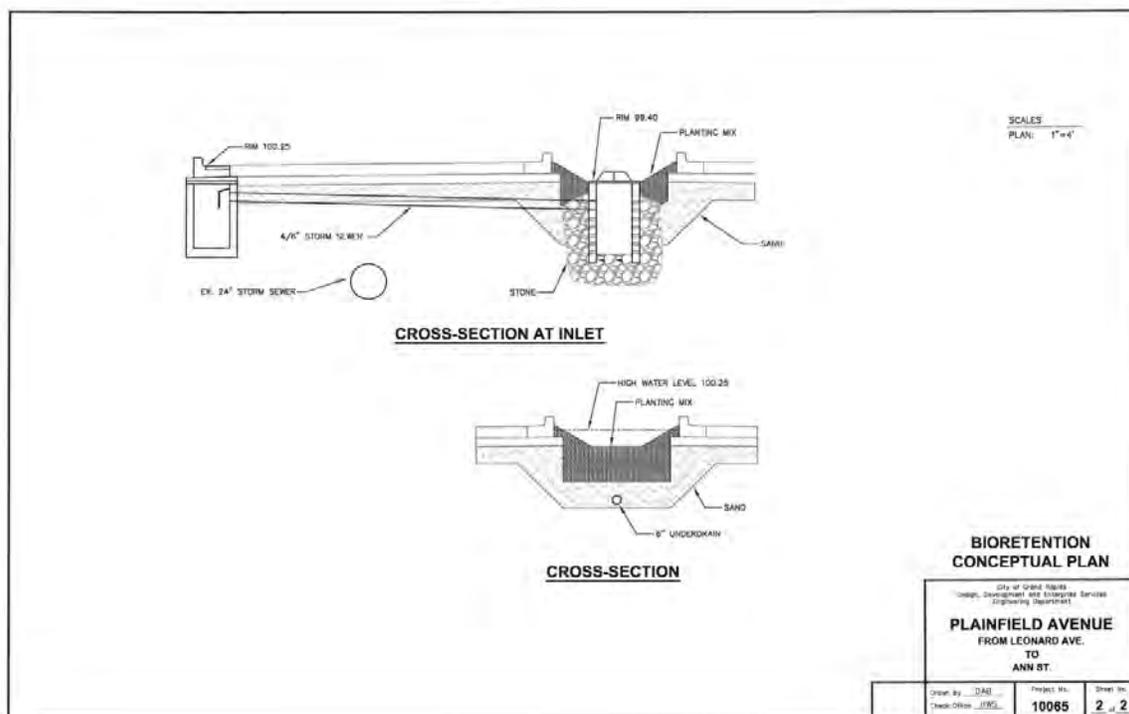


Figure 3: Section View - Bioretention Conceptual Plan

As Figure 4 illustrates, a 1-foot infiltration hole in the bottom of the inlet structure was provided to allow water to infiltrate into the ground after rain events. Each inlet casting rim was set at approximately 0.85 inches below the lowest gutter grade of the new catch basins at the outside edge of the roadway. The longitudinal slope of the island generally matched the slope of the roadway, but at no less than 0.5 percent. An outlet overflow structure was designed at the downstream end of each island, and the rim elevation was set to begin to discharge storm water back into the storm sewer if depths in the basin reach 0.25 feet below the lowest gutter grade. This was to ensure that the overflow structure would be in operation before any overflow could occur from the island to the street. In addition, if the island overflow system became plugged, the storm water in the gutter would bypass the new catch basins connected to that island and flow to the existing catch basins connected to the existing storm sewer system.

Soils play an essential role in fulfilling the water treatment goals of the islands and supporting plant establishment. The existing roadbed and underlying soil were excavated to a depth of approximately four feet, then backfilled with one and a half feet of sand and a minimum of two feet of special planting soil. The sand layer was placed to ensure good infiltration directly below the growing medium. A 6-inch underdrain was placed below the sand to collect groundwater and discharge it into the existing storm sewer to ensure that saturated conditions beneath the roadway do not persist for long periods of time. The planting mix is composed of 50 to 60 percent sharp sand, 20 to 30 percent topsoil and 20 to 30 percent compost. The sand component ensures good infiltration, while the topsoil and compost components provide a nutrient-rich medium to support plant establishment. In addition, the high cation-exchange capacity of the clay and organic fractions capture dissolved metals and other contaminants, removing them from storm water.

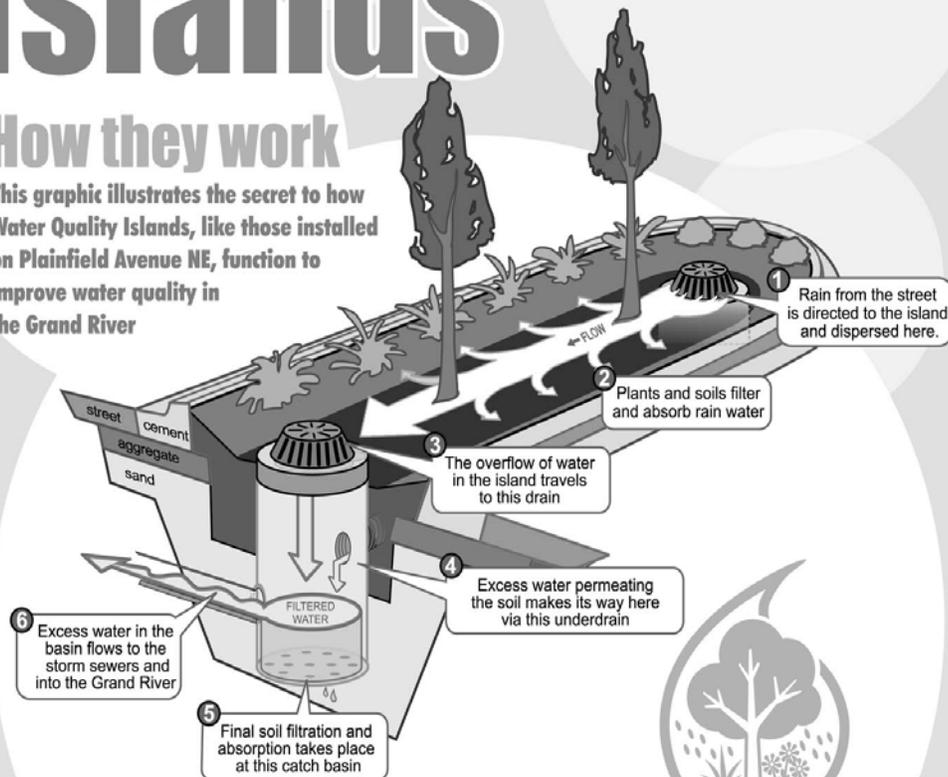
Island curb ends were designed with a special rolled curb end and reinforcing steel bars to prevent damage to the curb head from street snow plows. The depth of the curb was made to be two feet, two and a half inches, and three reinforcing bars were included in the curb to provide sufficient mass to set the curb in place and prevent movement with the limited and unconsolidated soil located behind the curb. Side slopes were set to a maximum of 1:2 vertical to horizontal. A 6-foot flat area was designed within the ends of each of the island areas to provide a more visible space for plantings. Two 4-inch conduits with caps were run under the roadway to each island for potential future installation of irrigation or electric service for holiday lighting. At the time of design, there was not sufficient funding for these improvements. However, installation of the conduits to prevent future damage to the street was considered wise.

Water quality improvements were expected to result from the project. The contributing area to all of the bioretention islands is 3.3 acres, or 143,748 square feet. The corresponding water volume generated from this area (based on the criteria of one inch of runoff from the impervious areas) is 11,979 cubic feet, or 89,609 gallons of storm water. No significant pervious areas were estimated in this calculation.

Water Quality Islands

How they work

This graphic illustrates the secret to how Water Quality Islands, like those installed on Plainfield Avenue NE, function to improve water quality in the Grand River



Benefits of the Plainfield Islands

Economic

- Beautifies and revitalizes the neighborhood
- Triggers additional investments
- Increases property values

Social

- Enhances pedestrian safety through traffic calming and increases driver awareness
- Heightened community pride
- Provides inspiration to other areas

Environment

- Filters out pollutants and keeps them from the Grand River
- Reduces the volume of water going to the river and decreases flooding
- Slows the velocity of water flowing to the river and minimizes erosion



Figure 4: Water Quality Islands – How They Work

The infiltration rate of the bioretention islands was assumed to be 12 inches per hour. The rating for total suspended solids removal was estimated to be high. Groundwater is well below the roadway in this area and underlying soils are generally sandy. It was anticipated that much of the storm water would infiltrate into the soil and recharge groundwater.

The plant material utilized in the islands was selected to withstand a harsh urban environment. The selected species are drought, heat and salt tolerant. They are also tolerant of shallow inundation for short periods of time. The designers worked with the city forester to ensure trees and shrubs were compatible with the city's urban forestry goals. The forester desired that trees be incorporated into the design due to their effectiveness in intercepting storm water. The southern islands contain Accolade elm (*Ulmus japonica x wilsoniana* 'Morton'), the Society of Municipal Arborists' 2012 Urban Tree of the Year. This large shade tree species was placed in this area due to a lack of shade trees. Smaller ornamental Capital callery pears (*Pyrus calleryana* 'Capital') were utilized in the northern islands. These trees provide year-round visual interest and have a narrow growth habit, so they will not grow into traffic lanes. Flowering shrubs, taller ornamental grasses and taller perennials were placed in the center of the islands, with cultivars two feet or less in height planted at the perimeter and ends of the islands. This ensures clear visibility for vehicles in turning lanes. The diverse array of vegetation provides a colorful display throughout the growing season, while providing valuable storm water treatment.

A cost benefit analysis was conducted for the bioretention islands in comparison to the conventional catch basin inlet devices, hydrodynamic separators and leaching basins. Catch basins are a cost effective method to control total suspended solids at \$21,408 per ton removed. Therefore, a minimum of two additional catch basins were provided at each island location. The existing catch basins were maintained in place as back-up and for larger storm events which exceed the capacity of the inlets to the bioretention islands. Although the islands were the most costly of these best management practices (BMP), they provide other benefits not provided by the other BMP's. These benefits include:

- **Reduced storm water runoff:** stores and filters storm water, which minimizes downstream bank erosion, reduces flood impacts and prevents the storm water from polluting local waterways
- **Increased groundwater recharge:** has the potential to increase groundwater recharge by directing water into the ground instead of pipes
- **Improved air quality:** improves air quality through uptake of air pollutants and the deposition of particulate matter
- **Reduced atmospheric CO₂:** reduces carbon dioxide emissions through direct carbon sequestration
- **Reduced urban heat island:** through evaporative cooling and reduction of surface albedo, the bioretention works to reduce the urban heat island effect and reduce energy use in the community.

A maintenance plan was developed for the islands. The plan was prepared to evaluate the estimated cost for maintenance and to develop a sustainable financing structure to ensure the islands would be maintained with limited city involvement. Maintenance tasks include:

- Inspect for and remove weeds and undesirable plants
- Inspect soil and repair eroded areas
- Mulch void areas
- Prune woody vegetation and remove herbaceous dieback at the end of the growing season
- Identify and treat diseased trees and shrubs
- Remove and replace dead and diseased vegetation
- Remove litter and debris
- Inspect and maintain the underdrain system to keep it functioning properly
- Inspect and remove accumulated sediments if buildup reaches 25% of the ponding depth
- Repair and replace damaged curbs and damaged signs
- Irrigate vegetation during times of extreme drought after the establishment period to provide one inch of water per week

The total estimated cost ranges between \$1,200 and \$2,900 per year. Assuming an initial fund of \$30,000 and a return on investment of five percent, approximately \$1,500 could be used for maintenance each year without additional resources required by the community. The city agreed to catch basin cleaning. The Creston Business Association acknowledged full responsibility for all other maintenance of the islands. The North Quarter Business Improvement District has recently been approved, which will provide additional options for care and maintenance of the islands in the future.

Conclusion

Public policy in support of green streets creates a foundation, but effective project development and implementation further requires both best practices and funding mechanisms. Faced with the challenges of a pilot project and a funding gap, the firm determination of all the stakeholders to work in partnership created a scenario that yielded positive results, with both immediate and long-term impacts.

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