



12. GREEN INFRASTRUCTURE PROGRAM

12.1 Introduction

As described in Sections 8.4.7 and 11.2.7 of this report, MSD's preferred combined sewer overflow (CSO) control alternative involves cost-effective gray infrastructure for urban streams and an enhanced green infrastructure program for CSOs that are directly tributary to the Mississippi River. This section of the Long-Term Control Plan (LTCP) describes the green infrastructure program for reduction of CSOs, particularly for the Mississippi River CSOs where extensive redevelopment is forecasted.

Gray infrastructure controls will reduce untreated overflows to Maline Creek and the River Des Peres to an average of four events in a typical year. These controls will also reduce CSO to the Mississippi River. As presented in Section 8, gray infrastructure for Mississippi River CSOs requires a minimum of \$1 billion and perhaps as much as \$4.3 billion. Also, as discussed in Section 3, water quality standards are met in the Mississippi River under existing conditions. The preferred alternative therefore primarily uses green infrastructure controls for CSOs that discharge to the Mississippi River. Successes with these efforts will also be considered for other locations within MSD's service area.

Green infrastructure refers to constructed projects that re-direct stormwater from reaching sewers by capturing and diverting it to locations where it is infiltrated into the ground, evaporated, taken up by plants, or reused. The use of plant materials to facilitate uptake and improve stormwater quality makes these practices literally green; their ability to provide more sustainable wet weather flow management by reducing energy consumption and carbon footprint makes them figuratively green.

MSD's selected alternative includes \$100 million in green infrastructure investments over a period of 25 years to reduce CSOs in the Bissell Point service area and to improve water quality in other areas. This amounts to a green infrastructure investment equivalent to 5.5% of MSD's CSO control investment, which is in the range of green infrastructure investment that other Midwestern utilities are making in their CSO control plans. For example, Sanitation District No. 1 of Northern Kentucky has proposed green infrastructure investment valued at about 3.5% of their total program cost and Kansas City, Missouri has proposed green infrastructure investment worth approximately 8% of their planned program.

MSD's green infrastructure program will use a variety of elements including the following:

- Identifying project partners and engaging stakeholders.
- Developing public education and outreach systems.
- Establishing demonstration projects and associated monitoring systems.
- Adopting policies and regulations to maintain and increase the number of green infrastructure projects.
- Investigation of incentives for green infrastructure implementation.
- Detailed opportunity analysis in the Bissell Point service area to identify specific green infrastructure projects, building on the preliminary green infrastructure analysis already performed (see Section 12.2.1 – Bissell Point Wet Weather Flow Reduction).
- Assessment of green infrastructure potential in the Lemay service area.

The overall objective for MSD's green infrastructure program is to identify and implement projects and programs that will significantly reduce CSOs and provide additional environmental benefit. A successful model for implementation of a green infrastructure program will incorporate some adaptive management



components, whereby data will be used to evaluate performance and these data will inform future decisions about refining the green infrastructure approaches.

12.1.1 Reasons for Incorporating Green Infrastructure in MSD's LTCP

MSD will use green infrastructure as part of the LTCP as an effective component of an overall water quality improvement strategy for the following reasons: EPA promotes the use of green infrastructure in CSO LTCPs; green infrastructure practices can be economical, environmentally-friendly, and sustainable complements to traditional CSO control techniques; and the public supports a measured green infrastructure program.

As discussed below, MSD will continue to evaluate low impact options like capturing rooftop runoff, reducing impervious surfaces, and retrofitting vacant or underused property to incorporate stormwater management systems. However, MSD faces a significant challenge to implementing green infrastructure, because MSD does not own most of the property where green infrastructure can be implemented to control wet weather impacts and does not control the land use/zoning regulations that influence the generation of stormwater. This makes it difficult to guarantee implementation of green infrastructure projects. To address this challenge, MSD plans to work with local units of government, private developers, and other stakeholders to implement the program described here. In addition to being a potentially significant element of MSD's CSO control program, there are a number of additional reasons for incorporating green infrastructure into MSD's CSO control plan, including those described below.

12.1.1.1 US EPA Endorsement of Green Infrastructure

The U.S. Environmental Protection Agency (EPA) and other organizations published a Statement of Support for Green Infrastructure in 2007 to bring together organizations that recognize the benefits of the use of green infrastructure to mitigate sewer overflows and reduce stormwater pollution (EPA et al., 2007). EPA encourages implementation of green infrastructure in CSO, SSO, and stormwater programs. EPA's goals for green infrastructure implementation include:

- Development of models to quantify stormwater storage and infiltration potential.
- Monitoring to verify CSO, SSO, and stormwater discharge reductions.
- Quantification of life-cycle costs.
- Increased federal, state, and local funding for green infrastructure initiatives.
- Elimination of barriers to the incorporation of green infrastructure in sewer programs.
- Preparation of guidance documents to assist in the development of green infrastructure initiatives.
- Development of green infrastructure programs to incorporate into CSO and SSO permits, management, operations, maintenance plans, and consent decrees.

EPA is promoting the use of green infrastructure particularly in urban environments where the environmental damage associated with traditional development is more extensive (EPA, 2009). The incorporation of green infrastructure into MSD's LTCP supports EPA's endorsement of green infrastructure for wet weather planning.

12.1.1.2 Ancillary Benefits of Non-Conventional Solutions to CSO Control

Green infrastructure implementation is considered a non-conventional approach to CSO control because it is a fairly recent concept in comparison to traditional gray infrastructure systems. Its implementation as part of major cities' long-term control plans has occurred only in the past few years. Nonetheless, in addition to reducing wet weather flows, green infrastructure solutions to CSO control can have many ancillary benefits. These benefits can include supplementing redevelopment efforts, helping to alleviate



CSO funding constraints, and providing aesthetic, educational, and recreational benefits to communities. As such, the inclusion of green infrastructure as an appropriate element of CSO LTCPs is becoming increasingly common.

One of the aspects of green infrastructure that makes it appropriate for use in CSO long-term control planning is the fact that it can be readily incorporated into urban development and redevelopment. Integration of green infrastructure into these projects is often more economical than retrofitting existing properties and it can offset the increased wet weather loads that conventional development/redevelopment projects create.

EPA concluded in a recent study (Field, 2009) that even as stand-alone projects, green solutions can in many cases be implemented less expensively than conventionally engineered drainage systems. Major costs of green infrastructure are acquisition of land and system installation (Field, 2009). Green solutions can provide insulation for buildings and mitigate urban heat island effects, decreasing utility costs. Conventional systems can be less expensive initially, but require more in terms of maintenance. The overall life cycle cost of green technology can therefore be much less.

Finally, green infrastructure provides benefits beyond runoff reduction. Green solutions are generally viewed as more aesthetically pleasing than traditional stormwater conveyance systems. Landscape features including shrubs, grass, herbs, and wildflowers can be part of systems that manage runoff. Green infrastructure adds green space to cities, increases recreational opportunities, creates wildlife habitat, increases groundwater recharge, improves air quality, increases property values, enhances urban quality of life, and improves human health (EPA, 2009).

12.1.1.3 Public Support for Green Infrastructure

The public engagement and stakeholder involvement process undertaken by MSD as part of the LTCP development indicates that there is widespread public and stakeholder support for green infrastructure. The public engagement process included: 1) key stakeholder interviews, 2) the establishment of a Stakeholder Advisory Committee, 3) stakeholder and community presentations, and 4) public open houses. Overall, the purpose of these activities was to educate the public about existing sewer conditions and the sewer overflow issue; review options for reducing combined sewer overflows; identify the public's preferred options; and explore opportunities for additional action by MSD and the public. Some details of the public input process related to green infrastructure are discussed below.

Stakeholder Advisory Committee

During their consideration of CSO control options, the Stakeholder Advisory Committee members voiced support of a general watershed approach to implement green infrastructure as part of the LTCP. They emphasized the need to complete preliminary research and appropriate a portion of the budget for testing the effectiveness of green infrastructure. The Committee also favored minimizing "greenwashing," a term used to describe the practice of spinning products and policies as environmentally friendly when they are not, a deceptive use of green marketing.

The stakeholders were also concerned about the high cost of traditional controls for CSOs discharging to the Mississippi River. The committee instead supported aggressive green infrastructure implementation for these CSOs. However, the committee recognized the need to research information and monitor effectiveness to identify the most effective practices so that money was not wasted on ineffective practices.



Public Open Houses

MSD has documented the results of their 13 public open house sessions designed to involve the public and gauge their opinions on MSD's CSO mitigation efforts and LTCP contents. During this process, the public expressed their preference for "Knee-of-Curve on Urban Streams plus Enhanced Green Program on the Mississippi River" as the level of control MSD should implement as part of its LTCP. The following were prioritized as most important: 1) make waterways safer for the people who use or live by them; 2) reduce the frequency of sewer overflows; 3) keep sewer rates as affordable as possible; 4) make waterways healthier for fish/wildlife; and 5) include green infrastructure as part of the project.

The public's comments on actions they would like MSD to take can be broadly categorized into education, working with others, and funding:

Education

- Provide brochures and educational programs to promote rain barrels, porous pavement, and other green infrastructure practices, as bill inserts.
- Educate school children, and increase public service announcements on radio and TV as well as segments on local news.
- Provide consistent and continuous communication of MSD's actions and dangers of inaction.
- Document the success or failure of green infrastructure demonstration projects, and make this information available to the public.

Working with Others

- Work with developers to implement construction practices that decrease runoff.
- Work with cities to use rain gardens for street medians.
- Work with highway departments to reduce runoff.

Funding

- Increase sewer bill rates modestly to fund CSO elimination measures.
- Seek federal or other matching grants.
- Along with green roofs and pervious pavement, issue a credit on stormwater bills for a customer's rain gardens and rain barrels.
- Provide incentives so that the public's cost of green infrastructure implementation is low.
- Charge much higher rates for large volume industrial users.
- Some members of the public believe that green infrastructure measures are too costly, and that St. Louis should not try to comply with the EPA's CSO requests.

In general, the Stakeholder Advisory Committee's and the public's comments align well. Both emphasize a desire for more green practices, public outreach and education opportunities, and partnerships to alleviate costs. The public is in favor of green infrastructure implementation as part of the LTCP as long as the projects do not put a great deal of a financial burden on the ratepayers. The public would like to become more educated on how they can be involved in the effort to implement green infrastructure into their homes and businesses. Some parties would like green infrastructure expanded to the entire MSD service area, not just the combined sewer service area.

12.1.2 The Role of Green Infrastructure in MSD's LTCP

To reduce CSOs, MSD must establish waterway priorities and identify the option or Level of Control (LOC) that best carries out these priorities (see section 8.1). MSD, the Stakeholder Advisory Committee and the public considered five Levels of Control.



Two of the scenarios involve the expandability of CSO controls to include green infrastructure. The selected alternative, Scenario 3 (Knee-of-Curve on Urban Streams plus Enhanced Green Program on the Mississippi River), involves some of the funding for gray infrastructure practices being diverted to green infrastructure initiatives. This scenario was developed due to stakeholders' concern about the high cost of traditional controls for CSOs discharging to the Mississippi River. Significant opportunities for green infrastructure implementation exist in the areas tributary to the Mississippi River, including the Bissell Point and Lemay service areas. Features include large impervious parking areas that could be converted to green parking and significant amounts of vacant or abandoned property that can be retrofitted to reduce stormwater volumes reaching the combined sewer system (CSS).

12.2 Potential Green Infrastructure Opportunities in MSD's CSS Area

To evaluate the potential applicability of green infrastructure to reduce CSO, MSD has conducted some preliminary analyses. These include a study of wet weather flow reduction opportunities in the Bissell Point CSS and an evaluation of green infrastructure opportunities at MSD's facilities. Based on these findings, MSD intends to conduct a detailed evaluation of the Bissell Point CSS area; construct and monitor several demonstration projects at MSD facilities; and conduct a preliminary opportunities analysis for the Lemay CSS area. MSD has also identified eight elements of a comprehensive green infrastructure program (as discussed in Section 12.3).

Based on the findings of a Bissell Point study discussed below, the green infrastructure techniques that are likely to be most applicable in MSD's CSS areas include green roofs, bioretention, green streets, green parking retrofits, rain barrels, and neighborhood-scale stormwater retrofitting. Because of the soil types in the CSS areas, rapid infiltration techniques are not recommended and are therefore not presented as part of the LTCP.

Neighborhood-scale stormwater retrofitting takes advantage of vacant and underused properties in the Bissell Point CSS that are owned by the Land Reutilization Authority (LRA). The LRA is an agency of the City of St. Louis whose mission is to acquire properties that have undergone tax foreclosure and facilitate their transition back to productive use. In addition to these general opportunities, MSD has identified a number of green infrastructure retrofit opportunities at their own facilities, both in the Bissell Point service area and outside of it. Lastly, opportunities may exist for green infrastructure retrofitting in the Lemay service area, although an opportunity analysis of Lemay has not yet been conducted. Each of these is described below.

12.2.1 Bissell Point Wet Weather Flow Reduction

MSD commissioned a preliminary study of green infrastructure in the Bissell Point service area to evaluate the potential for green infrastructure to reduce discharges from 11 target CSOs representing approximately 90% of the total average annual CSO volume from the Bissell Point CSS (LimnoTech, 2009). The study was used to identify green infrastructure techniques (mentioned above) that may be applicable in the main Bissell Point CSO drainage areas. The study also identified retrofit opportunities and their potential to reduce CSO volumes and peak rates. There are several challenges in implementing these green infrastructure measures in the Bissell Point service area, chiefly because opportunities for green infrastructure are, for the most part, located on property that is not owned by MSD.

Three of the eleven target CSO drainage areas (037 Palm, 038 Branch, and 047 Harlem) appear to have the greatest potential for green infrastructure to reduce CSO. These drainage areas contain large amounts of LRA lands, with Harlem having the most. Also, CSO drainage area 016, Old Mill Creek, located in downtown St. Louis, is able to yield a significant CSO response due to reductions in imperviousness despite the restriction on the amount of land available for stormwater retrofits.



Aerial photography was used to identify the types of opportunities appropriate in each drainage area. GIS was used to quantify areas, distances, and counts of relevant features to allow estimation of green infrastructure benefits in reducing imperviousness. Details will vary block to block in each of these service areas.

The 11 CSOs that were studied are estimated to discharge a total of 108 million gallons in a 4 month synoptic storm. If all of the green infrastructure retrofit measures outlined in the report were implemented, this volume could be reduced by approximately 12.5 million gallons (11.6%). In addition, supplemental hydraulic modeling of the Harlem CSO (Outfall 047) drainage area was conducted to evaluate annual CSO volume reduction. This supplemental analysis indicates that reduction of impervious areas through green infrastructure has the potential to significantly reduce CSO volume during a typical year (see Figure 12-1). The example in Figure 12-1 shows that a 20% reduction in imperviousness in the Harlem CSO drainage area could result in an annual CSO volume reduction of 225 million gallons and a peak overflow reduction of 229 million gallons per day. Based on these findings, it can be concluded that green infrastructure has the potential to substantially contribute to CSO control and to potentially reduce the size of traditional control measures. Further work is needed to validate these results, identify specific project opportunities, and develop estimates of project costs, but the preliminary results indicate that green infrastructure can significantly reduce some CSOs.

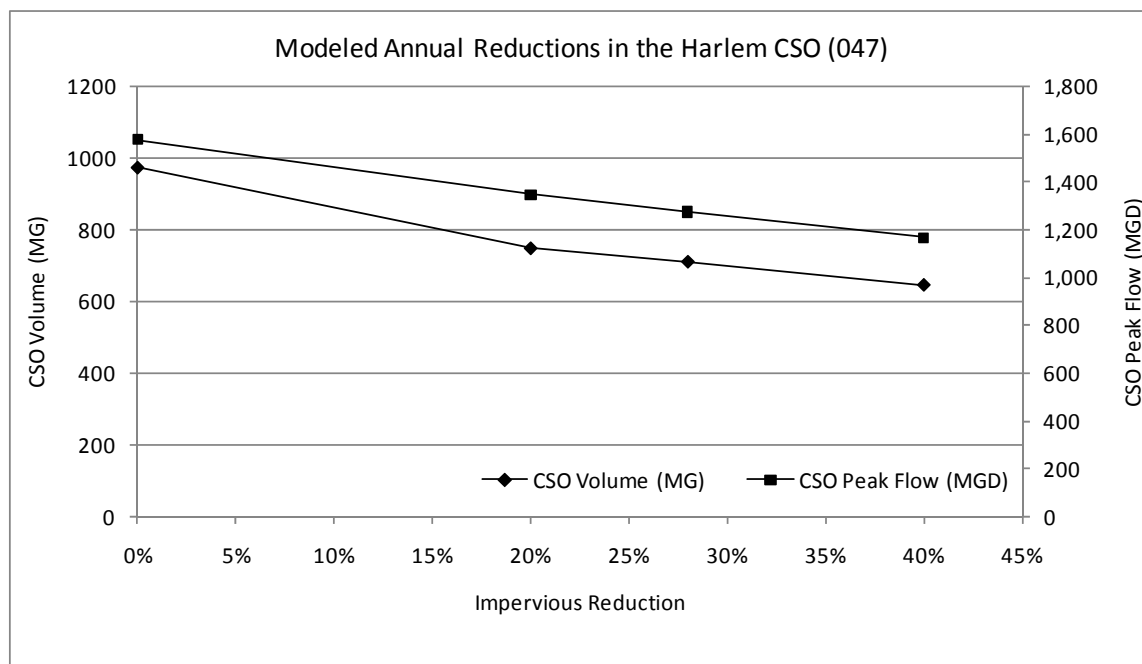


Figure 12-1 CSO Volume Reduction in the Harlem CSO Drainage Area

12.2.2 Green Infrastructure at MSD Facilities

By 2014, MSD plans to implement and evaluate green infrastructure techniques at some existing District facilities to serve as demonstration projects for public education purposes and to measure the effectiveness of various stormwater management practices in terms of CSO volume and frequency. In 2008, MSD commissioned a study of the potential for retrofitting their facilities with green infrastructure (MSD, 2008b). The report that was produced from this study was titled Greening the District. MSD has also included in its Strategic Business and Operating Plan implementation of the study’s findings and promoting the use of green infrastructure.



MSD's Greening the District report describes conceptual plans for retrofitting existing MSD facilities for this purpose. The document outlines incentives, goals, and pros and cons as well as property exhibits, location opportunities, and costs. The fundamental goal for Greening the District is for the post-development stormwater hydrograph to mimic the pre-development hydrograph for existing District facilities. Although most of the runoff from MSD facilities is discharged as stormwater and does not affect the CSS, findings are relevant for estimating potential effectiveness of similar controls in the CSS. Installation costs for green infrastructure techniques benefiting several WWTPs and additional sites were also provided.

MSD has also drafted a version of their Strategic Business and Operating Plan for fiscal years 2010–2014 (MSD, 2009). The plan emphasizes green infrastructure objectives at MSD facilities rather than costing information. The summary of green infrastructure planning at MSD facilities is as follows:

Milestones Year 1: 2010

- Identify and evaluate green infrastructure demonstration programs.
- Design appropriate green infrastructure for District facilities.

Milestones Years 2 and 3: 2011 - 2012

- Communicate stormwater and green infrastructure activities to stakeholders.
- Construct appropriate green infrastructure at District facilities and measure the effectiveness of various stormwater quality practices.

Milestones Years 4 and 5: 2013 - 2014

- Evaluate performance of green infrastructure demonstration programs.

Based on the findings of the Greening the District study, the two most promising facilities for green infrastructure retrofits in the CSS are the Market Street facility and the Sulphur Yard maintenance facility, described below.

- In 2008 MSD commissioned a Green Roof Feasibility Report (MSD, 2008a) for the Market Street headquarters building, which verified the feasibility of this retrofit project. The Market Street building is located in the Bissell Point service area, specifically within the drainage area of the Old Mill Creek CSO (Outfall 016), which was identified as having moderate to high potential for green infrastructure in the Bissell Point Study.
- Sulphur Yard's main office and garage building, in the Lemay service area, was originally built with a second story in mind. Therefore, minimal structural changes would be necessary to implement a green roof.

Both of these projects would provide highly visible demonstrations of green roof retrofitting technology. At the present, the runoff reduction benefits of these stand-alone projects have not been calculated, but their primary value would be as demonstration projects and to help establish MSD as a local leader in green infrastructure.

12.2.3 Lemay Wet Weather Flow Reduction

The Lemay service area covers 120 square miles, of which approximately 35 square miles contain combined sewers. As noted in Section 3.2, stormwater from an additional 12.1 square miles enters the Lemay combined sewer system. As this total area is comparable or larger than the Bissell Point combined sewer area, where opportunities for green infrastructure implementation have been identified, it is likely that green infrastructure opportunities also exist in the Lemay service area.



Recently, MSD has eliminated the impact of high river stages in the Lower and Middle River Des Peres and expanded the Lemay plant's wet weather treatment capacity. Future controls in the preferred CSO alternative are anticipated to include underground storage for wet weather flows. Green infrastructure in the Lemay service area might contribute to reduction of wet weather inflows and commensurate reductions in the size of wet weather storage facilities.

A preliminary study of the potential for green infrastructure to contribute to CSO reduction in the Lemay service area is planned, similar to the preliminary evaluation that was conducted for the Bissell Point service area. This evaluation is planned to be conducted in 2010. If the preliminary evaluation indicates that green infrastructure has the potential to significantly contribute to CSO reduction in the Lemay service area, a more detailed opportunity analysis may be conducted to identify specific projects. The study will also include estimation of the potential size reduction for underground wet weather storage in the Lemay service area.

12.3 The St. Louis Green Infrastructure Program

MSD is planning an ambitious \$100 million green infrastructure program over the next 25 years to complement gray infrastructure investment. The planned program is described in this section and consists of:

- Leadership
- Public education and outreach
- Partnerships
- Detailed analyses of opportunities in the Bissell Point CSS
- Preliminary analyses of opportunities in the Lemay CSS
- Continuation of the rain barrel program
- Completion of ongoing projects
- Demonstration projects

12.3.1 MSD as a Green Infrastructure Leader

Leadership is important to promote the acceptance and use of green infrastructure in the St. Louis community. Although the focus of green infrastructure investment as part of the LTCP will naturally be in the combined sewer service area, there is potential for evaluating green infrastructure elsewhere. It is likely that efforts could result in water quality improvements in receiving waters outside of the combined sewer service area, as well. MSD will use resources to evaluate the benefits of green infrastructure throughout its entire service area by implementing projects and programs, monitoring their outcomes, and publicizing the results. Sharing of information about these projects and programs will not only educate others about green infrastructure but will also provide information needed for wider scale implementation of these practices in the St. Louis area.

12.3.2 Public Education and Outreach

MSD will involve the public in the process of implementing green infrastructure practices via education and engagement, as public support for these programs and projects has high importance. In addition, monthly stormwater fees are expected to increase from the current \$0.14 per 100 square feet of impervious surface. These fees will continue to fund much-needed wet weather controls throughout MSD's service area. Public education will be important in explaining the rate increases and will provide a vehicle to show ratepayers how they can reduce their stormwater bill through their own green infrastructure projects.



Planned elements of the green infrastructure program will include:

- Coordination with existing programs
- Publication of green infrastructure literature
- Development of a green infrastructure web page
- Public open houses
- Tours of green infrastructure projects

These elements are discussed below.

12.3.2.1 Coordination with Existing Programs

Several public outreach and education programs currently exist that can be leveraged to enhance public outreach, education, and involvement in green infrastructure, including the following:

- **ShowMe Rain Gardens Partners** – MSD is currently partnered with the Soil & Water Conservation District of St. Louis, Missouri Botanical Garden, local governments, conservation agencies, private citizens, and corporations in the ShowMe Rain Gardens Program, a regional water quality initiative focused on promoting rain gardens as a means to water quality improvement and the mitigation of adverse stormwater impacts. MSD intends to continue this partnership and leverage it to promote green infrastructure throughout its service area.
- **Stream Teams** – Three thousand Stream Teams have been established state-wide with an estimated 60,000 members working to improve nearly 15,000 miles of adopted local streams. Past Stream Team projects have been chosen according to each Team’s interests and local needs. Some pick up trash, plant trees, or stencil storm drains, while others monitor water quality or help educate their community. Biologists trained in stream management and water quality are available to provide guidance and answer questions. The program is sponsored by the Missouri Department of Conservation, the Missouri Department of Natural Resources, and the Conservation Federation of Missouri. MSD coordinates with these agencies and the Stream Teams, and will educate them about the benefits of green infrastructure and encourage the Teams to implement “grass roots” green infrastructure projects.
- **Clean Rivers Healthy Communities Program** – MSD’s Clean Rivers Healthy Communities Program encourages the public to become part of the CSO control solution. The program is a multi-decade, multi-billion dollar initiative designed to improve the quality of the area’s rivers, streams, and creeks. The program offers an info-line at 314-768-CRHC and an informational website at www.cleanriversstl.com. The site gives residents, business owners, and municipalities, ways to implement green infrastructure techniques to become part of the Clean Rivers solution. MSD encourages the public to invite Clean Rivers representatives to present at local neighborhood or organizational meetings; attend public open houses; and participate in a Stream Team or Household Hazardous Waste Collection Events. This program will be used to provide green infrastructure education and to promote green infrastructure projects.
- **MSD Public Open Houses** – As part of the Clean Rivers Healthy Communities Program, MSD conducted 13 open houses designed to educate the public about MSD’s CSO control efforts as well as ascertaining the public’s preferences regarding MSD’s establishment of waterway priorities and selection of wet weather overflow controls. The project team sought to maximize participation in the open houses by organizing meetings across the region – five in St. Louis City and eight in St. Louis County. Members of the public unable to attend one of the 13 open houses could participate virtually through an online forum. This successful format will be continued to provide information and to obtain public feedback on green infrastructure projects.
- **Landscape Guide for Stormwater Best Management Practices** – MSD has developed the Landscape Guide for Stormwater Best Management Practice Design for St. Louis. This guide covers



topics such as invasive species, site preparation, planting design, plant selection, installation, management and landscaping criteria, and plant selection for stormwater BMPs including wet ponds, wetlands, infiltration basins, dry swales, surface sand filters, bioretention, and organic filters. Similar guides will be produced covering green infrastructure topics, such as introduction to green infrastructure, green infrastructure for residences, and green infrastructure for commercial properties.

- **St. Louis County Phase II Stormwater Management Plan** – The St. Louis County Phase II Stormwater Management Plan outlines a public education program that involves the distribution of educational materials to the community, outreach activities relating to the impacts of stormwater discharges on water bodies, and steps the public can take to reduce pollutant loadings in stormwater runoff. MSD, the coordinating authority under the permit, has completed the following public outreach initiatives (MSD, 2007):
 - Distributing brochures on pet waste management, yard waste, impacts from businesses, and more.
 - Sponsoring a stormwater school article contest.
 - Developing a stormwater pollution prevention video.
 - Airing four stormwater infomercials.
 - Conducting seminars for small businesses.
- **Other Environmental Groups** – In addition to the groups and programs outlined above, MSD plans to communicate with other environmental groups including, but not necessarily limited to, the River Des Peres Watershed Coalition and the Missouri Coalition for the Environment.

12.3.3 Building Partnerships with Others

MSD is seeking to build partnerships with the City of St. Louis, private developers, and the District's public school systems on green infrastructure projects. MSD's goal is to engage these partners to identify cost-sharing opportunities and incentives. This effort will be used to test how MSD's LTCP green infrastructure program is best spread across the combined sewer service area and the separate storm sewer area.

12.3.3.1 City of St. Louis

To date, MSD has not engaged in any formal partnering efforts with the City of St. Louis to pursue green infrastructure projects. However, there may be opportunities to work with the City's Department of Parks, Recreation, and Forestry to implement such projects or programs. Toward this end, MSD will conduct a series of scoping meetings with the Department and will work to generate a joint report to MSD's Board and the Mayor on joint opportunities.

12.3.3.2 Private Developers

MSD plans intensive education and engagement over time to involve developers in the process of improving water quality through the adoption of green infrastructure practices. MSD will take advantage of plan review for development and redevelopment projects within the Bissell Point and Lemay CSSs. During the plan review, developers will be provided with information on relative costs and benefits of green infrastructure and any incentives that MSD may be able to provide. Two examples, the Northside Regeneration and the Chouteau Lake and Greenway Projects are described below.

Northside Regeneration Project

An example of the opportunity for collaboration between MSD and developers is the North St. Louis redevelopment plan of private land developer McEagle Properties. This planned project features redevelopment of 500 acres of land in North St. Louis for mixed residential and commercial use. Some of the subject properties slated for redevelopment are adjacent to properties owned by the LRA. MSD is engaging the parties responsible for the North St. Louis redevelopment project to discuss the possibility of incorporating green infrastructure into the plans.



Some of the proposed solutions include permeable pavement (green streets), swales, stormwater attenuation structures, bioretention cells, and stream daylighting. McEagle Properties has been discussing their plans with MSD over the last eight months regarding project start-up, overall concepts, and ways to meet regulations.

Chouteau Lake and Greenway Project

Tower Grove Park, Forest Park, and the downtown St. Louis riverfront could all be connected if the Chouteau Lake and Greenway concept becomes reality. St. Louis-based developer McCormack Baron is planning a \$400 million mixed-use development project over the course of six to seven years. The result would be a 15 acre lake and up to 3,500 units of housing and commercial buildings. A “green loop” of landscaped park areas, bike paths and trails along the Mississippi River would connect the new district to the historic Soulard and LaSalle neighborhoods to the south, the commercial districts to the north and existing parks to the west.

The feasibility of this project depends upon a variety of unresolved challenges including the ability to relocate railroad lines and the availability of public and private funds. If the challenges of the Chouteau Lake and Greenway Project can be overcome, green infrastructure can be implemented as part of the project to help mitigate St. Louis CSOs. MSD will engage the parties involved in the project to identify green infrastructure opportunities in the Chouteau Lake and Greenway Project.

12.3.3.3 Public Schools

Stakeholders have expressed the need to educate the public on the benefits of green infrastructure to improve local water quality. Many believe that this education should begin early, at the elementary school level. This presents an opportunity for MSD to partner with public schools to incorporate green infrastructure education into the curriculum and/or creating green infrastructure projects at the schools themselves. This type of partnership is similar to one being implemented in the City of Cincinnati, where public schools are partnering with the sewer utility to incorporate green infrastructure into school properties. The Cincinnati Public School system is currently planning to retrofit schools with green roofs, porous concrete, rain gardens, and bioswales. These projects not only have benefit in reducing wet weather flows, but they serve as an excellent demonstration projects for the public and real education opportunities for students. MSD will seek to partner with St. Louis schools in a similar manner.

12.3.4 Bissell Point Opportunity Analysis

As described above, the preliminary Bissell Point study indicates that green infrastructure can have a significant benefit in reducing CSOs. The study provided preliminary quantification of these benefits and conceptually described the types of projects that can be implemented. Based on these results, MSD plans to conduct additional green infrastructure work in Bissell Point as described below.

12.3.4.1 Validation of Preliminary Findings

In the preliminary analysis, the benefits of green infrastructure were evaluated using hydraulic model simulations of the four-month synoptic storm event. A few test cases were performed using the full “typical year” rainfall simulation with the hydraulic model to evaluate how the four-month results would “scale up” on an annual basis. As a next step in advancing the Bissell Point analysis, MSD will conduct hydraulic model simulations of all major CSO drainage areas using the “typical year” rainfall simulation to fully validate the preliminary findings.



12.3.4.2 Detailed Opportunity Analysis

The preliminary Bissell Point study identified certain priority CSO drainage areas as having greater opportunity for green infrastructure retrofits and having higher potential benefit for CSO reduction. Based on these findings, more detailed, targeted evaluations of those CSO drainage areas will be performed to identify specific project opportunities that can be fully implemented or used as demonstration projects. This work will be conducted as an extension of the earlier Bissell Point study and will be performed in conjunction with the validation of results discussed above.

12.3.4.3 Develop Conceptual Designs and Costs

Once specific green infrastructure project opportunities are identified in the target CSO drainage areas of the Bissell Point service area, conceptual designs and planning-level cost estimates will be prepared. These will be reviewed, and MSD will select which projects to implement. The conceptual designs will also facilitate discussions with property owners, stakeholders, and potential partners.

12.3.4.4 Cost-Benefit Analysis of Green Infrastructure in Bissell Point

To estimate the potential benefit of selected green infrastructure projects, MSD will prepare a cost-benefit analysis of those projects. To the extent possible, this will involve modeling analysis of the selected projects to evaluate probable benefits for annual CSO volume reduction, peak CSO flow reduction, water quality improvements, and ancillary benefits. For a full evaluation, both capital and operation/maintenance costs will be considered for the life cycle of the projects.

12.3.5 Assessment of Lemay Opportunities

As previously discussed, no analysis of green infrastructure potential has been conducted for the Lemay service area, and significant gray infrastructure projects have been completed or are planned for wet weather control. However, it is possible that there may be opportunities to implement green infrastructure in Lemay to reduce the size of the planned gray projects. MSD will conduct a preliminary evaluation of green infrastructure potential in the Lemay service area, similar to the one conducted for the Bissell Point service area. This will involve a spatial analysis of the service area to identify green infrastructure retrofit potential and hydraulic modeling analysis to evaluate wet weather flow reductions. Emphasis will be placed on CSO drainage areas where gray infrastructure control measures are planned or are being contemplated. Any green infrastructure opportunities that appear to have the potential for significantly reducing wet weather flows will be evaluated in greater detail. Conceptual designs and planning-level cost estimates will be prepared for these projects, and they will be compared to the potential cost savings on gray infrastructure projects.

12.3.6 Rain Barrel Program

As part of the Phase II Stormwater Management Plan involving pollution prevention, MSD has offered its customers the opportunity to reduce stormwater runoff by purchasing 55-gallon rain barrels to collect and store rainwater. The pilot program offered rain barrels for \$45, limiting orders to four barrels per customer.

The MSD rain barrel program drew an overwhelming response, with the District selling 1,558 barrels. This was more than five times the expected number of sales. Because of the overwhelming success of this program, and the potential for rain barrels to reduce residential runoff, MSD plans to extend the program as part of their overall wet weather control planning effort.

12.3.7 Ongoing Projects

Several projects are already being conducted by MSD or with MSD's involvement that incorporate elements of green infrastructure, including those described below.



12.3.7.1 Permeable Pavement Project

The City of St. Louis Board of Public Service formed a partnership with MSD, the Missouri Department of Conservation, CH2M Hill, Southern Illinois University (SIUE), and East-West Gateway Council of Governments in mid-2007 to find ways to incorporate low impact development techniques into City of St. Louis projects. The team identified pervious paving as the first best management practice (BMP) to investigate due to the multiple benefits it provides and the ample opportunity to utilize the practice in City-owned projects (Yates, 2009).

The City of St. Louis has approximately 485 miles of alleys, and is seeking to develop an alley replacement program to provide for pervious pavements to be constructed in lieu of the more conventional asphalt or concrete pavements. This study aimed to evaluate the effectiveness of porous pavement on flow reduction and water quality improvement in combined sewers. The flows and water quality of samples taken from combined sewers at three alleys in the City of St. Louis are to be compared before and after porous pavements are implemented.

The project consists of three phases: Phase I to monitor and characterize the flows and water quality under existing conditions; Phase II to design and construct the porous pavement; and Phase III to monitor and characterize the flows and water quality under improved conditions where low impact development has been implemented.

The three pilot alleys were identified and equipment was installed to measure stormwater quantity and quality along with rainfall from May to July 2008. Results are currently being processed by SIUE. Phase II construction began with the permeable asphalt alley, which was completed in October 2008. Funding for the pervious concrete alley is being provided by the Ward 6 Alderwoman, Kacie Starr-Triplett. Funding is still being secured for construction of the permeable paver alley.

This pilot study data will be used to support a change in City of St. Louis policy to potentially require pervious paving in its alleys citywide. The data will also be used to promote change in private developments and other City paving projects where appropriate. The results will be used by MSD to determine if permeable pavements can be used as a BMP either in junction with other BMPs or as a stand-alone BMP.

12.3.7.2 Horseshoe Project

In 1952, prior to the formation of MSD, the City of St. Louis conducted a study to address flooding issues in the Harlem and Baden watersheds. The study recommended construction of a relief tunnel system that would intercept flow from the four main trunk lines and convey the intercepted flow to the Mississippi River. The City was unable to acquire sufficient funds to construct the relief tunnel. After a similar 2003 study conducted by Black & Veatch, the District requested the firm to develop a master plan to identify less expensive projects that could address local area flooding issues to be incorporated into the overall relief plan for the Harlem and Baden watersheds. The Hebert Stormwater Detention Basin and Sewer Separation project was identified as such a project.

The Hebert Stormwater Detention Basin and Sewer Separation Project (the Horseshoe Project) offers dual benefits to the community in terms of reduced volume and frequency of CSOs and local flooding. The project involves stormwater detention, which results in stormwater being released slowly into the CSS, as well as some sewer separation.

The site is located south of Interstate 70 approximately eight miles northwest of downtown St. Louis, within the Harlem and Baden watersheds. The stormwater detention basin will be located in the City of



St. Louis, at the confluence of the 12 foot horseshoe-shaped South Harlem Trunk Sewer (upstream drainage area 841 acres) and an 8 foot diameter tributary combined sewer (upstream drainage area 311 acres). Sewer separation will occur in the catchment area served by the 8 foot diameter tributary sewer. MSD is conducting a study to provide a preliminary design to separate stormwater runoff from the existing combined trunk sewers and detain 20 year stormwater runoff in a new proposed detention basin at the downstream end of the project area. The proposed detention basin will be approximately nine acres and have a capacity of 2,463,500 cubic feet. The basin will detain stormwater runoff from the 311 acre catchment area currently served by an existing 8 foot diameter combined sewer. The project is estimated to cost \$26 million.

Currently, property acquisition is underway. A church owns several of the properties needed by MSD. These properties have parking lots on them. MSD is planning to buy replacement properties, build pervious parking lots on them, and conduct a property exchange with the church. A preliminary sketch of the proposed parking lot layout has been drafted by MSD. The parking lots are estimated to be built within a year.

Preliminary designs of the sewer separation and detention basin have been drafted. MSD anticipates an 18 month final design period followed by construction beginning several years from now.

12.3.8 Demonstration Projects

MSD will implement green infrastructure throughout its service area by identifying demonstration projects, determining their associated costs, and building and monitoring the projects. Information from these projects will be used for future project planning. This will allow MSD to identify unintended consequences (positive and negative) and ascertain the most cost-effective technologies. Demonstration projects will provide developers and the public the chance to get comfortable with the green infrastructure program and build trust in its implementation.

Several projects have been identified in the Bissell Point service area as part of the preliminary green infrastructure study conducted by MSD. These include:

- **MSD Market Street Facility** – MSD will implement green roof technology at its Market Street headquarters as part of this plan, to demonstrate green roof retrofitting and to verify current cost estimates. The recent green roof feasibility study shows that the Market Street building is a good candidate for this technology and implementation at MSD headquarters will provide a high-profile example for the public. The Market Street building has approximately 24,225 square feet of rooftop area, more than half an acre of imperviousness.

This demonstration project is key because much of the impervious surface in the Old Mill Creek CSO drainage area, which encompasses much of the downtown area, is associated with rooftop runoff. This demonstration project will provide a well-publicized example of green roof retrofitting, and valuable engineering and economic data for other property owners.

MSD will also evaluate retrofitting the Market Street parking lot. The Market Street property has approximately 76,610 square feet of pavement.

- **Commercial parking lot retrofits** – Commercial parking lots present an attractive opportunity for green infrastructure, because many already incorporate green areas and many contain excess parking capacity that can be converted to bioretention. Specific projects have not been identified for this plan because MSD does not own commercial properties. However, many large commercial parking areas have been identified in the Bissell Point service area in CSO drainage areas that were identified as



having relatively high potential for green infrastructure retrofitting. MSD will identify specific candidate properties and work with property owners to design and implement retrofits that will serve as public demonstration projects. MSD will also seek to have green infrastructure incorporated into new commercial development by working with planning agencies.

- **Neighborhood-scale stormwater management** – Many locations within the Bissell Point service area are suitable for neighborhood-scale retrofitting to incorporate on-site stormwater management. This will take advantage of vacant and underused properties owned by the LRA. The LRA maintains, markets, and sells these properties and performs land assemblage for future development.

MSD plans to offer information on a range of green infrastructure techniques to implement in development and re-development projects. By working with municipalities, developers, and homeowners, MSD can encourage environmentally sustainable practices, such as rain gardens, green roofs, and bioswales. To provide an incentive for the use of green infrastructure in redevelopment of these areas, MSD will reduce stormwater utility fees, as a function of imperviousness reduction achieved by the green infrastructure.

It is expected that one neighborhood-scale demonstration project would be implemented within the first five years of this plan, incorporating several green infrastructure elements including rooftop runoff capture, centralized and/or decentralized bioretention, and collection of street runoff.

It is expected that the finalization of the Bissell Point opportunity analysis, described in Section 12.3.4, and the completion of similar assessment work in the Lemay service area, will lead to the identification of specific project locations, scopes, and designs.

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