GREEN INFRASTRUCTURE PROGRAM

A report evaluating the concept of a major storm water minimization program, utilizing green infrastructure and related methods

Prepared by

The Staff of the Metropolitan Sewer District of Greater Cincinnati, Hamilton County, Ohio, Cincinnati, Ohio, and their respective Legal Counsel

Prepared for

U.S. Environmental Protection Agency, Ohio Environmental Protection Agency, Ohio River Valley Water Sanitation Commission, and their respective Legal Counsel

July 31, 2007

TABLE OF CONTENTS

TABLE OF DEFINED TERMS AND ACRONYMS 4
I. INTRODUCTION AND ABBREVIATED SUMMARY 6
A. Introduction 6
B. Objectives of Report 6
C. Abbreviated Summary 8
D. Disclaimers 9
1. Settlement Discussion 9
2. A Work in Process 9
II. POLICY OBJECTIVES OF A POTENTIAL NEW PROGRAM 10
A. Minimize the Quantity of Storm Water Runoff to CSOs/SSOs 10
B. Improve the Water Quality of Local Creeks, Streams, and Rivers 11
C. Limit Rate Increases to MSD Customers 11
III. PROGRAM PRINCIPLES TO ACHIEVE POLICY OBJECTIVES 13
A. Introduction to Program Principles 13
B. Five Key Program Principles 14
1. Manage the Program and Storm Water Flows on a Watershed Basis 14
2. Prioritize Program Actions Starting with "Source Areas," then "Conveyance," and finally "End of Pipe" 16
3. Effectively Educate, Incentivize, and Involve the Public and Communities 18
4. Continuously Evaluate, Adapt, and Improve Program Effectiveness at the Local Level 20
5. Adequately Fund the Program and Create Financial Accountability for Storm Water Costs and Impacts 21
IV. POSSIBLE PROGRAM ELEMENTS OF NEW PROGRAM 23
A. Introduction 23
B. Technical Elements 23
1. Categories of Technical Elements 25
2. Factors in Choice of Technical Elements 34
3. Slopes 42
4. Soils and subsurface conditions 43
5. Economics 43
C. Legal and Policy Elements 43
1. Revise the WWIP and LTCP 44
2. Legislate Financial Incentives to Expedite Storm Water Minimization 45
3. Legislate LID and/or Storm Water Management Rules, Standards and Codes 49
V. DATA SUPPORTING PROGRAM ELEMENTS 58
A. MSD Lick Run Demonstration Project 58
B. Other Local Area Storm Water Minimization Projects 58
1. USEPA Shepherd Creek Study. 58
2. Civic Garden Center Study 59
3. Greenacres Foundation Projects 60

4. Columbia Township Commercial Redevelopment 60
5. The Arbors 61
6. Owl's Nest Park 61
7. Burnet Woods Park 62
8. City Gateway 62
9. 1600 Gest Street 63

C. Other Urban Area Storm Water Minimization/Green Program 63

VI. ISSUES FOR FURTHER EVALUATION AND CHALLENGES TO SUCCESS 68

A. Issues For Further Evaluation 69
1. Technical Element Feasibility 69
2. Potential Benefits/Outcomes Evaluations 70
3. Cost/ROI Evaluations 73

B. Potential Barriers, Challenges and Problems Facing a New Program 74
1. Technical Barriers 75
2. Legal Barriers 75
3. Policy Barriers 76
4. Funding 77
5. Measuring Success or Failure 79

VII. CONCLUSIONS 80

A. Background and Summary of Report 80

B. Key Conclusions 82
1. The Consent Decree "Problem" Requires a Significant, Creative Alternative 82
2. Available Information Indicates that "Green Infrastructure" is a Viable Alternative to Unaffordable, Massive "Grey" Construction 82
3. MSD's Program Policy Objectives and Program Principles Make Sense 82
4. The Program Elements Have a Good Likelihood of Succeeding 82
5. The LTCP Should Be Revised to Add the New Program and Reprioritize Some "Grey" Projects for Subsequent Review 83

C. Decisions 83

D. Next Steps 83

TABLE OF DEFINED TERMS AND ACRONYMS

ASIWPCA	Association of State and Interstate Water Pollution Control Administrators
BMP	Best Management Practice
CAGIS	Cincinnati Area Geographic Information System
City	City of Cincinnati, Ohio
Consent Decree	(i) the Consent Decree on Combined Sewer Overflows, Wastewater Treatment Plants and Implementation of Capacity Assurance Program Plan for Sanitary Sewer Overflows, and (ii) the Interim Partial Consent Decree on Sanitary Sewer Overflows, both entered on Jun 9, 2004 by the U.S. District Court, Southern District of Ohio, Western Division in *U.S. v. Board of County Commissioners of Hamilton County, Ohio and The City of Cincinnati,* C.A. No. C-1-02-107 (consolidated with C-1-02-108 and C-1-02-135) and all of their requirements.
County	Board of County Commissioners of Hamilton County, Ohio
CSO	Combined Sewer Overflow
Green Infrastructure	Interconnected network of open spaces and natural areas, such as greenways, wetlands, parks, forest preserves and native plan vegetation, that naturally manages storm water, reduces flooding risk and improves water quality.[1]
I/I	Infiltration and Inflow
LEED	Leadership in Energy and Environmental Design is a green building rating system that is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.[2]
LID	Low Impact Development
LID Center	Low Impact Development Center, a non profit organization dedicated to research, development and training for water resource and natural resource protection issues
LTCP	Long Term Control Plan, one of which was submitted by MSD on behalf of the County and City to USEPA, OEPA, and ORSANCO in June 2006
MS4	Municipal Separate Storm Sewer System

[1] See, Green Values Storm Water Tool Box.

[2] See, U.S. Green Building Council.

MSD	Metropolitan Sewer District of Greater Cincinnati, a county sewer district formed under Ohio Revised Code 6117.
NACWA	National Association of Clean Water Agencies
NRDC	Natural Resources Defense Council
OEPA	Ohio Environmental Protection Agency
ORSANCO	Ohio River Valley Water Sanitation Commission
ROI	Return on Investment
SSO	Sanitary Sewer Overflow
SWM	Storm Water Model
UC	University of Cincinnati
USEPA	United States Environmental Protection Agency
WQv	Water Quality Volume
WWIP	Wet Weather Improvement Plan

I. INTRODUCTION AND ABBREVIATED SUMMARY

A. Introduction

In June 2006, MSD submitted on behalf of the City of Cincinnati and Hamilton County (collectively, these three entities may be referred to as "MSD") a WWIP to USEPA, OEPA, and ORSANCO (collectively these three agencies may be referred to as the "Regulators"). In negotiations since that time, the Regulators have suggested that MSD consider the use of so-called "green infrastructure" methods and activities in a comprehensive and widespread manner. MSD has undertaken a significant and detailed study of this subject. This report, part of ongoing settlement negotiations to reach a final, approved WWIP, provides an interim summary of MSD's study and interim conclusions regarding a potential "green infrastructure" program.

B. Objectives of Report

The initial objective of this report was, and remains, to facilitate settlement of a key, disputed matter arising out of the Consent Decree litigation. However, because the subject of this report is complex from a number of perspectives, it is clear that the report has multiple, important objectives.

From a national perspective, one objective of the report is to recognize and put into action the "Green Infrastructure Statement of Intent" issued on April 19, 2007 by the Administrator of USEPA, and the leaders of NACWA, NRDC, LID Center and ASIWPCA. See Exhibit A. This Statement of Intent formalized a collaborative effort among these organizations to encourage the use of green infrastructure as a "prominent component of their Combined and Separate Sewer Overflow (CSO & SSO) and municipal storm water (MS4) programs." MSD (as an active member of NACWA) shares the desire of USEPA in this regard. MSD believes that this report has the potential to uniquely and powerfully advance the Statement of Intent.

From a local perspective, one objective of the report is to determine whether green infrastructure may serve as the primary solution to a tremendous problem facing the Consent Decree parties. These parties face the challenge of satisfying the Consent Decree's enormous and complex obligations in the face of growing economic problems. All of the parties clearly desire significant improvement to water quality currently impacted by MSD's CSOs and SSOs. If cost were no object, this could be done by conventional, so-called "grey" methods, such as massive deep storage tunnels. However, as discussed openly among the parties, MSD's service area faces huge economic problems due to its increased urbanization, population and industry losses, and related matters. MSD maintains that the sewer rate increases required through construction of massive "grey" solutions would be economically and socially devastating. This problem has the potential to create a stalemate or gridlock in finalizing the WWIP. It also presents a lose-lose situation where neither side obtains what it wants or needs. As recognized by USEPA, green infrastructure has the potential to provide water quality improvements at a fraction of the cost of "grey" infrastructure projects.[3] Good public policy requires implementation of a program which maximizes benefits in a cost effective manner. Thus, one objective is to determine whether a significant green infrastructure program can eliminate or significantly solve the complex problems facing MSD.

[3] "Green infrastructure may save capital costs associated with digging big tunnels and centralized storm water ponds, operations and maintenance expenses for treatment plants, pipes, and other hard infrastructure; energy costs for pumping water; and costs of wet weather treatment and repairing of storm water and sewage pollution impacts, such as stream bank restoration." Memorandum from Benjamin H. Grumbles, USEPA Assistant Administrator, to USEPA Regional Administrators re: Using Green Infrastructure to Protect Water Quality in Storm Water, CSO, Non-point Source and Other Water Programs, March 5, 2007 (Exhibit B). See also, Dapolito Dunn, A; Stoner, N., *Green Light for Green Infrastructure,* Environmental Law Institute, The Environmental Law Forum, May/June 2007 (Exhibit C). *Rooftops to Rivers: Green Strategies for Controlling Storm Water and Combined Sewer Overflows*, NRDC June 2006 (Exhibit D) (Table 6 of this article provides a cost comparison of urban storm water controls).

From the perspective of those preparing and reviewing this report, MSD's study and this document have eight related objectives:

1. Identify the Key Problem(s) and a Potential Solution;
2. Identify the Policy Objectives of a New Program;
3. Identify the Program Principles Upon Which a New Program Would Be Established and Operated;
4. Identify and Evaluate the Key Program Elements (Both From a Technical/Engineering/Scientific Perspective and a Legal/Policy Perspective);
5. Identify and Evaluate Available Data From Local And National Sources to Determine How Potential Program Elements Have Fared and to Predict Their Effectiveness if Used in a New Program;
6. Identify and Evaluate Issues Needing Further Evaluation or Which May Be Problem Issues in Creating or Implementing a New Program;
7. Analyze All of This Information Through Consideration of Unique Local Circumstances and the Requirements of the Consent Decree; and, Finally
8. Reach and Discuss Conclusions Regarding a Potential New Program and its Ability to Resolve, in Whole or in Part, the Key Problem(s).

C. Abbreviated Summary

MSD has examined whether the creation of a significant storm water management and minimization program, using green infrastructure, could become a significant element in its LTCP under the Consent Decree. This process has included a review of information and data available nationally and locally. Based on this review, the following conclusions were reached:

- The Consent Decree faces a significant implementation problem due to significant environmental needs and local affordability problems;
- Available information indicates that "green infrastructure" may be an effective alternative to unaffordable, massive "grey" construction projects in meeting those environmental needs;
- A new "green infrastructure" program should be based upon a few clear objectives and operating principles. MSD has identified some

which it believes are sensible. Such a program will need to have a large scope and major funding to meet its objectives;

- A large number of potential program elements, or methods of implementation, have been identified. MSD believes that many have a good likelihood of attaining the key program objectives; and,
- The LTCP should be revised to add a new storm water minimization program and reprioritize some potential "grey" projects for subsequent review after "green" efforts have been implemented.

MSD proposes that next steps in this process will be (i) review and discussion of this concept paper with the Regulators' staff and legal counsel, (ii) refinement of and agreement on concepts and implications for the LTCP, (iii) review at that point with respective managements, and, if acceptable to both, (iv) preparation of a mutually acceptable, revised LTCP.

D. Disclaimers

1. Settlement Discussion

This report is the work of staff for MSD, City and County, and their legal counsel, and does not yet represent the position of either the City or the County. The report is submitted to the Regulators for their review, analysis and our collective discussion. If the parties collectively reach tentative agreement on the key objectives, policies, and elements of a storm water minimization/green infrastructure program, then it can and will be discussed in detail with final decision-makers. Thus, this report is neither a proposal nor an offer.

2. A Work in Process

While the work undertaken for this report has identified substantial information, it is clear that comprehensive, long-term, detailed information on the subject of green infrastructure in a large and complex service area such as MSD's does not yet exist. There is much anecdotal data from new and sometimes experimental

programs in some cities and some suburbs.[4] This information has been reviewed in detail and there have been direct communications with the leaders of many of these efforts in various cities.[5] Many of MSD's staff and their advisors have attended conferences and seminars to learn about these efforts. As USEPA has indicated, there is no peer community nationally that has attempted a major, comprehensive program of this type, especially one spanning many political jurisdictions encompassed within one service area. There is also an absence of long-term studies regarding effectiveness of various potential program elements. Thus, the report is preliminary in nature and this inherent limitation must be understood by the reader.

II. POLICY OBJECTIVES OF A POTENTIAL NEW PROGRAM

The public policy objectives for a potential green infrastructure program are driven largely by the requirements of the Consent Decree and local affordability. Three objectives have been identified in this regard:

A. Minimize the Quantity of Storm Water Runoff to CSOs/SSOs

One objective of a new program will be to significantly reduce the *quantity* of storm water entering sewers in order to significantly reduce discharges from CSOs and SSOs. In the case of CSOs, the Consent Decree requires that CSO discharges be significantly reduced, therefore, MDS must either collect and treat combined, undiminished sewerage flows *or* reduce those flows before they reach the combined sewers. In the case of SSOs, the Consent Decree has the goal of eliminating SSO discharges, therefore, MSD must either expand capacity to handle undiminished flows *or* reduce or

Green Infrastructure Program Policy Objectives

1. Reduce Quantity
2. Improve Quality
3. Affordability

[4] See Exhibit E, Municipal Ordinances Spreadsheet.

[5] See Exhibit E, Municipal Ordinances Spreadsheet.

eliminate storm water flows from reaching non-combined sewers. These objectives both focus on flow elimination and/or reduction. The principles upon which a new program should operate to achieve this objective are discussed in Section III, below.

B. Improve the Water Quality of Local Creeks, Streams, and Rivers

Another objective of a new program will be to significantly improve the water *quality* in our local surface waters in order to attain and maintain water quality standards.[6] This objective focuses on water quality improvement by reducing or eliminating storm water flows into combined and sanitary sewers. As storm water flows are reduced or eliminated, the number and frequency of CSOs and SSOs will decrease. As a result, water quality in streams with CSOs and/or SSOs will improve. Reduction of sewer overflows is the Consent Decree's primary method for addressing the goal of improving water quality in local surface waters. If that goal can be achieved through methods that are complementary, supplemental, or alternative to conventional "grey" construction, those different methods deserve significant consideration and possible use.[7] This objective is a reminder that water quality (as well as public health) is a central theme of MSD's efforts. The principles upon which a new program should operate to achieve this objective are discussed in Section III, below.

C. Limit Rate Increases to MSD Customers

A further objective of a new program will be to limit rate increases to MSD customers resulting from achieving Consent Decree compliance and attaining the above objectives. As noted above, MSD has determined that construction of massive storage tunnels and related work would result in massive and lengthy rate increases which it believes to be unaffordable under USEPA's existing guidance policy and not sustainable under existing and expected future local economic and social conditions.

---

[6] The use of green infrastructure and LID storm water management techniques have improved water quality. See, Puget Sound Partnership, Low Impact Development.

[7] Studies have shown that the use of green infrastructure for storm water management has improved water quality by reducing pollutant loads in storm water runoff. See, Kollin, Cheryl, *How Green Infrastructure Measures Up to Structural Storm Water Services*, Storm Water, July/August 2006.

MSD recognizes and accepts the above objectives, which it believes to be in harmony with the Regulators' expressed views. *The challenge for the parties at this point in this complex matter is to attain all three objectives, not merely one or two objectives.* This third objective seeks to minimize or eliminate significant and expensive construction projects to store and convey storm water by minimizing storm water discharges to combined and sanitary sewers. It is believed that this has the potential to limit new, future rate increases otherwise needed to achieve the first two objectives. The principles upon which a new program should operate to achieve this objective are discussed in Section III, below.

It is recognized that there may be other objectives or reasons for the creation and implementation of a storm water minimization or green infrastructure program. Those could include a wide variety of themes, such as aesthetic improvements, flood control, enhanced property values, or more secured public drinking water supplies. Public policy dictates that the new program should produce the best benefit at the least cost. Certainly when resources are increasingly limited it is important to obtain the greatest benefit as efficiently as possible. Indeed, there is the potential that a new green infrastructure program might achieve a number of these varied objectives. However, the three objectives identified for a new program are the undisputable reasons why such a new program must be considered. They are the core of the program. They are the focus of the program. They are the standards against which a possible new program must be evaluated.

III. PROGRAM PRINCIPLES TO ACHIEVE POLICY OBJECTIVES

A. Introduction to Program Principles

Our study of existing and proposed green infrastructure programs in the United States and Canada has identified a large variety of existing and potential *methodologies*, the details of which are discussed in Section IV, below.[8] Some communities have implemented these methodologies after detailed and comprehensive thinking, while others appear to have started their use as experiments. The former communities have clear objectives, and then establish a set of core principles to guide them in selecting methods which will achieve those objectives. The latter communities appear to either be experimenting, or supplementing an existing "grey" program with an application of green infrastructure methodology.

Based on our study, we believe that it is critical that a new potential program be started with, and operated on, specific, guiding principles. Without the correct principles, a new program has little chance of achieving the three difficult objectives set forth in Section II. This Section discusses five principles which could be the basis to create and operate a *large, comprehensive, sustainable and permanent* green infrastructure program.

These principles, if selected, would guide MSD's activities, both internally and externally. Internally, these principles will assist MSD decision-makers and program operators in the development of long-term standards, rules, and policies, as well as the selection and use of green infrastructure methodologies. Hopefully, the result will be wise program design and effective ongoing program operation and evaluation. Externally, these principles will provide other stakeholders, including the Regulators, MSD ratepayers, and the public at large, a clearly articulated vision for the new program(s). The principles will also serve to explain why certain program choices are made and how the new program is designed and then implemented.

[8] See Exhibit E, Municipal Ordinances Spreadsheet.

B. Five Key Program Principles

We have identified five key principles upon which a new program would be established and operated. Some of these principles are borrowed, in whole or in part, from the work of other cities[9] and the research literature.[10] The principles were evaluated for their *local applicability* and their *sustainability* over an extended, future time period. By *local applicability*, we mean that the principle appears to be wise and appropriate for the known and expected conditions local to the MSD service area. By *sustainability*, we mean that the principle appears to be capable of remaining valuable and maintainable over an extended, future time period even as local conditions (climatic, economic, political, social) change. We welcome your input and comment as the choice of principles is critical to success.

Green Infrastructure Program Principles

1. Watershed Focus
2. Begin at the Source
3. Public Involvement
4. Sustainability
5. Economic Feasibility

The following principles were selected, and are not ranked in any order, as each is believed to be very important:

1. Manage the Program and Storm Water Flows on a Watershed Basis

This principle holds that a new storm water management program will be created and implemented on a "watershed basis." This means that program plans, activities, and measurements will be customized to address unique, watershed specific needs, conditions, opportunities and challenges. While the three program Objectives noted above will remain constant, the methods to achieve them will be flexible and adaptive to meet local and neighborhood needs.

This principle is not radical, but it is somewhat contrary to the field of water environment regulation. Leaders in the field now recognize that monolithic storm water and surface water management programs housed in separate departmental "silos" are

[9] See e.g., Baltimore, Maryland; Chicago, Illinois; Milwaukee, Wisconsin; Philadelphia, Pennsylvania; Portland, Oregon; and Toronto, Canada.

[10] See, e.g., *Out of the Crisis*, W. Edwards Deming, The MIT Press, 2000.

limited in their productivity.[11] Groundbreaking work in other areas of the nation has documented the value of watershed-based, customized approaches.[12]

Locally, MSD's WWIP was built on a watershed basis, with different approaches taken in such diverse areas as the Little Miami, Mill Creek, Duck Creek and Muddy Creek basins. Intuitively, those familiar with the MSD service area recognize that topographical, developmental history, and jurisdictional differences are significant. For example, most of the City of Cincinnati has had high construction density for the past century and is home to much current and historic industrial and commercial activity. Cincinnati also has significant housing, including one of the nation's largest percentages of multi-family dwellings. There is a significant amount of impervious surface area, and the City sits at the bottom of a "topographical funnel." By contrast, the nearby City of Montgomery has much lower construction density (with most growth occurring in the past 40 years), is largely residential with some commercial and virtually no industrial activity. Montgomery has much less impervious surface area, and sits near the top of a ridge, causing its storm water to quickly run out of its boundaries.

The design and implementation of a green infrastructure program, or management of storm water using a single, monolithic set of infrastructure plans, activities, or controls in these two diverse cities, is counter-intuitive. Considering there are 45 political jurisdictions within the MSD service area,[13] often sharing a watershed, we fear that a "one size fits all" approach to storm water management is doomed to failure.

The principle of creating and operating a watershed-based program may have several important implications. The mixture of "green infrastructure" versus "grey concrete" activities and projects will almost certainly differ by watershed in order to

---

[11] Portland, Oregon Watershed Management Program. York County, Virginia and the Town of Huntersville, North Carolina have adopted watershed management overlay regulations. Similarly, Mecklenburg County adopted watershed specific erosion control requirements for critical erosion control areas.

[12] *Id.*

[13] Please see Exhibit F which is a map of the MSD service area showing the 48 political jurisdictions.

achieve the three program Objectives. Some areas may be topographically well-suited for certain actions which may not work elsewhere (for example, man-made wetlands and conservation easements may be easier to create or obtain in areas where real estate is more readily available). Local community/neighborhood input and political acceptance of plans and activities may differ, thus causing variations by locality (for example, semi-rural areas may accept different restrictions than inner-city areas; some neighborhoods may be more environmentally progressive and desire and accept more green infrastructure). Some watersheds, or segments of them, have much more significant, current impairment than other areas – possibly necessitating much more significant, sizable, costly, lengthy, or comprehensive activities.

Another implication will be measurement and standard-setting to evaluate a new green infrastructure program. Federal and state surface water regulations already recognize that water body segments may have different water quality standards depending on features and uses. Similarly, evaluative methods and standards to judge the effectiveness of a green infrastructure program must be customized to specific watersheds or segments. A gallon of storm water minimization in one watershed may be disproportionately valuable (in terms of water quality, for instance) or costly (in dollars spent for prevention) compared to the same gallon in another watershed. A more thoughtful method of evaluation is thus necessary.

2. Prioritize Program Actions Starting with "Source Areas," then "Conveyance," and finally "End of Pipe"

Modern wastewater management practices in developed nations primarily focuses first on piping and treatment systems (such as publicly owned treatment works) which ensure that sewage collection and treatment is efficient and continuous. Major work in the past half century has resulted in the construction of huge and complex treatment plants and collection systems, many of which located east of the Mississippi River involved combining storm water systems with sanitary systems to save money and achieve efficiencies with one piping system. Planning for these systems in major metropolitan areas took on monolithic status and became more and more challenging

as sewers needed to be extended into topographically complex areas and treatment plants had to be enlarged or new ones constructed. In general, storm water source control or source minimization was not a key consideration in the design and management of these combined sewer systems.

This historic wastewater management paradigm (which is totally appropriate for wastewater management) is at odds with the second proposed principle for a green infrastructure program. This second principle holds that "source areas" for storm water management must be the *first priority* in the program, conveyance methods be a *second priority*, and "end of pipe" or treatment be a *third level priority– and the choice of last resort.* For many involved in treating or regulating wastewater in a combined storm and sanitary sewer system, this is a significant change. And, for citizens and elected leaders accustomed to moving water from their homes or businesses out and away for others to handle, this will be both counter-intuitive, and a major lifestyle change. This change, and its implications, is something that all involved in this negotiation must consider.

The driving force behind adoption of this principle for the MSD service area is *cost-effectiveness*. Simply put, the cost of continuing to follow the "old paradigm" is colossal and beyond the affordability of the MSD service area ratepayers. The "old paradigm" would most likely require construction of enormous storage and/or conveyance systems – often tanks or tunnels – to hold and transport storm water to sewage treatment plants. This paradigm would continue the historic pattern of transporting relatively clean storm water down and out with the dirty sanitary water irrespective of cost.

By contrast, the second principle ("source area first") recognizes that the cost of storm water conveyance and unnecessary treatment at the sanitary treatment plant can be significantly reduced if its quantity is significantly reduced.[14] And, it recognizes that MSD faces the opportunity to make significant cuts in its potential CSO/SSO control costs by keeping storm water out of what should primarily (for CSOs) and exclusively (for SSOs) be *sanitary sewer systems.* This is a case where huge capital expenditures may – must – be avoided in order to prevent significant and wide spread local economic harm and social dislocation.

As noted further below in Section V, existing data indicate that the second principle is not theoretical; storm water source reduction results in cost savings. The only issue is how much reduction is needed in order to achieve the three Objectives noted in Section II.

3. Effectively Educate, Incentivize, and Involve the Public and Communities

A change in lifestyle, such as that discussed above, for homeowners and businesses across a major metropolitan area cannot and will not occur simply because MSD and the Regulators reach agreement. The third principle holds that only through effective education, incentives, and involvement will the rate-paying public and their many, individual communities accept – indeed embrace – a new program. This principle has three different components that deserve discussion and thought.

Education will be required on multiple levels. Initially, the public and its leadership need to know that a new program is necessary to avoid protracted litigation and potentially colossal, additional sewer rate increases. Further, people need to

[14] Several municipalities have implemented "source control" stormwater management requirements. For instance, the City of Chicago's new storm water ordinance requires new development and redevelopment over a certain size to capture the first half-inch of runoff from all impervious surfaces on-site. In Portland, Oregon, parking lots are required to manage all storm water runoff in the parking lot interior or perimeter landscaping. Additionally, Portland's storm water regulations require all storm water from new development parcels created after the enactment of the regulations to fully manage all storm water on-site or within the original parcel. See, Milwaukee Metropolitan Sewerage District, Surface Water and Storm Water Rules Guidance Manual, Appendix L: Low Impact Development Documentation, Evaluation of Storm Water Reduction Practices.

understand that all three program Objectives are important and attainable through a new program. Moving beyond the "reason why," existing studies of green infrastructure efforts in other cities clearly indicate that people need to know "how to participate" in the program.[15] Because "participation" may be direct (e.g., residential controls) or indirect (e.g., public support for conservation easements), effective education will need to include a wide variety of messages and audiences, and be designed to achieve a variety of outcomes.

Incentives, specifically, *economic incentives* are a widely-used and critical component of a successful green infrastructure program.[16] USEPA has recognized that private property owners will require incentives for meaningful participation.[17] Economic incentives are used in urban and suburban communities to encourage local government, residential and commercial property owners, and non-profit organizations to use new storm water minimization programs, activities, standards, or practices. These range from low impact redevelopment/development standards, to rain barrel subsidies, to grants for changes in road building methods and materials. A detailed review of incentive methods, ordinances, statutes and programs is found in Section IV, below. For a new program to be *effective*, and to achieve its three Objectives, MSD expects that a significant amount of WWIP funds will need to be spent on both private sector and public sector property modifications and improvements. The use of these incentive funds will need to be focused according to the program principles set forth in this Section III.

---

[15] See, Portland, Oregon Clean Rivers Education Programs; San Francisco Clean and Green Programs; and Seattle, Washington's Green Guide.

[16] See, Exhibit G, Storm Water Management Financial Incentive Programs Spreadsheet.

[17] "Application of market mechanisms and incentives to reduce storm water runoff, An integrated hydrologic, economic and legal approach, Punam, P., Taylor, M, Hoagland, T., Thurston, H., Shuster, W., Environmental Science and Policy 8 (2005) 133-144.

Involvement by the public and the elected leadership in the many communities that are within the MSD service area is critical to a change in the "water paradigm" discussed above. It is clear that municipal ordinances, regulations, and policies governing land use, transportation, and related matters may be used to minimize storm water impacts, but changes to the status quo cannot occur without legislative support and amendments. Where watersheds cut across multiple jurisdictions (as is the case in the MSD service area), involvement and collaboration among and between the public and elected/appointed officials in those communities will be required. The widespread use of green infrastructure across private properties will require acceptance at the grass-roots level, rather than simply blind adherence to new programs and activities. This commitment to *involvement* is more than education by MSD; it is *ownership and participation in the actual program creation and implementation*. Thus, villages and cities would be asked to participate in watershed-focused efforts to meet the three Objectives, at program inception rather than at the point of implementation. It is expected that existing (or new) organizations with storm water -related duties or interest would be key stakeholders in this process.

4. Continuously Evaluate, Adapt, and Improve Program Effectiveness at the Local Level

Our fourth principle holds that new program methods will be subject to *ongoing evaluation*, *adaptation, and improvement.* From its inception, the new program will be considered a "work in progress" rather than a "completed work." This is a fundamental principle and one not always common to government programs, where our history has often trained us to believe that the "founding program" is sacred and unchangeable. Here, the program would be new and there is no national history or group of established, comprehensive, urban storm water minimization programs to serve as guides. Further, *unique local conditions* dictate that various methods must be examined and used (or not used) depending upon effectiveness.

The principle of continuous improvement is now common in business, government, and other areas of life. Focused on quality control and improvement, the underlying concept is to eliminate activities that add cost but do not add value, resulting in improved quality.[18] In government, these principles have special application. This principle rests on the assumption that a new program *is capable of* change and improvement *to identify new and better methods of meeting the program Objectives* and is highly attuned to *local conditions* which may require different adaptations and activities over time in different watersheds or locales.

This means that local communities and the public will regularly have opportunities to alter and improve the effectiveness of program methods and activities, building upon new data, new technologies, lessons learned in the program's prior years, and other changed conditions. For instance, as housing and construction patterns change within the MSD service area, old methods to minimize storm water may become ineffective, while new or different methods may become effective. This principle also means that periodic review and revision of the LTCP will be needed and welcomed as new data and information is obtained. The program must be founded and operated with the assumption that continuous study, change, and improvement will occur in order to attain and maintain program Objectives.

5. Adequately Fund the Program and Create Financial Accountability for Storm Water Costs and Impacts

The fifth principle holds that significant reductions in storm water impacts will require a significant set of program activities and a significant investment of funding. While private efforts will certainly be important, the core activities of the new program can and must be funded from the WWIP at levels sufficient to quickly create, build and operate a robust, effective program. As discussed further in Sections IV and V, below, several municipalities (and/or their sewer districts) have some form of storm water

[18] See, e.g., Value Based Management Website: The Deming Cycle and The Kaizen method of continuous incremental improvements. These web pages describe Deming's management cycle of Plan Do Study Act (PDSA) and Kaizen's elements: (1) teamwork, (2) personal discipline, (3) improved morale, (4) quality circles, and (5) suggestions for improvement.

minimization or green infrastructure program. The MSD program *will not be a minor activity added onto a "grey"-conventional program*. It will be a core LTCP program. Thus, its funding will need to be significant. While, as noted below in Sections IV and VI, exact costs are not yet known, the results desired from this program indicate that substantial, long-term funding from the WWIP will be required.

Coupled with substantial spending, there must be substantial financial accountability. Financial accountability will be more than simply evaluating costs and benefits from new program activities (although that will be important); it will be part of the paradigm shift. In the past, there has been relatively little cost applied to controlling storm water runoff on public or private property; as noted above, water was moved away as quickly as possible and its consequences, financial or otherwise, were born by those downstream. In addition, historically there was no regard for the quality of the storm water runoff. For a new, comprehensive program, the economics of storm water must also change.

In many communities, storm water fees have been the common method by which property owners "pay" for storm water runoff. Such fees can be used to discourage runoff as well as to fund government programs to either limit runoff or address its consequences. Generally based on gross impervious area calculations, such fees vary widely nationally in amount and use. Storm water fees remain unpopular and have been the subject of litigation in various places.[19]

Faced with monstrous rate increases even *with* a cost-saving green infrastructure program, significant increases in storm water fees within the MSD service area would worsen already difficult affordability problems. Thus, behavior-altering fees are an unlikely method of financial accountability for storm water runoff.

This means that new ideas will be needed. This report does not propose any, largely because it is outside its initial scope. However, it is clear that some system

[19] *Smith Chapel Baptist Church v. City of Durham*, 517 S.E.2d 874 (N.C. 1999); *Fulton County Taxpayers Association v. City of Atlanta*, No. 1999CV05897, 1999 WL 1102795 (Ga. Super., Sept. 22, 1999); *McLeod, et al. v. Columbia County*, 599 S.E. 2d 152 (Ga. 2004); *Wessels Co., v. Sanitation Dist. No. 1*, No. 2005-CA-002418-MR, 2007 WL 704118 (Ky. App. March 9, 2007).

will likely be needed to provide long-term incentives to minimize private property runoff and maximize methods which control or limit this runoff. Leadership by both MSD and the Regulators in identifying options and ideas appears necessary for this fifth and final principle to be wisely established.

IV. POSSIBLE PROGRAM ELEMENTS OF NEW PROGRAM

A. Introduction

This Section of the report introduces, analyzes and discusses a variety of possible program elements for a new storm water minimization program, incorporating green infrastructure. The Section is divided into two sub-sections. The first sub-section examines so-called "technical elements", which are, generally, physical methods for minimizing storm water runoff to sewers, such as rain barrels and man-made wetlands. The second sub-Section examines so-called "legal elements", which are, generally, law-based means to minimize storm water runoff, such as land use ordinances and financial incentives for public and private uses of technical elements. Each sub-section will identify and describe an individual element (or group of related elements), analyze usage feasibility and applicability factors, and discuss related matters.

This Section is intended to provide overview information on possible elements but not provide final determinations or judgments about which are best or least suited for use in a new program. While some data on specific elements may be included in this section, Section V "Data Supporting Program Elements", is devoted entirely and specifically to this subject.

B. Technical Elements

The objective of eliminating or reducing flows within MSD's Service Area through a green approach will be achieved by first understanding that the total size of impervious surfaces in a watershed is a significant, contributing cause of the problem. Impervious surfaces allow rain water from a storm event to run, often unimpeded, to the nearest stream because of proximity to that stream or through the storm sewers

discharging to that stream. Runoff also enters the combined sanitary sewer system, either directly through connections in the CSO areas or indirectly through I/I into sanitary sewers where the sewer system is separated and sewer pipe conditions are allowing I/I. The result of this runoff is costly treatment capacity requirements or worse – overflows and the potential impact to health and water quality.

Development in urban areas has caused and continues to cause the increase in impervious area. As impervious surfaces increase, so do storm water volumes (increased frequency and amounts of CSO/SSO, rate and severity of flooding), storm water velocities (increased erosion of stream banks, sedimentation), and disposition of pollutants (chemical and biological impacts). Parallel decreases, which exacerbate the problem, are realized in water quality, groundwater re-charge and the amount of natural drainage systems including riparian vegetative cover (degradation of habitat).

Praire Rain Garden in Maplewood, Minnesota. Source: www.ci.maplewood.mn.us

Green infrastructure has hydrology as its organizing principle. Green infrastructure describes a storm water management system composed of natural and man-made elements that replicate, to the extent practical, the natural (undeveloped) hydrology of a drainage area that has undergone development. Such a system usually consists of a continuum of controls, placed from the point where precipitation contacts the ground through the receiving waters. (See Figure 1).

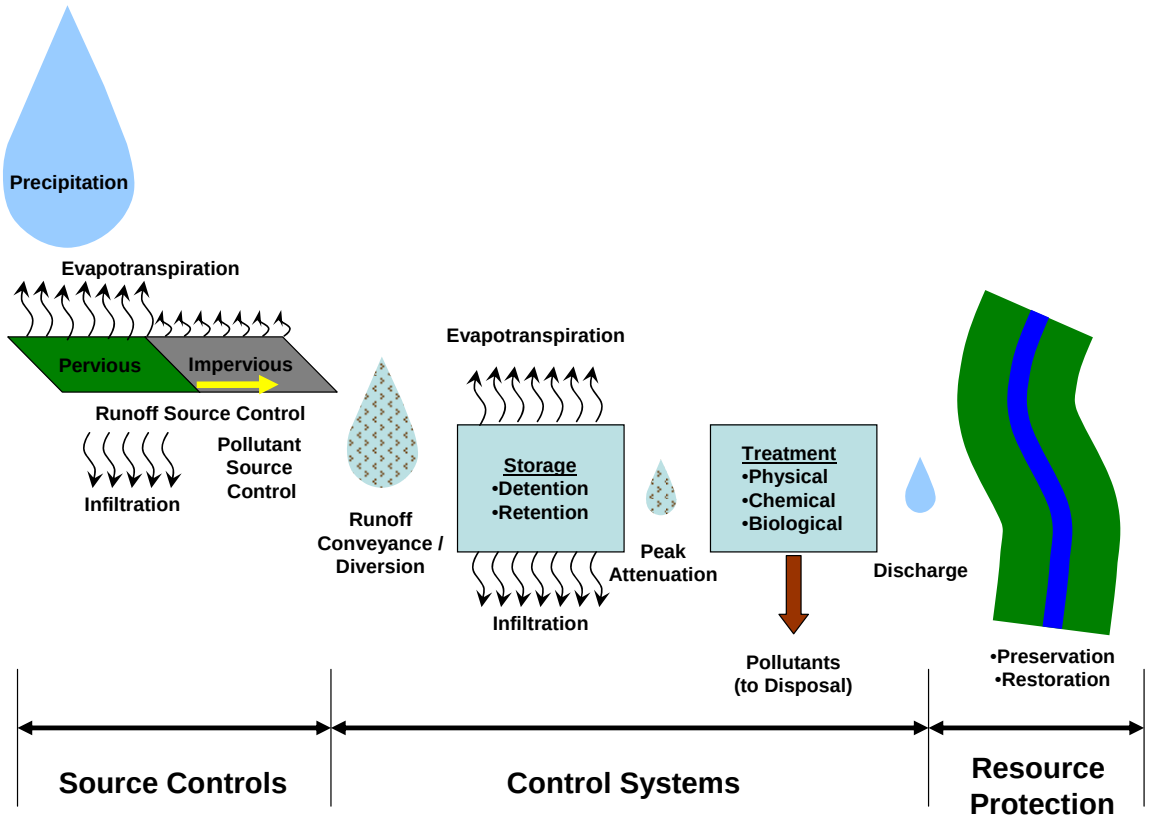

Figure 1. Illustration of "Green" Storm Water Management Infrastructure

1. Categories of Technical Elements

In addressing the runoff volume issue created by impervious areas, communities are looking to established LID practices for solutions. In the case of a community like Cincinnati, the approach to the solution must have a broad scale basis to achieve the maximum efficiency needed to address the magnitude of the problem. From the depicted continuum standpoint, this broad approach, coupled with typical BMPs by category, includes:

Pollutant source controls seek to minimize contact between pollutants and storm water. They are generally less important in a combined sewer system (where the storm water captured will be treated at a wastewater treatment facility or satellite treatment facility), although materials difficult or expensive to remove through a conventional treatment process are best managed at the source (similar to pretreatment

requirements for wastewater flows). Three subcategories of pollutant source controls exist:

1. ***Segregation*** of storm water from pollutants using roofs, diversions, containments, enclosures, etc. to prevent storm water from contacting a pollutant. As structural controls, segregation measures require strict design and maintenance standards, as well as close coordination with applicable building, plumbing, and fire codes.

2. ***Material and waste management*** seeks to select and use materials that minimize entry of pollutants into storm water. To be effective, such controls need to occur on a regional (e.g., the State of Minnesota's ban on phosphorus in most fertilizers) or national (unleaded gasoline) scale.

3. ***Cleanup*** source controls seek to remove pollutants from pavement (e.g., street sweeping), drainage systems (e.g., catch basin cleaning), and other areas before they can be washed away by rainfall runoff.

Table 1

Category	Primary Function	Subcategory	Types of Controls
Pollutant Source Control	Minimize contact of pollutants with storm water	Segregation	Roofs
			Enclosures
			Containments
		Material and Waste Management	Proper use and disposal
			Product reformulation
		Cleanup	Pavement cleaning
			Drainage System Cleaning
			Spill control

Runoff source controls are the first line of defense in an effective storm water management program, representing numerous ways to change (in a redevelopment and renovation context) and/or preserve (in a new development context) runoff characteristics at the point where rainfall contacts the surface. Four subcategories of controls exist:

1. ***Eliminate impervious surfaces*** by narrowing roadways, reducing parking, controlling density, or otherwise promoting more open space.

2. ***Pervious area management*** seeks to preserve and/or enhance the natural infiltration capacity of the soil by minimizing compaction and/or amending existing soils with those possessing high infiltration/soil storage capacity.

3. ***Vegetation management*** preserves and/or enhances the vegetation on a site, utilizing native species and protecting/providing other species that retain soil moisture and/or maximize evapotranspiration.

4. ***Permeable pavements and roof*** substitute surfaces that are typically impervious with those that promote percolation, evapotranspiration, and/or storage of runoff on-site.

Runoff controls are often in conflict with existing community zoning, subdivision, and development regulations and practices, requiring a comprehensive amount of re-thinking about and revision to these regulations to accommodate runoff control practices without negatively affecting property values and public safety. In some cases (e.g., steep slopes) runoff control measures may be infeasible and/or could create unsafe conditions (e.g., destabilized hillsides). Runoff controls (with the exception of permeable pavements and roofs) have no critical design or maintenance requirements. Permeable pavements present similar design and maintenance issues as infiltration control systems, while the design of vegetated roof must be properly coordinated with the structural design of the building.

Table 2

Category	Primary Function	Subcategory	Types of Controls
Runoff Source Control	Change the runoff characteristics at the point where rainfall contacts the surface	Eliminate Impervious Surfaces	Narrower Roadways
			Smaller Parking Lots
			Open Space Preservation
			Density Controls
		Pervious Area Management	Minimize Soil Compaction
			Amend Soils
		Vegetation Management	Protect Existing Vegetation
			Promote Native Vegetation
			Tree Replacement
		Permeable Pavements/Roofs	Porous Concrete
			Porous Asphalt
			Open Cell Pavers
			Vegetated Roofs

Conveyance/diversion systems direct impervious area runoff to storm water control systems. These elements may be as simple as the disconnection of a downspout to direct it into a rain barrel, or as complex as the complete separation of a combined sewer system. Runoff conveyance/diversion mechanisms provide no pollutant removal or quantity control by themselves, but are integral to effectively directing storm water from its source to appropriate control systems, and then to the receiving water. They may also be used to safely convey runoff down a slope without causing erosion. Conveyance/diversion systems are usually designed to convey flow from a wide range of storms, through a 100-year storm event, from the source of runoff, through control facilities, and to the receiving water.

Table 3

Category	Primary Function	Subcategory	Types of Controls
Runoff Conveyance/ Diversion	Direct impervious area runoff to a control system	Diversions	Disconnect Downspouts
			Direct Runoff Away from Pollutant Sources
			Direct Impervious to Pervious Surfaces
			Sewer Separation
		Conveyance	Curbs, Gutters, & Inlets
			Storm Sewers
			Vegetated Channels
			Paved/Rock-lined Channels
			Outfall Protection

Storage elements provide opportunities for runoff to infiltrate into the soil, evaporate into the air, be utilized by vegetation, and attenuate peak flows, as necessary to control erosion and prevent increased flooding. Three subcategories of control exist:

1. ***Reuse*** systems like rain barrels and cisterns capture the WQv and reuse it on-site as a source of non-potable water. Their size depends on how the water is reused – if reuse occurs within 24 to 48 hours of a rainfall event, the WQv should be used to size them, but if water will be retained from several storm events and reused during dry periods, larger systems are required. Reuse systems may be drained by gravity or with pumps, require screens or other mechanisms to control mosquito populations and minimize entry of leaves and other solids.

2. ***Swales and strips*** discharge the WQv through vegetation at shallow depths, providing opportunities for infiltration (depending on soils), peak flow attenuation, and pollutant removal through sedimentation, sorption, and biosedimentation. Swales and strips may be vegetated in three ways – grass, landscaping, and wetland/natural buffers. Strips are often used as pre-treatment for other controls (e.g., filters, infiltrators), but may not provide adequate pollutant and flow control on their own. Similarly,

basins, filters, and infiltrators may be designed in a swale configuration to provide adequate levels of pollutant and flow control.

Table 4

Category	Primary Function	Subcategory	Types of Controls
Control Systems: Reuse	Capture runoff and reuse it on-site	Reuse	Rain Barrel
			Cistern
Control Systems: Swales and Strips	Discharge runoff through vegetation at shallow depths	Swales	Grass
			Landscape
			Wetland
		Strips	Grass
			Landscape
			Buffer

Treatment elements remove pollutants from runoff through sedimentation, filtration, vortex separation, floatation, precipitation, coagulation, biological processes, and/or screening. Numerous subcategories of control exist:

1. ***Infiltrators*** capture runoff and infiltrate it into the soil, which filters, absorbs, precipitates, and biodegrades pollutants, recharges the groundwater, and provides moisture for vegetation. They are generally used in areas with soils able to infiltrate the WQv within 24 hours, and are generally preceded by pretreatment. Infiltrators come in a wide variety of configurations, including basins, trenches, swales, vaults, dry wells, and French drains. They are highly prone to clogging and must be constructed without compaction and routinely cleaned to maintain infiltration capacity.

2. ***Basins*** are designed to capture the WQv and slowly release it over 24 to 48 hours. They may be designed to completely drain or partially drain down to a permanent pool level. Basins control flow primarily through peak attenuation, slowing runoff from the full range of storms to replicate predevelopment conditions and compensate for increased runoff volumes. Volume control is also possible via infiltration in dry basins and evapotranspiration from wet basins, with more volume control possible if

the basins are decentralized. Basins including substantial aquatic vegetation, including wetland systems, remove pollutants by floatation, sorption, and uptake by the vegetation in addition to sedimentation occurring in all basins. Basins come in a variety of configurations, such as vaults, swales, and ponds. Maintenance is typically facilitated by providing a forebay or other pretreatment unit to remove gross solids and larger grain sediments, extending the period between major sediment removal operations.

3. ***Filters*** capture the WQv, and discharge it to the receiving water through an engineered filter media and underdrain system. The filter media may consist of sand, sand amended with organic materials to promote vegetated growth, or various media coarser than sand. A wide variety of filter configurations exist, including basins, linear, vaults, and vegetated cells (e.g., rain gardens). They are used where soils are not suited to infiltration of the full WQv, and, like a basin, release flows over 24 to 48 hours to attenuate peak flows adequately to compensate for increases in runoff volume. They also are effective at removing pollutants, depending on filter media, by sedimentation, filtration, sorption, and bioretention. Most filters are preceded by some form of pretreatment (e.g., basin, strip) to remove coarse solids and minimize clogging of the filter media.

4. ***Screens*** are nets, baskets, cartridges, racks, inlet inserts, and other controls that separate gross solids (litter, leaves, branches) and, with fine screens, some sediments, from runoff. They are typically employed as pretreatment for other controls, and provide no significant flow or volume control. Screens accumulate debris rapidly, requiring frequent maintenance and some form of bypass for larger storm events.

Table 5

Category	Primary Function	Subcategory	Types of Controls
Control Systems: Infiltrators	Capture runoff and infiltrate it into the soil	Infiltrators	Basins
			Trenches
			Swales
			Vaults
			Dry Wells/French Drains
			Cells
Control Systems: Basins	Capture runoff and release it slowly to the receiving water	Extended Detention Basins	Vaults
			Ponds (Basins)
			Dry Basin with Micropool
		Wet Extended Detention Basins	Vaults
			Ponds (Basins)
			Swales
		Wet Basins	Standard Vaults
			Oil-Water Separators
			Swirl Concentrators
			Ponds
			Wetlands
Control Systems: Filters	Capture runoff and discharge it to the receiving water through an engineered filter media and underdrain system	Fine Media Filters -- Sand	Basins
			Linear
			Vaults
		Fine Media Filters -- Amended Sand (e.g., bioretention, planter box)	Basins
			Lineal
			Cells, Filterra
			Vaults
		Fine Media Filters	Filter Swales
		Coarse Media Filters	Filter Trench
			Vaults
		Drain Inlet Inserts	Drain Inlet Insert
Control Systems: Screens	Separate gross solids from runoff	Nets	Floating
			In-Pipe
			Drain Inlet Insert
		Baskets	In-Pipe
			Drain Inlet Insert
		Screens	Inclined
			Linear
			Cartridge
			Swirl Concentrators
			Drain Inlet Insert
		Racks	Racks

Resource protection measures are taken to prevent or reverse physical degradation of receiving water. There are two types:

1. ***Preservation*** measures separate the receiving water resource (stream, lake, wetland) from surrounding development, achieved through zoning, open space conservation, conservation or drainage easements, setback regulations, floodplain management, and other similar measures. The amount of land to preserve may include, depending on preservation objectives, the resource itself, an area along the resource where vegetation stabilizes its banks and shades its waters, the floodplain and floodway of the resource, a meander zone suitable to accommodate the natural geomorphic processes of the stream, and any steep hillsides that may become destabilized if disturbed. In some cases, resource protection areas can serve as a buffer strip control measure, slowing sheet flow runoff that enters the area and filtering pollutants. Most other controls are prohibited from these areas since they may interfere with preservation goals. Typically, there is little maintenance associated with resource preservation, except for vegetation management suitable for natural areas.

2. ***Restoration*** methods seek to restore habitat and natural assimilative processes within the resource. Numerous effective methods exist for removing physical obstructions and channelization facilities; re-establishing habitat, new meander patterns and grade stabilization within streams; "re-connecting" entrenched streams to their floodplains; re-vegetating riparian zones; and building/restoring wetlands. Restoration projects may be very capital intensive, depending on the degree of existing degradation, and require periodic monitoring, maintenance, and refinement to effectively replicate natural conditions.

Table 6

Category	Primary Function	Subcategory	Types of Controls
Resource Protection	Measure taken to prevent or reverse physical degradation of a receiving water	Preservation	Watershed Protection Zoning
			Transfer of Development Rights
			Riparian Setbacks/ Buffers
			Acquisition/Easements
		Restoration	Stream Channel Stabilization
			Riparian Revegetation

The elements of a "green" infrastructure system are often deployed in a decentralized manner, allowing their integration into a wide variety of site conditions. More centralized controls can be integral to a "green" infrastructure system if they replicate natural hydrologic processes and/or compensate for site conditions precluding more decentralized measures. Additional details on the application of these controls to specific processes, as well as considerations for implementation, are attached in Exhibit H. Additional descriptions of the most commonly implemented BMPs, including advantages, disadvantages, costs and suggested maintenance has been prepared by the Milwaukee Metropolitan Sewerage District. Exhibit I includes Sections 1 and 2 of Appendix L of the Guidance Manual in Milwaukee's Surface Water and Storm Water Rules.

2. Factors in Choice of Technical Elements

The variety of "green" infrastructure approaches remains only a list of potential options until a myriad of factors within an urban watershed that affect its hydrology and/or limit the effectiveness of control measures can be analyzed. The following factors arise most often:

a. Development patterns and density

The following table addresses land use within the CSO area. Land use by MSD sewershed is included as Exhibit J.

Table 7

Land Use/ Impervious Area Type	Number of Properties	Area (Acres)	Percent of Land Use
Single Family Residential	103,726	19,746	100.0%
Rooftops		2,851	14.4%
Other Impervious		2,094	10.6%
Pervious		14,801	75.0%
Multi-family Residential	52,998	10,004	100.0%
Rooftops		1,165	11.6%
Parking		1,521	15.2%
Other Impervious		380	3.8%
Pervious		6,938	69.4%
Commercial	16,827	5,224	100.0%
Rooftops		985	18.9%
Parking		1,622	31.1%
Other Impervious		406	7.8%
Pervious		2,211	42.3%
Industrial	7,571	4,552	100.0%
Rooftops		1,272	27.9%
Parking		1,674	36.8%
Other Impervious		419	9.2%
Pervious		1,187	26.1%
Institutional/Public	30,516	12,730	100.0%
Rooftops		698	5.5%
Parking		2,322	18.2%
Other Impervious		581	4.6%
Pervious		9,129	71.7%
Parks/Open Space	489	800	100.0%
Other Impervious		71	8.9%
Pervious		729	91.1%
Arterial Roadways		5,000	100.0%
Roadway		2,130	42.6%
Other Impervious		1,000	20.0%
Pervious		1,870	37.4%
Local Roadways		8,000	100.0%
Roadway		3,156	39.5%
Other Impervious		2,000	25.0%
Pervious		2,844	35.6%
Total Area	212,127	66,056	100.0%
Rooftops		6,971	10.6%
Parking		7,140	10.8%
Roadway		5,286	8.0%
Other Impervious		6,950	10.5%
Pervious		39,709	60.1%

b. Road Right-of-Ways

Arterial and local road rights-of-way represent approximately 20 percent of MSD's combined service area. Roadways represent approximately 20 percent of the impervious area within the combined sewer area, with sidewalks and drives

representing another 11 percent of the impervious area in the combined service area. Road rights of way present unique opportunities for BMP implementation since they are owned by a public entity, are a major contributor of urban runoff, and in many cases receive runoff from adjoining private properties. Several strategies can be considered to incorporate "green" infrastructure into road rights-of-ways:

Curb extensions involve placing islands within parking lanes of roadways to intercept storm water in gutters along curbs and install a storm water control within the island to control flows and/or remove pollutants before discharge to the combined sewer system. Such systems can control most street runoff along with runoff from adjoining properties that is directed to the street's curb and gutter system. Table 8 illustrates how curb extensions can be employed for various sized roadway widths and curb inlet spacing under both Ohio EPA's new development and redevelopment WQv. Curb extensions can be placed within parking lanes of roadways, but not in travel lanes. A major impact of curb extensions is the loss of roadside parking. Table 8 indicates that approximately 20 to 25 percent of the parking would be lost along roadways if these facilities are sized to the full Ohio EPA WQv, but only 5 to 7 percent of the parking would be lost if facilities were sized to Ohio EPA's redevelopment WQv. Facilities would need to be somewhat larger if the road drain system receives runoff from adjoining properties, however parking impacts would be somewhat reduced if the tree lawn could be used for a portion of the facility (depending on slopes).

Planters within tree lawns and/or within wider sidewalks reduce impervious area and, if designed appropriately, could provide storm water control for a portion of the adjoining impervious area. Immediate opportunities may exist to retrofit such planters as ash trees infected by the ash borer are replaced.

Permeable pavements could be employed in place of traditional sidewalks, further reducing impervious area and/or provide opportunities for infiltration into the soil.

While road rights of ways provide significant opportunities for "green" infrastructure, numerous constraints exist. Not all roadways are suitable locations for

"green" infrastructure. Curb extensions are not appropriate for busy roads and/or those providing significant parking. Tree lawns are commonly elevated above the pavement, requiring excavation and potential impact to existing street trees. Some roadways are too steep for effective storm water control, while water, sewer, cable, telephone, gas, electric and other infrastructure within the right of way may interfere with storm water control locations. Further, filtering type controls require underdrains, increasing costs and requiring selection of appropriate vegetation to avoid root intrusion into the underdrain. Finally, construction costs might be prohibitive, unless the "green" infrastructure can be incorporated into a necessary road reconstruction project.

Table 8 - BMP Sizing for Roadways

Crown to Curb Width (ft)	Distance between Curb Inlets (ft)	Pavement Area (sf)	Water Quality Volume		Bioretention				Potential Street Parking Eliminated
					Rock Reservoir		Facility Dimensions		
			Rainfall Captured (inches)	Capture Volume (cf)	Depth (inches)	Void Ratio	Width (ft)	Length (ft)	
8	150	1200	0.75	75	24	30%	5	25	N/A
12.5	150	1875	0.75	117	24	30%	5.5	36	24%
15	150	2250	0.75	141	24	30%	8	29	20%
20	150	3000	0.75	188	24	30%	8	39	26%
25	150	3750	0.75	234	24	30%	8	49	33%
8	200	1600	0.75	100	24	30%	5	33	N/A
12.5	200	2500	0.75	156	24	30%	5.5	47	24%
15	200	3000	0.75	188	24	30%	8	39	20%
20	200	4000	0.75	250	24	30%	8	52	26%
25	200	5000	0.75	313	24	30%	8	65	33%
8	250	2000	0.75	125	24	30%	5	42	N/A
12.5	250	3125	0.75	195	24	30%	5.5	59	24%
15	250	3750	0.75	234	24	30%	8	49	20%
20	250	5000	0.75	313	24	30%	8	65	26%
25	250	6250	0.75	391	24	30%	8	81	33%
8	150	1200	0.15	15	24	30%	5	5	N/A
12.5	150	1875	0.15	23	24	30%	5.5	7	5%
15	150	2250	0.15	28	24	30%	8	6	4%
20	150	3000	0.15	38	24	30%	8	8	5%
25	150	3750	0.15	47	24	30%	8	10	7%
8	200	1600	0.15	20	24	30%	5	7	N/A
12.5	200	2500	0.15	31	24	30%	5.5	9	5%
15	200	3000	0.15	38	24	30%	8	8	4%
20	200	4000	0.15	50	24	30%	8	10	5%
25	200	5000	0.15	63	24	30%	8	13	7%
8	250	2000	0.15	25	24	30%	5	8	N/A
12.5	250	3125	0.15	39	24	30%	5.5	12	5%
15	250	3750	0.15	47	24	30%	8	10	4%
20	250	5000	0.15	63	24	30%	8	13	5%
25	250	6250	0.15	78	24	30%	8	16	7%

c. Public and Institutional Properties

Public and institutional properties provide numerous opportunities for implementing green infrastructure for many of the same reasons as road rights of way. Public and institutional land uses such as government buildings, schools, hospitals, parks, and churches comprise approximately 20 percent of the combined sewer area, and include approximately 13 percent of its impervious area, with parking representing roughly 2/3rd of this impervious area.

Parking represents approximately 8 percent of the total impervious area within the combined service area. Table 9 illustrates storm water control requirements for a range of parking lot sizes under Ohio EPA's new development and redevelopment WQv. This table indicates that bioretention storm water controls could consume nearly 10 percent of the lot area under Ohio EPA's new development WQv, but only about 2 percent of the lot area under Ohio EPA's redevelopment WQv. Using a permeable pavement within parking stalls would decrease the storm water control facility size to between 1 and 5 percent of the lot area. Parking losses could be minimized if the BMPs were installed within landscaped portions of the lot. Completely replacing the parking lot pavement with pervious concrete or asphalt is another control option, but would require excavation and placement of an underdrain and gravel bed under the pavement to manage percolated storm water in impermeable soils.

Table 9 – Alternative Storm Water Controls for Parking Lots

Parking Spaces				Drives			Rainfall Captured	Bioretention for Entire Lot							Bioretention for Drives Only, Pervious Pavement for Stalls							Pervious Pavement	
								Facility	Rock Reservoir		Facility Dimensions				Facility	Rock Reservoir		Facility Dimensions					
No. of Spaces	Width (feet)	Length (feet)	Parking Area (sq ft)	Width (feet)	Length (feet)	Area (sq ft)	(inches)	Capture Volume (cf)	Depth (inches)	Void Ratio	Width (ft)	Length (ft)	Area (sq ft)	Percent of Lot Area	Capture Volume (cf)	Depth (inches)	Void Ratio	Width (ft)	Length (ft)	Area (sq ft)	Percent of Lot Area	Unit Cost ($ / sq ft)	Cost
20	6	15	1800	18	120	2160	0.75	248	24	30%	8	52	412.5	9.4%	135	24	30%	8	28	225	5.4%	$10	$18,000
50	6	15	4500	18	300	5400	0.75	619	24	30%	8	129	1031.25	9.4%	338	24	30%	8	70	562.5	5.4%	$10	$45,000
100	6	15	9000	18	600	10800	0.75	1238	24	30%	8	258	2062.5	9.4%	675	24	30%	8	141	1125	5.4%	$10	$90,000
200	6	15	18000	18	1200	21600	0.75	2475	24	30%	8	516	4125	9.4%	1350	24	30%	8	281	2250	5.4%	$10	$180,000
300	6	15	27000	18	1800	32400	0.75	3713	24	30%	8	773	6187.5	9.4%	2025	24	30%	8	422	3375	5.4%	$10	$270,000
400	6	15	36000	18	2400	43200	0.75	4950	24	30%	8	1031	8250	9.4%	2700	24	30%	8	563	4500	5.4%	$10	$360,000
500	6	15	45000	18	3000	54000	0.75	6188	24	30%	8	1289	10312.5	9.4%	3375	24	30%	8	703	5625	5.4%	$10	$450,000
20	6	15	1800	18	120	2160	0.15	50	24	30%	8	10	82.5	2.0%	27	24	30%	8	6	45	1.1%	$10	$18,000
50	6	15	4500	18	300	5400	0.15	124	24	30%	8	26	206.25	2.0%	68	24	30%	8	14	112.5	1.1%	$10	$45,000
100	6	15	9000	18	600	10800	0.15	248	24	30%	8	52	412.5	2.0%	135	24	30%	8	28	225	1.1%	$10	$90,000
200	6	15	18000	18	1200	21600	0.15	495	24	30%	8	103	825	2.0%	270	24	30%	8	56	450	1.1%	$10	$180,000
300	6	15	27000	18	1800	32400	0.15	743	24	30%	8	155	1237.5	2.0%	405	24	30%	8	84	675	1.1%	$10	$270,000
400	6	15	36000	18	2400	43200	0.15	990	24	30%	8	206	1650	2.0%	540	24	30%	8	113	900	1.1%	$10	$360,000
500	6	15	45000	18	3000	54000	0.15	1238	24	30%	8	258	2062.5	2.0%	675	24	30%	8	141	1125	1.1%	$10	$450,000

Public/institutional buildings comprise nearly 700 acres of rooftop, which is about 3 percent of the total impervious area within the combined service area. Table 10 illustrates several methods available for controlling storm water from non-residential rooftops, including bioretention swales around the building, cisterns (either on the roof or underground), or a green roof. Roofs of public/institutional buildings provide excellent opportunities for storm water management, particularly in conjunction with

necessary roof replacement and/or landscape revitalization projects, but represent a small fraction of the total impervious area and must be accompanied by controls for other impervious areas to significantly affect CSO volumes.

Table 10 – Alternative Storm Water Controls for Non-Residential Rooftops

Building Size			Rainfall	Facility	Bioretention				Number of	Cistern			Greenroof	
					Rock Reservoir		Facility Dimensions							
Length (feet)	Width (feet)	Roof Area (sq ft)	Captured (inches)	Capture Volume (cf)	Depth (inches)	Void Ratio	Width (ft)	Length (ft)	Rain Barrels (60 gal ea)	Depth (feet)	Area (sq ft)	Cost	Low Cost ($10 / sf)	High Cost ($25 / sf)
100	25	2500	0.75	156	24	30%	8	33	20	4.0	8.1	$0	$25,000	$62,500
150	35	5250	0.75	328	24	30%	8	68	42	4.0	17.1	$0	$52,500	$131,250
200	40	8000	0.75	500	24	30%	8	104	63	4.0	26.0	$0	$80,000	$200,000
250	50	12500	0.75	781	24	30%	8	163	98	4.0	40.7	$0	$125,000	$312,500
400	150	60000	0.75	3750	24	30%	8	781	468	4.0	195.3	$0	$600,000	$1,500,000
600	200	120000	0.75	7500	24	30%	8	1563	936	4.0	390.6	$0	$1,200,000	$3,000,000
100	25	2500	0.15	31	24	30%	8	7	5	4.0	1.6	$0	$25,000	$62,500
150	35	5250	0.15	66	24	30%	8	14	9	4.0	3.4	$0	$52,500	$131,250
200	40	8000	0.15	100	24	30%	8	21	13	4.0	5.2	$0	$80,000	$200,000
250	50	12500	0.15	156	24	30%	8	33	20	4.0	8.1	$0	$125,000	$312,500
400	150	60000	0.15	750	24	30%	8	156	94	4.0	39.1	$0	$600,000	$1,500,000
600	200	120000	0.15	1500	24	30%	8	313	188	4.0	78.1	$0	$1,200,000	$3,000,000

d. Commercial/Industrial Properties

Commercial and industrial properties comprise about 15 percent of the combined service area and approximately 24 percent of its impervious area. Rooftops represent roughly 1/3rd of this impervious area, while parking represents another 50 percent. These properties provide similar opportunities for storm water control as those present in public and institutional properties, and Tables 9 and 10 illustrate the types and sizes of controls that would be appropriate for these properties. Opportunities for implementing storm water controls may be optimal when the property redevelops, allowing controls to be required by regulation. For remaining properties, a combination of education and incentive is the most likely strategy for incorporating storm water controls.

e. Residential Properties

There are over 150,000 residential properties within the combined sewer area, comprising nearly 50 percent of the combined service area and over 30 percent of its imperviousness. Since residential properties comprise such a large portion of the combined service area, they cannot be ignored under an effective "green" infrastructure

program. The shear number of residential properties represents a daunting task for implementing an adequate number of effective storm water controls to significantly reduce CSOs. Several strategies can be considered:

Disconnect downspouts. One simple method is to disconnect downspouts from the combined sewer system, an approach mandated by some communities and encouraged by others. Site conditions (e.g., slope, soils, available space between buildings and property lines) may preclude and/or limit the effectiveness of downspout disconnection.

Implement control on residential properties. Residents, through a combination of regulations and incentives, could be encouraged to increase the amount of storm water management provided on their own property. Table 8 illustrates several approaches that could be used. A typical residential rooftop with an impervious area of approximately 1200 sq ft would need approximately 11-60 gallon rain barrels, an 8 by 16 bioretention cell, or a 5 ft deep, 15.6 sq ft cistern to control the Ohio EPA WQv for new development. If the redevelopment WQv were used, these sizes would be reduced to 3-60 gallon rain barrels, an 8 by 5 ft bioretention cell, or a 5 ft deep, 3.1 sq ft cistern.

Drain residential properties into controls within the road ROW. Some or all of the impervious area on a residential property can be directed toward the road right of way if downspouts were disconnected and the property was graded to flow toward the ROW. Many properties or portions of these properties slope away from the public ROW, some re-grading of the property and/or conveyance may be needed to convey the storm water toward the ROW, and the ROW may not be large enough to accommodate the runoff from the adjoining properties.

Create pocket parks. In some densely developed neighborhoods undergoing redevelopment, select properties could be acquired for neighborhood parks. If these properties are located at lower elevations where storm water could be diverted into them, then storm water controls could be located within these parks. Such a strategy may help to both provide publicly-controlled storm water

management controls and serve as a catalyst for neighborhood redevelopment by increasing open space.

3. Slopes

Most "green" infrastructure relies on measures that are most effective in relatively flat sites. Runoff storage and infiltration is difficult when the natural terrain is steeply sloped (i.e., slopes greater than 15 percent, which occur in approximately 29% of Hamilton County, as shown in Table 1). Furthermore, attempts to retain runoff on-site could destabilize slopes and/or cause erosion as water flows down the slope, a chronic problem throughout Hamilton County.

Table 11
Soils and Slopes in Hamilton County

Slope Ranges	Acres	Percent
> 25%	48,947	18.5%
15 to 25%	27,561	10.4%
8 to 15%	43,328	16.4%
3 to 8%	81,737	30.9%
0 to 3%	57,443	21.7%
Total	*259,016*	*98.0%*
Hydrologic Soil Groups	**Acres**	**Percent**
A	4,248	1.6%
B	78,333	29.6%
C	169,206	64.0%
D	3,187	1.2%
Mixed	4,832	1.8%
Total	*259,806*	*98.3%*
Seasonal Water Table (feet below ground)	**Acres**	**Percent**
Less than 3 ft	74,120	28.0%
3 to 6 ft	33,910	12.8%
More than 6 ft	150,986	57.1%
Total	*259,016*	*98.0%*
Overall Suitability for Storm Water Controls	**Acres**	**Percent**
Suitable for Volume Control	52,471	19.9%
Suitable for Other Controls	130,827	49.5%
Limited Suitability	76,508	28.9%
Total	*259,806*	*98.3%*

4. Soils and subsurface conditions

Only about 20 percent of the soils in Hamilton County are well suited for volume control (Also in Table 1). Approximately 50 percent of Hamilton County consists of soils with relatively low infiltration rates, in addition to the 29 percent of the soils that coincide with slopes > 15 %. Appropriate storm water control measures are selected to be compatible with these soil and subsurface conditions. Soil types and slope categories by sewershed as well as areas with seasonably high water tables are included as Exhibit K. This same Exhibit K uses the combined information to calculate the overall suitability for control implementation. Graphic representation of these parameters is extremely helpful in the assessment. Examples of CAGIS maps representing these impervious, soil, slope and land use parameters are included in Exhibit L.

5. Economics

The full economic affects of "green" infrastructure require a "life cycle" understanding of initial costs, useful life, direct and ancillary cost savings, and maintenance needs. To some degree, these approaches shift storm water management costs and responsibilities to individual property owners, including individual residential property owners. The potential for opportunity impacts in the form of less available property because of BMP inclusion, the importance of sound education, periodic surveillance, and prompt enforcement by pertinent public agencies is increased even further.

In short, an effective "green" infrastructure program must be supported by sound design, routine maintenance, and governmental oversight to ensure that water quality regulatory responsibilities are met.

C. Legal and Policy Elements

This sub-section examines so-called "legal elements", which are, generally, law-based means to minimize storm water runoff, such as land use ordinances and financial incentives for public and private uses of technical elements.

This sub-section groups together various elements into a few "groups", provides additional description of individual elements within each group description, analyzes usage feasibility and applicability factors, and discusses related matters.

1. Revise the WWIP and LTCP

As an initial action, a new program should be memorialized in some form as part of the WWIP's LTCP document. Inclusion in the WWIP and LTCP will confirm that a green infrastructure program is part and parcel of MSD's WWIP and LTCP. This action is thus "legal" in nature rather than "technical", even though many of the implementing actions will be quite "technical" in nature. The new program would be designed and operated to address CSO and SSO related issues arising under the Consent Decree. A new program would therefore be both funded and enforceable through the Consent Decree. It would memorialize the basic outlines of the new program. It would confirm that "green" program elements are as valid as "grey" program elements in satisfying Consent Decree requirements (i.e., would be considered part of the injunctive relief as opposed to being part of a SEP).

Incorporation of storm water minimization elements into long-term control plans for managing combined sewer overflows is not a unique concept; it is advocated by leaders in wastewater treatment and the environmental community.[20] As is the case with "grey" elements under the WWIP and LTCP, actions taken as "green" elements would be reportable to the Regulators under the Consent Decree, as well as to the public. Because storm water minimization elements (whether legal or technical) are, by their very nature, flexible and adaptable to unique local conditions – plus the outcomes from their implementation are far less studied than those from "grey" elements – the WWIP and LTCP will need to reflect these differences. This may mean that periodic in-depth reviews every few years will be beneficial for MSD, the Regulators, and the public

[20] See, *Rooftops to Rivers: Green Strategies for Controlling Storm Water and Combined Sewer Overflows*, NRDC, 2006, p. 13; Dapolito Dunn, A; Stoner, N., *Green Light for Green Infrastructure,* Environmental Law Institute, The Environmental Law Forum, May/June 2007.

to study the outcomes and benefits of "green" versus "grey" elements, with adjustments to the overall LTCP to be made accordingly.

2. Legislate Financial Incentives to Expedite Storm Water Minimization

The size of the storm water minimization challenge locally argues in favor of using financial incentives to encourage local governments, businesses, and residents to take individual and group action to minimize storm water. Legislation which creates incentive programs, and rules or policies for implementation, will be required locally. While some of this legal action may take place through new MSD policies (enacted by the County pursuant to Ohio law), some may require legislation or rulemaking in various local villages and cities. Collectively, these actions constitute one significant potential "legal element" to a green infrastructure program.

a. Types of Incentives; Beneficiaries

MSD has surveyed cities and states nationally to determine the types of existing financial incentives for storm water minimization. A copy of MSD's survey results is attached in Exhibit G as its Storm Water Incentives Spreadsheet.

In general, existing incentive programs include the following:

- discounts and credits against fees;
- free or reduced price equipment or services;
- grant funds for purchases of equipment or services;
- grant funds to participate in the program;
- grant funds for educational programs;
- grant funds for large-scale projects (capital and/or operating/ personnel costs);
- grant funds for acquisition of real property (land) interests;
- enhanced scoring in applications for tax increment financing;
- sales tax exemptions for purchases of certain equipment;
- increased floor or site area bonuses;

- exemptions from certain building restrictions if green techniques are used; and
- exemptions or reductions in required storm water retention.

Beneficiaries of existing incentive programs include residential, commercial, industrial and/or governmental entities. As noted in Exhibit G, some incentives target specific beneficiaries (e.g., residential only), while others appear to have broad or universal availability.

Interestingly, USEPA's Office of Research and Development is currently conducting an experimental "incentive" program in one Cincinnati neighborhood. Details of this program are described in Section V a detailed white paper published by USEPA staff authors and a Fact Sheet on the study and describing the study are included in Exhibit M. In essence, USEPA is studying the results of a "reverse auction" method of incentives to residential property owners to install and maintain storm water runoff minimization equipment and techniques on their properties. A combination of cash and equipment grants to residential property owners, and related benefits are the primary incentives.

A report entitled *Public Funding Incentives for Private Residential and Commercial Watershed Projects,* prepared for the Montgomery County, Maryland Department of Environmental Protection by Resolve (Draft, March 2007), surveys and critiques types of incentive programs in Oregon, Minnesota, Illinois, Michigan, and Washington municipalities as well as in Washington, D.C.; a copy is included as Exhibit N.

b. Incentives to Public Entities

Because government entities own or control substantial storm water runoff "source areas", such as roads, streets, parking lots, buildings, sidewalks, and rights of way, their active and early participation in a new program will be essential to its

success.[21] A significant amount of the MSD service area is roads, streets, parks, and government-owned or operated land.[22] Many of these properties will need resurfacing, rehabilitation, or repair in the future and thus may be accessible for use of green infrastructure modifications. The amount of area available for work indicates that major storm water minimization gains are possible if these property owners and operators participate in the new program. However, because many local governments are financially weak, they may not have funds available to pay for "extra out of pocket costs" that may be incurred in transitioning to green infrastructure. There may be a need to provide economic incentives to motivate their adoption of certain green infrastructure practices and policies.

For example, if a significant method for reduction in storm water runoff involves changes in roadway design and construction, the extra costs associated with the use of green techniques over and above conventional techniques may justify an incentive to cover all or a portion of those extra costs.[23] The same might be true for installation of green roofs, or other techniques in building construction or reconstruction. The incentive would be justified by a significant, long-term reduction in storm water runoff versus MSD's expenditures on much more expensive "grey" construction to treat storm water.

By way of another possible example, if a political subdivision within the MSD service area enacts legislation requiring certain green techniques in public or private development or construction, a discount on MSD rates charged in that political subdivision might be justified due to the magnitude of benefits created toward Consent Decree compliance. As noted below in Section VI, there may be legal or policy barriers

---

[21] The City of Milwaukee created an Office of Environmental Sustainability. As part of the City's storm water management program, the Mayor directed city departments to reduce the amount of storm water runoff from city properties by 15% and is encouraging businesses and residents to do the same. The City also has plans to install a green roof on the municipal building.

[22] Public and institutional land uses such as government buildings, schools, hospitals, parks and churches comprise approximately 20% of the combined sewer area. See Section IV(A)(2), above.

that would need to be crossed before such a change could take effect. Nonetheless, this would be one form of incentive that might be productive.

The available information from across the nation does not indicate significant or widespread use of financial incentives. This may be because green infrastructure programs in other communities are either not a critical part of the community's LTCP or CSO/SSO reduction program, or because the community already has enacted numerous storm water minimization codes and rules without need for incentives. The key to serious consideration and prompt implementation of this incentive concept is the ability to obtain large volume reductions in CSO/SSO discharges on an expedited basis. MSD faces a large and unique challenge in this regard. Because neither the City nor the County control public entity behavior in the dozens political subdivisions that are *outside the political and legal control of the City or County but are still within the MSD service area,* incentives (rather than edicts) may be required to obtain major changes in the laws, rules, and practices within these non-defendant communities.

c. Incentives to Private Entities

The vast majority of incentive programs currently in place nationally are designed to influence behavior by *private* rather than *public or governmental* property owners and operators. A review of incentive programs (see Exhibit G) proves this point. Thus, the concept of providing some economic incentive from public funds to modify private property storm water management is neither rare nor isolated to one region, state, or community.

This should not be a surprise due to the need to motivate private individuals and entities to voluntarily act in a manner that would otherwise benefit them indirectly. As the existing USEPA "reverse auction" study's introductory paper notes "although the installation, operation, and maintenance costs for BMPs are relatively well

[23] Seattle's Street Edge Alternatives program Second Avenue Project reduced impervious surfaces over a 660 foot section of the street by 11% and added natural drainage features along the right-of-way. According to the project's website, storm water runoff volumes along this section of the street have been reduced by 99%.

known, these are only a portion of the total costs of adoption. Other costs, such as opportunity costs (e.g., the costs of partial loss of use of property and inconvenience of a BMP on the property) associated with BMP adoption are privately held by individual landowners, and transactions costs associated with a BMP placement program can potentially comprise a large share of total abatement adoption costs."[24] Because private property owners may incur not only extra out-of-pocket costs for the use of green techniques (above and beyond those for conventional storm water management methods such as flushing it off their property), but also added "opportunity costs", incentives may be needed to obtain the desired, new storm water management practices (such as retention on site).

Because public funds (whether from the sewer district, municipality, state, or federal governments) are used as incentives, a public benefit must be demonstrated under applicable law. Thus, a demonstration of the public benefit to the MSD service area ratepayers will be integral to all incentive programs. This generally should not be difficult due to the extraordinarily high costs associated with the use of "grey" construction alternatives to the "green" programs which would contain financial incentive elements for private party participation.

3. Legislate LID and/or Storm Water Management Rules, Standards and Codes

This group of legal actions encompasses a wide variety of statutory, regulatory and policy actions which might be taken to prompt public and private parties to minimize storm water runoff. Some may result in the use of green infrastructure, while others may result, due to choices made by impacted persons, in the use of small-scale "grey" methodologies. In either event, the overall goal will be to provide the best combinations of controls that are both result in the best benefits at the lowest costs. This will minimize the use of massive and expensive "grey" construction projects.

---

[24] "Application of market mechanisms and incentives to reduce storm water runoff, An integrated hydrologic, economic and legal approach, Punam, P., Taylor, M, Hoagland, T., Thurston, H., Shuster, W., Environmental Science and Policy 8 (2005) 133-144; see also, *Using Tradable Credits to Control Excess Storm Water Runoff*.

MSD has surveyed a large number of municipalities nationally to obtain information regarding their respective storm water minimization or "green" ordinances. In the absence of a central database at USEPA or elsewhere, available resources were generally anecdotal collections of examples. Attached as Exhibit E is a detailed and interactive Municipal Ordinances Spreadsheet describing programs in over 65

communities, and containing where applicable or available (a) local government department web site links, (b) copies of local storm water or "green" ordinances by internet link, (c) local contact person and information, and (d) information (sometimes included web links) on each locality's programs covering such subjects as:

- Green Roofs
- Green or Pervious Pavement
- Rain Barrels or Bioretention
- Downspout Disconnection
- Vegetated Swales/Rain Gardens
- Storm Water Fees
- Land Acquisition for Storm Water Use

MSD's review of these local programs and ordinances indicates that there are a wide and highly varied collection of programs in the nation; that a few programs attempt to be comprehensive, while most do not; that local storm water ordinances are often general or vague and rely on non-statutory guidance BMP guidance documents for details; and only a few appear to have more than low level, annual funding.

MSD has prepared a White Paper entitled "Communities in Focus: Local Storm Water Management Programs" which identifies twelve existing municipal programs and summarizes important information learned about these programs from MSD's research. A copy is provided as Exhibit O. A review of the White Paper indicates that legal elements are an integral part of these programs; however, none of these programs have an especially detailed or comprehensive legal program, thus none are "templates" for the County and City to use in the MSD situation. Also, most of the White Paper programs extend over only one or a few political subdivisions, unlike MSD whose service area extends over nearly three dozen cities, villages and townships.

The following subsections examine a few major subjects or topics where legal, legislative, or related policy actions may be taken to implement a new storm water minimization program.

a. Requirements on Public Properties

As part of a new program, the County and City (as well as other home-rule jurisdictions within the MSD service area) could choose by legislative action to self-impose upon themselves storm water management requirements that could cover a wide range of their properties and activities, including:

- Extraordinarily high storm water retention and release standards for all or certain types of public properties, which would exceed those required on private properties;
- Design and construction standards for all or certain types of public roads and streets which significantly minimize runoff to combined or separate sewers;
- Design and construction standards for all or certain types of parking lots, sidewalks, and other surfaces to increase permeability, reuse, and if necessary, storage for slow release of storm water;
- Design and construction standards for all or certain new and replacement roofs to favor green roof and related technologies to minimize storm water accumulation or runoff;
- Design and construction standards for all or certain types of new buildings and significantly renovated buildings to favor green technologies;
- Best management practice (BMP) requirements for all or certain public construction projects and long-term storm water management operations which would exceed those required on private properties;
- Establishing targets, goals, deadlines, or other standards internal to their own jurisdiction, or neighborhoods/communities within larger political subdivisions, for reductions in storm water discharges to sewers;
- Aggressive inspection and auditing of public buildings and properties for violations of storm water minimization ordinances, regulations or standards;
- Demolition (and subsequent revegetation or other action taken to decrease storm water runoff) of impervious surfaces at and on underutilized public properties, such as parking lots, abandoned properties, etc.;
- Integrate and coordinate governmental review and permitting of proposed site designs so that quantity and quality of storm water is

properly and consistently considered in light of desired objectives; and

- Construction of model facilities containing examples of multiple green infrastructure components to be used for education and training of government personnel, other governments considering the use of green technologies, commercial contractors, and commercial and residential property owners.

In general, the adoption of all or some of these self-imposed standards would serve multiple purposes. First, it could accelerate the new program's impact, especially if done at the inception of the program. Second, it could create a pool of "local experts" within local governments who would then be available for use by private parties as they consider green infrastructure options. Third, it could create a pool of knowledgeable and experienced private contractors, consultants, and advisors who would then be available for use by private parties. Fourth, it could create high-visibility programs early in the program, assisting both the credibility of the program and education of the public and other governments. The publicity which the City of Chicago has obtained locally and nationally for the installation of a green roof on its City Hall building is notable in this regard.[25]

In addition, public entities (whether the County through the county sewer district known as MSD, the City, or other political subdivisions) could acquire legal interests in large areas of real estate for use in the new program as "greenways", wetlands, or riparian corridors. The beneficial "green" uses of these areas in a potential new program is described further, above, in Section IV(B). Potential actions could include acquisition of fee simple title, long-term leaseholds, or conservation easements. As noted in Exhibit E, and further below in Section V, land acquisition programs are already being used in Atlanta, Philadelphia, and Milwaukee among other cities, with several cities planning to increase their land interests for these purposes.[26]

---

[25] See, American Society of Landscape Architects 2002 Award Winners and Green Roofs for Healthy City's 2007 Green Roof Awards of Excellence Winners. As previously discussed, the Mayor of the City of Milwaukee has directed a 15% reduction of storm water runoff volume from city properties.

[26] Atlanta, Georgia has adopted a Greenway Acquisition program to acquire and protect properties adjacent to selective rivers and creeks. Project Greenseams in Milwaukee, Wisconsin is a flood management program that permanently protects key lands containing water absorbing soils.

b. Requirements on Private and (often) Public Properties

Although public property may provide a significant and early contribution to storm water runoff reductions, meaningful private property contributions will be critical to the new program's success. A review of the Municipal Ordinances Spreadsheet (Exhibit E) clearly indicates that private property storm water runoff restrictions and storm water fees for utility actions are often elements of local storm water ordinances and programs. This Section reviews several legal elements that might be part of a comprehensive storm water minimization program, containing green infrastructure. While the legal elements described below are focused primarily on *private properties*, there is generally universal applicability to *public properties* also, if that is chosen by local officials. As noted above, public properties may be worthy of consideration for more significant legal requirements.

The following discussion examines several key topics and elements that may be part of the law-based side of a new program:

(i) Types of Regulated Properties

In general, current storm water regulation in much of the nation (as well as in Ohio and locally) has focused on properties over a certain size (often of impervious area) and of a certain type (often commercial/industrial but not residential). When a property exceeds a certain size and is of a certain type, then a set of local storm water management rules, often requiring implementation of Best Management Practices (BMPs), takes effect.

One legal element of a new program may be to *decrease the size* and/or *increase the categories or types* of properties that are subject to BMPs or related standards. This would increase the universe of properties subject to the new program when new construction or renovation occurs. Affected property owners would then look to those standards during construction or renovation and, if the standards encouraged or required runoff-minimization (overall or via certain methods), the universe of properties brought into the program by requirement (rather than voluntarily) could be significantly increased.

This element could be tailored or adjusted depending on watershed or segment of watershed (e.g., a segment heavily impacted by CSOs) or political subdivision to achieve incentive-based or other goals and timetables. Thus, areas targeted for substantial runoff reductions might be subject to smaller triggering size requirements or expanded, eligible property categories designed to control storm water at its source.

(ii) Storm Water Runoff Capture Requirements

Another method to increase the volume of storm water brought into the regulatory program is to increase the performance standards for on-site runoff capture.[27] Many storm water rules have focused on storm water event flow capture. Local area adoption of an aggressive standard (which could serve as the "floor" level on a sliding scale depending on whether the property is within a combined sewer area or separate sewer area) would provide additional control above and beyond that currently required by MSD or any other jurisdiction in Hamilton County for storm water run off quality protection, albeit at added private party cost.

[27] Some jurisdictions have implemented performance standards as part of their storm water management programs. As discussed in the attached White Paper: Communities in Focus, Local Storm Water Management Programs, Dane County, Wisconsin and Huntersville, North Carolina require sites to meet a percent reduction of total suspended solids in storm water runoff.

The actual methods by which storm water is then managed, used, treated or slowly discharged to sewers after capture can be regulated through BMPs. The BMPs can be structured to create hierarchies that favor certain BMPs over others. Financial incentives to select one method over another, due to added public benefit, may be considered.[28] This approach will have substantial impact on the design of new construction and redevelopment/renovation projects by not only requiring a focus on traditional volume reduction but could include the value added benefit of the treatment of the quality of the storm water through the use of certain BMPs.

These first two items, coupled together, could have substantial impact on new construction and renovation projects, with a focus on volume reduction. That legal element is not inherently "green", but is not biased against the use of green technologies.

(iii) Removing Legal Barriers to Green Technology

Long-time municipal zoning and building codes can present legal barriers to the use of green technology and thus are candidates for updating to eliminate or decrease those barriers. For example, ordinances that prevent vegetation in certain locations (near roads) or of certain sizes or types (e.g. anti-weed ordinances) may actually prohibit certain rain gardens or vegetated swales. Hillside development standards may require storm water conveyance from the source to be maximized. Municipal curb requirements (location and size restrictions on curb cuts) often *enhance storm water runoff* and prevent green methods of roadway drainage. As noted in one national report, mandated minimum street widths and building setbacks can increase imperviousness.[29]

---

[28] The Maryland Storm Water Design Manual outlines storm water retention requirements based on various site characteristics. Structural and non-structural methods may be utilized to meet these requirements. When innovative techniques are utilized, it is possible to reduce the amount of required storm water retention capacity. See the attached White Paper: Communities in Focus, Local Storm Water Management Programs, Exhibit O.

[29] See, *Rooftops to Rivers: Green Strategies for Controlling Storm Water and Combined Sewer Overflows*, NRDC, 2006, p. 15, citing J. Woodworth, *Out of the Gutter: Reducing Polluted Runoff in the District of Columbia* 52-8 (NRDC, July 2002).

(iv) Including LID Requirements in Local Codes

As LID standards become requirements in local codes governing construction and storm water management, water quality as well as water volume improvements are possible. The technical range of LID elements is discussed in Section IV(A), above; this Section merely notes that enactment of these elements will require legislative action, which may either adopt an entire LID standard or adopt certain standards for certain types of properties, projects, or possibly areas (watersheds).

(v) Increased Compliance Inspections and Enforcement

One legal element to a new program that may require no new enactments could be increased enforcement of existing storm water management ordinances and standards. For instance, MSD rules or local ordinances prohibit the discharge of storm water into separate sanitary sewers (e.g., inflow); this historic practice may not end until significant local inspection and enforcement occurs, much of which may need to occur on private property.[30]

Similarly, storm water retention requirements may require regular inspection to verify that both original construction and subsequent operations and maintenance have met these requirements. However, inspections and governmental intervention (e.g., to perform needed maintenance on a neglected BMP) comes at a cost to the government.

As increased storm water controls are implemented, whether they are green technologies or not, the use of formal inspections, operation and maintenance plans or agreements (or covenants) between private property owners and the local government (possibly MSD) may be an important means of securing long-term compliance and ensuring long-term, consistent reduction in runoff pollutants.[31] The

[30] Under Minneapolis, Minnesota's Rainleader Ordinance, if a property owner fails to comply with a disconnection order, the City may revoke any City-issued license held by the property owner. Pittsburgh, Pennsylvania requires a dye trace to be performed prior to the sale of real estate to confirm that rooftop drains are disconnected from the sewer.

[31] Nashville, Tennessee requires the use of an operation and maintenance agreement to ensure that storm water BMPs are maintained. See also, Municipal Ordinance Spreadsheet.

recording of these agreements or other documents associated with storm water controls in the land records of the county may ensure that future property owners are placed on notice and bound by such restrictions.

V. DATA SUPPORTING PROGRAM ELEMENTS

A. MSD Lick Run Demonstration Project

MSD's approach to a sound design for its green infrastructure plan starts with an assessment of one CSO. Lick Run (CSO 005) in the Mill Creek watershed was selected for detailed evaluation to determine the potential benefits of LID measures on a large MSD CSO. Lick Run is representative as a test catchment since its drainage area provides a mix of topography, land use and surficial soil characteristics. While the slopes encountered in this watershed are somewhat more severe than most other areas, additional model runs to test the varying parameters of the initial Lick Run assessment can be used as the foundation to extrapolate the potential benefits to other CSO areas.

Attached in Exhibit P is the initial assessment of the Lick Run watershed. This work reflects the potential for controlling impervious areas and significant positive impacts from a LID approach on the level of control of the selected CSO. These initial results, although preliminary before sensitivity and extrapolation efforts, indicate a comprehensive green infrastructure program will enhance a "grey" structural program and provide improvement in the control of the CSO. MSD is currently conducting an extrapolation of the Lick Run area preliminary assessment across the MSD CSO area; this effort will be provided to the Regulators once it is finished.

B. Other Local Area Storm Water Minimization Projects

1. USEPA Shepherd Creek Study.

The project will test storm water control by developing an approach that disperses runoff detention through the use of rain gardens and rain barrels. The study posits that, by combining these approaches, hydrological benefits will result from

reducing the in-stream damage that would continue to occur in a centralized system. The study is expecting cost savings in terms of meeting environmental quality standards. The Shepherd Creek watershed study area is approximately 1.8 square kilometers of mixed residential, forest and pasture. The area has separate storm and sanitary sewers. Approximately one-third of the watershed area includes parkland with mature deciduous forest.

Control of runoff and potential infiltration from proposed BMPs will be assessed from baseline watershed soil characteristics, slope aspects of each parcel, roof geometry, percent impervious surfaces and connectivity of this impervious to the storm sewers. Monitoring will include sediment loading, precipitation and selected soil and water quality parameters. The schedule for BMP installation is late 2007.

The details of this study and the auction approach for involving the public are discussed in a published article, which is attached as Exhibit Q. MSD sees great value in this study and intends to monitor (i) the accuracy of the predictions made for runoff retained and infiltration, (ii) the costs of the installations and the maintenance of these BMPs, (iii) the impact of loss of property use and inconvenience to the property owner; and (iv) the success of the auction concept.

2. Civic Garden Center Study

The outreach effort of the Cincinnati Civic Garden Center is focusing its educational programs on a sustainable demonstration garden and a unique learning laboratory. The intent is to convert a parking/storage site into a model sustainable garden with a specific goal –"to have net zero discharge offsite" – that positively contributes to water quality improvement. Its location is within the combined sewer portion of the MSD service area.

Storm water management elements include: (1) a green roof, (2) pervious and porous pavement, (3) rain gardens, (4) a bioswale, (5) sedimentation catchments, (6) recharge wells and a cistern. On-site waste water treatment will recycle treated water for irrigation. Demonstration of various regional plantings and soil amendment techniques will also be included.

The UC Institute for Sustainable Engineering will be assisting the Center with on-going research on the site. While the Center hopes to "set a new standard for urban change", the MSD is very interested in the data generated by the demonstration of the efficiency of the BMP installations, the ability to positively re-charge groundwater tables and, as always, the costs of construction and maintenance. The response from the public and the type of communication found to most effectively involve the public will be of key interest. Additional details of this Study are attached in Exhibit R.

3. Greenacres Foundation Projects

Billed as educational community outreach projects to educate on water resource issues, the Foundation conducts water quality monitoring on local rivers and streams and actually allows volunteers to test the samples for pH, conductivity, nutrients, sediment and bacteria. In its fifth year, the project provides the information gathered for watershed planning and protection activities. Its focus is in the Little Miami River watershed.

MSD certainly supports these educational activities and is very interested in the information generated. It is anticipated that MSD will be able, with some assistance, to influence the streams that are sampled by the volunteers, directing this work to areas where green infrastructure projects have been performed to document trends in improvement or changes in water quality that may not have been predicted.[32]

4. Columbia Township Commercial Redevelopment

The proposed 11.4 acre site will involve demolition of one existing building and construction of three new buildings. The property is tributary to a CSO. The developer, in cooperation with the MSD, is proposing to use green roofs and bio-retention areas in place of an underground detention system, to control post-development runoff.

[32] Exhibit S describes the activities associated with this water quality project.

The MSD is participating with the developer in this project for the piloting experience with two typical BMPs that will have to be accepted and implemented by the community for the green infrastructure initiative. While the bio-retention work is less expensive than underground storage, adding in the green roof would push the project cost approximately 30% above the underground detention price tag. The participation by the MSD facilitates the validation of BMP cost estimates and the efficiency of retention capabilities against predictions. The successful partnering between the MSD and a private section business will, hopefully, provide the template for further, similar endeavors.

5. The Arbors

Being implemented as part of the Neighborhood Development Pilot Program in Hamilton County, this project involves construction of a new home urban subdivision in a City of Cincinnati neighborhood called Pleasant Ridge. Estimated construction for these 14-lots is the spring of 2008. LEED design to be included in the construction involves (1) an entry gateway rain garden, (2) 720-feet of eco-swale, (3) a bio-retention pond and (4) a native landscape pocket park.

MSD's interest lies mainly in the monitoring that will be performed after construction. As part of the project presentation, in addition to the "living classroom" value of this green approach, information will be kept from monitoring wells and storm retention volume discharges as impacted by the BMPs.

6. Owl's Nest Park

The Cincinnati Park Board as part of its green initiatives program will construct three rain gardens as part of the Owl's Nest Park Renovation Project. The project is the result of a community-based master plan that was completed in 2006. The construction of the gardens is proposed as a partnership between the Park Board, the Owl's Nest Advisory Council, MSD, the Rain Garden Alliance and local EPA representatives specifically interested in environmental quality improvements in our

area. These rain gardens will help mitigate the storm water drainage problems found in urban areas like O'Bryonville, where this park is located.

The rain gardens at Owl's Nest will be designed to capture as much of the excess rainwater run-off as possible from the park and its associated landscape. While the project will provide another example of a BMP functioning to improve the community, MSD is interested in monitoring the impact that rain gardens will have in an urban park setting and recording runoff capture and infiltration statistics. The installation costs (estimated at $100,000) and maintenance effort at Owl's Nest Park will be of prime concern in extrapolating this data up to the scale that the MSD's service area will require.

7. Burnet Woods Park

MSD will be working with Cincinnati Parks (Parks) to complete improvements within the Burnet Woods Park. The park is located within the combined sewer system and has a combined sewer overflow (CSO) located within its boundary. This project is unique in that MSD will also be forming a partnership with both the USEPA) and the University of Cincinnati to construct rain gardens, roof gardens, or pervious parking in an effort to reduce storm water runoff, improving surface water quality, and decreasing capacity demand of the combined sewer system.

The Burnet Woods Park project will serve as a learning center for elementary students through graduate level research. The improvements within the park boundary will include a reconstructed/restored steam, outdoor classroom, living laboratory, rain gardens, and wetlands reducing the intrusion of storm water runoff generated by over 90 acres of land into the combined sewer system. MSD's participation will ensure access to the important data attained from monitoring the actual retention capabilities of the BMPs installed as well as the cost of these installations.

8. City Gateway

The City Gateway Project, while not a demonstration project that will provide MSD with new information for analysis, it is the type of work that will be

pursued, in a much broader sense, in the future. City Gateway involved wetland construction and planting along I-75 and is estimated to cost approximately $400,000.

9. 1600 Gest Street

MSD is considering options at its Gest Street property for capturing drainage from its 11-acres of buildings and other impervious surfaces. Early estimates place the costs of this study, design and construction at $500,000. Phase I of the proposed project will concentrate on the entrance area of the new administration building. Not only is this a good location for installing green technologies, it will provide educational exposure to the public.

Krueger and Hudepohl, an industrial property located on the east side of Woodrow Street and adjoined to the MDS property, has expressed a desire to install green technologies on its property to capture drainage from the building's roof, which drains into inlets on MSD's property. If installed, these green technologies would service an impervious area of approximately 3900 square feet.

Phase II of this project includes an assessment of all 68 acres of the Gest Street property and implementation of green projects to capture storm water run off. A conceptual plan of these proposed projects is attached as Exhibit T.

C. Other Urban Area Storm Water Minimization/Green Program

Many communities in the United States and beyond are implementing effective storm water management programs using "green" infrastructure methods through a combination of demonstration projects by governmental agencies, collaboration among various public and private entities, and regulations mandating implementation of storm water controls. Several factors are driving this trend:

- USEPA regulations and federal/state NPDES permits require property owners disturbing one acre or more to implement storm water quality/quantity controls for post-development runoff.
- USEPA regulations and federal/state NPDES permits have also been issued to local governments in virtually all "urbanized" areas of the United States, requiring these governments to implement storm water

management programs that include, among other things, requirements that storm water quality/quantity controls be constructed as part of new development and redevelopment projects.

- Communities with combined sewer systems are increasingly integrating storm water management practices into long-term control plans as a cost-effective way of reducing CSO volumes and overflow frequencies.
- Scientific research is revealing that most remaining urban stream degradation is directly attributable to changed stream flow regimes and the physical stream alterations that occur and/or are constructed to manage these stream flow changes.

Research of those communities has identified that actions to retrofit controls on private property are usually encouraged rather than required, with various incentives provided as encouragement. Regulation of storm water on currently developed private property is generally limited to downspout disconnection. Some communities now require that all downspouts be disconnected, supported by local government inspections and enforcement. Other communities encourage downspout disconnection, with regulations defining which downspouts are allowed to be disconnected and addressing how to disconnect them. Many states, local communities, and professional societies have developed sizing and/or performance criteria for storm water controls:

Pollutant Removal criteria are either expressed as (1) a percentage of the average annual load of targeted pollutants that the facility must remove, (2) the effluent concentration of pollutants from the control, or (3) a water quality capture volume and release rate that are presumed to meet pollutant removal targets and/or effluent concentrations.

Groundwater Recharge criteria either establish performance standards (e.g., no increase in runoff volume compared with pre-construction conditions) or establish the volume (per event, average annual) to capture, infiltrate, and/or evapotranspirate each event.

Stream Channel Protection criteria establish a particular volume or design storm and release rate criteria intended to prevent erosive velocities in downstream water bodies.

Flood Protection criteria are typically expressed as a relatively infrequent design storm (e.g., 25-year event) that must be either safely conveyed or detained and released at a rate that does not increase downstream flooding.

These criteria all relate to local hydrologic conditions, and are most correctly established based on a hydrologic/hydraulic study of the watershed. Since such studies can be costly, most communities establish criteria that are presumed to maintain local hydrologic conditions. As such, it may be inappropriate to adopt a criteria from another area, as these criteria may not be appropriate for local hydrologic conditions and do not achieve the community's storm water management objectives. Many communities and states typically establish cost-effective design criteria to capture and treat 80 to 90 percent of the average annual runoff volume. Ohio EPA recognized this issue, utilizing the ASCE/WEF Manual of Practice to develop a set of facility sizing and release rate criteria appropriate for hydrologic conditions in Ohio.

The most effective "green" infrastructure implementation strategies are commonly linked to the new development (to prevent hydrologic changes) and to redevelopment and/or renovation of existing development (to reverse hydrologic changes as feasible). Options are available for owners to retrofit "green" techniques voluntarily into their properties (e.g., downspout disconnection, where appropriate, is inexpensive and relatively easy to do). However, it is usually more cost-effective to perform this retrofit when maintenance or rejuvenation is needed (e.g., a green roof or porous pavement is more cost-effective to install when an existing roof or pavement needs to be replaced), or if long-term cost savings can be realized (e.g., retention and reuse of storm water can avoid lawn/landscaping irrigation costs).

The following information provides the detail behind the previously discussed summary of approaches. The research conducted by others is extensive and will serve to focus Cincinnati's broad approach on what was successful in other jurisdictions and those creative ideas, yet to be implemented, that can be mutually developed.

- "Communities in Focus" – Exhibit O summarizes research done on twelve communities that have or are preparing to implement green infrastructure approaches to help address their storm water and/or wastewater overflow issues. MSD is very interested in the effectiveness of the various project implementations and will monitor these communities for information related to costs and specific success with the various BMPs being tried. Based on this information and until these statistics become available, MSD may consider any of the following:

    1. Developing information, design criteria, standard specifications, methodology and planning considerations for public and private entities implements BMPs in support of the WWIP.
    2. Evaluating the cost/benefit of specifying a specific BMP capture rate for the first runoff in a rain event.
    3. A rigid system and gravel for certain impervious surface re-construction such as Chicago's alley pilot program.
    4. A private property rain garden program in conjunction with a voluntary rain barrel and mandatory downspout disconnection program.
    5. The use of inlet restrictors in selected areas to reduce storm water flow into the sewers.
    6. Selectively acquiring undeveloped property deemed "most suitable" for maximum infiltration on a large area scale.
    7. Creating a guidance document for maintaining BMPs after installation on private property. Guidance would also involve assistance and monitoring.
    8. Using the widest array of BMPs suitable to the specific conditions of a watershed.
    9. Coordinating an effort to address the quality of storm water prior to discharge.
    10. Linking the erosive affect of storm water velocity to an off-setting BMP approach.
    11. Working with the City on using vegetated curb extensions.
    12. Funding in-house experimental research to continually improve BMP designs.

- "Rooftops to Rivers" – Developed by the Natural Resources Defense Council, Exhibit D offers a comprehensive look at green strategies for controlling storm water and combined sewer overflows. A good overview of the issue facing many communities, this report offers policy recommendations developed from the national experience of the authors

and nine community case studies, five of which overlap with "Communities in Focus". Based on the information provided, MSD may consider any of the following:

1. Leading, by example, the advance "green" into typical infrastructure repair and upgrades on all MSD projects.
2. Expanding long-term monitoring for assessing green impacts.
3. Calculating the real cost of urban runoff control, accounting for those more qualitative aspects affecting the community.
4. Expanding MSD's hydraulic modeling approach to assess the effectiveness of BMPs, looking to trend the best opportunities for maximum improvement.
5. Investigating rain water re-routing alternatives in areas where infiltration is difficult or where wetlands will need to be avoided.
6. Combining green solutions with re-claiming brownfield sites in a watershed.
7. Accelerating the planned I/I work in a separated area.
8. Utilizing stepped vegetation when faced with severe slopes in a specific area.
9. Investigating the application of rain water harvesting for institutional landscaping needs.
10. Considering stream restoration where paved ditches presently exist, enhancing the habitat after concrete removal.

- "The Role of Low Impact Redevelopment in Integrated Watershed Management Planning" – The City of Philadelphia is presently implementing an aggressive LID infrastructure approach that will demonstrate a 20% reduction in directly connected impervious areas for all redevelopment work. Coupled with storm water Regulations for new developments, Philadelphia expects significant reductions in runoff entering its sewers and resulting savings when sizing its "grey" CSO solutions. MSD is very interested in monitoring the implementation issues that may arise during this effort.

  Exhibit U is a paper describing the challenges of this implementation, the green program envisioned and progress made through the date of the paper. Exhibit U includes the research that Philadelphia performed at the beginning of its planning effort. MSD is performing similar investigations, specific to its community and its significantly larger CSO challenge and benefits from the validation of its approach.[33] Based on the information provided, MSD may consider any of the following:

[33] Exhibit V provides additional information on Philadelphia's Watershed Approach to CSO Management.

1. Spending the needed time to consider the feasibility of BMP installations to get it right the first time.
2. Incorporating green infrastructure projects into the overall project schedule for the benefits gained from logistics and project consolidation.
3. Determining what constitutes success and how to measure that success.
4. Including storm water management into the early stages of the planning process as opposed to only during design.
5. A link between CSO control and other City initiatives, especially roadways, utilities, housing and parks.
6. Setting earth disturbance thresholds for developers to follow in creating storm water management plans for their projects.

VI. ISSUES FOR FURTHER EVALUATION AND CHALLENGES TO SUCCESS

This Section recognizes that a new program of the type contemplated by MSD appears to be unprecedented in dollar size, geographic and political scope, and legal and technical comprehensiveness. This size and complexity creates unusual data gaps which need to be addressed before program creation, let alone implementation. It may face special legal, political, and policy challenges that need to be understood by the Regulators and MSD prior to program creation.

The focus of this Section will be to identify these issues and challenges and evaluate how they are to be addressed. The purposes of this Section are to identify (a) issues which need further thinking, study, and evaluation (technically, legally, or otherwise), and (b) known or potential problems, challenges or barriers to the creation, implementation or success of a new storm water minimization program utilizing green infrastructure. Each subsection section will generally (i) identify and discuss the specific subject, (ii) analyze and discuss possible further work, and (iii) identify what role may be performed in resolving the issue or challenge by MSD and/or the Regulators and/or third parties.

A. Issues For Further Evaluation

This Subsection identifies issues which MSD believes need further thinking, study and evaluation prior to program creation; several issues will require subsequent (and ongoing) study during program implementation. As noted in Section III, one of the Program Principles is to "Continuously Evaluate, Adapt, and Improve Program Effectiveness at the Local Level." The subjects below are *not an entire, complete or final* listing, but rather primary issues which MSD recognizes at this time.

1. Technical Element Feasibility

a. Specific Subject

Technical element feasibility evaluations are key to understanding whether specific technical elements are *capable of being used* in all, some, or many parts and areas of the program. For instance, if a technical element requires high permeability soils, a feasibility evaluation will examine where such soils are present (or absent) locally.

MSD has conducted some very preliminary feasibility evaluations for this report, the results of which are discussed in Sections IV (A) and V. However, these are highly preliminary and (with respect to the Lick Run Demonstration Project) not complete.

b. Possible Further Work

The following are possible issues for further study:

- Completion of the Lick Run Assessment, including sensitivity of storm water runoff and CSO volumes to a range of green implementation scenarios, varying infiltration rates, infiltration capacity, recharge ratios, depression storage and evaporation times.
- Sizing storage elements at each catchment for verifying 24 to 48-hour releases while assessing constraints to these releases.
- Running model scenarios varying redevelopment projections, retrofits, water quality, rainfall, etc.

- Extrapolation of the Lick Run Assessment to the entire CSO area, including feasibility assessment of green infrastructure alternatives using Lick Run insight regarding facility sizing and managed impervious percentages.
- Determine a reasonable estimate of system-wide runoff control volume achievable with a green approach.
- Calculating the relation of green methods to interceptor/regulator hydraulics.
- Predicting inflow/outflow rates and volumes for specific BMPs.
- Applicability of Green Infrastructure to the SSO area.
- Impact of "green" on "grey" technologies, including evaluating "grey" facility size changes available for "green" implementations.
- Assessing land availability for the combined "grey"/"green" approach.

c. Roles of MSD, Regulators, Third Parties

The technical issues noted above will largely be studied by MSD, although it may request input from experts locally, regionally, and nationally, including those among the Regulators. If the Regulators can identify staff or outside experts with specific experience in this subject, they are requested to notify MSD with this information.

2. Potential Benefits/Outcomes Evaluations

a. Specific Subject

Further evaluation of the potential benefits and outcomes from the actual use of legal and technical elements is needed prior to program creation and will be ongoing prior to and during program implementation. At the initiation of the program, choices of methods will be based in large part on anticipated benefits. During program implementation, monitoring and reporting on benefits will be important to measure outcomes, compare with original estimates, and make mid-program adjustments accordingly.

The subject of benefit predictions and measurements is complex, as "benefits" may be measured in various ways; refinement of measurement standards and methods will be required at the point of project creation. While volume of storm water runoff prevented is one obvious method of defining benefit, is it the primary or exclusive standard? How does one quantify and give "credit" for legal elements of the program, such as changes in local storm water rules or building codes? These questions raise both technical and legal issues. Beyond the issue of measurement, there is the actual estimating of those benefits; that is the primary focus of this issue that requires further evaluation.

The goals of this work will be to refine preliminary benefit estimates so that both technical and legal elements can be categorized, ranked, or prioritized according to their relative benefits.

b. Possible Further Work

(i) Technical "benefit/outcome"

The following are possible issues for further study:

- Research the cost aspects of BMPs used successfully in other cities, including a literature review of installation and maintenance costs.
- Developing traditional costs (conventional roofs, pavement, landscaping, etc.) to get incremental changes from BMPs.
- Investigating regulations and inspection costs inherent to BMP installation.
- Evaluating the cost/benefit of capturing the first runoff of a rain event or restoring a stream that had been previously paved.
- Estimate the cost/value of socio-economic impacts related to BMPs, including the lost opportunity to use the property housing the BMP.
- The reduced roadway width and parking.
- Neighborhood re-vitalization.

- More attractive recreational area for business and residential development. This will necessitate an evaluation of the positive impact the work will have on existing water quality.
- The establishment of "green" businesses.
- Establishing a "green" marketplace for builders, remodelers, landscapers, etc.
- Evaluate a reasonable implementation schedule, including the time required to assess the impact of installed green facilities and the subsequent delay to "grey" facility design and construction.
- Periodically review and modify technical elements depending on available data and information.
- Time differential of solving private vs. public access for BMP implementation and a possible shift in priority to the most expedient approach. Discussion must look to timing MSD "green" with other agency renovation projects.
- The time required to produce the design and guidance manuals that private and commercial partners with MSD will need to participate in the green initiative.
- Estimate the cost of Plan "B", including the costs of "grey" after resizing.
- The most cost-effective "green"/"grey" blend.
- The cost of expanded monitoring and management.
- The cost of land, easements and access to the "green" and "grey" facilities.
- The cost of outreach, after a comprehensive approach is developed, including demonstrations/pilots for BMPs.
- The cost to achieve collaboration with other agencies in the service area.

(ii) Legal "benefit/outcome"

Possible issues that may need further refinement include:

- Agreement on definition of "benefit" to be used in defining results from new program activities.
- Presumptive "benefits" gained from changes in statutes, ordinances, regulations, adoption of LID or other BMP standards.

c. Roles of MSD, Regulators, Third Parties

The technical issues noted above will largely be studied by MSD, although it may request input from experts locally, regionally, and nationally, including those among the Regulators. If the Regulators can identify staff or outside experts with specific experience in this subject, they are requested to notify MSD with this information.

The legal issues noted above will initially be studied by MSD, but ultimately will need to be considered, discussed, and agreed upon among MSD and the Regulators. These legal issues are key issues to be resolved prior to new program creation.

3. Cost/ROI Evaluations

a. Specific Subject

MSD will need to conduct feasibility studies on major technical elements. MSD will need to conduct cost studies to determine what various technical elements cost. Once costs by watershed and/or technical element are estimated, and time periods for implementation are estimated, preliminary ROI work can and must be performed. ROI analysis will allow MSD to evaluate, compare and select among multiple technical options.

b. Possible Further Work

The following are possible issues for further study:

- Estimated costs for primary technical elements on some form of unit basis (e.g., by acre; by square foot) with adjustments if applicable for special applications and circumstances;
- Estimated quantities of primary technical elements, thus generating large-scale (by watershed, by entire program) costs for program implementation;
- Agreement on "benefits" measurements or assumed measurement standard for purposes of ROI analyses;

- Initial, preliminary ROI analyses by either technical element, legal element, watershed, and/or program area; and
- Initial recommendations regarding prioritization of technical and legal elements based upon initial, preliminary ROI analysis findings.

c. Roles of MSD, Regulators, Third Parties

The technical cost and ROI issues noted above will largely be studied by MSD, although it may request input from experts locally, regionally, and nationally, including those among the Regulators. If the Regulators can identify staff or outside experts with specific experience in this subject, they are requested to notify MSD with this information.

The legal "benefit" issues noted above will initially be studied by MSD, but ultimately will need to be considered, discussed, and agreed upon among MSD and the Regulators. If "benefit" issues cannot be resolved promptly, MSD will select a presumed definition for "benefit" and presumed measurement methods so that the ROI analyses may be conducted. Ultimately these legal "benefit" issues are key issues to be resolved prior to new program creation so that sound ROI analyses may be conducted and presented.

B. Potential Barriers, Challenges and Problems Facing a New Program

This sub-section identifies issues which MSD believes are currently known, or reasonably expected, to be barriers, challenges and problems which a new storm water minimization program will face. The purpose in identifying and evaluating these issues now is to (i) realistically assess what damage these problems may create to a new program and factor those assessments into pre-creation design of the program, and (ii) begin work now on solutions, collaboratively between MSD, Regulators, and possibly third parties. The subjects below are *not an entire, complete or final* listing, but rather primary issues which MSD recognizes at this time.

1. Technical Barriers

a. Specific Subject

Discussions will draw on the technical elements described previously and expand the feasibility and cost/benefit aspects to issues related to implementation and sustainability. It is critical to understand the technical complexities of a "green" program in order to ensure that the goals are achieved and positive impacts to water quality are maximized.

b. Possible Further Work

MSD will conduct technical research into these issues, working with available legal and technical resources.

c. Roles of MSD, Regulators, Third Parties

The technical issues noted above will largely be studied by MSD, although it may request input from experts locally, regionally, and nationally, including those among the Regulators. If the Regulators can identify staff or outside experts with specific experience in this subject, they are requested to notify MSD with this information.

2. Legal Barriers

a. Specific Subject

There are a few fundamental legal issues that need preliminary resolution prior to program creation, including:

- Ability of MSD to use revenues to fund a new program, specifically incentive programs for public and private property work designed to minimize storm water impacts;
- Whether such incentive programs may result in rate discounts or variations (in light of existing uniform rate practices under the existing County –City operating agreement for MSD);

- Ability of local storm water ordinances to require certain storm water management and minimization actions on public and private properties;
- Existence of existing state or local environmental or other laws and ordinances which may be significant barriers to, or assist in, the creation and implementation of a new program; and,
- Identification of key local law, ordinance and regulation changes likely to be needed to create and implement a new program.

b. Possible Further Work

MSD will conduct legal research into these issues, working with available legal and technical resources.

c. Roles of MSD, Regulators, Third Parties

The legal issues noted above will largely be studied by MSD, although it may request input from experts locally, regionally, and nationally, including those among the Regulators. If the Regulators can identify staff or outside experts with specific experience in this subject, they are requested to notify MSD with this information.

3. Policy Barriers

a. Specific Subject

There are a certain policy issues that may create unique or significant barriers to new program creation or implementation that should be considered by MSD and the Regulators and be studied for possible resolution prior to program creation, including:

- Potential competition (or cooperation) among and between the 45 political subdivisions that are within the MSD service area regarding storm water ordinances, building and zoning codes, choices of LID and BMPs, and acceptance of the new program. Methods that foster cooperation, especially among communities sharing a watershed, should be identified and fostered;

- Role of Phase II storm water regulation-required local ordinances; whether such ordinances can assist in new program implementation depends on policy choices among multiple, diverse political subdivisions within the MSD service area; and,
- Public land use modifications. A significant aspect of the new program will be to modify public land uses to quickly implement green infrastructure. This may result in changes in road and street construction, and changes to existing public land, such as parking lots and roofs. Large scale implementation will require multiple political subdivisions to agree to such changes on their property, much of which is outside the control of the City and County;

b. Possible Further Work

These large-scale policy problems need to be thought through by MSD and the Regulators. The goal should be to identify various ideas and options to eliminate or reduce the problems, so that those ideas and options can be shared with County and City leaders prior to new program creation.

c. Roles of MSD, Regulators, Third Parties

MSD and the Regulators should collaboratively study and discuss these issues in order to determine how these potential problems may be eliminated or significantly reduced prior to program creation.

4. Funding

a. Specific Subject

The primary barrier to funding is overall WWIP affordability, a subject discussed at some length between MSD and the Regulators. For purposes of this analysis, it is assumed that the vast majority (nearly all) of the funds required for a new program will come from MSD ratepayers. As noted above, cost estimates for a new program have yet to be made. However, MSD believes the costs will far exceed those of other municipalities with existing "green" storm water minimization programs.

By way of some comparison, a review of other municipal programs indicates that sizes of programs elsewhere are relatively small compared to the size of MSD's 2006 LTCP:

- Atlanta, Georgia and surrounding counties have committed $25 million in a Greenway Acquisition Project;
- Kent, Ohio is creating a $25,000 fund for the purchase of conservation easements;
- The Milwaukee Metropolitan Sewer District has spent approximately $4.35 million on a 50% cost-sharing program to implement LID, and will be spending another $4.35 million for that plan over the next 10 years. MMSD is planning to spend $20 million over some time period on land acquisition for its Green Seams program;
- Seattle, Washington's levy provides $16 million for land purchase for 18 new Neighborhood Parks in many of Seattle's most densely developed neighborhoods and $10 million to preserve Green Spaces such as forested hillsides and creek corridors. In addition, $5.7 million of the Levy's Opportunity Fund was designated toward acquisition projects. Seattle Parks has leveraged this $31.7 million to secure $21 million in private donations and city, county and state grants to augment the acquisition projects. Clearly, some of this is storm water/CSO/SSO related, but much of it is not; and
- In October 2006, King County Washington Executive Ron Sims proposed investing nearly $20 million in "green infrastructure" for 2007. Combined with his total investment to trails and open space in 2006, Sims' two-year budget commitment to "green infrastructure" would approach $40 million. Again, it appears that some of this may be CSO/SSO related, while some it is not.

A key barrier to be crossed early in this analysis is a decision to use of significant amounts of WWIP funding for storm water minimization, including green infrastructure, to meet the three program Objectives noted in Section II. Unlike "green elements" in some other municipal storm water programs, MSD's expenditures would be highly, if not exclusively, targeted on reductions in CSOs and elimination of SSOs.

b. Possible Further Work

MSD needs to conduct the costing, benefit, and ROI analyses noted above. MSD and the Regulators need to reach agreement on program dollar size and

schedule so as to resolve affordability issues. Then, MSD and the Regulators need to agree that substantial WWIP funding may be used for this new program.

c. Roles of MSD, Regulators, Third Parties

While MSD would take the lead in resolving the costing, benefit (except for legal issues which are shared with the Regulators), and ROI analyses, reaching agreement on the general sources and uses of funds for the new program will require participation by MSD, the Regulators, and ultimately many different community leaders and stakeholders.

5. Determining Success or Failure

a. Specific Subject

As noted above, defining "benefits" and standards and methods for determining benefits, is a key, early issue to resolve for MSD and the Regulators prior to program creation. This subject has local and national implications. Locally, it will determine whether the new program has achieved its three Objectives and whether expensive "grey" construction projects can be avoided. Nationally, it will determine whether a large-scale, comprehensive storm water minimization program using green infrastructure can serve to fundamentally alter future LTCPs to address CSO and SSO issues. Given the precedent-setting size and scope of the new program and its Objectives, making wise decisions about success and failure is extremely important. Some if not all of those decisions need to be made now.

These decisions tie into other significant, open issues, such as affordability, schedule and so-called reopeners. For instance, if the new program's first five years demonstrate benefits above certain standards, will that be deemed "success"? If so, what impact will that have on the other LTCP activities? If certain of those future activities might be made redundant or unnecessary, what mechanism or process will exist to revise the LTCP? There will be a clear need for regular review and revision of the LTCP as new data and information are available.

b. Possible Further Work

MSD and the Regulators need to define what constitutes "success" and "failure" in MSD's new program. The exact work process needed to reach agreement on this is uncertain.

c. Roles of MSD, Regulators, Third Parties

Only a collaborative process between MSD, Regulators, and any third parties with special knowledge in this subject, is likely to result in a wise decision. This should not be a negotiated issue, but one that uses collaborative decision-making to reach a decision.

VII. CONCLUSIONS

A. Background and Summary of Report

At the beginning of this report, we identified a key problem facing the Consent Decree parties: how can the Consent Decree's enormous and complex problems be satisfied in the face of major and growing economic problems in the MSD service area?[34]

We then recognized that USEPA has recently joined with a diverse group of national stakeholders in holding that green infrastructure has the potential to provide water quality improvements, especially in CSO/SSO LTCPs, at a fraction of the cost of so-called "grey infrastructure" construction projects.[35]

With these in mind, we indicated that one objective of this report was to determine whether a significant – indeed unprecedented – storm water minimization program using green infrastructure could eliminate or significantly solve the problem facing MSD and the Regulators in this Consent Decree's implementation.

The Report then identified three key policy Objectives for a new program:

[34] See, Section I(B) above.

[35] See, Exhibit A.

- Minimize the Quantity of Storm Water Runoff to CSOs/SSOs
- Improve the Quality of Local Creeks, Streams, and Rivers
- Limit Rate Increases to MSD Customers.

Following this, the Report identified and discussed Five Key Program Principles:

- Manage the Program and storm water Flows on a Watershed Basis
- Prioritize Program Actions Starting with "Source Areas", then "Conveyance", and finally "End of Pipe"
- Effectively Educate, Incentivize, and Involve the Public and Communities
- Continuously Evaluate, Adapt, and Improve Program Effectiveness at the Local Level
- Adequately Fund the Program and Create Financial Accountability for Storm Water Costs and Impacts

The Report then identified Technical Elements and Legal Elements, evaluated them and data from available local and national sources, and identified issues for additional, near-term evaluation and identified significant potential barriers to new program creation or implementation.

It is now appropriate to reach a few key conclusions about this potential new program.

B. Key Conclusions

The following are MSD's key conclusions regarding a potential new program:

1. The Consent Decree "Problem" Requires a Significant, Creative Alternative

The gap between local affordability and the size of the Regulators' desired LTCP program is so enormous, and presents such a huge legal and public policy issue, that it cries out for a creative, alternative approach.

2. Available Information Indicates that "Green Infrastructure" May Be an Effective Alternative to Unaffordable, Massive "Grey" Construction

Reviews of existing programs across the nation, conducted by entities as varied as USEPA headquarters, NACWA, NRDC, and now MSD, indicates that "green infrastructure" technical and legal elements are producing significant, measurable benefits in communities with CSO/SSO issues. And, these benefits appear to be created at costs significantly below the seven, eight, and nine-figure costs for conventional "grey" construction projects such as deep tunnels.

3. MSD's Program Policy Objectives and Program Principles Make Sense

MSD believe that a program of this size and scope must have its own Policy Objectives and Program Principles; it cannot be a supplemental activity or be a mere adjunct to the "real LTCP". Further, those Policy Objectives and Program Principles must fit MSD's unique situation if the new program is to succeed. From MSD's perspective, the existence, and specifics, of its proposed new program Policy Objectives and Program Principles are sensible.

4. The Program Elements Have a Good Likelihood of Succeeding

The potential new program has both technical (physical) and legal (laws, policies) elements which would form the core of the program's actual implementation.

This report has discussed a significant number and wide variety of potential elements, not all of which would probably be chosen and used. However preliminary, available data locally and nationally indicate that these elements have a good likelihood of success, meaning that they should significantly reduce discharges from CSOs and SSOs, improve overall water quality, and do so for much less than the Regulators' proposed Straw Man ideas.

5. The LTCP Should Be Revised to Add the New Program and Reprioritize Some "Grey" Projects for Subsequent Review

MSD recommends that the existing LTCP should be revised to add the new storm water minimization program following substantial further refinement and definition of the program, and dialogue with the Regulators. At the same time, the existing LTCP should be revised to reprioritize the scheduling of some "grey" projects until well after the new "green" program has been implemented and then only after reevaluation to determine whether such projects have become redundant, unnecessary, or are over-sized due to "green" program benefits. The LTCP would include some periodic reviews of "green" and "grey" elements to evaluate effectiveness and determine whether certain elements should be revised or eliminated.

C. Decisions

MSD requests that the Regulators' staff and legal counsel review this Report and then continue settlement discussions, subject to Federal Rule of Evidence 408, by discussing its contents and conclusions with MSD staff and counsel at their scheduled September meeting, if not earlier. MSD's staff and counsel respectfully request that the Regulators' staff and counsel accept the Report's findings and conclusions, which will open the door for detailed discussions on a final LTCP revision and approval.

D. Next Steps

MSD proposes several action steps by each of MSD and the Regulators as follows:

1. Regulators' staff and legal counsel review this Report;

2. Regulators provide feedback on this Report informally through legal counsel and staff discussions, either at the planned late September meeting of the respective parties or in advance via telephone;

3. Regulators and MSD negotiating teams (legal and technical) work collaboratively on a final, mutually acceptable version of this Report, including work on issues and problems identified in Section VI. Management for all parties is kept informed. This work can be done while negotiators continue discussions on other LTCP elements, affordability issues, and schedule issues;

4. LTCP will be revised by MSD to include the new storm water minimization program including green infrastructure elements, as well as other changes mutually acceptable to MSD and Regulators on "grey" project specifics and reprioritization, and schedules; and

5. MSD's and Regulators' negotiators reach tentative agreement and recommend revised LTCP to respective managements and clients for approval.

MSD respectfully requests comments and feedback from the Regulators on this Report not only to finally resolve the pending LTCP approval, but to create and then implement a new storm water minimization program with green infrastructure that is a model for the nation.

EXHIBITS

Exhibit A: Green Infrastructure Statement of Intent, April 19, 2007

Exhibit B: *Using Green Infrastructure to Protect Water Quality in Storm Water, CSO, Nonpoint Source and Other Water Programs*, Memorandum from Benjamin H. Grumbles, USEPA Assistant Administrator, to USEPA Regional Administrators, March 5, 2007

Exhibit C: Dapolito Dunn, A; Stoner, N., *Green Light for Green Infrastructure,* Environmental Law Institute, The Environmental Law Forum, May/June 2007

Exhibit D: *Rooftops to Rivers: Green Strategies for Controlling Storm Water and Combined Sewer Overflows*, NRDC June 2006

Exhibit E: Municipal Storm Water Ordinances Spreadsheet

Exhibit F: Map of MSD Service Area

Exhibit G: Storm Water Management Financial Incentive Programs

Exhibit H: Storm Water Controls and Flow/Pollution Control Processes

Exhibit I: Milwaukee Metropolitan Sewerage District, Surface Water and Storm Water Rules Guidance Manual, Appendix L: Low Impact Development Documentation (rev. September 2005)

Exhibit J: Summary of Impervious Area Associated with Land Use by Sewershed

Exhibit K: Summary of Soil Types, Slope, and Seasonal Water Tables by Sewershed

Exhibit L: CAGIS Maps

Exhibit M: *Application of Market Mechanisms and Incentives to Reduce Storm Water Runoff*, USEPA Office of Research and Development, Environmental Science and Policy 8 (2005) 133-144 and related documents

Exhibit N: Public Funding Incentives for Private Residential and Commercial Watershed Projects, prepared for the Montgomery County, Maryland Department of Environmental Protection by Resolve (Draft March 2007)

Exhibit O: Communities in Focus: Local Storm Water Management Programs

Exhibit P: Low Impact Development Assessment for Lick Run, prepared by XCG Consultants, Inc. (DRAFT July 2007)

Exhibit Q: USEPA Shepherd Creek Study

Exhibit R: Green Roof: Off the Grid - Civic Garden Center Study

Exhibit S: Greenacres Foundation Water Quality Project

Exhibit T: 1600 Gest Street Conceptual Plan

Exhibit U: Maimone, M., Smullen, J., Crockett, C., *The Role of Low Impact Redevelopment/Development in Integrated Watershed Management Planning: Turning Theory into Practice*, Philadelphia Water Department

Exhibit V: Clean Waters … Green City, Philadelphia's Watershed Approach to CSO Management Presentation