Reducing Combined Sewer Overflows

Toward Clean Water in Washington, D.C.

School of Public Affairs
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Contents

Preface

This report was prepared by the policy analysis workshop at the School of Public Affairs of the University of Maryland. The policy analysis workshop is a course in the master's program of the School. Each student devotes a full semester of course work to the study of an important public policy issue. This year there were seven students with undergraduate majors ranging from environmental engineering to economics to English. Their combined efforts amounted to more than 500 hours, including review of the literature, meetings with experts, field trips and other methods of study. The environmental section of the policy analysis workshop is supervised by Professor Robert H. Nelson of the environmental policy program of the School of Public Affairs. Copies of the report are also available on the web under "faculty papers" for Robert Nelson at www.puaf.umd.edu.

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Executive Summary

A combined sewer system consists of sewers that carry both storm water runoff and raw sewage. Normally, a combined sewer system transports the storm water and human waste to a treatment plant. Problems occur, however, when rain events overwhelm the volume of wastewater that either the sewer lines or the treatment plant are able to process or contain in a given time period. At that point, the wastewater must be redirected from sewage lines directly into rivers and streams. In addition to human waste, these overflows also contain debris from streets and toxic materials. Across the nation, there are 40,000 combined sewer overflow (CSO) events each year.

Today, approximately one-third of the area of Washington, D.C. is served by a combined sewer system that dates back to the late nineteenth and early twentieth century. As a result, billions of gallons of raw sewage spill into the Potomac and Anacostia Rivers and Rock Creek each year. The District's Water and Sewer Authority (WASA) has outlined an approach to resolving the CSO issue in its draft Long-Term Control Plan (LTCP) released in June 2001. However, this approach by itself will not significantly improve D.C. water quality. As other regions of the nation have discovered, a comprehensive watershed solution is needed. Such a solution will require the various players, including those in the District Government, the State of Maryland and the Federal Government, to coordinate their efforts.

Such coordination will require all involved to move beyond the current fragmented approach. A large disconnect exists between CSO control and storm water management. With WASA handling CSO discharges and the D.C. Department of Health (DOH) water quality standards, there is no overarching committee to bring the groups together. Environmental Protection Agency (EPA) regulations are the only guiding factor in addressing the full set of issues of water quality in the District. Also, coordination problems do not stop at the District city line. On the Anacostia River, there has been little coordination between the District and Maryland governments on water quality issues, despite the fact that the majority of water pollutants originate in Maryland. Non-government organizations sponsor functions for public comment and to disseminate information, but do not have powers of implementation. Neighborhood organizations and residents of the District do not appear to be focused on water quality either.

This report outlines a regulatory and institutional framework, under which a stronger watershed approach may be realized, as well as an overview of stakeholders that are in one way or another working to improve water quality in the Anacostia. While water resource management continues to proceed in a very technocratic and isolated manner, there is an opportunity now for much greater coordination among stakeholders and initiatives.

This report recommends that the best solution to the District's coordination problems lies in the establishment of a new watershed management organization for each waterbody. Such an organization would act as the steering authority for all water resource management activities – including CSO control, storm water management, habitat restoration, and recreational usage – carried out within the watershed. This new institution should be created with the watershed approach in mind, ensuring that ecological boundaries dictate jurisdictional participation. Membership would be required of all states, counties, local groups and other stakeholders who either directly affect or are affected by watershed management decisions. Most importantly, this organization would be given full authority to ensure that all policies made and actions taken within the watershed were in line with the group's common goals. This type of structure could encompass all of the District's watersheds as subunits, but more likely would involve the creation of separate organizations for each of the watersheds within D.C. – the Anacostia, the Potomac, and Rock Creek.

THE ANACOSTIA WATERSHED MANAGEMENT AUTHORITY

It is proposed in this report that the new organization for the Anacostia River would be called the Anacostia Watershed Management Authority (AWMA). It should hold the responsibility of overseeing all water resource decision-making within the Anacostia watershed. This new organization would require the participation of jurisdictional and stakeholder groups such as the Maryland Department of Environment, Prince George's and Montgomery Counties, the National Park Service, WASA, the D.C. Department of Health, D.C. land use and development authorities, the Anacostia Watershed Toxics Alliance, and the Anacostia Watershed Society. The inclusion of all players in the decision-making process should lead to major improvements in the comprehensiveness of the Anacostia watershed's management.

To ensure that decisive action is taken, AWMA would also have the authority to legally enforce watershed goals and management decisions. As such, watershed management decisions made by WASA and other organizations would require the approval of AMWA prior to being carried out. A lack of implementation authority is currently the chief impediment to successful efforts by groups such as the Anacostia Watershed Restoration Committee. The establishment of AWMA with clear legal authority therefore should act as a key stimulus for a more effective cleanup of the Anacostia River.

As proposed, AWMA could be further incorporated into a regionwide system of watershed management authorities. This overarching framework would include:

1. A national strategy for watershed management set by EPA;
2. The Chesapeake Bay Program as a model for setting guidelines for the Bay's overall watershed;
3. Individual tributary and other sub-watershed authorities, including the AWMA for the Anacostia River, who would then develop plans to guide the management of water resources within the smaller geographic watershed regions.

CSO CONTROLS ARE NOT ENOUGH

The District government invested $35 million in the initial efforts at CSO abatement (between 1988 and 1990). This included control measures such as 12 inflatable dams in the collection system and a swirl concentrator facility near RFK Stadium. However, this effort did not yield the desired results, due to lack of maintenance and other operational problems. The District is now in the process of completing a LTCP to reduce the volume of CSO outflows. The federally mandated LTCP includes a comprehensive assessment of changes that must be made over the next 20 years to bring the District's rivers up to water quality standards. Significant benefits will accrue from CSO remediation both for human health and the rivers of the area. However, the LTCP also shows that unless storm water and upstream nutrient loads from separated systems in the District, Maryland and Virginia are also reduced, the District's water quality standards will not be met.

The preliminary study for the draft LTCP considered options ranging from complete separation of the city's sewer system to implementing no controls at all. The study found that complete separation of the sewer system leading to total elimination of CSOs was not economically feasible. The report expressed an additional concern that, if the system were separated, untreated storm water (carrying suspended solids, toxins, and other pollutants) would flow directly into receiving waters, rather than first being treated at the Blue Plains Wastewater Treatment Plant facility.

The LTCP would drastically reduce both the number of overflow events and the total volume of overflows. In the case of the Anacostia River, CSO volumes would decline by over 95 percent after implementation of the LTCP's proposed measures. The LTCP is touted by WASA as the most technically and economically feasible plan for reduction of CSOs. Examining indicators cited in the LTCP, however, contradict the efficacy of the LTCP.

E. coli is considered a good indicator of the level of bacterial contamination in water systems. The predicted reduction in CSO discharges, along with a significant reduction (approximately 40 percent) in upstream nutrient loading, could result in only a few days of elevated bacteria levels for each water system. However, CSO controls alone do not show nearly the same level of beneficial effects. If nothing is done to address storm water problems, a critical omission of the LTCP, bacterial contamination would exceed acceptable levels in the Anacostia on as many as 289 days out of the year. Without additional controls to cut storm water and upstream nutrient loads, the District's rivers will remain out of compliance with water quality standards for much of the year. In Rock Creek, the number of days with elevated levels of *E. Coli* would reach 331 to 365 per year – even with the full implementation of the LCTP for CSOs. This brings into question the effectiveness of CSO control in managing the important water quality parameter of bacterial contamination.

In short, implementation of CSO controls alone falls far short of the measures that would be necessary to meet the D.C. water quality standards for the Anacostia and Potomac Rivers and Rock Creek. Control of upstream storm water loading remains central to reducing bacteria levels in D.C. waters. As a single element – not taken in concert with other watershed management measures – the LTCP's CSO control proposals do not appear to offer a sound solution to lowering bacterial pollution in D.C.'s waters. As such, communication and partnering with upstream authorities (including Maryland, Virginia, and West Virginia) are necessary in establishing a successful water quality management plan for the District.

The problem of CSOs is significant and daunting for the District of Columbia government. The District has a number of incentives for controlling outflows. They pose health risks, detract from the value of the rivers and their clean up is legally mandated. However, funding a project of the scale proposed by the LTCP will require coordination with the federal government and raising the rates of the residents, neither of which will be easy. The largest problem is that even if CSO outfalls are prevented completely, the waterbodies still will not meet the water quality standards because of upstream storm water flows.

WATERSHED MANAGEMENT IN OTHER CITIES

Three case studies from other cities were largely chosen because they all share the development of policies that expand the scope of CSO control to include a watershed approach with dual goals of improving water quality and managing storm water. A stronger emphasis was placed on source control, seeking to first retain or slow storm water runoff, rather than focusing exclusively on end-of-pipe solutions. This is not to say that end-of-pipe solutions such as tunnels, storage tanks and treatment plants were not considered, but rather, that efforts in those cities centered around the ultimate goal of improving water quality. Managing storm water runoff and eliminating or reducing CSO events were addressed in light of an overarching goal. Additionally, the cases considered the role of land use decisions and their impact on water quality – a key consideration for both new and existing property development.

The city of Portland, Oregon is a good example of a city that has altered policies and shifted priorities due to an expanded notion of "what's the problem?" During an extensive review of its CSO policy, including analysis of the CSO impact on the Willamette River, drainage and sanitary systems, wastewater treatment, endangered species listing, watershed heath and water quality data, Portland revised its CSO position by stressing urban storm water as the key issue. In addition to the three-year review of their CSO policy, a shift in emphasis also came from two other sources: 1) The National Marine Fisheries Service added several species of salmon to the list of endangered species. The City Council had also expressed its commitment to the restoration of those species. 2) Portland anticipated that the Oregon Department of Environmental Quality would soon set limits on the amount of pollutants entering the Willamette and its tributaries through the Total Maximum Daily Load (TMDL) standards process.

Portland also realized that their CSO program alone would not address key environmental concerns such as restoring native vegetation along creeks and streams, restoring floodplain function and fish and wildlife habitat, decreasing stream temperature, controlling soil and stream channel erosion and restoring the water quality of rivers and creeks. As stated in its Clean River Plan (CRP), "If the City places most of its emphasis on pipes for combined sewer overflows it will not address the needs of fish and wildlife in a timely manner, and clean and healthy watersheds will be a distant vision." The CRP shifted attention onto addressing CSO volume by decreasing storm water runoff through such projects as rooftop detention, infiltration basins, increased tree canopies, reconfigured driveways, parking lots and streets, to provide more pervious and vegetated soil, and routing storm water though constructed wetlands and swales.

Similar to Portland, both Toronto, Ontario and the Puget Sound region of Washington State have expanded CSO abatement strategies to include storm water management. In light of early data collection, which showed high levels of pollution from urban runoff, Toronto's city staff adopted the philosophy that source control should be considered first, followed by conveyance, and last by end-of-pipe solutions. More specifically, this meant that projects should first and foremost try to restore ecosystem integrity by preserving and re-establishing a natural hydrologic cycle and by protecting, enhancing and restoring natural features and functions (e.g., wetlands). However, understanding that Toronto is a highly urbanized area and the built environment vastly alters the natural hydrologic cycle, city staff has highlighted the need for projects that mimic natural processes of filtration and infiltration and contain storm water at the source (e.g. rain gardens, eco-roofs, porous pavements, and bioretention cells). Whereas the historical trend has been to quickly convey storm water offsite to streams, rivers and lakes, Toronto is changing this paradigm by viewing storm water as a resource—providing beneficial uses such as groundwater replenishment, and enhancing recreation and aesthetics of the city.

In the Puget Sound region, CSO control has been joined with storm water management. While the first CSO reduction programs, such as those in Seattle, focused primarily on constructing storage facilities, storm water management is being seen as a promising and important abatement strategy. In 2000, the Puget Sound Water Quality (PSWQ) Management Plan was reviewed and the strategies for storm water and CSOs updated to reflect the improved understanding about the critical effect that storm water has on water quality as well as habitat quality. Local governments are now required to develop storm water management plans and the State is responsible for maintaining standards, issuing permits, and providing assistance, guidance and training. According to the PSWQ Management Plan, the goal of the storm water and CSO program is "to protect and enhance the health of Puget Sound's aquatic species and habitat, natural hydrology and processes, and water quality, and to achieve standards for water and sediment by managing storm water runoff and reducing combined sewer overflows."

These three examples show that expanding the issues beyond combined sewer overflow to include storm water in improving water quality leads to a more comprehensive and integrated watershed management approach with better promise for improving water quality standards. The management plans that flow from these cases offer a model for the kind of coordination and multi-faceted solutions that are needed to protect and restore the nation's water resources.

THE NEED FOR WATERSHED MANAGEMENT

In the early 1990s, the U.S. experienced something of a paradigm shift toward ecosystem- or watershed-based approaches to natural resource management. This new concept strived to incorporate ecological, economic and social factors, through stakeholder coordination performed within natural geographic or ecological boundaries.

According to a 1993 Memorandum of Understanding between all federal agencies involved in environmental resource management "the goal of the ecosystem approach is to restore and sustain the health, productivity, and biological diversity of ecosystems and the overall quality of life through a natural resource management approach that is fully integrated with social and economic goals."

This approach builds from the interrelationship between natural systems and healthy, sustainable economies. Because ecosystems do not follow man-made political boundaries, management of ecosystems and human activities affecting them must take a perspective that looks beyond jurisdictional lines. This involves a shift from government's traditional focus on individual agency missions and jurisdictions to a broader, more comprehensive consideration of the roles of multiple agencies within larger ecological boundaries. Decision-makers must consider the broad-scale, long-term ecological consequences of their actions. The ecosystem approach also requires the involvement of the many stakeholders affecting or affected by environmental resource decisions, including federal, state, and local agencies, private and civic groups, and present and future residents of the area. Such coordination ensures the accurate definition of values being upheld through management decisions.

Effectively applying this broad approach also requires an understanding of how ecosystems function and what their current condition is. This involves the continuous building and communication of scientific information concerning ecosystem components and their complex interconnections. As ecological science grows and changes, resource managers and the frameworks they operate in must be able to adapt to insure state of the art knowledge is being applied at all times.

By highlighting the explicit connection between ecological health and economic welfare, the ecosystem approach forces the public and its leaders to look at the far-reaching implications of the choices they make concerning resource use. In addition, this emerging perspective encourages all involved stakeholders to build newly coordinated frameworks that can produce the best possible set of approaches to restoring and maintaining ecological resources. In its recently released guidance on Coordinating CSO Long-Term Planning with Water Quality Standards Reviews, EPA also stresses the importance of utilizing a watershed approach to "prioritize actions to achieve environmental improvements, promote pollution prevention, and meet other important community goals." Both the EPA's 1994 National Pollutant Discharge Elimination System (NPDES) Watershed Strategy and its 1996 report on "The Watershed Framework" outline principles and methods to be employed in undertaking a watershed approach to project development.

The ecosystem and watershed approach is currently being applied in many policymaking arenas, however its acceptance and success have been hindered by several factors. For instance, comprehensive planning approaches have proven more difficult and costly than more compartmentalized approaches, due to their need for broad coordination among stakeholders and all-inclusive data gathering. Breakdowns in coordination and an incomplete understanding of ecological factors can inhibit the strategic planning process and lead to taking the easiest, rather than the most effective long run approaches to environmental resource management. Also, while the call for ecosystem-based planning has been promulgated throughout federal, state and local governments, it exists only as a guiding principle and currently lacks the teeth needed to ensure full implementation.

For these reasons, implementation of genuine watershed management will require the development of new institutional structures of governance. In this report, we propose one such new institution, a new AWMA as described above.

SHORT TERM RESPONSES

The development of a new institutional mechanism for watershed management in the District's watersheds will take time. Meanwhile, WASA faces an immediate requirement to renew its National Pollutant Discharge Elimination System (NPDES) permit from EPA for CSOs. If the permit cannot be renewed, WASA would be in violation of the Clean Water Act and subject to potential penalties.

Based on the comments received following issuance of the draft LTCP in June 2001, WASA plans to present a final LCTP later in 2002. It is likely that there may be significant revisions to the final LCTP. In addition, the LTCP is ultimately only a plan, and the actual outcome may change significantly in the interim between plan, design, and implementation phases (over 20 years).

Ideally, the LTCP should incorporate an exhaustive analysis of WASA's final proposed action for CSOs, and justification for why various alternatives were considered but rejected.

ADAPTIVE MANAGEMENT IN PRACTICE

WASA's proposal, as detailed in the draft LTCP of June 2001, addresses the CSO issue by building tunnels at the largest CSO outfalls. Still in the planning stages, the entire CSO control policy would take perhaps 25 years and more than $1 billion. The tunnels would be constructed in phases, with the Anacostia tunnel(s) heading the list. Only after the Anacostia tunnel is completed will WASA draft a plan for the next tunnel. Spending $1 billion or more for a project that will require 20 to 25 years to complete merits careful analysis. One option might be an adaptive management strategy in which each step would be phased in based on what had been learned in the previous phases. For purposes of discussion, the following adaptive management alternatives are proposed.

Step 1 – Upgrade the existing combined sewer infrastructure. The numerous ways this could be implemented are found under "Real Time Controls" in Chapter 5. According to the Anacostia Watershed Restoration Committee, implementing all the modifications and optimizations of the existing system could reduce CSO discharges by as much as 80 percent. If this mitigation potential is realized, a large tunnel may lose its appeal, given the comparative costs and project duration for achieving similar results with upgrades.

Step 2 – Implement low impact development (LID) structures widely throughout the combined sewer area. Because LID integrates landscaping, architecture, and energy conservation in its best management practices, it offers a holistic treatment of CSO and storm water while improving the quality of life in communities. LID, in addition to diminishing the storm water problem, generates many positive externalities such as "greening" the cityscape with trees, shrubs, and vegetative swales. LID reduces energy costs by attenuating the need for heating and cooling of buildings. Another long-term benefit of LID is that due to ongoing maintenance and monitoring needs, it will generate employment opportunities. Last but not least, LID fosters community-building because it is an approach that depends on the cooperation of many neighbors to achieve its goal for the common good. As the effectiveness of LID is yet unproven, one plausible plan of action would be to implement LID in areas targeted to yield the greatest CSO abatement for the District. Given the urgency of addressing CSO issues, the top priority targets for LID might well be the current combined sewer areas in Northwest and Northeast D.C. Once these initial target zones were partially fitted with LID, cumulative observation of runoff data would inform the next step of the adaptive strategy with two possible outcomes:

1. LID is effective by itself in resolving the CSO problem. Runoff during wet weather events is no longer significant in causing sewer overflows.
2. LID is only partially effective. To complete the solution, a more capital intensive centralized solution is required, such as a tunnel.

Step 3 – In the event that LID is only partially effective, proceed with construction of one or more tunnels. Employing LID followed by a period of monitoring would establish a baseline for the ability of LID to handle runoff. It would allow time to decide what the capacity parameters of a tunnel would need to be, based on up-to-date information, which the LTCP is currently missing.

PARTIAL ADAPTIVE MANAGEMENT

The fully adaptive management approach risks that initial efforts (real time controls and LID) may be inadequate to achieve water quality objectives. A way of minimizing this risk would be to adopt an approach that might be labeled "partial adaptive management." Under this approach, WASA would proceed directly to construct the Anacostia tunnel. With 17 outfalls on the Anacostia River, such a tunnel would reduce predicted CSO events from 75 to 4, dramatically curtailing the volume of raw sewage flow that otherwise would pollute the river. The Anacostia has the greatest need for urgent action because it bears the majority of raw sewage dumped into the three receiving waters. By building at least one tunnel, WASA would likely avoid any EPA permit liability for not implementing an aggressive CSO control strategy for the Anacostia River.

Simultaneously, the existing system could be improved and LID implemented throughout the District. Depending on the results, tunnels for the Potomac River and Rock Creek might not be necessary. If additional tunnels were needed, the environmental impact of delayed mitigation of CSOs on these waterbodies would be considerably less damaging, relative to the Anacostia's burdens.

OVERVIEW OF CHAPTERS

Chapter 1 of this report provides an overview of the CSO problem in Washington. To address the volume of CSO overflows the District is now in the process of completing a LTCP. EPA's national CSO policy provides a flexible framework within which communities must act to reduce their overflows. The policy's objective is to improve water quality without mandating specific technologies. Instead, it recognizes the site-specific nature of CSOs and leaves the development of LTCPs to communities.

The federally mandated LTCP, as developed and released by WASA in draft form in June 2001, includes a comprehensive assessment of changes that must be made over the next 20 years to enable the District's rivers to meet water quality standards. The LTCP includes the construction of major storage tunnels and related facilities that would cost more than $1 billion. Significant benefits will be seen from CSO remediation both for human health and the rivers of the area.

However, while CSOs are a main source of pollutants to the Anacostia River, the Potomac River and Rock Creek, they are only a part of the total pollutant load. Major portions of the pollutants come from upstream sources. To have a significant effect on water quality, the CSO problem must be addressed within the context of wider water quality issues. There are a number of separate arenas in which these issues are being addressed. A lack of coordination between important players is a significant obstacle to the solution of water quality problems in the Washington area, including the CSO problem.

Although the District of Columbia is only now developing a LTCP for CSOs, other cities are further advanced in seeking solutions to this problem. Their experiences may offer valuable lessons for the District, WASA and other relevant stakeholders in formulating a watershed approach to improving water quality. Chapter 2 details the processes, programs and policies that two cities (Portland and Toronto) and one region (Puget Sound) have taken to address sewage and storm water pollution problems. These cities have had to develop new political institutions to provide the coordination required for an integrated consideration of full watershed problems.

Chapter 3 explores opportunities to apply a broader watershed approach to water quality policy and management. The watershed-based comprehensive analysis provided by EPA's Total Maximum Daily Load (TMDL) procedures and the broad coordination frameworks developed under the 2001 Anacostia Watershed Restoration Agreement and the Bay-wide Chesapeake 2000 Agreement are highlighted as important arenas that support the watershed approach. Coordination between the main players in the LTCP planning process is noted, however, greater coordination is needed. Finally, opportunities for greater citizen and organizational participation are also stressed.

Reduction of CSOs can be achieved by improvement of the operation of the existing combined sewer system as by building new infrastructure, such as storage tunnels. These alternatives are described in Chapter 4.

WASA's LTCP focuses largely on "end of pipe" solutions, specifically targeted at reducing combined sewage overflows through building new tunnels. Chapter 5 looks at low impact development (LID) as an innovative and cost-effective way to address CSO and storm water pollution. LID is a decentralized approach to storm water management that focuses on capturing rainwater at the source to reduce the volume of storm water flowing into the sewer system and discharging into local waterbodies. LID includes rain gardens, grass swales, greening roofs, tree boxes, and other methods that encourage infiltration and reduce storm water runoff.

While the theoretical concept behind LID is familiar, practical applications have been limited to date. As a result, it is difficult to estimate the precise effectiveness of LID in terms of the volume of storm water reduced, its long-term applicability and the cumulative long-term costs of implementation on a citywide scale. Funding for LID also poses a significant hurdle, as this approach is much different from centralized infrastructure projects. As LID projects have no (or low) asset value, it is more difficult to float bonds to finance these projects. Instead of neglecting LID, the D.C. government, Maryland and the EPA should move aggressively to explore its potential. They should invest in one or more LID demonstration projects. If the LID approach proves successful, stakeholders could save a sizable amount of money by using a greater application of LID practices.

Chapter 6 examines alternatives for achieving watershed management in the District's waterbodies and makes recommendations for how comprehensive watershed and adaptive management within the District and surrounding jurisdictions might take shape. A new Anacostia Watershed Management Authority is recommended. This Authority would act as a steering authority for all water resource management activities – including CSO control, storm water management, habitat restoration, and recreational usage. This unprecedented opportunity for leadership in actualizing watershed management could serve as a role model for the nation, and simultaneously achieve water quality standards for the District.

Glossary of Acronyms and Abbreviations

ANC	Advisory Neighborhood Councils
AWMA	Anacostia Watershed Management Authority
AWRC	Anacostia Watershed Restoration Committee
AWTA	Anacostia Watershed Toxics Alliance
BOD	Biochemical Oxygen Demand
CBP	Chesapeake Bay Program
COE	Army Corps of Engineers
COG	Metropolitan Washington Council of Governments
CRP	Clean River Plan
CWA	Clean Water Act
DCWQS	DC Water Quality Standards
DOH	Department of Health
EPA	Environmental Protection Agency
GIS	Geographic Information Systems
LID	Low Impact Development
LTCP	Long-Term Control Plan
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NPV	Net Present Value
O&M	Operating & Maintenance
PSWQ	Puget Sound Water Quality
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
WASA	Water and Sewer Authority

Chapter 1

The CSO Problem in Washington, D.C.

A combined sewer system consists of sewers that carry both storm water runoff and raw sanitary sewage. Normally, a combined sewer system transports the storm water and human waste together to a treatment plant (Blue Plains Wastewater Treatment Plant in the case of Washington, D.C.). In addition to human waste, these overflows also contain debris from streets and toxic materials. However, problems occur when rain events overwhelm the volume of wastewater that either the sewer lines or the treatment plant are able to process in a given time period. At that point, the wastewater must be redirected from sewage lines directly into the rivers and streams of Washington. Across the nation, there are 40,000 combined sewer overflow (CSO) events each year. Within Washington, D.C., millions of gallons of raw sewage spill each year into the Potomac and Anacostia Rivers and Rock Creek from CSO outfalls.

About one-third of the area of Washington, D.C. is served by a combined sewer system dating back to the late nineteenth and early twentieth century. The remaining two-thirds has a separated system with different sewage lines for sanitary sewage and storm water. Both the combined and separated systems are significant sources of pollution in Washington's rivers. A sense of urgency for addressing the CSO issue comes from the visible nature of raw sewage discharged from the CSOs and the added insult of flooding sometimes caused by CSOs, such as those experienced August 10-12, 2001.

The pollution caused by CSOs has numerous negative consequences on the District's water quality. The pollutants carried by storm water and added to CSOs are dangerous to humans and animals and make the water unsuitable for recreation. The pollutants may include: sediments, toxic chemicals (including cyanide, phenolics and trychloroethlene), metals (zinc, copper, lead), oxygen-depleting chemicals, fecal coliform, oil and grease, pesticides and fertilizers, and trash. There is a direct correlation between this pollution and impacts on human health. A case study in Santa Monica Bay in California found that the incidence of gastrointestinal illness went up by 111 percent from swimming near a flowing storm drain.

The District of Columbia Water and Sewer Authority (WASA) estimates the number of overflow events and volumes for the average year based on a representative three-year period. The three-year period selected was 1988, 1989 and 1990 – a relatively wet year, a relatively dry year and an average year. Table 1-1 indicates the predicted CSO volumes and events per year, based on these three years.

The D.C. Department of Health (DOH) classifies the District's waterbodies based on current use and designated use. All waters in the District with the exception of Hickey Run, Watts Branch, and the wetlands, are designated as Class A waterbodies (free from all discharges of untreated sewage). Due in part to CSO problems, all the waterbodies in the District are classified as Class B or lower, indicating that these waterbodies are to be used at best for secondary contact recreation.

The District government invested $35 million in the initial efforts at CSO abatement (between 1988 and 1990). This included control measures such as 12 inflatable dams in the collection system and a swirl concentrator facility near RFK Stadium. However, this effort did not yield the desired results, due to lack of maintenance and other operational problems. The District is now in the process of completing a Long Term Control Plan (LTCP) to reduce the volume of CSO outflows. The federally

Table 1-1: Overflow Volumes and Number of Events

	Anacostia	Potomac	Rock Creek	Total
CSO Overflow Volume (mil. gall./yr)	2,142	1,063	49	3,254
Number of Overflows/yr	75	74	30	179

mandated LTCP includes a comprehensive assessment of changes that must be made over the next 20 years to bring the District's rivers up to water quality standards. Significant benefits accrue from CSO remediation both for human health and the rivers of the area. However, the LTCP also shows that unless storm water and upstream nutrient loads from separated systems in the District, Maryland and Virginia are also reduced, the District's water quality standards will not be met.

THE CLEAN WATER ACT

The statutory framework for clean water policy – including the cleanup of CSOs – is provided by the Clean Water Act (CWA) of 1972 (amended in 1977 and 1987). The Act put primary responsibility in the hands of the Environmental Protection Agency (EPA) to establish effluent limits for source categories and to issue and enforce terms of permits to individual dischargers. If a state (or the government of the District of Columbia) has an approved program, the state can take over this responsibility. The CWA set a goal to achieve "fishable and swimmable" waters by 1983 and then to eliminate all discharges of pollutants by 1985. Although subsequent amendments in 1977 and 1987 postponed these deadlines, the "fishable and swimmable" standard remains a national policy objective. Moving beyond this specifically human perspective on water use, the 1977 amendments gave increasing emphasis to "the protection and propagation of a balanced population of shellfish, fish, and wildlife in the establishment of effluent limitations."

As a means of reaching the described objectives, the CWA led to the creation and enforcement of technology-based effluent standards, referred to as effluent limitations. Since production processes differ considerably between industries, individual discharge standards have had to be developed for each of them. Actual application of effluent limitations is subject to economic considerations, i.e. they must be applicable "at reasonable cost." With the imprecision of the language – "best available" and "reasonable cost" are not objective terms – it is difficult to combine the technological and the economic aspects in defining effluent standards in practice. Inherently, this gives some interpretative freedom to the EPA officials charged with the development of technology-based standards.

Pollution from major "point sources" is regulated and permitted under the National Pollutant Discharge Elimination System (NPDES) of the CWA. Section 402(a) specifically requires NPDES permits to provide for the attainment of water quality standards. To date, EPA has authorized 44 states and one territory to administer the NPDES program. EPA, through its regional offices, remains the permitting authority for the remaining six states and the District of Columbia. In contrast to permitted sites, "non-point sources" enter surface and/or groundwater in a diffuse manner, typically depending on weather conditions. Flows from agricultural fields and urban storm water run-off are the two most important sources of non-point pollution. In many water bodies, non-point sources are the primary cause of current pollution problems. The District is required to address both point (CSOs) and non-point sources (storm water) of pollution.

D.C. WATER QUALITY STANDARDS

The District's Water Quality Standards (DCWQS) call for the Anacostia and Potomac Rivers and Rock Creek to meet the designated Class A standard of fishable-swimmable. Even though the rivers are only at a current use of Class B or less because of elevated bacteria levels, the EPA found that the rivers still support wildlife. The species found in the rivers today however, are limited to adapters and extremophiles that can survive harsh conditions, a sliver of the historical biodiversity that once flourished.

Table 1-2 shows the current and designated uses of the Potomac and Anacostia Rivers and Rock Creek as classified by DOH.

CURRENT CSO POLICIES

The Role of EPA. EPA headquarters provides guidance documents and a variety of funding options for CSO-related projects. In the case of the District, EPA's Region 3 generally substitutes for the normal role of a state government, and in this case oversees CSO policy and reviews the submitted LTCP. EPA's national CSO policy provides a flexible framework within which communities must act to reduce their overflows. The policy's objective is to improve water quality without mandat-

Table 1-2: Waterbody Classifications in the District

Surface Water	Current Use	Designated Use
Anacostia River	B, C, D, E	A, B, C, D, E
Potomac River	B, C, D, E	A, B, C, D, E
Rock Creek	B, C, D, E	A, B, C, D, E

Surface Water Categories of Uses Which Determine Water Quality Standards

Category	Use
A	Primary contact recreation
B	Secondary contact recreation and aquatic enjoyment
C	Protection and propagation of fish, shellfish and wildlife
D	Protection of human health related to consumption of fish & shellfish
E	Navigation

ing specific technologies. Instead, it recognizes the site-specific nature of CSOs and leaves the development of an LTCP to communities. CSOs are considered point sources; therefore they are subject to the technology and water quality based requirements of the CWA.

The regulation of CSOs goes back to 1989, when EPA published the National CSO Control Strategy. States developed CSO strategies, and, if reviewed favorably, EPA approved them. After a period of dialogue with key stakeholders, the agency issued a revised CSO Control Policy in 1994. This policy became law with the passage of the Wet Weather Water Quality Act of 2000. The 1994 Policy provided guidance for planning, selecting and implementing CSO controls and ways to involve the public during the decision-making process. The policy established objectives for CSO communities and expectations for the application of NPDES requirements to CSOs. It allowed a phased approach to implementation, taking into account a community's financial capabilities.

In order to receive an NPDES permit, communities were required to implement and document "Nine Minimum Controls" (i.e., regular maintenance, including minor construction) no later than January 1, 1997. In addition, their LTCP must, among other things, include an evaluation of controls necessary to achieve a range of overflow events from zero to twelve per year, and take factors such as cost, reliability and operability of controls into account.

According to the CSO Control Policy, one of two possible approaches could be chosen in developing a LTCP. The first is to follow the "presumption approach." Certain performance criteria (i.e., four to six untreated overflow events or 85 percent capture by volume) would be presumed to provide an adequate level of control to meet water quality standards and demonstrate the effectiveness of their plan. Alternatively, by choosing the "demonstration approach," a CSO community would have to reduce CSO discharges to a level that would be sufficient to meet applicable water quality standards. Moreover, regardless of the approach chosen, LTCPs must contain a post-construction monitoring program to verify compliance with water quality standards and protection of designated uses as well as to ascertain the effectiveness of CSO controls.

Guidance. EPA provides guidance for the implementation of CSO controls in a number of documents, which cover technical, financial and permitting issues; they include, among other things, the "Guidance for Long-Term Control Plans." In this document, EPA recommends a detailed, nine-tiered planning approach for the LTCP that includes a public participation process, encourages permittees to evaluate water pollution control needs on a watershed management basis, and to coordinate CSO control efforts with other point and non-point source control activities.

One of the latest guidance documents released by EPA concerns the review of water quality standards as part of the LTCP process.[1] When developing an LTCP, a community is required to review and – where appropriate – revise water quality standards. This review contains a use attainability analysis, which is a "structured scientific assessment of the chemical, biological, and economic condition in a waterway" to determine whether currently enforceable water quality standards can be reached and whether justification for reclassification exists. States have considerable discretion to design water quality standards according to their particular climatic, hydrologic and seasonal conditions.

This is of particular importance because a "revision as appropriate" essentially means adjusting the ultimate goal to be reached. When talking to people within EPA, many point to this review as a way out of the above mentioned impediments to reaching water quality. Originally urged by Congress to provide more guidance on the review, EPA staff takes a position that can also be heard from others involved in D.C.'s LTCP implementation, including the Office of Management and Budget, which traditionally stresses a balance between cost and benefits and is more likely to favor an adjustment of goals rather than very high spending for the means. The LTCP found that reducing the CSOs to zero outflows per year was economically infeasible and there have been proposals to lower the DCWQS to allow for a set number of CSO discharges per year. However, environmental organizations are generally opposed to lowering the water quality standards and will have considerable influence on any final policy outcome

Separated Sewer System Regulation. In addition to the policy targeting CSOs outlined here, EPA regulates storm water in separated sewer areas. Under the NPDES Storm water Program of the CWA section 402(p), operators of Municipal Separate Storm Sewer Systems (MS4) require authorization to discharge pollutants into waterbodies. Operators have to submit comprehensive permit applications and are issued individual permits for each outfall. Phase I of the program, which started in 1990, required municipalities to obtain the NPDES permit and to develop a storm water management program designed to prevent harmful pollutants from being washed by storm water run-off into the MS4 area. The program included measures to identify major outfalls and pollutant loadings; detect and eliminate non-storm water discharges to the system; reduce runoff pollutants from industrial, commercial, and residential areas; and control storm water discharges from new development and redevelopment areas.

Legally, EPA treats non-point sources in a different manner from point sources. Moreover, non-point sources cover a broad range of sources including urban runoff. In practice, due to statutory differences, EPA deals with the two forms of sources in two distinct offices within its Office of Water. The Office of Wastewater Management handles point-source programs like the NPDES program, while non-point sources are the responsibility of the Office of Wetlands, Oceans, and Watersheds.

The District's LTCP. The District's Water and Sewer Authority is the lead agency for coordination of CSO control. The agency submitted a draft LTCP in June 2001. Based on EPA regulatory requirements, the conditions of the three waterbodies most affected by CSOs, financial capabilities, and other factors, the WASA plan proposed:

- System-wide low impact development retrofit;
- Rehabilitate the Main and O Street and Potomac pumping stations;
- Construct storage tunnels at the Northeast Boundary, along the Potomac in Georgetown, and at Piney Branch in Northwest;
- Separate sanitary and storm water for Luzon Valley; and
- Increased monitoring.

Following the "presumption approach" of the CSO Control Policy described above, the controls proposed

[1] EPA also offers a comprehensive guidance document concerning the models needed for simulating CSOs and their impacts on water quality. This document gives an overview of existing commercial and public domain models; some of the latter are available from EPA's Office of Research and Development. From WASA's point of view, the guidance has been helpful in preparing DC's LTCP. Even more important was the experience from other CSO communities in the past – some of which will be described in Chapter 2 of this report.

In addition to providing guidance documents, EPA has sponsored and conducted more than 15 workshops and seminars on various aspects of implementation of the CSO Control Policy. These courses are designed for dischargers, permit writers and other interested parties. The real challenge so far has been to get elected officials into these seminars to sensitize them for the CSO problems their communities have to deal with.

in this draft LTCP would lead to an overall 92 percent reduction in CSO volume. By receiving water, the number of overflow events drops from 75 to 4 per year in the Anacostia River, from 74 to 12 for the Potomac River, and from 30 to 4 in Rock Creek. Bacteria levels would be somewhat lower, dissolved oxygen higher; and trash from CSOs practically eliminated. The LTCP would also provide flood relief in the Northeast Boundary Area.

However, even with these CSO controls in place, other pollution sources would still prevent the District from meeting water quality standards (i.e., fishable-swimmable) much of the time. Following full implementation of the LTCP CSO program, safe levels for fecal coliform bacteria would still be exceeded 183 days/year in the Anacostia, 112 days/year in the Potomac and 294 days/year in Rock Creek. Upstream sources in Maryland and Virginia, and storm water from D.C.'s separate sewer will prevent the rivers from meeting water quality standards.

The LTCP proposed by WASA includes the construction of major storage tunnels and related facilities that would cost $1.1 billion. Implementation of the measures outlined in the LTCP would considerably increase costs to WASA's residential customers. The proposed construction would take place over a period of 20 years with work done at the Anacostia (years 5 to 13 after start), Rock Creek (years 14 to 18), and the Potomac (years 15 to 20). At present, WASA is considering compiled public comments and developing the final LTCP due to be completed in mid-2002.

On a much smaller scale ($3 million), the LTCP also contains proposals for low impact development (LID) retrofit measures that are designed to limit the volume of storm water at the source. LID practices rely on natural processes, such as the use of soil and vegetation to retain, detain, and treat contaminated storm water runoff. During the public comment period for the draft LTCP (which ended Fall 2001),over two thousand people submitted more than 400 comments (many duplicates). These comments suggested that a more thorough evaluation of the costs and benefits from LID at various application levels, and the possible expanded funding of LID could potentially benefit the CSO control plan.

POTENTIAL FUNDING SOURCES

Covering the full costs of the CSO program would impose a significant financial burden on sewer system users and the District government. Money from EPA for CSO-related projects is available through five distinct channels: the Clean Water State Revolving Loan Fund (SRF), specific line items in EPA's budget, Section 106 Water Pollution Control Program Support Grants, Section 104 Water Quality Cooperative Agreements, and the Section 319 Non-point Source Program. Table 1-3 shows money spent for projects nationwide through the first three programs between 1994 and 2001.

State Revolving Loan Funds. SRF programs are operating in all 50 states and Puerto Rico. States provide independent and permanent sources of low-cost financing for a range of water quality infrastructure projects, including CSO control and abatement projects; this money is then matched by federal funds. For the District of Columbia, which is not classified as a state, the SRF program is treated as a grant rather than a revolving loan. In nearly all years, SRF loans have represented the biggest annual inflow of money for CSO controls – $410 million in 2000.

Congressional Appropriations. Congress could appropriate money directly for a wide range of CSO control projects including sewer separation or tunnel storage as line items in EPA's annual budget. Unfortunately, after relatively high appropriations in 1994 and 1995, line item appropriations have played a much smaller role, with only $33 million in 2000, a situation not likely to change in the present administration.

Water Pollution Control Program Support Grants. As a third potential source of CSO funding for D.C., Section 106 Water Pollution Control Program Support Grants, can be given to states, tribes and the District of Columbia. Grants are designed to help agencies that administer programs related to water pollution. Since EPA does not require states to report on how Section 106 funds are used, the share allocated exclusively to CSO problems cannot be tracked. The total money spent per year has more than doubled in past years.

Table 1-3: EPA Funding Mechanisms for CSO Projects ($millions)								
Funding option	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
SRF Loans for CSO projects	245	191	168	140	158	273	411	n/a
Annual EPA budget Line items for CSO control projects	155	212	13	23	34	43	33	n/a
Annual Section 106 Grant Totals (CSO share unknown)	82	80	80	81	96	116	116	170

Section 319 of the Clean Water Act. In contradiction to the four point-source programs mentioned above, this is a non-point source program. It authorizes EPA to issue grants to States as well as the District of Columbia to assist them in implementing non-point source management programs or portions of management programs. Since water that has already entered the sewage system is considered to be a point source in the context of CSOs, Section 319 grants can only be used for storm water management practices such as LID techniques. These techniques seek to reduce the amount of water entering the sewer in the first place. Section 319 money cannot be used for "end-of-pipe" solutions such as building storage tunnels. Due to increasing attention to non-point source pollution in general, Section 319 appropriations have more than doubled since 1998, as shown in Table 1-4.

Table 1-4: Section 319 Non-Point Source Grants to States ($millions)				
	1998	**1999**	**2000**	**2001**
Grant Amount	105	200	200	238

[2] Under authority of CWA Section 104(b)(3), EPA also gives grants to state water pollution control agencies, nonprofit institutions, and individuals to prevent and reduce water pollution. Projects funded through this channel must be somewhat novel; ongoing programs or administrative activities do not qualify. Among the efforts eligible for funding under this program are research, environmental technology demonstrations, surveys, and studies related to pollution. From 1998 - 2000, $19 million has been appropriated annually for the total of all Section 104 projects. Past activities associated with CSO abatement and control were considerably less expensive than those financed through the other programs mentioned above; from 1998 - 2000, they totaled $2.5 million.

Funding for an LID project would, in principle, also be possible through a congressional line item appropriation. But as one EPA official in the non-point source branch put it, he could not envision EPA's Administrator going to Congress to ask for a considerable amount of money for LID. Although EPA "does not promote enormous tunnels," it omits a funding mechanism designated explicitly for smaller scale, decentralized projects. To some extent, this can be explained by the fact that EPA wrote its guidance for CSO funding options in 1995 when small-scale approaches like LID were not as much a part of the CSO discussion as they are now. Some within the Agency, however, do acknowledge a real lack of coordination between the NPDES branch and the non-point source branch.

CSO CONTROLS ARE NOT ENOUGH

The LTCP for CSOs, as developed by WASA, is designed to bring the District's waters up to current water quality standards. The preliminary study by WASA for the draft LTCP considered options ranging from complete separation of the city's sewer system to implementing no controls at all. The study found that complete separation of the sewer system leading to total elimination of CSOs was not economically feasible. The report expressed the additional concern that, if the system were separated, untreated storm water (carrying suspended solids, toxins, and other pollutants) would flow directly into receiving waters, rather than first receiving treatment at the Blue Plains facility (LTCP, 13-5).

WASA considers the LTCP the most technically and economically feasible plan for reduction of CSOs. As shown in Table 1-5, the LTCP would drastically reduce both the number of overflow events and the total volume of overflows. In the case of the Anacostia River, CSO volumes would decline by over 95 per-

Table 1-5: LTCP Wet Weather Water Quality Conditions			
Number of Annual Overflow Events, Select Locations			
	Anacostia River	**Potomac River**	**Rock Creek**
Location	Navy Yard	Mem. Bridge	Zoo
No Phase I Controls	75	74	30
After Completion LTCP	4	12	4
Annual Overflow Volume (mg/yr), All Outfalls in the Three Waterbodies			
No Phase I Controls	2142	1063	49
After Completion LTCP	96	157	11
Percent Reduction	95.5%	85%	78%

Source: WASA Draft LTCP, 2001, page 12-21

cent after implementation of the LTCP's proposed measures.

Table 1-6 shows the impact of the recommended LTCP would have on levels of *E. coli* in the District's waterbodies. *E. coli* is considered a good indicator of the level of bacterial contamination in water systems. The predicted reduction in CSO discharges, along with a significant reduction in upstream nutrient loading (approximately 40 percent reduction), could result in only a few days of elevated bacteria levels for each water system. Nonetheless, CSO controls alone do not exhibit the same level of beneficial effects.

Without additional controls to reduce storm water and upstream nutrient loads, the District's rivers will remain out of compliance with water quality standards for much of the year. Table 1-6 illustrates how important storm water treatment is to a meaningful decline in *E. coli* levels. In ignoring storm water problems as the LTCP does presently, bacterial contamination would exceed acceptable levels in the Anacostia on as many as 289 days out of the year. In Rock Creek, the full implementation of the LTCP would limit elevated *E. coli* levels to four days per year, given no other sources of *E. coli*. However, when existing storm water flows are introduced into the equation, the number of days with elevated levels of *E. coli* reaches 331 to 365 per year – even with the full implementation of the LCTP for CSOs. This deficiency brings into question the

Table 1-6: Number of Days That *E. coli* Levels Will Exceed 126/100 mL			
	Anacostia	**Potomac**	**Rock Creek**
Predicted number of CSO events per year with LTCP in place	4	12	4
Predicted number of days with excessive E. Coli levels with CSO controls (CSO loads only, no other loads present)[1,2]	1-18	0-5	0-3
Predicted number of days with excessive E. Coli levels with CSO controls (no change in storm water or upstream loads)	18-289	12-115	331-365
Predicted number of days with excessive E. Coli levelswith storm water and upstream nutrient loads reduced by 40%.	7-128	2-10	4 at DC/MD Boundary 168-173 Rest of River

1 Numbers taken from LTCP appendices. Levels of CSO events used are the LTCP proposed optimal level of control for CSOs. Anacostia—4 events per year, Potomac—12 events per year, Rock Creek—4 events per year. The LTCP lists predicted values for all possible levels of CSO control

2 Range of values given indicates the different number of days predicted for different locations along the rivers. See LTCP for numbers for specific locations.

Source: WASA Draft LTCP, Appendices B, C, D effectiveness of CSO control in managing the important water quality parameter of bacterial contamination.

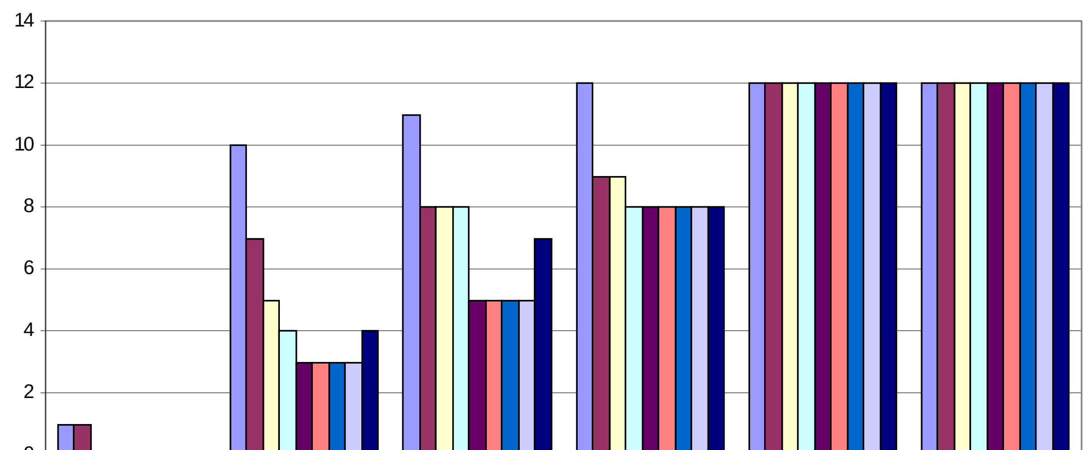
In short, implementation of CSO controls alone falls far short of the measures necessary to meet the D.C. water quality standards for the Anacostia and Potomac Rivers and Rock Creek. Control of upstream storm water loading remains central to reducing bacteria levels in D.C. waters. As a single element – not taken in concert with other watershed management measures – the LTCP's CSO control proposals do not appear to offer a sound solution to lowering bacterial pollution in D.C.'s waters. As such, communication and partnering with upstream authorities (including Maryland, Virginia, and West Virginia) are necessary in establishing a successful water quality management plan for the District.

As a further example of the pervasive impact of storm water on the river systems, Figure 1-1 provides additional details concerning the limited effects of CSO controls on the Anacostia River – in the absence of any accompanying change in storm water or upstream loads. At the District/Maryland border, *E. coli* levels will be unacceptable for 12 months of the year independent of any actions with respect to CSOs. At RFK Stadium, unacceptable levels of *E. coli* will exist for eight months or more per year – again independent of any decrease in CSOs. Without action to address storm water pollutant loads, other sites have similarly unacceptable water quality outcomes, despite the CSO strategy taken. Overall, none of the options concerning CSO control makes an appreciable difference by itself with respect to the ability to meet *E. coli* standards in the Anacostia River. It is only at Haines Point, where the Anacostia and Potomac merge, that implementation of CSO controls alone are potentially capable of bringing water quality into an acceptable range.

Figure 1-2 shows a much different outcome under the assumption that upstream reductions in storm water flows and associated pollutant loads can be achieved.

Figure 1-1: Effect of CSO Control on Fecal Coliform Concentrations (No Change in Upstream or Storm Water Loads)

E. coli -- # of Months Exceeding 126/100 mL



	Haines Point	South Capitol St.	Navy Yard	RFK Stadium	DC/MD Boundary	Confluence NE & NW Branch
No Phase 1 Controls	1	10	11	12	12	12
Phase 1 Controls	1	7	8	9	12	12
Pump Sta. Rehab.	0	5	8	9	12	12
12 Overflows/yr	0	4	8	8	12	12
8 Overflows/yr	0	3	5	8	12	12
4 Overflows/yr	0	3	5	8	12	12
2 Overflows/yr	0	3	5	8	12	12
0 Overflows/yr	0	3	5	8	12	12
Separation	0	4	7	8	12	12

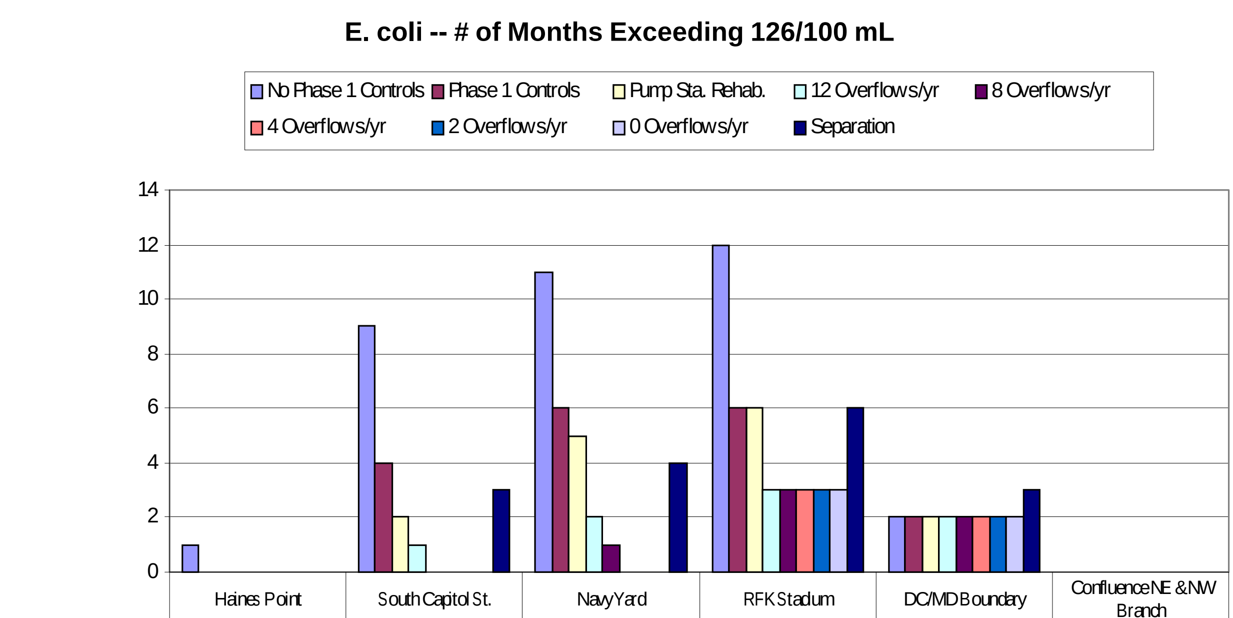
Source: DC WASA Draft LTCP, 2001, Appendix B

At the Maryland/District border, the number of months with unacceptable levels of *E. coli* drops from 12 to 2 months per year. At RFK Stadium, the combination of storm water controls and reductions in CSOs can bring water quality into the acceptable range for nine months of the year. Without the storm water controls, however, the ideal CSO strategy would achieve acceptable water quality at RFK during only four months per year.

Figures 1-1 and 1-2 are adapted directly from the most recent LTCP draft, and are thus representative of results modeled by WASA for all three waterbodies. Information is also available in the LTCP for the water quality measures of fecal coliform and dissolved oxygen. The results of modeling analyses for these measures of water quality show similar outcomes— significant decreases in pollutant loads when upstream storm water is reduced, but minimal effects from reductions in CSOs alone.

The bottom line is that, unless steps are taken to reduce pollution brought to the rivers by storm water runoff and upstream sources, the Potomac and Anacostia Rivers and Rock Creek will continually fail to meet D.C. water quality standards. Washington and the surrounding metro area must work together in order to truly improve water quality. Multi-state agreements such as the Chesapeake Bay Agreement can provide guidance for a wider watershed approach to controlling the health of these rivers. Some reduction in pollutants can result from implementation of the LTCP measures alone. Until a more broad agreement is created to serve as a legitimate stimulus for concerted action, it will be difficult if not impossible to restore the District's waters to full health.

Figure 1-2: Effect of CSO Control on Fecal Coliform Concentrations (Including Upstream and Storm Water Load Reductions



	Haines Point	South Capitol St.	Navy Yard	RFK Stadium	DC/MD Boundary	Confluence NE & NW Branch
No Phase 1 Controls	1	9	11	12	2	0
Phase 1 Controls	0	4	6	6	2	0
Pump Sta Rehab.	0	2	5	6	2	0
12 Overflows/yr	0	1	2	3	2	0
8 Overflows/yr	0	0	1	3	2	0
4 Overflows/yr	0	0	0	3	2	0
2 Overflows/yr	0	0	0	3	2	0
0 Overflows/yr	0	0	0	3	2	0
Separation	0	3	4	6	3	0

Source: DC WASA Draft LTCP, 2001, Appendix B

Chapter 2

Lessons from Toronto, Portland, and the Seattle Area

Although the District of Columbia is only now developing a LTCP for CSOs, other cities are much farther advanced in seeking solutions to this problem. Their experiences may offer valuable lessons for the District and WASA. Some of them, for example, have already had considerable experience with LID and may be able to address some of the major uncertainties perceived about LID by D.C. water quality planners. The District is not unique in being only a small part of a larger watershed containing many separate jurisdictions. In the case of D.C., like many other places, the watershed extends across state borders. This multi-jurisdictional aspect, as well as the high cost of water quality initiatives, necessitates strong cooperation between federal, state and local agencies.

This chapter details the processes, programs and policies that two cities (Portland and Toronto) and one region (the Puget Sound near Seattle) have taken to address water pollution.

TORONTO OVERVIEW

Toronto is located in a watershed that is approximately 2,092 square kilometers. Thirty-one percent of the watershed falls within the boundaries of the city; the rest lies within surrounding municipalities. The area has been divided into four sub-watershed areas, the combined sewer area, and the waterfront. Toronto experiences approximately 80 combined sewer overflow events per year and is in the process of finalizing its "Wet Weather Flow Management Master Plan" (WWFMMP), a partnership between agencies, the public and the city to improve the water quality of local rivers and Lake Ontario.

The WWFMMP was initiated in the fall of 1997. A Steering Committee was created to guide this process and included representatives from the Toronto Region Conservation Authority, the Ministry of Environment, the Waterfront Regeneration Trust, the Toronto municipalities, various citizen groups and members of the public. The main objectives of the plan were to: (1) develop an integrated plan for wet weather flow management based on a holistic/ecosystem based approach; (2) establish strong linkages and cohesiveness among Toronto and neighboring municipalities and agencies; (3) develop procedures, policies, and by-laws to direct municipal action to deliver the wet weather management goal; and (4) establish priorities for improvement works and other action to be undertaken on a city-wide basis.

The WWFMMP is being developed in a four-step process. Step one (completed December 1998) entailed collecting data on environmental conditions and developing a vision, goal and objectives to guide the planning process. Step two (currently underway) will culminate with the development of the WWFMMP, which will include by-laws, policies, projects, programs, a monitoring program, an implementation plan and funding mechanisms. Step three will focus on implementation, and step four will monitor the effectiveness of the plan and update it as needed.

PORTLAND OVERVIEW

Portland, Oregon is located on the Willamette River and is a part of the urban watershed of Johnson Creek, the Columbia Slough, Tryon Creek, Fanno Creek and Balch Creek. Combined sewers serve about 35 percent of the city's area, and 60 percent of the population, with 55 outfalls currently discharging approximately 3 billion gallons per year. During a three-year review of the CSO plan, Portland developed its Clean River Plan (CRP) after coming to the conclusion that "[CSOs were] only one factor in protecting and preserving the Willamette."

Faced with severe pollution in the Willamette River, poor watershed health and the loss of habitat for endangered salmon, Portland developed the Clean River Plan as a comprehensive approach to improve water quality.

The Clean River Plan aims at restoring native vegetation along creeks and streams, floodplain function, fish and wildlife habitat, water quality and controlling erosion with ten specific actions.

SEATTLE AREA (PUGET SOUND BASIN) OVERVIEW

The Puget Sound is an estuary, located in northwest Washington state and British Columbia, Canada, where salt water from the ocean mixes with fresh water that falls as precipitation, or drains from the surrounding area. More than 10,000 streams and rivers drain into the Sound and nearly 85 percent of the basin's annual surface water runoff comes from 10 rivers. The Puget Sound basin covers more than 16,000 square miles, home to almost 4 million people in the state of Washington.

During the 1970s and 1980s there was increasing concern about the deterioration of the Puget Sound, and by the mid-1980s there was general agreement that better coordination among agencies responsible for water quality was needed. In 1985, the Washington State Legislature created the Puget Sound Water Quality Authority (PSWQA) to develop and oversee the implementation of a management plan for the basin. The first PSWQ Management Plan was developed in 1987. In that same year the U.S. Congress established the National Estuary Program under Section 320 of the Clean Water Act. EPA approved the management plan as the Comprehensive Conservation and Management Plan for the basin in 1991. In 1996, the authorizing legislation expired and the State legislature enacted the PSWQ Protection Act that established the PSWQ Action Team and the Puget Sound Council to periodically review and update the management plan.

The PSWQ Management Plan is Washington's long-term strategy for protecting and restoring Puget Sound. It provides the framework for managing and protecting the Sound, and coordinates the roles and responsibilities of federal, state, tribal and local governments. In total 122 cities and counties are involved in implementing the management plan. At the core of the management plan lie three main goals: (1) preserving and restoring wetlands and aquatic habitats and the natural processes and functions that created them; (2) preventing increases in the introduction of pollutants to the Sound and its watersheds; and (3) reducing and ultimately eliminating harm from the entry of pollutants to the waters, sediments and shorelines of Puget Sound. Large in scope, the management plan applies an ecosystem approach on a watershed scale to improving water quality in the Sound,, and views prevention as the low-cost and logical management strategy.

DEFINING THE PROBLEM: BEYOND CSO TO WATER QUALITY

These three case studies were largely chosen because they all share the development of policies that expand the scope of CSO control to include a watershed approach to improving water quality and managing storm water. A stronger emphasis is placed on source control, seeking to first manage storm water runoff, rather than focusing exclusively on end-of-pipe solutions. This is not to say that end-of-pipe solutions such as tunnels, storage tanks and treatment plants are not considered, but rather, that efforts are being made to manage storm water runoff with the ultimate goal of improving water quality and also eliminating/reducing CSO events. Finally, these uses also consider the role of land use decisions on water quality—a key consideration for both new and existing development.

The city of Portland is a good example of how an expanded notion of "what's the problem?" has altered policies and shifted priorities. An extensive review of its CSO policy, including analysis on the CSO impact on the Willamette River, drainage and sanitary systems, wastewater treatment, endangered species listing, watershed heath and water quality data, led Portland to revise its position. Urban storm water was identified as a complementary issue to CSOs. In addition to the three-year review of their policy, a shift in emphasis also came from two other sources. First, the National Marine Fisheries Service had added several species of salmon to the list of endangered species and the City Council had sought the restoration of those species. Second, Portland anticipated that the Oregon Department of Environmental Quality would set limits on pollutants entering the Willamette and its tributaries, through the TMDL process.

Portland realized that their CSO program alone would not address key environmental concerns such as restoring native vegetation along creeks and streams, restoring floodplain function and fish and wildlife habitat, decreasing stream temperature, controlling soil and stream channel erosion and restoring the water quality of rivers and creeks. As stated in its Clean River Plan (CRP), "If the City places most of its emphasis on pipes for combined sewer overflows it will not address the needs of fish and wildlife in a timely manner and clean and healthy watersheds will be a distant vision." The CRP shifted attention onto addressing CSO volume by decreasing storm water runoff through such projects as rooftop detention, infiltration, increased tree canopies, reconfigured driveways, parking lots and streets, to provide more pervious and vegetated soil, and routing storm water though constructed wetlands and swales.

Toronto and the Puget Sound region responded similarly with expanded CSO abatement strategies including storm water management. In light of earlier data collection, showing high levels of pollution from urban runoff, Toronto's city staff adopted the philosophy that source control should be considered first, followed by conveyance, then by end-of-pipe solutions. More specifically, this meant that projects should first and foremost try to restore ecosystem integrity by preserving and re-establishing a natural hydrologic cycle and by protecting, enhancing and restoring natural features and functions (e.g. wetlands). Understanding that Toronto is a highly urbanized area and the built environment vastly alters the natural hydrologic cycle, city staff has highlighted the need for projects that mimic natural processes of filtration and infiltration and contain storm water at the source (e.g. rain gardens, eco-roofs, porous pavements, bioretention cells). Whereas the historical trend has been to convey storm water offsite to streams, rivers and lakes, Toronto is changing this paradigm by viewing storm water as a resource—providing beneficial uses such as groundwater replenishment, recreation, and aesthetic purposes.

The PSWQ Management plan was reviewed and the strategies for storm water and CSOs updated to reflect the improved understanding about the critical effect that storm water has on water quality as well as habitat quality. Local governments are now required to develop storm water management plans. The State is responsible for maintaining standards, issuing permits, and providing technical assistance, guidance and training. According to the PSWQ Management Plan, the goal of the storm water and CSO program is "to protect and enhance the health of Puget Sound's aquatic species and habitat, natural hydrology and processes, and water quality, and to achieve standards for water and sediment by managing storm water runoff and reducing combined sewer overflows."

These three examples have shown that defining the problem in terms of improving water quality leads to a more comprehensive and integrated watershed management approach with better promise for tangible results and regulatory compliance. The management plans that emerge from these cases offer a model for the kind of coordination and multi-faceted solutions that are needed to protect and restore the nation's water resources.

INSTITUTIONAL FRAMEWORKS

Policies and programs are most effective when they are place-based, taking into consideration the cultural, budgetary, and environmental conditions of an area. These case studies share similar philosophies for problem definition , and each has established its own institutional framework to set objectives and targets, develop policies and handle coordination efforts.

Steering Committees: The Case of Toronto. In 1997 a Steering Committee was created to guide the process for the development of the wet weather management plan. The Steering Committee acts in an advisory capacity to the Commissioner of Works and Emergency Services and the City of Toronto, including representatives from city, municipal and provincial staff as well as various citizen groups. It develops recommendations to the City Council on the advice of consultants, city staff and the public. The Toronto Region Conservation Authority (TCRA) also sits on the committee and has been an active partner with the City of Toronto in developing the master plan. In addition to providing knowledge, advice and data, TRCA also facilitates dialogue and information exchange with upstream municipalities. Five technical consultant teams have been retained to support the Steering Committee and the City, with each team responsible for developing a plan and strategy for each of the five study areas and the waterfront district.

The Steering Committee also has an official capacity for public outreach in the Public Consultation Secretariat, a key component in the process. The City's Public Consultation and Community Outreach Unit has retained a consultant to assist in the public consultation plan. Public input is also sought through consultation meetings, Internet communication and the WWFMMP newsletter. In order to engage upper watershed municipalities, meetings were held with nearly forty participants from three regional municipalities, seven local municipalities, and the Steering Committee and City staff. The purpose of these meetings was to introduce the WWFMMP and explore opportunities for collaboration. Meetings have also been held with representatives from government agencies including representatives from Environment Canada, the Department of Fisheries and Oceans, and the TRCA.

Centrally Organized Coordination and Delegation: The Case of Portland. Portland's Clean River Plan (CRP) was developed by the Bureau of Environmental Services (BES), the agency that provides the city's wastewater and storm water drainage services and works in the watershed to improve the water quality of rivers and streams. BES had, for some time, assessed the health of watersheds and developed a number of goals and objectives for individual watershed plans. These goals and objectives were then used to develop priorities for programs. Citywide coordination was needed to devise a template through which BES could develop and evaluate strategies in a consistent manner for all watersheds.

The CRP is a set of ten actions that depend on active and strategic cooperation with other governmental and non-governmental organizations. Dozens of agencies, the Willamette Restoration Initiative and numerous watershed councils are involved in this effort. The CRP is integrated with the City's Endangered Species Act programs, the City's storm water permit, the land use planning program and other key planning programs. City bureaus are to work in partnership at the staff, director and commission levels to achieve the action items in the plan. For the storm water management program, the CRP highlights a number of departments that are to consult with one another, including the Department of Transportation, Department of Planning, Parks Department, the Portland Development Corporation and the water bureaus.

BES staff have noted that coordination among the different entities remains one of the largest challenges. This may be the result of the unique commission form of government, which leads to "stovepipe" bureaus and bureau management. The commission form of government differs from most municipal governments because its members (four Commissioners and the Mayor) serve both as the City's legislative body and as administrators of city departments. While Portland's form of government is uncommon, its coordination difficulties are not. Local government departments rarely consult with one another and only tend to focus on specific duties and tasks, rather than the grand scheme.

Regional Water Quality Agreements: The Case of Puget Sound. The PSWQ Management Plan is somewhat different from the cases discussed in Toronto and Portland because it is a regional and state agreement. The plan guides the efforts of a larger number of stakeholders, including state and federal agencies and multiple local and tribal governments. Since 1992, the Puget Sound/Georgia Basin International Task Force has also connected scientists, agencies and policymakers in British Columbia, Canada and Washington State to improve the protection of common waters under the Shared Waters Program.

While the Management Plan has been in effect for the last fifteen years, the State legislature established the PSWQ Action Team, the Puget Sound Council and a governor-appointed chair, who manages both of these, to collectively review and update the management plan. The Action Team works with tribal and local governments, community groups, citizens and businesses as well as state and federal agencies, to develop and carry out two-year work plans that guide the protection of water quality and biological resources. Members of the Action Team are drawn from all levels of government and include the directors of ten state agencies, a city and a county representative, a representative from the federally recognized tribes and non-voting representatives from three federal agencies (including the EPA).

The Puget Sound Council advises the Action Team on work plan priorities and tracks the progress of state and local agencies responsible for implementing the plans. The Council is comprised of twelve members; eight are appointed by the governor and represent agriculture, business, cities, counties, the environmental community, the shellfish industry, and tribal governments, and four members are legislators selected by the leadership of the State Senate and House of Representatives. The Action Team also coordinates the Puget Sound Ambient Monitoring Program, which brings together local, state, tribal and federal agencies to assess trends in environmental quality in the Sound. Local liaisons form the outreach and technical assistance arm of the Action Team by providing governments, citizens, and businesses with tools and information such as model programs and ordinances, education materials and sources of funding.

While these communities and regions all face different environmental circumstances, they all have attempted to create formal capacities for coordination between agencies, different levels of government and the public—working to bring different perspectives together under the rubric of ecosystem management. In addition to better coordination, delineating specific responsibility to different stakeholders is also a step in the right direction towards creating a broad, yet practical strategy. These case studies also suggest that an interdisciplinary and multi-sectoral steering committee or action team can play a pivotal role in planning, such as a watershed management authority (Chapter 6). In the end, implementation at the local level still lends itself to centralized control, with a department such as the Bureau of Environmental Services.

ADAPTIVE MANAGEMENT: CREATING A PROCESS THAT WORKS

Watershed management includes a comprehensive set of policies, regulations and actions that often rely upon collaborative and coordinated actions to meet water quality and ecosystem health goals. However, effective management requires much more than defining the problem and creating institutional capacities to act. It also relies upon a process that is flexible enough to adapt to changing environmental circumstances and program performance and is coherent enough to provide clear direction and assign responsibility. At the outset such a process must include quality data collection that enables policymakers to understand the state of ecosystem health, identify the cadre of agencies and stakeholders that must be involved and propose potential areas for action. Goals are needed to provide the context for targeted action and baseline data is needed to provide benchmarks for performance measurement. The most successful programs involve a continuous process of action, evaluation and prioritization, linked to fundamental objectives and targets.

Adaptive management is defined as a formal systematic program of learning from the outcomes of management actions and allowing outcomes to direct adaptations. Linking management and science to achieve ecological sustainability often involves a team of scientists, managers, policymakers and the public, working to identify problems in quantifiable terms, implementing actions and monitoring changes. All three case studies have successfully used adaptive management strategies.

Establishing Baseline Data. All three case studies have collected extensive background data to help inform the decision-making process. In Toronto, "existing conditions" reports were developed by consulting teams for each subwatershed. They analyzed landform, river structure and stream geomorphology, groundwater, vegetation and wildlife, land use, the storm sewer system, storm water discharge and combined sewer overflows to provide a coherent picture of watershed health. Portland and Seattle followed similar trajectories.

It makes sense for one agency or department to do the data gathering (e.g., Portland's Bureau of Environmental Services). Data gathering is costly. Rather than starting from scratch and collecting data all at once, time and money may be saved by synthesizing data from various sources. The Steering Committee in Toronto, for instance, proposed harmonizing various GIS databases into a single accessible system, supported by a single agency.

Moreover, notions of baseline "existing conditions" should extend beyond the state of the natural environment and assess the impact of changing land uses. A review of current projects and regulations can help policymakers gain a better understanding of the roles and responsibilities of government organizations and agencies.

Setting Targets. Defining objectives and establishing targets are an integral part of adaptive management. Once baseline data is collected and analyzed, plans addressing desired goals can be drawn up.

In Toronto, thirteen objectives were developed with the ultimate goal of reducing and ultimately eliminating "the adverse impacts of wet weather flow on the built and natural environment within the City of Toronto, and to achieve a measurable improvement in water quality." In order to measure progress, indicators were created and variable targets set to evaluate different approaches. Once the indicators were identified, variable targets were defined: (1) what would be required to ensure existing conditions; (2) a moderate level of enhancement; and (3) attainment of Provincial Water Quality Objectives and other regulatory guidelines. Computer models were developed to test a number of the indicators. Table 2-1 demonstrates sample target information for Highland Creek in Toronto.

Another interesting approach used by Toronto is the use of computer modeling to assess storm water management strategies based upon land use. For each land use, storm water strategies were broken down into four categories: (1) minimum source control, (2) maximum source control, (3) maximum source control and conveyance options, and (4) end of pipe solutions only. Computer model results were then released to the public for comment. Table 2-2 provides an example.

Monitoring. Monitoring programs measure program performance and help synthesize data in a way that frames water quality issues in a more coherent and integrated fashion. In essence, monitoring programs form the basis for improvement.

The City of Portland has proposed an extensive monitoring program, projected to cost $7.5 million over the next twenty years. Portland's Clean River Plan is a long-term strategy implemented through a number of annual actions. Extensive monitoring programs track the effectiveness of activities. Program reviews occur on an annual basis—if actions and policies are meeting performance targets, programs will continue to their next phase without adjustment, and actions will be redefined if programs are not meeting performance targets.

Portland is in the process of implementing a number of monitoring projects and is working to link the Columbia Slough monitoring program to the TMDL process where nine locations for monitoring have been established to measure for parameters of concern. The monitoring program for the Willamette River also tests for the same pollutants and monitors weekly for bacteria (E.coli and fecal coliform), copper, lead and zinc at four locations. In order to comply with their NPDES, construction sites will be monitored and best management practices assessed for their effectiveness. Monitoring is scheduled to focus on in-stream locations to assess the storm water impacts from receiving streams and land use characteristics evaluated to assess storm water run-off trends. The industrial storm water program also requires a monitoring program and industrial sites that have permits to discharge into the City's municipal separate storm sewer system will be sampled and facilities required to submit monitoring reports. Finally, selected non-storm water discharges will be monitored including air conditioning condensate, potable water sources, individual residential car washing and flows from riparian habitats and wetlands.

Evaluation. Monitoring and evaluation work hand in hand. Although monitoring provides data, criteria are needed to provide the context for analysis. To address this, policymakers have to provide consistent methodologies and standards as guidance for local management strategies. Evaluation criteria have been established to present a consistent framework from which to assess programs and policies. These criteria are focused around: the magnitude of harm for the environment and human health, the persistence of threats, the potential for losses that could be construed as irreversible, the adequacy of programs to address all threats, the adequacy of existing management programs, cost-effectiveness, the establishment of a logical timeframe and the utilization of funding sources.

INCENTIVES, REGULATION AND INNOVATION

For the most part, water resource management proceeds in a technocratic and isolated way, with short-term and piecemeal solutions. Toronto, Portland and the Puget Sound are highlighted here for their innovations, but watershed management strategies have also been created for the Rouge River in Ohio and the Chattanooga River in Tennessee.

Addressing CSOs. To address its CSO problem, Portland plans to spend $407 million over the next twenty years on a variety of projects to eliminate CSO events. Since 1991, Portland has worked with the Department of Environmental Quality (DEQ) to develop an LTCP, which was finalized in 1994. Since then, Portland has requested that DEQ grant an extension of the LTCP whereby CSO events would be reduced by 94 percent into the Willamette River by 2020 (a nine year extension). The City proposed to implement "green solutions" (e.g. low-impact development, downspout disconnection, reforestation and streambank restoration) before designing the tunnel for the east side of the river. After a difficult negotiation with the City, DEQ concluded that an extension was not warranted because CSOs could be solved by conventional technologies (i.e., tunnels and pipes). DEQ continues to encourage the implementation of such "green solutions" and Portland has proceeded on a number of fronts to implement its Clean River Plan (for example, neighborhood watershed restoration activities, reforestation projects and eco-roofs).

Beginning in 1994, Portland started to work on CSO abatement projects that centered on engineered inflow control. Called "Cornerstone Solutions," Portland began an effort to reduce the amount of flow to the combined system. Some areas of the combined system were separated and facilities were built to treat storm water. To date, Portland has also installed approximately 2,800 groundwater infiltration sumps (with a total cost of approximately $160 million). Where pervious soils permit, sumps have been able to remove several billion gallons of storm water. Projects are also underway to separate creeks from the combined system, reducing the volume of overflows by approximately 260 million gallons per year.

To address CSOs to the Columbia Slough a large pipe was constructed to hold overflows, which are then pumped to a wet weather treatment facility, which provides primary treatment and dechlorination (approximate cost $180 million). On the west side of the Willamette, ten miles of new pipes, a tunnel and two pump stations are scheduled for construction (full operation is planned for 2006), reducing current overflows by 550 million gallons per year. A tunnel is also scheduled for the east side of the Willamette, which will be the biggest tunnel of them all.

Portland has indicated that it will invest in "green technology solutions" to remove as much storm water as possible from the sewer system before finalizing the design of the tunnel. Such green solutions include eco-roof projects, swales and a re-vegetation program. Since the design of the tunnel is still in its early stages, Portland hopes to demonstrate the effectiveness of source control. Evaluation of source control measures is taking place on two fronts: (1) though field implementation of pilot projects, which will be monitored by staff and (2) explicit modeling to simulate source control down to the block and individual property level. It is hoped that continued evaluation of projects and computer simulations will provide a higher level of confi-

Table 2-1: Sample Target Information for Highland Creek in Toronto

Objective: Meet guidelines for water and sediment quality			
Indicator	Status Quo	Moderate Enhancement	Significant Enhancement
Total Phosphorus (TP)	TP Dry = 0.022 mg/L TP Wet = 0.155 mg/L	TP Dry = 0.03 mg/L TP Wet = 0.1 mg/L (50% of the time)	TP (dry and wet) = 0.03 mg/L

Source: Progress Update, Toronto's Wet Weather Flow Management Plan, February 2002

Table 2-2: Example of Land Use Stormwater Strategies in Toronto				
Land Use	**Minimum Source Control Options**	**Maximum Source Control Options**	**Conveyance Options**	**End of pipe Options**
Commercial Properties	Rooftop restrictors Catchbasin restrictors in parking lots	Pervious pavement in parking lots; infiltrate roof run-off; underground storage; oil/grit separators; use of filters/bioretention (plus minimum options)	Pervious Technologies	e.g., Increased plant capacity; tanks; tunnels

Source: Progress Update, Toronto's Wet Weather Flow Management Plan, February 2002

dence in order to predict the impact of source control on the size and cost of infrastructure needed. While end-of-pipe solutions such as tunnels may be needed to eliminate or reduce CSO events, the city of Portland is an example of a shift to source control.

As part of the Puget Sound Water Quality Plan and in accordance with state and federal policies, a number of CSO projects are also underway throughout the Puget Sound basin. During the 1980s, Seattle developed and implemented its first CSO reduction program called the 201 Facility Plan, which focused primarily on constructing storage facilities. While these projects resulted in major reductions in CSO volume, overflows still exceed the state standard of one untreated overflow event on average per year.

King County (Seattle, WA) has planned over 20 CSO projects scheduled over the next 30 years, beginning with project construction along Puget Sound beaches (2010-2011) and ending with the final phase in 2030. The Denny Way/Lake Union CSO is the largest volume CSO discharge in the King County system. Overflows from two regulators, coupled with the overflows from the Elliot Bay outfall, discharge an average of 405 million gallons per year into Elliot Bay. Currently, overflows occur anywhere from 10 to 115 times a year.

To reduce these CSOs the Seattle City Council and the metropolitan King County Council signed a Memorandum of Agreement specifying how a joint project will be implemented by both jurisdictions in 1995. The County and City were also awarded a $35 million grant for the project by EPA in 1995. To reduce overflows, King County and Seattle Public Utilities use a mix of storage tunnels and channels for floatable [trash] control and treatment.

In 1998, the City of Seattle renewed its NPDES permit, which required that the city prepare an update to its 1988 CSO plan. In order to meet the state's legal CSO requirements, City of Seattle and King County staff worked with a consultant to develop goals and objectives for a CSO management plan. The group chose seven priority areas for targeted action based on frequency and volume of overflows and proximity to beaches. Consultants also created computer models based on data from monitoring stations at all CSO outfalls. With the help of the Citizens Drainage and Wastewater Advisory Committee, criteria were developed to rank the alternatives that included: storage, separation, increasing flow to the treatment plant, inflow and infiltration reduction (i.e., fixing defects in pipes and downspout disconnection), and reducing impervious area.

PROJECTS, REGULATIONS AND WATERSHED PLANNING

The Bureau of Environmental Services (Portland) estimates that a single mature tree with a crown of 30 feet intercepts 4,600 gallons of rainwater a year, transpiring up to 40 gallons of water a day. The city is now working to develop partnership for tree planting and stream bank restoration and plans to plant 63,000 trees along streets and in neighborhoods. BES also estimates that adding 4,000 acres of trees, tree canopy and native vegetation will reduce CSO volume by 495 million gallons per year.

Ancillary benefits include cooler stream temperatures, improved fish and wildlife habitat and reduced total suspended solids.

Focus has also been placed on decreasing impervious area and increasing inflow and infiltration to control storm water runoff. Proposed actions include expanding implementation of Portland's rooftop garden program to promote rooftop storage and treatment of storm water—approximately 60 square miles in Portland is impervious area with 20 square miles of that roof top area. Other projects include parking lot detention and landscape infiltration projects. BES is currently reviewing options that include providing incentives for street, parking lot and rooftop improvements that manage storm water runoff and changing city codes to require trees and vegetation for parking lots. Portland estimates that by managing storm water runoff it will be able to reduce CSOs by 500 million gallons each year and save $70 million in infrastructure costs for tunnels and other pipes needed to convey combined sewage.

Portland is a good example of a city attempting to use an innovative mix of strategies that fit into a larger scheme of protecting watershed health. Projects involve a large number of stakeholders, including multiple governmental agencies, environmental organizations, businesses and residents. The city is seeking long-term investments in public-private partnerships with citizens, businesses and organizations. The city has also developed and changed city codes to promote better ecosystem management. City standards have been refined for landscaping, street design and development patterns in riparian areas; development codes have been established to promote and require native landscaping; codes have been changed to require trees and vegetation in parking lots; and the City Council has adopted resolutions to bring erosion control policies under one title and code.

Two other strategies have also shown promise. Portland's MS4 permit outlines a number of Best Management Practices (BMPs) to address construction site runoff and the EPA is in the process of updating its construction storm water program. Silt fences are a common practice to prevent erosion. Constructed wetlands are also showing promise as a cost-effective solution, effectively managing storm water pollution and requiring little maintenance.

Storm water management is also emphasized in the Puget Sound basin. To help guide storm water management the Department of Ecology has developed the Storm water Technical Manual that lists the minimum technical standards that municipalities, industries and construction sites must maintain. Storm water control requirements have also been established for new development and redevelopment—for new development sited outside of the state's urban growth areas, development must have no net detrimental change in natural surface runoff and infiltration. Regional planning also serves to develop alliances to receive regulatory approval from multiple authorities for storm water management (e.g. the "tri-county" plan, which aims to meet both NPDES Phase 1 and ESA regulatory requirements).

- In 2001, the Departments of Ecology and Transportation released the Washington Storm water Management Study. It identified opportunities for improved efficiency and effectiveness, and approaches for removing barriers to such opportunities. The Department of Ecology is working to develop storm water technical manuals that can be used for all state regulatory programs. The study also highlighted the need for the creation of a coordination group that would work with local and state governments as well as carry out a coordination role with the federal government. Establishing consistency in policy and implementation with federal regulating agencies remains a challenge. Emphasizing collaborative decision-making, the coordination groups would also be charged with establishing coordination principles, and identifying annual goals, work plans, products, monitoring and research programs. The study also stressed the need for better promotion of non-capital options for managing storm water (i.e., options relating to the practices of individuals and households and community questions of land use planning and zoning).

The Use of Low-Impact Development. Portland's BES has initiated the Willamette Storm water Control Program, providing technical and financial assistance for a limited number of pilot projects that control storm water runoff. BES is funding fifteen demonstration projects to retrofit existing commercial sites, industrial properties, schools, religious institutions and apartment complexes in targeted CSO areas. Pilot project participants use a variety of storm water control strategies. To qualify for the program, projects must be part of an existing development, located in the city's combined sewer target area, remove runoff from at least 10,000 square feet of paved or roof area, and be completed by December 31, 2002. In return, pilot program participants can receive up to $30,000 for design and construction for their projects, which also are publicized.

Low-impact development is also being promoted in the Puget Sound basin. In June 2001, the Puget Sound Water Quality Action Team sponsored a LID conference where almost 400 elected officials and their staff, members of the development community, storm water engineers and other professionals, learned more about LID. The Storm Water Management Manual for Western Washington has also been updated and contains incentives to use LID. A new flow control standard serves as a disincentive to use standard development practices of storage and conveyance. The new standard requires a detention pond for a standard residential development that is 1.4 to 4 times larger than under the old standard, which translates into a loss of space available for development. Thus, developers have an incentive to apply LID practices that allow for natural drainage to smaller areas throughout the development site and reduce the size and cost of detention ponds. For example, if a residential development preserves 65 percent of a site in forest and has less than 10 percent impervious area, no flow control would be required for the property as long as runoff is directed to vegetated areas.

However, LID is not just encouraged in residential and suburban areas. Seattle has implemented a pilot project called SEA Streets, which aims to reduce the impact of "street-scapes" on local waterbodies by managing storm water runoff and minimizing impervious area. The key elements of the program are drainage improvements, street improvements, landscaping and tree preservation and planting. System designers combined traditional drainage features (i.e. culverts, catch basins, flow control structures) with interconnected swales, vegetation and soil amendments to manage storm water flow and discharge.

In areas where infiltration practices could not be used because of the lack of groundwater infiltration, biofiltration treatment was used to increase the length of time of flow paths. Any water that is not infiltrated flows into a temporary pool where it is treated and detained before conveyed into a downstream storm water network. Street improvements also drastically altered the design of streets. Straight, 60-foot right-of-way streets were replaced with 14-foot wide paved sections and grass shoulders that can still accommodate heavy vehicle loading.

The project cost $850,000, funded by money collected from drainage fees. The city estimates that conventional drainage methods and street improvements would have cost between $600,000 and $800,000. City staff expect that the significant research, design and communications budgets needed for the pilot project will be lower in the future, thus making the SEA street approach more economical.

Public Input and Participation. Toronto is an interesting example of public communication. It contracted with a consulting firm explicitly to guide and implement public consultation efforts. At the outset, the Steering Committee realized that a successful Master Plan was dependent on the advice, insight and expertise of a diverse group of stakeholders. "E-consultation" via Internet is being used to communicate with the public and allow citizens to provide feedback on the planning process.

The first "stage" of consultation focused on introducing the public to the issue and target-setting process. Consultation objectives included raising community awareness about wet-weather flow problems, providing the public with access to information, and community advice and feedback on the purposes and goals of the Master Plan process. Once public awareness was increased, the consultation plan focused on providing the public with a "long list" of wet weather flow management strategies, which after review, was pared down to a "short list" that was also open to public comment. From there policymakers worked with stakeholders on developing preferred management strategies. Once the draft of the

Plan is released, workshops will again be held and public input taken into consideration.

Toronto's public consultation plan was successful because it proceeded simultaneously on two tracks. Policymakers and the consultant team worked to develop effective communication tools and used multiple avenues to reach people. They created a distinctive project identity (the "Jump In! Get Involved!" campaign) that was advertised throughout the city through newsletters, fact sheets, a website, ads and displays. Furthermore, they made a concerted effort to make the planning process as transparent as possible and communicate technical information in a way that was clear and easy to understand and was relevant to a wide range of audiences. Second, Toronto's programs were created to provide interested stakeholders with a choice of how to become involved.

Portland and the Puget Sound basin have also worked to increase public awareness of watershed health and environmental stewardship. Newsletters serve as outreach tools by providing informational and promotional materials to residents, providing updates on research and monitoring activities, and informing citizens and businesses about pollution prevention and stewardship activities.

Portland and the state of Washington have also created institutional capacity for citizen and stakeholder involvement. In the Puget Sound, Public Involvement and Education or "PIE" is touted "one of the most powerful tools available to help protect and improve Puget Sound's water quality and marine resources." PIE works by awarding contracts to individuals, businesses, nonprofit organizations and local and tribal governments that create environmental programs in their communities that further the goals and objectives of the Puget Sound Water Quality Management Plan. For example a PIE contract was given to the SeaTac Businesses for Clean Water, a program that offers businesses technical assistance to identify and reduce sources of storm water pollution. Funded partly by the King County Department of Natural Resources, the program cost $45,000. Portland also provides funding for environmental stewardship activities – giving approximately $35,000 a year to community groups and organizations for Clean River activities through its Stewardship Grant Program.

Funding comprehensive water management plans. Limited funding for storm water management and CSO control plans continues to result in myopic and fragmented solutions. While watershed management is seen as a positive policy approach to coordinating and integrating efforts to improve water quality, coordination is often difficult due to the large number of stakeholders and responsible governmental agencies and dispersed sources of funding, targeted at distinct program areas. According to Barrett Walker in a recent Reason Public Policy Institute study, "achieving the goal of swimmable and fishable waters stated in the Federal Clean Water Act may eventually require additional steps such as comprehensive water resource management that combines water supply, sanitary sewage, storm water drainage and wildlife protection under a watershed-scale integrated water utility."

Bellevue, Washington (a suburb of Seattle) was one of the first storm water utilities established in the nation. User fees are based on the amount of impervious area, which gives incentives to residents and businesses to reduce impervious areas and provides a way to fund watershed improvements that offset runoff and pollution. Geographical Information Systems allow managers to calculate impervious area from aerial photographs. Funded by the user fees, the city has created an erosion control ordinance and a storm water management program. This was made possible through legislation passed by the state of Washington allowing storm water management to be funded using a system of cost-based user fees. Today, a typical resident pays approximately $100 per year. User fees are also an equitable way to fund projects since, unlike taxes, they treat government property and private property equally.

While the Puget Sound Water Quality Management Plan encourages the establishment of storm water utilities, they remain the exception for funding water quality improvement projects. Funding for sewer infrastructure improvements largely comes from sewer fees and wastewater treatment capital budgets. States environmental agencies also provide a significant source of funding. States then disseminate funding to municipalities for specific projects that meet overriding goals and legal requirements.

With regard to financing CSO related projects, States are able to secure funding though the State Revolving Fund (SRF); from 1988-1994 Oregon received $2.5 million (Washington did not receive any SRF funding) and from 1995-2000 Oregon and Washington have received $21 and $1.3 million in CSO loans respectively.

In Portland the BES estimates that it will cost $3.2 billion over the next 20 years to operate, maintain and improve the sewer and storm water system; fix the CSO problem; and accomplish the goals laid out in the Clean River Plan. For storm water management, Portland has received grant money from the EPA, including $1.5 million for its storm water management program, and has been lobbying in D.C. to secure more funding. Due to limited federal and state funding and the city's good bond rating, Portland is expected to finance most projects by floating bonds. Over the last few years, sewer rates have risen a little less than 10 percent per year and are expected to climb to $90 per month by 2020.

To ameliorate rate hikes, Portland is considering the use of customer incentives to promote storm water management and reduce the cost to residents and businesses. The city plans to begin the implementation of a storm water fee reduction program. Residents and businesses will be able to reduce their storm water fees by up to 35 percent by managing storm water runoff onsite. Additionally, the fee reduction program is revenue neutral. Those who do not act to reduce storm water runoff will end up paying more in fees, while those who do pay reduced fees.

Washington is similar to Oregon, with most funding coming from EPA and the state's Department of Ecology. While some areas in Washington (such as Bellevue) have utilized innovative funding mechanisms like the storm water utility, funding for CSO infrastructure has mainly come from State Revolving Fund loans, line items in congressional appropriations bills and through municipal financing (i.e., bonds, sewer rates).

The lack of funding for storm water management programs and projects remains one of the largest impediments to effective storm water management. Increasing regulations and urbanization with associated storm water treatment needs are putting pressure on local governments and developers to identify new funds or to redistribute existing funds. The state of Washington has estimated costs ranging from $1 million to $40 million per year (for the entire state). While costly, storm water costs must take into account the benefits of storm water management and hidden costs of storm water pollution (e.g., the costs from flood damage and contaminated sediment treatment). Because capital costs can be prohibitive, preventative approaches may reduce costs, such as land use planning, development standards, critical or sensitive area ordinances, LID, pollution prevention, and pubic outreach and education.

CONCLUSION

As the District of Columbia works to finalize its LTCP, develop TMDLs and meet its MS4 permit, it is useful to compare what other cities have done as they face similar policy dilemmas. After reviewing policies and programs in Toronto, Portland and the Puget Sound basin, a number of key lessons emerge:

1. Fragmented policies aimed at CSO control should be broadened under an integrated wet weather management strategy. While each of these case studies faces different environmental, political and economic circumstances, they all share in common the broadening of CSO strategies to encompass storm water management. In fact, some cities (e.g., Detroit, Portland, and Toronto) have concluded that CSO control alone will not improve water quality and have begun implementing comprehensive wet weather management strategies to reduce storm water runoff, restore ecosystem function and implement projects that mimic natural processes. While CSO control has not been abandoned, it has been brought under the rubric of watershed and ecosystem management with the ultimate goal of meeting Clean Water Act standards of "fishable and swimmable." It is also evident that storm water management needs to be more effective, particularly by placing a greater focus on pollution prevention and source control.

2. Developing an institutional framework to set goals and objectives is an important first step. A coherent

and effective wet weather strategy involves extensive collaboration and coordination to set goals and objectives. An institutional framework helps lay the foundation for delineating responsibility among various stakeholders as well as defining priorities. Given the wide array of local, state and federal clean water programs and policies, and problems reaching beyond jurisdictional borders, a framework is needed to provide consistency among different programs as well as to streamline ongoing efforts.

3. Target-setting and monitoring are needed to establish baseline conditions and the basis for program and policy evaluation. Storm water management is an ongoing effort; monitoring efforts are needed to provide policy feedback loops and to establish benchmarks for evaluating program performance. Each of these case studies has applied adaptive management, a core component of their wet weather strategies. EPA has also proposed adaptive management strategies for nonpoint source pollution management that may prove quite useful to local jurisdictions and state authorities (See Appendix B). As many strategies remain—to a large extent—unproven, monitoring is also needed to establish sound evidence for their impact on storm water control (e.g., LID).

4. Wet weather management is not a "one size fits all approach" but involves a mix of policies and incentives that are place-based. Rather than addressing CSOs, storm water runoff, environmental degradation in an isolated context, these cities are using a mix of policies that include: sewer infrastructure improvements, LID, public outreach, and land use planning. Strategies have also focused on using both regulation and incentives to promote sound watershed management.

5. A top-down approach is not as effective as a strategy that seeks public input and participation. Public outreach is needed to build community understanding of storm water management and educate citizens on the actions they can take to manage runoff (i.e., pollution prevention efforts). Given the potential costs of storm water management, volunteerism, community organizations and watershed management organizations are valuable resources that should not be overlooked.

6. Due to immense costs, innovative financing schemes and collaboration between federal, state and local agencies are necessary. Funding remains a key issue and storm water treatment is costly. Unless cities make stronger efforts to control runoff and prevent pollution, there will be costly consequences. Some also believe that the EPA will begin to take stronger action on storm water management. Innovative financing such as storm water utilities and revenue bonds, special purposes local option sales taxes, impact fees and systems development charges should be more actively pursued. Federal support for wet weather management should also be strengthened.

Chapter 3

Multiple Arenas of CSO Policy: The Need for a Watershed Approach

While CSOs are a main source of pollutants to the Anacostia, Potomac and Rock Creek, they are only a part of the total pollutant load. Major portions of the pollutants come from upstream sources of runoff that rely on separated systems of sewer and storm water disposal. To have a significant effect on water quality, the CSO problem must be addressed within the context of wider water quality issues. There are a number of separate arenas in which these issues are being addressed. A lack of coordination between important players can be a significant obstacle to the solution of water quality problems in the Washington area, including the CSO problem.

For example, by itself, reducing CSOs will not dramatically lower bacteria levels in the Anacostia River; other major pollution sources will still be present. Thus, even if the CSO problem were eliminated entirely, fecal coliform concentrations will exceed water quality standards 183 days/year. Besides CSOs, one of the main culprits in poor water quality is storm water runoff. Approximately 65 percent of surface area in the District is comprised of impervious surfaces. During wet weather events, storm water runoff carries with it pollution from streets, parking lots, lawns and construction sites. This can include significant quantities of organic matter as well as toxic substances.

Due in part to the multiple influences on water quality, WASA and other groups emphasize the importance of implementing a watershed approach to the control of water quality in the District. In 1998, the EPA convened a "Special Panel on Combined Sewer Overflows and Storm Water Management in the District of Columbia." The Special Panel issued a set of recommendations to improve the District's water quality, including implementation of a watershed approach to water quality management. In 1994, the Chesapeake Bay Program (CBP) organized an agreement between federal agencies for ecosystem management, which included the Anacostia River Demonstration Project. In concert with the Anacostia Watershed Restoration Committee (AWRC), the Army Corps of Engineers was given lead authority in applying ecosystem management concepts to an urban environment and it retains a major role in the fate of the Anacostia.

Remediating CSOs is a key component of any watershed plan for improving water quality, particularly so in the Anacostia River. Considering the enormous commitment of time and money called for by the current LTCP, WASA and other stakeholders must make certain that this large step is in the right direction. An integrated approach considers all watershed components, including its human population. The final plan for achieving full recovery of the Anacostia in the most efficient manner should utilize a comprehensive ecosystem-based, or watershed-based, approach to solving water quality problems.

GOALS OF WATERSHED MANAGEMENT

In the early 1990s, the U.S. experienced something of a paradigm shift toward ecosystem- or watershed-based approaches to natural resource management. This new concept strives to incorporate ecological, economic and social factors, through stakeholder coordination performed within natural geographic or ecological boundaries.

According to a 1993 Memorandum of Understanding between all federal agencies involved in environmental resource management "the goal of the ecosystem approach is to restore and sustain the health, productivity, and biological diversity of ecosystems and the overall quality of life through a natural resource management approach that is fully integrated with social and economic goals."

This approach builds from the interrelationship between natural systems and healthy, sustainable economies. Because ecosystems do not follow man-made political boundaries, management of ecosystems and human activities affecting them must take a perspective that looks beyond jurisdictional lines. This involves a shift from government's traditional focus on individual agency missions and jurisdictions to a broader, more comprehensive consideration of the roles of multiple agencies within larger ecological boundaries. Decision-makers must consider the broad-scale, long-term ecological consequences of their actions. The ecosystem approach also requires the involvement of the many stakeholders affecting or affected by environmental resource decisions, including federal, state, and local agencies, private and civic groups, and present and future residents of the area. Such coordination ensures the accurate definition of values being upheld through management decisions.

Effectively applying this broad approach also requires an understanding of how ecosystems function and what their current condition is. This involves the continuous building and communication of scientific information concerning ecosystem components and their complex interconnections. As ecological science grows and changes, resource managers and the frameworks they operate in must be able to adapt to insure state of the art knowledge is being applied at all times.

By highlighting the explicit connection between ecological health and economic welfare, the ecosystem approach forces the public and its leaders to look at the far-reaching implications of the choices they make concerning resource use. In addition, this emerging perspective encourages all involved stakeholders to build newly coordinated frameworks that can produce the best possible set of approaches to restoring and maintaining ecological resources. In its recently released guidance on Coordinating CSO Long-Term Planning with Water Quality Standards Reviews, EPA also stresses the importance of utilizing a watershed approach to "prioritize actions to achieve environmental improvements, promote pollution prevention, and meet other important community goals." Both the EPA's 1994 NPDES Watershed Strategy and its 1996 report on The Watershed Framework outline principles and methods to be employed in undertaking a watershed approach to project development.

The ecosystem and watershed approach is currently being applied in many policymaking arenas, however its acceptance and success have been hindered by several factors. For instance, comprehensive planning approaches have proven more difficult and costly than more compartmentalized approaches, due to their need for broad coordination among stakeholders and all-inclusive data gathering. Breakdowns in coordination and an incomplete understanding of ecological factors can inhibit the strategic planning process and lead to taking the easiest, rather than the most effective long run approaches to environmental resource management. Also, while the call for ecosystem-based planning has been promulgated throughout federal, state and local governments, it exists only as a guiding principle and currently lacks the teeth needed to ensure full implementation.

CSOs IN WATERSHED MANAGEMENT

Taking a broad watershed perspective of water resource management enables decision-makers to view the problem posed by CSOs as one source among many affecting the health of waterbodies and their associated ecosystem. By understanding all potential areas of improvement within a watershed (i.e., storm water, agricultural and urban runoff, contaminated sediment, unstable bank erosion, etc.), stakeholders can then consider the entirety of possible recovery measures to ensure that the most economical approach is taken in achieving their desired ecosystem goals. This requires extensive scientific knowledge of the particular watershed being managed, as well as the nature of pollution sources within the system. Communication between diverse sets of stakeholders, analysts, and decision makers is a key to success during the planning stages of watershed management.

Utilizing a watershed approach is also important to resolving the CSO problem, because CSO effluents are typically a combination of several pollution sources, which result from an array of human activities. Decision-makers involved in storm water management, wastewater management, development and land use planning, and public and industrial water usage all influence what goes into CSO effluent, and should logically be involving in deciding how CSOs will ultimately be controlled.

The watershed-based, comprehensive analysis provided by EPA's Total Maximum Daily Load (TMDL) procedures and the broad coordination frameworks developed under the 2001 Anacostia Watershed Restoration Agreement and the Bay-wide Chesapeake 2000 Agreement each support the watershed approach to water quality improvement and resource management. Table 3-1 provides an overview of these frameworks.

As an evident source of pollution reduction, CSO control plays a role in fulfilling the goals of each of these watershed-planning frameworks. However, the overall significance of CSOs is dependent on the scale of planning being employed. For example, at the largest, Bay-wide scale, the effect of CSO is minor compared to that of wastewater treatment plant effluent and agricultural runoff as sources of nutrient loading. But on a scale that considers only the Anacostia watershed, CSOs become a primary contributor of nutrient pollution. The challenge in defining the role of CSOs in comprehensive watershed planning lies in developing compatible goals that ensure healthy, sustainable water resources at every scale.

TMDLs IN THE DISTRICT

Section 303(d) of the 1972 Clean Water Act requires the development of a TMDL program for waterbodies where technology-based NPDES programs failed to sufficiently clean up the water. A TMDL is essentially the total amount (either volume or mass) of a single pollutant that a water body can accept during the course of one day and still meet established water

Table 3-1: Overview of Watershed Planning Frameworks

Planning Framework	Date	Scope	Purpose
TMDLs for DC's portion of the Anacostia River	BOD: Mar 2001 TSS (Draft): Jan 2002	Focus on specific pollutants from DC's portion of the watershed, with some consideration of Maryland's portion	• Determine loading limits for each pollutant violating water quality standards standards • Allocate reduction responsibilities among pollution sources
Anacostia Watershed Restoration Agreement	December 2001	The entire Anacostia River Watershed	• Develop goals to restore sustainability of the Anacostia watershed • Define specific targets needed to reach goals • Coordinate efforts of involved stakeholders to reach common goals
Chesapeake 2000 Agreement	June 2000	The entire Chesapeake Bay Watershed	• Develop broad goals to restore sustainability of the Bay and its watershed • Define pollution reduction and restoration targets to be met by a set time • Coordinate efforts between all watershed stakeholders to reach common goals

quality standards. The TMDL takes seasonal variations of pollutant loads, hydrologic activity, and water resource use into consideration. It also incorporates predictions concerning how these parameters may change in the future. As required by EPA, a TMDL document is a watershed-based plan designed to attain a particular pollutant load in a given water body. Since different TMDLs are prepared for different types of pollution, the same water body can have multiple TMDLs.

An acceptable level of TMDL is developed through a sequence of planning and research events, which include:

1. The identification of impaired waterbodies, including priorities based on the severity of pollution and uses of the water, known as the Impaired Waterbodies List,

2. Determination of sources of each pollutant causing the impairment, and

3. Determination of the pollutant load each water body is capable of handling.

After submitting this analysis to EPA for approval, the state is then required to develop and institute a plan to reach the established TMDLs – for example, a permitting system designating allowable loads for each contributor of pollution. Should a state fail to develop adequate TMDLs for continually impaired waters, EPA is required under CWA to establish its own TMDLs to be implemented by that state.

While the last 30 years have seen the bulk of congressional funding directed at technological fixes to point sources of water pollution, TMDL requirements have begun to receive greater attention as non-point sources have grown in importance in recent years. This increased attention has been primarily due to a wave of lawsuits, which began in the 1980s and continue today, brought by citizen and environmental groups against the EPA and individual states for not preparing TMDLs.

The District's TMDL analysis for the Anacostia River considers all sources of a given pollutant into the river. However, in-depth modeling analysis of specific sources and their required load reductions focus primarily on the portion of the watershed lying within the District. Pollutant loads coming from Maryland's Anacostia watershed area are characterized merely as an aggregate of "upstream" sources. With 83 percent of the Anacostia watershed lying outside D.C.'s border, the successful fulfillment of the reductions called for in its TMDLs remain highly dependent on the progress of Maryland in reducing its pollutant loads.

DOH released its first TMDL in March 2001. This initial analysis addresses Biochemical Oxygen Demand (BOD) in the D.C. portion of the Anacostia River. Most involved parties view low dissolved oxygen as the most serious water quality problem in the District's portion of the river. Oxygen is needed by the river's aquatic life for basic metabolic processes, and thus sustainability. Untreated wastes entering the river via CSOs, combined with nutrients (phosphorus and nitrogen) from upstream runoff, result in the depletion of dissolved oxygen in the water and widespread fish kills when conditions are at their worst. The District's TMDL for its portion of the Anacostia River calls for a 90 percent reduction of BOD loading from CSOs to meet current water quality standards.

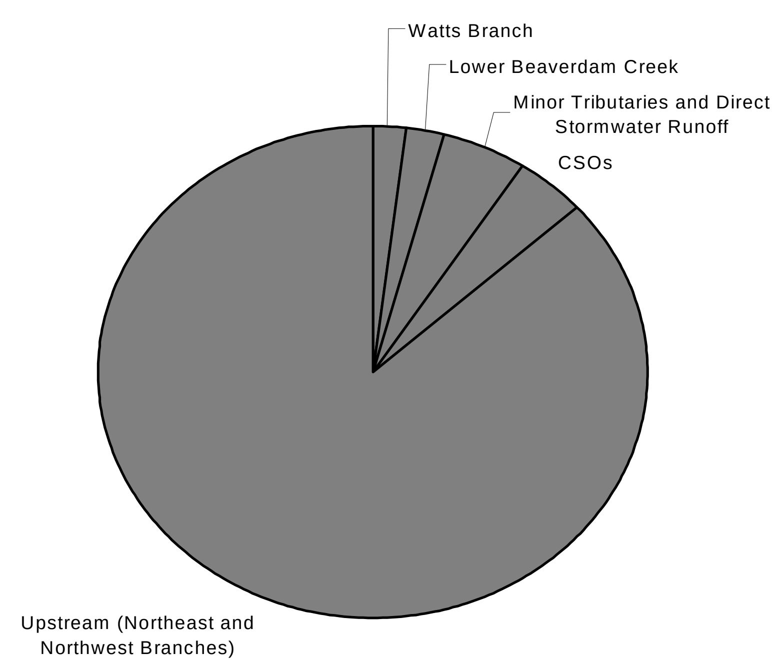
The TMDL also assumes that both Maryland and D.C. will reduce their storm water loads by 50 percent and their nutrient loads by 30 percent. Coordination with Maryland concerning the feasibility of such reductions is crucial to the successful implementation of the District's TMDL for BOD but little such coordination has been evident thus far. While the TMDL does call for BOD reductions by Maryland (up to 70 percent reduction in storm water runoff according to model scenarios run by DOH), there is no sign of absolute commitment from Maryland as to how and within what time period such reductions will be accomplished. Maryland is currently in the model-building stage of its analysis of the Anacostia watershed and will not produce a corresponding final TMDL for its portion of the River for some time. Existing materials do mention Maryland's voluntary commitment to a 40 percent reduction in nitrogen and phosphorus loading under the multi-state Chesapeake 2000 Agreement (discussed in the following section), but they do not indicate the nature of Maryland's plans for achieving such reductions. In addition, the 40 percent reduction by Maryland established in the Bay agreement still may not be enough to reach the BOD levels required by the District's TMDL.

DOH also released a draft of a TMDL for Total Suspended Solids (TSS) for the District's portion of the Anacostia in January 2002. TSS, resulting primarily from eroded soils carried by natural stream flows, storm water runoff, and CSOs, produces high turbidity in the Anacostia. By preventing sunlight from penetrating far beneath the water surface, high turbidity limits the growth of aquatic vegetation, upon which healthy river systems depend. While the problem of CSOs is often portrayed as the most substantial pollution source on the Anacostia, the contribution of CSOs to overall TSS pollution is actually quite minor. The nature of TSS loading sources, including CSOs for the Anacostia, are depicted in Figure 3-1, taken from the District's TSS TMDL draft.

Specifically, the TMDL draft calls for TSS loads from CSOs to be reduced by 90 percent, along with a reduction of 80 percent by all other sources. While a 90 percent reduction in CSO loading may not appear necessary from the seemingly insignificant role it plays in the overall TSS load, this is the same reduction required by the previously released TMDL for BOD. It is therefore apparent that this TMDL utilizes the recommendation of the BOD study published earlier, rather than developing its own specification for CSO reduction. Once again, this TMDL's goals remain extremely dependent on agreement by Maryland to achieve the desired reductions.

Overall, the development of TMDLs for the Anacostia has proven to be a highly resource-intensive process. They employ a drawn-out, stepwise approach to watershed planning by setting reduction goals one pollutant at a time. These analyses have appeared to adequately uncover the individual sources of a total pollutant loading into the water, which should help alleviate the burden of distributing cleanup responsibilities when the enforcement stage commences. However, these TMDLs remain truncated versions of the ideal watershed approach, as they divide assessment of the Anacostia according to both watershed and state lines. While EPA recommends that states coordinate their TMDL programs for watersheds held in common, this has proved to be a cumbersome and largely ignored piece of guidance for D.C. and Maryland. They have instead developed separate TMDLs for their own portions of the Anacostia.

Figure 3-1: Existing Annual TSS Load Distribution for 1989



THE 2001 ANACOSTIA WATERSHED RESTORATION AGREEMENT

In December 2001, officials from D.C., the State of Maryland, Montgomery County, and Prince George's County, reaffirmed their commitment to the Anacostia Watershed Restoration Agreement. It was originally drafted in 1987, which was done in coordination with the Army Corps of Engineers, the EPA, and the National Park Service, represented one of the first formal collaborations of government agencies to restore and protect the Anacostia and its watershed. A second Restoration Agreement, signed in 1991, provided an increased focus for restoration efforts by establishing specified goals in the form of a "Six-Point Action Plan." The six prescribed goals are:

1. Reduction of pollution loads,
2. Restoration of ecological integrity,
3. Improvement of fish passage,
4. Increase in wetland acreage,
5. Expansion of forest coverage, and
6. Increase in public and private participation and stewardship.

The original signing of the Anacostia Watershed Restoration Agreement coincided with the 1987 Chesapeake Bay Agreement. Anacostia signatories included the Mayor of the District of Columbia, the Governor of Maryland, and county executives from Prince George's and Montgomery counties. Biannual reports are published marking the progress of various projects. Other local organizations have sponsored a myriad of smaller initiatives. Some have been completed, and more are under way or in the planning stages.

The Anacostia Watershed Restoration Committee was established when the Anacostia Restoration Agreement was first signed in 1987. The Metropolitan Washington Council of Governments (COG) offered to serve as the administrator for the AWRC and to publish its newsletters. On May 10, 1999, a new draft of the restoration agreement added the creation of long-term indicators and targets for the six fundamental goals above. With a grant from the Summit Fund of Washington, COG developed 50 indicators that are intended to guide efforts to the year 2010. Annual summaries and report cards indicate progress toward the goals.

This comprehensive list is the result of "a highly public process designed to engage both the [governmental participants] and the public in the development of a suite of restoration indicators and related targets." Controlling CSOs is a significant element in the Restoration Agreement's goal of reducing pollutant loads. Specifically, the plan sets the target of a 95 percent reduction rate of current CSO flows before 2010. The Agreement also ties the need for reducing CSOs to its restoration indicators for bacterial contamination and BOD. This plan recognizes the need to coordinate with other ongoing water quality programs by incorporating the work of WASA's LTCP and the Anacostia's TMDLs into its own efforts. While the Agreement does set its own targets, it appears to leave final judgment to the determinations made in the LTCP and TMDLs. Consider the following passage, for instance:

> WASA is in the process of completing its Long Term Control Plan (LTCP) to determine what controls will be needed. However, these controls will not be fully understood until all LTCP modeling work is completed. For the purposes of this indicators project, an ultimate 95 percent capture rate and the initiation of CSO system improvements before 2010 is the provisional target. This may be revised once the LTCP is approved.

This deference to the contents of other plans could be due to the Agreement's view of the LTCP and TMDLs as more technically sophisticated programs, or simply because the Restoration Agreement is not legally binding – as are the other two programs. As a strategic plan, the Anacostia Watershed Restoration Agreement is more comprehensive and utilizes a broader watershed scale than the TMDL process. The Restoration Agreement cuts across the jurisdictional boundaries between Maryland and D.C. to consider the entire Anacostia Watershed as a complete system. It is also more inclusive in its characterization of degradation within the watershed, as compared to the single pollutant approach of TMDLs. This more strategic approach to watershed assessment and planning paints a broader picture of the situation for decision-makers, enabling them to better see those leverage points that can produce the most efficient progress in restoration.

The primary drawback to this broad plan appears to be its lack of precise technical analysis. While it does estimate targets for pollution reduction and other restoration measures, it does not provide the technical detail necessary to make accurate judgments, although the newly developed set of 50 indicators are a good step. In addition, this agreement carries no legal authority, and is therefore not truly enforceable. As such, the agreement has been effectively lost in D.C.'s public policy sphere and carries little weight in resource management discussions today. If coordinated properly, this broad watershed plan, coupled with more specific analyses like that of TMDLs, could prove to be a valuable approach to managing sustainable watersheds.

CHESAPEAKE 2000: A WATERSHED PARTNERSHIP

The Chesapeake 2000 Agreement is the fourth such bay-wide watershed management commitment issued by the EPA-sponsored Chesapeake Bay Program. Designed as a voluntary regional partnership between Maryland, Pennsylvania, Virginia, the District of Columbia, the Chesapeake Bay Commission and EPA, the agreement is the most comprehensive approach to solving restoration challenges of the Bay as a whole. A true embodiment of the ecosystem approach, the agreement recognizes the importance of all elements contributing to the Bay's complexity, along with the interconnectedness of all actions that take place within its watershed. The primary goal of Chesapeake 2000 is "to improve water quality sufficiently to sustain the living resources of the Chesapeake Bay and its tidal tributaries and to maintain that water quality into the future."

More specifically, each signatory to Chesapeake 2000 "agrees to the goal of improving water quality in the Bay and its tributaries so that these waters may be removed from the impaired waters list prior to the time when regulatory mechanisms under Section 303(d) of the Clean Water Act would be applied." This commitment requires the watershed to achieve and maintain a 40 percent nutrient (nitrogen and phosphorous) reduction goal based on 1985 pollutant discharge levels, develop sediment loading criteria, review and revise water quality standards, and eliminate chemical contaminant discharges Bay-wide.

The primary benefits of Chesapeake 2000 include the visibility it provides the region, lending impetus for action. In addition, it establishes a genuine partnership framework for the District to work within and gain support from. As one of the most far-reaching strategic watershed plans in the nation, Chesapeake 2000 provides a set of common goals for all of the District's water quality and restoration programs to strive for. Most importantly, the Agreement's section on "Priority Urban Waters" gives focus to cleanup of the Anacostia River (one of only three waters specified) as a key Chesapeake watershed goal.

Despite the fact that the Anacostia River is a minor contributor to the overall freshwater flow of the Chesapeake Bay, it has been singled out in Chesapeake planning as a water body in need of critical repair. This is primarily due to the Anacostia's existence as one of the few Bay waters that currently poses direct human health threats. As such, the Agreement sets the deadline of 2010 to reduce pollution loads to the Anacostia "in order to eliminate public health concerns and achieve the living resource, water quality, and habitat goals of this and past Agreements." Within the District, Chesapeake 2000 can play an important role in providing a common focus and needed stimulus to the independently operating and slow paced TMDL and LTCP processes.

Within the District, both the TSS and BOD TMDLs for the Anacostia River rely on the Chesapeake 2000 reduction commitment as the basis for future upstream loading predictions in its modeling analysis. The partial watershed analysis of the Anacostia's TMDL relies on the Bay-wide Agreement to fill such information gaps and act as a source of coordination in the absence of concurrent development of a TMDL for Maryland's portion of the Anacostia. The BOD TMDL also relies on the Bay Agreement's goals to set its own timeline. Referring to Chesapeake 2000, the TMDL notes that, "an agreement is in place which clearly demonstrates a commitment to the load reductions necessary to achieve the restoration of the river by the year 2010. This establishes a completion date for implementation of those activities allocated in this TMDL."

WASA's current LTCP also uses the Chesapeake 2000 Agreement as a source of support for pollution reduction via CSO control. The LTCP study contains a brief paragraph outlining the commitments and guidelines set forth in Chesapeake 2000, and ensures that its goals are in line with those of the Bay-wide agreement. However, because Chesapeake 2000 merely "represents a partnership arrangement" the LTCP also recognizes that "compliance is non-regulatory." In sum, the Chesapeake 2000 agreement provides impetus and direction, without obligation, for more narrowly scoped planning processes like those of the TMLDs and LTCP.

WASA AND WATERSHED MANAGEMENT

WASA's primary goal has always been to provide the citizens of D.C. and surrounding areas with adequate drinking water and sewage treatment services. The brunt of its business therefore lies in the maintenance and operation of the infrastructure necessary to fulfill these tasks, including the city's mammoth Blue Plains wastewater treatment plant. Only with mandates of the Clean Water Act and escalating public outcry has WASA's mission grown to include the control of CSOs. As WASA takes on this new task and develops its plan to control CSOs, two primary forces are acting on its decision-making. One is the EPA's requirement, backed by strong public demand, for it to produce an LTCP to meet the stringent water quality standards of fishable and swimmable waters in a timely fashion. The other force affecting WASA is the need to approach the CSO problem from a watershed perspective to ensure that its LTCP fits properly into a broader framework of approaches, whose goal is the eventual health and sustainability of the region's water resources. The question that now needs to be asked is: what sort of plan has WASA developed? Does the LTCP strive for the same goals of more strategic, comprehensive watershed management plans affecting the D.C. area?

A review of the most recent version of WASA's LTCP indicates that it has not been explicitly designed with the watershed approach as a founding principle. The LTCP does give brief mention to the goals set forth in the Anacostia's TMDLs and the Chesapeake Bay Agreement, noting that these goals coincide with those of WASA. Rather than applying such watershed planning aids as sources of continued guidance, it appears to use them merely as devices for rubberstamp approval of their intended actions. The strongest evidence of WASA's incorporation of a watershed approach in LTCP development comes from its inclusion of stakeholder input. While the extent to which stakeholders influenced the initial draft of the LTCP is uncertain, various meetings and an extensive public comment program have allowed diverse interests from around the District's watersheds to enter the subsequent planning process. Their effect, in the form of changes to the final LTCP, is yet to be seen.

Looking again at the three watershed planning frameworks discussed in this chapter, there appears to be widespread support for WASA's plan to drastically reduce CSOs along the Anacostia River. Both of the Anacostia's current TMDLs call for 90 percent reductions in CSO loading, which are slightly below the 95 percent reduction outlined in the LTCP's recommended plan. The Anacostia Watershed Restoration Plan recommendation for CSO cuts is precisely aligned with WASA's. And, while Chesapeake 2000 did not specify exact figures for CSO control, it clearly supports combined sewage cleanup and the critical need for restoration of the Anacostia.

Although all involved watershed planners demonstrate support for CSO control, none provide explicit guidance concerning the approach WASA should take to correct CSO problems. Embedded in the ecosystem approach is the need for coordination between a watershed's resource managers to create the best possible solutions to the problems of impaired waters. Due to their differing timelines and governing authorities, the LTCP and TMDLs have not been developed with close collaboration. There is little evidence that WASA has worked in concert with DOH to develop a coordinated approach to improving the Anacostia's water quality. WASA also does not appear to have been working closely with other city planners to produce the best set of approaches to reduce CSOs. The LTCP does little to incorporate the responsibilities of other authorities, such as storm water control and alternative land use planning, into its own design. Due to the close linkages between CSO control and storm water management, the WASA plan may be neglecting the potential for both activities to work simultaneously toward the common goal of decreased runoff.

There seem to be several obstacles to WASA's successful employment of broad, watershed-based planning. Of primary concern is the incomplete nature of the TMDL planning structure. A lack of coordination with Maryland in designing TMDL plans for the entire Anacostia watershed prohibits D.C. planners from fully understanding the limits they need to work within. This is partly the fault of D.C. and Maryland, and partly that of the EPA. Possessing the federal oversight authority for both jurisdictions, the EPA should be responsible for enforcing its own guidance on interstate coordination of TMDLs.

Also encumbering the District's efforts to formulate comprehensive watershed management strategies are the separate development processes for TMDLs and the LTCP within the District. According to EPA guidance, "it is important that LTCPs be developed and implemented in explicit coordination with TMDL evaluations and other watershed management planning." The justification lies in the mutual goal of TMDLs and LTCPs – the reduction of pollutant loads to meet specified water quality standards. In addition, the two processes parallel each other in many ways. Data gathering, watershed modeling, consensus building among stakeholders, and development of the best alternatives for pollutant load reduction are each common to both LTCP and TMDL analyses. It is apparent that coordination between these processes is not only essential to the development of common goals, but also important as a source of economy when devoting resources to their undertaking. The short time frames set by EPA for WASA's production of a CSO control plan serves as a further obstacle to proper application of watershed planning.

Despite its shortcomings in fully embracing a watershed approach to planning, the LTCP fits into current strategic watershed visions. Due to the deteriorated state of the Anacostia River, cleaning up this watershed has become a top priority on the lists of many resource managers, from D.C. officials to national leaders. With over one billion gallons of combined sewage flowing into its waters each year, CSOs have become the watershed's most visible need for improvement. With large scale CSO cleanup on the horizon, the most pressing issue now is the need for a comprehensive method for uncovering the most cost effective solutions to CSO control. Currently, the process of developing the technical aspects of this plan is significantly less coordinated than it could be. Opportunities for increased efficiency in controlling CSOs may be overlooked in the absence of greater collaboration among watershed managers in D.C. and Maryland.

COORDINATION BETWEEN WASA AND DOH

WASA and DOH are obligated by law to work together on the storm water runoff issue. Nevertheless, the two agencies have been involved in a debate over how to integrate and coordinate among the agencies to address the CSO issue. Budgetary and institutional mechanisms have also created delays in integration of agency policies. According to officials within the agencies, for example, they are still trying to understand who is responsible for which pipes in some parts of the District.

In the decision-making process, WASA has the primary responsibility, although any plan must have the approval of DOH. While DOH and WASA have shared data and conducted modeling systems together, there are still large gaps in communication. When WASA first came up with the LTCP, it planned to send the plan to EPA without sharing the plan with the mayor, represented by DOH. According to those familiar with interactions between DOH and WASA, the agencies are still learning in general how to interact with one another and this learning process takes time.

Furthermore, there is little transparency in the planning process. According to one source, WASA has been operating in a dark room emerging only long enough to offer drafts of the LTCP and receive comments. Currently, WASA is scheduled to present the next draft of the LTCP in June. Reviewers will be given one week to submit commitments and it is questionable how WASA will respond to the comments.

Although WASA and DOH have distinct missions and responsibilities, there is significant overlap regarding the improvement of water quality and watershed health. A broader approach to CSO control and storm water management will require even greater cooperation. WASA is primarily responsible for providing drinking water and wastewater treatment and collection and operating approximately 1,800 miles of sanitary and combined sewers as well the separate storm water system. DOH also has a distinct role in storm water management and water quality improvement: developing and enacting sediment and erosion control regulations, floodplain management, water quality monitoring, and supporting stream rehabilitation. Implementation of D.C.'s MS4 permit is shared between WASA, DOH and the Department of Public Works (DPW). As effective and economical CSO strategies require attention to multi-faceted strategies and watershed management approaches, there is certainly opportunity for greater coordination between DOH and WASA. For example, a MS4 task force was created to coordinate activities between DOH, WASA and DPW. Taking a broader approach to CSO control, a similar task force could be created to coordinate activities aimed at reducing CSOs and storm water pollution, perhaps specifically targeted at the Anacostia River.

THE DISTRICT/FEDERAL RELATIONSHIP

The D.C./Federal relationship has historically been difficult. During the Barry Administration and recent budget shortfalls, the Federal government intervened in D.C. politics with a control board. In a recent District report, the District proclaims that a "renaissance" has occurred in its relations with the Executive and Legislative branches of the Federal Government. In particular, the report cites support from key Congressional leaders and the Clinton Administration, which enacted the Restoration of Home Rule Act in 1999. The report then outlines a series of issues requiring District and Federal cooperation. These issues include: public school administration and funding, mental health services and costs of maintaining St. Elizabeth Hospital, police reimbursement, and the Anacostia River Cleanup.

As these descriptions suggest, a main element of the District/Federal relationship is funding. The report states that the river cleanup is one of Mayor Willams' highest priorities. The restoration of the Anacostia – cited as one of the most polluted waterways in the U.S. – "will help preserve the District's natural environment, improve habitation for wildlife and provide recreational opportunities for residents." The report then recommends that the Mayor, the Council and Authority should "collaborate with federal representatives to redefine the federal role in funding some traditional state functions."

The Federal government owns approximately 40 percent of the land area in the District. This property is tax-exempt and results in a substantial loss to the District's economy. A recent Brookings Institute study estimated that, based on a current commercial property tax rate of $2.15 per $100 of assessed value, the exempt property would generate $609 million in property tax revenue if it were taxable. If a lower commercial property tax of $1.31 per $100 were applied, $382 million in property tax revenues would be generated.

Of the 40 percent of District land owned by the Federal government, 14 percent of that land is in the combined sewer area. A WASA Memorandum from August 29, 2001 states that the Federal government contributes an average of 18 percent to the average annual CSO, yet has only been a ratepayer since 1996.

The National Park Service (NPS) is a major landowner along the Anacostia. Any plans for cleanup or revitalization of the Anacostia will have to work with this agency. However, NPS has appeared to take a very hands-off approach to protection or cleanup of the Anacostia region. One complaint about the Park Service is that it has let the riverfront properties languish as underutilized tracts that function currently as trash deposit sites for the river tides. Given the impact of erosion on water quality in the Anacostia, stream bank restoration and riparian buffers could make a substantial improvement in storm water management along the riverfront.

However, some have questioned NPS's approach and priorities. Most recently, the agency, in conjunction with D.C. Sports and Entertainment Authority, leased the parking lot surrounding RFK stadium to National Grand Prix Holdings to develop a grand prix style racetrack. Neighborhood associations and the local chapter of the Sierra Club protested the development of the racetrack, with air pollution and lack of public access the main concerns. These neighborhoods are already dealing with pollution generated by the Pepco power plant and have recently issued an informal survey that declared that residents of these neighborhoods suffer from elevated incidences of asthma. With the city already selling advance tickets to the event, the neighborhood groups and the Sierra Club have decided that their only recourse is to develop LID around the racetrack and parking lot perimeter.

NEIGHBORHOOD ROLES

The District government in recent years has sought an enhanced governing role for neighborhoods. In pursuit of this strategy, it has encouraged the formation of advisory neighborhood councils (ANCs) – elected bodies that can advise the District Council. Generally, at ANC meetings, which occur once a month, the neighborhood budget is reviewed and the police report is discussed. Redevelopment and gentrification remain the key concerns and the redevelopment of the waterfront mall has attracted some attention with community members participating in redevelopment discussions. However, these discussions have been occurring for the past three years and many in the community do not believe that change will actually occur in the Anacostia region. Environmental issues, such as cleanup of the Anacostia, are not seen as high or immediate priorities. For one, many sense that the river is beyond all hope – a "forgotten river" with little opportunity for water quality improvement, let alone a water body suitable for recreation.. Moreover, ANCs have focused on more pressing issues such as education and police protection. Yet clean up initiatives along the Anacostia are working to link environmental integrity with economic opportunity and social well-being. ANCs could potentially provide a significant forum for citizen participation within watershed planning and management.

OTHER INITIATIVES

The Anacostia Watershed Toxics Alliance (AWTA), administered by the Interstate Commission on the Potomac River Basin (ICPRB), is an important initiative focusing on the Anacostia restoration. The Alliance is a public-private partnership created in March 1999 to research and develop watershed-based solutions to toxic contamination in the river. AWTA formed partnerships with other Anacostia-focused restoration organizations like the AWRC, COG, Anacostia Watershed Society, and others and has worked to solicit funding for wetlands creation, LID projects, and toxic sediment capping. Their three-phase plan is now in the beginning of Phase 3, the cleanup phase. Phase 1 focused on data collection, while Phase 2 targeted filling data gaps and is being completed this spring. Phase 3 will focus on designing and implementing reasonable remedial actions necessary to effect restoration of the river such as source control and wetland restoration, as well as recommend effective monitoring strategies, and notify appropriate authorities of environmental conditions that are degrading river quality. AWTA's efforts to improve the water quality of the Anacostia and provide decision-makers with information on sources of contamination and risks to human and ecological health, makes it a key stakeholder in the Anacostia restoration process.

Another relevant and important stakeholder is the U.S. Navy- Naval District Washington, responsible for the Navy Yard campus in Southeast. Established in 1799, the Navy Yard is the oldest naval shore facility. Initially responsible for the manufacture of naval guns, industrial operations ended in the 1960s. The Navy Yard is located near the confluence of the Anacostia and Potomac Rivers, at the southern-most point of the Anacostia. A number of sites within the Navy Yard have been contaminated over the two hundred plus years of its operation with hazardous substances.

Environmentalists alleged that contaminated soil and sediments were being released into the Anacostia River.

The Justice Department issued a Consent Decree in April 1998 under which the Navy Yard and Southeast Federal Center agreed to cleanup actions. Remedial investigations are ongoing to determine remaining sites of concern, and a report is to be issued in summer 2002. Public participation since 1997 has been coordinated through the Restoration Advisory Board, which meets the first Wednesday of alternate months. The Navy Yard has completed storm sewer rehabilitation (July 1998 to May 2001), including numerous LID structures.

SMALLER GROUPS

A number of smaller organizations are also involved in the restoration of the Anacostia River.

The Port Towns Community Development Corporation (PTCDC.), a non-profit organization, formed by port towns surrounding the former Port of Bladensburg, is an initiative that could have substantial impact on watershed protection in the upper part of the Anacostia River and in Maryland. In an effort to revitalize the area, Bladensburg, Colmar Manor, and Cottage City, Maryland, have partnered with existing organizations. Suffering from failing infrastructure, lower quality jobs, and a degraded urban environment, the PTCDC develops projects to foster economic and environmental revitalization in tandem. With the help of Prince George's County Department of Environmental Resources (PGCDER), a portfolio of projects were initiated including: Anacostia River wetlands restoration, water quality retro-fit ponds, bio-retention rain gardens, fish-habitat structures, riparian reforestation, and streetscaping.

The Eyes of Paint Branch organizes community activities such as stream cleanups, field trips, bird walks, and tree plantings, and public education. Members are actively involved with monitoring the condition of the stream and coordinating with biologists and various organizations to ensure that the Paint Branch gets as much protection as possible. The Earth Conservation Corps (ECC), housed in the old Capitol Pump House on the Anacostia River, is a non-profit organization, which provides environmental education and restoration projects for disadvantaged youth who face violence and uncertain futures. Through tasks such as cleaning up the Anacostia River and returning the bald eagle to its natural habitat, young people are encouraged to develop a sense of community service and pride in themselves and their surroundings.

ANACOSTIA REAL ESTATE DEVELOPMENT

Watershed management should include consideration of economic as well as ecological and political factors affecting water quality and the use of bodies of water. In Maryland, economically depressed suburbs occupy the banks of the Anacostia with low-density populations. In D.C., the river runs through low and middle class neighborhoods with more impervious area than the Maryland communities and more people per square mile. National Park Service land buffers most of the river and it is hoped that reforestation efforts will establish an unbroken forest corridor ten miles long, mitigating erosion and runoff problems.

But what will happen behind these riparian buffers in city streets as restoration slowly proceeds apace? Redevelopment opportunities could provide the impetus to place a higher priority on the Anacostia clean up. At the same time, redevelopment also poses a significant threat of gentrification. The Anacostia Waterfront Initiative (AWI) targets five areas for revitalization: RFK Stadium, Near Southeast (west of the Anacostia), Southwest, Poplar Point (east of the Anacostia), and Anacostia and Kenilworth Parks. Key to making these attractive places to live, work, and shop will be short- and long-range plans that involve communities in the process, do not displace current residents, and offer job opportunities. As part of the Anacostia Waterfront Initiative, a river walk is planned to connect various environments along the river including open space, residential parcels, and shopping to surrounding neighborhoods and the rest of the District. On March 13, 2002, plans for a South Capitol Gateway Study were announced. It will determine the best ways to reconfigure the South Capitol Street corridor into an urban boulevard that enhances neighborhoods, and provides a symbolic gateway to the Nation's Capital. These areas correspond with Washington D.C. City Council Wards 6, 7, and 8. The Council members for these wards are

Sharon Ambrose, Kevin Chavous, and Sandy Allen, respectively.

Historically, these wards are the most poor, most economically depressed, and most crime-ridden in the city. It is likely that other issues – mainly affordable housing, crime and education – will remain the predominant concerns. While City Hall hopes that plans to revitalize the Southwest and Southeast waterfront will change the prospects for less advantageous parts of Washington, the challenge will be to ensure improvements in quality of life, environmental integrity and economic opportunity for current and future residents.

In addition to monitoring developments around the Navy Yard and Southwest in the Lower Anacostia River, there remains the problem of pollution from the Northeast and Northwest Branches and the Upper Anacostia River (above the D.C. city line). If these loadings were to be addressed, the attractiveness of recreational use would be manifest. Bladensburg Waterfront Park is enjoying a new lease on life after new buildings were constructed and facilities updated. The University of Maryland crew uses the river for practices, and it also serves as one of the staging areas for Earth Day trash outings. There are a number of small marinas and boat clubs between the Navy Yard and Benning Road. The members who kayak and canoe above the CSX rail bridge (where motorized boat traffic cannot pass) are strong supporters of restoration efforts. Both Anacostia Park and Kenilworth Aquatic Gardens are very busy on summer weekends, which means that people do like having parks on the river. How to make a stronger connection to the river by its recreational users is an important issue.

CONCLUSION

Although observers state that the relationships between the many agencies involved in District water issues are improving, the District's approach to water quality appears to be fragmented. WASA handles CSO discharges and DOH water quality standards; there is no over-arching committee to bring the groups together. EPA regulations are the only overarching guiding factor in addressing the issue of water quality in the District. Outside organizations such as AWRC and ICPRB are there to coordinate functions with the public and disseminate information, but do not act as advisory counsels. The ANCs do not appear focused on water quality at all.

This chapter has outlined a number of regulatory and institutional frameworks, under which a stronger watershed approach may be realized, as well as an overview of stakeholders that are in one way or another working to improve water quality in the Anacostia. While water resource management continues to proceed in a very technocratic and isolated way, there is opportunity for greater coordination among stakeholders and initiatives.

Given the financial demands placed on the city, ensuring water quality standards appears to be a concern only if EPA threatens action. If improving water quality in the District is a high priority for the EPA, more funding must be made available to address the issue. Within the District's water quality standards there is a provision made for "Special Waters of the District." These are waterbodies that have scenic or aesthetic importance to the District and their status directs that non-point source discharges, storm water and storm sewer discharges be controlled. Currently, the waterbodies receiving this designation are Rock Creek and its tributaries and Battery Kemble Creek and its tributaries. If the Anacostia Waterfront Initiative achieved the same status for the Anacostia River, perhaps this could provide another incentive for the District to address water quality in a watershed fashion.

At the heart of the combined sewer overflow and storm water pollution issues is the ultimate goal of improving the water quality of streams, rivers, lakes and bays. While CSOs are perhaps the most visible pollutant into local waterbodies, it is clear that overflows are inherently wet-weather flow events. In addition to CSOs, problems associated with wet-weather flow include surface and basement flooding, stream-bank erosion, and the destruction of fish and wildlife habitat. Many cities are revamping their CSO control policies under the realization that effective CSO control should entail an overall storm water management strategy.

Addressing storm water pollution requires that policymakers widen their scope to issues surrounding natural vegetation, floodplain functions, fish and wildlife habitat, erosion and land-use. CSO control and storm water management involve a wide array of agencies, including departments of environmental protection, health, public works and transportation as well as wastewater treatment agencies. Moreover, a watershed approach to water quality necessitates broader involvement and coordination of stakeholders and collaboration and partnership between private and public sectors, including residents and citizen organizations. While a strong understanding of environmental conditions throughout the watershed is important, policymakers must also be attuned to the social and economic needs of the surrounding community. Thus, if the goal is to improve the water quality of local waterbodies, policies and programs must be an integrated mix of strategies that address sewer infrastructure, storm water pollution, land use changes, and natural vegetative cover and hydrology and be based on a common understanding of the roles, priorities, and responsibilities of all stakeholders.

Chapter 4
Alternatives for the LTCP

Planning for better water quality of waterbodies in the Washington, D.C. area should take place on a watershed basis. This planning should address the problems of combined sewer overflows, needed reductions in storm water flows and associated pollution levels, and other relevant factors. Although set in this broader context, some of the most important decisions will involve considerations relating to CSOs. Reducing CSO levels can contribute importantly to the overall reductions in pollutant loads necessary to achieve the water quality goals of the District. In this chapter, alternative strategies for dealing with CSOs will be briefly examined. In June 2001, WASA released a draft LTCP. A final LTCP is due later in 2002. The LTCP will propose a strategy for reducing, or eliminating, CSOs into District waterbodies.

ALTERNATIVE TUNNEL CAPACITIES

The main focus of the draft LTCP, as released by WASA, is the construction of four tunnels along the Anacostia, the Potomac and Rock Creek. The rationale is that the storage tunnels convey and/or store the combined sewage during wet weather events CSOs would otherwise be unavoidable. The stored sewage can then be sent to Blue Plains, after the wet weather subsides.

Anacostia River. A major part of the CSO sewershed lies along the southern portion of the Anacostia River between RFK Stadium and the Washington Navy Yard. The LTCP proposes building two tunnels in this area with various options for configuration:

1. Poplar Point (which lies on the east bank of the Anacostia directly across from the Main and O Street facility) to the Main and O Street Pumping Station: This tunnel would connect to the Northeast Boundary outfall next to RFK. From the Northeast Boundary outfall, the tunnel would turn perpendicular to the river and parallel the existing Northeast Boundary Sewer to relieve street flooding in the Northeast Boundary Area.

2. Tunnel from Blue Plains to the Northeast Boundary: This tunnel consists of a storage/conveyance tunnel from Blue Plains to Poplar Point, extending under the Anacostia River all the way to the Northeast Boundary.

One set of LTCP alternatives would evaluate various tunnel storage capacities and calculate commensurate impacts on the predicted number of CSO events per year. As shown in Table 4-1, cost estimate options in the Anacostia Watershed were computed by WASA for different tunnel alternatives.

The Northeast Boundary tunnel would involve capital costs on the order of $1 billion and annual Operating and Maintenance (O&M) costs on the order of $10 million per year. The smallest tunnel capacity exam-

Table 4-1: Anacostia Watershed, Tunnel and Overflow Alternatives

Alternative	# of Overflows/Yr	Tunnel Capital Cost ($Mil)	Annual O&M ($Mil)	20-Year NPV ($Mil)
Tunnel from Poplar Point to Northeast Boundary	0	1,131	13.5	1,325
	2	876	10.2	1,022
	4	816	9.1	947
	8	770	8.5	892
Tunnel from Blue Plains to Northeast Boundary	0	1,285	15.1	1,502
	2	1,053	12.1	1,227
	4	984	10.9	1,140
	8	953	10.4	1,102

Table 4-2: Potomac Watershed, Tunnel and Overflow Alternatives				
Alternative	**# of Overflows/Yr**	**Capital Cost ($M)**	**O &M ($M/yr)**	**20-year NPV ($M)**
Tunnel from Georgetown to Potomac Pumping Station	0	640	8.8	766
	2	304	4.4	367
	4	246	3.7	299
	8	202	3.1	246

ined by WASA would reduce the number of CSO events to eight per year for a capital cost of $770 million and 20-year Net Present Value (NPV) of $892 million. Increasing the tunnel capacity to reduce predicted CSO events from eight per year to two per year would require an additional capital cost of $106 million and would increase the 20-year NPV by $130 million. The capital cost of reducing predicted CSO events to two per year with a tunnel from the Northeast Boundary to Blue Plains would be $1.05 billion. Reducing the predicted number of CSO events to zero would entail capital costs of $1.29 billion.

The highest costs would be associated with building a tunnel sufficient to eliminate any volume of predicted CSOs under wet weather conditions over the course of a reasonably normal year, a "zero tolerance" policy. (In practice, however, a hurricane or other extraordinary weather event is likely to overwhelm any system, no matter how large it is.) The additional capital cost of expanding tunnel capacity in order to move from two predicted CSO events to zero predicted CSO events would be $255 million.

Potomac River. This element of the draft LTCP consists of constructing a CSO storage tunnel (from outfall 029) west of the Key Bridge, parallel to Georgetown, terminating at the Potomac Pumping Station. Hence, the Georgetown CSOs would overflow directly into the new tunnel and a short pipeline would be required to convey CSO flow from Easby Point to the new tunnel. Additionally, dewatering facilities could be constructed at the Potomac Pumping Station.

The tunnel possibilities considered, and associated levels of CSO events per year, are shown for the Potomac Watershed in Table 4-2. For the Potomac, moving from a predicted level of two CSO events per year to zero CSO events per year would more than double the combined capital cost and 20-year NPV.

Rock Creek. As proposed in the draft LTCP, WASA would build a Storage tunnel (at CSO outfall 049), Piney Branch. The alternative tunnel capacities, predicted number of CSO events, and capital costs are shown in Table 4-3. The tunnel costs of the Rock Creek watershed are much less than for the Anacostia and Potomac, but a large increase in costs would still be required to attain zero CSO events.

TUNNELING COSTS

There are additional tunnel alternatives that might be examined, in addition to those already studied by WASA in its draft LTCP. The principal cost of such

Table 4-3: Rock Creek Watershed, Tunnel and Overflow Alternatives				
Alternative	**# of Overflows/Yr**	**Capital Cost ($M)**	**O &M ($M/yr)**	**20-year NPV ($M)**
Piney Branch Storage Tunnel; Separate CSO 059; Reconstruct Regulators for CSO 031, 033, 036, 037, 047 and 057; Relieve RCMI to proposed Potomac Tunnel	0	59	0.7	69
	2	41	0.5	48
	4	39	0.5	46
	8	36	0.4	42

Table 4-4: Tunneling Costs and Capacities			
Finished Diameter (Ft)	Rock Digging Costs $/LF[4]	Soil Digging Costs $/LF	Volume Gal/Ft
10	3,060	4,816	235
15	3,610	5,227	353
20	4,310	5,974	470
25	5,160	7,057	588
30	6,160	8,476	705

Source: WASA EPMC III: Tunneling Cost Data

alternatives is the cost of digging the tunnel itself. Table 4-4 shows the relationship between tunnel cost and tunnel capacity to store CSOs. (Tunnel capacity is achieved by increasing the diameter of the tunnel; the length of the tunnel is fixed.) Tunnel costs also depend on the excavation medium. For instance, as compared with hard rock, tunneling in soil is significantly more costly, as this requires shoring up the tunnel walls with concrete to ensure structural integrity.

IMPROVEMENTS TO THE EXISTING SYSTEM: REAL TIME CONTROL

The Real Time Control (RTC) system is a network of electronically controlled switches that add flexibility to the capacity of the sewer system. By adjusting to changes in the volume of runoff entering the sewers, switches, control gates, dams, and other structures slow the speed of the flow, giving Blue Plains a buffer in handling the high sewage loads caused by wet weather events. Simply upgrading the existing system to make it operate more efficiently, and optimizing existing storage capacity, could reduce CSO overflows significantly – by perhaps *80 percent* or more. The cost of such upgrades is uncertain but could be as little as $200 million in total. As stated by WASA, the multiple-tunnel plan would cost well in excess of $1 billion. This additional spending for tunnels would achieve CSO volume reductions of 96 percent for Anacostia, 85 percent for Potomac, and 78 percent for Rock Creek. An additional $800 million might yield only another 16 percent reduction in CSOs. With this in mind, tunnel building should be weighed against options that may yield much faster results at significantly lower cost. Real time operating improvements include:

Inflatable Dams. These balloon-like structures retain flow in the collection system, increasing the effective depth by which the combined sewage must rise before overflow occurs. During heavy storms, the dams deflate to reduce the risk of flooding and backup. Of the 12 dams installed by WASA, 9 are now heavily damaged and prevent sewage from being diverted to Blue Plains, even during dry weather. Replacing all 12 dams with seamless dams, sensors, and real-time controls will cost WASA about $2 million.[1]

Repair Northeast Boundary Swirl Concentrator. Swirl concentrators use centrifugal force to separate sewage by concentrating the major pollutants, debris, and sediments in the vortex of swirling water. Once separated, the remaining, cleaner flow is disinfected before it is discharged. Skimmed sewage is sent to the treatment plant. In 1990, the District installed a swirl concentrator at RFK Stadium as part of the Phase I CSO abatement programs and has subsequently installed three additional concentrators. However, due to operational difficulties, these concentrators are not in use at present. The EPA has provided WASA with $2 million to upgrade these facilities.[2]

Improve efficiency of existing infrastructure. Accumulated debris and sedimentation in pipes has reduced capacity of some sewer interceptors by as much as 60 percent. For instance, the deteriorated condition of the East Side Interceptor (which runs from the Northeast Boundary sewer to the Main and O Street Pumping Station) discharges sewage into the

[1] This will be included as part of WASA's Capital Improvement Program.

[2] Anacostia River Watershed Restoration Action Strategy, Internal Review Draft, DC, DOH, June 1999

Anacostia. It is supposed to be treated at Blue Plains. A sum of $3 million was appropriated for this purpose under the FY 99 D.C. Construction grants project. Periodic catchbasin cleaning would also make a perceptible contribution, an activity that has been a low priority for WASA.

Pumps. Blue Plains could treat a greater volume of water if pumping facilities were upgraded. The cost estimate for the rehabilitation of the Main and O Street facility is about $90 million, excluding an $8.5 million upgrade. At $11 million, rehabilitating East Street would be less expensive.

Trash Traps. Currently only one trash trap has been installed on the lower Anacostia at a cost of $250,000. The trap prevents floating debris conveyed by sewer lines to the waterfront from entering the river. WASA operates small motor boats equipped with mechanical jaws that periodically skim the river from the CSX Rail Bridge down to the confluence with the Potomac. The Army Corps of Engineers also operates boats and barges to retrieve larger debris and heavy items the WASA skimmers cannot handle. Above the CSX Rail Bridge, the majority of the Anacostia's length is neither skimmed nor monitored by WASA, or the COE. The floatables are not an ecological threat as much as a visual blight perpetuating the perception of neglect. Construction costs are estimated at $200,000 for end-of-pipe netting systems on outfalls, $16,000 each for bar racks, and $750 each for street level catch basin hood modifications. These all require regular cleaning and removal of debris to work effectively, again something that WASA historically has not attended to rigorously.

Table 4-5: Methods of Improving the Operation of the Existing System

Action Undertaken	Est. Costs ($)
Inflatable Dams	2,000,000
Repairing the Swirl Concentrator	2,000,000
Repairing the Pumping Stations	90,000,000
Trash Traps:	
Netting (end-of-pipe)	200,000
Catch Basin Hoods	750
Bar Rack	16,000
Clean up pipes and interceptors	30,000,000

CONCLUSION

Without a pressing reason, it may be difficult to justify spending over $1 billion to construct CSO storage tunnels. Even if the District does reduce its CSOs by 95 percent, as projected in the LTCP, it still will not meet mandated "fishable-swimmable" EPA water quality standards. Therefore, a more thorough analysis than has been done to date is warranted before any large-scale investment is undertaken. Ultimately, the goal to improve water quality must address CSOs, but not neglect stormwater in the process. Thinking in terms of watershed and not just one city sewer system will generate a better overall solution even if the coordination is unwieldy. Tunnels are most effective for containing occasional severe wet weather events, but do not yield aesthetic or ongoing economic benefit once completed. As discussed in Chapter , LID can offer both a daily contribution to aesthetic value and simultaneously help control all wet weather events. These characteristics are important in making investment decisions and need to be highlighted lest they be lost in the details of planning.

Many writers on the general subject of environmental policymaking in the United States have lamented the lack of flexibility and narrow vision of most environmental decision-making. Some writers have suggested that future environmental efforts should be based on strategies of watershed management and adaptive management. Despite wide advocacy of watershed and adaptive approaches to environmental management, so far EPA and other environmental agencies at the federal, state and local levels have found these newer approaches difficult to put into practice. These agencies have either been unable, or unwilling, to depart from their more traditional and familiar ways of doing things, in favor of a promising but unfamiliar approach that may offer better results.

Chapter 5
Controlling Stormwater at the Source

An alternative to full reliance – or even partial reliance – on large-scale infrastructure projects to capture CSOs would be to reduce the storm water volume before it enters the sewers. Low impact development (LID) is a relatively new approach to addressing storm water. The core principal of LID is use architectural, landscape, and vegetative features to reduce the proportion of impervious surface land area and to retain rainwater where it falls. The resulting decrease in volume of storm water runoff eases stress on the sewer system. The use of LID might be able to achieve water quality standards at much lower initial costs than more centralized approaches such as tunnels. Alternatively, a commitment of the same amount of money to LID – money otherwise intended for tunnel infrastructure – might be able to achieve greater improvements in water quality, compared to the tunnel-only alternative. Consideration of LID, along with tunnel options, would be integral to any implementation of a full watershed management approach.

LID tools include building rain gardens, grass swales, green roofs, tree boxes and other methods that encourage infiltration and retention of storm water runoff. While the theoretical principle behind LID is sound, practical applications have been limited. As a result, it is difficult to estimate the effectiveness of LID in terms of the volume of storm water reduced, its long-term applicability and the cumulative long-term costs of implementing it throughout the city. In addition, characteristics of every city differ and hence one cannot implement a standard cookie-cutter method to LID implementation. Certain areas of D.C. have high water tables and a greater injection of water would exacerbate the situation. Thus, while LID is a powerful tool in storm water management, it needs to be applied with knowledge of the affected area.

In addition to controlling storm water, LID generates several positive externalities including neighborhood beautification, community-building , and providing employment opportunities. Organizations like the Anacostia Watershed Society in Bladensburg and Earth Conservation Corps in D.C. are active in wetland and habitat restoration, building green roofs and rain gardens, making consistent progress in mobilizing the community along the Anacostia River.

LID IN THE DISTRICT

Within the District there are a small number of pilot LID projects; however, there have been gestures to expand the use of LID. DOH's Watershed Protection Division, which is the main DOH division involved with LID, is also charged with scrutinizing redevelopment plans to determine viability of LID. All developers with plans over 40,000 square feet are encouraged to incorporate LID. To assist developers, the Watershed Protection Division has created a manual on implementing LID. The Watershed Protection Division is promoting LID because, when compared with WASA's response to CSO, it is a low-cost solution to D.C.'s storm water and sewer runoff problems. Despite the practice advantage and inexpensiveness of LID, the Division of Watershed Protection views LID as a compliment to WASA's centralized approach.

Tree Cover. One potential plan to promulgate LID in the District involves increasing tree cover. Planting more trees water lowers runoff and in turn shores up soil stability. American Forests conducted a study of tree cover for the Washington, D.C. area. The study used geographic information systems (GIS) to document both green infrastructure, including tree cover, shrubs and grass, and gray infrastructure, including buildings, roads, utilities and parking lots. The density of tree cover in D.C. ranges from a high of 72 percent to a low of only 9 percent. In total, the region has 187,767 acres of tree canopy (46 percent), 110,300 acres of impervious surfaces (27 percent), and 70,747 acres of open space (17 percent). One value of this forest of tree cover is its ability to retain storm water. The total storm water retention capacity of the area is 949 million cubic feet, which results in

$4.7 billion saved in avoided storage of water (based on construction costs of $5 per cubic foot to build equivalent retention facilities). Trees intercept rainwater on their leaves, branches and trunks and slow storm flow thereby reducing the volume of water that a containment facility must store.[1]

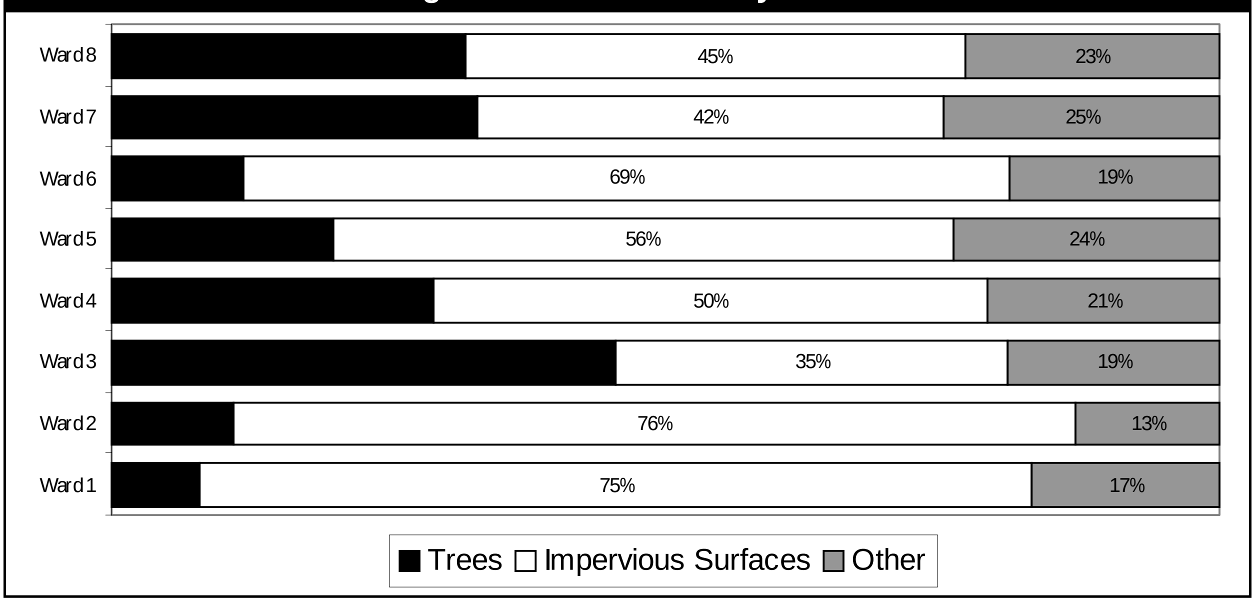
The potential for cost savings through an increase in tree cover is particularly evident in Ward 1 of the District. This ward currently has a tree cover of 3 percent; increasing the tree cover to 15 percent would result in $300,000 in storm water management and air quality benefits. In addition, the current value of the streamside vegetation along the Four Mile Run watershed, which drains into the Potomac River, is estimated at almost $4 million. This vegetation serves to reduce and slow runoff and provide shade to keep water temperatures at levels safe for fish, even though only 46 percent of the 2,400 acres is tree covered. On the lower Anacostia, 44 percent is impervious, 28 percent is tree covered, and 26 percent is open space. The value of the Anacostia's green infrastructure is $13.5 million for storm water control. Figure 5-1 and Table 5-1 describe the current land cover situation in D.C. and show the potential ecological benefits to be garnered from increased green infrastructure.

Vegetative Cover. Storm water runoff can lead to soil erosion, sedimentation, and increases in impermeable ground cover. The addition of vegetative covers – another method of LID likely to be adopted within a watershed framework – can be used to preserve existing vegetation and/or revegetate disturbed soils. These covers can increase infiltration, trap sediment, stabilize the soil and dissipate the energy of hard rain. The two methods evaluated by the EPA are adding sod by placing a strip of permanent grass cover and the alternative of preserving existing vegetation, which allows it to function as a natural buffer zone. These vegetative covers can be installed at relatively low cost and require little maintenance. The LID Center in Beltsville, Maryland has demonstrated that the maintenance cost can be included in the regular landscaping budget. In addition to controlling runoff and enhancing the beauty of an area, the proper plants can act as filters to remove pollutants from storm water. Vegetative covers can capture the first half-inch of rainwater, or the first flush during a storm event, which usually contains the heaviest load of pollutants.

Green Rooftops. A vegetated rooftop provides the benefit of capturing storm water in the same way veg-

[1] American Forests. Urban Ecosystem Analysis for the Washington DC Metropolitan Area: An Assessment of Existing Conditions and a Resource for Local Action. www.americanforests.com, February 2002

Figure 5-1: Landcover by Ward



Source: American Forests, 2002, www.americanforests.org etative covers do. “Green roofs” can help to slow down runoff during storm events. The roof covering also helps to keep the rooftop cooler in the summer and insulated in the winter, which reduces energy costs for heating and cooling a building. See Appendix C for a full list of storm water management practices.

LID UNCERTAINTIES

LID is a relatively new concept. To date, no large scale LID project has been executed, and hence the full potential effectiveness of the technology is unknown.

WASA is leery of committing to something new and untested on the scale that would be required to have a significant impact on total wet weather flows to the sewer system. One concern is that WASA will be liable if it fails to meet EPA targets. EPA might deny WASA its NPDES permit – dependent on approval of a satisfactory LTCP for dealing with District CSOs – with potentially severe negative consequences.

The LTCP acknowledges these uncertainties and emphasizes that few studies have been conducted for applying LID-retrofits to urban areas and the associated costs are highly site-specific. In addition, D.C. would need to modify its storm water management regulations to mandate LID techniques for new construction. Redevelopment occurs gradually; this limits the extent LID is implemented by retrofitting existing structures. According to WASA, it can implement LID on land that it owns, but it cannot assume responsibility for maintaining LID across the city. It is not as yet certain as to who would be able to undertake this responsibility.

D.C.’s Environmental Network is a coalition of stakeholders and environmental groups in the city who feel that LID should play a greater role in the LTCP. Major points of contention are related to WASA’s cost estimates and its assumptions regarding redevelopment cycles.

The D.C. Office of Planning and the EPA could undertake a pilot project to determine the true effectiveness of LID as a technique for storm water management. If it does indeed turn out to be effective as a strategy, D.C. officials can combat the storm water problem in this decentralized manner.

EPA VIEWS

Regarding LTCP implementation, the EPA may offer the flexibility to adopt wider experimentation with LID than WASA believes. The CSO Control Policy promulgated by EPA provides that schedules may be phased in based on the relative importance of adverse impacts upon water quality standards and designated uses, priority projects identified in the LTCP, and on a permittee’s financial capability. Moreover, “phased implementation also allows time for evaluating completed portions of the overall project and the opportunity to modify later parts of the project due to unanticipated changes in conditions.” This phased imple-

Table 5-1: Ecological Benefits of Green Infrastructure in the District

Ward	Air Pollution Lbs. Removed	Air Pollution Value	Storm Water Control Value	Retention Volume Required to Mitigate Loss of Trees
1	14,204.09	$35,054	$4,417,900	2,208,950
2	33,605.27	$82,934	$9,406,572	4,703,286
3	276,425.29	$682,183	$28,105,910	14,052,955
4	140,851.04	$347,603	$15,586,854	7,793,427
5	117,132.90	$289,069	$16,766,834	8,383,117
6	33,520.12	$82,723	$7,143,946	3,571,973
7	149,952.95	$370,065	$15,338,246	7,669,123
8	113,996.83	$281,330	$11,168,958	5,584,479

Source: American Forests, 2002, www.americanforests.org mentation is of particular interest with regard to the potential for use of LID.

EPA Region 3 is "very supportive" in terms of applying LID(-retrofit) techniques in D.C. as part of the LTCP. According to EPA, the technology has to be validated on site. Additionally, one should take into account that the pace of urban redevelopment (often gradual) determines the pace of LID retrofit. In its written comment, EPA Region 3 called for a "more thorough proposal for LID options" within the entire District, the identification of "specific mechanisms to implement [LID] District-wide." Region 3 also called for a review of various levels of application for LID projects to assess storm water flow reduction, and LTCP coordination with storm water management plans required by the MS4 permit.

More generally speaking, for Region 3, the LTCP is a "living document" that evolves over time. Apart from commenting on LID, EPA Region 3 made a total of 41 detailed comments on the LTCP covering several categories from cost issues to public participation. This shows how serious Region 3 takes its own role in implementing the overall CSO Control Policy.

From an enforcement perspective, there are few absolute requirements in the CSO Control Policy. Usually, the schedule for LTCP CSO control implementation does not exceed 15 years. As a practical matter, however, EPA allows for stretching out this period to 20 years so that D.C. can win political and public support for its LTCP. According to EPA officials interviewed for this project, the key in complying with the CSO Control Policy is to submit a LTCP which shows an "aggressive schedule for reducing CSOs;" what communities have to show is well-paced progress. This leaves room for a staged approach and for application of LID. Even with remaining uncertainties concerning the maintenance of LID facilities and the achievable reduction of water flow, EPA Region 3 would accept a LTCP that consists of a first phase of LID practices on a specified sewer shed over a given time period, and coupled with the subsequent building of a storage tunnel with the necessary adapted diameter.

Despite the regulatory flexibility in the choice of controls, such an approach has not been taken thus far by D.C. WASA for the following reason: WASA cannot force the placement of LID on private or public property that does not belong to WASA. It can only encourage private or public property owners to install LID if they are convinced that it will work. Furthermore, WASA has no expertise on LID, and cannot take responsibility for the performance of such facilities. According to one official, EPA itself is internally split on the flexibility issue with regard to wider application. One line of thinking mirrors the "LID first - tunnel second" approach with the hope of bringing down infrastructure costs. The other line of thinking is to do as much on the upfront planning as you can possibly do, based on the notion that any re-evaluation of plans becomes exceedingly difficult.

In regard to what is occurring in D.C. and elsewhere, EPA Region 3 sees the practical development of LID as an "evolutionary process;" the more experience there is concerning reliability and operability, the more it will or will not be applied in future LTCPs. The primary concern of current LID critics is that, in the past, LID projects in urban settings did not exceed a certain scale. In order to surmount this obstacle, pilot projects demonstrating LID application at a larger scale could accelerate the evolutionary learning process.

EPA's own evaluation of the controls applied by CSO communities for their respective LTCPs distinguishes the controls into three broad categories: collection system optimization/control (which has been dominated by sewer separation activities), treatment, and storage. Among the most frequently implemented LTCP controls are sewer separation, sewer rehabilitation, retention basins, and disinfection. According to EPA, it has no data showing to what degree LID has been part of any LTCP so far. EPA's perception is that in the context of CSOs, LID effectiveness has not yet been proven. Nevertheless, LID is promoted as an alternative comprehensive approach to storm water management that can be used to address a wide range of wet weather flow issues, including CSOs, TMDL permits, non-point source program goals, and other water quality standards. EPA recently granted $1 million to the District to study the feasibility of applying LID techniques to highly urbanized areas and to provide a website that gives guidance to local governments, planners and engineers for incorporating LID into their aquatic resource protection programs.

One EPA official stressed the importance of having a local leader at the political level that takes the initiative and presses ahead with a more widespread application of LID. He admitted that otherwise, partly due to the uncertainty associated with the responsibility for maintaining LID facilities, it could be hard to move forward. Estimated costs are shown in Table 5-2.

As to the storm water within the separated sewer shed, which covers more than 66 percent of D.C.'s total area, it makes an important contribution to the water quality as mentioned above. Regarding EPA's handling of the separate sewer system issue, D.C. has to hold a MS4 permit issued by EPA Region 3. The duration of that permit can theoretically be up to five years. In

Table 5-2: LID Costs

Costs for Small Commercial LID Retrofit				
Item	**Unit**	**Quantity**	**Cost**	**Subtotal**
Permeable Pavers	sq ft	21,780	$8	$174,240
Inlet Retro-fits	each	2	$3,500	$7,000
Street Tree Filters	each	2	$5,500	$11,000
Bio-retention Parking Areas	each	2	$4,500	$9,000
Bio-retention Sidewalk Areas	each	4	$3,500	$14,000
Total				**$215,240**
Cost per Acre				**$161,652**
Costs of High Rise LID Retrofits				
Item	**Unit**	**Quantity**	**Cost**	**Subtotal**
Street Tree Filters	Each	8	$5,500	$44,000
Bio-retention Parking Areas	Each	6	$4,500	$27,000
Bio-retention Sidewalk Areas	Each	4	$3,500	$14,000
Bio-retention Filter Strips	Each	5	$2,500	$12,500
Total				**$97,500**
Cost per Acre				**$19,979**
Cost for Commercial LID Retrofit				
Item	**Unit**	**Quantity**	**Cost**	**Subtotal**
Green Roofs	sq ft	70	$5	$354,720
Bio-retention Cells	sq ft	17,000	$4	$68,000
Total				**$422,720**
Cost per acre				**$144,273**
Cost for Row-house Retrofit				
Item	**Unit**	**Quantity**	**Cost**	**Subtotal**
Light crew disconnect downspouts/install rain barrels	Day	15	$435	$6,525
Bio-retention Cells	Cb yd	60	$2,500	$150,000
Total				**$156,525**
Cost per Acre				**$ 48,310**

the case of D.C., EPA Region 3 wants to stay flexible and therefore restricts the MS4 to a time-span of only three years; D.C.'s last permit became effective in 2000 and will expire in 2003.

Region 3's call for more coordination between the LTCP and the storm water management plans required by the MS4 permit reflect the notion of a watershed approach, as discussed in Chapter 5. This approach showed up on EPA's agenda during the Clinton Administration and is referred to frequently in CSO guidance documents. According to an EPA official, it is exactly this notion that creates "immense internal conflicts", although they may not be observable from the outside. It also marks the line between some EPA staff in the NPDES program and in the enforcement branch. Whereas the former stress the importance of the ultimate water quality and the interconnection of pollution problems, the latter emphasize the incremental character of environmental policy and the fact that "you have to start somewhere."

This EPA rift demonstrates doubt in claims of dramatic gains from increased coordination between CSOs and MS4. They see risk in delaying effective pollution reduction, in terms of CSOs. For the NPDES program staff, the pressures for an incremental process became more evident in preparing the recent report to Congress on CSOs. During this evaluation, enforcement officials surprised them by revealing that they had to bring lawsuits against many bigger CSO cities in order to actually enforce the CSO Control Policy. Fortunately, the watershed approach has many promoters within EPA headquarters and EPA Region 3. In 1998, they organized a special panel on CSOs and storm water management in D.C. to bring all stakeholders together.

LTCP FUNDING SOURCES

A major factor affecting the relative feasibility of LTCP alternatives is the availability of funding. Without large increases in fees charged to system users, WASA is unlikely to have the resources on its own to implement significant capital-intensive improvements. Table 5-3 shows the WASA operating budget; most of this money is already committed for routine activities of WASA and would not be available for major new initiatives.

If funding is available from EPA or other sources, for say, tunnels but not LID, the relative cost-effectiveness would have little practical significance. One concern with respect to a greater reliance on LID is that the money to implement this approach may be more difficult to obtain, compared to the familiar large-scale centralized projects like tunnels. LID has very little history. Some potential sources of new water quality funding for the District are shown in Table 5-4.

Existing funding sources are unlikely to be sufficient to support large capital expenditures by WASA. Funding of tunnels or other intensive infrastructure spending by WASA would appear to be feasible in only two ways: (1) a direct appropriation for this purpose by Congress, or (2) a large increase in user fees that would allow WASA to pay the costs from its own revenue. Fees might be dedicated to paying off bonds that WASA would issue for the purpose of funding new construction.

Sewer System Fees: User fees are charged regularly to all for wastewater utility services. Utilities can assess rates to cover their full costs including capital cost recovery ("full cost pricing"), or subsidize the costs of service with general revenues. Rates are usually measured in cents per 1,000 gallons of water withdrawn or discharged into the treatment system. Rate revenues link capital expenditures and operating budgets, and are a major factor in determining the rate base and rate structure. A WASA rate committee makes policy decisions to: subsidize classes of users (e.g., the elderly or disadvantaged, urban residents), raise block rates to encourage conservation, or lower block rates to promote economic development.

Currently, sewer rates are calculated as a proportion of water supplied to a commercial or residential unit.

Table 5-3: WASA's budget

	FY 202 Approved	FY 2003 Proposed	% Change
Operating Budget	$ 244,978,000	$ 253,743,000	3.6

Table 5-4: Potential Funding Sources			
Source	**Type**	**Amount**	**Remarks**
ISTEA	Grant	$ 171 mil	Could be used to retro-fit and redesign the roads, highways and transit systems in DC.
Clean Water SRF	Grant	$ 410 mil (Nationwide)	Grants for large-scale projects as well as smaller projects. Takes the characteristic of each individual community into consideration.
EDA	Loan		Loans for infrastructure and public works projects.
Grant 319	Grant	$ 2 mil	Used to finance small, decentralized projects that strive to achieve the objectives of the Clean Water Act.
Wet Weather Water Quality Act, 2000	Grant	$1.5 billion (total)	Funds for this are yet to be appropriated by Congress
NCPC	Federal funds	as required	Undertakes and oversees all projects and modifications on federal land.
Property taxes	Local revenue		Tax rate is relatively higher than the rest of the coun try. However as federal property is tax exempt, its revenue from property tax is low.
User fees	Revenue		Currently proportional to water consumption. To encourage LID, fee structure would reflect property's impervious area.
Municipal Bonds	Debt	$ 1 Billion	WASA floats bonds for Capital Improvement Program. Anticipatory bonds by the District.

This provides no incentive to reduce storm water runoff. Since calculating wastewater discharged could be difficult, charging rates in proportion to impervious surface area might be a solution. Additionally, these impervious-area-contingent rates could be structured to encourage LID, with credits given for implementing LID practices.

Despite avoiding payment of property taxes, federal facilities do pay for wastewater treatment on the same basis as other customers (through metered water use). The only difference for the federal government is how bills are treated. For example, the U.S. Treasury is billed quarterly (in advance) based on estimated consumption. An adjustment is made later based on the actual metered use. The Treasury then apportions the bill to the various federal departments.

Current sewer rates charged by WASA are shown in Table 5-5. However, WASA would need to apply a rate hike in order to fund the LTCP entirely with user fees. As mentioned earlier, those most likely to be affected by a rate increase would be the predominantly low-income minority residents in Northeast, Northwest, and Anacostia.

Suburbs in the regional watershed contribute to the sewage problem and D.C. residents rightly claim they may be forced to bear an unfair burden. If the suburbs of Maryland and Virginia that send sewage to Blue Plains contribute to the CSO and storm water

Table 5-5: WASA Sewer and Storm Water Fees	
Current sewer rate	$2.71 per CCF (hundred cubic feet)
DC stormwater fee	$1.75 flat per quarter/ year for residences 2% of the water rate/per ccf used for commercial, Federal, Municipal, DCHA 1.4% of the water rate/per ccf used for multi-family

Source: DC WASA Website www.dcwasa.com

abatement costs, it could greatly ease that burden, and reduce regional animosities.

Bonds: WASA intends to fund its capital improvement program, totaling $ 1.6 billion dollars by floating bonds and increasing its debt load to $1 billion by FY 2010. To cover the debt incurred, WASA wants to increase rates.

Anticipatory Bonds: Bonds linked to a particular area such as Anacostia, in anticipation of rising property values over a period of time are called anticipatory bonds. Hence, they could serve as a viable instrument to finance sewer and LID projects. The reputation of the Anacostia is rooted in social conditions and historically poor water quality. Improving water quality might transform the quality of life for area residents and would likely have a positive effect on real estate prices in CSO-affected areas.

CONCLUSION

As shown above, the CSO Control Policy and the MS4 program leave considerable discretion to the community in choosing the controls it deems appropriate. In terms of the flexibility of controls, D.C.'s water quality issue could be solved on its own. Regarding EPA Region 3's role in the LTCP development process, it took an active part by commenting comprehensively on the draft.

Although EPA does not promote enormous tunnels, it does not prohibit the construction of enormous tunnels either. This represents a problem if EPA indeed desires to foster LID application. Tunnel-building engineers have a much longer and often successful experience with their technology than do promoters of decentralized, small-scale technologies like LID. As a consequence, LTCP planning relies mainly on tunnels and other conventional technologies. The same is true for other cities. With a perceived lack of experience in LID application in urban areas, especially as part of LTCPs, moving LID implementation forward has been hindered by an unwillingness to take the first step under the perceived uncertainty.

Moreover, once a storage tunnel is built, it will be much harder to convince policymakers and communities to provide funding in order to explore the potential of LID on that particular sewer shed. Once $1 billion is spent and the tunnel is built, additional LID would no longer be necessary – at least not for the purpose of reducing current storm water flow. Instead, the centralized, large-scale technology would do the job. Given the budgetary constraints D.C. and other municipalities face, they are not very likely to invest into additional projects that go beyond the requirements of the CSO Control Policy.

Following an "evolutionary process," the policy recommendation for EPA might be "wait-and-see." From this perspective, LID will be implemented much more anyway if one assumes that it indeed has a high potential for reducing storm water volume. The essential point to recognize here is that LID has shown the potential of being less costly for many applications. It has been used successfully in suburban areas, and there are examples of successful use in urban areas. Nevertheless, further investigation is needed on construction costs, maintenance responsibilities, private/public cost sharing, and cost-effectiveness.

With this said, "wait-and-see" may not be appropriate, because sewage ratepayers in several hundred US communities would potentially benefit from applying LID to a higher degree. Unfortunately, there seems to be a critical threshold in terms of experience necessary for stepping forward with LID implementation, and, moreover, a lack of financial incentives for doing so.

Chapter 6
Resolving the CSO Issue: Adaptive Management and a New Institution

The development of a new institutional mechanism for full watershed management, as proposed in this report, will take time. Meanwhile, WASA faces an immediate requirement to renew its NPDES permit for CSOs from EPA. If the permit cannot be renewed, WASA would be in violation of the Clean Water Act and subject to potential penalties. One option would be to make the case to EPA that it is premature at this point to adopt an LTCP for CSOs, arguing that a more satisfactory overview mechanism for watershed management needs to be put in place. Making a CSO commitment at this time might involve very large future expenses. It is possible that, once a watershed framework of management is put into effect, more efficient ways of spending the money – significantly reducing costs of achieving more pollution reduction for a given level of spending – might be achieved.

In this concluding chapter, nevertheless, it will be assumed that WASA will go ahead to develop a LTCP for resolving the CSO issue. Based on the comments received following issuance of the draft LTCP in June 2001, WASA plans to present a final LCTP later in 2002. It is likely that there may be significant revisions to the final LCTP. In addition, the LTCP is ultimately only a plan, and the actual outcome may change significantly in the interim between plan, design, and implementation phases.

Ideally, the LTCP should incorporate an exhaustive analysis of WASA's final proposed action for CSOs, and justification for why various alternatives were considered but rejected. Alternatives that WASA might examine could include the adaptive management alternative described in this chapter, as well as relevant management considerations.

ADAPTIVE MANAGEMENT STEPS

The problem with the LTCP for the Anacostia and Potomac Rivers is that solving only the CSO problem would not, by itself, significantly improve the water quality of these receiving waters. One set of alternatives for the LTCP being developed by WASA depends on variable implementation timeframes for each element of the proposed alternatives.

WASA's proposal addresses the CSO issue by building tunnels to intercept overflows to the worst CSO outfalls. Still in the planning stages, the entire CSO control policy would take perhaps 25 years and more than $1 billion. The tunnels would be constructed in phases, with the Anacostia tunnel(s) heading the list. Only after the Anacostia tunnel is completed will WASA draft a plan for the next tunnel. Spending $1 billion or more for a project that will require 20 to 25 years to complete merits careful analysis. One option is an adaptive management strategy in which each step would be phased in based on what had been learned in the previous phases. For purposes of discussion, the following adaptive management alternatives is proposed.

Step 1 – Upgrade the existing combined sewer infrastructure. The numerous ways this step could be implemented are found under "Real Time Control" in Chapter 4. According to the Anacostia Watershed Restoration Committee, implementing all the modifications and optimizations of the existing system may reduce existing CSO discharges by as much as 80 percent. If this mitigation potential is manifested, a large tunnel may lose its appeal, given the comparative costs and project duration for achieving similar results with less effort.

Step 2 – Implement LID structures widely throughout the combined sewer area. Because LID integrates landscaping, architecture, and energy conservation in best management practices, it offers a holistic treatment of CSO and storm water while improving the quality of life in communities. LID, in addition to diminishing the storm water problem, generates many positive externalities such as "greening" the cityscape with trees, shrubs, and vegetative swales. LID reduces energy costs by attenuating the need for heating and cooling of buildings. Another long-term benefit of LID is that ongoing maintenance and monitoring needs will generate substantial employment opportunities. Last but not least, LID fosters community-building because it is an approach that depends on the cooperation of many neighbors to achieve its goal for the common good.

Because the effectiveness of LID is as yet unproven, one plausible plan of action would be to implement LID in areas targeted to yield the greatest CSO abatement for the District. Given the urgency of addressing CSO issues, the top priority targets for LID might well be the current combined sewer areas in Northwest and Northeast D.C. Once these initial target zones were partially fitted with LID, cumulative observation of runoff data would inform the next step of the adaptive strategy with two possible outcomes:

1. LID is effective by itself in resolving the CSO problem. Runoff during wet weather events is no longer significant causing sewer overflows.
2. LID is only partially effective. To complete the solution, a more capital intensive centralized solution is required, such as a tunnel.

Step 3 – In the event that LID is only partially effective, proceed with construction of one or more tunnels. Employing LID followed by a period of monitoring would establish a baseline for the ability of LID to handle runoff. It would allow time to decide what the capacity parameters of a tunnel would need to be, based on up-to-date information, which the LTCP is currently missing.

PARTIAL ADAPTIVE MANAGEMENT

A fully adaptive management approach risks that initial efforts (real time controls and LID) may be inadequate to achieve water quality objectives. A way of minimizing this risk would be to adopt an approach that might be labeled "partial adaptive management." Under this approach, WASA would proceed directly to construct one Anacostia tunnel. With 17 outfalls on the Anacostia River, such a tunnel would reduce predicted CSO events from 75 to 4, according to the draft LTCP. The Anacostia has the greatest need for urgent action because it bears the majority of raw sewage dumped into receiving waters. By building at least one tunnel, WASA would likely avoid any EPA sanctions for not implementing an aggressive CSO control strategy for the Anacostia River.

Simultaneously, the existing system could be improved and LID implemented throughout the District. Depending on the results, tunnels for the Potomac River and Rock Creek might not be necessary. If additional tunnels were later determined to be needed, the environmental impact of delayed mitigation of CSOs on these waterbodies would be considerably less damaging, relative to the Anacostia's burdens.

WATERSHED MANAGEMENT

The EPA, in document after document, recommends that water quality planning should be based on a full "watershed" or "ecosystem management" approach. Partial efforts to address water quality problems are likely to result in implementation of inferior steps relative to other potential actions. Unless the full range of potential measures for improving water quality are considered, it is unlikely that the most cost-effective solution will be implemented. Large savings may in fact be possible by substituting one method of reducing pollution loads for another – a prime motive for adopting a "cap and trade" system, as widely proposed for watersheds. As described in Chapter 2, such considerations have led other cities to devise new institutional mechanisms for planning for water quality, including resolution of CSO problems.

As described in Chapter 3, there are many arenas in which actions are being considered to improve the water quality of the Anacostia River – and to a lesser extent the Potomac River and Rock Creek. For the Anacostia these include the TMDL process in the District and in Maryland, the Chesapeake Bay Agreement, the Anacostia Watershed Restoration Agreement, the process for setting of official water quality standards, and others. There are multiple federal, state and local agencies involved in the Anacostia cleanup. More than 80 percent of the watershed of the Anacostia lies in Maryland, although the main part of the river itself– and thus the greatest surface water benefits – lies in Washington, D.C. At present, there are no adequate institutional mechanisms for linking and coordinating the entirety of cleanup activities on the Anacostia. The result is likely to be duplicative actions, excessive costs, and less cleanup than could in fact be achieved for the level of effort put forth.

There is a particular need to integrate centralized infrastructure planning, such as the CSO storage tunnels proposed by WASA, with decentralized approaches such as LID. The ideal solution would control storm water at the source. In theory at least, if LID is successful, the incidence of CSO events could be sharply reduced, and possibly eliminate the need for large-scale end of the pipe measures. LID offers significant ancillary benefits in terms of more trees, gardens, wetlands, and other improvements of the quality of the urban environment. Finding a means of coordinating CSO planning with LID implementation should therefore become a substantial goal of any institutional mechanisms for water quality management within District watersheds.

ALTERNATIVE INSTITUTIONS FOR ANACOSTIA WATERSHED MANAGEMENT

The case for a watershed approach to water quality management on the Anacostia River, Potomac River and Rock Creek – as developed in the several chapters of this report – is a strong one. However, realization of a watershed approach seems unlikely under existing institutional arrangements in the D.C. area. As described in Chapter 3, there are a variety of arenas in which the water quality problems of the D.C. area are being addressed. But none of the organizations engaged in this task has thus far shown the vision, staffing, financial resources, and coordinating authority to carry out a watershed approach.

If a watershed approach is to be implemented, it will require the designation of a lead organization to oversee the process. It could be a different organization for each of the waterbodies in the D.C. area. It also could be an existing organization that would be given expanded resources and authority. Or it could be instead a brand new organization created for the purpose of implementing watershed management. Among existing institutions that might be given this assignment, at least the following alternatives are worthy of consideration.

Chesapeake Bay Agreement. The District of Columbia and the surrounding states might jointly agree to incorporate watershed management of the Anacostia, Potomac and Rock Creek waterbodies within the framework of the existing Chesapeake Bay Agreement. This approach would include the following advantages and disadvantages:

Pros:

- The Anacostia, Potomac and Rock Creek waterbodies all receive runoff from other states, in addition to runoff from D.C. Although it would require the creation of new institutions, the Chesapeake Bay Agreement has an overarching view that encompasses all jurisdictions and would facilitate a management approach that included the full watersheds.
- The waterbodies in the D.C. area are significant contributors to the pollution loads in the Chesapeake Bay. Thus, there would be a strong incentive to find the most effective approaches to reducing pollutant loads from these waterbodies. More closely linking the water quality problems in D.C. with the fate of the Chesapeake Bay might open up greater access to funds.
- In implementing the Chesapeake Bay Agreement, the State of Maryland has adopted a tributary strategy and provided significant funding for planning

Step 2 – Implement LID structures widely throughout the combined sewer area. Because LID integrates landscaping, architecture, and energy conservation in best management practices, it offers a holistic treatment of CSO and storm water while improving the quality of life in communities. LID, in addition to diminishing the storm water problem, generates many positive externalities such as "greening" the cityscape with trees, shrubs, and vegetative swales. LID reduces energy costs by attenuating the need for heating and cooling of buildings. Another long-term benefit of LID is that ongoing maintenance and monitoring needs will generate substantial employment opportunities. Last but not least, LID fosters community-building because it is an approach that depends on the cooperation of many neighbors to achieve its goal for the common good.

Because the effectiveness of LID is as yet unproven, one plausible plan of action would be to implement LID in areas targeted to yield the greatest CSO abatement for the District. Given the urgency of addressing CSO issues, the top priority targets for LID might well be the current combined sewer areas in Northwest and Northeast D.C. Once these initial target zones were partially fitted with LID, cumulative observation of runoff data would inform the next step of the adaptive strategy with two possible outcomes:

1. LID is effective by itself in resolving the CSO problem. Runoff during wet weather events is no longer significant causing sewer overflows.
2. LID is only partially effective. To complete the solution, a more capital intensive centralized solution is required, such as a tunnel.

Step 3 – In the event that LID is only partially effective, proceed with construction of one or more tunnels. Employing LID followed by a period of monitoring would establish a baseline for the ability of LID to handle runoff. It would allow time to decide what the capacity parameters of a tunnel would need to be, based on up-to-date information, which the LTCP is currently missing.

PARTIAL ADAPTIVE MANAGEMENT

A fully adaptive management approach risks that initial efforts (real time controls and LID) may be inadequate to achieve water quality objectives. A way of minimizing this risk would be to adopt an approach that might be labeled "partial adaptive management." Under this approach, WASA would proceed directly to construct one Anacostia tunnel. With 17 outfalls on the Anacostia River, such a tunnel would reduce predicted CSO events from 75 to 4, according to the draft LTCP. The Anacostia has the greatest need for urgent action because it bears the majority of raw sewage dumped into receiving waters. By building at least one tunnel, WASA would likely avoid any EPA sanctions for not implementing an aggressive CSO control strategy for the Anacostia River.

Simultaneously, the existing system could be improved and LID implemented throughout the District. Depending on the results, tunnels for the Potomac River and Rock Creek might not be necessary. If additional tunnels were later determined to be needed, the environmental impact of delayed mitigation of CSOs on these waterbodies would be considerably less damaging, relative to the Anacostia's burdens.

WATERSHED MANAGEMENT

The EPA, in document after document, recommends that water quality planning should be based on a full "watershed" or "ecosystem management" approach. Partial efforts to address water quality problems are likely to result in implementation of inferior steps relative to other potential actions. Unless the full range of potential measures for improving water quality are considered, it is unlikely that the most cost-effective solution will be implemented. Large savings may in fact be possible by substituting one method of reducing pollution loads for another – a prime motive for adopting a "cap and trade" system, as widely proposed for watersheds. As described Chapter 4, such considerations have led other cities to devise new institutional mechanisms for planning for water quality, including resolution of CSO problems.

As described in Chapter 5, there are many arenas in which actions are being considered to improve the water quality of the Anacostia River – and to a lesser extent the Potomac River and Rock Creek. For the Anacostia these include the TMDL process in the District and in Maryland, the Chesapeake Bay Agreement, the Anacostia Watershed Restoration Agreement, the process for setting of official water quality standards, and others. There are multiple federal, state and local agencies involved in the Anacostia cleanup. More than 80 percent of the watershed of the Anacostia lies in Maryland, although the main part of the river itself– and thus the greatest surface water benefits – lies in Washington, D.C. At present, there are no adequate institutional mechanisms for linking and coordinating the entirety of cleanup activities on the Anacostia. The result is likely to be duplicative actions, excessive costs, and less cleanup than could in fact be achieved for the level of effort put forth.

There is a particular need to integrate centralized infrastructure planning, such as the CSO storage tunnels proposed by WASA, with decentralized approaches such as LID. The ideal solution would control storm water at the source. In theory at least, if LID is successful, the incidence of CSO events could be sharply reduced, and possibly eliminate the need for large-scale end of the pipe measures. LID offers significant ancillary benefits in terms of more trees, gardens, wetlands, and other improvements of the quality of the urban environment. Finding a means of coordinating CSO planning with LID implementation should therefore become a substantial goal of any institutional mechanisms for water quality management within District watersheds.

ALTERNATIVE INSTITUTIONS FOR ANACOSTIA WATERSHED MANAGEMENT

The case for a watershed approach to water quality management on the Anacostia River, Potomac River and Rock Creek – as developed in the several chapters of this report – is a strong one. However, realization of a watershed approach seems unlikely under existing institutional arrangements in the D.C. area. As described in Chapter 5, there are a variety of arenas in which the water quality problems of the D.C. area are being addressed. But none of the organizations engaged in this task has thus far shown the vision, staffing, financial resources, and coordinating authority to carry out a watershed approach.

If a watershed approach is to be implemented, it will require the designation of a lead organization to oversee the process. It could be a different organization for each of the waterbodies in the D.C. area. It also could be an existing organization that would be given expanded resources and authority. Or it could be instead a brand new organization created for the purpose of implementing watershed management. Among existing institutions that might be given this assignment, at least the following alternatives are worthy of consideration.

Chesapeake Bay Agreement. The District of Columbia and the surrounding states might jointly agree to incorporate watershed management of the Anacostia, Potomac and Rock Creek waterbodies within the framework of the existing Chesapeake Bay Agreement. This approach would include the following advantages and disadvantages:

Pros:

- The Anacostia, Potomac and Rock Creek waterbodies all receive runoff from other states, in addition to runoff from D.C. Although it would require the creation of new institutions, the Chesapeake Bay Agreement has an overarching view that encompasses all jurisdictions and would facilitate a management approach that included the full watersheds.
- The waterbodies in the D.C. area are significant contributors to the pollution loads in the Chesapeake Bay. Thus, there would be a strong incentive to find the most effective approaches to reducing pollutant loads from these waterbodies. More closely linking the water quality problems in D.C. with the fate of the Chesapeake Bay might open up greater access to funds.
- In implementing the Chesapeake Bay Agreement, the State of Maryland has adopted a tributary strategy and provided significant funding for planning

at the tributary level. There is already considerable experience in such planning that could be applied to waterbodies in the D.C. area.

- The Chesapeake Bay Program holds a long experience and close ties in working with EPA. The level of existing expertise associated with the implementation of Chesapeake Bay Agreement is high.

Cons:

- Due to the large geographic scope of the partnership, the Chesapeake Bay Agreement pose significant difficulties in coordination.
- In its current form, the Chesapeake Bay Agreement acts as a formal accord, but it does not have the full force of law.

The TMDL Process. The EPA's TMDL program allows resource managers to look at all sources of individual pollutants entering a water body. For example, pollution reduction strategies for Biochemical Oxygen Demand must consider CSOs, along with city storm water runoff and upstream nutrient loading sources. A more comprehensive and coordinated TMDL program would offer the following advantages and disadvantages as the setting for watershed management:

Pros:

- The TMDL program is federally mandated under Section 303(d) of the Clean Water Act. As such, if adequately operated and enforced, TMDLs can exhibit the teeth necessary to stimulate sound watershed management.
- This program uses complex modeling techniques to gain a highly specific understanding of the water body and its pollution sources. This accurate depiction of a watershed's situation can allow decision-makers to develop a more effective set of policy solutions concerning how resource management should be carried out.
- TMDL analysis can provide a clear picture of the level of pollutant load reductions that need to be made in order to reach water quality standards. This can then facilitate sound decision-making to determine the measures that will be taken to achieve such reductions.

Cons:

The TMDL program currently fails to produce the "big picture" needed for effective watershed management. Two improvements to the TMDL process must take place before it can become a truly effective watershed management tool.

- All pollution sources affecting a water system must be analyzed simultaneously, rather than in separate TMDLs.
- TMDLs must discontinue the splitting of watershed analyses along state lines.

Anacostia Watershed Restoration Agreement. Like the Chesapeake Bay Agreement, this partnership brings together jurisdictions within a single watershed in common. If given greater authority to guide policymaking, this framework would offer the following:

Pros:

- The Agreement has the potential to coordinate efforts between the D.C. government, the State of Maryland, Montgomery and Prince George's Counties, the National Park Service and other stake-holders to achieve the common goal of restoring the health of the Anacostia and its surrounding communities.
- Using a more focused ecosystem scale than the Bay Agreement, the Anacostia Watershed Restoration Agreement may face less difficulty in managing coordination between the stakeholders and management authorities involved.
- This framework's "Indicators & Targets" sketch a reasonable strategic plan of how to restore

sustainability to the Anacostia. This plan can then provide needed direction in guiding restoration and watershed management efforts.

Cons:

- Like the Bay Agreement, the Anacostia Agreement is only a written accord. It does not represent a law, and therefore has no binding force.
- The Anacostia Agreement has only limited funding.

Anacostia Waterfront Initiative. Operating under the goal of community revitalization, this D.C. initiative focuses on the community benefits of restoring the Anacostia watershed. As a coordination authority, it can offer the following:

Pros:

- Management decisions would be made in a framework that considers all watershed functions and services that affect human health and recreational usage benefits.
- With community economic development as a driving force, this framework ties the health of the water body to property and recreational value. This would allow trade-offs to be made, ensuring the most economical steps are taken to restore the greatest possible amount of benefits to the watershed.
- It would help put the people of the Anacostia region more in touch with watershed management, by getting them involved in decision-making that directly affects their community's future.

Cons:

- With its overall goal of economic community development, the Waterfront Initiative may focus on money-making moves rather than ecologically sustainable actions.
- Economic development in the community may push low-income residents out.
- The Waterfront Initiative has little power and only limited funding.
- The Waterfront Initiative has little power and only limited funding.

WASA in the Lead Role. In the absence of an effective, broad watershed management organization, WASA today is essentially playing the part of a resource manager in developing its plan to control CSOs. That is, the decisions it makes directly determine the future of water resources in the D.C. area. With its traditional mission of wastewater treatment guiding the brunt of its actions, WASA's institutional scope should be viewed as too narrow to effectively undertake comprehensive watershed management. WASA should, however, continue to play the important role of carrying out specific measures (namely CSO control and storm water reduction) that help achieve the larger goals of watershed restoration. Due to its specific, technical capabilities, WASA should continue its function as a manager of wastewater issues, rather than expanding its reach to more strategic watershed planning.

EPA Direct Administrative Responsibility. As the highest level executive authority for the Clean Water Act, EPA already holds the responsibility of strategically planning the nation's watershed management design. The identified deficiencies in coordination and comprehensive measures indicate the potential for improvement through federal supervision of watershed planning and management. One possible improvement could take the shape of an improved TMDL program as discussed previously. Stronger leadership at the watershed level by the EPA would offer the following:

Pros:

- At the national level EPA holds the advantage of retaining the widest scope of oversight, and is in the best position to ensure that coordinated efforts are directed at common watershed goals.
- Wielding the power of federal law, EPA's authority has the teeth necessary to trigger concerted action.
- The EPA could use Federal funding as an incentive, by directing grants and loans toward larger watershed management planning authorities, rather

than funding projects run only by individual jurisdictional entities like D.C. or the State of Maryland.

Cons:

- EPA itself is already struggling with its current inconsistency in terms of strategy. On the one hand, EPA wants certain technological fixes that can provide a clear short-term reduction in pollution. On the other hand, it advocates the watershed approach, which comes with less specific planning actions.
- With the total number of watersheds to be overseen, a stronger leadership by EPA would add significantly to the Agency's workload.

A NEW INSTITUTIONAL FRAMEWORK FOR WATERSHED MANAGEMENT

Each of the above frameworks or authorities is currently in existence and fully operational. Yet, the District and many other areas around the nation continue to lack the ability to design, and more importantly, carry out effective watershed management plans.

This report concludes that the best solution to the District's coordination problems lies in the establishment of a new watershed management organization. Such an organization would act as the steering authority for all water resource management activities – including CSO control, storm water management, habitat restoration, recreational usage, etc. – carried out within the watershed. This institution should be created with the watershed approach in mind, ensuring that ecological boundaries match up with jurisdictional participation. Membership would be required of all states, counties, local groups and other stakeholders who either affect or are affected by watershed management decisions. Most importantly, this organization would be given full authority to ensure that policies made and actions taken within the watershed are in line with common goals. This type of structure could encompass all of the District's watersheds, but more likely would involve the creation of separate organizations for each of the watersheds within D.C. – the Anacostia, the Potomac, and Rock Creek.

We thus propose a new organization, entitled the Anacostia Watershed Management Authority (AWMA), which should hold the responsibility of overseeing all water resource decision-making within the Anacostia watershed. This organization would require the participation of jurisdictional and stakeholder groups such as the Maryland Department of Environment, Prince George's and Montgomery counties, the National Park Service, WASA, DOH, D.C. land use and development authorities, the Anacostia Watershed Toxics Alliance, and the Anacostia Watershed Society.

The inclusion of all players in decision-making should lead to major improvements in the comprehensiveness of the Anacostia watershed's management design. To ensure that action is indeed taken, AWMA would also require the authority to legally enforce watershed goals and management decisions. Watershed management decisions made by WASA and other organizations would require the approval of AMWA prior to being carried out. A lack of authority is currently the chief impediment to successful implementation of decisions made by groups such as the Anacostia Watershed Restoration Committee. The establishment of AWMA's legal authority, therefore, should act as a key stimulus for actual, concerted efforts.

This proposed AWMA could be could be further incorporated into a nationwide hierarchical system of watershed management authorities. In such a hierarchy, watershed goals would be set at the national level and then be passed down to lower level management authorities, using ecological boundaries to determine each organization's jurisdiction. This overarching framework could play out as follows:

1. A national strategy for watershed management set by EPA;
2. The Chesapeake Bay Program would use these concepts to plan for the Bay's overall watershed;
3. Finally, watershed authorities, including one for the Anacostia basin, would develop plans to guide the management of water resources within the individual watershed.

This approach has many of the necessary elements in place at present. However, federal leadership by the

EPA to enhance coordination, along with a willingness by states and the District to look past political boundaries, will be needed for watersheds to be effectively managed as complete ecosystems.

SUMMARY

A comprehensive plan for the Anacostia River must not only prevent CSO outfalls, but also reduce other sources of pollutant loads and furthermore engage the community in utilizing the river. Once the LTCP is implemented, CSOs will be controlled at about 95 percent of their current levels and the rivers will be free of such discharges for the majority of the year. The remaining discharges will be less damaging than they are now because the first flush containing most of the trash, debris and pollutants will be captured and treated. However, runoff from upstream sources will continue to produce significant contributions to the District's water pollution problems, causing water quality standards to remain unattained in many cases.

Even though the Anacostia tunnel is first on the list for construction, the LTCP is projected out over 20 years, and there will not be a significant reduction in CSOs for many years to come. This leaves opportunity for more immediate implementation of LID controls within each of the rivers' watersheds, especially those in which the tunnel projects have a longer time frame, to prevent flooding and filter storm water long before the tunnels are in place. There are also many other interim steps such as cleaning up the trash along the river, providing easier public access, building hiking and bicycle trails along the river, and so forth that can generate significant public benefits in the short run.

While the LTCP and control of CSOs is legally mandated, the justification for their prevention comes with the belief that controlling CSOs and storm water pollution is part of a larger plan for improving the District's water resources. As controls are implemented and the rivers become cleaner, they will add value to the surrounding communities. By viewing the LTCP as a part of this process and working with other stakeholders in a genuine watershed approach, WASA can ensure that the benefits of CSO control have value beyond meeting legal requirements. CSO-related actions can protect human health, restore the aesthetic and recreational quality of the rivers, and help to improve the surrounding property values. If successful, the District will have demonstrated that the nation's capital can be a role model for environmental policy.

References

Adderley, Virgil, City of Portland, Bureau of Environmental Services, personal communication.

American Forests. “Urban Ecosystem Analysis for the Washington DC Metropolitan Area: An Assessment of Existing Conditions and a Resource for Local Action.” February 2002.

Anacostia Tidings. “Collaborative Approach Key to Remediation.” March 2002.

“About Us. Eyes of Paint Branch.” 4 May 2002 http://www.eopb.org/mission.shtml.

Anacostia River Watershed Restoration Action Strategy. Internal Review Draft, DC, DOH, June 1999.

Anacostia Watershed Toxics Alliance. “Fish Consumption Advisories, and Tumorous Fish

Anacostia River Watershed Database and Mapping Project,” March 2001.

Bureau of Environmental Services. *Portland’s Clean River Plan*. Portland, Oregon: March 2000.

Capacasa, Jon M., EPA Region 3, Water Protection Division, April 10, 2002, personal communication.

City of Toronto. “Wet Weather Flow Management Master Plan, Draft,” 2001.

City of Toronto. WWFMMP Update Newsletter. Vol. 1(1), November 2000.

Chesapeake Bay Program News Release, June 28, 2000.

Coffman, Larry, Prince Georges County Government. March 19, 2002, personal communication.

CounterPartner. “The Earth Conservation Corps and Matthew A. Henson.” December 2000. http://www.counterpart.org/news/20001211/a0006.asp.

Davenport, Christian. “Spills Plague Sewer Systems: Billions of Gallons Leak From Area Lines Each Year.” *Washington Post*, August 19, 2001.

D.C. Environmental Network (2001a). “Clean Water Campaign on WASA’s LTCP for Control of CSOs.” Nov 21, 2001.

D.C. Environmental Network (2001b), “Testimony on WASA’s proposed LTCP for Control of CSO,” 21 November 2001.

D.C. Office of Planning. “Plans for South Capitol Gateway Study Announced.” Press Release. 13 March 2002.

DeMillo, Andrew. “A Confluence of Causes: Ailing Sewers, Heavy Rainfall, Low Elevation

Fueled Damage.” *Washington Post*, August 19, 2001

District of Columbia Register. D.C. Water Quality Standards, January 21, 2000

Dwyer, Timothy, EPA, Team Leader, CSO Program, Office of Wastewater Management, Water Permits Division, April 16, 2002, personal communication.

EPA (2002), “EPA’s Report to Congress on Implementation and Enforcement of the CSO Control Policy.”.

Engineering and Mining Journal. “ The United States Environmental Protection Agency (EPA) recently expressed its intention to regulate mercury.” Vol. 202, No. 5, May 2002.

EPA (1995), “Combined Sewer Overflows: Guidance for Long-Term Control Plan,” 1995.

EPA (1998). “Lead In Your Home: A Parent’s Reference Guide.” June 1998.

EPA (2000a), "FY 2000 Annual Performance Plan and Congressional Justification," 2000

EPA (2000b), "FY 2003 Annual Performance Plan and Congressional Justification", 2000 Personal communication with Timothy Dwyer, EPA, Team Leader, CSO Program, Office of Wastewater Management, Water Permits Division, April 11,2002

EPA (2001a), "Combined Sewer Overflows. Principal Guidance Document," August 2001

EPA (2001b), "Guidance: Coordinationg CSO Long-Term Planning with Water Quality Standards Reviews." 2001

EPA (2001c), "EPA Comments on DC WASA Long Term Control Plan," 2001.

EPA/Low Impact Development Center (2002), "Urban LID Feasibility Study, Draft." 2002

Frederick, R., R. Goo, and M. Keefe. "EPA's Watershed Approach to Controlling Urban Nonpoint Source Pollution." USEPA, Nonpoint Source Control Branch, 2002.

Government of the District of Columbia, "District-Federal Relations: A Partnership for Success." January 2001.

Henrickson, Sarah E. et al. "Marine Swimming-Related Illness: Implications for Monitoring and Environmental Policy Environmental Health Perspectives," Vol. 109, No. 7, July 2001.

Huslin, Anita. "Aging Sewers Put A Costly Burden on Communities." *Washington Post*, January 8, 2001.

Jurries, Dennis, Oregon State Department of Environmental Quality, personal communication.

Kassa, Hailu and Micael S. Bisesi. Levels of polychlorinated biphenyls (PCBs) in fish: the influence on local decision making about fish consumption. *Journal of Environmental Health* Vol. 63. No. 8, April 2001.

King County and City of Seattle. *Denny Way/Lake Union CSO Control Facilities Plan*. July 1998.

Lezkus, Mary, EPA Region 3, Regional Storm Water Coordinator, May 2, 2002, personal communication.

Low Impact Development Center, "Low Impact Development Report."

Lura Consulting. *City of Toronto WWFMMP Consultation report*. February 2001.

Marcotte, Michael S., P.E., DEE, Deputy General Manager/Chief Engineer, WASA, personal communication.

Miller, Garison, EPA Region 3, Water Protection Division, April 16, 2002, personal communication.

Natural Resources Defense Council. *Stormwater Strategies: Community Responses to Runoff Pollution*. May 1999.

Portland Bureau of Environmental Services, USEPA Region 10 and Oregon Department of Environmental Quality, personal communication.

Perez, Michelle. "Maryland's TMDL Program: Offering More Problems Than Solutions?" May 2001.

Puget Sound Water Quality Action Team. *2000 Puget Sound Water Quality Management Plan*.

Rose, Joan B. et al. "Climate Variability and Change in the United States: Potential Impacts on Water- and Foodborne Diseases Caused by Microbiologic Agents." *Environmental Health Perspectives*. Volume 109, Supplement 2, May 2001.

Santner, Richard, Oregon State Department of Environmental Quality, personal communication.

Shipley, Amy. "2012 Olympics Bid Centers on Anacostia," *Washington Post*, April 11, 2002.

Siddique, Mohsin, LTCP Project Manager, DC WASA, April 22, 2002, personal communication.

Walker, B.P. *Preparing for the Storm: Preserving Water Resources with Stormwater Utilities*. Policy Study 275. Reason Public Policy Institute, January 2001.

WASA (2001), "Combined Sewer System Long Term Control Plan, Draft Report," June 2001.

WASA (2002a), "Briefing for the University of Maryland on Combined Sewer System Long Term Control Plan," March 12, 2002

WASA (2002b), "Combined Sewer System LTCP: Meeting Summary for Stakeholder Advisory Panel." Meeting No. 11, February 2002.

Washington State Department of Ecology and Washington State Department of Transportation. *Interim Report to the Washington State Legislature: Washington Stormwater Management Study*. January 2001.

Weinstein, Neil, Low Impact Development Center, April 16, 2002, personal communication.

XCG Consultants Ltd. Study Area 3: Humber River Existing Conditions Report. January 2001.

Appendix A

Benefits of Comprehensive Watershed Management

The goal of the LTCP developed by WASA for reducing CSOs is the achievement of water quality standards on the affected rivers and streams. These standards offer the prospect of benefits from many uses of the river, improvements in human health, a more aesthetically attractive environment, greater biological diversity, and so forth. The full realization of such benefits, as described above, will require a water quality plan that encompasses much more than CSOs alone. If a full watershed approach can indeed be realized, resulting in substantial improvements to water quality, additional sets of benefits must be taken into consideration by decision-makers.

REDUCTION IN ILLNESS

Swimmers come into contact with pathogens, toxins and irritants through a number of routes while submerged. These pollutants can enter through the ears, eyes, nose and mouth. In addition, absorption through the skin is significant because almost 100 percent of a swimmer's body is exposed to toxins in the water while submerged and this results in rapid spreading of the toxins throughout the body. One study by Cabelli et al. found that there is a direct relationship between counts of *E. coli* and marine enterococci and gastroenteritis among swimmers. The closer swimmers are to municipal wastewater sources, the more likely they are to become sick. Vulnerable populations, including the very young and very old, are at even higher risk of being severely affected by exposure to these pathogens. According to the EPA, untreated sewage causes 1.8 million to 3.6 million illnesses annually.

Swimming has been prohibited in the District since 1971. However, the Potomac River – and conceivably the Anacostia at some point in the more distant future – might provide attractive opportunities for swimming. One can imagine public recreation areas being created along the Potomac where hundreds of people could come on weekends to bath in the sun and to swim (with new controls established to prevent conflicts with boating uses of the river). The Washington area in general suffers from a lack of lakes, ponds and other fresh waterbodies available for such purposes. For reasons of access and the character of the shoreline, Chesapeake Bay also provides limited beach opportunities for the millions of people in the Washington metropolitan area.

REDUCTION IN EXPOSURE TO METALS AND TOXINS

Storm water often carries metals such as mercury and lead that can build up in fish. When the fish are consumed, human exposure can result in brain damage and developmental delays, especially in children. Mercury is emitted into the air by power plants and is washed out in rainwater, which carries it into lakes and rivers. In its methylated form, methylmercury can cause neurological damage in fetuses, newborns and infants. The main source of mercury to subsistence anglers may be freshwater fish. Lead can also be carried into rivers by storm water. It is picked up from contaminated soils and is absorbed because the body cannot tell the difference between lead and calcium. Long-term exposure to low levels of lead in children can lead to nervous system and kidney damage, learning disabilities, decreased intelligence, speech, language and behavior problems, poor muscle coordination, decreased muscle and bone growth and hearing damage. Acute exposure to high levels of lead in children can lead to seizures, unconsciousness and in some cases, death. In adults, high levels of lead can result in an increased chance of illness during pregnancy, harm to a fetus, including brain damage or death, fertility problems (in men and women), high blood pressure, digestive problems, nerve disorders, memory and concentration problems and muscle and joint pain.

Based on anecdotal evidence, many people in the Anacostia area rely on fishing as a significant source of protein. According to the Anacostia Watershed Toxics Alliance (AWTA), anglers can be seen daily fishing from parks and bridges. The bottom feeding fish they catch and consume, such as the brown bullhead catfish are in close proximity to contaminated sediments and are therefore considered good indicators of environmental conditions. These fish were found to have a 55 percent prevalence of liver tumors and a 23 percent prevalence of skin tumors in a 1996 survey conducted by the Fish and Wildlife Service near the CSX railroad bridge.

As mentioned above, the Anacostia River has a fish consumption advisory that was first issued in 1989 because of polychlorinated biphenyls (PCBs) and chlordane contamination of fish. The consumption advisory was then expanded to include any bottom dwelling fish and strengthened to protect pregnant women and children. The production and use of PCBs was banned in the United States in 1979, but because of their chemical stability, PCBs are insoluble in water and collect in sediments. PCBs are soluble in fats; these compounds resist biological and chemical degradation and bioaccumulate in lipid-rich tissues and organs. While the health effects of PCBs are still being debated, studies involving rats have shown PCBs to cause liver and thyroid cancer, reduced sperm count, increased numbers of abnormal sperm cells and reduced levels of thyroid hormones. However, these studies have been criticized for having small sample sizes and not adjusting for confounding variables. Despite the uncertainty surrounding the health effects of PCBs, many agree that they pose a potentially significant threat. As they are abundant in the sediments of the Anacostia River, they have become a focus of concern for citizens and public officials in the Washington area.

The great success in cleaning up the Potomac for fishing use shows the potential for a coordinated strategy across a full watershed to increase public use of a river body. In the space of 30 years, the fish populations of the Potomac have been largely restored, offering excellent new recreational opportunities in close proximity to the nation's capital.

REDUCTION IN DANGER TO WILDLIFE

An increase in impervious surface area has immediate and severe impacts on the species dependent on waterbodies. Greater impervious surface means that more water reaches a river at a faster rate, carrying more pollutants. The faster-flowing water causes more erosion and thus increased sedimentation of rivers. The water is often at a higher temperature than normal because it flows over heated concrete and rooftops. These conditions make it difficult for sensitive species to survive. As the water becomes heated and sedimentation increases, native fish populations can be displaced by heartier, and sometimes non-native species. Studies have found that anadromous fish eggs and larvae declined sharply when the area surrounding a stream was greater than 10 percent impervious surface. Other studies have found similar results with a loss in diversity beginning at 10 to 12 percent impervious surface and more tolerant cutthroat trout populations replacing Coho salmon at 10 to 15 percent impervious areas. Nutrients added to rivers from both sewage and fertilizer and animal waste carried by storm water, can create algal blooms, which use up the available oxygen and cause fish-kills – a phenomenon common to the Anacostia River. Trash carried in with storm water – another common occurrence in D.C. – can also cause lowered dissolved oxygen levels because oxygen is utilized in the decomposition process. In addition, "excess nutrients, along with the warm water temperature of recreational waters, provide an ideal growth medium for potentially harmful pathogens."

REDUCTION IN FLOODING

The District's aging sewer system causes other problems in addition to the direct health effects of being exposed to contaminated water. Every year millions of gallons of human waste not only spills from pipes at combined sewer overflows but also seeps through manholes and leaks from cracks in pipes. These problems occur when pipes become clogged with grease and are cracked by tree roots. The sewage can seep out into streams and rivers, but can also back up into homes. During intense rains, flooding in low spots throughout the city results in storm water carrying sewage into basements, breaking doors and destroying furniture and flooring. Intense storms such as the one on August 11, 2001 produce flows so large that the sewer system simply cannot handle the massive volume of water. Because the Anacostia River is most heavily affected by CSOs, and the worst flooding occurs in the Northeast section of the District that borders the Anacostia, the current LTCP recommends that a tunnel along the Anacostia be built first. The following is an example of the benefits to be gained from costs avoided through flood prevention: as a result of the August 11, 2001 storm, FEMA issued disaster housing checks totaling $2,015,380 and $289,600 in low-interest disaster loans for homeowners.

OTHER BENEFITS

In addition to the above benefits of a watershed approach that could lead to significant overall improvements in water quality, the D.C. community has additional incentives to prevent sewage from spilling into rivers used for drinking water and as a source of food. The communities on the Anacostia River are predominantly low-income and African American. Their circumstances dictate where they can afford to live, be it an unhealthy area or not. If the Anacostia were viewed as an attractive waterfront area, property values would rise bringing a much needed tax base to the District. Recreation is inhibited by the CSOs, but even with the prevention of all CSO outfalls, the level of recreation would most likely not increase significantly. The river would still be contaminated by storm water. In addition, there are very few access points to the river for boating or kayaking. Swimming would also still be unsafe because the PCB level of the sediments is so high. The concept of benefits from a clean Anacostia must be shifted from the idea of a fishable/swimmable river[1] to the equally valuable benefits of a river that does not damage resident's health and one that can be part of other forms of recreation such as hiking or biking along its banks. A fishable/swimmable river should remain the overarching goal, but the first goal should be to make the river valuable immediately. To truly add value to the Anacostia River, the surrounding community must be revitalized and people must be given access to the river. The National Arboretum and Anacostia Park are both extensive public land areas along the banks of the Anacostia that allow for access to the river and its surrounding area. However, these sites fulfill only a fraction of the overall potential benefits to be gained from the entirety of the District's water resources.

ANACOSTIA CLEANUP BENEFITS

Several organizations concerned with restoration and management of the Anacostia watershed make the connection between ecosystem health and economic and social health—a linkage that seems to be missing from Federal and local government activities. For many communities in the Anacostia region, such experiences could lead to higher income jobs and in turn increase home ownership. Past experience shows that communities are more willing to invest in something that is perceived as a valuable resource. Therefore, policymakers should view increased local involvement in watershed management as a top priority.

A reduction in CSOs and greater control of storm water shows the potential to for creating a more sustainable Anacostia River. The commensurate return of aquatic wildlife and ecosystem integrity could generate additional economic opportunity through higher property values, increased recreation opportunities, and even viable food sources. One logical extension would be the desirability of living close to the river to be able to enjoy it. While it is fairly certain that the banks will continue under federal jurisdiction, adjoining properties and those with access to the river walk and bicycle paths will certainly command premiums. These access points would become a point of neighborhood pride and centers of activity.

Under the assumption that projects like the Anacostia Waterfront Initiative are implemented, the city should then be able to establish tax or user fee mechanisms to fund water quality improvements. Whether it is in the form of a storm water utility, or a line item on water bills, there should be some method put in place to generate a steady stream of revenue that will be dedicated to installing more trash traps, storm water ret-

1 These standards must still be met; they are legally mandated by the District's Water Quality Standards.

rofits, or other sewer system improvements. Linking increased utilization of waterfront land should have a tangible connection to water quality issues. There are dozens of area organizations with good intentions and frequent contributions to the entire watershed, but until the Anacostia sees higher funding for restoration, access, and publicity, changes will remain incremental.

Appendix B

Portland's Clean River Plan: "Actions for Success"

Action	Same Projects	Cost	Timeframe
Aggressively control CSOs	New pipes, tunnels, treatment facilities	$407 million	Original proposed timeframe was 2020; agreement passed with state to control by 2011.
Plant trees, native vegetation and create buffers along streams	Tree planting, streambank restoration, new development standards to protect buffers and city trees, increase in-stream structure in creeks	$54 million over next 20 years	By 2006, tree planting and native vegetation will be well underway. By 2020, 4,000 acres of native trees and vegetation will be planted
Reduce stormwater flow and pollutants reaching streams	Expand residential roof drain disconnect program to businesses, eco-roof program, infiltration sumps, LID, implement and enforce stormwater management manual	$53 million over 20 years	Stormwater strategies will be tested and developed into new programs by 2006; full scale programs by 2015
Upgrade Portland's Eastside Sewer System	Sewer separation, pipes, in-line sewage storage, new pipes to increase capacity	$115 million	Next 15 years
Control erosion from construction and development	City erosion control code, erosion control education and training, enhanced erosion prevention	$7 million (to hire new staff and offer training, much of this cost is to be allocated to development permit applicants)	Over next 20 years
Increase pollution prevention and source control efforts	Increase outreach to businesses with pollution prevention and source control information, eco-logical business program, SoilTrader program	$7 million	Over next 20 years
Education and stewardship	Deliver K-12 and adult information programs, provide stewardship grants	$9 million	Over next 20 years
Floodplain restoration	Revegetation and streambank restoration	The city will allocate at least $4.5 million to match grant funds and other resources as they become available	Over next 20 years

Appendix C
Stormwater Management: Acceptable Practices for Water Quality[1]

Pond

Micropool Extended Detention Pond: Pond that treats the majority of the water quality volume through extended detention, and incorporates a micropool at the outlet of the pond to prevent sediment resuspension.

Wet Pond: Pond that provides storage for the entire water quality volume in the permanent pool.

Wet Extended Detention Pond: Pond that treats a portion of the water quality volume by detaining storm flows above a permanent pool for a specified minimum detention time.

Multiple Pond System: A group of ponds that collectively treat the water quality volume.

Pocket Pond: A stormwater wetland design adapted for the treatment of runoff from small drainage areas that has little or no baseflow available to maintain water elevations and relies on ground water to maintain a permanent pool.

Wetland

Shallow Wetland: A wetland that provides water quality treatment entirely in a wet shallow marsh.

Extended Detention Wetland: A wetland system that provides some fraction of the water quality volume by detaining storm flows above the marsh surface.

Pond/ Wetland System: A wetland system that provides a portion of the water quality volume in the permanent pool of a wet pond that precedes the marsh for a specified minimum detention time.

Pocket Wetland: A shallow wetland design adapted for the treatment of runoff from small drainage areas that has variable water levels and relies on groundwater for its permanent pool.

Infiltration

Infiltration Trench: An infiltration practice that stores the water quality volume in the void spaces of a gravel trench before it is infiltrated into the ground.

Infiltration Basin: An infiltration practice that stores the water quality volume in a shallow depression, before it is infiltrated it into the ground.

Dry Well: An infiltration practice similar in design to the infiltration trench, and best suited for treatment of rooftop runoff.

Filtering Practices

Surface Sand Filter: A filtering practice that treats stormwater by settling out larger particles in a sediment chamber, and then filtering stormwater through a sand matrix.

Underground Sand Filter: A filtering practice that treats stormwater as it flows through underground settling and filtering chambers.

Perimeter Sand Filter: A filter that incorporates a sediment chamber and filer bed as parallel vaults adjacent to a parking lot.

Organic Filter: A filtering practice that uses an organic medium such as compost in the filter, in the place of sand.

Bioretention: A shallow depression that treats stormwater as it flows through a soil matrix, and is returned to the storm drain system.

Open Channels

Dry Swale: An open drainage channel or depression explicitly designed to detain and promote the filtration of stormwater runoff into the soil media.

Wet Swale: An open drainage channel or depression designed to retain water or intercept groundwater for water quality treatment.

[1] New York State Stormwater Management Design Manual, October 2001 Prepared by: Center for Watershed Protection