Quality and Quantity:

Stormwater Management in Alewife Brook

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Abstract

The Alewife Brook Watershed is located in a highly dense, urban watershed in eastern Massachusetts. This report responds to two major impediments it faces; one is the existing infrastructure of Combined Sewer Overflows (CSO) and their permitting cycle, and the second is the management of stormwater quantity and quality in the four surrounding towns. Stormwater is a particular challenge in urban areas due to the vast quantities of impervious surface, the population density (the consumers of pollutant leaden cleaners, oils and fertilizers), as well as the basic challenge facing most older towns: degraded infrastructure of the storm and sewer system. The objective of the report is to analyze the current practices as well as to identify future challenges and potential strategies to improve the health and sustainability of this waterbody. This project was undertaken in partnership with the Tufts Water Systems, Science and Society program and Mystic River Watershed Association.

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EXECUTIVE SUMMARY

This report represents the culmination of an interconnected set of projects that participants in the Water: Systems, Science & Society (WSSS) Research Practicum, an academic course at Tufts University, in the spring of 2011, completed for the Mystic River Watershed Association (MyRWA), a nonprofit advocacy group based in Arlington, Massachusetts. The projects center on the Alewife Brook sub-watershed of the Mystic River Watershed in eastern Massachusetts. The Alewife Brook is located in the towns of Belmont and Arlington, and the cities of Cambridge and Somerville.

Participants in the WSSS Research Practicum undertook two projects that are thematically linked together by the concept of stormwater management. The Alewife Brook is a highly urbanized watershed, and faces unique watershed management challenges. The two projects seek to provide a comprehensive overview of the roles cities and towns, state agencies, and the public play in protecting the watershed. Project One provides an assessment of the stormwater management plans (SWMPs) and illicit discharge detection and identification efforts (IDDEs) of the four municipalities in the sub-watershed. Project Two presents an analysis of combined sewer overflow (CSO) control projects and water quality variances in the Alewife Brook. The key findings of each project, as well as recommendations for future advocacy strategies, are outlined below.

Project One: Analysis of Storm Water Management Plans and Illicit Discharge Detection and Elimination efforts – Including Effective Best Management Practices (BMPs)

Key Findings

- Initial research indicates that Cambridge leads the four communities in application of its SWMP and the inclusion of BMPs that appear to go above and beyond the minimal requirements.
- The draft 2010 Municipal Stormwater Sewer System (MS4) permits will attempt to increase the minimal regulatory baseline found in the 2003 permits. To achieve this, the draft 2010 permits increase the depth, breadth, and specificity of the BMPs required for a SWMP.
- To eliminate this variability and more adequately address illicit discharges, the draft 2010 permit contains very specific BMP requirements, implementation criteria, and reporting standards.
- Low Impact Development BMPs can provide lower cost option for significant stormwater system improvement especially in highly developed areas, such as the Alewife Brook watershed.
- If planned in advance and in conjunction with retrofits and new construction, Low Impact Development pilots can be used to achieve improved water quality and decrease stress on the capacity of existing sewer and storm water systems at minimal added cost.

Conclusions & Recommendations

Illicit discharge detection and elimination (IDDE) Programs are just one of the BMPs that will undergo significant changes in the new draft 2010 permit. Under the 2003 permits, MS4 communities were required to create IDDE Programs - specific content requirements are not a part of the permit. The annual reports indicate that there is a high degree of variation between the communities, in terms of BMPs selected for the Program and their implementation. IDDE Programs are resource intensive, so some communities couple IDDE with other stormwater management BMPs and projects.

Best Management Practices have a demonstrated a variety of effectiveness. Evidence shows that when low impact development strategies are pursued for degraded stormwater systems, the overall cost is equivalent or less compared to typical stormwater system improvement projects. Thus, plans for stormwater management moving forward ought to include language to encourage landowners to consider LID and BMP practices especially where there exists a high concentration of impervious surfaces.

Project Two: Analysis of the CSO Control Plan and Variance

Key Findings

- In future analyses of the CSO Control Plan and variance extensions, MWRA and DEP will rely primarily on CSO control cost information. This is due to the fact that a BCSO classification is necessary unless 100 percent of CSOs are eliminated. The current control plan will abate 98 percent of CSOs, allowing seven CSO events per year to occur in Alewife Brook.
- A Class BCSO designation would require the Massachusetts Department of Environmental Protection (DEP) to conduct a Use Attainability Analysis. DEP would need to show that full abatement of CSOs would result in widespread economic impacts.
- Municipalities – such as the city of Chicago – that began combined sewer separation projects early were able to take advantage of federal funding opportunities and have made significant progress towards CSO abatement.
- Public comments on the variance, case studies from other areas of the country, and increased understanding of the water classification process offer guidance for the future advocacy efforts of the Mystic River Watershed Association.

Conclusions & Recommendations

Continued CSOs may not be the most environmentally protective and cost-effective option available for management of the Alewife Brook. Recommendations include:

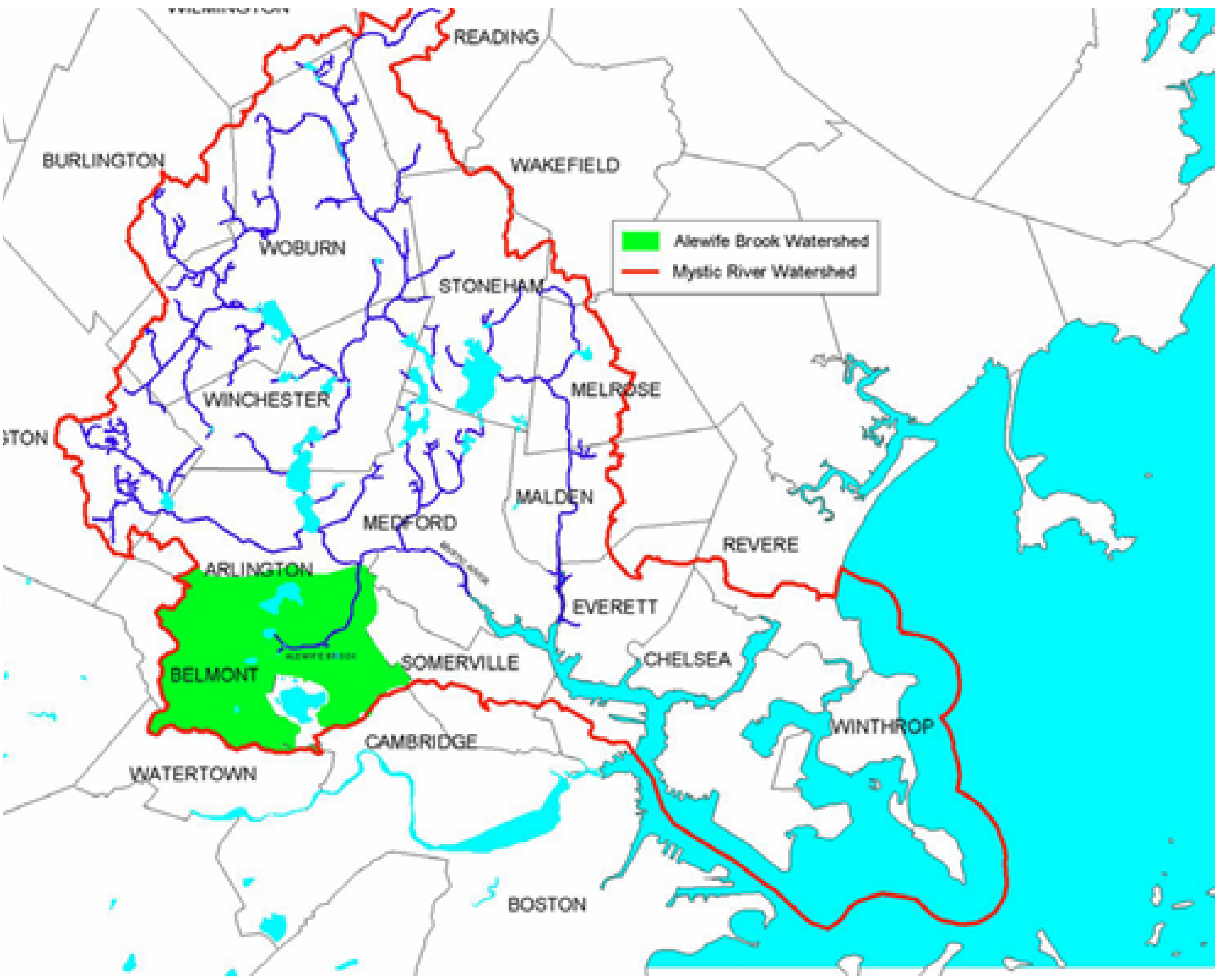
- Improved stormwater controls, through the use of green infrastructure techniques, should be adopted.
- A Total Maximum Daily Load (TMDL) analysis of pathogen loading sources in the Alewife Brook should be developed in order to better inform management efforts.
- Research into federal funding opportunities, unconventional economic analyses that examines project benefits, and even innovative water quality trading programs that lower costs should be explored further.

INTRODUCTION

Alewife Brook begins northwest of the Charles River, which separates Cambridge from Boston, Massachusetts. The brook is a tributary to the Mystic River, flowing for 2.3 miles from the Little River in Cambridge and Arlington to confluence with Mystic River in Arlington and Somerville. The brook drops approximately three feet in elevation and has been described as a "flashy basin", since low-lying areas of the subwatershed fill quickly during wet weather events. (Ash, et. al., 2007, pg. 7).

The subwatershed constitutes approximately ten percent of the greater Mystic River Watershed. The area surrounding it today is highly urbanized, and includes New England's most densely populated city – Somerville – with 18,851 people per square mile, according to US Census data. Cambridge has a density of over 15,700 per square mile. The towns of Arlington and Belmont have over 8,000 and 5,000 residents per square mile, respectively. The map below shows the Mystic River Watershed and the Alewife Brook watershed, highlighted in green.

Map 1: Mystic River Watershed showing Alewife Brook Watershed and Detail of AWB WatershedSource: *City of Cambridge DPW, Proposed Concord-Alewife Stormwater Management Guidelines*



Due to its urban setting, land use patterns and topography, Alewife Brook is significantly impacted by flooding, combined sewer overflows (CSOs) and high nutrient saturation. The purpose of this report is to examine challenges associated with stormwater management in the brook. To this end, two research projects were undertaken: an assessment of stormwater management plans and practices, and an analysis of the CSO control plan and variance.

The first chapter provides an assessment of stormwater management in the brook, and has two sections. The first section analyzes the range of stormwater management techniques – including best management practices – being used to address water issues in Alewife Brook, and offers judgments about the relative effectiveness of those approaches. The annual stormwater management plans of Arlington, Belmont, Cambridge and Somerville are examined, particularly in the context of new regulations governing Municipal Stormwater Sewer System (MS4) permits set forth by EPA in 2010. The second section provides an overview of low-impact development strategies for managing stormwater, highlights benefits and costs of each strategy, and shares case studies in innovative stormwater management from across the country.

The second chapter addresses the impact of combined sewer systems on water quality in the brook. Alewife Brook is considered a Class B water body, but is operating under a variance due to CSO pollution. When the variance (and its extensions) expires – expected by about 2020 – the Massachusetts Department of Environmental Protection (DEP) will have to decide whether it can continue the Class B designation, or whether the brook must be downgraded to Class BCSO – essentially permitting it to be permanently polluted by ongoing combined sewer overflows. The purpose of this section is to present a review of city, state, state agency, and federal EPA roles and processes for determining the water classification of Alewife Brook once it has completed a CSO control plan. An increased understanding of the water classification process, coupled with case studies from other areas of the country and public comments about the local CSO control plan, offer guidance for the advocacy efforts of MyWRA.

The report concludes by citing the need for increased public outreach and education regarding the challenges stormwater poses for Alewife Brook subwatershed. While the regulatory framework that protects the watershed is important, public advocacy on issues like CSO control and greater awareness of human impacts on the watershed are critical for sustainability in Alewife Brook.

STORMWATER CHALLENGES

STORMWATER PERMITS AND STORMWATER MANAGEMENT PLANS

Section 402 of the Clean Water Act (33 U.S.C. §1251 et seq.), establishes the National Pollutant Discharge Elimination System (NPDES). Through NPDES, the Environmental Protection Agency (EPA) or a delegated state agency, issues NPDES permits that allow point-sources to discharge into the surface waters of the United States. One such point-source is a stormwater sewer system.

Stormwater sewer systems are currently divided into two types: Phase I and Phase II. Phase I stormwater systems are those that exist in communities larger than 100,000 people. These large systems require a Phase 1 permit to discharge into waters. In Massachusetts, there are two Phase I municipalities, Boston and Worcester. Phase II stormwater permits began in 2003. Phase II communities are those that have a population of 100,000 people or less. These communities contain smaller stormwater sewer systems, and are therefore referred to as Municipal Stormwater Sewer Systems (MS4). There are currently 237 Phase II, MS4 municipalities in Massachusetts. The 4 municipalities of the Alewife Brook portion of the Mystic River watershed: the town of Arlington, the town of Belmont, the city of Cambridge, and the city of Somerville are all MS4 communities.

MS4 permits allow communities to discharge stormwater. Therefore, each of the 237 MS4 communities is required to obtain an MS4 general permit (EPA Region 1). The first MS4 permits were issued in 2003 and had a 5-year lifespan. Thus, these permits were set to expire in 2008. To obtain a permit, Massachusetts' MS4 communities had to complete the following process: 1) issue a Notice of Intent (NOI) for the MS4 permit to the EPA and DEP and receive their approval, 2) draft a Stormwater Management Program (SWMP) to be available for agency and public review and comments, 3) draft and submit a final SWMP for agency review and approval, 4) implement and enforce the SWMP, and 5) conduct and submit annual reports regarding the progress of implementing the SWMP. In Massachusetts, both the EPA and the Massachusetts Department of Environmental Protection (DEP) jointly issue the permits (314 CMR 3.06(11) (b)). MS4 communities therefore have to seek approval and file NOIs, SWMPs, and annual reports to both agencies.

The SWMPs are essentially a compilation of the MS4 permit requirements, documentation of how these requirements will be carried out and any other pertinent information the MS4 municipality feels should be included in their program. This additional information can be in the form of documents, maps, water quality testing results, or plans among other things. For example, Cambridge's SWMP includes maps that illustrate where CSOs are located within the city's jurisdiction (Woodbury 2011). MS4 permits require that municipalities develop, implement, and enforce 6 minimum controls measures (MCMs). The 6 minimum control measures are: 1) public education and outreach, 2) public participation and involvement, 3) illicit discharge detection and elimination program, 4) construction site stormwater runoff control, 5) stormwater management in development and re-development (post construction stormwater management), and 6) good housekeeping and pollution prevention. Thus, the SWMP is a plan that consists of and outlines the planned implementation of each of the 6 minimum control measures.

With each of these 6 minimum control measures, a municipality must develop, implement, and enforce best management practices (BMPs) to achieve these measures. Under the 2003 permits, what the BMPs actually entailed and how they were carried was largely at the discretion of the municipality. As will discussed below, the EPA offered very general requirements for the MCMs and the BMPs, thereby giving municipalities a lot of leeway and local control over the contents of their SWMPs. MS4 owner-operators were thus able to be as innovative as they'd like, so long as they generally met the 6 MCMs. Returning to BMPs, they can be physical or non-physical. For example, under the good housekeeping and pollution prevention MCM, all 4 of the Alewife Brook communities included a physical BMP to continue street sweeping. An example of a non-physical BMP would include a BMP under the public education and outreach MCM to develop a stormwater web page on their government's website. For the most part, the term "BMP" connotes a physical practice. For the purpose of this section however, a BMP will take on the SWMP's more generic, physical and non-physical meaning.

As stated, the 2003 MS4 permits were set for expiration and renewal in 2008. However by 2008, EPA had still not created or released a draft 2008 MS4 permit. Communities therefore continued to follow their 2003 SWMPs and BMPs, thus annually extending their original 5-year plans, goals, and deadlines. Many communities also added and revised BMPs to their permit over the years. So depending on the nature of the BMP, they were either continued throughout the years (2004-2010), completed during the original 5 year plan, completed and extended, or were not completed despite the time extension (See Appendices 1 through 5). This is permitted as MS4 communities must continue to manage their stormwater. In addition, so long as they continue to follow their SWMPs, these communities are in compliance since they are waiting on the EPA to formally continue, update, or change the MS4 permit requirements.

Draft 2010 MS4 Permits

Starting in 2010, the EPA released the new draft MS4 permits for public comment and review. The new permits are a significant shift from the 2003 general permits. First, Massachusetts MS4 owner-operators will no longer fall within 1 general MS4 permit. EPA Region 1 has created three different general permits. One general permit will cover, "operators located in the state of New Hampshire, a second for Operators located in the North Coastal watersheds of Massachusetts, and a third for Operators located in the Interstate, Merrimack and South Coastal watersheds of Massachusetts" (EPA Region 1). The 4 communities of the Alewife Brook- Arlington, Belmont, Cambridge, and Somerville- fall under this geographic scope of the North Coastal Watersheds permit. It is expected that the new permits will go into effect in July of 2011 (EPA Region 1 2011, Civian 2011). At this time, MS4 communities will be required to apply for the new permits and adjust their existing SWMPs and BMPs accordingly.

In addition to the creation of three new general permits, the draft 2010 MS4 permits contain a number of substantive changes. Though the 6 MCMs remain, the requirements under each of them, including the BMPs, are much more specific and comprehensive. MS4 owner-operators no longer have the freedom to pursue and report MCMs in general terms – terms and conditions, as will be discussed below, that were often seen as vague, ambiguous, and hard to verify. Communities will now have to pursue specific BMPs under specific reporting standards. Successfully meeting a BMP will also be less subjective, as communities will have to adhere to the criteria specified in the new MS4 permits so as to accurately report their progress and completion. Using the Public Education and Outreach MCM as an example, the 2003 MS4 general permit required that communities, "Develop education program to distribute educational material to the community (sic)" (EPA Region 1, Summary, 2011). The 2003 permit did not expand upon what constituted an education program, educational material, nor distribution, leaving this at the discretion of the municipality. On the other hand, the 2010 draft general permit requirements include but are not limited to, "Educational program must include education and outreach efforts to (1) residents, (2) businesses, institutions, and commercial facilities, (3) developers (construction), and (4) industrial facilities" and "Distribute a minimum of two educational messages over the permit term to each of the four audiences, for a total of at least eight educational messages. Space distribution at least a year apart." (EPA Region 1, Summary, 2011). This example illustrates that the 2010 draft general permits place much more specific, detailed obligations and criteria on MS4 communities. It can be argued that this shift towards more comprehensive and specific criteria will increase consistency among the MS4 communities' SWMPs, better define their responsibility, and improve efforts to assess the implementation as well as effectiveness of the SWMPs. Ultimately, a more regulatory demanding MS4 permit will result in improved stormwater management that in turn will result in improved water quality.

The "Relative Effectiveness" of SWMPs

To better understand the changes contained in the 2010 draft MS4 permits, and what impact, if any, these new permits will have on the four communities of the Alewife Brook, it is useful to first examine the 2003 SWMPs and the eight years of corresponding annual reports. As stated, all MS4 communities are required under the CWA to have a MS4 permit, which mandates the creation of a SWMP. Municipalities are then required to file annual reports detailing the implementation and enforcement of their SWMPs. However, this raises a number of questions, the first being, are the SWMPs effective? That is, are the MCM BMPs outlined actually being implemented and enforced and if so are they addressing the issues and improving the Alewife Brook's water quality?

Appendix 1 contains a listing of the BMPs contained in the 2003 SWMPs of each of the four Alewife Brook MS4 communities. For the most part, the 4 municipalities have the same BMPs. This is not surprising since the BMPs are very general and represent the minimum actions MS4s are legally required to perform. Therefore, simply comparing the BMPs across the SWMPs does not provide much information about the effectiveness of the SWMP. It does however provide an initial idea of what differences as well as relationships may exist between the communities in their stormwater management priorities. In regards to differences, one example is the priority the different communities place on pet waste. In the 2003 SWMPs, Arlington and Somerville included very specific BMPs for initiating public awareness campaigns concerning pet waste and stormwater. On the other hand, Belmont and Cambridge, while they may have addressed the issue through public education generally, did not include a specific pet waste BMP in their SWMPs. Relationships between communities and agencies are also evident in some of the BMPs. For example, Arlington, Belmont, and Cambridge each include BMPs regarding the A-B-C Stormwater Flooding Board, an inter-municipality group that was formed to address Alewife Brook flooding issues in all three communities. Though the effectiveness cannot be adequately determined with just this cursory look, there is at least evidence that the idea of watershed level, intergovernmental management exists and has been formalized through its inclusion in the SWMPs.

Through examining the SWMPs, it is easily determined what BMPs MS4 owner-operators are including to ensure that they meet the MCMs as required by the MS4 permit. However, this does not address whether or not the BMPs are being carried out. The required annual reports help in determining this. Though the 2003 MS4 permits were intended to last 5 years, these permits are actually still in effect. Therefore, communities have continued to supply annual reports based on the progress made on the original 2003 BMPs as well as any other BMPs that have been added or revised. Annual reports are to be reported "in good faith" (Civian 2011) and thus a high degree of deference is given to the municipality as the information contained in the annual reports is expected to be honest and accurate. Resource constraints at both the EPA and MassDEP render full verification of each element of the annual report impossible.

Appendices 2 through 5 are a compilation of the "BMP progress statements" contained in the 7 annual reports (2004-2010). As with the SWMPs, for the most part BMPs are similar between the communities, even the ones that were added and revised throughout the 8 years. Again, this is not surprising since the MS4 general permit contained the same general MCMs and BMPs to be employed and since the 4 communities of the Alewife Brook face similar stormwater management issues and challenges.

However, the annual reports, taken as "good faith efforts" of reporting do provide some insight into the effectiveness of the SWMPs. Based solely on the fulfillment of BMPs, Belmont is by far the town that has the "least effective" SWMP. Arlington and Somerville appear to be comparable both in terms of BMPs and number of BMPs fulfilled. Cambridge's annual reports indicate that the city is frequently fulfilling its BMPs, even ahead of schedule in some cases.

In terms of going above and beyond the minimum requirements, both Cambridge and Somerville are the outliers. Cambridge's reporting and criteria are very detailed and innovative almost mirroring the level of detail and reporting that will be required under the draft 2010 MS4 permits. Somerville's Illicit Discharge Detection and Elimination (IDDE) Program goes beyond minimum required in its inclusion of a dry weather sanitary sewer overflows (SSOs) monitoring BMP. All in all, the ranking of "least effective" to "most effective" SWMPs based on initial analysis of the annual reports and BMP fulfillment is: Belmont, Arlington, Somerville, and Cambridge. It is important to stress again that this "effectiveness" ranking is based solely on the reports and in no way considers political, economic, or institutional differences that exist between the 4 Alewife Brook communities. It can be argued that perhaps these exogenous criteria should not be taken into consideration, as the MS4 permit is a legal requirement and thus must be carried out to the full letter of the law. As the next section illustrates, this hard-and-fast rule may differ depending on who you are and what your relationship is to the MS4 permit.

Other Measures of "Relative Effectiveness"

The effectiveness of SWMPs is ultimately a subjective determination. Agencies may point to the fulfillment of the statutory requirements as proof of effectiveness. Without the MS4 permitting requirement, many municipalities probably would not be addressing these discharge issues let alone the 6 MCMs due to lack of political will, resources, and knowledge. One of the purposes of environmental law is to ensure that human health and environmental welfare become a part of social, political, and economic dialogues. From the agencies' perspective, the 2003 MS4 general permits were a step in the right direction in getting municipalities to begin addressing stormwater management through the creation of SWMPs.

Municipalities, the MS4 owner and operators, may view the effectiveness slightly differently than agencies. For an MS4, effectiveness may mean that the most pressing issues are being addressed first. Working with very limited financial resources and personnel coupled with the constant limiting factor of time, municipalities are often put in a position in which not all BMPs contained within the SWMP are treated equally. This may be especially true when unexpected events occur. In the Alewife Brook, flood events are becoming more and more common. When floods occur, working to identify and solve the infrastructure problems that led to or contributed to the flood take top priority in terms of time, funding, and personnel. This does not mean that municipalities are off the hook when BMPs are not implemented. Creating and adhering to the SWMP is required by law. However, except in extreme cases of non-compliance, agencies and municipalities, two entities that frequently face the same lack of resources issues, generally work together to address issues with implementing the SWMP (Civian 2011).

Advocacy groups and concerned citizens argue that the 2003 SWMPs have been largely ineffective (Herron 2011). In 2010, the Mystic River Watershed Association (MyRWA) conducted an internal review of the 2010 MS4 Annual Reports for all of the communities in the Mystic River Watershed (MyRWA 2010). MyRWA evaluated the statements of BMP progress and fulfillment provided in the annual reports using the following criteria: 1) Completed with verifiable detail, 2) Completed (best interpretation), 3) Ambiguous or unclear language, 4) Not documented, and 5) Not completed. MyRWA found that out of the 16 Mystic River watershed communities Cambridge ranked 1st, Arlington ranked 9th, Somerville

11th, and Belmont 13th (MyRWA 2010). In terms of overall SWMP effectiveness, regardless of ranking, Cambridge's program earned a "C" while the Arlington, Belmont, and Somerville's programs all failed (MyRWA 2010).

In addition to evaluating the overall effectiveness of the SWMPs, MyRWA also used the annual reports to try to determine if water quality standards were being protected. MyRWA looked for three water quality specific efforts: 1) MS4 has documented efforts to increase BMPs beyond minimal measures (e.g. street cleaning), 2) MS4 has specifically documented pollutants of concern identified in 303d impaired waters and the BMP targeted to reduce the pollutant (important to realize that almost every municipality mentions bacteria which is listed as impairment), and 3) MS4 has systematically measured and prioritized mitigation of largest sources of pollutants of concern (including illicit discharges or IDDE) (MyRWA 2010). To best determine if these efforts were included in the SWMPs and if they were being carried out, MyRWA applied the same six reporting criteria as listed above. According to MyRWA's applications and findings, all four of the Alewife Brook communities failed to carry out and/or achieve the three water quality protection measures (MyRWA 2010).

As this section illustrates, there are a number of ways to assess effectiveness (or lack their of) of both the SWMPs generally, the BMPs specifically, and other factors such as "protection of water quality standards." This variability in terms of both the definition of "effectiveness" and how to assess it is to be expected as under the 2003 permits and annual reports there is no hard-and-fast rules for what SWMPs should contain or achieve other than working on the 6 MCMs. And even what constitutes "working on" is subjective and prone to a wide variety of interpretation depending on who is asked. This inherent subjectivity coupled with the economic, temporal, and personnel constraints that all interested parties face results in a reality in which "actual effectiveness" is nearly impossible to determine. However, as the next section will show, the 2010 draft MS4 permits are much more robust and rigorous in their requirements as they attempt to promote "actual effectiveness" as well as decrease the level of subjectivity in evaluating SWMPs.

Draft 2010 MS4 Permits: Actual Effectiveness?

As illustrated in the section "Draft 2010 MS4 Permits," the breadth and depth of the requirements contained in the draft 2010 MS4 permits are a departure from the 2003 general permits. However, the question of effectiveness still remains. In a time of deep budget cuts, economic hardship, and bi-polar political unpopularity for cutting services and increasing spending, the ability of all the parties involved in the MS4 permitting process - the agencies, the municipalities, advocacy groups, developers, and the general public, among others – to develop, implement, enforce, and adhere to the new permits is uncertain. It is expected that institutionally, there will be little change. The EPA and DEP will still jointly carry out permitting responsibilities, though the extent of the role that each agency will play remains to be finalized. Municipalities are under the impression that the roles will remain the same (Woodbury 2011), whereas the DEP sees itself taking a greater role in providing MS4s "technical assistance" and less in permitting (Civian 2011).

In terms of funding, there is no illusion by any party that MS4 communities will be attempting to fulfill the new draft 2010 permit mandates with the same or even decreasing funding levels (Civian 2011, Woodbury 2011). The 2010 draft permit is aware of the time and resources required to adjust the SWMPs. The 2010 draft permit states, "If covered under the MS4-2003, continue to implement existing SWMP developed under MS4-2003 while updating SWMP pursuant to the new permit." (EPA Region 1, Summary 2011). By allowing communities time to adjust to the new permit while maintaining the previous permit's standards ensures that stormwater management issues will continue to be addressed using at least the 2003 BMPs during the interim. However, the reliance on 2003 permit standards will not go on indefinitely. The 2010 draft goes on to state that, "Compliance deadlines set forth in the MS4-2003 are not extended." This ensures that MS4 owner-operators will begin implementing the draft 2010 permit changes.

Two major substantive changes in the 2010 permits are: the highly detailed inclusion of sanitary sewer overflows as a part of IDDE Program and an increased focus on addressing impermeable surfaces. These two stormwater management issues are seen as the emerging issues for Massachusetts' urban MS4 communities (Civian 2011, Herron 2011, Woodbury 2011). Therefore, in continuing the analysis between the 2003 and draft 2010 permits, the IDDE Program MCM will now be examined.

Illicit Discharge Detection and Elimination (IDDE) Programs

The 2003 MS4 permits require MS4 owners to create, implement, and enforce an Illicit Discharge Detection and Elimination Program (IDDE Program). The IDDE Program is the third minimum control measure. Therefore the BMPs associated with IDDE are often designated in the third section of the SWMP and by the number 3. Under the 2003 permits, the EPA defined six general IDDE-specific BMPs; general in that they do not specifically define, step-by-step, how MS4 owner-operators should implement these BMPs. These IDDE-specific BMPs are: i) Develop, implement, and enforce a program to detect and eliminate illicit discharges, ii) Develop a MS4 map showing location of all outfalls and receiving waters and names, iii) Effectively prohibit, through a bylaw/ordinance, non-stormwater discharges into the MS4 and implement appropriate enforcement procedures and actions, iv) Develop and implement a plan to detect and address non-stormwater discharges including illegal dumping, into the MS4. Plan must include procedures to identify priority areas; locate illicit discharge; locate the source of the discharge; remove the source; and document actions and evaluate impacts of removal on MS4, v) Inform the public employees, businesses, and general public of hazards of illicit discharges and improper waste disposal, and vi) Address any allowable non-stormwater discharges if they are determined to be significant contributes of pollutants to the MS4.

Through the SWMPs, municipalities must address these six general actions. The four municipalities in this study all created an IDDE Program as required by the permit. However, the IDDE Programs varied in what BMPs were contained and/or how they were defined. The four municipalities IDDE Program BMPs under the 2003 permit are detailed in the charts below.

Arlington

The city of Arlington created its SWMP with the firm Faye, Spofford & Thorndike. The IDDE Program portion of their SWMP thus differs from other municipalities in that it includes specific IDDE BMPs as well as BMPs from other sections of the SWMP that have been deemed applicable to the IDDE section. Thus, other plans list BMPs that directly pertain to and are found only within the IDDE Program portion usually designated with the number 3, while Arlington IDDE BMPs are designated by the number 3 as well as the numbers of the other minimum standard for which the BMP was initially created.

Arlington's four IDDE Program specific BMPs follow the general standards outlined. BMPs 3-1 through 3-3, develop an IDDE Program, map the outfalls, and revise Arlington's bylaws to prohibit non-stormwater discharges into the city's MS4. BMP 3-4 differs in that it specifically identifies a plan to directly address a major and common illicit discharge contributor: sanitary sewer pipes and sanitary sewer overflows. The inclusion of this BMP allows Arlington to fulfill the more general requirements that a municipality to “develop and implement a plan to detect and address non-stormwater discharges.

BMP 3-1	Maintain Outfall Location Map
BMP 3-2	Revision of Existing General and Zoning Bylaws
BMP 3-3	Implement an Illicit Discharge Detection and Elimination Plan
BMP 3-4	Rehabilitate and Replace Sanitary Sewer Pipes
BMP 1-1	Place Educational Information on the Town’s Website
BMP 1-2	Conduct Household Hazardous Waste Collection Days
BMP 2-2	Educational Outreach for Spy Pond
BMP 2-3	Sponsor an Annual Cleanup at Spy Pond
BMP 2-4	Sponsor Storm Drain Marking Activities at Spy Pond
BMP 2-5	Sponsor Clean-up at Arlington Reservoir
BMP 4-2	Develop and Implement a Citizen Tip Line

Belmont

Like Arlington, the town of Belmont also created its SWMP with the firm Faye, Spofford & Thorndike. The IDDE Program portion of their SWMP also includes IDDE specific BMPs in addition to applicable BMPs from other MCM sections.

Belmont’s BMPs also follow the general standards including the development of an IDDE Program, mapping outfalls, adopting bylaws, and informing and training public employees as well as the general public. Belmont’s SWMP also includes a specific BMP to address SSOs.

BMP 1-1	Develop a Stormwater Web Page on Town Website
BMP 2-3	Sponsor Storm Drain Stenciling Program
BMP 3-1	Outfall Location Map
BMP 3-2	Develop and Adopt a Stormwater By-Law
BMP 3-3	Illicit Discharge Detection and Elimination Plan
BMP 3-4	Conduct I/I Removal from Sanitary Sewer
BMP 6-1	Training Program for Belmont DPW Employees

Cambridge

Cambridge’s BMPs reflect the 2003 MS4 permit requirements. The city’s annual reports however, contain much more in-depth programmatic details and criteria for each of the 4 BMPs listed. (See Appendix 4).

BMP 3.a	Update Stormwater Drainage System, Outfalls and Receiving Waters in GIS
BMP 3.b	Detect and Eliminate Illicit Discharges
BMP 3.c	Conduct Illicit Discharge Education Program
BMP 3.d	Develop Regulations Prohibiting Illegal Dumping of Non-Stormwater into the MS4

Somerville

The City of Somerville's SWMP contains both general and specific BMPs to achieve its IDDE Program. Somerville's plan addresses the fundamental components of the IDDE Program requirement including: developing an IDDE program, mapping stormwater outfalls, and developing ordinances and by-laws that prohibit illicit discharges.

BMP 3-1	Conduct dry weather outfall screening
BMP 3-2	Map stormwater outfalls and receiving waters
BMP 3-3	Map the stormwater collection system in GIS
BMP 3-4	Develop and implement plan to identify and remove non-stormwater discharges
BMP 3-5	Identify twin invert manholes and implement sanitary inflow prevention measures
BMP 3-6	Develop ordinance that prohibits non-stormwater connections to the MS4, gives the City authority to access buildings to search for and require redirection of illicit connections
BMP 3-7	Continue inspection of new construction for correct connection

IDDE Program's under the 2010 Draft MS4 Permits

The IDDE Program MCM in the new draft 2010 MS4 permits contains very different requirements than those found in the 2003 permits. This is not surprising, since each of the MCMs in the 2010 draft MS4 permit appear to be much more robust and comprehensive than their predecessors.

Under the 2010 permit, the IDDE Program is much more thorough, detailed, and intensive. The outlined BMPs shift from the six general actions to seventeen actions that vary from new administrative requirements to those that are conditional and must be performed sequentially. Unlike the previous permit, the 2011 permit IDDE BMPs specifically outline target areas, and evaluative criteria to determine both the extent of the IDDE problem as well as the municipality's effectiveness in addressing the problem.

Though illicit discharges can occur in a variety of ways, the requirements contained in the 2010 permits clearly indicate that SSOs are a major contributor to non-stormwater discharge into MS4s, adversely impact stormwater quality, and are a major concern on MS4 owners and operators. This was evident even in the 2003 SWMPs, since each of the 4 communities included specific BMPs to address SSOs in their IDDE Program (See Appendix 1). However, with the draft 2010 permits it is now obligatory that municipalities develop, implement, and enforce extensive and intensive IDDE Programs. This section, in fact, contains perhaps the strongest language of the entire permit when it states, "Prohibit Sanitary Sewer Overflows (SSOs) and all other illicit discharges to MS4 and require removal of such discharges." Under the new permit, it is no longer sufficient for MS4s to address illicit discharges as they arise (Woodbury

2011). Municipalities are now, in no uncertain terms, required to create and implement an IDDE Program with teeth.

CONCLUSION

The 2003 MS4 permits marked the first step agencies and municipalities took to better address stormwater management. Though highly imperfect, the 2003 permits raised the bar, insisting that communities attempt to meet 6 minimum control measures that would improve stormwater management, fix aging infrastructure, promote public awareness of community stormwater issues, and attempt to achieve the water quality, public health, and environmental goals first defined in 1972 by the Clean Water Act. Improving stormwater management and better water quality is simultaneously a short-term and long-term process. This is evidenced in the nature of the SWMPs – 5 year plans that are reported on annually, so as to ensure that specific short-term goals are being met, that best management practices are consistently implemented, and that progress is continually being made towards the long-term goal of meeting the high water quality standards that we as a society have collectively decided to aspire to.

The draft 2010 permits with their new, more rigorous and comprehensive SWMP drafting, implementation, enforcing, and reporting requirements will be new territory, especially for the agencies and MS4 owner-operators. Starting in July 2011, MS4 communities will have to begin the process of switching over from the BMPs in their 2003 SWMPs to the more rigorous ones required. However, this shift is occurring at a time when resources and additional capacity are at an all time low. There is no doubt that the high standards of the draft 2010 permit will be met, the question however is when. It is here that advocacy groups like MyRWA can play a key role. In addition to ensuring that municipalities and agencies are fulfilling their legally mandated and permitted goals, other influential players in stormwater management should also be engaged. As our report illustrates, these stakeholders include businesses, private landowners, and residents. Each of these identified stakeholders can play a key role in local stormwater management and regulation as businesses have the capital and in some cases social and economic interest to implement low impact development projects, stormwater mitigation measures, and public outreach. Corporate social responsibility is an increasingly important factor for businesses and MyRWA should capitalize on this.

Additionally, the Alewife Brook has the added and unique benefit of being located within communities whose populations are interested in stormwater management issues and sustainability. There is a growing movement in at least Somerville and Cambridge of residents taking the initiative to remove impervious surfaces from their property, attend river cleanups, and reclaim polluted and off-limit riverbanks. Again, though municipalities are obligated by law to effectively manage their water resources and infrastructure, expecting them to shoulder the responsibility of improving the water quality of the Alewife Brook is ignoring the vast and currently untapped resources public, private, and non-profit sectors have to offer. Just as there is no single solution or quick fix to improving the Alewife Brook (as the SWMPs show), there is also no single entity solely responsible for the current degradation or the future improvements. Improving stormwater management requires a collective and comprehensive effort on the part of all stakeholders. Only time till tell if the four Alewife Brook communities will rise to this challenge and restore a once pristine and beautiful water body. The combination of the 2010 permits, the growing sustainability movement amongst citizens and businesses, and the continuous work of advocacy groups is properly aligned and coordinated will ultimately make a safe, swimmable, fishable, and ecologically healthy Alewife Brook a reality.

Beyond the Stormwater Management Plans: Low Impact Development Strategies

INTRODUCTION

Topography, soil and bedrock geology, and land use (e.g., forested, residential, wetlands, commercial, industrial) are important characteristics that affect stormwater drainage within a watershed. Due to its urban setting, land use patterns and topography, the Alewife Brook watershed is severely affected by flooding, combined sewer overflows and high nutrient saturation in the brook itself. Bacterial counts in the Alewife consistently fail to meet standards, and water clarity and dissolved oxygen also remain poor in this area (MWRA, 2004), which are directly related to Phosphorous loading. from fertilizers, oils and cleaners.

Stormwater runoff is a significant source of pollution for all surface water bodies in the United States. In the course of streaming over roads, pavement, asphalt, and farmland, water attracts pollutants and deposits those into its receiving body of water. The effects of stormwater runoff thus increase with land development and urbanization (USEPA, 2007). The addition of impervious surfaces, and decrease in accessible natural soil, trees and vegetation result in changes to the conveyance of water through the environment. Impervious surface can be defined as natural or anthropogenic source that prevents the infiltration of water into soil, thereby changing the flow dynamics, sedimentation load, and pollution profile of storm water runoff (USGS, 1998). The changes in water flow often impede natural contaminant removal processes such as interception (with natural absorption elements such as roots and stems), evapotranspiration, infiltration and precipitation, which alter the flow over land rather than recharging the water table.

Although Arlington, Belmont, Cambridge and Somerville have completed required documentation of general steps to begin the stormwater management process (MS4s), there is a great deal left out of current and future permits. One fundamental void is existing residential and commercial building stock, which rarely needs new permits and thus remains generally unaddressed by the stormwater mangagement plans. Beyond that, as stated in the Stormwater Challenges section above, the stormwater "Best Practices" tend to be generic so that they can be used ubiquitously and their effectiveness is rather variable. Implementing strategies of Low Impact Development would be more aggressive and more effective for managing the stormwater issues facing the watershed. Low Impact Development (LID) strategies are often the most feasible, measureable and effective projects for managing stormwater quantity and quality. LID strategies are particularly suited for an urban context where runoff from pervious surface presents one of the most significant sources of non-point source pollution.

Low Impact Development (LID) is a stormwater management approach that aims to mitigate the effects of increased runoff and stormwater pollution. LID comprises a set of site design approaches and small-scale stormwater management practices that promote the use of natural systems for infiltration, evapotranspiration, and reuse of rainwater. These practices can effectively remove nutrients, pathogens, and metals from stormwater, and they reduce the volume and intensity of stormwater flows. The reason that these tools would be effective for the towns in the Alewife Brook watershed is that they tend to be lower cost options for managing a dense, urban landscape. This area has few feasible options for increasing its green space to counteract the effects of the development. Rather, Cambridge, Somerville, Belmont and Arlington will have to counteract a predominantly developed land mass contributing to this degraded water body. LID strategies can be effectively designed and implemented for water management in small or large areas. Local pilot studies in the Alewife Brook watershed could illustrate economically viability and implementation strategies for stormwater runoff mitigation. Subsequently, the towns would be better able to make informed policy decisions to incentivize LID projects. The following sections will highlight pertinent LID strategies that are either already in place in parts of the watershed or could be implemented locally based on research conducted for urban sites around the country. A few case studies of the local business district will be included as well. Then, the last section highlight several funding mechanisms used throughout New England and the country, which ought to be considered as part of a comprehensive stormwater management plan moving forward.

LID PRACTICES AND BENEFITS FOR THE ALEWIFE BROOK WATERSHED

There are two main problems associated with runoff: quantity and quality. Impervious surface, which tends to be the most common surface in the Alewife Brook watershed, increases the quantity of runoff pouring into local waterbodies.

Town	Square Miles Total	Square Miles Impervious	% Impervious
Arlington, MA	5.44	2.25	41.38
Belmont, MA	4.77	1.64	34.47
Cambridge, MA	7.16	4.16	58.05
Somerville, MA	4.14	3.18	76.65

Data Souce: Map Tracker ID 4291, March 3, 2010
Data Sources: TeleAtlas 2007, US Census Bureau 2000,
USGS 2009, MADEP 2008, MassGIS 2007

As shown in Table 1, the towns in the Alewife Brook watershed range from 36% average impervious area in Belmont to 76% average impervious cover in Somerville, making them highly susceptible to increased runoff flowing into the local watershed. The density of residents increases the potential for pollutants to enter the runoff, as people tend to be to use the pollutants: fertilizers, cleaners, motor oil. While Boston has approximately 12,000 people per square mile, Somerville has nearly 19,000 per square mile (US Census, 2000) and places with higher densities tend to incur worse water quality because people and their pets tend to be the users of Phosphorous-rich cleaners, fertilizers and oils.

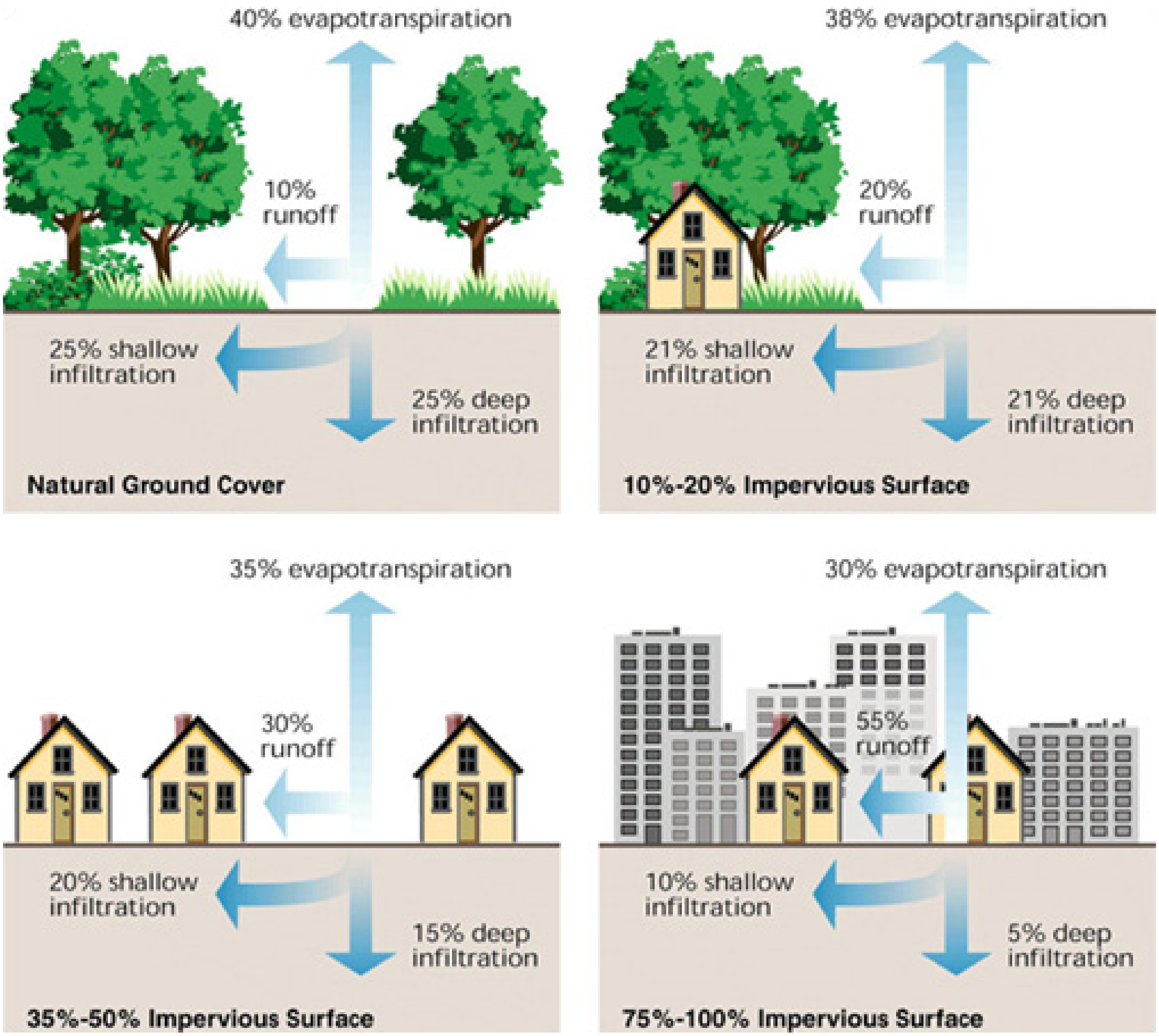


Figure 1: Water Transport based on impervious surface percentage of land coverage.

Figure 1. illustrates the infiltration differences between different types of landscapes; paving with impervious surface changes the ratio of water that runs off streets and roads into surface water bodies compared with recharging the water table (USGS, 1998). As the Alewife Brook sits squarely in a dense, urban landscape, it is requisite to understand how much of the average 43" of rainwater Massachusetts experiences per year is in fact running off pavement and cement and feeding directly into our rivers.

The LID site design approach is an arrangement of natural and engineered technologies, these are typically beyond the BMPs referred to by the EPA; these are strategies that typically demonstrate greater performance for mitigating stormwater runoff control and depending on the project can be achieved at minimal additional cost. The specific goals of LID projects address both quantity and quality of stormwater runoff:

- Peak flow control;
- Volume reduction;
- Water quality improvement (filter and treat pollutants); and
- Water conservation.

This section will demonstrate available strategies for minimizing stormwater runoff and improving water quality, which are significant parts of the solution for both stormwater management in general as well as the Combined Sewer Overflows experienced in the watershed today. Some of the basic descriptions of LID strategies is referenced from the Department of Resources in Marylan design guide for LID entitled "Low-Impact Development Design Strategies: An Integrated Design Approach." This section will also include several case studies, highlighting local strategies for LID, and lastly, will cover challenges and funding strategies.

Table 2 lists several LID technologies and their associated benefits. A brief description of commonly used LID practices and suitable applications follows.

Table 2: LID Practices and Benefits

LID PRACTICE / DEVICE	Peak Flow Control	Volume Reduction	Water Quality Improvement	Water Conservation
Bioretention Cell	•	•	•	
Cistern	•	•		•
Curbless Parking Lot Islands	•	•	•	
Downspout Disconnection	•	•	•	
BioSwale	•	•	•	
Green Roof	•		•	
Permeable Pavers/ Pavement	•	•	•	
Rain Barrel	•	•		•
Rain Garden	•	•	•	
Tree Planting	•	•		

(Source data: Low-Impact Development Design Strategies US EPA, 1999)

APPLICABLE PILOT STRATEGIES

Bioretention Cells (commonly known as a "rain garden")

Figure 2: Bioretention swale: Portland, Oregon
Courtesy: American Society of Landscape Architects HQs, Washington, DC

A bioretention cell (strip or trench) is an engineered natural treatment system consisting of a recessed landscaped area constructed with a soil mixture, an aggregate base, an underdrain, and native plant materials tolerant of the existing climate. The site can be graded to intercept runoff from paved areas, swales, or roof leaders. The soil and plants filter and store runoff, remove petroleum products, nutrients, metals, and sediments, and promote groundwater recharge through infiltration. The cells are designed to drain in 24 hours, with no risk of standing water and breeding of mosquitoes. They can be designed and built by homeowners and located near a drainage area, such as a roof downspout.

Typical Uses: Parking lot islands, edges of paved areas (roads or parking lots), adjacent to buildings, open space, median strips, swales.

Land Use: Ideal for commercial, industrial, and residential (urban, suburban). They are widely used in transportation projects (highway medians and rail projects). They are suitable for new construction and retrofit projects.

Average Cost: Residential costs average $3-$4 per square foot of size plus excavation and soil amendment costs. Plant materials are comparable to conventional landscaping costs. Commercial, industrial, and institutional site costs can range from $10-$40 per square foot, based on the need for control structures, curbing, storm drains, and underdrains.

Sample Rain Garden Case Study: Bellingham, WA:

For example, the LID Report shows that Bellingham, Washington saved $62,000 by retrofitting two parking lots—one at City Hall and the other at Bloedel Donovan Park—with rain gardens instead of installing underground vaults to manage stormwater.In Bellingham, WA, a retrofit project for a parking lot gave the following cost results:

Project	Conventional vault estimate	rain garden cost
Bloedel Donovan Park parking lots (4400 ft3 wet vault)	$52,800	$12,800

*City of Bellingham's estimate using approximate cost of $12.00/ft3 for an in-ground storage and treatment device and based on construction costs for similar projects in the Bellingham area

The cost of the rain garden retrofit at Bloedel Donovan Park (2003):

Construction Activity/Material	**Cost**
Labor	$3,600
Vehicle use	$1,900
1 ½ day excavator rental:	$500
Washed rock	$805
Amended soil	$1,650
PVC/grates/catch basins/fabric/other misc	$1,000
Concrete	$1,200
Asphalt	$1,200
Debris removal	$300
Plants	$400
WCC crew planting time	$265
TOTAL	$12,820

Maintenance: Routine maintenance is required and can be performed as part of the regular site landscaping program (i.e., biannual evaluation of trees and shrubs, regular pruning schedule). The use of native, site-appropriate vegetation reduces the need for fertilizers and pesticides.

Permeable Pavement

Disconnecting impervious areas is a fundamental component of the LID approach. Roofs, sidewalks, and paved surfaces are disconnected from each other to allow for more uniform distribution of runoff into pervious areas. Conveying runoff into vegetated areas keeps the water from directly entering the storm drain network, reduces runoff volume, and promotes distributed infiltration.

Since paved surfaces make up a large portion of the urban (or developed) landscape, the use of permeable pavement is very effective at stabilizing the hydrologic condition of a site. Permeable surfaces can be used in conjunction with subsurface infiltration galleries (subsurface retention facilities) as seen in Section 6.

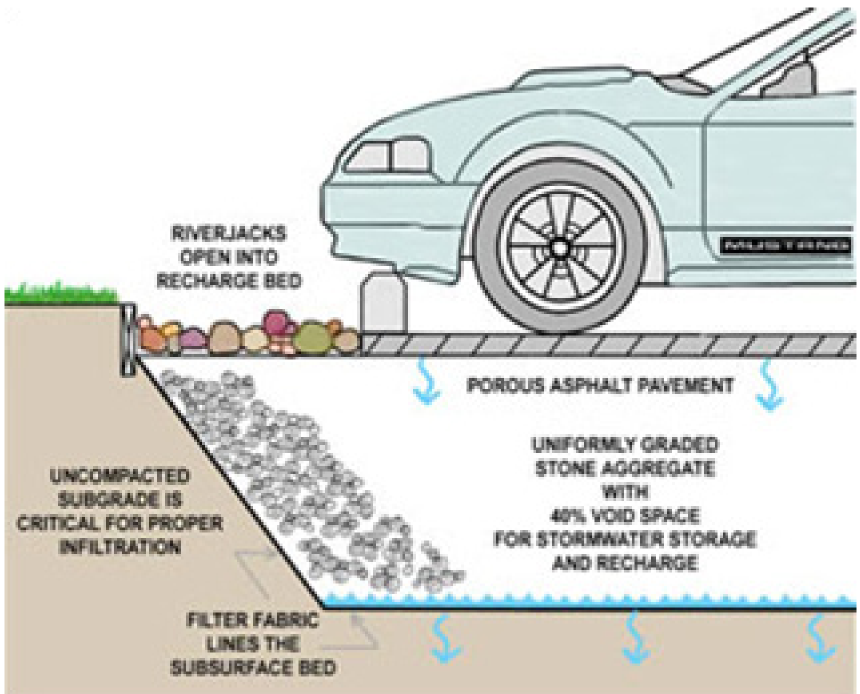


Figure 3: Permeable Pavement
Image: Cahill Associates, Inc. 2004

A secondary benefit of permeable paving is its performance in snowy conditions. Cahill Associates reports an increase in demand for the installation of permeable asphalt in the Northeast as a result of reduced maintenance costs (snow shoveling and desalting) due to rapid snowmelt on permeable surfaces.

Types of permeable pavement include permeable asphalt, permeable concrete, grid block pavers, plastic grids, vegetated grids, Belgium block, turf block, gravel, cobbles, brick, natural stone, etc.

Typical Uses: Parking bays, parking lanes, sidewalks, roads. Blocks and porous pavement are generally used in high traffic parking and roadway applications; respectively grid systems are more commonly used in auxiliary parking areas and roadways.

Land Use: Ideal for commercial, industrial, and residential (urban, suburban, ultra-urban); suitable for new construction and retrofit projects.

Approximate Cost: Varies according to product. Typically, the cost is higher than conventional paving systems; however, they help reduce the overall storm water infrastructure costs.

Permeable Pavement Maintenance, according to University of Rhode Island Case Study:

Removing Snow and Ice

- Do not apply abrasives such as sand or cinders on or adjacent to porous pavement
- Snow plowing is fine but should be done carefully (i.e. set the blade approximately 1" higher than usual)
- Salt application is not acceptable due to the close proximity of the drinking water wellfield. Environmentally benign deicers such as Ice-Ban, which is produced by Natural Solutions Corporation of Chesapeake, VA, are permissible.

Preventing Clogging of Pavement Surfaces

- Vacuum pavement at least four times per year with a commercial cleaning unit and transport the removed material to a previously designated disposal area. The use of pavement washing systems or compressed air units is not recommended.
- Maintain planted areas adjacent to pavement to prevent soil washout
- Inspect planted areas on a semi-annual basis and remove any litter.
- Replant and/or stabilize any bare spots or eroded away areas
- Mow the vegetated islands and infiltration basin at least once per growing season. The grass vegetation should not be cut to a height less than four inches.
- Immediately clean any soil deposited on pavement
- Do not allow construction staging, soil/mulch storage, etc. on unprotected pavement surface.
- Do not stockpile snow on pavement surface. Sand and grit in snow will clog pavement.
- Clean inlets draining to the subsurface bed twice per year.

Inspecting the Surface

- Inspect the porous pavement surface annually for deterioration or spalling.

Source: http://www.uri.edu/ce/wq/NEMO/Publications/PDFs/PP.URICaseStudy.pdf

Disconnected Downspouts

Each downspout on a house can drain approximately 12 gallons of water per minute during a one-inch rainfall. This is a simple, low-cost solution for a problem that occurs all too often. Many new developments are constructed such that the rain downspout is placed just above the driveway, pouring out onto residents' impervious surface, which is full of petroleum by products of driving. Thus, a simple solution can be found by simply changing the location of that downspout, with minimal cost or impact to the owner. Downspouts account for nearly 25% of runoff from a typical 1 family residential unit. Downspouts can be disconnected from underdrains and the runoff directed to vegetated areas to reduce runoff volume, promote infiltration, and change runoff timing.

The barriers to disconnecting or redirecting downspouts start with property structural design. One cannot just simply redirect their downspouts anywhere onto their property — runoff should be redirected to soft, landscaped surfaces such as lawns, gardens or swales to allow for penetration. Also, if a property has too high a grade, infiltration will not be possible (MARC, 2008). It may also be difficult to disconnect downspouts if properties are too close together, because runoff will have no space to infiltrate and may instead wind up flooding someone else's basement or damaging the building's foundation. To overcome a property's structural barriers, rain barrels can be used to collect redirected runoff. However, there are also barriers associated with the use of rain barrels. As mentioned above, for a simple disconnection where a rain barrel is not involved, the cost is a meager $9 USD, but if a rain barrel is required, the cost jumps to approximately $90 USD.

ALEWIFE BROOK WATERSHED CASE STUDIES

Alewife Brook Parkway Vegetated Bioswale

Project Summary

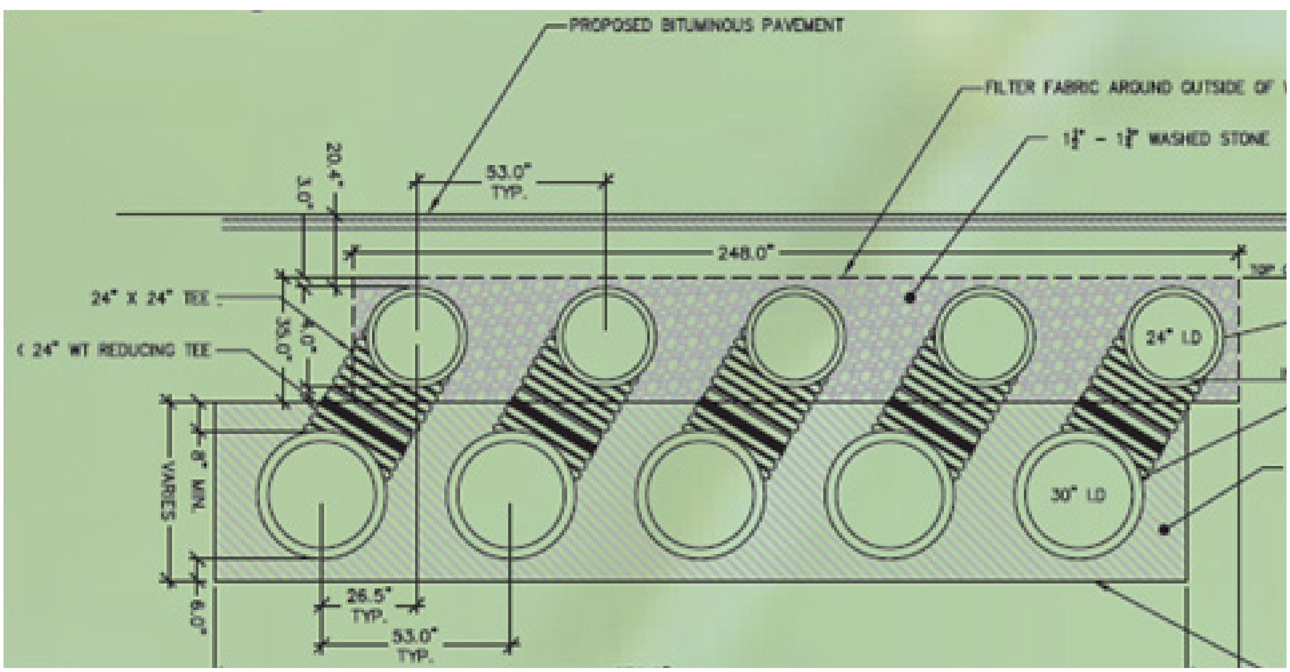
During the design of 211 + 321 Alewife Brook Parkway, Linear Retail Properties and Samiotes Consultants, the project's civil engineer, worked in cooperation with the city to address the stormwater treatment and storage requirements for the 47,000 square foot site.

Project Details

A vegetated or grassed swale is an area with dense vegetation that retains and filters the first flush of runoff from impervious surfaces. This is in fact already built on the Alewife Brook parkway. It is constructed downstream of a runoff source. After the soil-plant mixture below the channel becomes saturated, the swale acts as a conveyance structure to a bioretention cell, wetland, or infiltration area.

There is a range of designs for these systems. Some swales are designed to filter pollutants and promote infiltration and others are designed with a geo-textile layer that stores the runoff for slow release into depressed open areas or an infiltration zone.

The design for the development at Alewife Brook parkway is as follows:



In this case, the engineer, worked in cooperation with the city to address the stormwater treatment and storage requirements for the 47,000 square foot site. The construction of lower impact design elements such as bio- swales, infiltration basins and rain gardens work together to treat and reduce stormwater runoff and to promote infiltration. Benefits from these stormwater management systems include:

- Mitigation of the peak discharge rate for the 25-year storm event down to below the predevelopment 2-year event
- Reduction of total suspended solids and phosphorous from the stormwater runoff draining to the Alewife Brook
- Increased onsite groundwater recharge

- Maximization of green space utilizing native drought-resistant plants without the need for a separate irrigation system. (Cambridge, 2010).

Typical Uses: Edges of paved areas (roads or parking lots), parking lot islands, intermediary common spaces, open space, or adjacent to buildings.

Land Use: Commercial, industrial, residential (urban, suburban, ultra-urban); transportation projects (highway medians and rail projects); new construction and retrofit projects.

Approximate Cost: $0.25 per square foot for construction only; $0.50 per square foot for design and construction.

Maintenance: Routine maintenance is required. Maintenance of a dense, healthy vegetated cover; periodic mowing; weed control; reseeding of bare areas; and clearing of debris and accumulated sediment.

Additional Benefits: Easily customized to various projects (size, shape, and depth) and land uses; enhances aesthetic value of site; uses small parcels of land, easements, right-of-ways; easily retrofitted into existing buildings/open space.

Whole Foods, Inc. Case Study

In the case of the Alewife Brook, Lee Kane, the Sustainability Czar at Whole Foods Inc. has suggested that a partnership might be created to repurpose their own barrels, which currently are a cost to the company to dispose of or recycle. More discussion will be needed between city officials, MyWRA and Whole Foods Inc. to determine if this is feasible. The interest, however, is there because it would alleviate the pressure on Whole Foods Inc. and create a public educational campaign they would support.

Rain Barrels and Cisterns

A simple, non-invasive way to mitigate stormwater runoff is to harvest and reuse it on site. Rain barrels are placed outside of a building at roof downspouts to collect and store rooftop runoff for later reuse in lawn and garden watering. They can be used to change runoff timing and to reduce runoff volume. Rain barrels have many advantages in urban settings. They take up very little space, are inexpensive, and are easy to install.

Typical Uses: Placed outside of homes or businesses to irrigate landscaping.

Land Use: Residential, commercial, industrial.

Approximate Cost: Rain barrels can range from approximately $20 to $120; the cost of cisterns varies depending on their size, material, location (above or below ground), and whether they are prefabricated or constructed on site. They range in volumes from hundreds of gallons for residential use to tens of thousands of gallons for commercial and industrial use.

Maintenance: Rain barrels require regular maintenance by the home/ business owner, including draining after rainstorms and removal of leaves and debris collected on screens. Cisterns, along with all their components and accessories, should undergo regular inspection at least twice a year.

Tree Planting Program, Cambridge MA

One LID process is planting more trees in an urban environment. Cambridge, MA has created a program that installs nearly 300 trees annually and has been recognized as a Arbor Day Foundation's "Tree City, USA" for the last 18 years. The intent of the program is to create green space, beauty, safety as well as mitigate runoff. Residents can request a tree planting for the sidewalk and beyond their sidewalk on their private property, if the sidewalk is too narrow. The program pays a significant amount of the total cost of the project. The program has been very successful and the United States Forest Service says trees can increase property values as much as 10 percent. Therefore, a $200,000 assessment of a house on a lot with three mature trees might owe as much as $20,000 of its value to your trees. A study completed in Portland, Oregon determined that Portland's street trees have a capital value of $1.1 billion, which translates to $45 million in benefits annually (Wells, 2010).

Other LID Technologies

- Green Roofs—Vegetated rooftops that use a plant-soil complex to store, detain, and filter rainfall. They reduce runoff volume and improve runoff timing. These multilayered systems use a lightweight soil mixture and sedums (not grass) to provide energy conservation benefits and aesthetic improvements to buildings. They can be used on expansive concrete roof buildings ("big boxes") or small-scale residential roof structures.
- Pollution Prevention Lawn Care—Proper fertilizer and pesticide applications will significantly contribute to lowering nutrients and chemical impairments. These include fall fertilization to decrease nutrient runoff. More research is required to determine precisely the market for non-Phosphorous based-fertilizers; however these are becoming more accessible. Currently the state of NY is investigating a pilot to eliminate Phosphorus-based fertilizers from large-scale distributors such as Home Depot.

STORMWATER MANAGEMENT FUNDING MECHANISMS

Stormwater Utility

Over 800 communities around the country have adopted a stormwater utility in order to offset costs for stormwater maintenance and programs including compliance, planning, capital improvements and repair. In South Burlington the Stormwater Utility was established in 2006 and has since improved the water quality of six local streams as well as removing waste from septic systems from leeching into Lake Champlain, the regions primary drinking source. The Utility fee is assessed based on impervious area of a property and the monthly fee is projected for multi-tenant houses based on average square footage of residences: 2700 square feet per single family house = $4.50 per month, $2.25 if that unit is a duplex and $1.50 per unit for a triplex. The program has accrued over $1 million annually.

New England Cities with Stormwater Utilities:

Chicopee, Massachusetts
Lewiston, Maine
Newton, Massachusetts
Reading, Massachusetts
South Burlington, Vermont

Stormwater Utility fees are typically based on property type or area and are charged to both tax-paying and tax-exempt properties, which, based on the variety of tax-exempt organizations in the area, is one reason this method is particularly applicable for this watershed. Burlington's method of assessing a stormwater utility is just one among several options. That method is entitled Equivalent Residential Unit, which is used by more than 80% of stormwater utilities (USEPA, 2009). As explained, it bills by the percentage of impervious area on a parcel, regardless of the parcel's total area. Another way to assess the billing is by Intensity of Development, which chargers owners by the type of development at the site. For example, a light development project might be a new playground (1% to 20% impervious) would be charged $0.12 per 1,000 square feet while very heavy development of a paved, biotechnology plant with a parking lot (71% to 100% impervious) would be charged $0.32 per 1,000 square feet. The last method of assessing a stormwater utility is via Equivalent Hydraulic Area, in which parcels are billed based on the stormwater generated by their impervious and pervious area. Although this method can be more accurate than the others because it is based on whole-site assessment of water flow, it is also more time consuming to the owner and evaluator at the utility (USEPA, 2009).

Other potential funding mechanisms:

- General Fund: stormwater maintenance paid through overall property taxes. Advantage: residents already pay into this account, the change might be incremental. Disadvantage: allows stormwater to be overlooked until there is a major problem.
- Special Assessment Districts or Regional Fund: This allows a variety of towns or municipalities to feed into the same aaccount based on the regional needs. Advantage: this would be applicable for the Alewife Brook. Disadvanatge: Requires a great deal of coordination between town in determining collection of fees and which projects will be funded.
- System Development Charges: A connection fee or tie-in charge for new customers entering the stormwater system. Advantage: simple way to add a new fee, no comparison with existing taxes. Disadvantage: does not incorporate existing sites contributing to runoff.
- Grants and Loans: Connecticut and Maine have established systems that enable the State to aid in the creation of a stormwater utility by matching funds a community raises or by loaning at a rate low enough that the town could repay within ten years Stormwater projects not covered by NPDES can be funded through Clean Water Act section 319 nonpoint source grant programs administered by states. (USEPA, 2009)

CONCLUSION

Low impact development strategies have mitigated costs where existing improvements are required in the stormwater system, which as stated, is the case for most watersheds. Although towns tend to delay water system improvements until a disaster strikes, most systems are impaired well before that point and would benefit from an overarching strategy to decrease the water flow into the system. If towns alter building codes and retrofit codes to incorporate methods of mitigation, there could be significant improvements in watersheds across the country, including in the Alewife Brook.

Some low impact solutions for stormwater management are not pursued simply due to the fact that constituents and residents are unaware of the problems in the watershed and are not aware that they could be part of the solution. For example, when asking Whole Foods at Fresh Pond in Cambridge, MA why they did not implement any stormwater management strategies the Eco Czars at first admitted to not knowing the issues the watershed faced in the first place (Kane, 2011). As we look to the issues challenging this watershed, it is important to realize that some of the problems are opportunities in disguise. Businesses are not fundamentally opposed to improving the conditions of the ecological health of their environment. However, businesses tend to require a strong investment and potentially a return, in financial terms or in customer interest, to show that a strategy is worth pursuing. If a fee were assessed for stormwater utility upgrades, the business case would be easier to prove to local businesses.

Businesses interviewed thus far, which include Whole Foods and TJ Maxx have indicated that they are interested in low impact development and water reuse although the cost benefit analysis will not meet their needs for return-on-investment, especially in the cases of retrofitting their existing buildings as they are not the owners of their sites. As most of the area is already developed, it is important to seek solutions that encourage even retrofit projects to pursue strategies that address the system's stormwater needs and the ecological health of the watershed at-large.

ANALYSIS OF CSO CONTROL PLAN AND VARIANCE

INTRODUCTION

Early cities and towns were built with combined sewer and stormwater systems that served to rid the municipality of human waste and stormwater, improving human health and preventing flooding. However, as cities have grown and the amount of impervious surface has increased, combined sewer systems have had to manage greater volumes of water than they were designed to hold. In order to relieve pressure in the system during wet weather events, combined sewer systems are designed to discharge directly into a water body. The water discharged contains both stormwater and sewage. These discharge events are known as combined sewer overflows, and contribute to significant impairment of receiving waters nationwide.

Combined sewer systems have lingering water quality impacts in Massachusetts. This report focuses on the impact of CSOs in Alewife Brook. The goal of this project is to develop a more thorough understanding of city, state, state agency, and federal EPA roles and processes for determining the water classification of Alewife Brook once a CSO control plan is completed. The initial sections of this chapter outline the regulations and processes governing water body classification and designated uses. The second section presents a detailed review of CSO control in Alewife Brook and prospects for downgrading the brook's water classification to Class BCSO. The remaining sections provide an overview of public comments on the variance and case studies that highlight similar CSO challenges in other parts of the country. Finally, the report offers recommendations to guide the advocacy efforts of the Mystic River Watershed Association.

There are eight CSO outfalls along the Alewife Brook that release untreated stormwater and sewer discharges into the water body. The Massachusetts Water Resources Authority (MWRA) estimates that annual CSO discharges have been reduced by 34 percent since 1987, when MWRA began implementing a long-term CSO control plan. Nonetheless, according to the Massachusetts Department of Environmental Protection (DEP), the Alewife Brook still does not meet "swimmable and fishable" water quality standards due to CSOs. The DEP is in the process of deciding whether to petition EPA to change water body classification in order to allow occasional CSOs. In undertaking this process, the agency would need to show that full abatement of CSOs would result in substantial and widespread economic impacts.

When all work has been completed, an assessment will be performed in the Alewife Brook and a final decision will be made regarding the water quality standards. According to Mark Casella, CSO Program Manager at the Massachusetts DEP, "The project the MWRA is undertaking with regard to the Alewife is ongoing and probably will continue beyond 2015. Any conclusions we would draw regarding the water quality standards and our assessment of them would be premature at this time." The city of Cambridge, DEP, and MWRA have noted that CSO elimination and attainment of the Class B standard remains the goal for Alewife Brook. However, the situation in Alewife Brook is particularly challenging since total CSO elimination would be very expensive.

BACKGROUND

Water Quality Standards

States are responsible for promoting water quality standards under the federal Clean Water Act and parallel state laws. Any permit for a CSO discharge requires compliance with Massachusetts Surface Water Quality Standards (314 CMR 4.00). Water quality standards contain classifications of water bodies, designation of uses, criteria to protect the uses, and antidegradation provisions. Any discharge, including CSO discharges, is allowed only if it meets the criteria and the antidegradation standard for the receiving segment. Water quality standards are reviewed every three years.

Water bodies are classified as A, B, or C (SA, SB, or SC for marine waters). All waters in Massachusetts are currently either Class A (source of public water supply) or Class B ("fishable/swimmable"). Qualitative criteria are established for each water body classification. Antidegradation provisions protect the designated and existing uses of waters. Uses of water bodies include habitat, recreation, fishing, and water supply.

Water Body Classifications

- Class B or SB – CSOs are eliminated.
- Class B(CSO) – CSOs remain but must be compatible with water quality goals.
- Variance – CSOs remain when allowed under a short term modification of water quality standards through an NPDES/MA permit.
- Partial Use Designation – CSOs remain with moderate impacts resulting in intermittent impairment of water quality goals.
- Class C – CSOs remain, causing permanent and sustained impairment.

Source: 314 CMR 4.00. Massachusetts Surface Water Quality Standards

National CSO Control Policy

EPA's CSO Control Policy, published in 1994, emerged out of negotiations among municipal organizations, environmental groups, and state agencies. The policy provides the national framework for control of CSOs through the NPDES permitting program.

In all cases, NPDES permits for CSOs require technology-based controls – known as the "nine minimum controls." These measures are intended to reduce the impact of CSOs without requiring intensive engineering work or feasibility studies. Examples of the controls include the requirement that combined sewer systems undergo regular maintenance, maximize water flow to water treatment facilities, prohibit CSOs during dry weather, control solids and floatable materials, and provide public notification of CSO events. Communities are also expected to develop "long-term CSO control plans" that outline how compliance with Clean Water Act water quality standards will ultimately be achieved.

The EPA 1994 CSO Control Policy – Fundamental Principles

- The policy contains four fundamental principles to ensure that CSO controls are cost-effective and meet local environmental objectives:
- Clear levels of control to meet health and environmental objectives
- Flexibility to consider the site-specific nature of CSOs and find the most cost-effective way to control them
- Phased implementation of CSO controls to accommodate a community's financial capability
- Review and revision of water quality standards during the development of CSO control plans to reflect the site-specific wet weather impacts of CSOs

Water Quality Assessment Methodology

Every two years, states are required to assess and report on whether water bodies meet the water quality standards for their designated uses. The reliability of water quality data is critical.

According to the Massachusetts Department of Environmental Protection (DEP), it is EPA policy that "any individual or group performing work for or on behalf of EPA establishes a quality system to support the development, review, approval, implementation, and assessment of data collection operations." (2010, Pg. 43) The Massachusetts DEP has created a Quality Management Plan to ensure that data collected meet quality requirements. The plan has been approved by EPA.

The Massachusetts DEP performs water testing to gather information about dissolved oxygen levels, water temperature, pH, bacteria levels, color and turbidity, oil and grease, and taste and odor. Each water body is assessed as "supported" or "impaired" in the context of its designated use and corresponding numerical criteria for each testing category listed above.

Additionally, according to DEP CSO Program Manager Mark Casella, computer models are used to shed light on how CSOs impact water quality. Modeling of the MWRA system – based upon data submitted during wet weather events – simulates conditions in order to evaluate alternatives for the elimination of overflows to the receiving waters.

Downgrading a Designated Use

If a state is unsure a given water body can attain the water quality standards for its designated use, it can petition EPA to downgrade the water body's designated use. State agencies must prepare a Use Attainability Analysis (UAA) to justify any change in designated use.

The UAA must document the infeasibility of attaining higher levels of pollution control. EPA has sixty days to approve, or ninety days to disapprove, the UAA. Russel Martin, EPA Region 5 CSO Regional Contact, stated in an interview that to his knowledge, no UAA has been approved by EPA anywhere in the nation that resulted in the downgrading of a water body's designated use.

Classification downgrades to a partial-use designation or to Class BCSO also require UAAs. Where CSOs are involved, state agencies prepare the UAA based on long-term CSO control plans. EPA requires that the UAA be based on a "structured, scientific assessment of the existing water body conditions, including the chemical, physical and biological attributes, as well as the economic dependence and impacts associated with the water body usage." (Mann, 1999, pg. 874)

Downgrading a Watershed – Use Attainability Analysis

The water quality standards regulation includes a total of six factors that may be the basis for concluding that a use is not attainable (see 40 CFR 131.10(g)). These factors are as follows:

1. Naturally occurring pollutant concentrations prevent the attainment of the use;

2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met;

3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place;

4. Dams, diversions, or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use;

5. Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or

6. Controls more stringent than those required by Sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.

Source: U.S. Environmental Protection Agency. "What are the 40 CFR 131.10(g) factors?" http://water.epa.gov/scitech/swguidance/standards/uses/uaa/about_uaas.cfm

Water Quality Variances

A variance represents an alternative to lowering a water body's designated use. According to EPA, "A state may wish to include a variance as part of a water quality standard, rather than change the standard across the board, because the state believes that the standard ultimately can be attained." (EPA, 2010) Under EPA's program, a variance does not require a formal UAA, and does not affect the designated use of a water body receiving CSO discharges.

ALEWIFE BROOK

The Alewife Brook is currently classified as a Class B subwatershed, although it is operating under a variance. The Massachusetts DEP evaluates Class B waters based on their suitability for aquatic life, primary contact recreation, and secondary contact recreation. The water quality of the brook is impacted by pollutants and bacteria from sources such as urban stormwater runoff, illicit discharges, and CSOs. According to the Massachusetts DEP Water Quality Assessment Report (March 2010), Alewife Brook does not meet water quality standards for its designated uses. Its designated uses and sources of impairment are summarized in the table below.

Class B Designated Use	Description	Status	Source of Impairment	Notes
Aquatic Life	Habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions	Impaired	Sediment loading due to CSOs	
Primary Contact	Recreation - swimming	Impaired	CSO and urban stormwater runoff	*E. coli geometric means were calculated for the samples from three stations from 2002-2007. Yearly geometric means exceeded standards in 18 out of 18 samples*
Secondary Contact	Recreation - boating	Impaired	CSO and urban stormwater runoff	

Table adapted from: Massachusetts Department of Environmental Protection. "Mystic River Watershed 2004-2008 Water Quality Assessment Report". March 2010. Pg. 7

CSO Long-term Control Plan

There are eight CSO outfalls along the Alewife Brook that release untreated stormwater and sewer discharges into the water body. MWRA estimates that annual CSO discharges have been reduced by 34 percent since 1987, when MWRA began implementing a long-term CSO control plan. (MWRA, 2009)

In a 1985 landmark court case, the Commonwealth of Massachusetts was cited with non-compliance of the Clean Water Act, and ordered to reduce pollution in the Boston Harbor and its tributaries. The case settlement also required MWRA to take corrective actions to eliminate or greatly reduce CSOs in several water bodies, including Alewife Brook. MWRA is currently in the process of implementing a long-term CSO control plan, the CSO Control Project.

The CSO Control Project's objective is to reduce and eliminate CSO activations to achieve a level of CSO control consistent with existing water quality standards. In total, there are 35 CSO control projects, which include sewer separation, existing CSO treatment facility upgrades, new CSO treatment facilities, relief sewers, and outfall repairs. The plan was finalized in 1997. Construction will be completed in 2015, and verification of all projects will be finished by 2020. An independent State Auditor's report on the status of the program projected that the planning, design and construction of the CSO Control Plan will cost $856.3 million – more than double the initial estimate. The net annual operation and management costs are expected to be approximately $102 million. (MWRA, 2010)

MWRA is directly responsible for many of the CSO control projects, and is working with each of the four CSO communities in the Boston area on implementation of projects affecting community systems. A stormwater basin and new stormwater outfall will be constructed to accommodate the separated stormwater flows, prevent any increase in flooding levels along Alewife Brook, and provide a level of stormwater treatment. Most of the design and construction work is being done by the city of Cambridge and MWRA, with city funding. (MWRA, 2006)

According to a public notice issued in 2009, MWRA expects that the CSO control projects will reduce annual CSO volume in Alewife Brook by 85 percent, and bring CSO discharges into compliance with water quality standards 98 percent of the time, on average. In addition, by 2015, 94.5 percent of the remaining CSO volume will be chemically treated at the CSO facilities located at Cottage Farm, Prison Point, Somerville Marginal and Union Park.

The Control Plan for Alewife Brook includes sewer separation of CSO outfalls CAM004 and CAM400, Somerville Marginal CSO facility upgrades, and Somerville baffle manhole separation. These plans are depicted in Figure 1, on the next page. Sewer separation is a common CSO mitigation technique, and involves separating the combined piping system into two separate sewers – one for stormwater, the other for sanitary sewer overflow. One of the potential advantages of sewer separation is that other infrastructure construction projects can be conducted simultaneously, making it cost effective. (US EPA, 1999)

Sewer separation work completed in Alewife Brook has reduced CSO activations from 63 to 25, in a typical year. MWRA estimates that CSOs will be reduced to seven occurrences annually, once the long-term control plan is implemented. (MWRA, 2007) When all work has been completed, an assessment will be performed in Alewife Brook and a final decision will be made regarding the water quality standards.

Figure 1. CSO outfalls along Alewife Brook
Source: MWRA, 2010. http://www.mwra.state.ma.us/03sewer/html/sewcso.htm

Water Quality Variances in Alewife Brook

DEP and EPA have concluded that Class B water quality standards cannot be attained in Alewife Brook prior to the CSO Control Project's completion in 2020. In exchange for implementing a more rigorous control plan, MWRA will be issued a series of five consecutive variances during this timeframe.

> "DEP has agreed to issue to the MWRA, and the United States Environmental Protection Agency (EPA) has agreed to approve, 5 consecutive variances, up to three years duration each, of the mandated water quality standards for the Charles River and Alewife Brook/Upper Mystic River. The variances will be granted through the year 2020, and will require the MWRA to comply with the CSO milestones and levels of control referenced in Schedule Six as amended."
>
> - Schedule Six Compliance Order Number 199, United States District Judge Richard G. Stearns, May 8, 2006

A three-year CSO variance was issued for the Alewife Brook by DEP on March 5, 1999. The variance was intended to allow DEP time to implement some if its CSO control plans prior to making a long-term decision regarding appropriate levels of CSO control. In 2002, DEP extended the variance until September 2003. The extension was intended to allow Cambridge, Somerville, and MWRA (the permitees) to finish compiling stormwater sampling data, which DEP would use to make its final water quality standard determination. On July 1, 2003, MWRA submitted its Final Variance Report to EPA and DEP. Variances were extended every three years thereafter, with the current variance expiring in 2013.

Class B Attainment

The Class B standards adopted by the Massachusetts DEP require combined sewer system owners to eliminate all CSO discharges either by sewer separation or relocation of discharges to less sensitive areas. Where 95 percent of CSOs are eliminated, water bodies may be classified according to the Class BCSO partial-use designation. (Mann 1999, pg. 870) Class BCSO waters will not achieve Class B standards during large storm events, although they may achieve high levels of CSO control overall. MWRA estimates that CSO control projects will bring Alewife Brook into compliance with water quality standards 98 percent of the time, on average.

According to an assessment of the Massachusetts DEP CSO policy, "DEP will only change a classification to BCSO after approving a Facilities Plan submitted by the permittee…which shows that infrequent CSO discharges are the most environmentally protective and cost-effective option available." (Mann, 1999, pg. 871)

DEP may change a water body's designated use based on the long-term control plan if it believes that elimination of all CSOs is economically infeasible. MWRA would need to convince DEP that costs of total CSO elimination would result in "substantial and widespread social and economic impact" (EPA, online).

Financial Impact Assessment

Both EPA and Massachusetts DEP policy allows states to change designated uses of water bodies to reflect impacts of CSOs when total elimination of CSOs would cause "substantial and widespread social and economic impacts." The decision to downgrade Alewife Brook to Class BCSO would rely on a financial impact assessment of full CSO control. EPA approved a finding by MWRA in 1998 that additional CSO controls in the MWRA service area would produce substantial economic impacts. The study relied on forecasts of economic conditions expected to be present in 2005. (Stavin, 2004, pg. 36)

MWRA submitted its Final Variance Report to EPA and DEP on July 1, 2003. The report included a project affordability analysis, which reaffirmed the 1998 finding that the CSO Control Plan would result in widespread economic impacts. EPA has approved this analysis, stating that "The MWRA's detailed financial impact assessment considered the effect of expected sewer rate increases, and, appropriately, median household income as adjusted by the relatively high cost of housing in the Boston area." (Haas, 2010, pg. 6)

"Substantial and Widespread Social and Economic Impacts"

EPA determines whether substantial economic harm has occurred based on an assessment of household impacts. Sewer separation costs should not exceed two percent of median household income in a community. (Mann, 1999) According to Russell Martin, CSO Regional Contact for EPA Region five, "the analysis gauges the financial hardship within a two-percent-point of pain that the city can endure. If a CSO control plan would cause such hardship, then a city can choose to go about the Use Attainability Analysis process" and potentially downgrade a water body's designated use, rather than implementing the control plan.

While EPA is responsible for approving a state's UAA, states are responsible for interpreting their economic circumstances and determining where there is substantial and widespread economic hardship.

EPA's *Economic Guidance for Policy Standards Handbook* requires that economic impact analysis demonstrate:

- that the polluting entity, whether privately or publicly owned, would face substantial financial impacts due to the costs of the necessary pollution controls (substantial impacts or would interfere with development), and
- that the affected community will bear significant adverse impacts if the entity is required to meet existing or proposed water quality standards (widespread impacts or important development).

EPA guidance also notes that if an entity is publicly owned, households in the community will bear the cost of pollution control programs through an increase in user fees or taxes. The economic impact analysis must therefore "consider the community's ability to obtain financing and the general economic health of the community." (EPA, online) EPA developed what is known as the "two percent screener threshold" to assess economic impact. Where household impacts are being assessed, sewer separation costs should not exceed two percent of median household income in a community. According to comments made by the city of Cambridge during a 2003 public hearing, CSO abatement costs are apportioned over the entire MWRA service area.

Harvard University professor Robert Stavins conducted an affordability analysis on behalf of MWRA in 2004. The report compared shelter cost burdens in the MWRA service area with burdens other metropolitan areas nationwide would face if sewer costs rose to EPA's two percent threshold. The report concluded that economic burdens in the MWRA service area are well above those that typically would lead to a finding of "substantial and widespread economic and social impact."

However, Stavins notes a key weakness of the EPA *Guidance* workbook: it lacks any benefit/cost analysis. As the case studies below will show, municipalities that have undertaken full CSO abatement projects have seen economic benefits in the form of increased tourism and recreation. The decision-making process on whether to undertake long-term CSO control projects "requires a broader role for benefits analysis than the *Guidance* itself acknowledges." (Stavins 2004, pg. 35)

Public Comments

> "Due to non-CSO impacts (i.e. storm water, illegal connections, overland runoff, and other sources), a higher level of CSO control will not result in increased hours of Class B attainment."
>
> - MWRA, July 2007

Public hearings were conducted each time the variance was renewed for Alewife Brook. Citizens were able to submit written comments or state their concerns during public meetings. Public comments related to the variance extensions come from a variety of sources: the city of Cambridge public meeting held June 11, 2003; meeting minutes of the Town of Arlington Conservation Commission from June 5, 2003; a letter from the Mystic River Watershed Association to DEP in 2004; and the DEP hearing on August 26, 2010. The list below summarizes the range of public comments on the Alewife Brook variance:

- Flood waters may contain CSO discharges, and residents are not aware. Better signage is necessary.
- All CSO discharges into Alewife Brook should be eliminated.
- Water quality standards in the Alewife Brook should not be relaxed to Class BCSO. Class BCSO is unacceptable as it allows peak pollution rates at times when peak flows occur.
- The water quality standard approach to controlling discharges is not sufficient to protect the Alewife Brook. The TMDL (total minimum daily load) approach should be used since it allows for the pollution source to be eliminated.
- Part (4)(b)(ii) of the CSO Control Policy requires a TMDL.
- Treatment or disinfection of CSO discharges should be considered instead of or in addition to sewer separation.
- Floatable controls should be installed everywhere along the Alewife Brook.
- Modeled versus metered flows from Cambridge CSOs vary significantly. CSO limits should be based on metered data coupled with existing plans to reduce CSO activations and volumes.
- Understanding of the most cost-effective options for eliminating CSOs, as well as the impact of CSOs and other sources on receiving water quality, is incomplete. Additional work is needed to improve the analysis of options for reducing CSOs.
- The public should be allowed to review all components of the economic analysis, and not just the final ratio comparing costs to economic benchmarks. This includes determining various factors that affect a community's ability to pay sewer charges (e.g., housing subsidies), the options MWRA has in distributing costs among ratepayers, and the rationale for the distribution of expenditures among components of the MWRA system.

The city of Cambridge, MWRA, and DEP have responded to the comments above. The city of Cambridge noted that CSO elimination and attainment of the Class B standard remains the goal for Alewife Brook. However, the situation in Alewife Brook is "especially difficult", since total CSO elimination is very expensive, as are the flood basins the city would need to construct in order to prevent additional flooding during wet weather events. Additionally, the city asserted that even if CSOs are eliminated, "water quality data shows that there would be continuing violations of water quality criteria during wet weather due to storm water discharges." (City of Cambridge, 2003) Additional responses to public comments come from DEP and are summarized below:

- Treatment of CSO discharges is challenging because of limitations on the capacity of CSO storage technologies. Additionally, sewer separation is the only technology which can eliminate CSO discharges, and where elimination is the goal, the feasibility of sewer separation must be considered first.
- Due to non-CSO impacts, a higher level of CSO control will not result in increased hours of Class B attainment.
- No TMDL is currently being conducted for the Alewife Brook. However, DEP asserts that TMDL analysis is not necessary to determine the appropriate level of CSO control, since the state already requires that CSOs be either eliminated or reduced to the extent feasible.
- Unless all CSO discharges are eliminated under all conditions, the B standard is not met. At this time, no feasible plan to completely eliminate CSO discharges under all conditions has been identified.
- MassDEP reviews its water quality standards, subject to EPA approval, every three years, and

both the standards and the classifications for the CSO-impacted receiving waters are reviewed. When all work has been completed, an assessment will be performed in the Alewife Brook and a final decision will be made regarding the water quality standards.

CASE STUDIES

The Center for Sustainable Systems at the University of Michigan conducted a CSO control survey of each of the 50 states and several regional EPA offices in late 2009. The survey sought to benchmark CSO controls and sources of funding nationwide. Results showed that 27 percent (eight of 30 respondents) have eliminated more than half of the CSOs in their region. Nearly 60 percent of state agencies reported that their regions have eliminated fewer than half of combined sewer systems. Among those surveyed, 44 percent indicated the existence of green infrastructure projects, which reduce surface runoff volumes that contribute to CSOs. Green roofs, rain gardens, bioswales, permeable pavement, and rain barrels are examples of projects undertaken as part of CSO mitigation. The EPA Region 1 office, which includes Massachusetts, did not note any green infrastructure projects. (Bulkley, et. al., 2009)

Have other water bodies in the nation faced classification downgrades due to CSO pollution? How are other municipalities and state agencies coping with the challenges presented by combined sewer systems? Interviews with EPA regional CSO coordinators conducted by WSSS Research Practicum students shed additional light on CSO abatement experiences in other municipalities across the country.

Chicago River, IL

There are probably a dozen waterways in Indiana that have faced potential downgrades as a result of CSO pollution. However, in the Chicago River basin, stronger CSO controls have resulted in a petition by the city of Chicago to upgrade the designated use of the waterway. The city was able to implement the first phase of its control plan successfully, and reaped many benefits, including improved water quality. The city was able to fund the control plan with federal money and a state revolving fund.

Russell Martin, CSO Regional Contact for EPA Region 5, cited the city's early involvement in CSO separation as a major factor in its success with CSO control. Chicago formed the "Chicago Underflow Plan" in the 1970s – essentially an early CSO control plan, and was well-positioned a few years later to apply for federal government construction grants. The money allowed the city to complete what became Phase I of a CSO control plan. The city is currently in Phase II, and expects to finish by 2029. In the meantime, many areas of the Chicago have benefited from increased recreation and tourism. (Russell Martin, personal communication, March 22, 2011)

Indianapolis, IN

The city of Indianapolis approved a $1.8 billion, 20-year long-term CSO control plan in 2007. The plan is expected to limit CSO discharges to one or two events per year, and abate 95-97 percent of wet weather sewer flows. Overflows currently occur 45-80 times per year. The city submitted a UAA to EPA on the grounds that levels of CSO control beyond those outlined in the long-term control plan would produce substantial and widespread economic hardship.

The UAA demonstrates that "affected streams are unsafe for recreational use due to high stream flows and other pollutant sources during those periods when sewer overflows will occur after plan implementation.

Controls beyond those planned by Indianapolis also would cause widespread social and economic impacts." (City of Indianapolis, 2007, pg. 4) The CSO Regional Contact for EPA Region 5, which includes Indiana, was able to confirm that this UAA has not been approved by EPA at this point.

Milwaukee, WI

"Separating combined sewer systems may contribute to improvements to water quality due to the reduction or elimination of sanitary discharges to receiving water bodies. However, the increased storm water discharges resulting from sewer separation could decrease the positive impacts of the separation unless storm water discharges are mitigated." (EPA, 1999, p.2) This was the case in the Menomonee River, Kinnickinnic River, and Milwaukee River in Milwaukee, WI.

The city of Milwaukee invested over $1 billion in CSO controls. (Russell Martin, personal communication, March 21, 2011) CSO discharges were reduced to four activations per year or less. This was completed from 1980-1993 in an effort known as the Milwaukee Water Pollution Abatement Program (WPAP). The CSO long-term control plan in the WPAP concludes that even if periodic CSOs and Sanitary Sewer Overflows were eliminated, there would still be days when water quality standards for fecal coliform would not be met because of non-point source pollution.

The Menomonee River, Kinnickinnic River, and Milwaukee River have water quality variances for fecal coliform and dissolved oxygen. The variances were determined before the WPAP, and no changes to the classifications of any of the rivers are currently proposed. Water quality monitoring indicates that non-point sources of pollution are the primary cause of impairment, and that CSOs account for less than ten percent of non-attainment. (Gerald Novotny, personal communication, March 22, 2011)

Delaware River, PA

Regional authorities submitted a UAA to EPA in 1990 that resulted in an upgrade for a few segments of the river for use as primary recreation. However, the segments of the river that are subject to CSOs were never designated for primary contact recreation, nor will they be in the future. Primary and secondary contact recreation uses do not exist for a portion of the Delaware River/Estuary due to CSOs in Philadelphia and Camden, NJ. (Denise Hokowski, personal communication, April 5, 2011)

Minneapolis-St. Paul, MN

In 1984 the State Legislature enacted a program to separate remaining sewers in ten years and provided more than $100 million in grants for a long-term control program. The Federal grants program was still active then, and more than $30 million in federal grants were used. Over 98 percent of the State's sewers have been separated, and only eight potential discharge points remain out of a total of 85. No overflows have occurred in over 2 years. (Bulkley et. al., 2009)

RECOMMENDATIONS

Public comments, case studies from other areas of the country, and increased understanding of the water classification process offer guidance for the advocacy efforts of the Mystic River Watershed Association. Possible message points for future hearings to renew the Alewife Brook variance are outlined below. The advocacy strategies and message points can be divided into three categories: "No-brainers", which represent tried and true strategies that remain relevant; "No regrets" strategies, which are riskier but may produce favorable results; and "No prisoners" approaches, which represent strategies that target and seek to change regulations at the federal level.

No-brainers

Comprehensive analysis of potential project financing mechanisms

Understanding of the most cost-effective options for eliminating CSOs, as well as the impact of CSOs and other sources on receiving water quality, is incomplete. Additional work is needed to improve the analysis of options for reducing CSOs.

Conceptual planning for treatment (disinfection) of CSO discharges should begin

DEP maintains that where CSO elimination is the goal, the feasibility of sewer separation must be considered first. Not enough consideration has been given to options for reducing bacteria levels during wet weather events after the CSO long-term control plan is implemented.

No Regrets

Variance Extension beyond 2020

The implication of a variance extension is that city and state agencies ultimately believe the Class B standard can be maintained. Conducting the UAA required to downgrade the Alewife Brook to BCSO is time consuming and costly. Time and money could be better spent conducting a TMDL, or examining ways to close the remaining CSO outfalls on the brook.

TMDL & Green Infrastructure Advocacy

A pathogen TMDL should be developed for Alewife Brook. The TMDL approach is better than the water quality standard approach because it allows for pollution sources to be identified and eliminated. A TMDL would also allow for better planning and informed application of low-impact development and green infrastructure projects. In its petition to downgrade the brook to Class BCSO, DEP will need to show that continued CSOs represent the most environmentally protective and cost effective control options. More can be done to reduce volumes of surface runoff in the Alewife Brook.

No Prisoners

Require a Benefit/Cost Analysis in lieu of "Affordability Analysis"

As economist Robert Stavins acknowledges, it is "ultimately not possible to separate questions regarding the economic impact of additional controls from questions regarding the benefits of those controls." (Stavins, 2004, pg. 35) The city of Chicago realized large economic benefits from tourism upon implementing tighter CSO controls. The same benefits could be enjoyed by residents in the Alewife Brook area. These benefits should be weighed against the costs of the CSO Control Plan.

Water Quality Trading Programs

Water quality trading is a market-based approach for controlling nonpoint and point sources of pollution. Water quality trading in Alewife Brook might reduce costs of nonpoint and point source pollution control. If costs of other pollution control are recovered through this kind of program, perhaps additional funding would be available for controlling CSO discharges.

Like the cap-and-trade system under the Clean Air Act, water quality trading would allow facilities facing high pollution control costs to purchase pollution reduction credits from a facility facing lower control costs, thus reducing their cost of compliance.

Trading may lower pollution abatement costs significantly in certain instances. For example, the World Resources Institute has completed a study on benefits of trading phosphorus credits. The study concluded that the cost estimate for point source controls ranged from $10.38 per pound of phosphorus in Wisconsin to $23.89 per pound in Michigan, and that trading between point and nonpoint sources could reduce control costs to $5.95 per pound in Wisconsin to $4.04 in Michigan. (Mehan, 2003). The EPA issued a Water Quality Trading Assessment Handbook in 2004, and has sponsored eleven pilot projects to assess trading opportunities. (Scarlett, 2010) The Handbook states that trading must occur within the same watershed. In addition, only trading of nutrients and sediment loading is permitted at this time.

In Alewife Brook, baseline levels of pollution could be established for phosphorus or other sources of impairment through a TMDL process or by using state and local requirements as the baseline. Facilities in the Mystic River watershed would trade pollution credits based on their costs of compliance with that baseline.

CONCLUSION

Full elimination of CSOs requires funding and political will. In municipalities with both, significant progress has been made toward CSO abatement. In future analyses of the CSO Control Plan and variance extensions, MWRA and DEP will rely primarily on project cost information, rather than water quality information. This is due to the fact that a BCSO classification is likely unless 100 percent of CSOs are eliminated. The CSO Control Project will bring the brook into compliance only 98 percent of the time, on average. Thus, the main question is whether full removal of CSO outfalls is economically feasible in the Alewife Brook. Research into federal funding opportunities, unconventional economic analysis that examines project benefits, and even innovative water quality trading programs that lower costs should be explored further.

Project Conclusions

The Alewife Brook faces a variety of stormwater issues from Combined Sewer Overflows to flooding to rainwater runoff, all of which lead to the overall impairment of the watershed's ecological health. The surrounding towns have completed the required paperwork and plans to pass state and federal law, but those have not yet been implemented to a degree satisfactory to concerned local citizens. (Herron, 2011) These towns have budgets with required spending budgeted for schools, service and other vital necessities. Assessing fees and allocating funds for what is not yet a disaster is not often viewed as a priority for most towns struggling to recover from the past years' recession. (Woodbury 2011)

Although Somerville, Belmont, Arlington and Cambridge have taken significant steps forward in terms of stormwater management – developing stormwater management plans, hiring staff dedicated to water quality issues in the watershed, and detaching longstanding CSOs – Alewife Brook is still an impaired watershed threatened by runoff, sewage and pollution. Reflecting on the issues facing the brook, it is important to realize that the watershed's problems are, unfortunately, not unique. Nationally, 40 percent of assessed waters fail to meet water quality standards and urban streams have tended to fare worse than the national averages. (Bitting, Kloss 2008) USGS studies of urban streams find that concentrations of total Phosphorus exceed EPA's goal for nuisance growth in 70 percent of streams, insecticides are usually at a higher concentration than in agricultural areas, and fecal coliform bacteria commonly exceed recommended standards for water recreation. (USGS, 2008) In addition, combined sewer systems in nearly 750 municipalities deliver 850 billion gallons of untreated overflows to urban waters each year. (USEPA, 2004) Retrofits to stormwater infrastructure are increasingly necessary to reduce runoff and pollution, but upgrades to those systems are capital intensive projects, which strain town and city budgets. EPA estimates current wastewater infrastructure needs an investment in excess of $200 billion, with $10 billion needed for stormwater management and $60 billion needed for CSO correction. (USEPA, 2008) While the economic burden is significant, this presents an opportunity to analyze our existing infrastructure for existing problems and to plan and budget for future improvements.

We have some recommendations for improving the health of the Alewife Brook based on our findings:

1. Determine whether a stormwater utility fee is an option for the four towns in the watershed.
2. Determine an effective strategy for reaching out to the business community and especially the landlords and owners of the larger areas of impervious surfaces. Their tenants might be more interested in investing if they understand their landlord is supportive.
3. Prepare targeted material to educate residents about human impacts on the watershed. For example:
    - Low-Impact Development Manual
    - Pollution Prevention Fact Sheet
    - Car Care and Lawn Care Brochure
    - Disposal of Household Hazardous Waste Manual
    - Homeowners Drainage Manual

Somerville, Belmont, Arlington and Cambridge have an opportunity to lead the way of sustainable planning for stormwater management as there are very few case studies demonstrating similar comprehensive approaches in other areas around the country. This is a chance for these communities to lead, rather than to follow. Hopefully this will serve as a guide to understanding the legal and ecological challenges facing Alewife Brook and how to effectively prepare to solve those challenges in the near future.

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