

Section 9 Adaptive Management, Green Infrastructure, and Integrated Watershed Planning

PWSA is proposing an evaluation of the ability of green infrastructure and integrated watershed management (IWM) to assist in the control of combined sewer overflows as the first step of a broader adaptive management plan aimed at optimizing the recommended approach to meeting the requirements of the Consent Order and Agreement. PWSA believes that an integrated approach which utilizes a combination of 'green' and 'gray' solutions to address combined sewer overflows and which considers all types of pollutant sources in the watershed to holistically address water quality challenges has the potential to be more cost-effective than a 'gray' only approach and may result in additional triple-bottom-line benefits to the Authority, the city, and its rate payers.

9.1 ADAPTIVE MANAGEMENT

The following sections detail a short-term adaptive management implementation plan designed to objectively assess the ability of green infrastructure to assist in the control of combined sewer overflows and IWM to achieve more efficient compliance with broader water quality standards. This proposed planning process would be conducted at the same time as initial 'gray' improvements called for in the baseline compliance approach, but would be completed in time to allow for development of an optimized compliance approach should findings indicate a hybrid solution or IWM approach would result in lower costs and greater benefits. The short-term adaptive management implementation plan includes planning and analysis, education and outreach, and implementation and monitoring of demonstration projects.

In addition to evaluation of the ability of green infrastructure to assist in the control of CSOs, the plan also includes exploration and evaluation of IWM approaches. IWM approaches have been demonstrated in multiple locations across the country to more efficiently and cost-effectively meet the federal Clean Water Act requirements related to the water quality impacts of CSOs, SSOs, and other source pollution including stormwater. PWSA's IWM evaluation aims to consider CSOs and SSOs in context with others pollutant sources that impact waterway water quality (such as stormwater runoff and dry weather sources) and is in general alignment with USEPA's June 2012 Integrated Planning Framework.

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PWSA recognizes that green infrastructure and IWM approaches will require extensive collaboration between regional partners, such as ALCOSAN and other municipalities, as well as PaDEP, ACHD, and USEPA. PWSA is committed to working with these partners to explore and evaluate these different alternatives to meeting water quality standards in our region's waterways in a more cost-effective manner.

9.2 GREEN INFRASTRUCTURE OVERVIEW

Green infrastructure refers to a variety of strategies designed to mitigate the effects of development on the surrounding environment, typically using smaller, distributed management practices which infiltrate, evapotranspire, and/or detain stormwater runoff on-site. Source control, or practices which prevent, eliminate or control the collection of stormwater or groundwater in combined or sanitary sewer systems, is often also considered a form of green infrastructure. Green infrastructure, both in combined and separated sewer areas, is typically a major component of a broader IWM strategy. The widespread use of green infrastructure practices to manage urban stormwater runoff can create sustainable improvements to urban environments, decrease the quantity of runoff, reduce peak discharges from urban areas, and remove significant levels of stormwater pollutants. Furthermore, the use of green infrastructure typically leads to an increase in the amount of vegetated or green spaces in ways that compliment community functions, improve the urban habitat, and support revitalization of urban neighborhoods. Green infrastructure utilizes the concepts of environmentally sustainable practices such as low impact development, smart growth, or environmental site design.

In addition to supporting improvements in water quality, green infrastructure practices have been shown to offer numerous other social, economic, and environmental benefits. These include urban greening and revitalization, increases in property value, creation of pedestrian corridors, creation of urban habitat, increases in tree cover and reduction of the urban heat island effect, creation of community spaces and amenities, and traffic calming. Green infrastructure practices are often incorporated into beautification projects, vacant parcel revitalization, transportation corridor upgrades, and recreational spaces.

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Green infrastructure can typically be applied in two different manners: as part of a typical development project (either new development or redevelopment), or as a retrofit project which aims to add stormwater management where there previously was none. When used for new development or redevelopment, green infrastructure practices are used in place of traditional practices such as detention basins. Ordinances or other development regulations typically dictate the type and extent of stormwater controls required. When used to retrofit existing development, green infrastructure is inserted into a site to mitigate the detrimental effects of historic site design or land planning approaches. In both situations, green infrastructure manages runoff on-site to lessen downstream impacts and to improve the quality of water discharging from the site.

9.2.1 Common Green Infrastructure Practices

Green infrastructure, environmental site design, or low impact development typically has two components: general site design and stormwater control measure (SCM) design. Sustainable site design typically consists of reducing impervious cover to the maximum extent possible, maximizing open space, and ensuring runoff is routed through natural features rather than conveyed across impervious surfaces. SCM design typically consists of utilizing a group of SCMs, sometimes in series, to meet water quality treatment and peak flow control requirements. Examples of typical green infrastructure SCMs include bioretention (rain gardens), infiltration trenches or basins, stormwater wetlands, wet ponds, filtration practices, permeable pavement, green roofs (as shown in Figure 9-1), and rainwater harvesting.

Some of these SCMs, such as bioretention and green roofs, provide significant green space, while others, such as infiltration and permeable pavement, may incorporate vegetation, but vegetation is not central to their function. Because these SCMs are generally small and distributed, these practices can be incorporated into the built environment in innovative ways that take advantage of under-utilized spaces and provide community amenities. Green infrastructure SCMs are often incorporated into public right-of-ways and other existing public and private development where opportunities for larger centralized solutions are impractical or not feasible.

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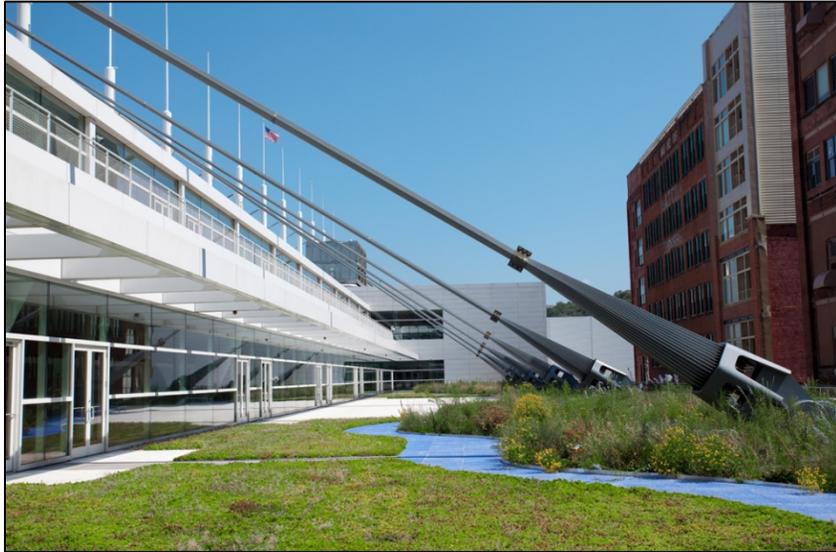


FIGURE 9-1. GREEN ROOF AT THE DAVID L. LAWRENCE CONVENTION CENTER

It is important to note that stormwater controls do not act in a vacuum. Stormwater requirements are often set by local ordinances and development regulations. These local regulations dictate the extent and type of stormwater management required when developing a new site or redeveloping a previously developed site. In addition, the types or locations of stormwater controls allowed may also be limited by existing code requirements or zoning standards which were not developed with green infrastructure in mind. Furthermore, various incentive programs can be established to encourage or support improvements in stormwater management on both existing development and new development.

It is also important to note that stormwater improvements are not limited to the site scale. Broader environmental restoration efforts, such as stream restoration, establishment of riparian buffers, and wetland creation, can significantly aid in the protection of water quality.

9.2.2 Using Green Infrastructure to Control Sewer Overflows

Combined sewer overflows typically occur during heavy rain events where the combined sewer system is surcharged by an influx of stormwater. Controlling the total volume of stormwater, timing of discharge, and peak discharge rate can assist

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in reducing or eliminating the frequency and total volume of overflows. Green infrastructure controls are typically designed to manage runoff from a one inch rainstorm, which typically correlates to the 85th to 95th percentile storm (meaning 85 or 95 percent of storms are one inch or smaller).

Managing the first one inch or more of runoff has two effects. First, it reduces the total volume of stormwater runoff which reaches the treatment plant during both large and small storm events. Reducing the volume of runoff which reaches the treatment plant has the potential to reduce treatment cost. Source control (inflow & infiltration) offers a similar opportunity to reduce the volume of stormwater runoff entering a combined or separated sewer system. Second, management of the first one inch of runoff reduces the peak discharge from a site which can lead to a reduction in peak flows in combined sewer lines. By reducing peak flows, there is the potential to limit the occurrence and volume of overflows which typically only occur at elevated flow rates.

The potential reduction in peak flow rate in a sewer line, through the use of green infrastructure, is directly correlated with the extent of green infrastructure implemented. Depending on the sewershed, it may or may not be feasible to add stormwater controls to a large enough area to significantly reduce peak flows in a sewer line. Therefore, there are three distinct possibilities:

1. Combined sewer overflows can be addressed through the widespread use of green infrastructure improvements alone (no changes to conveyance system).
2. Combined sewer overflows can be addressed through the use of capacity/storage improvements alone (no changes to on-site stormwater controls).
3. Combined sewer overflows can be addressed by a combination of green infrastructure and capacity/storage improvements.

The third option is known as a hybrid solution, which incorporates both 'green' and 'gray' solutions. Depending on the sewershed and the sewer system dynamics, green infrastructure solutions, or a hybrid solution, have the potential to reduce the cost of compliance compared to a strictly 'gray' only solution and may be able to offer secondary social and economic benefits. PWSA believes that a hybrid solution, utilizing green infrastructure implemented throughout the various sewersheds

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served by both PWSA and ALCOSAN can have a significant impact on CSO reduction.

In addition, green infrastructure can be used in Municipal Separate Storm Sewer System (MS4) areas to manage stormwater runoff quality and prevent the discharge of pollutants carried in stormwater runoff to the region's waterways. Improvements to stormwater controls in the region's MS4s are anticipated to be a key component of an IWM approach to achieve compliance with broader water quality standards.

9.2.3 Triple Bottom Line Benefits of Green Infrastructure

Numerous studies have been conducted to assess the secondary benefits of green infrastructure solutions. Secondary benefits are typically catalogued in a concept called the triple bottom line (TBL). The TBL considers economic, social, and environmental benefits when selecting the most cost effective solution.

Consideration of the TBL supports the sustainable stewardship of both community infrastructure and environmental resources. While 'gray' infrastructure, such as capacity or storage improvements, provides a more straightforward and direct method to control overflows, it offers few secondary benefits. In contrast, green infrastructure provides many benefits beyond controlling overflows. Economic revitalization, neighborhood development, retention and attraction of residents, businesses, and visitors, and many other secondary benefits are often not quantified in a typical bottom line cost estimate which considers only monetary factors.

As shown in Figure 9-2, the TBL can be broken out into its three separate components: economic, social, and environmental. For economics, the direct factors consist of the capital costs and costs associated with operation and maintenance. Indirect economic impacts can include job creation, property value increases, business retention and attraction, increased visitor expenditures, and worker productivity. For environment, the direct factors consist of fewer combined sewer overflows and sanitary sewer overflows and associated pollution reduction. The indirect environmental impacts include habitat creation, cleaner air and water, compliance with tangential regulatory programs, and lower energy and potable water usage. The societal factors may be less apparent; however, they may be significant and include psychological improvement, aesthetic value, reduction in

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traffic incidents, increased recreational opportunities, resident involvement and pride, community acceptance and appreciation, and public education and outreach.



FIGURE 9-2. TRIPLE BOTTOM LINE

Many of the aspects listed overlap or magnify results in the other bottom line categories. For instance, increased aesthetic value in older neighborhoods may lead to fewer vacancies, improvements in safety, increases in property value, and opening of new businesses to serve residents.

PWSA recognizes the TBL benefits associated with green infrastructure and aims to consider these benefits in optimizing the recommended compliance approach. PWSA will also look to coordinate these efforts with other sustainability initiatives at the city and county levels. As PWSA implements green infrastructure early demonstration projects, the Authority will document TBL benefits to inform and support future decision making related to green infrastructure.

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9.2.4 Existing Green Infrastructure Efforts

Numerous green infrastructure initiatives have been ongoing for many years within Allegheny County and the City of Pittsburgh. These previous efforts have helped to raise awareness for the role and potential benefit of green infrastructure in managing combined sewer overflows and building a more sustainable community in which to live and work. There are numerous grass roots organizations and local developers that have implemented or who are currently designing green infrastructure projects across the city and the county. Widespread support and public outreach for green infrastructure already exists across the community, through organizations such as Three Rivers Wet Weather (3RWW) and the Green Infrastructure Network, which will ease the challenges of implementing, operating, and maintaining a large network of green infrastructure SCMs. Table 9-1 outlines a brief summary of select previous or ongoing efforts which PWSA will benefit from as the Authority moves forward with implementing a green infrastructure program.

9.2.5 Evolution of Approach to Controlling Combined Sewer Overflows

Approaches to controlling combined sewer overflows continue to evolve. Previous efforts typically consisted of 'gray' infrastructure improvements such as sewer separation, capacity enhancement, or addition of overflow storage. Many 'gray' infrastructure programs have been successfully implemented across the country to control combined sewer overflows. However, in the past five years, a shift towards the use of green infrastructure to manage combined sewer overflows has occurred, both locally and nationally. Major combined sewer overflow programs across the region have evolved to incorporate green infrastructure components, with the level of green infrastructure utilized varying between each program. Examples of green infrastructure programs in Pennsylvania include programs at the Philadelphia Water Department and the City of Lancaster. Other examples in the region include programs in Cleveland, Cincinnati, Washington D.C., and New York City.

TABLE 9-1. EXISTING GREEN INFRASTRUCTURE EFFORTS

Entity	Description
PWSA	<p>Greening the PWSA Wet Weather Feasibility Study Charrettes. PWSA, with support from local foundations, facilitated a series of three charrettes where the Authority brought together a wide-range of regional stakeholders, including ALCOSAN, to explore the incorporation of green infrastructure into the PWSA Wet Weather Feasibility Study and to identify and address major challenges and barriers to incorporating green infrastructure in the Pittsburgh region. These charrettes were a major success, and kicked off PWSA’s efforts to lead the broader implementation of GI in the region.</p> <p>PWSA Preliminary Assessment of Green Infrastructure Evaluation Tools. PWSA tested the feasibility and practicality of incorporating the results of 3RWW SUSTAIN GI siting analysis with the Regional SWMM model for use as a tool to evaluate the impacts and potential cost of utilizing green infrastructure to aid in control of combined sewer overflows in both the McDonough’s Run and Nine Mile Run sewersheds. This effort included siting of green infrastructure practices using the 3RWW SUSTAIN/Rainways tool and combined sewer system modeling using SWMM to evaluate reductions in peak flow, volume, and overflow events and corresponding impacts to proposed ‘gray’ solutions. A preliminary cost comparison was performed to test the use of this approach to quantify cost/benefit. These studies are currently being updated to reflect more recent information and more accurately quantify the cost-benefits of implementing green infrastructure.</p> <p>Panther Hollow Watershed Restoration – Schenley Park. PWSA has embarked on a collaborative effort with Pittsburgh Parks Conservancy, Pittsburgh Department of Public Works, and ALCOSAN to restore the 177 acres of the Panther Hollow watershed that lies within Schenley Park. This shed is part of the larger Four Mile Run watershed, and in its current state of distress most of the runoff flows into the combined sewer system contributing to the overflow events along the Monongahela River. The first of two phases are set to be constructed in the fall 2013 and will include infiltration trenches, tree groves, and replacement of large lawns with native meadows near Beacon Avenue. Simultaneously, the second phase involves retentive grading, constructed wetlands, and “no mow” fairways on the Schenley Park Golf Course. Later phases will consist of evaluating opportunities for stream daylighting and strategic sewer separation with green infrastructure treatment to disconnect sources of stormwater from the combined sewer system and to restore natural hydrologic stream functions to the existing headwaters. The future phase will also involve a “skinny</p>

TABLE 9-1. EXISTING GREEN INFRASTRUCTURE EFFORTS

Entity	Description
PWSA	<p>street” treatment to Schenley Drive incorporating vegetative swales, permeable paving, and linear rain gardens. This shed area is bisected by dozens of widely used and highly valued trails, and possesses a high level of public awareness and engagement. The implementation of green infrastructure in Panther Hollow has great potential for being a source of inspiration to launch other green stormwater BMPs throughout the City of Pittsburgh.</p> <p>Green Infrastructure Technical Advisory Committee (GITAC). PWSA has established a nine-member committee to provide objective, expert advice to the Authority on incorporating green infrastructure and policies into PWSA’s feasibility plan, design standards, and other areas of operation as appropriate. Drawn from the community at large, the GITAC members are selected based on their specialized knowledge and expertise in the fields of stormwater management, landscape architecture and design, ecological preservation/restoration, community development, urban issues, and public policy.</p> <p>Penn Avenue Corridor Improvements. The redesign/reconstruction of this urban arterial corridor includes GI BMPs like infiltration tree pits, curb bump-outs with bio-swales, and permeable paving.</p>
Three Rivers Wet Weather (3RWW)	<p>Development of the Rainways Tool. Created and maintained a tool that is available for residents to analyze private properties for green infrastructure opportunities. The tool can also be used by engineers/developers analyze the possible benefits of green infrastructure in public areas.</p> <p>Public Outreach. 3RWW keeps a publically-available comprehensive inventory of public and private GSWI installations throughout the Pittsburgh metropolitan area. 3RWW has also led or participated in multiple source control demonstration projects and efforts to educate residents, engineers/developers, and public officials.</p> <p>Municipal Green Infrastructure Analysis. 3RWW completed a green infrastructure analysis for three sewersheds within the ALCOSAN service area, Nine Mile Run, Girty’s Run, and McNeilly Run, to aid in the identification and assessment of green infrastructure improvements. 3RWW will continue to evaluate green infrastructure opportunities in other sewersheds to support incorporation of green infrastructure into municipal feasibility studies.</p>

TABLE 9-1. EXISTING GREEN INFRASTRUCTURE EFFORTS

Entity	Description
	<p>Conceptual Green Infrastructure Design. Through a Technical Assistance Grant from the USEPA, 3RWW conducted a detailed planning/design study to evaluate best approaches to incorporating green infrastructure into three city neighborhoods including Swisshelm Park, Brookline and Point Breeze. The conceptual design includes estimates of costs and benefits to the combined sewer system. The draft Point Breeze neighborhood conceptual design report is attached as an example and for reference in the Wet Weather Feasibility Study Appendix D.</p>
ALCOSAN	<p>Preliminary Green Infrastructure Evaluations. The ALCOSAN Wet Weather Plan presents an evaluation of the ability of green infrastructure to provide wet weather control in reach of the planning basins. The analysis, as presented in that WWP, identifies a relatively small number of areas in which green infrastructure would be effective in playing a substantive role in controlling CSOs. ALCOSAN has proposed completing a follow-up regional evaluation of green stormwater infrastructure and other source controls.</p> <p>Downspout Disconnection Analysis. Field investigations were conducted and used to for an analysis of the feasibility and effects of instituting a rooftop disconnection program. Based on the estimated amount of properties which were qualified for rooftop disconnection in the pilot area, this amount was extrapolated and used this to model and estimate the effects of implementing a more widespread program. The results of this study are available to the municipalities, to encourage implementation of rooftop disconnection within combined sewersheds.</p> <p>Stream Restoration and Direct Stream Inflow Removal. Recent stream restoration projects include the restoration of Nine Mile Run in Frick Park, Jack’s Run stream and the daylighting of the culverted stream in Sheraden Park. Three major stream inflow re-routing projects are planned including a project to divert acidic discharges into Dooker Hollow in North Braddock Borough. As part of the efforts to eliminate direct stream inflows, five stream inflow removal projects and three stream restoration projects have been completed with three more projects ongoing.</p>

TABLE 9-1. EXISTING GREEN INFRASTRUCTURE EFFORTS

Entity	Description
Green Infrastructure Network (GIN)	Coordinated by the Pennsylvania Environmental Council and 3RWW, the GIN is a voluntary partnership of more than 35 organizations, businesses, authorities, academia and governments working to document and encourage green infrastructure throughout Allegheny County as well as to develop protocols for monitoring green infrastructure and its effectiveness.
Allegheny County	Allegheny County is collaborating with municipalities and other governmental agencies to create stormwater management plans for each designated watershed within the county. These plans will work towards meeting the Pennsylvania Storm Water Management Act (Act 167) with objectives to preserve and restore natural hydrologic and hydraulic functions, decrease stream bank erosion, implement nonstructural solutions, and encourage stormwater management incorporating sound land use and water practices.
Pittsburgh UNITED	Pittsburgh UNITED along with 3RWW has received a federal grant to evaluate the costs and benefits of green infrastructure. The results of this study will be shared with 83 municipalities within the ALCOSAN service area fostering a deeper understanding of cost effective ways to implement green infrastructure.
Congress of Neighboring Communities (CONNECT)	CONNECT's mission is to unite the communities and municipalities creating Pittsburgh urban core. It has used these connections to create an outreach campaign emphasizing the use of green infrastructure and its importance as part of municipal wet weather plans.
Nine Mile Run Watershed Association	The Nine Mile Run Watershed Association provides outreach to residents within the watershed on topics including improved rainwater management through the use of technologies such as rain barrels, rain gardens, or tree plantings. Their mission includes the use of innovative urban ecology projects designed to directly involve the community in helping improve the health of Nine Mile Run, which is the largest urban stream restoration project in the United States completed by the U.S. Army Corps of Engineers.

TABLE 9-1. EXISTING GREEN INFRASTRUCTURE EFFORTS

Entity	Description
Clean Rivers Campaign	The Clean Rivers Campaign is an outreach and advocacy program working to educate the public on stormwater issues and encourage ‘green’ solutions within Allegheny County. Outreach efforts include holding public meetings between private residents, local organizations, and policymakers.
City of Pittsburgh	The city has amended its zoning ordinance to include ‘green’ strategies to the maximum extent practicable as part of stricter stormwater volume reduction standards. New stormwater standards have also been enacted which require retention of the first 1 inch of runoff and encourages GI practices like maintaining natural drainage patterns, impervious disconnection, and riparian buffers.
Mount Lebanon Municipality	A new stormwater utility was implemented in 2011 which created incentives for large property owners to decrease impervious areas and for smaller property owners to implement on-site stormwater controls. The revenue from this program will be used on stormwater infrastructure improvements and maintenance.
East Liberty Development Corporation	East Liberty Development developed an innovative Green Vision for redevelopment of the urban district of East Liberty. The overlay plan took an inventory of existing environmental systems and recommends sustainable ‘green’ strategies intended to simultaneously improve the urban landscape and economy while improving the natural environment.
Various Private/Public Entities	<p>‘Green’ building practices. The City of Pittsburgh is currently ranked 8th in the nation for the number of LEED-certified buildings with more than 60 more buildings pursuing LEED certification. These LEED-certified facilities represent a new push for green technology and utilize an assortment of green infrastructure technologies.</p> <p>Green Up Pittsburgh. While not directly targeting stormwater issues, Green Up Pittsburgh’s goal is to add green space within the city by planting on vacant lots or recently demolished sites, which ultimately will reduce surface runoff and improve the urban environment.</p> <p>TreeVitalize and Tree Pittsburgh. Both groups work to increase permanent tree cover throughout the Pittsburgh metropolitan area.</p>

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In addition to a shift towards the use of green infrastructure, many programs across the country have explored the use of an adaptive management framework that allows for the regular and continual re-evaluation and optimization of compliance plans. This also aligns with recent efforts by USEPA to promote an integrated watershed planning framework which aims to align the compliance activities of various water quality related permits to meet our broader water quality goals in the most efficient and affordable manner.

9.2.6 Green Infrastructure Goals and Objectives

Under the requirements of its Consent Order and Agreement (COA), PWSA's primary goal is to meet consent order combined sewer overflow control obligations on-schedule and in the most cost effective manner for its rate payers. Within the context of the COA, PWSA desires to achieve water quality improvements in the most effective and efficient manner possible. In consideration of these goals, PWSA has several specific objectives for its adaptive management plan to incorporate green infrastructure and IWM concepts.

- First, the authority aims to identify the optimal combination of 'green' and 'gray' solutions, in addition to watershed-based controls, and watershed controls, which result in the greatest cost savings and benefits to the Authority, the city, and the rate payers. This process should maximize the "water quality" benefit of every dollar spent on required overflow control activities and consider triple-bottom-line benefits of proposed solutions.
- Second, PWSA aims to implement green infrastructure solutions inside an adaptive management and/or IWM framework which gives the Authority the needed flexibility to meet its various water quality obligations in the most cost effective manner over the duration of the implementation period. This includes consideration of other water quality concerns, such as compliance with its MS4 permit and existing and future TMDLs, in addition to overflow control obligations.
- Third, PWSA aims to be the regional leader in promoting, facilitating, and implementing improved stormwater controls, particularly green infrastructure, and other IWM approaches on a regional basis. The Authority recognizes that a regional and coordinated effort will be required to address the various water quality issues facing the region. PWSA will continue to play a key leadership role in assisting upstream municipalities, the county, and ALCOSAN to address regional water quality issues.

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9.3 PUBLIC PARTICIPATION

The 'Greening the Pittsburgh Wet Weather Plan Charrette Project' was developed with a primary objective to develop a consensus approach to reviewing, recommending and incorporating a plan for the implementation of green infrastructure into the PWSA Wet Weather Feasibility Study. The project was comprised of three charrettes designed to identify green infrastructure opportunities, associated benefits and concerns, and the legal, institutional, and financial obstacles. From February to April 2013, three charrettes were held to explore these various topics. Overall, 125 independent individuals participated, representing a diverse array of public, private, and non-profit organizations. In fact, each charrette had nearly equal representation from all three sectors. These individuals collectively donated over 1,000 hours of their time to assist the PWSA in its effort to better understand the challenges and opportunities associated with green infrastructure. Overall, the charrettes provided a forum for stakeholders to learn more about the wet weather planning process, to build new partnerships, and to share their knowledge about green infrastructure with PWSA.

The charrettes resulted in the identification of many challenges and opportunities, and the development of recommendations to support successful development of a green infrastructure program. Participants identified PWSA as an ideal entity to lead the region's green infrastructure efforts with the support of the city, other agencies, local NGOs, industry stakeholders, universities, and many other partners.

Participants also recommended the creation of a stormwater utility to consolidate stormwater responsibilities and assist in the funding of green infrastructure efforts. In addition, the participants recognized the need for a comprehensive education and engagement campaign. The participants recognized the need for a coordinated plan to overcome impediments to the use of green infrastructure and to encourage, facilitate, and even incentivize the use of green infrastructure throughout the region. A more complete and detailed description of the charrettes and their findings can be found in Appendix B and are summarized below.

- **Charrette 1.** The focus of the first charrette was to assess and evaluate preferred approaches to incorporating green infrastructure in Pittsburgh. First a leading engineering consultant presented an overview of green infrastructure approaches employed in other cities across the country.

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The presentation gave details on the types of green infrastructure used, performance indicators, public outreach methods, and cost benefits. Then participants were split into working groups to discuss which GI solutions were most appropriate for public, private, and residential property. Facilitators worked with each working group to complete worksheets outlining specific technologies, where they were currently being used, benefits, and barriers to implementation.

- **Charrette 2.** The focus of the second charrette was to understand and to develop approaches to overcome existing institutional barriers to green infrastructure. First, key institutional leaders held a panel to discuss institutional barriers and opportunities for collaboration and coordination of green infrastructure efforts. Next, the charrette featured two working groups: the first engaged participants in addressing the barriers outlined by the panelists, and the second asked participants to identify potential sites for early demonstration projects. Tables for the first working group were organized into four general categories: Authority and Partnerships, Design and Implementation, Maintenance and Monitoring, and Rules and Regulations. Tables for the second working group were organized by watershed: Saw Mill Run, Nine Mile Run, and A-22, as well as one for the entire city.
- **Charrette 3.** The focus of the third charrette was to review and assess the process identified to incorporate green infrastructure into PWSA's feasibility study. First, PWSA's consultant presented an overview of the draft green infrastructure section of the feasibility study. Next, two working groups allowed participants to react to and expand upon what was presented. For the first working group, participants discussed what they found exciting to them about the green infrastructure section as well as what was missing and what concerns they had. The second working group focused on how PWSA could partner with other organizations to implement what was outlined in the green infrastructure section. The charrette concluded with a presentation on how green infrastructure was implemented in other countries, highlighting the importance of collaboration and challenges associated with operation and maintenance.

PWSA recognizes that public participation and collaboration is an integral part of a successful and effective green infrastructure plan and is committed to continued public outreach and participation efforts.

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9.4 CHALLENGES AND OBSTACLES

The public involvement process identified six major categories which encompass the major challenges and obstacles to implementing a hybrid approach using both 'green' and 'gray' solutions to control combined sewer overflows. These include: authority to implement, education and outreach, regulatory/zoning, financial, maintenance, and monitoring. These challenges are described in more detail in Table 9-2.

Questions of authority and ownership surfaced at nearly every level of the discussion during the charrettes. At the highest level, the City of Pittsburgh is just one of 83 municipalities within the ALCOSAN service area, with each having to respond to its own COA, despite the fact that stormwater does not recognize municipal boundaries. Within each of these municipalities, there are many different parties with authority over stormwater management. Inside the City of Pittsburgh, City Planning, the Bureau of Building Inspection, Public Works, and PWSA all review and approve stormwater plans. In addition, regional entities such as County Conservation Districts also have authority over stormwater. These relationships are further complicated as the entities ultimately responsible for water quality, such as PWSA and ALCOSAN, do not regulate land development or own significant amounts of land inside the service area.

Collaboration among all entities with a role in managing stormwater will be required to break down barriers to green infrastructure and support wide spread implementation of green infrastructure throughout the region. Furthermore, extensive education and outreach will be needed to ensure stakeholders and leaders at all levels, from school children to homeowners to business owners to elected officials, understand the importance of a comprehensive stormwater management plan to mitigate pollution to receiving waters, and endorse and fund green infrastructure and IWM strategies.

Additional challenges identified through the public involvement process are detailed in Table 9-2. Included in the table are recommendations developed by PWSA and the charrette participants to overcome the identified challenges.

TABLE 9-2. SUMMARY OF CHALLENGES AND OBSTACLES

Challenge / Obstacle	Description
Authority to Implement	<p><u>Description of Challenge</u> PWSA has not traditionally been responsible for establishing or enforcing stormwater management standards.</p> <p><u>Recommended Approach to Overcome</u> Create inter-agency task force to initiate the process of working with other city departments and other agencies/organizations to consolidate responsibilities for stormwater management.</p>
Education and Outreach	<p><u>Description of Challenge</u> Implementation of green infrastructure will occur in both the public and private realm and will require the public to be an active participant in planning and implementation.</p> <p><u>Recommended Approach to Overcome</u> Create Green Infrastructure Advisory Committee as a primary interface with the public and develop additional education and outreach programs.</p>
Regulatory	<p><u>Description of Challenge</u> Existing stormwater regulations may not be sufficient to support a broad-based approach to improving stormwater management in the region.</p> <p><u>Recommended Approach to Overcome</u> Work with the city, county, and other stakeholders to adopt new stormwater ordinances and/or requirements which promote and/or require green infrastructure to address both new development and redevelopment activities.</p>
Zoning	<p><u>Description of Challenge</u> Existing zoning regulations may limit or prohibit the use of certain green infrastructure practices or sustainable site design strategies.</p> <p><u>Recommended Approach to Overcome</u> Initiate efforts to resolve zoning issues to make green infrastructure easier to permit and implement.</p>

TABLE 9-2. SUMMARY OF CHALLENGES AND OBSTACLES

Challenge / Obstacle	Description
Cross Department Collaboration	<p><u>Description of Challenge</u> Other city departments have responsibilities related to stormwater and/or implementing projects which require stormwater management. The opportunity exists to consolidate responsibilities related to stormwater and/or to coordinate green infrastructure efforts of all departments.</p> <p><u>Recommended Approach to Overcome</u> Create inter-agency task force to initiate the process of working with other city departments and other agencies/organizations to consolidate responsibilities for stormwater management. Establish standardized policies across all city departments to identify and capitalize on opportunities to incorporate green infrastructure into projects under development or planned for the future.</p>
Cross Agency Collaboration	<p><u>Description of Challenge</u> Other entities, such as the county, the Conservation District, ALCOSAN and PennDOT, have responsibilities or interests related to stormwater management. The opportunity exists to consolidate responsibilities related to stormwater and/or to coordinate green infrastructure efforts of all entities.</p> <p><u>Recommended Approach to Overcome</u> Create inter-agency task force to initiate the process of working with other agencies/organizations to consolidate responsibilities for stormwater management. Establish standardized policies across agencies to identify and capitalize on opportunities to incorporate green infrastructure into projects under development or planned for the future. Coordinate with Regionalization Study which has similar goals.</p>
Interface with ALCOSAN	<p><u>Description of Challenge</u> As part of the ALCOSAN collection system, it is important for PWSA to coordinate activities related to the interface of proposed ‘green’ and ‘gray’ solutions. The activities of each authority should complement each other and represent an integrated plan to address combined sewer overflows.</p>

TABLE 9-2. SUMMARY OF CHALLENGES AND OBSTACLES

Challenge / Obstacle	Description
	<p><u>Recommended Approach to Overcome</u> Coordinate closely with ALCOSAN to develop recommended hybrid solutions and IWM approaches which minimize cost of compliance for both authorities. Collaborate with ALCOSAN in the assessment and evaluation of green infrastructure alternatives.</p>
Interface with Tributary Municipalities	<p><u>Description of Challenge</u> Twenty-four municipalities are tributary to PWSA’s collection system. Success of green infrastructure activities will likely require implementation of green infrastructure in all sewersheds served by PWSA’s collection system. In addition, collaboration across municipal boundaries will be required to implement IWM approaches.</p> <p><u>Recommended Approach to Overcome</u> PWSA will serve as a regional leader in green infrastructure and IWM, assisting tributary municipalities in developing and implementing green infrastructure solutions.</p>
Timing	<p><u>Description of Challenge</u> Due to compliance schedules laid out for both ALCOSAN and PWSA, there is not time available to delay planned ‘gray’ improvements to analyze and assess the optimal role of ‘green’ improvements.</p> <p><u>Recommended Approach to Overcome</u> Use a phased implementation approach which simultaneously implements time-sensitive ‘gray’ solutions while planning and assessing ‘green’ solutions. Configure schedules so recommended compliance approach can be modified before major resources are expended on ‘gray’ approaches.</p>
Demonstrated Efficacy	<p><u>Description of Challenge</u> At present there is not a sufficient number of monitored green infrastructure projects to demonstrate the effectiveness of green infrastructure solutions in mitigating combined sewer overflows and general water quality improvement. In addition, sufficient monitoring and analysis has not been conducted to assess the potential of integrated watershed planning approaches to more cost-effectively address water quality issues.</p>

TABLE 9-2. SUMMARY OF CHALLENGES AND OBSTACLES

Challenge / Obstacle	Description
	<p><u>Recommended Approach to Overcome</u> Develop and implement multiple early demonstration projects which will be monitored to determine effectiveness at reducing both site runoff, discharge of stormwater pollutants, and combined sewer overflows. Explore and evaluate opportunities for integrated watershed planning.</p>
Financial	<p><u>Description of Challenge</u> Additional funds will be required to implement planned compliance activities. PWSA must determine the most equitable means of raising the required funds. It is anticipated that a stormwater utility, or stormwater service fee, which charges customers based on their contribution of stormwater runoff, may assist in equitably distributing the costs of controlling combined sewer overflows.</p> <p><u>Recommended Approach to Overcome</u> Develop recommendations for new or modified funding mechanisms and financial incentives which promote incorporation of green infrastructure.</p>
Maintenance	<p><u>Description of Challenge</u> There exist many challenges in maintaining a large number of green infrastructure practices, especially when many are expected to be constructed on private property and managed by private landowners or entities. Regular maintenance and eventual rehabilitation or replacement of green infrastructure practices will be essential to meeting long-term compliance obligations.</p> <p><u>Recommended Approach to Overcome</u> Develop comprehensive maintenance manual to provide standardized guidance on maintenance responsibilities, maintenance expectations, and specific maintenance activities recommended for each type of green infrastructure practice. Build partnerships with other stakeholders to help maintain green infrastructure and ensure its long-term functionality. Dedicate and set aside maintenance funds within PWSA’s budget similar to replacement and rehab funds set aside for “gray” assets to ensure ongoing funding for green infrastructure maintenance.</p>

TABLE 9-2. SUMMARY OF CHALLENGES AND OBSTACLES

Challenge / Obstacle	Description
Monitoring	<p><u>Description of Challenge</u> In order to assess the effectiveness of a green infrastructure practices, significant monitoring will be required to determine baseline conditions and assess incremental progress towards compliance goals.</p> <p><u>Recommended Approach to Overcome</u> Develop a comprehensive monitoring and tracking plan to establish procedures and methods to assess the performance of green infrastructure and to measure downstream water quality improvements.</p>

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9.5 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

PWSA is interested in optimizing its approach to meeting compliance objectives through the use of green infrastructure and IWM. PWSA believes that integrated approaches which utilize a combination of 'green' and 'gray' solutions, in addition to watershed-based controls, to address water quality challenges can be more cost-effective than a 'gray' only approach and may result in additional triple-bottom-line benefits to the Authority, the city, and its rate payers. PWSA is proposing an adaptive management plan to assess the optimal balance of 'green' and 'gray' solutions, to demonstrate the performance of green infrastructure solutions, and to explore and evaluate IWM approaches for the PWSA service area and connected municipalities. In addition, the initial phases of this plan aim to overcome challenges which could inhibit the implementation of green infrastructure or other IWM approaches at the scale required to aid in the control of combined sewer overflows.

PWSA recommends an adaptive management approach which follows a thorough and objective process to evaluate the ability of green infrastructure and hybrid 'green'/'gray' solutions to meet compliance objectives in a more cost-effective manner. This process would utilize an upfront four-year-long, short-term implementation plan to assess the ability of green infrastructure, and other IWM approaches, to assist in meeting compliance objectives. The process includes three decision points, spaced evenly over the four-year period, to inform a decision on whether or not to continue with the further evaluation/implementation of green infrastructure and IWM. Depending on the results of this assessment, a Revised Feasibility Study may be submitted to formally request permission to modify or alter the recommended compliance approach. This process may also include or culminate in a formal proposal to PaDEP, ACHD, and USEPA to utilize an integrated planning framework. This process aims to provide objective guidance to both PWSA and the regulators as to the most effective and beneficial means of complying with the COA. Should the process determine that a hybrid approach, or IWM approach, is not more cost-effective or beneficial, PWSA would continue with implementation of the baseline compliance approach detailed in this Feasibility Study.

The short-term implementation plan outlined in the following sections allows for the initial compliance actions outlined in the baseline compliance approach to proceed

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as planned while this initial assessment of green infrastructure and IWM's ability to support compliance efforts is completed. The adaptive management approach offers the potential for continued optimization of compliance approaches as progress is made, assessed, and targets reevaluated. PWSA recognizes that 'gray' improvements will likely always be required, but believes that the scale of 'gray' improvements may be able to be downsized and a more cost-effective balance of 'green' and 'gray' solutions, and watershed-based controls, may be found which offers the greatest benefits to the community at the most affordable cost. This potential downsizing of 'gray' improvements could be realized for both the PWSA and ALCOSAN regional facilities.

9.5.1 Adaptive Management Framework

An adaptive management framework recognizes that continued evaluation of progress towards compliance and reevaluation of recommended future compliance activities can support a long-term reduction in compliance cost, while optimizing water quality improvement. An adaptive approach bases future actions on the success of previous actions, allowing for continual improvement. It focuses on monitoring and regular re-assessment in order to achieve goals in the most cost-effective and beneficial manner. While an adaptive approach is more difficult for compliance plans which include a smaller set of larger improvements, compliance approaches which utilize hundreds or thousands of smaller improvements are well-suited for re-evaluation and enhancement through an adaptive management process.

The short-term implementation plan detailed in this section is the first step towards an adaptive management approach. The proposed plan aims to optimize the mix of 'gray' and 'green' solutions, and watershed-based controls, to minimize compliance costs and maximize benefits to the Authority, the city, and the rate payers. The proposed plan aims to establish a process through which the success of compliance activities, both 'green' and 'gray', is regularly evaluated and future solutions are recommended based on the effectiveness of previous projects and the potential for new or innovative solutions. This adaptive management process will start with the potential revision of the Feasibility Study at the completion of the four-year adaptive management plan, and will continue at regular intervals through the remainder of the implementation schedule. Such a process allows for the flexibility needed to

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meet water quality goals through the most cost-effective and beneficial means. This process has been approved by the USEPA for use by several communities across the country, and aligns with the USEPA's Integrated Planning Framework. This process is particularly applicable to green infrastructure programs, where the rate of redevelopment and development of new or improved technologies can greatly impact compliance needs and approaches.

9.5.2 Integrated Watershed Management

PWSA's IWM approach is based on the principles and elements espoused in USEPA's Integrated Planning Framework. The IWM approach recognizes that combined sewer overflows are just one source of pollution affecting waterways, and that compliance with the COA may not achieve attainment of broader water quality standards mandated under the Clean Water Act unless other pollution sources are also controlled. The USEPA's integrated planning framework promotes the ability to manage compliance efforts across the spectrum of pollutant sources and water quality related permits and programs.

The framework allows for flexibility to develop the optimum combination of 'gray', 'green' solutions, and watershed-based controls, required to meet the broader goal of attainment of water quality standards, not just the goals associated with combined sewer overflows. There is the potential that solutions addressing pollutants outside of the combined sewer system, such as stormwater runoff and dry weather sources, may be more cost effective and may provide greater water quality improvements faster than improvements to the combined sewer system. Therefore, an integrated approach looks to minimize the ultimate cost of compliance with water quality standards by looking outside individual permits or compliance programs to identify and optimize solutions which can help restore water quality on a holistic watershed basis in the most cost effective and efficient manner.

PWSA proposes assessing the potential for IWM through a demonstration program in the Saw Mill Run sewershed. This process will assess a wide variety of improvements, aimed not only at controlling combined sewer overflows, but at meeting broader water quality standards through a combination of pollution control strategies.

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Saw Mill Run is an optimal sewershed in which to target this assessment of integrated watershed planning on a demonstration scale for the following reasons:

- The completed TMDL study for this watershed establishes stringent requirements for the reduction of discharges of phosphorus.
- There is a high concentration of PWSA CSO structures in this watershed.
- There is a mix of combined and separate sanitary sewer systems operating within the watershed.
- ALCOSAN's Recommended Plan proposes the deferral of the identified required ALCOSAN Saw Mill Run interceptor and tunnel improvements until an unspecified time after 2026.
- Addressing the various pollution sources in this watershed has a greater potential for improving water quality compared to projects that strictly focus on the larger waterways such as the Monongahela and Allegheny Rivers.

Initial efforts to assess the role and potential of IWM in the Saw Mill Run sewershed will include watershed and source characterization, assessment of pollutant source context, identification of demonstration projects, and assessment and development of an integrated controls program. The analysis will also include a comparison between traditional control plans and IWM control plans, both in terms of effectiveness in improving water quality and in affordability.

If the analysis demonstrates that greater water quality and public health improvements can be made at an equal or lower cost than the improvements recommended in the baseline compliance approach, PWSA may submit a formal proposal to PaDEP, ACHD, and USEPA to utilize an integrated planning framework for a portion of or all of the PWSA service area.

9.5.3 Proposed Schedule and Decision Points

PWSA intends to conduct a four-year, in-depth evaluation to determine the ability of green infrastructure to cost-effectively assist in the control of combined sewer overflows and IWM to achieve more efficient and cost-effective compliance with broader water quality standards. This evaluation will be conducted in parallel with the planning and design of 'gray' infrastructure capacity enhancements outlined in the baseline compliance approach for this period. Recognizing the challenges

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inherent in delivering substantive flow control through green infrastructure, PWSA has outlined a three-stage process to guide the implementation and assessment of initial green infrastructure and IWM activities. The following sections introduce three different adaptive management implementation plans: the 'Year 1 Adaptive Management Implementation Plan', the 'Year 2 & 3 Adaptive Management Implementation Plan', and the 'Year 4 Adaptive Management Implementation Plan'. Each stage is accompanied by a decision point which has been designed to assess progress and determine if PWSA should move forward with efforts to modify the baseline compliance approach to include green infrastructure and IWM or revert to the baseline compliance approach detailed in this Feasibility Study. This process aims to provide objective guidance to both PWSA and the regulators as to the most effective and beneficial means of complying with the COA.

The three decision points are summarized as follows:

- **Decision Point 1.** In order to move through Decision Point 1, preliminary efforts must indicate both regional and regulatory support for accelerated incorporation of green infrastructure practices and/or IWM principles. The items outlined in the 'Year 1 Adaptive Management Implementation Plan' are intended to be a roadmap to gather and coordinate support for incorporation of green infrastructure and IWM into PWSA's compliance approach. If regional and regulatory support have not been achieved at the end of Year One, PWSA will revert to the baseline compliance approach. If regional and regulatory support has been achieved by the end of Year One, PWSA will move forward with the 'Year 2 & 3 Adaptive Management Implementation Plan'.
- **Decision Point 2.** In order to move through Decision Point 2, green infrastructure and IWM planning and early demonstration activities must demonstrate technical justification that green infrastructure and/or IWM can cost-effectively assist PWSA in meeting its combined sewer overflow control obligations or broader water quality standards. The items outlined in the "Year 2 & 3 Adaptive Management Implementation Plan" are intended to be a roadmap to evaluate and demonstrate the effectiveness of green infrastructure and IWM. If activities demonstrate that green infrastructure and/or IWM at the scale required is not feasible or is not cost effective, PWSA will revert to the baseline compliance approach. If activities demonstrate that green infrastructure can assist in cost-effectively meeting compliance objectives, PWSA will move forward with the 'Year 4 Adaptive Management Implementation Plan'.

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- **Decision Point 3.** In order to move through Decision Point 3, monitoring and assessment of early demonstration activities must show effectiveness in controlling runoff and the potential for managing combined sewer overflows or improving water quality. The items outlined in the 'Year 4 Adaptive Management Implementation Plan' are intended to be a roadmap for wrapping up planning level activities for full scale implementation of green infrastructure and/or IWM. If the performance of early demonstration activities shows that green infrastructure and/or IWM is not able to cost-effectively contribute to the control of combined sewer overflows or improvement in water quality, PWSA will revert back to the baseline compliance approach. If activities demonstrate efficient performance of green infrastructure and/or IWM controls, PWSA will submit a revised plan incorporating green infrastructure and/or IWM to the regulators for consideration.

Assuming PWSA is able to navigate through the three decision points detailed above, at the conclusion of this process PWSA may submit a Revised Feasibility Study for review and approval by PaDEP and ACHD and/or a formal proposal to PaDEP, ACHD, and USEPA to utilize an integrated planning framework for a portion of or all of the PWSA service area. At the discretion of PWSA and with approval by the regulators, modifications to the COA may be required. The short-term adaptive management implementation schedule is depicted in Figure 9-3.

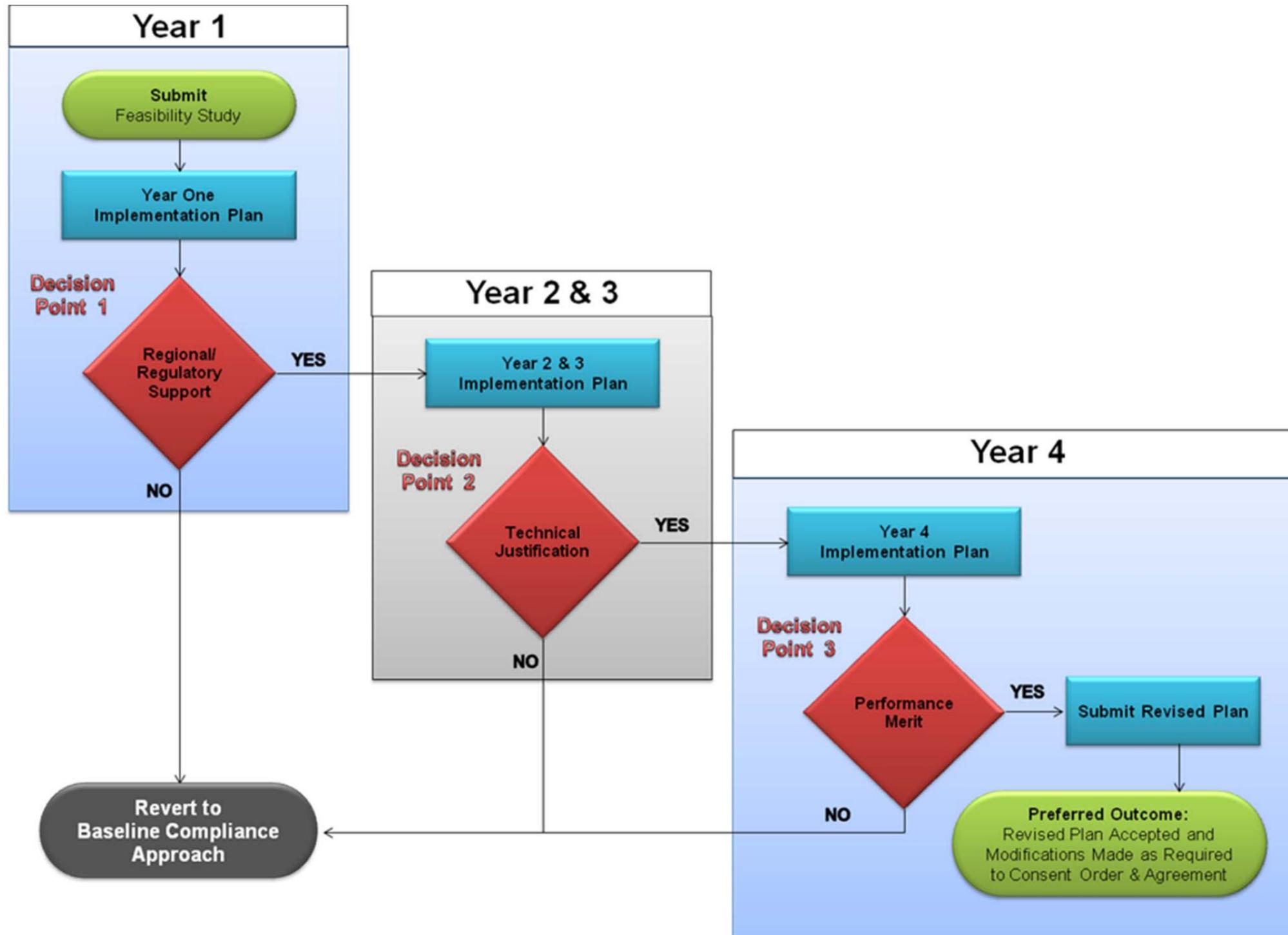


FIGURE 9-3. PROPOSED ADAPTIVE MANAGEMENT SCHEDULE AND DECISION POINTS

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9.5.4 Proposed Adaptive Management Implementation Plan

The following sections detail the three adaptive management implementation plans developed to comprehensively assess over a four-year period the ability of green infrastructure to assist in the control of combined sewer overflows and IWM to achieve more efficient and cost-effective compliance with broader water quality standards. Each implementation plan contains both planning activities and implementation activities, and is intended to build on efforts initiated or completed in previous stages.

Year 1 Adaptive Management Implementation Plan. The Year 1 plan focuses on building support behind efforts to expand the use of green infrastructure and IWM in the region and culminates in the initiation of several early demonstration projects which will be used to assess the effectiveness of such practices. The anticipated Year 1 actions are listed here, and discussed in detail in Table 9-3 at the end of this sub-section.

- Submit feasibility study
- Coordinate with regulators
- Develop Inter-Agency Task Force
- Develop Green Infrastructure Advisory Committee
- Coordinate with regional partners
- Initiate implementation of early demonstration projects
- Plan for additional early demonstration projects
- Initiate changes to promote and facilitate the use of green infrastructure

Year 2 & 3 Adaptive Management Implementation Plan. The Year 2 & 3 plan focuses on implementing green infrastructure and IWM projects and assessing the ability of system-wide green infrastructure to assist in the control of combined sewer overflows and the ability of IWM to improve broader water quality. The plan also includes several complimentary actions which will support the implementation, upkeep, and assessment of high quality green infrastructure practices throughout the region. The anticipated Year 2 & 3 actions are listed here, and discussed in detail in Table 9-4 at the end of this sub-section.

- Implement early demonstration projects

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- Conduct system-wide green infrastructure alternatives assessment
- Assess costs and benefits of IWM approach
- Develop green infrastructure design manual
- Develop green infrastructure maintenance manual
- Develop recommendations on funding mechanisms and financial incentives
- Develop monitoring and tracking plan
- Initiate further changes to promote and facilitate the use of green infrastructure
- Determine how to involve non-profits or community groups who can assist in implementing green infrastructure

Year 4 Adaptive Management Implementation Plan. The Year 4 plan focuses on developing a detailed plan to implement green infrastructure and IWM concepts into PWSA's compliance approach. This includes extensive assessment of completed projects, and determination of both the effectiveness and cost of utilizing green infrastructure to assist in the control of combined sewer overflows and IWM to improve water quality. The anticipated Year 4 actions are listed here, and discussed in detail in Table 9-5 at the end of this sub-section.

- Monitoring and assessment of early demonstration projects and other regional projects
- Implement recommendations on funding mechanisms and financial incentives
- Initiate further changes to promote and facilitate the use of green infrastructure
- Develop recommendations on green infrastructure implementation targets
- Develop recommendation on IWM targets
- Develop and submit revised feasibility study
- Coordinate with regulators

The detailed summaries of anticipated actions planned for Year 1, Year 2 & 3, and Year 4 are provided in Tables 9-3, 9-4, and 9-5, respectively.

TABLE 9-3. YEAR 1 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
Submit Feasibility Study	<p><u>Description of Action</u> Section 15, Paragraph D of the Consent Order and Agreement requires that PWSA submit a Feasibility Study within 6 months after ALCOSAN submits a Wet Weather Plan (WWP). ALCOSAN submitted their draft WWP in January 2013.</p> <p><u>Deliverables and Schedule</u> PWSA will submit the Feasibility Study to PaDEP and ACHD by July 31, 2013, in accordance with the requirements of the Consent Order and Agreement.</p>
Coordinate with Regulators	<p><u>Description of Action</u> PWSA will meet with PADEP and ACHD to discuss PWSA’s proposed plan to evaluate and demonstrate the ability of green infrastructure to assist in the control of combined sewer overflows and IWM to improve water quality. PWSA anticipates that these initial discussions will result in either a formal or informal partnership agreement, which details how the PWSA, PADEP, ACHD, and potentially others, work together to assess the proper role of green infrastructure and IWM in the Pittsburgh region.</p> <p><u>Deliverables and Schedule</u> Development of a partnership agreement which supports PWSA’s plan to evaluate green infrastructure and IWM.</p>
Develop Inter-Agency Task Force	<p><u>Description of Action</u> PWSA will develop and regularly convene an inter-agency/inter-departmental task force to streamline responsibilities and permitting processes for stormwater, specifically green infrastructure, as well as mitigation of pollutant sources other than typical CSO and SSO discharges. This task force will be composed of all city departments and outside agencies or organizations which currently set stormwater standards or regulate/permit stormwater. These responsibilities are currently spread across many departments and agencies/organizations and create roadblocks to the rapid adaptation, adoption, and implementation of green infrastructure. Headed by PWSA, this task force will meet</p>

TABLE 9-3. YEAR 1 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
	<p>regularly to identify areas where responsibilities could be consolidated and opportunities to streamline the permitting and approval process.</p> <p><u>Deliverables and Schedule</u> At the conclusion of Year 1, the task force will issue recommendations to be implemented in Year 2 which streamline responsibilities and permitting processes for stormwater management, specifically green infrastructure, as well as mitigation of other watershed pollutant sources.</p>
<p>Develop Green Infrastructure Technical Advisory Committee</p>	<p><u>Description of Action</u> PWSA will form and regularly convene an advisory committee to provide objective, expert advice to PWSA on incorporating green infrastructure and IWM into its policies, planning and design standards, and other areas of operation as appropriate. The advisory committee will consist of nine members selected by application from the following fields: organized labor, development community, environmental organizations, other relevant NGOs, City of Pittsburgh, academia, consulting engineers, and foundation community. The committee will meet monthly, report to PWSA frequently, and issue regular progress reports to the public.</p> <p><u>Deliverables and Schedule</u> Formation of this committee is currently in progress. The committee will hold regular meetings and issue regular recommendations to PWSA. At the conclusion of Year 1, the committee will issue a report summarizing the achievements made in incorporating green infrastructure IWM, as well as the continued challenges to both efforts.</p>
<p>Coordinate with Regional Partners</p>	<p><u>Description of Action</u> Recognizing that PWSA shares facilities and services with other regional partners, a key initial action will be to coordinate IWM and green infrastructure activities with appropriate regional partners. At a minimum, partners are anticipated to include upstream contributing municipalities, ALCOSAN, and 3RWW. PWSA will also be coordinating with 58 other municipalities as part of the effort to incorporate IWM on a regional basis.</p>

TABLE 9-3. YEAR 1 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
	<p><u>Deliverables and Schedule</u> Coordination efforts will identify areas where regional partners can work together to support adoption and implementation of green infrastructure. Efforts should also assist in aligning schedules and implementation activities to maximize the potential for cost benefits associated with the use of green infrastructure for combined sewer overflow control.</p>
<p>Initiate Implementation of Early Demonstration Projects</p>	<p><u>Description of Action</u> PWSA will work with other organizations to identify and construct an initial set of early demonstration projects. Projects will either be sponsored directly by PWSA or co-sponsored by PWSA if under the jurisdiction of a different department or agency. PWSA’s contribution is estimated at \$500,000 to \$2,000,000 for each project. Projects are anticipated to consist of projects currently under-development which can be modified to feature green infrastructure or source control. Each demonstration project will be monitored to assess the benefit of green infrastructure approaches.</p> <p><u>Deliverables and Schedule</u> PWSA, or the partnering organization/entity, shall issue a request for construction bids for each identified early demonstration project before the close of Year 1. A first early demonstration project in Schenley Park, co-sponsored by ALCOSAN and the Parks Conservancy, is already under development</p>
<p>Plan for Additional Early Demonstration Projects</p>	<p><u>Description of Action</u> PWSA will work with other organizations to identify and develop an additional set of early demonstration projects. Projects will either be sponsored directly by PWSA or co-sponsored by PWSA if under the jurisdiction of a different department/agency. PWSA’s contribution is estimated at \$500,000 to \$2,000,000 for each project. One or more of the early demonstration projects are anticipated to be located in the Saw Mill Run watershed to aid in the assessment of IWM approaches. Each demonstration project will be monitored to assess the benefit of GI and/or IWM approaches.</p>

TABLE 9-3. YEAR 1 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
	<p><u>Deliverables and Schedule</u> PWSA, or the partnering organization/entity, shall issue a Request for Proposals (RFP) for planning/design services for each identified early demonstration project before the close of Year 1.</p>
<p>Initiate Changes to Promote and Facilitate the Use of Green Infrastructure</p>	<p><u>Description of Action</u> With support from the Inter-Agency Task Force and the Green Infrastructure Advisory Committee, PWSA will identify and initiate changes to the ordinances, permit processes, development regulations, codes and zoning requirements which will both remove barriers to the use of green infrastructure and promote or facilitate the use of green infrastructure.</p> <p><u>Deliverables and Schedule</u> At the conclusion of Year 1, PWSA shall issue a report detailing the changes made to promote or facilitate the use of green infrastructure. This report should also detail the changes/actions identified for consideration in Year 2.</p>

TABLE 9-4. YEAR 2 & 3 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
<p>Implement Early Demonstration Projects</p>	<p><u>Description of Action</u> PWSA will work with other organizations to design and construct an additional set of early demonstration projects. Projects will either be sponsored directly by PWSA or co-sponsored by PWSA if under the jurisdiction of a different department or agency PWSA’s contribution is estimated at \$500,000 to \$2,000,000 for each project. One or more of the early demonstration projects are anticipated to be located in the Saw Mill Run watershed to aid in the assessment IWM approaches. Each demonstration project will be monitored to assess the benefit of green infrastructure and/or IWM approaches.</p> <p><u>Deliverables and Schedule</u> PWSA, or the partnering organization/entity, shall issue a request for construction bids for each identified early demonstration project before the close of Year 2. All construction on early demonstration projects, both those initiated in Year 1 and those initiated in Year 2, should be completed by the close of Year 3.</p>
<p>Conduct System-Wide Green Infrastructure Alternatives Assessment</p>	<p><u>Description of Action</u> PWSA will conduct a system-wide alternatives analysis to identify best green infrastructure approaches, assess the benefit/impact of green infrastructure, and to determine the relative cost effectiveness of a hybrid approach compared to the baseline compliance approach. This analysis will be conducted for all sewersheds with improvements planned as part of the baseline compliance approach, and will determine the recommended balance of ‘green’/’gray’ improvements for each sewershed. This effort will be coordinated with ALCOSAN’s green infrastructure planning and assessment activities, in addition to other IWM planning activities.</p> <p><u>Deliverables and Schedule</u> PWSA will issue a report detailing the findings of the system-wide green infrastructure alternatives analysis by the close of Year 2. The report will be modified, based on comments from Regional Partners and Regulators, and re-issued by the close of Year 3.</p>

TABLE 9-4. YEAR 2 & 3 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
<p>Assess Costs and Benefits of IWM Approach</p>	<p><u>Description of Action</u> PWSA will conduct an assessment, focused on the Saw Mill Run watershed, of the costs and benefits of utilizing an IWM approach, as detailed by the EPA’s Integrated Planning Framework, to meet water quality objectives. This analysis will consider approaches to improving and protecting water quality which could offset or minimize the need for improvements to the combined sewer system.</p> <p><u>Deliverables and Schedule</u> PWSA will issue a report detailing the findings of the IWM planning assessment by the close of Year 2. The report will be modified, based on comments from regional partners and regulators, and be re-issued by the close of Year 3.</p>
<p>Develop Green Infrastructure Design Manual</p>	<p><u>Description of Action</u> PWSA will lead the development of a green infrastructure design manual. Ideally, this will be a collaboration of PWSA and other regional partners which can serve as a regional design manual. The design manual will serve as the consolidated design guidance for green infrastructure, establishing performance standards and providing easy to follow guidance for the planning, design, construction, and post-construction phases of green infrastructure projects. The manual will provide a standardized design process to be used by both public and private entities. This manual would be designed to be flexible in order to accommodate different size projects and unique site conditions and constraints.</p> <p><u>Deliverables and Schedule</u> PWSA will issue the draft design manual for review by regulators, regional partners, and the general public by the close of Year 2. The design manual will be modified, based on comments, and be re-issued as final by the close of Year 3.</p>

TABLE 9-4. YEAR 2 & 3 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
<p>Develop Green Infrastructure Maintenance Manual</p>	<p><u>Description of Action</u> PWSA will lead the development of a green infrastructure maintenance manual. Ideally, this will be a collaboration of PWSA and other regional partners which can serve as a regional maintenance manual. The manual will include two sections, the first for maintenance of publicly owned and maintained green infrastructure practices, and the second for privately owned and maintained green infrastructure practices. The maintenance manual will detail maintenance responsibilities, maintenance expectations, and specific maintenance activities recommended for each type of green infrastructure practice. In addition, the manual will detail in-situ tests which can be used to assess the performance/functioning of a green infrastructure practice, and will detail enforcement strategies, where applicable, for practices which are not maintained properly.</p> <p><u>Deliverables and Schedule</u> PWSA will issue the draft maintenance manual for review by regulators, regional partners, and the general public by the close of Year 2. The design manual will be modified, based on comments, and be re-issued as final by the close of Year 3.</p>
<p>Develop Recommendations on Funding Mechanisms and Financial Incentives</p>	<p><u>Description of Action</u> PWSA will continue the evaluation of existing and potential funding mechanisms, such as an impervious area based stormwater fee, to most equitably allocate the cost of compliance activities among rate payers. The analysis will include assessment of incentives inside the rate structure to encourage addition of stormwater management to individual properties. The analysis will also include assessment of the proper jurisdiction for a stormwater fee (i.e. PWSA service area only or county-wide).</p> <p><u>Deliverables and Schedule</u> PWSA will issue a report detailing recommended funding mechanisms and incentives to support the cost of compliance activities by the close of Year 2. The report will be modified, based on comments, and be re-issued as final by the close of Year 3.</p>

TABLE 9-4. YEAR 2 & 3 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
<p>Develop Monitoring and Tracking Plan</p>	<p><u>Description of Action</u> PWSA will develop a monitoring and tracking plan to detail the method and means of assessing the system-wide implementation and performance of installed green infrastructure or IWM controls. This plan will include a system, such as the Rainways Regional Green Infrastructure Map, to track the installation of green infrastructure or IWM controls. It will also establish monitoring goals, procedures, benchmarks, locations, and quality assurance protocols required to assess the performance of installed components and to quantify progress towards compliance. This information will inform the adaptive management process.</p> <p><u>Deliverables and Schedule</u> PWSA will issue a draft monitoring and tracking plan for review by PaDEP and the ACHD by the close of Year 2. The plan will be modified, based on comments, and be re-issued as final by the close of Year 3.</p>
<p>Initiate Further Changes to Promote and Facilitate the Use of Green Infrastructure</p>	<p><u>Description of Action</u> With support from the Inter-Agency Task Force and the Green Infrastructure Advisory Committee, PWSA will identify and initiate changes to the ordinances, permit processes, development regulations, codes and zoning requirements which will both remove barriers to the use of green infrastructure and promote or facilitate the use of green infrastructure.</p> <p><u>Deliverables and Schedule</u> At the conclusion of Year 2, PWSA shall issue a report detailing the changes made to promote or facilitate the use of green infrastructure. This report should also detail the changes/actions identified for consideration in Year 3. At the conclusion of Year 3, PWSA shall issue a report detailing the changes made to promote or facilitate the use of green infrastructure. This report should also detail the changes/actions identified for consideration in Year 4.</p>

TABLE 9-4. YEAR 2 & 3 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
<p>Determine How to Involve Non-Profits or Community Groups who can Assist in Implementing Green Infrastructure</p>	<p><u>Description of Action</u> PWSA will review policies and procedures for supporting or funding efforts of non-profit organizations or community groups working on implementation and maintenance of green infrastructure practices in neighborhoods served by PWSA. Recognizing that certain types of green infrastructure solutions are best implemented and maintained at the community scale, PWSA will develop a standardized program or means to support these groups in their efforts to implement and maintain green infrastructure practices. This process will include a determination of cost-effectiveness and long-term assurances.</p> <p><u>Deliverables and Schedule</u> PWSA will issue a formal policy outlining under what circumstances and through what means PWSA can support or fund green infrastructure initiatives of non-profit organizations or community groups by the close of Year 2.</p>

TABLE 9-5. YEAR 4 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
<p>Monitoring and Assessment of Early Demonstration Projects and Other Regional Projects</p>	<p><u>Description of Action</u> PWSA will implement the procedures outlined in the monitoring and tracking plan in order to assess the impact of green infrastructure, source control, and other IWM practices implemented to date. This assessment will include projection of future impacts/benefits based on continued expansion of green infrastructure and/or IWM efforts. This will also include assessment of challenges and obstacles overcome by the early demonstration projects and a projection of future activities inside sewersheds of interest.</p> <p><u>Deliverables and Schedule</u> PWSA will issue a draft report detailing the collected performance information by the middle of Year 4. The final report will be rolled into a Revised Feasibility Study to be issued at the close of Year 4.</p>
<p>Implement Recommendations on Funding Mechanisms and Financial Incentives</p>	<p><u>Description of Action</u> PWSA will initiate implementation of recommended funding mechanisms needed to support compliance efforts. This will also include implementation of recommended financial incentives to encourage and facilitate addition of stormwater management to individual properties.</p> <p><u>Deliverables and Schedule</u> PWSA will have new/modified funding mechanisms in place, or on the path towards approval, by the close of Year 4.</p>
<p>Initiate Further Changes to Promote and Facilitate the Use of Green Infrastructure</p>	<p><u>Description of Action</u> With support from the Inter-Agency Task Force and the Green Infrastructure Advisory Committee, PWSA will identify and initiate changes to the ordinances, permit processes, development regulations, codes and zoning requirements which will both remove barriers to the use of green infrastructure and promote or facilitate the use of green infrastructure.</p>

TABLE 9-5. YEAR 4 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
	<p><u>Deliverables and Schedule</u> At the conclusion of Year 4, PWSA shall issue a report detailing the changes made to promote or facilitate the use of green infrastructure. This report should also detail any remaining the changes/actions identified for consideration in subsequent years.</p>
<p>Develop Recommendations on Green Infrastructure Implementation Targets</p>	<p><u>Description of Action</u> PWSA will develop an adaptive management plan which details the conversion of previously identified ‘gray’ infrastructure components into green infrastructure or hybrid solutions. This process will establish general green infrastructure implementation targets, such as ‘greened acres’, for each sewershed, and will outline alternative approaches to meeting compliance goals if initial activities do not achieve the level of performance anticipated or are more costly than anticipated. The plan will outline a regular process for evaluating progress and adjusting or modifying the compliance approach accordingly.</p> <p><u>Deliverables and Schedule</u> PWSA will develop an initial adaptive management plan for internal review by the middle of Year 4. The final plan will be rolled into a Revised Feasibility Study to be issued at the close of Year 4.</p>
<p>Develop Recommendation on Integrated Watershed Planning Targets</p>	<p><u>Description of Action</u> PWSA will develop a recommended IWM planning document for the Saw Mill Run sewershed. This plan will consider and assess alternative approaches to meeting water quality objectives and will establish management targets to be used to assess progress towards compliance. The plan will outline a regular process for evaluating progress and adjusting or modifying the compliance approach accordingly. This plan could also include recommendations for the incorporation of IWM concepts into other PWSA sewersheds.</p>

TABLE 9-5. YEAR 4 ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Action	Description
	<p><u>Deliverables and Schedule</u> PWSA will develop an initial integrated watershed planning document for the Saw Mill Run sewershed for internal review by the middle of Year 4. The final plan will be rolled into the Revised Feasibility Study to be issued at the close of Year 4.</p>
<p>Develop Revised Feasibility study</p>	<p><u>Description of Action</u> If indicated by previous steps, PWSA will update the feasibility study to detail a revised path to compliance which includes the hybrid approach recommended by previous steps. The hybrid approach is anticipated to include green infrastructure components and potentially IWM concepts while utilizing an adaptive management approach to implement the plan most cost-effectively over the course of the implementation period.</p> <p><u>Deliverables and Schedule</u> PWSA will submit the Revised Feasibility Study to PaDEP and ACHD by the close of Year 4.</p>
<p>Coordinate with Regulators</p>	<p><u>Description of Action</u> PWSA will work with PaDEP, ACHD, and USEPA to address issues and concerns related to the Revised Feasibility Study. Any changes necessary to the Revised Feasibility Study will be addressed expeditiously by PWSA.</p> <p><u>Deliverables and Schedule</u> After negotiation, regulators will accept the Revised Feasibility Study and modify the Consent Order and Agreement as necessary.</p>

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9.5.5 Preliminary Cost Estimate

The estimated cost of the activities proposed in the short-term adaptive management implementation plan is summarized in Table 9-6. Anticipated costs include costs carried by PWSA only, which include estimated staff time and consultant and contractor costs. Additional costs may be carried by other coordinating partners who participate with PWSA on certain activities proposed in the adaptive management implementation plan. The anticipated four-year total cost of the adaptive management implementation plan is estimated at \$9.6 million.

TABLE 9-6. ESTIMATED COST OF SHORT-TERM ADAPTIVE MANAGEMENT IMPLEMENTATION PLAN

Proposed Phase	Estimated Cost
Year 1 Adaptive Management Plan	\$ 1,500,000
Year 2 & 3 Adaptive Management Plan	\$ 7,250,000
Year 4 Adaptive Management Plan	\$ 850,000
TOTAL	\$ 9,600,000

9.6 LONG-TERM GOALS AND OBJECTIVES

PWSA is interested in identifying the optimum balance between gray infrastructure, green infrastructure, and watershed-based controls in terms of cost of compliance, impact on water quality, and broader benefits to rate payers. The actions presented in the preceding sections constitute an objective plan to evaluate the potential impact of green infrastructure and IWM approaches and to determine the best combination of solutions or approaches moving forward. The proposed approach represents a prudent and objective assessment of cost and benefit leading to reevaluation of the recommended baseline compliance approach. The goal of this process is to implement a long-term program for improving water quality, utilizing an optimal combination of 'gray' and 'green' solutions, and watershed-based

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controls, to cost effectively reduce discharge of pollutants into the region's waterways in accordance with the Consent Order and Agreement.

PWSA recognizes the wide-ranging benefits green infrastructure can provide the community, such as urban greening and revitalization, and is committed to supporting a broader effort to improve the management of water resources throughout the city and the region. In addition to the combined sewer overflow Consent Order and Agreement, PWSA is also subject to MS4 permit conditions and existing and future TMDL obligations. PWSA recognizes that large-scale implementation of green infrastructure and IWM approaches may help the Authority, the city, and the region to meet their various short- and long-term water resources challenges. Therefore, an integrated approach to improving water quality, including combined sewer overflow reductions, is anticipated to offer benefits to rate payers.

PWSA is committed to implementing an integrated approach to managing water resources and looks forward to building on the foundation of integrated water resources management established in the four-year adaptive management plan. Ultimately, PWSA envisions a paradigm shift in the way stormwater is managed throughout the development process, supporting the Authority's efforts to restore, protect, and preserve water quality while creating more sustainable urban environments.