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NATIONAL NETWORK ON WATER QUALITY TRADING

Working With the Market:

Economic Instruments to Support Investment in Green Stormwater Infrastructure

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Executive Summary

Urban stormwater runoff is one of the most significant environmental issues facing communities today. Flooding, water supply, water quality, habitat degradation, and other impacts associated with stormwater runoff are increasing due to ongoing urbanization, a more episodic climatic regime, and rising global temperatures.

Communities are in need of cost-effective and innovative ways to drive investment and implementation of green infrastructure for stormwater management. This report summarizes how stormwater managers can work with market forces, applying “economic instruments” to address these critical issues and meet their stormwater program goals. Economic instruments recognize and deliberately work within the economic system to create action or drive investment that meets environmental goals. They include the use of rebates, subsides, trading, and mitigation. Economic instruments are a useful tool for stormwater managers because they can:

- Increase the coverage of green infrastructure on both public and private lands, for new development and urban retrofits;
- Provide flexibility for regulated entities trying to meet stormwater requirements;
- Provide a vehicle for both public and private investments; and
- Enhance the efficiency of delivering benefits associated with stormwater infrastructure.

Incentives-based approaches motivate the installation of stormwater controls by offering cost avoidance, financial gain, or program/project support. Stormwater programs often use rebates, subsidies, or project/logistical support as an incentive for private parties to install green infrastructure. Mitigation- or credit-based approaches are those in which stormwater benefits are quantified as a currency or “credit” and traded between parties to mitigate or offset regulatory requirements. This creates an incentive for pollution controls to occur where it is most cost-effective to do so. These programs provide flexibility for regulated parties and create an incentive to develop new, more cost effective methods to reduce pollution and/or control stormwater volume.

While economic instruments have the potential to attain greater cost-efficiencies and performance in green infrastructure investment, policy and programmatic barriers limit their widespread use. These barriers include:

- **Technical Capacity**: The development of a trading or mitigation framework requires specialized skills that many communities may not have. Off-the-shelf tools and resources, such as “road map” guides, templates, or workshops could help smaller and mid-sized communities apply economic instruments within their stormwater programs.
- **Market Size**: Trading areas and units of currency constrict potential market size. Where appropriate, permits with consistent pollutants and units can open market opportunities.
- **Quantification**: Quantifying pollutant reductions to use as a units of trade is challenging. Standard assessment methods and performance-based investment vehicles can help.

The National Network on Water Quality Trading, Storm and Stream Solultions LLC, Green Infrastructure Leadership Exchange, Oregon Solutions, and the Water Environment Federation engaged over 50 experts in stormwater management and trading to explore these nascent and evolving approaches. This report summarizes the content and take aways from that process: the motivations that drive investment in stormwater infrastructure; a set of program options that work with market forces for more effective and efficient investment in stormwater infrastructure; the issues that limit these approaches and ways to get beyond these hurdles. If proven effective, we expect economic instruments to become more common elements in stormwater programs across the country.

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I. Introduction

The impacts of stormwater are significant and rising. Stormwater pollution is the only major increasing source of water pollution across much of the United States (U.S. EPA, 2012). Impervious areas effectively store pollutants, such as heavy metals, oils and grease, and bacteria, all of which get washed into storm drain systems and then out to rivers, streams, and estuaries, often without any treatment. Urban stormwater runoff can increase the intensity of localized flooding and major flood events, which have the potential to cause massive property damage and even loss of life. These effects will likely be exacerbated in the future as urban areas continue to expand, new areas are developed, and the effects of sea level rise and climate change place more pressure on our infrastructure through increased episodic periods of drought and intense precipitation.

Communities are in need of cost-effective and innovative ways to drive investment and implementation for stormwater management. This report, based upon input provided by professionals in the water quality trading and stormwater management fields, focuses on how policies that recognize and utilize economic forces, known as "economic instruments," can support the voluntary implementation of green infrastructure on private property, improve effectiveness and efficiency of green infrastructure practices, and provide new streams of financing for the installation and maintenance of stormwater infrastructure.

National Network on Water Quality Trading

The National Network was formed in 2012 to establish a national dialogue on how water quality trading can best contribute to clean water goals. That includes providing options and recommendations to improve consistency, innovation, and integrity in water quality trading. The Network is funded by the NRCS Conservation Innovations Grant Program.

National Network participants come from diverse backgrounds, representing utility, agriculture, environmental, regulatory, and practitioner communities. National Network hosts collaborative dialogues to discuss and advance the state of knowledge on trading and trading-related topics. In 2016, the National Network on Water Quality Trading gathered over 50 experts in stormwater management and water quality trading to explore the use of economic instruments within stormwater management programs.

This event was convened in collaboration with the Green Infrastructural Leadership Exchange and Water Environment Federation's Stormwater Institute. This report summarizes the content and takeaways from that process.

Green Infrastructure for Stormwater

Green infrastructure has emerged as one way to manage stormwater that can be highly cost effective, resilient, and support multiple community benefits. Green infrastructure (GI) is an approach to water management that protects, restores, or mimics the natural water cycle (American Rivers, 2016). GI practices include green roofs, bioretention facilities, permeable pavements, street trees, planter boxes, bioswales, downspout disconnections, and rainwater harvesting. Beyond reducing runoff through infiltration, GI practices have been shown to mitigate other effects of urbanization, such as reducing airborne particulates, reducing energy costs, lowering ambient air temperatures, enhancing community health and safety, and increasing the social and economic value of urban areas (Miller 2007, Wise 2007, Currie and Bass, 2008, Wise et al. 2010, American Rivers, 2016).

GI restores the watershed's capacity to capture rain where it falls, infiltrating or intercepting it before it can become runoff. However, implementing GI across the landscape means working on private property and retrofitting existing development, both of which are outside the jurisdiction of utility managers or local governments. This report describes how stormwater program managers can overcome this challenge by using economic instruments to encourage voluntary installation of GI on private property.

The term "stormwater" refers to the dynamic where precipitation (rainfall, snowmelt) overwhelms the landscape's capacity for infiltration or interception (e.g., rain drops are stored or evaporate from the tree canopy), which leads to the generation of runoff.

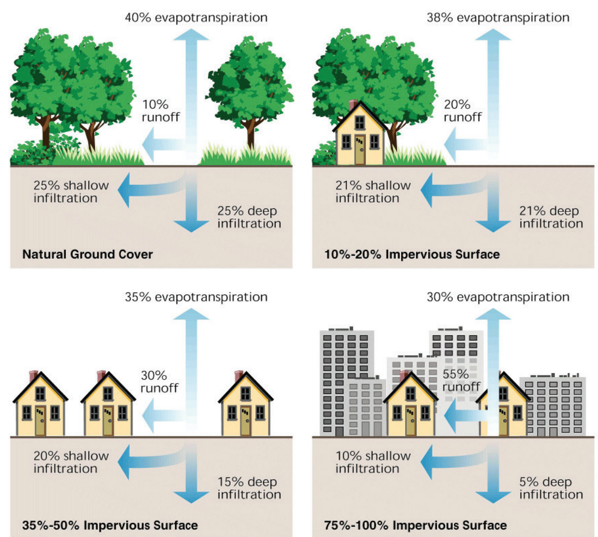

Figure 1. Impervious surfaces reduce infiltration and are often a major driver of stormwater runoff.
Source: U.S.EPA 2003a

Funding and Financing Infrastructure Investment

There is a funding gap in the stormwater sector that is pushing communities to seek new resources and financing for infrastructure investment. Existing data suggest that as much as $150 billion in investment is needed for communities to meet their stormwater management needs over the next 20 years (U.S.EPA, 2012c). Yet most communities lack sustainable and adequate revenue for stormwater infrastructure investments. Of the 7,500+ communities regulated for stormwater runoff, it is estimated that less 1,500 have developed a user-based fee program specifically for stormwater infrastructure (these are often referred to as "stormwater utilities" or "stormwater authorities") (GILE, 2016). Most other programs rely on general funds, which are inconsistent in availability and amount. This lack of reliable revenue causes those same communities to struggle to access public and private financing (e.g., municipal bonds, State Revolving Fund loans) and hinders long-term capital planning efforts (GILE, 2016).

Revenue for Stormwater Infrastructure Needs

- The most common form of dedicated funding for stormwater programs is from fees collected through a stormwater utility fee program.
- Approximately 1,500 communities out of the 7,500 regulated MS4 programs have established stormwater utilities.
- Most communities with regulated stormwater programs use general funds to address stormwater infrastructure investment.
- The lack of dedicated funding limits financing options and capacity and hinders long-term capital planning efforts.

This report covers the drivers that motivate entities to invest and participate in stormwater management programs, evaluates the range of economic instruments from which stormwater managers can draw, and the highlights policy barriers that complicate the use of economic instruments to drive finance and installation of stormwater infrastructure. The report focuses on GI, but the same concepts and approaches are highly applicable to other forms of stormwater management as well (e.g., engineered retention or onsite treatment facilities).

II. Drivers

This section describes the factors that motivate public and private entities when they make decisions about if and how to invest in stormwater management. Understanding these driving motivations provides an important foundation for understanding and appreciating how economic instruments can be applied.

Regulatory Drivers

The strongest drivers for stormwater infrastructure investment by communities and private entities are those associated with regulations. Communities are typically responding to state and federal regulations associated with implementation of the Clean Water Act including the National Pollution Discharge Elimination System and Total Maximum Daily Load programs. State and federal permits are often the basis or local building and development code, which act as regulatory drivers for private entities.

i. National Pollutant Discharge Elimination System (NPDES) - MS4 and CSO Programs

Urban stormwater runoff is regulated most directly through the National Pollution Discharge and Elimination System (NPDES). Specifically, the Municipal Separate Storm Sewer System (MS4) program, which addresses flows in separate storm sewer systems, and the Combined Sewer Overflow (CSO) policy program (U.S. EPA, 2016b). Some communities may be further driven toward specific targets or actions if they are implementing storm and sewer controls under a consent decree.

Amendments made to the Clean Water Act in 1987 created the MS4 permit program, which now covers 7,500 regulated communities and entities. MS4 permit holders are required to develop programs that outline how they will address pollution associated with flows in their storm sewer system (U.S. EPA, 2016b).

Stormwater regulatory drivers and milestones in the U.S.

1978	1987	1990	1994	1999	2008	2011	2014
Nationwide Urban Runoff Program launches	Clean Water Act amendments address nonpoint source pollution	Phase I Municipal Separate Storm Sewer System permitting program established	Combined Sewer Overflow Control Policy published	Phase II Municipal Separate Storm Sewer System permitting program established	National Research Council releases report on urban stormwater management	Integrated Planning Framework developed	Proposed national stormwater rule deferred Green Infrastructure Collaborative formed Memorandum on stormwater permits and total maximum daily loads revised

Figure 2. Regulatory drivers for stormwater management have evolved over the past 40 years. Source: WEF 2015.

In 1989 and subsequently in 1994, EPA developed policies to consistently address Combined Sewer Overflows (CSOs) within the NPDES program. CSO events discharge raw or partially-treated sanitary flows into receiving waters when a Combined Sewer System (CSS), which conveys both surface drainage and sanitary flows, is overwhelmed. (U.S. EPA, 2016b). Many of the 772 communities with CSO discharges have developed programs to reduce overflows. The standard "grey infrastructure" approach is the use of underground storage systems (i.e., tunnels) to hold large volumes of combined storm and sanitary flows during wet weather events. More recently, the use of GI has emerged as a complimentary solution to reduce surface runoff volumes.

ii. Total Maximum Daily Load Program

Total Maximum Daily Loads (TMDLs) are watershed-scale assessments that determine the amount of pollutant loading that a waterbody can handle on a daily basis and still be considered healthy (or "unimpaired") (U.S. EPA 2017). Within this "pollution diet," historical data and computer modeling are used to develop Wasteload Allocations (WLAs), which assign specific pollutant load reductions to specific traditional point source discharges (industrial and wastewater effluent, etc.). The TMDL also sets "load allocations" (LAs) to nonpoint sources (e.g., agriculture, forestry), wherein load reductions are assigned to an entire sector (U.S. EPA 2017). Initially, urban runoff and MS4s were considered a nonpoint source and assigned a LA, but since 2010, EPA clarified that MS4s should be considered a point source and assigned a WLA during TMDL plan development (U.S. EPA, 2010). The result of this shift is that WLAs now have the potential to be integrated into MS4 permits much the same as is done with more traditional point sources (e.g., wastewater, industrial discharges, etc.), providing specific load-based targets.

iii. Stormwater Manuals and Development Permits

State and local government set the performance standards to which various types of structures (e.g., residential and commercial buildings) must be constructed. These design and performance standards are spelled out in technical guidance documents (e.g., stormwater manual) and required via development permitting processes. These standards often prescribes the inclusion of treatment practices that will manage stormwater at the property or project scale. The approaches considered in this report are frequently paired with design and performance standards to allow developers more flexibility and create opportunities for private financing.

Non-Regulatory Drivers

While regulatory drivers typically provide the primary motivation for public and private entities to invest in stormwater management, it is important to note that municipal decision makers (e.g., city council) are motivated to consider the additional benefits of any major investment. That may include climate resiliency, the effect on local economic development, and improved ecosystem services. It is these ancillary benefits that most often support the use of green over gray infrastructure to meet regulatory requirements. The subsections below describe how the benefits of GI relate to a suite of non-regulatory drivers.

i. Economic Development

Using Utility Funds for Multiple Benefits

Revenue from a stormwater utility fee typically comes with a legal obligation to spend those funds on the operation, maintenance, and rehabilitation of stormwater drainage systems. Stormwater managers may gain traction for GI investment with multiple social and economic co-benefits, but should be careful to maintain a justification for how the actions contribute to meeting stormwater goals.

Economic benefit is an important co-benefit offered by the implementation and maintenance of GI. In a study of three Mid-Atlantic communities, the Environmental Finance Center estimated that the return on every dollar invested in stormwater infrastructure could range from between $1.45 to $3.16 (Environmental Finance Center, 2013). These economic returns are in the form of revenue from the creation of jobs, both directly and indirectly, as well as goods and services (e.g., landscaping and plant material).

The economic benefits of GI are even greater when ecosystem services (water quality, habitat, climate regulation, etc.) and social benefits (e.g., public health, well-being) are included. In Philadelphia, a 2009 study by Stratus Consulting estimated that using GI to address CSOs would generate over 20 times the economic benefit compared with the gray infrastructure alternative. Major sources of benefit in this study included public health (see below), property value, air quality, energy consumption, and recreational use. This kind of payoff is likely to be an important consideration for communities interested in economic development/redevelopment.

ii. Public Health

Public health is a strong motivator for municipal decision makers, and GI has a suite of well-documented health benefits. Greener streetscapes and more greenspace have been shown to reduce stress (Ward Thompson et. al., 2016), increase physical activity (Bauman et. al., 2016), improve air quality (Nowak et. al., 2014), and restore attention in students with ADHD (Fisher Taylor and Kuo, 2011). Tree plantings also reduce the “urban heat island effect,” which is associated with heat-related illnesses and deaths. In the 2009 study by Stratus Consulting described above, it was estimated that a GI approach to managing Philadelphia’s CSO events would generate an additional $1.7 billion in economic benefit over 40 years (compared to a gray infrastructure approach) from

Figure 3. Asphalt absorbs and retains heat, making urban areas hotter than rural areas, affecting energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality. Tree plantings for stormwater benefit also help address urban heat island. Image courtesy of Chris Ford. License CC BY-NC 2.0.

the reduction of asthma and heat-related illnesses and deaths alone. Stormwater investments that prioritize urban greening have the potential to make a real impact on the health, and health care costs, for the local community.

iii. Climate Change and Resiliency Drivers

Many cities are looking for ways to reduce or mitigate the effects of climate change. Urban areas across the world will be affected by rising sea levels and increased precipitation resulting in flooding, as well as periods of more extreme heat and cold (United Nations, 2017). GI practices provide multiple benefits that address these threats. Trees or green roofs can reduce rooftop temperatures in urban areas by 40 to 60 degrees Fahrenheit (Gaffin et al, 2005) and provide habitat for birds and other wildlife. Effective stormwater management is also highly related to control of nuisance flooding. Communities can claim flood insurance discounts under the Community Rating System (CRS), developed by the Federal Emergency Management Agency (FEMA), for utilizing GI practices, which provides another strong incentive for GI and stormwater management infrastructure investment overall (U.S. EPA, 2016a).

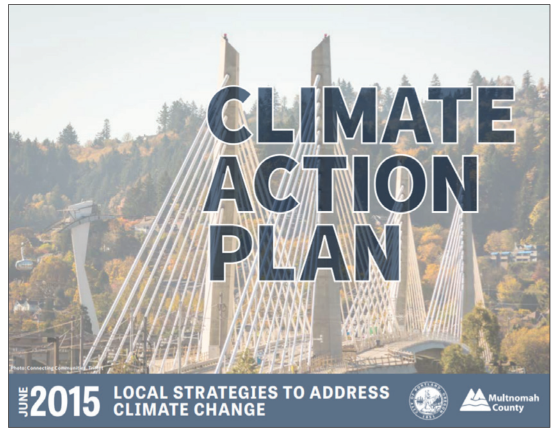

Figure 4. Many cities have climate action plans. Stormwater management activities, particularly green infrastructure, may support climate and resilience goals in these plans. Portland, Oregon's climate action plans are pictured above.

iv. Stewardship and Corporate Sustainability

Many cities and private companies see value in signaling their support for the environment through sustainability investments. Individuals and non-corporate entities (e.g., faith-based organizations, schools) may also be motivated out of a sense of stewardship. The adoption of GI on buildings, parks, and other facilities is one way to signal commitment to sustainability and stewardship. These individuals and entities motivated by stewardship ethic or sustainability goals are good targets for GI incentive programs.

v. Expediency, Reduced Uncertainty

Permit approval for new development or redevelopment projects can be a long and expensive process. Delays during any stage in the development process add to the final costs of the project, which can increase price paid by the end user (e.g., buyers of residential units) and/or reduce returns for developers and their investors. Making the permit review process faster, easier, or less uncertain is valuable to permittees.

III. Economic Instruments for Stormwater Infrastructure Investment

Webster defines the word "economy" as "efficient use of material resources" as well as "a system especially of interaction and exchange" (Merriam-Webster, 2017). These definitions are reflected in use of the term "economic instruments" in this document (sometimes referred to as "market -based approaches").

"Economic instruments" is used here to cover a wide array of frameworks that recognize and deliberately work within the economic system to create action or investment that meets environmental goals. It includes the use of incentivizing, subsidizing, trading, or offsetting/mitigating impacts. Economic instruments fall into two categories: "incentive-based" and "mitigation or credit-based" approaches (see Figure 5). Incentive-based approaches use financial gain, cost avoidance, or non-financial benefits to motivate or encourage someone to act in a certain way.

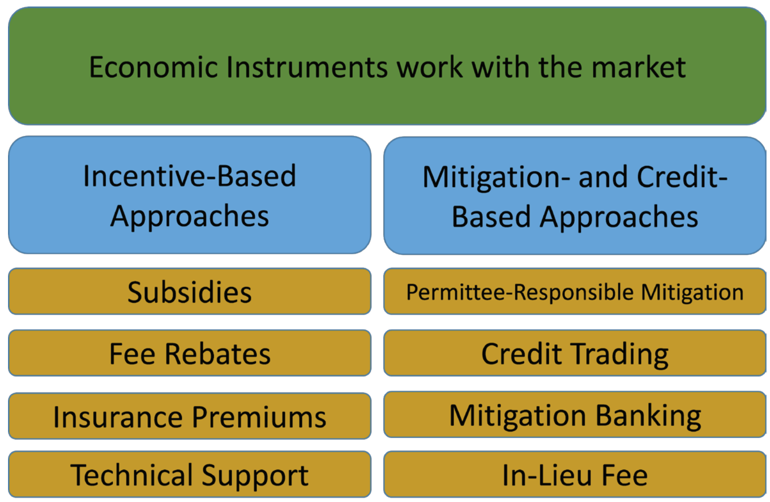

Figure 5. "Economic instruments" is the umbrella term for incentive-based approaches and those based on mitigation or credits.

In mitigation or credit-based frameworks, a party is provided flexibility in offsetting their actions at other sites or by other parties in order to meet their regulatory obligations. A credit is a currency representing units of environmental improvement, generated by a party going above and beyond their own regulatory obligations. Those credits are either saved for later use, or sold to those for whom it is more expensive to generate environmental improvement, and are therefore motivated to purchase a credits as a means of regulatory compliance.

As the examples below demonstrate, economic instruments are a useful tool for stormwater managers because they can:

- Increase the coverage of GI on both public and private lands, for new development and urban retrofits;
- Provide flexibility for regulated entities trying to meet stormwater requirements;
- Provide a vehicle for both public and private investments; and
- Enhance the efficiency of delivering benefits associated with stormwater infrastructure.

There is currently a great deal of interest and momentum around programs that utilize economic instruments to create cost efficiencies, innovation, and improved performance and coverage of stormwater GI. Within the last five years, the first stormwater retention trading program was established in Washington, D.C. (DOEE, 2016), Philadelphia launched an innovative incentive-based subsidy program to "green" thousands of acres of existing impervious cover (NRDC, 2013), and numerous publications have touched on how economic instruments can support financing and implementation of GI (U.S. EPA 2009; Francis, 2010; Great Lakes Protection Fund, 2017).

This section provides a thorough list of program types and specific examples where these ideas have been applied.

Incentive-Based Approaches

An "incentive" motivates or encourages someone to act in a certain way. Within the stormwater sector, specific incentives include cost avoidance (i.e., a reduction in payment based upon a specific action taken or goal attained), financial gain (i.e., payment made based upon a specific action taken or goal attained), or program/project support (i.e., reduction in time or fees associated with municipal review). The approaches presented in this section are based on one, or multiple, of these incentives. Additionally, some cities utilize multiple aspects of each approach – for instance, a cost-based subsidy coupled with a fee/rebate program.

Incentive-Based Approaches

Cost Avoidance

- Fee Reduction Vehicles Rewarding of onsite adoption of GI through cost avoidance associated with stormwater fees.
- Insurance Premium Discounts / Risk Reduction: Cost avoidance for property owners who adopt GI practices onsite through reduced flood insurance premiums.

Financial Gain

- Subsidies: Direct payment to a property owner who wishes to adopt onsite stormwater infrastructure.

Program/Project Support

- Land Development Project Support: Incentives for land developers in the form of reduced plan review time and dedicated informed technical plan reviewers among other administrative efforts.

i. Fee Reduction Vehicles (Credits/Rebates/ Discounts)

Where a stormwater utility or equivalent entity exists, it is common to offer rate payers a reduction in their stormwater fee for providing on-site stormwater management. This type of fee reduction engages the public on stormwater issues and incentivizes the adoption of stormwater infrastructure at the parcel or site level. Fee reduction vehicles may be referred to as a "discount," "rebate," or as a "credit" depending on the publication or programs.

Nearly half of communities with a stormwater fee offer a reduction in stormwater-related fees associated with on-site investments in Best Management Practices (BMPs), with approximately half of fee reduction programs targeting only non-residential properties (Black & Veatch, 2014). Fee reduction programs are often designed to reduce stormwater volume, reduce peak flow, or improve water quality (as opposed to pollution or spill prevention, etc.). Many offer a maximum reduction of 50% to 75% of the fee, though a significant number provide reductions above and below this range (Black & Veatch, 2014).

In some instances, prescriptive actions are required (e.g., rain barrel installation). Other programs focus on a target outcome (e.g., retention of a specific amount of runoff). Some communities have MS4 and CSO programs each with their own revenue generation vehicle, in which case rebates may be provided for in one or both programs. For instance, in Washington, D.C. the Clean Rivers program associated with DC Water's CSO program allows for a 4% discount on the Impervious Area Charge and there is another discount provided by DC's Department of Energy and Environment (DOEE), which offers a maximum of 55% off their stormwater fee when adopting on-site GI (DOEE, 2016).

ii. Subsidies

Subsidies – a direct payment based upon specified action, such as the installation of a BMP – are another form of incentive frequently applied by stormwater utilities. For example, the City of Austin, Texas will provide up to $500 to install rainwater harvesting systems onsite (U.S. EPA, 2009). Prince George's County, Maryland will pay up to for $4,000 for rain barrels, permeable pavement, rain gardens, and other onsite GI treatment on residential properties and up to $20,000 for non-residential properties (Prince George's County, 2017). In some cases, the subsidized BMPs make the participant eligible for a fee reduction, resulting in a layering of incentives. The Philadelphia Water Department is rewarding private parties that provide the most cost-efficient urban retrofit projects through a grant as well as a major reduction (80%) on stormwater fees to the property owner engaged in on-site retrofitting (NRDC, 2013).

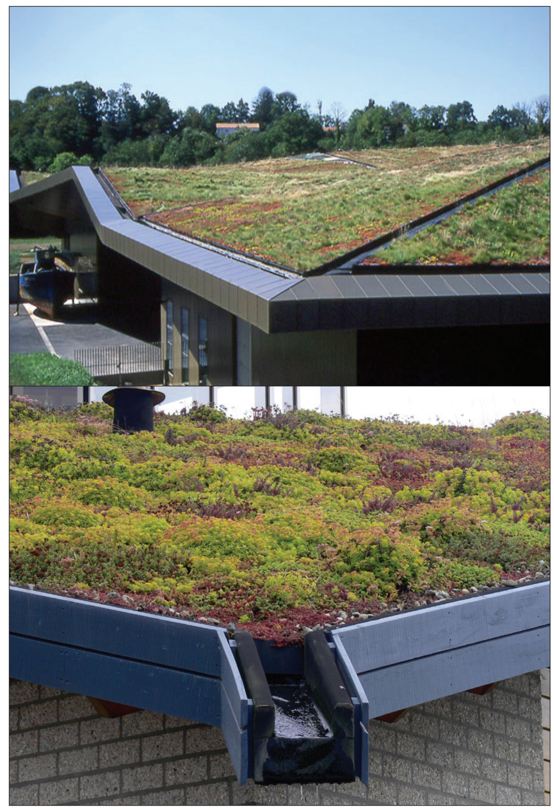

Figure 6. Prince George's County provides a $12/sq. ft. subsidy for installing green roofs on commercial and residential properties. Photo credit: Simon Garbutt.

iii. Insurance Premium Discounts/Risk Reduction

Another incentive-based approach is based upon the premise that a proactive investment in GI will enhance the resilience of a community and therefore reduce the incidence and significance of flood-related damages. For example, the Community Rating System within the National Flood Insurance Program allows reduced insurance rates for homeowners in communities who adopt specific practices to reduce flood risk and enhance resilience overall, including the development of GI-focused building codes, ordinances, and a focus on runoff volume as well as peak flow (U.S. EPA, 2016a). In another example that has been proposed but not yet implemented, the City of New Orleans has proposed the Resilience Retrofit Program in collaboration with the University of

New Orleans and representatives from the reinsurance industry, including Swiss Re, to research the effects of individual adaptation measures and retrofits on flood insurance premiums (City of New Orleans, 2016).

iv. Land Development Project Support

Land developers looking to adopt GI practices for new and redevelopment projects often face an inflexible regulatory permitting process at the local level and/or regulatory staff that lack the technical knowledge to review and approve site designs incorporating GI (National Association of Home Builders, 2017). To overcome these barriers, state and local agencies can provide expedited plan reviews for proposed development that includes GI, reducing the time required to gain regulatory permits. Similarly, some communities have specialized staff members with a strong technical background that are dedicated to the review of GI-focused projects in order to enhance plan review services.

Mitigation- and Credit-Based Approaches

Market-style approaches that create efficiencies by taking advantage of cost heterogeneities in generating stormwater benefits.

- Permittee-Responsible Mitigation: Scenario in which the same party is responsible for both the impact and mitigation actions.
- Credit Trading: Multiple parties buy and sell credits. Credits are generated by going above and beyond one's own regulatory requirements.
  - Water Quality Trading: Trading for compliance by an NPDES permit holder, subject to U.S. EPA WQT Policy of 2003.
  - Stormwater Trading: Trading programs that provide flexibility for those covered by local development regulations and/or permits. Credits are not used by an NPDES permit holder.
- Mitigation: Approach where a site or suite of sites is conserved and managed over a set period of time for the purpose of providing ecological functions and services (e.g., flow retention, pollutant reduction, expressed as credits). The bank acts like a bank account from multiple buyers can purchase credits to meet regulatory obligations.
- In-Lieu Fees: Programs wherein the permittee can choose to pay a fee to compensate for some or all of the regulatory obligation associated with the proposed project.

Mitigation- and Credit-Based Approaches

The second major category of economic instruments used to support effective and efficient stormwater management takes advantage of the variation in cost-to-compliance between different sites or parties. These approaches contain established rules for the generation, purchase, and use of stormwater benefits. Stormwater benefits, often quantified as a currency or credit, are tied to a pollutant of interest (e.g., lbs of nitrogen). Credits can be bought, sold, or traded to mitigate or offset regulatory requirements. The involved parties may be public (e.g., municipality) or private (e.g., mitigation banker). Transactions typically occur when one party can generate the desired outcome at a much lower cost than the other.

Mitigation and credit-based approaches provide regulated parties flexibility in meeting a performance standard and create an incentive to develop new, more cost effective methods to reduce pollution and/or control stormwater volume.

Permittee responsible mitigation, credit trading, stormwater banking, and in lieu fee programs are all considered mitigation and credit-based approaches. These categories and definitions are consistent with those used in the Clean Water Act 404 program

(Compensatory Mitigation for Losses of Aquatic Resources, 2008) and the Endangered Species Act (ESA) (Compensatory Mitigation Policy, 2016).

These programs can be established and administered in a number of different ways, which allows for different types of transactions.

i. Permittee-responsible Mitigation (Offsets)

Permittee-responsible mitigation includes activities or projects undertaken by a permittee (e.g., developer), authorized agent, or contractor, to provide compensatory mitigation. "Offset" is another common term used to refer to a scenario in which the same party is responsible for both the impact and mitigation actions. Permittee-responsible mitigation tends to be associated with one-time actions, the benefits of which may or may not be quantified as credits. These programs typically allow a project or program owner to find another site (usually within a specific geographic area, such as a watershed or jurisdiction) that can provide treatment equivalent with or greater than the impact of the permitted action(s). The permittee retains responsibility for the maintenance and performance of the offsite treatment for some discrete period of time, or in perpetuity.

The City of San Diego is considering the implementation of a "stormwater quality improvement credit program" under its regional MS4 permit. This program may allow new and redevelopment projects to comply with surface water runoff quality treatment and channel protection requirements through partial or complete offsetting investments on another site if they can demonstrate that the offsite project will result in greater overall water quality benefit to the watershed when compared to implementing treatment onsite at the new and redevelopment project. This program is referred to as an "Offsite Stormwater Alternative Compliance Program" (or shortened to "Alternative Compliance"). This program is envisioned to enhance flexibility for developing property within the City's jurisdiction while concurrently incentivizing improvements to water quality in locations that otherwise may not see improvements in the near term. This program has not yet been established; however, two workgroups have been formed to develop the details of the program (V. Gummadi, personal communication, January 2017).

ii. Credit Trading

Trading involves buyers and sellers transacting quantified and verified units of environmental benefit. Trading programs may use direct monitoring to determine the credits available from a given practice, others use data and/or modeling to set an assumed level of performance for each eligible practice type, then verify that it was implemented correctly (National Network, 2015).

Trading programs can occur where a cap or a limit exists for a specific pollutant/parameter of interest (e.g., TMDL for nutrients, infiltration requirement for development projects). Sellers generate credits for reductions above and beyond their allowable load or discharge (also known as their "baseline"). Credits are the currency that can be sold to others for whom pollutant reductions are less cost-effective. Trades can occur through bi-lateral contracts, or the program may have an exchange or a "clearinghouse" through which multiple parties can offer, buy, and sell credits.

This category is further divided into "water quality trading," where credit transactions are used by an NPDES permittee to achieve compliance; and "stormwater trading" programs, which provide flexibility for those covered by the rules and local regulations that the permittee uses to implement their permit. The key difference is whether credits are used by an NPDES permit holder to achieve compliance. If so, the program is subject to provisions of the Clean Water Act (e.g., anti-degradation, anti-backsliding, no localized impacts, etc.) as described in 2003 U.S. EPA Water Quality Trading Policy (hereafter 2003 WQT Policy; U.S. EPA, 2003). If not, there may be considerably more flexibility in how the program can be implemented to achieve the desired environmental outcomes.

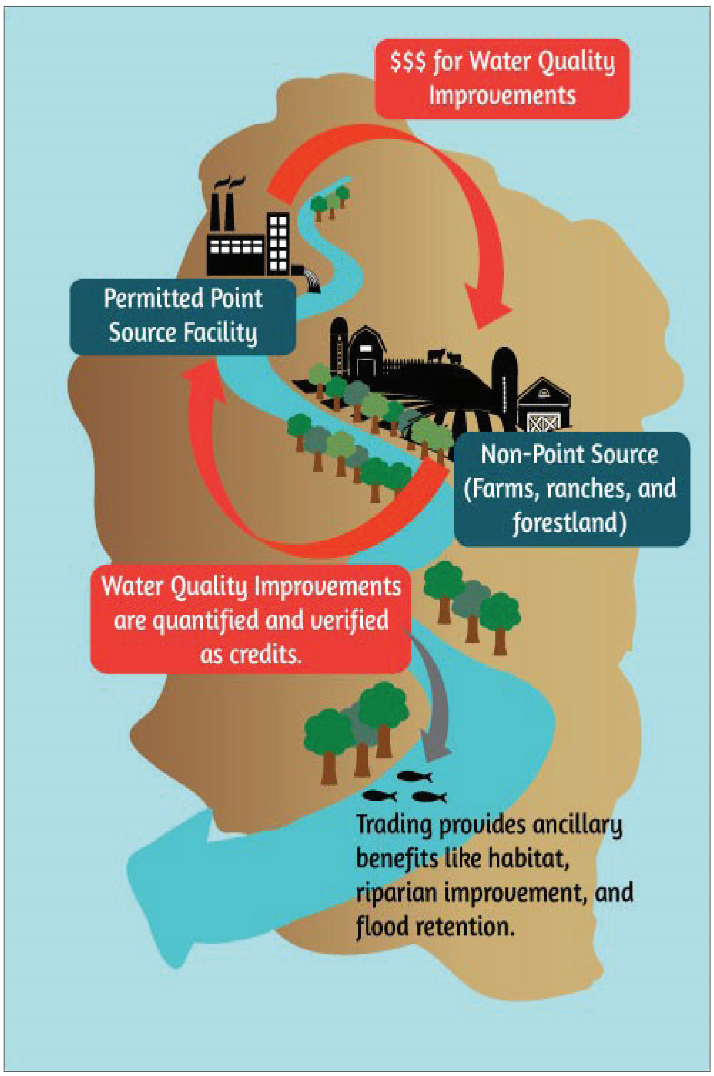

Figure 7. Water quality trading in the waste water context involves purchase of credits by NPDES holders, typically from conservation and restoration actions on farms, forests, and ranches. Graphic courtesy of Willamette Partnership.

Water Quality Trading

In water quality trading (WQT), the pollutant "cap" typically comes from a local or regional TMDL. There are numerous examples of WQT from the wastewater sector as highlighted in the recent report by the National Network on Water Quality Trading (NNWQT, 2015).

The Chesapeake Bay region is active in the use of WQT to address stormwater, driven by nutrient reductions required in the Chesapeake Bay TMDL. Virginia's water quality trading program allows those that disturb land over a one-acre threshold to purchase nutrient credits to offset the impacts of the project. There are project size considerations (sites over 10 acres must provide 75 percent of required treatment onsite unless a waiver can be gained) as well as spatial considerations (sites under 10 acres can only purchase nutrient offset credits from a nutrient bank established within the same eight-digit hydrologic unit code as the project). In 2012, Virginia Department of Environmental Quality began allowing the MS4 sector to engage in trading to address nutrient load reduction requirements. Virginia's nutrient trading program is perhaps the most active trading program in the country generating credits from nonpoint sources (WEF, 2012).

Maryland is also exploring the use of water quality trading for MS4 permittees. In early 2016, the State of Maryland announced its intent to include MS4s in an existing water quality trading program in an effort to help MS4 Phase I communities to meet a new requirement to retrofit 20% of existing untreated impervious cover within their jurisdiction (State of Maryland, 2016).

Stormwater Trading

Stormwater trading facilitates transactions between parties at the site or parcel level. For instance, a developer might be able to generate credits by adopting GI on his/her parcel that goes above and beyond a required retention threshold in their development permit. This type of program is not subject to the 2003 WQT Policy because transactions occur between parties who do not hold NPDES permits.

Washington, D.C. Stormwater Retention Credit (SRC) program is the first and best known example of a stormwater trading program whose currency is stormwater retention. Under the SRC trading program, developers are responsible for meeting a 1.2-inch retention standard established in DOEE's 2011 MS4 permit (DOEE 2013). Half of the required retention volume must be met on site and the remaining amount can be met through the purchase of stormwater retention credits. Retention credits are generated by development or redevelopment project owners retaining more than is required on their site, or by property owners undertaking voluntary retrofits. Credits can be sold to those for whom on-site retention is more expensive or impossible.

A similar program has been established in Chattanooga, Tennessee, also driven by a retention requirement associated with an MS4 permit. In Chattanooga's program, there is a performance standard to capture between 1 and 1.6 inches on a given site (referred to as "stay-on volume"), depending upon location in the city (City of Chattanooga, 2017).

iii. Mitigation

Mitigation banking is another approach through which permittees can seek lower cost options to meet permit conditions. In a mitigation program, a site or suite of sites is conserved and managed over a set period of time for the purpose of providing ecological functions and services (e.g., flow retention, pollutant reduction, expressed as credits) that are later used to compensate for impacts occurring elsewhere to the same functions and services. A stormwater bank acts like a bank account from multiple buyers can purchase credits to meet regulatory obligations.

Many state DOTs have investigated or developed mitigation programs to address water quality conditions within their MS4 permits. The Maryland State Highway Administration and Delaware DOT established stormwater quality mitigation banking programs in 1992 and 1999 respectively (State of New Jersey, 2009). In both cases, the transportation department developed an agreement with the state environmental regulatory agency in addition to the existing policy guidance. Activities associated with land development also create potential demand for mitigation of stormwater runoff.

iv. In-Lieu Fees

"In-lieu fee" (ILF) (also known as "fee-in-lieu") programs provide project developers who cannot easily or cost-effectively meet regulatory requirements onsite with the option to pay a fee instead. The revenue collected through an ILF program administrator (governmental or nonprofit natural resources manager) is used to support environmental investments that fulfill mitigation obligations associated with the permitted action. This approach has its origins in the mitigation banking sector; however, the U.S. Corps of Engineers (USACE) differentiates ILF from banking in that payments are not necessarily made in advance of project impacts and arrangements associated with ILF revenue does not prescribe the details of mitigating efforts (U.S. Fish & Wildlife, 2000).

Stormwater ILF programs commonly tie the fee level to the volume or a rate of runoff generated. The pooled revenues are then used by the program administrator to install practices intended to offset the stormwater impacts of those projects. Park Ridge, Illinois; Aspen, Colorado; and San Antonio, Texas utilize an ILF approach as the sole option for developers who cannot address runoff impacts onsite (Arcadis, 2016). The DOEE and the Chattanooga stormwater trading programs have an option to pay to an ILF rather than purchase credits or complete investments onsite to meet regulatory obligations. Policy considerations and challenges associated with ILF programs have been addressed in detail in the literature and are therefore not explicitly consider here (Stephenson and Tutko, 2016).

v. Layering Economic Instruments

It is common for communities to apply multiple economic instruments for enhanced GI and stormwater infrastructure investment. For instance, both the DOEE and Chattanooga stormwater trading programs utilize credit trading and an ILF option. DOEE also provides fee reduction as a financial motivator to adopt GI at the site level. The City of San Diego is considering a program that provides developers the option to use offsite investments, ILFs, or credit transactions to maximize flexibility. The State of Maryland's "Aligning for Growth" (AfG) program (still under development) covers land development activities and septic loadings. It allows for permittees to meet pollutant (especially nitrogen) load reduction requirements through a combination of on-site treatment to the maximum extent practicable, pay into a fee-in-lieu fund, purchase credits, or offsite remediation.

IV. Policy Challenges / Barriers for Economic Instruments

Stormwater programs that feature economic instruments have many advantages – they can increase cost-efficiency in address environmental issues, draw in new and non-traditional stakeholders into environmental investments, and engage with the private sector for needed investment and project delivery support – however, they are the exception and not the rule. Multiple hurdles currently limit the application of economic instruments in the stormwater sector. This section lays out those barriers and potential solutions to help communities and interested parties move past them.

Incentive-Based Approaches

Policy Challenges / Barriers

Incentive-Based Approaches

- Fee Rebate or Subsidy Setting
- Tax Codes
- Upfront Capital
- Maintenance Responsibility

Mitigation- and Credit-Based Approaches

- Programmatic Costs and Complexity
- Trading Area and Units of Trade
- Quantifying Credible Units of Trade
- Credit Life
- Balancing Local Impacts with Cost Effectiveness
- Holistic Stormwater Management

Existing fee reduction and subsidy programs often struggle to gain participation from community members. A study of seven other communities in Illinois with a fee/rebate program highlighted that participation rates was 5% or less in all cases (Village of Winnetka, 2013).

There are a few dynamics likely to be driving low participation. This section will cover challenges related to setting the "right" level of fee reduction or subsidy, questions about how the tax code should treat subsidies, finding upfront capital to install GI, and ensuring long term maintenance of GI practices. Another barrier not considered in this report is the potential for misalignment between property developer and property ownership, wherein the developer that would need to make investment does not own the property and therefore will not receive the benefit.

i. Designing the Right Rebate or Subsidy

In order for fee reductions or subsidies to drive the adoption of on-site stormwater infrastructure, the associated cost savings need to provide a sufficiently attractive financial incentive. Participation struggles if the cost of stormwater infrastructure is higher than the stormwater fee, such that no amount of reduction could fully offset costs (Resources for the Future 2001, Doll et al, 1999, Thurston, 2005). Similarly, if the stormwater fee revenue cannot support subsidies that sufficiently cover the cost of GI installation, opportunity costs, and maintenance, they will be less attractive to property owners and developers.

For both fee reductions and subsidies, this problem stems from insufficient funding. Increasing user fees or establishing other dedicated funding streams are seemingly simple ways address a funding gap, but almost always face political and statutory impediments. In this case program managers should consider a) layering other types of incentives (e.g., technical assistance); b) reducing barriers to participation (e.g., streamline long or burdensome administrative processes); c) marketing the programs in a way that relates directly to property owner values (e.g., focus on reducing localized flooding instead of stormwater volume); and d) supporting outreach that builds and awareness of stormwater impacts and a culture of stewardship.

ii. Tax Codes

Currently, the IRS considers a rebate on a stormwater utility fee as taxable income. This view could effectively reduce and limit overall participation in incentive-based programs. In 2015, two federal legislators and 32 others signatories sent a letter requesting that the IRS not consider rebates associated with on-site adoption of water conservation and stormwater infrastructure as taxable income. They suggested instead that the IRS establish parity with energy efficiency rebates, which currently enjoy a non-taxable status by the IRS (Huffman, 2015). Clarification by the IRS on this point would help to remove this barrier for on-site adoption of stormwater infrastructure.

iii. Upfront Capital

Costs associated with onsite stormwater infrastructure implementation, operations, and maintenance can be significant. In the absence of subsidies, or where subsidies are capped, lack of capital may limit participation in incentive-based programs, even for those developers or homeowners that want to use GI on site. This hurdle may addressed through efforts to reduce GI implementation costs either through aggregating enough projects that the implementation benefits from economies of scale and/or through more efficient project delivery enabled by integrated services, where the same company manages design, installation, and ongoing maintenance. Low-cost private financing may also help to addresses capital cost challenges.

iv. Maintenance Responsibility

Green roofs, bioswales, rain gardens, and many other stormwater BMPs need ongoing maintenance to continue providing the expected benefits. Due to the relatively young age of most stormwater programs and the lack of data on long-term BMP performance, it is difficult to develop a confident prediction of the effort and cost to maintain BMP function over the life of the practice. Property owners may not be willing to take on an uncertain, ongoing maintenance obligation, and public entities may be hesitant to pay upfront costs without any of assurance that adequate maintenance will be provided to keep the practice functioning. Stormwater program managers can address these issues through the development and application of robust maintenance agreements, providing incentives that respect whole lifecycle costs for onsite stormwater infrastructure, and allowing for third-party agents to provide operations and maintenance services at a reasonable rate and at a high level of performance and accountability.

Barriers/Challenges for Mitigation- or Credit-Based Approaches

Administering and funding a mitigation- or credit-based program can be daunting for communities due to capacity, technical, and policy issues. This section describes a number of potential barriers along with potential solutions.

i. Programmatic Costs and Complexity

The development of a trading or mitigation framework in particular requires specialized skills that many communities may not have access to or be able to fund, such as public infrastructure funding/financing, policy/regulatory analysis, and legal support. This lack of understanding and resources likely limits the adoption of programs using economic instruments. “Off-the-shelf” tools and resources, such as guides, templates webinars, and workshops that explain the process to establish and operate a market-based program, would help smaller and mid-sized communities implement programs that include economic instruments for stormwater management infrastructure investment.

Figure 8. Green infrastructure, like this bioswales in Emeryville, CA will require maintenance to continue functioning as designed. Photo credit: Creative Commons, license CC BY-SA4.0.

ii. Trading Area and Units of Trade

Markets like to be big – they are most efficient when there are multiple buyers and sellers making transparent transactions with a clear unit of trade. This is difficult to accomplish with water quality trading and stormwater markets because eligible participants need to be within a restricted geographic area and using the same units of trade.

Trading programs set a boundary within which buyers and sellers can trade. This "trading area" is defined such that there is a clear link between the credited pollution reduction and the permitted discharger ultimately using those credits (National Network, 2015). Trading areas may coincide with a TMDL boundary, watershed boundary, or jurisdiction.

Units of currency also limit trading partners. Municipalities may have different units of trade because water quality issues and/or permits cover different pollutants. This narrows the potential number of trading participants and makes it more difficult to establish a functioning market. Where appropriate, consistent permitting, specifically consistent pollutants and units, can open market opportunities to more participants.

iii. Quantifying Credible Units of Trade

MS4 programs have historically relied on technology-based permitting. In technology-based permitting, compliance is based the presence or absence of a particular technology or practice with an assumed level of performance and an assumed level of care to inspect and maintain it. Trading programs, on the other hand, need a specific, discrete, and credible unit to act as the tradeable commodity. Quantifying units of pollution as a credit gives the buyer a clear understanding of what they are getting for their money.

Quantifying units of pollutant removal in stormwater systems; however, is challenging. Pollutant loading can vary by orders of magnitude because precipitation, which drives pollutant delivery, is chaotic and inconsistent from month to month and year to year. This is particularly true as we begin to experience the predicted effects of climate change. Additionally, treatment capacity for stormwater management practices and systems varies over time depending upon several factors, most importantly the amount of inspection and maintenance performed over the lifetime of the infrastructure.

Monitoring BMP performance is a seemingly straightforward solution, however, the ability and cost to monitor different pollutants can vary greatly. It is relatively easy and inexpensive to monitor runoff rate and volume as well as turbidity/sediment, but far more costly to monitor metals, bacteria, and nutrients. The cost for monitoring certain pollutants may limit the ability to support a credible trading program until technological improvements can reduce the cost and increase the reach of monitoring across a landscape or watershed.

Quantifying Baseline

Quantifying pollution reductions is also part of setting the baseline in a trading program. Trading participants generate credits for reductions above and beyond their allowable load or discharge, known as their "baseline." For example, a strip mall parking lot may be required to reduce nitrogen discharged from the site by 30%, and if they can reduce beyond this point, they can generate credits that can be sold to others who cannot meet this baseline.

Another potential solution is to base the trading currency on a proxy that is easier to measure. For example, turbidity/sediment, or runoff retention can provide a proxy for nitrogen or phosphorus that is much more cost-effective to monitor. Permittees would need to get regulatory approval for using a proxy and should be prepared to provide data supporting the connection between the pollutant and proxy.

Trading program developers can also account for uncertainty using conservative estimates of effectiveness or trading ratios. Section 5 of the National Network Building a Water Quality Trading Program publication provides extensive coverage of mechanisms to manage uncertainty in trading programs (National Network, 2015).

iv. Credit Life

The National Network on Water Quality Trading defines credit life as the approved, quantified, and reviewed period of performance (National Network, 2015). Trading program developers will need to decide whether to use long- or short-term credits. Long-term or permanent credits are often used to offset permanent impacts from land development (e.g., species and wetland mitigation programs). Permanent credits require protection in perpetuity, which limits options for future development and/or reduces flexibility around how the site can be used in the future. Credit developers are likely to pay (and charge) more to develop permanent credits because of this high opportunity cost. A more limited credit life (e.g., 1 to 5 years) provides greater flexibility to those generating credits, potentially encouraging more participation and lower credit prices, but may be unacceptable or limiting for a credit buyer (e.g., land developer) who could lose regulatory coverage if those credits go away.

Emerging Investment Frameworks

Private investors may be willing to take on monitoring costs under new and emerging frameworks. Performance-based contracts and some public private partnerships (P3s) are structured such that program performance is tied to private investor returns. These investment vehicles are likely to spur innovation in the use of models, monitoring, and sampling methodologies to assess performance in a cost-effective way.

A solution to this situation would be for the public sector (municipality, utility) to provide assurance or support to buyers seeking to replace credits from re-purposed sites. They might require the credit developer to provide significant (e.g., 1 year) notice prior to allowing credits to expire. They might also provide additional flexibility (e.g., grace period before penalties apply) or facilitate the connection between those buyers and a new source of credits.

Figure 9. It may be cheaper to attain stormwater benefits higher up in the watershed where rural land uses dominate.

v. Balancing Local Benefits with Cost Effectiveness

There may be significant cost differences based on whether stormwater practices are installed in the urban (often downstream) portion of the watershed, or in upstream (often less developed) areas. Incentive and mitigation- or credit-based programs will need to consider how program policies drive the spatial distribution of stormwater practice installation. For instance, consider a community that chooses to invest in GI within their urban footprint to address water quality issues related to regulatory requirements as well as local flooding, economic development/revitalization, public health, and/or social well-being of residents. The benefits to local waters and community members are clear, however, working within the urban matrix often carries a high cost driven by property value and use of BMPs with more engineering (e.g., bioswales, green roofs). Alternatively, if that community is not responding to a local TMDL, they may design their program to allow or even encourage investments in upstream agricultural areas. Despite a lower price tag, this may not necessarily garner as much public support because it fails to secure social benefits locally. Program managers should consider the community values and budget flexibility to find a responsible and optimal balance between these two options. Managers should also consider prioritizing education for rate payers about watershed dynamics and the relative cost-effectiveness of different locations as a means of gaining public support for investments outside of the urban core.

vi. Holistic Stormwater Management

Watersheds are driven by many interconnected forces. For instance, water that infiltrates into shallow groundwater drives baseflows for perennial headwater streams. A certain amount of baseflow is needed to support healthy populations of aquatic biota and riparian ecosystems. Impervious cover disrupts this linkage, driving runoff events that further impact stream biota by increasing the frequency and intensity of erosive flows. Erosive flows lead to channel enlargement, resulting in local streams that act more like engineered sewers than natural systems – supporting rapid conveyance of high volumes of water. These flows ultimately generate more pollutants through stream erosion as well as costly impacts to downstream infrastructure through flooding and scouring (Walsh et al. 2005).

Stormwater managers should consider how incentives or mitigation and credit-based approaches address the causes of erosion (excessive volume and rate of runoff) and not just the symptom (stream channel degradation). Consider a credit program that is driving credit generators to reduce sediment and nutrients in stormwater flows. If it is functioning well, the program will lead to an optimal economic outcome that identifies and drives investment in least-cost solutions. However, if most the cost-effective way to reduce pollutant loads is to treat stormwater downstream of the urban area, once it is heavily laden with sediment and nutrients, the program is addressing the symptom and not the cause of polluted flows.

Figure 10. Sustained high flows lead to bank erosion and down cutting, which pulls sediment into the creek and disconnects the waterway from its floodplain. Photo credit: Soil-net.com CC BY-SA 2.0

It is also possible that the optimal economic outcome isn't necessarily the highest value outcome. Contrast one program where simple projects provide one dimensional treatment at a low cost (e.g., detention will reduce peak flow and provide limited water quality treatment, but will not provide co-benefits) with another that prioritizes multi-benefit GI practices in urban areas. The latter may be more expensive, but would also provide multiple the benefits to the community and a higher level of treatment.

Program managers seeking an integrated watershed-based approach can consider increasing credits for efforts that promote on-site treatment in priority areas (e.g., neighborhoods with the highest impervious cover), or provide additional credits for stream restoration projects in watersheds where the hydrologic stress caused by stormwater has been addressed via retention and robust enhanced/extended detention controls. This type of approach would encourage the use of multi-benefit projects where they can be most effective.

V. Conclusion

Urban stormwater runoff is one of the most significant environmental issues facing communities today. Flooding, water supply, water quality, habitat degradation, and other impacts associated with stormwater runoff are increasing due to ongoing urbanization, a more episodic climatic regime, and rising global temperatures.

The challenges associated with stormwater are complex and require sophisticated solutions. Stormwater flows are chaotic and unpredictable because they are driven by weather and tied to land use. Management needs to operate across public and private properties. The current funding gap in this sector necessitates addressing these challenges in a highly cost-effective manner.

As Ben Franklin stated, "necessity is the mother of invention." Daunting problems force us to develop innovative solutions. Economic instruments that harness the power of incentives and markets, such as rebates, trading, and offsets, are among these solutions. Economic instruments can incentivize GI on private land, create opportunities for private infrastructure investment, and drive innovation of more efficient and effective practices. Through programs that reward private property owners for onsite adoption of GI practices, stormwater managers may be able to greatly increase needed infrastructure in urban areas without the use of command-and-control methods. By providing flexible options to land developers and landowners, such as the use of project offsets and in-lieu fees, infrastructure may be installed where it can have the greatest effect at the lowest cost. By allowing regulated entities to utilize trading programs to responsibly and more cost-effectively meet NPDES requirements, they have the opportunity to save money and work within the holistic nature of watersheds.

The use of economic instruments for stormwater infrastructure investments are relatively nascent and evolving, so many programmatic and policy challenges remain. Stormwater program managers are struggling to create a subsidy or fee reduction program that effectively incentivizes property owners to change their behavior while being financially sustainable, trading program developers struggle to define credit life and currencies that engage a sufficiently large market while protecting local water quality. These challenges highlight the need for ongoing efforts and research to refine these approaches and meet these challenges head-on with clear and effective solutions.

We expect that collaborative groups, such as the National Network on Water Quality Trading, the Water Environment Federation, and others in the water sector, will continue to explore these issues in order to highlight the technical and policy barriers that limit new and innovative approaches, discuss the potential benefits these approaches can provide, and generate ideas on how to best tap into the opportunities that emerging frameworks can provide.

This document has laid out the issues currently facing stormwater managers today and the motivation for investment in stormwater infrastructure; presented a set of program options that employ incentives and mitigation- or credit-based approaches for more, more effective, and more efficient investment in stormwater infrastructure; and highlighted the current status of issues that limit these approaches. The future will hopefully see more discussion and new examples to further these approaches. If proven effective, we expect economic instruments to become more mainstream and common elements of stormwater programs across the country.

VI. More Information

For more information on this report and the National Network on Water Quality Trading, please contact:

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