Stormwater Management Challenges and Opportunities

A Site Evaluation within the SW Ecodistrict, Washington, D.C.

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Executive Summary

In the spring of 2013, a group of nine American University graduate students participating in the American University Local-Scale Design Practicum partnered with the National Capital Planning Commission (NCPC) to produce this report, an evaluation of stormwater management strategies and potential green infrastructure implementation in an area around Tenth Street SW between the National Mall and Banneker Park, part of NCPC's SW Ecodistrict. NCPC's SW Ecodistrict Plan examines how built assets and natural resources can be used more efficiently and can contribute to the economic vitality and environmental health of the District of Columbia.[1] The plan also serves as a roadmap to achieving these goals by using district-scale sustainable practices to integrate land use, transportation, and environmental planning with high performance buildings, landscape, and infrastructure.[2]

The SW Ecodistrict Plan's development scenario has four geographic focus areas: Independence Quarter; Tenth Street Corridor and Banneker Park; Maryland Avenue and Seventh Street Corridors; and Southwest Freeway. Due to the large scope of the SW Ecodistrict's development area, the focus of this report is narrowed to a hybrid of the four focus areas, which for the duration of this report will be called the Tenth Street Corridor Site. This report defines the boundaries of the Tenth Street Corridor Site as follows: starting at Independence Avenue, stretching south to the Southwest Freeway and extending a block east to Ninth Street and a block west to the Twelfth Street Tunnel/Expressway. This study area includes the following properties: L'Enfant Plaza and Hotel, L'Enfant South, the Department of Energy's (DOE-) Forrestal Complex, CIM Urban Real Estate Investment Trust (REIT), and U.S. Postal Service Headquarters.

This report is guided by stormwater goals from NCPC's SW Ecodistrict Plan and seeks to help the District of Columbia meet the requirements set out in multiple regulatory documents that affect the District. Such requirements include DC's new stormwater regulations; Executive Order 13514 *Federal Leadership in Environment, Energy and Economic Performance*; and Mayor Gray's Sustainable DC Plan.

In urbanized areas, large quantities of precipitation run off of impermeable surfaces and transfer pollutants from these surfaces to DC's waterways. Advanced stormwater management is essential to improving water quality in rivers and streams and offering potential for use in buildings to serve non-potable water needs.

[1] The National Capital Planning Commission. The National Capital Planning Commission. *The SW Ecodistrict: A Vision Plan for a More Sustainable Future*. Comp. The National Capital Planning Commission. N.p.: n.p., 2013. The National Capital Planning Commission. Web. 26 Apr. 2013. <http://www.ncpc.gov/swecodistrict>.

[2] Ibid.

This report does the following:

- Analyzes District stormwater regulations
- Documents best practices in low-impact development (LID) and green infrastructure, as support to scenario development
- Presents optimal design scenarios for the Tenth Street Corridor Site, based on research of these regulations
- Analyzes potential LID strategies with respect to environmental and economic benefits to stakeholders and to the city
- Evaluates and recommends the creation of a district-scale water system scenario including potential governance structures and phasing
- Identifies areas for further research needed to implement either proposed scenario

Within the context of the design scenarios proposed for the Tenth Street Corridor Site, these three stormwater goals from NCPC's SW Ecodistrict plan were utilized:

1. Increase pervious surface area to 35%
2. Retain water from all 95th percentile rain events, defined in the District as those that produce up to 1.7" in 24 hours
3. Reduce potable water usage within buildings by 50%

The first scenario examines a "Business as Usual" or status-quo case for the Tenth Street Corridor Site. Calculations of land cover using Geographic Information Systems data determined that the Tenth Street Corridor Site contains only 16.5% pervious surface and 83.5% impervious surface. By comparison, this is more than twice the imperviousness as the District average of 39%.[3] Due to currently high and likely escalating costs related to stormwater management of these surfaces, this report proposes two alternate scenarios to reduce stormwater runoff and potable water usage. These are Scenario One: Individual Property Analysis, and Scenario Two: Total Site Analysis. Each scenario was designed by the practicum group and verified by a stormwater management professional. In addition, this report includes a cost-benefit analysis for each proposed scenario to better inform the final recommendations.

For Alternative Scenario One: Individual Property Analysis, the projected stormwater fees for each individual property are examined to show the costs and benefits of implementing green infrastructure and to determine compliance with the project goals. This scenario concludes that while it is possible for the individual buildings to meet or maximize the three goals on their own, the costs are higher and there is a payback period between 17 to 24 years. This extensive payback period is likely to deter building owners from making significant upfront investments. Thus, this individualized-site approach is not recommended.

[3] "Washington DC: A case study of how green infrastructure is helping manage urban stormwater challenges." NRDC. NRDC, n.d. Web. 27 Apr. 2013. <http://www.nrdc.org/water/pollution/rooftopsii/files/RooftopstoRivers_WDC.pdf>.

Alternative Scenario Two: Total Site Design, makes the assumption that the NCPC SW Ecodistrict Plan is realized and a district-scale water system is implemented. A district-scale water system is a type of a decentralized water management where the system for water collection, treatment, and distribution is shared among property owners instead of piping the water to an outside water treatment plant. This scenario concludes that the combination of LID features recommended would maximize the goals while shortening the payback period; the project could regain its investment in 12.59 years.

Overall, this report concludes that meeting the three stormwater goals of the NCPC SW Ecodistrict Plan on the Tenth Street Corridor Site is only possible with considerable financial investment. Initial review found that meeting the established goals were often in competition and required tradeoffs. The most cost-effective way to meet or maximize each goal would be the implementation of a district-scale water system such as the one in Alternative Scenario Two. This presents increased savings and a shortened payback period for stakeholders within the Tenth Street Corridor Site.

Table of Contents

List of Tables and Figures

List of Boxes

Acronyms and Abbreviations

BID: Business Improvement District
BMPs: Best Management Practices
CCF: One Hundred Cubic Feet
CSOs: Combined Sewer Overflows
CSS: Combined Sewer System
DC: District of Columbia
DCOP: DC Office of Planning
DCRA: DC Department of Consumer and Regulatory Affairs
DDOE: District Department of the Environment
DDOT: District Department of Transportation
DOE: Department of Energy
EISA: Energy Independence and Security Act of 2007
EO: Executive Order
EPA: Environmental Protection Agency
ERU: Equivalent Residential Unit
ESCO: Energy Services Company
FTS: Federal Triangle South
FY: Fiscal Year
GIS: Geographic Information Systems
GSA: General Services Administration
IAC: Impervious Area Charge
IgCC: International Green Construction Codes
JBG: JBG Companies
LCB: Living City Block
LEED: Leadership in Energy and Environmental Design
LID: Low-Impact Development
MOU: Memorandum of Understanding
MS4: Municipal Separate Storm Sewer System
NCPC: National Capital Planning Commission
NLCD: National Land Cover Database
NPDES: National Pollutant Discharge Elimination System
RFI: Request for Information
RFP: Request for Proposal
ROW: Public Right of Way
SRC: Stormwater Retention Credit
SW: Southwest
SWRv: Stormwater Retention Volume
TRAM: Tiered Risk Assessment Management
US: United States
USGS: US Geological Survey
USPS: US Postal Service Headquarters

1. INTRODUCTION

Over the past several years there has been considerable movement towards creating a more sustainable urban environment in Washington, DC. Many Federal and city agencies, NGOs, businesses and citizen groups have been working simultaneously to apply new environmental policies, regulations, fee structures, financial incentives and funding opportunities in hopes that an integrated effort will give rise to more holistic and collaborative approaches towards achieving urban sustainability. Perhaps this is most evident through the unveiling of the District's first-ever sustainability plan by the DC Mayor's Office in 2011. The *Sustainable DC Plan: A Vision for a Sustainable DC* aspires to make the District "the greenest, healthiest and most livable city in the nation" within 20 years.[4]

The Mayor's office is not alone in the effort to make DC a more sustainable city. The timing of several sustainable development plans and initiatives that target the Southwest quadrant of the city include the DC Office of Planning (OP) *Maryland Avenue Southwest Small Area Plan*, the General Services Administration (GSA) *Federal Triangle South Request for Information* (RFI), and the CSX Corporation *National Gateway Program* which provide a unique and unprecedented opportunity for collaboration.

Seizing this opportunity for collaboration, the National Capital Planning Commission (NCPC) has published the *SW Ecodistrict Plan: A Vision Plan for a More Sustainable Future* in partnership with 17 Federal and local agencies that make up the SW Ecodistrict Task Force and technical Working Group. The NCPC is the Federal government's central planner for the District of Columbia metropolitan area and is primarily responsible for the SW Ecodistrict Plan.[5] The SW Ecodistrict Plan uses an "environmental framework" to divide urban sustainability issues into four environmental focus areas: energy, water, waste and green infrastructure. The plan further categorizes these sustainability issues into strategies that can be applied on an individual building-scale or a district-scale.

Urban sustainability faces many challenges, one of which is the issue of stormwater and its management. Urbanization and hardscapes intensify the amount of stormwater to be managed in any given rain event. Stormwater runoff presents two primary issues for urban centers: increased flooding and polluted waterways. Traditionally, stormwater management focused on flood or quantity controls exclusively, but more recent management strategies seek to improve the quality of stormwater runoff as well. Increased growth to our urban centers will not abate; therefore, concerted attention should be given to how cities and property owners can manage stormwater.

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[4] *A Vision for a Sustainable DC*. N.p.: n.p., 2010. *The District of Columbia*. Web. 26 Apr. 2013. <http://sustainable.dc.gov/sites/default/files/dc/sites/sustainable/publication/attachments/sustainable%20DC%20Vision%20Plan%202.2.pdf> 2.

[5] The National Capital Planning Commission. The National Capital Planning Commission. *The SW Ecodistrict: A Vision Plan for a More Sustainable Future*. Comp. The National Capital Planning Commission. N.p.: n.p., 2013. The National Capital Planning Commission. Web. 26 Apr. 2013. <http://www.ncpc.gov/swecodistrict>.

The American University Stormwater Policy and Design Project Team is charged with investigating on-site water use, stormwater management and potential district-scale strategies for water capture and use.

This report is broken down into four major sections: introduction, scenarios, recommendations, and the appendix. The introduction includes a description of the site, stormwater characteristics, and relevant stormwater polices. The scenarios section lays out the Business as Usual scenario, Alternative Scenarios One: Individual Property Analysis, and Alternative Scenario Two: Total Site Analysis. The recommendations section consists of governance, phasing and stormwater management strategies as well as areas for further research. Relevant and supporting documentation can be found in the appendix.

The Tenth Street Corridor Site Today

Currently, the Tenth Street Corridor Site disrupts physical, natural, and design continuity between the National Mall and the SW Waterfront. This report defines the boundaries of the Tenth Street Corridor Site as follows: starting at Independence Avenue, stretching south to the Southwest Freeway and extending a block east to Ninth Street and a block west to the Twelfth Street Tunnel/Expressway. This study area includes the following properties: L'Enfant Plaza and Hotel, L'Enfant South, DOE-Forrestal Complex, CIM Urban REIT, and the U.S. Postal Service Headquarters. The site has a dearth of natural vegetation, an abundance of concrete structures, and, both in scale and material usage, projects an overall lack of hospitality. The architectural style of much of the area can be characterized as Brutalist, an architectural style predominant in the 1960s that favored the use of concrete as a predominant building material. The result on this vegetation-barren site is to, separate humans from the natural environment.

Property Owners

Within the Tenth Street Corridor Site, there are two Federally-owned and three privately-owned properties. The following ownership analysis is essential in understanding the challenges and opportunities in creating an ideal governance structure for a stormwater management system.

US Department of Energy Forrestal Complex (DOE-Forrestal Complex)

The DOE-Forrestal Complex was built between 1965 and 1969 and consists of three main structures, which range from two to eight stories. The DOE-Forrestal Complex presently houses the US Department of Energy, which is owned and operated by GSA. GSA's main responsibilities include owning and operating Federal property and land, optimizing Federal land use, creating a more efficient workplace, and reducing operating costs for the Federal government. GSA has the authority to develop buildings and land for which it is responsible, sell property, establish partnerships, and carry out plan recommendations such as those in the NCPC SW Ecodistrict Plan. GSA development plans and building operations in relation to the DOE-Forrestal Complex must be carried out in accordance with Executive Order 13514, "Federal Leadership in Environmental, Energy, and Economic Performance" (see Stormwater Policy Analysis section for more information). GSA recently issued an RFI (last updated on January 16th 2013) for the area referred to as "Federal Triangle South", which includes the DOE-Forrestal Complex.[6] The RFI is meant to help GSA assess long term development needs for the area.

US Postal Service Headquarters (USPS)

USPS has occupied a thirteen-floor structure on Tenth Street since 1972, three years after it was built. The property is owned and operated by USPS and not by GSA. USPS is a Federal agency that is mandated to provide postal service within the United States and has explicit authority from the US Constitution. The Board of Governors of USPS sets the policy, procedure, and postal rates for USPS. Of the eleven members of the

[6] *REQUEST FOR INFORMATION: Update #2 Federal Triangle South*. Washington DC: U.S. General Services Administration, 2012. The District of Columbia: Sustainable DC. Web. 26 Apr. 2013. <https://www.fbo.gov/utils/view?id=b3305267de6da7c1ea9b103b20ae04d1>.

board, nine are appointed by the President and confirmed by the US Senate. The nine appointed members then select the US Postmaster General, who oversees the day-to-day functions of the USPS. The Postmaster General and the Board of Governors will play a key role in approving and implementing any changes to the USPS site.

L'Enfant Plaza and Hotel

The L'Enfant Plaza development was completed in 1973. There are three properties within two buildings, encompassing office space, commercial uses, and a 372-room hotel. Between 2003 and 2007 the JBG Companies and CIM Group owned the property in a joint venture.[7] This ended when the CIM Group sold their portion of ownership to JBG. The JBG Companies has a mission to be a world-class investor, owner, developer, and manager of real estate in the Washington DC area.[8] JBG has also committed itself to being an engaged and responsible member of the communities in which its properties are located. Therefore, JBG believes that each development they undertake should enrich the area through the development of sustainable communities, the advancement of affordable housing, and the promotion of public art.[9]

L'Enfant South

L'Enfant South is an eight-story office tower with underground parking and is owned by Heyman Properties, LLC. According to their website, Heyman Properties is a leading developer, owner, and manager of commercial real estate in the Northeast United States and actively supports the communities it serves through participation in local civic and non-profit organizations.[10]

It is important to note that Heyman Properties filed suit against JBG in DC's Superior Court in September of 2012 to stop JBG from moving forward with construction of a twelve-story office building on the center plaza between the L'Enfant Plaza and Hotel and L'Enfant South buildings. Heyman Properties claims that JBG does not have the right to build the office project because of easements established by the DC Redevelopment Agency, which built the entire L'Enfant Plaza complex in 1966.[11] The ongoing lawsuit could prove to be an obstacle to cooperation.

CIM Urban Real Estate Investment Trust (Urban REIT)

This ten-story building was built in 1987 and has a contemporary design that includes a glass facade, maximum window line, and a sizable patio. The building is owned by the CIM Group who describes themselves as a transformational urban real estate and infrastructure investment firm. According to their website, the CIM Group has a holistic,

[7] "Investments." *CIM: Investments*. CIM Group, 2013. Web. 27 Apr. 2013. <http://cimgroup.com/investments/byProductTypeInvestmentDetails.aspx?id=90>.
[8] "About." *The JBG Companies : Creating and Enhancing Valye for More than 50 Years*. The JBG Companies, 2013. Web. 27 Apr. 2013. <http://www.jbg.com/about-jbg>.
[9] Ibid.
[10] "Company: Overview." *Heyman Properties. Heyman Properties*, 2008. Web. 27 Apr. 2013. <http://www.heymanproperties.com/company.aspx>
[11] Krouse, Sarah. "L'Enfant Plaza building owner sues JBG." *The Washington Business Journa*l (2010): n. pag. *Washington Business Journal.* Web. 27 Apr. 2013. <http://www.bizjournals.com/washington/stories/2010/10/18/ story1.html?page=all>.

community-based investment philosophy that aims at correlating with the needs of the community in both the short and long term.[12]

Figure 1.1: Map of Tenth Street Corridor Site

Other Stakeholders

It is important to note that the District Department of Transportation (DDOT) is responsible for the public right-of-way (ROW) land that is typically found between property lines, including sidewalks, roads, green spaces, and alleyways. The DDOT ownership represents a significant portion of the Tenth Street Corridor Site with the upkeep and maintenance of the L'Enfant Promenade. CSX Corporation owns and operates the railway that intersects the Tenth Street Corridor Site at Maryland Avenue.[13] They are currently engaged in investments to upgrade bridges and tunnels in the DC area through the National Gateway Program.[14] In addition, the National Park Service (NPS) is responsible for the development and administration of the public lands that bookend but are not part of the Tenth Street Corridor Site, specifically the National Mall and Banneker Park.

[12] CIM Group. CIM, 2013. Web. 27 Apr. 2013.
[13] "10th Street Lower Track." *National Gateway.* National Gateway, n.d. Web. 12 Mar. 2013. <http://www.nationalgateway.org/projects/project/63>.
[14] "About National Gateway." *National Gateway*. National Gateway, n.d. Web. 12 Mar. 2013. <http://www.nationalgateway.org/background/about>.

Additional institutions holding jurisdiction within the study area include a variety of Federal, city, private and public entities. The most notable of these are the NCPC, US Environmental Protection Agency (EPA), District of Columbia Office of Planning (OP), District Department of the Environment (DDOE), and DC Water. For more information on these, see the Stormwater Policy Analysis, Governance, and Phasing sections.

Site Stormwater Characteristics

To summarize the stormwater characteristics of the Tenth Street Corridor Site, the following table outlines characteristics for each property and the total site including the amount of impervious area, runoff from a 1.7" rain event which is the 95th percentile rain event in the District of Columbia, annual runoff and water use per building.

Table 1.1: Stormwater Characteristics of Tenth Street Corridor Site

	% Impervious	Runoff from 1.7" Rain Event (gal)	Annual Runoff (gal)	Annual Potable Water Use (gal)
DOE-Forrestal Complex	78%	385,221	8,916,730	25,494,872
L'Enfant Plaza & Hotel	86%	237,423	5,495,653	51,970,500
L'Enfant South	84%	59,903	1,386,578	6,149,735
Urban REIT	76%	62,284	1,441,682	7,000,000
USPS	88%	76,989	1,782,077	13,429,775
ROW	86%	774,376	17,924,534	-
Total Site	**83.5%**	**1,596,196**	**36,947,254**	**104,044,882**

There are three stormwater management goals from the NCPC SW Ecodistrict Plan that guide this report. The first goal is to increase permeable surface area of the site to 35%, which equals a reduction to 65% impervious area. Calculations of land cover using Geographic Information Systems data determined that the Tenth Street Corridor Site contains only 16.5% pervious surface and 83.5% impervious surface. By comparison, this is more than twice the imperviousness as the District average of 39% and higher than the SW Ecodistrict, which is 80% impervious. On the individual property level, imperviousness varies from a low of 76% at the Urban REIT site to a high of 88% at USPS.[15]

The second goal calls for retaining rain from all 95th percentile rain events, defined in the District as those that produce up to 1.7" in 24 hours. Collectively, 1,596,196 gallons of stormwater runs off of the Tenth Street Corridor Site after hitting the roofs, roads, sidewalks, and compacted turf and landscaped surfaces during each 1.7" rain event. In order to meet the stormwater retention goal, the site would therefore have to retain and/or infiltrate 1,596,196 gallons of water over a 24-hour period. This is an important basis for designing the capacity of water retention facilities and the size of other Low Impact Development (LID) features. On an individual building basis, the DOE-Forrestal Complex would have to retain the largest volume of runoff to comply with the 1.7" retention goal.

[15] "Washington DC: A case study of how green infrastructure is helping manage urban stormwater challenges." NRDC. NRDC, n.d. Web. 27 Apr. 2013 <http://www.nrdc.org/water/pollution/rooftopsii/files/ RooftopstoRivers_WDC.pdf>.

Over the course of a year with an average of 39.35 inches of rainfall, the 42-acre site produces 36,947,254 gallons of stormwater runoff - enough to fill 56 Olympic-sized pools.[16] As the Tenth Street Corridor Site is fully contained within the District's Municipal Separate Storm Sewer System (MS4), all of the stormwater from the site runs untreated into the Potomac River, washing contaminants from roadway vehicles and other sources of surface pollution directly into the River. On an individual building level, the runoff breakdown ranges from a high of 8,916,730 gallons per year from the DOE-Forrestal Complex and a low of 1,386,578 gallons per year from L'Enfant South. Note that the total annual runoff from each property does not equal the total runoff for the site because the ROW areas are not included in each site's calculation.

The third goal is to reduce potable water usage on the site by 50%. Currently, most buildings within the Tenth Street Corridor Site are estimated to have outdated water fixtures and thus assumed to be fairly inefficient. Annual potable water use within each building can be found in Table 1.1. In this case, the highly trafficked L'Enfant Plaza and Hotel has the highest potable water use, most likely resulting from its mixed uses.

Alternative Scenario One: Individual Property Analysis and Alternative Scenario Two: Total Site Design attempt to optimize these three goals in their design and analysis.

[16] "Normal Monthly Precipitation (Inches)." *The National Oceanic and Atmospheric Administration*. NOAA, n.d. Web. 27 Apr. 2013. <http://www.ncdc.noaa.gov/oa/climate/online/ccd/nrmlprcp.html>.

Stormwater Policy Analysis

This section of the report will find the best approaches for the Tenth Street Corridor Site to comply with all relevant regulations and mandates while remaining on the forefront of efficiency and reducing costs to the maximum extent possible as well as finding opportunities for profit.

Public Mandates for Federal Properties

The federal government is sometimes referred to as the nation's largest landlord and energy consumer; it operates more than 500,000 facilities that make up an estimated area greater than three billion square feet. In the past, approximately $30 billion has been spent per year on purchasing and substantially renovating federal facilities, and it has been estimated that the federal government also spends $7 billion per year on energy in across its facilities. These two costs present an opportunity for GSA and USPS to transform their facilities by using sustainable, energy-saving technologies and practices on a wide scope. In fact, many executive orders, laws, and regulations have recently been established to reach these goals of high performance and sustainability in federal work facilities.

Of these recently established mandates, Executive Order 13514 (EO 13514), the Energy Independence and Security Act of 2007 (EISA), and EPA-issued Technical Guidance are the main sources of federal stormwater management recommendations and regulations.

Executive Order 13514

President Obama signed EO 13514, "Federal Leadership in Environment, Energy, and Economic Performance" in October of 2009. This executive order builds upon the requirements of a pre-existing executive order (EO 13423), and contains numerous agency-wide requirements on various issues like greenhouse gas and energy reduction, water use efficiency, pollution prevention, waste reduction, sustainable acquisition, electronic stewardship, and other sustainability aspects.[17] Most important for this report, EO 13514 contains goals for the reduction of potable water by 26% and the reduction of industrial, landscaping and agricultural water consumption by 20% through the year 2020 on all Federally-owned properties.

Energy Independence and Security Act of 2007 (EISA)

In December of 2007, Congress enacted the Energy Independence and Security Act of 2007. With regard to stormwater runoff requirements and management, Section 438 of this legislation establishes strict stormwater runoff requirements for federal development and redevelopment projects.[18] The intent of Section 438, as defined by the EPA, requires that federal agencies develop and redevelop applicable facilities (those with a building footprint over 5,000 square feet) in a manner that maintains or restores stormwater runoff to the maximum extent

[17] "Federal Stormwater Management Requirements." *The United States Environmental Protection Agency*. EPA, 5 Nov. 2012. Web. 19 Feb. 2013. <http://www.epa.gov/oaintrnt/stormwater/requirements.htm>.
[18] Ibid.

technically feasible. The statute is intended to ensure that receiving waters, such as rivers or streams, are not negatively impacted by changes in runoff temperature, volumes, durations, and rates resulting from federal projects and facilities.

EPA Technical Guidance

As a result of Congress enacting Section 438 of the Energy Independence and Security Act of 2007 and the President signing EO 13514 on "Federal Leadership in Environmental, Energy, and Economic Performance," the EPA, in coordination with other federal agencies, has created a "Technical Guidance" document to help federal agencies comply with Section 438 through the use of a variety of stormwater management practices. The guidance is intended to provide a step-by-step framework that will help federal agencies restore pre-development site hydrology by retaining all rainfall less than or equal to the 95th percentile rainfall event on site through infiltration, evaporation/transpiration, and capture for use at the same retention levels that occurred prior to development. However, it is important to note that this document is intended solely as guidance and is neither a regulation nor a substitute for statutory provisions or regulations. This guidance does not have any binding requirements on federal agencies.

As funds become available, the federal government is investing in modernization of structures to make sustainability and space efficiency improvements that will reduce operating costs. These sustainability and efficiency improvements, like the ones proposed for the NCPC SW Ecodistrict Plan in Washington, DC and more specifically the Tenth Street Corridor Site, respond directly to EO 13514 and Section 438 of EISA, which require agencies to reduce greenhouse gas emissions, manage stormwater, and reduce water use and waste by 2015. The Federal agencies that have buildings within the Tenth Street Corridor Site are now presented with the opportunity to become leaders in supporting not only cutting-edge efficiency improvements, but to simultaneously transform a resource-intensive building environment into one that is able to capture, manage, and reuse a majority of its resources. The following buildings and agencies within the Tenth Street Corridor Site are obligated to meet the federal requirements: DOE-Forrestal Complex and USPS.

These Federal initiatives also pose challenges for buildings in urban areas like those in the Tenth Street Corridor Site. Since federal agencies are required to install retrofits wherever opportunities exist, many agencies are currently still in the process of compiling technical data on their inventories of stormwater management practices at various facilities. Thus, the goals set in EO 13514 and Section 438 of EISA might not be achieved in time for the mandated completion date of 2015. Once the inventory is fully assessed, the federal facilities in the Tenth Street Corridor Site can then begin to quantify the benefits of existing stormwater practices and identify cost-effective opportunities for future green infrastructure projects.

Public Mandates for Private Properties

Private development or redevelopment in the District of Columbia must comply with its new green building code. GSA issued a Request for Information (RFI) on December 7, 2012 for the redevelopment of the Federal Triangle South site, which includes the DOE-Forrestal Complex.[19] If ownership shifts to the private sector, based on GSA's authority to dispose of or redevelop federal property, owners will have to comply with DC's green building code. The District passed the Green Building Act in 2006, and the newly proposed green building code ended its public comment period on February 22, 2013.

The newly proposed DC green building code is based on the 2012 International Green Construction Code (IgCC) and builds upon the DC Green Building Act of 2006. The main goals of the newly proposed green building code are to improve water and energy efficiency, reduce heat island effect, and improve indoor environmental quality.[20] The newly proposed DC green building code would initially apply to all new construction and substantial renovations to commercial buildings of 10,000 square feet or more and to multifamily residential buildings four stories or higher and over 10,000 square feet. The newly proposed DC green building code permits several compliance paths, of which there are two that are most relevant for the site: Leadership in Energy and Environmental Design (LEED) or the IgCC of 2012. IgCC standards are more stringent than LEED requirements and thus may cost more to implement but in the long run could achieve greater efficiency gains and provide a more sustainable standard for buildings in the District.

However, various types of green infrastructure will be needed for the redevelopment of the DOE-Forrestal Complex in order to meet the newly proposed DC green building code. Therefore, it would be in the best interest of developers to implement several types of green infrastructure now to achieve District goals and to save costs over a longer period of time. At the very least it is recommended that private developers adhere to LEED certification standards to meet the newly proposed DC green building code requirements. If possible or financially feasible, this section also recommends following the IgCC codes to meet the new requirements. While the IgCC compliance path may be a larger investment up front, as noted above, it may be more beneficial in the long run.

District of Columbia Policies and Fees

The EPA requires that the District of Columbia control pollution from stormwater runoff under the National Pollutant Discharge Elimination System (NPDES). Under NPDES, the EPA has issued permits for all sewer and stormwater outfalls because they discharge directly into the District's waterways.

Two types of municipal sewer systems exist in DC. The combined sewer system (CSS) joins wastewater and stormwater into the same sewer pipes and covers nearly one third

[19] *REQUEST FOR INFORMATION: Update #2 Federal Triangle South*. Washington DC: U.S. General Services Administration, 2012. The District of Columbia: Sustainable DC. Web. 26 Apr. 2013. <https://www.fbo.gov/utils/view?id=b3305267de6da7c1ea9b103b20ae04d1>.

[20] Cliff, Majersik, and IMT. "Institute for Market Transformations." District of Columbia Resident Resource Center. District of Columbia, 20 Feb. 2008. Web. 10 Apr. 2013. <http://rrc.dc.gov/green/lib/green/pdfs/ Green_b-codes.pdf>.

of the city. During heavy storms the system often overflows and sends untreated sewage and stormwater into waterways. The municipal separate sanitary and stormwater sewer system (MS4) separates wastewater and stormwater and covers the remaining two-thirds of the city. Although wastewater and stormwater are not mixed in this system, all stormwater proceeds untreated into waterways, carrying with it any pollutants it has picked up.

The District must complete capital improvement projects to comply with EPA permits and reduce water pollution. To fund these improvements the District currently assesses two fees: the Impervious Area Charge (IAC) and the Stormwater Fee. Each of these fees is based square footage of impervious area and assessed monthly on water bills. Two agencies are responsible realizing these capital improvements in addition to their primary functions: DC Water and the District Department of Environment (DDOE).

DC Water

DC Water is the water and sewer authority in the District of Columbia that oversees and collects several fees established for District water users. The fees discussed here are those that directly contribute to and fund DC Water projects, operations and the conveyance and treatment of water. Fees addressed include Retail Water, Retail Sewer and the Impervious Area Charge (IAC). DC Water instituted the $2.6 billion dollar Clean Rivers Project in order to comply with the District's NPDES permit issued by the EPA. To fund the project DC Water has adopted a "polluter pays" philosophy that puts the burden of payment directly onto the users through the IAC. DC Water determined that the IAC is the most equitable way to recover the costs of the Clean Rivers Project as opposed to a volumetric charge for water used, because the IAC is based on a property's contribution to rainwater runoff.

The IAC will rise over time to fund the Clean Rivers Project in its entirety. Over the last five years, DC Water has also instituted annual increases for Retail Water and Sewer Services. Of DC Water fees, the IAC has the most aggressive increase at nearly 672% for non-residential customers over this period. According to DC Water's rate and fee projections, the IAC could rise from the current rate of $9.57 to $28.77/Equivalent Residential Unit (ERU) by 2019. See Tables 1.2 and 1.3 for fee escalation details.

Table 1.2: Water Rates and Fees for Non-Residential Customers FY 2009-2013[21]

Fee type	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	% Increase, 2009 - 2013
Water /CcF*	$2.30	$2.51	$3.10	$3.24	$3.42	48.69%
Sewer /CcF	$3.31	$3.61	$3.79	$4.18	$5.59	68.88%
IAC /ERU**	$1.24	$2.20	$3.45	$6.64	$9.57	**671.77%**

** 1Ccf- One Hundred Cubic Feet*

*** 1ERU- One Equivalent Residential Unit or One Thousand Square Feet*

[21] D.C. Municipal Regulations. "Final Rulemaking: Rates for Water Service Rates for Sewer Service." *DC Regulations*. District of Columbia, n.d. Web. 27 Apr. 2013. <http://www.dcregs.dc.gov/Gateway/ChapterHome.aspx?ChapterID=33094>.

Table 1.3: Projected Retail Water Rates and Fee Changes for Non-Residential Customers FY 2014-2019[22]

Fee type	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	% Increase 2009 - 2019
Water /CcF	$3.42	$3.66	$3.88	$4.13	$4.38	$4.58	$4.74	106.08%
Sewer /CcF	$5.59	$4.47	$4.74	$5.05	$5.35	$5.59	$5.79	71.90%
IAC /ERU	$9.57	$14.52	$17.66	$20.33	$23.19	$25.49	$28.77	**2,220.16%**

While all fees are rising, the IAC is rising exponentially, indicating that the IAC presents significant current and future costs to consumers in proportion to standard Retail Water and Sewer fees. This stresses the opportunity for cost savings that can be realized through instituting LID strategies that reduce impervious surfaces. Additional savings on Retail Water fees can also be realized if LID strategies capture and use stormwater.

The District Department of the Environment (DDOE)

DDOE is the leading authority on energy and environmental issues affecting the District of Columbia. DDOE levies the Stormwater Fee of $2.67 per 1,000 square feet of impervious area on District property. The Stormwater Fee applies to all properties in the District of Columbia including residential, commercial, and Federally-owned sites.[23]

Policies regulating stormwater and associated fees show no sign of abating. The fees will remain the same at least until October 2016 but could be raised by DDOE if the EPA permit requirements for DC's MS4 become more stringent, forcing DDOE to make further capital improvements and pass these costs on to property owners. For planning purposes, it is recommended to assume that the $2.67 per ERU cost will continue at least until October 2016. The analysis of the Tenth Street Corridor Site below continues the assumption that the fee remains at $2.67 through 2019.

At present, no program exists to reduce stormwater fees; however DDOE is in the process of developing a stormwater fee discount program called RiverSmart Rewards. The program "will provide water and sewer ratepayers the opportunity to receive up to a 55% discount off the Stormwater Fee to property owners who implement measures to manage and reduce stormwater runoff."[24] Once the program goes into effect, ratepayers will be able to apply for discounts that could be retroactively assessed back to May 1, 2009, the implementation date of the Stormwater Fee. This program is expected to become active following final rulemaking in late summer 2013.

[22] "Projected Clean River IAC Charges FY2010-FY2019 in Presentation to the DC Water Retail Committee." *DC Water*. District of Columbia Water and Sewer Authority, 28 June 2011. Web. 27 Apr. 2013. <http://www.dcwater.com/news/publications/DCWSR%20Committee%20 Material%2006-28-11.pdf>.

[23] "Changes to the District's Stormwater Fee." *The District Department of the Environment*. The District of Columbia, n.d. Web. 27 Apr. 2013. <http://green.dc.gov/service/ changes-districts-stormwater-fee>.

[24] "Changes to the District's Stormwater Fee." *The District Department of the Environment*. The District of Columbia, n.d. Web. 27 Apr. 2013. <http://green.dc.gov/service/ changes-districts-stormwater-fee>.

Because both the Impervious Area Charge and Stormwater Fee are based on the amount of impervious surface on properties it can levy large monthly fees on heavily developed commercial areas. By acting now to reduce impervious area and stormwater runoff, property owners and managers including the Federal government can take advantage of rebate programs to reduce both fees currently being levied on every square foot of impervious area on the site. Taking action now will protect those properties from potential escalating costs in the future. Since RiverSmart Rewards rebates can be applied retroactively, the sooner impervious area is converted the sooner potential savings could begin to accrue.

Stormwater Retention Credit Trading Program

The Stormwater Retention Credit (SRC) trading system proposed by DDOE has the potential to provide environmental and monetary benefits to the Tenth Street Corridor Site. By certifying LID projects that retain stormwater through the SRC program, public and private facilities can mitigate the environmental effects associated with excess runoff, qualify for the RiverSmart Rewards stormwater fee discounts mentioned above, and generate profit by selling SRCs on the market.

A stormwater retention credit-trading program works similarly to an emissions cap-and-trade program. Regulated entities must meet certain levels of stormwater retention but to improve the flexibility and cost savings of such ecological requirements, credits are awarded and then can be traded accordingly. A DDOE SRC is equal to one gallon of stormwater retention volume over one year and DDOE will certify the stormwater retention volume of any retrofits installed in the District since May of 2009.

The SRC program is set up as a way for sites to comply with the Proposed Rulemaking on Stormwater Management and Soil Erosion and Sediment Control put forth by DDOE in August 2012.[25] However, the buildings within the Tenth Street Corridor Site will not be considered “regulated sites” when these rules are expected to go into effect in June of 2013. Nonetheless, any buildings that undergo redevelopment projects disturbing 5000 square feet or more in the future, such as the DOE-Forrestal Complex, will be regulated by the new stormwater requirements. [26] Therefore, this is an opportunity to get ahead of the curve and achieve a cost savings through the sale of SRCs in the meantime. Once a site becomes regulated, it must retain at least a 1.2” rain event, but it can still accrue and sell SRCs if retrofits are designed to meet the standards of a 1.7” rain event.

This report recommends that NCPC work to familiarize the owners within the Tenth Street Corridor Site with the SRC program and help move them forward through the steps of SRC certification once the program is in place. The first step for each site would be to develop and obtain DDOE approval of a Stormwater Management Plan. This will allow the site to continue in the process of SRC certification as retention retrofit projects are developed.

[25] "DC Stormwater Regulations and Federal Facilities Webcast." *Chesapeake Stormwater Network*. N.p., 2012. Web. 27 Apr. 2013. <https://connect-test.moo.umd.edu/p8pco1m23rl/>.

[26] *REQUEST FOR INFORMATION: Update #2 Federal Triangle South*. Washington DC: U.S. General Services Administration, 2012. The District of Columbia: Sustainable DC. Web. 26 Apr. 2013. <https://www.fbo.gov/utils/ view?id=b3305267de6da7c1ea9b103b20ae04d1>.

2. SCENARIOS

This report presents three stormwater management scenarios for the Tenth Street Corridor Site. Scenario One is the Business as Usual case which assumes no change from the current stormwater strategy. Scenario Two examines independent stormwater management strategies at the individual property level. Scenario Three analyzes the feasibility of a shared stormwater management system that incorporates ROW areas modeled after district-scale systems. The cost-benefit analyses for all three scenarios were calculated with data from a 2013 to 2019 timeframe, based on currently available projections of fees.

Business as Usual Scenario

Based on the information in the ownership analysis, stormwater characteristics of the Tenth Street Corridor Site, and the policy overview in the Introduction, this section calculates the associated stormwater charges affecting each property to determine the costs of “doing nothing” on the site or a business as usual scenario.

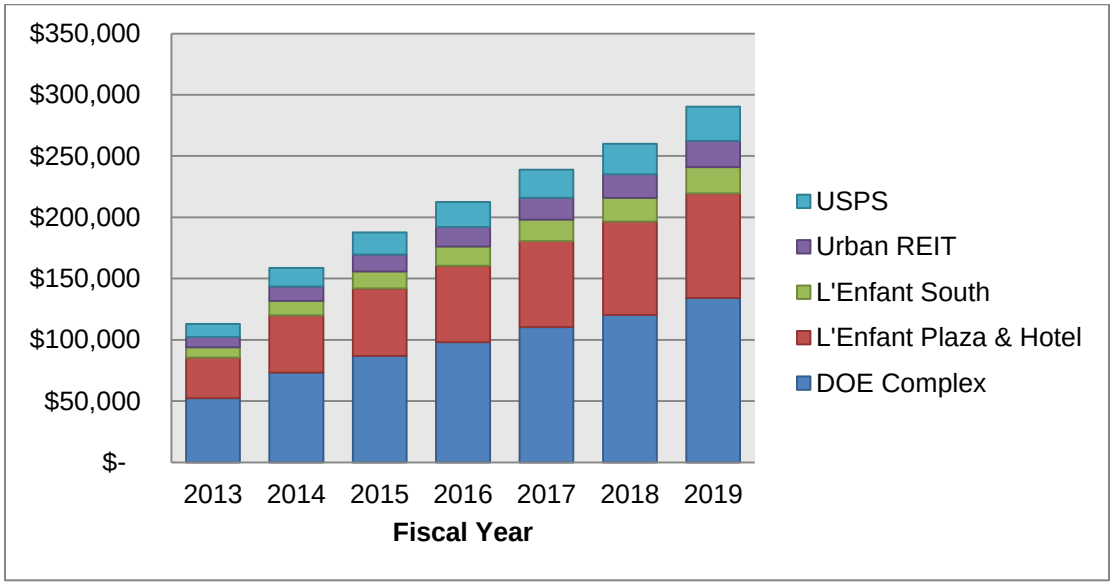
The DC Water IAC and the DDOE Stormwater Fee are directly proportional to the amount of impervious area on each property. The current fees for each property in fiscal year 2013 are already steep and will only continue to escalate if the current amount of impervious area is maintained. Collectively, fees for property owners in the Tenth Street Corridor Site currently total $113,034 for FY 2013. By 2019 the fees are projected to 157% higher and total $290,341 if no changes to the impervious area are made.

A breakdown of the annual cost of impervious surface by property owner is contained in the following table.

Table 2.1: IAC and Stormwater Fee by Property FY 2013-2019

IAC/Stormwater Fees	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
DOE-Forrestal Complex	$ 52,270	$ 73,409	$ 86,818	$ 98,220	$110,434	$120,256	$ 134,263
L'Enfant Plaza & Hotel	$ 33,216	$ 46,648	$ 55,169	$ 62,415	$ 70,176	$ 76,418	$ 85,318
L'Enfant South	$ 8,335	$ 11,706	$ 13,844	$ 15,662	$ 17,610	$ 19,176	$ 21,410
Urban REIT	$ 8,384	$ 11,774	$ 13,925	$ 15,754	$ 17,713	$ 19,288	$ 21,535
USPS	$ 10,829	$ 15,208	$ 17,986	$ 20,348	$ 22,878	$ 24,913	$ 27,815
SITE TOTAL	**$ 113,034**	**$158,746**	**$187,743**	**$212,400**	**$238,811**	**$260,051**	**$ 290,341**

Figure 2.1: IAC and Stormwater Fee FY 2013-2019

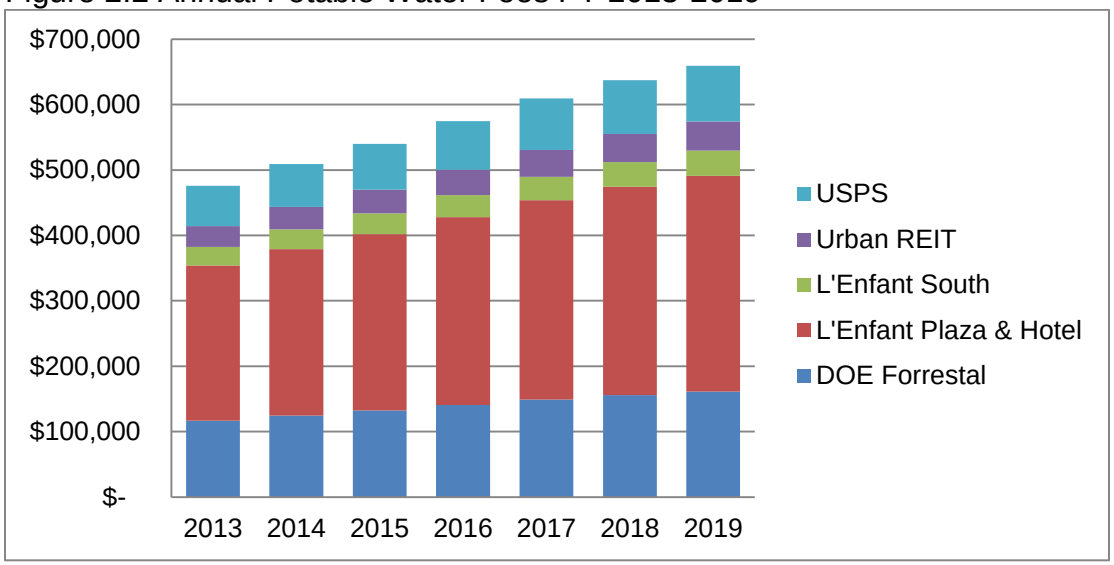


In FY 2013 one CCF (100 cubic feet) of potable water costs $3.42. As with the IAC and Stormwater Fee, the water charges are predicted to escalate at a rate of 106% over 2009 rates to $4.74 in FY 2019. Assuming no decreases in potable water usage, the current water costs across all properties total $475,713 increasing to $659,322 per year in FY 2019.A breakdown of the cost of water per property owner is found in the following table.

Table 2.2: Annual Potable Water Fees by Property FY 2013-2019

Water Fees	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
DOE- Forrestal Complex	$116,567	$124,748	$132,246	$140,767	$149,288	$156,105	$161,558
L'Enfant Plaza & Hotel	$237,619	$254,294	$269,580	$286,949	$304,319	$318,215	$329,332
L'Enfant South	$28,118	$30,091	$31,900	$33,955	$36,010	$37,655	$38,970
Urban REIT	$32,005	$34,251	$36,310	$38,650	$40,989	$42,861	$44,358
USPS	$61,404	$65,713	$69,662	$74,151	$78,640	$82,230	$85,103
TOTAL	**$475,713**	**$509,097**	**$539,698**	**$574,472**	**$609,247**	**$637,066**	**$659,322**

Figure 2.2 Annual Potable Water Fees FY 2013-2019



Due to high and escalating costs, it is important to investigate strategies to reduce stormwater runoff and potable water usage. The following section introduces the methodology for crafting Alternative Scenarios One and Two which investigate the capacity of LID to reduce stormwater runoff and analyze the costs and benefits of these strategies.

Methodology for Alternative Scenarios One and Two

Design Methodology

After extensive review of local and federal resources on stormwater management practices, six main LID strategies were chosen as a focus for the Tenth Street Corridor Site: green roofs, permeable pavement, roof collecting cisterns, ground collecting cisterns, bioretention, and street trees. The decision to focus on these six strategies was based on recommendations in the DDOE *Stormwater Management Guidebook* and the EPA *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act*.

The EPA Technical Guidance presents recommendations for federal agencies in order to comply with the stormwater runoff requirements of retaining the 95th percentile rain event. In addition to presenting a variety of strategies, the document offers nine case studies of federal buildings around the country and highlights four practices that EPA found to be the best based on known performance data and cost. These are bioretention, permeable pavements and pavers, cisterns and green roofs. The *DDOE Stormwater Management Guidebook* is intended to help land and building owners within the District comply with stormwater management regulations. It offers thirteen Best Management Practice (BMP) categories as recommendations. Although no one practice is required or encouraged above others, the four highlighted by the EPA are also included amongst DDOE's BMPs. These can be found along with a summary of each in Table 2.3.

Table 2.3: Selected Low Impact Development Features

Bioretention (vegetated swale)	**Cistern**	**Green Roof**	**Permeable Pavement**	**Street Trees**
				
Practices that capture and store stormwater runoff and pass it through a filter bed of engineered soil media comprised of sand, soil, and organic matter. Filtered runoff may be collected and returned to the conveyance system, or allowed to infiltrate into the soil.	Water storage tank; capacities range from 250 to over 30,000 gallons. Multiple tanks can be placed adjacent to each other and connected with pipes to balance water levels and to tailor the volume of storage needed. Storage tank volumes are calculated to meet site occupant water demand and stormwater storage volume retention objectives.	Installed on existing and new roof structures, and consisting of a waterproof, root-safe membrane; a drainage system; a lightweight growing medium; and plants. Green roofs reduce rooftop and building temperatures, filter pollution, lessen pressure on sewer systems, and reduce the heat island effect.	A surface paving system designed to capture and temporarily store the Stormwater Retention Volume (SWRv) by filtering runoff through voids in the pavement surface into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system, or allowed to partially infiltrate into the soil.	Trees located in public spaces that retain the first tenth of an inch of rain, with root systems that increase the porosity of soils. Typically, they are planted in tree boxes or continuous tree strips in public ROW. Trees also help to mitigate the urban heat island effect, increase aesthetics and promote urban biodiversity.

The following table outlines how each LID feature can be applied towards the three goals of the SW Ecodistrict Plan.

Table 2.4: Low Impact Development Features Relative to Goals

	Bioretention	Cistern	Green Roof	Permeable Pavement	Street Trees
					
Cost	**$32.50/ft^2**	**$27/gal**	**$16-17/ft^2**	**$15/ft^2**	**$15.23/ft^2**
50% Reduction		✓			
1.7" Rain Event	✓	✓	✓	✓	✓
35% Pervious	✓		✓	✓	✓

A number of assumptions informed the decision-making process as to the appropriate LID features for the Alternative Scenario One and Two site designs. The assumptions were based on general site characteristics, LID suitability and attainment of the three SW Ecodistrict goals.

A major physical and design challenge of the Tenth Street Corridor Site is that it is partially built on elevated structures. While the elevated areas are not ideal for bioretention and permeable pavement, these practices are still possible if a liner is installed to capture the water and convey it to another location. Additionally, some retention and evapotranspiration can occur reducing the amount of water that needs to be conveyed.

To determine the storage volume of each LID feature designed to meet the 95th percentile rain event and its corresponding cost, the storage volume formulas from the *DDOE Stormwater Management Guidebook* were used. The calculations (see Appendix 8) were then verified by a DDOE stormwater management professional to ensure accuracy[27]. The calculations to determine LID feature storage volume used "typical" measurements given by the Guidebook. The *EPA Technical Guidance* provided appropriate percentages and placements of green roofs and permeable pavement on a site. The EPA assumes a conservative estimate of 30% of roof area to be converted into a green roof, based on structural capacity and space for other rooftop equipment.[28] It also assumes a maximum percentage of 60% of total paved area of a site to be

[27] Lemoine, Leah. Personal Interview. 12 Apr. 2013.

[28] EPA Office of Water. ". Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act." *The United States Environmental Protection Agency*. EPA, Dec. 2008. Web. 27 Feb. 2013. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>.

converted to permeable pavements, taking into consideration that it is not appropriate for high traffic or loading areas.[29]

Trees manage stormwater by retaining the first tenth of an inch of rain and the root systems increase the porosity of soils, which together help to control the quality and quantity of runoff. Even though saplings will not manage stormwater to the same extent as mature trees, stormwater retention volume (SWRv) calculations are based on a mature tree retention volume. The use of street trees is not considered in Alternative Scenario One, however it is in Alternative Scenario Two[30].

Many technical specifications regarding installation of LID features are beyond the scope of this report. The *DDOE Stormwater Management Guidebook* should be consulted prior to implementation for more detailed information.

For most of the existing buildings, it is assumed that the buildings do not have the internal plumbing required by building codes (a purple piping system) to properly use rainwater within the building. Additionally, it is assumed that the new DOE Complex, as new construction, will incorporate a purple-pipe system to enable water reuse. Therefore, additional uses for the captured rainwater and stormwater are suggested.

Cost-Benefit Analysis Methodology

A cost-benefit analysis was created for each of the scenarios. The costs analyzed in each scenario include the installation and maintenance of each proposed LID per square foot. Costs were determined based on average LID costs as outlined by DC Water's preliminary cost estimates for each BMP and corroborated by a professional in the Stormwater Management Division at DDOE[31]. Savings were then calculated by anticipating the discount of fees that would occur from each proposed scenario, which includes reduced potable water fees, IAC fees, and stormwater fees, as well as the accumulation of Stormwater Retention Credits[32]. A green roof subsidy offered by Anacostia Watershed Society, of $5.00 per square foot and capped at $20,000 was included for each design that utilized green roofs. It is assumed in Alternative Scenario Two, all properties utilizing green roofs would be able to receive this subsidy, for a total of $80,000.

The benefits from implementation of the proposed scenarios are not only attributed to the savings but also to the achievement of the three SW Ecodistrict goals. While outside the scope of this research, other significant benefits exist from the possible implementation of Alternative Scenarios One and Two, benefits that are difficult to assess in monetary terms but that have tangible benefits for the greater community. The

[29] EPA Office of Water. ". Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act." *The United States Environmental Protection Agency*. EPA, Dec. 2008. Web. 27 Feb. 2013. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>.

[30] Lemoine, Leah. Personal Interview. 12 Apr. 2013.

[31] Ibid.

[32] "Green Infrastructure Summit 2012." *DC Water*. District of Columbia Water and Sewer Authority, 29 Feb. 2012. Web. 27 Apr. 2013. <http://www.dcwater.com/education/pdfs/Green_Infrastructure_Summit_II.pdf>.

addition of green infrastructure will result in a decreased urban heat island effect. Infiltration systems such as bioretention and permeable pavement act as non-point source pollution controls that will improve water quality in neighboring waterways. Enhanced aesthetics of the existing landscape will increase connectivity to the National Mall and create an inviting environment to foster increased worker productivity and improve property values. Additionally, the cost of conveyance, i.e. transporting water to and from different LID features, was not included in the cost-benefit calculations; properties should expect to pay an additional 3 to 5% of the total cost of the project.

Alternative Scenario One: Individual Property Analysis

In this scenario, the projected stormwater fees and IACs for each individual building are examined to show the benefits of implementing green infrastructure designed to comply with the SW Ecodistrict goals of retaining the 95th percentile rain event, reducing potable water use by 50% and increasing pervious surfaces to at least 35% of the site area. The design analysis considers the implications of each particular building in the Tenth Street Corridor Site implementing an individual stormwater management system. Each design has a cost-benefit analysis to show how each building can reduce their fees in the future and incur stormwater retention credits based on particular LID features. To do this, each section lays out specific LID features an individual building could implement on their own property to reach the goals outlined above and illustrates whether or not this is cost effective.

USPS Headquarters

Table 2.5: USPS Property Characteristics

	**Property owner**: Federal Government
	Area: 84,167 ft^2
	Roof Area: 60,788 ft^2
	Existing Impervious Area: 88%
	Existing Pervious Area: 12%
	Current Total Annual Runoff: 238,229 ft^3; 1,782,077 gal

Table 2.6: USPS Percentage of Goals Achieved with Proposed Design

	Reduce Potable Water Use by 50%	Retain Stormwater from a 1.7" Rain Event	Increase Permeable Surfaces to 35%
Percentage of Goal Achieved	**18%**	**87%**	**108%**

The USPS property is mostly filled by the building footprint, with minimal open area for LID intervention around the building. The north and west side of the buildings are landscaped, the south side is covered almost completely with a loading and parking area, and the east side with the entrance to the building is elevated, allowing for no infiltration of stormwater on this side.

In order to maximize the stormwater management benefits of implementing green infrastructure at the USPS site, the following combination of LID techniques are recommended: green roof, cistern(s), and bioretention. Taking into consideration EPA recommendations and existing roof installations the recommended green roof area was 35% of total roof area. The remaining runoff from the roof will need to be captured in cisterns with a combined storage capacity of 51,052 gallons. It is recommended that 4,581 square feet of landscaped areas on the west and north side of the building be converted to bioretention features. See Box 2.1 on the next page for an example of bioretention swales in Seattle. Since the elevation of this area is lower, it eases gravity-fed stormwater conveyance from all surrounding impervious and pervious surfaces of the property.

Box 2.1: Bioretention: High Point Natural Drainage System, Seattle, WA

The High Point Natural Drainage System is the largest natural drainage project that Seattle has undertaken.[33] The project was designed in partnership with the Seattle Housing Authority and treats about 10% of one of Seattle's priority watersheds. The project cost was about 2.7 million dollars above what a traditional drainage system would cost. However, Seattle Public Utilities has agreed to cover the upfront costs as the project would save them money over time.

The High Point NDS covers 34 blocks from 35th Avenue SW to High Point Drive SW and SW Juneau Street to SW Myrtle Street in West Seattle. Bioretention are used to naturally filter stormwater and landscaped ponds or as wetlands to hold the overflow of stormwater. Drainage pipes redirect stormwater from the houses into the yards, stormwater flows across porous sidewalks into the bioretention and the streets are made of permeable pavement, allowing for further collection of the stormwater before it reaches bioretention along the street's crossing points.[34] The streets are sloped to one side and cut in to the curb to direct stormwater into planted and grass swales. High Point has over 11,000 linear feet of these bioretention swales and the system meets standards by treating stormwater runoff from a 6- month, 24-hour storm.[35]

Implementation of LID techniques at the USPS site helps to achieve two of the three NCPC SW Ecodistrict Plan goals. The potable water reduction goal will not be met by implementing LID features alone. It is recommended that USPS undertake an aggressive strategy to retrofit water fixtures and fittings to achieve water efficiency targets mandated by EO 13514.

In the case of USPS, the design scenario would incur financial savings through reduced IAC and the Stormwater Fee, the creation of stormwater credits, and potential water cost savings if the collected water on the property is used on site in place of potable water. For USPS, which has a considerable amount of landscaping, the water could likely be used to offset potable water use for irrigation.

The tables below outline costs and financial benefits of the proposed design scenario. As the IAC and Stormwater Fee increase overtime, the savings would also increase. Using the average savings per year over the 7-year period for which the fees are known, the project would have a simple payback of 18.7 years.

[33] "High Point Natural Drainage System." Seattle Public Utilities. Seattle.gov, n.d. Web. 28 Apr. 2013. <http://www.seattle.gov/util/MyServices/DrainageSewer/Projects/GreenStormwaterInfrastructure/CompletedGSIProjects/HighPointNaturalDrainageSystem/index.htm>

[34] SvR Design Company. "How High Point Drainage Works to Recharge our Groundwater and to Protect the Creek." Seattle Public Utilities. Seattle.gov, n.d. Web. 28 Apr. 2013. <http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/spu02_020007.pdf>.

[35] Lenth, John, Andy Rheaume, and Tracy Tackett. "Lessons Learned from Monitoring Bioretention Swales in West Seattle's High Point Neighborhood." Seattle Public Utilites. Seattle.gov, n.d. Web. 28 Apr. 2013. <http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/ spu02_020015.pdf>.

Table 2.7: USPS Project Features and Costs

Design Technology	Size of System	Total Cost
Green Roof	21,276 ft^2	$340,413
Green Roof Subsidy	-	($20,000)
Permeable Pavement	-	-
Cistern	51,052 gal	$1,378,416
Bioretention (Vegetated Swale)	4,581 ft^2	$148,869
Total Project Initial Investment		**$1,847,698**

Table 2.8: USPS Financial Incentives

Financial Incentive	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Impervious Area Charge Savings	$2,443	$3,707	$4,509	$5,190	$5,921	$6,508	$7,345
Stormwater Fee Reduction	$1,652	$1,652	$1,652	$1,652	$1,652	$1,652	$1,652
Stormwater Credits	$66,634	$66,634	$66,634	$66,634	$66,634	$66,634	$66,634
Potable Water Fee Reductions*	$5,403	$5,782	$6,129	$6,524	$6,919	$7,235	$7,488
Savings	**$76,132**	**$77,775**	**$78,924**	**$80,001**	**$81,126**	**$82,029**	**$83,119**

*Assuming all captured rainwater is used to offset potable water needs

L'Enfant South

Table 2.9: L'Enfant South Property Characteristics

	**Property owner**: Heyman Properties, LLC
	Area: 67,210 ft^2
	Roof Area: 53,525 ft^2
	Existing Impervious Area: 84%
	Existing Pervious Area: 16%
	Current Total Annual Runoff: 185,359 ft^3; 1,386,578 gal

Table 2.10: L'Enfant South Percentage of Goals Achieved with Proposed Design

	Reduce Potable Water Use by 50%	Retain Stormwater from a 1.7" Rain Event	Increase Permeable Surfaces to 35%
Percentage of Goal Achieved	**35%**	**98%**	**121%**

L'Enfant South also has little area on their property not taken up by the building footprint. Like USPS, the front of the building (the north side) is elevated providing no infiltration opportunities, while the east and south sides are lower, on solid ground. The south side in particular is appropriate for LID features.

It is recommended that L'Enfant South cover 30% of their roof area with green roof. Raised areas of the roof may constrain the area available for this feature. Up to 60% of the impervious ground surface of the site could be converted to permeable pavement. One suitable area for this feature is the parking area along the south side of the building (not including loading areas), which could infiltrate directly into the ground. Another potential area is on the north side of the building, specifically the sidewalk in front of the entrance. Permeable pavement in this area would need to drain to the lower level through a conveyance system as this portion is on an elevated structure. A cistern would also be necessary to capture the remaining runoff from the roof not captured by the green roof. To contain the runoff, the cistern would need to have a 46,229 gallon capacity. Bioretention would also be necessary. A bioretention feature of 321 square feet would be able to capture the runoff from the total permeable area of 10,462 square feet. An appropriate place for this feature would be on the landscaped area on the south side of the building. This would also allow for gravity-assisted capture of runoff from the permeable pavement system on the north side of the building.

Taken together, these four LID features would make considerable progress towards two of the three goals, excluding the goal to reduce potable water use by 50%. Water efficiency retrofits, water capture and use system, or a combination of the two would help reduce the amount of potable water demanded of DC Water.

For L'Enfant South, the implementation of this particular design scenario would have a payback period of 17.14 years, based on known projections for fee increases up to FY 2019. The most significant savings derive from the generation of stormwater credits if all design features are implemented to capture the 95th percentile rain event, illustrated in the Financial Incentives table below. Unfortunately, the extensive payback period may limit the incentive to implement all of the aforementioned stormwater management technologies to meet the established goals. However, this should not deter Heyman Properties, LLC from utilizing select stormwater management technologies and water efficiency upgrades to accrue financial savings in the long-term. Various fee increases related to stormwater management are expected to continue; thus, employing LID technologies sooner will have the added capability of reducing potable use for toilets, irrigation or exterior washings, thereby assisting L'Enfant South property in avoiding substantial future costs.

Table 2.11: L'Enfant South Project Features and Costs

Design Technology	**Size of System**	**Total Cost**
Green Roof	16,058 ft^2	$256,920
Green Roof Subsidy	-	($20,000)
Permeable Pavement	1,934 ft^2	$29,007
Cistern	46,229 gal	$1,248,181
Bioretention (Vegetated Swale)	321 ft^2	$10,439
Total Project Initial Investment		**$1,524,547**

Table 2.12: L'Enfant South Financial Incentives

Financial Incentive	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**
Impervious Area Charge Savings	$2,066	$3,135	$3,813	$4,389	$5,007	$5,503	$6,211
Stormwater Fee Reduction	$1,449	$1,449	$1,449	$1,449	$1,449	$1,449	$1,449
Stormwater Credits	$58,453	$58,453	$58,453	$58,453	$58,453	$58,453	$58,453
Potable Water Fee Reductions*	$4,892	$5,236	$5,550	$5,908	$6,265	$6,552	$6,780
Savings	**$66,860**	**$68,272**	**$69,265**	**$70,199**	**$71,174**	**$71,957**	**$72,894**

*Assuming all captured rainwater is used to offset potable water needs

L'Enfant Plaza and Hotel

Table 2.13: L'Enfant Plaza and Hotel Property Characteristics

	**Property owner**: JBG Companies
	Area: 262,962 ft^2
	Roof Area: 136,510 ft^2
	Existing Impervious Area: 86%
	Existing Pervious Area: 14%
	Current Total Annual Runoff: 734,662 ft^3; 5,495,653 gal

Table 2.14: L'Enfant Plaza and Hotel Percentage of Goals Achieved with Proposed Design

	Reduce Potable Water Use by 50%	Retain Stormwater from a 1.7" Rain Event	Increase Permeable Surfaces to 35%
Percentage of Goal Achieved	**19%**	**100%**	**85%**

There is not a great deal of opportunity on the L'Enfant Plaza and Hotel area for permeable pavements or bioretention because it is primarily on an elevated structure and contains limited landscaping. Additionally, the existing landscape of compacted cover in the middle plaza area is planned to be redeveloped into a new building. With this in mind, the design scenarios did not anticipate that JBG would invest in redeveloping the middle plaza for bioretention and permeable pavement, given that they would not experience a payback prior to the new construction.

In order to meet the SW Ecodistrict goals, a combination of green roofs and cisterns for both roof and surface ground runoff are proposed. Thirty percent of the roof area of the two buildings can be converted to green roofs. A cistern would be necessary to capture the remainder of the roof runoff, as well as the water that drained from the green roof feature (about 50%). Since neither permeable pavements nor bioretention are particularly feasible, an additional cistern would be needed to capture the runoff falling on both the impervious and pervious ground surfaces. This would result in cisterns with a combined capacity of 217,894 gallons.

The results of these LID features make good progress toward two of the three goals. Since L'Enfant Plaza and Hotel consumes a lot of potable water, by far the most of all buildings in the Tenth Street Corridor Site at almost 52 million gallons per year, using captured water would only offset a small amount of potable water use. Again, interior

water fixture and piping retrofits would be necessary in order to use collected stormwater inside the building.

The costs of establishing all of the proposed stormwater management technologies are detailed below in the Project Costs table and have an anticipated payback period of 21.73 years. Due to structural limitations to implement more affordable LID features of bioretention and permeable pavement and the reliance on cisterns to meet the goals, costs are considerable. However, savings are also significant, most notably in the accumulation of stormwater credits, accounting for $237,423 in annual savings. Additionally, the L'Enfant Plaza and Hotel property can experience cost-savings following the design scenario and use the water captured to replace potable water for irrigation of landscaping in the middle plaza prior to its redevelopment.

Table 2.15: L'Enfant Plaza and Hotel Project Features and Costs

Design Technology	**Size of System**	**Total Cost**
Green Roof	40,953 ft^2	$655,248
Green Roof Subsidy	-	($20,000)
Permeable Pavement	-	-
Cistern	217,894 gal	$5,883,127
Bioretention (Vegetated Swale)	-	-
Total Project Initial Investment		**$6,518,375**

Table 2.16: L'Enfant Plaza and Hotel Financial Incentives

Financial Incentive	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**
Impervious Area Charge Savings	$4,703	$7,136	$8,679	$9,991	$11,396	$12,527	$14,139
Stormwater Fee Reduction	$5,887	$5,887	$5,887	$5,887	$5,887	$5,887	$5,887
Stormwater Credits	$237,423	$237,423	$237,423	$237,423	$237,423	$237,423	$237,423
Potable Water Fee Reductions*	$23,059	$24,677	$26,160	$27,846	$29,531	$30,880	$31,959
Savings	**$271,072**	**$275,122**	**$278,149**	**$281,147**	**$284,238**	**$286,716**	**$289,407**

*Assuming all captured rainwater is used to offset potable water needs

Urban REIT

Table 2.17: Urban REIT Property Characteristics

	**Property owner**: CIM Group
	Area: 75,266 ft^2
	Roof Area: 55,322 ft^2
	Existing Impervious Area: 76%
	Existing Pervious Area: 24%
	Current Total Annual Runoff: 192,725 ft^3; 1,441,682 gal

Table 2.18: Urban REIT Percentage of Goals Achieved with Proposed Design

	Reduce Potable Water Use by 50%	Retain Stormwater from a 1.7" Rain Event	Increase Permeable Surfaces to 35%
Percentage of Goal Achieved	**32%**	**97%**	**132%**

Located on D Street SW, the Urban REIT building adjoins Tenth Street SW and runs alongside the railroad. The site features sidewalks on the south side with tree boxes, a small entrance area on the west side that attaches to Tenth Street SW and some narrow green space on the east side of the building. The north side features a side roof deck as well as a landscaped area on the ground with some trees. The site is well suited for green roof coverage but less so for permeable pavement.

Overall, it is recommended to install green roofs, cisterns and bioretention features. A conservative 30% of roof space could be converted to green roofs. The north side lower deck is a particularly appropriate site for green roofing as it is visible to passersby on Tenth Street SW and would promote awareness of the NCPC SW Ecodistrict Plan goals. The cistern will capture the remaining runoff from the roof that is not captured by green roof. Very little impervious ground area exists on the site (only 1,758 square feet) and it would not make a significant impact to convert this to permeable pavement. Instead, bioretention is recommended for the pervious areas on the north and east side of the building to collect drainage from the impervious ground cover on the rest of the site.

These changes would make good progress towards two of the three goals, though they will result in minimal reductions in the use of potable water.

The tables below outline costs and financial benefits of the proposed design scenario for the Urban REIT property. As a bioretention system just over 2,000 square feet (out of 18,186 square feet of currently permeable surface on the site) would successfully manage all of the stormwater runoff from the impervious and pervious ground and a

significant amount of turf or landscaping could also exist. Therefore, it is assumed that all of the captured rainwater could be used to offset potable water use for irrigation, exterior washing, or other uses on the site. Using the average savings per year over the 7-year period for which the fees are known, the project would have a simple payback of 17.7 years.

Table 2.19: Urban REIT Project Features and Costs

Design Technology	**Size of System**	**Total Cost**
Green Roof	16,597 ft^2	$265,546
Green Roof Subsidy	-	($20,000)
Permeable Pavement	-	-
Cistern	47,781 gal	$1,290,086
Bioretention (Vegetated Swale)	2,023 ft^2	$65,759
Total Project Initial Investment		**$1,601,390**

Table 2.20: Urban REIT Financial Incentives

Financial Incentive	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**
Impervious Area Charge Savings	$1,906	$2,892	$3,517	$4,049	$4,619	$5,077	$5,730
Stormwater Fee Reduction	$1,492	$1,492	$1,492	$1,492	$1,492	$1,492	$1,492
Stormwater Credits	$60,170	$60,170	$60,170	$60,170	$60,170	$60,170	$60,170
Potable Water Fee Reductions*	$5,056	$5,411	$5,737	$6,106	$6,476	$6,771	$7,008
Savings	**$68,624**	**$69,965**	**$70,916**	**$71,817**	**$72,756**	**$73,510**	**$74,400**

*Assuming all captured rainwater is used to offset potable water needs

DOE - Forrestal Complex

Table 2.21: DOE-Forrestal Complex Characteristics

Current Site

Proposed Site

Property owner: General Services Administration
Area: 476,723 ft^2
Projected Roof Area: 233,100 ft^2
Projected Impervious Area: 65%
Projected Pervious Area: 35%
Projected Total Annual Runoff: 1,073,535 ft^3; 8,030,589 gal

Table 2.22: New DOE Complex Percentage of Goals Achieved with Redevelopment

	Reduce Potable Water Use by 50%	Retain Stormwater from a 1.7" Rain Event	Increase Permeable Surfaces to 35%
Percentage of Goal Achieved	**99%**	**68%**	**100%**

This design scenario is based on the assumption that the DOE-Forrestal Complex will be demolished and replaced with LEED Platinum Certified buildings (hereto referred to as “new DOE Complex”). Therefore, recommendations are based on a number of well-informed assumptions.

In addition to meeting LEED water efficiency standards, the new DOE Complex building design will incorporate a purple pipe system that will make stormwater use practical and cost effective. The calculations used to make recommendations for the new DOE Complex are based on future building footprint estimates provided by NCPC, assumed to be the roof square footage. Additionally, the roof square footage used is based exclusively on the newly proposed buildings that fall within the defined Tenth Street Corridor Site (see Appendix 5). It is assumed that the new DOE complex will use the

available roof space for solar panels; therefore green roofs were not considered a design option. The remainder of the site is as of yet unknown and will largely depend on the developer that takes on the project. It is assumed that the 35% pervious area will be built into the developer's design, thereby attaining the increase in permeable surface goal. The developer should consider including permeable pavements and bioretention as they serve a dual purpose, creating permeable area as well as retaining stormwater. However, this report does not recommend specifics on placement and square footage. A final consideration is that because the new DOE complex will be a new development within DC, the developer will need to comply with the new stormwater management regulations, such that the complex will need to retain all stormwater produced in a 1.2" rain event on-site.

Despite this array of assumptions, more details can be provided specifically on cisterns. Under the assumptions outlined above, the new DOE Complex would be able to fully integrate a stormwater collection system into its building water uses. Using rainwater collected from the total estimated roof area would exceed the total estimated water use by toilets, which account for approximately 40% of total water use, and if fully utilized, reduce potable water fees resulting in a savings of approximately $30,000 annually. The new buildings will also utilize higher efficiency toilets and faucets, which will enable a substantial potable water reduction compared to the current site. The cistern capacity recommended is based on the difference in capture from roofs between the 1.2" and 1.7" rain event because it is assumed that redevelopment of the site will already retain the 1.2" rain event.

The payback for installing additional cistern capacity to retain the 1.7" rain event was determined to be 18.85 years. This includes costs savings for decreases in potable water use and the accumulation of stormwater retention credits. Reductions in the Stormwater Fee and IAC were not factored into the cost-savings calculations because there was not sufficient information for the anticipated design of the new development from which to generate them.

Table 2.23: New DOE Complex Water Use, Cost and Incentives

Total New Complex Water Use	10,947,150 gal
Cistern Retention Capacity From Roofs*	69,022 gal
Cost of Cistern	$1,863,589
Estimated Potable Water Fee Annual Reductions**	$29,866
Estimated annual Stormwater Credit***	$69,022

*Includes only DOE Complex buildings within the Tenth Street Corridor Site
**Average Annual Reduction between 2013 - 2019
***Redeveloped site must capture 1.2" rain event. Stormwater Credit is the difference between the 1.7" and the 1.2" rain event. 1.7" is the maximal quantity retained for SRC.

Conclusions for Individual Site Analysis

While it is possible for the individual buildings to meet or maximize the three goals on their own, the designs result in high costs and a payback period between 17 to 24 years. This extensive payback period does not generate incentive for building owners to make excessive upfront investments. Thus, this individualized approach is not recommended.

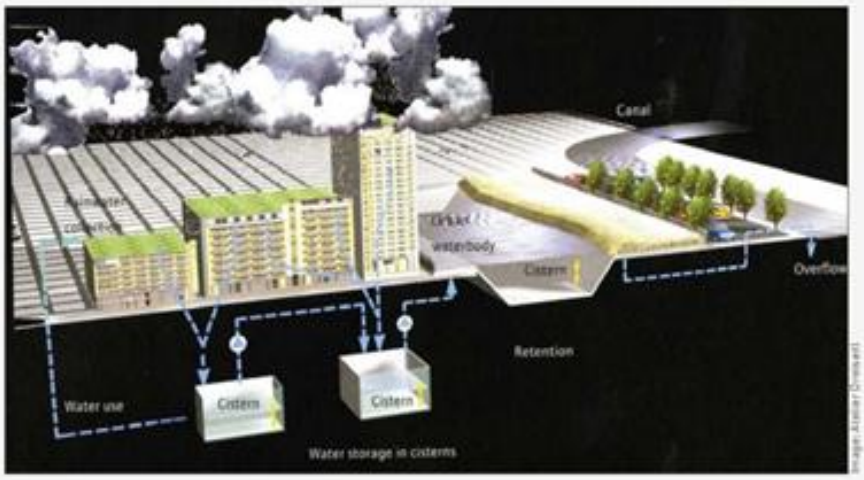
There are also challenges unique to considering each property individually. First, due to outdated plumbing fixtures and lack of a purple pipe system for water reuse in most buildings, it is difficult for each building to meet the goal of 50% potable water reduction on their own. Excluding the new DOE Complex, the other buildings only make 18-35% progress. Only some of the potable water use can be replaced by captured rainwater. Therefore, water efficient plumbing retrofits should be considered first to contribute to this goal. Further information on EPA WaterSense fixtures can be found in Report Recommendations.

In implementing LID features, there is also the challenge of the elevated structures. Permeable pavements and bioretention are not ideal on areas that are not on solid ground, because it limits their retention capabilities. Therefore, green roofs and cisterns are more heavily relied upon. However, it is possible to utilize areas for bioretention of some sites (like USPS and L'Enfant South) that are on solid ground, taking advantage of gravity to feed water from the elevated portions.

Alternative Scenario Two: Total Site Analysis

The design scenario for the total site makes the assumption that the NCPC SW Ecodistrict Plan will be realized. It is assumed that the DOE-Forrestal Complex will be entirely redeveloped with the aim of securing a LEED Platinum certification. The new DOE Complex will be 1.8 million square feet, with occupancy of 5300, and will have high efficiency water fixtures as well as a purple pipe system. The other buildings will retain their existing square footage and occupancy. The property owners of these buildings will most likely find it cost-prohibitive to install a purple pipe system. The report considers that there will be a new building in L'Enfant Plaza, but due to an as-yet undetermined design, it is not included in the cost-benefit analysis.

Box 2.2: District-Scale Water Systems



District-scale water system refers to a type of decentralized water management where the system for water collection, treatment, and distribution is shared among the buildings in the district instead of piping the stormwater and wastewater to an outside water treatment plant.[36] The goal of this system is to reduce the amount of both stormwater and wastewater that has to be sent to the centralized water treatment plants in order to reduce energy and water inefficiencies. Specifically, in Washington DC, the Blue Plains Wastewater Treatment Plant uses about 24-27 MW of power, which equates to 576-648 MWH of energy per day.[37] While energy consumption does not correlate directly with stormwater flow, pumping of water accounts for about 10% of the plant's energy usage so energy usage does increase during a storm.

District-scale water systems seek to accomplish the goals of improved stormwater management through a variety of methods such as creating a system to capture, filter, and use stormwater, reducing potable water use, and establishing a greywater use system. In order to use the water captured in cisterns, a purple pipe system may be established in buildings in order to reuse the water. District-water management provides a means to control stormwater and to distribute water with greater efficiency by reducing the amount of energy necessary in water treatment by using a shared system to utilize resources. Thus, district-scale water systems offer communities the promise of increased resiliency in the face of increased droughts, heavy storms, and floods due to a changing climate as well as increased energy efficiency and environmental quality.

[36] Taylor, T., and R. Goldstein, eds. "Sustainable Water Resources Management, Volume 3: Case Studies on New Water Paradigm." Decentralized Water Resources Collaborative. Water Environment Research Foundation, Jan. 2010. Web. 28 Apr. 2013. <http://www.decentralizedwater.org/documents/DEC6SG06a/Case%20Studies%20on%20New%20Water%20Paradigm.pdf>.

[37] Suzuki, Ryu. E-mail interview. 20 Mar. 2013.

This scenario assumes that all the property owners in the Tenth Street Corridor Site agree to participate in a district-scale stormwater management plan. For background information on a district-scale water system see Box 2.2 on previous page. This requires a governance strategy to bind the property owners together (see Governance section). In the design analysis, we recommend LID features and consider the implications of being able to gather additional rainwater and stormwater runoff from ROW areas as well as sharing the captured water for potable water reduction. The cost-benefit analysis calculates the savings for all property owners combined in a broader stormwater system, including reductions in the IAC and Stormwater Fee and the benefits of stormwater retention on a larger scale.

Table 2.24: Tenth Street Corridor Site Characteristics

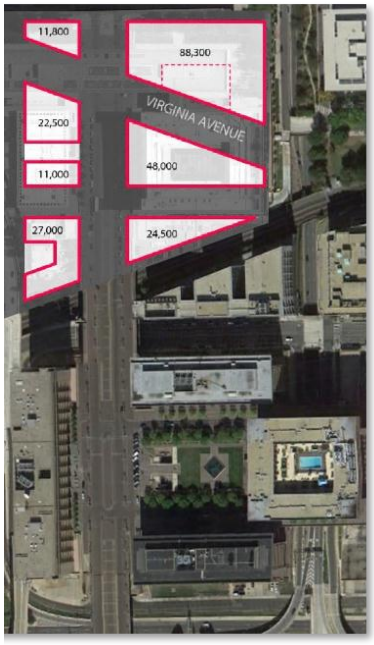
	**Property owner**: Mix of Federal and Private
	Area: 1,832,650 ft^2
	Roof Area: 539,245 ft^2
	Existing Impervious Area: 79%
	Existing Pervious Area: 21%
	Current Total Annual Runoff: 4,827,194 ft^3; 36,109,924 gal

Table 2.25: Tenth Street Corridor Site Percentage of Goals Achieved with Proposed Design

	Reduce Potable Water Use by 50%	Retain Stormwater from a 1.7" Rain Event	Increase Permeable Surfaces to 35 %
Percentage of Goal Achieved	**34%**	**100%**	**100%**

The total site presents unique challenges and opportunities for stormwater management at a district level, compared to an individual property design basis. In addition to the individual properties, there is inclusion of the right of way: streets and sidewalks that encompass 737,331 square feet of impervious surface within the site. There is also additional infrastructure to consider, for example the hollow areas under Tenth Street SW, which are particularly suitable for cisterns. It is also important to consider the

aesthetics of the area as a whole as well as in the broader context of the SW Ecodistrict Plan and the site's position situated between the National Mall and the SW Waterfront.

To this end, the total site design incorporates street trees, green roofs, permeable pavement, cisterns, and bioretention areas.

While street trees do not provide the most significant storage volume compared to other LID features, the total site design acknowledges that they are essential to the aesthetics of the site, particularly to provide design continuity from the National Mall. Redevelopment plans for the DOE-Forrestal Complex should incorporate a building design that retains the existing mature trees on the project site. If the existing trees are removed and replaced with saplings it could take ten to thirty years for them to reach the current canopy cover, thus delaying the full stormwater management potential of the tree canopy. In addition to medium-term stormwater management benefits, maintaining mature tree canopy during the demolition and construction phases will lessen site stormwater runoff, airborne contaminants, and noise pollution related to building activities. The portion of Tenth Street SW that is north of Maryland Avenue would be the most suitable place for new trees. About half of the sidewalk in this area could be converted from impermeable to permeable surface through the construction of tree boxes with a tree canopy of 42,000 square feet or the equivalent of twenty-one mature Northern Red Oak trees. This amount of tree coverage would retain 231,807 gallons of rainwater annually and reduce the reliance on cisterns to retain stormwater during a large rain event.

Compared to the individual site design scenario, the amount of roof surface devoted to green roofs is doubled to the more liberal 60%. Under the district-wide scenario, the green roof depth was also increased from three to six inches, doubling the retention capacity. This increases the price to $17 per square foot. This was done to decrease the amount of cisterns needed, since they are the most expensive component of the site design. Again, this scenario assumes that the new DOE Complex will have solar panels in lieu of green roofs while the other buildings will all have green roofs. See Box 2.3 on the next page for an example of how green roofs can play into a stormwater management system.

Box 2.3: Sidwell Friends Middle School, Washington, DC

Awarded LEED Platinum in 2007, the Sidwell Friends Middle School is an amazing combination of LIDs, green infrastructure and sustainable design. The structure has reduced municipal water use by 90% and 80% of onsite plants are native plant species.[38] A green roof and constructed wetland reduce stormwater runoff, improve the quality of infiltrated runoff and reduce potable water use. The green roof slows rainwater flow and diverts it through a series of downspouts to the wetland and rain garden. The constructed wetland is part of a closed-loop system that recycles the naturally filtered water back to the building. The wetland processes and treats wastewater and stormwater from the green roof, which is reused in toilets and cooling towers. The wastewater management system cleans 3,000 gallons of water per day and reuses the treated water once it has been circulated through the wetland for 3 to 5 days. The combination of native plants, stormwater capture, onsite sewage treatment and water reuse have reduced the school's water consumption by 93% as well as providing a research and education tool for students.[39]

Since much of the site is elevated, it is less cost effective to install permeable pavements because the water would still need to drain elsewhere, such as to bioretention or cisterns, to be retained or stored. However, for a relatively low cost, it is possible to achieve 100% of the goal to increase permeable surfaces to 35% of the total site by installing permeable pavement on the sidewalk area of the public right of ways. At the very least, this would slow the water flow to other LID features. If installing permeable pavements is deemed inefficient, then the total site design would still achieve 95% of the goal to increase permeable surfaces to 35% with the implementation of the other features as recommended.

Two types of cisterns are recommended for the total site design. First, the installation of cisterns is recommended to capture all roof runoff that is not retained by green roofs. It is important to separate roof runoff, which requires less treatment, from street level stormwater runoff, which requires additional treatment due to pollutants that are likely to be found on roadways. In addition, if the buildings have internal downspouts, water from rooftops should be routed to cisterns in the basement. If a building has external downspouts, then it is recommended to invest in bioretention systems with a greater retention capacity, as roof runoff could be diverted into these systems instead of through costlier green roofs or cisterns. Bioretention as a whole is comparatively less expensive per cubic feet of storage volume. In this scenario, it is assumed that all downspouts are internal. Additionally, separate cisterns are recommended to capture all runoff from impermeable ROW surface that is not managed by the bioretention system

[38] USGBC. "Project Profile: Sidwell Friends Middle School Washington, D.C." United States Green Building Council. USGBC, 2007. Web. 28 Apr. 2013. <http://www.usgbc.org/ShowFile.aspx?DocumentID=3943>.

[39] American Society of Landscape Architects. "Designing our Future: Sustainable Landscapes: Sidwell Friends School Washington, D.C., U.S.A." American Society of Landscape Architects. American Society of Landscape Architects, n.d. Web. 28 Apr. 2013. <http://www.asla.org/sustainablelandscapes/sidwell.html>.

(see following section). The ideal place for these cisterns would be in the hollow area under Tenth Street SW, as it is a central location and could gather water from all over the site.

To meet the 50% potable water reduction goal 44,748,580 gallons of water would need to be captured annually. In Alternative Scenario Two, the cisterns are designed to capture 15,240,360 gallons over a year. The amount captured would provide more than is needed by the new DOE complex, about 11 million gallons of water a year, replacing 100% of their non-potable water uses. However, Alternative Scenario Two will capture more stormwater than the new DOE complex could use. As no other buildings within the site will have purple pipe systems, the remaining stormwater could be used for site irrigation, hardscape washing, or other uses within the Tenth Street Corridor Site. If at some point other properties on the site redevelop with purple pipe systems, more water would need to be captured to fully offset 50% of the potable water use within all of the buildings given water consumption today.

If the site wanted to access more stormwater annually, bioretention features could be connected to cisterns at a cost premium of 3-5% of the bioretention total cost. Since the cisterns are designed to retain the 1.7” rain event, they would rarely be at full capacity and would be able to store the additional capture from bioretention based on annual rainfall estimates.

Rain and stormwater capture and use necessitates the Tiered Risk Management Assessment (TRAM) process through DDOE (see Appendix 12). There are additional uses for the captured rain and stormwater from the Tenth Street Corridor Site that should be investigated and are not considered in depth in this report. For example, the collected water could be used by the cogeneration plant within the SW Ecodistrict or sold to the National Mall for irrigation.

Bioretention is an ideal LID because even though it is the most expensive of the four, it needs the least amount of space to capture the most amount of water. In addition, it is a highly visible and attractive LID strategy, showcasing nature as well as ecological design. For the Total Site design, it is assumed that the suggested bioretention areas from the individual site design are adopted by each building. In addition, this report recommends a bioretention feature in the median or on the outside edges of Tenth Street SW, depending on the final street design and gradient of streets. It is determined that about 17% of Tenth Street SW would need to be converted to bioretention to capture the necessary stormwater from the surrounding area. The median would be an appropriate spot as water could drain from a Tenth Street SW re-graded to slope towards the center bioretention feature. Alternately, if the street is graded with the highest point in the middle, then the bioretention areas could be installed on the outer edges. Because most of Tenth Street SW is in fact a bridge, it would still be necessary to have an impermeable liner under the bioretention feature to drain whatever water is not infiltrated or evapotranspired through the practice.

Together, these features make good progress in reaching the three goals. One hundred percent of water from a 1.7" rain event would be retained through the various features. One hundred percent of the goal to increase permeable square footage to 35% would be reached. Finally, the changes would achieve 34% of the goal to reduce potable water use by 50% or more. This design scenario captures a greater quantity of water than all of the individual sites combined as it also captures from the ROW.

Cost-Benefit Analysis of Total Site Design

A district-scale water system managing the total site would acquire additional benefits beyond that of the individual properties as the management of stormwater collected from neighboring right-of-way areas would incur additional fee reductions and credits as well as reduced potable water demand. The total project would cost $22,817,078.43. Each property installing green roof would be able to individually apply for green roof subsidies, potentially reducing the cost of the project by $80,000.00 for a total cost of $22,737,078.43.

Combining the individual property impervious area charges, stormwater fees, and potable water reductions as well as potential stormwater credits; the project could regain its investment in 12.59 years. Please refer to Table 2.26 and 2.27 for details of the cost and financial incentives. Further details on the analysis can be found in Appendix 11.

Table 2.26: Tenth Street Corridor Site Project Features and Cost

Design Technology	**Size of System**	**Total Cost**
Trees	42,000 ft^2 (canopy)	$319,830
Green Roof	189,766 ft^2	$3,226,019
Green Roof Subsidy	-	($80,000)
Permeable Pavement	33,662 ft^2	$504,930
Cistern	658,415 gal	$17,777,192
Bioretention (Vegetated Swale)	30,435 ft^2	$989,108
Total Project Initial Investment		**$22,737,078**

Table 2.27: Tenth Street Corridor Site Financial Incentives

Financial Incentive	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Impervious Area Charge Savings	$21,793	$33,065	$40,215	$46,295	$52,808	$58,046	$65,515
Stormwater Fee Reduction	$38,793	$38,793	$38,793	$38,793	$38,793	$38,793	$38,793
Stormwater Credits	$1,564,652	$1,564,652	$1,564,652	$1,564,652	$1,564,652	$1,564,652	$1,564,652
Potable Water Fee Reductions	$69,677	$74,567	$79,049	$84,142	$89,235	$93,310	$96,570
Savings	**$1,694,914**	**$1,711,076**	**$1,722,708**	**$1,733,882**	**$1,745,488**	**$1,754,800**	**$1,765,529**

Conclusions for Total Site Analysis

Alternative Scenario Two allows for some distinct considerations compared to Alternative Scenario One. The inclusion of ROW increases the amount of water that could be collected on the site. The addition of trees, permeable pavement, and bioretention to ROW areas will greatly increase the stormwater retention capacity of the site. This will transform the area into a more sustainable and inclusive neighborhood. The final design will depend on the layout of Tenth Street SW which is under discussion by NCPC and DDOT. If all the recommended changes are implemented, the Total Site will enjoy a shorter payback time of 12.59 years compared to Alternative Scenario One with paybacks of 17-24 years.

A few design recommendations may change depending on certain features of the final layout of the total site. For example, if the buildings are found to have internal or external downspouts, what can be done with water collected from the roofs will change. The placement of bioretention on Tenth Street SW will depend on the percent grade of the street design. Finally, it will be up to developers to decide whether or not to install permeable pavements on the elevated portions of the site in order to attain the goal of 35% permeable surfaces.

Further decisions also need to be made on what to do with the water that will be captured by the LID features. Water collected from the total site could only reduce potable water usage by 17%[40] even after assuming that the DOE-Forrestal Complex is redeveloped to a LEED-certified building with efficient fixtures and a purple pipe system. In order to most efficiently and cost effectively meet the 50% potable water reduction goal it is advised that water efficiency be first used to reduce water use within the buildings. This would require properties other than DOE to retrofit their plumbing fixtures and insert new piping systems. Information on EPA WaterSense plumbing fixtures can be found in Scenario Methodology. If the water is to be used outside of the Tenth Street

[40] Total stormwater collected in cisterns amounts to 36,217,083 gallons annually, which would meet only 17% of the total potable water used over the total site (89,497,160 gallons annually) resulting in 34% attainment of the potable water reduction goal.

Corridor Site, it should be noted that it is most viable to use the water within a one-block radius of the site because of the high costs of pumping water to farther distances.

It is also important to note that designing LID features to capture the 1.7" rain event is costly because the 95th percentile event is infrequent and will result in underutilized LID infrastructure. For instance, building cistern capacity of 658,414 gallons would capture the 1.7" rain event, but 95% of the time would not need to be holding at that capacity. For green roofs, there are implications of whether sufficient water would be supplied annually to irrigate a green roof that is built to that 1.7" standard. It would be more cost effective to design to the 1.2" rain event except for regulated buildings under the Proposed Rulemaking on Stormwater Management and Soil Erosion and Sediment Control, which would not be able to take advantage of the SRC trading program if they did not meet the 1.7" rain event.

3. RECOMMENDATIONS

Governance

The implementation of a shared approach to stormwater management raises the issue of roles and responsibilities in the future management of a district-scale system. See Box 3.1 for an example of a governance structure that is currently used by Living City Block. Three possible ownership and management structures could be applied to Alternative Scenario Two in order to maximize the financial benefits of the project and minimize the payback period, thus ensuring greater participation and reduction of stormwater. In addition to the benefits of working together on a district-scale stormwater system, cooperative governance could provide other future benefits such as leveraging public and private resources, applying for grant funding as an association and achieving savings on implementation of additional sustainability features through economies of scale. Please see Appendix 13 for a more detailed explanation of possible ownership

Box 3.1: Living City Block

Living City Block (LCB) is a non-profit organization that was founded in 2010 to promote and facilitate resource efficiency at the city-block level to lessen ecological footprints as well as increase neighborhood cohesion and attractiveness.[41] LCB's model provides benefits through aggregation. Nearly all commercial buildings in the United States are small to mid-size properties and many of these buildings cannot afford energy retrofits to become more efficient on their own. LCB works to create a formal consortium of building owners in a block, both residential and commercial.[42] Founder and President Llewellyn Wells stresses that there must be a legal agreement of the building owners because a.) there is no other way to make sure it is binding and b.) financiers are more likely to fund a project with a formal agreement.[43] This can be accomplished in several ways. It is best to look first at existing structures within the area one wants to address.

Once the building owners are bound together, LCB becomes a third party aggregator for equity and debt financing. The association creates a purchasing bloc (for retrofits) and increases the economy of scale while LCB acts as a manager. Besides arranging the financing, they ensure that the retrofits are completed on schedule and overall goals are achieved. The aggregation encourages the building owners to consider sustainability issues at a neighborhood level (or district-scale) instead of just in their own building. From the success of their projects, LCB hopes to show that more efficient built environments lead to healthier and more productive people. [44]

[41] *Living City Block*. Living City Block, n.d. Web. 27 Apr. 2013. <http://www.livingcityblock.org>.
"What We Do." Living City Block. Living City Block, n.d. Web. 6 Feb. 2013.
[42] "About." Living City Block. Living City Block, n.d. Web. 12 Mar. 2013. <http:// www.livingcityblock.org/about-2/about/>.
[43] Wells, Llewellyn. Personal interview. 20 Mar. 2013.
[44] "What We Do." Living City Block. Living City Block, n.d. Web. 6 Feb. 2013. <http://www.livingcityblock.org/what-we-do/>.

and management structures for district-scale systems and example systems, and see Tenth Street Corridor Site Today, Property Owners for details on potential stakeholders that may be involved in a district-scale water system.[45]

1. Cooperative Model – This model consists of a fully cooperative arrangement, with shared ownership of the physical infrastructure as well as shared management and operations activity through a board of private stakeholders – a board made up of the property owners within the system boundaries, possibly by establishing a committee or association.

2. Cooperative, Privately Operated Model – In this model, ownership of the physical infrastructure is shared among the property owners while the maintenance and operations are managed by a private company. The private company could be one of the property owners within the district, or an outside contractor.

3. Private Model – Under this architecture, the physical infrastructure is owned by a private entity. A Water Purchase Agreement structure would be initiated with property owners allowing stormwater management systems to be installed on their property. Property owners would participate in the system receiving a reduced share of the financial benefits. The majority of the financial incentives would be absorbed by the private owner who provided the initial investment. This type of system is analogous to a Power Purchase Agreement which is a third-party method to finance renewable energy projects, typically solar photovoltaic arrays, such as the array on the American University campus which is owned by Washington Gas.[46]

The Cooperative, Privately Operated Model (Option 2) may be best suited to the system proposed in Alternative Scenario Two. Options 1 and 3 may experience numerous complications due to the complex relationship between property owners, the potential for changes in ownership and participation as well as possible obstacles in leasing property for stormwater management technologies to a private entity. The costs of operation and ownership models are difficult to estimate and are not included in our cost-benefit analysis. The additional costs of such a governance system will extend the payback on the project. However, the benefits of district-scale governance could also potentially reduce certain costs if coordination between property managers and other relevant stakeholders is maintained. For example, coordinating infrastructure development schedules could reduce costs of excavation and maintenance.[47]

Before a management structure is selected, further research should be undertaken to verify the legality and feasibility of the potential structure.

[45] For more information see supplemental document “Governance and District-Scale Water Systems”
[46] O'Brien, Chris. "Solar PPA: American University." American University. American University, n.d. Web. 27 Apr. 2013. <http://www.epa.gov/greenpower/documents/AU_Solar_PV_121312.pdf>.
[47] "District Energy for Portland: Laying the Groundwork for Implementation: Development, Ownership & Governance Models." District Energy for Portland. Portlandoregon.gov, 31 Mar. 2011. Web. 27 Apr. 2013. <http://www.portlandoregon.gov/bps/article/349828>.

Phasing

The implementation of a multi-stakeholder project such as the one proposed in Alternative Scenario Two, based on a district-scale water system, needs to be strategically planned. Development of a phasing plan is necessary to ensure project safety, financial feasibility, and greater functionality of the site during redevelopment. The plans created during this process will help property owners manage time, cost, change, risk and other issues. Redevelopment of this scale has the potential to shut down businesses and remove all tenants from the site area. As an alternative, phasing the implementation and construction processes will allow some areas of the site to always remain open and functional. The following section serves as a guideline for the implementation of Alternative Scenario Two.

Phase 1. Inform Stakeholders and Begin Outreach

The following are suggested steps to follow when initiating stakeholder involvement and engagement:

1. Create a Tenth Street Corridor Site proposal to send to stakeholders as read ahead material. Such material would include detailed physical site information, relevant policy requirements, proposed system changes, and costs/benefits for stakeholders.
2. Hold a community meeting to determine level of intent/interest of all parties. Property owners, Federal and district agencies, utilities, and interest groups should all be included. One way to structure this meeting is a symposium, which would invite stakeholders, experts, and other city agencies that may have created district-scale systems in the past. The intended goals of the community meeting are to share information with all parties, finalize a Memorandum of Understanding (MOU) from each interested property owner, designate a governing structure/body, and define roles of participants. It is important to investigate the legal ramifications of designing a MOU and governing structure. Please see Areas for Further Research section for more details.
3. Allot sufficient time and resources for finalizing a governing structure for the project as it will take considerable time and effort to reach an agreement (see Governance section for more information).
4. Once steps 1-3 are completed, begin the search for funding opportunities. See Box 3.2 on the next page for an example of funding opportunities. Apply for funding through appropriate channels such as grants, subsidies, rebates, etc. Then create formal budget to account for costs, benefits and a payment and incentive distribution arrangement for approval by property owners.

Phase 2. Gather Technical Information

The following are recommended technical processes needed for implementation of a district-scale water system. This list is a guide but is not exhaustive:

1. Perform a risk assessment to determine both qualitative and quantitative risk involved in pursuing retrofits and redevelopments.

2 Conduct structural and engineering analyses of the site to determine design feasibility and placement.
3 Acquire all relevant project permits through the DC Department of Consumer and Regulatory Affairs (DCRA). Allow ample time and resources for this process.
4 Produce technical stormwater and water use audits to establish baseline data and to enable future benchmarking.
5 Develop a total site DDOE approved stormwater management plan for the Tenth Street SW Corridor Site.
6 Implement Tiered Risk Assessment Management (TRAM) in compliance with the DDOE's water quality end-use standards for harvested stormwater for non-potable use. See 8-step process in Appendix 12.

Phase 3. Finalize Stakeholder Involvement
The following are suggested steps to follow when determining final development plan and stakeholder participation:

1 Hold a second community meeting to finalize involvement and commitment of different stakeholders.
2 Initiate the Request for Proposal (RFP) process to attract potential site developers and detailed work proposals.
3 Select final development proposal and assign contractor.

Box 3.2: Financing for the Yesler Terrace Project, Seattle, WA

The Yesler Terrace Project, led by the Seattle Housing Authority and the major stakeholder CollinsWoerman, features the sustainable redevelopment of a 36-acre public housing community.[48] This is a massive project that includes district-scale water, energy and waste management. The project is expected to take approximately 15 to 20 years to complete and will require over $90 million in infrastructure costs. The U.S. Department of Housing and Urban Development (HUD) originally awarded Seattle Housing a grant of $10.27 million in August of 2011 and later awarded a $19.73 million HUD Choice grant in December of 2012.[49] In addition to these grants, the Seattle Housing Authority has also received 60 new Housing Choice Vouchers that will provide the project $560,000 worth of subsidies per year. This funding will help start the project, which will ultimately lower costs for consumers. The project has spurred $227 million of local economic and community investment.

Phase 4. Implementation
1 Begin Construction
- Stage I: New DOE Complex. The proposed redevelopment of the DOE Complex will meet LEED Platinum certification, including installation of a purple pipe system for water reuse. Given this planned redevelopment, the

[48] Moddemeyer, Steve. Yesler Terrace: Sustainable District Study. Comp. CollinsWoerman and Gibson Economics. N.p.: n.p., 2010. Seattle.gov. Web. 24 Feb. 2013. <http://www.seattle.gov/environment/documents/YT_Sustainable_District_Study.pdf>.

[49] "Housing: Seattle Housing Authority Receives $19 Million To Revitalize Yesler Terrace Neighborhood." *US Senator Patty Murray: Working for Washington State*. Senate.gov, 12 Dec. 2012. Web. 27 Apr. 2013. <http://www.murray.senate.gov/public/index.cfm/newsreleases?ContentRecord_id=3cf4241e-bfb0-4f83-9de8-9b5ce2d396fd>.

new DOE Complex is a logical starting point for a district-scale water system. The DOE project could generate enthusiasm and motivation for a district-scale system from other property owners in the area. In addition this redevelopment could stimulate financial interest from other parties for further sustainable initiatives. If the new DOE complex is designed to go above and beyond basic Federal requirements and manage runoff from the 1.7" rain event it will demonstrate the environmental and economic advantages of stormwater management to other property owners.

- Stage II: Urban REIT, L'Enfant Plaza and Hotel, L'Enfant South, USPS. The remaining buildings of the site will be retrofitted as part of the second stage of construction. However, certain LID retrofits such as green roofs can be implemented earlier, concurrently or after stage I. Funding such a large project may be a challenge and there may be obstacles blocking a site-wide, comprehensive stormwater management strategy such as the one that is proposed. Nevertheless, property owners should still take advantage of the financial incentives of installing LID strategies and work together to capitalize on economies of scale. For example, if property owners began with installing green roofs or bioretention, they could benefit from the related green roof subsidy and bulk-rate discounts. By working together, even on a smaller scale, property owners still maintain greater bargaining power for implementation than they would alone.

2 Begin Operation and Maintenance
- Maintain the development to pass regular DDOE inspection standards.

3 Evaluate performance
- Begin benchmarking of water use and stormwater retention once construction is completed.

Tenth Street Corridor Site Recommendations

Overall, meeting the goals of the NCPC SW Ecodistrict Plan on the Tenth Street Corridor Site is only possible with considerable financial investment. Initial review found that the established goals of, maximizing retention to capture 1.7" event, 50% potable water reduction and increasing permeable surfaces to 35% were often in competition and required tradeoffs. The most cost effective way to meet or maximize each goal would be the implementation of Alternative Scenario: Total Site Design. This presents increased savings and a shortened payback period. Additionally, this enables economies of scale, which would result in lowered costs from this report's cost estimates. It would also result in a shared governance structure for the system, which may result in further benefits in future shared resource systems and external sources of funding.

50% Potable Water Reduction

Cisterns are the best LID for meeting the 50% potable reduction goal because they are the only suggested LID that enables long-term storage for use. In considering captured water use, it is cost-prohibitive for all buildings, except the new DOE Complex, to install a purple pipe system for using captured rainfall. Thus it is this report's recommendation that the new DOE Complex use as much of the captured rainfall for their non-potable water uses, i.e. toilet fixture flushes, cooling towers. With treatment, the remaining cistern water could be used for the cogeneration plant's operations, landscape irrigation, exterior hardscape cleaning, or sold to other sites near or within the SW Ecodistrict such as the National Mall. See Box 3.3 about cistern capture and water use at Portland State University.

Box 3.3: Cistern Rain Capture: Stephen Epler Hall, Portland, OR

Stephen Epler Hall is a LEED Silver building constructed by Portland State University. The main focus of this building is to improve efficiency by reducing water and energy consumption. The stormwater management features of this building are aimed at engaging the public and generating interest in improved stormwater management. The stormwater system reduces the building's water requirements by 110,000 gallons annually and saves Portland State University roughly $1,000 a year. The system is designed to divert 26% of the stormwater from Stephen Epler Hall and the surrounding residence halls into a cistern.[50] Rain from the 12,000 square foot roof surface is diverted to splash boxes and then flows to bioretention where it infiltrates through soil and gravel and collects in a large underground cistern. The water is treated using ultraviolet light before being recycled for toilet flush water in the restrooms and in land irrigation. The university expects to harvest 230,000 gallons per year from the hall's stormwater cisterns.[51]

Stormwater collected from the total site using the recommended LID systems in Alternative Scenario Two, if treated and used, could only reduce potable water usage by 35.5% even after assuming that DOE is redeveloped as a LEED-certified building with high efficiency fixtures. In order to most efficiently and cost effectively meet the 50% reduction goal it is advised that water efficiency upgrades to

[50] "Stephen Epler Residence Hall Stephen Epler Residence Hall." *Portland State University Institute for Sustainable Solutions*. Portland State University, n.d. Web. 27 Apr. 2013.<http://www.pdx.edu/sustainability/stephen-epler-residence-hall>.

[51] "Stephen E. Epler Hall Case Study." *Portland State University Institute for Sustainable Solutions*. Portland State University, n.d. Web. 27 Apr. 2013. <http://www.pdx.edu/sites/www.pdx.edu.sustainability/files/sus_epler_case_study.pdf>.

interior plumbing fixtures to all buildings is first employed to reduce total water use. See Box 3.4 below for an example of efficient fixtures that could be used. Additionally, these upgrades will further benefit property owners with cost savings in anticipation of escalating DC Water's Retail Water fees.

Box 3.4: EPA's WaterSense Program

A more cost effective way of reducing potable water usage in buildings is through water efficiency. According to the EPA, WaterSense toilets use only 1.28 gallons per flush, as opposed to the Federal requirement of 1.6 gallons per flush.[52] This is a 20% reduction in water usage. This could amount to $90 per year in reduced water bills and over $2,000 over the lifetime usage of the toilets. Installing WaterSense urinals can save between 0.5 to 4.5 gallons per flush.[53] WaterSense faucets are required to use a maximum of 1.5 gallons per minute, which is a 30% reduction from the current standard of 2.2 gallons per minute.

Use of Water and Water Retrofits

In order to achieve the goal of reducing potable water use by 50%, it is necessary to replace water used by the properties that is currently potable with rainwater or treated stormwater. Possible uses for captured water are: flushing of toilets and urinals, landscape irrigation, mechanical processes, exterior washing, replenishment of water features, and fire suppression. The District of Columbia's standards for captured and reclaimed water can be found in Appendix N of the *DDOE Stormwater Management Guidebook.* This document outlines a "Tiered Risk Assessment Management" (TRAM) strategy to determine the pollutants of reclaimed water, the likelihood of exposure of different reclaimed water uses and finally, the treatment necessary. The District of Columbia requires an application process that considers these features and submits a Stormwater "Treatment" Plan to DDOE. See Appendix 12 for more information.

1.7" Rainfall Event Capture

In order to meet the established goals, it is recommended to implement the following LID to the specifications contained in the design proposal: green roofs, cisterns, bioretention, permeable pavement and street trees. Overall, bioretention systems manage the most stormwater for the least cost and over the smallest area. For any property, even those regulated for a 1.2" rain event, it is recommended to install LID that retains a 1.7" rain event to take full advantage of the SRC program. See Appendix 8 for details about depth, soils, etc., that were used to calculate retention.

Increase Permeable Surfaces to 35%

It is advised that all properties directly mitigate stormwater runoff from impervious surfaces by implementing green infrastructure and LID strategies that increase permeable surface to take advantage of cost-savings through both a reduced DC Water Impervious Area Charge and DDOE Stormwater Fee. This reflects a direct financial

[52] "Water Efficient Toilets." *EPA Water Sense*. EPA, n.d. Web. 27 Apr. 2013. <http://www.epa.gov/WaterSense/products/toilets.html>.
[53] "WaterSense Specification for Tank-Type Toilets." *EPA WaterSense*. EPA, 20 May 2010. Web. 27 Apr. 2013. <http://www.epa.gov/WaterSense/docs/revised_het_specification_v1.1_050611_final508.pdf>.

incentive for increasing permeable spaces as the DDOE and DC Water assess fees based on impervious area cover per property. The most obvious increases for permeable area would begin with installing green roofs, but as mentioned previously, unless connected to cistern or other grey infrastructure, the savings are only linked with these two reduced fees. If connected with other LID features it could result in potable water reductions and applicable retail water fees.

This small percentage increase in permeable surfaces is difficult for most buildings to achieve due to available area constraints. Through implementation of Alternative Scenario Two, there is greater opportunity to increase permeable surfaces as opposed to individual properties because of the availability for permeable transitions in ROW. This report recognizes that the process for instituting Alternative Scenario Two will be lengthy. Thus, individual property owners should take immediate action to install some of the elements from Alternative Scenario Two since rebates from the RiverSmart Rewards program can be recouped retroactively.

Areas for Further Research

Funding

Since a district-scale water system will be costly and expensive for stakeholders in the Tenth Street Corridor Site, a combination of grant funds, investments, and financing might help offset some of the costs for the project. For examples of funding strategies, see Box 3.5 below.

Box 3.5: Third Party Financing

Third party financing is one funding scenario for the Tenth Street Corridor Site. Rather than each property in the site paying a share of the upfront costs, a developer or investor could pay for a majority of the improvements. Property owners could enter into a "water purchase agreement" with the developer wherein they agree to purchase the water captured for a fixed price and term. Since the properties also see savings in the form of reduced IAC, Stormwater Fee, and stormwater credits, a shared savings model similar to an energy services company (ESCO) could also be established to help make the project payback to the investor. Property owners benefit from reduced, stable water costs over time, reduced fees from what they would pay without LID improvements, and little to no capital investment up front. A developer would benefit from selling water to properties within the Tenth Street Corridor Site or others such as the National Mall and could retain stormwater credits or share fee savings with property owners.

One such company that does water purchase agreements is Sustainable Water, which "enables bulk water purchasers to use recycled water to realize immediate, guaranteed cost savings without upfront capital or risk." [54]

Legal Investigation of Governance Structures

If a district-scale water system were to be implemented, a qualified entity would need to investigate the legality of governing a decentralized water system in the District of Columbia. The entity would also need to discuss ownership of LID features once the structures are paid off. For example, if one owner within the system decided to sell their property, there would need to be a set of guidelines that provide instructions for selling their partial ownership of the LID infrastructure to ensure the longevity of the whole district-scale water system. Considering the presence of federal property owners on the site, this is an area where the federal sector can lead by example in undertaking the development and implementation of guidelines for the creation of a shared, district-level water management system.

Water Use Options

This report emphasizes options for the use of captured rainwater and stormwater within the Tenth Street Corridor Site. Primary emphasis has been given to irrigation and toilet flushing. It is recommended to complete further research into other water end-use options for the site as well as the associated treatment requirements.

[54] "Extending the Life Cycle of Water." Sustainable Water. Sustainable Water, n.d. Web. 28 Apr. 2013. <http://sustainablewater.com/>

Due to increases in research and innovation of water treatment technologies, such as advances in membrane bioreactors, the collection of greywater and wastewater has become increasingly common for “fit for purpose” reuse. Provided that more buildings redevelop or renovate with purple pipe systems, these technologies may prove indispensable in reaching potable water reduction goals for a district-scale water reuse system.

Other Areas for Further Research

The establishment of a constructed wetland at the Banneker Park site to retain and treat stormwater and potentially wastewater should also be researched. The potential and feasibility of mining the MS4 to intercept stormwater runoff and reduce the capture and conveyance costs associated with a district-scale water system should also be investigated.

4. APPENDIX

Appendix 1. Key Terms and Glossary

1.2" Rainfall Event - For the Washington, DC area this is a 90th percentile rainfall event whose precipitation total is greater than or equal to 90 percent of all 24-hour storms on an annual basis

1.7" Rainfall Event - For the Washington, DC area this is a 95th percentile rainfall event whose precipitation total is greater than or equal to 95 percent of all 24-hour storms on an annual basis

American University Stormwater Policy and Design Project Team - The practicum group that consists of nine graduate students in the Global Environmental Politics program in the School of International Service at American University.

Best Management Practice (BMP) - Structural or nonstructural practice that minimizes the impact of stormwater runoff on receiving waterbodies and other environmental resources, especially by reducing runoff volume and the pollutant loads carried in that runoff.[55]

Blackwater - Water that is discharged from toilets.[56]

Bioretention - Practices that capture and store stormwater runoff and pass it through a filter bed of engineered soil media comprised of sand, soil, and organic matter. Filtered runoff may be collected and returned to the conveyance system, or allowed to infiltrate into the soil.[57]

Cistern - Water storage tank; capacities range from 250 to over 30,000 gallons. Multiple tanks can be placed adjacent to each other and connected with pipes to balance water levels and to tailor the volume storage needed. Storage tank volumes are calculated to meet site occupant water demand and stormwater storage volume retention objectives.[58]

District-Scale - Infrastructure systems within major public service areas that are scaled and designed for efficient, environmentally sound, resource-conserving application at a 'district' scale.[59]

Green Infrastructure - An adaptable term used to describe an array of products, technologies, and practices that use natural systems – or engineered systems that mimic natural processes – to enhance overall environmental quality and provide

[55] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. V-2.
[56] The National Capital Planning Commission. The National Capital Planning Commission. *The SW Ecodistrict: A Vision Plan for a More Sustainable Future*. Comp. The National Capital Planning Commission. N.p.: n.p., 2013. *The National Capital Planning Commission*. Web. 26 Apr. 2013. <http://www.ncpc.gov/swecodistrict>. p35.
[57] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. p96.
[58] Ibid p47
[59] Moddemeyer, Steve. *Yesler Terrace: Sustainable District Study*. Comp. CollinsWoerman and Gibson Economics. N.p.: n.p., 2010. *Seattle.gov*. Web. 24 Feb. 2013. <http://www.seattle.gov/environment/documents/YT_Sustainable_District_Study.pdf>. p8.

utility services. As a general principal, Green Infrastructure techniques use soils and vegetation to infiltrate, evapotranspirate, and/or recycle stormwater runoff.[60]

Green Roof – Installed on existing and new roof structures, and consist of a waterproof, root-safe membrane; a drainage system; a lightweight growing medium; and plants. Green roofs reduce rooftop and building temperatures, filter pollution, lessen pressure on sewer systems, and reduce the heat island effect.

Greywater – A type of non-potable water that is generated from domestic activities such as laundry, dishwashing, and bathing.[61]

Impervious Area Charge (IAC) - Part of DC Water's Clean Rivers Program that aims to reduce pollution in the Anacostia and Potomac rivers and Rock Creek. The charge applies to all lots, parcels, properties and private streets in the District of Columbia. The Clean Rivers IAC is based upon the amount of impervious surface on the property.[62]

Impervious - A surface area which has been compacted or covered with a layer of material that impedes or prevents the infiltration of water into the ground, examples include conventional streets, parking lots, rooftops, sidewalks, pathways with compacted sub-base, and any concrete, asphalt, or compacted gravel surface and other similar surfaces.[63]

Infiltration - The process through which runoff penetrates into soil from the ground surface.

Low Impact Development (LID) - A land planning and engineering design approach to manage stormwater runoff within a development footprint. It emphasizes conservation, the use of on-site natural features, and structural best management practices to store, infiltrate, evapotranspirate, retain, and detain rainfall as close to its source as possible with the goal of mimicking the runoff characteristics of natural cover.[64]

New DOE Complex - Redevelopment of the DOE-Forrestal Complex site will include LEED Platinum Certified building(s) and a building footprint of 1.8 million square feet.

NCPC SW Ecodistrict Plan - The SW Ecodistrict Initiative is a comprehensive effort to transform a 15-block federal precinct just south of the National Mall into a showcase of sustainable urban development. In addition to accommodating the future space needs of the federal government, the Ecodistrict will extend the civic qualities of the

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[60] "Glossary." *The United States Environmental Protection Agency*. EPA, n.d. Web. 27 Apr. 2013. <http://www.epa.gov/oaintrnt/glossary.htm>.

[61] The National Capital Planning Commission. The National Capital Planning Commission. *The SW Ecodistrict: A Vision Plan for a More Sustainable Future*. Comp. The National Capital Planning Commission. N.p.: n.p., 2013. *The National Capital Planning Commission*. Web. 26 Apr. 2013. <http://www.ncpc.gov/swecodistrict>. p35.

[62] "Impervious Area Charge." *DC Water*. District of Columbia Water and Sewer Authority, n.d. Web. 27 Apr. 2013. <http://www.dcwater.com/customercare/iab.cfm>.

[63] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook> V-3.

[64] Ibid. V-4.

National Mall, create new places to live, and promote a vibrant, open, and walkable neighborhood and workplace. The Initiative involves 17 federal and district agencies and is being led by the National Capital Planning Commission.[65]

Permeable Pavement – A surface paving system designed to capture and temporarily store the Stormwater Retention Volume (SWRv) by filtering runoff through voids in the pavement surface into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system, or allowed to partially infiltrate into the soil.[66]

Pervious - A surface type of high porosity that allows water to pass through: permeable.

Potable Water - Water that has been processed and treated so that it is clean enough to drink. It is pumped to buildings within the district from the municipal water system.[67]

Public Right of Way (ROW) - The surface, the air space above the surface (including air space immediately adjacent to a private structure located on public space or in a public right of way), and the area below the surface of any public street, bridge, tunnel, highway, lane, path, alley, sidewalk, or boulevard.[68]

Rainwater - Precipitation that falls onto the rooftop of buildings in the study area and is captured before it runs onto the ground or into the municipal storm system. Rainwater is distinct from stormwater because of the lower level of treatment required if captured directly from rooftops.

Read Estate Investment Trust (REIT) - A security that sells like a stock on the major exchanges and invests in real estate directly, either through properties or mortgages. REITs receive special tax considerations and typically offer investors high yields, as well as a highly liquid method of investing in real estate.[69]

Retention - Keeping a volume of stormwater runoff on site through infiltration, evapo-transpiration, storage for non-potable use, or some combination of these.[70]

Retention Capacity - The volume of stormwater that can be retained by a best management practice or land cover change.[71]

Retrofit - A best management practice or land cover change installed in a previously developed area to improve stormwater quality or reduce stormwater quantity relative to current conditions.[72]

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[65] The National Capital Planning Commission. The National Capital Planning Commission. *The SW Ecodistrict: A Vision Plan for a More Sustainable Future*. Comp. The National Capital Planning Commission. N.p.: n.p., 2013. *The National Capital Planning Commission*. Web. 26 Apr. 2013. <http://www.ncpc.gov/swecodistrict>.

[66] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook> p74.

[67] The National Capital Planning Commission. The National Capital Planning Commission. *The SW Ecodistrict: A Vision Plan for a More Sustainable Future*. Comp. The National Capital Planning Commission. N.p.: n.p., 2013. *The National Capital Planning Commission*. Web. 26 Apr. 2013. <http://www.ncpc.gov/swecodistrict>.

[68] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. V-5.

[69] "Real Estate Investment Trust - REIT." *Investopedia*. Investopedia, n.d. Web. 27 Apr. 2013. <http://www.investopedia.com/terms/r/reit.asp>.

[70] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. V-6.

[71] Ibid. V-6

[72] Ibid. V-6

Runoff - That portion of precipitation (including snow-melt) which travels over the 1and surface, and also from rooftops, either as sheet flow or as channel flow, in small trickles and streams, into the main water courses.[73]

Runoff Coefficient - A value ranging from 0.00 to 1.00 for different surface types, this is the amount of water that cannot be absorbed or rather runs off. Additionally this can be expressed as a rate by converting the coefficient to a percentage, ex. 0.25-runoff coefficient equals 25% runoff rate.

Stormwater - Precipitation that falls onto rooftops and the ground. It is distinct from rainwater because it requires higher levels of treatment. Currently, all stormwater from the site is captured by the MS4 and conveyed untreated into the Potomac River.

Stormwater Fee - Based on impervious area cover of a site, administered by DC Water and directed to DDOE for LID throughout the DC area.

Stormwater management - Retention, detention, or treatment of stormwater on site or via conveyance to a shared best management practice.[74]

Stormwater Retention Credit (SRC) - One gallon (1 gal.) of retention capacity for one (1) year, as certified by the District Department of Energy.[75]

Stormwater Retention Volume (SWRv) - The capacity of a low impact development (LID) practice to retain an amount of stormwater determined by the annual rainfall or rainfall event.

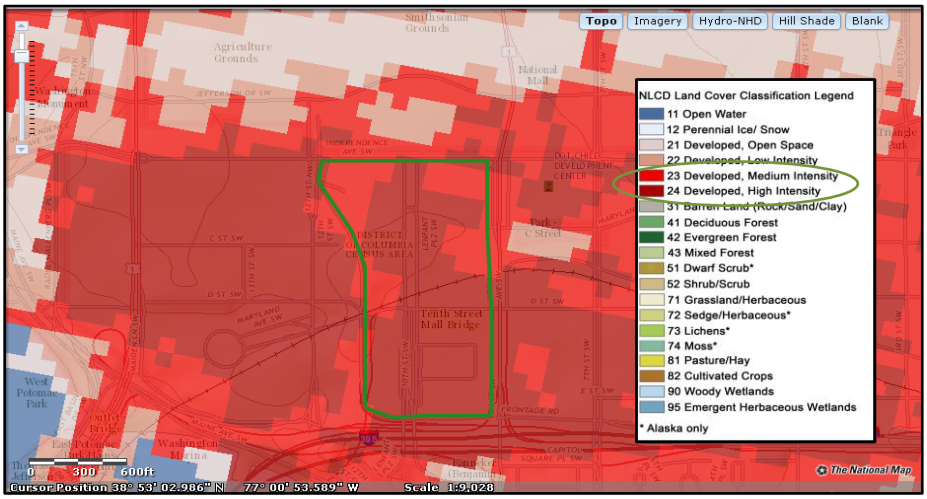
Street Trees - Trees located in public spaces that retain the first tenth of an inch of rain, with root systems that increase the porosity of soils. Typically, they are planted in tree boxes or continuous tree strips in public ROW. Trees also help to mitigate the urban heat island effect, increase aesthetics and promote urban biodiversity.

Tenth Street Corridor Site - The study area that begins with a northern boundary at Independence Avenue, stretching south to the Southwest Freeway and extending a block east to Ninth Street and a block west to the Twelfth Street Tunnel/Expressway.

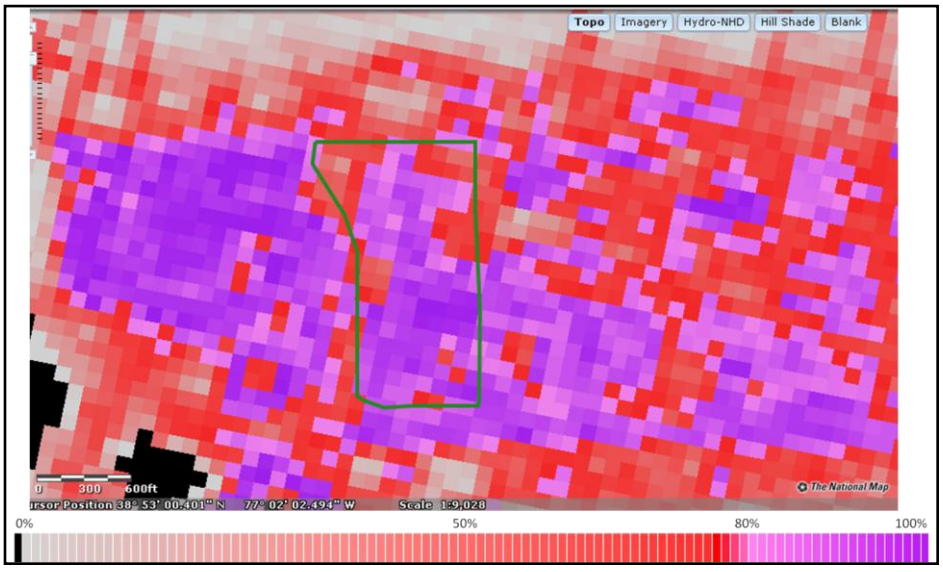
[73] Ibid.V-6
[74] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. V-4.
[75] Ibid. V-7

Appendix 2. Tenth Street Corridor Site Land Cover

A US Geological Survey (USGS) map depicting land cover of the site makes it evident that the Tenth Street Corridor Site as it exists today is extremely urbanized and highly developed. A majority of the Tenth Street Corridor Site is defined as “Developed, High Intensity” land with some “Developed, Medium Intensity” land mixed in meaning that impervious surfaces account for 50%-100% of the entire site.



The National Land Cover Database (NLCD) Percent Developed Impervious surface provides nationally consistent estimates of the amount of man-made impervious surfaces present over a given area in a seamless form. The map is derived from satellite imagery, using classification and regression tree analysis where values range from 0 to 100%, indicating the degree to which the area is covered by impervious features. In this case visual representation as to the extent of imperviousness of each area is provided. The site is highly impermeable. Calculations of land cover using GIS to calculate square footage show that the Tenth Street Corridor Site contains only 16.5% pervious surfaces.



Appendix 3. General Information and Assumptions

Goals (adapted from SW Ecodistrict Plan)

- Retain 95th percentile rain event (For the DC region, the 95th percentile rain event is when a storm produces up to 1.7 inches in 24 hours[76])
- 50% potable water reduction
- Increase pervious surfaces from the existing 20% to at least 35% overall in SW Ecodistrict

Tenth Street Corridor Site

- The Tenth Street Corridor Site begins with a northern boundary at Independence Avenue, stretching south to the Southwest Freeway and extending a block east to Ninth Street and a block west to the Twelth Street Tunnel/Expressway
- DOE-Forrestal Complex will be demolished and a new building will take its place with LEED Platinum certification, dual-flush toilets, and a purple pipe system
- There will be an additional building on the L'Enfant Plaza property
- Study area is entirely part of the MS4 (municipal separate stormwater sewer system)[77]
- All stormwater from the Tenth Street Corridor Site runs directly into the Potomac, it does not go to Blue Plains Water Treatment Plant[78]

Calculations

- Entire streets on the edge of study area were included to calculate collection of stormwater runoff
- Runoff collected from streets and other ROWs can be used for stormwater retention credits
- Annual water use per building was provided by NCPC (see Appendix 7)
- Stormwater retention credits will be valued at approximately $1/gallon
- Average annual rainfall in the DC region is 39.35 inches[79]
- Water Use Reduction Calculations
    - Calculations to determine the "50% potable water use reduction" were based on average annual rainfall captured and total water use per building. Due to limited information pertaining to the breakdown of current water use in buildings, water reductions assume that all captured water can be used to replace potable water uses.
- Impervious and Pervious Surface Baseline Calculations

[76] EPA Office of Water. ". Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act." *The United States Environmental Protection Agency*. EPA, Dec. 2008. Web. 27 Feb. 2013. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>.
[77] "Combined Sewer System." *DC Water*. District of Columbia Water and Sewer Authority, n.d. Web. 27 Apr. 2013. <http://www.dcwater.com/wastewater_collection/css/default.cfm>.
[78] Ibid.
[79] "Normal Monthly Precipitation (Inches)." *The National Oceanic and Atmospheric Administration*. NOAA, n.d. Web. 27 Apr. 2013. <http://www.ncdc.noaa.gov/oa/climate/online/ccd/nrmlprcp.html>.

    - Surface types were simplified into the following categories with corresponding runoff coefficients[80]
        - Impervious surfaces (concrete, asphalt, etc.) have a 0.95 runoff coefficient
        - Compact pervious surfaces (turf grass, footpaths, etc.) have a 0.25 runoff coefficient
        - Vegetated areas have a 0.00 runoff coefficient. However, there are no pervious surfaces of this type within the study area
- LID Runoff Coefficients
    - Green roofs in Alternative Scenario One have a 0.50 runoff coefficient. In Alternative Scenario Two green roofs have twice the retention capacity with a 0.00 runoff coefficient
    - Permeable pavement has a 0.00 runoff coefficient
    - Bioretention systems have 0.10 runoff coefficient
    - Tree canopy has a 0.85 runoff coefficient and converted permeable area under the canopy is considered compacted surface with a 0.25 runoff coefficient
- Building occupancy
    - USPS – 2,254
    - Urban REIT – 1,250
    - DOE-Forrestal Complex – 4,200
    - New DOE Complex – 5,300
    - L'Enfant South – 1,200
    - L'Enfant Plaza and Hotel
        - Office – 4,000; Hotel – 230 rooms

Low Impact Development features

- Calculations for the storage volume of green roofs, permeable pavement and bioretention were based on formulae in the DDOE Stormwater Management Guidebook along with typical measurements for many of the characteristics (as follows). The actual calculations can be found in the Appendix 8.
- Green roofs
    - EPA assumes a conservative estimate of 30% of a roof's impervious area can be converted to a green roof based on structural capacity and space for other rooftop equipment[81]
    - Extensive green roofs range from 3 to 6 inches in depth.[82] For Alternative Scenario One, green roofs are assumed to be 3 inches in depth while Alternative Scenario Two assumes 6 inches of depth.
    - Media and drainage layer porosity are both assumed to be 0.25[83] [84] [85]

[80] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. p11.
[81] EPA Office of Water. ". Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act." *The United States Environmental Protection Agency*. EPA, Dec. 2008. Web. 27 Feb. 2013. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>. p28.
[82] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. p26.
[83] Ibid.

    - Drainage layer depth is assumed to be .25 inches thick[86]
- Permeable pavement
    - EPA assumes the maximum percentage of permeable pavement that should be installed is 60% of the total paved area[87]
    - Depth of the reservoir layer is assumed to be approximately 1 foot[88]
    - The effective porosity for the reservoir layer is assumed to be 0.35[89]
    - Assumes no underdrain[90]
- Bioretention
    - EPA assumes that bioretention is most appropriately placed in areas that are already permeable. For the scenarios in the report, estimates for bioretention on the individual properties and total site varied.
    - Depth of the filter media is assumed to be 2 feet[91]
    - Effective porosity of the filter media is typically 0.25 according to the DDOE Stormwater Management Guidebook
    - Depth of the underdrain and underground storage gravel layer is assumed to be 9" deep[92]
    - Effective porosity of the gravel layer is typically 0.4 according to the DDOE Stormwater Management Guidebook
    - The maximum ponding depth average is 6 inches[93]
- Cisterns
    - Calculations for storage volume of cisterns were based on the LEED Reference Guide for Green Building Operations and Maintenance Formulae
    - There should be separate stormwater and rainwater cisterns due to necessity of different locations as well as distinct levels of treatment required
    - There will be some sort of pretreatment of stormwater or rainwater before entering cisterns

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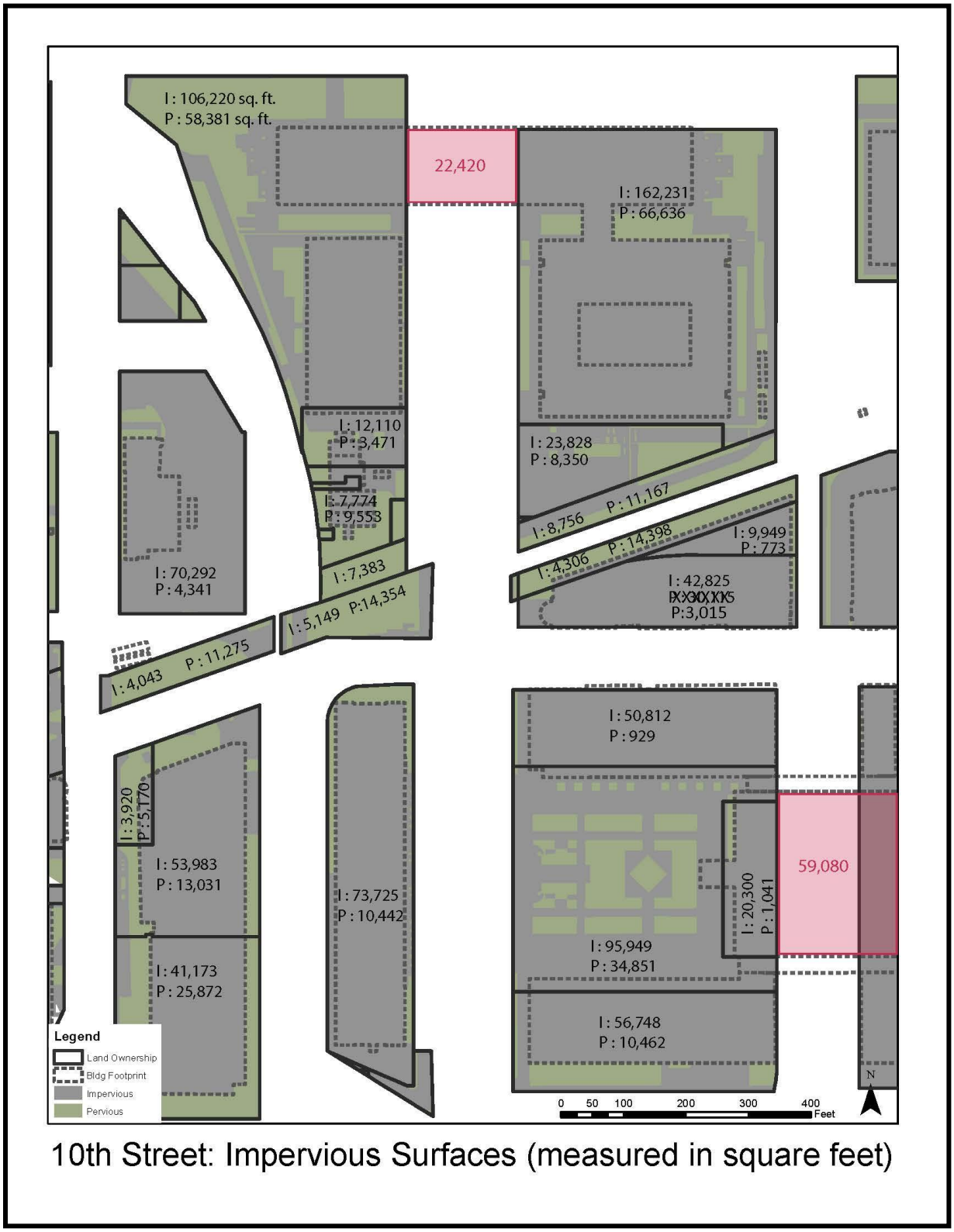
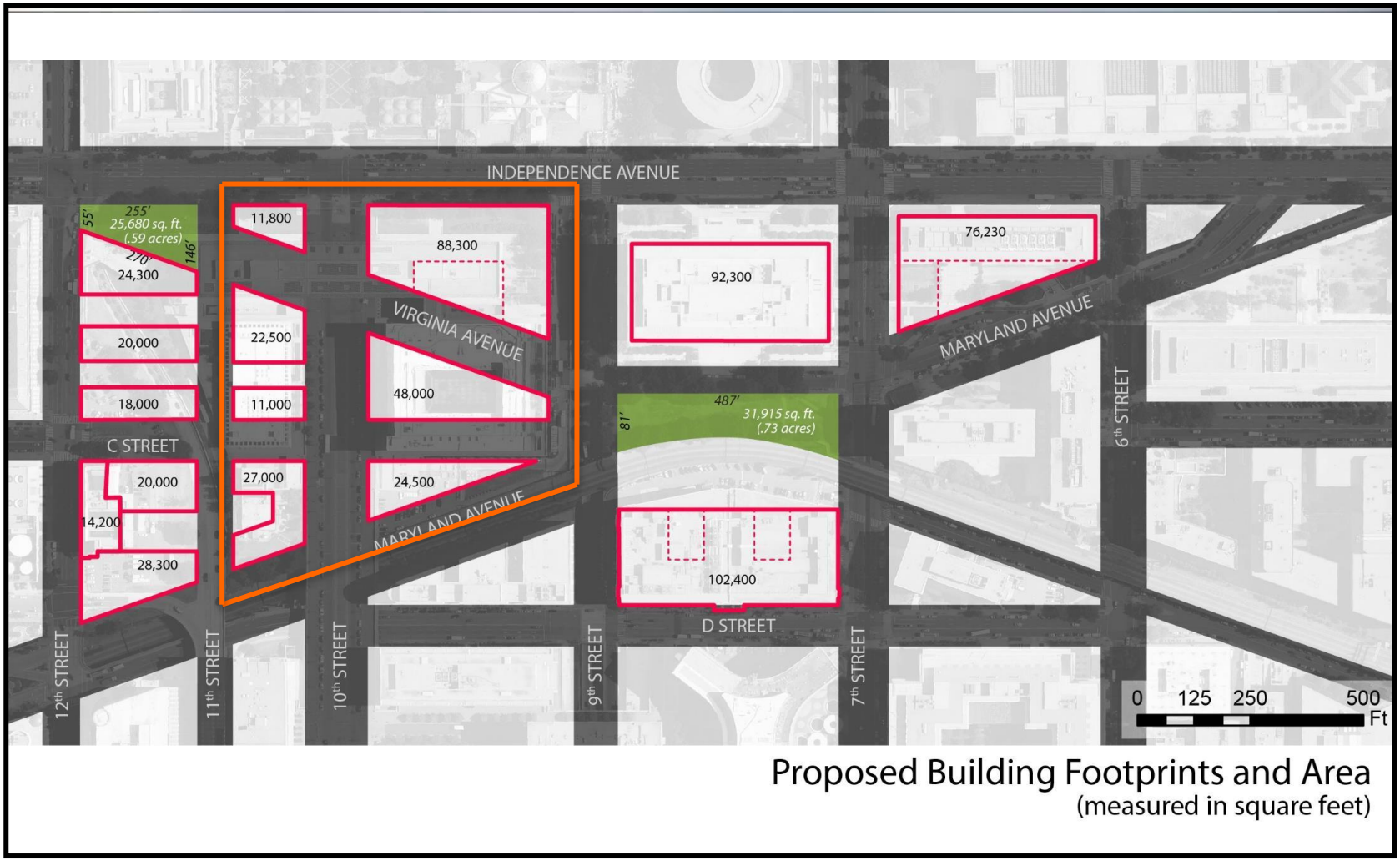
[84] "Greenroofs." 4.1. City of Indianapolis: Stormwater Design and Specification Manual. N.p.: n.p., n.d. Upper White River Watershed Alliance. Web. 28 Apr. 2013. <http://www.uwrwa.org/bmpTool/factSheets/4_1_Green_Roofs.pdf>.
[85] "Appendix A - Standards and Specifications." Queen Anne's County Maryland. WordPress, n.d. Web. 28 Apr. 2013. <http://www.qac.org/Docs/PublicWorks/esdm/9_QA_ESDManual_ APPENDIX%20A.pdf>.
[86] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. p31.
[87] EPA Office of Water. ". Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act." *The United States Environmental Protection Agency*. EPA, Dec. 2008. Web. 27 Feb. 2013. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>. p27-28.
[88] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>.
[89] Ibid.
[90] Lemoine, Leah. Personal Interview. 12 Apr. 2013.
[91] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. p108.
[92] Ibid. p108.
[93] Lemoine, Leah. Personal Interview. 12 Apr. 2013.

Appendix 4. Impermeable and Permeable Square Footage Map (NCPC)



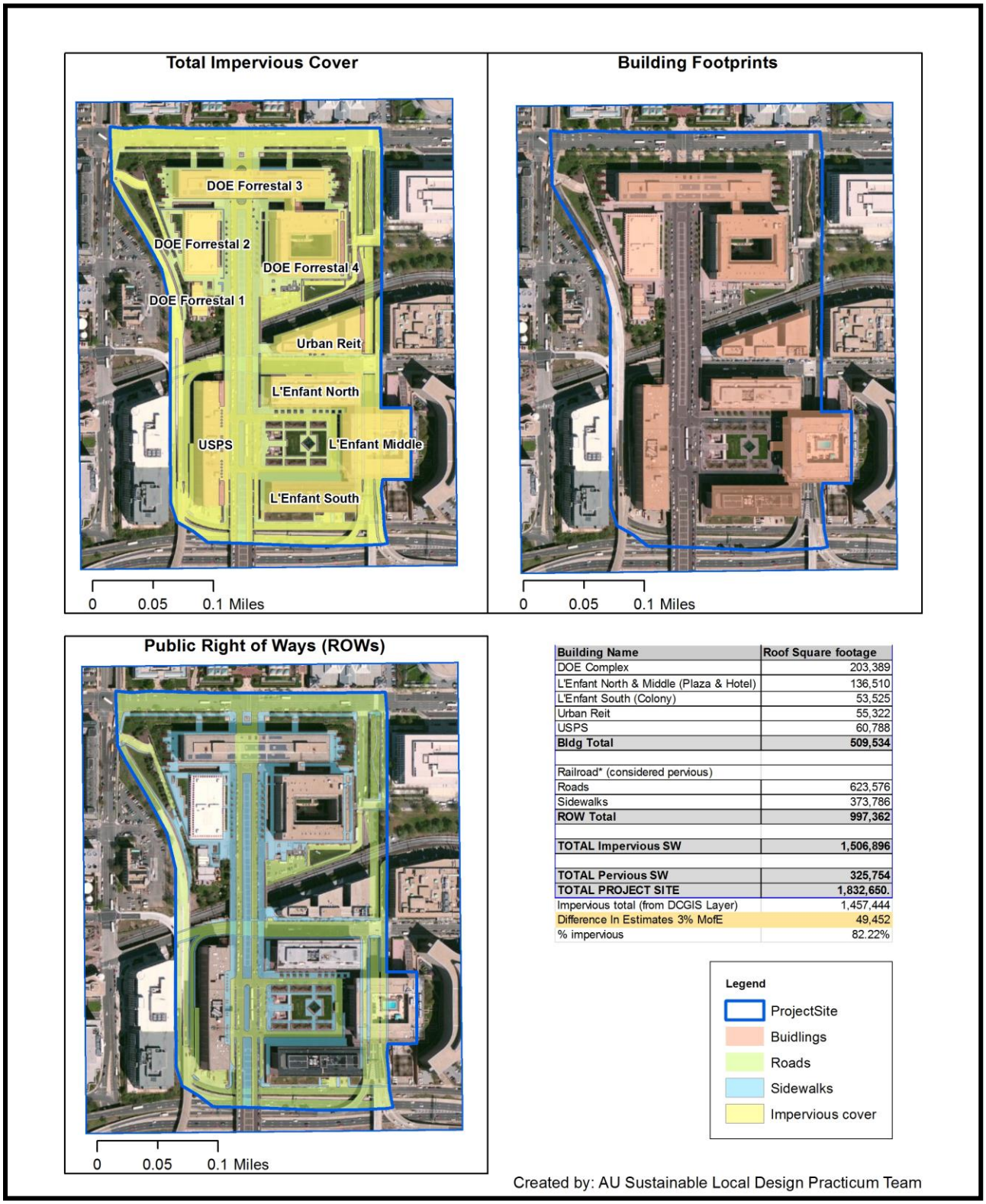
10th Street: Impervious Surfaces (measured in square feet)

Appendix 5. Map of Building Footprint Square Footage for New DOE Complex (NCPC)



Portion of buildings considered in analysis

Appendix 6. Building Footprint (Roof) and Right of Way Map (AU Team)



Building Name	Roof Square footage
DOE Complex	203,389
L'Enfant North & Middle (Plaza & Hotel)	136,510
L'Enfant South (Colony)	53,525
Urban Reit	55,322
USPS	60,788
Bldg Total	**509,534**
Railroad* (considered pervious)	
Roads	623,576
Sidewalks	373,786
ROW Total	**997,362**
TOTAL Impervious SW	**1,506,896**
TOTAL Pervious SW	**325,754**
TOTAL PROJECT SITE	**1,832,650.**
Impervious total (from DCGIS Layer)	1,457,444
Difference In Estimates 3% MofE	49,452
% impervious	82.22%

Legend
ProjectSite
Buidlings
Roads
Sidewalks
Impervious cover

Created by: AU Sustainable Local Design Practicum Team

Appendix 7. Water Use per Building (from NCPC 5/2011)

	370 L'Enfant Plaza, Urban REIT	L'Enfant Plaza Complex - North Office Building	L'Enfant Office (same bldg as Hotel)	L'Enfant Plaza Complex- South Office Building	L'Enfant Plaza Hotel (hotel and office in same bldg.)	USPS	DOE- Forrestal
							
Address	370 L'Enfant Plaza	955 L'Enfant Plaza	470/490 L'Enfant Plaza	950 L'Enfant Plaza	480 L'Enfant Plaza	475 L'Enfant Plaza	
GSF	404,773 sf	284,062 (all office) 8 floors above ground/4 below	434,615	415,143	265,228 (total bldg. gsf = 699,843)	1.5 million sf	1,808, 147 gsf Note: the small day care building on the southwest part of the site is 7,984 gsf
Water Use	7,000,000 gallons (17.29gal/gsf)	13,094,250 annual water gal	11,662,875 gallons	6,149,735 gallons	27,213,375 gallons	13,429,775 gallons	25,494,872 gallons (14.1 gal/gsf)
Toilets	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Appendix 8. Storage Volume Formulae[94] and Calculations for LID

Green Roofs

$$Sv = SA \times \frac{[(d \times \eta_1) + (DL \times \eta_2)]}{12}$$

Where,
Sv = storage volume (cu. ft.)
SA = green roof area (sq. ft.)
d = media depth (in.) (minimum 3 in.)
η_1 = media porosity (typically 0.25 but consult manufacturer's specifications)
DL = drainage layer depth (in.)
η_2 = drainage layer porosity (consult specific product specifications)

Storage volume for green roofs = [152,860.2 sq. ft. ((3 in. * 0.25) + (0.25 in. * 0.25)]/12 = **10,349.91 cubic feet (or 0.07 cubic feet per square foot)**

Where:

- SA = 152,860.2 sq. ft. = 509,534 sq. ft. * 0.3 - Assumed for these modeling analyses that up to 30% of a roof's impervious area could be converted into a green roof based on structural capacity and space for other rooftop equipment[95]
- d = 3 in. - Extensive green roofs range from 3 to 6 inches[96]
- n1 = 0.25 (typical)
- DL = 0.25 in. – Drainage layer depths for extensive green roofs range from 0.25-1.5 inches thick[97]
- n2 = 0.25[98] [99] [100]

[94] Taken directly from the DDOE Stormwater Management Guidebook and LEED Reference Guide for Green Building Operations and Maintenance; Assumptions for each calculation are elaborated on in Appendix 3
[95] EPA Office of Water. ". Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act." *The United States Environmental Protection Agency*. EPA, Dec. 2008. Web. 27 Feb. 2013. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>. p28.
[96] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. p26.
[97] Ibid. p31.
[98] "7 Stormwater Management Practice Design Guidelines." Chapter 7. City of Philadelphia Stormwater Management Guidance Manual. Comp. Philadelphia Water Department Office of Watersheds. N.p.: n.p., n.d. 7-1-7-110. Philadelphia Water Department. Web. 28 Apr. 2013. <http://www.pwdplanreview.org/WICLibrary/chapter%207.pdf>. p6-7.
[99] "Greenroofs." 4.1. City of Indianapolis: Stormwater Design and Specification Manual. N.p.: n.p., n.d. Upper White River Watershed Alliance. Web. 28 Apr. 2013. <http://www.uwrwa.org/bmpTool/factSheets/4_1_Green_Roofs.pdf>.
[100] "Appendix A - Standards and Specifications." Queen Anne's County Maryland. WordPress, n.d. Web. 28 Apr. 2013. <http://www.qac.org/Docs/PublicWorks/esdm/9_QA_ESDManual_ APPENDIX%20A.pdf>.

Bioretention

$$Sv_{practice} = SA_{bottom} \times [(d_{media} \times \eta_{media}) + (d_{gravel} \times \eta_{gravel})] + (SA_{average} \times d_{ponding})$$

Where:

$Sv_{practice}$	=	total storage volume of practice (cu. ft.)
SA_{bottom}	=	bottom surface area of practice (sq. ft.)
d_{media}	=	depth of the filter media (ft)
η_{media}	=	effective porosity of the filter media (typically 0.25)
d_{gravel}	=	depth of the underdrain and underground storage gravel layer (ft)
η_{gravel}	=	effective porosity of the gravel layer (typically 0.4)
$SA_{average}$	=	the average surface area of the practice (sq. ft.) typically = ½ x (top area plus the bottom (SA_{bottom}) area)
$d_{ponding}$	=	the maximum ponding depth of the practice (ft.)

Bioretention Storage Volume = 214,998 sq. ft. * [(2 ft. * 0.25) + (0.75 ft * 0.4)] + (270,376 sq. ft. * 0.5 ft.) = **307,186.4 cubic feet (or 1.14 cubic feet per square foot)**

Where:

- SAbottom = 214,998 = 2/3 of the total area of the practice - Assuming all pervious areas of site are converted to bioretention[101]
- dmedia = 24 inches – There is a minimum depth of 24 inches[102]
- nmedia = 0.25 (typical)
- dgravel = 0.75 ft. – Assume that depth of the underdrain and underground storage gravel layer is at least 9" deep[103]
- ngravel = 0.4 (typical)
- SAaverage = 270,376 sq. ft. = 1/2 (325,754 + 214,998)
- dponding = 6 inches – Assuming that the average ponding depth is 6 inches[104]

[101] EPA Office of Water. ". Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act." *The United States Environmental Protection Agency*. EPA, Dec. 2008. Web. 27 Feb. 2013. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>.
[102] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. p108.
[103] Ibid. p108.
[104] Lemoine, Leah. Personal Interview. 12 Apr. 2013.

Permeable Pavements

$$Sv = d_p \times \eta_r \times A_p$$

Where:

A_p = the permeable pavement surface area (ft^2)

Permeable pavement storage volume = 0.97 ft. * 0.35 * 598,417.2 sq. ft. = **203,162.64 cubic feet (0.204 cubic feet per square foot)**

Where:

- Depth of the reservoir layer (dp) = 0.9683 ft – Depth is usually 12-24 inches[105]
- Effective porosity for the reservoir layer (nr) = 0.35[106]
- Ap = (0.6*997,362)= 598,417.2 - Assumed maximum percentage applied is 60% of the total paved area[107]
- Assuming no underdrain[108]

[105] DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>.
[106] Ibid.
[107] EPA Office of Water. "Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act." *The United States Environmental Protection Agency*. EPA, Dec. 2008. Web. 27 Feb. 2013. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>.p27-28.
[108] Lemoine, Leah. Personal Interview. 12 Apr. 2013.

Cisterns[109]

Volume of Captured Runoff

V, (cubic feet) = (P)(Rv)(A)/12''

Where
- V = volume of captured runoff
- P = average rainfall event (inches)
- Rv = 0.05 + (0.009)(I) where I = percent impervious of collection site
- A = area of collection surface (square feet)

Minimum Drawdown Rate: Assesses the minimum drawdown rate necessary to empty the tank before the next rainfall event

Qr (cubic feet per second) = Tank Capacity (cubic feet) / Rainfall Event Interval (seconds)

Where
- Qr = minimum drawdown rate
- Rainfall event interval = 72 hours, DDOE Guidebook, p 44

Tenth Street SW Corridor Site (roof and ground runoff)

1.2 inch rain event:

Volume of captured runoff = (1.2 * 0.788 * 1,832,650) / 12'' = **144,412.82 cubic feet** or 1,080,283 gallons (1 cubic foot = 7.48052 gallons)

Where:
- P = 1.2 inches
- Rv = 0.788
- I = 88%
- A = 1,832,650 square feet

Minimum drawdown rate = Qr = 144,412.82 cubic feet / 259,200 seconds = **0.56 cubic feet per second**

1.7 inch rain event:

Volume of captured runoff = (1.7 * 0.788 * 1,832,650)/ 12'' = **204,584.82 cubic feet** or 1,530,400.8 gallons

[109] Adapted from LEED Reference Guide for Green Building Operations and Maintenance Formulae

DOE Forrestal Complex (Roof and ground runoff)

1.2 inch rain event:

Volume of captured runoff **=** (1.2 * 0.95 * 203,389)/ 12'' **= 19,321.96 cubic feet** or 144,538 gallons (1 cubic foot = 7.48052 gallons)

Where:

- P = 1.2 inches
- Rv = 0.95
- I = 203,389 square feet
- A = 203,389 square feet

Minimum drawdown rate = Qr = 19,321.96 cubic feet / 259,200 seconds = **0.07 cubic feet per second**

1.7 inch rain event:

Volume of captured runoff **=** (1.7 * 0.95 * 203,389)/ 12'' **= 27,372.77 cubic feet** or 204,762 gallons

USPS Building (Roof runoff)

1.2 inch rain event:

Volume of captured runoff = **(**1.2 * 0.95 * 60,788)/ 12'' **= 5,774.86 cubic feet** or 43,198.96 gallons (1 cubic foot = 7.48052 gallons)

Where:

- P = 1.2 inches
- Rv = 0.95
- I = 60,788 square feet
- A = 60,788 square feet

Minimum drawdown rate = 5,774.86 cubic feet / 259,200 seconds = **0.02 cubic feet per second**

1.7 inch rain event:

Volume of captured runoff = **(**1.7 * 0.95 * 60,788)/ 12'' **= 8181.05 cubic feet** or 61198.52 gallons (1 cubic foot = 7.48052 gallons)

Appendix 9. Current Tenth Street Corridor Site Area and Runoff

AREA		RUNOFF			
		1.7" rain event runoff		Average annual	
Building Name	**Square Footage**	**Cubic Feet**	**Gallons**	**Cubic Feet**	**Gallons**
Building Roof Impervious Area					
DOE Complex	203,389	27,373	204,763	633,599	4,739,651
L'Enfant North & Middle (Plaza & Hotel)	136,510	18,372	137,432	425,257	3,181,144
L'Enfant South (Colony)	53,525	7,204	53,886	166,742	1,247,313
Urban Reit	55,322	7,445	55,696	172,340	1,289,189
USPS	60,788	8,181	61,199	189,367	1,416,566
Roof Total	**509,534**	**68,575**	**512,975**	**1,587,305**	**11,873,864**
Site Impervious Area					
DOE Complex	152,482	20,522	153,512	475,013	3,553,346
L'Enfant North & Middle (Plaza & Hotel)	89,631	12,063	90,236	279,219	2,088,705
L'Enfant South (Colony)	3,223	434	3,245	10,040	75,107
Urban REIT	1,758	237	1,770	5,477	40,967
USPS	12,937	1,741	13,024	40,301	301,476
Site Area Total	**260,031**	**34,996**	**261,787**	**810,051**	**6,059,601**
Public Right of Way Impervious Area					
Public Roads and Sidewalks	737,331	99,232	742,310	2,296,940	17,182,303
ROW Total	**737,331**	**99,232**	**742,310**	**2,296,940**	**17,182,303**
TOTAL Impervious SW	**1,506,896**	**202,803**	**1,517,073**	**4,694,295**	**35,115,767**
Building Site Pervious Area					
Pervious Right of Ways	121,033	4,287	32,066	99,222	742,231
DOE Complex	101,710	3,602	26,947	83,381	623,733
L'Enfant Plaza & Hotel	36,821	1,304	9,755	30,186	225,804
L'Enfant South	10,462	371	2,772	8,577	64,158
Urban REIT	18,186	644	4,818	14,909	111,525
USPS	10,442	370	2,766	8,560	64,035
TOTAL Pervious SW	**298,654**	**10,577**	**79,124**	**244,834**	**1,831,486**
TOTAL PROJECT SITE	**1,805,550**	**213,380**	**1,596,196**	**4,939,129**	**36,947,254**

Appendix 10. Individual Site Design and Cost-Benefit Analysis Calculations

USPS Headquarters	
	**Property owner**: Federal Government
	Area: 84,167 ft^2
	Roof Area: 60,788 ft^2
	Existing Impervious Area: 88%
	Existing Pervious Area: 12%
	Current Total Annual Runoff: 238,229 ft^3; 1,782,077 gal

Current Site	**Total Area (ft^2)**	**Total Annual Potable Water Use (gal)**	**Rainfall in 1.7" Event (gal)**	**Current Permeable Area (ft^2)**	
	84,167	13,429,775	76,989	10,422	
Design Option	**Area Managed by LID (ft^2)**	**Reduced Annual Runoff (gal)**	**Rainfall Retained in 1.7" Event (gal)**	**Permeable Surface Area Change (ft^2)**	**Size of System (ft^2 or gal)**
Green roofs	21,276	234,852	10,146	21,276	21,276
Permeable Pavement	0	0	0	0	0
Sub Total	21,276	234,852	10,146	21,276	
Cistern, Roof capture	60,788	1,181,714	51,052	0	51,052
Cistern, Ground capture	0	0	0	0	0
Bioretention (Vegetated Swales)	15,554	308,163	5,435	0	4,581
Total	**97,618**	**1,724,728**	**66,634**	**21,276**	
SW Ecodistrict Goals		**Gallons needed for 50% potable water reduction goal**	**Water to be retained to achieve 1.7" Rain Event Goal (gal)**	**Permeable square feet needed for 35% goal**	
		6,714,888	76,989	29,458	
% of Goal Achieved		**18%**	**87%**	**108%**	

USPS Cost-Benefit Analysis

Design Option	Cost/Ft^2 or Gallon	Total Cost	Subsidy
Green roofs	$ 16.00	$ 340,412.80	$ 20,000.00
Permeable Pavement	$ 15.00	$ -	-
Cistern	$ 27.00	$ 1,378,416.15	-
Bioretention (Vegetated Swales)	$ 32.50	$ 148,869.10	-
Total Project		**$ 1,867,698.05**	**$ 20,000.00**

USPS Savings	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	7 year total	Average annual
IAC Fee	$ 9.57	$ 14.52	$ 17.66	$ 20.33	$ 23.19	$ 25.49	$ 28.77	-	-
Stormwater fee	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	-	-
Old fees	$ 10,828.73	$ 15,207.99	$ 17,985.95	$ 20,348.10	$ 22,878.34	$24,913.15	$27,814.97	$139,977.23	-
New Fees with Riversmart Rewards	$ 6,733.32	$ 9,848.81	$ 11,825.09	$ 13,505.57	$ 15,305.62	$16,753.22	$18,817.62	$ 92,789.25	-
Savings with Riversmart Rewards	**$ 4,095.40**	**$ 5,359.19**	**$ 6,160.86**	**$ 6,842.53**	**$ 7,572.72**	**$ 8,159.93**	**$ 8,997.35**	**$ 47,187.98**	**$ 6,741.14**
Stormwater Credit	**$ 66,633.93**	**$ 66,633.93**	**$ 66,633.93**	**$ 66,633.93**	**$ 66,633.93**	**$66,633.93**	**$66,633.93**	**$466,437.50**	**$ 66,633.93**
Water fee ($/CCF)	$ 3.42	$ 3.66	$ 3.88	$ 4.13	$ 4.38	$ 4.58	$ 4.74	-	-
Water $ savings if all cistern water offsets potable water use	**$ 5,402.65**	**$ 5,781.78**	**$ 6,129.32**	**$ 6,524.25**	**$ 6,919.18**	**$ 7,235.13**	**$ 7,487.88**	**$ 45,480.19**	**$ 6,497.17**
Total Savings	**$ 76,131.98**	**$ 77,774.90**	**$ 78,924.11**	**$ 80,000.71**	**$ 81,125.83**	**$82,028.99**	**$83,119.16**	**$559,105.67**	**$ 79,872.24**

Payback (Years)	20.00
Payback w/water fee reduction (Years)	18.70

L'Enfant South	
	**Property owner**: Heyman Properties, LLC
	Area: 67,210 ft^2
	Roof Area: 53,525 ft^2
	Existing Impervious Area: 84%
	Existing Pervious Area: 16%
	Current Total Annual Runoff: 185,359 ft^3; 1,386,578 gal

Current Site	**Total Area (ft^2)**	**Total Annual Potable Water Use (gal)**	**Rainfall in 1.7" Event (gal)**	**Current Permeable Area (ft^2)**	
	67,210	6,149,735	59,903	10,462	
Design Option	**Area Managed by LID (ft^2)**	**Reduced Annual Runoff (gal)**	**Rainfall Retained in 1.7" Event (gal)**	**Permeable Surface Area Change (ft^2)**	**Size of System (ft^2 or gal)**
Green roofs	16,058	177,250	7,658	16,058	16,058
Permeable Pavement	1,934	45,064	1,947	1,934	1,934
Sub Total	17,991	222,314	9,604	17,991	
Cistern, Roof capture	53,525	1,070,064	46,229	0	46,229
Cistern, Ground capture	0	0	0	0	0
Bioretention (Vegetated Swales)	10,462	60,631	2,619	0	321
Total	**81,978**	**1,353,009**	**58,453**	**17,991**	
SW Ecodistrict Goals		**Gallons needed for 50% potable water reduction goal**	**Water to be retained to achieve 1.7" Rain Event Goal (gal)**	**Permeable square feet needed for 35% goal**	
		3,074,868	59,903	23,524	
% of Goal Achieved		**35%**	**98%**	**121%**	

L'Enfant South Cost-Benefit Analysis

Design Option	Cost/Ft^2 or Gallon	Total Cost	Subsidy
Green roofs	$ 16.00	$ 256,920.00	$ 20,000.00
Permeable Pavement	$ 15.00	$ 29,007.00	-
Cistern	$ 27.00	$ 1,248,180.84	-
Bioretention (Vegetated Swales)	$ 32.50	$ 10,439.06	-
Total Project		**$ 1,544,546.90**	**$ 20,000.00**

L'Enfant South Savings	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	7 year total	Average annual
IAC Fee	$ 9.57	$ 14.52	$ 17.66	$ 20.33	$ 23.19	$ 25.49	$ 28.77	-	-
Stormwater fee	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	-	-
Old fees	$ 8,335.15	$ 11,705.98	$ 13,844.24	$15,662.45	$17,610.04	$19,176.28	$21,409.89	$107,744.02	-
New Fees with Riversmart Rewards	$ 4,819.78	$ 7,121.92	$ 8,582.28	$ 9,824.04	$11,154.17	$12,223.86	$13,749.32	$ 67,475.36	-
Savings with Riversmart Rewards	**$ 3,515.37**	**$ 4,584.05**	**$ 5,261.97**	**$ 5,838.41**	**$ 6,455.87**	**$ 6,952.43**	**$ 7,660.57**	**$ 40,268.66**	**$ 5,752.67**
Stormwater Credit	**$ 58,452.73**	**$ 58,452.73**	**$ 58,452.73**	**$58,452.73**	**$58,452.73**	**$58,452.73**	**$58,452.73**	**$409,169.13**	**$ 58,452.73**
Water fee ($/CCF)	$ 3.42	$ 3.66	$ 3.88	$ 4.13	$ 4.38	$ 4.58	$ 4.74	-	-
Water $ savings if all cistern water offsets potable water use	**$ 4,892.20**	**$ 5,235.51**	**$ 5,550.21**	**$ 5,907.83**	**$ 6,265.44**	**$ 6,551.54**	**$ 6,780.41**	**$ 41,183.14**	**$ 5,883.31**
Total Savings	**$ 66,860.30**	**$ 68,272.30**	**$ 69,264.91**	**$70,198.97**	**$71,174.05**	**$71,956.70**	**$72,893.71**	**$490,620.93**	**$ 70,088.70**

Payback (Years)	18.34
Payback w/water fee reduction (Years)	17.14

L'Enfant Plaza and Hotel	
	**Property owner**: JBG Companies
	Area: 262,962 ft^2
	Roof Area: 136,510 ft^2
	Existing Impervious Area: 86%
	Existing Pervious Area: 14%
	Current Total Annual Runoff: 734,662 ft^3; 5,495,653 gal

Current Site	**Total Area (ft^2)**	**Total Annual Potable Water Use (gal)**	**Rainfall in 1.7" Event (gal)**	**Current Permeable Area (ft^2)**	
	262,962	51,970,500	237,423	36,821	
Design Option	**Area Managed by LID (ft^2)**	**Reduced Annual Runoff (gal)**	**Rainfall Retained in 1.7" Event (gal)**	**Permeable Surface Area Change (ft^2)**	**Size of System (ft^2 or gal)**
Green roofs	40,953	452,057	19,530	40,953	40,953
Permeable Pavement	0	0	0	0	0
Sub Total	40,953	452,057	19,530	40,953	
Cistern, Roof capture	136,510	2,729,087	117,902	0	117,902
Cistern, Ground capture	126,452	2,314,509	99,991	0	99,991
Bioretention (Vegetated Swales)	0	0	0	0	0
Total	**303,915**	**5,495,653**	**237,423**	**40,953**	
SW Ecodistrict Goals		**Gallons needed for 50% potable water reduction goal**	**Water to be retained to achieve 1.7" Rain Event Goal (gal)**	**Permeable square feet needed for 35% goal**	
		25,985,250	237,423	92,037	
% of Goal Achieved		**19%**	**100%**	**85%**	

L'Enfant Plaza & Hotel Cost-Benefit Analysis

Design Option	Cost/Ft^2 or Gallon	Total Cost	Subsidy
Green roofs	$ 16.00	$ 655,248	$ 20,000
Permeable Pavement	$ 15.00	$ -	-
Cistern	$ 27.00	$ 5,883,127	-
Bioretention (Vegetated Swales)	$ 32.50	$ -	-
Total Project		**$ 6,538,375**	**$ 20,000**

L'Enfant Plaza & Hotel	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	7 year total	Average annual
IAC Fee	$ 9.57	$ 14.52	$ 17.66	$ 20.33	$ 23.19	$ 25.49	$ 28.77	-	-
Stormwater fee	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	-	-
Old fees	$ 33,215.59	$ 46,648.37	$ 55,169.36	$ 62,414.92	$ 70,176.08	$ 76,417.57	$ 85,318.48	$ 429,360.35	-
New Fees with Riversmart Rewards	$ 22,625.98	$ 33,626.15	$ 40,604.04	$ 46,537.46	$ 52,893.11	$ 58,004.30	$ 65,293.30	$ 319,584.34	-
Savings with Riversmart Rewards	**$ 10,589.61**	**$ 13,022.21**	**$ 14,565.32**	**$ 15,877.46**	**$ 17,282.96**	**$ 18,413.27**	**$ 20,025.18**	**$ 109,776.01**	**$ 15,682.29**
Stormwater Credit	**$ 237,423.38**	**$ 237,423.38**	**$237,423.38**	**$ 237,423.38**	**$237,423.38**	**$237,423.38**	**$237,423.38**	**$ 1,661,963.64**	**$ 237,423.38**
Water fee ($/CCF)	$ 3.42	$ 3.66	$ 3.88	$ 4.13	$ 4.38	$ 4.58	$ 4.74	-	-
Water $ savings if all cistern water offsets potable water use	**$ 23,058.69**	**$ 24,676.84**	**$ 26,160.15**	**$ 27,845.72**	**$ 29,531.30**	**$ 30,879.76**	**$ 31,958.53**	**$ 194,110.99**	**$ 27,730.14**
Total Savings	**$ 271,071.67**	**$ 275,122.43**	**$278,148.85**	**$ 281,146.56**	**$284,237.64**	**$286,716.41**	**$289,407.08**	**$ 1,965,850.63**	**$ 280,835.80**

Payback (Years)	23.94
Payback w/water fee reduction (Years)	21.73

Urban Reit	
	**Property owner**: CIM Group
	Area: 75,266 ft^2
	Roof Area: 55,322 ft^2
	Existing Impervious Area: 76%
	Existing Pervious Area: 24%
	Current Total Annual Runoff: 192,725 ft^3; 1,441,682 gal

Current Site	**Total Area (ft^2)**	**Total Annual Potable Water Use (gal)**	**Rainfall in 1.7" Event (gal)**	**Current Permeable Area (ft^2)**	
	75,266	7,000,000	62,284	18,186	
Design Option	**Area Managed by LID (ft^2)**	**Reduced Annual Runoff (gal)**	**Rainfall Retained in 1.7" Event (gal)**	**Permeable Surface Area Change (ft^2)**	**Size of System (ft^2 or gal)**
Green roofs	16,597	183,201	7,915	16,597	16,597
Permeable Pavement	0	0	0	0	0
Sub Total	16,597	183,201	7,915	16,597	
Cistern, Roof capture	55,322	1,105,989	47,781	0	47,781
Cistern, Ground capture	0	0	0	0	0
Bioretention (Vegetated Swales)	19,944	103,570	4,474	0	2,023
Total	**91,863**	**1,392,760**	**60,170**	**16,597**	
SW Ecodistrict Goals		**Gallons needed for 50% potable water reduction goal**	**Water to be retained to achieve 1.7" Rain Event Goal (gal)**	**Permeable square feet needed for 35% goal**	
		3,500,000	62,284	26,343	
% of Goal Achieved		**32%**	**97%**	**132%**	

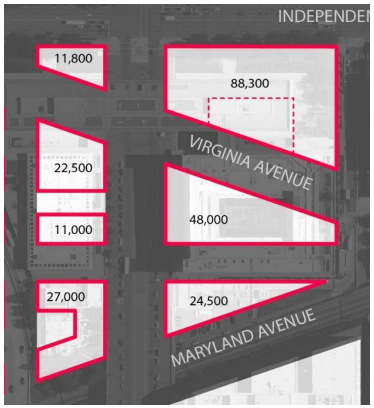
Urban REIT Cost-Benefit Analysis

Design Option	Cost/Ft^2 or Gallon	Total Cost	Subsidy
Green roofs	$ 16.00	$ 265,546	$ 20,000
Permeable Pavement	$ 15.00	$ -	-
Cistern	$ 27.00	$ 1,290,086	-
Bioretention (Vegetated Swales)	$ 32.50	$ 65,759	-
Total Project		$ 1,621,390	$ 20,000

Urban Reit	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	7 year total	Average annual
IAC Fee	$ 9.57	$ 14.52	$ 17.66	$ 20.33	$ 23.19	$ 25.49	$ 28.77	-	-
Stormwater fee	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	-	-
Old fees	$ 8,383.91	$ 11,774.46	$ 13,925.24	$ 15,754.08	$17,713.07	$ 19,288.47	$21,535.14	$108,374.37	-
New Fees with Riversmart Rewards	$ 4,986.13	$ 7,390.84	$ 8,916.26	$ 10,213.35	$11,602.74	$ 12,720.08	$14,313.50	$ 70,142.89	-
Savings with Riversmart Rewards	**$ 3,397.78**	**$ 4,383.62**	**$ 5,008.98**	**$ 5,540.73**	**$ 6,110.33**	**$ 6,568.40**	**$ 7,221.64**	**$ 38,231.48**	**$ 5,461.64**
Stormwater Credit	**$ 60,170.04**	**$ 60,170.04**	**$ 60,170.04**	**$ 60,170.04**	**$60,170.04**	**$ 60,170.04**	**$60,170.04**	**$421,190.30**	**$ 60,170.04**
Water fee ($/CCF)	$ 3.42	$ 3.66	$ 3.88	$ 4.13	$ 4.38	$ 4.58	$ 4.74	-	-
Water $ savings if all cistern water offsets potable water use	**$ 5,056.44**	**$ 5,411.28**	**$ 5,736.55**	**$ 6,106.17**	**$ 6,475.79**	**$ 6,771.49**	**$ 7,008.05**	**$ 42,565.78**	**$ 6,080.83**
Total Savings	**$ 68,624.27**	**$ 69,964.94**	**$ 70,915.57**	**$ 71,816.95**	**$72,756.17**	**$ 73,509.93**	**$74,399.73**	**$501,987.56**	**$ 71,712.51**

Payback (Years)	18.93
Payback w/water fee reduction (Years)	17.68

New DOE complex



Property owner: General Services Administration

Area: 476,723 ft^2

Projected Roof Area: 233,100 ft^2

Projected Impervious Area: 65%

Projected Pervious Area: 35%

Projected Total Annual Runoff: 1,073,535 ft^3; 8,030,589 gal

Current Site	Total Area (ft^2)	Total Annual Potable Water Use (gal) (est. new complex)	Difference b/w 1.7" and 1.2" rain event*	Current Permeable Area (ft^2)	
	476,723	10,947,150	102,041	179,295	
Design Option	**Area Managed by LID (ft^2)**	**Reduced Annual Runoff (gal)**	**Rainfall Retained in 1.7" Event (gal)**	**Permeable Surface Area Change (ft^2)**	**Size of System (ft^2 or gal)**
Green roofs	0	0	0	0	0
Permeable Pavement	0	0	0	0	0
Sub Total	0	0	0	0	
Cistern, Roof capture	233,100	5,432,017	69,022**	0	69,022
Cistern, Ground capture	0	0	0	0	0
Bioretention (Vegetated Swales)	0	0	0	0	0
Total	**233,100**	**5,432,017**	**234,674**	**0**	
SW Ecodistrict Goals		**Gallons needed for 50% potable water reduction goal**	**Water to be retained to achieve 1.7" Rain Event Goal (gal)**	**Permeable square feet needed for 35% goal**	
		5,473,575	102,041	179,295	
% of Goal Achieved		**99%**	**68%**	**100%**	

*DOE must meet the 1.2" rain event when it redevelops

**Cisterns estimated to only be as big as the difference between the 1.7" rain event and the 1.2" rain event roof runoff

New DOE Complex Costs and Savings

Design Option	Cost/Ft^2 or	Total Cost	Subsidy
Green roofs	$ 16.00	$ -	-
Permeable Pavement	$ 15.00	$ -	-
Cistern	$ 27.00	$ 1,863,589	-
Bioretention (Vegetated Swales)	$ 32.50	$ -	-
Total Project		$ 1,863,589	$ -

DOE Savings	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	7 year total	Average annual
Stormwater Credit	**$ 69,021.82**	**$ 69,021.82**	**$ 69,021.82**	**$ 69,021.82**	**$ 69,021.82**	**$ 69,021.82**	**$ 69,021.82**	**$ 483,152.76**	**$ 69,021.82**
Water fee ($/CCF)	$ 3.42	$ 3.66	$ 3.88	$ 4.13	$ 4.38	$ 4.58	$ 4.74	-	-
Water $ savings if all cistern water offsets potable water use	**$ 24,834.50**	**$ 26,577.28**	**$ 28,174.82**	**$ 29,990.20**	**$ 31,805.59**	**$ 33,257.90**	**$ 34,419.75**	**$ 209,060.04**	**$ 29,865.72**
Total	**$ 93,856.33**	**$ 95,599.10**	**$ 97,196.64**	**$ 99,012.03**	**$ 100,827.41**	**$ 102,279.72**	**$ 103,441.57**	**$ 692,212.80**	**$ 98,887.54**

Payback Years*	**18.85**
*Based on stormwater credits and water savings alone	

It is unknown how the ground area of DOE will redevelop, however it is assumed that the ground areas of new DOE complex will meet the 35% pervious goal. Assumptions about the size of bioretention systems and permeable pavement are not made. Solar panels are assumed to be placed on all DOE roofs so green roofs are not included. A roof cistern is assumed to be the best strategy to capture the roof runoff difference between the 1.2” rain event (which must already be managed for the whole site) and the 1.7” rain event (which is the SW Ecodistrict goal). Since managing a 1.2” rain event is a requirement when redeveloping, DOE would only be eligible to receive stormwater credits for the difference between the 1.2” and 1.7” rain events.

Appendix 11. Tenth Street Corridor Site Design and Cost-Benefit Analysis Calculations

Tenth Street Corridor Site	
	**Property owner**: Mix of Federal and Private
	Area: 1,832,650 ft^2
	Roof Area: 539,245 ft^2
	Existing Impervious Area: 79%
	Existing Pervious Area: 21%
	Current Total Annual Runoff: 4,827,194 ft^3; 36,109,924 gal

Current Site	**Total Area (ft^2)**	**Total Annual Potable Water Use (gal)***	**Rainfall in 1.7" Event (gal)****	**Current Permeable Area (ft^2)**	
	1,832,650	89,497,160	1,557,913	384,197	
Design Option	**Area Managed by LID (ft^2)**	**Reduced Annual Runoff (gal)**	**Rainfall Retained in 1.7" Event (gal)**	**Permeable Surface Area Change (ft^2)**	**Size of System (ft^2 or gal)**
Trees	42,000	231,807	10,015	21,000	21,000
Green roofs	189,766	4,189,438	180,992	189,766	189,766
Permeable Pavement	0	0	0	33,662	33,662
Sub Total	189,766	4,421,245	191,007	244,428	
Cistern, Roof capture	539,245	8,376,793	361,894	0	361,894
Cistern, Ground capture	515,931	6,863,567	296,520	0	296,520
Bioretention (Vegetated Swales)	267,360	16,555,478	715,230	12,803	30,434
Total	1,520,127	36,217,083	1,564,652	257,231	
SW Ecodistrict Goals		**Gallons needed for 50% potable water reduction goal**	**Water to be retained to acheive 1.7" Rain Event Goal (gallons)**	**Permeable Sq Ft needed for 35% goal**	
		44,748,580	1,557,913	641,428	
% of Goal Achieved		**34%**	**100%**	**100%**	

*Includes estimated water reductions from new DOE complex
**Runoff totals assume new DOE complex surfaces

Tenth Street Corridor Site Cost-Benefit Analysis

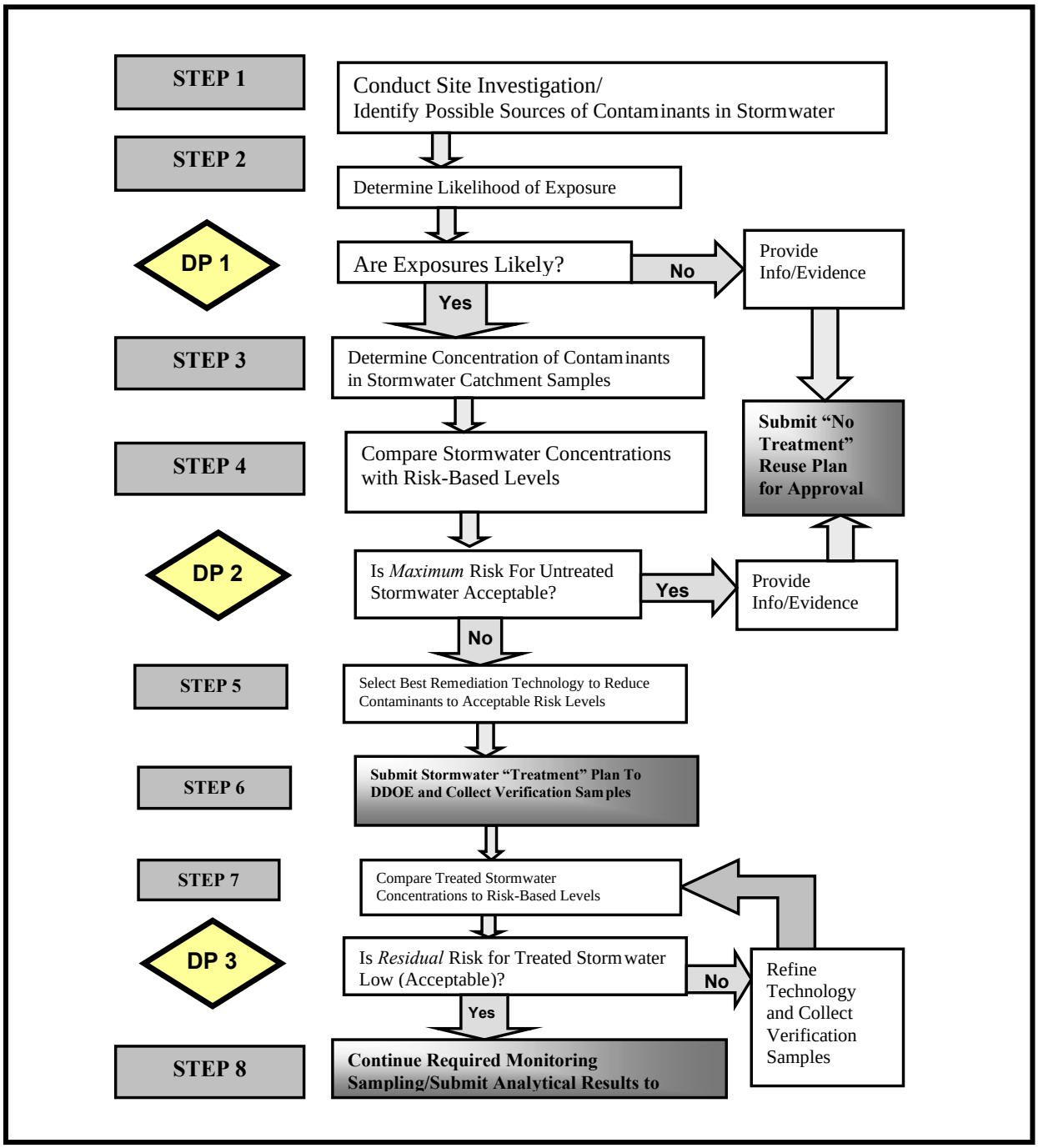
Design Option	Cost/Ft^2 or Gallon	Total Cost	Subsidy
Green roofs	$ 17.00*	$ 3,226,018.60	$ 80,000.00
Permeable Pavement	$ 15.00	$ 504,930.00	-
Cistern	$ 27.00	$ 17,777,192.27	-
Bioretention (Vegetated Swales)	$ 32.50	$ 989,107.57	-
Trees**	$ 15.23	$ 319,830.00	-
Total Project		$ 22,817,078.43	$ 80,000.00

Tenth Street Corridor Site	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	7 year total	Average annual
IAC Fee	$ 9.57	$ 14.52	$ 17.66	$ 20.33	$ 23.19	$ 25.49	$ 28.77	-	-
Stormwater fee	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	$ 2.67	-	-
Old fees	$ 104,449.60	$ 146,690.25	$ 173,485.32	$ 196,269.67	$ 220,675.38	$ 240,302.35	$ 268,292.11	$ 1,350,164.67	-
New Fees with Riversmart Rewards	$ 43,863.66	$ 74,832.22	$ 94,476.92	$ 111,181.17	$ 129,074.12	$ 143,463.55	$ 163,984.13	$ 760,875.78	-
Savings with Riversmart Rewards	**$ 60,585.94**	**$ 71,858.03**	**$ 79,008.40**	**$ 85,088.50**	**$ 91,601.26**	**$ 96,838.80**	**$ 104,307.98**	**$ 589,288.90**	**$ 84,184.13**
Stormwater Credit ***	**$ 1,564,651.60**	**$1,564,651.60**	**$1,564,651.60**	**$1,564,651.60**	**$1,564,651.60**	**$ 1,564,651.60**	**$1,564,651.60**	**$10,952,561.21**	**$1,564,651.60**
Water fee ($/CCF)	$ 3.42	$ 3.66	$ 3.88	$ 4.13	$ 4.38	$ 4.58	$ 4.74	-	-
Water $ savings if all cistern water offsets potable water use	**$ 69,677.02**	**$ 74,566.63**	**$ 79,048.78**	**$ 84,142.13**	**$ 89,235.48**	**$ 93,310.15**	**$ 96,569.90**	**$ 586,550.08**	**$ 83,792.87**
Total Savings	**$ 1,694,914.55**	**$ 1,711,076.26**	**$ 1,722,708.78**	**$ 1,733,882.23**	**$ 1,745,488.34**	**$ 1,754,800.55**	**$ 1,765,529.48**	**$ 12,128,400.19**	**$ 1,732,628.60**

Payback (Years)	13.20
Payback w/water fee reduction (Years)	12.59

*Green roof depth is 6” rather than 3” in this scenario. The additional cost of a deeper green roof system is assumed to add $1.00 per square foot. The additional cost is likely to be somewhat offset by economies of scale achieved by building green roofs on all Tenth Street Corridor Site buildings
**Trees are an additional Low-Impact Development technique added to ROW in the total site scenario
***Stormwater credit assumes credit for stormwater managed from ROW in addition to each site property

Appendix 12. Tiered Risk Assessment Management (TRAM): water quality end use standards[110]



[110]DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>. N-8.

Appendix 13. District-scale Systems Ownership and Management

	100% Public <---------- > 100% Private										
TYPE	**Utility**						**Non-Utility**				
PHYSICAL INFRASTRUCTURE OWNERSHIP	Full Utility Owned infrastructure		Partial Utility Owned infrastructure				Occupant Owned Infrastructure				Independent Non-Utility Service Provider Owned Infrastructure
							Multiple Owner		Single Owner		
MANAGEMENT/ OPERATIONS STRUCTURE	Full Utility Management		Utility may/may not manage system				Joint Management	Independent Private Service Provider Managed	Single Owner Managed	Independent Private Service Provider Managed	Independent Non-Utility Service Provider Managed
Adjusted Hyams Model	Vertically Integrated		Unbundled				CO-OP 1	CO-OP 2	Campus 1	Campus 2	Independent Provider
Adjusted PSI Model	**Municipal** Department Operation	**Municipal** Subsidiary Operation	**Hybrid** Municipal Ownership, Split Operation	**Hybrid** Split Assets	**Hybrid** Joint Cooperation Agreement	**Hybrid** Non-Utility Ownership, Municipal Operation	**Cooperative**		**Hybrid** Non-Profit Ownership and Operation	**Hybrid** For Profit Ownership and Operation	**Private**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Example Systems	Southeast Falls Creek NEU — Vancouver, BC Beaverton Round Central Plant — Beaverton, OR Central Hudson Gas and Electric - NY City of Naperville's smart grid initiative - IL	Markham Energy Corporation — Markham, ON	Lonsdale Energy — North Vancouver, BC	Southampton District Energy Scheme — Southampton, UK San Diego Gas and Electric - Borrego Springs, CA	Birmingham District Energy Scheme — Birmingham, UK	University of Oklahoma, with concession to Corix Utilities Yellowknife — Yukon Territory	Texas Medical Center Central Heating and Cooling Services Corporation (TECO) Rochester District Heating — Rochester, NY Eno, Finland Heating Cooperative		District Energy St. Paul — St. Paul, MN Cornell University campus system - NY New York University's (NYU) microgrid in Washington Square Park - NY	Enwave District Energy Limited — Toronto, ON Burrstone Energy Center - Utica, NY	Dockside Green — Victoria, BC The Woking Town Centre Energy Station - Woking Borrough, UK Seattle Steam — Seattle, WA Brewery Blocks — Portland, OR
Plausible Scenarios for SW Ecodistrict (Yes, No, Unlikely)	N	N	U	Y	Y	Y	Y	Y	N	N	Y

Recommended Structures for Scenario Three, Disctrict-Scale Water System within the Tenth Street Corridor Site

Sources: Berry, Trent; 2012, *Ownership Models for Sustainable Neighborhood Infrastructure*, Compass Resource Management, [Presentation Slides] http://www.sf-planning.org/ftp/files/plans-and-programs/emerging_issues/sustainable-development/SF_EcoDistrict_Presentation_Series_Ownership_Models_Trent_Berry.pdf, King, Michael; 2012, *Community Energy: Planning, Development and Delivery*, International District Energy Association, http://www.districtenergy.org/community-energy-planning-development-and-delivery, Hyams, Michael, 2010, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*, New York Energy Research and Development Authority, Portland Sustainability Institute, 2011, *District Energy Development, Ownership & Governance Models*, Prepared for the City of Portland, http://www.portlandoregon.gov/bps/article/34982

5. WORKS CITED

"10th Street Lower Track." *National Gateway*. National Gateway, n.d. Web. 27 Apr. 2013. <http://www.nationalgateway.org/projects/project/63>.

"About." *The JBG Companies : Creating and Enhancing Valye for More than 50 Years*. The JBG Companies,2013. Web. 27 Apr. 2013. <http://www.jbg.com/about-jbg>.

"About." Living City Block. Living City Block, n.d. Web. 12 Mar. 2013. <http:// www.livingcityblock.org/about-2/about/>.

"About National Gateway." *National Gateway*. National Gateway, n.d. Web. 12 Mar. 2013. <http://www.nationalgateway.org/background/about>.

American Society of Landscape Architects. "Designing our Future: Sustainable Landscapes: Sidwell Friends School Washington, D.C., U.S.A." American Society of Landscape Architects. American Society of Landscape Architects, n.d. Web. 28 Apr. 2013. <http://www.asla.org/sustainablelandscapes/sidwell.html>.

"Appendix A - Standards and Specifications." Queen Anne's County Maryland. WordPress, n.d. Web. 28 Apr. 2013. <http://www.qac.org/Docs/PublicWorks/esdm/9_QA_ESDManual_APPENDIX%20A.pdf>.

Atelier Dreseitl. "Rainwater Harvesting." EcoBuilding Pulse. EcoBuilding Pulse, Mar. 2011. Web. 28 Apr. 2013. <http://www.ecobuildingpulse.com/Images/NZW_tcm131-1075029.PDF>.

Badger, Emily. "Greening an Entire Block Instead of Just One Building." *The Atlantic Cities* (2012): n. pag. *The Atlantic Cities*. Web. 27 Apr. 2013. <http://www.theatlanticcities.com/jobs-and-economy/2012/04/greening-entire-block-instead-just-one-building/1759/>.

Bower, Stephanie. "Concept A Watercolor." Seattle Office of Sustainability and Environment. Seattle.gov, 2 Nov. 2010. Web. 28 Apr. 2013. <http://www.seattle.gov/environment/documents/YT_Sustainable_District_Study.pdf>.

"Canal Park Opens to the Public." *OLIN*. OLIN, n.d. Web. 27 Apr. 2013 <http://www.theolinstudio.com/blog/canal-park-opens-to-the-public/>.

"Canal Park Sustainability." *Canal Park*. Canal Park, 2012. Web. 27 Apr. 2013. <http://www.canalparkdc.org/about/sustainability>.

"Changes to the District's Stormwater Fee." *The District Department of the Environment*. The District of Columbia, n.d. Web. 27 Apr. 2013. <http://green.dc.gov/service/changes-districts-stormwater-fee>.

CIM Group. CIM, 2013. Web. 27 Apr. 2013.

City of Seattle, and Seattle Public Utilities, comps. Seattle's Natural Drainage Systems: A Low Impact Development Approach to Storm Water Management. Seattle: SPU, 2007. Seattle.gov. Web. 24 Feb. 2013 <http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/spu02_019984.pdf>.

Cliff, Majersik, and IMT. "Institute for Market Transformations." *District of Columbia Resident Resource Center*. District of Columbia, 20 Feb. 2008. Web. 10 Apr. 2013. <http://rrc.dc.gov/green/lib/green/pdfs/Green_b-codes.pdf>.

"Combined Sewer System." *DC Water*. District of Columbia Water and Sewer Authority, n.d. Web. 27 Apr. 2013. <http://www.dcwater.com/wastewater_collection/css/default.cfm>.

"Company: Overview." *Heyman Properties*. Heyman Properties, 2008. Web. 27 Apr. 2013. <http://www.heymanproperties.com/company.aspx>.

D.C. Municipal Regulations. "Final Rulemaking: Rates for Water Service and Rates for Sewer Service." *DC Regulations*. District of Columbia, n.d. Web. 27 Apr. 2013. <http://www.dcregs.dc.gov/Gateway/ChapterHome.aspx?ChapterID=33094>.

"DC Stormwater Regulations and Federal Facilities Webcast." *Chesapeake Stormwater Network*. N.p., 2012. Web. 27 Apr. 2013. <https://connect-test.moo.umd.edu/p8pco1m23rl/>.

DDOE. "DDOE Stormwater Management Guidebook." *The District Department of the Environment*. The District of Columbia, 7 May 2009. Web. 27 Apr. 2013. <http://ddoe.dc.gov/publication/stormwater-guidebook>.

"District Energy for Portland: Laying the Groundwork for Implementation: Development, Ownership & Governance Models." *District Energy for Portland*. Portlandoregon.gov, 31 Mar. 2011. Web. 27 Apr. 2013. <http://www.portlandoregon.gov/bps/article/349828>.

Drake, Erin, Matthew Goyak, and Matthew VanSoest. "Sidwell Friends Middle School Case Study: Washington, D.C." Ball State University Department of Architecture. BSU, n.d. Web. 28 Apr. 2013. <http://cms.bsu.edu/About/AdministrativeOffices/BBC/Fellows/RecentProjects/CharterSchools/CaseStudies/Private/-

/media/WWW/DepartmentalContent/BBC/CharterSchools/ PDFs/9%20Sidwell%20Friends%20Middle%20School85x11.ashx>.

EPA Office of Water. ". Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act." *The United States Environmental Protection Agency*. EPA, Dec. 2008. Web. 27 Feb. 2013. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>.

"Extending the Life Cycle of Water." Sustainable Water. Sustainable Water, n.d. Web. 28 Apr. 2013. <http://sustainablewater.com/>

"Federal Stormwater Management Requirements." *The United States Environmental Protection Agency*. EPA, 5 Nov. 2012. Web. 19 Feb. 2013. <http://www.epa.gov/oaintrnt/stormwater/requirements.htm>.

"Glossary." *The United States Environmental Protection Agency*. EPA, n.d. Web. 27 Apr. 2013. <http://www.epa.gov/oaintrnt/glossary.htm>.

"Green Infrastructure Summit 2012." *DC Water*. District of Columbia Water and Sewer Authority, 29 Feb. 2012. Web. 27 Apr. 2013. <http://www.dcwater.com/education/pdfs/ Green_Infrastructure_Summit_II.pdf>.

"Green Roofs." 4.1. City of Indianapolis: Stormwater Design and Specification Manual. N.p.: n.p., n.d. Upper White River Watershed Alliance. Web. 28 Apr. 2013. <http://www.uwrwa.org/bmpTool/factSheets/4_1_Green_Roofs.pdf>.

GreenShape LLC. A photograph of Sidwell Friends Middle School. GreenShape LLC. GreenShape LLC, n.d. Web. 28 Apr. 2013. <http://www.greenshape.com/sidwell-friends-middle-school-washington-dc/>.

Herrera Environmental Consultants, Inc. "High Point Phase I Block Scale Monitoring." Seattle Public Utilties. Seattle.gov, Apr. 2008. Web. 28 Apr. 2013. <http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/spu02_020013.pdf>.

"High Point Natural Drainage System." Seattle Public Utilities. Seattle.gov, n.d. Web. 28 Apr. 2013. <http://www.seattle.gov/util/MyServices/DrainageSewer/Projects/GreenStormwaterInfrastructure/CompletedGSIProjects/HighPointNaturalDrainageSystem/index.htm>.

"Housing: Seattle Housing Authority Receives $19 Million To Revitalize Yesler Terrace Neighborhood." *US Senator Patty Murray: Working for Washington State*. Senate.gov, 12 Dec. 2012. Web. 27 Apr. 2013. <http://www.murray.senate.gov/public/index.cfm/newsreleases?ContentRecord_id=3cf4241e-bfb0-4f83-9de8-9b5ce2d396fd>.

"Impervious Area Charge." *DC Water*. District of Columbia Water and Sewer Authority, n.d. Web. 27 Apr. 2013. <http://www.dcwater.com/customercare/iab.cfm>.

"Investments." *CIM*. CIM Group, 2013. Web. 27 Apr. 2013. <http://cimgroup.com/investments/byProductTypeInvestmentDetails.aspx?id=90>.

Krouse, Sarah. "L'Enfant Plaza building owner sues JBG." *The Washington Business Journal* (2010): n. pag. *Washington Business Journal*. Web. 27 Apr. 2013. <http://www.bizjournals.com/washington/stories/2010/10/18/story1.html?page=all>.

Lemoine, Leah. Personal interview. 12 Apr. 2013.

Lenth, John, Andy Rheaume, and Tracy Tackett. "Lessons Learned from Monitoring Bioretention Swales in West Seattle's High Point Neighborhood." Seattle Public Utilites. Seattle.gov, n.d. Web. 28 Apr. 2013. <http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/spu02_020015.pdf>.

Living City Block. Living City Block, n.d. Web. 27 Apr. 2013. <http://www.livingcityblock.org>.

Moddemeyer, Steve. *Yesler Terrace: Sustainable District Study*. Comp. CollinsWoerman and Gibson Economics. N.p.: n.p., 2010. *Seattle.gov*. Web. 24 Feb. 2013. <http://www.seattle.gov/environment/documents/YT_Sustainable_District_Study.pdf>.

The National Capital Planning Commission. The National Capital Planning Commission. *The SW Ecodistrict: A Vision Plan for a More Sustainable Future*. Comp. The National Capital Planning Commission. N.p.: n.p., 2013. *The National Capital Planning Commission*. Web. 26 Apr. 2013.<http://www.ncpc.gov/swecodistrict>.

NSI. "Sidwell Friends Middle School, Washington D.C." Natural Systems International. NSI, n.d. Web. 28 Apr. 2013. <http://www.natsys-inc.com/media/sidwellfriendsschool3.pdf>.

"Normal Monthly Precipitation (Inches)." *The National Oceanic and Atmospheric Administration*. NOAA, n.d. Web. 27 Apr. 2013. <http://www.ncdc.noaa.gov/oa/climate/online/ccd/nrmlprcp.html>.

O'Brien, Chris. "Solar PPA: American University." *American University*. American University, n.d.Web. 27 Apr. 2013. <http://www.epa.gov/greenpower/documents/AU_Solar_PV_121312.pdf>.

Photograph of Canal Park. The International Review of Landscape Architecture and Urban Design. Topos Magazine, 27 Nov. 2012. Web. 28 Apr. 2013. <http://www.toposmagazine.com/blog/model-for-sustainable-design-canal-park-in-washington-dc.html>.

"Projected Clean River IAC Charges FY2010-FY2019 in Presentation to the DC Water Retail Committee." *DC Water*. District of Columbia Water and Sewer Authority, 28 June 2011. Web. 27 Apr. 2013. <http://www.dcwater.com/news/publications/DCWSR%20Committee%20Material%2006-28-11.pdf>.

"Real Estate Investment Trust - REIT." *Investopedia*. Investopedia, n.d. Web. 27 Apr. 2013.<http://www.investopedia.com/terms/r/reit.asp>.

A rendering of Stephen Epler Hall. Portland State University Institute for Sustainable Solutions. PSU, n.d. Web. 28 Apr. 2013. <http://www.pdx.edu/sites/www.pdx.edu.sustainability/files/sus_epler_case_study.pdf>.

A Rendering of Wazee Street. Living City Block. Living City Block, 2010. Web. 28 Apr. 2013. <http://www.livingcityblock.org/wp-content/uploads/2010/04/Transformational-Workshop-100426.pdf>.

REQUEST FOR INFORMATION: Update #2 Federal Triangle South. Washington DC: U.S. General Services Administration, 2012. *The District of Columbia: Sustainable DC*. Web. 26 Apr. 2013. <https://www.fbo.gov/utils/view?id=b3305267de6da7c1ea9b103b20ae04d1>.

Seattle Public Utilities. Concept Drawing of Seattle's SEA Street. Associated General Contractors of Washington. Seattle Daily Journal of Commerce, 6 Mar. 2000. Web. 28 Apr. 2013. <http://www.djc.com/news/enviro/11005068.html>.

Seattle Public Utilities – Natural Drainage System Program. Seattle: SPU, n.d. Seattle Public Utilties. Web. 28 Apr. 2013. <http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/spu02_019986.pdf>.

"7 Stormwater Management Practice Design Guidelines." Chapter 7. City of Philadelphia Stormwater Management Guidance Manual. Comp. Philadelphia Water Department Office of Watersheds. N.p.: n.p., n.d. 7-1-7-110. Philadelphia Water Department. Web. 28 Apr. 2013. <http://www.pwdplanreview.org/WICLibrary/chapter%207.pdf>.

Sisolak, Joe, and Kate Spataro. "Toward Net Zero Water: Best Management Practices for Decentraliizing Sources and Treatment." Ed. Cascadia Green Building Council.

EcoBuilding Pulse. Hanleywood, Mar. 2011. Web. 28 Apr. 2013. <http://www.ecobuildingpulse.com/Images/NZW_tcm131-1075029.PDF>.

"Stephen E. Epler Hall Case Study." *Portland State University Institute for Sustainable Solutions*. Portland State University, n.d. Web. 27 Apr. 2013. <http://www.pdx.edu/sites/www.pdx.edu.sustainability/files/sus_epler_case_study.pdf>.

"Stephen Epler Hall." *The Landscape Voice*. Landscape Voice, n.d. Web. 27 Apr. 2013. <http://landscapevoice.com/stephen-epler-hall/>.

"Stephen Epler Residence Hall Stephen Epler Residence Hall." *Portland State University Institute for Sustainable Solutions*. Portland State University, n.d. Web. 27 Apr. 2013.<http://www.pdx.edu/sustainability/stephen-epler-residence-hall>.

A Vision for a Sustainable DC. N.p.: n.p., 2010. *The District of Columbia*. Web. 26 Apr. 2013. <http://sustainable.dc.gov/sites/default/files/dc/sites/sustainable/publication/attachments/sustainable%20DC%20Vision%20Plan%202.2.pdf>.

"Street Edge Alternatives." Seattle Public Utilities. Seattle.gov, n.d. Web. 28 Apr. 2013. <http://www.seattle.gov/util/MyServices/DrainageSewer/Projects/GreenStormwaterInfrastructure/CompletedGSIProjects/StreetEdgeAlternatives/index.htm>.

Suzuki, Ryu. E-mail interview. 20 Mar. 2013.

SvR Design Company. "How High Point Drainage Works to Recharge our Groundwater and to Protect the Creek." Seattle Public Utilities. Seattle.gov, n.d. Web. 28 Apr. 2013. <http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/spu02_020007.pdf>.

Taylor, T., and R. Goldstein, eds. "Sustainable Water Resources Management, Volume 3: Case Studies on New Water Paradigm." Decentralized Water Resources Collaborative. Water Environment Research Foundation, Jan. 2010. Web. 28 Apr. 2013. <http://www.decentralizedwater.org/documents/DEC6SG06a/Case%20Studies%20on%20New%20Water%20Paradigm.pdf>.

USGBC. "Project Profile: Sidwell Friends Middle School Washington, D.C." United States Green Building Council. USGBC, 2007. Web. 28 Apr. 2013. <http://www.usgbc.org/ShowFile.aspx?DocumentID=3943>.

- - -. "Sidwell Friends Middle School LEED Case Study." United States Green Building Council. USGBC, 2008. Web. 28 Apr. 2013. <http://leedcasestudies.usgbc.org/finance.cfm?ProjectID=775>.

"Washington Canal Park." *Office of the Deputy Mayor for Planning and Economic Development*. District of Columbia, n.d. Web. 27 Apr. 2013. <http://www.dc.gov/DC/DMPED/Projects/Development+Projects/Washington+Canal+Park>.

"Washington Canal Park Staff Recommendations." *The National Capital Planning Commission*. NCPC, June 2010. Web. 27 Apr. 2013. <http://www.ncpc.gov/DocumentDepot/Actions_Recommendations/2010June/Washington_Canal_Park_Recommendation_6713_June2010_.pd>.

"Washington DC: A case study of how green infrastructure is helping manage urban stormwater challenges." *NRDC*. NRDC, n.d. Web. 27 Apr. 2013. <http://www.nrdc.org/water/pollution/rooftopsii/files/RooftopstoRivers_WDC.pdf>.

"Water Efficient Toilets." *EPA Water Sense*. EPA, n.d. Web. 27 Apr. 2013. <http://www.epa.gov/WaterSense/products/toilets.html>.

WaterSense. WaterSense Logo. WaterSense: An EPA Partnership Program. EPA, n.d. Web. 28 Apr. 2013. <http://www.epa.gov/WaterSense/images/wspromolabel_look.jpg>.

"WaterSense Specification for Tank-Type Toilets." *EPA WaterSense*. EPA, 20 May 2010. Web. 27 Apr. 2013. <http://www.epa.gov/WaterSense/docs/revised_het_specification_v1.1_050611_final508.pdf>.

Wells, Llewellyn. Personal interview. 20 Mar. 2013.

"What We Do." Living City Block. Living City Block, n.d. Web. 6 Feb. 2013. <http://www.livingcityblock.org/what-we-do/>.

"Yesler Terrace Redevelopment." *Seattle Housing Authority*. Seattle Housing Authority, 2013. Web. 27 Apr. 2013. <http://www.seattlehousing.org/redevelopment/yesler-terrace/>.

District of Columbia
Stormwater Policy Analysis

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I. Executive Summary

This report serves as a summary document of the various stormwater policies and fees that apply in the District of Columbia. This includes regulations and associated fees from the federal government, the District Department of the Environment, and the District's water and sewer authority, DC Water. It is important to understand all of the applicable policies and fees from these entities as many of them layer on top of one another and sometimes overlap.

In addition to a comprehensive overview of the main policies and associated fees, this report also explores their applicability to the Tenth Street SW Corridor Site within the National Capital Planning Commission's SW Ecodistrict. Each policy and fee is analyzed in the context of the Tenth Street SW Corridor Site and the NCPC SW Ecodistrict Plan that is looking to install low impact development projects to improve stormwater capture and water use within the site. Key recommendations are given in order to take advantage of potential cost savings and other benefits related to the policies and fees.

The majority of the recommendations endorse immediate actions along the lines of the NCPC SW Ecodistrict Plan to continue with LID and stormwater retrofits. It is the opinion of the authors of this report that the furtherance of the plans regarding the Tenth Street SW Corridor Site will not only improve the stormwater system and help to move NCPC toward their goal of increased stormwater retention, but may also save site owners money in the form of projected cost savings or avoided fees.

II. Table of Contents

III. Key Policy Recommendations

The goal of this report is to find the best ways for the Tenth Street SW Corridor Site to comply with all relevant regulations and mandates while remaining on the forefront of efficiency and reducing costs to the highest degree or even finding opportunities for profit. In order to accomplish all of these goals for the site in question, this report recommends the following actions in the Tenth Street SW Corridor Site.

1) Fully assess the inventories of stormwater management practices at the three federal facilities within the site in order to identify cost effective opportunities for future green infrastructure projects. The federal buildings presently liable for these federal mandates, without including the proposed teardowns and redevelopments, are:
    - U.S. Department of Energy Forrestal Complex,
    - U.S. Postal Service Building on Tenth St SW,
    - Cotton Annex Building

2) Implement water conserving practices and fixtures and reduce impervious surfaces in response to rising DC Water fees. Inaction to implement said techniques will result in the acceptance of substantial costs.

3) Directly mitigate impervious surfaces by implementing green infrastructure and low impact development (LID) strategies such as green roofs, porous parking surfaces and other onsite vegetation to reduce the Impervious Area Charge collected via DC Water. As rates are expected to rise drastically, it is recommended that extensive projects be instituted which convert significant portions of impervious surfaces to generate cost-savings as well as environmental benefits. Implemented projects can have dual uses like green roofs, which not only contribute to water-saving goals but also are shown to contribute to energy-savings as well.

4) Begin using the DDOE Draft Stormwater Management Guidebook and adopting best practices on the Tenth Street SW Corridor Site as it is likely that the final ruling on the District's Proposed Rulemaking on Stormwater Management and Soil Erosion and Sediment Control as well as the Draft Stormwater Management Guidebook will not diverge drastically from what has already been proposed.

5) Assume that the DDOE stormwater fee of $2.67 per Equivalent Residential Unit will continue at least through 2016 and the RiverSmart Rewards program will be adopted.

6) Take immediate action on stormwater quantity control measures such as LID projects, structural controls, and rainwater reuse, among others since rebates owed from the RiverSmart Rewards program can be recouped retroactively.

7) Create and get DDOE approval of a Stormwater Management Plan for each building within the Tenth Street SW Corridor Site or for the entire site itself as a first step in the Stormwater Retention Credit application and certification process. The SRC program is part of the RiverSmart Rewards program and can reduce costs for proposed low impact development and efficiency measures in the site.

IV. Stormwater Policies and Fees

A. Public Mandates for Federal Properties

Executive Summary:
The federal government is sometimes referred to as the nation's single largest landlord and energy consumer because it operates more than 500,000 facilities that make up an estimate of greater than 3 billion ft^2. In the past, approximately $30 billion has been spent per year on purchasing and substantially renovating federal facilities, and it has been estimated that the federal government also spends $7 billion per year on energy in such facilities. Thus, these two costs present an opportunity for the federal government to transform their facilities by using sustainable, energy-saving technologies and practices on a large scale. In fact, many executive orders, laws, and regulations have recently been established to reach these goals of high performance and sustainability in federal work facilities.

Background:
The following is background on technical information on the relevant federal mandates and policies related to stormwater:

1. Executive Order 13514: "Federal Leadership in Environmental, Energy, and Economic Performance"[1]

   Executive Order 13514, signed by President Obama in 2009, contains numerous agency-wide requirements on various issues like greenhouse gas and energy reduction, water use efficiency, pollution prevention, waste reduction, sustainable acquisition, electronic stewardship, and other sustainability aspects.[2] This executive order seeks to build upon the requirements of a pre-existing executive order (EO 13423), which requires federal agencies to ensure that new construction and major renovations comply with the 2006 Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU).

   The MOU established a common set of sustainable "Guiding Principles" for integrated design, energy performance, water conservation, indoor environmental quality, and materials aimed at helping federal agencies and organizations to do the following:[3]
   - "Reduce the total ownership cost of facilities;
   - Improve energy efficiency and water conservation;
   - Provide safe, healthy, and productive built environments;

[1] Environmental, Energy. "Executive Order 13514." (2010).
[2] "Federal Stormwater Management Requirements." *Greening EPA*. U.S. Environmental Protection Agency, 5 Nov 2012. Web. 19 Feb 2013. <http://www.epa.gov/oaintrnt/stormwater/requirements.htm>.
[3] Ibid.

- Promote sustainable environmental stewardship."[4]

More specifically, EO 13514 has created a set of requirements aimed at existing federal buildings. The President has called upon federal Agencies to "lead by example" to address a wide range of environmental issues, including stormwater runoff. Federal buildings are now required to have at least 15% of each agency's existing facilities (above 5,000 gross ft^2) and building leases (above 5,000 gross ft^2) meet the "Guiding Principles" (found in the MOU) by the end of fiscal year 2015.[5] Also, the EO seeks to pursue cost-effective strategies, like highly reflective and vegetated roofs to minimize the consumption of energy, water, and materials for federal buildings.

Some key goals of the "Guiding Principles for Sustainable Existing Buildings" and EO 13514 that are important to note and apply to the Tenth Street SW Corridor Site are outlined below:

- From Executive Order 13514, "Improve water use efficiency and management by":[6]
  - Reduce potable water or drinking water consumption intensity by 2% annually through the fiscal year 2020 (relative to agency's water consumption baseline in the fiscal year 2007). In other words, reduce potable water use by 26% by the end of fiscal year 2020 with the use and implementation of water management strategies like water-efficient and low-flow fixtures and efficient cooling towers.[7]
  - Reduce agency industrial, landscaping, and agricultural water consumption by 2% annually, or 20% by the end of fiscal year 2020 (relative to the baseline of the agency's water consumption in fiscal year 2010).[8]
  - Implement water reuse strategies that reduce potable water consumption to a level consistent with state laws.[9]
  - Receive guidance from the EPA within 60 days on the implementation of section 438 of the Energy Independence and Security Act of 2007 (discussed in a later section).[10]

[4] United States. Environmental Protection Agency. *FEDERAL LEADERSHIP IN HIGH PERFORMANCE and SUSTAINABLE BUILDINGS MEMORANDUM OF UNDERSTANDING*. 2006. Print. <http://www.epa.gov/oaintrnt/documents/sustainable_mou_508.pdf>.
[5] "Federal Stormwater Management Requirements." *Greening EPA*. U.S. Environmental Protection Agency, 5 Nov 2012. Web. 19 Feb 2013. <http://www.epa.gov/oaintrnt/stormwater/requirements.htm>.
[6] Environmental, Energy. "Executive Order 13514." (2010).
[7] Ibid.
[8] Ibid.
[9] Ibid.
[10] Ibid.

- From the "Guiding Principles for Sustainable Existing Buildings," under the section titled "Protect and Conserve Water:"[11]
    - Indoor Water Goals: Two options can be used to measure indoor potable water use performance:
        - Option 1: Reduce potable water use by 20% compared to a water baseline calculated for the building. The water baseline, for buildings with plumbing fixtures installed in 1994 or later, is 120% of the Uniform Plumbing Codes 2006, and the water baseline for plumbing fixtures older than 1994 is 160% of the Uniform Plumbing Codes 2006.[12]
        - Option 2: Reduce building measured potable water use by 20% compared to building water use in 2003 or a year after with quality water data.[13]
    - Outdoor Water Goals: Three options can be used to measure outdoor potable water use performance:
        - Option 1: Reduce potable irrigation water use by 50% compared to conventional methods.[14]
        - Option 2: Reduce building related potable irrigation water use by 50% compared to measured irrigation water use in 2003 or a year thereafter with quality water data.[15]
        - Option 3: Use no potable irrigation water.[16]
    - Measurement of Water Use: The installation of water meters for building sites with significant indoor and outdoor water use is encouraged. If only one meter is installed, reduce potable water use (indoor and outdoor combined) by at least 20% compared to building water use in 2003 or a year thereafter with quality water data. [17]

2. Energy Independence and Security Act of 2007 (or EISA)

    In December of 2007, Congress enacted the Energy Independence and Security Act of 2007. In regards to stormwater runoff requirements and management, section 438 of this legislation establishes strict stormwater runoff requirements for federal development and redevelopment projects.[18] Section 438, titled "Storm Water Runoff Requirements for Federal Development Projects", states the following:

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[11] United States. Environmental Protection Agency. *FEDERAL LEADERSHIP IN HIGH PERFORMANCE and SUSTAINABLE BUILDINGS MEMORANDUM OF UNDERSTANDING*. 2006. Print. <http://www.energystar.gov/ia/business/Guiding_Principles.pdf>.
[12] Ibid.
[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] Ibid.
[18] "Federal Stormwater Management Requirements." *Greening EPA*. U.S. Environmental Protection Agency, 5 Nov 2012. Web. 19 Feb 2013. <http://www.epa.gov/oaintrnt/stormwater/requirements.htm>.

> "The sponsor of any development or redevelopment projects involving a Federal facility with a footprint that exceed 5,000 ft^2 will use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology[19] of the property with regard to the temperature, rate, volume, and duration of flow." [20]

The intent of section 438, as defined by the EPA, requires that federal agencies develop and redevelop applicable facilities (over 5,000 ft^2) in a manner that maintains or restores stormwater runoff to the maximum extent technically feasible. In fact, the statute is intended to ensure that receiving waters, such as rivers or streams, are not negatively impacted by changes in runoff temperature, volumes, durations, and rates resulting from federal projects and facilities. The EPA foresees that Section 438 can be achieved through the use of the green infrastructure/low impact development infrastructure tools—to be discussed later.

3. Technical Guidance (issued by the EPA)

As a result of Congress enacting Section 438 of the Energy Independence and Security Act of 2007 and the President signing Executive Order 13514 on "Federal Leadership in Environmental, Energy, and Economic Performance," the US EPA, in coordination with other federal agencies, has created a "Technical Guidance" document to help federal agencies comply with Section 438 by using a variety of stormwater management practices. Such recommended practices include reducing impervious surfaces, using vegetative practices, porous pavements, cisterns, and green roofs.[21] The guidance is intended to provide a step-by-step framework that will help federal agencies maintain pre-development site hydrology by retaining rainfall on site through infiltration, evaporation/transpiration, and re-use at the same retention levels that occurred prior to development.

The EPA provides a series of options for site designers to use in order to comply with Section 438 of EISA (see Table 1 on next page):

- **Option 1**: Design, construct, and prevent the off-site discharge of the precipitation from all rainfall events less than or equal to the 95th percentile rainfall event[22] to the maximum extent technically feasible.[23]

[19] The EPA defines "predevelopment hydrology" as the "combination of runoff, infiltration, and evapotranspiration rates and volumes that typically existed on a site before human-induced land disturbance occurred (e.g., construction of infrastructure on undeveloped land such as meadows or forests)."

[20] Congress, U. S. "Energy independence and security act of 2007." *Public Law* 110-140 (2007).

[21] United States. Environmental Protection Agency. *Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings* . 2009. Print. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>.

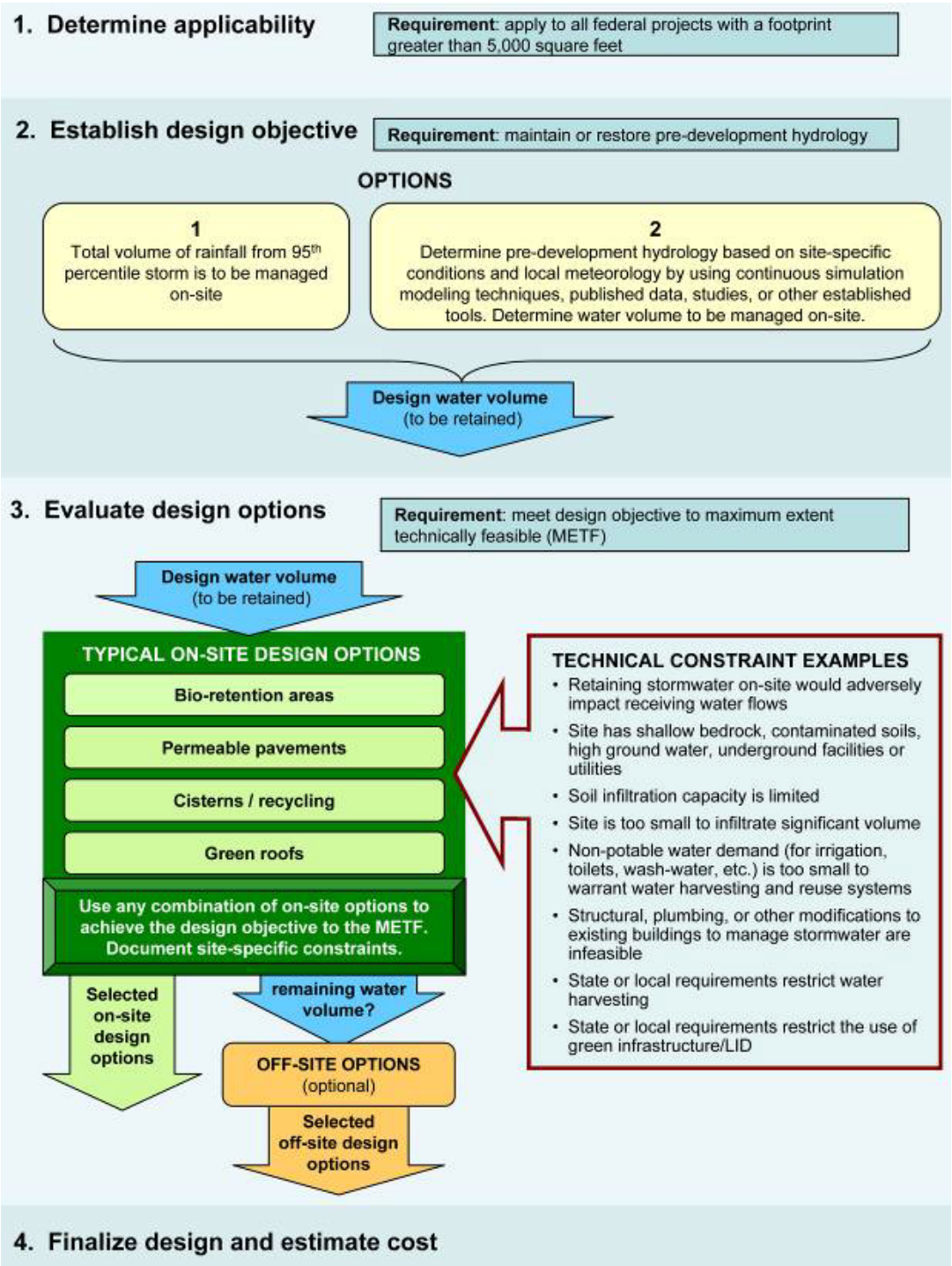
[22] The EPA defines the 95th percentile rainfall event "as a precipitation amount which 95 percent of all rainfall events for the period of record do not exceed. In more technical terms, the 95th percentile rainfall event is defined as the measured precipitation depth accumulated over a 24-hour period for the period of record that ranks as the 95th percentile rainfall depth based on the range of all daily event occurrences during this period."

- **Option 2**: Design, construct, and maintain stormwater management practices that preserve the pre-development runoff conditions following construction. This allows the designer to conduct site-specific hydrologic analysis to determine the pre-development runoff conditions instead of using the estimated volume approach of Option 1.[24]

However, it is important to note that this document is intended solely as guidance and is neither a regulation, nor is it a substitute for statutory provisions or regulations. This guidance does not have any binding requirements on federal agencies and does not confer any legal rights or impose legal obligations upon any member of the public. The EPA foresees that Section 438 can be achieved through the use of the green infrastructure/low impact development infrastructure tools—to be discussed later.[25]

[23] Sissine, Fred. "Energy Independence and Security Act of 2007: a summary of major provisions." LIBRARY OF CONGRESS WASHINGTON DC CONGRESSIONAL RESEARCH SERVICE, 2007.
[24] Ibid.
[25] "Federal Stormwater Management Requirements." *Greening EPA*. U.S. Environmental Protection Agency, 5 Nov 2012. Web. 19 Feb 2013. <http://www.epa.gov/oaintrnt/stormwater/requirements.htm>.

Table 1: Section 438 Implementation Process:[26]



[26] United States. Environmental Protection Agency. *Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings* . 2009. Print. <http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf>.

Analysis:
As funds become available, the federal government is investing in modernization of structures to make energy and space efficiency improvements that will reduce operating costs. These energy efficiency improvements like the one proposed for the NCPC SW Ecodistrict Plan in Washington, D.C., more specifically the Tenth Street SW Corridor Site, respond directly to Executive Order 13514 and Section 438 of EISA, which require agencies to reduce greenhouse gas emissions, manage stormwater, and reduce water use and waste by 2015. The federal agencies that have buildings within the Tenth Street SW Corridor Site are now presented with the opportunity to become leaders in supporting not only cutting-edge efficiency improvements, but to simultaneously transform a resource-intensive building environment into one that is able to capture, manage, and reuse a majority of its resources. The following buildings and agencies within the Tenth Street SW Corridor Site currently seek to meet the federal requirements:

- U.S. Department of Energy's Forrestal Complex
- U.S. Postal Service Building on Tenth Street SW
- Cotton Annex Building

However, these federal initiatives also pose challenges for buildings in urban areas like the Tenth Street SW Corridor Site. Since federal agencies are expected and required to install retrofits wherever opportunities exist, many agencies are currently still in the process of compiling technical data on their inventories of stormwater management practices at various facilities. Thus, the goals set in E.O. 13514 and Section 438 of EISA might not be achieved in time by their mandated completion of 2015. Once the inventory can be fully assessed, the federal facilities in the Tenth Street SW Corridor Site can then begin to quantify the benefits of existing stormwater practices and identify cost-effective opportunities for future green infrastructure projects.

B. Public Mandates for Private Properties

Background:

The General Service Administration (GSA) issued a Request for Information (RFI) on December 7, 2012 for the redevelopment of the area that the RFI refers to as the "Federal Triangle South" (FTS) site. The FTS site is defined as the area bounded by Independence Avenue to the North, 6th Street to the East, Maryland Avenue, and portions of D Street to the South, and 12th Street to the West.[27] This site would include the following federal buildings that are relevant to the Tenth Street SW Corridor Site: Cotton Annex and the Department of Energy Forrestal Complex.

The RFI issued by GSA illustrates the need to explore strategies that leverage the value of the government's owned assets to acquire the types of spaces that tenant federal agencies need to satisfy their mandated missions. Therefore, the RFI suggests that some of the federal sites within the Tenth Street SW Corridor Site (the Cotton Annex and the Department of Energy Forrestal Complex) may be open to private sector development. This potential development aims to meet GSA's goals of leveraging the value of public office buildings and land with the Tenth Street SW Corridor Site to develop new, efficient, and sustainable facilities that will revitalize the surrounding area with a vibrant mix of commercial, residential, and institutional uses. GSA has been granted the authority to dispose of and redevelop federal property through the following mechanisms:

- Federal ownership where GSA retains the property;
- Traditional disposal[28] where the federal property is declared as "excess, and then [sold through] public auctioned or sealed bid with the highest bid winning";
- Ground lease historic property[29] where a historic property is leased to a developer who then follows local planning and development regulations;
- Leaseback[30] where GSA conveys property to a developer either by fee simple or ground lease and then the developer leases building space back to GSA with purchase option or ownership by operation of ground lease for GSA;
- Acquisition exchange[31] when the developer provides GSA with real property or construction services like value that GSA identifies, upon acceptance GSA conveys federal property to developer.

If the buildings in the Tenth Street SW Corridor Site shift to private sector ownership, based on GSA's authority to dispose of or redevelop federal property, all new private development or redevelopment will have to follow the new green building code established by the District of Columbia. Washington, D.C. just completed a public comment period on what is considered to be the most environmentally stringent set of building codes in the country. These codes, once implemented, will apply to all substantially renovated commercial buildings larger than 10,000 ft^2 and multifamily

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[27] United States of America. General Services Administration. *Request for Information Update #2 Federal Triangle South*. 7 December 2012. Print.
[28] 40 U.S.C. § 545
[29] Sec. 111 of NHPA; 16 U.S.C. § 470h-3
[30] 40 U.S.C. § 585(c)
[31] 40 U.S.C. §§, 581 (c), 3304; Sec 412 of PL 108-447

buildings four stories or taller.[32] These codes are anticipated to result in the use of 30 percent less energy compared to projects under the existing regulations[33] and will force the development community to rethink how projects are designed and constructed.

The District of Columbia's codes were last amended in 2006 with the Green Building Act, which required all buildings constructed in the District to be LEED certified. The 2006 act extended these requirements to all new construction in the District, and also required that the mayor submit a comprehensive set of green building codes by January 2008. As a result of this requirement, D.C. enacted new construction codes pertaining to residential and commercial properties that included many environmental and energy amendments in 2008.[34] Some of the key highlights from this 2008 follow-up act were ENERGY STAR ® cool roofs for low-rise residential buildings, on-site retention of stormwater for all buildings, commercial and residential low-flow plumbing fixtures, and improved energy efficiency for residential and commercial buildings.[35]

Newly Proposed D.C. Green Building Codes

The newly proposed green building codes are based on the 2012 International Green Construction Code (IgCC) and overlap in some instances with the District's Green Building Act (2006). The District's new proposal is set to include some modifications to the IgCC and tries to customize it for the D.C. area and for the feasibility of application. The main goals of the new D.C. green building codes are to improve water efficiency, improve energy efficiency, reduce the heat island effect, improve indoor air quality and reduce indoor moisture and mold. [36] The following are a few key points in the proposed DC code:

- The Green Code would initially apply to all commercial buildings of 10,000 ft^2 or more and all multifamily residential buildings four stories or higher and over 10,000 ft^2.
- The Green Code would apply to new construction and substantial renovations that meet the above dimension standards.
- The Department of Consumer and Regulatory Affairs (DCRA) will issue a Green Building Program Manual by spring of 2014 to provide guidance concerning the D.C. Green Code.
- In order to ensure flexibility, the Green Code would permit alternative compliance paths, including the following:
    - Leadership in Energy and Environmental Design (or LEED) certification under the D.C. Green Building Act of 2006
    - International Green Construction Codes of 2012

[32] "District Department of the Environment." Greening D.C. Building Code. N.p., 16 Nov 2011. Web. 10 Apr 2013. <http://green.dc.gov/publication/greening-dc-building-code>.
[33] Ibid.
[34] Sobin, Rodney, and Nicole Steele. "Alliance to Save Energy." Washington, D.C.: Energy-Efficient Building Policy. Web. 10 Apr 2013. <http://www.ase.org/resources/washington-dc-energy-efficient-building-policy>.
[35] Ibid.
[36] Majersik, Cliff. "Institute for Market Transformations." Greening D.C. Building Code. 20 FEB 2008. Web. 10 Apr 2013. <http://rrc.dc.gov/green/lib/green/pdfs/Green_b-codes.pdf>.

- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard of 189.1
- Enterprise Green Communities and Certification.

Since the Enterprise Green Communities and Certification option applies to residential construction and the ASHRAE Standard of 189.1 is simply a compliance option in the IgCC of 2012, neither serve as logical compliance paths for the Tenth Street SW Corridor Site. Therefore, the two main possible code compliance paths for the Tenth Street SW Corridor Site are through LEED or the IgCC of 2012.

Analysis:

Compliance through LEED Certification

Since 2008 the District has required Leadership in Energy and Environmental Design (LEED) certification standards for environmental performance at the "Silver" level or higher for all non-residential, public buildings in the District and remains an integral part of the District's sustainability strategy. Since 2012, the LEED certification requirement has become more inclusive to incorporate all new private development projects, 5,000 ft^2 or larger. These private development projects are only required to meet LEED certification at the "certified" level or higher. The importance of LEED and its applicability to the Tenth Street SW Corridor Site for the scope of this report, resides mainly in the water efficiency component of LEED. In order achieve the NCPC SW Ecodistrict Plan potable water reduction goals and to comply with the newly proposed green codes, site owners would need to attain LEED water efficiency credits. In order to achieve LEED water efficiency credits, the following credit options need to be considered:

- Credit 1.1: Water Efficient Landscaping: Reduce potable water use for landscaping by 50% (1 point)[37]
- Credit 1.2: Water Efficient Landscaping: Eliminate Potable Water Use for Lanscaping and Irrigation (1 Point in addition to Credit 1.1),[38]
- Credit 2: Innovative Wastewater Technologies: Reduce potable water use for building sewage by 50% or treat 50% of wastewater on site (1 point)[39]
- Credit 3.1: Water Use Reduction: Implement water efficiency strategies to achieve a 20% Reduction in water use (1 point)[40]
- Credit 3.2: Water Use Reduction: Implement water efficiency strategies to achieve a 30% Reduction in water use (1 point in addition to Credit 3.1)[41]

The D.C. Department of the Environment (DDOE) has released a guidebook on Green Buildings and has provided a list of suggested strategies on how to meet the water efficiency requirements of LEED. This list includes installing low flow water fixtures, modifying cooling equipment, treating wastewater on site, and installing drought

[37] LEED For New Construction and Major Renovations. U.S. Green Building Council, Web. 10 Apr 2013. <http://www.usgbc.org/ShowFile.aspx?DocumentID=1095>.
[38] Ibid.
[39] Ibid.
[40] Ibid.
[41] Ibid.

resistant vegetation, among others.[42] All of the suggestions, listed by DDOE in the guidebook, would help the Tenth Street SW Corridor Site achieve all five LEED water efficiency credits. However, there is another alternative to the LEED credit scheme: the International Green Building Codes of 2012 (IgCC).

Compliance through the IgCC

The IgCC guidebook has an entire chapter devoted to "Water Resource Conservation, Quality, and Efficiency," (Chapter 7) which sets forth provisions to establish the means of conserving water, protecting water quality, and providing for safe water consumption.[43] The IgCC of 2012 provides a more in-depth approach to water efficiency than does LEED. The 2012 handbook covers requirements such as fixtures, fittings, equipment, and appliances; HVAC systems and equipment; water treatment devices and equipment; metering; non-potable water requirements; rainwater collection and distribution systems; gray water systems; reclaimed water systems; and alternative onsite non-potable water sources.[44] The IgCC standards are more stringent and strict than LEED requirements, but in the long run could achieve greater efficiency gains and provide a more sustainable outcome for buildings in the District. Given the District's increasing emphasis on sustainability and efficiency in building codes, this route of compliance may also be more beneficial for site owners in the long run. By investing in stricter guidelines now, site owners will remain in compliance for a longer period, as it is likely that the District will tighten regulations again.

Concluding Remarks:

In conclusion, various types of green infrastructure will be needed for the redevelopment of the GSA owned sites in order to meet D.C.'s up-and-coming green building codes. Therefore, it would be in the best interest of the developer to implement several types of green infrastructure to obtain District goals and to avoid the costs of compliance with the new D.C. Green Code in the future. At the very least it is recommended that private developers adhere to LEED certification standards to meet the new building code requirements. Also, LEED is planning to issue a refined version or the v4 in the summer of 2013. This new version will weigh water efficiency as a more prominent "impact category" than it has in the past. Therefore more points will be rewarded to buildings that achieve water efficiency and quality credits. However, if possible or financially feasible, this report recommends following the IgCC codes to meet the new building code requirements. While the IgCC compliance path may be a larger investment up front, as noted above, it may be beneficial in the long run.

[42] "District Department of the Environment." The Guide to Green Buildings. Web. 10 Apr 2013. <http://green.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/GuideToGreenBuildings.pdf>.
[43] "International Code Council." Chapter 7 - Water Resource Conservation, Quality, and Efficiency. N.p., n.d. Web. 10 Apr 2013. <http://publicecodes.cyberregs.com/icod/igcc/2012/icod_igcc_2012_7_section.htm?bu2=undefined>.
[44] Ibid.

C. DC Water Policies and Fees

Executive Summary

This brief seeks to explain the fees established for district water users, and collected by DC Water. The fees considered are those that directly contribute and fund DC Water projects, operations and the conveyance and treatment of water. Fees addressed include Retail Water, Retail Sewer and the Impervious Area Charge (IAC). Analysis shows that while all fees are rising, the IAC is rising exponentially, indicating that the IAC presents significant current and future costs to consumers in proportion to standard Retail Water and Sewer fees. This stresses the opportunity for cost savings that can be realized from instituting low impact development (LID) strategies to reduce impervious surfaces.

Background

In 2005 with a federal consent decree, DC Water instituted the $2.6 billion dollar Clean Rivers Project. DC Water is charged with the cleaning up the Anacostia, Rock Creek and Potomac Rivers which have been substantially polluted over the years due to combined sewer overflows (CSOs) which discharge into these rivers. CSOs are the consequence of an antiquated combined sewer system (CSS) that combines wastewater and stormwater into the same sewer pipe and covers nearly one third of the city. The Clean Rivers Project is a long-term control plan that will reduce CSOs by 96 percent by building three large-scale tunnels to store rain overflows and consolidating many combined sewer outlets.[45] To fund the project DC Water has adopted a "polluter pays" philosophy that puts the burden of payment directly onto the users through an Impervious Area Charge (IAC).

Analysis

The IAC charge was devised to encourage users to install green roofs and other green infrastructure, which would increase permeable surfaces to save money for users and decrease CSO events in the greater DC area. The IAC will rise over time to fund the Clean Rivers Project in its entirety even with users instituting water conservation efforts and green infrastructure. This is because the IACs are collected to directly fund the costs of the $2.6 billion federally mandated project. DC Water determined that the IAC is the most equitable way to recover the costs of the Clean Rivers Project as opposed to a volumetric charge (for water used), because the IAC is based on a property's contribution to rainwater runoff. Even properties without water charges, such as parking lots, are covered by the IAC. Because charges are based on the amount of impervious area on a property, owners of large office buildings, shopping centers and parking lots are charged more than owners of modest residential dwellings.[46] Additionally, since the charge is a fee and not a tax, DC Water is able to collect from all users, including those that are typically tax-exempt, such as universities, hospitals and federal and district government. The IAC is not linked to reductions in water use; when/if users reduce

[45] O'Cleireacain, Carol, "Cleaner Rivers for the National Capitol Region: Sharing the Costs" (Washington: Brookings, 2012)

[46] District of Columbia Water and Sewer Authority, "Impervious Area Charge." *DC Water*. 2013. Web. 9 February 2013 http://www.dcwater.com/customercare/iab.cfm

water usage for cost savings standard water fees will continue to rise, not only due to inflation but to finance DC Water operations.

Over the last five years, DC Water has instituted annual increases for Retail Water, Sewer Services and the IAC, with the IAC having had the most aggressive increases at nearly 672% for non-residential customers over this period (see Table 1). According to DC Water's rate and fee projections, the IAC could rise to $28.77/ERU by 2019 (see Table 2). While these fees are not concrete, there is little expectation that annual increases will be abated. As it stands, the IAC places a significant cost burden on users that can only be mitigated by reducing impervious surface on properties.

Table 1. Water Rates For Non-Residential Customers over 5year period[47]

Fee type	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	% Increase
Water /CcF*	$2.30	$2.51	$3.10	$3.24	$3.42	48.69%
Sewer /CcF	$3.31	$3.61	$3.79	$4.18	$5.59	68.88%
IAC /ERU**	$1.24	$2.20	$3.45	$6.64	$9.57	**671.77%**

** 1Ccf- One Hundred Cubic Feet*
*** 1ERU- One Equivalent Residential Unit or One Thousand Square Feet*

Table 2. FY 2014 – 2019 Projected Retail Rates and Fee Changes[48]

Fee type	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	% Increase from FY 2009
Water /CcF	$3.42	$3.66	$3.88	$4.13	$4.38	$4.58	$4.74	106.08%
Sewer /CcF	$5.59	$4.47	$4.74	$5.05	$5.35	$5.59	$5.79	71.90%
IAC /ERU	$9.57	$14.52	$17.66	$20.33	$23.19	$25.49	$28.77	**2,220.16%**

[47] DC Water "Final Rulemaking; Rates for Water and Sewer Service" (September 18, 2009; September 17, 2010; August 12, 2011; July 27, 2012) available at http://www.dcregs.dc.gov/Gateway/ChapterHome.aspx?ChapterID=33094

[48] D.C. Water, "Projected Clean River IAC Charges FY2010-FY2019." In presentation to D.C. Water Retail Rate Committee (June 28, 2011), p. 34., available at www.dcwater.com/news/publications/DCWSR%20Committee%20 Material%2006-28-11.pdf

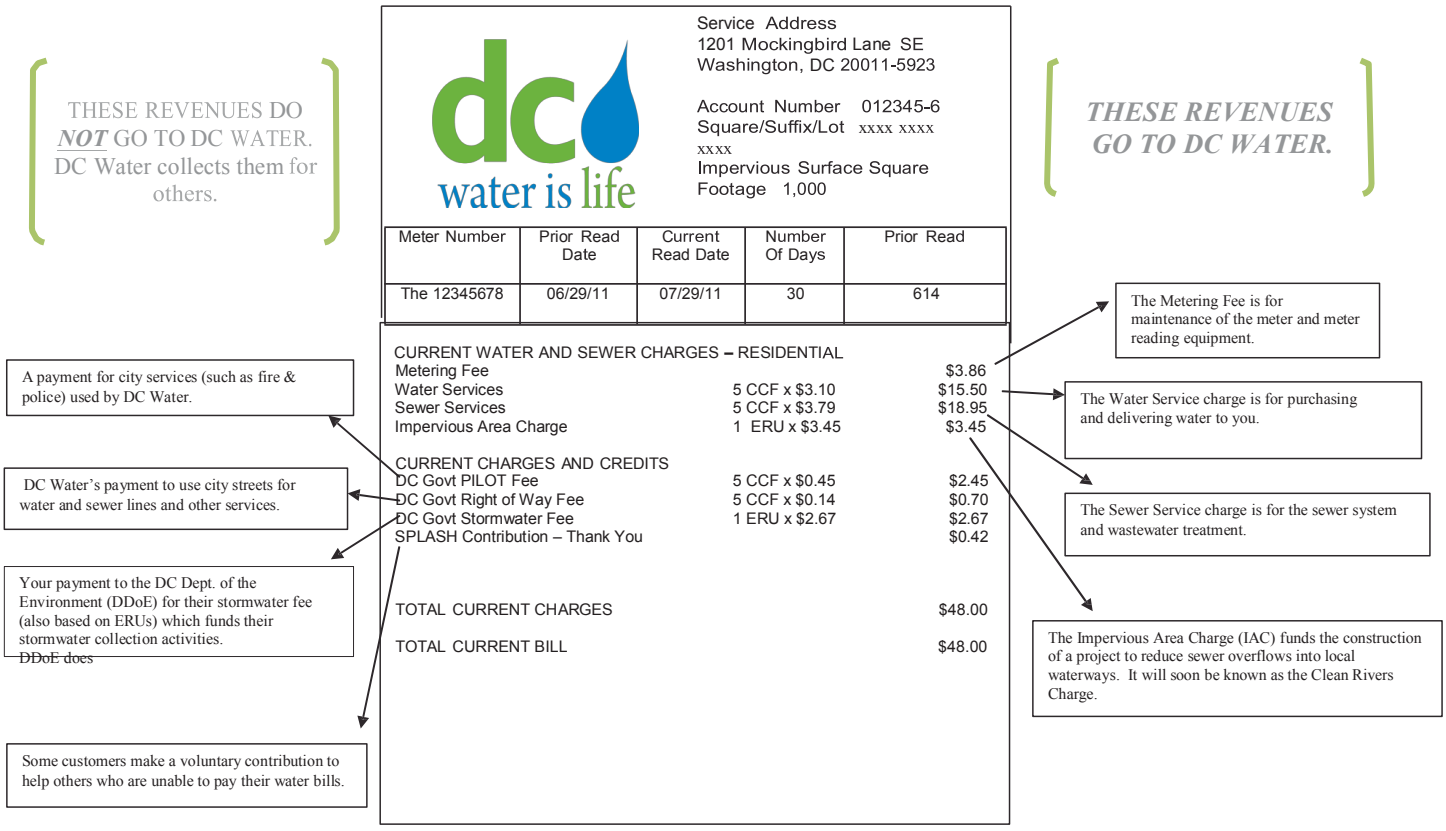
Another mentionable aspect of the IAC is that a large portion of DC impervious land is located in the public right of way (ROW) and thus not subject to the charge. ROW lands are all of the publicly owned property between the property lines on a street and include, but are not limited to, the roadway, tree spaces, sidewalks and alleys. DDOT is the agency responsible for these lands, however they do not pay the IAC to DC Water for these areas. DDOT does utilize two strategies/approaches to reduce the quantity and improve the quality of storm water in the city's ROWs: low impact development (LID), such as bioretention (rain gardens), grass swales, tree box filters, vegetated filter strips, and pervious pavements, and Green Alleys, which filtrate water on site by replacing asphalt or concrete alleys with pervious pavers.

Concluding Remarks

DC Water fees will continue to rise with significant increases, which will demand that large property owners, such as CIM Urban Reit, GSA and JBG, must implement water conserving practices and fixtures and reduce impervious surfaces. Inaction to implement said techniques will result in the acceptance of substantial costs. Implementing green infrastructure and low impact development strategies such as green roofs, porous parking surfaces and other onsite vegetation will reduce the IAC because it directly mitigates impervious surfaces. As rates are expected to rise drastically, it is recommended that extensive projects be instituted which convert significant portions of impervious surfaces to generate cost-savings as well as environmental benefits. In addition, green roofs not only contribute to water-saving goals but also are shown to contribute to energy-savings. Implementing gray infrastructure, such as cisterns and holding tanks for grey-water use within a building, however, will not reduce the IAC. Such implementations affect the District Department of the Environment's (DDOE) stormwater charge, which is collected by DC Water, but separate from the IAC. This charge is addressed and further elaborated upon in the stormwater brief.

Appendix

Figure 1. DC Water Bill Explained[49]



[49] O'Cleireacain, Carol, "Cleaner Rivers for the National Capitol Region: Sharing the Costs" (Washington: Brookings, 2012)

D. DDOE Policies and Fees

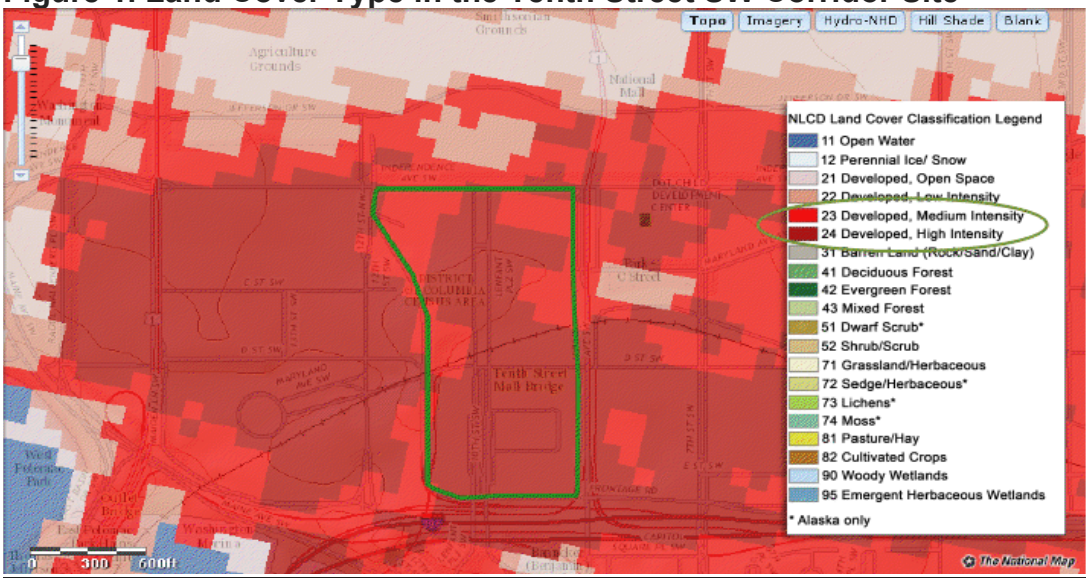
Executive Summary

In order to pay for improved water quality through stormwater management, the District Department of the Environment levies a $2.67 fee per 1,000 ft^2 of impervious area on the property. The fee applies to all properties in the District of Colombia including residential, commercial, and federally owned sites. Policies regulating stormwater and associated fees, although coming under fire in some places, show no sign of abating. Analysis indicates that the fees remain the same at least until October 2016, but could be raised by DDOE in the case that the EPA permit requirements for DC's Municipal Separate Storm Sewer System (MS4) become more stringent and DDOE is forced to pass costs of complying onto property owners.

Background

43% of the District of Columbia's land area is impervious[50], 80% of the Southwest Ecodistrict land area is impervious[51], and 82.22% of the land area within the Tenth Street SW Corridor Site is impervious (See Figures 1 and 2). Such land cover leads to vast volumes of stormwater running off of roofs, streets, sidewalks, and other hardscapes even during relatively mild rainfall events. Stormwater picks up pollutants and debris from all of these surfaces and either overwhelms the combined sewage and stormwater system before out letting into a waterway or, as in the case of the Tenth Street SW Corridor Site, runs directly into one of DC's rivers or streams.

Figure 1. Land Cover Type in the Tenth Street SW Corridor Site[52]

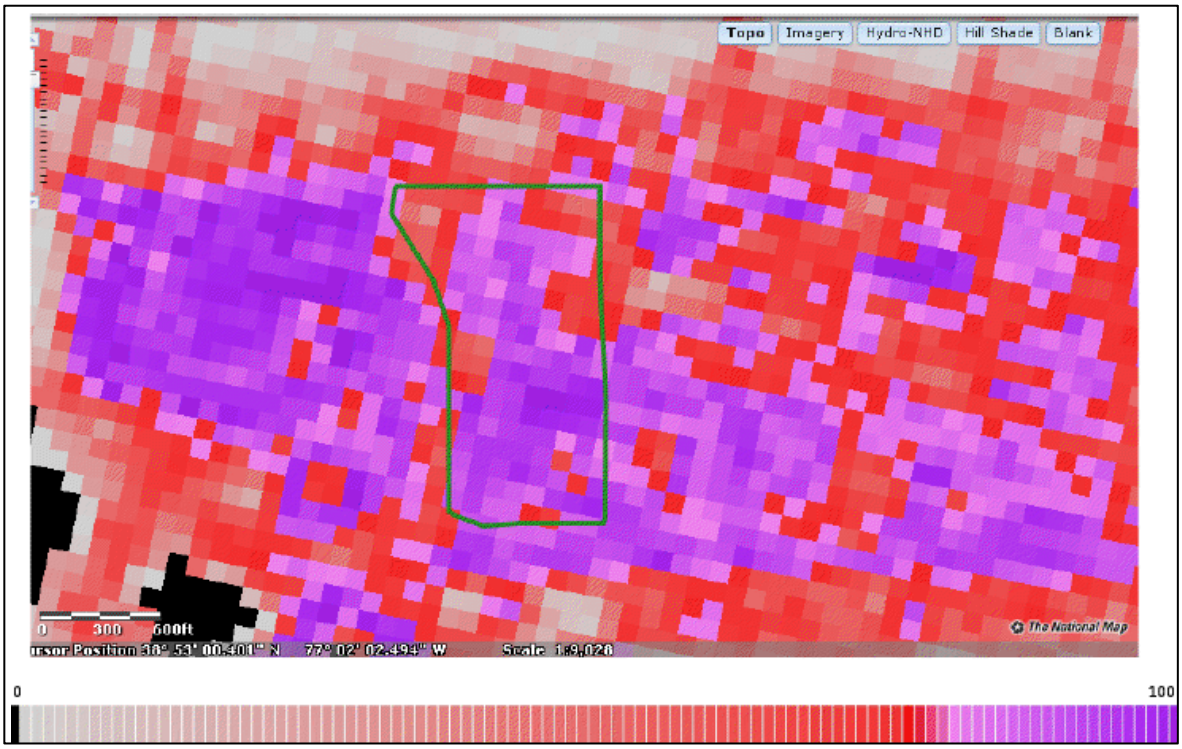


[50] Van Wye, Brian. "DC Stormwater Regulations and Federal Facilities Webcast." Chesapeake Stormwater Network. 12 Dec 2012. Webcast. <http://chesapeakestormwater.net/2012/12/dc-stormwater-regulations-and-federal-facilities-webcast/>

[51] National Capital Planning Commission. "The Southwest Ecodistrict: A Vision Plan for A More Sustainable Future" January, 2013. Page 48.

[52] United States. US Geological Survey. "National Land Cover Database 2006: Land Cover". National Map Viewer. <http://viewer.nationalmap.gov/viewer/>

Figure 2. Percentage of Developed Imperviousness in the Tenth Street SW Corridor Site[53]



In order to enact improvements to the stormwater system in DC, pay for stormwater projects, and ultimately clean up the Potomac and Anacostia Rivers, several key policies have been adopted.

The federal government requires that the District control pollution from stormwater runoff, under the National Pollutant Discharge Elimination System (NPDES). NPDES was created by the Clean Water Act and requires permits for all direct discharges of wastewater. Typically this applies to "point-source" polluters such as wastewater treatment plants, utility plants, and industrial processes. The government of the District of Columbia is also required to obtain NPDES permits for its Municipal Separate Storm Sewer System (MS4) which discharges "non-point source" stormwater directly into waterways in and surrounding DC.[54] The current permit is valid until October 7, 2016. DC Water also has a NPDES permit and is responsible for limiting discharges in the combined sewer system (CSS) which is why it also charges a Clean Rivers Impervious

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[53] United States. US Geological Survey. "National Land Cover Database 2006: Impervious Surface". National Map Viewer. <http://viewer.nationalmap.gov/viewer/>

[54] Environmental Protection Agency. "National Pollutant Discharge Elimination System (NPDES) Fact Sheet." 2 Nov 2012. <http://www.epa.gov/reg3wapd/pdf/pdf_npdes/stormwater/DCMS4/MS4FinalLimitedModDocument/Final_Mod_FactSheet_11-2-12.pdf>

Area Charge (IAC) to pay for upgrades that will allow that system to comply. (See policy brief on the Clean Rivers Impervious Area Charge for more information.)

In order to pay for the pollution control efforts and treatment of stormwater, the District Department of the Environment (DDOE) assesses a stormwater fee. The fees are based on the average amount of impervious surface on properties and as such can levy large monthly fees on heavily developed commercial areas. All properties, including federally owned properties, are subject to the fee as President Obama signed into law "An Act to Amend the Federal Water Pollution Control Act to clarify Federal responsibility for stormwater pollution," requiring federal agencies to pay reasonable service charges, including those pertaining to stormwater assessments on January 4, 2011.[55] The stormwater charge is currently paid through water bills, which DC Water collects and, in turn, passes on to DDOE. The fee provides a dedicated funding source to pay for low impact development projects such as green roofs, rain gardens, tree planting, street sweeping, and other activities that reduce the quantity and improve the quality of stormwater runoff.

In 2010, DDOE set the stormwater fee rate at $2.67 per Equivalent Residential Unit (ERU) of impervious surface, an area equivalent to 1,000 ft^2. Unlike DC Water's Clean Rivers Impervious Area Charge, the DDOE stormwater fee has not escalated in that time and remains at $2.67 for FY 2013[56]. The fee is structured to generate approximately $13.2 million per year and may be altered by DDOE as necessary to comply with the requirements of the District's NPDES permit for the MS4 system.[57]

Residences are charged according to a tiered structure and all non-residential properties (federally owned and commercial) are charged based on an assessment of the actual impervious area on the property, reduced to the nearest 100 ft^2.[58] In 2012 federal property within the Southwest Ecodistrict area paid approximately $6,800/month in combined IAC and stormwater fees. Due to escalations in IAC fees, the monthly costs are projected to rise to approximately $32,000/month or $384,000/year for federal properties or $48,000/month or $576,000/year for both federal and private properties within the Ecodistrict.[59]

At present, no program exists to reduce stormwater fees; however DDOE is in the process of developing a stormwater fee discount program called RiverSmart Rewards. The program "will provide water and sewer ratepayers the opportunity to receive up to a

[55] 111th Congress, 2nd Session. S. 3481. "To amend the Federal Water Pollution Control Act to clarify Federal responsibility for stormwater pollution." <http://www.gpo.gov/fdsys/pkg/BILLS-111s3481enr/pdf/BILLS-111s3481enr.pdf>
[56] DC Water. "Current Rates." http://www.dcwater.com/customercare/rates.cfm#understanding
[57] District Department of the Environment. "Notice of Final Rulemaking: Stormwater Fee Revisions." <http://green.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Stormwater%20Fee%20Notice%20of%20Final%20Rulemaking.pdf>
[58] District Department of the Environment. "Changes to the District's Stormwater Fee." <http://green.dc.gov/service/changes-districts-stormwater-fee>
[59] National Capital Planning Commission. "The Southwest Ecodistrict: A Vision Plan for A More Sustainable Future" January, 2013. Page 39.

55% discount off the stormwater fee to property owners who implement measures to manage and reduce stormwater runoff."[60] Once the program goes into effect, ratepayers will be able to apply for discounts that could be retroactively assessed back to May 1, 2009, the implementation date of the impervious area stormwater fee.

A final ruling on the District's Proposed Rulemaking on Stormwater Management and Soil Erosion and Sediment Control as well as the Draft Stormwater Management Guidebook will incorporate public comments and will be released for another round of public comments in the spring of 2013.

Nearby in Virginia, however, a federal court determined in a suit brought by VA Attorney General Ken Cuccinelli that the EPA cannot force or require the state to regulate stormwater flow as the Clean Water Act only permits the EPA to regulate pollutants and stormwater itself is not considered a pollutant. Although this ruling has the potential to create a precedent for other precincts, the ruling likely will not impact the DC stormwater requirements as the case in question sought to restrict the flow of stormwater into the creek to deal with sediment. [61]

Analysis

Although stormwater fees have remained stable to date, the fees may be altered by DDOE at any time as necessary to comply with the requirements of the District's MS4 Permit requirements legislated by the EPA. DC's MS4 permit is valid until at least October 2016 at which point a new permitting process will begin. The Virginia case shows that some are fighting back against stormwater regulations and accompanied financial impacts to agencies and municipalities. However, water pollution management by point-source water polluters has long been accepted. Trends locally and at the national level suggest that action on non-source water pollution is increasingly being strengthened, taken up, and adopted by those ultimately responsible for pollution as in the case of the DC MS4 requirements.

Therefore, it is likely the final ruling on the District's Proposed Rulemaking on Stormwater Management and Soil Erosion and Sediment Control as well as the Draft Stormwater Management Guidebook will not diverge drastically from what has already been proposed. It is suggested to begin using the Stormwater Management Guidebook and adopting best practices on the Tenth Street SW Corridor Site.

For planning purposes, it is further recommended to assume that the $2.67 per ERU cost will continue at least until October 2016. It is also safe to assume that the RiverSmart Rewards program will be adopted. Given that rebates owed from the RiverSmart Rewards program can be recouped retroactively, taking immediate action on stormwater quantity control measures such as low-impact development projects, structural controls, rainwater reuse, among others is advised.

[60] District Department of the Environment. "Changes to the District's Stormwater Fee." <http://green.dc.gov/service/changes-districts-stormwater-fee>

[61] Holeywell, Ryan. "Judge: EPA Can't Treat Stormwater as Pollutant." Fed Watch. 8 Jan 2013. <http://www.governing.com/blogs/fedwatch/Judge-EPA-Cant-Treat-Stormwater-as-Pollutant.html>

Concluding Remarks

Action on stormwater resulting from DC's MS4 program is required by the government of DC. By acting to reduce impervious area and stormwater runoff, property owners and managers including the federal government can take advantage of rebate programs to more than halve the stormwater fees being levied on every square foot of impervious area on the site. Although the fees are stable through 2016, action now will protect those properties from potential escalating costs in the future and since the rebates can be retroactively applied, the sooner impervious area is removed the more potential savings would accrue.

E. Stormwater Retention Credit Trading Program

Executive Summary

The Stormwater Retention Credit (SRC) trading system proposed by the District Department of the Environment (DDOE) has the potential to provide an environmental as well as monetary benefit to the Tenth Street SW Corridor Site. By certifying future low impact development (LID) projects that retain stormwater through the SRC program, public facilities as well as private facilities can improve the environmental effects associated with excess runoff, obtain a discount on the DDOE stormwater impervious surface fees (both the Impervious Area Charge and the Stormwater Fee), and generate profit by selling SRCs in the market. It is recommended that NCPC work to familiarize the site owners with the SRC program and help move them forward through the steps of SRC certification once the program is in place. To collect and reuse the largest amount of stormwater for the lowest cost, it is also recommended that the Tenth Street SW Corridor Site owners create an aggregate or pooled system to take advantage of any economies of scale involved in the LID retrofit process.

Background

A stormwater retention credit-trading program works similarly to an emissions cap and trade program. Regulated entities must meet certain levels of retention, just as cap and trade programs have emissions limits. However, to improve the flexibility and cost savings of such ecological requirements, credits are awarded and then can be traded accordingly. In the most basic sense, entities with high costs of additional stormwater retention are given the option to buy credits instead of installing retrofits while entities with low costs of retention can go above and beyond the requirements, receive credits, and sell them for a profit. The goal of credit trading systems in general is to maximize cost savings for all parties while making compliance easier and more ubiquitous for regulated entities.

More specifically, the Stormwater Retention Credit (SRC) trading system is a sub section of the Proposed Rulemaking on Stormwater Management and Soil Erosion and Sediment Control that was put forward by DDOE in August 2012.[62] The Proposed Rulemaking contains regulation that, for the first time ever, includes stormwater retention requirements in the District. The new proposed stormwater retention regulations requires that regulated sites be able to retain the amount of runoff that would occur from a 90th percentile rain event—or a storm that results in 1.2” of rainfall.[63] This retention capacity is dubbed the Stormwater Retention Volume, or the SWRv and is based on the amount of impervious surface at each site. The SWRv is measured in gallons and can be entirely retained by the owner on site or through a combination of on-site and off-site retention. Regulated sites are obligated to retain at least 50% of their calculated SWRv on site and the portion of the SWRv not retained on site is referred to

[62] Chesapeake Stormwater Network. 2012. *DC Stormwater Regulations and Federal Facilities Webcast*. Retrieved from https://connect-test.moo.umd.edu/p8pco1m23rl/

[63] Ibid.

as the Off-Site Retention Volume (OSRv). Sites can choose to achieve their mandatory OSRv in one of the following ways:[64]

A. Use Stormwater Retention Credits (SRCs) equal to the amount of the OSRv
B. Pay an in-lieu fee (ILF) to DDOE for the amount of the OSRv, the cost of which is $3.50 per one gallon of retention for one year
C. A combination of options A and B

Essentially, SRCs are a form of off-site retention that can be used to satisfy the OSRv required by any regulated site that does not retain its full SWRv on site. SRCs have a limited life span of one year, which starts only when it is used to satisfy such an OSRv in a specific year. And it is important to note that an unused SRC can be banked indefinitely for the future, can be traded, and can be voluntarily retired without being used. So which sites are regulated under the proposed rulemaking? Sites regulated by the new proposed retention requirements are sites that are conducting major land disturbing activities, such as new development, or sites conducting substantial improvement activities, such as renovation or redevelopment. Both a major land disturbing activity and a substantial improvement activity are defined by the following:[65]

A. Construction soil disturbance is equal to or greater than 5000 ft^2

   OR

B. Construction costs (self reported by the site owner) are 50% of the assessed property value
   AND
   The building footprint, or combined footprint of building and land disturbance, is equal to or greater than 5000 ft^2

The use of SRCs however is not limited to regulated sites. Non-regulated sites are able to apply for certification of SRCs based on retention retrofit projects that occurred after 2009. The incentive for non-regulated sites to apply for SRCs is the opportunity to bank or sell those credits, received for already planned or completed retrofit projects, for a profit. Eligible retrofit projects can be certified by DDOE for up to three years worth of SRCs at one time, which reduces the administrative costs of re-applying every year. This means that up to three years worth of SRCs can also be bought or sold at one time for sites in the SRC market.

Analysis

Specifically in the context of the Tenth Street SW Corridor Site, SRCs have multiple uses. Given the abovementioned parameters for a regulated site under the Proposed Rulemaking on Stormwater Management and Soil Erosion and Sediment Control, the buildings included in the Tenth Street SW Corridor Site will not be considered “regulated sites” when these rules are expected to go into effect in June of 2013. This means that the buildings within the site will not have retention requirements or a mandatory SWRv

[64] District of Columbia. District Department of the Environment. *Draft Stormwater Management Guidebook.* 2012. Print.
[65] Ibid.

or OSRv volume to comply with. Yet given the intention of NCPC to improve stormwater management for the Tenth Street SW Corridor Site through several DDOE Best Management Practices (BMPs) such as cisterns, opportunities arrive for cost savings. Additionally, any buildings in the Tenth Street SW Corridor Site that embark on redevelopment projects that disturb 5000 ft^2 or more in the future, such as the Cotton Annex or Department of Energy Forrestal Complex[66], will be regulated by these stormwater requirements. Therefore, this is an opportunity to get ahead of the curve, and also achieve a cost savings in the meantime.

Any retention retrofits that are installed by site owners within the Tenth Street SW Corridor Site are eligible to apply for SRCs through the DDOE application process. Any certified SRCs would accrue to the site owner and could either be sold for a profit on the SRC market or be banked for future use with potential construction projects in mind. In the latter case, the SRCs could then be used to meet OSRv requirements once sites complete future construction and are considered regulated sites. This has implications for the sites included in GSA's 2012 Request For Information (RFI) as well as the proposed Maryland Ave decking and redevelopment. Those sites are likely to be regulated in the future due to planned redesign or reconstruction and will have both SWRv and OSRv requirements. The ability of current retrofits to bank SRCs for the future could be used to cover the first few years of regulation at no cost to property owners. Within the Tenth St SW Corridor Site there is also an opportunity for site owners to work together and collect stormwater across property lines. If site owners can reach an agreement, the trading program does not require that SRCs be certified site by site. This allows cost savings for planned retrofits by taking advantage of economies of scale such as building larger cisterns that collect greater amounts of stormwater across property lines. If properties aggregate for the SRC trading program, it will improve the options for designing a stormwater retention system within the Tenth Street SW Corridor site while also saving money for property owners and increasing the amount of stormwater retention.

The amount of SRCs that each site can be credited depends on the extent of their retention retrofits. Because the Tenth Street SW Corridor Site is currently unregulated, it is eligible to be credited with SRCs for retrofits that increase the current level of site retention and do not exceed the SRC ceiling—retention levels required for a 1.7" rain event. (See Figure 1 on next page) Any retrofit project that is completed with the intention to apply for SRCs must do the following to receive DDOE certification:[67]

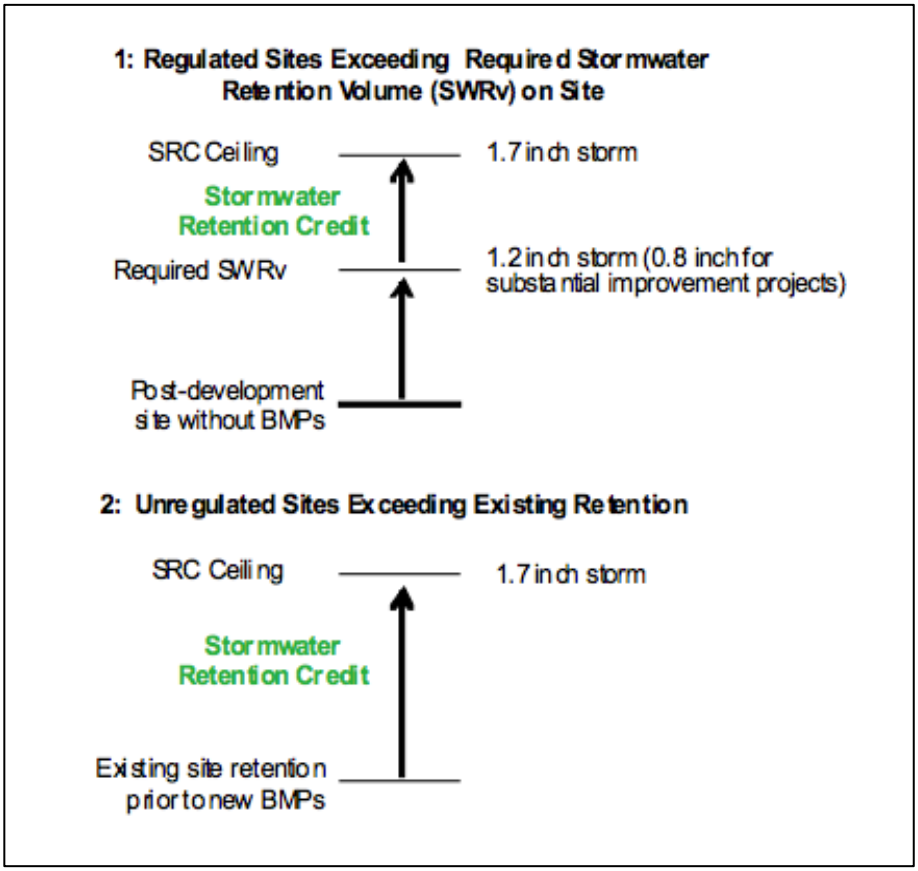
- Retain a volume of stormwater in excess of the regulatory requirements or existing retention, but below the SRC ceiling
- Be designed and installed in accordance with a DDOE-approved Stormwater Management Plan (SWMP)
- Pass a DDOE inspection once construction is finished as well as ongoing maintenance inspections

[66] United States of America. General Services Administration. *Request for Information Update #2 Federal Triangle South*. 7 December 2012. Print.
[67] District of Columbia. District Department of the Environment. *Draft Stormwater Management Guidebook.* 2012. Print.

- Provide a maintenance contract to DDOE or a maintenance agreement if the site owner chooses to carry out maintenance themselves

These steps are required by DDOE in order for them to grant certification to any specific project. The details of the retention volume was already discussed, but a DDOE-approved Stormwater Management Plan is suggested to be predicated on the advice in the DDOE Draft Stormwater Management Guidebook which can be found through DDOEs website or here: http://ddoe.dc.gov/draftstormwaterguidebook. The remaining steps do not provide much additional burden on the site owner, but will ensure that the installation continues to generate SRCs well into the future. See Figure 2 in the Appendix for the key milestones in the process of SRC generation.

Figure 1: Retention Volumes that are Eligible for SRCs (2. Unregulated Sites)[68]



Another benefit of the SRC trading program for the Tenth Street SW Corridor Site is an opportunity for a discount on district stormwater and impervious area fees. DDOE has proposed a rule to allow a discount on its Stormwater Fee – up to a maximum of 55% for retention capacity that retains the 1.2-inch storm on a property. The Stormwater Fee is already a required payment for every building in the Tenth Street SW Corridor Site, so

[68] District of Columbia. District Department of the Environment. *Draft Stormwater Management Guidebook.* 2012. Print.

this discount could result in serious cost savings. DC Water is also planning to conduct its own rulemaking process to establish a discount on the Impervious Area Charge (IAC). It is expected that DC Water will undertake that process in the next year and that the maximum discount available for the IAC will be less than the 55% maximum discount on DDOE's Stormwater Fee. It is understood at this point in time that DC Water will use DDOE's BMP technical specifications and process for determining how much retention is achieved by retention capacity and that applicants will apply through DDOE for the discount on both fees. To understand more about the Stormwater Fee and the Impervious Area Charge, see the Brief on Water Fees.

Concluding Remarks

Though the Stormwater Retention Credit (SRC) trading program has yet to go into effect, its benefits to the Tenth Street SW Corridor Site include cost savings through discounted District water fees, and the potential for profit as a result of selling certified SRCs to market SRC buyers. It is recommended by this report that NCPC work with the stakeholders in the Tenth Street SW Corridor Site to educate them on the benefits of the SRC trading program to each site owner. There is a financial incentive for each site owner to take advantage of the SRC trading program as a part of his or her stormwater improvements. In addition, the first step for each site is to create and get DDOE approval of a Stormwater Management Plan. This will allow the site to continue in the process of SRC certification as retention retrofit projects are developed.

Appendix

Figure 2: Key Milestones for the Generation of SRCs[69]

Key Milestones for the Generation of SRCs:

1. Receive DDOE approval of proposed SWMP.
2. Install BMPs and/or make land cover changes.
3. Pass DDOE's post-construction inspection.
4. Submit application for DDOE certification of SRCs, including:
   a. As-built SWMP and
   b. Current maintenance agreement or maintenance contract.
5. Receive DDOE certification for up to three years' worth of SRCs.
6. Maintain retention capacity and pass subsequent inspections.*
7. Submit application for DDOE certification of SRCs, including:
   a. Current maintenance agreement or maintenance contract.
8. Receive DDOE certification for up to three years' worth of additional SRCs.

*Steps 6, 7, and 8 can be repeated indefinitely

[69] District of Columbia. District Department of the Environment. *Draft Stormwater Management Guidebook.* 2012. Print.

V. Conclusion

This report has given background and technical information on all regulations and associated fees from the federal government, the District Department of the Environment, and the District's water and sewer authority, and DC Water that pertain to stormwater management. The relationships between the different regulations and fees has been discussed with the intention to make clear how best to comply with all levels.

All of these policies, mandates, and fees have specific applicability to the Tenth Street SW Corridor Site, which is the area under study by the American University Stormwater Policy and Design Project. The site specific information will be the basis of further study of the area and will help lead to a cost benefit analysis and proposed design scheme in line with the NCPC SW Ecodistrict Plan.

Finally, the recommendations of this report are directed towards site owners and the National Capital Planning Commission so that they may implement the appropriate stormwater management techniques within the Tenth Street SW Corridor Site. It is hoped that the recommended actions in this report will supplement the NCPC SW Ecodistrict Plan and give some more specific guidance on how to proceed within the Tenth Street SW Corridor Site.

Governance and District-Scale Water Systems

How they apply to the Tenth Street Corridor Site

Prepared for National Capital Planning Commission
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I. Executive Summary

The *Tenth Street SW Corridor Interim Streetscape and Stormwater Policy Project Proposal* will inform the NCPC and other interested parties of optimal stormwater management and green infrastructure design scenarios and strategies with respect to the environmental and economic benefits of NCPC's *SW Ecodistrict Plan*. A necessary first step is to understand the views and interests of the various stakeholders of the plan and where their participation in project planning and implementation is required. This report:

- Characterizes the stakeholders of the proposed district-scale water system;
- Identifies the local institutions and processes that these stakeholders can use to achieve the plan's water management goals;
- Provides a foundation and strategy for involving the stakeholders in the planning and implementation phases of the plan, including identifying various governance structures, as well as financing, legislative and policy tools that can assist stakeholders as the project develops.

In addition to an overview of the stakeholders in the Tenth street corridor site, this report will serve as an analysis of best practices for designing a district-scale water system. District-scale water systems offer communities the promise of increased resiliency in the face of increased droughts, heavy storms, floods due to a changing climate as well as increased energy efficiency and environmental equity. This report explores scenarios, best practices, and microgrid systems on the local level that could potentially make a district-scale water system viable in the Washington, D.C in the Tenth street corridor site.

II. Table of Contents

III. Stakeholders

Background:

The primary stakeholders of the district-scale water system are its direct beneficiaries: the property owners and building administrators who opt-in to the proposed district-scale water system. Property owners in the Tenth street corridor site include the federal government and private real estate companies. The six-block study area includes the buildings of the U.S. Department of Energy – Forrestal Complex, U.S. Postal Service Headquarters, the CIM Urban Reit, LLC building, the L'Enfant Plaza Hotel, and L'Enfant Colony, LLC buildings. Figure 1 provides information on potential beneficiaries of the district-scale water system. The SW Ecodistrict that encompasses the site is part of the Municipal Separate Stormwater Sewer System (MS4); this means that all stormwater runoff is piped directly into the adjacent Washington Channel and Potomac River, and greywater and wastewater produced on site is conveyed to the DC Water Blue Fields Water Treatment plant for processing. There are a host of federal and local policies, laws, regulations, fees, as well as credits and rebate programs that apply to stakeholders who are considering opting-in to the district-scale water system.

Other stakeholders -- institutions holding jurisdiction within the study area -- include a variety of federal, city, private and public entities. The most notable of these are the National Capital Planning Commission (NCPC), General Services Administration (GSA), National Park Service (NPS), District Department of Transportation (DDOT), District of Columbia Office of Planning (OP), District Department of the Environment (DDOE), DC Water, and the CSX Corporation. This report discusses their roles and contributions below.

National Capital Planning Commission

The NCPC is the federal government's central planner for the District of Columbia metropolitan area. The *SW Ecodistrict Plan: A Vision Plan for a More Sustainable Future* is a partnership initiative led by the NCPC involving 17 federal and local agencies that make up the SW Ecodistrict Task Force and technical Working Group. The NCPC had the primary responsibility in oversight of the SW Ecodistrict Plan with their principal consultant, ZGF Architects.[1]

General Services Administration (GSA)

The GSA is a federal agency that owns and operates federal property and land, including the U.S. Department of Energy – Forrestal Complex. Their main responsibilities include optimizing federal land use, creating a more efficient workplace, and reducing operating costs for the federal government. They have the authority to develop buildings and land for which they are responsible, sell property and land, and establish partnerships, and carry out plan recommendations such as those in NCPC's SW Ecodistrict plan. GSA development plans and building operations must be carried

[1] National Capital Planning Commission, "The SW Ecodistrict: A Vision Plan for a More Sustainable Future", January 2013, available at http://www.ncpc.gov/swecodistrict

out in accordance with Executive Order 13514, "Federal Leadership in Environmental, Energy, and Economic Performance". The GSA recently issued an RFI (last updated on January 16th 2013) for the area referred to as the "Federal Triangle South". The RFI is meant to help the GSA assess long term development needs for the area.

National Park Service (NPS)

The NPS is responsible for the development and administration of the public lands that bookend the Tenth Street Corridor Site, specifically the National Mall and Banneker Park. They have the authority to establish partnerships with SW Ecodistrict partners, as well as to develop and implement stormwater management goals. The inclusion of Banneker Park in the Tenth street corridor site study area has not been fully defined by the American University Stormwater Policy and Design Project team.

District Department of Transportation (DDOT)

DDOT is responsible for the public right-of-way land that is typically found between property lines, including sidewalks, roads, green spaces and alleyways. This represents a significant portion of the Tenth Street Corridor Site, also known as L'Enfant Promenade. Though DDOT is responsible for public rights-of-way, DC Water does not apply the Clean Rivers Impervious Area Charge (IAC) to these rights-of-way. In the MS4 areas, DDOT is responsible for catch basin and street level sewer maintenance, and is working to incorporate green infrastructure and other low-impact development (LID) techniques to rights-of-way. DDOT's 2010 Sustainability Plan outlines its commitment to improving and increasing tree canopy and protecting street trees as well as to "increasing the use of low-impact development design features in transportation projects to enhance stormwater retention capacity and protect local waterways from pollution"[2]. The sustainability plan states a goal of a 5% reduction of stormwater runoff annually.[3]

District of Columbia Office of Planning (OP)

The OP (and DDOE) are responsible for the District's Sustainable DC initiative, proposed by Mayor Gray in 2011, that aspires to make the District "the greenest, healthiest and most livable city in the nation" within 20 years.[4] OP and DDOE have convened working groups to develop a comprehensive vision and strategy framework called "A Vision for a Sustainable DC". This includes proposed legislation such as the Anacostia River Clean Up and Protection Fertilizer Act and goals that aim to increase

[2] District Department of Transportation, "2010 Sustainability Plan", p. 33, available at http://dc.gov/DC/DDOT/Projects+and+Planning/Environment/Sustainability+Plan/2010+Sustainability+Plan+PDF
[3] Ibid. p. 34.
[4] District of Columbia government, "A Vision for a Sustainable DC", December, 2010, p. 2, available at http://sustainable.dc.gov/sites/default/files/dc/sites/sustainable/publication/attachments/sustainable%20DC%20Vision%20Plan%202.2.pdf

green roofs by 1.5 million square feet, expand stormwater retention and infiltration infrastructure by 100%, and double the area of wetlands in the city.[5]

The OP also undertakes "Small Area Plans" that focus on specific needs around Washington, DC.[6] In December 2010, the OP released the first draft "Maryland Avenue Southwest Small Area Plan".[7] The OP plan is complementary to the SW Ecodistrict plan, focusing solely on Maryland Avenue between 12th and 9th Streets SW. The OP plan proposes decking Maryland Avenue within the Tenth Street Corridor study area and incorporates LID techniques and green infrastructure design approaches to the redevelopment of the traverse.[8]

District Department of the Environment (DDOE)

The Municipal Separate Storm Sewer System (MS4), which covers approximately two-thirds of the city (including Tenth Street SW), is managed by DDOE; DC Water manages the Combined Sewer System (CSS), which covers the other one-third. The DC government is required to have a National Pollutant Discharge Elimination System (NPDES) permit issued by the authority of US EPA's Region 3 to operate the MS4. The DDOE assesses stormwater fees to pay for pollution and sedimentation control based on regulations that are enforced by the federal government on stormwater management. Stormwater fees help DDOE pay for low-impact development (LID), or "green" infrastructure, projects that improve the quality of water and reduce the quantity discharged into local waterways without relying on the installation of more costly "grey" infrastructure.

DDOE defines low-impact development (LID) in the draft "Stormwater Management Guidebook" as "a land planning and engineering design approach to manage stormwater runoff within a development footprint. It emphasizes conservation, the use of on-site natural features, and structural best management practices to store, infiltrate, evapotranspire, retain, and detain rainfall as close to its source as possible with the goal of mimicking the runoff characteristics of natural cover."[9]

In addition to fees, the DDOE has proposed assessing and certifying Stormwater Retention Credits (SRC) and Best Management Practices (BMP) credits for land cover changes that reduce impervious surfaces. Furthermore, in 2012 DDOE proposed the Stormwater Retention (SWR) Program to work in conjunction with other DDOE stormwater management regulations, such as meeting Stormwater Retention volume

[5] District of Columbia government, "A Vision for a Sustainable DC", December, 2010, p. 29, available at http://sustainable.dc.gov/sites/default/files/dc/sites/sustainable/publication/attachments/sustainable%20DC%20Vision%20Plan%202.2.pdf

[6] District of Columbia Office of Planning, "Small Area Plans and Studies All Wards," 24 October 2012, available at http://planning.dc.gov/DC/Planning/In+Your+Neighborhood/Wards/Small+Area+Plans,+Studies,+and+Reports+for+All+Wards

[7] District of Columbia Office of Planning, "Maryland Avenue Southwest Plan," 2011 available at http://planning.dc.gov/DC/Planning/In+Your+Neighborhood/Wards/Ward+6/Small+Area+Plans+&+Studies/Draft+Maryland+Avenue+SW+Plan

[8] Ibid. p. 3-6 to 3-8

[9] District Department of the Environment, "Stormwater Management Guidebook," 2012. Appendix V-Definitions, p V-4, available at http://ddoe.dc.gov/node/226332

(SWRv), and is in the process of proposing a stormwater rebate program called RiverSmart Rewards to customers who implement measures to reduce stormwater runoff.

More detailed information on DDOE's regulations, fees, as well as credit and rebate programs can be found in the section on Stormwater Retention credits in the District of Columbia's Water Policies and Fees Report.

DC Water

DC Water is a quasi-independent authority of the DC government. Operations and finances are not tied to the DC government budget, which allows it to reinvest all money collected from user fees, grants and the sale of revenue bonds.[10] Federal regulations, such as the Safe Drinking Water Act (SDWA) and Clean Water Act (CWA) require perpetual and costly infrastructure upgrades. To pay for these upgrades, as well as pollution and sedimentation control measures and permits (such as the NPDES permit), DC Water assesses District businesses and property owners the Clean River Impervious Area Charge (IAC). DC Water also collects stormwater fees on behalf of the DDOE and transfers the funds quarterly.[11] This helps DDOE pay for costs associated with the MS4.

CSX Corporation

The publically traded CSX Corporation, headquartered in Jacksonville, Florida, owns and operates the railways and railway tracks that intersect the 10th Street Corridor at Maryland Avenue. The CSX Corporation has partnered with over 300 public and private organizations and individuals to improve rail connectivity between Mid Atlantic seaports and consumers and manufacturers in the Midwest.[12] The multi-stage railroad construction project called the National Gateway Program aims to upgrade existing bridges and tunnels, such as the Maryland Avenue railway tunnel that passes underneath 10th Street, to allow passage of double-stack freight trains.[13]

<u>Analysis</u>:

The stakeholder snapshots shown above outline areas where institutional programs and processes can be fashioned into an integrated stormwater management approach that is best suited for the 10th Street SW Corridor Site. The timing of several sustainable development plans and initiatives such as the SW Ecodistrict Plan, A Vision for a Sustainable DC, the Maryland Avenue Southwest Small Area Plan, the Federal Triangle South RFI, and the National Gateway Program provide a unique opportunity for

[10] DC Water, "Who We Are", available at http://www.dcwater.com/about/history.cfm, viewed on February 10, 2013
[11] DC Water, "Capital Improvement Program", p. VI-2, http://www.dcwater.com/investor_relations/CIP_sections/2011/Stormwater_Service_Area.pdf, viewed on February 11, 2013
[12] National Gateway, "About National Gateway", available at http://www.nationalgateway.org/background/about, viewed on March 12, 2013
[13] National Gateway, "10th Street", available at http://www.nationalgateway.org/projects/project/63, viewed on February 10, 2013

collaboration. At the same time, new federal and city mandates are raising operations and maintenance costs, as well as stormwater fees for building owners and operators.

The property owners and building administrators need to conduct comprehensive analysis of the costs and benefits associated with the district-scale water system and LID and green infrastructure design approaches. An integrated stormwater management approach can help stakeholders meet increasingly challenging government standards while at the same time reducing costs associated with water usage, stormwater fees and the IAC. To do this there must be a full understanding of federal and local policies and regulations, as well as potential credits and rebates. The *Tenth Street SW Corridor Interim Streetscape and Stormwater Policy Project Proposal* is working to identify local institutions and processes that can be used by stakeholders to achieve the SW Ecodistrict Plan water management goals, and may include governance structures, as well as finance, legislative and policy tools that can be used by stakeholders. This will help to provide a foundation and strategy for involving the stakeholders in the planning and implementation phases of the SW Ecodistrict Plan.

Recommendations:

The district-scale water system will require unprecedented partnerships and agreements between the federal government, District of Columbia, and public and private entities, including property owners who have yet to exist. Given the 20-year outlook of NCPC's *SW Ecodistrict Plan*, agreements and partnerships must be forward-looking and adaptable with opt-in opportunities for new development and the ability to meet rising stormwater management fees. This project proposal will identify various governance structures, as well as financing, legislative and policy tools that can assist stakeholders as the project develops.

All stakeholders of the district-scale water system must be included in each phase of the plan, from the planning stage to the implementation and monitoring phases. There should also be a concentrated effort to involve local business owners, building occupants, residents and other civil-society groups that reside within or hold interest in NCPC's SW Ecodistrict plan.

Figure 1: Potential beneficiaries of the district-scale water system

Building	Address	Owner	Partnership	Property Notes
U.S. Department of Energy – Forrestal Complex	900 Independence Avenue / 201 9th Street / 1000 Independence Avenue	GSA	Federal	Several structures
U.S. Postal Service Headquarters	475 L'Enfant Plaza	U.S. Postal Service	Federal	640,000 square-foot office building
CIM Urban Reit	370 L'Enfant Plaza / 901 D Street	CIM Urban Reit, LLC	Private	10-story 378,000-square-foot office building, ENERGY STAR Certified
L'Enfant Plaza Hotel (and Office Buildings)	429/470/480/ 490 L'Enfant Plaza	JBG Companies www.jbg.com/properties Potomac Creek Associates, LLC is a JBG entity	Private	Mixed-use project consists of two office buildings, newly renovated retail promenade featuring national retailers, light filled food court with outdoor seating, and a full service 372-room hotel.
L'Enfant Colony – South Office Building	950 L'Enfant Plaza	Heyman Properties LLC (www.heymanproperties.com) L'Enfant Colony, LLC is a Heyman entity	Private	Eight-story 300,000-square-foot office tower with underground parking.

IV. Case Studies

1. Living City Block

Background:

Living City Block (LCB) is a non-profit that was founded in 2010 to promote and facilitate resource efficiency at the city-block level to improve ecological footprints as well as increase neighborhood cohesion and attractiveness. Their mission is "to create and implement a replicable, exportable, scalable and economically viable framework for the resource efficient regeneration of existing cities, one block at a time."[14] Ultimately, the organization wants other groups to take their model and implement it, eliminating the need for LCB altogether.

LCB's model is one of benefits through aggregation. Ninety-five percent of all commercial buildings in the United States are small to mid-size properties[15] and many of these buildings cannot afford energy retrofits and become more efficient on their own. LCB works to create a formal consortium of building owners in a block, both residential and commercial.[16] Founder and President Llewellyn Wells stresses that there must be a binding, legal agreement of the building owners because a.) there is no other way to make sure it *is* binding and b.) financers are more likely to fund a project with a binding agreement.[17] This can be accomplished in several ways. It is best to look first at existing structures within the area you want to address. For example, a Business Improvement District is a special taxation district that every member elects to join and then pays to fund improvements within the BID. If a BID currently exists, they could create a special improvement district within specifically geared towards energy improvements. Another option is a building owner's association agreement, which operates similar to a homeowner's association: owners join and pay fees and the association has the right to represent the building owner's based on a charter. The types of legal governance structures vary by city and a legal team is required to fully research the options.

Once the building owners are bound together, LCB becomes a third party aggregator for equity and debt financing. The association creates a purchasing bloc (for retrofits) and increases the economy of scale. LCB acts as a manager. Besides arranging the financing, they ensure that the retrofits are completed on schedule and overall goals are achieved. The aggregation encourages the building owners to consider sustainability issues at a neighborhood level instead of just in their own building. From the success of their projects, LCB hopes to show that more efficient built environments lead to healthier and more productive people.[18]

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[14] *Living City Block.* Living City Block. 2013. Web. 6 February 2013.
< http://www.livingcityblock.org/>
[15] Badger, Emily. "Greening an Entire Block Instead of Just One Building." *The Atlantic Cities*. The Atlantic Mag., 16 April 2012. Web. 6 February 2013.
< http://www.theatlanticcities.com/jobs-and-economy/2012/04/greening-entire-block-instead-just-one-building/1759/>
[16] "About." *Living City Block.* Living City Block. 2013. Web. 12 March 2013. <http://www.livingcityblock.org/about-2/about/>
[17] Wells, Llewellyn. Personal interview. 20 March 2013.
[18] "What We Do." *Living City Block*. Living City Block, 2013. Web. 6 February 2013.
< http://www.livingcityblock.org/what-we-do/>

Living City Block also works to create an Integrative Master Plan Team with various stakeholders including building owners, representatives from local schools and business, and professional architects and planners.[19] This process is fairly straightforward because most parties included are stakeholders in one way or another.[20] Local schools and businesses have an interest in improvements in their area and creating added value for the community at large, even if the improvements don't directly affect their building. On the other hand, industry professionals have a motivation to be involved in an innovative project as well as to highlight their own work. The building owners themselves are essential to the success of the project. Without their interest and willingness, the project cannot move forward. LCB also works to consider the owners' priorities in the initial phases.[21]

The organization has two main projects on its docket, the first in Denver's Lower Downtown (LoDo) district and the second in Brooklyn Gowanus. In both instances, LCB has partnered with local organizations and focused on a specific area to achieve its goals. In the LoDo project, there are 17 buildings with over 40 owners and a collective physical footprint of 750,000 square feet. Their goals focus on reducing energy consumption in three phases: first achieving 50 percent block-wide energy use reduction by 2012, then 75 percent reduction by 2014 with a full measurement and verification program in place, and at least two net-zero historic building retrofits that will serve as demonstration buildings by 2016.[22] To begin, the LoDo project is addressing eight adjacent buildings having a total of four owners. The building owners pay a utility fee to LCB that is comparable (but slightly lower) to their existing bill; LCB acts as an energy services company (ESCO), and organizes the loans and implements the retrofits.[23] Once the utility bills decrease as the result of the increased efficiency, the financial savings between the old and new bill go to paying off the loans that LCB negotiated. The whole process is designed to be the least cost intensive for the building owners as possible.[24] As of March 2013, the Denver project has been officially shut down, largely due to the low energy, water and waste prices in Colorado.[25]

The Gowanus project has similar goals on a timeline from 2013 – 2017 with an additional focus on stormwater. Some of the methods and technologies that are being considered in this project are solar hot water, insulation, micro-wind power, higher efficiency water heaters, and better machinery.[26] As of March 2013, this project is on hold.[27]

[19] Curley, Emily, "Living City Block: A Case Study." 10 July 2012.
[20] Wells, Llewellyn. Personal interview. 20 March 2013.
[21] "Living City Block." *Gowanus Canal Community Development Corp.,* n.d. Web. 10 February 2013. < http://gowanus.org/gccdc/?page_id=309>
[22] *Living City Block.* Living City Block., 2013. Web. 6 February 2013. < http://www.livingcityblock.org/>
[23] Badger, Emily. "Greening an Entire Block Instead of Just One Building." *The Atlantic Cities*. The Atlantic Mag., 16 April 2012. Web. 6 February 2013.
[24] Wells, Llewellyn. Personal interview. 20 March 2013.
[25] Ibid. 20 March 2013.
[26] "Living City Block." *Gowanus Canal Community Development Corp.,* n.d. Web. 10 February 2013. < http://gowanus.org/gccdc/?page_id=309>
[27] Wells, Llewellyn. Personal interview. 20 March 2013.

Living City Block's ultimate objective is that the systems that they help to put in place will become "an embedded part of the community forever" and that whatever governance structure that is put in place is able to run the system after Living City Block withdraws.[28]

Analysis:

LCB's model of creating neighborhood-scale energy efficiency by uniting building owners in a selected area is a great and innovative idea. However, it has yet to be proven successful, particularly after the revelation that neither project is moving forward at this time. The greatest difficulty is first, to persuade the building owners to participate, and secondly, to maintain their interest and cooperation. Creating a binding agreement can ensure their involvement and the aggregation itself overcomes barriers as it allows for a pool of assets and a greater return on investment. The building owners will receive benefits by deciding to join. Determining which governance structures are legal, and which ones may already exist in the area of interest is a preliminary step that needs to be completed. Once the association is created, convincing banks to trust it and ensuring that each individual building owner is credit-worthy could also pose a challenge.

In terms of long-term sustainability, there are several complications that need to be worked out as soon as possible in a project timeline. For example, once the finance of a water or energy system is paid off, who owns it? If the association or other governance structure is the owner, there are questions of what happens when one party wants to sell their building. How will the transfer of their piece of ownership of the system be accomplished and/or how will the future owner of the building be forced to participate in the association and operation of the system? This again requires professional-level research on real estate law in the particular area that the project is in.

While these steps seem to have been accomplished in the LoDo and Gowanus projects, LCB has been unable to move achieve its energy reduction goals in the areas.

Recommendations:

The LCB projects and NCPC's SW Ecodistrict plan in Washington, DC share some of the same challenges. While much of the land and a majority of buildings in NCPC's SW Ecodistrict plan are owned and managed by the federal government, there are other owners and managers as well, including distinct federal agencies, the DC government and private business. The creation of a district water system in this area would require the same type of cooperation amongst building owners that LCB's projects do. NCPC's SW Ecodistrict plan already has a leg-up because of the existing task force and working group that created the plan. There is already willingness, and in some cases a federal mandate, to make improvements.

LCB's creation of the Integrative Master Plan Team with the various stakeholders at the table is a great way to ensure commitment and ongoing support as well as management of the project into the future. Although a task force already exists, it would be helpful to

[28] Ibid.

have a separate group focus entirely on a district water system involving only those stakeholders in the Tenth Street SW Corridor.

In order to be successful, it would be necessary to create a governance structure, like a BID or building owner's association, to manage the green infrastructure and decentralized water system, as LCB did. This body would have control over the utility bills and retrofits of each building, regardless of ownership. In this way, all the buildings in the area would benefit from bulk pricing for new water efficient infrastructure and retrofits, such as new low-flow sink and toilet fixtures and rainwater cisterns. NCPC's SW Ecodistrict plan may also consider using this technique to gain funding for these projects, in the absence of financing from the building owners (federal and private) themselves. The SW Ecodistrict Plan specifically mentions the need to create a new governance entity managed by a board of public and private representatives explicitly tasked with coordinating, developing, financing and maintain district-wide green infrastructure improvements and water or energy systems.[29] This would achieve the three goals laid out above: cooperation amongst building owners, creation of a Master Plan Team for a district water system, and the facilitation of the project by one body.

Based on the information from President and Founder of Living City Block Llewelyn Wells, additional research is needed into the District of Columbia's laws regarding governance structures and real estate law to determine what structures are legal and appropriate as well as what terms members could be locked into when joining such an association. This would dictate what would happen when properties within the area were bought and sold. This is of particular relevance if the property that contains the current Department of Energy building is rebuilt and sold to a private entity.

2. Decentralized Water Systems

Background:

Currently, most cities use centralized water systems in which both stormwater and wastewater drain into concrete pipes, often a combined stormwater-wastewater sewer leading to the municipal water treatment plant[30]. In the past, city officials planning the water infrastructure focused on the short term costs, so they preferred to build one pipe for both stormwater and wastewater and one centralized water treatment plant since it the initial cost was lower than building separate systems for stormwater and wastewater**Error! Bookmark not defined.**. Water management responsibilities, such as ensuring the quality and quantity of potable water, stormwater management, flood control, and wastewater treatment, have traditionally been divided among separate agencies. In some cases, lack of collaboration among agencies has led to conflicting goals and inefficiencies in water management.

A reliance on centralized water infrastructure may result in several problems. First, it puts the cities at risk for flooding whenever there are large amounts of weather-induced precipitation that exceeds the pipe's limits. In cities with combined sewer systems,

[29] National Capital Planning Commission. (January 2013). *The SW Ecodistrict Plan, A Vision Plan for a More Sustainable Future.* Washington, DC.

[30] Cascadia Green Building Council. 2011. Toward Net Zero Water: Best Management Practices for Decentralized Sourcing and Treatment.

where stormwater and wastewater are collected in combination and flow through the same pipes,[31] heavy rainfall may cause the amount of stormwater to exceed the capacity of the pipes, with the result that the wastewater and stormwater spill out into the streets, rivers, lakes, streams and oceans in a combined sewer overflow. This toxic overflow puts entire communities and ecosystems at risk.

Second, centralized water systems are not very cost- or energy-efficient as the systems treat stormwater, which may be minimally polluted, to the same extent as wastewater, which is biologically contaminated. However, the same high level of filtration is needed for the entire volume when the stormwater combines with the wastewater, thus raising costs and energy usage. In Washington, DC the Blue Plains Wastewater Treatment Plant uses about 576-648 MWH of energy per day, and energy usage for pumping the water accounts of 10% of its energy demand[32]. Thus, the wastewater treatment plant's energy usage will increase during storm events when it has to process an increased amount of water.

Decentralized wastewater systems, on the other hand, use a combination of efficient and low-cost techniques. District water management is a form of decentralized wastewater system, in that responsibility of collecting, treating, and reusing the water is shared among the buildings in the district. In order to manage the water within the district, low impact development (LID) techniques such as green infrastructure may be utilized, but is not necessary for inclusion in a district water system. Green roofs, vegetated swales, pocket wetlands, cisterns, rain gardens, and other practices are some of the LID methods that may be used to meet the goal of stormwater management on site. District water management provides a means to control stormwater and to distribute water with greater efficiency by reducing the amount of energy necessary in water treatment by using a shared system to reuse resources.

In Washington, DC, about one-third of the District is served by combined sewer, while about two-thirds is served by separate storm and sewers (MS4)[33]. The Tenth Street SW Ecodistrict Corridor Site falls under the areas treated by separated storm and wastewater sewers. While that is preferable to the combined sewer system, it is still very important that the corridor site reduces its stormwater runoff in order to improve the water quality of the stormwater runoff onsite, and prevent the release of vehicle-related contaminants and excess nutrients accumulated from the soil into the Potomac River. Thus, this section will focus on best practices that NCPC's SW Ecodistrict plan can implement in a decentralized, district scale water system to avoid stormwater runoff and lower the costs incurred by reduced stormwater sent to the centralized wastewater system.

[31] Slavin, Matthew L., comp. Sustainability in America's Cities. Washington DC:Island Press, 2011. Print.
[32] Suzuki, Ryu. 2013. Blue Plains Wastewater Treatment Plant. Email
[33] Karimi, Hamid. District Department of the Environment (DDOE). 2010. Removing Impediments to Green Roofs in Washington, DC.

Analysis:

District water systems work to achieve more sustainable water management in a more holistic manner through three main methods: water efficient plumbing fixtures and technologies; stormwater retention and reuse; and decentralized wastewater treatment, resource recovery, and reuse. In order to create an effective district scale water system, planners should take into account all three aspects. However, to align with the stormwater focus of this report, this section will focus on the second method: best practices to capture and use stormwater.

One method that many district scale water systems may use is the installation of a large cistern or cisterns underground to collect rainwater. This cistern or cisterns will allow for the recycling of and transmission of the rainwater into the surrounding structures for various non-potable uses. A district water system such as the one proposed here for the NCPC's Southwest Ecodistrict project provides many benefits to the area and the surrounding community, including increased resource efficiency, creating a sustainable, local, and dependable resource through water recycling, increasing the resiliency of the area to extreme weather events, including flooding, increasing the environmental value of the area, and even potentially increasing property values.

Another method to district storm water management is the installation of green infrastructure and low impact development technologies (LID). Green roofs on the buildings, for example, would add the benefit of reducing the urban heat island effect. However, in terms of cost, green roofs have one of the higher first costs per square foot. For a single building, it may cost $31.80 per square foot to establish a green roof.[34]

However, despite the higher initial costs, green roofs bring many other environmental benefits, such as avoidance of combined sewer overflows associated with rapid runoff; but if maximum water collection is the goal, with a green roof, less water might ultimately be available for non-potable uses within the building.

Other LID features that can be installed to capture, infiltrate, and/or treat rainwater include rain gardens, pervious concrete pavers, gravel bed detentions, bioswales, and native landscaping. Similar to green roofs, rain gardens seek to use plants (and their root systems) to capture, evapotranspirate, and cleanse some of the rainwater. Pervious concrete pavers and gravel bed detentions allow stormwater to drain down into the ground instead of running off into the sewer pipes. Bioswales are used to filter out some of the pollutants in stormwater before entering the waterways.

Seattle, Washington, for example, uses internal policies that require green infrastructure in public property standards[35]. They use the Natural Drainage System (NDS) approach, which supports the use of green infrastructure at the site level and in terms of large

[34] Electric Power Research Institute (EPRI). 2010. Sustainable Water Resources Management.
[35] The Civic Federation, comp. Managing Urban Stormwater with Green Infrastructure:Case Studies of Five U.S. Local Governments. Chicago: The Civic Federation, 2007. CNT: Center for Neighborhood Technology. Web. 24 Feb. 2013. <http://www.cnt.org/repository/GreenInfrastructure ReportCivicFederation%2010-07.pdf>.

development planning and design". Seattle Public Utilities (SPU) recognized that the traditional pipes and storm water systems in Seattle were not controlling the volume of stormwater as intended and were harming stream ecology. The Natural Drainage System (NDS) approach was created as a result of this concern. The NDS approach uses natural technologies to provide environmental benefits and storm water control[36]. These include narrower roadways to reduce impervious surfaces, vegetated street side swales, biofiltration, increased street-side landscaping, increased community interaction and public education**Error! Bookmark not defined.**. According to the SPU's website, Natural Drainage Systems cost 10 to 20 percent less than traditional street redevelopment with curb, gutter, catch basins, asphalt and sidewalks[37]. The SPU has conducted cost benefit analysis on their Natural Drainage Systems and have compared them to traditional street drainage systems. The results showed that their SEA street project, complete with a NDS system cost only 325,000 dollars per block to provide stormwater management with high ecological benefits such as protection for aquatic biota and the bioremediation of pollutants. Traditional street drainage costs 425,000 dollars per block for stormwater control and provides no ecological benefits. In order to ensure a thorough analysis, other streets, both traditional and fitted with NDS were compared and analyzed. The SPU found that there were average savings of 280,000 dollars per block[38]. It is important to note that in order for the Southwest Ecodistrict to be both environmentally sound and sustainable, natural technologies should be considered.

There is currently a sustainable district being constructed in Seattle, Washington that is similar to the one proposed by the National Capital Planning Commission. This project, led by the Seattle Housing Authority and major stakeholder CollinsWoerman, features the redevelopment of the Yesler Terrace, a 36 acre public housing community[39]. This is a massive project, including district water management, district energy systems and district waste management. The project was approved in October of 2012 by the Seattle City Council and is expected to take approximately 15 to 20 years. Like the Southwest Ecodistrict, this project aims to feature potable drinking water in their district water management system. They aim to use the cisterns to reduce the amount of potable water through the collection of rainwater for gray wastewater and the recirculation of gray and black wastewater. The water system will require purple pipe dual plumbing and a distribution loop to return treated water to the buildings throughout the site. It is important to note that while the capital cost of their water reuse treatment system would cost approximately 10 million dollars, with added costs of 650,000 to 750,000 dollars per year for operation and maintenance; these incremental costs would be offset by annual savings of approximately 2.3 million dollars. This economic benefit

[36] EPA Office of Wetlands, Oceans and Watersheds, comp. Green Infrastructure Case Studies: Municipal Policies for Managing Stormwater with Green Infrastructure. N.p.: EPA, 2010. EPA: The Environmental Protection Agency. Web. 24 Feb. 2013. <http://www.epa.gov/owow/NPS/lid/gi_case_studies_2010.pdf>.
[37] City of Seattle, and Seattle Public Utilities, comps. Seattle's Natural Drainage Systems: SPU, 2007. Seattle.gov. web. 24 Feb. 2013. <http://www.seattle.gov/util/groups/public/ @spu/@usm/documents/webcontent/spu02_019984.pdf>.
[38] SPU Cost Benefit Analysis http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/spu02_019986.pdf
[39] Moddemeyer, Steve. Yesler Terrace: Sustainable District Study. Comp. CollinsWoerman and Gibson Economics. N.p.: n.p., 2010. Seattle.gov. Web. 24 Feb. 2013. <http://www.seattle.gov/environment/documents/ YT_Sustainable_District_Study.pdf>.

is all due to the water and sewer savings generated through the implementation of a district water system. Centralized water systems incur high costs by treating stormwater and wastewater in the same process. A district water system with a stormwater and rainwater catchment cistern would help solve that issue.

The cisterns proposed by the NCPC for stormwater collection will have to hold the stormwater generated by a 1.7" rain event. Therefore, unlike smaller projects which feature cisterns on roofs, this project will require the tanks to be grounded. Weight will prove to be a serious concern in the installation of these cisterns. These cisterns would need to be below ground, located on 10th street.

The advantages of a rainwater harvesting system such as a cistern are that it is a sustainable system that makes use of a natural resource, it reduces potable water use, flooding, stormwater runoff and erosion, and promotes water conservation[40].

Unfortunately, there are drawbacks to using cisterns for rainwater harvesting. The cisterns can be costly to install depending on the size and the system and the payback period could vary. They require regular maintenance and should they not be installed correctly, could attract mosquitoes. The cisterns will collect chemicals, pesticides and other pollutants as they will be collecting mainly stormwater. Rainfall can be limited and uncertain and this affects the cistern's ability to reduce potable water use for the site[40]. Additionally, to use a cistern, a purple pipe infrastructure and pump system would need to be established.[41] This purple pipe infrastructure would be needed since the stormwater collected from the cistern would not be a high enough standard to be potable so separate pipes would have to be established to keep the stormwater separate from the potable water. A pump system would be needed to pump the water from the underground storage tank to the building aboveground to be used. Thus, if the costs of establishing the purple pipe and pump infrastructure are included, which would vary based on building and tank size, the costs of establishing a cistern will be significantly higher.

The drawbacks can be mitigated through proper maintenance and installation, and sufficient processing and proper use of the collected rainwater. The cisterns will have to be monitored and a maintenance process will have to be drafted for the overall success of the system.

<u>Recommendations</u>:

The goal of NCPC's SW Ecodistrict plan is to retain all the stormwater that falls during a 95th percentile rain event, which is equivalent to 1.7 inches of rain in 24 hours. Thus, creating a plan for a district scale water system will prove to be essential. These measures, taken together, will help to reduce stormwater runoff and thus, reduce vehicle-related contaminants and nutrient loading to the river. The shared cistern will

[40] San Diego Public Utilities http://www.sandiego.gov/water/conservation/rainwater.shtml#advantage
[41] http://www.rainwatermanagement.com/System-Designs.html Rainwater Management. 2013. Rainwater System Designs.

reduce costs and utilization of green infrastructure will beautify the area and improve the overall quality of life.

V. District-Scale Water System Ownership and Management Structures

Background:

Distributed energy generation and district-scale water systems (DSWS) share many similarities. For example, both types of systems are typically connected to a centralized system and thereby involve municipalities or utility companies. Also, they both include localized resources, either through on-site generation in the case of electricity or on-site collection in the case of water. They may involve a single resource user, or they may involve numerous users, such as residential, commercial or government institutions. There are differences as well. Excess electricity generated as part of a microgrid system is usually sold back to the utility or additional customers[42] while collected water from a DSWS is typically used within the system. Additionally, the generation of electricity, maintenance of electric loads and monitoring of demand requires careful operation and design[43]. The collection and distribution of rain water and grey water will require some maintenance and operation, but as long as rainfall amounts, climate trends, and cistern capacity are correctly gauged, it is not likely to be as sensitive as onsite electrical generation is to minor fluctuations. These similarities enable the ownership and management structures of microgrid systems to guide the development of new DSWS while the differences prevent exact duplication of one system to another. Even within the same type of system, duplication is not ideal, as the conditions will differ from site to site.

Aside from management similarities, the physical infrastructure of distributed generation systems and DSWS is also similar. As defined by Robert Dohn of Siemens, a microgrid is a discrete energy system consisting of distributed energy sources (e.g. renewables, conventional generation, storage) and loads capable of operating in parallel with, or independently from, the main grid. A microgrid includes electricity generation, a distribution system, consumption and storage, and manages them with advanced monitoring, control and automation systems.[44] In place of electricity generation, DSWS may include rainwater or grey water collection to meet local demand for non-potable water uses. Additionally, an effective DSWS must be capable of storing collected water and operating water "load" in parallel with potable water supply which requires appropriate management and distribution of water as needed for non-potable uses.

Distributed generation and district-scale water systems also share similar benefits. One of the major benefits of each system is efficiency.[45] Centralized electricity production

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[42] Markvart, Tom; 2006, *Microgrids: Power systems for the 21st Century?* Refocus**,** Volume 7, Issue 4**,** July–August 2006, Pages 44, 46, 48 http://dx.doi.org/10.1016/j.bbr.2011.03.031

[43] Dohn, Robert L. 2011, *The business case for microgrids White Paper: The new face of energy modernization.* Siemens, http://www.energy.siemens.com/us/pool/us/energy/energy-topics/smart-grid/downloads/The%20business%20case%20for%20microgrids_Siemens%20white%20paper.pdf

[44] Ibid.

[45] King, Michael, 2012, *Community Energy: Planning, Development and Delivery*, International District Energy Association, http://www.districtenergy.org/community-energy-planning-development-and-delivery

can lead to losses during conversion and distribution. Centralized water systems experience losses in both water and energy. When potable water is used for non-potable needs such as toilets or irrigation, there is a greater demand for water from the central supplier. Central water utilities expend great amounts of electricity in the purification of the water supply and so by utilizing alternative water sources for non-potable needs such as through rainwater or grey water, you greatly reduce demand on the central utility. Through these efficiency gains, both distributed generation and district-scale can save money on utility bills and provide financial incentives.

Distributed generation systems also experience greater flexibility and resilience[46]. DSWS establish flexibility in water use options and decrease demand on the water utility. Fully independent water systems with treatment facilities may increase resiliency even further by allow islanding to disconnect from the utility. With both types of systems, on-site storage of local water or electricity for building and property functions ensures independence from central utilities and allows for control and security during times of power failure or drought.

Analysis:

With a similar arrangement involving various parties sharing a locally derived resource, both distributed generation and district-scale water systems can have similar ownership and management architecture. Although they will not be identical, there are a number of basic arrangements possible.

Michael Hyams in his research on microgrid deployment in the state of New York outlines nine physical and virtual ownership and service models in two major categories, utility and non-utility.[47] Two of these schemes involve virtual microgrid systems which can be excluded from application to district-scale models as they depend on existing infrastructure owned by utilities. As most buildings do not collect their own rainwater, DSWS will always require new physical infrastructure to collect, store and distribute rainwater/grey water and therefore virtual models are not applicable. Additionally, the merchant sale models are not likely to apply to district-scale systems as collected rainwater/grey water will not be sold outside the system. These models can be adjusted however, to eliminate the sale of water while still including the variation in management options.

In addition to Hyams research, the Portland Sustainability Institute (PSI) has identified four ownership and operating models with eleven subcategories depending on organizational structure.[48] Many of the PSI models show overlap with the Hyams models. Both sets of models combine to frame a set of architecture strategies for district-scale water systems. Figure 1.1 outlines the typography for these different systems, drawn from both the Hyams and PSI models. Adapting these to the

[46] Ibid.
[47] Hyams, Michael, 2010, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*, New York Energy Research and Development Authority
[48] Portland Sustainability Institute, 2011*, District Energy Development, Ownership & Governance Models*, Prepared for the City of Portland, http://www.portlandoregon.gov/bps/article/349828

infrastructure requirements of a district-scale water system, the following 11 models can be proposed.

1. **Vertically Integrated, Publicly Operated Model** – In this model, the physical infrastructure, i.e. piping, storage containers and building specific collection technology are owned by the public utility or municipality. The collection, distribution, maintenance and operation of the system are fully managed by the same utility or municipality.
2. **Vertically Integrated, Subsidiary Operated Model** – Under this architecture, the public utility or municipality own the physical infrastructure but operations and maintenance are preformed through a subsidiary agency owned by the municipality.
3. **Hybrid, Unbundled Model** – Systems under this scenario allow the public utility or municipality to own the physical infrastructure, but maintenance and operations are managed by a completely separate company.
4. **Hybrid, Unbundled, Shared Ownership Model** – In this model, physical infrastructure is separated by different ownership arrangements, partially owned by the municipality or public utility. Under this arrangement, the maintenance and operations may be performed either by the public utility, the municipality or by a separate company.
5. **Hybrid, Unbundled Cooperative Model** – Under this system, the infrastructure may be all, or partially owned by the public utility or municipality, however the maintenance and operations are performed by a cooperative board, chaired by public and private stakeholders.
6. **Hybrid, Unbundled, Publicly Operated Model** – This architecture may have a single owner of the physical infrastructure or joint ownership between property owners, however the maintenance and operations are performed by a public utility company.
7. **Cooperative Model** – This model describes a fully cooperative arrangement with shared ownership of the physical infrastructure as well as shared management and operations activity through a board of private stakeholders making up the property owners within the system boundaries.
8. **Cooperative, Privately Operated Model** – In this model, ownership of the physical infrastructure is shared among the property owners while the maintenance and operations are managed by a private company.
9. **Non-Profit Model** – This system is both owned and operated by a single entity, a non-profit organization without shareholders which may or may not also own the properties being serviced by the system. The organization may contract out management, but maintains control.
10. **For-Profit Model** – In this model the system is owned and operated by a for-profit, publicly traded company. Physical infrastructure is owned, maintained and managed by the corporation.
11. **Private Model** – Under this architecture, the physical infrastructure is owned by a private entity. The PSI study breaks this model into two categories, regulated and unregulated because in a distributed generation system, electricity rates might be dictated by state or local utilities commission. However under a district-scale water system, there is nothing to sell back to the utility and therefore regulations of this sort do not apply.

Recommendations:

Due to the unique context of NCPC's proposed SW Ecodistrict and Tenth Street Water System in regards to the number and type of property owners and occupants, not all of the aforementioned models are applicable. With multiple property owners on Tenth Street, the single-owner models are impossible and exclusive municipality-owned models are unlikely. Private scenarios may also be challenging ashigher rates of return are required and charges to customers may be higher.[49] However, depending on the end use of the collected water, a private model may be possible. Considering the benefits and weaknesses of each model and the potential for cooperative relations between property owners, the amount of financial savings potential from a water system and the level of involvement in which the city, federal government and water utility could have there are six potential arrangements that may work for the Tenth Street Water System. Highlighted in figure1.1, options 4 through 8 and 11 are models to consider and evaluate in greater detail for the SW Ecodistrict Tenth Street Water System.

Models 4, 5 and 6 would involve the participation of the local DC government with some level of ownership of infrastructure or an operational and managerial role. The property owners would also participate as partial owners or buyers and sellers within the system. Models 7 and 8 would require cooperative ownership of the system among property owners and developers. Management could be performed by the cooperative or by a private organization. Model 11 would be fully privatized, possibly through a power purchase agreement where collection and management were fully conducted by a private organization. Dockside Green in Victoria, British Columbia is a fully privatized district-scale water system which established financial viability through extensive water efficiency design features.[50] The system uses both rainwater and wastewater, treating all collected water on site thus eliminating sewer fees and reducing potable water needs.

A first step in evaluating which model may best suit the needs of NCPC's SW Ecodistrict plan will involve collecting commitments from all potential stakeholders and partners. This may involve creating a memorandum of understanding or letter of intent to help unify involvement of all parties and gain a deeper understanding of the roles each property owner or stakeholder may be willing to play. I would suggest engaging all the stakeholders, including property owners, the utility, and relevant federal and local government institutions in a survey or other information gathering process to collect data on individual property owner plans for areas within the district-scale water system, draw out expectations and concerns, and determine specific needs and abilities of all stakeholders.

Additionally, it may be beneficial to host a symposium with experts from the field of decentralized energy and water systems to share ideas and discuss potential

[49] King, Michael, 2012, *Community Energy: Planning, Development and Delivery*, International District Energy Association, http://www.districtenergy.org/community-energy-planning-development-and-delivery

[50] Water Environment Research Foundation, 2009, *When to Consider Distributed Systems in an Urban and Suburban Context, Case Study: Dockside Green, Victoria, British Columbia, Canada*, http://www.werf.org/i/c/Decentralizedproject/When_to_Consider_Dis.aspx

governance models for the SW Ecodistrict. This would provide DC Water and the property owners with the opportunity to learn more about the potential ownership and operational models and engage the community as well as consult with experts on management best practice.

	100% Public <----------										----------> 100% Private
TYPE	**Utility**						**Non-Utility**				
PHYSICAL INFRASTRUCTURE OWNERSHIP	Full Utility Owned infrastructure		Partial Utility Owned infrastructure				Occupant Owned Infrastructure				Independent Non-Utility Service Provider Owned Infrastructure
							Multiple Owner		Single Owner		
MANAGEMENT/ OPERATIONS STRUCTURE	Full Utility Management		Utility may/may not manage system				Joint Management	Independent Private Service Provider Managed	Single Owner Managed	Independent Private Service Provider Managed	Independent Non-Utility Service Provider Managed
Adjusted Hyams Model	Vertically Integrated		Unbundled				CO-OP 1	CO-OP 2	Campus 1	Campus 2	Independent Provider
Adjusted PSI Model	**Municipal** Department Operation	**Municipal** Subsidiary Operation	**Hybrid** Municipal Ownership, Split Operation	**Hybrid** Split Assets	**Hybrid** Joint Cooperation Agreement	**Hybrid** Non-Utility Ownership, Municipal Operation	**Cooperative**		**Hybrid** Non-Profit Ownership and Operation	**Hybrid** For Profit Ownership and Operation	**Private**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Example Systems	Southeast Falls Creek NEU — Vancouver, BC Beaverton Round Central Plant — Beaverton, OR Central Hudson Gas and Electric - NY City of Naperville's smart grid initiative - IL	Markham Energy Corporation — Markham, ON	Lonsdale Energy — North Vancouver, BC	Southampton District Energy Scheme — Southampton, UK San Diego Gas and Electric - Borrego Springs, CA	Birmingham District Energy Scheme — Birmingham, UK	University of Oklahoma, with concession to Corix Utilities Yellowknife — Yukon Territory	Texas Medical Center Central Heating and Cooling Services Corporation (TECO) Rochester District Heating — Rochester, NY Eno, Finland Heating Cooperative		District Energy St. Paul — St. Paul, MN Cornell University campus system - NY New York University's (NYU) microgrid in Washington Square Park - NY	Enwave District Energy Limited — Toronto, ON Burrstone Energy Center - Utica, NY	Dockside Green — Victoria, BC The Woking Town Centre Energy Station - Woking Borrough, UK Seattle Steam — Seattle, WA Brewery Blocks — Portland, OR
Plausible Scenarios for SW Ecodistrict (Yes, No, Unlikely)	U	U	U	Y	Y	Y	Y	Y	N	N	Y

Sources: **Berry, Trent**; 2012, *Ownership Models for Sustainable Neighborhood Infrastructure*, Compass Resource Management, [Presentation Slides] http://www.sf-planning.org/ftp/files/plans-and-programs/emerging_issues/sustainable-development/SF_EcoDistrict_Presentation_Series_Ownership_Models_Trent_Berry.pdf, **King, Michael**; 2012, *Community Energy: Planning, Development and Delivery*, International District Energy Association, http://www.districtenergy.org/community-energy-planning-development-and-delivery, **Hyams, Michael**, 2010, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*, New York Energy Research and Development Authority, **Portland Sustainability Institute**, 2011*, District Energy Development, Ownership & Governance Models*, Prepared for the City of Portland, http://www.portlandoregon.gov/bps/article/3498

VI. Conclusion

A district-scale water system will require unprecedented partnerships and agreements between the federal government, District of Columbia, and public and private entities. Given the 20-year outlook of NCPC's *SW Ecodistrict Plan*, agreements and partnerships must be forward-looking and adaptable with opt-in opportunities for new constructions and ability to meet rising stormwater management fees. Due to the complexity of implementation and the various governance components, it is important to examine and gather information on decentralized water systems in other locations around the United States, and perhaps sponsor a symposium of experts from the field of decentralized water systems. These opinions, best practices, and case studies can further help NCPC and their goals to create a SW Ecodistrict in the District of Columbia.