COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Hunts Point Food Distribution Center: Greening an Industry

Final Report

**Prepared by students of the Master of Public Administration,
Environmental Science and Policy program,
School of International and Public Affairs,
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1.0 Executive Summary

One of the world's largest food distribution centers is located on the Hunts Point peninsula in the South Bronx, New York. The Hunts Point Food Distribution Center (the Market) occupies 329 acres of the maritime industrial site at the confluence of the Bronx and East Rivers. Stormwater and wastewater at the Market pose significant threats to the nearby and downstream ecosystem functions, biological diversity, public health, recreation, economic activity, and general community well-being.[1] Since many members of the Hunts Point community rely on the rivers for subsistence fishing and recreational activities, reducing pollution from the Market will have significant implications for the improvement of the quality of life in nearby communities.

As the site of the Market was once occupied by a coal gasification plant, the underlying soil is highly contaminated and requires an impervious cap to prevent contaminants from further leaching into the groundwater.[2] This cap, however, increases the volume and velocity of water running over the pavement, which collects and transports a large amount of pollutants such as oil, garbage, and organic refuse directly into the Bronx and East Rivers.[3] As a result of this direct runoff, water quality of the nearby rivers is greatly diminished thus necessitating potentially costly remediation.

In addition to the adverse impacts of direct stormwater runoff, another concern is wastewater generation at the Market. A reduction in the wastewater produced will help to alleviate the current burden on the Hunts Point Water Pollution Control Plant, and may attenuate the pending expansion of the facility. This expansion is expected to exacerbate air, water, and odor pollution that will adversely impact the local community while costing the City approximately $700 million.[4]

Furthermore, the lack of thorough water management protocol at the Market exacerbates stormwater and wastewater concerns. In response, the Columbia University project team proposed a comprehensive Environmental Management Plan for the existing markets, sustainable guidelines for future development, and policy recommendations to incentivize change. This document may also be used as a model to catalyze future environmental action in this region.

While further research is necessary to confirm the feasibility of the proposed plan, the project team believes there is significant potential for improving the stormwater and wastewater management at the Market. Moreover, the incorporation of these recommendations into the operations of current and future projects will not only benefit those directly impacted by the Market, but will also provide a solid foundation for the long-term integration of future management plans to address additional environmental concerns at the Market.

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[2] Zias, Kay. Personal interview. New York City Economic Development Corporation. 28 February 2006.
[3] New York City Department of Environmental Protection. New York Harbor Water Quality Report.2003. Accessed 27 February 2006. <http://www.nyc.gov/html/dep/hwqs/html/cso.html.>
[4] Hunts Point Task Force, City of New York. Hunts Point Vision Plan. 2004

2.0 Introduction

The Hunts Point community, located in the South Bronx, New York, is situated in one of the most environmentally degraded areas of the United States.[1] The community is located on the Hunts Point peninsula at the convergence of the Bronx and East Rivers and is encumbered with solid waste transfer stations, power plants, waste treatment plants, and many other polluting industrial activities. Due to these sources and the heavy diesel truck traffic, the Hunts Point community suffers from poor air quality, noise pollution, limited green space, and heavily polluted water bodies. Furthermore, nearly forty-five percent of the 12,000 residents in this community are living in poverty.[2] Not only is Hunts Point one of the most economically impoverished region in New York, the area is also host to a number of environmental detriments that expose the residents to a disproportionate amount of risk factors for asthma and other health concerns.[3] In 2003, the asthma hospitalization rate among children in the Bronx was the highest in New York City at 31 percent of which the Hunts Point Community experienced the highest rates.[4]

Figure 1: Trucks at the Market

Of particular concern is the Hunts Point Food Distribution Center (the Market) that spans the eastern half of the Hunts Point peninsula. Through the daily Market operations, the local air quality is degraded by the high diesel truck traffic (Figure 1). The Market also contributes to greenhouse gas emissions due to high-energy usage and adversely impacts both the Bronx and the East Rivers due to the direct and indirect contamination of the nearby water bodies.

While each of the above issues uniquely affects the health of the community, stormwater and wastewater at the Market pose a significant threat to the nearby and downstream ecosystem functions, biological diversity, public health, recreation, economic activity, and general well-being of the community.[5] Stormwater enters the nearby Bronx and East Rivers via direct runoff or stormwater discharge, while the wastewater generated from the Market is directed to the Hunts Point Water Pollution Control Plant (WPCP). The lack of thorough stormwater and wastewater management structures at the Market exacerbate the related impacts and therefore must be taken into consideration when offering recommendations for mitigation.

Furthermore, as many members of the Hunts Point community rely on the rivers for subsistence fishing and recreational activities, reducing this pollution from the Market will therefore have significant implications for the improvement of the quality of life in nearby communities. Reducing the volume of wastewater generated at the Market will also positively impact the community by reducing the burden on the already stressed Hunts Point WPCP. Currently, the City has plans to expand the WPCP as it is unable to manage the present capacity of stormwater and wastewater during high rainfall events.[6,7] This expansion will most likely exacerbate air, water, and odor pollution in the area. Furthermore, at more than 150 feet tall, the WPCP expansion would be the largest structure on the Hunts Point horizon. As a result of these factors, it is clear that an effective and comprehensive stormwater and wastewater management plan at the Market is vital to the promotion of clean and healthy waterways. This will not only improve the health of the marine ecosystem, but will also enhance the well-being of the community by increasing access to environmentally safe rivers.

3.0 Background of the Problem

The Columbia University project team (project team) looked at improving the stormwater and wastewater management at the Market. Since stormwater and wastewater have different definitions, properties, and challenges, the project team addressed each issue separately.

3.1 History

Development on the Hunts Point peninsula is a classic case of the historic "fill and build" damage to the tidal wetlands as seen over much of New York City's coastline.[8] Healthy tidal wetlands act as a natural filter by absorbing silt and organic material from stormwater runoff. Furthermore, wetlands provide storm control, wildlife habitat, and aesthetic value to the area.[9] However, as the development of Hunts Point commenced in the early 1900s, the health and expanse of tidal wetlands sharply declined. As a result, municipalities continue to struggle with finding urban stormwater and wastewater management strategies to manage the water and restore the health of their water bodies.

Development of Hunts Point accelerated in 1904 with the construction of the first subway line connecting the Bronx to Manhattan.[10] In 1925, a coal gasification facility was established on the eastern half of the Hunts Point peninsula (Figure 2).[11] The facility operated until the early 1950s, during which time it contaminated the underlying soils with coal tar, polychlorinated biphenyls (PCBs), cyanide, lead, asbestos, and other by-products of the gas manufacturing process. The area has since been designated a brownfield site, which is defined by the United States Environmental Protection Agency (EPA) as abandoned, idled, or underused industrial and commercial properties where expansion or redevelopment is complicated by real or perceived contamination.[12]

Figure 2: Coal Gasification Plant

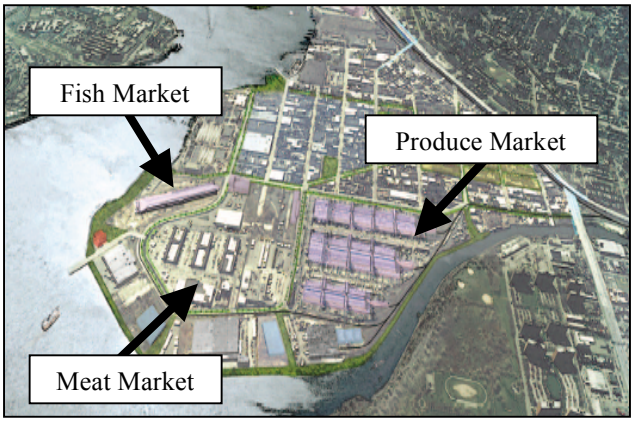


Figure 3: Hunts Point Food Distribution Center

Today, the Hunts Point Food Distribution Center occupies the majority of this brownfield site (Figure 3). Due to the harmful nature of these chemicals, an impervious cap was constructed to prevent contaminants from leaching into the groundwater. [13] This impervious cap presents a large challenge to conventional stormwater and waste-water mitigation strategies, as many of them require extensive excavation or groundwater infiltration.

Furthermore, the geography of the Market exacerbates the adverse impacts of stormwater runoff as it lies in a floodplain at the confluence of the Bronx and East Rivers. Due to the slope of the floodplain, direct surface runoff from the majority of the peninsula traverses the Market's vast paved lots before discharging into the rivers.[14] The specific site characteristics of the Market present a unique challenge to mitigating stormwater runoff.

Historically, the New York City municipal water management system collects and treats both stormwater and wastewater. Management of water quality in New York City began in the late 1800s with the installation of combined sewer systems (CSS), which exist throughout much of the City. Over seventy years later, WPCPs were added to the system. Presently, the CSS are designed to collect domestic sewage, industrial wastewater, and stormwater runoff in the same pipe and transport the combined water to a WPCP where it is treated and released into a nearby water body.[15] When the amount of wastewater in the sewer system exceeds capacity, the system's design allows for the excess water to overflow and discharge directly into nearby water bodies without being treated.[16] This discharge, known as combined sewer overflow events (CSOs), often occurs after heavy rainfall or snowmelt. Such events release stormwater, untreated human and industrial waste, toxic material, and debris into natural waterways.[17] However, CSO events are not a problem at the Market as designated pipes carry the wastewater from the Market to the Hunts Point WPCP while the untreated stormwater flows directly to the Bronx and East Rivers. [18] Regardless, the stormwater and wastewater strategies recommended for the Market provide a model for the development and application of future management plans throughout New York City where CSOs are common.

3.2 Stormwater

While stormwater is water that originates during precipitation events such as rain or snowmelt, stormwater runoff is the excess water that does not penetrate the ground. This surface runoff directly or indirectly carries nutrients and pollutants to nearby waterways.[19] The large impervious pavement cap at the Market and the high amount of pollution from market activities increases the amount of polluted stormwater that runs into the adjacent rivers. The cap increases both the volume and velocity of the stormwater, which results in a higher concentration of pollutants entering the water bodies.[20] As stormwater runs along on the roofs and vast paved surfaces, it collects oil, garbage, and organic refuse in its path before entering the rivers.[21] Based on recent observations at the site, it is apparent that the rate and concentration of pollutants in the stormwater runoff pose the largest threats to the health of the Bronx and East Rivers. While a stormwater management plan would ideally address the pollution, velocity, and volume of the water, the project team focused primarily on recommendations to mitigate pollution.

Water quality can be measured using physical, biological, chemical, and pathogenic indicators. Physical indicators include water circulation, habitat loss, rainfall, salinity, water temperature, and total suspended solids (TSS). TSS, for instance, is a quantifiable indicator of the amount of large sediments, algae, and solid waste present in the water.[22] TSS levels can also be an indicator of contamination from waste facilities and drainage ditches.[23] High TSS affects the turbidity or cloudiness of the water body limiting the amount of sunlight that can penetrate to the bottom, which adversely affects the health of the aquatic ecosystem.[24] Suspended solids can block the gills of fish and shroud their vision as they hunt for food.[25] Furthermore, suspended solids are a concern because they provide a mode of transportation for contaminants around harbors.[26]

Stormwater runoff can also alter the biology and chemistry of nearby water bodies as revealed by concentrations of the following indicators: dissolved oxygen, Chlorophyll a, nutrients, PCBs, and heavy metals. For example, PCBs are a group of chemicals that are commonly used in coolants

and lubricants in transformers, capacitors, and other electrical equipment.[27] PCB contamination presents a severe environmental danger to ecosystem and human health in the Hunts Point region, as many residents rely on subsistence fishing. These contaminants accumulate in the tissue of fish and shellfish, which can cause harm to humans who consume them.[28] A New York State Health Department survey found the Hunts Point area of the South Bronx to be one of several New York City locations where residents often catch and eat fish contaminated with PCBs.[29] Sediment toxicity tests conducted by the National Oceanic and Atmospheric Administration in 1991 discovered significant levels of the toxic PCB chemical in areas adjacent to Hunts Point.[30] Therefore, it is apparent that the negative impacts associated with stormwater runoff directly threaten the health of the Hunts Point community members.

3.3 Wastewater

Wastewater contains waste products from daily activities ranging from the flushing of toilets to food processing. Wastewater is split into two categories: greywater and blackwater. Greywater contains relatively few pollutants as it results from activities such as showering or washing dishes. Blackwater, on the other hand, contains pathogens resulting from human waste and food processing.[31] Based on these definitions, the majority of wastewater at the Market is blackwater as many of the daily activities involve washing down equipment and market areas after food processing. The primary goal for improving wastewater management at the Market is to identify potential ways of reusing the wastewater for other purposes in order to reduce the overall quantity of water going to the Hunts Point WPCP. One potential option for reusing the wastewater from the Market is to irrigate the proposed South Bronx Greenway Project (Figure 4), which will provide continuous waterfront access from Riverside Park to Barretto Point Park.[32]

Figure 4: Sketch of potential waterfront improvement near the Fulton Fish Market

In analyzing the problems associated with wastewater at the Market, it is important to understand how it is currently managed. The Hunts Point treatment plant is one of 14 WPCPs owned by the New York City Department of Environmental Protection (DEP).[33] While the facility claims that it has enough capacity to handle the average daily flow, it is not adequately prepared to handle significant precipitation, which would then result in a CSO event.[34]

One indication of CSO events is the presence of various pathogens, such as fecal coliform (FC) and enterococcus often found in raw or partially treated sewage.[35] Increased concentrations of FC indicate a high potential for the presence of other pathogens and the likelihood that there is some contamination from the distribution systems.[36] In the New York Harbor, FC levels generally increase after periods of rainfall or snowfall due to the CSO events and direct stormwater runoff.[37] However, improvements to the primary and secondary wastewater treatment plants began with the initiation of the 1980 Regulator Improvement Project, which resulted in a significant reduction of pathogens in the Inner Harbor and the Upper East River/Western Long Island Sound.[38]

The most recent CSO abatement program, Administrative CSO Consent Order, was issued in 2004 by the New York State Department of Environmental Conservation (DEC) and the New

York City DEP. The 2004 Consent Order requires the City to adopt a more comprehensive watershed-based approach to reduce the influx of stormwater and to expand facilities at the Hunts Point WPCP, among other plants, to treat an increased volume of wastewater.[39]

The Hunts Point WPCP upgrade is a multi-phase project intended to improve process efficiency, reduce manpower requirements, improve reliability, and maintain compliance with all applicable permit requirements and Consent Orders. Subsequent to the initiation of the project, the City entered into the New York State Pollutant Discharge Elimination System Administrative Consent Order-Nitrogen Reduction Agreement, which also required the retrofitting of existing treatment units to reduce nitrogen loadings into the East River and Long Island Sound. The changes to the Hunts Point WPCP, located on the north side of the upper reach of the East River, will be under construction until 2014.[40]

While the expansion of the WPCP poses the aforementioned implications for the neighboring community, it appears to be moving forward regardless of any reduction in wastewater. However, the Market can strive to mitigate the production of wastewater to reduce its burden on the WPCP, which hopefully will reduce the impacts of the plant on the community. Furthermore, the actions at the Market can be a model for other facilities to minimize their wastewater production thereby reducing the need for long-term future expansions of this and other WPCPs.

3.4 Relevant Legislation

3.4.1 Federal Regulations

The first version of the Federal Water Pollution Control Act, also known as the Clean Water Act (the Act) was originally enacted in 1948.[41] However, amendments of 1972 and 1987 yielded two major provisions to reduce water pollution. The first provision authorizes federal financial assistance for the construction of municipal sewage treatment plants. The second provision delineates regulatory requirements for industrial and municipal discharges into the navigable waterways of the United States.[42]

While the Act establishes broad objectives for reducing water pollution, the responsibility for implementing and enforcing these provisions is delegated to individual states. Under the Act, all point source discharges into the nation's waters are illegal unless they are authorized by a National Pollutant Discharge Elimination System (NPDES) permit.[43] These permits are the Acts principal enforcement tools. NPDES permits set numerical effluent limitations on the discharge of pollutants into a body of water in order to protect overall water quality standards. These permits also explicitly specify pollution control technologies applicable to each pollutant being discharged and establish a deadline for complying with these regulations.[44]

Furthermore, the Clean Water Act, section 303, establishes the water quality standards and Total Maximum Daily Load (TMDL) programs.[45] TMDL is the maximum amount of a pollutant that a water body can receive from all point and nonpoint sources and still meet water quality standards.[46] The TMDL permitting process is a water quality-based approach to implementing water quality standards.

3.4.2 State Regulations

New York State implemented the State Pollutant Discharge Elimination System (SPDES) program to control wastewater and stormwater discharges in accordance with the Act. However, the SPDES is broader in scope than is required by the Act as it controls point source discharges to groundwater as well as to surface waters.[47] The Division of Water within the Department of

Environmental Conservation is charged with protecting the water bodies within New York State by regulating wastewater discharges, monitoring water quality, and controlling surface runoff.

3.4.3 Local Regulations

New York City also aims to reduce water pollution through local initiatives. Two of these initiatives are the Floatables Reduction Program and the Nitrogen Reduction Program, both of which are implemented by the New York City Department of Environmental Protection (DEP).

Floatables are water-borne litter and debris that enter water bodies surrounding New York City and are carried via stormwater through storm drains and sewers.[48] In order to reduce floatables, each of the City's 130,000 storm drains were inspected and electronically mapped.[49] Hoods were installed at all storm drains to capture floatables and the DEP and its contractors periodically clean debris from catch basins. The DEP has also installed booms at 23 locations to capture floatables that are discharged from combined sewer outlets.[50] DEP skimmer vessels are also used to remove floatables from boomed sites.[51]

The Nitrogen Reduction Program aims to reduce the amount of Total Nitrogen (TN) from the effluent from New York City's 14 WPCPs.[52] These WPCPs are being retrofitted with Biological Nitrogen Removal systems as well as froth elimination systems in order to reduce the amount of TN in the effluent from the plants.[53] The City is undertaking this project to meet the Nitrogen specifications outlined in the SPDES permits.

4.0 Market Background

4.1 History

In 1980, New York City rezoned the Hunts Point peninsula from East 149th street to the Bruckner Expressway as an Industrial Park. Shortly thereafter, the New York City Economic Development Corporation (EDC) initiated construction of the Market to revitalize the Hunts Point peninsula after the area experienced severe economic decline during the 1960's.[54] Today, numerous food distribution companies operate at the Market and distribute products to nearly 15 million people in the New York tri-state area.[55] Three main distributors control the majority of these operations: The Hunts Point Terminal Market (Produce Market), the Hunts Point Cooperative Market (Meat Market), and the Fulton Fish Market (Fish Market).[56]

4.2 Hunts Point Terminal Market (Produce Market)

Historically, the City of New York constructed small public market facilities for wholesalers in the area.[57] In 1967, the City built the Produce Market on the Bronx River to accommodate both wholesalers and farmers. Currently, it houses approximately 23 merchants, 297 employees, and is open Monday through Friday operating 24 hours a day.[58] In 1972, the ownership shifted from the City to private owners, and has since fallen into disrepair.[59] Many of the buildings are vacant, underutilized, or in extremely poor condition.[60] Plans to upgrade or rebuild the facility are pending as numerous vendors note the lack of refrigeration units and warehouse space.

The stormwater collects in parking lot storm drains and flows directly into the nearby water bodies.[61] According to the wholesalers at the Produce Market, an insignificant amount of organic waste enters the stormwater stream.[62] However, the project team observed large amounts of trash and organic debris littering the parking lots (Figure 5). [63] The Produce Market is also equipped with an antiquated stormwater system whereby under-ground sand neutralizing vaults remove oil and other particulates. As the vaults appear to be in good condition after forty years, the project team questions whether the system is actually filtering out pollutants or sediment from the stormwater.[64]

Figure 5: Trash at the Produce Market

Since water accelerates the decomposition of fruits and vegetables, vendors rarely wash the produce. Therefore, the majority of water consumed at the markets is from the cleaning of work areas, which varies in frequency between vendors. While some vendors wash daily, others limit washing to twice a week.[65] The relatively minimal wastewater produced from daily operations flow to floor drains located inside the market that lead to the WPCP for treatment.

4.3 Hunts Point Cooperative Market (Meat Market)

Built in 1960, the Meat Market is home to 47 independent wholesale food businesses primarily involved in the production, processing, distribution, and sale of meat products throughout the New York tri-state area. It consists of six large refrigerator/freezer buildings including a new state-of-the art refrigeration plant. The total refrigerated space in the Meat Market is

approximately 700,000 square feet. Due to the need to keep meat products refrigerated, the Meat Market uses large amounts of energy to keep these refrigeration units below 34°C.[66] Ambient temperatures greatly influence the ability of the market to maintain these temperatures, and therefore there is a significant difference between energy consumption during the winter and summer months.[67] As many of the Meat Market technologies are outdated, the management would like to upgrade and integrate the facility into a more cost-effective energy saving operation. Meat Market professionals believe that there is significant potential for incorporating environmentally friendly energy reducing technologies and practices into daily operations.[68]

Figure 6: Washing machines at Meat Market

Despite the vendors' efforts to minimize the amount of organic debris that enters the storm-water and wastewater systems, the project team observed employees hosing down meat-cutting machinery outside the market near storm drains, which lead directly to nearby water bodies (Figure 6).[69] In addition, due to strict United States Department of Agriculture (USDA) regulations, vendors must regularly clean common areas with hot water. After this is done, contaminated water enters the floor drains that lead directly to the WPCP.

4.4 Fulton Fish Market (Fish Market)

Historically, the Fish Market was located in lower Manhattan at the South Street Seaport near the Brooklyn Bridge. The market opened at that site in 1807 on land donated to New York City and served as a general market for fish and other goods.[70] The City relocated the Fish Market to the Hunts Point peninsula in 2005 where it reopened its doors in January 2006.

Due to the recent relocation, there is minimal documented information available regarding the operations at the Fish Market. Therefore, the majority of information collected by the project team relates to the design and construction of the Fish Market, which was provided by the architects of the building, Cybul and Cybul Architects. A major goal of the design was to enable efficient transportation of fish into and out of the facility. Also, as energy costs continue to rise, it is estimated that the largest component of operating costs will soon shift from employee salaries to energy expenses. Thus, Cybul and Cybul incorporated energy efficiency components into the design as well (Figure 7). In addition, managers at the Fish Market believe that the current parking lot is not large enough to accommodate trucks during full capacity and thus future plans for the Fish Market include constructing a parking lot for the facility in one of the adjacent vacant lots. This will further contribute to stormwater runoff considerations in the area.

Figure 7: Inside the Fish Market

As vendors at the Fish Market wash down work areas every two to four hours, the wastewater collects in the nearby floor drains. According to Cybul and Cybul, the drains were constructed at 25-foot intervals to reduce the water required to clean facility by 40% (Figure 8). Additionally, sediment and grease traps were installed into the drains in order to remove the organic waste resulting from processing before flowing to the WPCP. Despite these measures, water usage at the Fish Market remains higher than both the Meat and Produce Markets.

Figure 8: Drains at Fish Market

5.0 Evaluation of Technology Options

After gaining an informed understanding of the specific stormwater and wastewater considerations at each market, the project team evaluated the feasibility of various mitigation technologies. To do so, the project team developed a five-phase elimination process described in the following sections. In Phase 1 the project team conducted a thorough, however not exhaustive, investigation of general stormwater and wastewater mitigation technologies. Next, in Phase 2, the technologies identified in Phase 1 were analyzed and compared to relevant case studies. The purpose of the first two phases was to identify both the breadth of technologies available and those that were applicable to sites similar to the Market. Finally, in Phases 3-5, the project team determined the feasibility of the remaining technologies based on structural, economic, as well as political and social considerations for each market. Technologies that the project team eliminated throughout these phases can be found in Appendix 1. The analysis and resulting selection of feasible technologies are discussed below.

Technology Options Analysis
Phase 1: General Mitigation Technologies
Phase 2: Case Study Criteria
Phase 3: Structural Feasibility Analysis
Phase 4: Economic Feasibility Analysis
Phase 5: Political and Social Feasibility Analysis

5.1 Phase 1 – General Mitigation Technologies

The first phase of the options analysis explored general technologies that minimize the impacts of stormwater and wastewater at the Market. These options include traditional and innovative structural best management practices (BMP) of low impact development (LID), which are used to control and treat stormwater. In addition, the preliminary wastewater options include those that most effectively minimize building water usage to reduce the amount of wastewater produced. These options were then organized into categories based on their function. For stormwater, these categories are Manufactured Treatment Devices (MTDs)—mechanisms that are incorporated into stormwater systems to pre-treat stormwater—, Collection/Reuse Systems, Conveyance Systems, and Infiltration/Filtration Systems. For wastewater, the project team divided technologies into categories that reduce, reuse, or recycle wastewater.

Without costly remediation of the contaminated soils, the constraints associated with a brownfield greatly restrict the potential technologies that may be implemented at the Market. While limited remediation at some future date might be conceivable, the project team assumed this option to be politically infeasible at the present time. Consequently, the project team eliminated any technologies that require extensive excavation or groundwater infiltration. While the list of preliminary recommendations is not exhaustive, it covers a wide range of structural BMP mitigation strategies for stormwater and wastewater than can be built upon in future studies.

5.2 Phase 2 – Case Study Criteria

Phase 2 compared the options of Phase 1 to relevant case studies. These case studies were identified based on specific criteria set by the project team to ensure that sites documenting the success of selected technologies had similar characteristics to the Market. Case studies were analyzed based on the following criteria: climate of the project location; characteristics of the site; zoning; location of the site; usage; and project funding sources. For summaries of each case study, refer to Appendix 2.

5.2.1 Description of Case Study Criteria

Climate is a critical factor for this analysis as it determines the volume, frequency, and temperature ranges affecting stormwater management systems. For example, certain plants that may have a high capacity for water retention may also require a warm or tropical atmosphere. New York City is subject to extreme hot and cold temperatures and periodic heavy precipitation in the form of rain or snow, which must also be true of those cases selected for analysis.

The *characteristics* of the Market site are also important in selecting relevant project models. The Market occupies a large area, is situated atop a brownfield site, and has impervious paved surfaces for the large parking lots and roads. As a result, the case studies chosen needed to mimic similar characteristics.

Zoning or type of development of the project is also taken into consideration for those sites that shared a similar climate with the Market site. The project team eliminated case studies that were residential or dealt with natural resource management or remediation, and retained those case studies that described industrial, municipal, and commercial projects.

While the *location* criterion overlaps with site characteristics, it further assisted in the identification of cases that had limited accessible open space, were located near water bodies, and reported contamination of nearby marine bodies as a result of stormwater runoff.

Usage was another category used to determine relevant cases. Those involved in the handling or distribution of consumables like the Market, were included in our case study analysis.

Funding was taken into account to exclude single homeowners or small-scale private investments from our analysis. This criterion was the least significant in our case study evaluation, as it will be explored below in the economic feasibility section (Section 5.4).

5.2.2 Case Study Technology Analysis

While numerous case studies were examined, the following examples illustrate how they were used to offer recommendations. For example, states that exemplified similar climate to New York City such as New Jersey, Pennsylvania, and Illinois showed successful use of raingardens and green roofs. Furthermore, industrial and commercial sites that incorporated the Blackwater Biofilter Systems showed the potential use of these technologies at the Market. In addition, based on the information gathered from the case studies, the selected technologies were divided into short-term and long-term recommendations. The project team designated short-term as one to three years (1-3 yrs) and long-term as more than three years (3+ yrs) or applicable to New Construction. Therefore, if the case studies exemplified the possibility of the chosen options at the Market, they continued to the next phase of analysis.

5.2.3 Chosen Stormwater Technologies

The following stormwater technologies were recommended at the conclusion of Phase 2 and are listed in Table 1: StormFilter, BaySaver Separation System, Enviropod, AquaGuard, green roofs, rain barrels, cistern, vegetated buffers, raingardens, and constructed wetlands. Below are brief descriptions of their form and function.

Table 1: Stormwater Phase 2 Options

Short-Term	Long-Term
MTDs	**INFILTRATION/FILTRATION**
Stormfilter	Vegetated Buffers
BaySaver Separation System	Raingardens
Enviropod	Constructed Wetlands
Aqua-Guard	
COLLECTION/REUSE	
Green Roof	
Rain Barrels	
Cistern	

Manufactured Treatment Devices

The *StormFilter*® (Figure 9) is a passive stormwater filtration system that can be installed into existing storm drains.[71] It is intended to remove non-point source pollutants such as TSS, oil and grease, nutrients, organics, and debris.[72] When stormwater enters the storm drain, it percolates through cartridges that remove particulates, adsorb pollutants, and redirect stormwater to the discharge system.

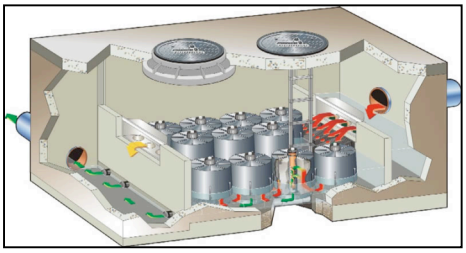


Figure 9: StormFilter Vault

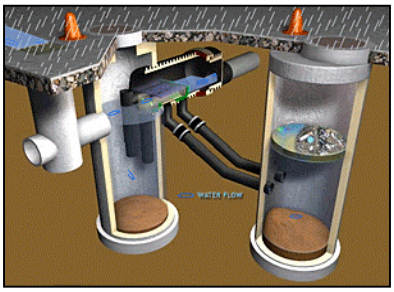


Figure 10: BaySaver System

The *BaySaver® Separation System* (Figure 10) is designed to use gravitational separation as a means of capturing sediments, oils, trash, and debris.[73] Coarse sediments are removed in the first structure while finer sediments and floating pollutants are removed and trapped in the second structure. The BaySaver Separation System is a versatile and flexible BMP device that can be retrofitted into existing storm drains or incorporated into new and existing developments.[74]

The *Enviropod ™* (Figure 11) is designed to fit into existing storm drains. As stormwater enters the drain, trash and other pollutants larger than the screen are captured and retained, while oil is caught as it passes over the oil adsorbent pads.[75] Also, the Enviropod may be customized to meet site-specific requirements and can also be a pretreatment device with other mitigation techniques.[76,77]

Figure 11: Enviropod

The *Aqua-Guard*™ (Figure 12) filters sediment, debris, and pollutants such as dissolved oil, nutrients, and metals.[78] It attaches to the underside of pipes connected to parking lot drains and other entrances to the storm drainage system.[79] First, stormwater passes through the sediment collection/storage area where debris and particulates are removed. Next, the water flows through the filter media, which removes finer pollutants such as dissolved oil and nutrients. Filtered stormwater leaves the device through the bottom of the mechanism and connects to the existing stormwater system.

Figure 12: Aqua-Guard

Stormwater Collection and Reuse

Figure 13: Green Roof

Green roofs (Figure 13) are constructed of multiple layers, including a vegetative layer and a drain layer. They reduce stormwater runoff volumes and are most effective in areas with substantial amounts of impervious surfaces.[80] Green roofs in urban areas offer a variety of benefits such as extending the life of roofs, reducing energy costs, and conserving valuable land that may otherwise be installed with stormwater runoff controls.[81]

Rain barrels (Figure 14) are retention devices placed below roof downspouts to collect precipitation during storm events. They offer no pollutant removal benefits but act as quantity controls and can help reduce the cumulative effects of stormwater downstream.[82] Furthermore, the water collected in the barrels may be re-used to irrigate lawns and vegetations. *Cisterns* function in a similar manner to rain barrels but offer larger stormwater storage capacity.[83]

Figure 14: Rain Barrel

Infiltration/Filtration Systems

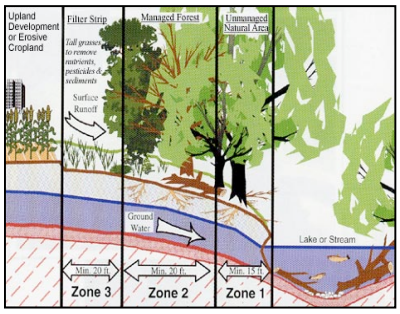


Figure 15: Vegetated Buffer

Vegetated buffers (Figure 15) are natural or cultivated areas of vegetation that protect the water quality of adjacent water bodies by providing filtration and detention of stormwater runoff.[84] They offer the stormwater benefits of reducing velocity of stormwater runoff and removing sediments. Vegetated buffers are most useful in floodplain areas, particularly near wetlands, along stream-banks, and on steep slopes.[85] The size of the vegetated buffer, maintenance considerations, and a site's ability to support vegetation could pose limitations to the applicability of this stormwater management system.

Raingardens (Figure 16) are shallow depressions comprised of a soil bed, native vegetation, and a sand layer with a perforated underdrain pipe. The purpose of the system is to retain, treat, and convey stormwater to a nearby pipe system or water body.[86] It is designed to temporarily store stormwater so pollutants such as TSS, nutrients, metals, hydrocarbons from petroleum and oil products, and bacteria are removed. Raingardens can easily be installed in lawns, parking lot islands, median strips, and unused lot areas.

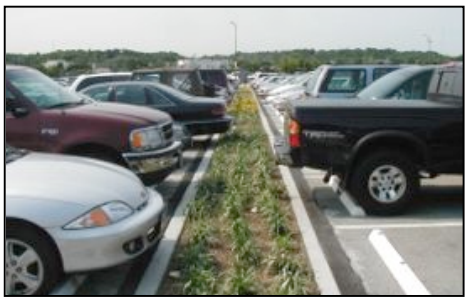


Figure 16: Raingarden

Figure 17: Wetlands

Constructed wetlands (Figure 17) remove a wide range of stormwater runoff pollutants while providing wildlife habitat.[87] There are numerous types of constructed wetlands. However, the free water surface system (FWS) best mimics a natural system wherein water flows over the bed surface and is filtered by planted aquatic plants and established microbes.[88] Differing land area requirements, vegetation, and degrees of reliability for pollutant removal must be considered in the design of a successful FWS wetland.

5.2.4 Chosen Wastewater Technologies

Based on the aforementioned case studies, the selected wastewater technologies include: Water-saving devices, Blackwater Biofilter System, Steam Chillers, Greywater Reuse Piping System, and Living Machines®. The Clearwater System and Blivet™ sewage treatment plant were eliminated as the Clearwater System is applicable mainly to homes and the Blivet is used when an established WPCP is not close in proximity.

Table 2: Wastewater Phase 2 Options

Short-Term	Long-Term
REDUCE	**REUSE**
Water-Saving Devices	Steam Chillers
Blackwater Biofilter System	Greywater Reuse Piping System
	RECYCLE
	Living Machines

Wastewater Reduction

Water-Saving Devices (Figure 18), such as low-flow spouts on hoses, low flow toilets, and water-saving sinks, have the potential to dramatically reduce the consumption of potable water at the Market.

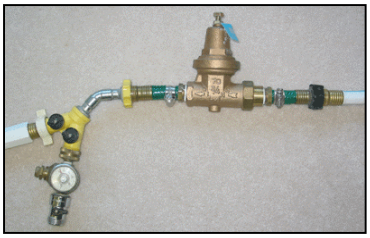
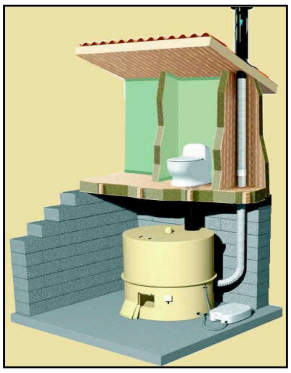


Figure 18: Water-saving Device



The *Blackwater Biofilter system* (Figure 19) uses microorganisms to break down organic wastes without the need for water or chemicals.[89] The breakdown is achieved using four rotating compost chambers used at different times within the cycle.[90] This technology reduces the incoming material to 10% of its original quantity.[91] Furthermore, wastewater collected by the system is either evaporated or has the potential to be connected to the septic system.[92]

Figure 19: Blackwater Biofilter System

Wastewater Reuse

Steam Chillers (Figure 20) provide energy-efficient refrigeration or air conditioning by first changing water to vapor and then condensing it. However, if the water used in the system is cold, a significant amount of energy must be used to vaporize it thereby reducing the efficiency of the system. If the chiller has hot wastewater available for circulation, it uses less electric energy than a standard chiller and provides a more economically feasible opportunity for waste-water reuse.

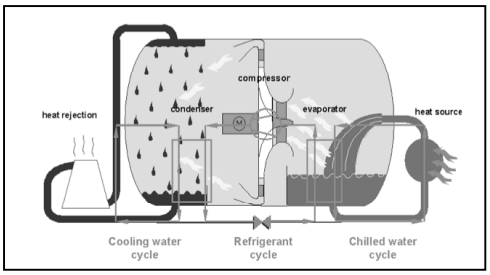
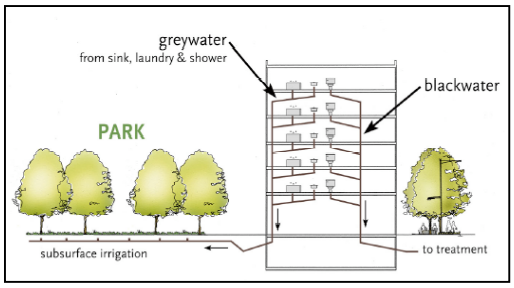


Figure 20: Steam Chiller



Greywater Reuse (Figure 21) for irrigation requires that the water to be collected separately from the toilet flow, stored, and treated prior to being redistributed. The irrigation process may occur through a subsurface drip irrigation system.

Figure 21: Greywater Reuse Piping System

Wastewater Recycling

Living Machines (Figure 22) are comprised of six tanks that use biological and ecological components as a natural wastewater treatment system. The filtered water that is produced by Living Machines can be used for non-drinking water uses and is also suitable for discharge into water bodies.[93] Living Machines designs may be site-specific and potentially accommodate 600 to 750,000 gallons of water per day.

Figure 22: Living Machine

5.3 Phase 3 – Structural Feasibility

The next phase in determining appropriate stormwater and wastewater recommendations for the Market was to analyze the aforementioned options with respect to their structural feasibility. In this analysis, the project team considered the size and area available at each market as well as the ease of installation and maintenance.

5.3.1 Stormwater Structural Analysis

Technologies that met the general requirements noted above or required further expert analysis were retained for economic analysis. Such stormwater technologies include: StormFilter, BaySaver Separation System, Enviropod, Aqua-Guard, green roofs, rain barrels, cistern, vegetated buffers, raingardens, and constructed wetlands.

Manufactured Treatment Devices

The *StormFilter* can be installed underground to allow for the use of surface space for development, or above ground if excavation is not preferable.[94] Due to its compact design, the cost, construction, and excavation are relatively small.[95] The StormFilter is a practical addition to the Market site and is available in a High Flow model that treats runoff from large sites.[96]

Since the *BaySaver Separation System* connects to existing storm drains and is available in five standard sizes, installation will cause only limited site disturbance.[97] Maintenance is fairly easy as access to the system is available through the two manhole covers and is cleaned using a Vactor Truck (Figure 23), which vacuums all debris and sediment and removes it from site.[98,99] Quarterly inspection is required for best efficiency to determine maintenance frequency and may be completed within two to four hours.[100] The BaySaver requires a second manhole to regulate the system and therefore installation is also contingent on a soil analysis of the facility. Thus, while further site-specific research is needed, the BaySaver provides a viable solution to mitigating the effects of stormwater and should thus be considered a possible short-term stormwater pollutant filtering measure at the Market.

Figure 23: Vactor Truck

The *Enviropod* and other filtering technologies are applicable to commercial and industrial sites such as the Market. The device is most suitable as a pretreatment solution and works most effectively when coupled with other technologies such as wetlands. Due to its minimal site disturbance and relative ease of installation, the Enviropod is a possible short-term technology for filtering stormwater at the Market.

Since the *Aqua-Guard* attaches below the surface to the pipes in parking lot drains and other entrances to the stormwater system, it is another feasible option for the Market.[101] If properly maintained, the Aqua-Guard is a feasible short-term solution, as it does not require infiltration or extensive excavation of the contaminated soil below the concrete surface.[102]

Stormwater Collection and Reuse

Green roofs are ideal in urban areas with excessive stormwater runoff.[103] Once a properly installed green roof is well established, its maintenance requirements are usually minimal.[104] These maintenance requirements include inspection of the roof membrane, the most crucial element of a green goof, as well as routine inspection and maintenance of the drainage layer.[105] Other requisite maintenance activities include watering, fertilizing, trimming, weeding, and inspection.[106] Properly designed systems may often be added to existing rooftops without additional reinforcement or structural design requirements.[107] Design should be developed for the storm events that most significantly contribute to CSOs, hydraulic overloads, and runoff problems for a given area.[108]

In addition, green roofs have secondary energy benefits such as cooling the building. This is particularly advantageous for facilities that expend a large amount of energy to keep the indoor facilities refrigerated. Green roofs should be further pursued for as they not only mitigate stormwater runoff, but they also reduce energy usage. Although the three markets require a further engineering analysis to determine if the strength, size, and pitch of each roof can support green roofs, this option is a viable short-term recommendation as there is significant roof space available at the site.

While *rain barrels* and *cisterns* are not feasible for the individual markets in the short-term, they are feasible for both the long-term and future construction. These technologies are easily obtained and relatively easy to implement. Two constraints for these devices include the lack of a transportation mechanism for the water and the lack of a potential destination for reused stormwater. Thus, if a proper means of transporting the collected stormwater is established, as well as a designated area for efficient reuse at the Market site, these technologies would dramatically reduce the amount of stormwater runoff as well as water consumption.

Infiltration/Filtration

Vegetated buffers are well suited for areas in a floodplain, such as the Market, and are highly effective at removing sediment concentrations in stormwater runoff. Again, while this technology could prove beneficial for the Market, a site-specific analysis is needed to determine the most feasible location and construction of the vegetated buffers. Furthermore, vegetated buffers require routine maintenance such as pest control, mowing, fertilizing, liming, irrigation, and pruning to ensure healthy plant growth.[109] Thus, while vegetated buffers require further analysis and offer a potential long-term option, they may be more difficult to incorporate than other technology options.

While *raingardens* require strategic placement to allow for proper interception with stormwater runoff, they do not necessarily require a large amount of space.[110] The size of the area should be approximately five to seven percent of the drainage area multiplied by the crop "c" coefficient, which represents the type of ground cover.[111] Furthermore, sandy and clay soils respectively require areas of 20-30% and 60% of the drainage area.[112] In addition, the amount of required maintenance is relatively little and generally involves mulching, weeding, and watering to establish strong growth.[113,114] Raingardens may also be incorporated with minimal excavation as they could be incorporated into the area where the Fish Market parking lot meets the East River bank or in the depressed green spaces that surround the Meat and Produce Markets. Thus, they would occupy a fairly small area and would be able to address the direct runoff volumes that drain across the parking lot and flow untreated into the nearby rivers. As such, raingardens remain a plausible long-term option at the Market with the need for further site-specific analysis.

Incorporating *constructed wetlands* to treat stormwater runoff at the Market would increase water quality in the nearby rivers. However, a major concern for the use of a constructed wetland for stormwater pollution abatement is the large area needed to effectively treat and/or remove pollutants from the stormwater. When constructing a wetland for stormwater pollution abatement purposes there are many variables that need to be considered. A few examples of these variables include the velocity of stormwater flow, size of the catchment area, type of pollutants being removed, climate, and aquatic ecology of the area.[115] In addition, the impact of the constructed wetland may inhibit navigation and therefore further research is needed along with approval by the appropriate agencies. While a constructed wetland could potentially be a long-term option, significant research must be completed in order to determine its feasibility at the Market.

5.3.2 Wastewater Structural Analysis

The following wastewater technologies were kept based on the structural feasibility in the current markets or future construction: water-saving devices, Blackwater Biofilter, steam chillers, greywater reuse piping system, and Living Machines. The fact that there is minimal potential for greywater reuse will be accounted for in the economic analysis. This section addresses whether or not the physical mechanism can be integrated into the Market.

Wastewater Reduction

Water-saving devices greatly contribute to the reduction of wastewater. Replacing old toilets and faucets with new low-flow fixtures has proven to be highly effective at reducing water usage and consequently reducing wastewater. Installation is similar to conventional faucets, maintenance will not change, and some local utility companies offer to install low-flow aerators on the faucets for free. Not only will these devices save water thereby reducing the volume of wastewater produced, but they will also generate financial returns for the facility that installs them

Low-flow hoses are another option to reduce wastewater. However, this may not be practical solution for the Market since vendors primarily use the hoses for washing down the floors. Without adequate water pressure and flow, it would be very difficult to thoroughly clean the floors. Thus, further analysis is necessary to determine whether there are water-saving devices with sufficient pressure for the hoses. Furthermore, periodic inspection is necessary to ensure that these devices are working properly. If they are not already in use at the Market, these and other water-saving devices are highly feasible for short-term wastewater mitigation.

As the *Blackwater Biofilter System* requires a significant amount of space below existing toilets to house the ecological components, it is more difficult to incorporate this system into current infrastructure. However, if planned at the onset of design, the Biofilter System could readily be incorporated into new construction.

Wastewater Reuse

As *steam chillers* require further analysis, they remain a prospect for wastewater mitigation. Steam chillers are suitable for process cooling and industrial air-conditioning and are applicable where low-cost or waste steam is readily available. Steam chiller equipment is larger and heavier than electric equipment and in some cases may require structural modifications to existing buildings.[116] Thus, the following questions are examples of information that is needed to determine the feasibility of installation into the existing Market infrastructure. What is the temperature of the water used to clean the area? What is the capacity and cost to turn the available water into steam? How clean does the water need to be in order to use it for an absorption chiller? Would it need to be filtered first? Is there sufficient space available? After addressing these unknowns, it will be possible to recommend or eliminate this technology.

Greywater reuse would require extensive rerouting of the current drainage pipes. Thus, while it is physically possible at the current markets, the following analysis will determine if it is also economically feasible. Regardless, the incorporation of a greywater reuse piping system is significantly more cost-effective in new construction.

Wastewater Recycling

While the *Living Machine* requires significant space, it can also be located adjacent to the building within a greenhouse. The roof is not a possible location as the Living Machine is too heavy. Furthermore, the Living Machines require extensive maintenance and therefore must be easily accessible. In order to decide how much space the Living Machines will take up, it is imperative to know how much wastewater is produced at the specific site. Therefore, the Living Machine may be a viable short-term recommendation because it will turn blackwater into greywater, which can then be used for non-drinking uses such as flushing toilets, thereby reducing the amount of water treated at the WPCP.

5.4 Phase 4 – Economic Feasibility

Phase 4 determined the economic feasibility of those options deemed structurally viable in Section 5.3. Technologies found to be economically impractical were eliminated. The economic assessment also included an investigation of potential funding opportunities for those options deemed physically and economically possible at the Market. These sources are divided into Non-Governmental Sources, State Funding Sources, and Federal Funding Sources (Appendices 3a-3c). Although not included in this report, there is also private funding available for wastewater and stormwater mitigation techniques that should be explored further.

5.4.1 Methodology

As few businesses are willing to invest in projects that do not return financial benefits, it is important to understand the economic costs and benefits associated with each option when assessing the potential for feasible technologies at the Market. Financial returns can be achieved from both the installation of new technologies that save water and energy and through increased productivity and support resulting from heightened public image as a responsible and environmentally conscious business. Still, the cost of improving stormwater and wastewater management must be less than or equal to the total benefit that the improvements will produce in order to be a fiscally conservative decision. Estimating the costs and benefits of the technologies and practices can be a difficult task, as the project specific parameters of this project site are not fully known. Intangible elements, such as those discussed below, are additional items that, although difficult to quantify, need to be accounted for in an economic analysis. Nevertheless, general assessments may be made to identify which technologies and practices may be more economically feasible or pose less economic risk than other options for a particular project site. For example, businesses run a risk of incorporating strategies dependent on increased public image as this benefit is difficult to predict. How to weigh this risk in an economic analysis is subjective and can result in differing feasibility conclusions.

Those technologies and practices in which the expected benefits exceed the proposed costs are economically feasible. Options become less feasible as the costs outweigh the benefits. However, the availability of incentives such as funding or grants can greatly increase the economic feasibility of a project. Additionally, it is important to note that options that are not feasible in the existing markets, due to the cost of retrofitting, may be so when included in a new structure.

The critical first step in an effective economic feasibility study is to gather as much information as possible regarding the physical layout and functioning of a site. Some questions to consider include: What is the square footage of the building? What is the acreage of the property? How much of the property is required for parking or roadway? How many toilets, urinals, sinks, and faucets are there? Where are the stormwater and wastewater drains located? How does the plumbing work? It is also important to know the current utility usage and costs at a facility. This would include items such as water consumption and annual cost; annual wastewater treatment charges; electricity/gas consumption and annual cost; stormwater fees[5]; and current facility maintenance fees including inspection, repair, and landscaping. In addition, it is beneficial to understand the hydrogeology and biology around the site. Relevant data includes average rainfall, soil composition and quality, water table fluctuations, and ground water quality. This information can provide a more accurate assessment of the economic feasibility of each option.

The next recommended step, and perhaps the most challenging aspect of conducting an economic feasibility study, is to account for intangible and uncertain costs and benefits such as the opportunity cost of land and space. Putting a value on aesthetic appeal, marketing benefits, or influence on property value is subjective and difficult to assess. The public relations component that should be considered in the benefits is becoming more valuable as corporate accountability is a growing concern for the public. Showing care and concern for the health and well being of local communities and environments can garner significant brand appeal for a business, which in turn, can yield financial returns. Specifically in locations such as the Market where environmental justice is a profound concern of the surrounding community, minding one's industrial impact is imperative if a business wants to avoid community conflict. Moreover, it is hard to predict how utility prices, which affect savings estimates, will change in the future. Given the likelihood that water and energy prices will continue to rise, these uncertainties are reasons to take action and incorporate energy and water efficient infrastructure rather than to avoid implementation of such technologies.[117]

Once the requisite information is collected, the general estimations of the economic costs and benefits associated with the recommended technologies and practices can be adapted to determine more project and site-specific costs and benefits. When conducting a site-specific cost-benefit analysis the net present value of the project should also be calculated. So long as the net present value is positive, one may anticipate that the proposed project will at least break even.

An additional step in determining the economic feasibility of a project is to compute the payback period for each technology and practice. The payback period is defined by the amount of time it takes for the initial investment to be recovered by the yielded savings and increased revenues and can be used as another tool to determine whether a project is economically feasible. As sponsors tend to prefer investments that yield short-term returns, the payback period can be used to justify projects that offer quick payback. Typically, financial returns will be recognized most rapidly with projects resulting in water and/or energy savings. This type of data, indicating the timing of financial returns, may be influential in procuring government as well as other types of funding.[118] Unfortunately, some of the most effective technologies with the longest life-cycle returns do not produce observable benefits for several years. Consequently, it may be more difficult to obtain funding to cover their high capital investment costs.

[5] The applicability of stormwater fees varies with geographic location. New York City does not currently have a stormwater fee policy.

5.4.2 Economic Analysis

In light of the limitations on access to necessary information and the short duration of time in which to complete this study, the project team was not able to conduct a full cost/benefit analysis as described above. However, the project team did perform a preliminary economic analysis necessary for proper decision-making, which describes the cost feasibility of each technology relative to the other technologies. The feasibility is based on the expense of the option and the associated maintenance costs. Where possible, the project team identified direct financial savings and the potential magnitude of intangible benefits that would discount the cost of the option. Appendix 4 contains tables summarizing the results for each technology.

Manufactured Treatment Devices

Manufactured Technological Devices vary widely in their costs and do not directly generate tangible financial savings as they do not reduce the amount of stormwater. However, if the social and health costs associated with polluted stormwater and substantial loads of wastewater are internalized in the valuation, then investment in these devices may be rendered economically feasible. Installation of these devices may also produce indirect financial benefits from publicity for being an environmentally conscious business.

Stormwater Collection and Reuse

Green roofs can be costly to construct especially as a retrofit project if the existing roof needs reinforcing. The simplest type, extensive green roofs, do have the potential to be economically feasible due to financial savings earned from reduced energy usage and less frequent need to replace the underlying, traditional roof. These savings coupled with the increase in the facility's value from the addition of this amenity and the intangible benefits from public and community relations (particularly if the roof is used as an educational tool) can make green roofs economically feasible. Green roofs also have the potential to create financial savings if used in other areas of New York City as they greatly reduce the amount of stormwater flowing to the WPCP through combined sewers.

Rain barrels and *cisterns* are clearly economically feasible. These options are not expensive and can produce further financial savings if the retained water is used for non-potable uses in place of potable municipal water.

Infiltration/Filtration Systems

Vegetated buffers are one of the least economically feasible option unless bundled with incentives. They traditionally occupy larger expanses of land, which can be costly depending on local property values and they require more expensive landscaping. Land preparation and maintenance contributes to their costliness. Cost-sharing assistance may be offered by some organizations such as The Natural Resource Conservation Service to make buffers a more feasible option. Their relatively high-profile quality may produce benefits in terms of public relations and their aesthetic appeal could potentially increase property values. Vegetated buffers could also potentially reduce adjacent parking lot and building temperatures as well as carbon dioxide levels, which in turn may add to the desirability of this option.

Raingardens vary in cost depending on their size. Small raingardens are highly cost-effective and minimally reduce parking space area. Larger raingardens can also be economically feasible since they decrease the cost of constructing traditional stormwater piping systems and particularly if landscaped areas already exist at a site. Raingardens also have significant aesthetic appeal and may have the secondary benefits of temperature and carbon reduction as described above.

Wetland restoration is a very costly endeavor that is most likely not economically feasible unless substantial incentives and funding are obtained to reconcile the construction costs. The cost of restoration varies depending on the size of the area needed for an adequate Wetland and will be higher in areas where contaminated soils must be excavated and/or significant fill must be brought in to construct a wetland. On the other hand, there are a number of funding and grant opportunities available to support wetland restoration. Furthermore, the public recognition for completing such an environmentally beneficial project has the potential to garner additional business and revenue for a company.

Wastewater Reduction

Water-saving devices are extremely cost-effective. Their purchase prices are comparable to those of traditional devices and some companies offer free installation when they are purchased. Substantial savings can accrue through reduced water usage and energy needed for hot water.

Blackwater Biofilter Systems are expensive when compared to conventional toilets. However, they are economically feasible as they reduce water consumption thus also reducing associated water and wastewater charges.

Wastewater Reuse

Steam chillers are expensive and require incentives to subsidize the initial capital cost. While they will produce financial savings by reducing energy consumption, the payback period is lengthy.

Greywater reuse piping systems are expensive to implement into an existing structure since they require a dual plumbing system. Depending on the extent of the system, significant financial returns can be obtained through decreases in water usage bills and consequently water and wastewater charges. However, integrating the system into current infrastructure is cost-prohibitive and thus should be pursued when planning new construction at the Market.

Wastewater Recycling

Living Machines are expensive to construct. Unless being used in a warm climate where a greenhouse is not necessary to protect the plants, this is not an economically feasible option. While Living Machines may produce financial returns by reducing water and wastewater costs, the payback period is lengthy. However, incentives can reduce construction costs while intangible benefits from public relations can increase their value Thus, while Living Machines may be possible, they are more economically feasible when integrated into new construction..

5.4.3 Cost Comparison

Given the above information, the following chart is intended to provide a basic spectrum of the initial investment costs associated with each stormwater and wastewater management option. This spectrum does not take into consideration any of the benefits from the technologies and practices or the potential for funding opportunities. Thus, one should not assume that options listed as less costly have a shorter payback period or are necessarily more economically feasible than more costly options. It is also important to note that many of the cost estimates may vary depending on the size of the respective project. However, despite these considerations, this chart can be useful when a project proposal is developed within a certain budget. For example, if a business is only willing or able to spend minimally to improve its stormwater and wastewater management then it should look at options such as education and training, low-flow devices, and rain barrels.

Table 3: Cost Spectrum for Technology Options

Stormwater Management Options	New Sites/Facilities	Retrofit Projects
Education/Training[6]	$ -- $$	$ -- $$
Manufactured Treatment Devices		
StormFilter	$$$ -- $$$$	$$$ -- $$$$
BaySaver Separation System	$$$ -- $$$$	$$$ -- $$$$
Enviropod	$	$
Aqua-Guard	$$	$$
Green Roofs	$$$	$$$ -- $$$$
Rain Barrels	$	$
Cisterns	$$	$$
Vegetated Buffers	$$$	$$$
Raingardens	$$	$$$
Constructed Wetlands	$$$$$	$$$$$
Wastewater Management Options	**New Sites/Facilities**	**Retrofit Projects**
Education/Training	$ -- $$	$ -- $$
Water-Saving Devices	$	$
Blackwater Biofilter System	$$	$$
Steam Chillers	$$$$$	$$$$$
Living Machine	$$$$$	$$$$$

$ = 0–1000; $$ = 1001–10,000; $$$ = 10,001–20,000; $$$$ = 20,001–100,000; $$$$$ = 100,000+

5.5 Phase 5 –Political and Social Feasibility Analysis

The fifth and final phase addresses the social feasibility of the EMP. This phase examines two essential aspects of the implementation process which include the potential political barriers and the effects the EMP will have on the quality of life for the Hunts Point community. It is important to customize each plan to the particular market dynamics and consider the impact it will have on the neighboring community. By doing so, key stakeholders will be more likely to cooperate with or support the plan, thus ensuring its successful implementation.

The potential political barriers mainly include the distinct market cultures and organizational structures. When planning an EMP these factors should be taken into account so as to maximize and facilitate the vendors' receptivity to modifications and additions to daily operating procedures. Appropriate governance and training programs are contingent upon the hierarchal order of operations currently in place at each market. For instance, if a management board comprised of several vendors supervises market operations, it will be necessary to adjust the governance and training requirements of the EMP to fit this dynamic.

The second aspect of this analysis is the potential of these mitigation strategies to contribute positively to the quality of life for the Hunts Point community. For instance, vegetative buffers along the edge of the parking lot at the Fish Market would be a pleasant addition to the aesthetic

[6] For analysis on Education/Training, see Section 6.2

and function of the future South Bronx Greenway Project. Furthermore, limiting the amount of wastewater that the Market sends to the WPCP will decrease the need for its expansion in the future. Limiting the volume of stormwater that directly enters the rivers will decrease the large amounts of pollution that presently enters the watershed, which will reduce the contamination flowing into the rivers. This will allow the ecosystems to recover and will enhance the community's access to and enjoyment of the Bronx and East Rivers.

6.0 Environmental Management Plan

The culmination of this feasibility study resulted in the creation of a three-part Environmental Management Plan (EMP). The EMP was designed with the following sections: (1) Market Specific Technology Recommendations; (2) Education and Training Program; and (3) Operations and Maintenance Plan. This plan should also establish a governance structure to assure compliance with the plan and be flexible enough to incorporate future areas of interest such as improved energy efficiency.

6.1 Market Specific Technology Recommendations

6.1.1 Produce Market Recommendations

Structural Feasibility: Stormwater

Parking Lot

The Produce Market offers numerous opportunities for stormwater mitigation by retrofitting the storm drains located in the impervious parking lot. Thus, the MTDs including the StormFilter, BaySaver Separation System, Enviropod, and Aqua-Guard are relatively easy to employ. Another feasible technology is the raingarden, which is also applicable to parking lots. However, as noted above, this technology requires further analysis to determine the ideal design and construction given the constraints of the Produce Market site.

Roof

As there is significant roof space available at the Produce Market, green roofs are another viable option. At this time, a structural analysis needs to be completed to determine if the current roof can withstand the weight of a green roof. However, as previously noted, the Produce Market is slated for renovation or reconstruction. If the Produce Market is rebuilt, it is a prime opportunity to ensure the structural capacity to support a green roof while also employing the additional sustainable guidelines outlined in Section 7.0.

The rooftop and interconnected drainage spouts also offer the potential for utilizing rain barrels. It is important to note, however, that since the Produce Market has relatively minimal reuse potential, the intentional use of collected water from such devices is not necessary at this time. Nevertheless, there may be significant potential for stormwater collection and reuse in the long-term as the South Bronx Greenway Project is planned to extend along the boundaries of the Produce Market.

Coastline

As the Produce Market sits on the bank of the Bronx River, a vegetated buffer and constructed wetland are also feasible. However, until the ideal size of the wetlands is determined, the limited width of the Bronx River may render this strategy infeasible upon further analysis. Thus, the vegetated buffer is more feasible as it requires less construction and space than wetlands.

Economic Feasibility: Stormwater

As they are simple retrofits of existing storm drains, the MTDs offer the most cost-effective means of minimizing stormwater concerns at the Produce Market. While these technologies are quite similar in function, there are significant cost variances due to the distinctions between them. It is therefore important to choose the best option for the number and size of the existing drains.

According to the economic spectrum in Table 3 of Section 5.4.3, green roofs, vegetated buffers, and raingardens are relatively similar in terms of retrofitted costs. However, as these recommendations require further analysis, the associated costs must also be taking into account

when calculating the cost of implementing these technologies. Although constructed wetlands are the most cost-intensive improvement, it is important to note that there is significant funding available for such projects. With respect to determining the ultimate feasibility of constructed wetlands, the extent of renovation or rebuilding of the Produce Market should also be factored into the evaluation.

Table 4: Produce Market Stormwater Recommendations

Short-Term	Long-Term
MTDs	**INFILTRATION/FILTRATION**
StormFilter	Vegetated Buffers
BaySaver Separation System	Raingardens
Enviropod	Constructed Wetlands
AquaGuard	
COLLECTION/REUSE	**COLLECTION/REUSE**
Green Roof	Rain Barrels
	Cistern

Structural and Economic Feasibility: Wastewater

As determined above, the Produce Market does not produce a significant amount of wastewater. While mitigating the effects of stormwater takes priority at this market, there are still potential opportunities of incorporating water-saving devices on faucets, toilets, and hoses to further minimize water consumption at the Produce Market. This option is cost-effective and easily installed thus is an attractive choice for the Produce Market. Furthermore, while it may be structurally possible to retrofit pipes to redirect greywater for reuse, it may be more cost-effective to pursue this option when the Produce Market is renovated or rebuilt.

6.1.2 Meat Market Recommendations

Structural Feasibility: Stormwater

Parking Lot

As with the Produce Market, the Meat Market offers similar opportunities for stormwater mitigation on the vast paved areas. Thus, the above MTDs and raingardens are also applicable to the Meat Market. However, this area also requires further analysis to determine the ideal site-specific design and construction criteria.

Roof

Although there is significant roof space available at the Meat Market, it is unknown whether its tar roofs would be able to support green roofs during the heat of summer. Therefore, before installing green roofs, the Meat Market requires further structural analysis. If the roof is adequate, green roofs should be considered a viable option.

The rooftop and related drainage spouts also offer the potential for utilizing rain barrels or cisterns. However, similar to the Produce Market, the Meat Market has relatively minimal reuse potential for water that is non-potable. Thus, at this time, the water collected by such devices cannot be put to use. However, if the Meat Market enhances surrounding vegetation, stormwater collection has the potential to be redirected for irrigation and should be considered at that time.

Economic Feasibility: Stormwater

Similar to the Produce Market, the MTDs offer the most cost-effective means of minimizing stormwater concerns at the Meat Market. It is also important to assess the relative costs of the various MTDs when choosing the most appropriate option for this site. Pending the outcome of a thorough roof analysis, green roofs could be a viable option and should be considered at that time. Again, as further research is needed, the additional cost for the roof study should be incorporated into the overall estimate of retrofitting the roofs of the Meat Market with green roofs.

Table 5: Meat Market Stormwater Recommendations

Short-Term	Long-Term
MTDs	**INFILTRATION/FILTRATION**
StormFilter	Raingardens
BaySaver Separation System	
Enviropod	
Aqua-Guard	
COLLECTION/REUSE	
Green Roof	

Structural and Economic Feasibility: Wastewater

The Meat Market produces a greater amount of wastewater than the Produce Market. Thus, the potential for mitigating wastewater is greater than at the Produce Market. Incorporating water-saving devices where feasible can reduce water usage at the Meat Market. This option is cost-effective, easily installed, and thus is a viable option for the Meat Market. On the other hand, while retrofitting pipes for reusing the greywater is structurally possible, the cost of doing so outweighs the potential savings in conserving water since the majority of water used at the Meat Market must be potable. Another option unique to the Meat Market is the potential for greywater reuse with a steam chiller. However, the majority of available water at the Meat Market is blackwater, which requires additional equipment to convert it to greywater. While these technologies are possible, the costs associated with their integration and retrofitting the existing pipe system would be significant. Therefore, they are not a viable option. However, this illustrates the importance of integrating such technologies into new construction in order to maximize their potential while minimizing the related costs.

6.1.3 Fish Market Recommendations

Structural Feasibility: Stormwater

Parking Lot

As with the other markets, the Fish Market also has an extensive paved parking lot area. Thus, the MTDs and raingardens are also applicable to the Fish Market. As with the above recommendations, this site requires further analysis to determine the ideal design and construction criteria.

Roof

The pitched nature of the Fish Market roof significantly increases the velocity of the stormwater runoff, and thus it requires greater rooftop stormwater mitigating techniques than the other markets. However, while green roofs are generally feasible on pitched roofs, it is necessary to conduct a site-specific roof analysis to determine if it is economical feasibility to do so at the Fish Market.

The rooftop and related drainage spouts also offer the potential for the use of rain barrels or cisterns. While the Fish Market does not currently have a need for stormwater reuse, the proposed South Bronx Greenway Project covers the periphery of the Fish Market property and therefore may present a need for such stormwater collection devices.

Coastline
While the Fish Market sits on the East River, it is quite similar to the Produce Market. Thus, pending future analysis as noted above, a vegetated buffer and constructed wetland are also feasible options.

Economic Feasibility: Stormwater

Similar to the above markets, the MTDs offer the most cost-effective means for minimizing stormwater concerns at the Fish Market. It is again important to assess the relative costs of differing MTDs when choosing the most appropriate device for this site. While further analysis of the roof and costs is required, retrofitting the roof of the Fish Market with a green roof could be a viable option and should not be eliminated from consideration.

Table 6: Fish Market Stormwater Recommendations

Short-Term	Long-Term
MTDs	**INFILTRATION/FILTRATION**
StormFilter	Vegetated Buffers
BaySaver Separation System	Raingardens
Enviropod	Constructed Wetlands
Aqua-Guard	
COLLECTION/REUSE	**COLLECTION/REUSE**
Green Roof	Rain Barrels
	Cistern

Structural and Economic Feasibility: Wastewater

The Fish Market produces the most wastewater of the three markets. Thus the incorporation of water-saving devices, if not currently employed, can dramatically reduce water usage at the Fish Market. This option is cost-effective, easily installed, and thus is a viable option. However, since the Fish Market recently opened, the movement for further renovation or retrofits within the building may encounter political resistance.

6.2 Education and Training

To ensure proper incorporation of these technologies, each market should develop its own appropriate education and training program to provide stormwater and wastewater management information to all employees. An ideal education and training program would have two parts: a basic level of training for all market employees along with a more robust intermediate level of training for one or two select individuals of authority at each market.

The basic level of training should educate every employee on the importance of improved stormwater and wastewater management. Additionally, training should address how to incorporate these technologies into daily operations, including but not limited to providing

strategies for monitoring and reducing water consumption, as well as any necessary changes to operations to ensure proper maintenance of newly incorporated equipments.

The intermediate level of training should be pursued by a few individuals of authority within each market, preferably senior supervisors or officers. For these individuals, the training should provide a more comprehensive understanding of the technologies incorporated into each market, as well as other potential technologies for improving stormwater and wastewater management. Additionally, these courses should provide the tools necessary for these key individuals to educate employees of the market about the basics of water management and other personnel that oversee the operations and maintenance of these newly incorporated technologies.

Education and training are one of the more easily implemented strategies as they can be provided for relatively minimal cost. Furthermore, there are numerous funding opportunities available to reduce the cost even further. For instance, New York State currently provides training events in the area of stormwater management. Also, many companies and agencies offer free educational materials such as brochures, videos, and posters. On-site training sessions for employees are the most cost-effective. Off-site professional courses, though more expensive, are still cost-effective with regard to the benefits they produce. The benefits of increased education and training result in more efficient operation of facilities as well as a better awareness of water and energy conservation. Moreover, having senior supervisors or officers directly responsible for implementation greatly increases overall performance. For the cost analysis of the Education and Training program, please refer to Appendix 4.

6.3 Operations and Maintenance (O&M)

Finally, for long-term sustainability of these technologies, it is essential to develop an O&M plan for the incorporated stormwater and wastewater options. Based upon the recommendations above for the education and training programs, those individuals who complete the intermediate level of training should be responsible for the implementation of the O&M plan.

The O&M plan should not only provide for the initial training of market employees, but also should include regular operations and maintenance reporting strategies. Additionally, the plan should include a user-friendly forum for daily reporting of problems with the maintenance of the new technologies or violations of stormwater and wastewater guidelines. Employees should also be rewarded for reporting problems.

By having a comprehensive O&M plan, the Market will not only increase the positive environmental impacts from these technologies, but also will reduce the overall long-term costs associated with the integration of the chosen technologies.[119]

7.0 Sustainable Guidelines

To complement the Environmental Management Plan, the project team outlined sustainable guidelines for stormwater and wastewater management that may be used as a tool for interest groups and the City at the inception of development plans at the Market. The purpose of these guidelines is to provide a foundation upon which current and future markets may develop, improve, and expand traditional stormwater and wastewater management plans. Furthermore, the incorporation of these guidelines into future projects, such as the proposed Anheuser-Busch and Baldor Specialties Food facilities, may provide a model for the integration of management plans that address other environmental concerns at the Market.

Sustainable Guidelines: Stormwater Management
1. Include stormwater control strategies at the inception of the design phase for new development. This will guarantee that stormwater control strategies are integrated at the onset of development plans, which will minimize costs and ensure effectiveness.[120]
2. Implement a Stormwater Management Plan that reduces the impact of stormwater on the community and the environment. This plan should be an integrated approach that includes increasing employee awareness, training employees for proper operation and maintenance of low impact development technologies, and developing a public outreach and participation component.
3. Hire an Environmental Health and Safety Specialist to review, train, and enforce compliance with the implemented Stormwater Management Plan. In addition, this specialist will be responsible for other environment-related responsibilities outlined in the Stormwater Management Plan.
4. Conduct soil analysis to identify the extent of contaminated soils and take advantage of opportunities to implement appropriate technologies and strategies to the maximum extent feasible (e.g. porous pavement).
5. Design landscaped areas to accommodate stormwater volume in order to minimize runoff. Use stormwater controls in current market structure to the maximum extent possible. For instance, construct concave landscape areas at the site periphery or in parking lot islands and use native vegetation on fencing for stormwater control.[121]
6. Incorporate stormwater control strategies that complement and enhance the aesthetics and function of the proposed South Bronx Greenway Project.
7. Assess the potential for stormwater reuse, such as site irrigation, and incorporate related technologies to the maximum extent feasible.[122] For example, rain barrels can collect runoff from building surfaces for on-site use.
8. Maximize the use of open roof area for green roofs while considering other environmental devices such as rain barrels and photovoltaic cells. Open roof area is the available space not occupied by conventional building infrastructure such as cooling units.
9. Improve or develop a solid waste management plan to reduce debris entering the stormwater system. This plan should pay particular attention to procedures during peak rain and snow events.

Sustainable Guidelines: Wastewater Management
1. Include wastewater control strategies at the inception of the design phase for new development. This will guarantee that wastewater control strategies are integrated at the onset of development plans, which will minimize costs and ensure effectiveness.[123]
2. Implement a Wastewater Management Plan that reduces the impact of wastewater on the community and the environment. This plan should be an integrated approach that includes increasing employee awareness of wastewater concerns, training employees for proper operation and maintenance of water conservation practices and greywater recycling technologies, and developing a public outreach and participation component.
3. Hire an Environmental Health and Safety Specialist to review, train, and enforce compliance with the implemented Wastewater Management Plan. In addition, this specialist will be responsible for other environment-related responsibilities outlined in the Wastewater Management Plan.
4. Install wastewater out-meters to measure the volume of wastewater leaving the facility and establish a mandatory reporting schedule whereby a designated central authority reviews usage per time period.
5. Improve billing transparency to promote water usage awareness and allow for easy public access to usage rate reports and related documents.
6. Assess the potential for greywater reuse and include appropriate wastewater reuse technologies to the maximum extent feasible.[124] For example, wastewater from washbasins can be redirected to flush toilets and irrigate surrounding landscape.
7. Use ecology-based natural filtering technology for blackwater when feasible as opposed to chemical treatment.[125] Examples of natural filtering technology include Living Machines and Blackwater Biofilter Systems.

8.0 Policy Recommendations

In conjunction with these sustainable guidelines, the project team also developed preliminary policy recommendations. The first recommendation is to increase collaboration among the key stakeholders in order to determine the concerns, priorities, and potential resolutions of important stormwater and wastewater issues. In addition, the installment of out-meters to measure the volume of wastewater produced would allow for the potential implementation of a variable collection fee. As the fee would depend on the amount of wastewater produced at a given market, this would provide incentive for market operators to reduce their wastewater production. Furthermore, a portion of this revenue should be set aside to supplement funding for DEP programs dedicated to improving the health of Hunts Point waterways. However, a full policy analysis is required in order to assess the political and logistical feasibility of the proposed policy recommendations.

9.0 Conclusion

Despite the numerous physical challenges at the site, the project team believes that there is significant potential for improving the stormwater and wastewater management in both the short and long-term at the Market. The recommended Environmental Management Plan, in conjunction with the sustainable guidelines and policy recommendations, lays the foundation for improving the environmental sustainability of the Market. However, further research and cost-benefit analyses are needed to assess the site-specific feasibility of the recommended strategies. Additionally, significant efforts must be made to involve major stakeholders including the City, market vendors, and the community in order to ensure that the implementation of the above recommendations provides the Hunts Point community with access to clean and healthy waterways.

Appendix 1: Eliminated Technologies

1.0 Manufactured Treatment Devices (MTDs)

The following are descriptions of those MTDs that were eliminated from further consideration on account of their need for extensive excavation or retrofitting.

Aqua-Swirl Concentrator™

The Aqua-Swirl Concentrator (see Figure 1.1[7]) provides removal of sediment, floating debris, and free-oil.[126] A combination of gravitational and hydrodynamic drag forces cause solids to drop out of the flow and migrate to the center of the chamber where velocities are the lowest.[127]

Figure 1.1: Aqua-Swirl™ Concentrator

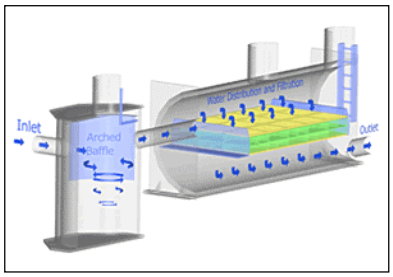


Figure 1.2: Aqua-Filter™ Stormwater Filtration Chamber

Aqua-Filter™ Stormwater Filtration Chamber

The Aqua-Filter Stormwater Filtration System (see Figure 1.2[8]) is designed for sites that require advanced treatment of stormwater runoff discharging to sensitive receiving waters.[128]

Downstream Defenders®

Hydrodynamic Vortex Separators (HDVS) (see Figure 1.3[9]) like Downstream Defenders differ from other types of vortex separators in that the internal flow modifying components have been designed to ensure that the current generation of HDVS are highly efficient and use relatively low energy. Downstream Defenders can be used at new developments, retrofit, construction sites, streets and roadways, parking lots, car-wash stations, industrial and commercial facilities, and wetland protection.[129]

Figure1.3: Downstream Defender®

[7] USEPA. Aqua- Swirl Concentrator. Accessed 3 May 2006 <http://epa.gov/boston/assistance/ceitts/stormwater/techs/aquaswirl.html>.

[8] USEPA. Storm Water Virtual Trade Show Aqua-Filter™ Stormwater Filtration System. 1 May 2006 .http://epa.gov/boston/assistance/ceitts/stormwater/te chs/aquafiltersys.html. 1 May 2006.

[9] Hynds Environmental: Hynds Downstream Defender. 3 May 2006 http://www.Hynds.co.nz/environmental/c_ss_dstream_def.htm.

High Efficiency Continuous Deflective Separator Unit (CDS)
The CDS technology separates and retains pollutants by diverting flow into a pollutant separation and containment chamber (see figure 1.4[10]).[130] The separation and containment chamber consists of a containment sump in the lower section and an upper separation section.[131] Gross pollutants are separated within the chamber using a perforated plate allowing the filtered water to pass through to a volute return system and then to the outlet pipe.[132]

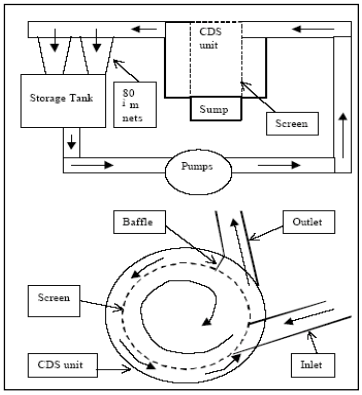


Figure 1.4: Sketch of CDS unit and Flow Schematic

Figure 1.5: HydroBrake®

HydroBrake®
HydroBrake (see figure 1.5[11]) behaves like a standard orifice during low flow conditions, discharging flows at a low operating head. During high flow conditions, the device establishes a rotational flow pattern. The rotational velocities in the inlet section cause an air-cored vortex to form in the outlet section.[133]

Stormceptor®
Stormceptor (see figure 1.7[12]) is a technology that separates and retains floating and sinking pollutants including sediment, hydrocarbons, and debris, under rapid flow conditions using a hydrodynamic separator.[134] The Stormceptor® System is a vertically oriented cylindrical structure made of concrete and fiber reinforced plastic, designed to separate oil and sediment from stormwater.[135]

Figure 1.7: Stormcepter®

[10] Schwarz, T. and Wells, S. (1999) "Storm Water Particle Removal using Cross-Flow Filtration and Sedimentation," in Advances in Filtration and Separation Technology, Volume 12, ed. by W. Leung, American Filtrations and Separations Society, pp.219-226
[11] CONTECH Stormwater Solutions. HydroBrake. http://www.vortechnics.com/produ cts/hydrobrake. 3 May 2006.
[12] EPA. Stormwater Virtual Trade Show: Stormceptor®. 3 May 2006 .http://epa.gov/boston/assistance/ceitts/stormwater/techs/stormceptor.html.

StormScreen®

StormScreen (see figure 1.8[13]) protects downstream waterways by targeting and removal of trash, debris, and coarse contaminants at high flow rates. Direct screening of runoff guarantees removal of solids larger than the screen perforations while the passive, siphon-actuated design of the cartridge ensures that the entire surface area of the screen is used evenly during every storm.[136]

Figure 1.8: StormScreen®

VortCapture ™

VortCapture (see figure 1.9[14]) utilizes the hydrodynamic separation system to capture trash and organic debris for all particles greater than 5 mm in size.[137] Stormwater runoff enters the unit tangentially to promote a swirling motion in the screened treatment chamber.

Figure 1.9: Vortcapture™

VortClarex™

VortClarex (see figure 1.10[15]) employs a coalescing media to remove free oil from contaminated stormwater flows.[138] Stormwater enters the VortClarex system via a non-clog diffuser and is distributed across the chamber width.[139] Heavier solids drop out as the outlet behind the T-pipe traps the oil and the treated water exits the system.

Figure 1.10: VortClarex™

Figure 1.11: VortFilter™

VortFilter™

The VortFilter System (see figure 1.11[16]) has a sedimentation basin and filter basin deck with VortFilter cartridges.[140] As stormwater enters the sedimentation basin, heavy particles settle to the bottom and floating pollutants rise to the surface. As flow increases, the stormwater is forced through the media cartridges where fine particulates are removed. The treated water is discharged through the cartridge outlet, onto the filter basin deck, and ultimately exits through the VortFilter outlet pipe.[141]

[13] Core-Rosion Products.Stormscreen. 19 April 20 2006 http://www.corerosion.com/viewer. cfm ?linkID=http://sto rmwaterinc.com:80/products/stormscreen.
[14] CONTECH Stormwater Solutions. Vortcapture. http://www.vortechnics.com/products/vortcapture. 3 May 2006.
[15] CONTECH Stormwater Solutions. VortClarex. http://www.vortechnics.com/products/vortclarex. 3 May 2006
[16] CONTECH Stormwater Solutions.VortFilter..http://www.vortec hnics.com /products/vortfilter. 3 May 2006

VortSentry®

VortSentry (see figure 1.12[17]) is a hydrodynamic separator with an internal bypass that ensures treatment chamber velocities remain low, which improves performance and eliminates the risk of re-suspending settleable particles.[142] The system is housed inside a lightweight concrete manhole structure for easy installation and unobstructed maintenance access.

Figure 1.12: VortSentry™

Figure 1.13: Vortechs™ Stormwater Treatment System

Vortechs™

Vortechs Stormwater Treatment System (see figure 1.13[18]) is a hydrodynamic separator designed to remove sediment, particles, free oil, and grease.[143] Stormwater flows enter the unit tangentially to the grit chamber, which promotes a gentle swirling motion. The majority of solids that settle are left behind as stormwater exits the grit chamber via two apertures on the perimeter of the chamber.

2.0 Infiltration/Exfiltration

Dry/Wet Swales

Swales (see figure 2.1[19]) are long narrow tracts of land that usually flank both sides of the street. They direct and slow the flow of stormwater and provide detention during periods of heavy precipitation. Dry swales were eliminated based on their need for extensive excavation. Wet swales were eliminated because they are used for groundwater recharge, which is not desired for this site.

Figure 2.1: Stormwater Swale

Figure 2.2: Infiltration Basin

Infiltration Basin

An infiltration basin (see figure 2.2[20]) is a facility constructed within highly permeable soils that provides temporary storage of stormwater runoff. An infiltration basin does not normally have a structural outlet to discharge runoff. Instead, outflow from an infiltration basin is released through the surrounding soil. Infiltration basins were eliminated because of the lack of permeable soil at the Market site.

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[17] CONTECH Stormwater Solutions.VortSentry..http://www.vortec hnics.com /products/vortsentry. 3 May 2006

[18] CONTECH.Stormwater Solutions: Vortechs. ttp://www.contechstormwater.com/products/vortechs. 18 April 2006

[19] GoldCoast Waterfuture. Pimpama Coomera. 3 May 2006.http://www.goldcoast.qld.gov.au/t_gcw.asp?PID=2969.

[20] California Government. Division of Environmnetal Analysis. Infiltration Basins and Trenches. Accessed on May 5 2006. http://www.dot.ca.gov/hq/env/stormwater/ongoing/pilot_studies/bmps/details/ib_trenches/

Infiltration Trenches

Infiltration trenches (see figure 2.3[21]) are excavated trenches with material to permit the filtration and percolation of water into subsoils.[144] Stormwater from impervious areas, such as pavement or rooftops, is routed into the trenches for treatment. [145] These systems are effective at recharging groundwater contributing to stream baseflows.[146]

Figure 2.3: Infiltration Trench

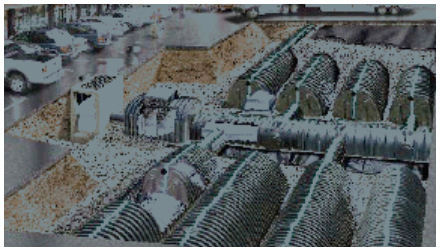

Figure 2.4: Typical Infiltration Drainfield Schematic

Infiltration Drainfields

Similar to a septic system, the drainfield itself (see figure 2.4[22]) consists of layers of topsoil, aggregate stone, sand, and, filter fabric with an observation well located at one corner of the system to monitor the flows.[147] They are also effective at improving water quality by filtering pollutants and decreasing runoff volumes. [148]

Pervious Pavement

Pervious paving systems are paved areas (see figure 2.5 [23]) that produce less stormwater runoff than conventional paving. Pervious pavement was eliminated because installation requires extensive excavation and creates groundwater infiltration, which is impossible due to the site's status as a brownfield.

Figure 2.5: Pervious Paved Area

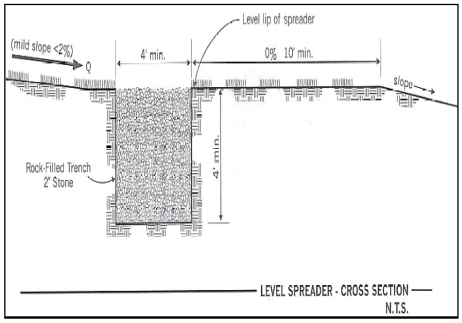

Figure 2.6: Components of a Level Spreader

Level Spreaders

Level spreaders, consist of a depression in the soil surface that spreads the stormwater flow onto a flat area across a gentle slope (see figure 2.6[24]). Level spreaders are not pollutant reduction devices but, rather, improve the efficiency of other facilities such as vegetated swales, filter strips, or infiltration devices.

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[21] HydroCon Stormwater Treatment. Accessed 5 May 2006. http://www.hydrocon.com.au/ausprojects.html

[22] City of Salem Departments of Public Services and Planning and Community Development. Urban Stormwater Management Guidebook.2005. Accessed may 5 2006. http://www.woodardcurran.com/resource/Guidebook_Final.pdf

[23] Source:http://colorado.construction.com/2005/09/01/CC_09_2005_ Porous2_lres.jpg . 24 March 2006.

[24] U.S. Department of Housing and Urban Development. Office of Policy and Research. The Practice of Low Impact Development, Section 2.3.1: Infiltration Systems, p.39. July 2003

Vegetative/Filter Strips

Vegetative and filter strips (see figure 2.7[25]) are low-grade vegetative areas that permit sediment deposition during sheet flow.[149] It is an area designed to remove suspended solids and other pollutants from stormwater runoff utilizing mechanisms such as sedimentation, filtration, adsorption, infiltration, biological uptake, and microbacterial activity..

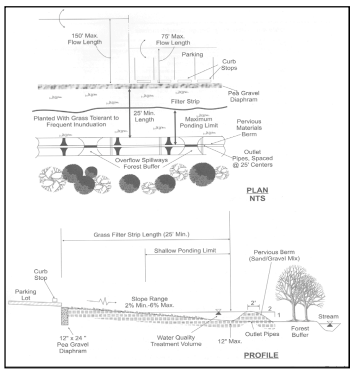

Figure 2.7: Vegetative/Filter Strips

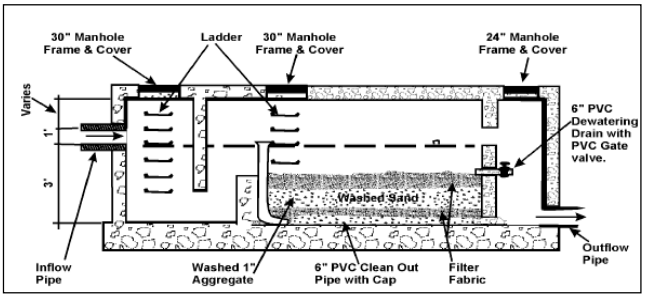

Figure 2.8: Sand Filter Design

Sand Filters

Sand filters (see figure 2.8[26]) consist of four basic zones; Trash, debris, and coarse sediment are removed in the forebay zone, while further filtration is conducted in the sand zone. The sand bed underdrain allows the sand bed to drain freely while the overflow must safely convey the runoff from unusually large volumes of stormwater during severe storms.

Exfiltration Trenches

Exfiltration trenches function (see Figure 2.9[27]) similarly to infiltration basins (see above) with the exception that they have an underdrain system built into the bottom of the trench.[150] After water percolates through the soil media where pollutants are removed, it enters the perforated drain tile and is conveyed to a local stormwater drain system. Though they are highly effective in removing pollutants and sediment from stormwater, exfiltration trenches were eliminated on account of the extensive excavation needed to install them.[151]

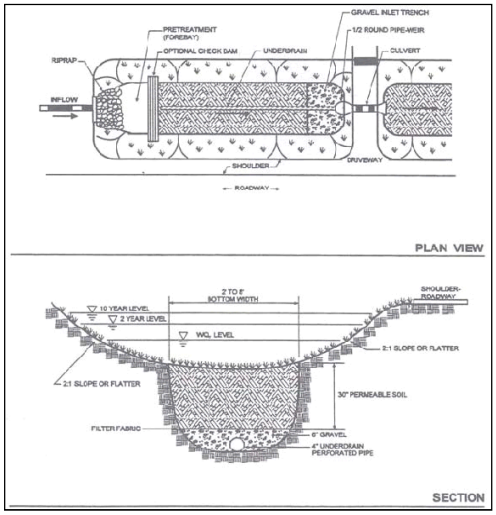

Figure 2.9: Components of Exfiltration Trench/Dry Swale

[25] U.S. Department of Housing and Urban Development. Office of Policy and Research. The Practice of Low Impact Development, Section 2.3.2: Filtering Systems, p.40. July 2003

[26] EPA. Stromwater Technology Fact Sheet: Sand Filters. September 1999.

[27] U.S. Department of Housing and Urban Development. Office of Policy and Research. The Practice of Low Impact Development, Section 2.3.1: Filtering Systems, p.41. July 2003

3.0 Collection/Reuse

Rainstore3

Rainstore3 (see figure 3.1[28]) is a plastic modular system designed to contain stormwater underground. This allows for the construction of porous asphalt pavements above the underground storage tank that allows for stormwater infiltration. Stormwater flows through the drain into a sediment filter and is conveyed to the Rainstore3 cells via an inlet pipe.

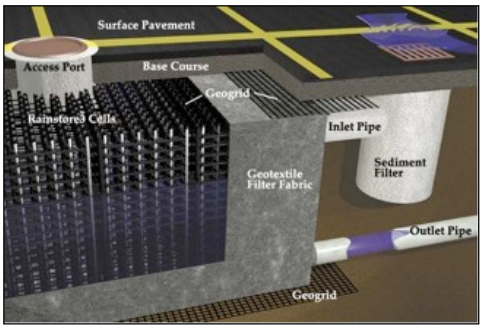

Figure 3.1: Components of Rainstore3 stormwater storage system.

Figure 3.2: Components of Wet Pond Detention System

Wet Pond

A wet pond is a stormwater facility constructed through filling and/or excavation that provides both permanent and temporary storage of stormwater runoff.[152] It consists of a permanent pool that detains stormwater and attenuates runoff inflows and promotes settlement of pollutants (see figure 3.2[29]).

Extended detention basin

An extended detention basin (see figure 3.3[30]) is constructed through filling and/or excavation that provides both permanent and temporary storage of stormwater runoff.[153] It has an outlet structure that detains stormwater and attenuates runoff inflows and promotes settlement of pollutants. Furthermore, they remove pollutants such as TSS and sediments.

Figure 3.3: Components of Extended Detention Basin

[28] Source: http://www.invisiblestructures.com/RS3/rainstore.htm, accessed on March 24, 2006
[29] Protection our Waters. Detention & Infiltration Basins http://clean-water.uwex.edu/plan/images/wetdetention.jpg
[30] Nemo Nevada. Bioretention and Swales. Accessed 6 May 2006. http://www.unce.unr.edu/western/SubWebs/NEMO/Bioretention.htm

4.0 Wastewater

Blivet

The Blivet (see figure 4.2[31]) is a stand-alone packaged sewage treatment plant comprising primary settlement, aerobic zone, final settlement (humus tank), and sludge storage. This device replicates the treatment processes used at wastewater treatment facilities, but on a smaller scale and with limited influent quantities. Because the Blivet is typically used at sites that lack access to a water pollution control plant and/or generate minimal influent, it is not properly suited to handle to amount of wastewater generated at the Market.

Figure 24.1 Blivet

Clearwater Treatment System

The Clearwater treatment system (see figure 4.3[32]) separates blackwater from greywater. This problem is addressed by treating greywater wastes from blackwater wastes with two separate decomposition and extended aeration containers.[154] Organic wastes (solids) are biologically altered into odorless carbon dioxide and water vapor in the separation tank, and the remaining water, greywater, is aerobically treated to filter and remove pollutants in the extended aeration tank.[155] Clearwater treatment systems would require extensive retrofitting of existing buildings, and therefore are not suitable for the Market site. Furthermore, they are most applicable for small structures such as single-family homes.

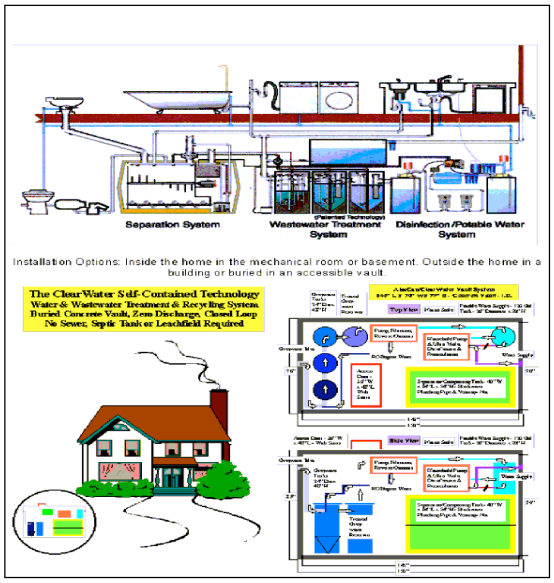

Figure 4.2: Clearwater Treatment System

[31] BMS. The BMS Blivet: Package Sewage Treatment Plant. 3 May 2006. http://www.bannow.com/
[32] EPA CEIT. Wastewater Virtual Trade Show.http:/ /www.e pa .gov/ne/assistanc/ceitts/wastewater/techs/clearwater.html

Appendix 2: Case Studies

PART I: Stormwater Technologies

Greenville Yards, Jersey City, N.J

The site in is a brownfield located Jersey City's harbor, immediately adjacent to the Hudson River. There are no plans to remove the soil contamination. Still, the site is was renovated to accommodate two new frozen food warehouses with 72 truck bays, large parking lots, and a new drainage systems. In order to meet New Jersey's strict stormwater regulations, engineers incorporated StormFilters.

Technology	Zone	Criteria Fulfilled
StormFilter	Industrial/Urban	• Identical weather to New York, comparable rainfall, extreme hot/cold temperatures • Active industrial site in an urban area, located on top of un-remediated brownfield • Adjacent to the Hudson River • Comparable usage: frozen food warehouses, truck depots, large parking lot space

Source: StormFilter. 2006. CONTECH® Stormwater Solutions Inc. http://www.stormwater360.com/products/stormfilter 18 April 2006.

Queens, NY (JFK International Airport)

In order to comply with state and federal stormwater regulations, the owners and authorities of JFK International Airport purchased 30 Baysaver Units, 17 of which have already been installed. The Baysaver units play an integral role in removing trash, debris, and hydrocarbon such as jet fuel and oil from the stormwater system before they enter the neighboring marine bodies of the Long Island Sound, the Hudson River, and the Atlantic Ocean.

Technology	Zone	Criteria Fulfilled
Baysaver Separation System	Industrial, Commercial, Urban	• Located in the tri-state area region, similar climate to New York City • Subject to oil and gasoline contamination and debris accumulation • Proximity to water bodies and vast impervious surfaces

Source: News and Events. 2005. Baysaver Technologies, Inc. http://www.baysaver.com/news-CaseStudies.cfm 18 April 2006.

Upper Parramatta River, Australia

The St. Martins Mega-Centa and Shopping Village is Upper Parramatta River, Australia suffers from many sources of pollutants including litter from consumers, gasoline and oil from vehicles, and leachate from waste receptacles. As a stormwater pit insert, the enviropod was relatively simple and cheap to install compared to current in-line and end-of-pipe technologies.

Technology	Zone	Criteria Fulfilled
Enviropod	Urban	• Subject to periodic heavy rainfall • Site has large impervious areas • Proved effective at an large urban facility

Source: Morison, Peter. Experiences with Stormwater Pit Pollutant Traps: The Upper Parramatta River Stormwater Source Control Project. Holroyd City Council, Merrylands, Australia. http://www.uprct.nsw.gov.au/cleanstreams/Seminar%20Talks/Peter%20Morison.htm 01 May 2006.

General, Northeast U.S.
Though no specific case studies are immediately available for analysis, Aqua-Guard is highly adaptable to new development project as well as into existing facilities. Some examples include highway and transportation facilities, bases and berthing wharfs, and residential and coastal communities.

Technology	Zone	Criteria Fulfilled
Aqua-Guard	Urban/General	• Can customize to site • Has been applied to various sites in northeast United States

Sources: AquaGuard Waterproofing Corporation. <http://www.aquaguardwaterproofing.com/what_customers_say.asp>; AquaShield. <http://www.aquashieldinc.com/>

Justice Center, Seattle WA
The green roof on the Justice Center requires little to no maintenance, as the selected plants are drought resistant. The additional benefit is energy use reduction, which is particularly relevant to the refrigeration facilities at the Market.

Technology	Zone	Criteria Fulfilled
Green Roof	Commercial	• Located in Washington State, similar latitude to New York; also receives heavy rainfall • Adheres to Seattle's Sustainable Building Policy, which we hope to provide for South Bronx development projects • Though green roof may not be an option for the fish market, it remains a possibility for the meat and produce markets • This case includes energy reduction benefits, which is a secondary concern (particularly for the refrigerated facilities of the complex)

Source: Sound Action Team. March 2003. *Natural Approaches to Stormwater Management: Low Impact Development in Puget Sound*. Olympia. p.24

Apex, NC
In an effort to conserve water, the town of Apex, NC sells rain barrels to its residents. The barrels are placed under a house's downspout to collect rainwater from the roof. A screen on the opening of the barrel will keep out debris and prevent mosquitoes from breeding. These barrels hold 65 gallons and are equipped with a ¾ inch brass spigot to be used to fill watering cans or connect to a standard garden hose. The barrels are equipped with an overflow hose to route excess water from the home foundation.

Technology	Zone	Criteria Fulfilled
Rain Barrel	Residential	• North Carolina receives periodic heavy rainfall • Rain barrels achieve low-impact development guidelines in stormwater management

Source: Town of Apex. "Rain Barrels." http://www.apexnc.org/depts/pw/rain_barrel.cfm 28 April 2006.

Annapolis, MD

The Philip Merrill Environmental Center, headquarters to the Chesapeake Bay Foundation, has installed cisterns to collect water for use in fire suppression, hand-washing, cleaning processes, and cooling. The rain collection system also minimizes stormwater runoff.

Technology	Zone	Criteria Fulfilled
Cistern	Commercial Office Building	• Maryland receives rainfall similar to New York • The Center produces a large volume of runoff, which is collected by the cisterns

Source: Hyland, Tim. "CBF Headquarters Wins Architecture Award." The Capital. October, 30 2001. http://www.hometownannapolis.com/nat_merrill.html 01 May 2006.

King Street Center, Seattle WA

Through the reuse of rainwater, the King Street Center is able to flush its 105 toilets throughout the year. By adopting this technology, King County captures water that would otherwise be wasted and avoids overloading its sewer system. As a long-term technology, this method may be a viable consideration for Hunts Point as its adoption is a possible incentive to save on water expenses.

Technology	Zone	Criteria Fulfilled
Rainwater Collection (can use rain barrels)	Commercial Office Building	• Located in Washington State, similar latitude to New York; also receives heavy rainfall • Though the technology was incorporate into a different type of building type that the Market facilities, it could be applicable as a long-term recommendation or sustainable guideline • Possible incentive to save on water expenses

Source: Puget Sound Action Team. March 2003. *Natural Approaches to Stormwater Management: Low Impact Development in Puget Sound*. Olympia. p.18

Felician Sisters Convent Coraopolis, PA

Renovation of the Convent, a 161,400 square-foot 70-year old building, included the Convent's water collection system. To reduce potable water use, rainwater is collected in a cistern. The rainwater is then channeled into an underground cistern with a 28,000 gallon holding capacity, and then pulled into cooling towers that use 48,000 gallons of water to cool the building.

Technology	Zone	Criteria Fulfilled
Roof Rainwater Capture via Cistern	Residence/School	• Pennsylvania has comparable weather including extreme hot/cold temperatures and heavy rainfall and snowmelt events • Technology and infrastructure were incorporated into an existing building • The project uses roof rainwater in coordination with cooling towers to help cool the building during warm weather, which may be highly applicable to the Market's refrigeration units

Source: Podurgiel, Bob. September 22, 2005. "All Can Share in Storm Water Management." Pittsburgh Post-Gazette.
Source: Green Building Alliance. Pittsburg, PA. http://www.gbapgh.org/casestudies_FelicianSisters.asp 01 May 2006.

Prince George's County, MD

As a cost-effective approach to stormwater management that also provided flood control and water quality benefits, the Prince George's County's Department of Environmental Resources retrofitted facilities using end-of-pipe structural stormwater treatment controls.

Technology	Zone	Criteria Fulfilled
Raingarden	Municipality	• Maryland's climate, though more mild, is comparable to New York's in amount of precipitation • Provides example of municipal involvement with stormwater mitigation

Source: EPA. National Pollutant Discharge Elimination System (NPDES).
http://cfpub.epa.gov/npdes/stormwater/casestudies_specific.cfm?case_id=14&CFID=18531189&CFTOKEN=45679045 01 May 2006.

Pembroke Town Hall, MA

In order to implement a stormwater management plan by 2008 that complies with the Clean Water Act, the town of Pembroke sought to filter out pollution that slicks off car windshields or splashes under tires under raingardens. Their purpose is to filter pollutants collected by stormwater that flows across parking lots, roads, and roof shingles directly into street catch basins and eventually into rivers and streams.

Technology	Zone	Criteria Fulfilled
Raingarden	Suburban, Municipal	• Massachusetts has comparable climate, including heavy precipitation • Detention feeding into a wetland, coupled with the long-term solution to build one, could provide a practical solution to stormwater management

Source: Johnson, Carolyn Y. November 3, 2005. "Chasing Water Goals Area Towns Install 'Natural' Filters." Boston Globe.

Bellingham City, WA

Whatcom Creek flows through the city of Bellingham and into Bellingham Bay. The city constructed a raingarden to treat stormwater runoff from the City Hall parking lot before it entered the creek. To install the raingarden, the city only had to surrender three of its 60 parking spaces.

Technology	Zone	Criteria Fulfilled
Raingarden	Urban	• Located in Washington State, similar latitude to New York; also receives heavy rainfall • Integrated into existing parking lot space, only required small area

Source: Puget Sound Action Team. March 2003. *Natural Approaches to Stormwater Management: Low Impact Development in Puget Sound*. Olympia. p.5

Bellingham City, WA

The Boundary Bay Brewery expanded the winter parking area while promoting a summer beer garden and performance area. A reinforced grass pavement system was constructed to replicates natural conditions for slowing and infiltrating stormwater runoff and increased the aesthetic appeal.

Technology	Zone	Criteria Fulfilled
Vegetated Buffers	Urban	• Located in Washington State, a place with similar latitude to New York; also receives heavy rainfall • Good example of end-of-pipe remedial solution to stormwater • Increased aesthetic appeal for patrons

Source: Puget Sound Action Team. March 2003. Natural Approaches to Stormwater Management: Low Impact Development in Puget Sound. Olympia. p.5

Union County, PA

Wetland restoration projects have focused in the Lake Erie coastal plain, the glaciated areas of northwestern Pennsylvania and the lower Susquehanna River Basin. Siege Property in Union County, PA was restored in 1997 and continues to provide a water quality benefit for a tributary of Buffalo run by trapping sediment and nutrients from two upstream farm fields.

Technology	Zone	Criteria Fulfilled
Constructed Wetland	Rural, Suburban	• Water quality improvement, floodwater storage, fish and wildlife habitat, and biological productivity • Water filtration process of wetlands removes much of the water's nutrient and pollutant load by the time it leaves a wetland

Source: Partners for Fish and Wildlife. <http://www.fws.gov/partners/pdfs/PA-needs.pdf> 25 March 2006;
Wall, John. Penn State Wetlands Project Seeks Scientific Evaluation Criteria. 7 January 1997. < http://aginfo.psu.edu/News/jan97/wetlands.html> 25 March 2006.; EPA. "Functions and Values of Wetlands." September 2001. < http://www.epa.gov/owow/wetlands/pdf/fun_val.pdf>; Pennsylvania Wetland Replacement Project: Monitoring Report. <http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/wwec/general/wetlands/WetReplaceFd-2000.htm>

Chatham, North Carolina

At the former Triangle School Wastewater Treatment Facility in Chatham, North Carolina wastewater is now cleaned for reclamation and reuse using constructed wetlands and a greenhouse containing soil filters and an aquatic ecosystem. This is the first on-site treatment facility in North Carolina that purifies water and reclaims nutrients from the wastewater to be used as fertilizer for landscape plants.

Technology	Zone	Criteria Fulfilled
Constructed Wetland	General	• Though this southern state does not share a similar climate to New York City, the project is adaptable • Immediate improvement of water quality • Has added benefits of improved air quality and increased green space

Source: Water Recycling Alternative Wastewater Treatment Overview. http://www.waterrecycling.com/index.htm 25 April 2006.

PART II: Wastewater Technologies

Dallas, TX

In January of 2005, the city of Dallas engaged in an effort to reduce the city's water use by five percent over the next five years. City officials retrofitted municipal facilities with water-saving devices from low-flow toilets to sprinkler systems in addition to education efforts and rebate programs. It is estimated that the reduction in Dallas' water sales would cost the water department $20 million. Water-saving devices include low-flow toilets, flow restrictor valves, and other innovative technology designed to minimize water consumption from everyday activities.

Technology	Zone	Criteria Fulfilled
Water-Saving Devices	Urban	• Though water usage may be higher in Texas than in New York the implementation of water-saving devices saves the city a significant amount of water

Source: Ramshaw, Emily. January, 11 2005. "Dallas Officials Lay out Plans to Cut Water Use." The Dallas Morning News.

New York, NY

Con Edison Solutions designed and completed Brooklyn College's new chilled water facility in June 2000. The chillers consist of three steam-driven and two electric-driven chillers, each with a 2000-ton capacity. This system allows the facility to achieve energy during period of high electric demand.

Technology	Zone	Criteria Fulfilled
Steam or Absorption Chillers	Urban	• Large urban network • Located in New York • Incorporated into an existing site

Source: Dormitory Authority State of New York. "Brooklyn College, ConEd Install Chilled Water Plant. January 14, 2000. http://www.dasny.org/dasny/news/2000/coned.php 01 May 2006.

Source: Energy Solutions Center. "Steam Turbine Chillers." http://www.energysolutionscenter.org/tech/tech_turbinechillers.asp 01 May 2006.

Woodbridge, Tasmania, Australia

The Blivet™ is a patented pre-packaged treatment system that is often used in the absence of a municipal sewer system and can be sited in both urban and rural locations. In this case, the Blivet was used to rectify the area's failing septic tanks, wherein sewage was finding its way into groundwater and the ocean. This Blivet was chosen because of its relatively small ecological footprint, ease of maintenance, and mobility.

Technology	Zone	Criteria Fulfilled
Blivet	Residential	• The climate is temperate • The site is residential, located near homes and roads, and adjacent to water bodies

Source: Butler Manufacturing Services, Ltd. The BMS Blivet™ Package Sewage Treatment Plant. http://www.bannow.com/ 17 April 2006.

Savage River, Australia

The Blivet™ was used in the development of a mining location and facility, as it was able to mitigate the levels of biological oxygen demand, suspended solids, and ammonia. This technology was chosen due to its reliability, minimal maintenance, and cost-effectiveness.

Technology	Zone	Criteria Fulfilled
Blivet	Industrial	• The climate is temperate • The site is a secluded location for a mining facility with severe water contamination issues

Source: Sewage Treatment Plant extends life at Savage River mine. Water Recycle Group. Canberra, Australia. http://www.waterrecycle.com.au/pdf/blivetec04.pdf#search='blivet%20case%20studies 21 April 2006.

Cambridge, MA

The Carousel Composting Toilet System uses microorganism's biological processes for the aerobic decomposition to break down organic wastes, blackwater, without the need for water or chemicals.[33] The breakdown is achieved using four rotating compost chambers. The system was installed in the Center for Sustainable Building's Sustainable House project. Its micro-flush toilets serve a two-bedroom unit in a three-family home.

Technology	Zone	Criteria Fulfilled
Blackwater Biofilter (carousel toilet)	Residential	• Extreme cold temperatures with large spring snow melt; period rainfall • The site is a residential area with wastewater issues

Source: United States Environmental Protection Agency. EPA New England's Center for Environmental Industry and Technology. "Clearwater Treatment System." Connecticut: 2006.

Montague, MA

The Carousel Composting Toilet System uses microorganism's biological processes for the aerobic decomposition to break down organic wastes, blackwater, without the need for water or chemicals. The breakdown is achieved using four rotating compost chambers used at different times within the cycle. In this case, the system was installed in a three-bedroom house.

Technology	Zone	Criteria Fulfilled
Blackwater Biofilter (carousel toilet)	Residential	• Extreme cold temperatures with large spring snow melt; periodic rainfall • The system can be installed in an existing building

Source: United States Environmental Protection Agency. EPA New England's Center for Environmental Industry and Technology. "Clearwater Treatment System." Connecticut: 2006.

Rochester, MN

The Clearwater Treatment System separates blackwater from greywater, thereby removing 80-90% of nitrates, and reducing water consumption by 40 to 80%. The system was integrated into the County-owned home of a park caretaker. The system effectively cleaned food wastes and human waste out of wastewater.

Technology	Zone	Criteria Fulfilled
Clearwater Treatment System	Residential	• Extreme cold temperatures with large spring snow melts • The site is located near a park • The system was integrated into an existing building

Source: Equaris Corporation. Terry Lee, Kimm Crawford, and Tony Hill. "Testing and Analysis of the Equaris Systems: Analysis of Monitoring Results of the Separation and Greywater Treatment System at Chester Woods Park, Olmsted County, Minn." 1998. www.alascanofmn.com/default.asp?page=Testing 21 April 2006.
Source: United States Environmental Protection Agency. EPA New England's Center for Environmental Industry and Technology. "Clearwater Treatment System." Connecticut: 2006.

Conserve School, Land O' Lakes, WI

The Conserve School, a private boarding school in northern Wisconsin, installed a Living Machine to treat over 38,000 gallons per day of wastewater generated by the school's community. The school chose to invest in the system not only for its functional and environmental benefits, but also because it serves as a 'living laboratory' for environmental education.

Technology	Zone	Criteria Fulfilled
Living Machine®	Rural	• Located in a greenhouse due to extreme cold temperatures • Designed to handle the full capacity of the school's wastewater production • Used for educational purposes

Source: Living Machine Systems. 2006. Living Designs Group, LLP. http://www.livingmachines.com/display/ShowGallery?moduleId=241356&galleryId=16858 07 May 2006.

City of Emmen Zoo, Netherlands

Host to 1.5 million visitors annually and home to hundreds of animals, the Noorder Zoo generates an extremely large volume of wastewater. The Living Machine installed at the zoo is designed to treat all 220,000 gallons per day of wastewater generated at the site. The purified water is then reused for flushing toilets and other non-potable uses. As a result, the zoo boasts an 84% reduction in water consumption.

Technology	Zone	Criteria Fulfilled
Living Machine®	Mixed use	• Designed to handle the full capacity of the zoo's wastewater production • Treated water is reused to flush toilets and for other non-potable uses • Yielded a significant reduction in water consumption

Source: Living Machine Systems. 2006. Living Designs Group, LLP. http://www.livingmachines.com/display/ShowGallery?moduleId=241356&galleryId=16857 07 May 2006.

Appendix 3a: NGO or Nonprofit Funding Opportunities

This section provides three categories of information about foundations and organizations that offer funding opportunities to support community development and environmental projects.

1. Those supporting community development
2. Those supporting environmental projects
3. Those supporting both community development and environmental projects

1.0 Support for Community Development

New York Foundation

The foundation was granted charitable status in March 1950 and is located in New York, New York. The foundation's purpose is to support organizations that are working on problems of urgent concern to residents of disadvantaged communities and neighborhoods. In their most recent reporting year ending December 2004, the foundation reported assets of $76,356,688 (ledger value) and income of $22,245,317. The foundation's major donors are reported as: Louis A. Heinsheimer, Alfred M. Heinsheimer, and Lionel J. Salomon.

Application Deadline	March 1, July 1, and November 1
Funding Level FY 2004	$4.5 million
Typical average amount awarded	$19,281
Typical lowest amount awarded	$25,000
Typical highest amount awarded	$150,000
Primary Address	The New York Foundation 350 Fifth Avenue, Room 2901 New York, NY 10118-0016
Primary Telephone	(212) 594-8009
Primary Contact	Madeline Lee, Executive Director
Primary Internet	www.nyf.org
Associated Keywords	Neighborhood development, community development, disadvantaged populations, families, minorities, economically disadvantaged, human services
Eligible Organizations	Support is primarily provided for New York State.
Eligibility Constraints	Funding is primarily provided for continuing support, operating funds, program funding, seed funding, technical support. Does not fund individuals, capital campaigns, research, or conferences

Independence Community Foundation

This foundation was granted charitable status in July 1999 and is located in Brooklyn, New York. The foundation's purpose is to support the renewal and revitalization of low-income and moderate-income neighborhoods. In their most recent reporting year ending December 2004, the foundation reported assets of $84,643,459 (ledger value) and income of $31,902,136. The foundation's major donor is reported as: Independence Community Bank Corporation.

Application Deadline	For letter of inquiry: March 30 and September 30
Funding Level FY 2003	$5.4 million
Typical average amount awarded	$17,872
Typical lowest amount awarded	$25,000
Typical highest amount awarded	$260,000
Primary Address	Independence Community Foundation 182 Atlantic Avenue Brooklyn, NY 11201-5604
Primary Telephone/Fax	(718) 7222-2300 (ph), (718) 722-5757
Primary Contact	Marilyn Gelber, Executive Director
Primary Internet	www.icfny.org
Associated Keywords	Neighborhood development, community development, disadvantaged populations, families, minorities, economically disadvantaged, human services
Eligible Organizations	Support is primarily provided for New York State.
Eligibility Constraints	Does not fund general operating support, individuals, political contributions, or deficit financing

H. Van Ameringen Foundation

The foundation was granted charitable status in June 1967 and is located in New York, New York. The foundation's purpose is to support AIDS organizations, community development, gay and lesbian organizations, health, and social and human services. In their most recent reporting year ending December 2004, the foundation reported assets of $31,665,338 (ledger value) and income of $2,559,127. The foundation's major donor is reported as: Henry P. van Ameringen.

Application Deadline	Not available
Funding Level FY 2004	$3.2 million
Typical average amount awarded	$31,158
Typical lowest amount awarded	$50,000
Typical highest amount awarded	$130,000
Primary Address	H. Van Ameringen Foundation 509 Madison Avenue New York, NY 10022-5501
Primary Telephone	(212) 758-6221
Primary Contact	Henry P. Van Ameringen, President
Associated Keywords	Community development, social/human services, health
Eligible Organizations	Support is primarily provided for New York State and California.
Eligibility Constraints	Funding is generally provided for operating funds, matching/challenge funding, program funding, and seed funding. Does not fund individuals

Gebbie Foundation, Inc.

This foundation was granted charitable status in November 1965 and is located in Jamestown, New York. The foundation's purpose is to support arts & culture, children & youth, community development, education, and human services. In their most recent reporting year ending September 2004, the foundation reported assets of $71,950,692 (ledger value) and income of $32,764,859.

Application Deadline	April 1, August 1, and December 1
Funding Level FY 2004	$1.9 million
Typical average amount awarded	$68,635
Typical lowest amount awarded	$100,000
Typical highest amount awarded	$500,000
Primary Address	Gebbie Foundation 308 Hotel Jamestown Building Jamestown, NY 14701
Primary Telephone/Fax	(716) 487-1062 (ph), (716) 484-6401 (fax)
Primary Contact	Dr. Thomas M. Cardman, Executive Director
Associated Keywords	Community development, education, children and youth, human services
Eligible Organizations	Support is primarily provided for New York State.
Eligibility Constraints	Funding is generally provided for building, capital, continuing support, operating, matching/challenge, and seed funding. Does not fund sectarian or religions organizations, or individuals.

Ernst C. Stiefel Foundation C. O. Coudert Brothers

This foundation was granted charitable status in May 1997 and is located in New York, New York. The foundation's purpose is to support arts and culture, community development, education, and social and human services. In their most recent reporting year ending December 2004, the foundation reported assets of $9,487,668 (ledger value) and income of $3,635,582. The foundation's major donor is reported as: Ernst C. Stiefel.

Application Deadline	None
Funding Level FY 2004	$652,500
Typical average amount awarded	$25,096
Typical lowest amount awarded	$20,000
Typical highest amount awarded	$250,000
Primary Address	Ernst C. Stiefel Foundation C. O. Coudert Brothers 1114 Avenue of the Americas, New York, NY
Primary Telephone	Not available
Primary Contact	Kenneth R. Page
Associated Keywords	Social/human services and community development
Eligible Organizations	Support is primarily provided for New York, NY.
Eligibility Constraints	Funding is generally provided for continuing support, operating funds, matching/challenge funds, and research funding. Does not fund individuals

BTM Foundation, Inc.

This foundation was granted charitable status in March 1997 and is located in New York, New York. The foundation's primary purpose is to support the preservation and development of urban communities. In their most recent reporting year ending December 2004, the foundation reported assets of $5,306,599 (ledger value) and income of $321,550. The foundation's major donor is reported as: Bank of Tokyo-Mitsubishi Trust Company.

Application Deadline	May 27
Funding Level FY 2004	$147,500
Typical average amount awarded	$9,219
Typical lowest amount awarded	$8,000
Typical highest amount awarded	$50,000
Primary Address	BTM Foundation, Inc 1251 Avenue of the Americas New York, NY 10020
Primary Telephone	(212) 782-4627
Primary Contact	Beth Gilroy, Vice President
Associated Keywords	Community development, housing and shelters, economic development, economically disadvantaged
Eligible Organizations	Support is primarily provided for New York, NY.
Eligibility Constraints	Funding is generally provided for matching gifts, operating, and program funding. Does not support political or religious organizations

Citigroup Foundation

The foundation was granted charitable status in March 1995 and is located in New York, New York. The foundation's purpose is to support community development organizations and education programs. In their most recent reporting year ending December 2003, the foundation reported assets of $131,761,174 (ledger value) and income of $60,802,294. The foundation's major donors are reported as: Citicorp, Citibank, N.A., and Citigroup Inc.

Application Deadline	Not available
Funding Level FY 2003	$52.5 million
Typical average amount awarded	$25,810
Typical lowest amount awarded	$250,000
Typical highest amount awarded	$1.2 million
Primary Address	Citigroup Foundation 850 Third Avenue, 13th Floor, New York, NY 10022-6211
Primary Telephone/Fax	(212) 559-9163 (ph), (212) 793-5944 (fax)
Primary Contact	Not available
Primary Internet	www.citigroup.com/citigroup/corporate/foundation/index.htm
Associated Keywords	Building communities and entrepreneurs, education
Eligible Organizations	Support is provided nationally and internationally.
Eligibility Constraints	Funding is principally provided for matching gifts and operating funds.

Paul D. Schurgot Foundation, Inc.

This foundation was granted charitable status in February 1972 and is located in New York, New York. The foundation's purpose is to support children and youth, communications, community development, health, higher education, hospitals, international aid, medical research, and social and human services. In their most recent reporting year ending December 2004, the foundation reported assets of $10,426,804 (ledger value) and income of $2,859,411.

Application Deadline	February 13 and April 9
Funding Level FY 2004	$424,000
Typical average amount awarded	$19,273
Typical lowest amount awarded	$5,000
Typical highest amount awarded	$50,000
Primary Address	Paul D. Schurgot Foundation, Inc. 280 Madison Avenue, 1102 New York, NY 10016
Primary Telephone	Not available
Primary Contact	Not available
Primary Internet	Not available
Associated Keywords	Community development
Eligible Organizations	Support is primarily provided for New York, NY
Eligibility Constraints	The foundation only contributes to pre-selected organizations. Funding is limited primarily to New York, NY, and support is not provided for individuals.

2.0 Support for the Environment

Ellsworth Kelly Foundation, Inc.

This foundation was granted charitable status in December 1991 and is located in Spencertown, New York. The foundation's purpose is to support arts and culture, education, and the environment. In their most recent reporting year ending December 2004, the foundation reported assets of $17,434,993 (ledger value) and income of $24,209,287.The foundation's major donor is reported as: Ellsworth Kelly.

Application Deadline	Not available
Funding Level FY 2004	$600,000
Typical average amount awarded	$66,667
Typical lowest amount awarded	$10,000
Typical highest amount awarded	$100,000
Primary Address	Ellsworth Kelly Foundation P.O. Box 220, Specertown, NY 12165
Primary Telephone	(518) 392-5326
Primary Contact	Jack Shear, Secretary-Treasurer
Associated Keywords	Environment, arts/culture, wildlife preservation
Eligible Organizations	Support is provided nationally
Eligibility Constraints	Does not fund individuals

Hope Goddard Iselin Foundation

This foundation was granted charitable status in January 1972 and is located in New York, New York. The foundation's purpose is to support outdoor aesthetic enhancements and recreation projects. In their most recent reporting year ending March 2004, the foundation reported assets of $2,254,437 (ledger value) and income of $960,279. The foundation's major donor is reported as: Hope Goddard Iselin.

Application Deadline	Not available
Funding Level FY 2004	$90,00
Typical average amount awarded	$45,000
Typical lowest amount awarded	$40,000
Typical highest amount awarded	$100,000
Primary Address	Hope Goddard Iselin Foundation P.O. Box 2004 New York, NY 10109-9901
Primary Telephone	Not available
Primary Contact	Not available
Associated Keywords	Environment, community development
Eligible Organizations	Support is provided nationally
Eligibility Constraints	Funding available for building funds, endowments, and program funding. The foundation does not currently accept unsolicited applications. Grants principally in the eastern U.S. Grant requests for individuals are not accepted.

Knapp Fund

This foundation was granted charitable status in June 1939 and is located in New York, New York. The foundation's purpose is to support education, the environment, health, medical research, and social and human services. In their most recent reporting year ending August 2004, the foundation reported assets of $2,380,681 (ledger value) and income of $77,214. The foundation's major donor is reported as: George O. Knapp.

Application Deadline	Not available
Funding Level FY 2004	$1.1 million
Typical average amount awarded	$10,000
Typical lowest amount awarded	$10,000
Typical highest amount awarded	$50,000
Primary Address	Knapp Fund 570 Lexington Avenue, 29th Floor, NY, NY 10022-6837
Primary Telephone	Not available
Primary Contact	Not available
Associated Keywords	Environment, education, social/human services
Eligible Organizations	Support is provided principally in New York, Connecticut, Florida, and Pennsylvania.
Eligibility Constraints	Funding available for building funds, operating funds, and program funding. The foundation does not currently accept unsolicited applications. Grant requests for individuals are not accepted for matching gifts and no loans.

3.0 Support for Community Development & the Environment

New Land Foundation, Inc.

This foundation was granted charitable status in October 1942 and is located in New York, New York. The foundation's purpose is to support children and youth, civic and community development, the environment, family planning, foreign affairs, and international aid. In their most recent reporting year ending December 2004, the foundation reported assets of $24,438,586 (ledger value) and income of $3,213,355. The foundation's major donor is reported as: Muriel M. Buttinger.

Application Deadline	February 1 and August 1
Funding Level FY 2004	$1.7 million
Typical average amount awarded	$15,437
Typical lowest amount awarded	$25,000
Typical highest amount awarded	$150,000
Primary Address	New Land Foundation, Inc 1114 Avenue of the Americas New York, NY 10036
Primary Telephone	(212) 479-6162
Primary Contact	Not available
Associated Keywords	Environment, civic/community development
Eligible Organizations	Support is provided nationally
Eligibility Constraints	Grant requests for individuals are not accepted; no loans

Charles Evans Hughes Memorial Foundation, Inc.

This foundation was granted charitable status in October 1942 and is located in New York, New York. The foundation's purpose is to support children and youth, civic and community development, the environment, family planning, foreign affairs, and international aid. In their most recent reporting year ending December 2004, the foundation reported assets of $24,438,586 (ledger value) and income of $3,213,355. The foundation's major donor is reported as: Muriel M. Buttinger.

Application Deadline	2 grant cycles per year: spring and fall
Funding Level FY 2005	$1 million
Typical average amount awarded	$25,382
Typical lowest amount awarded	$35,000
Typical highest amount awarded	$75,000
Primary Address	Charles Evans Hughes Memorial Foundation 130 East 59th Street New York, NY 10022-1302
Primary Telephone	(212) 594-8009
Primary Contact	Lauren Katzowitz, Secretary
Associated Keywords	Environment, historic preservation, health
Eligible Organizations	Support is primarily provided for New York, Washington, D.C., New Mexico, and Massachusetts
Eligibility Constraints	Funding is provided for annual campaigns, continuing support, and scholarships. Does not fund individuals

Great Island Foundation

This foundation was granted charitable status in May 1999 and is located in New York, New York. The foundation's purpose is to support arts and culture, botanical organizations, children and youth, education, the environment, social and human services, and women. In their most recent reporting year ending December 2004, the foundation reported assets of $4,736,874 (ledger value) and income of $414,488. The foundation's major donors are reported as: Eliot Chace Nolen and Wilson Nolen.

Application Deadline	Not available
Funding Level FY 2004	$288,615
Typical average amount awarded	$13,744
Typical lowest amount awarded	$10,000
Typical highest amount awarded	$200,000
Primary Address	Great Island Foundation 114 West 47th Street, Suite Taxvas New York, NY 10036
Primary Telephone	Not available
Primary Contact	Not available
Associated Keywords	Environment, botanical organizations, arts/culture, social/human services
Eligible Organizations	Support is primarily provided for New York State.
Eligibility Constraints	Does not fund individuals

Louis and Anne Abrons Foundation, Inc.

This foundation was granted charitable status in August 1951 and is located in New York, New York. The foundation's purpose is to support arts and culture, civic and community development, education, the environment, Jewish organizations, major New York City institutions, and social and human services. In their most recent reporting year ending December 2004, the foundation reported assets of $23,256,758 (ledger value) and income of $5,356,189. The foundation's major donors are reported as: Anne S. Abrons and Louis Abrons.

Application Deadline	Not available
Funding Level FY 2004	$4 million
Typical average amount awarded	$29,138
Typical lowest amount awarded	$60,000
Typical highest amount awarded	$370,000
Primary Address	Louis and Anne Abrons Foundation 437 Madison Avenue New York, NY 10022-7001
Primary Telephone	(212) 756-3376
Primary Contact	Richard Abrons, President
Associated Keywords	Environment, economically disadvantaged, civic/community development, minorities/immigrants
Eligible Organizations	Support is primarily provided for New York, NY
Eligibility Constraints	Funding provided for building funds, program funding, continuing support, research funding. Does not fund individuals

Ohrstrom Foundation, Inc.

This foundation was granted charitable status in February 1957 and is located in New York, New York. The foundation's purpose is to support all levels of education. Funding is also available for arts and culture, including museums, civic and community development, conservation, the environment, hospitals, and medical research. In their most recent reporting year ending May 2004, the foundation reported assets of $17,441,377 (ledger value) and income of $10,080,232. The foundation's major donors are reported as: members of the Ohrstrom Family.

Application Deadline	Not available
Funding Level FY 2004	$2 million
Typical average amount awarded	$35,725
Typical lowest amount awarded	$50,000
Typical highest amount awarded	$1 million
Primary Address	Ohrstrom Foundation, Inc 101 Park Avenue, Suite 3500 New York, NY 10178-0061
Primary Telephone	(212) 696-6079
Primary Contact	Not available
Associated Keywords	Environment, natural resources, civic/community development
Eligible Organizations	Support is primarily provided for New York and Virginia
Eligibility Constraints	Funding is not available for: individuals; deficit financing; scholarships; fellowships; research funding; special projects; publication funding; conferences; loans

Appendix 3b: State Grant Opportunities

This section provides potential assistance opportunities from New York State for projects at the Hunts Point Food Distribution Center. The section is split into three groups:

1. Opportunities specifically addressing stormwater management
2. Miscellaneous opportunities
3. Additional potential resources

The latter section provides resources that can be used to learn of other opportunities not listed here as well as a few funding opportunities that could be applicable to Hunts Point in the distant future if significant cleanup actions were to take place.

1.0 Opportunities Addressing Stormwater Management

Stormwater Training Events – NY State Department of Environmental Conservation

The New York State Department of Environmental Conservation offers a variety of statewide courses that address stormwater management issues. These courses target a number of different audiences; however, ones that may be applicable to the Hunts Point Food Distribution Center include Stormwater Management Practice and Design and SWPPP Review. While it is not feasible to send everyone from the markets to these courses, this may provide the opportunity to educate a few key individuals at each market who will be influential in implementing the stormwater management techniques learned in the course. More information on these courses is available at: http://www.dec.state.ny.us/website/dow/calendar.html.

Environmental Protection Fund Local Waterfront Revitalization Program – NYS DOS Division of Costal Resources

The New York Department of State Division of Coastal Resources provides grants to improve waterfronts throughout the state. Eligible projects include urban waterfront redevelopment and preparing or implementing water body/watershed management plans. The current high priorities for this program are proposals that improve the access to waterfronts, redevelopment of urban waterfronts, or projects located in a Greenway Compact Community.[156]

Application Deadline	May 26, 2006
Is a matched amount required?	Yes
Match Amount	50% matching requirement
Primary Address	Local Waterfront Revitalization Program Bureau of Fiscal Management, 10th Floor, Suite 1000 New York State Department of State 41 State Street Albany, NY 12231-0001
Primary Telephone	(515) 474-6000
Primary Email	coastal@cos.state.ny.us
Primary Internet	http://www.nyswaterfronts.com/grantopps_EPF.asp
Eligible Organizations	Municipalities

2.0 Miscellaneous Opportunities

2006 Environmental Justice Community Impact Grant Program – NY State Department of Environmental Conservation

This program provides funds specifically for projects that deal with environmental justice issues, and is ideal for projects in Hunts Point where the community is excessively exposed to multiple environmental risks. These projects must also include a research, action, and education component.[157] Examples of projects that might relate to the Hunts Point Food Distribution Center include working on neighborhood revitalization through sustainable development and improving water quality to reduce the potential harm on subsistence fishers.[158] In order for projects at the Market to be eligible for this grant, a non-profit organization must be involved as a partner.

Application Deadline	Applications will be available to the public in early spring.
Typical lowest amount awarded	$2,500
Typical highest amount awarded	$25,000
Other details on funding	The funds are awarded based on the scope of the project identified.
Primary Address	Monica L. Kreshik Environmental Justice Coordinator OR Douglas E. Morrison Environmental Program Specialist NYSDEC Office of Environmental Justice 625 Broadway Albany, New York 12233-1500
Primary Telephone	518-402-8556
Primary Email	ej@gw.dec.state.ny.us
Primary Internet	http://www.dec.state.ny.us/website/ej/ejgrants.html
Eligible Organizations	An eligible applicant must be a community group that focuses on addressing environmental and/or public health problems in their community; must be located in the proposed project area; and must have 25% or more of its members and board of directors (if the community group has a board of directors) living in the proposed project area. Also, the community group must either be a not-for-profit corporation (NFP) or partner with an NFP that will act as the financial agent for the applicant community group.
Eligibility Constraints	The New York State Department of Environmental Conservation (NYSDEC) is requesting applications for state assistance funding under the Environmental Justice Community Impact Grant Program. Eligible grant projects must address exposure of communities to multiple environmental harms and risks and include a research, action and education component.

3.0 Additional Potential Resources

New York State Assembly – Grant Action News

This website provides monthly newsletters that provide information on upcoming grant opportunities in New York State. This will be a good resource for continual assessment of potential funding opportunities for stormwater and wastewater management projects at the Hunts Point Food Distribution Center. The website is: http://assembly.state.ny.us/gan/

The Hudson River Estuary Grants Program – NY State Department of Environmental Conservation

The New York State Department of Environmental Conservation started the Hudson River Estuary Program in 1999 to help municipalities and non-profits meet the goals of the Hudson River Estuary Action Agenda. This program distributes over $1 million annually in five categories[159]:

1. Community Interpretive Centers and Education
2. Open Space Planning, Inventory, and Acquisition
3. Community-based Habitat Conservation and Stewardship
4. Watershed Planning and Implementation
5. Hudson River Access: fishing, boating, swimming, hunting, hiking, or river watching.

While the grants focus on the Hudson River, there may be an opportunity to explore this further for projects at the Hunts Point Food Distribution Center that may benefit the overall estuary system. For more information, the website is:
http://www.dec.state.ny.us/website/hudson/grants.html.

Clean Water/Clean Air Bond Act – NYS DOS Division of Coastal Resources

This Act, which passed in November 1996, funds a variety of environmental related programs. Portions of the Act are intended for projects that promote clean water, solid waste, air quality, and restoration of brownfields. Many of these areas may overlap with or include stormwater and wastewater improvements in Hunts Point.[160] More information is available on the website at: http://www.nyswaterfronts.com/grantopps_cleanairbond.asp

Brownfield Cleanup Program – NY State Department of Environmental Conservation

This program, which was established in 2003, is modeled after the New York State Department of Environmental Conservation's Voluntary Cleanup Program. This program provides incentive in the form of tax credits.[161] As the Hunts Point Food Distribution Center lies directly on a Brownfield, this program may be an option in the long-term, if the city decides to pursue brownfield remediation at this site. More information is available at: http://www.dec.state.ny.us/website/der/bcp/.

Brownfield Opportunity Areas Program – NYS DOS Division of Coastal Resources

This program assists communities in fostering redevelopment by providing resources that address local brownfields.[162] Again, as the Hunts Point Food Distribution Center lies directly on a Brownfield, this program may be an option in the long-term. More information is available at: http://www.nyswaterfronts.com/grantopps_BOA.asp

Appendix 3c: Federal Grant Opportunities

This section provides information about federal grant programs and funding opportunities. It is organized into four sections:

1. Funding to construct wetlands (p.62)
2. Funding to improve wastewater management (p.72)
3. Funding to improve stormwater management (p.75)
4. Miscellaneous opportunities. (p.77)

1.0 Funding to Construct Wetlands

Bring Back the Natives Grant Program

The National Fish and Wildlife Foundation (NFWF) program provides funds to restore damaged or degraded riverine habitats and their native aquatic species through watershed restoration and improved land management. The Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (FWS), and USDA Forest Service (FS) also provide finding for restoration projects.

Application Deadline	This program has two funding cycles. See Web site for details.
When Funds are Available	Funds are usually ready for disbursement several months after the grant is awarded. Funds are given out on a reimbursement basis, so fund disbursement depends on the grantee's particular project.
Is a matched amount required?	Yes
Match Amount	A 1:1 match is required, but at least a 2:1 match is preferred. Applicants with a 2:1 or higher match will be competitive in the selection process."
Funding Level FY 2004	$1 million
Funding Level FY 2005	$1.1 million
Funding Level FY 2006	Unavailable
Typical lowest amount awarded	$10,000
Typical highest amount awarded	$100,000
Primary Address	Mr. Corey Grace National Fish and Wildlife Foundation: Southwest Office 28 Second Street, 6th floor, San Francisco, CA 94105
Primary Telephone	(415)778-0999 x234
Primary Email	corey.grace@nfwf.org
Primary Internet	www.nfwf.org/programs/bbn.cfm
Secondary Address	National Fish and Wildlife Foundation 1120 Connecticut Ave., NW, Ste. 900 Washington, DC 20036
Secondary Telephone	(202) 857-0166
Associated Keywords	Outreach/Education, Fisheries , Invasive Species , Land Acquisition , Monitoring , Partnerships , Research , Restoration , Floodplains/Riparian Zones , Watershed Management , Wetlands , Wildlife
Eligible Organizations	Community/Watershed Group, Nonprofit Groups, Educational Institution , Conservation District , Local Government , State/Territorial Agency , Tribal Agency , Federal Agency
Eligibility Constraints	Please check with NFWF for information on federal agency eligibility.

Coastal Program

The U.S. Fish and Wildlife Service (FWS) Coastal Program works to conserve healthy coastal habitats on public or private land for the benefit of fish, wildlife, and people in 22 specific coastal areas. The program forms cooperative partnerships designed to:

- Protect costal habitats by providing technical assistance for conservation easements and acquisitions
- Restore coastal wetlands, uplands, and riparian areas
- Remove barriers to fish passage in coastal watersheds and estuaries.

Program biologists provide restoration expertise and financial assistance to federal and state agencies, local and tribal governments, businesses, private landowners, and conservation organizations such as local land trusts and watershed councils.

Application Deadline	Contact your local Coastal Program office to find out necessary deadlines.
When Funds are Available	Check with the individual Coastal Program locations
Match Amount	Match is encouraged.
Funding Level FY 2004	$10 million
Funding Level FY 2005	$11.7 million
Funding Level FY 2006	$13 million
Typical lowest amount awarded	$5,000
Typical highest amount awarded	$50,000
Typical median amount awarded	$15,000
Other details on funding	This program provides financial assistance in the form of cooperative agreements. The listed budget includes both administrative costs and project funding.
Primary Address	U.S. Department of the Interior U.S. Fish and Wildlife Service Branch of Habitat Restoration, Division of Fish and Wildlife Management and Habitat Restoration 4401 North Fairfax Drive, Room 400, Arlington, VA 22203
Primary Telephone	(703) 358-2201
Primary Email	Please contact by telephone or mail.
Primary Internet	www.fws.gov/coastal/CoastalProgram/ (Contact information for the specific locations is available on the website)
Secondary Internet	www.cfda.gov (program number 15.630)
Legislative Authority	Fish and Wildlife Act of 1956, 16 U.S.C. 442 (a)- 754, Fish and Wildlife Coordination Act of 1958, 16 U.S.C. 661-667(e)
Associated Keywords	Agriculture, Best Management Practices, Coastal Waters, Outreach/Education, Fisheries, Forests, Invasive Species, Land Acquisition, Monitoring, Nonpoint Source Control, Partnerships, Restoration, Floodplains/Riparian Zones, Stormwater Management, Watershed Management, Wetlands, Wildlife
Eligible Organizations	Business, Community/Watershed Group, Nonprofits, Educational Institution, Private, Conservation District, Local Government, State/Territorial Agency, Tribal Agency, Federal Agency
Eligibility Constraints	Limited to geographic areas with a Coastal Program location.

Coastal Services Center Cooperative Agreements

The National Oceanic and Atmospheric Administration (NOAA) guides the conservation and management of coastal resources through a variety of mechanisms, including collaboration with the coastal resource management programs of the nation's states and territories. The mission of the NOAA Coastal Services Center (CSC) is to support the environmental, social, and economic well being of the nation's coasts by linking people, information, and technology. The vision of CSC is to be the most useful governmental organization to those who manage and care for our nation's coasts. In FY-04, CSC will support activities in the following areas: Landscape Characterization and Restoration, GIS Integration and Development, Coastal Remote Sensing, Information Resources, Pacific Services Center, and Integrated Ocean Observing Systems. Eligible applicants are institutions of higher education, hospitals, other non-profits, commercial organizations, foreign governments, organizations under the jurisdiction of foreign governments, international organizations, and state, local and Indian tribal governments.

Application Deadline	Usually in the fall of the year. For more information refer to the link listed under "Primary Internet."
When Funds are Available	Usually in the summer
Average annual # of applicants	Varies depending on program area. Consult website for details.
Typical % of applicants funded	Varies depending on program area. Consult website for details.
Is a matched amount required?	Case-dependant
Match Amount	Varies depending on program area. Check the website.
Funding Level FY 2004	$3 million
Funding Level FY 2005	$4.67 million
Funding Level FY 2006	Not available
Typical lowest amount awarded	$54,700
Typical highest amount awarded	$406,000
Typical median amount awarded	Varies depending on program area. Consult website for details.
Primary Address	U.S. Department of Commerce National Oceanic and Atmospheric Administration National Ocean Service, Coastal Services Center 2234 South Hobson Ave.,Charleston, SC 29405-2413
Primary Telephone	(843) 740-1185
Primary Email	James.L.Free@noaa.gov
Primary Internet	www.csc.noaa.gov
Secondary Internet	www.cfda.gov (Search on program 11.473)
Legislative Authority	16 U.S.C.1456C, 15 U.S.C.1540, 33 U.S.C.1442, 33 U.S.C.883(a-e)
Associated Keywords	Agriculture, Best Management Practices, Coastal Waters, Outreach/Education, Fisheries, Land Acquisition, Nonpoint Source Control, Partnerships, Planning, Pollution Prevention, Restoration, Floodplains/Riparian Zones, Source Water Protection, Stormwater Management, Watershed Management, Wildlife
Eligible Organizations	Business, Community/Watershed Group, Nonprofit Groups, Educational Institution, Conservation District, Water and Wastewater Utilities, Local Government, State/Territorial Agency, Tribal Agency
Eligibility Constraints	Varies depending on program area. For more information, consult the Web site listed under "Primary Internet."

Community-based Restoration Program

The NOAA Community-based Restoration Program (CRP) provides funds for small-scale, locally driven habitat restoration projects that foster natural resource stewardship within communities. CRP seeks to bring together diverse partners to implement habitat restoration projects to benefit living marine resources. Projects might include:

- Restoring salt marshes, mangroves, and other coastal habitats
- Improving fish passage and habitat quality for anadromous species
- Restoring/creating oyster reefs, replacing exotic vegetation with native species
- Removing dams
- Similar projects to restore habitat or improve habitat quality for populations of marine and anadromous fish.

Partnerships are sought at the national and local level to contribute funding, land, technical assistance, workforce support, or other in-kind services.

Application Deadline	Application deadlines vary for each funding opportunity. Application deadline information is posted on the NOAA Restoration Center home page. For more information refer to the link listed under "Primary Internet."
When Funds are Available	Funds are available on an ongoing basis depending on the deadline.
Average annual # of applicants	450
Typical % of applicants funded	25%
Is a matched amount required?	Yes
Match Amount	1:1 match is usually required. The match may be in a variety of forms
Funding Level FY 2004	$10 million
Funding Level FY 2005	$10 million
Funding Level FY 2006	$3 million
Typical lowest amount awarded	$30,000
Typical highest amount awarded	$250,000
Primary Address	U.S. Department of Commerce National Oceanic and Atmospheric Administration Office of Habitat Conservation, HC-3 1315 East-West Highway, Silver Spring, MD 20910
Primary Telephone	(301) 713-0174
Primary Email	Melanie.Gange@noaa.gov
Primary Internet	http://www.nmfs.noaa.gov/habitat/restoration/funding_opportunities/funding.html
Secondary Email	Robin.Bruckner@noaa.gov
Secondary Internet	www.cfda.gov (Search on program 11.463)
Legislative Authority	Multiple authorizations, including the Fish and Wildlife Coordination Act, 16 U.S.C. 661-666
Associated Keywords	Coastal Waters, Outreach/Education, Fisheries, Invasive Species, Monitoring, Nonpoint Source Control, Partnerships, Restoration, Floodplains/Riparian Zones, Wetlands
Eligible Organizations	Business, Community/Watershed Group, Nonprofit Groups, Educational Institution, Conservation District, Local Government, State/Territorial Agency, Tribal Agency
Eligibility Constraints	Also eligible are regional governmental bodies and public or private agencies or organizations.

Five-Star Restoration Program

The EPA supports the Five-Star Restoration Program by providing funds to the National Fish and Wildlife Foundation and its partners. These groups then make subgrants to support community-based wetland and riparian restoration projects. Competitive projects will have a strong on-the-ground habitat restoration component that provides long-term ecological, educational, and/or socioeconomic benefits to the people and their community. Preference will be given to projects with a larger community stewardship effort and include a long-term management activities.

Application Deadline	March
When Funds are Available	Early June of each year
Average annual # of applicants	200-250
Typical % of applicants funded	20-25%
Funding Level FY 2004	$500,000
Funding Level FY 2005	$500,000
Funding Level FY 2006	$500,000
Typical lowest amount awarded	$5,000
Typical highest amount awarded	$20,000
Typical median amount awarded	$10,000
Other details on funding	Southern Power will contribute an additional $200,000 for use in funding projects in its Service areas
Primary Address	U.S. Environmental Protection Agency Room 6105 (4502 T), USEPA Wetlands Division Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460
Primary Telephone	(202) 566-1225
Primary Email	price.myra@epa.gov
Primary Internet	www.epa.gov/owow/wetlands/restore/5star/
Secondary Address	National Fish and Wildlife Foundation 1120 Connecticut Ave., NW Suite 900, Washington, DC 20036
Secondary Telephone	202-857-0166
Secondary Email	matthew.hurley@nfwf.org
Secondary Internet	www.nfwf.org/programs/5star-rfp.cfm
Legislative Authority	Clean Water Act, section 104(b)(3)"
Associated Keywords	Best Management Practices, Coastal Waters, Economic Development, Outreach/Education, Fisheries, Invasive Species, Monitoring, Partnerships, Restoration, Floodplains/Riparian Zones, Source Water Protection, Stormwater Management, Watershed Management, Wetlands, Wildlife
Eligible Organizations	Business, Community/Watershed Group, Nonprofit Groups, Educational Institution, Private Landowner, Conservation District, Water and Wastewater Utilities, Local Government, State/Territorial Agency, Tribal Agency
Eligibility Constraints	The public or private entity must engage in community-based restoration to be eligible. Projects must include a strong on-the-ground wetland, riparian, or coastal habitat restoration component and should also include training, education, outreach, monitoring, and community stewardship components.

National Coastal Wetlands Conservation Grant Program

The U.S. Fish and Wildlife Service's National Coastal Wetlands Conservation Grant Program provides matching grants to states and territories for coastal wetland conservation projects. Funds may be used for acquiring land or conservation easements, restoration, enhancement, or management of coastal wetland ecosystems. Projects must provide for long-term conservation of coastal wetlands.

Application Deadline	Project proposals are submitted in early June.
When Funds are Available	Grants are awarded near the beginning of the Federal Fiscal year, in October/November.
Average annual # of applicants	30-45 proposals submitted
Typical % of applicants funded	Varies, in the range of 40 to 60 percent.
Is a matched amount required?	Yes
Match Amount	Federal, with restrictions.
Funding Level FY 2004	$17 million
Funding Level FY 2005	$13 million
Funding Level FY 2006	$15 million
Typical lowest amount awarded	$200,000
Typical highest amount awarded	Limit of $1 million per project.
Typical median amount awarded	$750,000
Primary Address	Sally Valdes Division of Fish and Wildlife Management and Habitat Restoration, U.S. Fish and Wildlife Service 4401 N. Fairfax Drive, Arlington, VA 22203
Primary Telephone	(703) 358-2201
Primary Email	sally_valdes@fws.gov
Primary Internet	www.fws.gov/coastal/CoastalGrants/
Secondary Address	Brian Bohnsack Division of Federal Assistance, U.S. Fish and Wildlife Service 1951 Constitution Ave., NW, Washington, DC 20240
Secondary Telephone	(703) 358-1801
Secondary Email	brian_bohnsack@fws.gov
Secondary Internet	www.cfda.gov (program number 15.614)
Legislative Authority	Coastal Wetlands, Planning, Protection and Restoration Act, section 305, Title III, Public Law 101-646, 16 U.S.C. 3954
Associated Keywords	Coastal Waters, Fisheries, Land Acquisition, Monitoring, Nonpoint Source Control, Partnerships, Pollution Prevention, Restoration, Floodplains/Riparian Zones, Stormwater Management, Watershed Management, Wetlands, Wildlife
Eligible Organizations	State/Territorial Agency
Eligibility Constraints	Eligible states are restricted to those bordering on the Atlantic Ocean, the Gulf of Mexico (except Louisiana), the Pacific Ocean coasts and the Great Lakes, as well as Puerto Rico, Virgin Islands, Guam, the Commonwealth of the Northern Mariana Islands, the Trust Territories of the Pacific Islands, and America Samoa.

Native Plant Conservation Initiative

The National Fish and Wildlife Foundation's Native Plant Conservation Initiative (NPCI) supports on-the-ground conservation projects that protect, enhance, and/or restore native plant communities on public and private land. Projects typically fall into one of three categories and may contain elements of each: protection and restoration, information and education, and inventory and assessment. Applicants are encouraged, when appropriate, to include a pollinator component in their project. This program is funded by the BLM, FS, FWS, and National Park Service (NPS).

Application Deadline	This program has two funding cycles. Pre-proposals are due 02/17/06 or 8/26/06. Please contact the NFWF prior to submitting a proposal to determine if your project is competitive.
When Funds are Available	Due to the nature of the federal funds the Foundation administers this RFP, and all awards are contingent upon the Foundation's receipt of the funds from each of the federal agency partners and their allocations to each of the initiatives under this RFP.
Average annual # of applicants	50
Typical % of applicants funded	20%
Is a matched amount required?	Yes
Match Amount	Applicant must contribute a minimum of 50% of the total project cost through non-federal matching funds or "in-kind services."
Typical lowest amount awarded	$5,000
Typical highest amount awarded	$40,000
Typical median amount awarded	$35,000
Primary Address	National Fish and Wildlife Foundation, 1120 Connecticut Avenue, NW, Suite 900, Washington, DC 20036
Primary Telephone	(202) 857-0166
Primary Email	ellen.gabel@nfwf.org
Primary Internet	www.nfwf.org/programs/npci.cfm
Legislative Authority	None
Associated Keywords	Best Management Practices, Outreach/Education, Forests, Invasive Species, Land Acquisition, Monitoring, Partnerships, Planning, Restoration, Floodplains/Riparian Zones, Wetlands, Wildlife
Eligible Organizations	Community/Watershed Group, Nonprofit Groups, Educational Institution, Conservation District, Local Government, State/Territorial Agency, Tribal Agency, Federal Agency
Eligibility Constraints	While the review committees will select the most appropriate projects for each source of funds, it may be helpful to note that BLM, NPS, and FS funds each come with certain restrictions and requirements. For more information please click on the program name and refer to the link listed under "Primary Internet" and select "NPCI").

North American Wetlands Conservation Act Grants Program

The FWS's Division of Bird Habitat Conservation administers a matching grants program to carry out wetlands and associated uplands conservation projects in the United States, Canada, and Mexico. Grant requests must be matched by a partnership with nonfederal funds at a minimum 1:1 ratio. Conservation activities supported by the Act in the United States and Canada include habitat protection, restoration, and enhancement. Mexican partnerships may also develop training, educational, and management programs and conduct sustainable-use studies. Project proposals must meet certain biological criteria established under the Act. Visit the program web site for more information.

Application Deadline	Visit the program web site for current application deadlines. (Click on the listing under "Primary Internet".)
Is a matched amount required?	Case-dependant
Match Amount	Cost-share partners must match grant funds 1:1 with U.S. non-federal dollars
Funding Level FY 2004	$59 million
Funding Level FY 2005	$61.6 million
Funding Level FY 2006	$71.6 million
Typical highest amount awarded	$50,000 for Small Grants; $1 million for Standard Grants
Typical median amount awarded	Not available
Primary Address	U.S. Department of the Interior U.S. Fish and Wildlife Service North American Waterfowl and Wetlands Office (NAWWO) 4401 North Fairfax Drive, Room 110, Arlington, VA 22203
Primary Telephone	(703) 358-1784
Primary Email	r9arw_nawwo@fws.gov
Primary Internet	http://birdhabitat.fws.gov
Secondary Internet	www.cfda.gov (program number 15.623)
Legislative Authority	North American Wetlands Conservation Act; Coastal Wetlands, Planning, Protection, and Restoration Act"
Associated Keywords	Agriculture, Best Management Practices, Coastal Waters, Drinking water, Fisheries, Forests, Ground Water, Land Acquisition, Monitoring, Nonpoint Source Control, Partnerships, Planning, Point Source Control, Restoration, Floodplains/Riparian Zones, Stormwater Management, Wastewater, Water Conservation, Watershed Management, Wetlands, Wildlife
Eligible Organizations	Business, Nonprofit Groups, Private Landowner, Local Government, State/Territorial Agency, Federal Agency
Eligibility Constraints	Those eligible for Act grants include public, private, for-profit, and nonprofit entities or individuals who have established a habitat conservation partnership.

Wetlands Program Development Grants

The EPA's Wetland Program Development Grants are intended to encourage comprehensive wetlands program development by promoting the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. Projects build the capacity of states, tribes, and local governments to effectively protect wetland and riparian resources. Projects funded under this program support the initial development of a wetlands protection, restoration or management program; or support enhancement/refinement of an existing program.

Application Deadline	Deadlines are determined annually and vary from region to region.
When Funds are Available	Grants often approved within 4 months of completed app.
Average annual # of applicants	200
Typical % of applicants funded	50%
Is a matched amount required?	Yes
Match Amount	25%
Funding Level FY 2004	$15 million
Funding Level FY 2005	$9.5 million
Funding Level FY 2006	$19.5 million
Typical lowest amount awarded	$11,000
Typical highest amount awarded	$500,000
Typical median amount awarded	$250,000
Other details on funding	Regional RFPs (for States, Tribes, and local governments), and Headquarter RFPs (for interstate associations, intertribal consortia, and non-profit, non-governmental organizations) can be found at: http://www.epa.gov/owow/wetlands/grantguidelines/
Primary Address	Contact regional EPA office or Headquarters office
Primary Telephone	Please contact EPA regional wetland coordinator
Primary Email	(800) 832-7828 (contractor operated)
Primary Internet	www.epa.gov/owow/wetlands/grantguidelines/
Secondary Address	U.S. Environmental Protection Agency Office of Wetlands, Oceans and Watersheds Wetlands Division (4502T), Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460
Secondary Telephone	(800) 832-7828 (contractor operated)
Legislative Authority	Clean Water Act, Public Law 92-500, section 104(b)(3), 33 U.S.C. 1254(b)(3)
Associated Keywords	Coastal Waters, Outreach/Education, , Fisheries, Forests, Monitoring, Nonpoint Source Control, Planning, Restoration, Floodplains/Riparian Zones, Stormwater Management, Watershed Management, Wetlands, Wildlife
Eligible Organizations	Nonprofit Groups, Local Government, State/Territorial Agency, Tribal Agency
Eligibility Constraints	Non-profit, NGOs that undertake activities to advance wetland programs on a national basis are eligible.

State Wildlife Grant Program (Non-Tribal)

The FWS State Wildlife Grant (SWG) program provides grants to states, territories, and the District of Columbia for wildlife conservation. The SWG program provides funds to help develop and implement programs that benefit wildlife and their habitat, including species that are not hunted or fished. Although not directly eligible for these grants, third parties such as nonprofit organizations may benefit from these funds by working directly with their states to see if either grants or partnering opportunities are available.

Application Deadline	No deadline. State fish and wildlife agencies may submit applications until all funds are obligated.
When Funds are Available	Upon appropriation by Congress and FWS' approval of the state's grant application
Average annual number of applicants	Up to 56 eligible states and territories
Typical % of applicants funded	All eligible projects are funded dependent on appropriations
Is a matched amount required?	Yes
Match Amount	A 25 percent non-federal match is required for planning activities. A 50 percent non-federal match is required for all other activities.
Funding Level FY 2004	$61 million
Funding Level FY 2005	$63 million
Typical lowest amount awarded	No minimum
Typical highest amount awarded	No state may receive more than its annual allocation
Primary Address	Contact the state fish and wildlife office directly (see http://offices.fws.gov/statelinks.html for contact information).
Primary Telephone	(703) 358-1854
Primary Email	Genevieve_Larouche@fws.gov
Primary Internet	http://offices.fws.gov/statelinks.html
Secondary Address	U.S. Fish and Wildlife Service, Division of Federal Assistance, 4401 N. Fairfax Drive, Mail Stop MBSP-4020, Arlington, VA 22203
Secondary Telephone	(703) 358-2156
Secondary Email	tim_hess@fws.gov
Secondary Internet	www.fws.gov
Legislative Authority	Department of the Interior and Related Agencies Appropriations Act for Fiscal Year 2004 and other previous legislation
Associated Keywords	Best Management Practices, Fisheries, Forests, Invasive Species, Land Acquisition, Monitoring, Partnerships, Planning, Research, Restoration, Floodplains/Riparian Zones, Water Conservation, Watershed Management, Wetlands, Wildlife
Eligible Organizations	Community/Watershed Group, Nonprofit Groups, Conservation District, Local Government, State/Territorial Agency
Eligibility Constraints	Only lead state and territorial fish and wildlife service agencies and eligible tribes may apply directly for funding. To establish eligibility for these funds, the states and territories must submit a Comprehensive Wildlife Conservation Plan by 10/01/05. Third parties may work directly with their individual states to see if funds or partnering opportunities are available.

2.0 Funding to Improve Wastewater Management

Community Development Block Grant Program

The Department of Housing and Urban Development sponsors this program, which is intended to develop viable communities by providing decent housing and a suitable living environment by expanding economic opportunities primarily for persons of low and moderate income. Recipients may initiate activities directed toward neighborhood revitalization, economic development, with the provision of improved community facilities and services. Specific activities may include public services, acquisition of real property, relocation and demolition, rehabilitation of structures, and provision of public facilities and improvements, such as new or improved water and sewer facilities.

Application Deadline	Varies. Contact the unit of government that administers the CDBG
When Funds are Available	January 1 and October 1 of a given year
% of funded applicants	There will be approximately 1,880 grantees for FY '06
Is a matched amount required?	No
Funding Level FY 2004	$4.9 billion
Funding Level FY 2005	$4.7 billion
Funding Level FY 2006	$3.75 billion
Typical lowest $ awarded	No minimum. Formula allocations.
Typical highest $ awarded	Approximately $220 million
Primary Address	Contact your state's CDBG grantees (see list at www.hud.gov/offices/cpd/communitydevelopment/programs/contacts/)
Primary Telephone	(202) 708-1577
Primary Email	Contact your state's CDBG grantees (see list at www.hud.gov/offices/cpd/communitydevelopment/programs/contacts/)
Primary Internet	www.hud.gov/offices/cpd/communitydevelopment/programs/index.cfm
Secondary Address	Headquarters: Department of Housing and Urban Development Office of Block Grant Assistance, Community Planning and Development, 451 7th Street, SW, Washington, DC 20410
Secondary Telephone	(202) 708-3587
Legislative Authority	Housing & Community Development Act, 1974, Title I, amended
Associated Keywords	Best Management Practices, Coastal Waters, Economic Development, Land Acquisition, Planning, Pollution Prevention, Restoration, Floodplains/Riparian Zones, Source Water Protection, Stormwater Management, Wastewater, Watershed Management
Eligible Organizations	Business, Community/Watershed Group, Nonprofit Groups, Educational Institution, Private Landowner, Water and Wastewater Utilities, Local Government, State/Territorial Agency
Eligibility Constraints	Central cities in a Metropolitan Statistical Area (MSA); other cities >50,000 people in the MSA and urban counties of at least 200,000 are eligible for the Entitlement Grants. State governments distribute to local governments that are eligible for the State Program Grants. Under CDBG, only the identified eligible units of government directly receive CDBG allocations from HUD. Other units of local government, non-profits, and other groups may receive CDBG funds by applying to the unit of government through which they participate in the program.

Public Works and Development Facilities Program

This program provides assistance to help distressed communities attract new industry, encourage business expansion, diversify local economies, and generate long-term, private sector jobs. Among the types of projects funded are water and sewer facilities, primarily serving industry and commerce; access roads to industrial parks or sites; port improvements; business incubator facilities; technology infrastructure; sustainable development activities; export programs; brownfields redevelopment; aquaculture facilities; and other infrastructure projects. Specific activities may include demolition, renovation, and construction of public facilities; provision of water or sewer infrastructure; or the development of stormwater control mechanisms (e.g., a retention pond) as part of an industrial park or other eligible project.

Application Deadline	Applications are accepted on a continuous basis and are processed as funds become available. Funding information appears annually in the Federal Register.
Is a matched amount required?	Yes
Match Amount	Typically 50%, but might vary
Funding Level FY 2004	$200 million
Funding Level FY 2005	$164 million
Primary Address	Contact your EDA regional office: See: www.eda.gov/AboutEDA/Regions.xml
Primary Telephone	Contact your EDA regional office
Primary Email	Contact your EDA regional office
Primary Internet	http://www.eda.gov/InvestmentsGrants/Investments.xml
Secondary Address	Headquarters: U.S. Department of Commerce Economic Development Administration, Public Works Division 14th Street and Constitution Ave., NW, Washington, DC 20230
Secondary Telephone	(202) 482-5268
Secondary Internet	www.cfda.gov (Search on program 11.300)
Legislative Authority	Economic Development Administration Reform Act (Public Law 105-393), which replaces and amends the Public Works and Economic Development Act of 1965.
Associated Keywords	Drinking water, Economic Development, Pollution Prevention, Source Water Protection, Stormwater Management, Wastewater
Eligible Organizations	Community/Watershed Group, Nonprofit Groups, Educational Institution, Private Landowner, Conservation District, Water and Wastewater Utilities, Local Government, State/Territorial Agency, Tribal Agency
Eligibility Constraints	Proposed projects must be consistent with an approved regional Comprehensive Economic Development Strategy (CEDS). EDA evaluates proposals and invites formal applications.

Water Quality Cooperative Agreements

These EPA grants are provided to help states, Indian tribes, interstate agencies, and other public or nonprofit organizations develop, implement, and demonstrate innovative approaches relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. This includes watershed approaches for combined sewer overflow, sanitary sewer overflows, and storm water discharge problems, pretreatment and sludge (biosolids) program activities, decentralized systems, and alternative ways to measure the effectiveness of point source programs.

Application Deadline	Prospective grantees should work with the appropriate Regional or Headquarters Office to develop a preliminary package or proposals and submit these to the Regions. Deadlines are established by the Regional and Headquarters offices individually.
When Funds are Available	Check on website.
Average annual number of applicants	450
Typical % of applicants funded	10%
Is a matched amount required?	No
Funding Level FY 2004	$18.9 million
Funding Level FY 2005	$17 million
Typical lowest amount awarded	$5,000
Typical highest amount awarded	$500,000
Typical median amount awarded	Average amount awarded is $100,000
Primary Address	Barry Benroth Office of Wastewater Management (4204M), U.S. EPA, Room 7324J, EPA East, 1200 Pennsylvania Avenue NW., Washington DC 20460
Primary Telephone	(202) 564-0672
Primary Email	benroth.barry@epa.gov
Primary Internet	www.epa.gov/owm/cwfinance/waterquality.htm
Secondary Internet	www.cfda.gov (Program Number 66.463)
Legislative Authority	Clean Water Act, Section 104(b)(3), Public Law 92-500, as amended, 33 U.S.C. 1254(b)(3)"
Associated Keywords	Agriculture, Best Management Practices, Coastal Waters, Drinking water, Outreach/Education, Fisheries, Forests, Invasive Species, Land Acquisition, Monitoring, Nonpoint Source Control, Partnerships, Planning, Point Source Control, Pollution Prevention, Research, Restoration, Floodplains/Riparian Zones, Source Water Protection, Stormwater Management, Wastewater, Watershed Management, Wetlands, Wildlife
Eligible Organizations	Community/Watershed Group, Nonprofit Groups, Educational Institution, Water and Wastewater Utilities, Local Government, State/Territorial Agency, Tribal Agency
Eligibility Constraints	Also eligible are state water pollution control agencies and interstate agencies.

3.0 Funding to Improve Stormwater Management

Nonpoint Source Implementation Grants (319 Program)

Through its 319 program, EPA provides formula grants to the states and tribes to implement nonpoint source projects and programs in accordance with section 319 of the Clean Water Act (CWA). Nonpoint source pollution reduction projects can be used to protect source water areas and the general quality of water resources in a watershed.

Application Deadline	Varies by state. Consult the lead nonpoint source agency in your state (for contact information click on the link listed under "Secondary Internet").
When Funds are Available	Varies by state
Average annual # of applicants	55 states and territories receive grants.
Typical % of applicants funded	Percentage of applicants who receive money is highly variable by state and within state from year to year.
Is a matched amount required?	Case-dependant
Match Amount	States provide 40% non-Federal match for whole grant. Recipients within state typically provide 40% match for each project, but this may be negotiable with a given state.
Funding Level FY 2004	$237 million
Funding Level FY 2005	$207 million
Funding Level FY 2006	$206 million
Typical lowest amount awarded	Check with the state agency that administers the 319 Grant
Typical highest amount awarded	Check with the state agency that administers the 319 Grant
Typical median amount awarded	Check with the state agency that administers the 319 Grant
Primary Address	U.S. Environmental Protection Agency Office of Wetlands, Oceans and Watersheds Nonpoint Source Control Branch (4503T), Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460
Primary Telephone	(202) 566-1203
Primary Email	nandi.romell@epa.gov
Primary Internet	www.cfda.gov (search on program 66.460)
Secondary Internet	www.epa.gov/owow/nps/contacts.html
Legislative Authority	Clean Water Act, section 319(h)""
Associated Keywords	Best Management Practices, Coastal Waters, Outreach, Education, Forests, Land Acquisition, Monitoring, Nonpoint Source Control, Partnerships, Planning, Point Source Control, Pollution Prevention, Restoration, Floodplains/Riparian Zones, Source Water Protection, Stormwater Management, Watershed Management, Wetlands, Wildlife
Eligible Organizations	Community/Watershed Group, Nonprofit Groups, Educational Institution, Private, Conservation District, Local Government, State/Territorial Agency, Tribal Agency, Federal Agency
Eligibility Constraints	The immediate grantees are designated state and territorial NPS agencies. State/local governments, universities, and nonprofit organizations.

Pollution Prevention Grant Program

This grant program provides project grants to states and tribes to implement pollution prevention projects. The grant program is focused on institutionalizing multimedia (air, water, land) pollution prevention as an environmental management priority, establishing prevention goals, providing direct technical assistance to businesses, conducting outreach, and collecting and analyzing data. The program includes new P2 measurement requirements in compliance with EPA policy, and now requires applicants to work towards reducing pollution, conserving energy and water, and saving dollars through P2 efforts; as identified in EPA's Strategic Plan under Goal 5: Compliance and Environmental Stewardship: Objective 5.2: Improve Environmental Performance Through Pollution Prevention and Innovation.

Application Deadline	The application deadlines vary by region. Consult the regional pollution prevention contact for exact date (click on the link listed under "Primary Internet").
When Funds are Available	Grants are usually awarded between June and September.
Average annual # of applicants	200
Typical % of applicants funded	30%
Is a matched amount required?	Yes
Match Amount	States are required to provide at least 50% of total project costs
Funding Level FY 2004	$4.8 million
Funding Level FY 2005	$5 million
Funding Level FY 2006	$5 million
Typical lowest amount awarded	$20,000
Typical highest amount awarded	$200,000
Typical median amount awarded	$80,000
Primary Address	U.S. Environmental Protection Agency Office of Pollution Prevention and Toxic Substances Pollution Prevention Division (7409 M) 1200 Pennsylvania Ave., NW, Washington, DC 20460
Primary Telephone	(202) 564-8857
Primary Email	amhaz.michele@epa.gov
Primary Internet	http://www.epa.gov/oppt/p2home/grants/ppis/ppis.htm
Secondary Address	Regional contacts can be found on the Web at: http://www.epa.gov/oppt/p2home/resources/regions.htm
Secondary Internet	www.cfda.gov (Search on program 66.708)
Legislative Authority	Pollution Prevention Act, Section 6605
Associated Keywords	Air Quality/Deposition, Agriculture, Best Management Practices, Economic Development, Outreach/Education, Monitoring, Partnerships, Planning, Point Source Control, Pollution Prevention, Research, Solid Waste, Source Water Protection, Stormwater Management, Water Conservation
Eligible Organizations	State/Territorial Agency , Tribal Agency
Eligibility Constraints	Beneficiaries may include states and local governments, Indian tribes and nonprofit organizations.

4.0 Miscellaneous Funding Opportunities

Coastal Zone Management Administration/ Implementation Awards

This program assists states in implementing and enhancing Coastal Zone Management (CZM) programs that have been approved by the Secretary of Commerce. Funds are available for projects in areas such as coastal wetlands management and protection, natural hazards management, public access improvements, reduction of marine debris, assessment of impacts of coastal growth and development, special area management planning, regional management issues, and demonstration projects with potential to improve coastal zone management.

Application Deadline	Varies by state. Consolidated state CZM program applications are provided to NOAA in April through June.
When Funds are Available	Usually in July and October
Average annual number of applicants	34
Is a matched amount required?	Case-dependant
Match Amount	Formula grants; Non-federal match required. Program enhancement grants; no match required
Funding Level FY 2004	$140.2 million
Funding Level FY 2005	$129.5 million
Funding Level FY 2006	$71.5 million
Typical lowest amount awarded	$300,000
Typical highest amount awarded	$ 2 million
Typical median amount awarded	$1.3 million
Primary Address	U.S. Department of Commerce National Oceanic and Atmospheric Administration National Ocean Service 1305 East-West Highway, Silver Spring, MD 20910
Primary Telephone	(301) 713-3155 x188
Primary Email	john.king@noaa.gov
Primary Internet	http://www.ocrm.nos.noaa.gov/czm/
Secondary Internet	www.cfda.gov (Program Number 11.419)
Legislative Authority	Coastal Zone Management Act of 1972; Coastal Zone Act Reauthorization Amendments of 1990; Coastal Zone Protection Act of 1996
Associated Keywords	Best Management Practices, Coastal Waters, Outreach/Education, Land Acquisition, Monitoring, Nonpoint Source Control, Planning, Restoration, Stormwater Management, Wetlands, Wildlife
Eligible Organizations	Community/Watershed Group, Nonprofit Groups, State/Territorial Agency
Eligibility Constraints	Coastal states only, including Great Lakes states, Puerto Rico, Virgin Islands, Guam, American Samoa, the Trust territories of the Pacific, and the Commonwealth of the Northern Mariana Islands. Most states provide some funds to local groups and nonprofit

Environmental Justice Collaborative Problem-Solving Cooperative Agreements

In 2003, the Office of Environmental Justice (OEJ) initiated the first Environmental Justice Collaborative Problem-Solving (CPS) Cooperative Agreements Grant Program. The purpose of the program is to provide financial assistance to affected local community-based organizations who wish to engage in constructive and collaborative problem-solving by utilizing tools developed by EPA and others to find viable solutions for their community's environmental and/or public health concerns

Application Deadline	See Internet site for details
Is a matched amount required?	No
Funding Level FY 2004	$3 million
Funding Level FY 2005	$0 (not funded in FY05)
Funding Level FY 2006	$1.5 million
Typical highest amount awarded	$100,000
Typical median amount awarded	$100,000
Primary Address	U.S. Environmental Protection Agency Office of Environmental Justice (2201A) Ariel Rios Bldg., 1200 Pennsylvania Ave., NW Washington, DC 20460
Primary Telephone	(202) 564-0152; hotline (800) 962-6215
Primary Email	sato.ayako@epa.gov
Primary Internet	www.epa.gov/compliance/environmentaljustice/grants/
Secondary Internet	www.cfda.gov (Search on program number 66.306)
Legislative Authority	Multiple authorizations including the Clean Water Act, section 104(b)(3); Safe Drinking Water Act, section 1442(b)(3)Solid Waste Disposal Act, Section 8001(a);Clean Air Act, Section 103(b) (3);Toxic Substances Control Act, Section 10(a); Federal Insecticide, Fungicide, and Rodenticide Act, Section 20(a)
Associated Keywords	Air Quality/Deposition, Drinking water, Economic Development, Outreach/Education, Enforcement/Compliance, Fisheries, Monitoring, Pollution Prevention, Research, Solid Waste, Watershed Management
Eligible Organizations	Community/Watershed Group, Nonprofit Groups, Educational Institution
Eligibility Constraints	An affected local community-based organization is defined as: 1) a grassroots group that is not affiliated with a larger national, regional, or state organization; 2) located in the same area as the environmental and/or public health problem that is described in the application and where the residents of the affected community reside; 3) focused primarily on addressing the environmental and/or public health problems of the residents of the affected community; and 4) comprised primarily of members of the affected community.

Appendix 4: Economic Cost Tables

Table 7: Manufactured Treatment Devices (MTDs)			
	Costs	**Benefits**	**Other Considerations**
StormFilter	• 6ft. by 12ft. filter = $15,000 (filters a flow-through volume of 0.3 cfs). • 8ft. by 18ft. filter = $30,000 (filters a flow-through volume of 0.8 cfs). • Larger units = $30,000 - $200,000 (filter greater than 0.8 cfs). • Full maintenance can be provided by Stormwater Management for $100 per cartridge on average. One cartridge can treat a peak flow of 15 gpm.	Positive publicity as an environmentally conscious business.	Structural life is 50 years; cartridge life is guaranteed as long as maintenance contract is upheld with Stormwater Management, Inc. but it generally needs replacement every 20 years. Size of filter necessary is extremely sensitive to the flow of the treatment area.
BaySaver Separation System (5K System)	• Separator Unit = $7990. • Preparation/Installation = $10,300. • Treatment costs = $3000-$8000 per acre.	Positive publicity as an environmentally conscious business.	Lack of maintenance reduces system's efficiency. There are 3 size options: 1K system treats a drainage area of 1.2-1.6 acres, 3K system treats a drainage area of 1.6-4.4 acres, 5K system treats a drainage area of 4.4-8.0 acres.
Enviropod	• Number of basins required is dependent on the flow of the treatment area. • $600 - $1000 per catch basin.[a] • Number of basins required is dependent on the flow of the treatment area. • Maintenance requires periodic emptying of basins.	Positive publicity as an environmentally conscious business.	
Aqua-Guard	• AG-18 (smallest size) = $1350 AG-24 (medium size) = $1950 AG-36 (largest size) = $2750 • Maintenance requires quarterly inspection and after significant storm events with cleaning of the filter screen when full. • Removal for cleaning may require lifting equipment adding additional costs.	Improved public relations by demonstrating environmental consciousness.	Can be adapted to fit most catch basins or storm drains making retrofit projects possible.

Sources: NH DES, 2002[163]; [a]Jordan, 2006[164]

Table 8: Green Roofs		
Costs	**Benefits**	**Other Considerations**
$12 - $25 per square foot. Some maintenance is required (comparable to normal landscaping costs)	Reduce average New York City building energy costs by $0.15 per square foot (2004 prices). Can reduce winter energy costs if designed appropriately. Adds protection to the roof so it does not have to be replaced as frequently. Adds value to the building as an amenity and by increasing its aesthetic value. Offers an educational tool for the community, which is important for public relations and provides free marketing.	Extensive green roofs are less expensive and require less maintenance than intensive roofs.[a] Extensive roofs add less load to a roof (12-50 lbs. per sq.ft.) than intensive roofs (80-150 lbs. per sq.ft.) but they are not typically designed for public access.[a] Green roofs can be self-sustaining after the first 2 years.

Sources: Kerr & Yao, 2004[165]; [a]US EPA, 2006[166]

Table 9: Cisterns		
Costs	**Benefits**	**Other Considerations**
Cost of construction varies greatly depending on size, material, location (below ground is more expensive). Pre-manufactured unit costs: Small = $160 (165 gallon polyethylene) - $660 (350 gallon fiberglass) Large = $950 (2000 gallon galvanized steel) -- $10,000 (5000 gallon fiberglass/steel composite or 10,000 gallon fiberglass). Additional costs if infrastructure such as gutters, filters, inflow/outflow pipes and water treatment systems are needed.	Savings on water bill by reusing rainwater. Reduces need for off-site storm drain systems and the costs associated with their construction and maintenance.	More expensive than rainbarrels. Excavation requirements can make them costly. Rainwater has no chlorine, lime, or calcium so it is often better for plumbing and plants than municipal water.

Source: LID Center, 2006[167]

Table 10: Rain Barrels		
Costs	**Benefits**	**Other Considerations**
Unit cost: $90-$150 Some additional costs for accessories such as down spout, guttering.	Savings on water bill by reusing rainwater. May qualify for stormwater fee reductions. Reduces need for off-site storm drain systems and the costs associated with their construction and maintenance.[a]	Some water utility companies may offer them at a discounted price. Can be made as opposed to purchased (instructions can be found online). Rainwater has no chlorine, lime, or calcium so it is often better for plumbing and plants than municipal water.

Sources: MN DNR, 2006[168]; [a]LID Center, 2006[169]

Table 11: Vegetated Buffers			
Costs		**Benefits**	**Other Considerations**
Cost of seeds	$20/acre/year (annual seeds) $250/acre (perennial seeds)	Provides flood control and reduces risk of water damage to the site. Aesthetic appeal can increase property value.	Native perennial grasses are both ecologically and economically preferable. The Natural Resource Conservation Service offers cost-share assistance up to 75% on this type of stormwater management strategy.
Land preparation (seeding, chiseling, equipment)	$200/acre		
Maintenance (mowing, weeding)	$200/acre/year		

Source: Rein, 1999[170]

Table 12: Raingardens			
Costs		**Benefits**	**Other Considerations**
New project	$10 - $40 per square foot (Recommended minimum dimensions are 15 feet by 40 feet but 25 feet is the preferred width.) This estimate includes Construction and planting. Landscaping costs = about $5.50 per square foot for a combination of shrubs and ground cover.[a]	Decreases the cost of constructing traditional stormwater piping system.	Any landscaping costs that would be required for the site regardless of whether biorentention areas or raingardens were constructed should be subtracted when estimating the net cost of the project.
Retrofitting project	$6,500 on average in addition to the new project cost per bioretention area. Additional cost is associated with demolition of existing concrete, asphalt, and existing structures and the replacement of fill material with planting soil.		
Maintenance	Periodic inspection and maintenance is comparable to typical landscaping costs (mulching, weeding, watering etc.).	Using vegetation appropriate to the site can reduce the need for fertilizer, pesticide, and water use.	Maintenance requirements will decrease as the area becomes naturally self-sustainable. Depending on pollutant loads, soils may need to be replaced within 5-10 years of construction.

Sources: CASQA, 2003[171]; [a]Urban Environmental Institute, 2002[172]

Table 13: Wetland Restoration		
Costs	**Benefits**	**Other Considerations**
Typically about 25% more expensive than stormwater ponds of an equivalent volume. Cost Equation[a]: $C = 30.6^{Vx0.705}$ Where: C = Construction, design, and permitting cost. V = Wetland volume needed to control the 10-year storm. Example: $57,100 for a 1 acre-foot facility $289,000 for a 10 acre-foot facility $1,470,000for a 100 acre-foot facility	No direct financial savings. Marketing Amenity -- Can be used as a marketing tool because it demonstrates corporate responsibility and environmental concern to the public.	Requires a large footprint, typically 4-6% of the contributing drainage area. If the land value around a site is high, a wetland will be less appealing. Numerous funding opportunities are available to make the construction of wetlands a more viable option for stormwater management. A wetland can significantly improve water quality, which is a major benefit for the entire area. Local governments may be willing to contribute to the construction and maintenance costs since it will reduce the amount of water that their facilities need to treat.
Maintenance costs will vary as requirements are dependent on local regulatory agencies (i.e. health and vector control). It generally includes vegetation harvesting in the summer, semiannual inspection, and periodic removal of trash, debris, and sediment.		

Sources: CASQA, 2003[173]; [a]Schueler, 1997[174]

Table 14: Water-Saving Devices			
Costs		**Benefits**	**Other Considerations**
Ultra low-flow toilet (maximum of 1.6 gallons per flush (gpf))	Comparative to conventional toilets. Typically range from $150 - $350 per toilet [a]	Reduce water use from traditional 3.5 gpf to 1.6 gpf per fixture or approximately 54%.[b]	Payback period is 1-3 years but can be just months. It varies based on the average use of each fixture.[c] If hot water is used for the faucets, energy costs associated with heating the water can be reduced. Some local utility companies install low-flow fixtures for free.[d] The installation of low-flow devices is a no-risk investment.[d]
Ultra low-flow flush urinals (maximum of 1.0 gallons per flush)	Comparative to conventional urinals. Typically range from $120 - $300 per urinal [a]	Reduce water use from traditional 2.0-3.0 gpf to 1.03 gpf per fixture or approximately 50-66%.[c]	
Low-flow faucets/aerators (.5 gallons per minute (gpm))	Typically cost around $300 for both [b]	Reduce water use from traditional 3.0 gpm to 0.5 gpm per fixture or approximately 83%. [b]	

Sources: [a] TOTO USA, Inc, 2006[175]; [b] NYCWasteLe$$, 2006[176]; [c]Hounsell, 2003[177]; [d] Flex Your Power Organization, 2006[178]

Table 15: Blackwater Biofilter System		
Costs	**Benefits**	**Other Considerations**
Unit costs: Medium Carousel = $2,600 Large Carousel = $3,875 Total cost of typical accessories = $1000 Installation costs = $300 if state requires installation of composting toilet to be done by a plumber. Maintenance requires emptying anywhere from twice a year to once every four years.	Savings in water usage bill by reusing wastewater. Savings from eliminating all wastewater charges (assuming a wastewater meter is present). Produces a dry composted end-product that can be used as a soil conditioner.	Space needs to be available underneath the bathroom where the Carousel can be installed. May increase energy costs because of heater component.

Source: US EPA, 2006[179]

Table 16: Living Machines®			
Costs		**Benefits**	**Other Considerations**
Lease cost	$15 per square foot per year.	Reuse of water results in savings on water bill. Aesthetic appeal can increase property value. [b] Marketing Amenity -- Can be used as a marketing tool because of it uniqueness.	Incentives may be available for subsidization of construction costs. The federal government has funded the construction of several Living Machines as demonstrations.[b] Expected payback period is project specific but estimated at 15 years. More cost competitive with traditional conventional treatment systems at flow volumes up to 1,000,000 gpd, when located in warmer climates that do not require the use of a green house to protect the plants from cold weather.[b]
Operation and Maintenance cost	$82,000 per year (based on a Living Machine for a 4 block area).		
Dual plumbing	Separate plumbing lines need to be installed to transport grey water to toilets. Conservative estimate = $1.50 per square foot.		
Piping	$100 per square foot.		

Present Worth Comparison of "Living Machines®" and Conventional Systems[b]			
Process	**40,000 gpd**	**80,000 gpd**	**1 million gpd**
Living Machine w/ greenhouse	$1,077,777	$1,710,280	$10,457,542
Living Machine w/out greenhouse	$985,391	$1,570,246	$9,232,257
Conventional System	$1,207,036	$1,903,751	$8,579,978

Sources: [a]Urban Environmental Institute, 2002[180]; [b]US EPA, 2002[181]

Table 17: Steam Chillers					
Costs-Benefit Analysis					**Other Considerations**
	Electric Chiller (baseline)	Small chillers (capacities < 300 tons)	Medium chillers (300 tons ≤ capacities < 1,000 tons)	Large chillers (capacities ≥ 1,000 tons)	Under NYSERDA's NCP*, cost-effective measures are eligible for incentives of up to 70% of the incremental cost over standard practice. The average incentive is $396 per ton. Without incentives the estimated payback period for steam chillers is between 8.5 and 28 years depending on the type of chiller installed. With incentives the estimated payback can be reduced to 2.5-8.4 years.
Installed Cost	$164,000 (small) $495,000 (medium) $958,000 (large)	$237,000 - $336,000	$644,000 - $944,000	$1,270,000 - $1,873,000	
Incremental Cost		$73,000 - $172,000	$150,000 - $450,000	$312,000 - $915,000	
Electric Benefit/Cost Ratio		1.5 -3.4	1.4 – 4.0	1.4 - 3.8	
Additional Operation and Maintenance Costs		$0.012 per ton-Hr	$0.012 per ton-Hr	$0.012 per ton-Hr	
Additional Space and Structure Costs		$120 per square feet of site space	$120 per square feet of site space	$120 per square feet of site space	
Fuel costs (gas/steam)		$0.75 per Therm	$0.75 per Therm	$0.75 per Therm	
Annual Energy Savings				492,468 kWh-558,558 kWh	

Source: Yousef et.al, 2003[182]

*NYSERDA = New York State Energy Research and Development Authority; NCP = New Construction Program

Table 18: Education and Training (SW/WW)		
Costs		**Other Considerations**
In-house employee training program	Highly variable with costs directly related to labor and associated overhead costs.[a] Example: • 1 Stormwater Engineer receives 20 hours of training over the course of the year at an hourly rate of $15/hr times an overhead multiplier of 2 (to account for other expenses) = $600. • 5 Plant Managers receive 10 hours of training per year at an hourly rate of $20/hr times an overhead multiplier of 2 = $2,000. • 100 Plant Employees receive 5 hours of training per year at an hourly rate of $10/hr times an overhead multiplier of 2 = $10,000. Total Cost of Training = $12,600.[a]	Online or webcast programs are less expensive than traditional classroom courses and conferences.[b] Discounts are often available for groups.[b] Be sure to consider transportation costs to/from training. Take advantage of free educational material (posters, brochures, videos, books etc.) offered by other institutions.[a]
Outside Agency Courses and Conferences	Typically cost between $300 and $600.[b]	

Sources: [a]EPA Storm Water Management Fact Sheet: Employee Training. 1999; [b]Environmental Resource Center

Appendix 5 - Glossary[183]

Ambient temperature: Temperature of the surrounding air or other medium.

Best Management Practices (BMPs): Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources

Blackwater: Water that contains animal, human, or food waste.

Brownfield: abandoned, idled, or underused industrial and commercial property where expansion or redevelopment is complicated by real or perceived contamination

Chlorophyll-a: The major pigment found in all oxygen-evolving photosynthetic organisms such as higher plants and red and green algae.

Coal gasification facility: A facility in which the conversion of coal to a gaseous product takes place.

Combined Sewage Overflow (CSO): Discharge of a mixture of storm water and domestic waste when the flow capacity of a sewer system is exceeded during rainstorms.

Combined Sewer System (CSS): A sewer system that carries both sewage and storm-water runoff to the local Wastewater Pollution Control Plant.

Conveyance: The process of water moving from one place to another.

Detention: The process of catching and holding water (essentially stormwater) for a short period of time.

Dissolved Oxygen (DO): The available oxygen in water which is vital to fish and other aquatic life. DO levels are considered a most important indicator of a water body's ability to support desirable aquatic life. Secondary and advanced waste treatments are generally designed to ensure adequate DO in waste-receiving waters.

Enterococcus- Bacteria normally found in the feces of humans and many animals.

Fecal Coliform: Bacteria found in the intestinal tracts of mammals. Its presence in water or sludge is an indicator of pollution and possible contamination by pathogens.

Filtration: A treatment process, under the control of qualified operators, for removing solid (particulate) matter from water by means of porous media such as sand or a man-made filter; often used to remove particles that contain pathogens.

Floatables: Water-borne litter and debris that enter water bodies via stormwater through storm drains and sewers

Floodplain: The flat or nearly flat land along a river or stream or in a tidal area that is covered by water during a flood

Greywater: Domestic wastewater composed of wash water from the kitchen, bathroom, laundry sinks, tubs, and washers.

Groundwater recharge: Replenishment of water that circulates in underground aquifers.

Heavy metals: Metallic elements with high atomic weights; (e.g. mercury, chromium, cadmium, arsenic, and lead); can damage living things at low concentrations and tend to accumulate in the food chain.

Impervious cap: A hard surface area which either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development; and/or a hard surface area which causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development.

Infiltration: the slow passage of a liquid through a filtering medium

Low Impact Development (LID): Strategies that integrate green space, native landscaping, natural hydrologic functions, and various other techniques to generate less runoff from developed land.

Manufactured Technology Devices (MTDs): Mechanisms that are incorporated into stormwater systems to pre-treat stormwater

Non-organic waste: Waste materials that are chemical substances of mineral origin such as pesticides, sewage, or hormones.

Non-point source pollution: Sources of pollution that enter the environment from broad areas that are hard to identify and monitor such as fertilizer from agricultural land.

Nutrients: Any substance assimilated by living things that promote growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

Organic waste: Waste material which comes mainly from animal or plant sources. Organic waste generally can be consumed by bacteria and other small organisms.

Pathogens: Microorganisms (e.g., bacteria, viruses, or parasites) that can cause disease in humans, animals and plants.

Payback period: Defined by the amount of time it takes for the initial investment to be recovered by the yielded savings and increased revenues and can be used as another tool to determine whether a project is economically feasible.

Point source pollution: Source of pollution that enters the environment at a single, readily identified entry point such as a sewage water outflow.

Polychlorinated Biphenyls: A group of toxic, persistent chemicals used in electrical transformers and capacitors for insulating purposes, and in gas pipeline systems as lubricant.

Potable water: Water that is safe for drinking and cooking.

Recycle: To extract and reuse; or to recondition and adapt to a new use or function

Reduce: To decrease the amount of waste generated

Reuse: The use of items for a similar or adapted use rather than discarding as waste

Retention: The process of collecting and holding storm water runoff with no surface outflow.

Retrofit: To furnish with new or modified parts or equipment not available or considered necessary at the time of manufacture.

Runoff: Water that ultimately flows over ground surfaces into drainage facilities, rivers, streams, springs, seeps, ponds, lakes, and wetlands as well as shallow groundwater.

Salinity: The percentage of salt in water.

Sewage treatment plant: A facility containing a series of tanks, screens, filters, and other processes by which pollutants are removed from water. Most treatments include chlorination to attain safe drinking water standards.

Sludge: A semi-solid residue from any of a number of air or water treatment processes; can be considered a hazardous waste.

Sludge treatment plant: A facility that converts sludge into usable products such as fertilizer.

Solid waste transfer station: A facility where municipal solid waste is unloaded from collection vehicles and briefly held while it is reloaded onto larger long-distance transport vehicles for shipment to landfills or other treatment or disposal facilities.

Stormwater: Water that originates during precipitation events (rain or snowmelt). Water that does not penetrate the ground becomes surface runoff that carries nutrients and pollutants to nearby waterways or storm drains.

Suspended solids: Small particles of solid pollutants that float on the surface of, or are suspended in, sewage or other liquids. They resist removal by conventional means.

Sustainable development: Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Tidal wetlands: A wetland that is inundated by tidal waters. They can act as a natural filter of runoff by absorbing silt and organic material, along with providing storm control, wildlife habitat, and aesthetic value to the area

Total Maximum Daily Load (TMDL): Maximum amount of a pollutant that a water body can receive from all point and non-point sources and still meet water quality standards

Total suspended solids (TSS): A measure of the suspended solids in wastewater, effluent, or water bodies, determined by tests for "total suspended non-filterable solids."

Wastewater: Water that contains waste products from daily activities ranging from the flushing of a toilet to a manufacturing process.

Appendix 6 – Figure Citations

Figure 1: *Trucks at the Market*. Unay Cruz
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