The Wetlands at Long's Park: The City of Lancaster's Park Enhancement and Water Treatment Project

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Highlights

- Innovative use of a natural treatment system within a public park to improve water quality
- Demonstrated unique features such as floating wetland islands and iron-enhanced media filter
- Incorporated passive recreational and educational features to engage the public

Introduction

The City of Lancaster, Pennsylvania, has constructed an innovative water quality improvement project in one of its public parks (Long's Park) to capture and treat stormwater runoff as part of its Chesapeake Bay Pollutant Reduction Plan. Runoff quality improved by the project will result in reduced nitrogen, phosphorus, and sediment loading to the Little Conestoga Creek Watershed in the Lower Susquehanna River Basin, which will ultimately contribute to improved water quality in Chesapeake Bay. In addition to its anticipated water quality benefits, the project was designed to complement the park as an aesthetic and recreational amenity. Walking trails, boardwalks, and a viewing platform provide unique passive recreational opportunities, while signage will educate visitors and the public at large.

Background

The Long's Park water quality improvement project includes a proposed pump station to convey water from the 1.2 ha (3-acre) Long's Pond within the park to a constructed natural treatment system (NTS) consisting of a treatment train that includes a forebay equipped with floating wetland islands (FWI), an iron-enhanced media filter, and two constructed wetland marshes, with discharge to Long's Pond. Public recreational use features were incorporated into the project in the form of all-weather access trails to the NTS that wind around the site in addition to a boardwalk/ viewing platform that enables public access through the lower marsh. Combined, these facilities are expected to create a unique and engaging experience for park visitors (Figure 1).

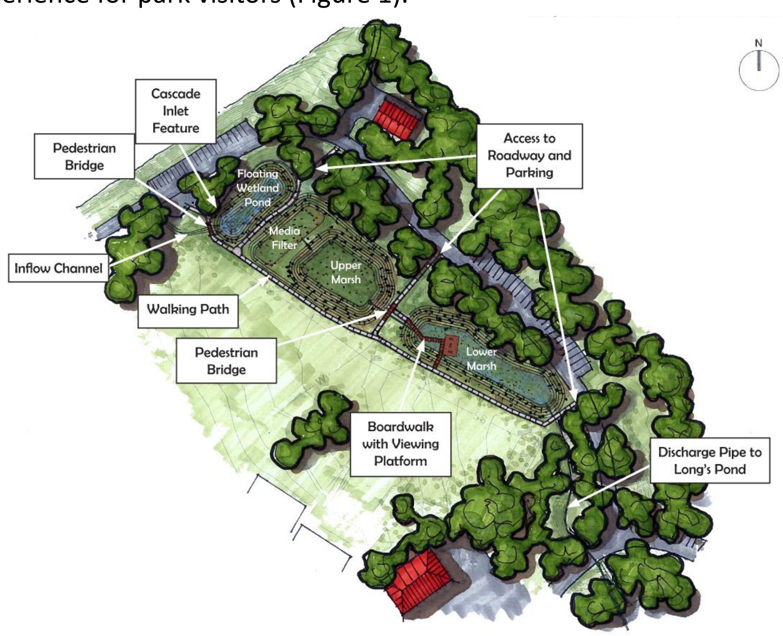

Figure 1. Long's Park Water Quality Improvement Project Illustrative Site Plan

Key Findings

The Long's Park NTS is projected to reduce stormwater runoff total suspended solids (TSS) and nutrients. Based on the daily water balance model conducted for this system over the 24-year period of record (1997-2020), the annual average inflow the NTS receives is approximately 166,558 liters (44,000 gallons) per day. This total inflow includes stormwater runoff from approximately 3.1 ha (7.7 acres) of contributing drainage area and a continuous 95 liters per minute (25 gpm) flowrate from Long's Pond. This flow was used to predict the water quality performance of the Long's Park water quality improvement project.

The NTS's capacity to improve stormwater quality was evaluated using current approaches to modeling treatment wetland performance. Common stormwater constituents include nutrients, suspended solids, metals, bacteria, and organic compounds. Left untreated, these pollutants can result in the eutrophication of downstream water bodies and impairment of aquatic ecosystems. NTS are documented to be an effective means of removing stormwater-derived contaminants. The primary removal mechanisms of NTS include solids settling, metal adsorption and precipitation, microbial transformation to gaseous compounds, and plant uptake and burial. The water quality model results indicate that on an annual average basis, the treatment system will provide a reduction of 9 kg (20 pounds) of phosphorus, 45kg (100 pounds) of nitrate, and 5443 kg (12,000 pounds) of TSS. These reductions result in a 50% reduction of TP, 32% reduction of TN, and 95% reduction of TSS.

Recommendations

As an increasingly popular approach to water management, NTS are sustained by renewable natural sources of energy such as solar radiation, wind, gravity, and energy storage in biological and chemical forms. In the quiescent conditions typical of constructed pond and wetland environments, solids are removed through passive settling, phosphorus is removed through biological uptake and solid sorption and settling, and nitrate is removed through denitrification in naturally low oxygen environments found in bottom layers of sediments and decomposing organic matter. With lower operating costs, less energy consumption, and fewer residuals produced than conventional active treatment, NTS provide cost-effective solutions for treatment of various types of water inflows including stormwater.

In addition to the water quality performance that NTS can provide, the long retention times and inherent storage volumes minimize variation in outflow water quality. Since stormwater flow and water quality varies and is not always consistent, wetlands act as a “buffer” and provide storage for flow equalization and runoff flow attenuation. Importantly, given the proposed park setting, NTS offer aesthetic and habitat benefits by creating open green spaces in urban settings that the public can enjoy for passive recreation. It is anticipated that the Long’s Park Water Quality Improvement Project, which was recently awarded the ACEC-PA Diamond Award for Water Resources, will become an amenity complementary to the public use of Long’s Park. A boardwalk, trails, pedestrian bridge, and a viewing platform are included in the project design and are expected to be valuable additions to the park and community.

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East Branch Chagrin River Restoration for Water Quality and Habitat Improvement

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Highlights

- River Restoration was used to reduce sediment and nutrient erosion from riverbanks.
- Dam removal for aquatic passage and habitat restoration were additional benefits of the project.
- The project site is a highly used public park and steelhead fishery which influenced project goals.

Introduction

The Chagrin River Watershed Partners with support from the City of Willoughby, Ohio Department of Natural Resources, Western Reserve Land Conservancy, and Biohabitats completed a large-scale river restoration at the confluence of the Chagrin River and the East Branch of the Chagrin River. The goals of the project were sediment and nutrient reductions in the Chagrin River and Lake Erie. Additional goals include improved aquatic passage and habitat restoration.

Methodology or Background (for case study)

Project Background

The Chagrin River Watershed Partners (CRWP) initiated the East Branch Chagrin River Restoration Project which included the Daniel's Park Dam Remnant Removal Project. The erosion issues at the Chagrin River and the East Branch of the Chagrin River have been exacerbated by three human activities: watershed development, impoundment structures, and the partial breach of Daniel's Park dam leading to a positive hydraulic feedback loop creating conditions conducive for erosion. Over the past several decades, incremental development in the watershed and the resulting increased impervious surfaces have increased the volume of runoff directly entering the watershed, thus increasing river velocities and erosive forces during storm events. Within the Chagrin River, the low head dam built in 1920 to create a municipal water supply pool partially collapsed in 2005. The dam's collapse led to a lower base flow creating a positive feedback loop of erosion and sediment deposition.

River Restoration Design Approach and Techniques

The selected design approach aimed to restore the functional attributes of the riparian and river corridor to the maximum extent practicable. Our restoration approach was essentially a three-part approach that involves 1) removal of Daniel's dam remnants, 2) stabilization of the eroding banks on the Chagrin River using bendway weirs and engineered log complex and 3) stabilization of the East Branch Channel by realigning the channel confluence (w/ Chagrin) and creation of Oxbow wetlands in the abandoned channel.

Historically this watershed and river would have been heavily forested, thus large wood debris would have played a much larger role in providing habitat and stabilizing banks. Our approach deviated from the typical rip-rap bank applications as they provide little habitat value and increase water temperatures and downriver sheer stresses. A large wood complex provides bank stability, roughness, and aquatic habitat.

The restoration approach incorporated several techniques to ensure channel and bank stability, create and maintain aquatic and terrestrial habitat features and enhance the riparian forest structure. Figure 1 below shows the restoration techniques proposed for the site.

Figure 1. Proposed restoration elements at the East Branch Chagrin Restoration Site

Key Findings

Below are the quantities of project elements that were constructed for this project.

- Stabilized 685 linear feet of eroding riverbank on the Chagrin River, created a bankfull bench, removed the point bar on the eastern bank of the Chagrin River, re-aligned the transverse riffle, and restored 1.5 acres of riparian forest
- Removed the dam remnants and stabilized the 0.5 acre restored area to improve river hydraulics, aquatic habitat, and steelhead fishing.
- Realigned 700 linear feet of the East Branch of the Chagrin River and restored 1 acre of the old channel to oxbow wetland habitat.
- Invasive species management of 74.8 acres of forest.

Figure 2. Constructed Engineered log bank protection and bendways weirs

Recommendations

Lessons learned and recommendations for future study include the following:

- Since this site is a popular park and fishing destination, early public outreach was necessary to ensure that public access and fisheries impacts were considered during the project design and construction process.
- Riverbed and bank conditions should be monitored as project area reaches equilibrium to ensure that sediment reduction and other river and wetland restoration goals are being achieved.

Delaware River Bacteria Study

An Evaluation of the Occurrence and Sources of Fecal Indicator Bacteria in the Camden-Chester-Philadelphia Region and Opportunities for Remediation

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Highlights

- A recreational water quality study targeting the Delaware River in Camden-Chester-Philadelphia.
- The Study increased the understanding of temporal and spatial nearshore FIB concentration variability.
- The Study identified focus areas for enhancing recreational water quality improvements.

Introduction

The Delaware River Bacteria Study is an independent, science-based water quality and water policy study. It evaluates the occurrence and sources of fecal indicator bacteria (FIB) in the Camden-Chester-Philadelphia region of the Delaware River and opportunities for remediation. These bacteria are used as an indicator of recreational water quality by state and federal regulatory agencies. The Delaware River Basin is a source of water for drinking, agricultural and industrial use for over 15 million people, making it a critical resource to the region and nation. The Study Area is the 27-mile stretch of the Delaware River from mile 108 to mile 81 and the tidal reaches of the tributaries to the main stem where the water quality standards have been set to meet FIB levels appropriate for boating recreation. Meanwhile, the Study Area has developed a history of recreation due to improved water quality and expanded waterfront access. The report aims to identify major challenges to achieving swimmable waters within this Study Area and opportunities to accelerate improvements.

This report reviews existing and new data in the context of meeting FIB levels appropriate for swimming recreation. It focuses on combined sewer overflow (CSO) policy and long-term control plans (LTCPs), which describe the planning, design, construction, and monitoring of CSO controls to result in compliance with the water quality-based requirements of the Clean Water Act (CWA), while also reviewing other relevant CWA programs and policies. The study engaged a multi-disciplinary team to conduct a comprehensive analysis of water quality data for FIB, existing water quality programs and investments, water quality regulation and policy, opportunities and constraints inherent in the current regulatory framework, and opportunities and constraints inherent in the socioeconomic landscape of the Study Area. It involved desk top research; stakeholder engagement through meetings, as well as group and individual interviews; data collection and analysis; and regulatory and policy review.

Methodology

Objective 1: Understanding existing FIB water quality conditions and identifying knowledge gaps

Statistical analysis was conducted on existing FIB data, including center channel and nearshore data resulting from monitoring efforts led by the Delaware River Basin Commission (DRBC) and Philadelphia Water Department (PWD). To fill in gaps, the team conducted a supplemental nearshore monitoring effort at 15 sites on the Delaware River in the summer of 2021 designed to explore differences in wet-weather and dry-weather water quality conditions. Use of human-associated DNA markers was also piloted as an approach to understanding the source of FIB loads.

Objective 2: Understanding the timing & extent of FIB water quality improvements from committed investments

The project team reviewed the LTCPs for water utilities on the Delaware River including PWD, Camden County Municipal Utilities Authority (CCMUA) and Delaware County Regional Water Quality Control Authority (DELCORA).

The team conducted interviews and reviewed relevant state and federal policies governing CSO management. This report focuses on LTCPs because they provide the most scope for adaptive management. While stormwater management and other CWA programs can drive future improvements and were also reviewed, these programs are not currently focused on reducing bacteria levels in the waterways directly impacting the Study Area, so they are not currently driving significant investments.

Objective 3: Identifying additional opportunities for improved FIB water quality
Three approaches were used to identify additional opportunities for improved FIB water quality in the Study Area. First, the project team engaged stakeholders through group meetings and interviews to understand their concerns and how those concerns might constrain or support opportunities for remediation. Second, the project team conducted a desktop review of LTCPs beyond the Study Area to identify best practices that might translate to the Study Area. Third, the project team used a suitability analysis of existing recreation access sites to identify potential focus areas for further investment.

Key Findings

The data showed that nearshore FIB levels are highly variable and localized and that remediating CSOs remains central to attaining swimmable water quality in the Study Area. Mapping of MS4 outfalls and additional monitoring would help fill knowledge gaps regarding the source of highly localized bacteria levels and direct additional investments. Remediating MS4 and CSO impacts at specific sites is likely to be less expensive than systemwide CSO remediation strategies. To identify the best near-term investments, regional stakeholders need to increase their understanding of specific site-level conditions and fit actions to those conditions. Because debt financing is dependent on repayments from ratepayers, new non-debt funding should be targeted for new investments to limit the additional burden on the Study Area communities . Use of human-associated DNA markers was piloted as an approach to understanding the source of FIB loads. There is a weak but significant positive association between the human-specific HF183 Bacteriodes and E. coli concentrations. This confirms that FIB is generally from a human source and is therefore a meaningful indicator of human health risk in the Study Area. Nearshore FIB monitoring programs in the Study Area have significant room for improvement.

The three utilities in the study area have LTCPs to reduce CSOs and have committed to substantial investments over the coming years. Investments targeted to CSO remediation currently total $667 million, and planned investments over the next five-year period total more than $1 billion.

Six focus areas were identified for further investment. Pyne Poynt Park, Chester Riverfront, Bartram's Garden, John Heinz National Wildlife Refuge, River Fields, and Frankford Arsenal Boat Ramp may be good candidates for piloting approaches to better understand the nature and cause of bacteria impairments and to design pollution reduction strategies to assist in achieving swimmable waters in the Delaware River.

Recommendations

Ensure that the Study Area cities develop and document clear community priorities for river-based water recreation to direct and drive LTCP/MS4 implementation. This includes: 1) advocate for non-debt financing at the federal and state level for water quality upgrades in CSO watersheds to accelerate LTCP timelines; 2) develop a community based science monitoring network and use the data to better inform the public about bacteria levels; 3) accelerate investments in Green Stormwater Infrastructure (GSI) in communities bordering the Study Area; 4) continually improve implementation of the nine minimum controls (NMC) outlined in each LTCP and communicate these activities to the public; and 5) incorporate climate change risks into CSO remediation strategies.

The recommended actions to meet site-specific conditions at the focus areas include the following actions in CSO sewershed areas impacting the focus area: 1) implement GSI projects; 2) prioritize planned pipe lining; and 3) prioritize planned infiltration and inflow management activities. In areas near the focus areas the Study recommends piloting inlet filters and outfall netting. Other recommendations include mapping MS4 outfalls, implementing GSI and other best management practices to address identified challenges, and initiating or expanding bacteria monitoring programs with data shared on public platforms.

Stormwater Quality Treatment: More Than just TSS, TP, and TN

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Highlights

- Understanding the water quality parameters of concern for a project is an important input when selecting SCMs to manage the storm runoff stream.
- Water quality pollutants of concern include sediment, deicing agents, petroleum hydrocarbons, nutrients, oxygen demanding substances, metals (both total and dissolved), certain bacteria, Herbicides and pesticides, and Debris/litter.
- The six primary treatment mechanisms considered most appropriate for stormwater will be reviewed along with a summary of common Stormwater SCMs providing each treatment mechanism.

Introduction

The goal of water quality treatment is to protect the quality and beneficial uses of receiving waters. Water quality treatment is a primary function of stormwater practices and should be given thoughtful consideration. This presentation will provide an overview of pollutants of concern found in storm runoff, treatment mechanisms effective at removing the pollutants of concern, and treatment processes associated with common stormwater management practices.

Presentation Summary

A primary goal of Pennsylvania's water quality regulations in Title 25 Chapter 93 and Chapter 102 of state code is the protection of water quality and aquatic habitat in waters of the Commonwealth. In addition to providing treatment for TSS, TN, and TP, identifying other pollutants of concern early in project design will aid in determining which water quality treatment practices will be most effective at achieving the goal of protecting commonwealth waters.

Pollutants of concern have been identified by Clary et.al (2020a, and 2020b), Pitt et. al (2018) and others as

- Sediment, including sand, silt, and other suspended solids;
- Deicing agents (salt);
- Petroleum Hydrocarbons, including oil and grease, and combustion by-products;
- Nutrients (Nitrogen and phosphorus);
- Oxygen demanding substances (Chemical oxygen demand and biological oxygen demand);
- Metals, both total and dissolved;
- Certain bacteria;
- Herbicides and pesticides; and
- Debris and litter.

There are six primary treatment mechanisms considered most appropriate for treating these pollutants These include hydrologic attenuation (volume management), sedimentation/density separation, sorption, filtration, uptake/storage, and microbially mediated transformation. Targeted pollutants best treated by individual treatment mechanisms will be reviewed along with the stormwater practices best suited at providing the identified treatment processes.

References

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Environmental Sampling and Analysis of Microplastics – Focus on Stormwater Management Sites

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Microplastics (MPs) are an emerging class of contaminants that have been found in all reachable parts of the world including in the human body. Despite their ubiquity, the full scope of their harmful environmental and health effects is not yet clear. Thus, there is an urgent need to quantify and characterize MPs in the environment. However, MP collection and analysis is currently complex, time-consuming, and expensive, and there are not yet standard methods. Significant effort was put towards creating standard procedures for collection, quantification, and chemical characterization of microplastic particles from urban stormwater (water), bioretention media (soil), and dry deposition (air) using bench scale laboratory methods, Fourier Transmitted Infrared Spectroscopy (FTIR), and Raman spectroscopy.

An overview of MP analysis procedures will be covered, and some recommendations on sampling will be discussed. Current challenges and future improvements in MP analysis at GSI sites will be the main focus. Both FTIR and Raman spectroscopy can be used to determine what types of plastic particles are in the samples and should offer complementary information. To most accurately characterize MPs, a reliable and accessible library containing FTIR or Raman spectral outputs specifically for environmental samples should be chosen. Quality control and contamination avoidance procedures will also be touched on.