Using Constructed Wetlands to Improve and Protect New York State Water Quality

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Preface

The purpose of this guide is to serve as an aid for community leaders and employees, farmers, and landowners in understanding how natural and constructed wetlands improve and protect the water quality of New York State. This guide includes information regarding wetland types, services (ecosystem services/values) provided by wetlands, and lastly how constructed wetlands are created to treat wastewater. Case study examples are provided on two constructed wetlands implemented to treat different types of wastewater. The case studies are provided to demonstrate applicability and feasibility of constructed wetlands as a waterwater treatment practice. Information on regulations and permitting typically associated with constructed wetland construction as well as general wetland permitting is also included.

The information in this guide was derived from government sources and scientific reports, and tailored to fit the needs of small, rural municipalities, farm operators, landowners, and interested citizens. The Syracuse University Environmental Finance Center (Syracuse EFC) created this guide with support from USDA Rural Development.

Located at the Syracuse University Center for Sustainable Community Solutions (CSCS), Syracuse EFC enhances the administrative and financial capacities of state and local government officials, nonprofit organizations, and private sectors to make change toward improved environmental infrastructure and quality of life.

Syracuse EFC facilitates the development of sustainable and resilient communities throughout US EPA Region 2 (New Jersey, New York, Puerto Rico, US Virgin Islands, and eight tribal nations), across the US, and internationally.

More information can be found at *syracusecoe.org/efc*.

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Introduction: What Is a Wetland?

The common definition of a wetland differs among various government agencies; however federal definitions consistently describe a wetland as having “wet soils vegetated with hydrophytes.”[1] Wetlands are further described as a generic term “for all the different kinds of wet habitats – implying that it is land that is wet for some period of time, but not necessarily permanently wet.”[2] State agencies define wetlands on a broader scale, so as to include many different kinds and types within their governance area, and typically involve the presence of certain plant species.[3]

Common Wetland Definitions

Federal (United States Environmental Protection Agency, Clean Water Act): As stated in the “Wetlands Overview” developed by the Environmental Protection Agency (EPA), wetlands “are transition zones where the flow of water, the cycling of nutrients, and the energy of the sun meet to produce a unique ecosystem characterized by hydrology, soils, and vegetation—making these areas very important features of a watershed.”[4] “Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.”[5]

Federal (United States Fish and Wildlife Service): “Wetlands are land transitions between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For the purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominately hydrophytes; (2) the substrate is predominately undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.”[6]

State (New York State Department of Environmental Conservation): “Wetlands (swamps, marshes, bogs, and similar areas) are areas saturated by surface or groundwater sufficient to support distinctive vegetation adapted for life in saturated soil conditions. Wetlands serve as natural habitat for many species of plants and animals and absorb the forces of flood and tidal erosion to prevent loss of upland soil.”[7]

1) Tiner, Ralph. 1996. 2) Ibid. 3) Ibid. 4) USEPA. 2004. Wetlands Overview. 5) USEPA Regulations 40 CFR 230.3 (t) 6)Cowardin et al., 1979. 7)NYSDEC Wetlands Website. Accessed 2014

What Is the Importance of a Wetland?

Wetlands are important ecosystems as they provide goods and services for the well-being of humans. The EPA defines ecosystem goods and services as "life-sustaining benefits we receive from nature."[8] These goods and services are essential for maintaining life as we know it; clean air, water, food availability, and human health are essential, yet difficult to assign a value in terms of economics, or monetary value, and for this reason it is difficult to estimate the precise value of wetlands.[9] Since wetlands do not function exactly alike, value cannot be applied broadly across all wetlands. However, value may be assigned to a wetland based on its functions to society, such as "revenue generated from the sale of fish that depend on the wetland, by the tourist dollars associated with the wetland, or by public support for protecting fish and wildlife."[10] Within this document, since goods and services are of value, the terms will be used interchangeably with the term "value."

In 1984, Ralph Tiner of the Department of the Interior, Fish and Wildlife Service, prepared a document containing major wetland values. These values were divided into three main categories: fish and wildlife values, environmental quality values, and socio-economic values. Examples of each type of value are below.

Fish and Wildlife Values: Wetland provides habitat for fish, shellfish, waterfowl, bird, and furbearers. Additionally, wetlands support biodiversity.[11]

Environmental Quality Values:[12] Wetland protects and enhances water quality by filtering pollutants, removing sediment from surface water, oxygen production, nutrient regulation and recycling, and chemical and nutrient absorption, as well as aquatic productivity, microclimate regulation, and world climate.

Socio-economic Values: Socio-economic values describe goods and services that are most appreciated and recognized by humans since they "provide either dollar savings or financial profit."[13]

Wetlands protect property by providing natural hazard regulation such as flood control, wave damage protection, and erosion control. Other values include groundwater recharge and water supply, timber and other natural products (such as food production), energy source (peat), livestock grazing, fishing and shellfishing, hunting and trapping, recreation, aesthetics, cultural values, education, and scientific research.

8) USEPA Ecosystem Services Website. Accessed 2014. 9) USEPA. 2001. Document: EPA 843-F-01-002c. 10) Ibid. 11) Kentula, Mary and Virginia Engle. 2008. 12) Tiner, Ralph. 1984.; USEPA Ecosystem Services Website. Accessed 2014. 13) USEPA. 2001. Document: EPA 843-F-01-002c.

Natural Wetland Types

Naturally formed wetlands exist in various types, such as marshes, swamps, bogs, and fens. Each of these wetland types may be further broken down and categorized based on the area the wetland is present in, how long water is retained, and type of vegetation present. Below are the EPA definitions of each broad wetland type.

Classified as a type of marsh, this wet meadow is subject to periodic saturation, which is reflected in the variety of wet soil adaptive vegetation present.

Marsh: A wetland that is "periodically saturated, flooded, or ponded with water and characterized by herbaceous (non-woody) vegetation adapted to wet soil conditions. Marshes are further characterized as tidal marshes and non-tidal marshes."[14] There are several types, including freshwater marshes, wet meadows, wet prairies, prairie potholes, playas, and vernal pools.[15]

Swamp: A wetland that is "fed primarily by surface water inputs and are dominated by trees and shrubs."[16] Swamps can "occur in either freshwater or saltwater floodplains" and "are characterized by very wet soils during the growing season and standing water during certain times of the year."[17]

Bog: A wetland that is "characterized by spongy peat deposits, a growth

14) USEPA. 2001. Document: EPA 843-F-01.002b. 15) Ibid. 16) Ibid. 17) Ibid. 18) Ibid. 19) USEPA. 2000. Document: EPA/625/R-99/010. 20) USEPA. 2001. Document: EPA 843-F-01.002b.; USEPA. 2000. Document: EPA/625/R-99/010. 21) USEPA. 2000. Document: EPA/625/R-99/010.

of evergreen trees and shrubs, and a floor covered by a thick carpet of sphagnum moss."[18]

Fen: A wetland that is "groundwater-fed peat-forming wetlands covered by grasses, sedges, reeds, and wildflowers," with willow and birch trees also common.

Constructed Wetlands

Constructed wetlands are defined by the EPA as "artificial wastewater treatment systems consisting of shallow (usually less than 1 m deep) ponds or channels which have been planted with aquatic plants, and which rely upon natural microbial, biological, physical, and chemical processes to treat wastewater."[19] Literature suggests that the main purpose for implementing a constructed wetland is for wastewater treatment, be it municipal, agricultural, or privately generated wastewater.[20] However, implementing a constructed wetland may result in additional benefits, such as providing habitat for local wildlife, or it may be solely implemented for that purpose. A constructed wetland is subject to different requirements and permitting if it is being implemented as mitigation to replace lost wetlands.[21]
Wastewater may require treatment for several reasons. The application of a constructed wetland is appropriate where wastewater is generated from agricultural processes or where wastewater must meet "specific water quality discharge criteria."[22] Implementation of a constructed wetland may occur in rural and urban settings. Advantages and disadvantages for implementing this type of practice over other practices exist for both settings and are presented below.

Advantages of implementing a constructed wetland for wastewater treatment include: (1) flexibility in site location, (2) potential to treat more wastewater in smaller areas than natural wetlands, (3) optimal size can be designed for anticipated waste, (4) design flexibility to "accomplish a variety of treatment objectives," (5) no alteration of natural wetlands are required to implement a constructed wetland, and (6) habitat types within an area may increase due to the existence of the feature.[23]

Disadvantages of implementing a constructed wetland for wastewater treatment include: (1) cost to design and construct, as well as maintenance time and cost, (2) finding optimal location (having suitable land), (3) breeding habitat for nuisance insects and disease vectors, (4) possible odor, and (5) if toxins are present in the wastewater, pretreatment may be required so as to avoid bio-accumulation of these

22) USEPA. 2010. "Clean Water Act Section 401." 23) Hammer, Donald A. 1989. 24) USEPA. 2000. Document: EPA/625/R-99/010. 25) Ibid 26) USEPA. 2010. "Clean Water Act Section 401." 27) NRCS. 2010. Constructed Practice Standard: Constructed Wetland.

toxins in wildlife.[24] If implemented in an urban setting, public opinion and perception may also need to be addressed.

Implementation of this type of treatment system "should be engineered and constructed in uplands, outside of waters of the United States, unless the source water can be used to restore a degraded or former wetland."[25] As with all wastewater treatment systems, a collaborative approach should be taken if many parties are involved, be they public or private. If there is a community-based watershed program, the implementation of a construction wetland should be planned within the broader scope of that program.[26]

Site and Design Considerations

Development of a well-prepared plan, including the design of the constructed wetland, is necessary. Specifications for the dimension, species of vegetation with planting plan/schedule, and site stabilization should be included in the plan.[27] General criteria provided by the Natural Resources Conservation Service practice standard for constructed wetlands includes inlet and outlet controls; embankment height corresponding to anticipated volume of a 25-year, 24-hour storm; suitable soils for embankment and plantings; consideration of supplying water to support vegetation during dry periods; a pretreatment or primary settling basin; and avoid letting livestock access to constructed wetland area. The following should be considered when implementing a constructed wetland and are dependent upon the purpose of implementing the constructed wetland: substrate suitability; soil chemistry; hydrology/geomorphology such as surface and groundwater flow patterns, use, quantity, and chemistry, vegetation type; critical

An experimental wetland tests the adaptive capacity and water quality treatment aspects of various vegetation.

28) USEPA. 2000. Document: EPA 843-B-00-003. 29) USEPA. 2010. "Clean Water Act Section 401." 30) Hammer, Donald A. 1989. 31) Mishiri, Gerald A. 1993.

wildlife habitat; cultural/socioeconomic impacts; surrounding landscape; land use/zoning as well as land availability; impacts to health and safety; surface materials and soils; bedrock depth; topography; and available construction materials.[28]

Additionally, EPA suggests designing a constructed wetland with diverse “soft structures,” incorporating the natural landscape with native vegetation, avoiding the creation of stagnant water areas to reduce or eliminate the presence of mosquitos, as well as incorporating a buffer zone and transition zone.[29]

Specifications and criteria for implementing a constructed wetland are available from various sources. The following reference material may be of help when considering implemention of a constructed wetland:

1. The Natural Resource Conservation Service National Engineering Handbook, Part 637, Chapter 3: Constructed Wetlands.
2. The Natural Resources Conservation Service Practice Standard: Constructed Wetland. Code 656.
3. Construction Specification 656 for Constructed Wetlands. Technical Guide Section IV. Document number: PA 656-SP1. Pennsylvania. October 2011.

Operations and Maintenance

Along with a plan to build the constructed wetland, an operations and maintenance plan should be developed to keep the constructed wetland running optimally. Included in this plan should be safety requirements, as well as requirements for “water management, cleanout of sediment, maintenance of structures, embankments, and vegetation, control measures for vectors and pests, and containment of potential pollutants during maintenance operations.”[30]

Maintenance of the constructed wetland may demand easy access to filter cells, if multiple cells are used. Each cell may be managed differently, according to its purpose. Furthermore, constructed wetlands may be subject to “intentional, programmed disturbances” in order to mimic natural systems.[31] These disturbances enhance species diversity; increase sediment and detrital surface area which maximizes microbial growth and storage capacity; favor anaerobic conditions which enhance retention of nutrients and organic matter; favor hydrology that will allow microbial access to dissolved organic matter, space for growth and storage, and provide “alternative electron acceptors to oxygen” to maximize retention.[32]

32) USEPA. 2000. Document: EPA 843-B-00-003. 33) Hammer, Donald A. 1989.

Other considerations include wildlife controls, as excessive use may cause degradation. Maximizing diversity of plant species may be a simple way to control undesirable species. Along those lines is the awareness of the seed bank present in soils if soils are imported from another area. Undesirable species may be present in soils from other areas. Accommodation for meteorological extremes is another consideration as large-volume storms can erode sensitive or vulnerable areas within your constructed wetland. Lastly, public acceptance of the constructed wetland may be required if the practice is being implemented in a public area of high visibility.

Did you know? *Constructed wetlands can be constructed for wetland habitat or effluent treatment with varying degrees of each in between. Constructed wetland effluent has potential to be used to restore degraded wetlands. There are, of course, standards to be met for the effluent, and a case must be made that the effluent will enhance the aquatic system, both structurally and functionally. Determination of whether this is an option for your situation will be made by regional authorities. Contact your local NRCS agency today and inquire about Agriculture Conservation Easement Program (ACEP), as there are wetland reserve easements that may be of interest.*

Permitting (Federal, State, Tribal, and/or Local Regulations)

Understanding exactly when and why you need federal, state, tribal, or other local permits is often confusing. Permit applications generally require some sort of design and plan for water effluent coming from a construction site and/or from a conservation practice under certain circumstances, and always when this water is to enter a water of the United States. This section aims to clarify when and what permit is needed in the case of implementing a construction wetland.

Let's first address the issue of whether your newly implemented constructed wetland will be considered a water of the United States. "When constructed wetlands systems are designed, built, and operated for the purpose of wastewater treatment, the constructed wetlands treatment systems are not considered waters of the United States."[33] If the constructed wetland is to be implemented to restore a wetland and is therefore placed within the boundaries of a previous wetland, then the constructed wetland will be considered a water of the United States and strict regulations will follow regarding the quality of water entering the system.

It should go without saying that the constructed wetland should be implemented in an upland location, outside of the waters of the United States. All wastewater treatment systems are to be designed

34) USEPA. 2004. Document: EPA 832-R-04-001. 35) Mishiri, Gerald A. 1993. 36) USEPA. 2000. Document: EPA 843-B-00-003. 37) Hammer, Donald A. 1989.

to meet the requirements of the Clean Water Act to protect the country's waterways; requirements are stated as a minimum discharge comparable to secondary effluent.[34] Secondary treatment, and the resultant effluent, have approximately 90 percent of organic material filtered from it, mainly through biological processes.[35]

However, it is possible for a constructed wetland to become a water of the United States if it is no longer used as a treatment wetland.[36] A constructed wetland may be considered a water of the United States if the constructed (treatment) wetland maintains wetland characteristics after its use as a treatment wetland and "the following conditions apply: (1) it is an interstate wetland, (2) it is adjacent to another water of the United States (other than a water which is itself a wetland), or (3) it meets the interstate commerce requirements for an isolated intrastate water of the United States."[37]

Find below common permit requirements for building and use of a constructed wetland. The case may be that no permits are required at all for implementing the constructed wetland.

Federal Permitting

Section 401: A State Water Quality Certification stating that the proposed activity will comply with state water quality standards must be obtained for every applicant of a federal permit for any activity that may result in a discharge to a water body. Often, this is issued in connection with a Section 404 permit. Any/all activities resulting in impacts to a water of the United States require a 401 permit.

Section 402: National Pollutant Discharge Elimination System
A general construction stormwater permit must be obtained for discharge of pollutants from point sources. The following criteria apply:

- *If the amount of land disturbed is greater than or equal to 1 acre and stormwater discharges to a water of the United States.*
- *If there will be a discharge of fill and/or dredged material into a water of the United States.*

This permit will set "specific discharge limits for point sources discharging pollutants into water of the United States and establishes monitoring and reporting requirements, as well as special conditions."[38] In New York State, this program is administered by the state.

Section 404: Discharge of Dredged or Fill Materials
If any dredged or fill material will enter a water of the United States,

38) USEPA NPDES Section 402 Website. Accessed 2014. 39) USEPA Section 404 of the Clean Water Act Website. Accessed 2014. 40) USEPA. 2010. "Clean Water Act Section 401."

a Section 404 permit is required. According to the EPA website regarding Section 404 permitting, “activities in waters of the United States regulated under this program include fill for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and mining projects.”

If a constructed wetland has no discharge, it may be considered an exempt farming activity similar to the construction and maintenance of farm or stock ponds.

Certain activities, including many normal farming activities, are exempt from Section 404 regulation. Examples of exempt activities include maintenance to drainage ditches, construction and maintenance of farm or stock ponds, construction and maintenance of farm and forest roads, and other normal farming activities.

The applicant “must demonstrate that the discharge of dredged or fill material would not significantly degrade the nation’s waters and there are no practicable alternatives less damaging to the aquatic environment.”[39]

Clean Water Act Section 401 Certification:
States and tribes have the authority to certify federal permits as compliant with local water quality standards. No permit shall be issued unless 401 certification has been issued by the State or tribe. “Under §401, a federal agency cannot issue a permit or license for an activity that may result in a discharge to waters of the United States until the state or tribe where the discharge would originate has granted or waived

41) USEPA NPDES Section 402 Website. Accessed 2014. 42) Hammer, Donald A. 1989. 43) NYSDEC State Pollutant Discharge Elimination System Website. Accessed 2014. 44) NYSDEC Website “SPDES Permit Program: Do I Need a Permit?” Accessed 2014. 45) NYSDEC Website “Introduction to SEQR.” Accessed 2014. 46) NYSDEC State Pollutant Discharge Elimination System Website. Accessed 2014. 47) Ibid.

§401 certification.[40] The central feature of CWA §401 is the state or tribe's ability to grant, grant with conditions, deny, or waive certification. By granting certification, with or without conditions, the federal permit or license can be issued consistent with any conditions of the certification. Similarly, denying certification prohibits the federal permit or license from being issued.

A waiver allows the permit or license to be issued without state or tribal comment. States and tribes make their decisions to deny, certify, or condition permits or licenses based in part on the proposed project's compliance with EPA-approved water quality standards. "In addition, states and tribes consider whether the activity leading to the discharge will comply with any applicable effluent limitations guidelines, new source performance standards, toxic pollutant restrictions, and other appropriate requirements of state or tribal law."[41]

New York State Permitting

"Environmental and regulatory considerations vary from state to state for various wastewaters to be treated and for the entity proposing to construct a wetland treatment system."[42] The following permits are for construction and/or discharges in New York State.

New York State Pollution Discharge Elimination System (SPDES)
This program is "broader in scope than that required by the Clean Water Act in that it controls point source discharges to groundwaters as well as surface waters."[43] A permit is required if an outlet or discharge pipe will "discharge wastewater into the surface waters of ground waters of the state."[44]

State Environmental Quality Review (SEQR)
It is required that "all state and local government agencies" consider environmental impacts during decision-making and therefore need to complete an Environmental Impact Statement if environmental impacts are anticipated.[45] If environmental impacts are not anticipated, then a "determination of nonsignificance is prepared."[46] SEQR applies to "all state or local government agencies, including districts and special boards and authorities, whenever they must approve or fund a privately or publicly sponsored action."[47]

Actions undertaken by individuals on their private land are not subject to SEQR unless public funds are utilized.

48) Schueler, T.R. and H.K. Holland. 1994. 49) Ibid. 50) CH2MHILL and CHA. 2011

Case Studies

Two case studies are presented below. They differ in both spatial and temporal aspects. Case Study 1 presents various experimental constructed wetlands implemented for large-scale treatment in an urban setting, while Case Study 2 presents a constructed wetland implemented on a farm for specific farm-related wastewater. Information presented, if available, includes the problem being addressed and therefore the purpose of implementing a constructed wetland, location and background information, permitting requirements, system description, and system effectiveness.

Case Study 1: The Use of a Constructed Wetland Pilot Project for Sanitary Sewage and Stormwater Overflow in an Urban Setting

Problem and Purpose

Urbanization can drastically alter the natural hydrologic cycle within an area and destroy natural areas like wetlands that contribute to services such as water quality and stormwater runoff control. “Monitoring and modeling studies have consistently indicated that urban pollutant loads are directly related to watershed imperviousness.”[48] Along with an increase in pollutant loading, impervious surfaces contribute to larger volumes of stormwater runoff within an area as compared to a vegetated area; as stormwater gains volume, the capacity for this water to carry sediments and rocks as well as erode road surfaces increases.[49] Additionally, pollutants carried by stormwater runoff include trace metals, materials from cars (exhaust particles, fluids, tubings, linings), salts, pesticides, herbicides, and fertilizers, to name a few.

For the application of stormwater treatment, a pilot program incorporating three constructed wetlands was implemented to test the effectiveness of each and to serve as an area for public education. The program was implemented as part of an Onondaga County program called Save the Rain, in which the primary goal is to improve the water quality in Onondaga Lake. In Syracuse, N.Y., storm events present a water quality challenge because of the type of sewer system currently installed in parts of the city: combined sewer overflows (CSOs). Compounding the issue, the urbanization of small watersheds within and around Syracuse has resulted in a dramatic decline of wetland areas. Therefore, wetland functions, like stormwater retention and filtration for water quality, are not being carried out. During storm events,

51) Ibid. 52) NYSDEC Website “Introduction to SEQR.” Accessed 2014.

stormwater runoff and sanitary sewage may overflow wastewater treatment plants, resulting in the overflow material being sent indirectly into Onondaga Lake. Overflow material in this case includes all materials that stormwater may carry as well as raw sewage. It is anticipated that this constructed wetland system will reduce unwanted bacteria, excess nutrients that may lead to eutrophication, total suspended solids, and biochemical oxygen demand (5-day).[50] A possible method to ameliorate the water quality issues of Onondaga Lake in light of these obstacles is the implementation of constructed wetlands.

Location and Background Information

The Harbor Brook Watershed Area in Syracuse collects sanitary sewage and stormwater, which then discharges into the Harbor Brook Interceptor Sewer (HBIS). Due to the fact that in the City of Syracuse, CSOs are common and carry both stormwater and sanitary sewer water during storm events, flow overwhelms the system, dumping untreated sewage and stormwater via CSOs into Onondaga Lake. As compared to the alternative of building a new wastewater treatment plant, constructed wetlands offer a cost-effective and sustainable alternative. An alternative practice to building and maintaining another wastewater treatment facility, such as the implementation of a constructed wetland, is a suitable solution for large communities with wastewater capacity issues.

The project is located near the intersection of Velasko Road and Onondaga Boulevard in Syracuse on about 34 acres of continuous, county-owned land. Identifying the optimal location was difficult given the nature of the surrounding area, which is very urban and with many different property owners in a given area. Therefore, it was advantageous to seek out a large site of undeveloped land. This land was previously used as the site of a county-owned retention basin. Site location selection involved county and city officials and engineers.

Permitting Explained

Investigations for environmental resources identified the project area as having both state and federally regulated wetlands and a stormwater management basin. Also the project will involve the relocation of stormwater outfall into Harbor Brook and the relocation of a ditch inhabited with wetland vegetation.[51] A joint application for permit was prepared and submitted to the state Department of Environmental Conservation and the U.S. Army Corps of Engineers to obtain the permits identified. The following permits and approvals were therefore required:

53) CH2MHILL and CHA. 2011. 54) Ibid. 55) Ibid.

1. A State Pollutant Discharge Elimination System (SPDES) permit was required for the modification of the stormwater outfall (CSO 018) to Harbor Brook to address relocation and treatment.
2. Onondaga County, being a public entity, had to undergo a State Environmental Quality Review (SEQR). "SEQR requires the sponsoring or approving governmental body to identify and mitigate the significant environmental impacts of the activity it is proposing or permitting."[52] The project was determined a Type I action, as it is likely to result in impacts to the environment and require a full Environmental Assessment Form (FEAF). A Negative Declaration was anticipated to be issued since "the project is intended to improve water quality from CSO 18 and the project impacts are occurring on previously disturbed lands."[30]
3. To relocate the outfall and impacts of the wetland ditch, which is for facility design, a U.S. Army Corps of Engineers Nationwide Permit (NWP) No.43- Stormwater Management Facilities was applied for.
4. Also to relocate the outfall into Harbor Brook, a permit modification of Article 15 Protections of Waters was addressed. Harbor Brook is classified as a Class B waters.
5. Required in conjunction with the NWP and Article 15 permit, a Section 401 Water Quality Certification was applied for from NYSDEC.
6. "SPDES General Construction Permit for land disturbances in excess of one acre. A Stormwater Pollution Prevention Plan will be prepared and a Notice of Intent submitted to NYSDEC."
7. As per several permit conditions, the project coordinated with the NYS Natural Heritage Program; U.S. Fish and Wildlife Service; and NYS Office of Parks, Recreation and Historic Preservation to ensure no impacts to protected species and cultural resources.

System description

It is estimated that the wetlands, once implemented, will be able to capture and treat 13.6 million gallons of combined sewage from a catchment area of 145 acres.[53] Wetland parameters and characteristics were determined to handle the annual CSO flow of 13.6 million gallons with consideration given to handling the estimated 42 overflow events per year and for volume and peak flow rates for one-year, two-hour storm events.[54] Three types of constructed wetlands were installed

56) CH2MHILL and CHA. 2011. 57) Ibid

during this project: a floating wetland, a vertical down flow wetland, and a subsurface flow wetland.

Combined sewage flow will initially be subject to grit and floatables removal, which has an overall goal of reducing the required maintenance on the system by protecting “the constructed wetland treatment system from an influx of inorganic material,” preventing degradation of the constructed wetlands in general via solids deposition. This may, therefore, require manual removal, by preventing clogging of water transport pipes, preventing attraction of unwanted wildlife, and to “ensure an aesthetically pleasing and attractive area.”[55] The orientation of the three constructed wetlands was designed with flexibility so that optimal efficiency can be determined through research and data collection of possible scenarios. Flow control structures were installed allowing water treatment to occur in series, parallel or series/parallel within and between the constructed wetlands.[56] Treated flow is discharged to Harbor Brook via one outflow.

Wetland Type Descriptions[57]

Floating Wetland Island

This wetland consists of a “man-made floating island of wetland vegetation with roots that extend down into the water column below the island mat.” The vegetation consists of native species that do not require regular maintenance to maintain wetland effectiveness. The design of the wetland in particular allows for constant variability in water depth and therefore storage capacity; water depth may vary from one to five feet. Also, the wetland will be aesthetically pleasing, having high habitat value, cultivating mosquito predators such as dragonflies and amphibians.

Surface Flow Wetland

This low-cost wetland “most closely resembles a natural wetland” with constant presence of surface water under dry conditions, with water depth being variable within the wetland itself. The wetland will have a high storage capacity. Other wetland functions this particular wetland will serve include re-aeration of water and high-quality wildlife habitat. Native vegetation will inhabit the wetland.

Vertical Down Flow Wetland

This wetland was designed to withstand regular draining and flooding. Designed with sand and gravel beds, percolation of water through these layers provides pollutant filtration. Regular draining of this wetland is advantageous, as it does not provide habitat for mosquitoes.

58) Baker, L.A. 1992.; Dressing, S.A. 2003. 59) NYSDEC Wetlands Website. Accessed 2014. 60) Gottschall, N., et al. 2007. 61) Inamdar, Shreeram P. , et al. 2002.

What About Citizen Concerns for Constructed Wetlands?

Concerns from citizens included mosquito problems, unpleasant odors, drinking water contamination, safety for small children as well as other safety and health issues. Public perception and involvement were continuous and essential to implement a project of this nature in an urban setting. In the first stages of project development, the EPA issued a guidance statement, which addressed citizens' concerns. In this statement the EPA strongly suggested considering the perception of the constructed wetland by the public. By doing so, the community can feel involved and therefore provide support for such a project. Being honest about the goals and objectives of the project will help gain public support and approval. By planning a project with community involvement early in the process, the planning team will help ensure public support and approval for the goals and objectives while developing a safe project for everyone to enjoy. Creation of interpretive program was also implemented using field photography and graphic documentation of all steps and techniques used in wetland construction and creation, vegetative community establishment, and wildlife habitat enhancement to keep the public informed.

Other Considerations Before Implementation

Other considerations before implementation include water table elevation, discharge location, berms and maximum water depth, geotechnical recommendations (fill types, buried pipe depth, material composition), cell lining (required or not) and groundwater impacts, compensatory storage, water level control, and site security.

Maintenance

The grit and floatables removal system maintenance includes general monitoring to ensure the system is working optimally and to remove floatables that the removal screen did not get, which is to be done manually and is not expected to occur regularly. The wetland treatment system requires operation attention, as flow controls and weirs are responsible for the movement of wastewater to and from wetland types. During the periods in between storm events, supplemental water may be required to keep organisms, including plants, alive in the wetlands. Maintenance may also be required to control mosquitoes, nuisance wildlife, and odors.

System Effectiveness

Monitoring is currently under way to analyze the effectiveness of the system.

62) USEPA National Drinking Water Regulations; 1989 Total Coliform Rule Website. Accessed 2014 63) Dressing, S.A. 2003. 64) Ibid. 65) Hammer, Donald A. 1989.; Baker, LA. 1992. 66) Baker, LA. 1992
67) Bartlett, C. 2014. Personal Communication. 68) USEPA and Department of Army. 2014. Clean Water Act Section (f) (1) (A) Interpretive Rule.

Case Study 2: Effectiveness of a Constructed Wetland for Treatment of Agricultural Runoff

Problem and Purpose

Agricultural runoff is among the highest contributors of nonpoint source pollutants to nearby freshwater systems.[58] Pollutants resulting from agricultural activities include nutrients, sediments, and pathogens.[59] Nutrients of concern when dealing with agricultural wastewater are most notably nitrogen and phosphorus, as they can lead to eutrophication of surface waters.[60] Pathogens present in fecal coliforms, which are present in wastewater runoff from agricultural activities, are also a leading cause of pollution in surface waters, behind nutrients and sediments.[61] The U.S. EPA has published “a maximum contamination level of zero for total coliforms, including fecal coliforms and E. coli.”[62] Fecal coliforms pollute surface waters adjacent to agricultural activities as livestock manure contains fecal bacteria. Furthermore, it has been found that land applications of manure, or simply livestock in pastures adjacent to surface waters, are significant polluters in terms of fecal coliforms.[63] Concentrated animal feeding operations (CAFOs) are major contributors of fecal coliforms,[64] as well as nutrient pollutants, which can impair local watersheds if not properly managed.

Water samples are taken to measure the effectiveness of the wetland on water quality improvement. Duckweed present on the surface is an indication of nitrogen removal from the water.

62) USEPA National Drinking Water Regulations; 1989 Total Coliform Rule Website. Accessed 2014 63) Dressing, S.A. 2003. 64) Ibid. 65) Hammer, Donald A. 1989.; Baker, LA. 1992. 66) Baker, LA. 1992
67) Bartlett, C. 2014. Personal Communication.

To address the issue of agricultural pollutants entering surface waters, constructed wetlands have been developed and implemented as a type of best management practice (BMP) used for the function of filtration of agricultural wastewater to maintain water quality of nearby surface waters. Constructed wetlands were proven to reduce nutrient loading into nearby surface waters by providing nutrient storage.[65] As presented by Gottschall et al. (2007), the use of constructed wetlands to treat agricultural waste is appropriate because of "their relatively low construction and operating costs, and their demonstrated effectiveness." However, the effectiveness of a constructed wetland may vary over time and scheduled maintenance and disturbances may be necessary to maintain effectiveness.[66]

Location and Background Information

The constructed wetland was implemented to treat agricultural wastewater runoff from a livestock operation during heavy rain events. In other words, the wetland is treating high-flow, low-concentration of agricultural waste per volume of stormwater. The main source of the wastewater consisted of leachate from the farm's feedstock pile. During non-rain events, the pile still releases low-flow, high-concentration leachate, which is then moved into storage for field application. The constructed wetland was implemented in 2007 as an alternative to spreading the high-flow, low-concentration wastewater with machinery on fields, of which the estimated cost is 6 cents per gallon. Construction of this practice took approximately 1.5 months and total costs were approximately $25,000.[67]

The wetland was separated into five segments to allow retardation of water flow, which prolongs biological activity and enables sedimentation to improve water quality.

Permitting Explained

No permits were applied for during the construction of this conservation practice because, as described by the Clean Water Act, this activity is considered exempt from EPA oversight. It is a normal farming activity which is necessary to conserve and protect soil, “water and related resources in order to sustain agricultural productivity.”[68] The construction of such conservation practices must be in “conformance with NRCS technical standards” and would therefore not require pre-approval from the Corps of Engineers or the EPA. Before the implementation of the constructed wetland, the previous land use of the site was old pasture. The constructed wetland discharges into a vegetated area and not a water of the United States.

System Description

The total capacity of the constructed wetland is calculated to be approximately 2,127,367 gallons (or about 284,407 ft3), which surpasses the volume of water anticipated during 24 hours of a 25-year storm event. The area for stormwater runoff that contributes to the constructed wetland includes rooftops and driveways of and around the livestock operation. Stormwater runoff from these sources carries with it leachate from feed and manure. Water is collected and pumped from a primary catchment basin to a secondary basin, which is located at the beginning of the constructed wetland. There are four filter cells following out of the second catchment basin, each separated by a wall of fill with a spillway for water transport.

Maintenance

Ongoing costs include pump and electrical switch operation to pump stormwater/wastewater from the primary catchment basin to the secondary catchment basin. Otherwise, mowing and dredging of solids from the settling cells should be performed when necessary.

System Effectiveness

The effectiveness of the constructed wetland to filter out nutrients was analyzed as a collaborative effort between institutions of higher education, private testing companies, and the regional Soil and Water Conservation District. To measure the effectiveness of the constructed wetland at removing pollutants from wastewater, water samples were obtained at the inflow and outflow of each filter cell as well as the secondary catchment basin.

There were strong correlations between concentration of pollutants and distance from source (secondary catch basin). As the distance from the catch basin increased, concentration of many pollutants decreased. Most notably are the agricultural pollutants commonly attributed to water quality degradation such as total nitrogen, nitrate, and phosphorus. At the outflow of the constructed wetland, all concentrations of pollutants were lower than those present in nearby surface waters. This same trend is apparent for fecal coliforms as well.


A single filter cell shows the detention capacity of the wetland.

Applicability and a Permitted Practice: Vegetated Treatment Areas

According to the New York State Department of Environmental Conservation's General Permit for Concentrated Animal Feeding Operations (CAFOs), water discharging from a vegetated treatment area (VTA) is not "considered process-generated waste water." Conversely, water discharging from a constructed wetland located on a CAFO is subject to water quality standards and may therefore not be suitable as a conservation practice in a CAFO setting. The implementation of a constructed wetland should be seriously thought out and a management plan should be developed to ensure optimal filtration of pollutants throughout use.

A vegetated treatment area is a standard practice engineered by the NRCS, code 635. It is defined here as "an area of permanent vegetation used for agricultural wastewater treatment." There are variables to consider before implementing any standard practice, plans should be made, and you should consult with your local NRCS agency.

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