TREATMENT WETLAND RESEARCH & IMPLEMENTATION IN CENTRAL NEW YORK as part of Wetlands, Watersheds and Resources Technical Assistance partnership Forum Thursday March 22, 2012 Center of Excellence

By Richard Smardon PhD Professor of Environmental Studies, SUNY/ESF

Green Infrastructure & wetlands

- Drivers
  - Urban runoff water quality & CWA
  - Flooding & erosion control prevention
  - Air quality & microclimate improvement
  - Improving urban health & amenities
  - Growth control vs. urban regeneration

Green Infrastructure Questions

- Issues affecting GI implementation
  - Obstacles to implementation (NSF/USFS Ultra)
  - Cost effectiveness (Jaffe et al 2010)
  - Emergy analysis (Rodriguez 2011)
  - Life cycle analysis (Rodriguez 2011)
  - Effectiveness in providing ecological services (see CNT 2010)

Ongoing Research projects

- CNY Watershed Project > Harbor Brook CSO Treatment Wetlands
- Agricultural Waste Treatment Wetlands
- Green Infrastructure NSF/ US Forest Service ULTRA project in Syracuse, NY

HARBOR BROOK TREATMENT WETLAND CASE STUDY #1

- PROJECT PARTNERSHIP:
  - ATLANTIC STATES LEGAL FOUNDATION
  - SUNY COLLEGE OF ENVIRONMENTAL SCIENCE & FORESTRY
  - ONONDAGA COUNTY + CITY OF SYRACUSE
- PILOT STUDY: IDENTIFY SITES FOR CSO TREATMENT > BUILD w/CH2Mhill

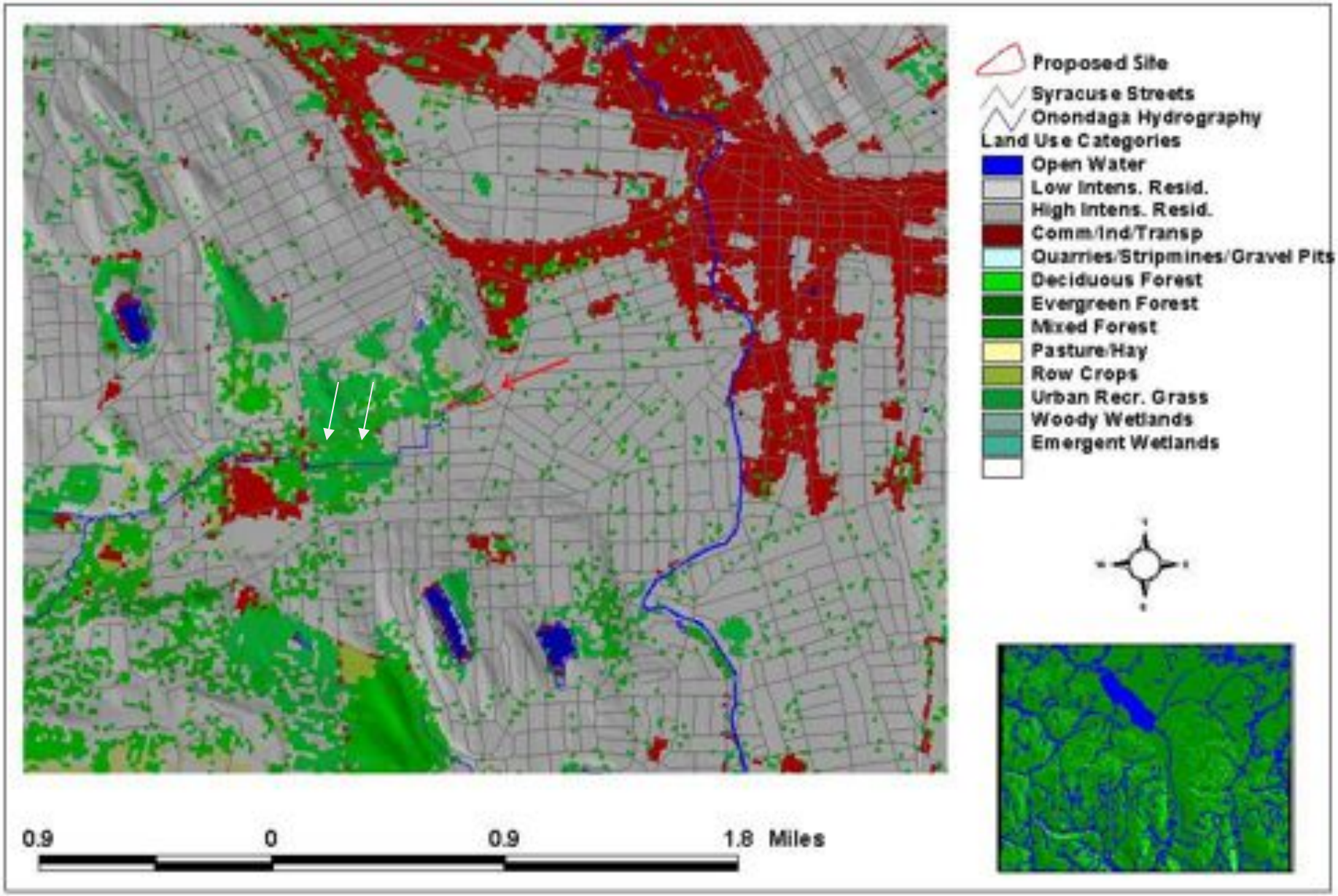
PLANNING STRATEGY IMPLEMENTATION

- Review of sites proposed for creating treatment wetlands
- Eleven sites reviewed for : access, land availability, engineering feasibility, hydrology, soils, drainage area, and upstream CSO loading

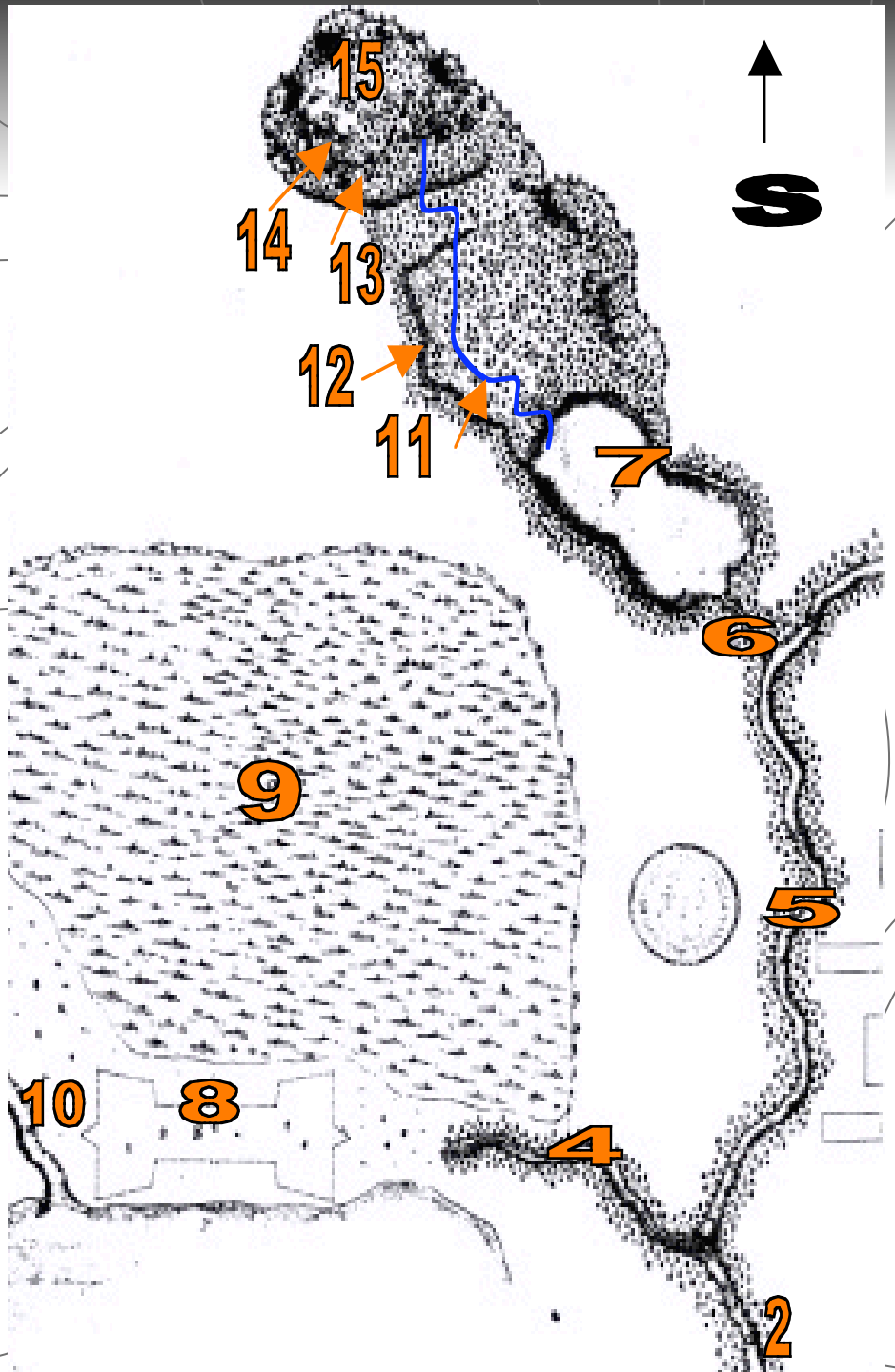
PLANNING PROJECT RESULTS

- Harbor Brook = selected site
- Site design for wetland treatment
- Land/existing facility availability
- Topography
- Compatible environmental resources

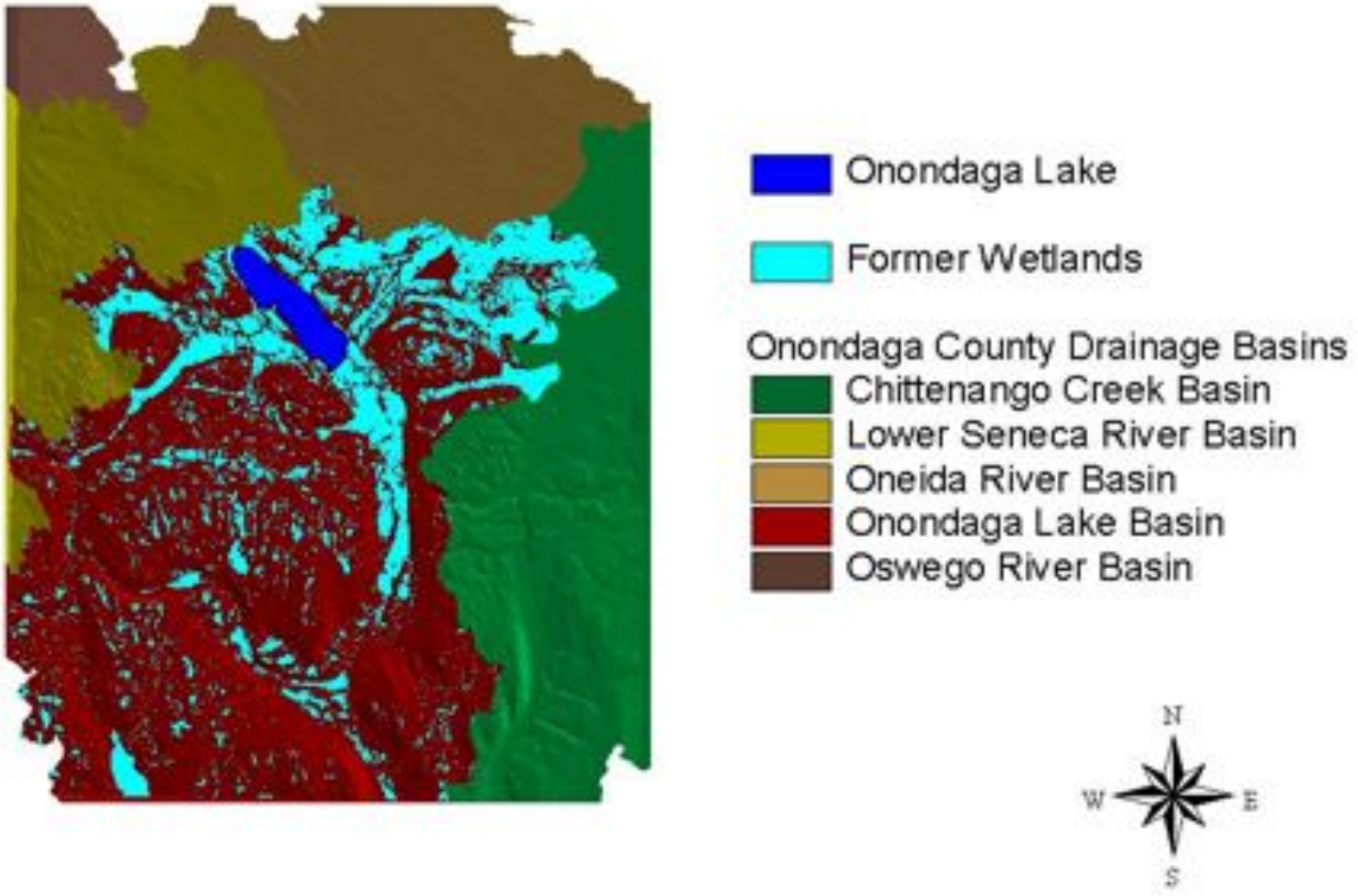
Proposed Constructed Treatment Wetland Site at Delaware and Grand Avenues, Syracuse, NY

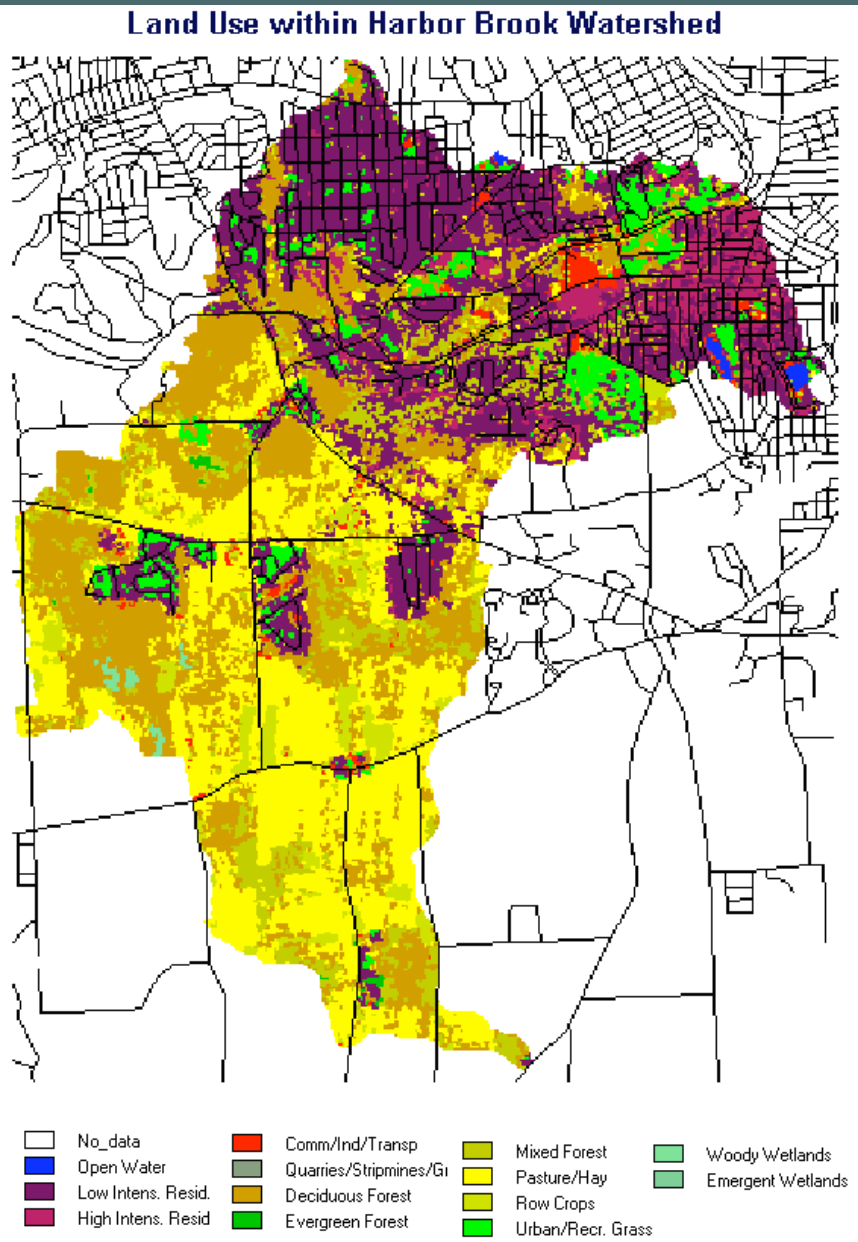


Map of Frontenac's Expedition Route against the Onondagas, 1696. Source: Naval Department, Government of France.



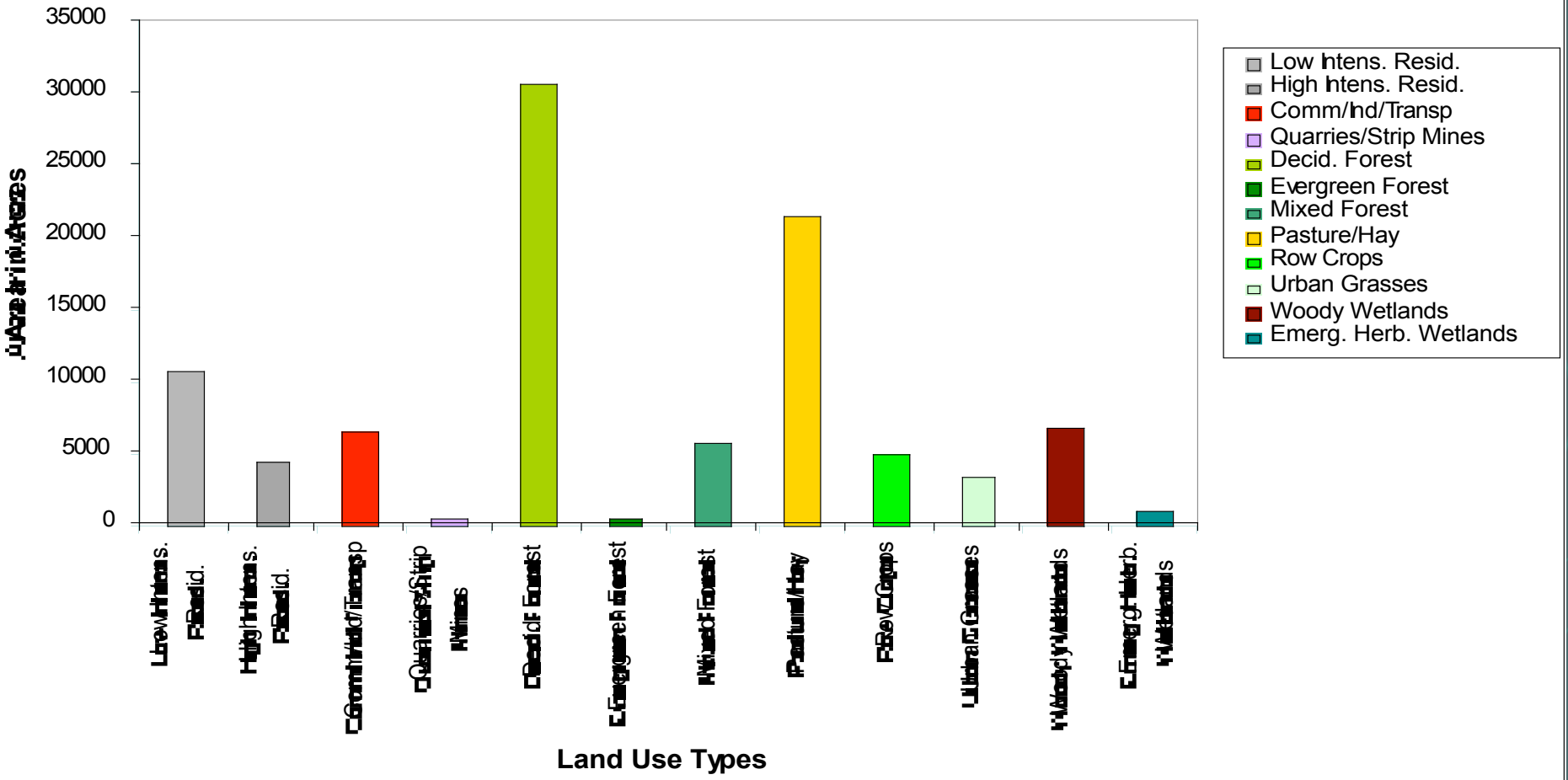
Onondaga Lake Drainage -- Estimated Former Wetlands



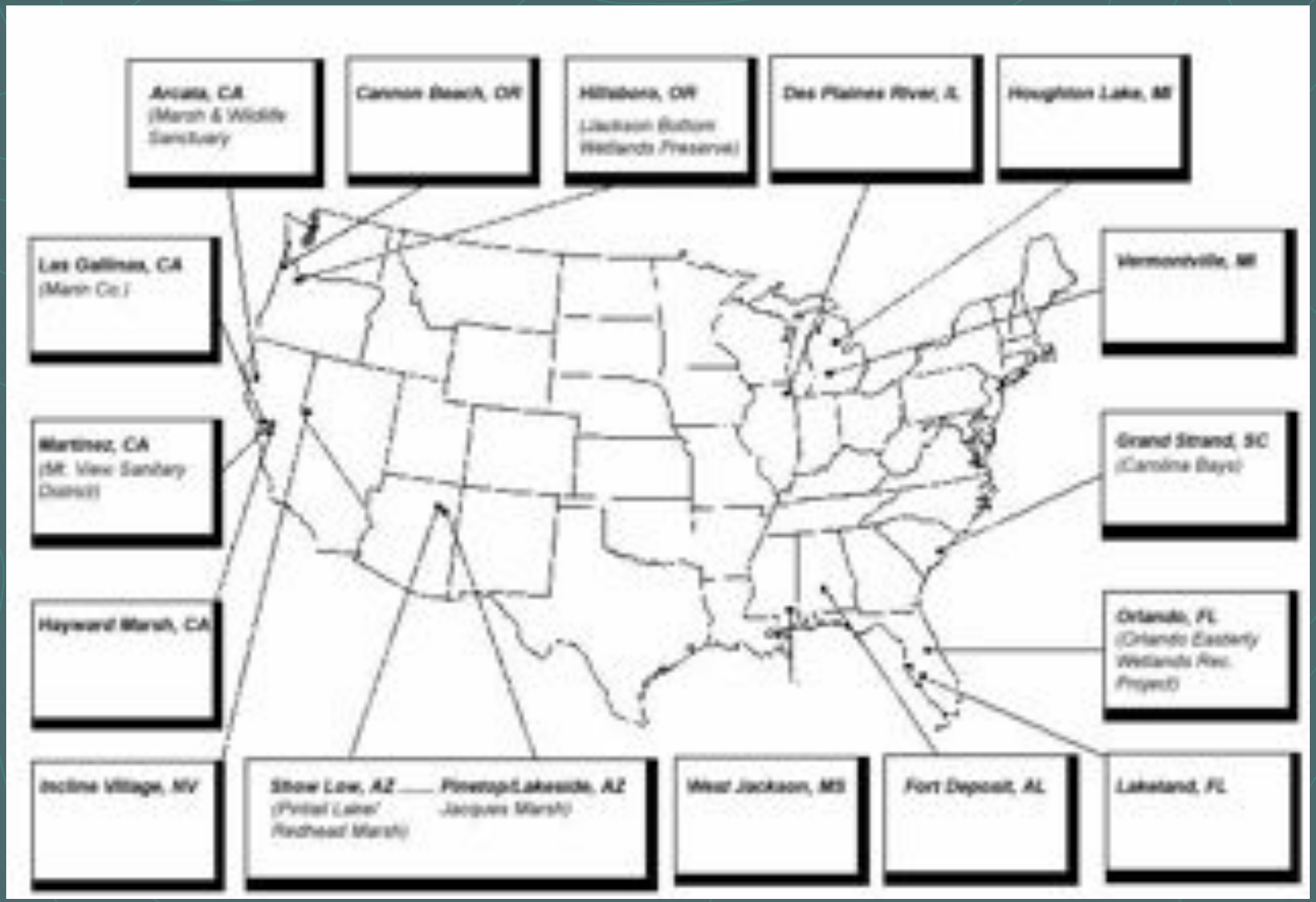


Harbor Brook Watershed Delineation and Land Use Characterization

Present Day Land Use in Areas of Former Wetlands (Onondaga Lake Drainage)



Successful Constructed Wetlands Case Studies in US



Results

- The planted gravel beds achieve better than 90% removal of chemicals than the planted soil beds which remove around 80%
- Ammonia-35% was removed in all beds
- Oxidized nitrogen was always low in each bed
- Phosphorus removal showed to be insignificant in the gravel beds but not in the soil beds

Aerial View of Current site

Typical streambed character

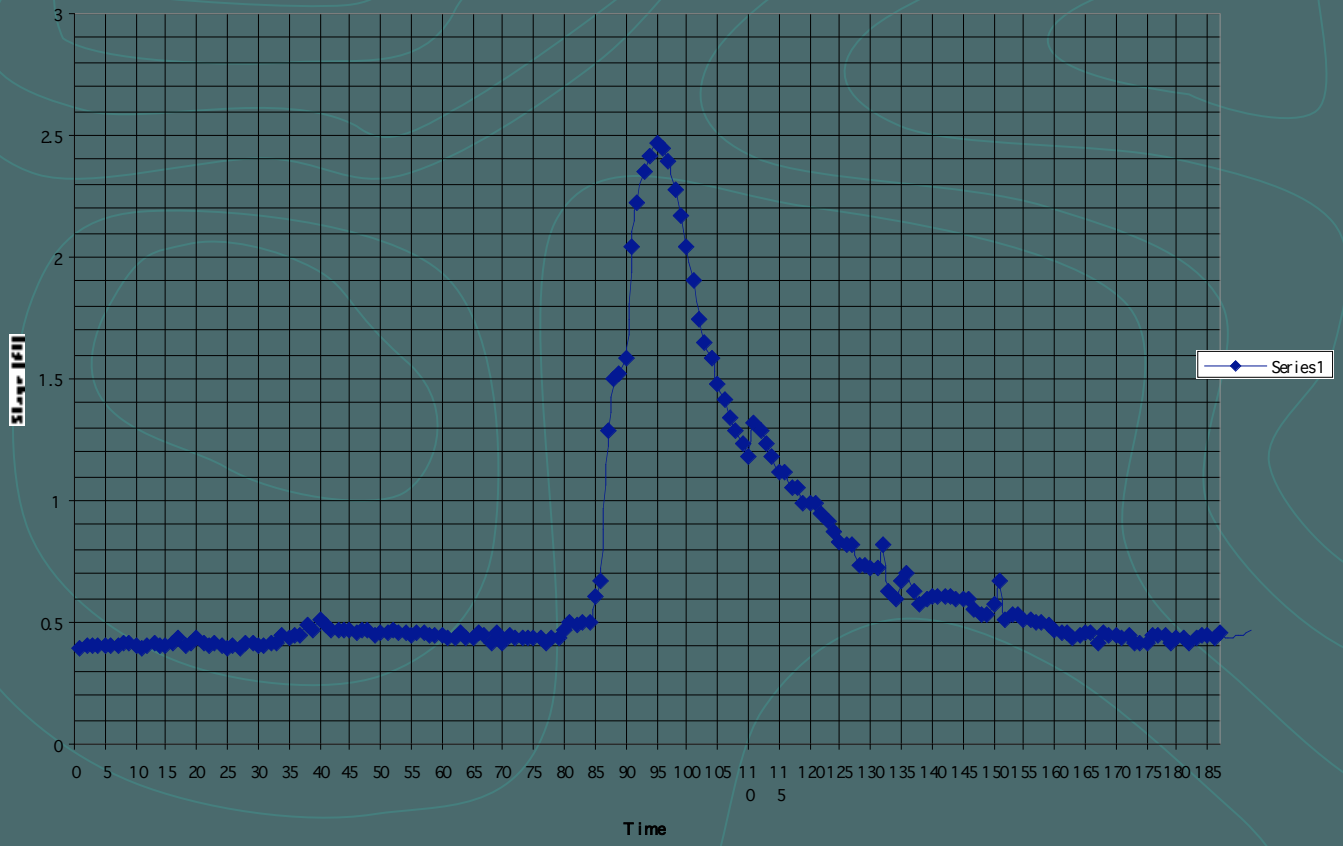
CSO Inlets

View of Harbor Brook wetland site

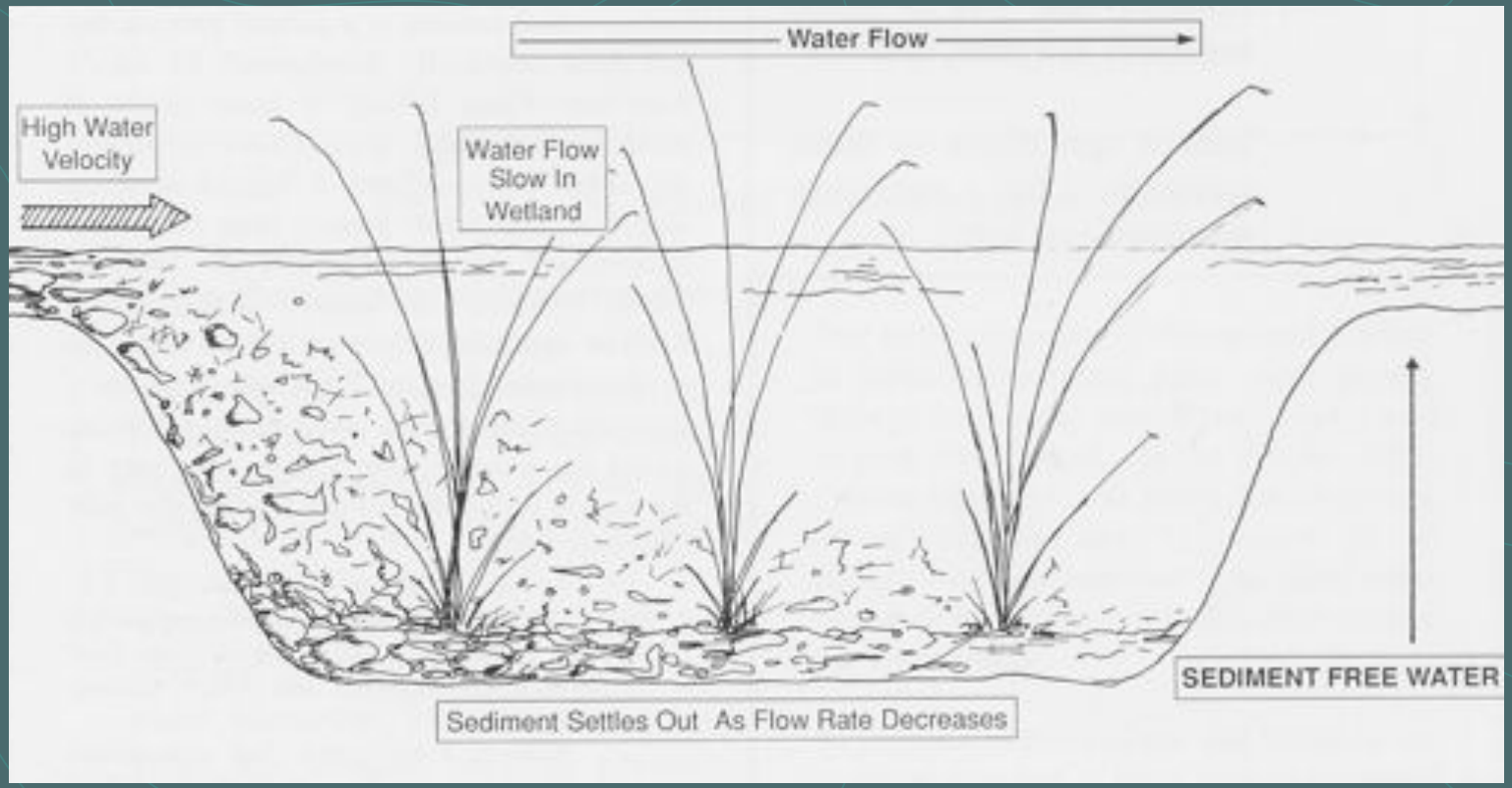
Water issues:

Fecal Coliform Bacteria
Phosphorus Overload
Nitrogen Overload

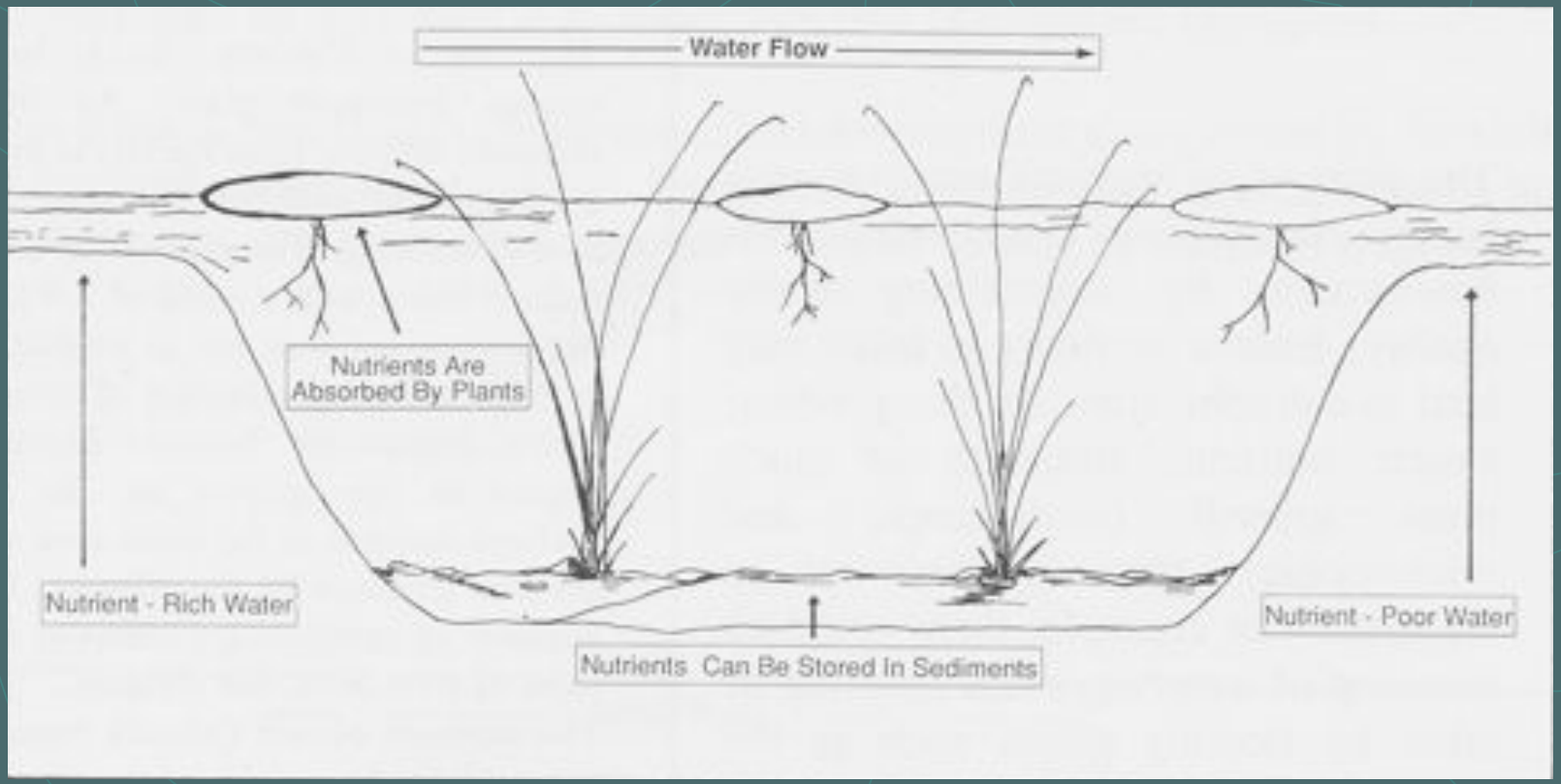
Stage Derived from Manning's Equation for Harbor Brook At Velasco Road, 1 yr. Storm



Slow Particulate Sediment Flow



Nutrient flow & absorption in sediment & vegetation



WETLAND DESIGN CHANGE #1

Subsurface wetland treatment design for CSO
Features of the design include:

- Distributional inflow system
- Series of subsurface treatment beds allows
- Year round aerobic & anaerobic processes
- Outflow collection system
- Potential for created wetlands on surface using treated discharge

HARBOR BROOK SYRACUSE, NEW YORK
CSO WATER TREATMENT DEMONSTRATION PROJECT

Introduction

The following is a conceptual design for a flow delivery and subsurface flow constructed wetland for treating CSO #78, which discharges into Harbor Brook near the corner of Bellevue Avenue and Velasko Road. This project is meant to be a demonstration project for CSO #78 for a 1 year, 2-hour design flow, 86cfs and 1.17MG.

The flow data is from a report dated March 2002, Moffa and Associates, ***Harbor Brook CSO Abatement Facilities Plan, Onondaga County Department of Water Environmental Protection, Syracuse, New York.***

Stage I

Flow Delivery System
Grit & Floatable Removal System

Figure #1 Flow Directional Device (FDD): This device is placed inside the CSO before the outfall. The directional device consists of a 3-inch concrete flow diverter wall, which directs the flow to a 15-inch trough located in the CSO Divergent Influent Trench Structure, during low flows. During high flows, the water will flow over the flow diverter wall to utilize the full width of the CSO and the CSO Divergent Influent Trench Structure.

Figure #2 CSO Divergent Influent Trench Structure: The trench structure is a 7-foot wide trench modified with a 15-inch channel in the center of the trench. The channel maintains the velocity of the water at 2 fps during low flows. In a storm event the flow will flood the channel and utilize the full 7-foot width of the trench. The trench wall height was calculated based on the maximum height of the creek during a storm event to prevent flooding into the structure. The effluent of the CSO Divergent Influent Trench Structure will drop into the spillway area of the CSO Diversion Structure.

Figure #3 CSO Diversion Structure: This structure is designed to regulate the varying flow volumes that are characteristic of a CSO. The influent first enters a large spillway chamber, which is lined with 7 weirs set at different elevations. The varying weir elevations are arranged in a stepped formation to control the varying flow volumes that enter the large chamber. As the chamber fills, the water will start to flow over the lowest set weir. Each weir discharges into an individual chamber with a 15-inch pipe located at the bottom. As the flow increases the first weir will start to surcharge causing the chamber level to rise forcing the flow over to the next weir. The surcharging ability of the first weir will max out when change in the CSO hydraulics cause the seventh weir to commence operation. This allows for timed utilization of each chamber's volume.

The CSO Diversion structure regulates the flow without the use of electricity or manual work. This is the only structure in Stage one that has a drain located in the spillway chamber. Each weir has an individual chamber with a 15-inch pipe located at the bottom that flows to a CDS System.

Figure #4 Continuous Deflective Separator (CDS): The CDS is a process structure designed to remove grit and floatables that are found in the CSO discharge. The CDS technology features a patented non-blocking, indirect screening technique developed in Australia in 1992. It uses a fine screen that does not block, because the screening is carried out by a small secondary hydraulic force, (indirect filtration), while the primary hydraulic force is employed to wash the screen on a continuous basis. The solids that are separated are contained within the sump and/or separation chamber of the processor and will not be washed out by the peak flows that it may experience. The CDS for this project will be designed to handle 10-14cfs flows. There will be 7 CDS units because there are 7 weirs, one unit to remove grit and floatables from each weir. The CSO event will dictate how many units will be running at any time.

Stage II

Biological Treatment of the CSO Water
Alternative Subsurface Constructed Wetland

Figure #5: Wetlands Distribution Structure: After the grit and floatables have been removed, the effluent from all the CDS units now enters the wetland distribution structure. This structure is a dual chambered, designed to handle large and highly variable hydraulic flows. The first chamber receives all the flow from the 7 CDS units. Located in the bottom of the first chamber are two 15-inch pipes that transport the flow to cell #1 or cell #2 subsurface. When the flow becomes too great for the 15-inch pipes to handle, the flow surcharges chamber #1 and flows into chamber #2. At the bottom of these chambers are two 30-inch pipes, which deliver the flow on the surface of either cell #1 or cell #2. This structure also requires no electricity or valves to operate.

Figure #6: Alternative Subsurface Constructed Wetlands: This is where physical, chemical, and biological treatment of the water takes place. The cells are labeled Cell #1 A&B and Cell #2 C&D. Each cell is constructed with a liner to keep the CSO water in and keep the ground water out. The liner also divides the cell in half forming a wall and sides A&B or sides C&D. In the diagram any explanations labeled cell #1 or side A&B will also refer to cell #2 or sides C&D because of identical construction. Each cell has an influent structure 400-feet long. The influent pipe can flow to either side A and/or side B from the 15 inch pipe located in chamber #1 wetland distribution structure. Cell #1 has four 15-inch quarter turn influent valves, two located on side A and two located on side B. These valves make it possible to flow to either one side or both sides at the same time depending on the event that is happening. Each valve will have an actuator that is operated by a small PLC and a flow sensor that will be programmed to open and close the valves depending on the flow. At the bottom of the cell is a perforated subsurface 15-inch pipe. The pipe is 200 feet long on side A and 200 feet long on side B. The rock media in the influent end will have a size between 4 and 8 inches, and be embedded in a space 20 inches deep and 2 feet wide. This is where the 15-inch subsurface pipe is located. The surface flow 30-inch pipe that originates in chamber #2 is not separate. It lays on top of cell #1 across sides A&B with no separation. Each 30-inch pipe has one 30-inch quarter turn valve that is used to control the flow to either cell #1 or to cell #2. These valves will be controlled by the same PLC that controls the subsurface valves running sides A&B. The rock media inside the cell will be between 2 and 3 inches in size. The cells will be 200 feet wide at an effluent depth of 30 inches. The effluent end of the cell will look the same as the subsurface piping of the influent structure of the cell. The media at the effluent end will be 2-3 inches rather than 4-8 inches, as at the influent side. It will be located at the bottom of the cell and be a 15inch perforated pipe located on side A and on side B.

Each side of a cell is capable of holding 250,000 gallons of water subsurface. Thus, cell #1 has a total holding capacity of 500,000 gallons subsurface. The cell walls act as a berm and are capable of holding one million of gallons of surface water during a major storm event. The surface water will be treated when the cell drains are opened. The cell has the ability to store the CSO water and treat it at the same time. The surface flow will only happen during large flow events, most of the time the flow will be subsurface. After movement through the treatment wetlands, the treated CSO flow then moves to the Treated Effluent Structure.

Figure #7: Treated Effluent Structure: The Treated Effluent structure is pre-cast and strongly resembles a pre-cast manhole. Each cell has two Treated Effluent Structures, one for side A and one for side B. This structure has a telescopic valve used to control the water level in the cell. A 15-inch quarter turn valve is used to drain the cell. It is opened or closed by an actuator that is controlled by the same PLC that operates the influent valves.

Stage III

Treated Effluent Possibilities

Figure #8: Pump Station: The cell effluent is below the level of the creek because the terrain is flat and the effluent needs to be pumped up to reach the elevation of the Creek. The treated effluent now can be used for pond (fish, plant, and amphibian) studies, surface wetland studies, and a possible multi-staged multi-media filter that uses no electricity or chemicals to remove fecal coliforms, ammonia and T-P.

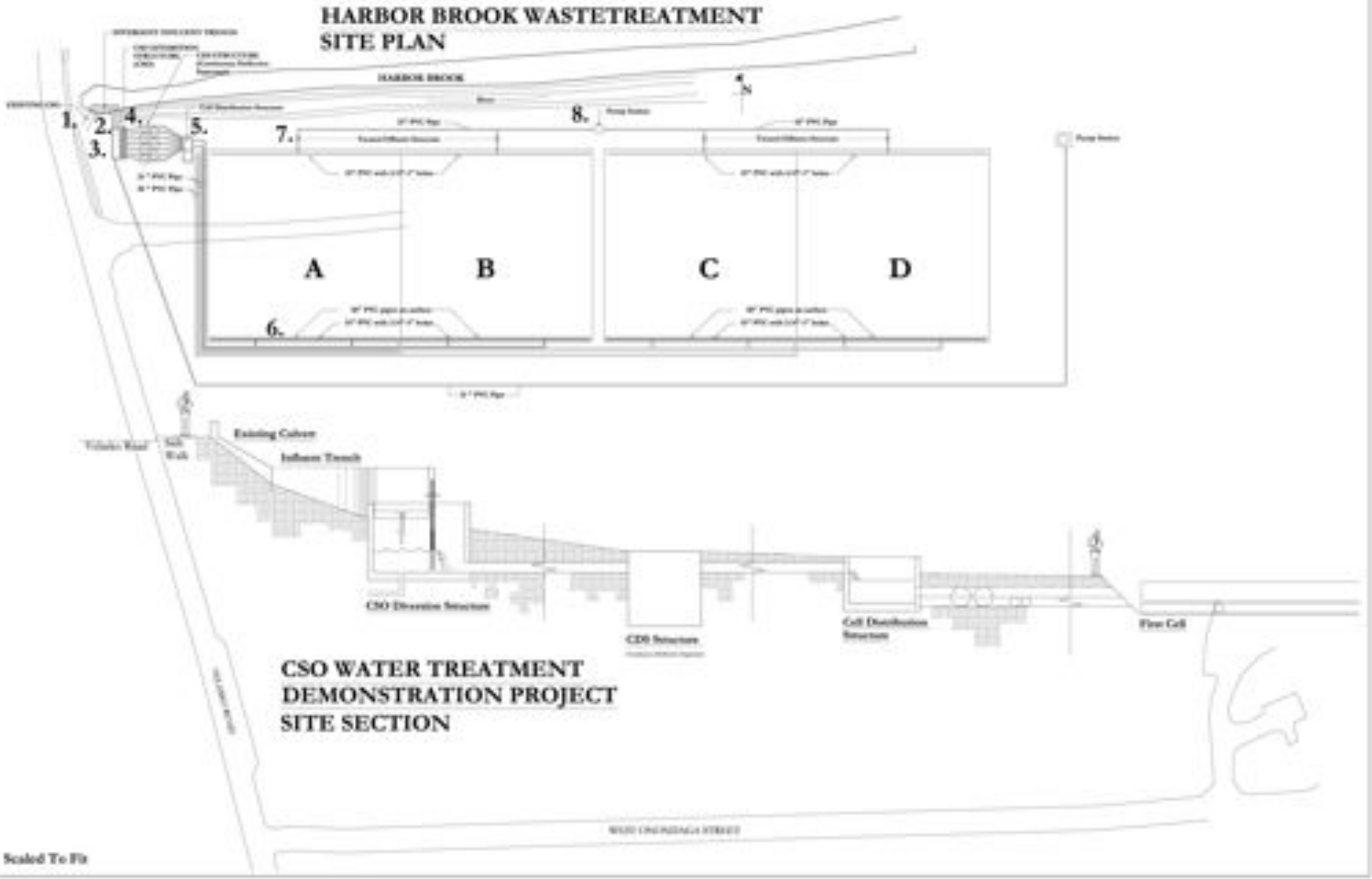
Sponsors

This is a Project of Atlantic States Legal Foundation and SUNY - ESF
Randolph G. Pace Environmental Institute funded in part by the US Environmental Protection Agency. The project is being conducted in cooperation of and the Onondaga County Department of Water - Environmental Protection and the City of Syracuse.

DISCLAIMER

The following drawings are only conceptual and are not to be used as construction documents. These drawings and ideas are the property of Steve Gnatzuno & SUNY-ESF and may not be duplicated without proper authorization. We will not be held responsible for the use of the conceptual ideas presented in this display should they be used without formal consent.

HARBOR BROOK SYRACUSE, NEW YORK
CSO WATER TREATMENT DEMONSTRATION PROJECT: PLAN & SECTION



Scaled To Fit

HARBOR BROOK SYRACUSE, NEW YORK

CSO WATER TREATMENT DEMONSTRATION PROJECT - DETAILS

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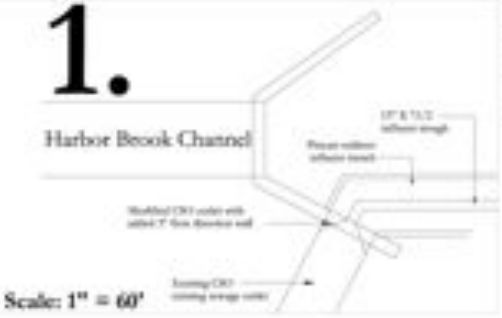

Scale: 1" = 60'

Berm Section Detail

Scale: 1" = 60'

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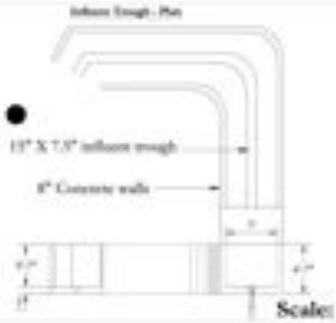

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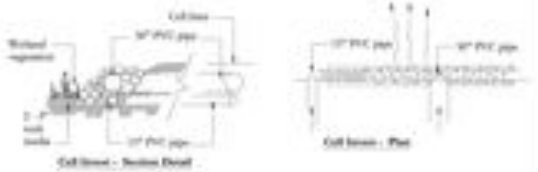

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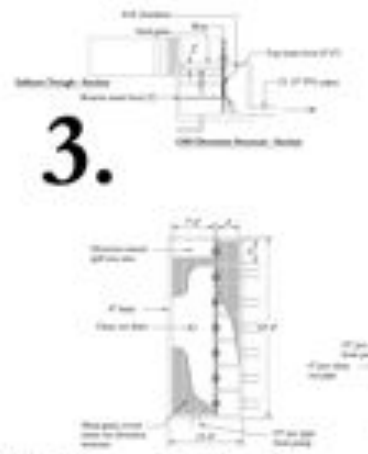

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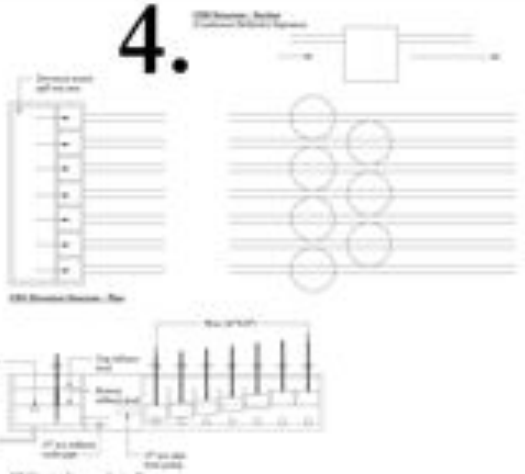

Scale: 1" = 80'

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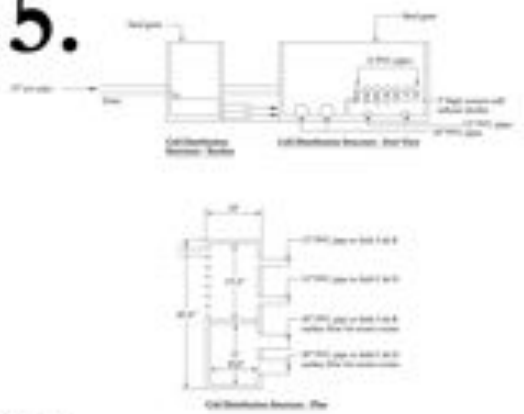


Scale: 1" = 80'

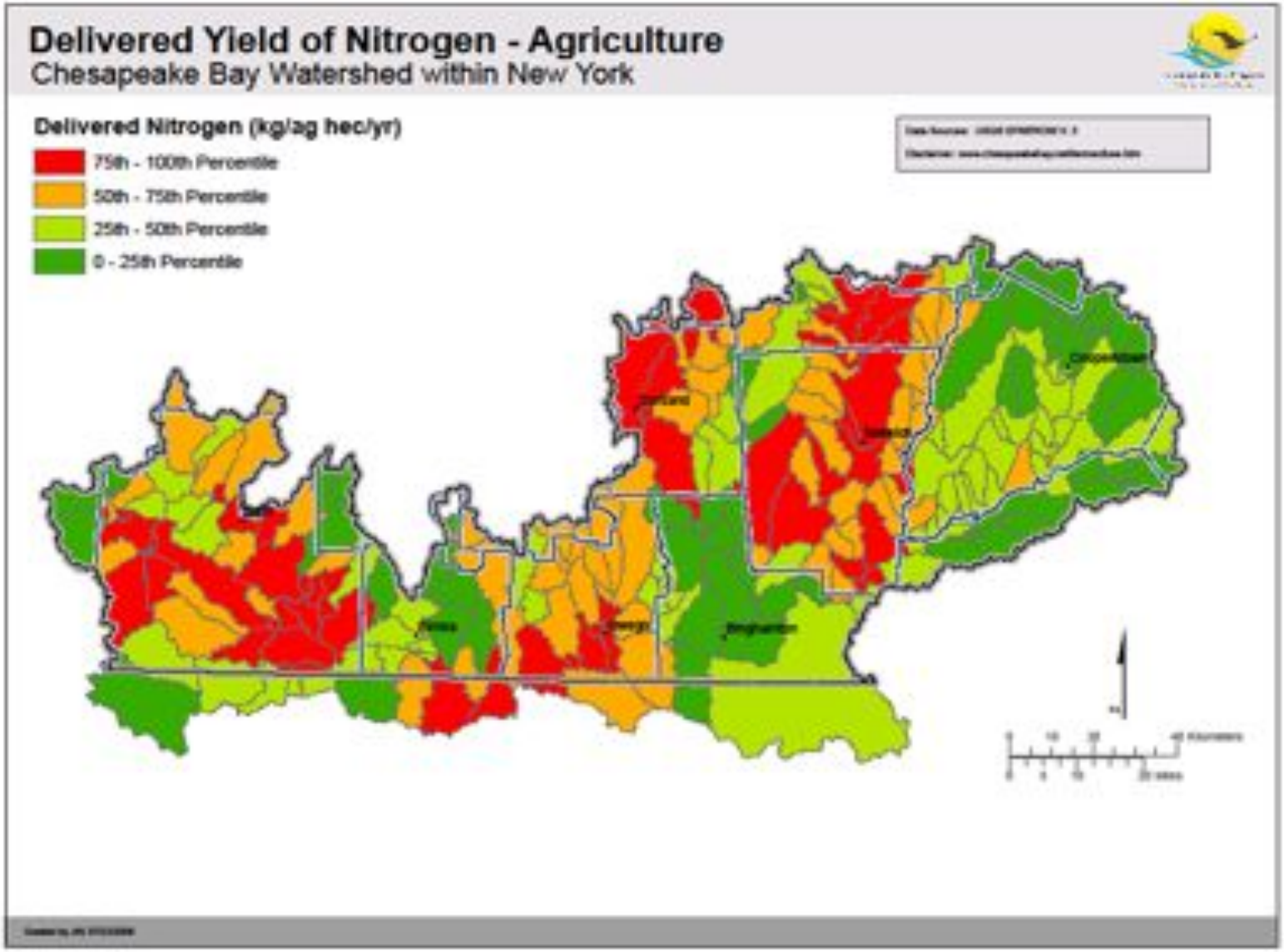
Aquatic plants in future wetland

Treatment wetland design change #2

- Lower Levels of Phosphorus, Nitrates and Fecal Coliform Bacteria from CSO
- Through design of 3 linked wetlands: floating islands, vertical and horizontal
- SUNY/ESF will operate & monitor 3 treatment wetlands for removal effectiveness for organics and coliform bacteria

Second Case Study: Agricultural WQ Treatment with Restored Wetlands

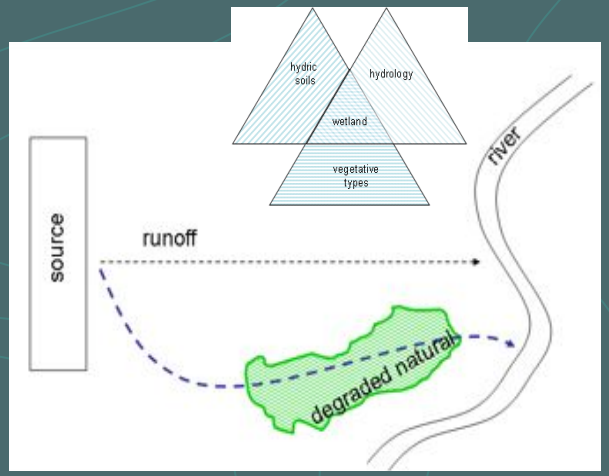
- By Lauren Johnson, PhD NRCS
- under Prof. R.C. Smardon's direction as a PhD graduate student at SUNY/ESF



Map of Delivered Yield of Nitrogen-Agriculture: The map identifies the Upper Chenango River Watershed (located north of Norwich, NY) as being in the: 75th – 100th Percentile of Delivered Nitrogen (kg/ag hec/yr).

Source

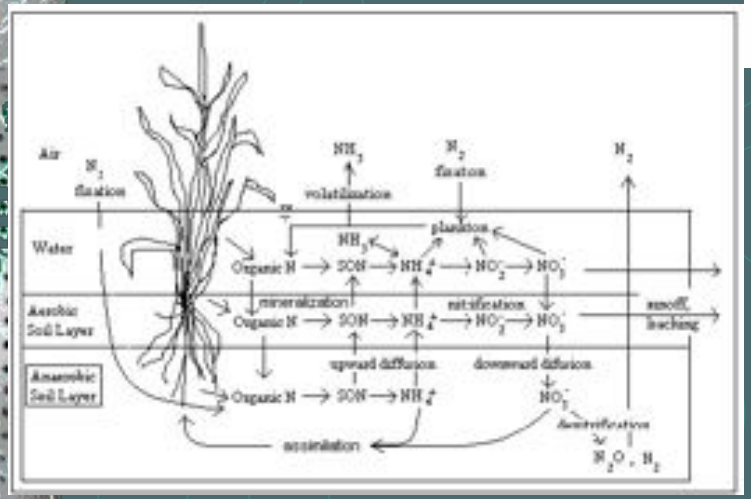
(typical) Palmetier Farm-Sherburne, NY



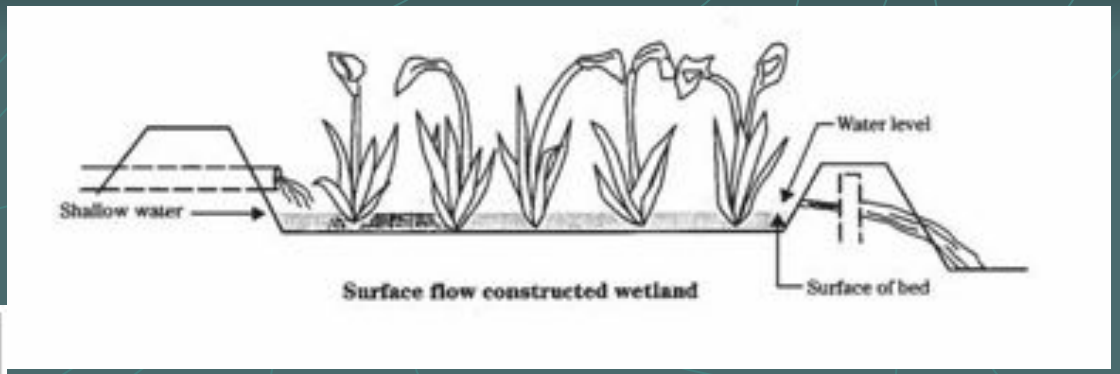
- *There are few, if any, negative aspects to wetland development. Positioning wetlands to aid in water quality improvement and habitat enhancement, when these objectives are paramount. The overall goal of the USC wetland program is to develop a wide array of wetlands that meet the specific criteria of the funding program, while attempting to integrate these designs into a plan that maximizes local benefits.*

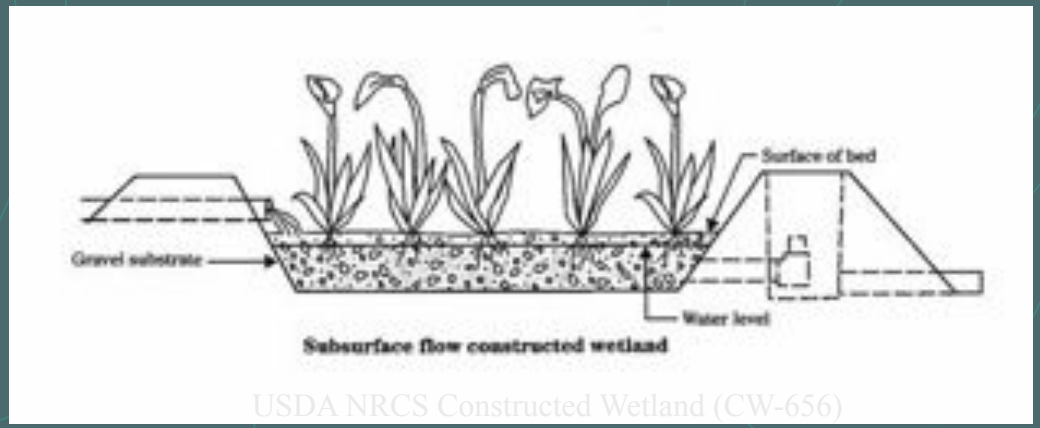
Susquehanna River and Chesapeake Bay Watershed Strategic Plan (USC 2004)

Biotransformation Function



Nitrogen Transformation In Wetlands—adapted from Mitsch and Gosselink (1993)

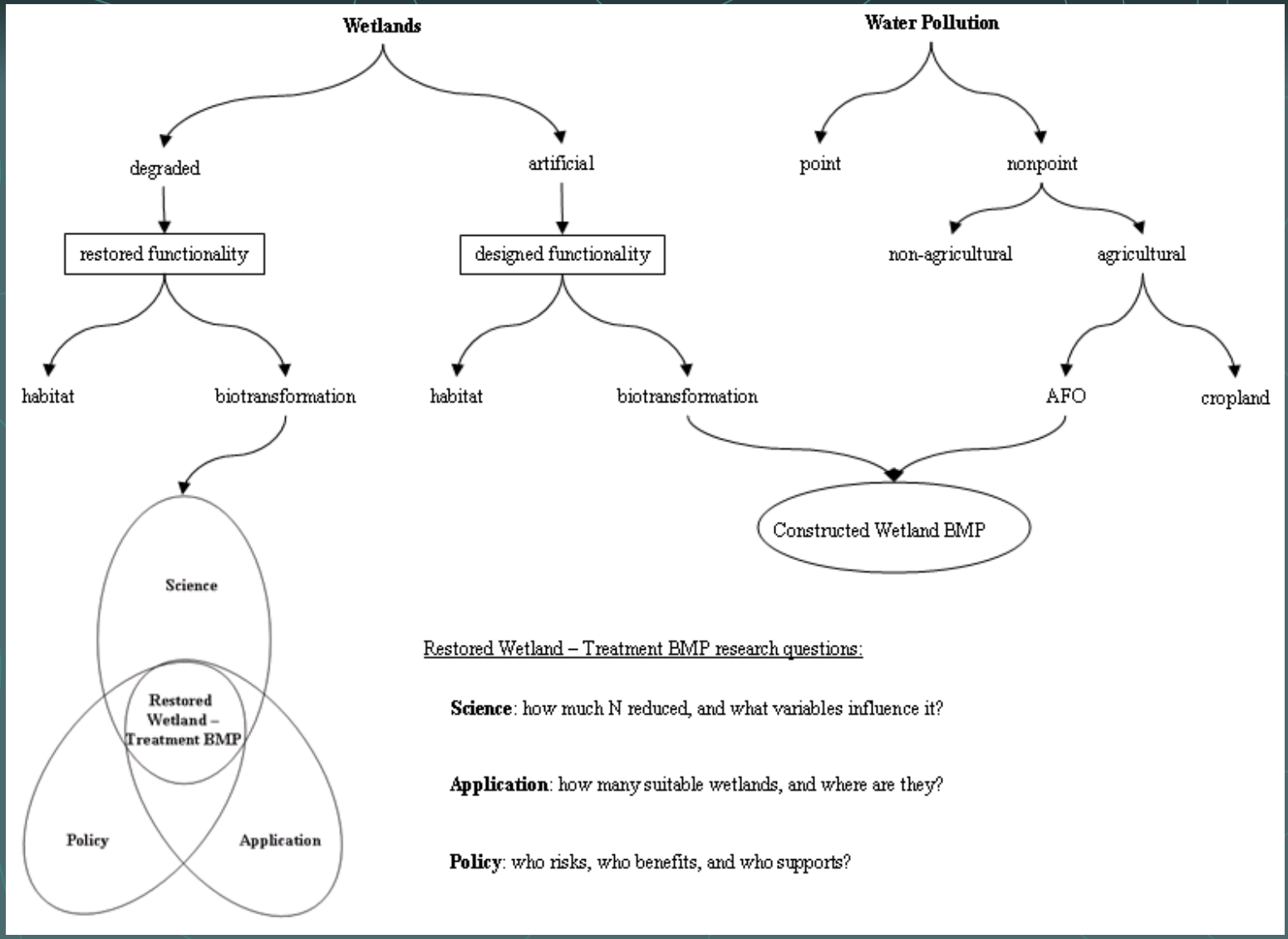




USDA NRCS Constructed Wetland (CW-656)

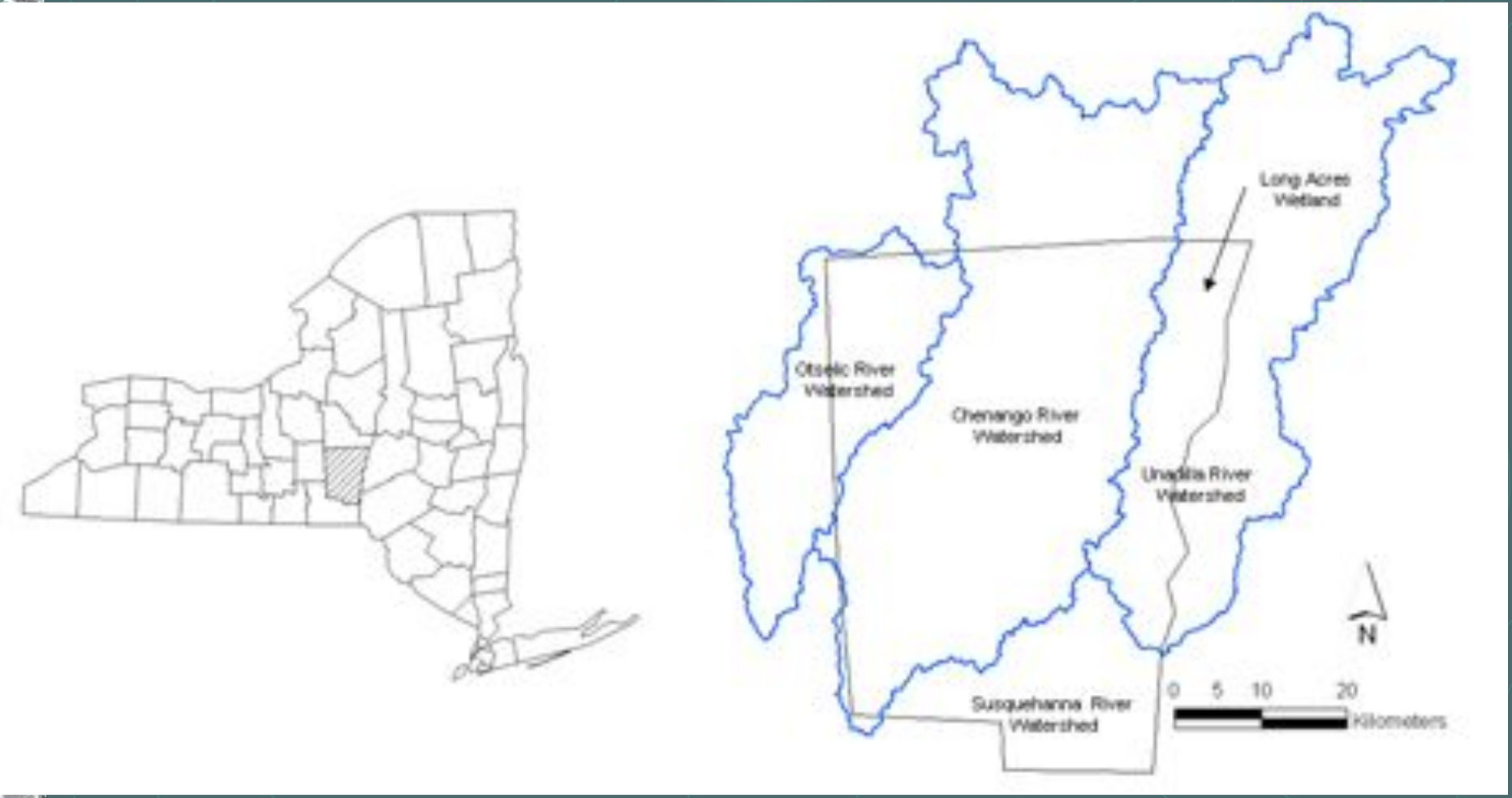
Constructed Wetlands—adapted from USDA NRCS 2005

Wetland Research



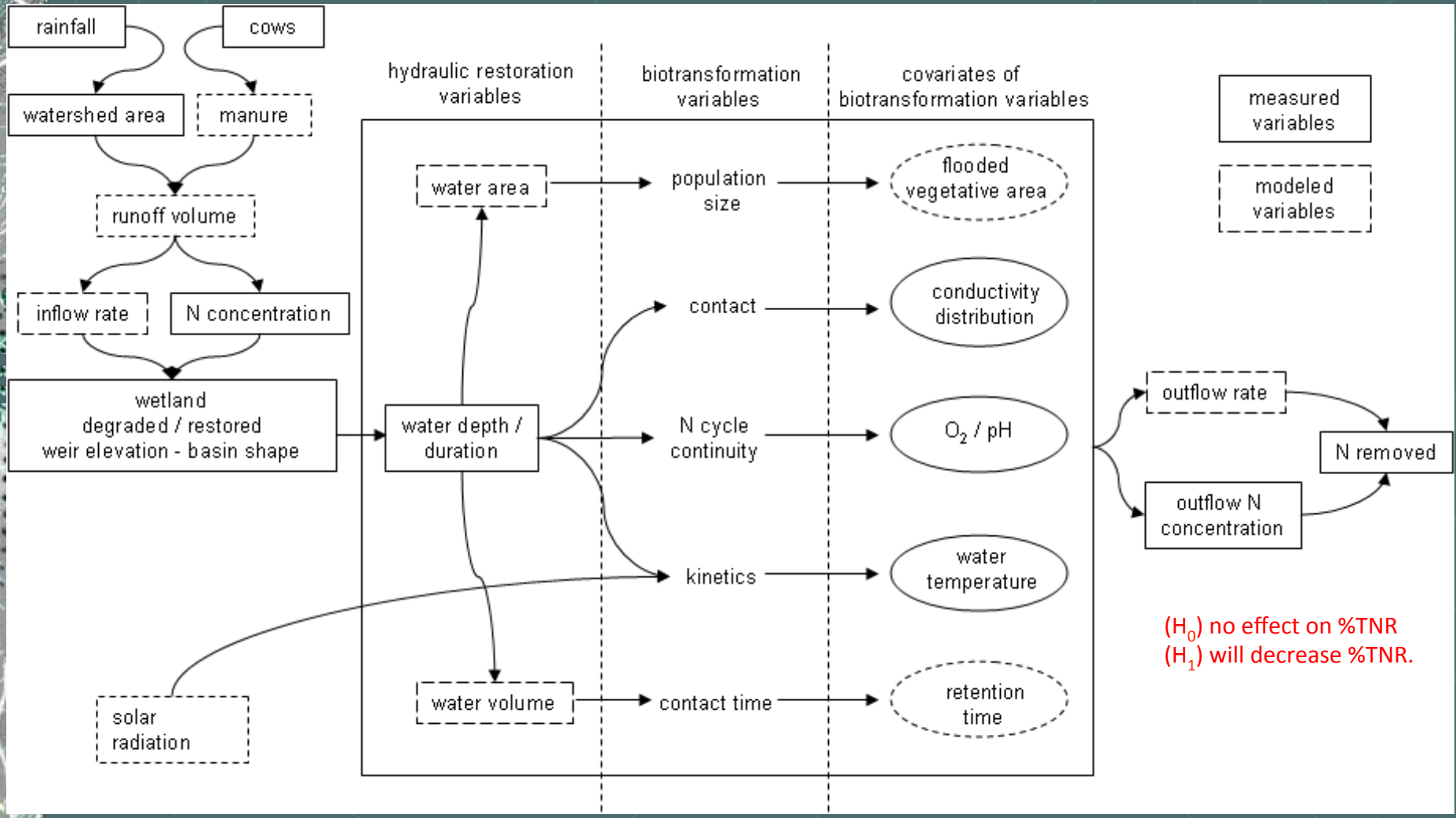
Conceptual Framework of the Research: The flow diagram illustrates the deductive reasoning leading to the proposed Restored Wetland – Treatment BMP, and the interplay of wetland science, application, and policy with the three related research questions.

Wetland Research Study Areas



Maps of Study Areas: The maps show the locations of Chenango County, its major watersheds, and the Long Acres Wetland.

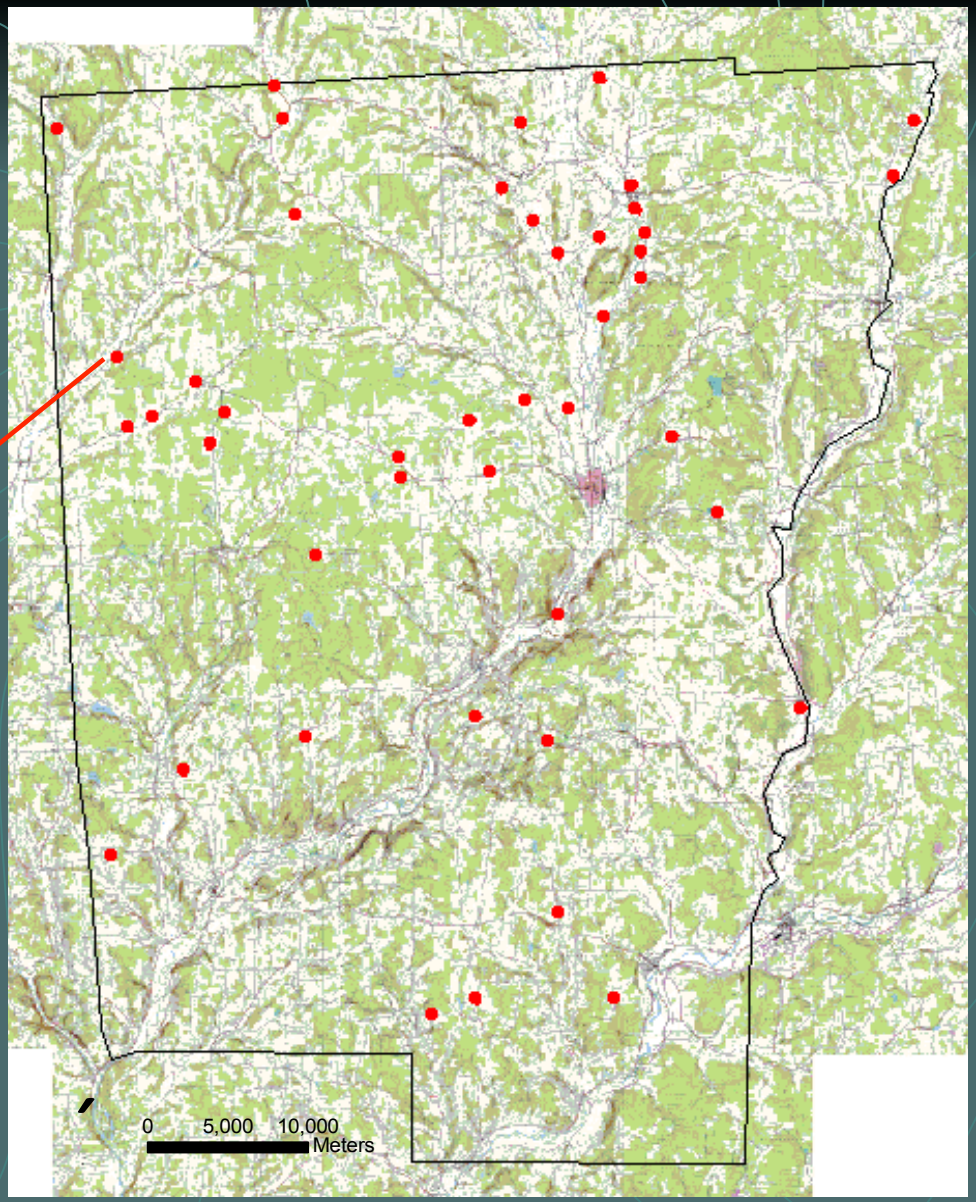
Wetland Science



Hydraulic Restoration Variables: The flow diagram illustrates nitrogen polluted runoff interacting with wetland biotransformation variables and their as measurable covariates.

Wetland Application

(typical) Tanis Farm – Pitcher, NY

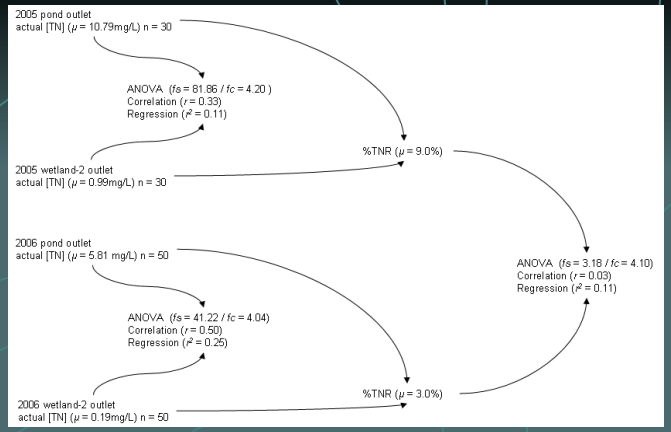


Map of 44 Selected hydric polygons/farms

Findings

(H_0) no effect on %TNR
(H_1) will decrease %TNR.

Finding 1 – The restored Long Acres Wetland significantly reduced N in runoff

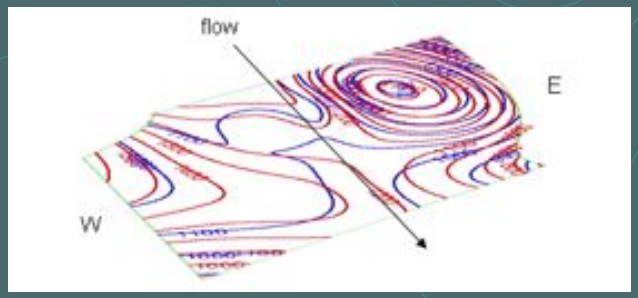


pre- and post-restoration [TN] and %TNR

related research- enhanced habitat function

muskrat house

future research -
advective flow



2D horizontal conductivity 2005 / 2006

Findings

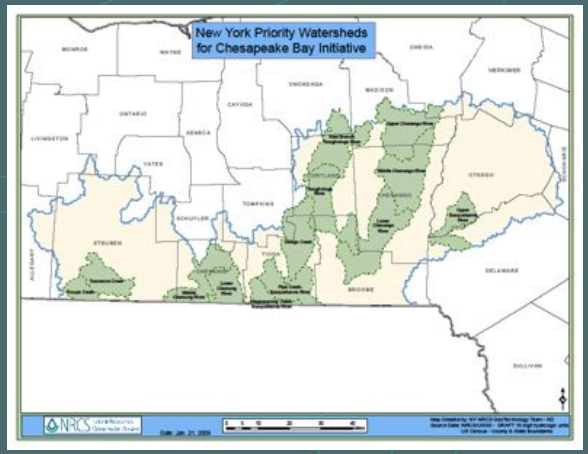
(H_0) no drained wetlands are suitable
(H_1) all drained wetlands are suitable

Finding 2 – restorable degraded wetlands are readily available

valley soil	Chenango number	Chenango percent	Unadilla number	Unadilla percent	Susquehanna number	Susquehanna percent	Otselic number	Otselic percent
Ad	1	2%						
At	5	11%					2	5%
Cm	11	25%	1	2%	4	9%	2	5%
Cn	4	9%					2	5%
Sa			1	2%				
Wa	8	18%	2	5%			1	2%
totals	29	66%	4	9%	4	9%	7	16%

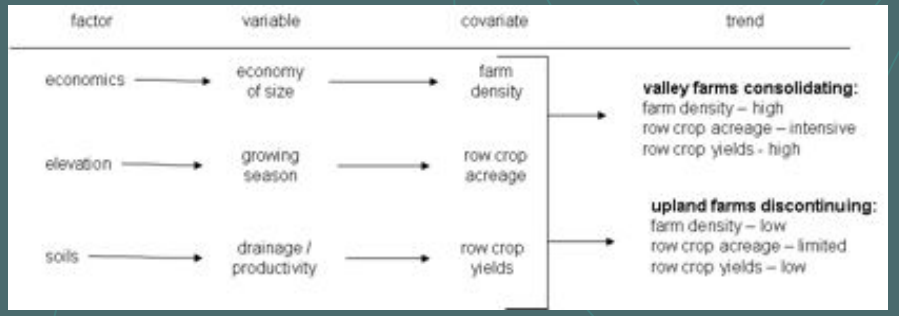
Distribution of the Final 44 Hydric Soil Polygons

related research - applicable to other places



Targeted Susquehanna Basin Watersheds

future research - trends of agriculture

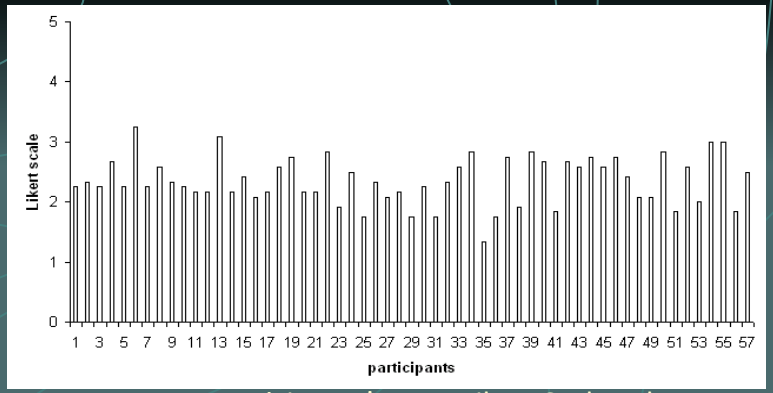


Cornell Model: predicts valley areas will support dairy farms

Findings

(H_0) the majority of surveyed stakeholders "will oppose"
(H_1) the majority of surveyed stakeholders "will support"

Finding 3 – RW-T BMP is generally supported by wetland stakeholders



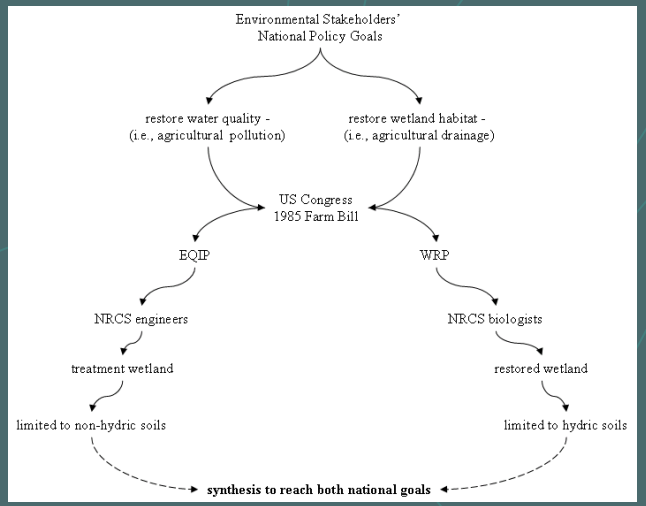
survey participants' mean Likert Scale values

wetland stakeholder-
dairy farmer

wetland stakeholder-
rural resident

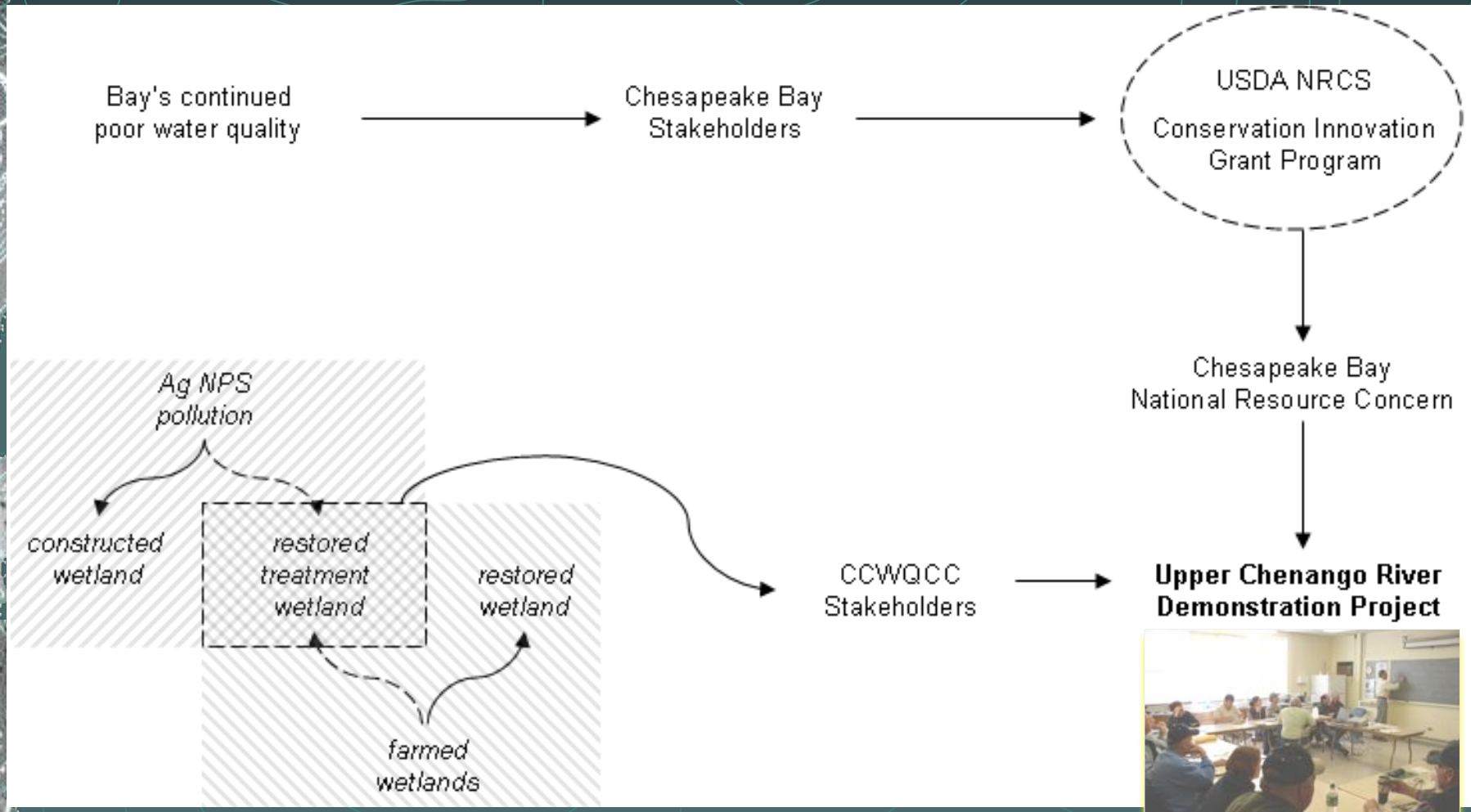
related research - groups are divergent in ideology

future research - wetland policy change is required



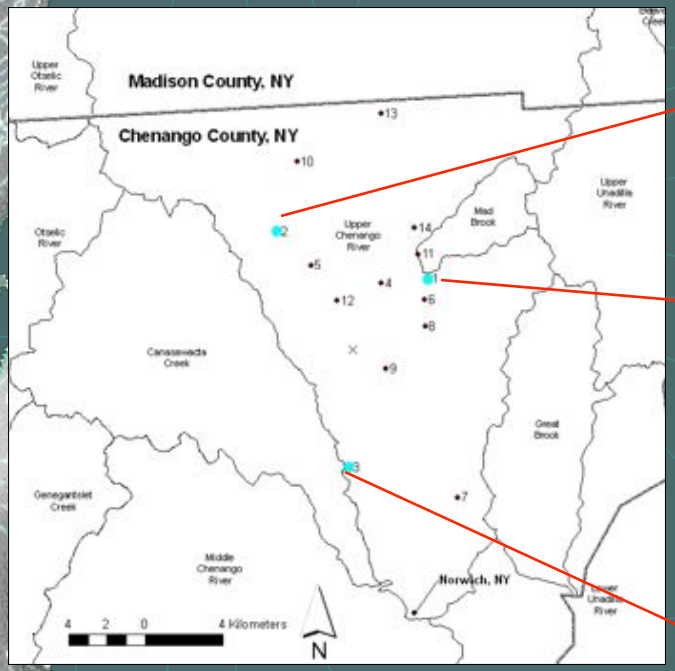
Water Quality-Wetland Restoration Policy Schism

Synthesis

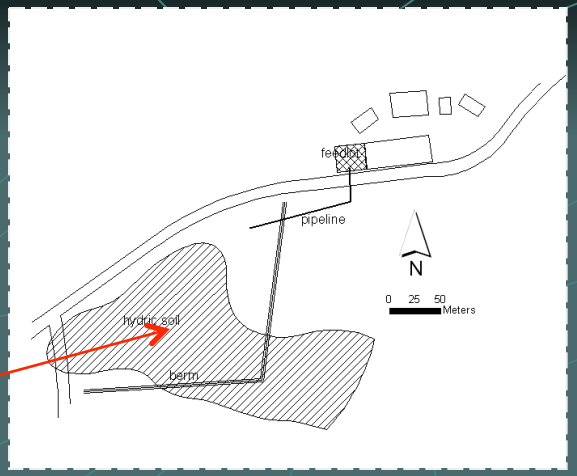


Flow Diagram of Water Quality-Wetland Stakeholders' Interactions: The flow diagram illustrates the linkage and capacity building between the Chesapeake Bay Stakeholders and the Chenango County Water Quality Coordinating Committee, providing an opportunity to implement restored wetland-treatment projects through a demonstration project.

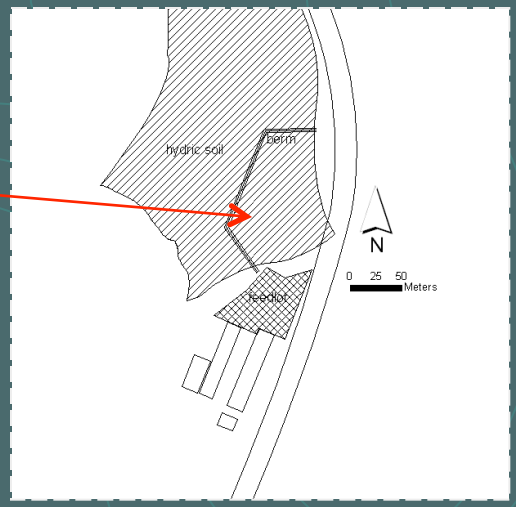
Synthesis



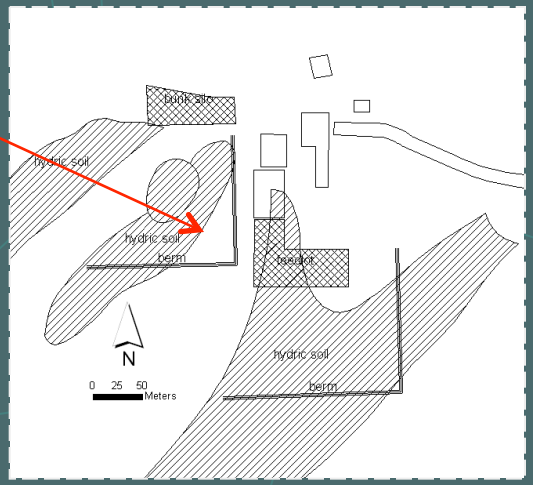
Map of Suitable Upper Chenango River Sub-Watershed Farms: The map shows the locations of 14 dairy farms with suitable drained wetlands with corresponding farmer motivational ranking number (“1”- highest ranked).



Ingert Farm-Smyrna, NY



Harmon Farm-Sherburne, NY



Proskine Farm-Norwich, NY


Questions?