Source Water Protection & Watershed Restoration in the Raritan Basin

NJ Water Supply Authority
Kathy Hale, Principal Watershed Protection Specialist
(908) 685-0315 x228 khale@raritanbasin.org
Bob O'neil, Principal Watershed Protection Specialist
(908) 685-0315 x225 roneil@raritanbasin.org

www.raritanbasin.org & www.njwsa/wpu
www.njriverfriendly.org www.njriverfriendlyfarm.org

7th Annual Water Monitoring & Education Summit
November 18, 2009

NJ Water Supply Authority

•Manage Spruce Run, Round Valley & Manasquan Reservoirs, D&R Canal as water supply sources

•Raritan System provides water supply to public & private water utilities serving 1.3+ million people in Central NJ

•Management of water supply infrastructure

•Watershed management planning & implementation projects

•River-Friendly programs

•Open space preservation & management

•Stream assessment & restoration

•Stormwater management projects – planning & implementation

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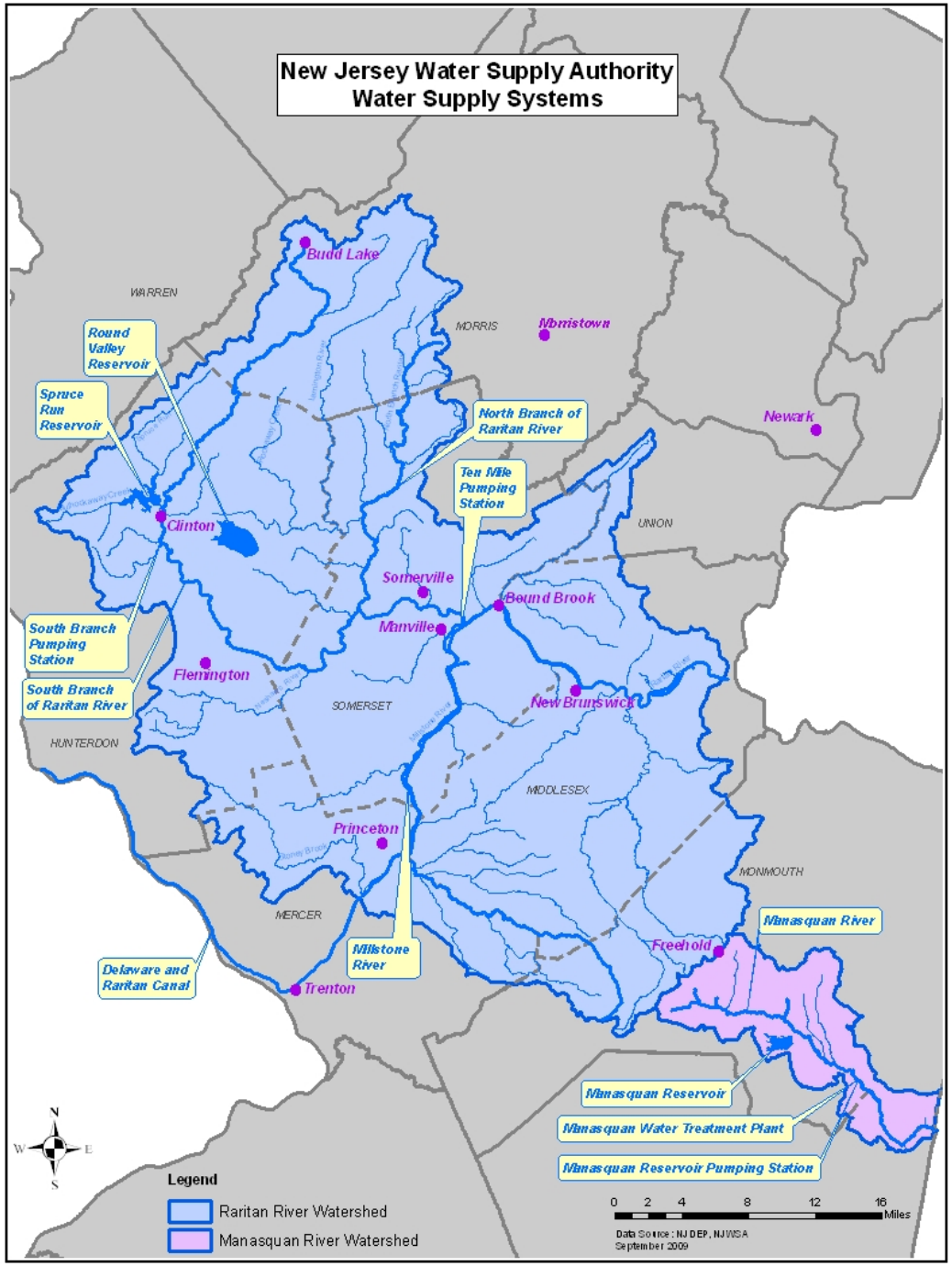
New Jersey Water Supply Authority
Water Supply Systems
Budd Lake
Round Valley Reservoir
Spruce Run Reservoir
Clinton
Flemington
South Branch Pumping Station
South Branch of Raritan River
North Branch of Raritan River
Ten Mile Pumping Station
Somerville
Manville
Bound Brook
New Brunswick
Princeton
Millstone River
Delaware and Raritan Canal
Trenton
Morristown
Newark
Manasquan River
Freehold
Manasquan Reservoir
Manasquan Water Treatment Plant
Manasquan Reservoir Pumping Station
WARREN
MORRIS
UNION
SOMERSET
HUNTERDON
MIDDLESEX
MONMOUTH
MERCER
N
W
E
S
Legend
Raritan River Watershed
Manasquan River Watershed
0 2 4 8 12 16
Miles
Data Source: NJDEP, NJWSA
September 2009

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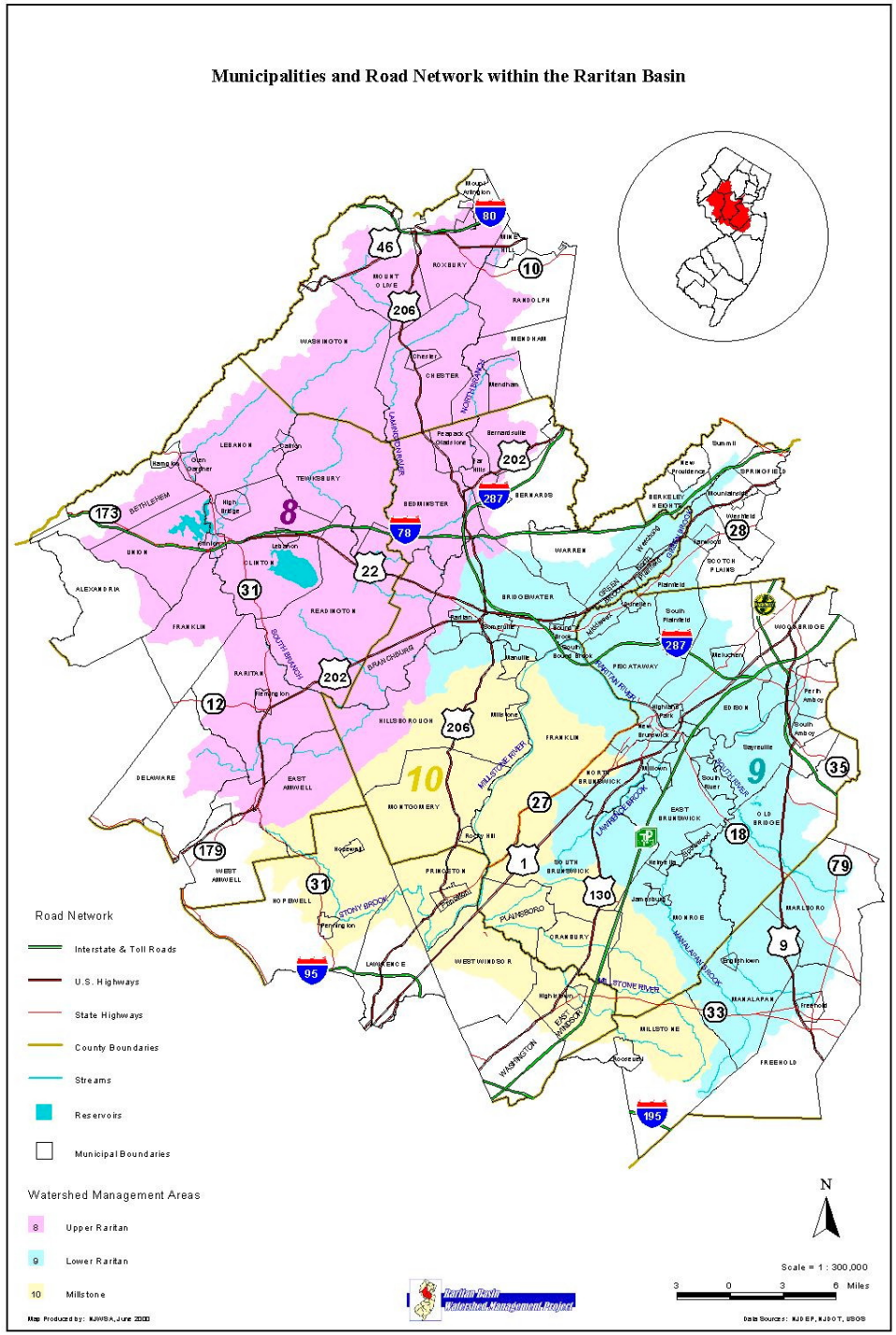
Raritan River Basin

- Largest river basin located entirely in the state of NJ
- ~1,100 mi^2, parts of 7 counties & 100 municipalities
- Surface water systems provide water to 1.5 million people



Why Source Water Protection?

Spruce Run and Round Valley Reservoirs provide 160 MGD to Central New Jersey (part of 225 MGD system)

Round Valley – pumped storage

Spruce Run – natural stream flow

Spruce Run Reservoir showing impacts of excessive nutrients and sediments

Tributary streams showing impacts of land uses and stormwater

Protecting Water Resources

What to Do?

Assess Current and Future Problems

Protect Critical Areas

Prevent Increased Pollutant Loads and Stormwater Flows

Remedy Existing Problems

How to do it?

- Stormwater improvements
- Riparian buffer improvements
- Stream restoration projects
- Land acquisition
- Municipal ordinance improvements
- Better land management by existing land uses

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Raritan Basin Partners

•Watershed Associations
•Nonprofits – North Jersey RC&D, NJ Conservation Foundation, Hunterdon Land Trust Alliance, Land Trust of NJ
•Municipalities
•Counties
•Educational Institutions – Rutgers University, NJ Institute of Technology
•Utilities – Middlesex Water Company, New Jersey American Water Company, Stony Brook Regional Sewerage Authority, Middlesex County Utilities Authority, Morris County Municipal Utilities Authority, Somerset Raritan Valley Sewerage Authority
•State agencies – Delaware & Raritan Canal Commission, Highlands Council, NJDEP, NJ Department of Agriculture
•Federal Agencies – NRCS, US Department of Agriculture, USGS, USEPA
•County Soil Conservation Districts
•Americorps Watershed Ambassadors
•Consultants
…….and many more

Background Information

- 1999 - Watershed Protection Unit formed
- 1999 - Raritan Basin Council formed to oversee C&A process
- 2001 - C&A completed, 7 technical reports + 3 background reports
- 2001 - WMA committees formed
- 2002 - Basin-wide Management Plan completed
- 2003 - Raritan Basin Watershed Alliance formed
- 2002 and Ongoing - Watershed Restoration Plans
- Ongoing - Implementation Projects
- Ongoing - Monitoring & Evaluation

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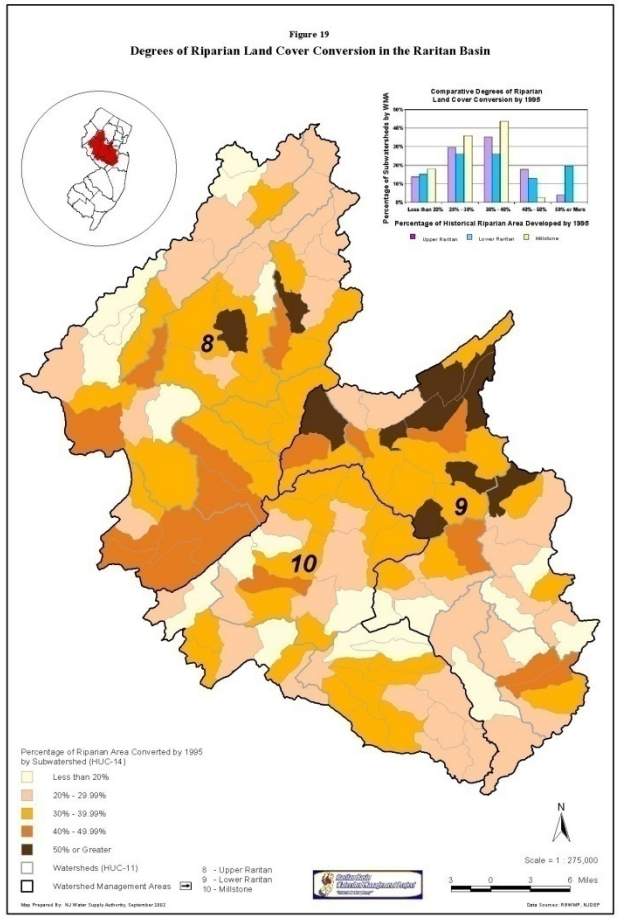
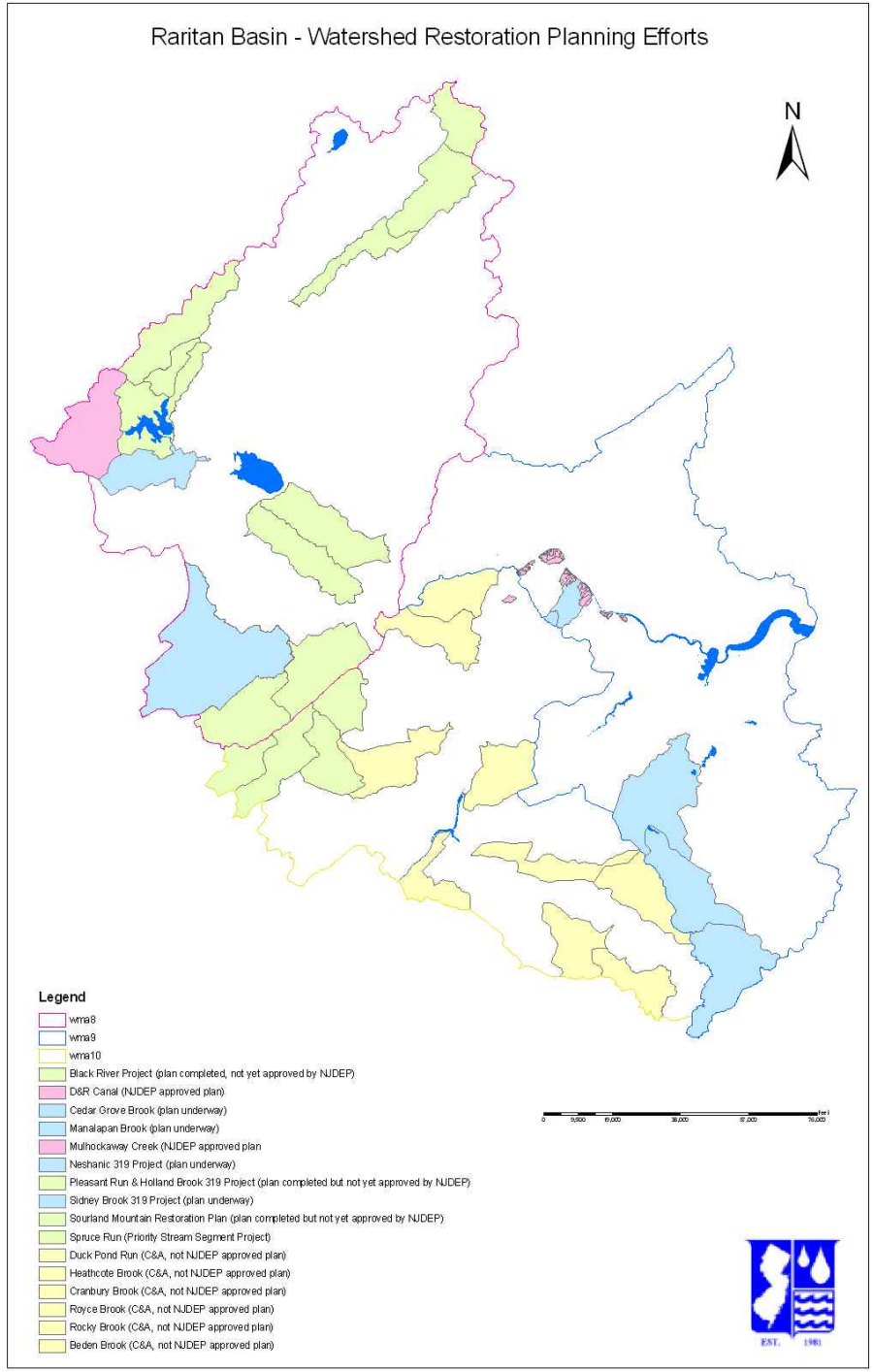
Raritan Basin
Watershed Management Plan

- 2002, www.raritanbasin.org
- Identified six critical issues:
  - Surface Water Pollution
  - Loss of Riparian Areas
  - Biological Impairment of Streams
  - Loss of Ground Water Recharge
  - Water Supply Limitations
  - Stormwater Impacts
- 30% of historic riparian areas converted to urban and agricultural uses
- Nonpoint sources provide majority of pollutants



Raritan Basin Watershed Planning Efforts



Step 1.
Select a sub-watershed of interest

Why do you want to do a plan?

- Preservation
- Restoration
- Implement a TMDL
- Local interest
- Document baseline conditions

What is the parameter(s) of concern?

Phosphorus?

Sediment?

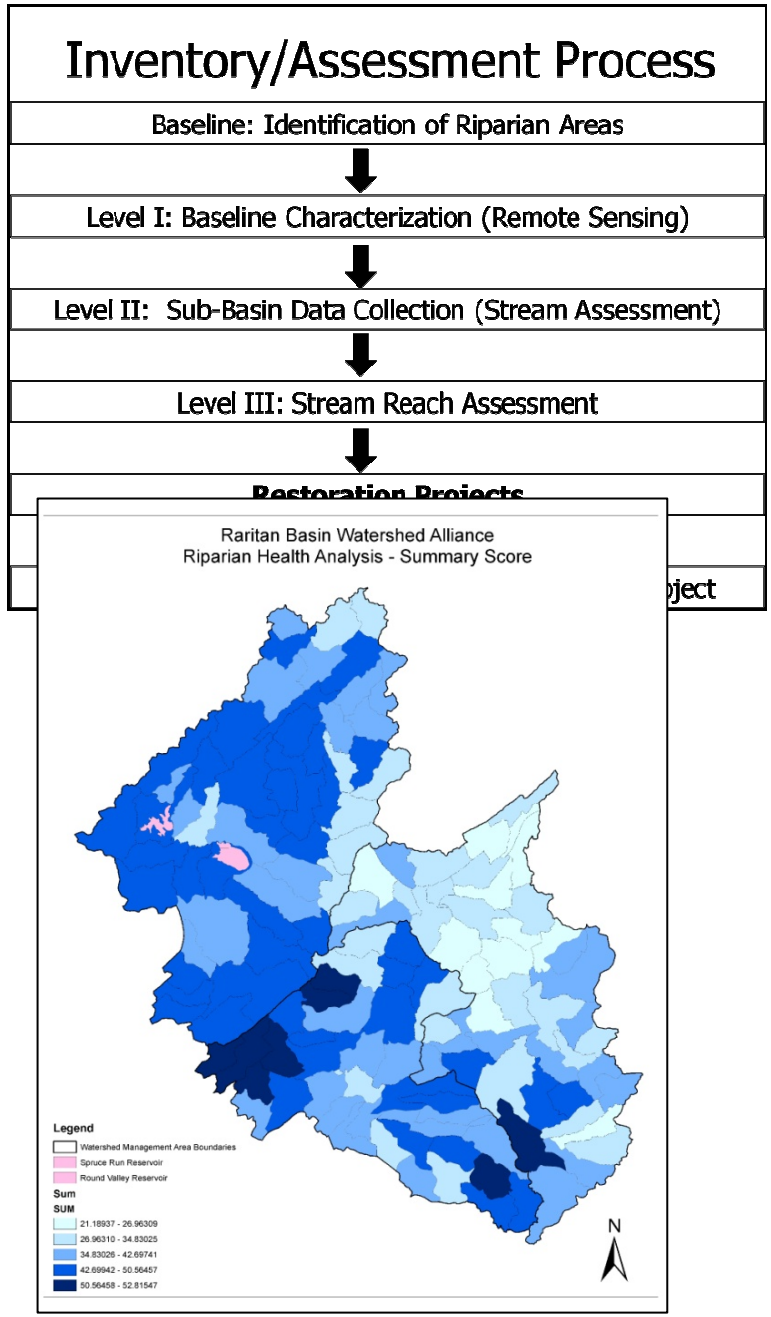
Bacteria?

Use existing models/guidance/data

e.g. RBWA Riparian Health Assessment

RBWA Riparian Health Assessment

- Level I: Used available geographic information system (GIS) data @ riparian and watershed scale
- Characterization of HUC-14s – In need of restoration, Under stress, In good condition (focus on preservation)
- No field data acquisition



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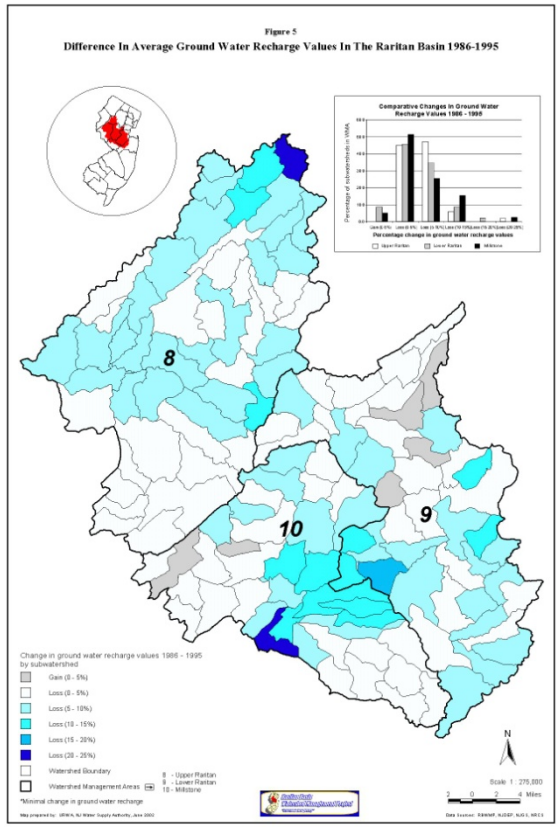
Step 2.
Characterization & Assessment

Assemble existing data & compare current status to standards and desired conditions

- Raritan Project C&A Data – groundwater recharge, riparian areas (delineation and losses), water quality, septic system density….
- TMDLs – fecal coliform, phosphorus, temperature
- NJDEP/USGS water quality & flow monitoring
- NJDEP, non-profit, municipal biological monitoring
- GIS layers – parcels, streams, infrastructure, land use
- RBWA Road Crossing Inventory
- Variable source area hydrology – areas that generate the most runoff
- CCPI Model – best areas for BMP implementation
- Municipal information – ordinances, master plan



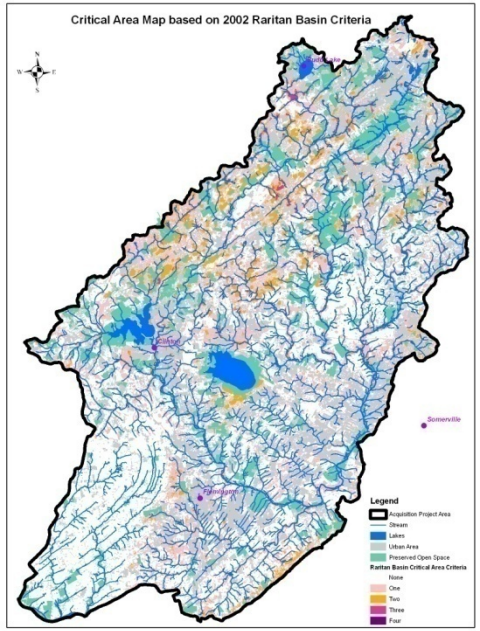
Open Space Criteria

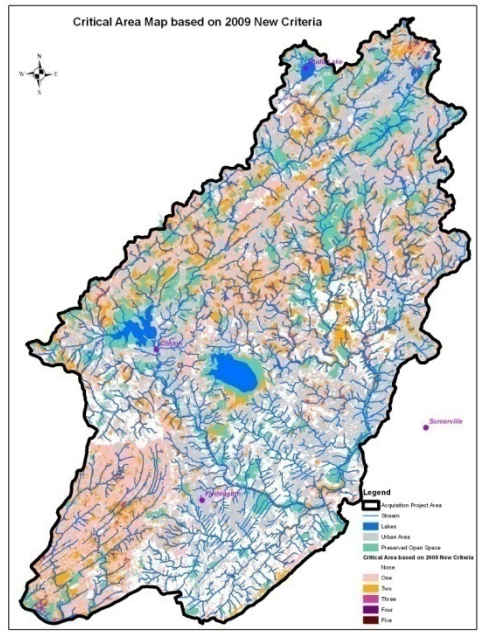
Raritan Basin Water Resources Protection Open Space Criteria (2002):

1.Riparian Area
2.Primary Groundwater Recharge
3.Wellhead Protection Area
4.Critical Habitats

NJWSA Criteria (2009):

- Riparian Area
- Highly erodible soils
- Critical habitat (Landscape Project)
- Dense Forest
- Groundwater & Aquifer Recharge
- Isolated wetlands & buffers





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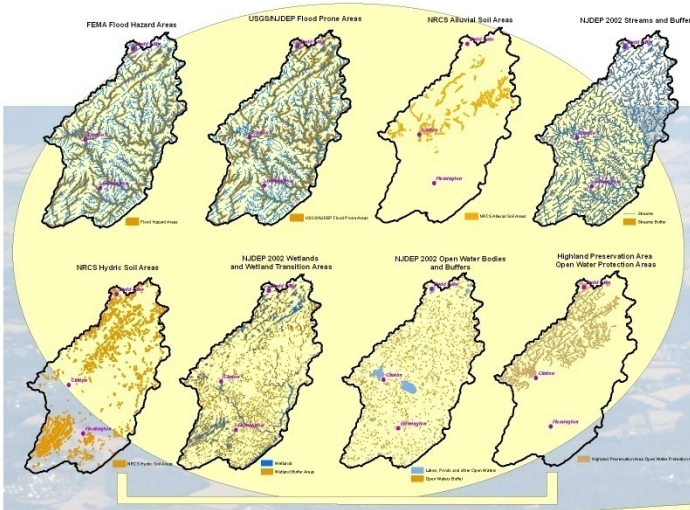
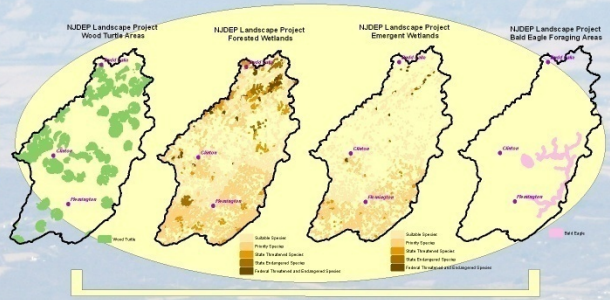
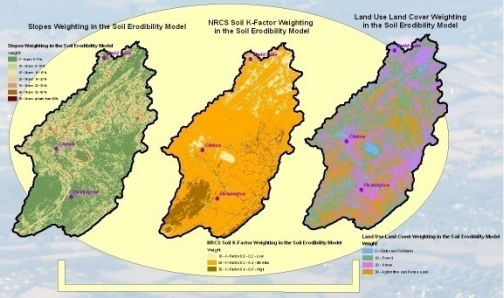
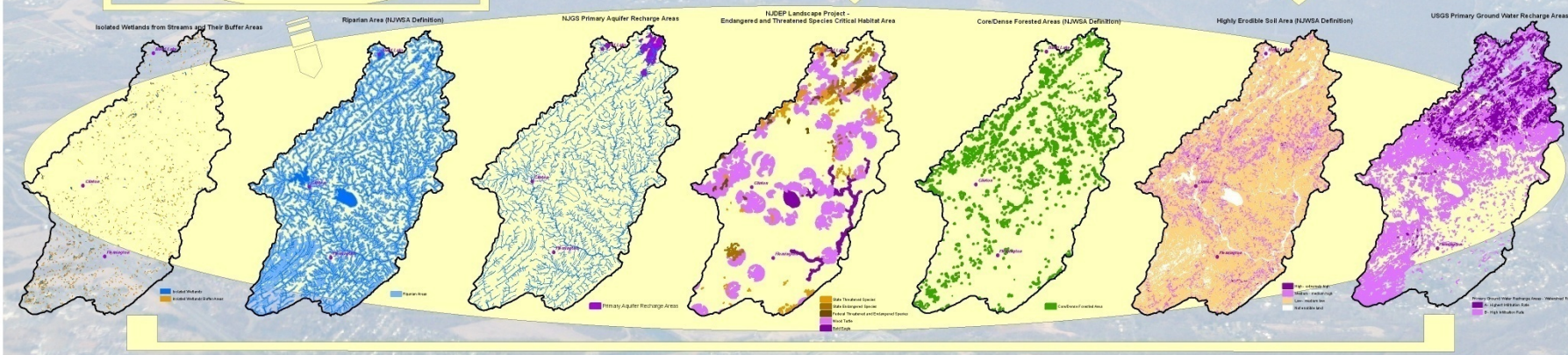
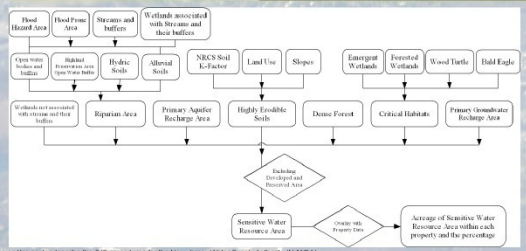
Identification of Potential Properties for Open Space Preservation based on Sensitive Water Resources











NJWSA July 2009

The maps on this poster describe the GIS procedures for the New Jersey Water Supply Authority (NJWSA) Open Space Sensitive Water Resource Area Criteria database. The database is created based on the selected criteria for open space acquisition by NJWSA acquisition workgroup. All potential properties will be first evaluated through this database to determine the number of criteria present and the sensitive water resource area coverage.

The criteria for the review are: riparian area delineation, core/dense forests, critical habitats/threatened & endangered species (emergent wetlands, forested wetlands, wood turtle, and bald eagle), highly erodible soil, primary ground water recharge, primary aquifer recharge, and isolated wetlands & their associated buffers.

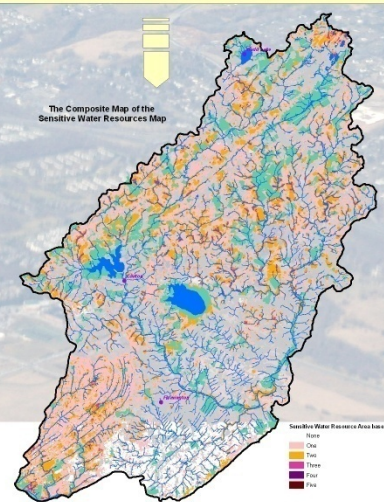
All the criteria are weighted equally in this database. Further scoring might be added based on project requirement. The whole procedure involves four steps.

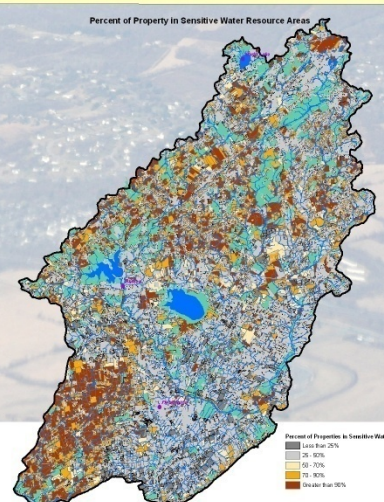
Step 1 is to create the individual data layers for the seven major components of the database. Riparian corridor zone and highly erodible soils are the two which require a lot of data manipulation, spatial analysis and geoprocessing. The riparian area definition comes from the Raritan Project Riparian Methodology (NJWSA, 2000), which is used as a baseline for identifying all riparian areas in the acquisition project area. The highly erodible soil definition comes from Jeremiah Bergstrom's paper "A GIS-based analysis to identify riparian buffer restoration sites".
Step 2 is to combine all the seven major criteria into one seamless database for the sensitive water resource area.
Step 3 involves identifying all the preserved open space and developed areas. We will exclude the preserved area and the developed areas from the database to see how many historical sensitive water resource areas have been preserved as open space and how many sensitive water resource areas have been lost due to urban development.
Step 4 will evaluate individual properties by calculating the percentage of each property having sensitive water resource areas. This process is batch processed by GIS tools, which gives a quick and efficient analysis to see the comparative water resource values on each property.

The final result will rank each property relatively based on their sensitive environmental values (percentage in critical area) and the property size (acreage of each property). The whole process involves intensive GIS data manipulation and analysis using readily available GIS information, remote sensing, aerial photography and available

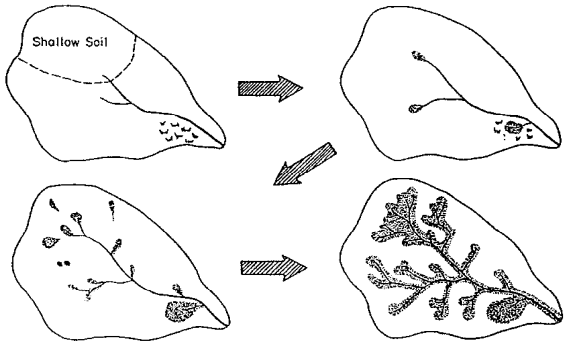
Highly Erodible Soil Definition

	Class Values	Weight
K-Factor	0.0 – 0.2 (low)	10
	0.2 – 0.4 (medium)	20
	0.4 – 0.6 (high)	30
Land Use	Water	0
	Wetlands	0
	Forest	10
	Urban	20
	Agriculture	30
	Barren Land	30
Slopes	0 – 5%	5
	5 – 10%	10
	10 – 15%	15
	15 - 20%	20
	20 - 30%	30
	30 - 50%	40
	>50%	50
	Class Values	Erosion Susceptibility
Erosion Susceptibility Theme	0	Not erodible land
	1 – 10000	Low - medium low
	10001 – 20000	Medium - medium high
	>20001	High - extremely high

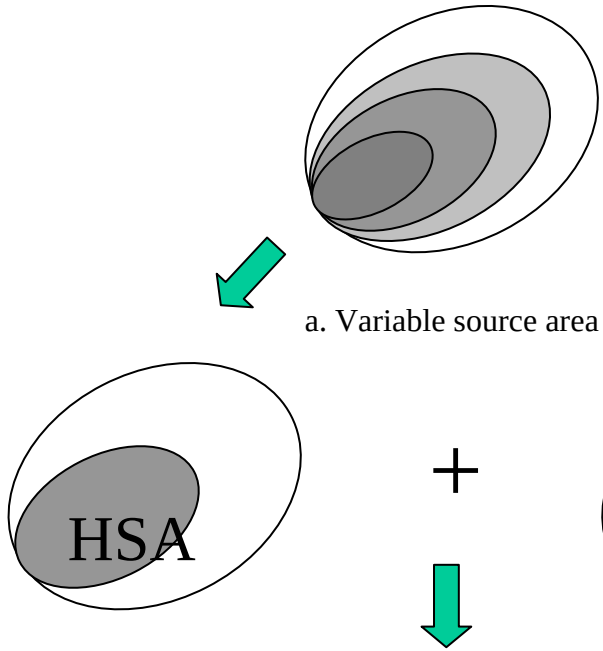




Variable Source Area Hydrology & Critical Source Areas



VSA defined by soil, slope & topographic index



a. Variable source area (VSA) pattern

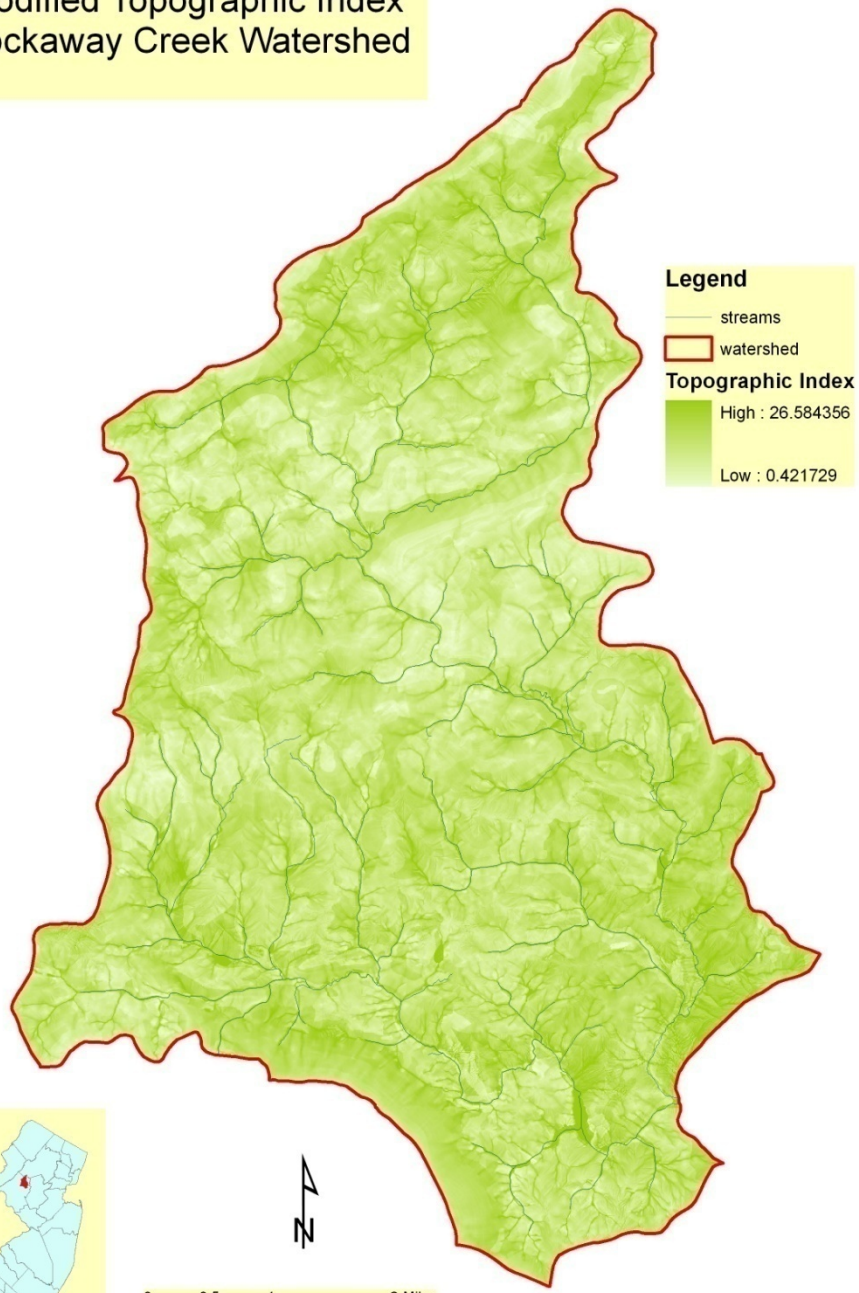
b. Hydrologically sensitive area (HSA)

c. Pollutant source areas

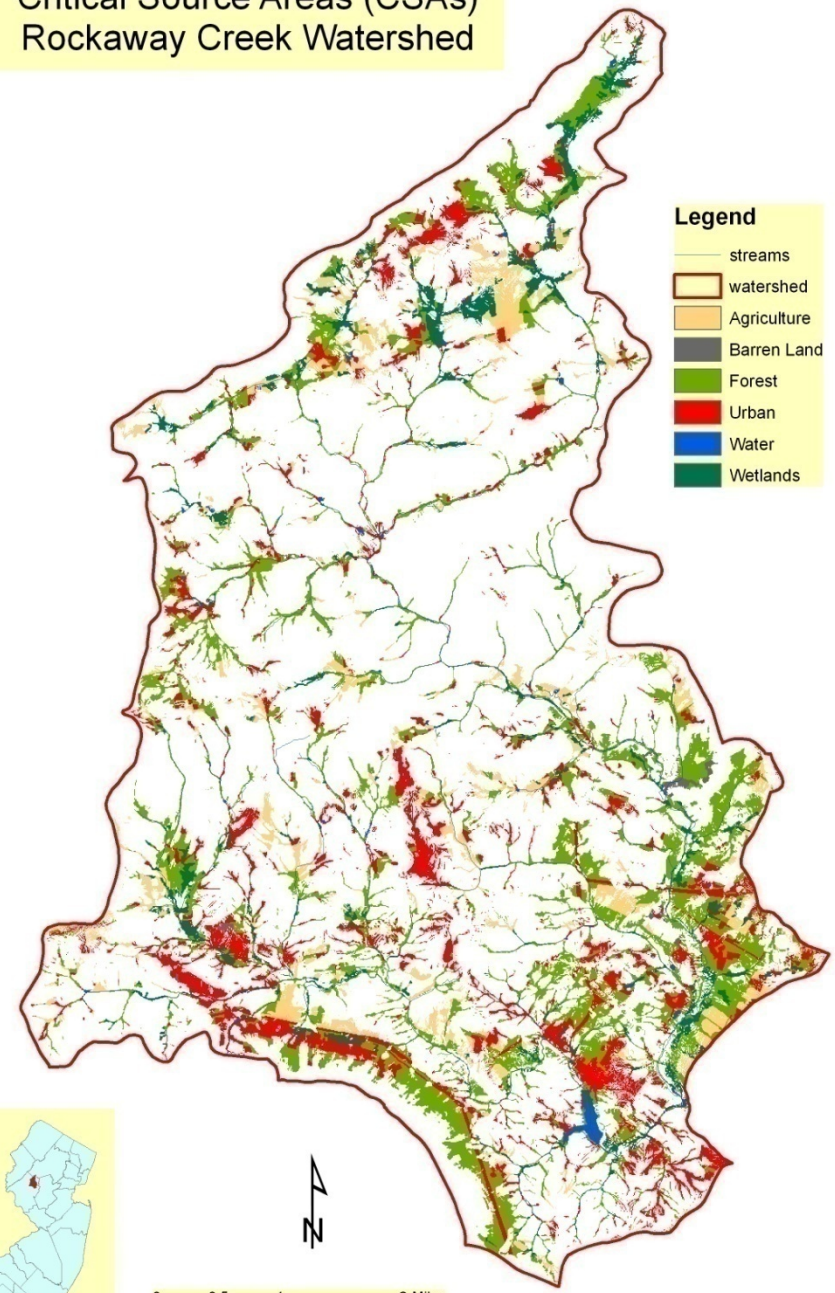
d. Critical source area (CSA)

(Qiu, EM, 2009; Qiu et al, JSWC, 2009)

Modified Topographic Index
Rockaway Creek Watershed



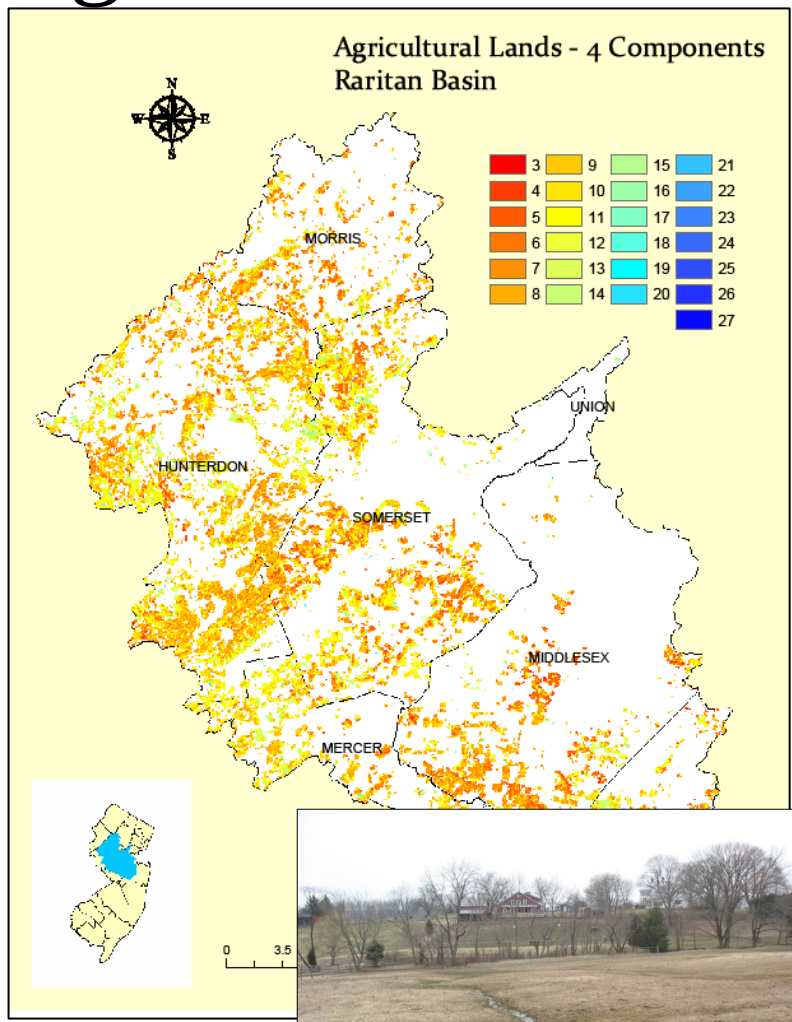
Critical Source Areas (CSAs)
Rockaway Creek Watershed



CCPI Model – Ag Buffer Plan

Prioritization of ag lands for restoration

- Soil Erodibility
  - USDA-NRCS Soil Erodibility Index (EI)
- Hydrologic Sensitivity/Runoff Potential
  - Modified Topographic Index (TI) from USDA-NRCS
- Wildlife Habitat
  - NJDEP Non-game and Endangered Species Program's Landscape Project
- Impervious Surface
  - NJDEP Land Use/Land Cover Data



Step 3.
Fill in the data gaps

- Think back to WHY a plan is needed
- What data are needed to determine what & where the problems are?
- What data are needed to identify potential pollutant sources?
- Design a monitoring program & data collection plan
  - Water quality monitoring
  - Stream assessment
  - Infrastructure inventory
  - Municipal data

Water Quality Assessment

- For regulatory compliance: measure concentration and flow
  - Caution: concentration alone can be masked by variations in flow volume, need to measure both
  - Analogy: Concentration = strength of lemonade after lemonade mix is added to a glass of water
- For determination of contaminant source(s) and levels of contribution: measure flow and concentration, and estimate load
  - Load = Concentration x Flow (unbiased from any variations in either concentration and/or flow)
  - Analogy: Load = amount of lemonade mix before it was added to the glass of water

Potential Pollutant Sources

Roads – total suspended solids, sediment, turbidity, conductivity (also metals and oil)

Agriculture – boron, ammonia, nitrate, total phosphorus, coliform bacteria, total suspended solids, turbidity, pH, conductivity, total Kjeldahl nitrogen, sediment

Septic system and public wastewater discharge – boron, nitrate, total phosphorus, coliform bacteria, conductivity, total Kjeldahl nitrogen, pH

Geese and other wildlife – total phosphorus, coliform bacteria, total suspended solids, turbidity, conductivity, total Kjeldahl nitrogen, ammonia, pH

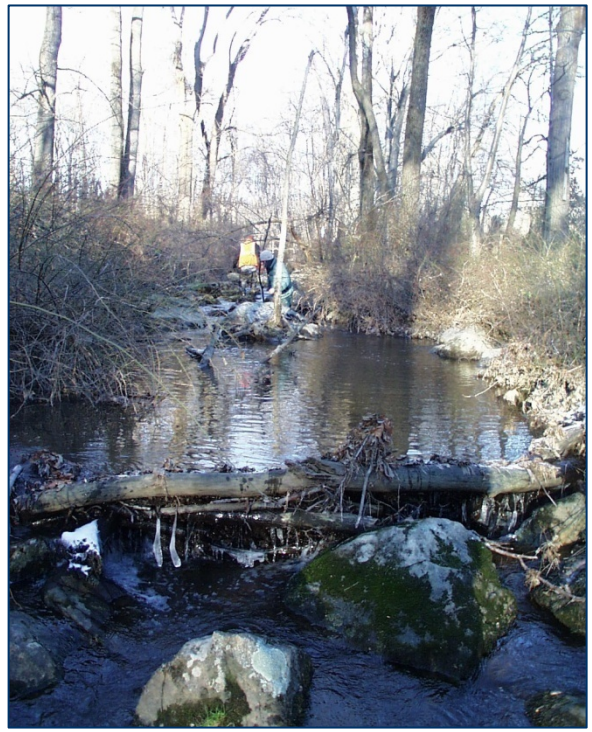
Lawn maintenance – total phosphorus, nitrate, pH

Streambank erosion – total suspended solids, turbidity, total phosphorus, nitrate, total Kjeldahl nitrogen, pH, sediment

Stream Assessment

aka – Where are they going with those waders?

- USDA-NRCS Stream Visual Assessment Protocol (SVAP)
- Scores based on physical and biological indicators
- Assess overall stream health
- Identify potential restoration sites – where are the problems and what can we fix
- Completed for Spruce Run, Mulhockaway Creek, Neshanic River, modified protocol for Manalapan Brook



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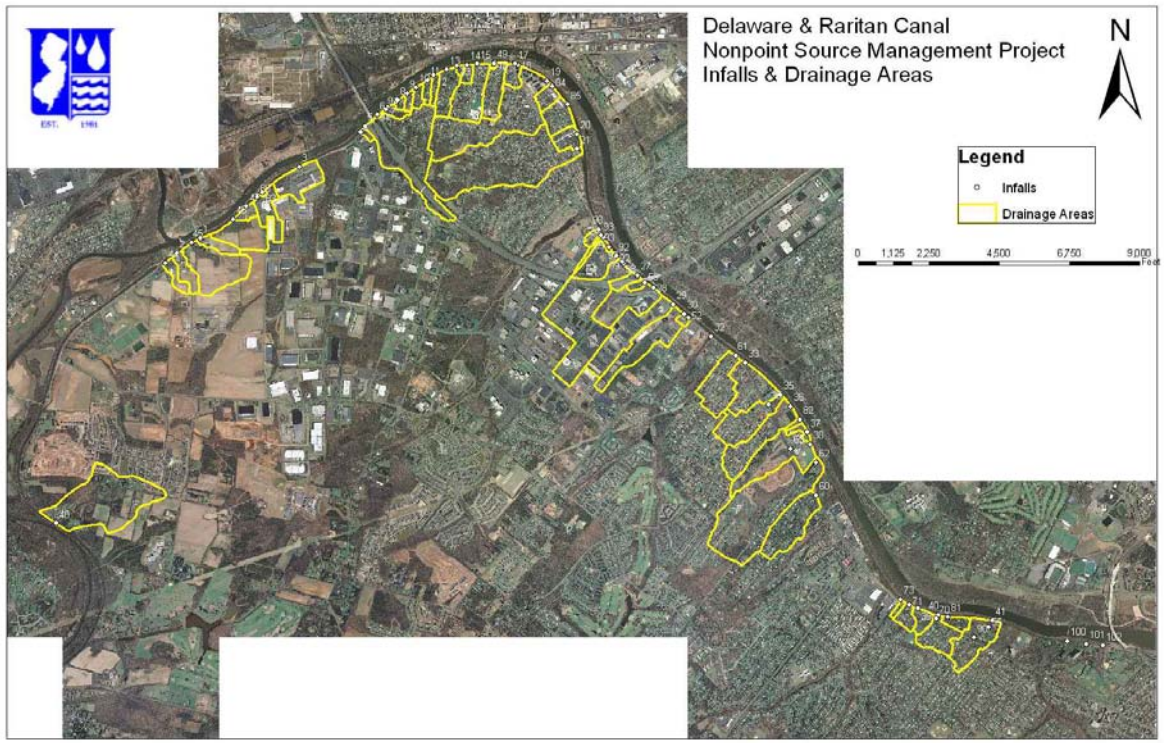
Infrastructure Inventory

MULHOCKAWAY CREEK STORMWATER MANAGEMENT AND WATERSHED RESTORATION PLAN
DECEMBER 2007

Table 10. Stormwater Inventory Summary

Feature Type	Description	Located Features	Photographs of Feature Types
Swales & Ditches	Flow paths greater than 2 inches in depth which convey concentrated stormwater flow	260	339
Outfall Pipes	Structures where stormwater exists or is discharged from a piped conveyance system	460	572
Culverts	Structures through which convey permanent non-ephemral water bodies through road embankments and other obstructions	96	138
Catch Basins	Inlets through which surface stormwater enters a piped conveyance system	1072	n/a
Pipe Inlets	Structures where concentrated stormwater flow enters the piped conveyance system via horizontal or nearly horizontal pipe in the absence of a catch basin	245	n/a
Detention Basins	Bermed or excavated areas designed to hold and detain peak stormwater flows caused by impervious surfaces	24	89
Detention Basins Inlets	Pipes where stormwater enters or discharges into a detention basin from a piped conveyance system	34	44
Detention Basins Discharges	Pipes where stormwater exits or is discharged from a detention basin	23	48
Detention Basin Outlet Structures	Structure which controls the flow of water from the interior of a detention basin to the receiving water body or conveyance to a receiving wate		
Best Management Practices	Structures created to aid in the improvement of water qu		
Dams & Diverters	Structures and/or berms designed to impound water or f debris, which impound water and impede flow		
Confluences	Locations where two streams converge		
Areas of Concern	Locations of suspected or potential detriments to water		
Stream Photographs			
Other Photographs			
Total Features			
Total Photographs			



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Municipal Assessment

Regional Analysis: Lockatong/Wickecheoke Watershed Plan

Key	No Provisions	Could be Improved	Very Good
	0 points	1 point	2 points

	Delaware Township	Franklin Township	Kingwood Township	Raritan Township
Master Plan (General)				
Water Resource Goals				
Resource Protection Element				
Water Resources Element				
Water Budget				
Build-Out Analysis				
Wastewater Management Plan				
Stormwater Management Plan				
Environmental Resource Inventory				
Environmental Commission				
Ordinances / Regulations (General)				
Steep Slopes				
Riparian Corridors				
Woodlands/Trees				
Wellhead Protection				
Well Testing				
Septic Management				
Soil Erosion and Sedimentation Control				
Floodplains				
Wetlands				
Nutrient Management - Farm				
Nutrient Management - Lawn				
Impervious Surface Ratios				
Pet Waste Ordinance				
Litter Control Ordinance				
Improper Disposal of Waste Ordinance				
Wildlife Feeding Ordinance				
Containerized Yard Waste Ordinance				
Yard Waste Collection Program				
Illicit Connection Ordinance				
Water Conservation				
31 categories - 62 point maximum	22 of 62 = 36%	22 of 62 = 36%	16 of 62 = 26%	43 of 62 = 69%

Existing Conditions

	Delaware Township	Franklin Township	Kingwood Township	Raritan Township
Master Plan (General)				
Water Resource Goals				
Resource Protection Element				
Water Resources Element				
Water Budget				
Build-Out Analysis				
Wastewater Management Plan				
Stormwater Management Plan				
Environmental Resource Inventory				
Environmental Commission				
Ordinances / Regulations (General)				
Steep Slopes				
Riparian Corridors				
Woodlands/Trees				
Wellhead Protection				
Well Testing				
Septic Management				
Soil Erosion and Sedimentation Control				
Floodplains				
Wetlands				
Nutrient Management - Farm				
Nutrient Management - Lawn				
Impervious Surface Ratios				
Pet Waste Ordinance				
Litter Control Ordinance				
Improper Disposal of Waste Ordinance				
Wildlife Feeding Ordinance				
Containerized Yard Waste Ordinance				
Yard Waste Collection Program				
Illicit Connection Ordinance				
Water Conservation				
31 categories - 62 point maximum	59 of 62 = 95%	52 of 62 = 84%	59 of 62 = 95%	54 of 62 = 87%

After Implementation

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Step 4.
Bringing it All Together: The Watershed Restoration/ Protection Plan

- NJDEP – 9 minimum elements
- Identify sources of pollutants
- Recommend projects
- Estimate load reductions
- Timeline
- Figure out how to fund projects

Step 5.
The Fun Stuff-
Implementation

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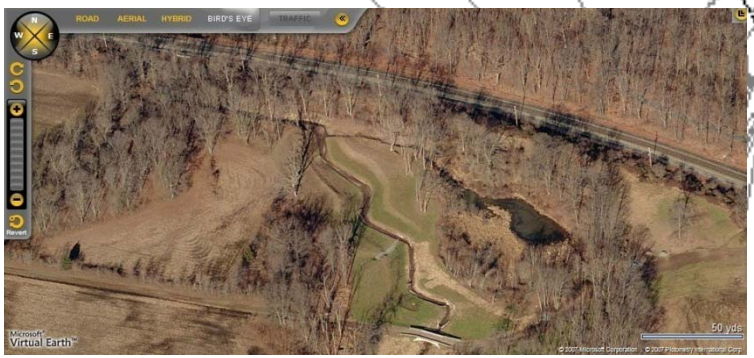
Simple projects and…

….not so simple



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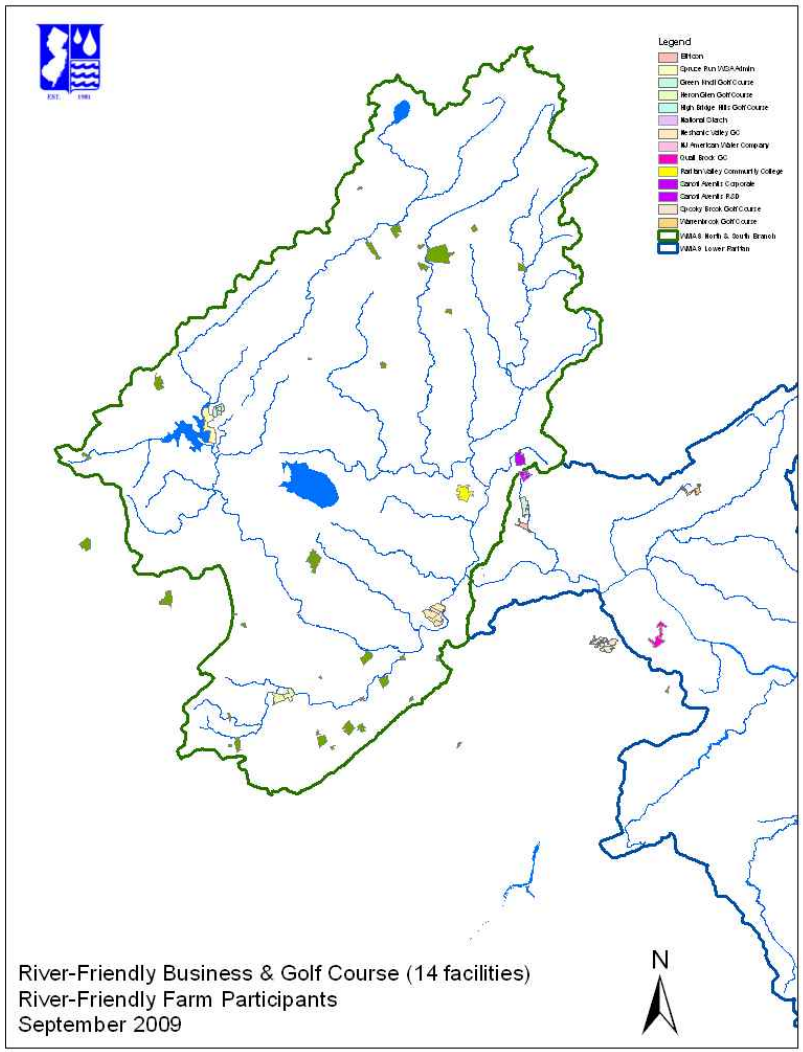
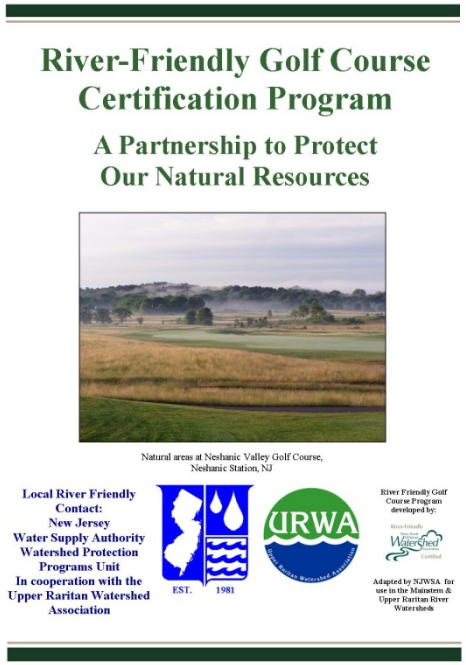
River Friendly Programs



- Golf Course
- Business
- Farm
- Resident



Stormwater Improvements

- Retrofit existing facilities- basins, etc.
- Disconnection of impervious surfaces
- Rain barrels/Rain gardens

Rain barrel

Rain garden at Ethicon, Inc.

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Stream & Riparian Restoration
Agricultural BMP Implementation
Open Space Acquisition
Education

River-Friendly Resident

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New Jersey Water Supply Authority
www.njwsa.org/wpu

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Municipal Implementation

- Master Plan Updates
  - ✓Environmental Resource Inventory
  - ✓Conservation Element & Open Space Plan
- Land Use and Development Regulations
  - ✓Zoning
    - Minimum lot sizes
    - Impervious surfaces
  - ✓Site Plan Review
    - Cluster / Lot averaging options
    - Protection of critical features
- Best Management Practices
  - ✓Reduction of NPS pollution

Master Plan & Ordinance Revisions

- Stormwater management
  - Regulatory compliance
  - Innovative site design
  - Best management practices
- Protect sensitive areas
  - Limit impervious cover
  - Stream corridor buffer
  - Protection of steep slopes
  - Protection of upland forests
- Design Guides
  - Protect community character
  - Low impact development

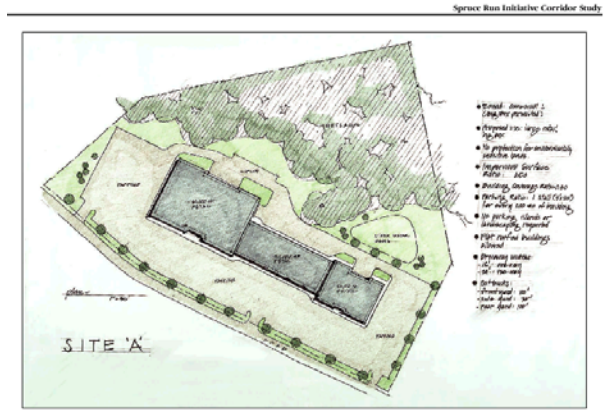

Figure 11A
Potential Development under Current Regulations
Non-Node Area

Figure 11B
Potential Development under Recommended Regulations
Non-Node Area

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Step 6. Monitoring & Evaluation

aka how do we know if it's working (or not)

- Define indicators/criteria
- Define "success"
- Link physical restoration to water quality restoration goals
- Set measurable goals & objectives
- Identify when modifications are necessary

Stream Restoration Project
- Photo-monitoring
- Visual observation
- Macroinvertebrate sampling
- Fish sampling
- Habitat sampling
- Vegetation surveys
- Geomorphology surveys

Stormwater Improvement Project
- Photo-monitoring & visual observation
- Water quality monitoring

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Monitoring the Hoffman Park & Crystal Springs Projects

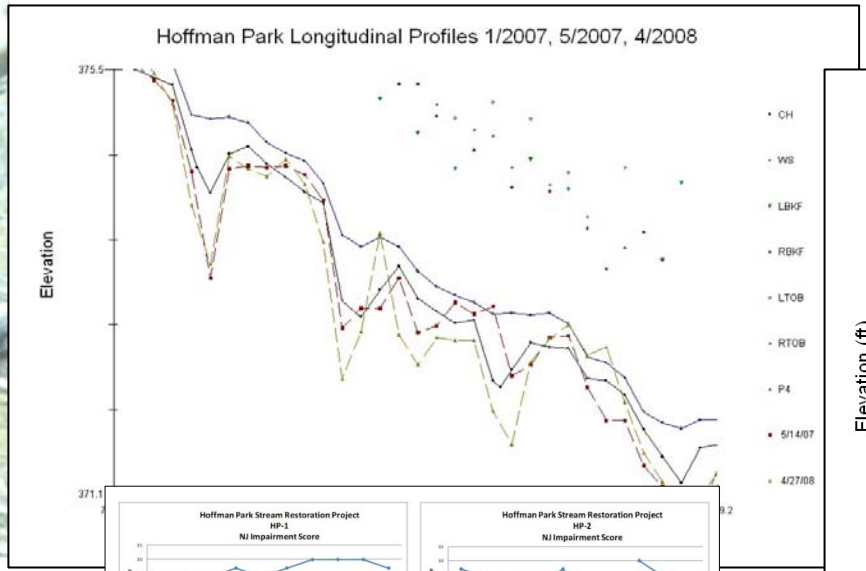
Pre-Construction:

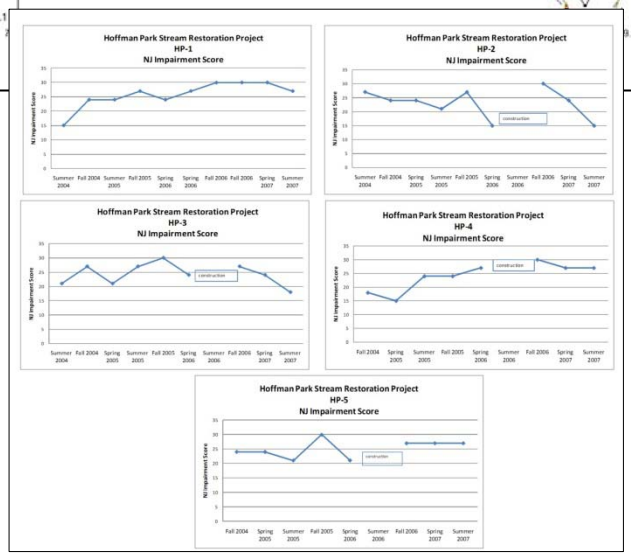
•Photomonitoring/Visual Observations – Frequent
•Macroinvertebrate Sampling - 3x/year
•Habitat Assessment – 1x/year
•Geomorphology Survey – once

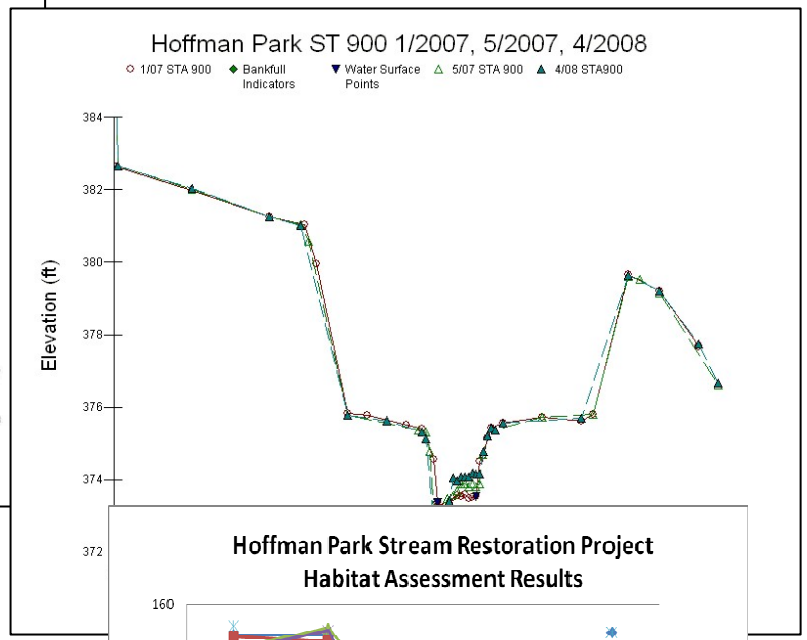
Post-Construction:

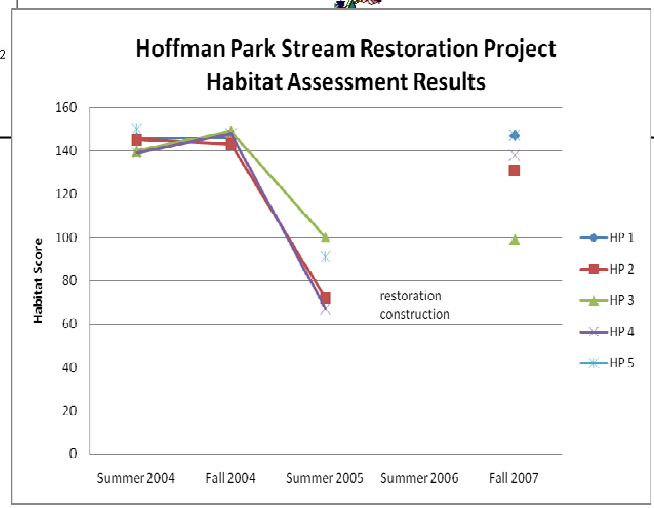
•Photomonitoring/Visual observations – Frequent
•Macroinvertebrate Sampling – 3x/year to end of grant period, 1-2x/year thereafter
•Habitat Assessment – 1x/year
•Geomorphology Survey – 1x/year, additional if flows or visual observations indicated need
•Vegetation Monitoring – 1x/year at HP

Hoffman Park: Post-Construction Data









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Monitoring & Evaluation (continued)

Estimating Load Reductions

- WQ monitoring is expensive!
- Modeling – simpler way to estimate load reductions
  - ✓STEP-L model
  - ✓WinSLAMM

Open Space

- Baseline evaluation
- Management plan

Adaptive Management

- Plan and budget for it
- Project plan should identify when it is needed, i.e.
  - ✓WQ goals not met in 3 years, or
  - ✓Vegetation survival target not met, or
  - ✓Stream dimensions not achieved

Funding

Be creative!

- NJDEP 319(h) Nonpoint Source Grants
- NJDEP – Corporate Business Tax Funding
- Municipal stormwater mitigation plans
- In-kind services – counties & municipalities
- USDA-NRCS: WHIP, AWEP, EQIP
- Farm Service Agency (FSA):CREP, CRP
- US Fish & Wildlife: Partners for Fish & Wildlife
- US EPA: 5 Star Grant Program
- ANJEC municipal grants
- NOAA

Lessons Learned

- Effective watershed management addresses new and existing development
- Effective implementation requires detailed planning
- Effective projects require partnerships
- Utilize all your contacts/networks
- Be patient
- Adapt projects as needed
- Don’t give up!

NJWSA Source Water Protection Efforts

- Mulhockaway Creek Watershed Plan & Implementation
- D&R Canal Watershed Plan & Implementation
- Rockaway Creek- Protection of Critical Source Areas for Water Resource Protection through Community-based Land Use Planning & Ordinances
- Cedar Grove Brook Watershed Restoration Plan (NJIT lead)
- Manalapan Brook Watershed Restoration Plan (Middlesex County lead)
- Neshanic River Watershed Restoration Plan (NJIT lead)
- Sidney Brook Watershed Restoration Plan (Union Twp. Lead)
- Spruce Run/Rocky Run Stream Segment Management Plan
- River-Friendly Programs - Golf Course, Business, Resident, Farm
- Rain Garden/Rain Barrel Initiative (Peter's Brook focus)
- Walnut Brook Stream Stabilization & Wetland Mitigation Project (NJRC&D lead)
- Riparian Restoration Plan for Agricultural Lands (NJRC&D lead)
- Lockatong/Wickecheoke Watershed Plan & Implementation
- Manasquan River NPS Plan
- Addressing Agricultural NPS Pollution in Priority Watersheds
- Open Space Preservation & Management
- Municipal Assessment
- Stream Assessment & Restoration
- …….

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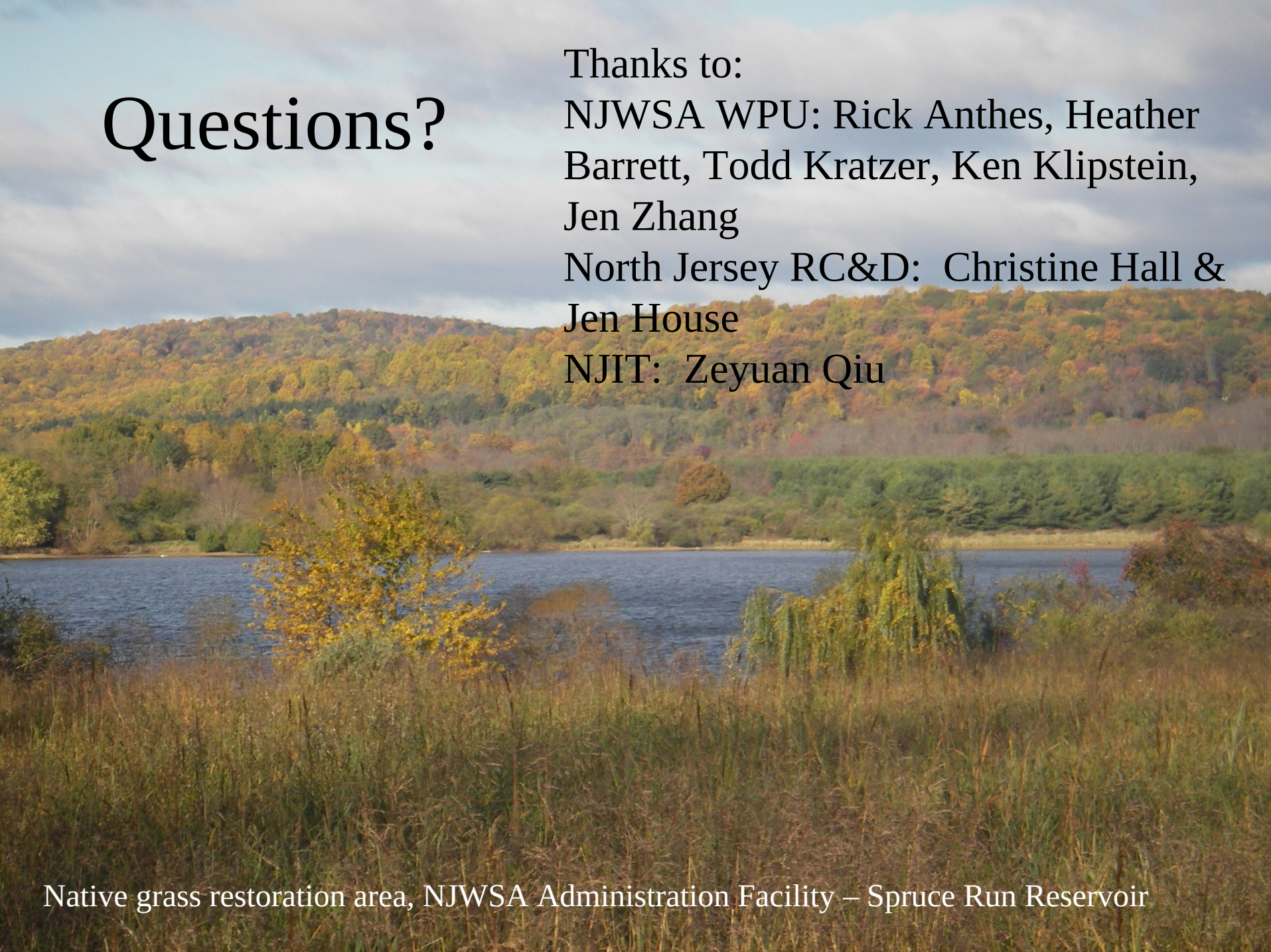
Questions?

Thanks to:
NJWSA WPU: Rick Anthes, Heather Barrett, Todd Kratzer, Ken Klipstein, Jen Zhang
North Jersey RC&D: Christine Hall & Jen House
NJIT: Zeyuan Qiu



Native grass restoration area, NJWSA Administration Facility – Spruce Run Reservoir