# NEW YORK STATE WATER RESOURCES INSTITUTE

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# Water Resource Infrastructure in New York: Assessment, Management, & Planning – Year 3

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*Photos taken by Steve Stanne & Srinagesh Gavirneni*

Hudson River Estuary

The **New York State Water Resources Institute (NYS WRI)** and the **New York State Department of Environmental Conservation (DEC) Hudson River Estuary Program (HREP)** has undertaken a coordinated research effort on water resource infrastructure in New York State, with a focus on the Hudson and Mohawk River basins.

The primary objective of this multi-year program is to bring innovative research and analysis to watershed planning and management. In particular, WRI-HREP is working to address the related topics of water infrastructure, environmental water quality, and economic vitality, especially as they pertain to land use planning and management in the Hudson and Mohawk watersheds. The WRI-HREP program coordinates individual research efforts so as to fit within the context of, and be responsive to, New York State's growing concerns about aging public infrastructure, economic constraints on public investment, and the recent requirement for State planning agencies to incorporate principals of "smart growth" as promulgated in the 2010 Smart Growth Public Infrastructure Policy Act.

In the following pages we report on progress made in **year three (2014-2015)**. Projects are discussed within the following broad themes:

1) **Infrastructure Assessment** - Water-related infrastructure including water supply and wastewater treatment facilities, distribution networks, decentralized treatment installations, dams, constructed wetlands, "green" infrastructure, etc., and their current state and effectiveness at providing water and ecosystem services regionally at reasonable cost
2) **Economic Vitality** – Benefit/cost analyses of infrastructure development and regional economic vitality with respect to water infrastructure and its effect on private and public investment and industrial development
3) **Integrated Management & Planning** - Integration of scientific, economic, planning/governmental and/or social expertise to build comprehensive strategies for public asset and watershed management, including application of smart growth principles
4) **Source-Water Protection** - The economics and benefits of source watershed protection strategies and the use of ecological services to meet water supply and quality needs, as opposed to treatment at point of delivery
5) **Technology** – Water resource-related technologies that enhance treatment efforts, increase system efficiency, or provide novel tools for monitoring and assessing water use and quality

Following this summary we also include:

- A link to the full versions of final reports, which are available at our website http://wri.cals.cornell.edu/grants-funding
- Outreach efforts currently underway
- How we are adapting our efforts to support research and create effective outreach products
- A list of recently funded projects

**For a copy of previous summary reports,** please contact Brian Rahm (bgr4@cornell.edu), or go to https://wri.cals.cornell.edu/grants-funding

## **Infrastructure Assessment** - Water-related infrastructure including water supply and wastewater treatment facilities, distribution networks, decentralized treatment installations, dams, constructed wetlands, "green" infrastructure, etc., and their current state and effectiveness at providing water services regionally at reasonable cost

Cross-cutting impressions

*Previous research suggested* that decentralized and "green" infrastructure approaches, such as the use of septic systems, and vegetated stormwater detention basins, respectively, are common and can be effective. However, these systems also suffer from lack of rigorous design in some cases, and are susceptible to failure due to challenges associated with on-going maintenance. For green infrastructure to deliver on its promise of improved and cost-effective stormwater management, continued monitoring is necessary to generate a better understanding of robust technologies and their environmental benefits over a range of conditions. For "grey" infrastructure systems, such as engineered water treatment facilities and sewer distribution networks, application of regional and watershed systems analyses could help to improve efficiency of financing models, and improve environmental outcomes. Municipal asset management is also a critical need.

*Current research* focuses on three systems: ditches, culverts and decentralized wastewater treatment. Management of roadside ditches in both suburban and agricultural areas was found to be inconsistent, and often at odds with water and air quality goals. Ditches were generally sources of nutrients to surface waters, and could emit high levels of greenhouse gases, especially if poorly drained. Negative impacts associated with ditches could be reduced through better management of lawn and agricultural fertilizer application, as well as improved ditch drainage and maintenance. Culverts were found to be sensitive to likely increases in heavy precipitation driven by climate change, and were often undersized and poorly designed for the passage of aquatic organisms. Current work on septic systems reinforced previous results, and suggests that such systems can perform well under certain conditions, but that challenges remain associated with maintenance and governance.

What researchers found

*Photograph of a suburban ditch*

Project Title: **Road ditches in the suburban landscape: potential hotspots for nutrient transport and cycling**, Todd Walter (Cornell University)

This study evaluated nutrient cycling in grassed road ditches in a suburban watershed. A water quality survey was conducted for twelve ditches and the streams to which they drained. While some ditches had high soluble reactive phosphorus concentrations, overall stream levels remained low. $NO_x$ concentrations increased from upstream to downstream, and were likely due to contributions from ditches. Application of lawn fertilizer was identified as a probable influence on ditch nutrient concentrations as well as emission of some greenhouse gases. Homeowners are encouraged to minimize fertilizer application. Also, ditches should be designed so as to minimize standing water. Key findings include:

- **Ditches were sources of nitrogen and phosphorus** – nitrate increases were observed in receiving

streams, though concentrations were still low compared to agriculture-impacted streams
- **Wet ditches emitted methane**, while ditch **soils had high denitrification rates**
- Detrimental environmental impacts could be reduced through **better management of lawn fertilizer and more effective ditch drainage**

*A roadside ditch during wet weather*

Project Title: **Assessing the condition of roadside ditches and their management**, Rebecca Schneider (Cornell University)

A decade of research has documented the significant contributions of roadside ditches to stream flooding and pollution. However convincing policy-makers of the need to address these problems has been difficult without evidence of the actual status of practices by town highway staff. A survey was conducted in 2014 to assess the condition of roadside ditches and current ditch management practices in the Hudson Valley and across NYS. There were 63 responses from town highway superintendents located throughout the 10 Hudson River counties. Overall, this survey documented that roadside ditch management is less than ideal, with the majority of ditches routinely scraped, left exposed, and directly contributing sediments to streams. The most frequently reported impediments were insufficient resources (i.e. time, manpower, equipment, money) and disagreement with landowners over the right-of-ways. This assessment provides a critical, and previously missing, piece of evidence needed to demonstrate the importance of improving roadside ditch management throughout the Hudson Valley and across NYS. Key findings include:

- Roadside ditch **management is less than ideal**, with a majority of ditches routinely scraped and directly contributing sediments to streams
- Significant barriers to improving ditch management were **insufficient resources** (i.e. time, manpower, equipment, money) and **disagreement with landowners over right-of-ways**
- Survey findings, in combination with research on flooding and pollution in streams, provides a solid **framework to engage policy-makers** in order to make changes in ditch management practices

*Sampling greenhouse gases in the field*

Project Title: **Greenhouse gas emissions from New York state septic systems**, Todd Walter (Cornell University)

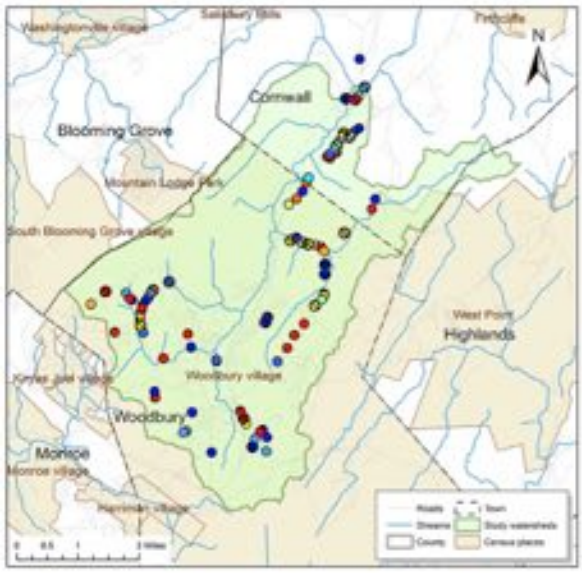
Onsite septic systems are a practical way to treat wastewater in rural or sparsely populated areas of New York State. Water pollution has always been a concern with such systems; we sought to determine whether septic systems have the potential to contribute to air pollution as well through the release of greenhouse gases (GHGs). We measured the flux of $CH_4$, $CO_2$, and $N_2O$ from the most likely locations for gas emissions during normal operation of the septic system: the soil over the leach field and sand filter, and from the roof outlet vent. We found that the majority of all gas emissions are released from the roof vent. However, gas flux comparisons suggest that biological processes in the soil, especially in the leach field, can influence the type and quantity of gas released. The total vent, sand filter, and leach field GHG emissions were 0.12, 0.045, and 0.046 tonne $CO_2e$ capita$^{-1}$ year$^{-1}$, respectively. Key findings include:

- This is the **first time GHG emissions have been reported from leach field soils**
- As currently implemented, septic systems are likely **not a large contributor to greenhouse gas emissions**
- **Continuation of this work** is planned to determine the microbial communities and activity level in the soil over septic system components, particularly the leach field.

Project Title: **Reevaluating onsite wastewater systems: expert recommendations and municipal decision-making**, Sridhar Vedachalam (Cornell University)

Onsite wastewater treatment systems (OWTS) serve 20–25% of the households in the US. Urbanization and new environmental standards are leading many communities that currently rely on OWTS to think of alternatives. We study this decision-making in 19 municipalities across the US through the unique lens of feasibility reports commissioned by the respective municipalities and authored by engineering/design consulting firms. Although not representative of the entire U.S., the small sample of feasibility reports evaluated here is indicative in nature and provided significant insights about the inputs that help municipalities make decisions on complex issues. Key findings include:

- Reports **omitted essential information** relevant to decision-makers, and were not generally of high quality
- Reports evaluated a **balanced mix of decentralized and centralized treatment options**, and final recommendations were not biased in any particular direction
- Most municipalities **failed to take follow-up action** on report recommendations, calling into question the motive behind commissioning these reports




*Maps of municipal culvert networks*

Project Title: **Identifying and prioritizing undersized and poorly passable culverts**, Todd Walter & Art DeGaetano (Cornell University)

Road culverts are ubiquitous and have traditionally been designed for maximum efficiency, i.e. the smallest culvert that can accommodate the design flow. This approach is driven largely by economic considerations – smaller culverts cost less. However, this approach does not account for the dynamic nature of landscapes and climate. In recent decades peak storm runoff rates have been increasing, thus leading to undersized culverts and the risk of erosion, flooding and road washout. Additionally, culverts are often identified as barriers to aquatic organisms. The objective of this project was to identify undersized culverts under both current and future precipitation conditions, as well as culverts that impede aquatic and riparian organisms. An online tool was developed for determining culvert capacity and mapping upgrade opportunities in culvert networks. Key findings include:

- State-owned roads tended to have **longer return periods** than town or county-owned roads
- Under future (2050) precipitation conditions, about 25% of culverts have **lower associated return periods** than they have now
- Town-managed **culvert suitability was correlated with town population**, but not with watershed slope, impervious area, or median income

## **Economic Vitality** – Benefit/cost analyses of infrastructure development and regional economic vitality with respect to water infrastructure and its effect on private and public investment and industrial development

Cross-cutting impressions

*Previous research suggested* that industrial activity in some sectors, such as energy and fuel transportation, has been increasing. However, local and regional benefits resulting from this activity are overestimated, and the burden of cost associated with emergency preparedness and environmental risk falls disproportionately on local communities. Despite this, regional economic vitality is indeed linked to water resources and related infrastructure. Public infrastructure investment creates a foundation upon which commerce and private investment can thrive. Alternatively, poor public water infrastructure and regional coordination can be a barrier to economic growth, and can lead to or exacerbate environmental risks. Because the public often does not see such infrastructure, its value is underestimated. Private and industrial investment in water resource infrastructure is also essential. There is an opportunity to better use, market, and brand regional water resources to promote water-related businesses, and build on existing water technology industries.

Project Title: **The Hudson River Valley: Economic development through water**, Mark Milstein (Cornell University)

This document builds on the first round of research from the Center for Sustainable Global Enterprise, which examined the role of water-related assets in the Hudson Valley of New York as an economic catalyst for the region. This report investigates in more detail: 1) the viability and the steps necessary to develop a regional water technology sector hub, and 2) ways to use the river as part of a more comprehensive tourism sector. In both cases the goal is to improve the climate for development and commercialization in the region through the leverage of water-related assets.. Key findings include:

- The Hudson Valley **shares attributes of other water cluster regions**, but lacks structure and mechanisms for effective development
- Regional stakeholders express interest in **increased collaboration and perceive economic benefits** for developing a cluster, but see no clear support for doing so
- Tapping the Valley's tourism potential would require **targeted/prioritized spending and coordination** in destination assets and promotion

*Brotherhood Winery in the Hudson Valley*

## **Integrated Management & Planning** - Integration of scientific, economic, planning/governmental and/or social expertise to build comprehensive strategies for public asset and watershed management, including application of smart growth principles

Cross-cutting impressions

*Previous research suggested* that effective management of water resource assets at the municipal level requires appropriate planning, financing, technology, management, maintenance and community buy-in. At the watershed and/or regional scale, water resource management presents a challenge because of various and competing stakeholder perspectives, and low incentives for coordination. That being said, analyses at the watershed scale reveal region-specific characteristics that could help inform water resource management decision-making. The capital-intensive nature of water infrastructure makes it difficult to incorporate changes in the system after initial investment decisions have been made. More complete assessments of water resources are needed at the watershed and regional scale so that stakeholders can come together to find common ground.

*Current research* focuses on providing decision support to municipal and regional decision makers, and also on assessing and incorporating smart growth concepts in state and local code. For managers of public facilities, online reviews and social media are providing an increasing stream of information that could assist them in facility management, marketing, and outreach. At the same time, traditional forms of media such as local newspapers are still important barometers and shapers of public thinking on major water resource issues. For municipalities facing complex infrastructure challenges, analyses suggest that decision-makers face difficult tradeoffs, but could benefit from a mix of problem-solving approaches and, where appropriate, intermunicipal agreements. Smart growth continues to hold promise as a tool to mitigate water resource infrastructure challenges, and researchers are making stronger links between landscapes and human and ecological health in urbanized areas. But, smart growth needs to be combined with other management and engineering efforts. At the state level, New York is increasingly adopting a unique leadership position in smart growth policy, though the results of this policy require time to assess, and are dependent on local planning processes.

What researchers found

Project Title: **Automated analysis of online reviews to improve visitor experience in New York state parks**, Srinagesh Gavirneni (Cornell University)
As more and more patrons are registering their facility visit experience in the form of online reviews and blogs, there is an opportunity for facility management to improve the service operations by addressing reviewer concerns. This data however, lacks structure, is voluminous and is not easily amenable to manual analysis. In this project, we design, develop, and implement software systems that download, organize, and analyze the unstructured text from reviews and other social media platforms in order to help facility managers identify strategies to improve the visitor experience at their facilities. Key outcomes include:

- A live system for **review collection, processing and storage**
- A software model for **identifying positive and negative sentiments** in reviews
- A methodology to **extract themes of interest** from positive and negative sentiments

*The Hudson valley contains many public park facilities, has a growing population, and is a significant tourist destination*


*Local newspapers in the Hudson valley*

Project Title: **The themes of the Hudson River: a content analysis of newspapers along the Hudson River,** Clifford Scherer (Cornell University)

The Northeastern United States has recently experienced widespread flooding from both inland flooding and storm surge from Superstorm Sandy in 2012 to Hurricane Irene and Tropical Storm Lee in 2011. Hundreds of flash floods are reported each year in the Northeast US, ranging from minor road floods to severe inundations of towns (NCDC, 2012). The reports in the National Climatic Data Center (NCDC) Storm Events database (NCDC, 2012) indicate an average of 5 fatalities per year and property damages averaging $254 million per year in the Northeast region between 2001 and 2011. Furthermore, for those living directly on the coast, storm surge is the most dangerous and potentially deadly risk presented to them. In addition to flood and surge from hurricanes, sea level rise is occurring at unprecedented rates. With the threat of sea level rise combined with New York's risk of inland flooding and hurricane storm surge, effective public communication that builds support for public policy aimed at addressing these risks is of critical importance.

Key findings include:

- We conducted a **content analysis of local newspaper reports of flood-related issues** along the Hudson River
- The dominant picture presented by these reports is one of **government-led action on current and past flood-related problems**
- Relatively **little mention is made of community involvement** in addressing current and past problems with even less mention made of community involvement in averting future problems

Project Title: **Further development and applications of a planning support system for managing change in water infrastructure systems in Hudson River municipalities**, Kieran Donaghy (Cornell University)

In this second stage of development of a prototype planning support system (PSS) for managing change in water infrastructure systems in Hudson River and Mohawk River communities, we have constructed a model that characterizes interdependencies and co-evolution of residential development, daily demands for water, daily draws of water from the Catskill and Delaware Aqueducts when the aqueducts are in service, and water sharing between communities when they are not in service. Our analysis is focused on the potential exigencies of the City of Newburgh, the Town of Newburgh, and the Town of New Windsor over the period of 2012-2035. The characterization of water sharing is predicated on implementation of infrastructural improvements recommended by the Orange County Water Authority's *Northeast Orange County Water Supply Project Facility Plan* of 2014. The model supports examination of the potential effects of smart-growth policy implementation and can be used to facilitate development of inter-municipal agreements.

Key findings include:

- Based on population projections the anticipated capacity expansion of the **city's water infrastructure system appears inadequate** for providing the water of Northeast Orange County municipalities **in the event that there are service outages** of the Catskill and Delaware Aqueducts
- **Demand for water appears to be manageable** in part through conservation measures and the implementation of appropriate water fee schedules
- **Smart-growth policies can influence development patterns** but will need to be combined with conservation and demand management efforts and a more ambitious program of infrastructure replacement to accommodate water needs by 2035


*Visualization of a CSO in the Albany pool*

Project Title: **Visualizing landscape change,** Brian Davis (Cornell University)

Visualization of landscape change at multiple scales can help communicate complex information more clearly. This promises to help bridge existing divides between technical disciplines and specific publics affected by issues related to combined sewer overflows (CSO) specifically, and hydraulic infrastructure more generally. This project develops analytical visualizations and spatial interpretations of data sets and performance standards in the 2011 Albany Pool *Combined Sewer Overflow Long-Term Control Plan*. It also creates a new data set through collection and analysis of historical aerial photographs of the Capital Region from 1952 to 2011, specifically focusing on changes in forest cover and paved areas. Simultaneously, a field technique is developed and tested at pilot sites for capturing actual sewer overflows into the Hudson River. Conclusions are drawn about the relative importance of forest cover change and impervious surface area in contributing to CSO in Troy. Also identified are implications for the new field technique as a means to better understand the extents and impacts of CSO in Troy in conjunction with chemical and spatial analysis. Key findings includes:

- Forest cover within the CSO area has increased, even as **beach closures and ecosystem degradation have become larger problems**, potentially due to suburban development
- Low altitude aerial photography can **document and analyze morphological characteristics and performance effects** of combined sewer overflows
- The design of landscapes in the sewershed can have **major implications for human and ecosystem health** along urbanized riverbanks

*The New York State Capitol*

Project Title: **Integration of smart growth into New York state policy and programs**, David Kay (Cornell University)

New York is rarely if ever situated by planning advocates or detractors, not to mention policy scholars, in the pantheon of states such as Oregon and Maryland that have led the nation in adopting state smart growth policies. During the past decade, however, a cumulatively significant weave of policies and legislation has been drawn through New York's existing institutional fabric to condition state and local land use decision making. The emergent pattern bears a strong and deliberate imprint of smart growth policies and goals, though the smart growth label is still often in small print or entirely absent. This project considers the outlines of this pattern, its overall coherence, and its appropriateness for the diverse State of New York and its almost 1,600 general purpose local governments. Key findings include:

- New York deserves to be grouped with others considered to be **smart growth states**
- Smart growth at the state level is a multidimensional concept with **different interpretations and emphases of basic principles** that vary by state
- In a home rule state, the importance of **functional state-local partnerships in planning and implementation** cannot be overestimated

## **Source-Water Protection** - The economics and benefits of source watershed protection strategies and the use of ecological services to meet water supply and quality needs, as opposed to treatment at point of delivery

Cross-cutting impressions

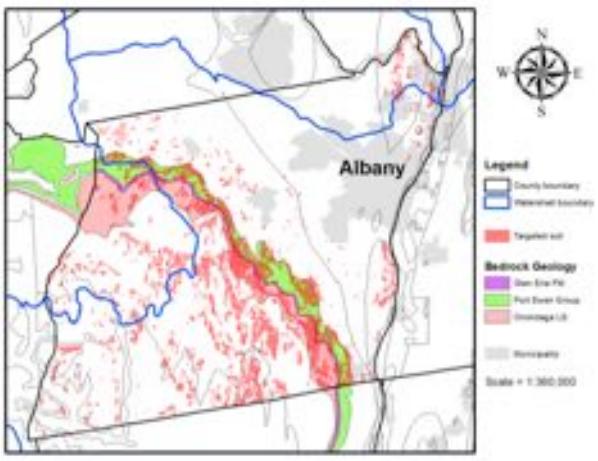
*Previous research suggested* an urgent need to characterize the economic and environmental costs and benefits of ecosystem services provided by source watershed protection, particularly in areas where grey infrastructure is aging and funding is limited. While the New York City watershed management program serves as an example of how source water protection can viably meet water supply quality goals without extensive water treatment, less is known about how municipalities with fewer resources can also leverage benefits from this approach. Water resources managers and planners will have to continue to explore and balance the costs and benefits of various development scenarios if we want our understanding of watershed protection to be robust.

*Current research* focuses on rural areas in which some agricultural practices, such as manure spreading, represent a possible threat to groundwater when combined with thinly-soiled karst topology. More information on the exact location of this topology can help protect groundwater by indicating areas where farmers can adjust practices to avoid contamination.

What researchers found

Project Title: **Identifying sinkholes and manure management setbacks using LiDAR and aerial photography**, Paul Richards (SUNY Brockport)
Manure application in the early spring is a major source of groundwater contamination in New York State. In the past 10 years there have been at least four well contamination events, the most recent of which occurred last year in Onondaga County. In each of these events, thinly-soiled karst, which provides an easy pathway for manure to travel into the groundwater, was implicated. For this reason the NYSDEC have implemented a new set of manure management guidelines that must be followed by all Confined Animal Feed Operators. According to these guidelines, manure application is not allowed in the early spring on fields that contain specific soil series that are believed to only occur in thinly-soiled karst areas. The guidelines also state that manure application is not allowed within 100 feet of sinkholes and that catchment areas associated with sinkholes must also follow early spring management rules. These guidelines are an important step forward, but implementing them will be difficult in many counties of New York, because sinkhole and thinly-soiled karst areas have not been mapped. This study mapped sinkholes and exposed bedrock areas in order to identify which of the targeted soil types are actually associated with thinly-soiled karst. Key findings include:

- Identification and mapping of all **sinkholes and thinly soiled karst areas** in the county using LIDaR, available water and gas well logs, aerial photography and available geological information
- Identification and mapping of **delineated setbacks associated with sinkholes**, with production of a set of high quality geo-rectified maps that farmers and certified crop advisors can use to help agricultural producers comply with the new manure management guidelines




*A map of bedrock geology in Albany county*

## **Technology** – Water resource-related technologies that enhance treatment efforts, increase system efficiency, or provide novel tools for monitoring and assessing water use and quality

No research conducted this year

## Full versions of final reports are available at our website http://wri.cals.cornell.edu/grants-funding

### **Outreach** – How have we been communicating results of our work?

For a complete listing of outreach activities performed by WRI and HREP staff, please see our website at http://wri.cals.cornell.edu/news

### **Year Four (2015-2016)** - How we are adapting our efforts to support research and create effective outreach products?

The fourth year of this coordinated effort launched a number of new analyses and continued several others. New investigators were invited to strengthen our ability to conduct interdisciplinary work. All researchers were encouraged to consider partnering with each other, a municipality, state agency, or other research institution, and we feel this current report reflects our continued success in this regard. The Community and Regional Development Institute (CaRDI) at Cornell University continues to be a strong partner in our research and outreach efforts, and we are actively working to expand our network to other groups on campus such as New York Sea Grant. As we have in previous years, WRI will continue to encourage collaborative, multi-disciplinary projects as a way to provide holistic assessment of issues related to water resource infrastructure, and its effect on ecology, environment, people and the economy.

### **2015-2016** – Funded projects for the next year

Funded projects fall within two administrative categories. Competitive research involves investigators from institutions across the state who responded to a formal request for proposals. These researchers will work largely independently, but can be contacted and consulted regarding opportunities for cooperation and outreach. Coordinated research involves Cornell faculty who have agreed to meet quarterly to facilitate discussion and synergy among individuals, as well as with staff from WRI, HREP and the Mohawk River Basin Program (MRBP).

Competitive Projects

Project Title: **Assessment of the Effectiveness of Green Infrastructure at Improving Water Quality and Reducing Flooding at the Watershed-Scale** (Katherine Meierdiercks – Siena College)

Project Title: **Emerging Organic Pollutants: From College Campuses to Cayuga Lake** (Susan Allen-Gil – Ithaca College)

Project Title: **Assessment of Sediment Properties in the Impoundment of an Aged Dam in the Hudson River Watershed** (Weiming Wu – Clarkson University)

Coordinated Projects

Project Title: **Design for Climate-resilient Hudson River Communities** (Josh Cerra - Cornell University; Landscape Architecture)

Project Title: **Visualizing Landscape Change: public space and CSO's in the Hudson River Watershed** (Brian Davis - Cornell University; Landscape Architecture)

Project Title: **Analysis of Needs for Combined Sewer System Capacity Expansion and Financial Implications in the Context of Other Changes to Water Infrastructure Systems in Hudson River Municipalities (**Kieran Donaghy - Cornell University; City & Regional Planning)

Coordinated Projects (continued)

Project Title: **Software System for Downloading, Organizing, and Analyzing Online Reviews of Water-Centric Recreation Areas in the Hudson River Watershed** (Srinagesh Gavirneni - Cornell University; Johnson School of Management)

Project Title: **The Water Infrastructure Finance and Innovation Act (WIFIA): Lessons for the Hudson Valley** (Rick Geddes - Cornell University; Policy Analysis & Management)

Project Title: **Target and suspect screening for micropollutants in the Hudson River Estuary during a single recreational season** (Damian Helbling - Cornell University; Civil & Environmental Engineering)

Project Title: **Event: Policy, education, and research dialogue** (CaRDI- Cornell University)

Project Title: **Investigating the landscape - wide nitrogen transport and denitrification ($N_2$, $N_2O$) potential of roadside ditch networks in a sub-catchment of the Hudson River watershed** (Rebecca Schneider - Cornell University; Natural Resources)

Project Title: **Septic systems, water quality and GHG emissions** (Todd Walter - Cornell University; Biological & Environmental Engineering)

In addition to the projects listed above, WRI staff and interns, in cooperation with Hudson River Estuary Program and Mohawk River Basin Program staff will conduct research related to infrastructure effectiveness, economic vitality, integrated management, smart growth, and watershed protection. For more information on these efforts please contact Brian Rahm (bgr4@cornell.edu).

For information on the HREP and MRBP Action Agendas please see:
HREP - http://www.dec.ny.gov/lands/5104.html
MRBP - http://www.dec.ny.gov/lands/58571.html