Reporting Period: March 1, 2013 – August 31, 2013
Project Title: Implementing Credits and Incentives for Innovative Stormwater Management
Principal Investigator(s): Amy H. Brennan
Project start date: November 15, 2011
Report compiled by: Amy H. Brennan
Contributing team members and their role in the project:

- *Project Coordination and Fiscal Agent:* Amy H. Brennan; Chagrin River Watershed Partners, Inc.
- *Collaboration Lead:* Heather Elmer; Old Woman Creek National Estuarine Research Reserve with Ona Ferguson; Consensus Building Institute providing Collaboration Technical Assistance
- *Applied Science Investigator:* Jay D. Dorsey; ODNR, Division of Soil and Water Conservation
- *Additional project team members:*
  - Breann M. Hohman and Crystal Dymond; Erie Soil and Water Conservation District
  - Frank Lopez and Cheryl Wolfe-Cragin; Old Woman Creek National Estuarine Research Reserve
  - Keely Davidson-Bennett, Chagrin River Watershed Partners, Inc.

A. Progress overview:

The goal of this project is to promote the implementation of Low Impact Development (LID) and other innovative stormwater systems in the Ohio Lake Erie Basin by addressing barriers to implementation, gathering data on local best management practices (BMPs), building capacity of local stormwater professionals, and developing tools to effectively guide communities and consultants toward more sustainable stormwater management. This project will also highlight the role of LID in adapting to changes in rainfall volumes and intensities due to climate change. The project team includes the Chagrin River Watershed Partners (CRWP), Old Woman Creek National Estuarine Research Reserve (OWC NERR), Ohio Department of Natural Resources Division of Soil and Water Resources (ODNR-DSWR), Erie Soil and Water Conservation District (Erie SWCD), and the Consensus Building Institute (CBI).

Planned activities during this reporting period included: meetings, coordination, and documentation with the project team and collaborative learning group (CLG), document lessons learned, assist with design and oversee construction of BMPs, characterize site soils at BMP locations, design sites to allow for monitoring equipment installation and install equipment as sites are constructed, begin monitoring, develop, calibrate, and validate models, provide training through CLG, and provide technical assistance on adoption and implementation of local codes. CRWP entered into contracts with Cardno/JFNew to complete modeling work in coordination with our Applied Science Investigator, Jay Dorsey from ODNR-DSWR. The Project Team has been working closely with our monitoring contractor, North Carolina State University (NCSU)/Biohabitats, to complete the monitoring plans, order monitoring equipment, install monitoring equipment as sites are constructed, complete evaluation of monitoring data and present this information to the CLG. The project team selected six (6) sites to assist with the design and possible monitoring of BMPs and has been working with each of these site owners and their engineers on design of BMPs. NCSU and CLG members have commented on the design as well providing additional learning opportunities for design and monitoring for all involved. ODNR-DSWR completed infiltration tests at Pepper Pike, Holden Arboretum, Orange Village and Willoughby Hills. Monitoring equipment has been installed at the Perkins Township Administration Building and Pepper Pike City Hall. Construction is underway at Willoughby Hills and Orange Village with construction slated for Holden Arboretum in early September and at Old Woman Creek NERR in late September/early October.

The CLG provided comments on a checklist for code review that was developed in concert with the Ohio Balanced Growth Program. CRWP is coordinating comments with staff from Cleveland State University. CRWP and Erie SWCD continue to work with communities to adopt and implement model zoning codes to promote good land use decisions and promote LID. CRWP is also revising our model regulations for stormwater management and off street parking and provided adoption and implementation assistance to numerous CRWP Member communities.

B. Working with Intended Users:

CLG meetings held during this reporting period on April 24, 2013 and July 18, 2013 included site visits to the Perkins Township Administration building to view stormwater BMPs and monitoring equipment and Pepper Pike City Hall to view construction of a pervious paver parking area. Meetings also included discussions on design lessons learned, how to accurately track the costs of BMP design and construction, presentations by monitoring contractor North Carolina State University on installation of flow monitoring equipment, preliminary data for the Perkins site and monitoring plans for other sites, presentations by modeling contractor Cardno/JFNew on development and sensitivity analysis of SWMM models, and informal training focused on the HyperTool for modeling bioretention systems. CLG members provided feedback on a code review checklist, proposed training and tools, and the approach for developing site-based case studies.

More detail, including full presentations and meeting summaries are posted online at http://www.crwp.org/index.php/projects/research-projects/nerrs-science-collaborative. Likewise, on this site is a project update that was sent to the CLG between meetings to keep them abreast of project activities. An additional email update that was focused on construction progress at monitoring sites was distributed in August and will be made available online this fall. Attendance at CLG meetings continues to be strong. University researchers with an interest in stormwater research have also attended CLG meetings and observed monitoring equipment installation.

Our project team has been involved with the design and construction of six sites that are engaging additional intended users through review of stormwater BMP designs and discussion of how to incorporate monitoring at each site. The project team and monitoring contractors have been involved in all of the discussions. As sites reached a 60% design level, the entire CLG was invited to participate in meetings in person or as a part of a conference call and all site design iterations and meeting notes have been posted to a public ftp site to provide additional opportunities to comment on all sites. A designated project team lead is coordinating the project team's interactions with all sites and documenting the design, construction, and monitoring process to lay the groundwork for development of case studies and training materials.

C. Progress on project objectives for this reporting period:
Objective 1: Engage stormwater professionals in a collaborative process to identify and remove regulatory and technical barriers to implementation of LID in Ohio.
1. Completed activities and products:
    a. Held two collaborative learning group (CLG) meeting on April 24 and July 18 2013.
    b. Produced and distributed two project updates (emails) for CLG members and others interested in the project (sent out April 17 and August 21).
    c. Documented lessons learned, conflict, and ideas from CLG meetings in summaries, which are widely shared, and in our private project notes on lessons learned housed on Basecamp.
    d. Provided opportunities for CLG members to comment on site design for potential monitoring sites.
    e. Invited design engineers to participate in CLG meetings.
    f. Coordinated CLG member input on design of LID practices.
    g. Gathered initial CLG member input on content and format for site-based case studies and on proposed training, tools and outreach.

Objective 2: Quantify BMP specific and site level hydrology for local soil and climate characteristics.
1. ODNR staff characterized the site soils, including soil and subgrade infiltration at all six BMP locations. During this reporting period, ODNR completed infiltration tests at Pepper Pike, Orange Village, Willoughby Hills, and Holden Arboretum.
2. The project team has assisted with the design, construction oversight, and monitoring of 6 sites with 10 separate LID BMPs to track hydrologic performance and to calibrate and validate models.
    a. Perkins Township Administration Building: Two bays of porous concrete designed and installed.
    b. Pepper Pike: Construction of pavers finished the week of August 9th.

c. Willoughby Hills: Two bays of permeable pavement (using interlocking concrete pavers) are currently under construction. We will also be monitoring water quality at this site and working with NCSU will provide additional studies on clogging of permeable pavers that will inform maintenance concerns and directly address concerns raised by the CLG.

d. Orange Village: Permeable pavers are being installed and construction and the bioretention cell has been partially constructed and is going to be finalized soon using grass seed, mulch, and plantings.

e. Holden Arboretum: Construction of two bioretention cells slated for September 4-5, 2013.

f. Old Woman Creek: One paving contractor has declined to bid on the installation of porous asphalt at this site because they are unable to control the production process sufficiently with such a small quantity to ensure that the mix will meet all specifications and perform as required. Old Woman Creek NERR has provided a list of other potential subs and is awaiting a response from the state term contractor.

3. Installed monitoring equipment and begin analyzing data for :

a. Perkins Township installed April 2-3, 0213. Outflow from porous concrete is being monitored using pressure transducers and a weir box. NCSU also installed an onsite weather station to monitor site specific weather conditions.

b. Pepper Pike: NCSU installed monitoring equipment on outflow of pavers and a full weather station on August 1-2, 2013.

Objective 3: Simultaneously model treatment of water quality and quantity volumes to meet local and state requirements.
CRWP and Applied Science Investigator, Jay Dorsey of ODNR have been working with Cardno/JFNew to develop climate data sets for hydrologic characterization based on historic data and develop unit base SWMM models and complete a sensitivity analysis for hydrologic characterization of the following stormwater BMPs:

1. Bioretention Cells
2. Permeable Pavements
3. Green Roofs
4. Dry Detention Basins
5. Grass Swales
6. Soil Renovation
7. Grass Filter Strips
8. Underground Detention
9. Infiltration Trenches

Our team developed a comprehensive scope for all modeling activities that we would like to complete for this project. This scope exceeds our initial budget and scope for our modeling activities so we are currently investigating opportunities for additional funding to complete the full scope and expand our deliverables under this project.

Objective 4: Adapt models to include rainfall runoff scenarios anticipated as a result of climate change and characterize climate change adaptation functions of LID BMPs.
The project team continues to explore the status of current research on development of climate data sets that may be adapted as inputs to our modeling to determine the performance of stormwater BMPs under future project climatic conditions. Members of the project team will attend the "Preparing Stormwater Systems for Climate Change" workshop in Monroe, Michigan on Thursday, October 10, 2013. The workshop will include a regional climate overview by Dan Brown, Research Associate at the Great Lakes Integrated Sciences and Assessment Center (GLISA). The city of Grand Rapids, Huron River Watershed Council, and other watershed and stormwater professionals will discuss potential climate change impacts and adaptation strategies. This workshop will include breakout sessions led by the University of New Hampshire Stormwater Center, NOAA Coastal Services Center, North Carolina State University Stormwater Engineering Group, Minnehaha Creek Watershed District, and Old Woman Creek National Estuarine Research Reserve (NERR) that will highlight regional vulnerability assessments, economics and performance of LID and green infrastructure, and approaches for community engagement.

Objective 5: Develop and provide training and technical assistance materials to build capacity of stormwater professionals and communities to implement LID approaches.

1. Provide informal training to the CLG:
    a. The CLG meetings on April 24 and July 18 2013 provided training to CLG members on: BMP design and construction, flow monitoring, and stormwater modeling, including the HyperTool for modeling bioretention systems.
2. Provide formal training and technical assistance to stormwater professionals: Project team members participated in planning and presenting three training sessions sponsored by the Northeast Ohio Stormwater Training Council:
    a. July 9th: CRWP organized a workshop on residential stormwater BMP's for landscapers in cooperation with the Ohio Landscape Association and Ohio Nursery and Landscape Association. There has been interest in repeating this workshop in the Columbus area.
    b. CRWP has planned an additional workshop focused on Commercial BMP Maintenance training for landscapers at Cleveland Metroparks West Creek Stewardship Center to be held October 1st.
    c. OWC NERR is planning a workshop focused on Preparing Stormwater Systems for Climate Change in Monroe, MI in collaboration with Michigan Sea Grant and the Great Lakes Adaptation Assessment for Cities. Project team and CLG members will be invited to participate and some project team members will lead sessions focused on our project.
3. Model regulations that remove regulatory barriers to LID:
    a. Model codes and a code review checklist were presented at the July 2013 CLG meeting. The group reviewed the checklist and provided feedback on how it could be used and opportunities for improvement.
4. Provide technical assistance on the adoption and implementation of local codes and project recommendations.
    a. CRWP assisted Mayfield Village with riparian setback code language and Mentor with updated parking standards.
    b. CRWP is also working on updates to Erosion and Sediment Control and Stormwater Management codes.
5. Support development of Ohio specific guidance on design, construction, cost, operation and maintenance of BMPs:
    a. CRWP distributed the draft checklists developed with Cuyahoga County Board of Health, Cuyahoga SWCD, Ohio EPA and ODNR-DSWR on the operation and maintenance of stormwater BMPs for Ohio at the July 9th Landscaper workshop.

What data did you collect?
- Flow monitoring data for Perkins and Pepper Pike sites.
- CLG input on BMP design and monitoring.
- Soil and site characterization data for modeling at Pepper Pike, Orange Village, Willoughby Hills, and Holden Arboretum.
- Lessons learned during design and construction of sites.
- CLG input on tracking BMP design and construction costs, proposed training, and codes checklist.

Has your progress in this period brought about any changes to your methods, the integration of intended users, the intended users involved or the project objectives?
The CLG requested winter monitoring and water quality monitoring at sites that was not originally proposed for these sites. After exploring the availability of monitoring equipment from NCSU, Ohio EPA, and OWC NERR, we plan on monitoring for an extended season, monitoring water quality monitoring at Willoughby Hills and Old Woman Creek NERR. In addition, NCSU proposed to monitor the porous paver and asphalt installations at Willoughby Hills and OWC NERR to determine how quickly the impervious/porous interface clogs with sediment. This clogging study will allow us to provide better guidance on permeable pavement maintenance requirements and address another key barrier (maintenance) as identified by the CLG.

Have there been any unanticipated challenges, opportunities, or lessons learned?
There have been challenges with locating a contractor to install the porous asphalt parking area at Old Woman Creek NERR. One contractor declined to bid on the project because the asphalt plant can't guarantee that the mix meets specifications for such a small quantity.

There have been a few deviations from the construction details at Pepper Pike and Orange Village in the delivery of rock subgrade for porous pavers that was round, not angular and did not appear to be well washed as plans specified. This rock may cause pavers to have uneven settling as the rounded rock can shift. The infiltration rates at both of these sites were very low so the lack of washing may not affect performance of these systems.

What are your plans for meeting project objectives for the next six months?
In the coming six months, we anticipate holding one CLG meeting (September 18). In 2014, we expect to have two CLG meetings and for them to last from approximately 9am to 3pm. We will continue to develop and send project updates to CLG members and others interested in the project at the mid-point between meetings. We will begin laying the groundwork for development of training and tools based on project results and will engage CLG members in planning and pilot testing of training and tools associated with the project.

Objective 1:
1. One CLG meeting.
2. Produce one project update.
3. Establish a framework and process for development of project case studies. Produce case studies for at least three projects.
4. Informal training on stormwater monitoring equipment, protocols, and data management for CLG members, project partners and others.
5. Finalize summaries of lessons learned on design and construction.

Objective 2:
1. Work with monitoring contractor to fully instrument BMPs to track hydrologic performance at Orange Village, Willoughby Hills, Holden Arboretum, and Old Woman Creek NERR.
2. Begin data collection from monitoring sites and subsequent analysis of data.
3. Observe construction at Old Woman Creek NERR, Orange, Holden, Willoughby Hills sites.
4. Summary of research findings for Ohio BMPs including hydrologic performance and cost.
5. Create guidance on hydrologic sampling protocols.
6. Summary report on site characterization; and design, construction, and costs for BMPs installed as part of this project.

Objective 3:
1. Develop site scale models of the Perkins Township and Orange Village sites with Cardno/JFNew. Additional site scale models are currently proposed to be developed by ODNR and NCSU.
2. Continue to explore additional funding opportunities to complete desired scope of modeling that exceeds original project scope.

Objective 4:
1. Continue to explore climate change data availability for modeling.

Objective 5:
1. Provide informal training through CLG meetings.
2. Formal training at the September CLG meeting that will include a presentation by Dr. Bill Hunt from NCSU on NCSU's research on rainwater harvesting systems and a residential green street project in Wilmington, North Carolina. Additional engineers in our project area are invited to attend this part of our CLG meeting.

3. Provide technical assistance on the adoption and implementation of local codes and project recommendations.
4. Develop case studies of monitoring sites that cover BMP design, construction, costs, performance, maintenance, regulatory and permit issues, and lessons learned.
5. Solicit CLG feedback/testing of training and tools.
6. Highlight project and monitoring sites at the National Nonpoint Source Monitoring Conference in October 2013. CRWP and NCSU will present on this project and a site tour will include visits to several monitoring sites.
7. Begin development of training materials on BMP life cycle.
8. Give a presentation at a Preparing Stormwater Systems for Climate Change workshop in October 2014.
9. Submit an article to a state-wide newsletter for watershed and stormwater professionals.

D. **Benefit to NERRS and NOAA: List any project-related products, accomplishments, or discoveries that may be of interest to scientists or managers working on similar issues, your peers in the NERRS, or to NOAA. These may include, but are not limited to, workshops, trainings, or webinars; expert speakers; new publications; and new partnerships or key findings related to collaboration or applied science.**

We continue to build long term monitoring capacity, and hope we might be laying the groundwork for a stormwater research center in Ohio. This may be applicable to other projects and regions. A Kent State University faculty member is interested in visiting one of the sites during equipment installation. A University of Toledo professor that observed installation of equipment at Perkins Township has received a grant to do similar monitoring work in Northwest Ohio.

E. **Describe any activities, products, accomplishments, or obstacles not addressed in other sections of this report that you feel are important for the Science Collaborative to know.**

The Collaboration Lead gave an invited presentation on the project as part of a session on Expert Engagement in Great Lakes Research at the International Association of Great Lakes Research Conference at Purdue University in June 2013.