NERRS Science Collaborative Progress Report

Reporting Period: September 1, 2014 – February 28, 2015
Project Title: Implementing Credits and Incentives for Innovative Stormwater Management
Principal Investigator(s): Keely Davidson-Bennett
Project start date: November 25, 2011
Report compiled by: Keely Davidson-Bennett
Contributing team members and their role in the project:

- *Project Coordination and Fiscal Agent:* Keely Davidson-Bennett, Chagrin River Watershed Partners, Inc.
- *Collaboration Lead:* Frank Lopez, Old Woman Creek National Estuarine Research Reserve, with Ona Ferguson of the Consensus Building Institute providing Collaboration Technical Assistance
- *Applied Science Investigator:* Jay D. Dorsey, ODNR - Division of Soil and Water Resources
- *Additional project team members:*
    - Heather Elmer and Kristen Buccier, Chagrin River Watershed Partners, Inc.
    - Breann M. Hohman, Erie Soil and Water Conservation District
    - Ryan Winston, North Carolina State University

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 stormwater control measures (SCMs), 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 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), North Carolina State University (NCSU), and the Consensus Building Institute (CBI).

Our project team monitored bioretention and permeable pavement stormwater controls at Old Woman Creek NERR, Perkins Township, the Holden Arboretum, Ursuline College, Orange Village, and Willoughby Hills through early December 2014. Results analyzed to date indicate runoff reductions of 17– 98% for the monitored permeable pavement sites. The monitored bioretention cells reduced runoff by 55-77%. These systems were situated over clay soils and thus show promise for LID practices over poor soils and in harsh climates.

B. Working with Intended Users:

In September, we surveyed CLG members regarding the August 22 CLG meeting. Of 13 CLG and project team members responding to the survey:

- 92.3% said participating in the project is a good use of their time.
- 84.6% said participating has increased their knowledge of LID design, construction, and performance “a lot” or “a great deal”
- 92.3% are using information from this project in their current work and decision making.

Survey respondents also offered the following feedback on the project:

- “The process was valuable in that it lasted a long enough period of time, included the appropriate people (agencies, townships, etc.), and was facilitated extremely well to get good discussions and results. The fact that so many people showed up at the last meeting and that another meeting is desired speaks highly to the

high quality of the experience. Also, enough sites were observed through the construction period that many different lessons were learned."

- "Greatly expanded my knowledge on LID practices and calculations. Collaborating with government and private consultants was very useful."
- "Because we were able to observe the construction process throughout and talk directly to contractors at times, I learned a great deal about the construction aspect of LID. The input of others in the room regarding their experience was extremely valuable. I hope to learn more about LID performance as these sites are monitored over a longer period throughout the year."
- "Being onsite during construction, and getting feedback from other project members doing the same, has helped me better understand some critical points for communication (through design guidance, plans, and on-site supervision) during construction to increase the likelihood of a successful project."
- "My approach to every design project has changed. I know what LID practices can benefit a site much better now, and how to implement them."
- "I truly think about upstream management now and educational efforts needed to get everyone to do their part."
- "Design, monitoring, and professional networking have all been useful in consideration of green infrastructure and policy creation."

We have begun planning for the final CLG meeting, which will be held on April 22, 2015. The purpose of this meeting is to share project results and discuss policy implications, outstanding research questions, and next steps. The NSC team also intends to meet with Ohio EPA stormwater staff in June to discuss potential ways to translate research results into policy. Additionally, we are planning a training in June 2015 for stormwater professionals in northern Ohio that will be offered twice, once in northeastern Ohio and once in Erie County, that will share bioretention and permeable pavement performance information and design, construction, and maintenance tips for these SCMs. The training will also include potential new crediting mechanisms for LID. Furthermore, Old Woman Creek NERR plans to integrate NSC findings and CLG feedback into additional trainings on bioretention and permeable pavement design and construction with speakers from North Carolina State University to be offered in fall 2015.

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. Conducted survey to gather feedback on the project from CLG members, project team, contractors, and partners.
    b. Sent project update on January 30, 2015 to share available results with CLG members and others interested in the project.

Objective 2: Quantify BMP specific and site level hydrology for local soil and climate characteristics.

We monitored bioretention and permeable pavements at Old Woman Creek NERR, Perkins Township, the Holden Arboretum, Ursuline College, Orange Village, and Willoughby Hills through early December 2014. Results analyzed to date indicate the following:

The bioretention cell at Ursuline College reduced runoff by 77%, the herbaceous bioretention cell at Holden Arboretum by 58%, and the woody herbaceous bioretention cell at Holden Arboretum by 55%. This suggested that there was little difference in bioretention hydrologic performance due to plant type in the first year after installation. The bioretention cell at Ursuline College had the following water balance: 61% exfiltration, 16% abstraction +

evapotranspiration, 20% underdrain flow, and 3% overflow. It completely captured 80% of monitored storm events; that is, 80% of runoff events produced no underdrain flow or overflow. Due to tighter soils at the Holden Arboretum site, exfiltration accounted for between 29-37% of the annual hydrologic fate, with greater underdrain flow observed. This suggested that underlying soil saturated hydraulic conductivity substantially impacts the fate of water in tight HSG D soils.

Over the two year monitoring period, the pervious concrete at Perkins Township reduced runoff by 53.8%. The permeable interlocking concrete pavers in the large bay at Willoughby Hills reduced runoff by 38.4% and those in the small bay reduced runoff by 16.7%. This suggested that even over poorly infiltrating soils, the inclusion of an internal water storage (IWS) zone (upturned elbow in the underdrain) allowed water to slowly "leak" into the tight underlying soils. The IWS zone provided storage within the aggregate for the following event, increasing the initial abstraction in each watershed. The annual hydrology for each of these sites showed abstraction between 8-13%, exfiltration between 3.5-44%, and drainage between 46-81%. Not surprisingly, the site with the worst infiltration rate and highest hydrologic loading ratio (Willoughby Hills Small) reduced runoff the least. Orange Village, with much higher measured infiltration rates (as high as 1.5 in/hr) reduced runoff by >98%; however, it should be noted that the curtain drain installed at the site probably induced additional drainage beyond what would be expected under more natural conditions.

3. Investigated permeable pavement maintenance needs by conducting quarterly surface infiltration testing.

Maintenance needs for permeable pavement were quantified using two different types of surface infiltration tests: the ASTM method and a simple infiltration test (SIT) devised by NCSU staff. These two tests were run quarterly at three sites (Willoughby Hills, Orange Village, and Perkins Township). Surface infiltration rates decreased the most (indicating the worst clogging) near areas that received run-on from impermeable pavement, beneath trees where leaves were ground into the pavement by car tires, and where run-on from vegetated areas entered the permeable pavement. Statistical tests showed that a linear relationship existed between the ASTM and SIT's predicted surface infiltration rates. Since the SIT takes as much as 60% less time to complete, this would allow maintenance personnel to assess the need for maintenance in a quicker and easier fashion. Additionally, maintenance was completed on various permeable pavement sites using different types of street sweepers. All maintenance types significantly improved surface infiltration rates, with sweepers with higher suction providing the best improvements in surface infiltration rates.

4. Monitored water quality from PICP at Willoughby Hills and Old Woman Creek and bioretention at Ursuline College.

   a. We collected water quality samples from Willoughby Hills October 2013 – October 2014. We collected 16 samples from the small bay of pavers and 9 samples from the large bay of pavers. Contrary to other studies, pollutant concentrations were generally higher in samples from the permeable paver underdrains than the control samples from the adjacent asphalt parking lot. However, because of the runoff reduction provided by the permeable pavement, copper, zinc, nitrogen, and phosphorus loads leaving the site were reduced by the permeable pavement system. Total suspended solids loads were higher for the permeable pavement system than the control. We think increases in pollutant concentrations were related to a maturation period of the permeable pavement system. The final four samples had much lower pollutant concentrations, suggesting that performance suffered immediately post-construction due to leaching of sediment from the subgrade.

Objective 3: Simultaneously model treatment of water quality and quantity volumes to meet local and state requirements.

Cardno JF New has completed most of its USEPA Storm Water Management Model (SWMM) modeling. The technical memorandum regarding this work is available on the project website at: http://www.crwp.org/files/Preliminary_NERRS_SC_LID_SCM_Performance_Model_Study_2014.pdf. ODNR and Cardno JFNew are working on site-based SWMM models for bioretention and permeable pavement.

ODNR continues to use the volume reduction data generated by Cardno JFNew to develop and evaluate a crediting mechanism for the Critical Storm Method peak discharge control guidance. Over the next couple months, ODNR will complete quantification and evaluation of the remaining practices, and begin to develop the framework through which LID practices can receive appropriate credit toward meeting water quality volume (WQv) and Critical Storm Method requirements. This should allow us to have the crediting guidance and tools drafted by project completion.

NCSU is building DRAINMOD models of permeable pavement installations at Perkins Township and Willoughby Hills and bioretention cells at Holden Arboretum and Ursuline College. DRAINMOD is an agricultural drainage model that effectively models SCMs with underdrains. At this point, one of the four sites has been calibrated against the field data.

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.

In March, modeling subcontractor NCSU will test bioretention and permeable pavement performance using dynamically downscaled moderate (RCP 4.5) and severe (RCP 8.5) climate data projections for mid-century (2050s). This will be completed for the four sites listed above: Perkins Township, Willoughby Hills, Ursuline College, and Holden Arboretum. Results will show how the performance of bioretention and permeable pavement stormwater controls shifts under greater intensity and depth precipitation events.

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

1. Provide formal training and technical assistance to stormwater professionals:
    a. Project team members assisted with 2 inspection and maintenance workshops on stormwater control measures presented by Bill Hunt and Bill Lord of NCSU in October. Old Woman Creek sponsored these trainings.
    b. ODNR-DSWR co-facilitated a bioretention construction and oversight training with Summit Soil and Water Conservation District on September 25, 2014.
    c. NCSU presented project results at the International Low Impact Development Conference in Houston, Texas in January 2015.
    d. CRWP compiled inventories of its stormwater-related technical assistance in 2014 for the communities of Eastlake, Willoughby, Kirtland, Painesville, Kirtland Hills, Painesville Township, Madison Township, Willoughby Hills, Concord, Perry Village, Bainbridge Township, Russell Township, Woodmere, Pepper Pike, Bentleyville, Moreland Hills, Solon, South Russell, Mayfield Village, Mayfield Heights, Orange Village, and Wickliffe. These inventories helped CRWP better understand the current state of local stormwater management programs and identify additional community technical assistance needs.
2. Model regulations that remove regulatory barriers to LID:
    a. CRWP is working on updating its model Comprehensive Stormwater and Erosion and Sediment Control codes to comply with the new Ohio Construction General Permit and Municipal Separate Storm Sewer

System (MS4) permit and to incorporate lessons learned from this project and encourage communities to credit LID towards meeting flood control requirements.

3. Provide technical assistance on the adoption and implementation of local codes and project recommendations.
    a. CRWP assisted Chagrin Falls Township and Solon with implementing their Erosion and Sediment Control and Comprehensive Stormwater codes.
    b. CRWP is working with Great Lakes Mall in the City of Mentor on a USEPA Great Lakes Restoration Initiative-funded parking lot retrofit to incorporate permeable pavement, bioretention, infiltration chambers, and tree pits to treat stormwater on its site. The site currently does not have any stormwater management, and we are trying to capitalize on the sandy soils to infiltrate stormwater. In addition, CRWP hopes that this project encourages the mall's owner, Simon Property Group, to consider stormwater retrofits at the other malls it owns across the country.
    c. CRWP assisted in increasing the prevalence of LID stormwater practices by helping Bainbridge Township apply for an Ohio EPA 319 grant to install permeable pavers in a parking lot within a Township park. Bainbridge was notified that this project has been recommended for funding.

What data did you collect?

- Water quantity monitoring data at Perkins Township, Willoughby Hills, Orange Village, Holden Arboretum, Ursuline College, and Old Woman Creek
- Water quality data at Willoughby Hills, Ursuline College, and Old Woman Creek
- Permeable pavement maintenance data at Willoughby Hills, Orange Village, and Perkins Township
- CLG feedback

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?
No.

Have there been any unanticipated challenges, opportunities, or lessons learned?
The CLG's request for an additional meeting so that they can see project results before they are presented at the Ohio Stormwater Conference is creating some unanticipated extra work for the project team. However, we are glad that the CLG is so interested in project results.

What are your plans for meeting project objectives for the next six months?
Objective 1:

1. Final CLG results meeting in April 2015.
2. Meet with Ohio EPA stormwater staff in June 2015 to discuss potential policy implications of project results.

Objective 2:

1. Draft, review, and finalize monitoring report and post to project website.

Objective 3:

1. Draft, review, and finalize DRAINMOD modeling report for bioretention at Ursuline and Holden Arboretum and permeable pavement at Willoughby Hills and Perkins.
2. Complete analysis of Critical Storm Method credits for nine LID SCMs based on monitoring data and completed SWMM volume reduction estimates.

Objective 4:

1. Use future climate data in DRAINMOD to predict future performance of bioretention and permeable pavement and include results in modeling report.

Objective 5:

1. Begin developing training on permeable pavement for designers and/or installers.
2. Share results with Ohio stormwater professionals at the Ohio Stormwater Conference May 6-8, 2015 and at workshops to be held June 9 and 10 at 2 locations in northern Ohio.
3. Share project results with a national audience at the ASCE/EWRI Conference May 17-21, 2015 in Austin, Texas.
4. Update CRWP model codes for Conservation Development, Erosion and Sediment Control, Comprehensive Stormwater Management.
5. Provide technical assistance on the adoption and implementation of local codes and project recommendations.

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.

Our team facilitated a professional sharing session at the NERRS annual meeting with other NSC projects in November 2014 to discuss the NERRS role in stormwater management. This dialogue will continue at the March 31 – April 1 transfer workshop. This project resulted in NSCU partnering with North Carolina NERR for a 2015 NSC proposal. We are working on pulling together our final reports that will be available in June.

CLG presentations, meeting summaries, articles, and other project information are available online at http://www.crwp.org/index.php/projects/research-projects/nerrs-science-collaborative.

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.
None