

Developing Credits and Incentives for Innovative Stormwater Management

Collaborative Learning Group Meeting

July 17th, 2013, 9:00 am-3:00 pm

Site visit of Pepper Pike City Hall, Meeting held at Willoughby Hills Community Center

Draft Meeting Summary

Group Members Present: Dan Bogoevski (Ohio EPA), Justin Czekaj (Aurora), Carlo DeMarchi (CWRU), Eric Dodrill (Perkins Township), Lynette Hablitzel (OEPA), Rachel Webb (NEORS), Betsy Yingling (NEORS).

Project Team Members Present: Amy Brennan (CRWP), Will Brown (OWC NERR/TIDES), Keely Davidson-Bennett (CRWP), Jay Dorsey (ODNR), Heather Elmer (OWC NERR / ODNR).

Observers & Staff: Kristi Arend (OWC), Krista Baldauf (OWC), Tom Denbow (Biohabitats), Kevin Grieser (Biohabitats), Scott Isenberg (Cardno JF New), Michelle LaRose (Cardno JF New), Ryan Winston (NCSU).

Next Steps:

- Jay Dorsey- Infiltration tests at demonstration sites beginning construction
- Ryan Winston & Kevin Grieser- Installation of monitoring equipment at newly constructed demonstration sites
- Project Team- Prepare meeting summary & project update
- Will Brown- Document progress & develop pilot case study

Site Visit: Pepper Pike City Hall

Joe Gigliotti, Chagrin Valley Engineering, the design engineer for Pepper Pike, described the stormwater practices in the design of the stormwater retrofit currently under construction at the Pepper Pike City Hall. The project team will be monitoring the permeable paver installation at the site, but the retrofit also includes a “snowmelt swale” and a turfed bioretention cell that will not be monitored. The site design has five 6” steps to address the slope of the area where the pavers are to be installed, and a 3’ x 3’ catch basin that will be large enough to accommodate the equipment needed for monitoring. There will be no berms constructed between the steps.

In response to a question about the source of project funding, Amy Brennan replied that the project construction was funded by the Ohio EPA Surface Water Improvement Fund (SWIF) and monitoring is funded by our NERRS Science Collaborative project. Dan Bogoevski asked if the site would meet water quality volume standards. Jay Dorsey said the practice didn’t meet current water quality volume standards since the retrofit design did not include a sump or a modified outlet structure; and that the project was not required to meet NPDES water quality volume standards because it is less than an acre. This project would likely meet the standard for redevelopment as it reduces the impervious cover by

more than 20%. Carlo DeMarchi asked whether the site could qualify for a NEORS credit. Rachel Webb and Betsy Yingling said pervious pavement installations in NEORS's service area, which meet Ohio EPA water quality volume standards, can get a stormwater fee credit reduction and that any pervious pavement installations that replace impervious surfaces can qualify for an NEORS recalculation of the impervious area fee.

Jay Dorsey reported that four out of five infiltration tests at the construction site were successful, with results ranging from 0.01 to 0.05 inches/hour. A question was raised about whether the tests had been performed after soil compaction had occurred on the site. Jay replied that a small tracked skid steer had been in the excavated area prior to the testing, so there was only a minimal degree of soil compaction. Ryan Winston expected that monitoring on site would be relatively simple, with only one weir box installed in a catch basin in the pervious paver area. The site also includes water table monitoring wells in each of the subgrade steps below the pervious pavers.

Welcome and Introductions

Amy Brennan welcomed and thanked everyone for attending the meeting and Heather Elmer reviewed the objectives for the session. Ground rules were established and everyone was asked to introduce themselves to the group.

Pepper Pike Infiltration Testing and Site Visit Wrap-Up

Jay Dorsey presented on infiltration testing at the Pepper Pike site. Despite some ponding at the site during recent rain events, Jay was able to conduct four successful tests. The surface area at the construction site had been relatively wet, but the underlying soil was dry. Observed infiltration rates were .01, .01, .02, and .05 inches per hour. Jay described some of the new test materials he used for the infiltration tests, such as Mariotte bottles manufactured by Turf Tec International, that can be bought as a set (a small and large bottle for \$550 dollars) or as an entire kit (a more expensive option). He emphasized the importance of having a good seal during infiltration tests to ensure successful results. During this round of testing, Jay used a post driver designed for soil tests to drive the test ring into the soil.

Participants shared their reflections on the Pepper Pike site visit. They discussed whether or not the BMPs at the site would meet Ohio EPA water quality standards. The project does not currently meet water quality requirements of the RWLD manual. However, Amy Brennan thinks it would meet the redevelopment standards and suggested that it could get credit for reducing impervious area. In order to qualify for water quality credit, it would need to meet the Ohio EPA water quality volume standards. Several people raised concerns about the site design and execution of the construction process. Rachel Webb expressed concern about design engineers leaving critical items up to the contractor to decide rather than specifying them. The catch basin was at a lower elevation than needed, because the outflow pipe was at a higher elevation than what was planned in the original site design. This means that the catch basin will frequently have standing water and there will be less room for installation of monitoring equipment. Both Ryan Winston and Jay Dorsey raised concerns about the use of rounded #57 stone, instead of angular stone, that is more likely to cause settling at varying rates. This problem could lead to

an uneven paving surface (ripple effect), and is thought to have the greatest impacts on paver or asphalt surfaces. The original design also called for washed stone to reduce the likelihood of clogging issues; however the stone being used for construction was not well washed.

Other comments and discussion focused on how to ensure the use of correct methods and procedures during the construction phase of public projects so that they are built according to site design. People suggested that local government be encouraged to play an active role in pre-construction meetings that include discussions about design, construction, and SWP3 plans.

Perkins Monitoring Data and Site Update

Site Updates

Eric Dodrill presented an update on the Perkins site. The pervious concrete has been fully installed and monitoring is underway. There was loose gravel left over from construction that needed to be removed, so a household pressure washer was used to clean the surface of the concrete. Loose gravel was pushed into the center aisles and then swept up to remove it from the site. Future maintenance will be conducted by using a vacuum-sweep truck. The use of a pressure washer for the initial round of maintenance, to remove left over gravel from construction, was the recommendation of the Ohio Concrete Association. Ryan Winston requested that the maintenance dates get recorded so that changes in the monitoring data can be linked to specific maintenance events.

Eric Dodrill reported that, although some of the plastic did blow off during the curing process, the pervious concrete appears to be sound. In other areas of the Perkins site, landscaping has been installed and the grass seeding has been largely successful. The swale has been stabilized and the only areas that may need to be re-seeded are at the bottom of the swale that has been periodically underwater. A potential re-development project next door could impact the swale in the future. The asphalt parking lot still needs to be stabilized and resurfacing is scheduled to be completed by this fall. Eric noted that the trustees are impressed with the new parking lot and have been very supportive of the project.

Ryan Winston and Jay Dorsey briefly turned the discussion to the effects of salt on permeable concrete. There is a small company in New England that manufactures 6' X 6' slabs and gutters made out of permeable concrete. These precast slabs can be connected onsite with eye hooks. Ryan was unsure of the exact cost, but maintained that because the concrete was cured in a warehouse it would likely be more resistant to salt exposure. Jay noted that the National Concrete Association is currently having an internal debate about issues of curing and salting. Current research suggests that pervious concrete should *not* be salted during the first year. Eric noted that during the first winter that the concrete was installed at Perkins, no salt was needed, though there were a few occasions when the concrete was slick during early morning hours.

Monitoring Update

Ryan Winston reviewed site plans and installation of monitoring equipment at the Perkins site. Data collection has been ongoing since April 3, 2013. The onsite rain gauge and weather station record local meteorological conditions. Two weirs have been set up to monitor the eastern and western pavement

applications, and there is a monitoring well to determine the water level at two minute intervals for the western permeable pavement application. The weather station recorded just under five inches of rain in April and May. For a rainfall event to be considered a storm, it must exceed 0.1 inch of precipitation. During the April and May period, there were two major storms recorded. Storm events are examined according to rainfall depth, rainfall duration, average intensity, antecedent dry period, and peak five minute intensity (an indicator of predicted flow rate if the watershed was completely impervious).

Monitoring results from the water level loggers at each of the weir boxes were very similar (that is very good news). The east application drains a 0.57 acre watershed and the west application has a 0.43 acre watershed drainage area. During five of the storm events recorded to date, there was no outflow from the west application, whereas during every storm event, there was at least some outflow from the east application. The five-minute peak rainfall intensity for Perkins was significantly lower (approximately a 90% reduction) than predicted peak flow from a conventional parking lot. Measured drawdown rates (.016 in/hr) were very similar to what Jay calculated based on infiltration testing (.01 in/hr). The Saxton soil water calculator also predicted a similar result for that soil type to what was actually measured. The total exfiltration to date (April-May) is 3,123 cubic feet of water or 23,300 gallons.

Betsy asked how the permeable concrete pavement area would compare to using compacted turf grass in a similarly sized area. Currently permeable pavement is thought to be at least as good as grass in terms of infiltration, so it would good to have a direct comparison. Jay replied that according to a presentation on soil hydrologic capacity of ballfields given at the Ohio Stormwater Conference by Stu Schwartz, turf grass is more similar to concrete than is commonly thought. Ryan supported Jay's response by saying that just over 30 % of the water volume at Perkins was lost to infiltration, which would mean that the pervious concrete area infiltrated triple the amount of rainfall as turf grass.

Clogging & Maintenance

Many people have asked how to conduct maintenance for stormwater BMPs over months and years, and how to determine appropriate frequency of maintenance. Ryan identified a few different methods for determining how much clogging is occurring in permeable pavement installations, and thus when maintenance is needed. He recommended any of the following tests: single ring test (ASTM C1701), bucket test, visual inspection, and NCSU simple infiltration test. Ryan noted that clogging first occurs on the leading edge of permeable pavement applications where impervious surfaces drain onto pervious pavements. NCSU generally considers maintenance to be unnecessary until clogging occurs on greater than 20% of the pavement surface area. Clogging can be measured in permeable concrete by placing TDR sensors at intervals parallel to the interfacing edge along the flow-path distanced at 1ft, 3ft, 5ft, and 10ft. A current sensor installation is being monitored at NC Central University Law School, and two more are planned for Willoughby Hills Community Center and Old Woman Creek NERR. Monitoring will assess changes in hydraulic loading rates as clogging progresses. TSS (inlet vs outlet) will also be recorded at each site to determine the TSS loading rate. Finally, infiltration tests will be conducted 3-4 times a year at each site. If clogging occurs quickly at either location, maintenance could be performed to compare post-maintenance monitoring results to initial monitoring results.

CLG members asked Ryan why he didn't choose to put the sensors at different depths in the aggregate to measure vertical clogging. He responded that the assumption used for permeable concrete is that clogging mostly occurs at the surface; however this may need to be a consideration for porous asphalt applications (such as will occur at Old Woman Creek). Amy added that at Cawrse & Associates, TDRs installed at different depths showed preferential pathways through gravel subgrade, thus monitoring at different depths may not give accurate data.

Site Updates

Old Woman Creek National Estuarine Research Reserve

As a result of recent conversations with Flexible Pavements of Ohio, the designers changed some design features of this site. The depth of the surface course was increased by 0.25 inches, and the use of PG88-22 binder (rated for higher temperatures) was recommended by industry sources. Since contractors haven't been precisely following equipment specifications, the new features should help to make the design more "dummy-proof". The bidding process has started and will be assisted by NCSU and Biohabitats as needed; Flexible Pavements of Ohio may be part of the pre-construction meeting. A slot drain will be used to collect inlet water quality samples that can be used to compare to outlet samples.

Orange Village

The old concrete has been removed, but otherwise construction has not yet started. The contractor for this site is Seitz Builders.

Willoughby Hills

Pre-construction meetings have been progressing, but the mayor has expressed concerns about the aesthetics of the water quality monitoring boxes, that the group has been trying to resolve. Suggestions included using bushes and plantings, digging a pit for the box, using a fake rock, or disguising the box as something else. Later during the meeting, Keely and Ryan met with the Mayor and he agreed to allow monitoring equipment to be installed for both water quantity and quality (including TDR installation to look at clogging).

Holden Arboretum

Holden staff will construct the bioretention cells at this site in August. CLG members suggested building one bioretention cell to meet specifications from the previous Rainwater and Land Development manual and building the second cell according to the newly revised specifications to allow for a direct comparison. Another CLG member suggested using different depths for the bioretention cells, but there were concerns that a retrofit using this design may be difficult to implement given the existing infrastructure. It was also suggested to stay away from the part of the parking lot that gets heavily salted during the winter months to prevent excessive stress to plants in the bioretention cell and to limit the amount of salt reaching the storm sewer. The last suggestion for this site was to try planting both native and non-native grasses so that their performance can be directly compared. People are interested to learn which plants are best suited to living in bioretention cells in Ohio and recommended that this should be investigated, particularly given Holden Arboretum staff expertise in this area. Jay will

be performing infiltration tests at the Holden site in late July and assisting Holden staff with design of bioretention cells.

Tools and Outreach for 2014

Heather Elmer presented a summary on anticipated products that will be produced from this project in the coming year or so.

CLG Suggestions for Tools

- Format for training: Smaller trainings that are more interactive might be more effective. Half day training might be better than full day. Concern about presenters with limited time, so can't ask them to present too frequently; there must be a balance between the presenters' and attendees' needs.
- Develop a model long-term maintenance agreement that includes a simple checklist that could be used by a HOA resident. Use standard agreements, with maintenance checklists in a separate document to avoid incurring legal fees for review of actual maintenance procedures.
- Ensure that communities have an adequate understanding of their responsibilities to follow-up and make sure that the proper amount of maintenance is actually occurring.
- Use a pre-bid meeting checklist to ensure proper notes are discussed.
- Facilitate the integration of maintenance projects into local budgets. So far this has only happened in limited areas with stormwater utilities and drainage districts (e.g. Geauga County drainage maintenance districts).
- Develop a training session on how to design a BMP for maintenance, as there are many instances where stormwater practices are not getting properly maintained. Key audiences for trainings include:
 - Home builders associations, realtors and developers: these groups, if well trained, could encourage homeowners to ask the right questions and gather knowledge about stormwater infrastructure before significant problems occur.
 - Engineers: young engineers may not have the skills to adequately design stormwater projects. Training for modeling and design would be most effective when performed in small groups with a specific focus. The project could work with engineering programs at local universities, provide trainings with incentives for attendance (e.g. no/low cost registration, CEUs for attendance, etc.), host more targeted meetings that feature tools for specific skill sets, or organize open house days at BMP demonstration sites.
 - Construction workers could be a good audience for construction site field trips; however that may be a hard event to organize. Depending on audience, an open house format may be an appropriate training format, the group suggested considering half day trainings with activities for smaller groups with high levels of interactivity. Target specific audiences and offer training for each audience at different skill levels.

Suggestions for the Case Studies about the Project's Sites

Heather Elmer and Will Brown introduced the idea of using case study research as a way to learn and train others about the project. The group identified many key areas and types of information that could be important to include in a case study report, including: cost information, effectiveness of BMPs (performance data), differences in state or federal (or local) stormwater requirements, critical storm requirements, stormwater reductions per square foot for specific BMPs, pre-bid and pre-construction lessons learned, contractors input, rainwater specifications, lessons learned, and barriers to implementation. Will Brown will be writing case studies in fall 2013 for at least three project demonstration sites.

Codes Updates & Codes Checklist

Heather Elmer reviewed outcomes from the discussions at the summer 2012 CLG meeting about municipal codes. Amy Brennan then described the model codes and codes checklist CRWP has been using (developed by Kirby Date, Cleveland State University) and used the City of Mentor parking lot code as a case study. CLG members had some time to talk in small groups about when and how model codes or a codes checklist might be useful, and then shared their feedback with the full group:

- **Parking Codes:** Rachel noted that the Northeast Ohio Areawide Coordinating Agency might be able to assist with updating parking codes or performing a parking needs assessment for the northeast part of Ohio. Amy will investigate with Pam Davis of NOACA.
- **Possible need for checklist for rural and urban areas:** Betsy Yingling noted that the suggestion for open channels over a curb-and gutter systems wouldn't work well in an urban environment.
- **Dan voiced the need for a mechanism in the checklist allowing communities to address deficiencies in their local codes with links to specific sources for code language.** Amy noted model codes available for most of these and balanced growth website link to several examples for communities to go to for model code language.
- **Under Development Regulations:**
 - Betsy expressed concern about easements for all stormwater practices. Amy noted most local codes require easements and maintenance agreements to facilitate proper upkeep and maintenance of stormwater infrastructure. There was a lot of debate as to whether it would be possible or practical for a community to hold the multitude of easements that would be needed to properly maintain stormwater infrastructure on private property. Group discussion on this topic also involved the question of whether or not the maintenance of stormwater infrastructure on private property should even be the responsibility of public entities. Eric noted that in Perkins Township, easements are now required on much of the new stormwater infrastructure and county maintains dry basins through the county ditch program. The county maintains inlets and outlets for wet ponds, but would likely use maintenance agreements for stormwater infrastructure such as permeable parking.
 - Instead of infrastructure easements, long-term maintenance agreements could be used as a mechanism to ensure proper maintenance of stormwater infrastructure on private property.

- Under number 7 – need to add property owners as maintenance responsible party for non-residential developments.
- Concerns about format of checklist and whether it is usable for communities.

Modeling Presentation

Michelle LaRose and Scott Isenberg from Cardno/JF New presented an update on development of unit area SWMM models for bioretention, pervious pavement and several other stormwater BMPs including grass swales, dry detention basins, soil renovation, grass filter strips, underground detention, infiltration trenches and green roofs. They are working with guidance from Rainwater and Land Development and other stormwater design resources including the Michigan LID manual, SWMM user's manual, and monitoring data/literature to determine which design parameters have the greatest impact on BMP performance. In Phase I, Cardo established default parameters for each BMP and then evaluated BMP performance with varied BMP to watershed ratio for A,B,C, and D soils.

Cardno presented a spreadsheet detailing which input parameters were selected for each BMP and which parameters will be changed to evaluate the sensitivity of key parameters to inform both inputs for future models and potentially highlight design parameters that are most important for BMP performance. CLG Members were encouraged to comment on a spreadsheet outlining parameters to be investigated for the sensitivity analysis.

Results of bioretention analysis indicated that depth of soil media does not affect performance. Cardno noted that the storage heights and underdrain offset results did not make a lot of sense and require additional investigation. For pervious pavements, industry notes that pavers have initial infiltration rates ranging from 40-200 inches/hour and concrete up to 1,000 inches/hour, so this is not likely to be a limiting factor. Changing the storage depth of underlying gravel media did not significantly impact results, but underdrain offset or sump depth makes a big difference in performance of systems. Jay and Ryan raised several concerns about data analysis including presenting data with less than 5% changes as these are probably not significant, consideration of existing published research to determine if results are accurate or an indicator of bad model inputs, and appropriateness of 1 and 5% area of BMP to Area of Impervious ratios. Additional analysis was needed from presentation data to look at conclusions presented at the meeting.

Next steps for modeling include completing a sensitivity analysis of BMP parameters and to integrate BMPs at site level using real rainfall data and consider combinations of BMPs.