Bioswale Effectiveness Monitoring in Cuyahoga County
Chagrin River Watershed Partners, Inc.
Lake Erie Protection Fund: SG 337-08

ABSTRACT

Chagrin River Watershed Partners' (CRWP) project for *Bioswale Effectiveness Monitoring in Cuyahoga County* was part of the water quality and flow monitoring plan to demonstrate the effectiveness of low impact development (LID) stormwater best management practices in Northeast Ohio. US EPA's National Community Decentralized Demonstration Program, and CRWP funded design, construction and monitoring of LID demonstration projects in the Chagrin River watershed. LID practices use soil and plant-based filtration to remove pollutants through physical, biological and chemical treatment. Bioswales were installed along Sterncest Road in Orange Village, to manage chronic flooding from roadway and residential runoff. CRWP is monitoring to measure the effectiveness of the bioswale to reduce nonpoint loadings and runoff flows and promote similar practices in new and redeveloped areas. The grant contributed to monitoring equipment installation and data collection. The data analysis from April 2008 – November 2009 shows the bioswales are infiltrating runoff and treating stormwater as intended with some seasonal variations. For example average concentrations of inorganic nitrogen in the soil media ranged from a low of 0.02 mg/L in summer to a high of 0.64 mg/L during winter months. Even with the seasonal variation the bioswales are removing pollutants associated with sediments and particulate matter, and transforming and removing nutrients.

LAKE ERIE PROTECTION FUND

SMALL GRANT - FINAL ACCOUNTING

Grant Number: 337-08

v2010

Budget Categories	Orignal Budget	Funds Spent	Current Balance	Matching Funds
A. Salaries & Wages				
Staff (LID Coordinator, Director, Admi	3794.28	3794.28		4500.00
B. Fringe Benefits				
CRWP Rate	590.72	590.72		
C. Total Salaries & Benefits (A+B)	$4,385.00	$4,385.00	$0.00	$4,500.00
D. Non-expendable Equipment				
Suction Pump for lysimeter samples	687.18	687.18		
Sampling supplies	12.82	12.82		
E. Expendable Materials & Supplies				
	0.00	0.00		
F. Travel				
	0.00	0.00		
G. Services or Consultants				
Contract with USGS	9915.00	9915.00		
H. Computer Costs				
	0.00	0.00		
I. Publications/Presentations				
	0.00	0.00		
J. All other direct costs				
	0.00	0.00		
K. Total Direct Costs (C thru J)	$15,000.00	$15,000.00	$0.00	$4,500.00
L. Indirect Costs				
Total Costs (K + L)	$15,000.00	$15,000.00	$0.00	$4,500.00

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Ohio | Lake Erie Protection Fund

I certify that the grant expenitures listed and descriptions of the charges are true and accurate to the best of my knowledge. These expenditures represent approved grant costs that have been previously paid for and for which complete documentation is on file.

	Signature	Date
Project Director	Rachel Weber	12/17/2009
Authorizing Agent	Amy H. Brennan	12/17/2009
Fiscal Agent	Amy H. Brennan	12/17/2009

Chagrin River Watershed Partners, Inc *December 2009*

Bioswale Effectiveness Monitoring in Cuyahoga County
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Budget Report

The Salaries & Wages and Fringe Benefits budget categories were modified by 1% to account for change in the fringe benefits between the 2008 and 2009 fiscal years. $21.28 was moved from Fringe Benefits to Salaries and Wages. Under the non-expandable equipment $12.81 of the $700 budget was used to purchase supplies for the water quality sample collection. All modifications were verbal described and approved by Lake Erie Protection Fund wit no formal written request necessary because changes were less than 5% of the project budget.

Bioswale Effectiveness Monitoring in Cuyahoga County
Chagrin River Watershed Partners, Inc.
Lake Erie Protection Fund: SG 337-08
Technical Report

ABSTRACT

Chagrin River Watershed Partners' (CRWP) project for *Bioswale Effectiveness Monitoring in Cuyahoga County* was part of the water quality and flow monitoring plan to demonstrate the effectiveness of low impact development (LID) stormwater best management practices in Northeast Ohio. US EPA's National Community Decentralized Demonstration Program, and CRWP funded design, construction and monitoring of LID demonstration projects in the Chagrin River watershed. LID practices use soil and plant-based filtration to remove pollutants through physical, biological and chemical treatment. Bioswales were installed along Sterncest Road in Orange Village, to manage chronic flooding from roadway and residential runoff. CRWP is monitoring to measure the effectiveness of the bioswale to reduce nonpoint loadings and runoff flows and promote similar practices in new and redeveloped areas. The grant contributed to monitoring equipment installation and data collection. The data analysis from April 2008 – November 2009 shows the bioswales are infiltrating runoff and treating stormwater as intended with some seasonal variations. For example average concentrations of inorganic nitrogen in the soil media ranged from a low of 0.02 mg/L in summer to a high of 0.64 mg/L during winter months. Even with the seasonal variation the bioswales are removing pollutants associated with sediments and particulate matter, and transforming and removing nutrients.

PROJECT SUMMARY

Chagrin River Watershed Partners, Inc. (CRWP) is a non-profit organization formed in 1996 by 16 watershed communities to provide technical assistance to local governments and park districts on land use related issues. CRWP works with members to address current, and minimize new, flooding, erosion, and water quality problems. Today CRWP serves 36 members, representing 94% of the Chagrin River watershed. The Chagrin watershed is a high quality resource threatened by increasing impervious surface and stormwater impacts related to urban/suburban development. The development pressure in the watershed will continue as communities grow and parcels with natural resource constraints, such as steep slopes, riparian areas, and wetlands are developed. The problems in the Chagrin watershed are caused by land development and suburbanization activities that have historically lacked effective stormwater control, filled headwater streams, channelized watercourses, and filled and drained wetlands.

This Project contributed to the monitoring of water quality and flow data for one of CRWP's low impact development (LID) demonstration projects. With support from the US Environmental Protection Agency's National Community Decentralized Demonstration Program, CRWP funded the design, construction and monitoring of four LID demonstration projects in the Chagrin River watershed. LID stormwater management practices use soil and plant-based filtration devices that remove pollutants through a variety of physical, biological, and chemical treatment processes. Bioswales were installed along Sterncest Road, a residential road in Orange Village, Ohio as an alternative method to managing chronic flooding problems. The bioswales were designed to receive storm water runoff from the adjacent roadway and overland runoff from the residential area. The bioswale data collected for this project is being used to measure the effectiveness of such retrofits to reduce nonpoint loadings and runoff flows, and promote this stormwater practice in both new and redeveloped areas.

ACTIVITIES AND TIMELINE

1. *Install Equipment*: In April 2009, the US Geological Service (USGS) installed 2 sets of suction lysimeters and flow monitors in the bioswale. The rain gage was installed less than half a mile away at Orange Village Hall to prevent vandalism.
2. *Collect Samples*: CRWP collected samples from April 2008 to November 2009 under this project. Monitoring will continue through November 2010. During the first year of sample collection CRWP collected data from 15 storm events. The sample season was extended year round to allow for collection during winter rain events.
3. *Process Samples*: CRWP partnered with the Northeast Ohio Regional Sewer District (NEORSD) to process collected samples. USGS monitored and maintained the rain gauge and data collection from the flow monitor. This work was completed through October 2009 under this grant. This work will continue through November 2010.
4. Summarize Data: In July 2009 CRWP worked with the USGS, NEORSD, and USEPA National Risk Management Research Laboratory (NRMRL) to review the first year of data for information on the soil infiltration function of the bioswale. See the Work Products for a summary of data.
5. Share findings on project: CRWP presented information on the bioswale project to CRWP Members, engineers, plan reviewers, Ohio EPA, ODNR, and other watershed stakeholders throughout the project. See the Work Products section for more detailed information.

WORK PRODUCTS AND DISSEMINATION

From this project CRWP was able to collect and analyze the first year of water quality and flow data from the Orange Village bioswale demonstration project. The first year of data is presented below. This project also allowed CRWP to circulate information on the Orange Village and other demonstration projects through fact sheets, presentations, and video.

Water Quality and Flow Data

From April 2009 through November 2009 CRWP and the USGS collected water quality and flow data from 2 bioswale areas at the Orange Village project. The goal of the long-term monitoring project for the Orange Village site is to evaluate the performance of the bioswales to determine water quality and quantity control for 2 years following installation. To accomplish this goal CRWP collected the following:

- Rainfall data.
- Frequency of overflow of stormwater runoff into the storm sewer through a catch basin in the bioretention area during storm events.
- Water quality of stormwater runoff at 3 points in the bioswale.

Below are the results from an initial review of the flow data collected between April 2009 and November 2009 and water quality data from April 2008 to April 2009, and initial impressions of how the bioswale is functioning. CRWP will work with USGS and USEPA NRMRL to do an official review at the completion of the monitoring program in November 2010. This data is subject to revision until this official review is completed.

Rainfall Data

- Between 4/2/2008 and 11/25/2009 the rain gage at Orange Village recorded 74.6 inches of precipitation. During that time there were 31 rain events that resulted in rain fall depths greater than 0.75 inches in a 24 hour period.
- Of these 31 events, 11 caused the bioswale on the north side of the road to overflow.
- For this area, the 24 hour, 1 year rain event is 2.04 inches (http://hdsc.nws.noaa.gov/hdsc/pfds/orb/oh_pfds.html). The only precipitation event that exceeded the 1 year frequency was on 10/1/2008 at 2.23 inches (2.01 inches on 8/29/09).
- The rain gage records at a 10 minute interval and the maximum 10 minute precipitation was 0.81 inches on 7/8/08 at 17:20.
- Table 1. Precipitation events at the Orange Village rain gage that exceed 0.75 inches in a 24 hour period. Highlighted events occurred during periods when snow was accumulated on the ground.

Event	Date	Maximum 24 hour precipitation	Event	Date	Maximum 24 hour precipitation
1	5/3/08 19:10	1.21	17	2/12/09 4:10	1.16
2	5/8/08 3:10	0.76	18	3/8/09 21:10	1.79
3	6/10/08 16:00	1.09	19	3/11/09 5:00	0.94
4	6/22/08 17:10	1.10	20	4/3/09 15:40	0.84
5	7/3/08 13:50	0.88	21	4/15/09 10:50	1.09
6	7/9/08 7:40	1.86	22	4/20/09 19:00	1.23
7	7/13/08 9:50	1.45	23	6/20/09 8:10	0.95
8	8/10/08 20:10	1.03	24	7/1/09 3:20	1.13
9	9/13/08 4:40	1.89	25	7/18/09 11:10	1.69
10	10/1/08 5:00	2.23	26	7/23/09 14:30	0.88
11	10/16/08 9:20	0.83	27	8/11/09 6:00	1.70
12	10/28/08 13:00	1.12	28	8/29/09 7:00	2.01
13	11/15/08 23:00	1.37	29	9/27/09 7:50	1.14
14	12/1/08 5:20	0.83	30	9/30/09 8:20	1.53
15	12/10/08 7:20	0.83	31	10/2/09 13:30	1.12
16	12/24/08 17:20	1.29			

Frequency of Overflow to the Catch Basin

The bioswale is designed to promote infiltration along the swale as it moves runoff to landscaped areas around catch basins. The area around the catch basins is designed to fill up with water to a maximum depth of about six inch. If the water exceeds the six inch depth, it will enter into the catch basin and flow directly to the storm sewer without treatment. Below is a measurement of the duration of time that runoff overflowed into the catch basin during rain events.

- 11 events resulted in enough runoff to cause stormwater to pool around at least one of the monitored bioswale areas and overflow into the catch basin, discharging runoff directly into the storm sewer system.
- Table 2. Overflow events for the Orange Village bioswale (north side of the road).

Event	Begin overflow	Overflow Duration (minutes)	24 hour precipitation at start of overflow (inches)
1	4/4/08 6:42	129	0.54
2	5/3/08 19:44	149	1.00
3	7/8/08 17:17	25	1.15
4	10/3/08 6:23	116	0.26
5	3/9/09 11:30	119	1.21
6	7/1/09 20:22	219	0.37
7	7/17/09 14:46	5	1.07
8	8/1/09 0:16	157	0.59
9	8/10/09 15:32	66	0.74
10	8/29/09 5:18	48	1.89

- Five of the ten events occurred during rain events that were less than the 0.75 inch standard. Possible explanations for these events are:
  - 4/4/08 – The bioswales had just been installed and were not fully functioning.
  - 10/3/08 – 3.23 inches of precipitation in the preceding 4 days.
  - 7/1/09 – 1.18 inches of rain in previous 48 hours.
  - 8/1/09 – Unknown
  - 7/17/09 – 0.74 inches of rain in 24 hours
- Starting 11/27/2008 through 4/7/2009 there were periods of time when significant snow was piled on the overflow grates and the instrument measured snow melt. This data is not an indicator of overflows and was disregarded. Because of this we may have missed a few overflow events.

Water Quality Data

Water quality samples were collected and analyzed for 17 rain events. Because of the effectiveness of the bioswale to infiltrate runoff during the rain events, surface runoff samples were not available for all the sample collection events. Three types of samples for water quality were collected from bioswales.

1. *Surface Runoff* is channeled directly from impervious surfaces, which in this case is the roadway and when not immediately infiltrated collects around the catch basin where it is collected for sample analysis.

2. *Soil Media (Lysimeter)* media samples are collected from within the bioswale media, and demonstrate the treatment potential of this management practice.
3. *Catch Basin* samples receive some runoff from connected source areas, overflow from the bioswale, and any water that filters through the bioswale media.

Concentrations for each of the parameters fall within the expected range for urban and suburban runoff, with none of the aggregate values representing exceptionally high levels of pollution. Samples were processed for:

- Nitrogen series
- Chloride
- Total metals
- Dissolved metals
- Total phosphorus
- Total suspended solids (TSS)
- Turbidity
- Escherichia coli (E. coli)

There were not enough samples at this time to analyze for zinc, and the patterns for total metals are comparable to dissolved metals. Water quality results for the remaining parameters are presented below. Target concentrations for the Chagrin River, referenced below are from the state endorsed *Chagrin River Watershed Action Plan,* 2009. See the CRWP website to review the Plan.

Total Phosphorus (TP): a nutrient and one of the primary pollutants of concern for Lake Erie, because when it gets into streams and lakes it can cause algal blooms that can lead to oxygen depletions and fish kills. Phosphorus standards for the Chagrin River watershed range from 0.08mg/L for headwater streams to 0.17mg/L for small rivers. Typical concentrations of total phosphorus in urban runoff range from 0.5 to 5.0 mg/L.

- Surface Runoff
  - Samples were only collected in the spring and winter, due to lack of available runoff to sample.
  - Average concentrations for total phosphorus in surface runoff varied little, with values of 0.11 mg/L in the spring and 0.12 mg/L in winter.
- Soil Media (lysimeter)
  - Average concentrations range from a low of 0.02 mg/L in winter to a high of 0.20 mg/L during spring months; average concentrations in summer and fall were 0.16 and 0.04 mg/L respectively.
- Catch Basin
  - Average concentrations range from a low of 0.10 mg/L in winter to a high of 0.31 mg/L during fall months; average concentrations in spring and summer were 0.14 and 0.29 mg/L respectively.

Phosphorus inputs via runoff to the bioswale are highest in the summer and fall months, but as shown, phosphorus is removed effectively within the soil column of the bioswale. Highest removal rates, as a percentage of runoff to the bioswale, are found in fall and winter, while highest mobilization of TP in the bioswale soils occurs in the spring, either because of soluble fertilizer inputs or via increased microbial activity.

Dissolved Total Nitrogen (DIN): a nutrient and pollutant of concern in surface waters, because when it enters streams and lakes it causes algal blooms that can lead to oxygen depletions and fish kills. Nitrogen is primarily a concern for eutrophication of estuarine and coastal waters, and is considered important for management of Lake Erie's waters. Target nitrate-nitrite concentrations for the Chagrin River watershed range from 1.00mg/L for headwater streams to 1.5mg/L for small rivers. Concentrations ranging from 2 to 10 mg/L are typical for urban runoff.

- Surface Runoff
    - Samples were only collected in the spring and winter, due to lack of available runoff to sample.
    - Average concentrations ranged from a low of 0.08 mg/L in the spring to a high of 0.22 mg/L in winter.
- Soil Media (lysimeter)
    - Average concentrations range from a low of 0.02 mg/L in summer to a high of 0.64 mg/L during winter months; average concentrations in fall and spring were 0.21 and 0.16 mg/L respectively.
    - Low concentrations of DIN in the bioswale soil media in the spring and summer show active transformation and uptake processes.
    - Concentrations of DIN increase in the fall and winter as plants die back.
- Catch Basin
    - Concentrations as high 3.4 mg/L.
    - Average concentrations range from a low of 0.49 mg/L in spring to a high of 2.54 mg/L during fall months; average concentrations in summer and winter were 0.82 and 0.65 mg/L respectively.
    - Catch basin samples more closely match expected values for surface runoff.

The results show a seasonal trend in DIN concentrations and that the bioswale soil media is removing DIN from stormwater moving through the system. The DIN concentration in the bioswale soil media are being reduced in the spring and summer when both plants and soil microbial processes are the most active, and treatment is reduced in the soil during fall and winter when the plants are dormant.

Ammonia: a nutrient and pollutant of concern because it can both contribute to eutrophication at low concentrations and cause fish kills at higher concentrations (lethal concentrations for fish range from 0.2 to 2.0 mg/L depending on temperature, pH, and species). Overall concentrations of ammonia for all sample types are low, with the highest values measured in the bioswale soil water during the spring.

- Surface Runoff
    - Samples were only collected in the spring and winter, due to lack of available runoff to sample.
    - Average concentrations ranged from a low of 0.02 mg/L in the spring to a high of 0.18 mg/L in winter.
- Soil Media (lysimeter)

  - Average concentrations range from a low of 0.13 mg/L in fall to a high of 0.39 mg/L during spring; average concentrations in summer and winter were 0.27 and 0.20 mg/L respectively.
  - Comparatively high concentrations of ammonia nitrogen in the bioswale soil media in the spring and summer show active transformation and uptake processes.
- Catch Basin
  - Average concentrations range from a low of 0.05 mg/L in spring to a high of 0.15 mg/L during fall; average concentrations in summer and winter were 0.06 and 0.08 mg/L respectively.

Surface runoff in urban areas has typically low ammonia concentrations, as shown by the Orange Village data. In soils, ammonia results from nitrogen fixation, which is probably not significant here, and microbially-mediated decay of organic matter. High concentrations in spring and early summer are likely a result of increasing microbial activity in the spring and summer, or from soluble fertilizer inputs.

<u>Chloride:</u> Is a pollutant of concern in streams because of the long term potential for salinization of urban streams and because of toxicity effects on stream microbial communities and macroinvertebrates from high seasonal chloride concentrations. Concentrations of chloride greater than 230 mg/L may impair aquatic life use over time in freshwater ecosystems (chronic criteria).

- Surface Runoff
  - Samples were only collected in the spring and winter, due to lack of available runoff to sample.
  - Average concentrations ranged from a low of 4.5 mg/L in the spring to a high of 46 mg/L in winter.
  - Low winter values may be due in part to the collection of snow samples.
- Soil Media (lysimeter)
  - Average concentrations range from a low of 57 mg/L in spring to a high of 345 mg/L during winter; average concentrations in summer and fall were 75 and 86 mg/L respectively.
  - Low concentrations in spring are likely the result of dilution effects from high rainfall volumes.
- Catch Basin
  - Average concentrations range from a low of 151 mg/L in fall to a high of 408 mg/L during summer; average concentrations in spring and winter were 164 and 232 mg/L respectively.
  - Catch basin samples more closely match expected values for surface runoff; high average summer concentrations are the result of a single storm event in early June 2008.

The chloride concentrations in the soil media and surface runoff result from winter salt applications. The concern for long-term bioswale performance is that salts may accumulate in the soil, potentially decreasing pollutant retention and impeding plant growth.

Dissolved Aluminum: Aluminum is not a pollutant of concern from an ecological or water quality standpoint for concentrations typically observed in urban runoff. Aluminum in urban runoff and surface water is largely associated with sediments and particulate matter, which makes it a good surrogate for sediment, TSS, and other mineral pollutants. Since total aluminum was not measured in lysimeter samples, all values are reported as dissolved aluminum, filtered to 0.45 micron. Dissolved concentrations for runoff and catch basin samples are typically 25% of total concentrations.

- Surface Runoff
  - Samples were only collected in the spring and winter, due to lack of available runoff to sample.
  - Average concentrations ranged from a high of 332 mg/L in the spring to a low of 107 mg/L in winter.
- Soil Media (lysimeter)
  - Average concentrations range from a low of 5 mg/L in spring to a high of 18 mg/L during summer; average concentrations in fall and winter were 7 mg/L.
- Catch Basin
  - Average concentrations range from a low of 79 mg/L in summer to a high of 237 mg/L during spring; average concentrations in fall and winter were 154 and 115 mg/L respectively.

Aluminum, iron, manganese and other metallic automobile parts suffer significant corrosion during winter months, therefore high concentration of dissolved aluminum in the spring for both the catch basin and surface runoff samples are expected to result from this source.

Iron: The behavior of iron in the environment is similar to aluminum as described above, except that iron is more important for soil redox reactions and biological processes. As for aluminum, dissolved values are used and range from 5 to 31% of total iron.

- Surface Runoff
  - Samples were only collected in the spring and winter, due to lack of available runoff to sample.
  - Average concentrations ranged from a high of 312 mg/L in the spring to a low of 132 mg/L in winter.
- Soil Media (lysimeter)
  - Average concentrations range from a low of 6.5 mg/L in fall to a high of 49 mg/L during spring; average concentrations in winter were 13 mg/L.
- Catch Basin
  - Average concentrations range from a low of 157 mg/L in winter to a high of 572 mg/L during fall; average concentrations in spring and summer were 317 and 221 mg/L respectively.

Aluminum, iron, manganese and other metallic automobile parts suffer significant corrosion during winter months, therefore high concentration of dissolved aluminum in the spring for both the catch basin and surface runoff samples are expected to result from this source.

Copper: The behavior of copper in the environment is similar to iron as described above, except that copper is present in much smaller amounts, and its concentration and distribution are therefore controlled by its reactions with particles and organic matter. Freshwater criteria for copper vary depending on the pH, ionic strength, and concentration of organic matter, but values for dissolved copper greater than 5 to 10 micrograms per liter (microgram/L) may be cause for concern. The data below show that bioretention may be a good management practice for removing metals from urban runoff, with the caveat that concentrations may build up in soils over time and require maintenance.

- Surface Runoff
  - Samples were only collected in the spring and winter, due to lack of available runoff to sample.
  - Average concentrations ranged from a high of 6.7 micrograms/L in the spring to a low of 13.4 micrograms/L in winter.
- Soil Media (lysimeter)
  - Average concentrations range from a low of 3.3 micrograms/L in fall to a high of 4.8 microgram/L during spring; average concentrations in winter were 4.0 micrograms/L.
- Catch Basin
  - Average concentrations range from a low of 4.2 micrograms/L in winter to a high of 13.6 micrograms/L during fall; average concentrations in spring and summer were 7.9 and 11.2 micrograms/L respectively.

E. coli and Total Suspended Solids (TSS): Values for *E. coli* and TSS were only measured in some surface runoff and catch basin samples, rather than in all samples, for two reasons: 1) sample volumes were not sufficient, especially for lysimeters; and 2) both are associated with particles and not expected to be present in lysimeter samples because of the bioswale's filtration processes. *E. coli* is an indicator of fecal bacteria contamination, with a water quality criteria for the Chagrin River watershed at 126 CFU/100 mL (colony forming units) for primary contact recreation. Concentrations of *E. coli* measured in surface runoff averaged 1029 CFU/100 mL, while concentrations in the catch basin were slightly lower at 849 CFU/100 mL. Both values are typical for urban runoff, and both exceed Ohio's water quality standard.

TSS standards for the Chagrin River are 17mg/L for high flows and 5mg/L for low flow conditions in headwaters streams, and are 70mg/L for high flows and 5mg/L for low flow conditions in small streams. High concentrations of sediment in freshwater systems can damage habitat and transport pollutants. Measured concentrations for TSS averaged 174 mg/L in surface runoff, and a significantly lower 17 mg/L in catch basin samples.

The overall data, while still inconclusive in some areas, does show that the bioswales are functioning as intended. They are infiltrating runoff, removing pollutants associated with sediments and particulate matter, and transforming and removing nutrients, as shown for inorganic nitrogen and phosphorus. The data does bring up several questions that will be reviewed further when all the data is collected. These questions include:

- Will salt levels in the soil media build up over time, and will this interfere with bioswale function and plant growth?
- Will more definite, predictable seasonal patterns emerge for nutrient cycling in the bioswale as plants become further established?
- To what level will the bioswale be able to remove dissolved metals such as zinc and copper, and will this vary on a seasonal basis?
- Will metals or other pollutants such as polycyclic aromatic hydrocarbons (PAHs) accumulate in surface soils of the bioswale?

Education and Information Dissemination

To disseminate information on the utility and function of bioswales for stormwater quality and quantity control, specifically the option of bioswales as an alternative to ditch enclosure in developed communities, CRWP developed a two page fact sheet, and videos on the project instillation and monitoring to distribute and promote at workshops, trainings and CRWP website (enclosed with report). The videos and fact sheets can be viewed from the following website:

http://www.crwp.org/LID/orange_bioswale.htm

Along with fact sheets and videos, CRWP participated in workshops, presenting on the Orange Village and other demonstration projects to local engineers, planners, technical experts, stormwater managers, developers and elected officials. CRWP also provided quarterly updates and information on the Orange Village project to CRWP Members at quarterly board of trustee meetings. Below is a list of workshops and presentations CRWP presented at over the course of the project period.

- Ohio Ecological Landscaping Conference, *Innovative Stormwater Management in Northeast Ohio*, October 29, 2007
- Ohio Environmental Protection Agency Stormwater Training Workshop, *Orange Village and Pepper Pike Bioretention Retrofit Projects*, February 13, 2008
- Cleveland Engineering Society Annual Conference, *Controlling the Impacts of Land Use Change through Effective Stormwater Management Solutions*, March 12, 2008
- Ohio Water Environment Association, *Controlling the Impacts of Land Use Change through Effective Stormwater Management Solutions*, May 7, 2008
- Northeast Ohio Stormwater Conference, *Controlling the Impacts of Land Use Change through Effective Stormwater Management Solutions*, May 21, 2008
- CT Consultants Professional Development Seminar, *Green Infrastructure in Northeast Ohio*, December 12, 2009. (138 participants)

Presentation of Water Quality and Flow Data Results

In 2009 CRWP was able to present on the first year of water quality and flow data at the following workshops (presentations enclosed with report):

- Stormwater System Design and Performance with the University of New Hampshire Stormwater Center, August 5-6
- Green Infrastructure in Northeast Ohio, November 4

The Stormwater System Design and Performance workshop was open to engineers and planners across Ohio and highlighted various traditional and innovative storm water practices, their applicability to different sites, and their effectiveness as water quality treatment BMPs for storm water. There were 115 participants at the workshop with another 78 participating throughout the state through satellite locations. The second day of the workshop was a field tour that highlighted the Orange Village and other innovative storm water management best management practices in Northeast Ohio. The group included 41 participants from all the local soil and water conservation districts, Ohio Environmental Protection Agency (EPA) and Ohio Department of Natural Resources representatives, and local communities.

The Green Infrastructure in Northeast Ohio workshop outlined the benefits of green infrastructure and design, and retrofit projects. The workshop was open to engineers and planners across Ohio. There were 113 participants at the workshop.

CONCLUSION

Data collected through this Project, as well as the 3 other demonstration projects, have increased public and private sector understanding of low impact development (LID) in Northeast Ohio and facilitated application of innovative stormwater practices basin wide. At the same time this project has been able to demonstration that LID can be an effective tool to manage and treat stormwater to meet Ohio EPA's General Construction Site NPDES Permit. At the close of the monitoring program in 2010 CRWP, in partnership with the USGS and USEPA NRMRL, will conduct the final analysis of all the collected data. The goal is to use these results to connect the benefits of LID to the *Chagrin River Watershed TMDL Study* and *Chagrin River Watershed Action Plan* and *Chagrin River Watershed Balanced Growth Plan* to promote these innovative stormwater practices to CRWP Members and Northeast Ohio communities.