Chagrin River Watershed Partners, Inc.

Water Quality Treatment and Runoff Reduction Performance of Roadside Bioretention

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Chagrin River Watershed Partners

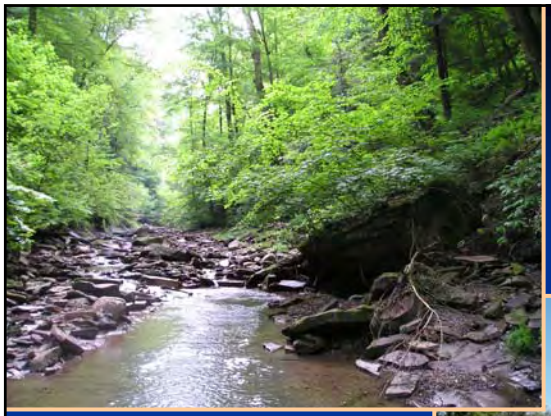
- **Formed in 1996 by watershed communities. Supported by member dues and grants.**
- **Work directly with 36 cities, villages, counties, townships, and park districts to minimize flooding and erosion as communities grow.**
- **Focus on improving development practices and site design to reduce long term infrastructure costs.**
- **Majority of members required to comply with Ohio EPA's Phase II requirements.**

CRWP Sponsoring Members

Flooding, Erosion, and Water Quality Problems:

The Impacts of Land Use Change

- ✓Increase in impervious cover
- ✓Loss of floodplains
- ✓Increase in flooding, erosion & water quality problems
- ✓Increase in infrastructure costs and resident complaints



Riparian areas, streams & wetlands…..

<u>Sink</u> for storm water and its pollutants

<u>Free</u> flood and erosion control & water quality protection

Replace with impervious surfaces

<u>Source</u> of storm water & pollutants

<u>Impervious =</u>

- ✓Parking lots
- ✓Roads & driveways
- ✓Roof tops


Conventional Site Design: Storm Water Management Goals are to...
Collect
Concentrate
Convey
Centralized
Control
"Good Drainage"


Once storm water is in a pond or a pipe, cost-effective management options are limited.

Solution?

- ✓ Better Site Design for **New** Subdivisions
- ✓ Better Placement of **New** Homes and Additions.
- ✓ Riparian Setbacks, Conservation Development, and Other Tools to Enable Communities, Developers, and Builders to Improve.

Evaluate Barriers in Existing Regulations

- **Parking Codes**
  - May require asphalt or concrete paving materials.
  - Number of parking spaces.
- **Ensure code changes are consistent throughout the zoning, building and subdivision codes.**
- **Development Site Design**
  - Consider options of Planned Unit Developments, Conservation Developments, or Compact Development.
  - Riparian and wetland setbacks.

Low Impact Development Demonstration Project

CRWP received US EPA grant *Demonstrate Innovative Approaches to Distributed Storm Water Management in Northeast Ohio*

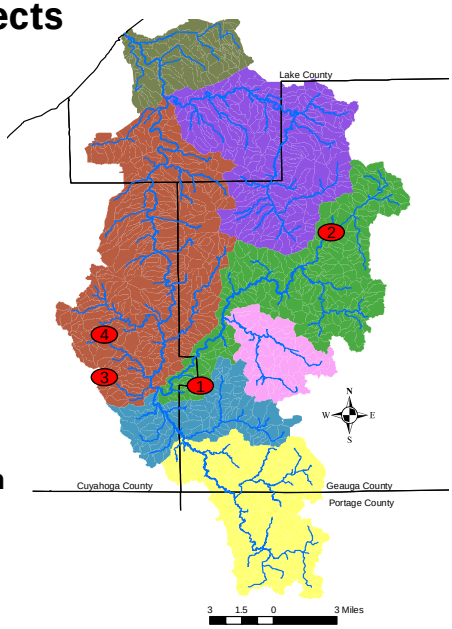
US EPA National Community Decentralized Demonstration Project

CRWP Demonstration Project

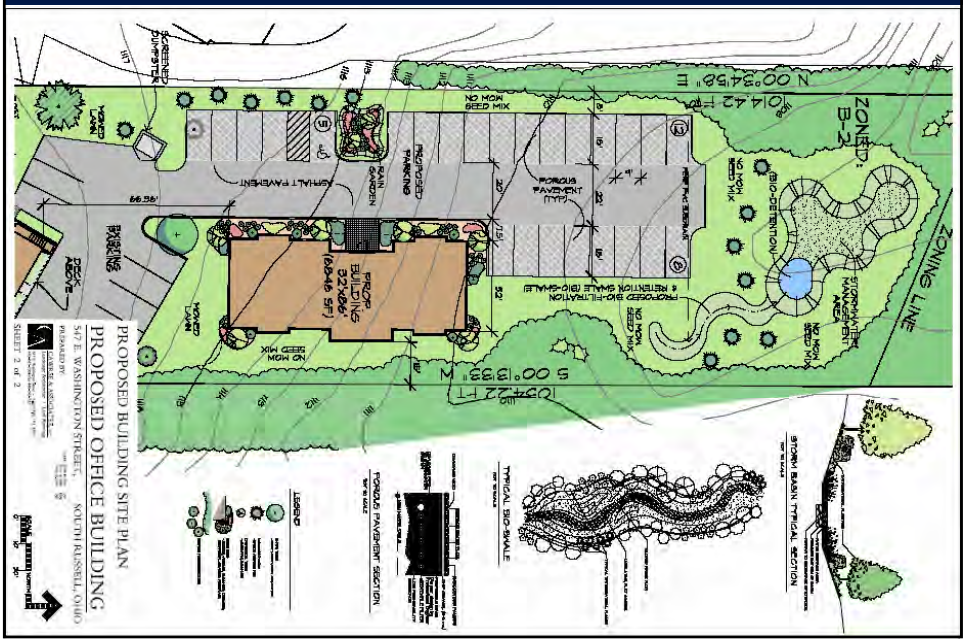
- **Goal:** Address barriers to LID implementation in NE Ohio on **local** projects.
- **Project funds:**
  - Develop local codes that encourage distributed approaches to storm water management.
  - Technical assistance to CRWP members.
  - **Design, construction, operation, and maintenance of structural LID practices.**
  - **Monitoring of LID practices after installation.**

Demonstration Projects

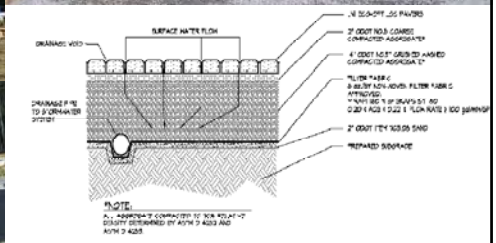
1. **Cawrse and Associates Storm Water Project, South Russell**
2. Munson Township Scenic River Retreat Rain Garden Project
3. **Orange Village Bioswale Project, Sterncrest Road**
4. **Pepper Pike Bioretention Project, Fox Hollow Drive and Chagrin Boulevard**



Cawrse and Associates



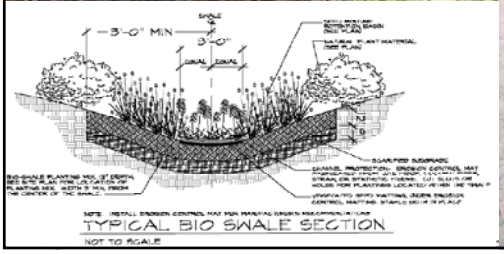
Permeable Parking Area



UNILOCK ECO-OPTILOC PAVER SECTION

NOT TO SCALE

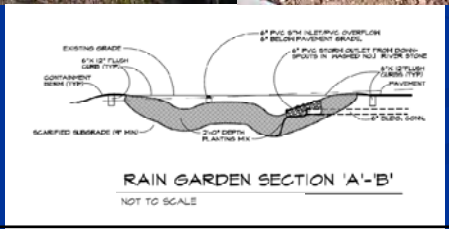
Vegetated Swale



TYPICAL BIO SWALE SECTION

NOT TO SCALE

Rain Garden



Flow and Quality of runoff from BMPs

Under Drain from Paver System

Surface Flow From Pavers System

Pepper Pike Retrofit Project

- Modify existing drainage swale and install bioretention in residential & public areas.
  - Fox Hollow Drive – Residential Subdivision
  - Chagrin Boulevard – Orange Campus High School

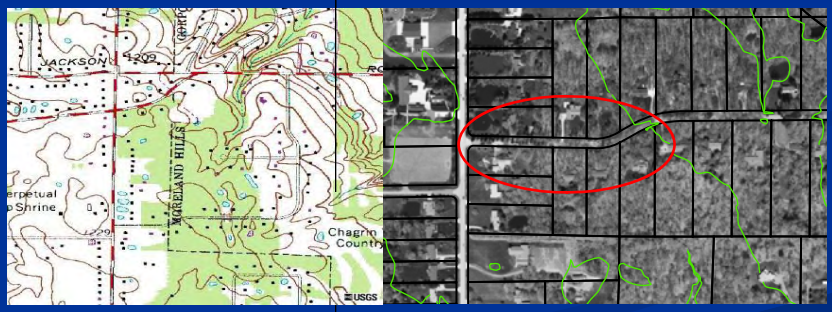

Fox Hollow Drive


Chagrin Blvd.

- Goal is to provide option to ditch culverts.

Orange Village – Sterncrest Retrofit

Replace existing storm system with bioswale system along the north and south sides of Sterncrest Road to fix flooding problems.



Moreland Hills provided additional funding.

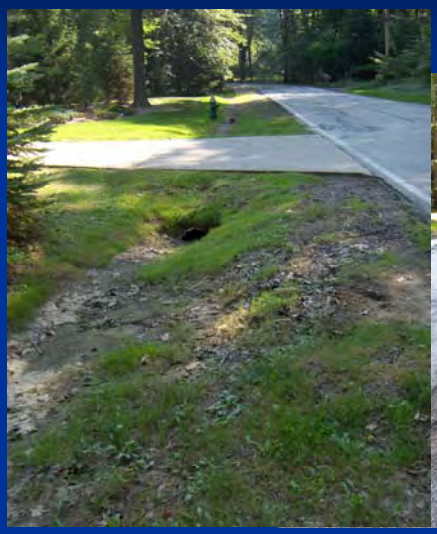
Project Monitoring

- Monitor bioretention cells and catch basins.
- At what rain events are the bioretention cells ponding water prior to overflow into catch basin?
- What is the frequency of overflow into the catch basin?
- What is the **quality** of runoff:
  - Before infiltration through the bioretention areas?
  - After infiltration through bioretention areas?

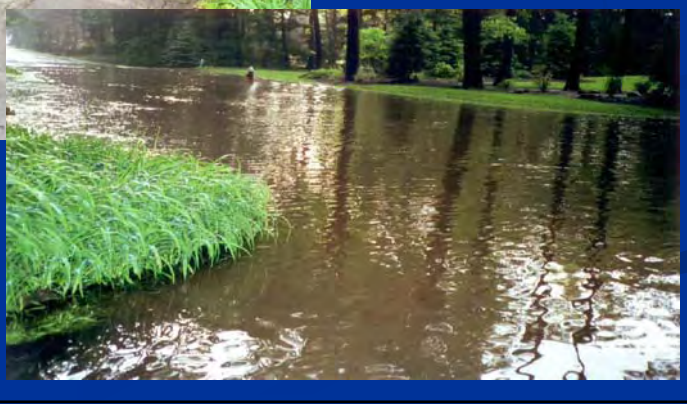
Project Partners

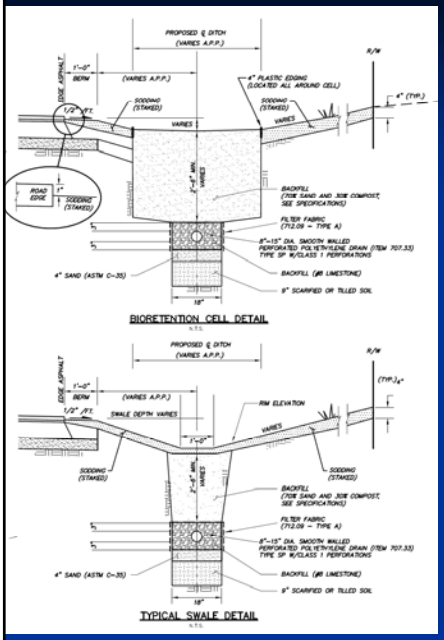
- **U.S. Geological Survey**
  - Equipment installation and maintenance
  - Quantity Analysis
- **Northeast Ohio Regional Sewer District**
  - Water Chemistry Sample Analysis
- US EPA, Region 5 – Cleveland Office
  - Sampling Equipment
- **US EPA, National Risk Management and Research Laboratory** - Cincinnati, OH
  - Chemical Analysis
- **Lake Erie Protection Fund**
  - Funding for monitoring program

Before Installation



Before Installation

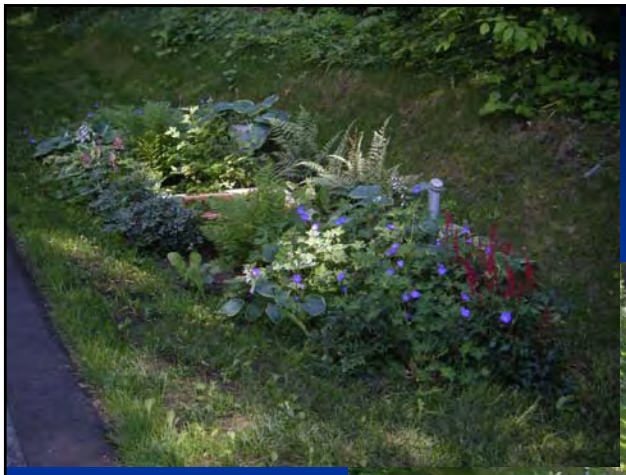




- Bioretention and bioswales designed for WQv.
- The soil mix design 70/30 mix with compost material instead of peat.
- Organic Leaf Compost: MN DOT Grade 2.
  - Minimum organic content 30%
  - C/N Ratio of 6-20:1
- Sand - AASHTO M-6/ASTM C-33
- Edger between bioretention area and swale sod

Sterncrest:
6 months after construction

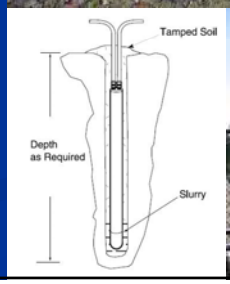
Sterncrest: 15 months after construction



Sterncrest: 18 months after construction

Monitoring Equipment

- 4 Suction lysimeters in bioswale areas near catch basin
  - Small well to sample quality of water in the soil
- Conductivity sensor in the catch basin to measure overflow duration
- Rain gage



First Year Results: Flow

(April 3, 2008 - June 22, 2009)

- 21 rain events > 0.75 inches in 24 hours
  - Every month, except January represented
- Does not include extended periods when snow covered the structure

Data subject to revision until after an official review is completed by the USGS Ohio Water Science Center.

Date	24 hour total
05/02/08	1.02
05/03/08	0.99
06/10/08	0.8
07/03/08	0.85
07/08/08	1.63
07/13/08	0.75
08/09/08	0.77
09/12/08	1.87
09/13/08	0.9
09/30/08	1.46
10/01/08	1.12
10/27/08	0.99
11/15/08	1.37
12/24/08	1.29
02/11/09	0.92
03/08/09	1.64
03/10/09	0.84
04/03/09	0.84
04/15/09	0.86
04/20/09	1.14
06/20/09	0.76

First Year Results: Flow

(April 3, 2008 - June 22, 2009)

- Six events causing overflow into catch basin
  - Rain event >1.5 inches or snow melt preceding overflow event saturating soil
  - Typical summer thunderstorm: High intensity - 1.15 inches of rain in 1-hour
- Shows that the bioretention is working year round

Overflow	Duration (minutes)
4/4/08	129
5/3/08	149
*7/8/08	25
10/3/08	116
3/9/09	119
4/7/09	9

Data subject to revision until after an official review is completed by the USGS Ohio Water Science Center.

First Year Results: Quality

(April 3, 2008 - June 22, 2009)

- Water Quality samples are taken from:
  - Storm water ponded around catch basin
  - Lysimeter samples of water extracted from soil
  - Catch basin/underdrain flow
- Water Quality data limited because 10 events with surface runoff were available to sample.
- Data provides evidence of treatment during movement of storm water through the bioretention cell.

Water Quality Analysis

- **Dissolved Total Nitrogen**
- E. coli
- Chloride
- Total Metals
- Dissolved Metals
- **Total Phosphorus**
- Total Suspended Solids
- Turbidity

First Year Results - Quality

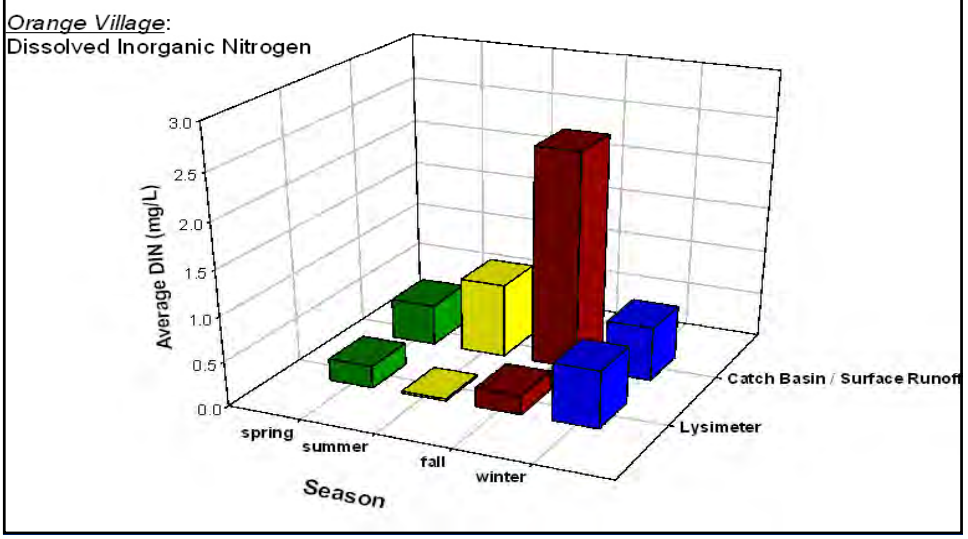
(April 3, 2008 - June 22, 2009)

- Dissolved Inorganic Nitrogen (DIN), primarily nitrate (NO3), nutrient and pollutant of concern in surface waters
- Bioretention cell is removing DIN from storm water moving through system in spring, summer, and fall
  - Lowest concentrations in summer and fall
  - Denitrification by soil microbes plus plant uptake using DIN and reducing concentrations
- DIN concentration in the winter similar in lysimeter and catch basin samples
  - Microbes and plants inactive leaving more DIN in the soil water

Data subject to revision until after an official review is completed.

First Year Results - Quality

(April 3, 2008 - June 22, 2009)



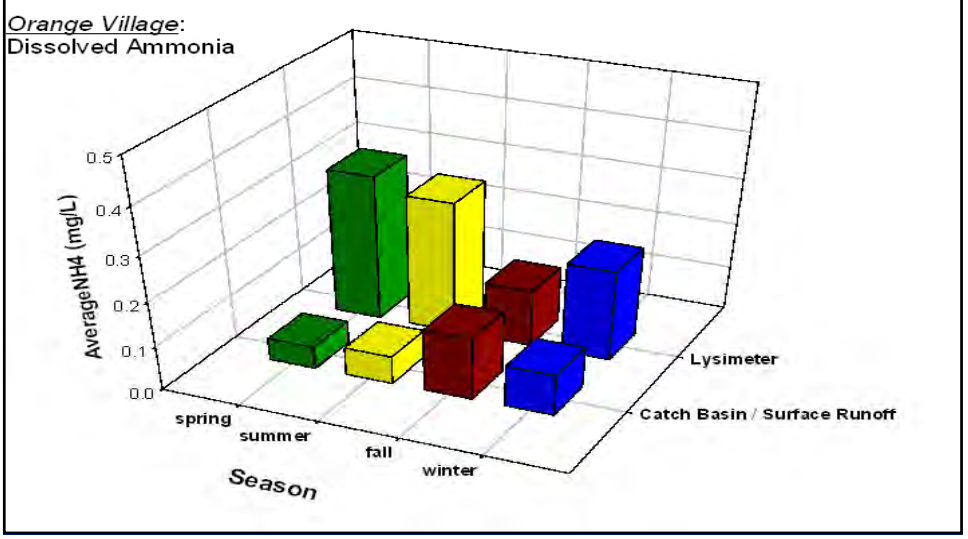
First Year Results - Quality

(April 3, 2008 - June 22, 2009)

- Ammonia (NH4) – Nutrient available for plant uptake, but toxic to aquatic organisms at high concentrations
- Overall low concentrations – not a pollutant of concern at these concentrations
- Higher concentrations in soil water (Lysimeter)
  - Possibly due to decomposing organic material, low levels of plant uptake, and slow nitrification (conversion to nitrate)

First Year Results - Quality

(April 3, 2008 - June 22, 2009)



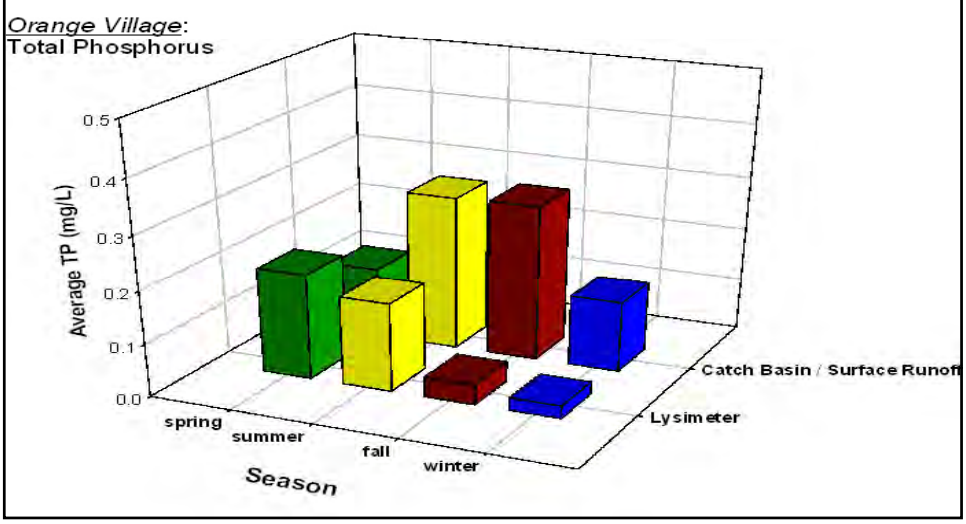
First Year Results - Quality

(April 3, 2008 - June 22, 2009)

- Total Phosphorus – nutrient and pollutant of concern for streams and lakes
- Lysimeter (soil water)
  - Demonstrates removal by sorption and filtration in summer, fall, and winter
  - Higher concentration in the spring and summer, possibly due to fertilizer inputs
- Catch Basin
  - High concentrations in Summer and Fall
  - Possibly due to: fertilizers, sediment inputs, and leaf debris (decomposition of organic matter)
- Overall concentrations are low

First Year Results - Quality

(April 3, 2008 - June 22, 2009)



What Does all this Mean?

- What is the maximum level of ponded water in the bioretention cells if now overflow into the catch basin?
  - 10 events with standing water in cell. 6 were overflow events.
  - Always drained within 24 hours.
- What is the frequency of overflow into the catch basin?
  - Overflow occurs during high intensity rains events or when soils were saturated from preceding rain or snow melt.
  - Rain events greater than 1.5 inches or rain coupled with snow melts.
- Are the bioretention cells providing treatment to storm water runoff?
  - Preliminary data indicates runoff filtrating through bioretention cell is being treated.

Monitoring Program

- Continue 2-year monitoring program
  - Orange Village through 2009
  - Pepper Pike through summer 2010
  - Cawrse and Associates through 2010
- Conduct full analysis with report at the close of each program.
- Findings will be presented at future training events.


Questions?