Chagrin River Watershed Partners, Inc.

Green Infrastructure Design & Construction Case Studies

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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

CDM
CT Consultants
Chagrin Valley Engineering, Ltd.
The C.W. Courtney Company
ES Enviro Science Incorporated
The Holden Arboretum
Ohio Central Basin Steelheaders
Partners Environmental
Stantec
Trout Unlimited Emerald Necklace Chapter
URS
Western Reserve Federation of Conservationists
Western Reserve Land Conservancy Our Land. Our Legacy.

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

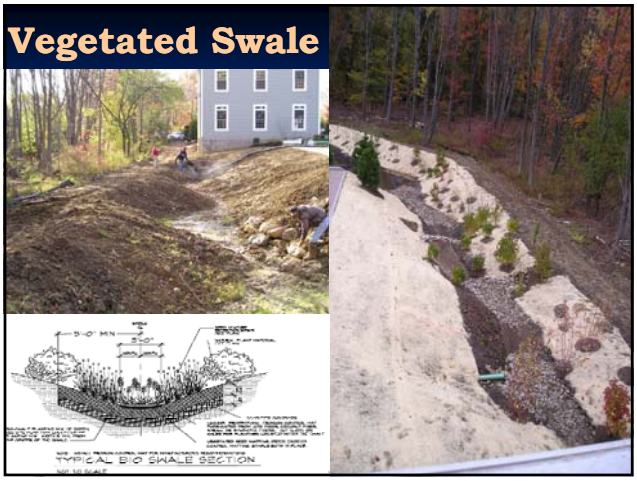
Project Partners

- **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

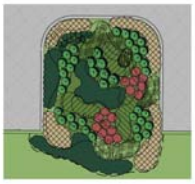
Cawrse and Associates

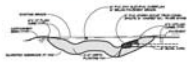
Permeable Parking Area

Vegetated Swale



Rain Garden





Cost of Installation

- Parking Lot and Drive: $72,000
  - Paver system, earthwork, excavation, curb, soil borings
  - Pavers System: $7-8 SF - product, stone and labor
- Swale - $21,000
  - Vegetation, planting, soil mix, soil stabilization, rock and earthwork
- Rain Garden/Bioretention: $8,600
  - Vegetation, planting, earthwork, and soil mix
- Engineering: $12,500
  - Civil engineering, landscape architect and survey fees
- **Total: $116,741**

Snow Removal

- Typical snow plow used through out the winter
- Salt added once – just in case

Maintenance – Paver System

- Remove debris such as leaves or salt residue
- Sweep parking lot at least every 2 years
- Replace top layer gravel
- Replace pavers as necessary
- Monitor under drain outfall for changes
- No Traditional Infrastructure to maintain

Not an Approved Stormwater WQ Practice per Ohio EPA Requirements
Should still be included in Maintenance Agreement

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

- Goal is to provide option to ditch culverts.

Pepper Pike Retrofit Project

- City approached homeowners for involvement
- Maintained by City for 3 years
  - Landscaping becomes responsibility of homeowner
- Develop a planting plan for installers and homeowners
- Cost to Install: $57/LF
  - 800 LF of Bioretention
  - Installed by City Service Department
  - Project total $45,000

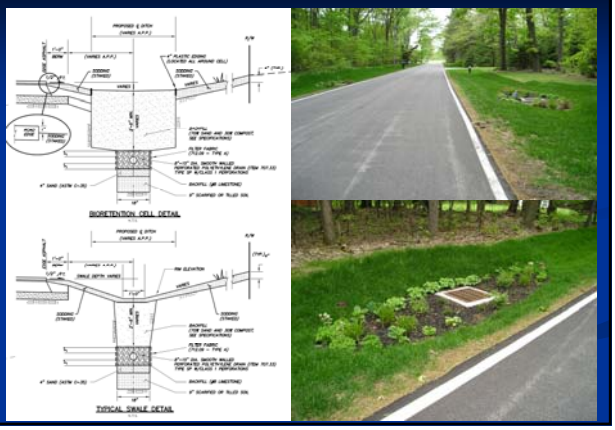
Orange Village – Sterncrest Retrofit

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.

Before Installation

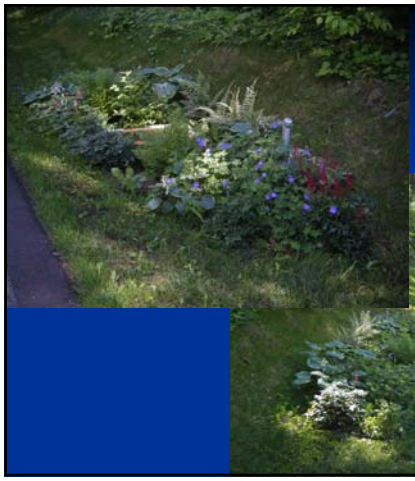
Sterncrest Bioretention



Sterncrest Bioretention

- Cost to Install: $115/LF
  - 1100 LF of Bio-Swale
  - 1100 LF storm sewer pipe
  - 9 Bioretention Areas
  - Sod installation for swales – immediate stabilization
  - Project total $126,000
- Can save on cost by having the service department install plants

Sterncrest: 15 months after construction



Sterncrest: 18 months after construction

Maintenance

- First 2-Years
  - Plant establishment
  - Soil stabilization in swale and around bioretention area - Recommend Using SOD
- Beyond 2nd Year
  - Monitor infiltration
  - Prevent open soil near cells/swales
  - Replace top 12" when infiltration lessons
  - Removed soil could be soil waste

Monitoring – Year in Review

Orange Village Project Monitoring

- What size rain events are causing overflow into the catch basin from the bioretention cells?
- What is the frequency and duration of overflow into the catch basin?
- What is the **quality** of runoff:
  - Before infiltration through the bioretention areas?
  - After infiltration through bioretention areas?
  - In the Catch Basin?

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 (inches)
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
10/03/08	1.12
10/27/08	0.99
11/15/08	1.37
12/24/08	1.29
02/11/09	0.92
03/09/09	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**
- **Total Phosphorus**
- E. coli
- Chloride
- Dissolved Metals
- Total Metals
- TSS
- Turbidity

First Year Results - Quality

April 3, 2008 - June 22, 2009

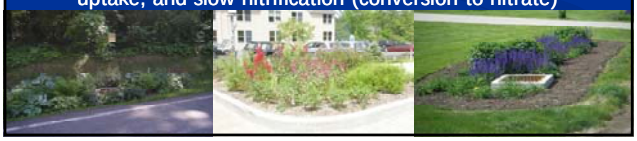
- Dissolved Inorganic Nitrogen (DIN), primarily nitrate (NO_3), nutrient and pollutant of concern in surface waters
- Bioretention cell is removing DIN from storm water moving through system in spring, summer, and fall
  - Lowest concentrations in summer and fall
  - Denitrification by soil microbes plus plant uptake
- DIN concentration in the winter similar in lysimeter and catch basin samples
  - Microbes and plants inactive leaving more 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

- Ammonia (NH_3) – 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)
  - 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

- 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

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.