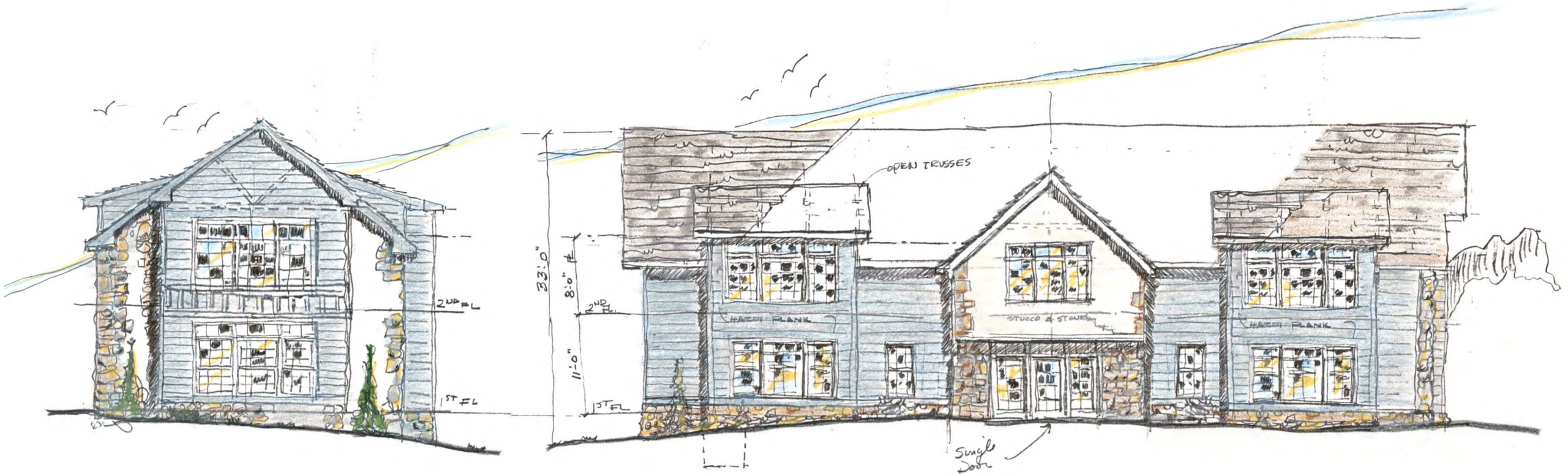
Cawrse & Associates, Inc.
Office Building Green Infrastructure

Permeable Pavement, Rain Garden, Bio-Swales and Bio-Retention



Craig Cawrse, FASLA

CT Consultants, Inc.

8150 Sterling Court, Mentor, OH 44060

440-951-9000

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The Sustainable Site

Project Goals

- Reduce stormwater runoff from new construction

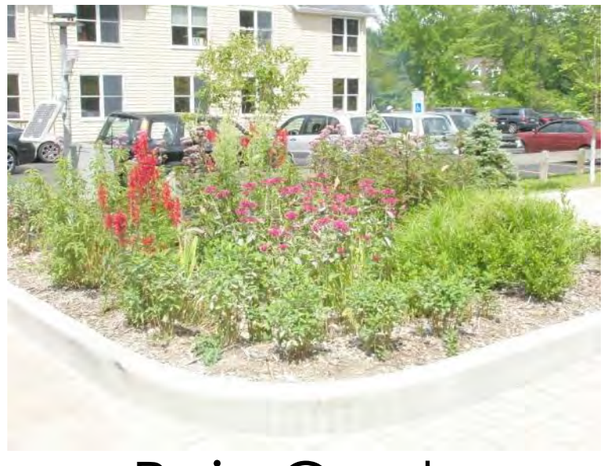
- Design an office site that would protect and embellish the property by utilizing a detailed stormwater management system, while conserving the surrounding vegetation and open space, assuring water quality, reducing runoff, and stream preservation.

- Relieving downstream problems, managing stormwater runoff, and Chagrin River Watershed Partners' goal of reducing hydrologic impact

- To accomplish this goal, the site was planned with an innovative stormwater management system, one that had not been constructed in the area before.

Sustainable Site Design Cawrse & Assoc. New Office Building

Bio-retention/Bio-swale



Rain Garden

Permeable Pavers

Permeable Pavers Subdrainage

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Permeable Pavement Construction

- Permeable pavement using concrete pavers
- 25 cars, 8,200 s.f.

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Permeable Pavement Construction

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Permeable Pavement Construction

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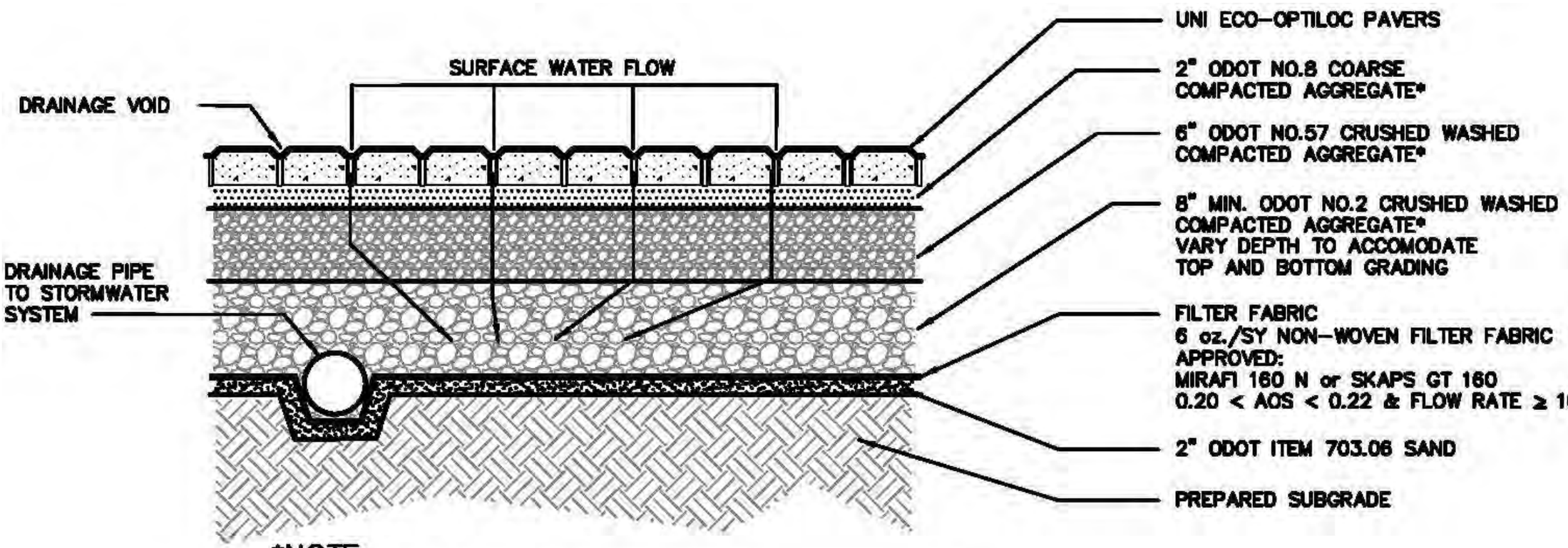
Permeable Pavement



*NOTE:
ALL AGGREGATE COMPACTED TO 70% RELATIVE DENSITY DETERMINED BY ASTM D 4252 AND ASTM D 4253.

ECO-OPTILOC PAVER SECTION

NOT TO SCALE

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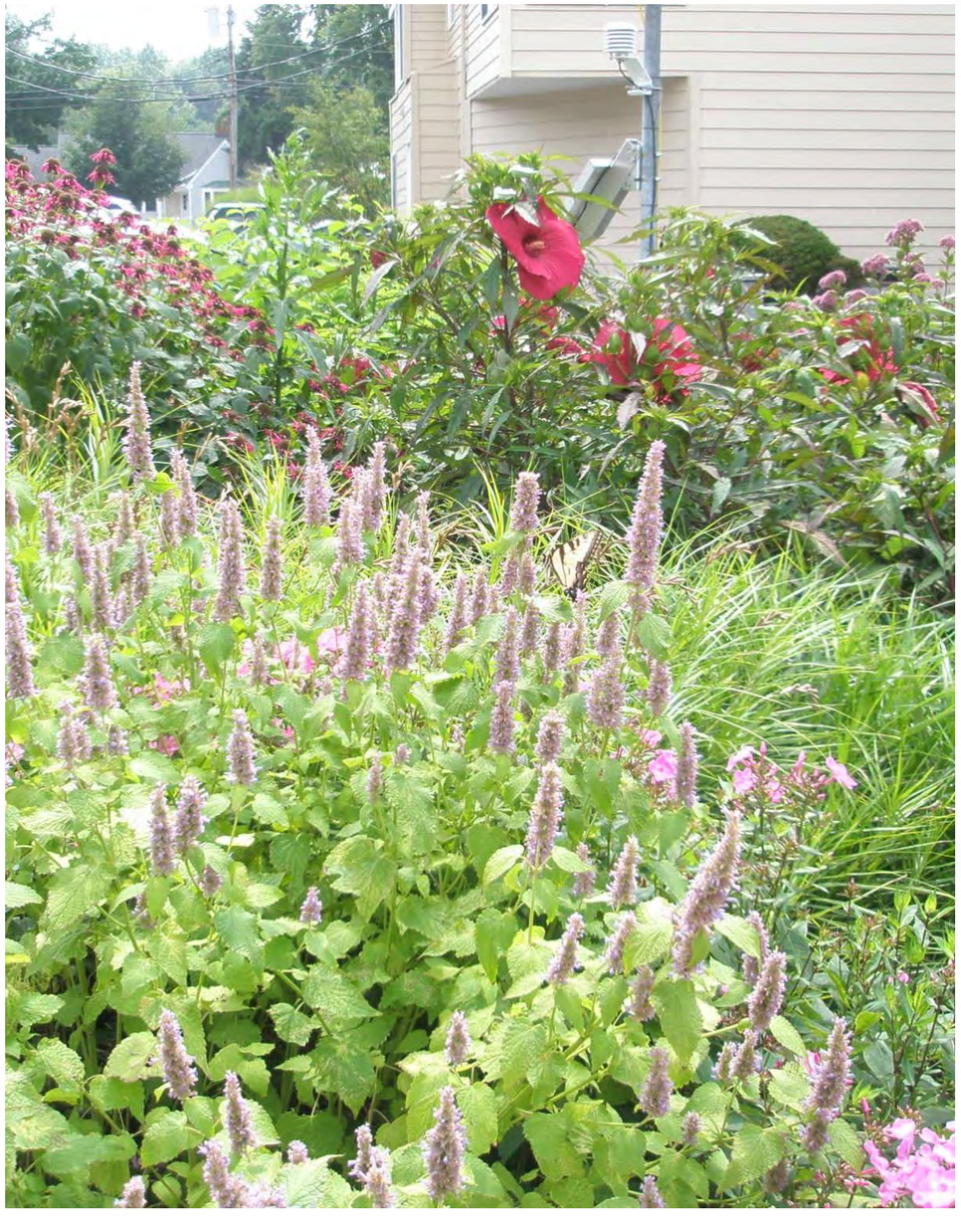
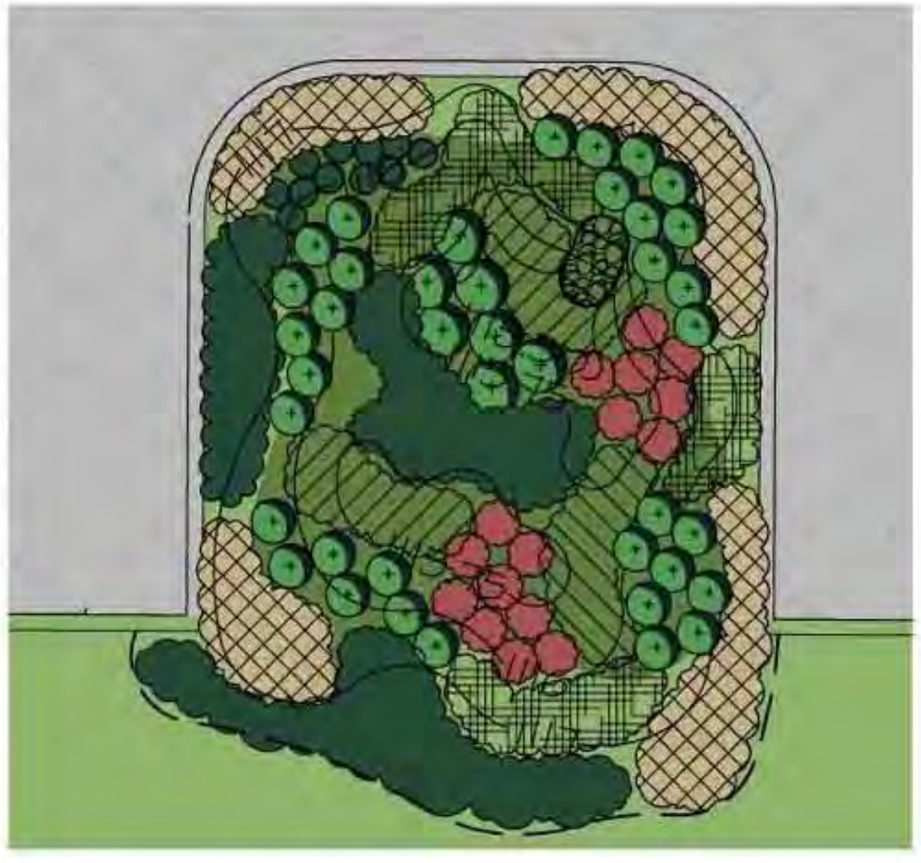
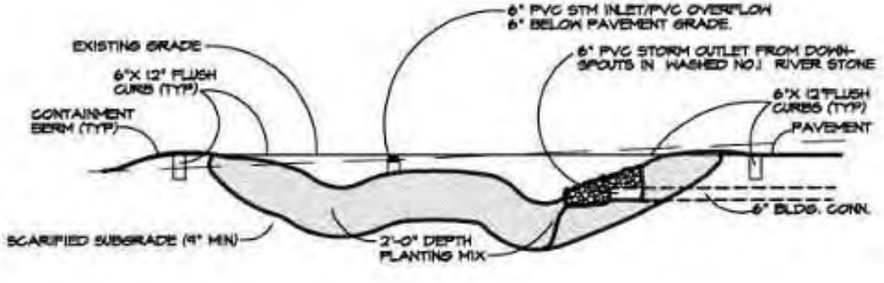
Rain Garden

<u>Rain Garden Plant List</u>

- New England Aster
- Palm Sedge Grass
- Silky Dogwood
- Joe Pye Weed
- Seven Son Flower
- Lord Baltimore Hibiscus
- Iris
- Little Henry Sweetspire
- Red Cardinal Flower
- Great Blue Lobelia
- Bee-Balm
- Northern Bayberry
- Garden Phlox
- Jacob's Ladder







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Rain Garden Construction

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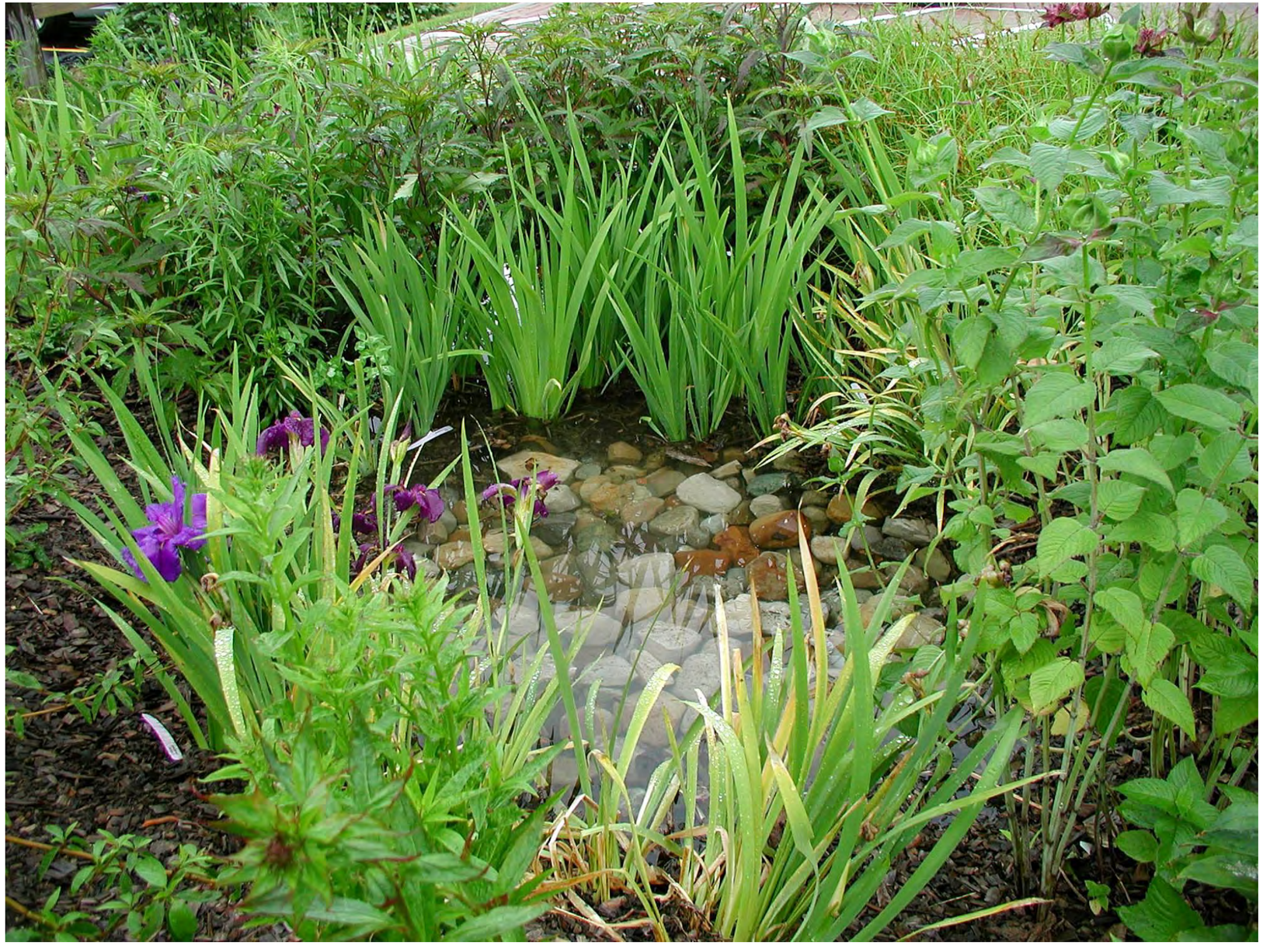
Rain Garden Construction



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Rain Garden

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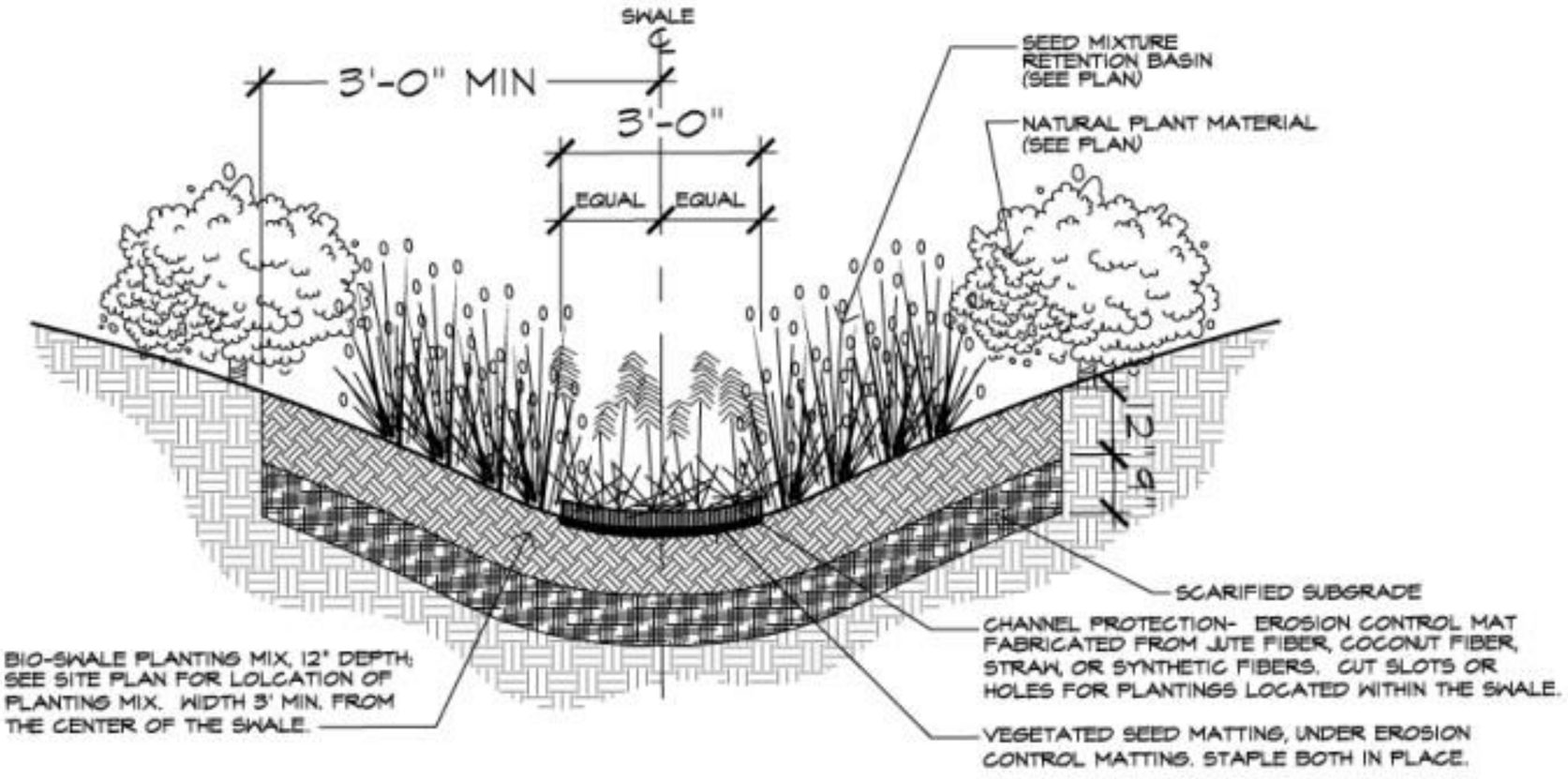
Bio-Swale Section



NOTE: INSTALL EROSION CONTROL MAT PER MANUFACTURER'S RECOMMENDATIONS

1 / SD-2 TYPICAL BIO SWALE SECTION

NOT TO SCALE

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Bio-Swale

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Bio-Swale

The Sustainable Site

Bio-Swale

Bio-swale Plant List

- Sweet Flag
- Alleghany Serviceberry
- Common Pawpaw
- River Birch Whips
- Palm Sedge Grass
- Summersweet
- Red Osier Dogwood
- Witchhazel
- Deciduous Holly
- Dwarf Sweetspire
- Spicebush
- Cutleaf Smooth Sumac
- Black-Eyed Susan
- Giant Pussy Willow
- Arrowwood Viburnum
- American Cranberrybush

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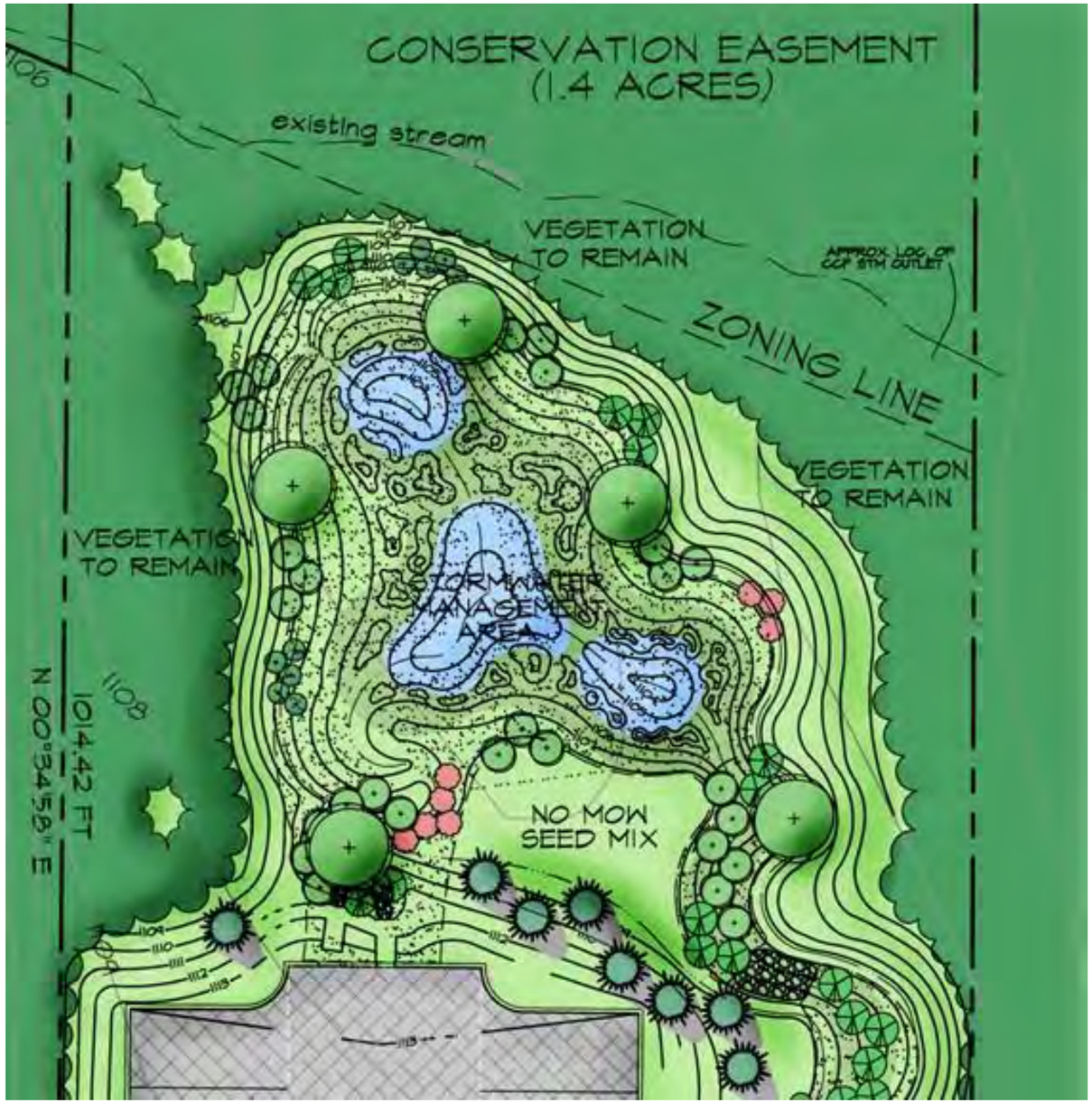
Bio-Detention



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Bio-Detention Construction

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Bio-Detention

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Bio-Detention

Bio-detention Plant List

- Common Milkweed (Moist)
- Butterfly Weed (Dry)
- New England Aster (Moist)
- Palm Sedge Grass (Moist)
- Rattlesnake Master (Moist/Dry)
- Ox Eye Sunflower (Up Slope)
- Cardinal Flower (Moist)
- Threadleaf Blue Star (Up Slope)
- Monkey Flower (Saturated)
- Wild Bergamot (Up Slope)
- Foxglove Beardtongue (Dry)
- Great Softstemmed Bullrush (Moist)

Monitoring Equipment

Automatic Samplers and Flow Gauge ●

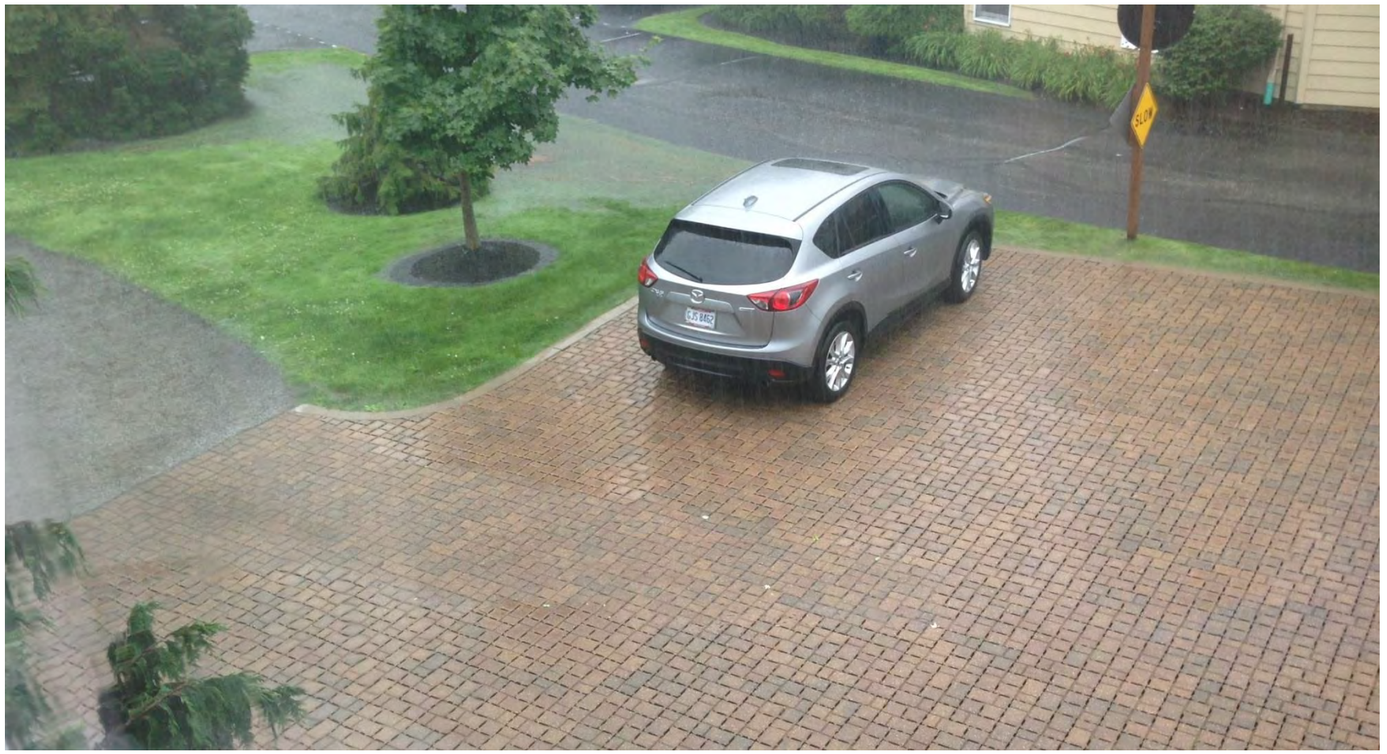
Rain Gauge ●

Monitoring Equipment

- Case study; monitoring and data collection
- U.S.G.S. report: Hydraulic Characteristics of Low-Impact Development Practices in Northeastern Ohio, 2008–2010
- By Robert A. Darner and Denise H. Dumouchelle

A Case Study – Data Summary

- 5 of 30 rain events less than 0.2 in.
  - 63% average reduction of runoff
  - 40 minutes delay from the beginning of rain event to discharge
- 25 of 30 events of total rain between 0.31 and 1.57 in.
  - 17% average reduction of runoff
  - 10 minutes delay from the beginning of rain event to discharge
  - Rain events lasting about 26 hours with discharge lasting about 52 hours
- Water Quality Data: No Pollutants of Concern from Pavement



A Case Study – Data Summary

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A Case Study – Data Summary

Permeable Pavement Findings

- Preferential Pathways forming within Aggregate Base Material

Rain Garden Findings

- Adding to Runoff Reduction Volumes, Evapotranspiration
- Maturing plantings and root structure penetration into Soils
- Underlying soils creating deeper infiltration

A Case Study – Data Summary

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Water Quality Data Summary

- Phosphorus levels below threshold of 0.08 mg/L for Headwater Streams Dissolved nitrate and nitrate levels below threshold of 1.0 mg/L for Headwater Streams

- Low levels of chloride detected during winter, especially during the spring, most events below 30 mg/L

- Chloride concentrations of 230 mg/L may impair aquatic life over time in freshwater ecosystems

- Dissolved Heavy Metal Data TBA

A Case Study – Conclusion

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Permeable Pavement System

- Pavement System ability to self-de-ice and commitment to managing de-icing applications reduces the presence of increased levels of chloride in stormwater runoff.

- Permeable Pavers allow for normal snow plowing equipment which includes metal snow plowing blades.


BOONE

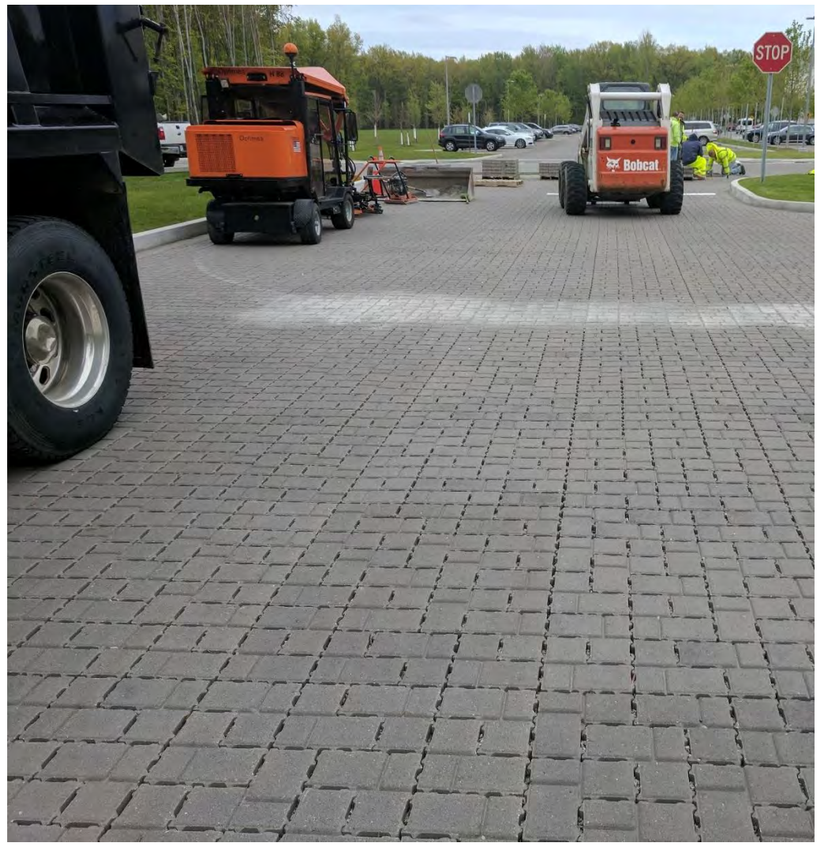
FAIRWOOD GLEN – PRIVATE RES. HOUSING

RICHFIELD VILLAGE – GREEN PARKING LOT

UH AHUJA - GREEN INFRASTRUCTURE PARKING LOT

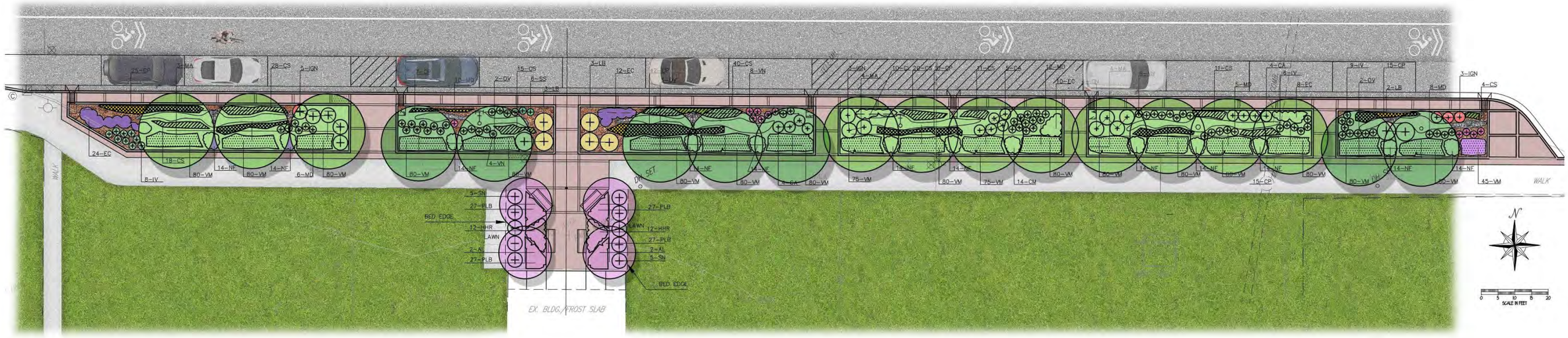
CCF CLE. MAIN CAMPUS - PERVIOUS PAVEMENT

CCF AVON – PERMEABLE PAVEMENT

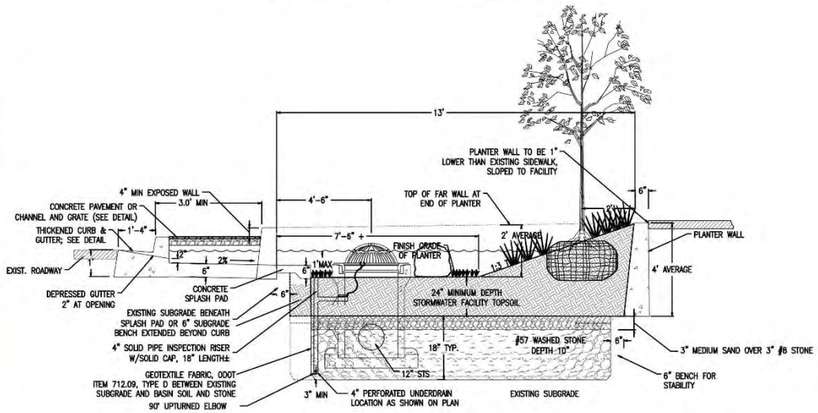


CCF AVON – PERMEABLE PAVEMENT

UH EUCLID – BIO-SWALE



GRATE & FRAME DETAIL



PLANTER ADJACENT TO STREET

MADISON AVE. GREEN INFRASTRUCTURE

CITY OF LAKEWOOD

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Village of Kirtland Hills
Baldwin Road Infiltration Swale

Chagrin River Watershed Partners, Inc.

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TRADITIONAL STORMWATER SYSTEMS...

Composed of pipes and roadside ditches

Designed to move stormwater as fast as possible

Send large amounts of untreated polluted stormwater and sediment into unprotected waterways

Harm stream health and lower water quality

Can be costly to maintain and upgrade

A MORE INNOVATIVE APPROACH: SLOW IT DOWN AND SOAK IT IN

The Village of Kirtland Hills, through an Ohio EPA Surface Water Improvement Fund Grant, installed 12,500 square feet of vegetated infiltration swales and check dams along Baldwin Road near Holden Arboretum.

The project will reduce stormwater volume and sediment in the Village's storm sewer system and improve water quality in the East Branch of the Chagrin River, and demonstrates how enclosed storm sewer systems converted to vegetated infiltration areas can improve temperature, habitat and nutrient targets for maintaining stream quality.

Infiltration swales and check dams improve stream health by slowing stormwater down, giving it time to soak into the ground and be cleaned before it reaches our streams.


nearmap

Questions

Craig Cawrse, FASLA
Director of Landscape Architecture
CT Consultants, Inc.
440.530.2361
ccawrse@ctconsultants.com

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