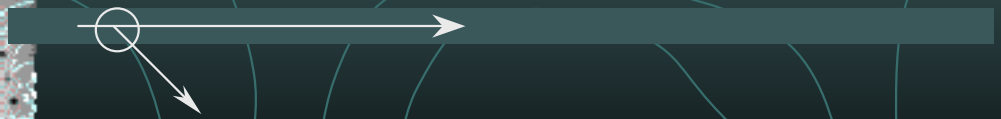
A Case Study

The Sustainable Landscape

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



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A Case Study

The Sustainable Landscape

- **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, reduced runoff, and stream preservation.
  - To accomplish this goal, the site was planned with an innovative stormwater management system, one that had not been constructed in the area before.
  - Because of this approach, the Chagrin River Watershed Partners, Inc. awarded the project a grant to help defray the cost of the proposed permeable pavers, rain garden, bio-swale and bio-retention basin.

A Case Study

Sustainable Site Design – New Office Building

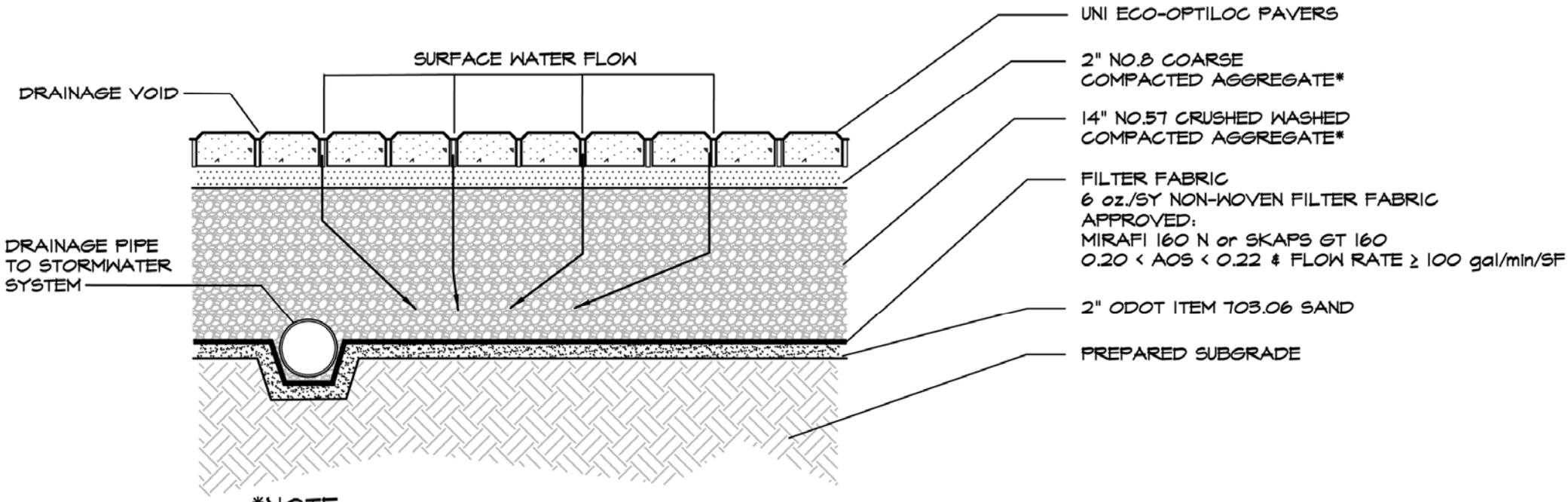
Bio-retention/Bio-swale

Rain Garden

Permeable Pavers

The Sustainable Landscape

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

Permeable Pavement Construction

Permeable Pavement Construction

Permeable Pavement Construction

Permeable Pavement Construction

Permeable Pavement Construction

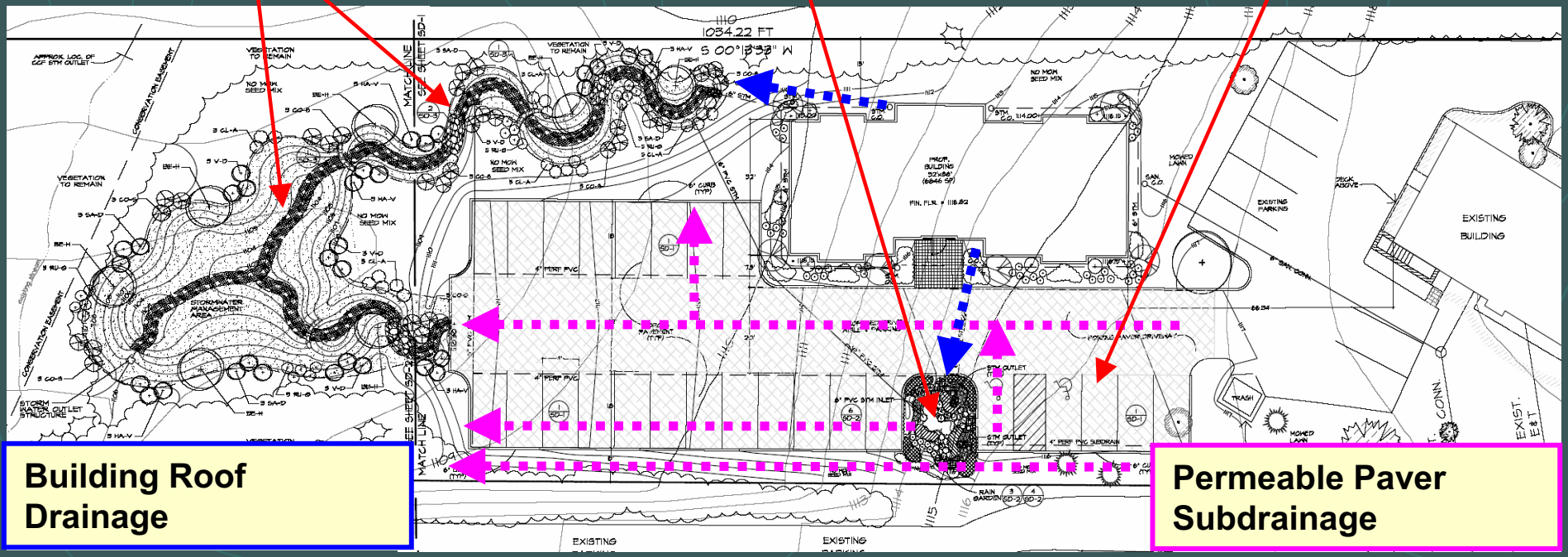
The Sustainable Landscape

- Roof Drainage and Subdrainage

Bio-retention/Bio-swale

Rain Garden

Permeable Pavers



Permeable Pavement Construction

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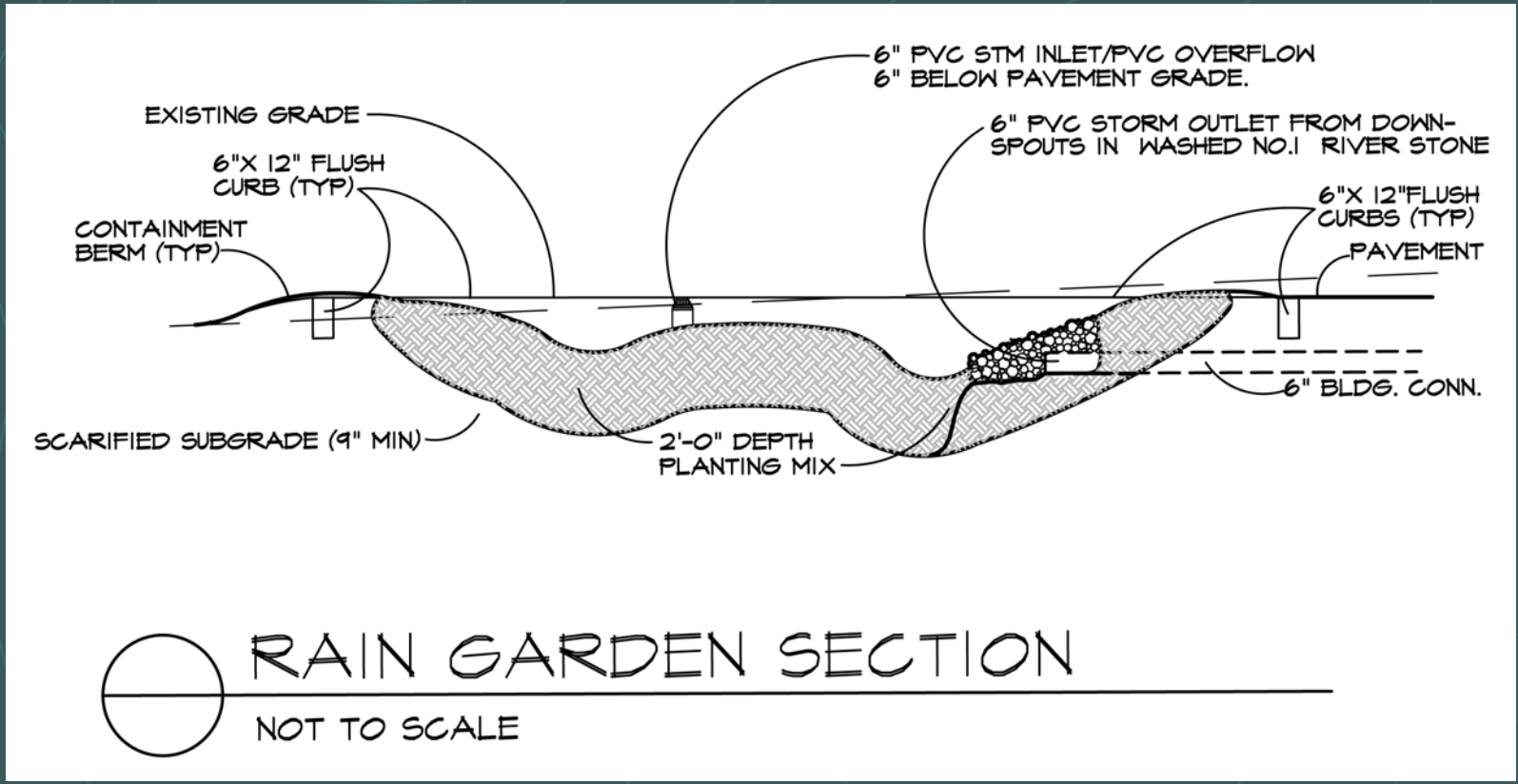
The Sustainable Landscape

- Rain Garden



Rain Garden Construction

Rain Garden Construction

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Rain Garden Construction


Rain Garden Construction

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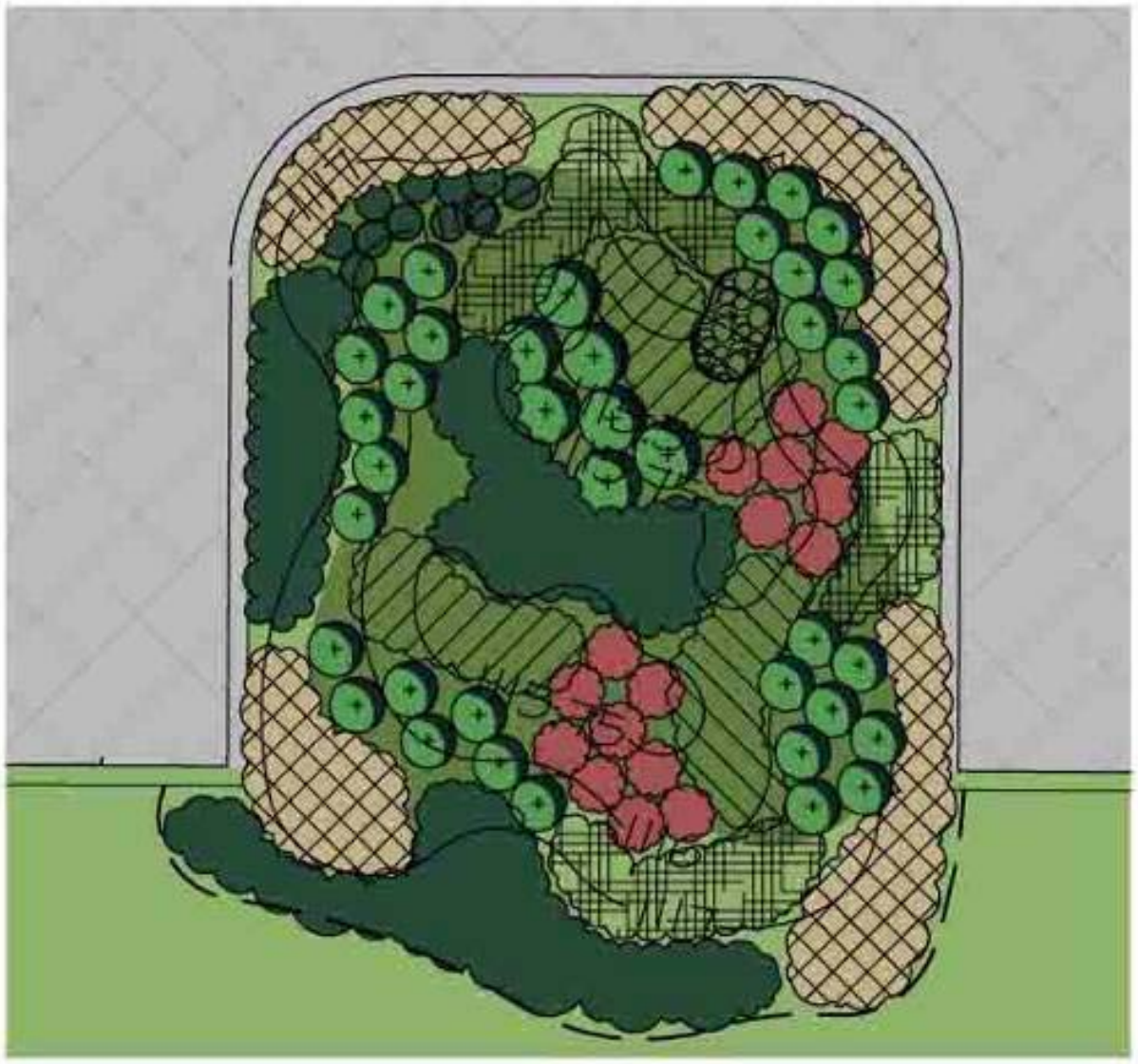
Rain Garden

Rain Garden Plant List

- 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



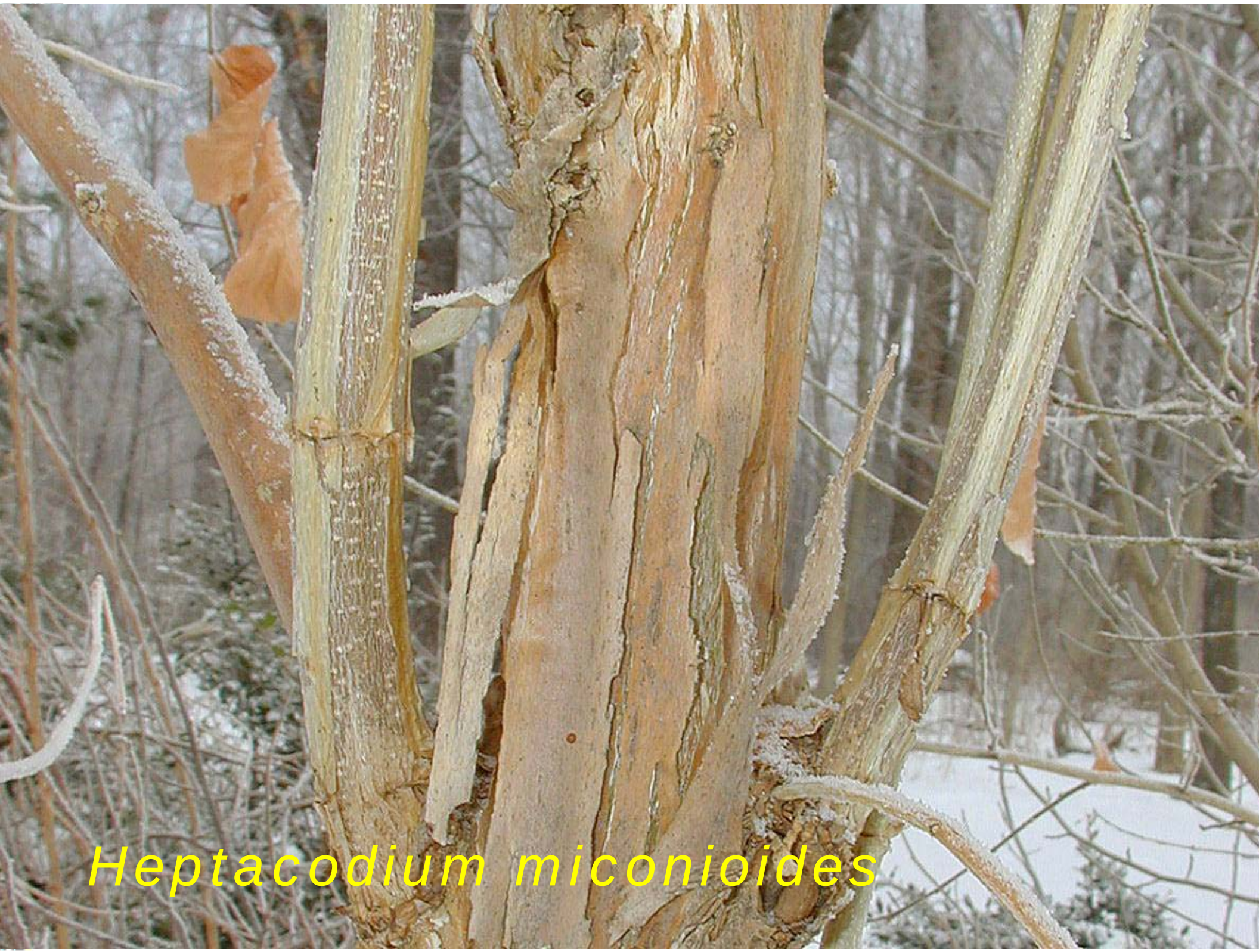

Rain Garden


Carex muskingumensis
Palm Sedge


Cornus amomum
Silky Dogwood


Eupatorium f. 'Gateway'
Joe Pye Weed


Heptacodium miconioides


Heptacodium miconioides


Hibiscus moscheutos


Rain Garden Construction

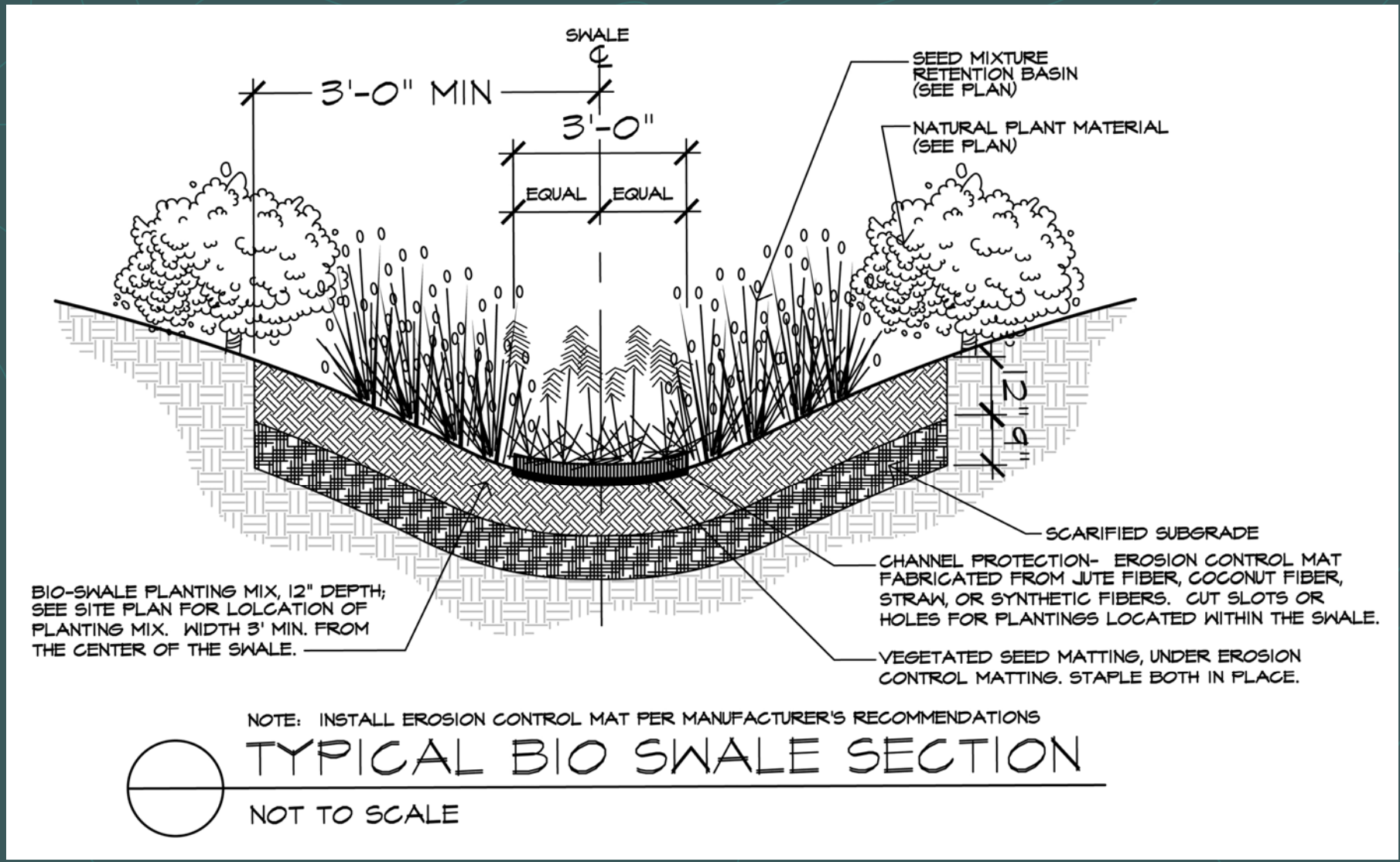
Rain Garden Construction

The Sustainable Landscape

- Bio-Swale

The Sustainable Landscape

- Bio-Swale



Bio-Swale Construction

Bio-Swale Construction

Bio-Swale Construction

Bio-Swale Construction

Bio-Swale Construction

Bio-Swale Construction

The Sustainable Landscape

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

Bio-Swale Construction

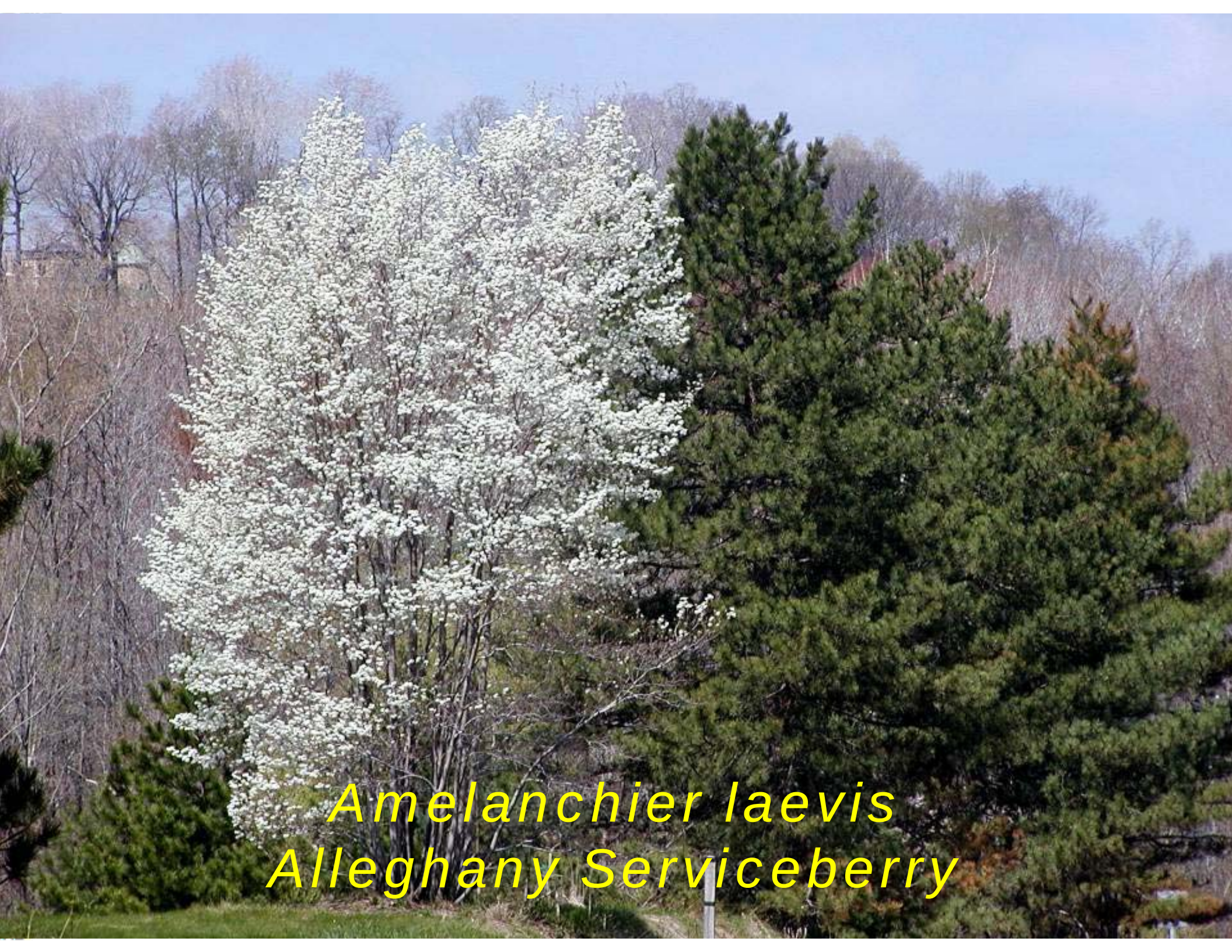
Bio-Swale Construction

Bio-Swale Construction

Bio-Swale Construction


Freedom Lawn I


Freedom Lawn I

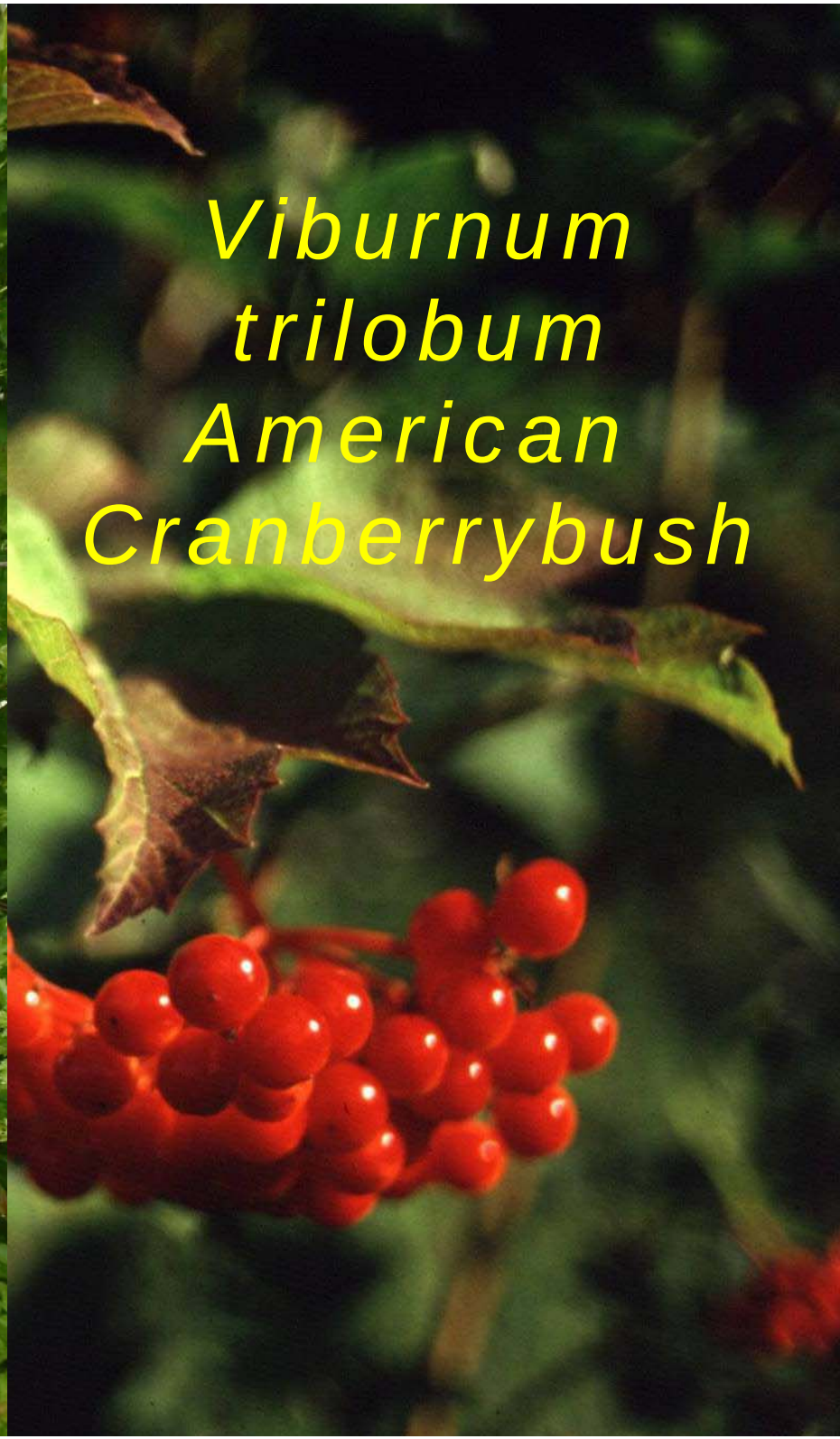

Amelanchier laevis
Alleghany Serviceberry

Betula nigra
River Birch


Cornus sericea
Redtwig Dogwood

Hamamelis virginiana
Common Witchhazel

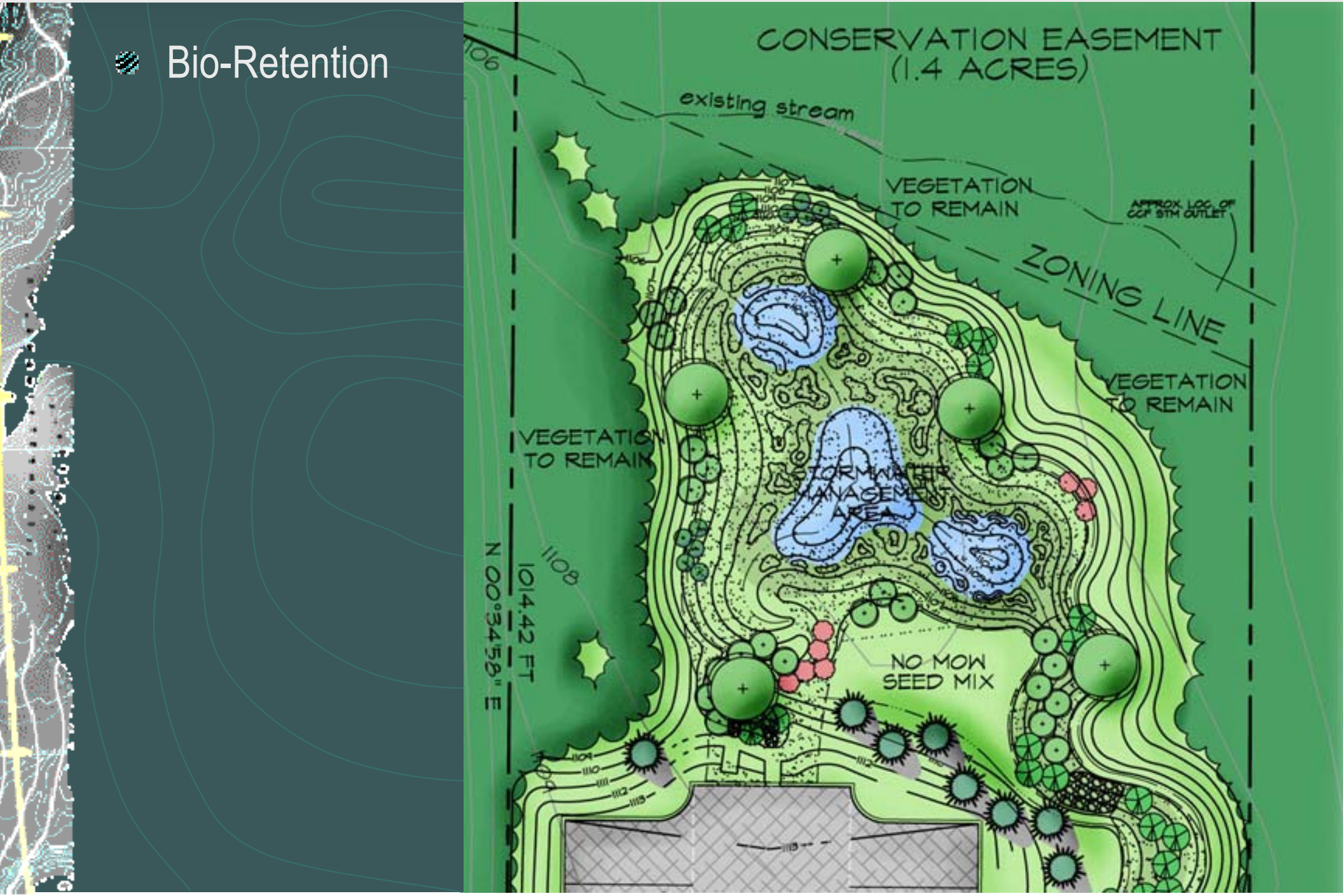
Lindera benzoin
Spicebush



Viburnum trilobum
American Cranberrybush

The Sustainable Landscape

- Bio-Retention



Bio-Retention Construction

Bio-Retention Construction

Bio-Retention Construction

- Bio-Retention Construction

Bio-Retention Construction

Bio-Retention Construction

Bio-Retention Construction

The Sustainable Landscape

Bio-Retention

Bio-detention Plant List

- Swamp 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)

Bio-Retention Construction


Bio-Retention Construction


Bio-Retention Construction

Bio-Retention Construction


Asclepia incarnata ‘Soulmate’
Swamp Milkweed


Carex muskingumensis
Palm Sedge


Heliopsis helianthoides
Ox Eye Sunflower


Amsonia hubrichtii
Threadleaf Blue Star

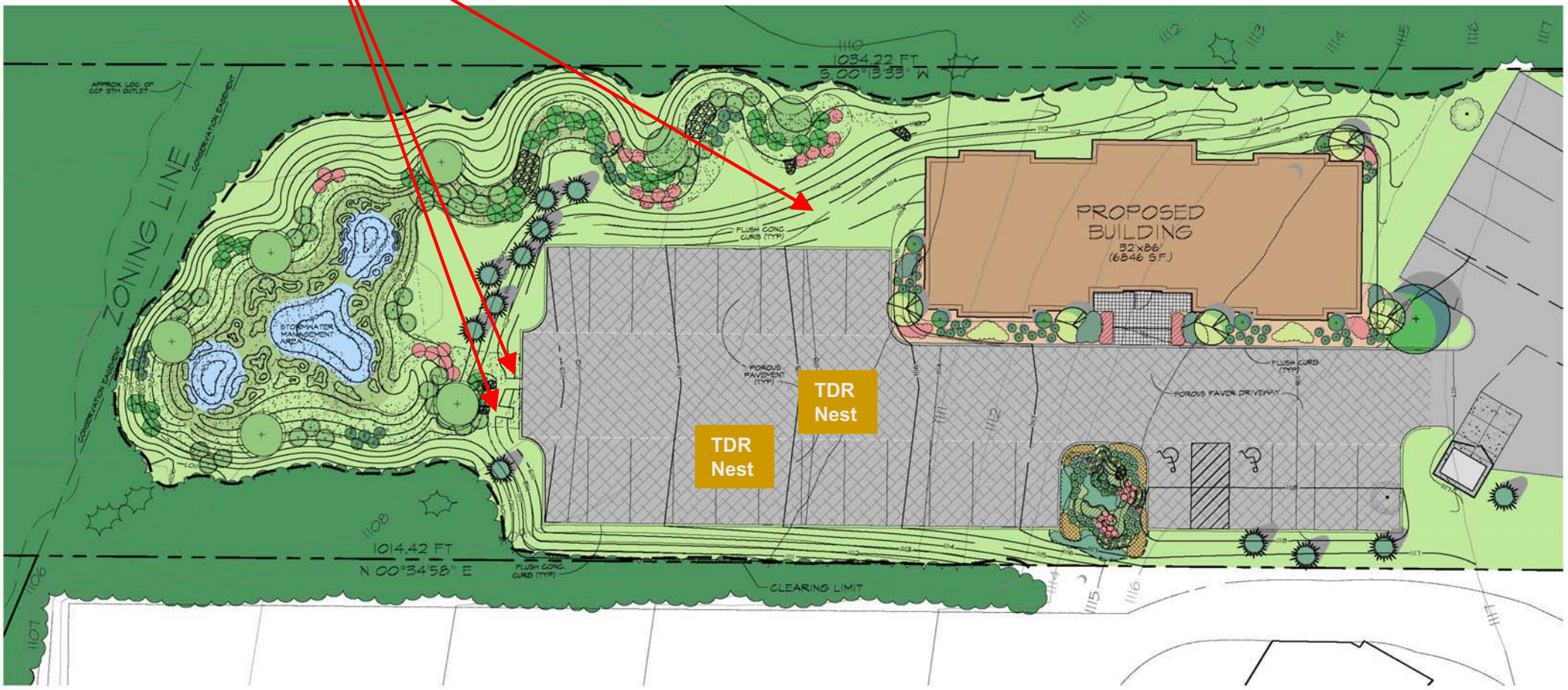

Amsonia hubrichtii
Threadleaf Blue Star


Monarda d.
'Marshall's Delight'


Scirpus validus
Softstem Rush

Monitoring Equipment

- Automatic Samplers and Flow Gage



Monitoring Equipment

- Case study; monitoring and data collection

Monitoring Equipment

- Case study; monitoring and data collection

A Case Study

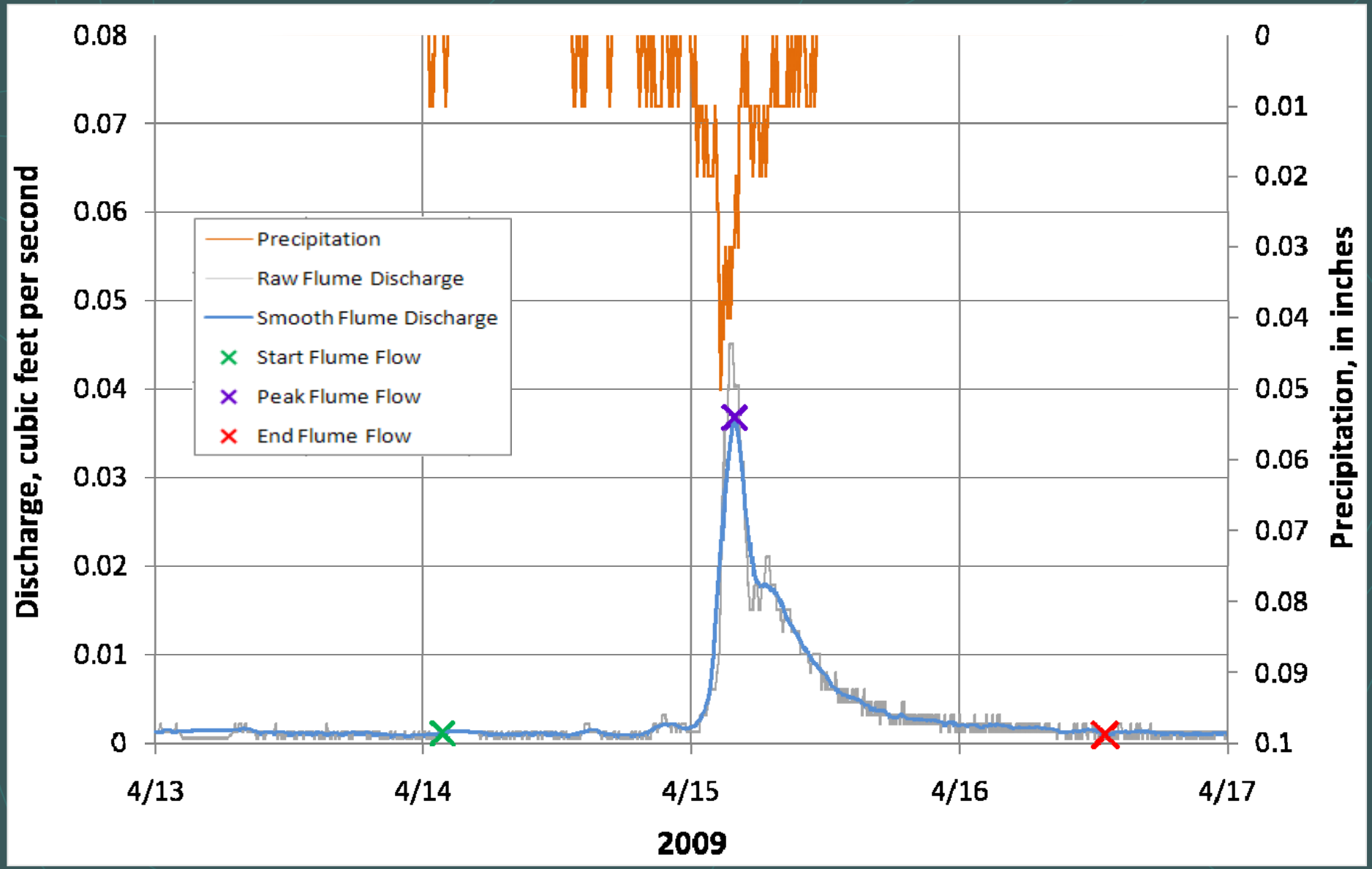
Data Summary
March 30 to November 5, 2009

- 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

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

A Case Study

Data Summary, April 14, 2009



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Permeable Pavement in Winter


Rain Garden in Winter

Bio-Swale in Winter

A Case Study

The Sustainable Landscape

- Wildlife Benefits

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The Sustainable Landscape

- Bird's Eye View