Sustainable Stormwater BMPs from the Municipal Perspective



Charles Eaton, PE, LEED-AP

Director, Municipal Services

SOIL AND WATER CONSERVATION SOCIETY

CME

Speaker

Charles Eaton, PE, LEED-AP

Director of Municipal Services, CME Associates, Inc.

- Professional Engineer licensed in CT, MA, NH, NY and RI
- 20+ years of experience in civil engineering and construction administration
- Bachelor's Degree in civil and environmental engineering
- Specializes in Stormwater Management
- Committee Member for 2013 Rhode Island Soil Erosion and Sediment Control Handbook update
- USDA/NRCS Technical Service Provider in CT, MA, and RI
- Extensive experience with design and improvement of Stormwater drainage and treatment
- Served as the Consulting Engineer and Town Engineer for municipalities throughout Southern New England

SOIL AND WATER CONSERVATION SOCIETY

CME

Goals for Sustainability

- Simple and consistent BMP design
- Efficient and cost effective maintenance of stormwater BMPs by DPWs
- Continued effectiveness of BMPs

SOIL AND WATER CONSERVATION SOCIETY

CME

Overview


Need for BMPs and how they affect public works departments


Development and construction of BMPs


Strategies to reduce maintenance costs


Costs associated with maintenance


Design ordinance


Retrofit of existing BMPs


Tips for successful construction


Interactive BMP Design

SOIL AND WATER CONSERVATION SOCIETY

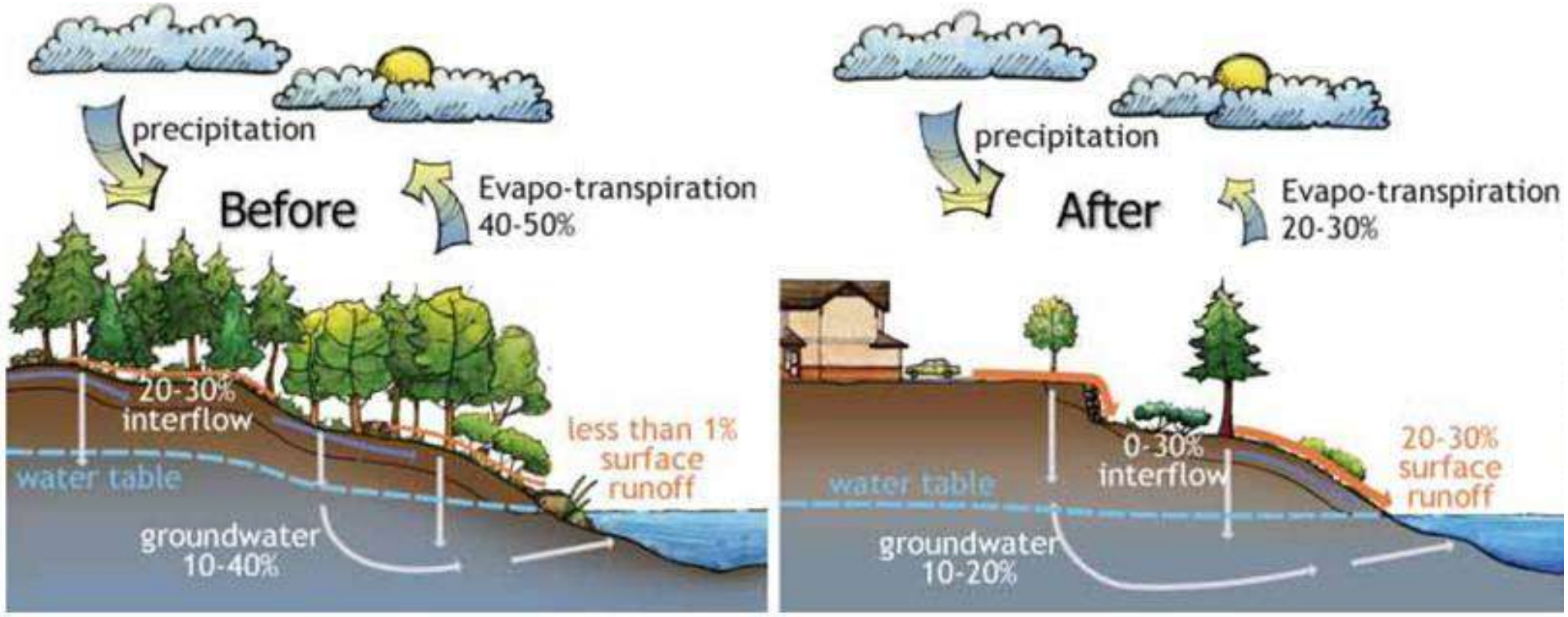
CME

Why We Need Stormwater BMPs

SOIL AND WATER CONSERVATION SOCIETY

CME

How Development ***Changes the Cycle***



Before

Most precipitation is absorbed by vegetation, evaporates, or infiltrates through the ground.

After

Vegetative absorption and ground infiltration is reduced; surface runoff is increased.

Image courtesy of Puget Sound

Why Do We ***Need*** Stormwater BMPs?

Prevent and Mitigate Stormwater Impacts

- Quality
- Quantity
- Recharge





SOIL AND WATER CONSERVATION SOCIETY

CME

Stormwater ***Quality***

Basin – Swale – Rain Garden

- Typically Treat 1” of Rainfall from Impervious Areas
- Water Quality Volume

SOIL AND WATER CONSERVATION SOCIETY

CME

Stormwater ***Quality***

Hydrodynamic Separator

- Typically Treat 1” of Rainfall from Impervious Areas
- Water Quality Flow
- Avoid Mixing of Additional Stormwater

SOIL AND WATER CONSERVATION SOCIETY

CME

Stormwater Quantity

Detention – Retention

- Typically Reduce Proposed Peak Flows to Existing Peak Flows
  (2 through 100 year storm events)

SOIL AND WATER CONSERVATION SOCIETY

CME

Stormwater Recharge

Function of Proposed Impervious Area

Hydrologic Soil Group	Groundwater Recharge Depth(CT)	Groundwater Recharge Depth(MA&RI)
A	0.4 inches	0.6 inches
B	0.25 inches	0.35 inches
C	0.10 inches	0.25 inches
D	0 inches	0.1 inches

SOIL AND WATER CONSERVATION SOCIETY

CME

Typical Types of BMPs

SOIL AND WATER CONSERVATION SOCIETY

CME

Typical *Types of BMPs*

Wide Variety:

- Catch Basins
- Hydrodynamic Separators
- Forebays
- Basins
- Rain Gardens
- Swales
- Infiltration Systems
- Filters
- Permeable Pavements

SOIL AND WATER CONSERVATION SOCIETY

CME

Why They Become Ineffective

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs *Stop Working*?

Lack of Maintenance – Some causes are:

Access

- Physical
- Legal

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs *Stop Working*?

Design

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs *Stop Working*?

Cost

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs *Stop Working*?

Site Constraints

- Requires specialized tools / training
- Overly time consuming

Result: deferred maintenance

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs *Stop Working*?

Construction Practices

SOIL AND WATER CONSERVATION SOCIETY

CME

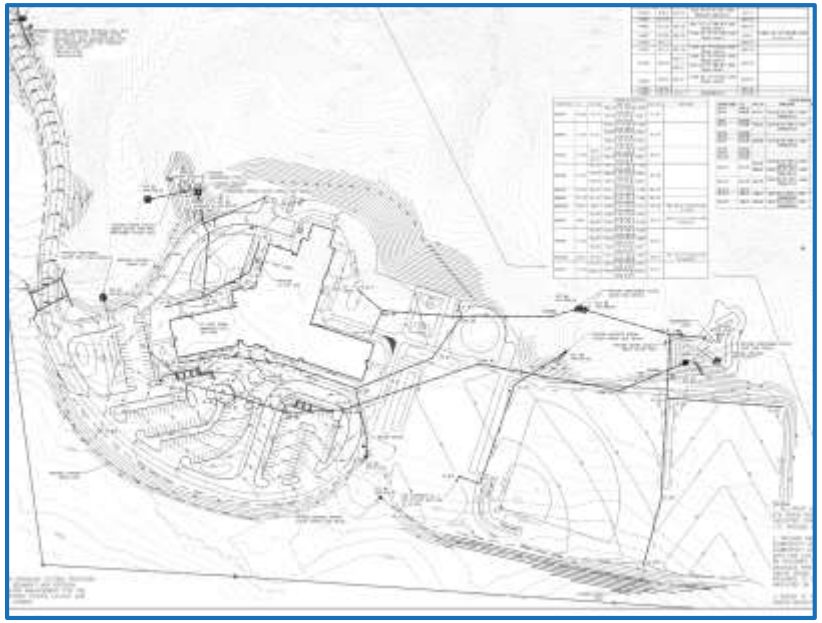
Case Study I

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study I

Sedimentation and Erosion Control



SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study I

Sedimentation and Erosion Control

Construction – Summer 2005

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study I

Sedimentation and Erosion Control

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study I

Sedimentation and Erosion Control

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study I

Sedimentation and Erosion Control

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study I

Sedimentation and Erosion Control

Fall 2013

SOIL AND WATER CONSERVATION SOCIETY

CME

Case Study II

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study II

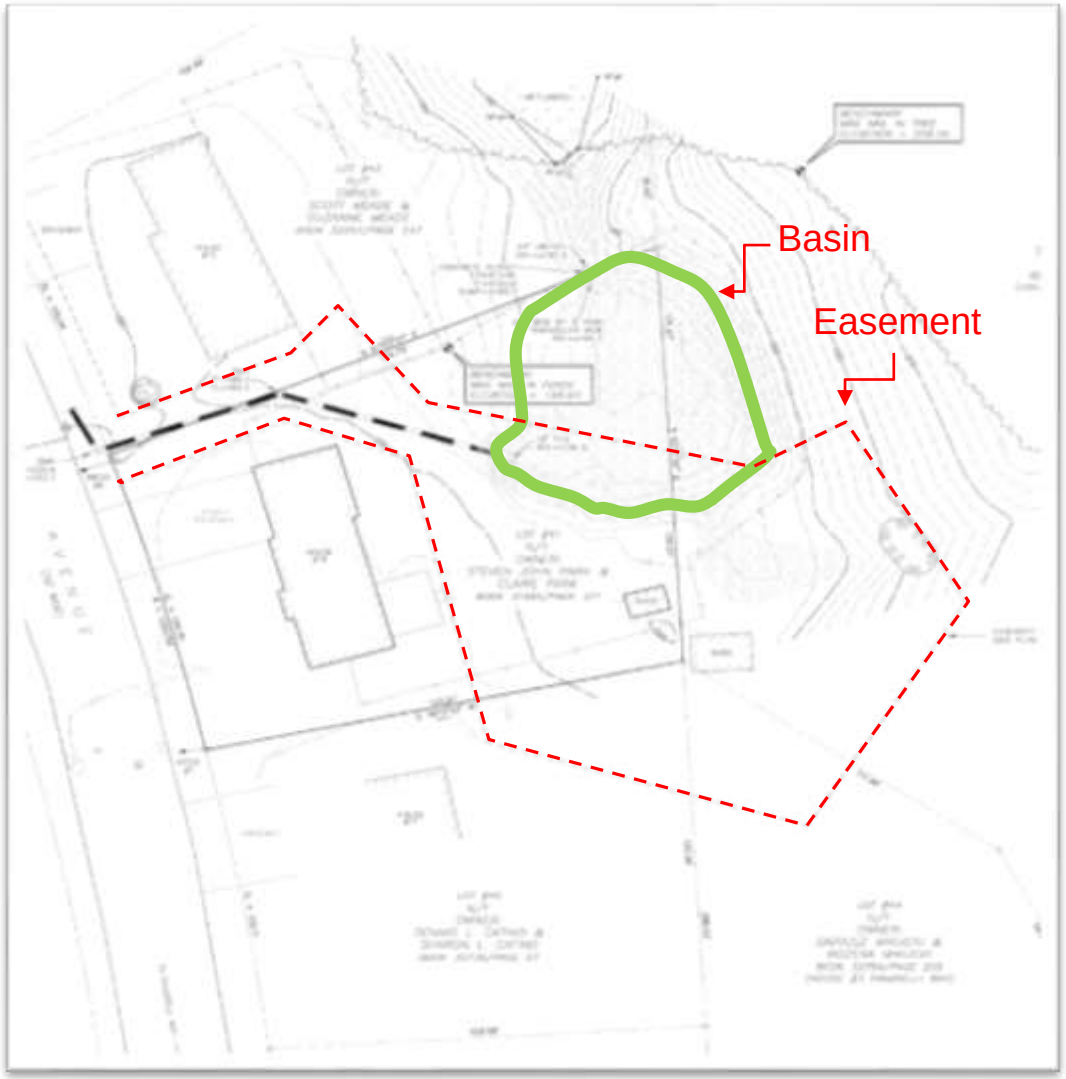
Construction & Access

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study II

Construction & Access



Why Do BMPs Stop Working: Case Study II

Construction & Access

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study II

Construction & Access

Initial Review

Retrofit Complete

SOIL AND WATER CONSERVATION SOCIETY

CME

Case Study III

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study III

No Maintenance

Constructed – Approximately 1996

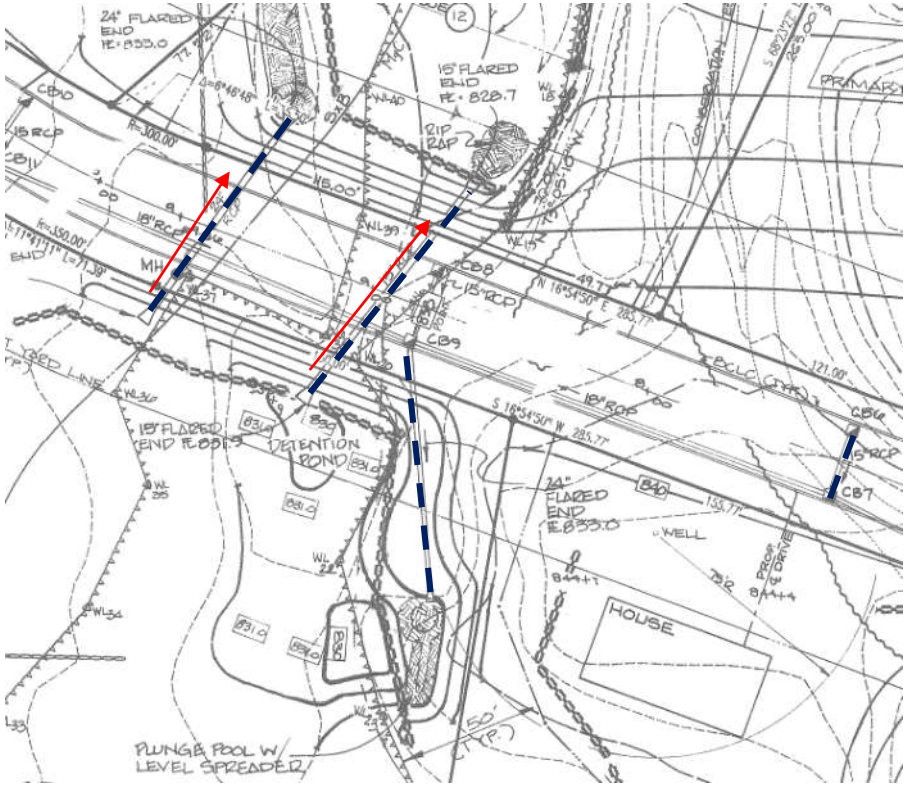
SOIL AND WATER CONSERVATION SOCIETY

CME

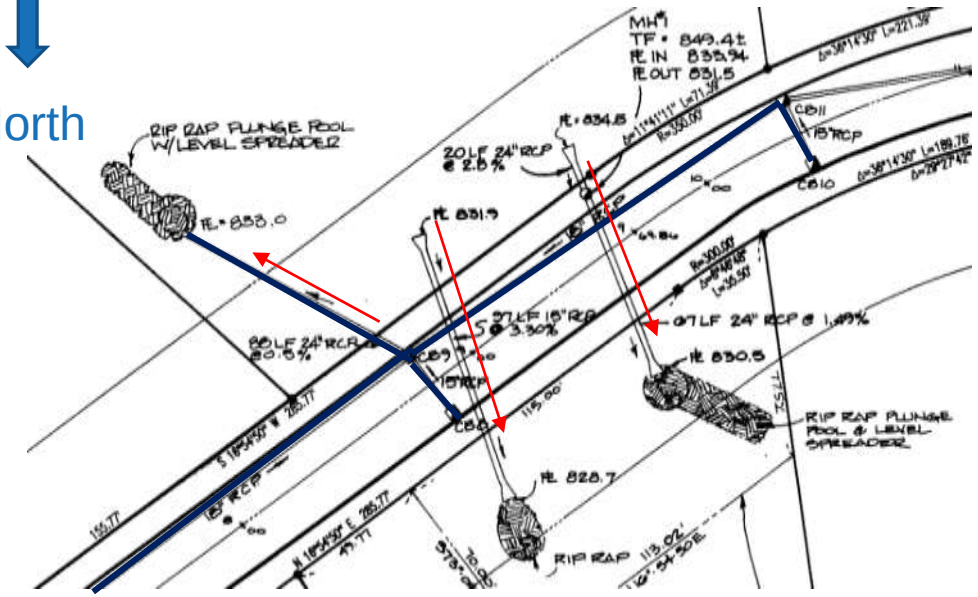
Why Do BMPs Stop Working: Case Study III

No Maintenance

North



North



Why Do BMPs Stop Working: Case Study III

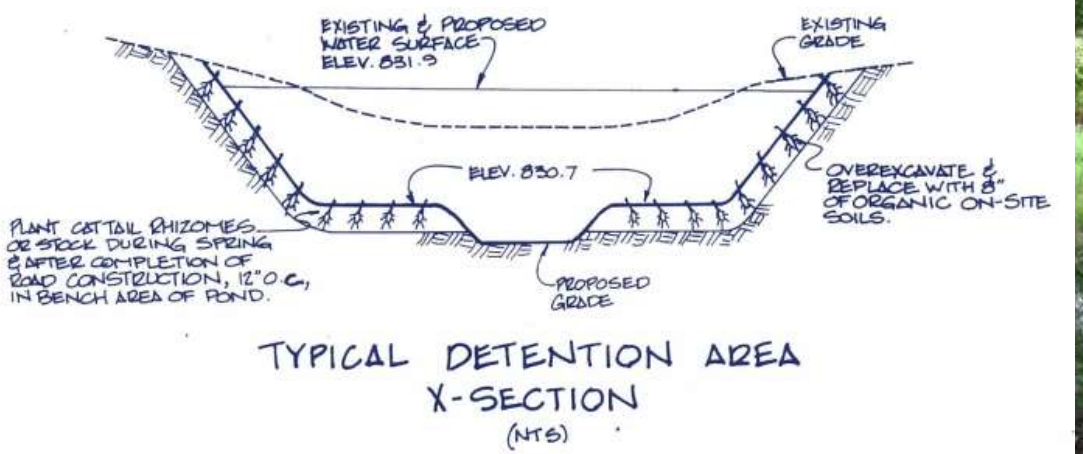
No Maintenance

SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study III

No Maintenance



SOIL AND WATER CONSERVATION SOCIETY

CME

Why Do BMPs Stop Working: Case Study III

No Maintenance: Downstream results

SOIL AND WATER CONSERVATION SOCIETY

CME

Development and Construction of BMPs

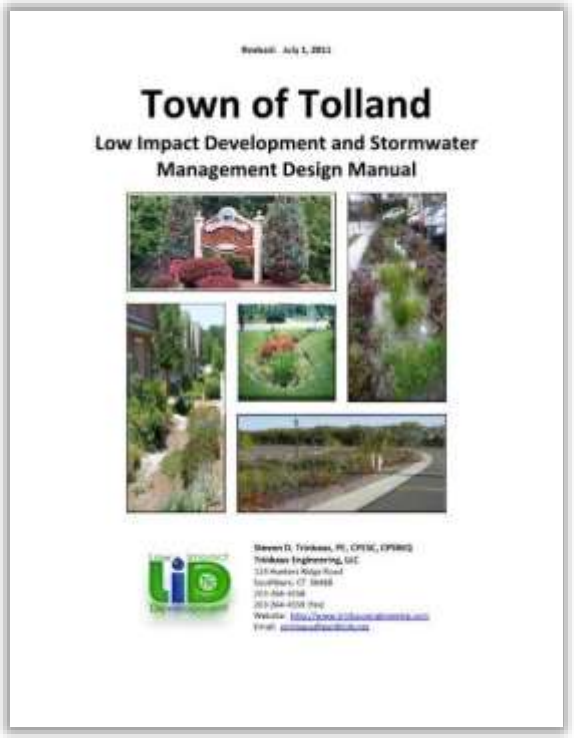
SOIL AND WATER CONSERVATION SOCIETY

CME

How BMPs are *Developed & Constructed*

Design

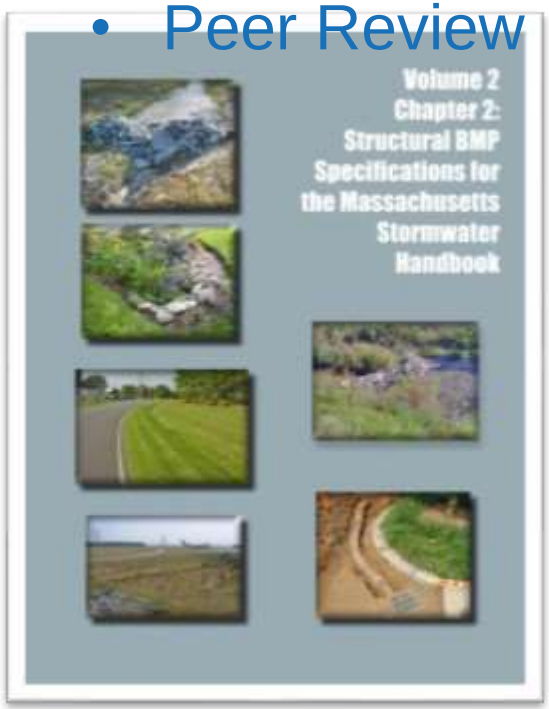
- Minimum standards and performance criteria for stormwater provided by local or state regulations

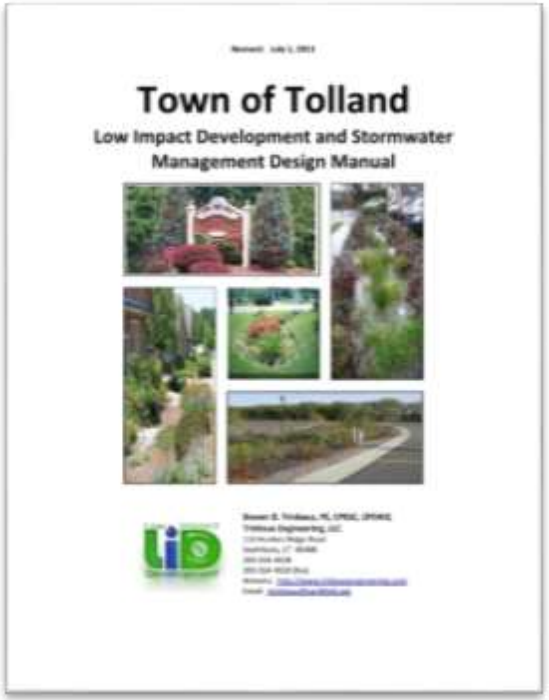


How BMPs are *Developed & Constructed*

Local Review and Approval

- Town / City Engineer Review
- Peer Review
- Local Board / Commission Review
- *Public Works?*





SOIL AND WATER CONSERVATION SOCIETY

CME

How BMPs are *Developed & Constructed*

Consider Owners Ability to Maintain the BMP

- Equipment
- Manpower
- Knowledge & Skill

Specify the Correct BMP for the Ability of the DPW

How BMPs are *Developed & Constructed*

Majority of Construction done by Developer/Contractor

DPW may have little to no control over construction

- Proper E&S Control and Plan
- Inspection Parameters
- DO NOT USE DURING CONSTRUCTION

SOIL AND WATER CONSERVATION SOCIETY

CME

Required Maintenance

SOIL AND WATER CONSERVATION SOCIETY

CME

Required Maintenance

Typical Maintenance Requirements

- Sediment Removal
- Light Oils
- Mowing
- Erosion Repair
- Compaction

SOIL AND WATER CONSERVATION SOCIETY

CME

Suggestions for Typical Practices

SOIL AND WATER CONSERVATION SOCIETY

CME

Design Strategies to *Reduce Maintenance Costs*

Forebays

First Means of Collecting Sediment

- Limit Riprap
- Provide Easy Access
- Concrete Bottom
- Size for Sediment Load

SOIL AND WATER CONSERVATION SOCIETY

CME

Design Strategies to *Reduce Maintenance Costs*

Swales & Basins

- Limit Riprap
- Provide Access to Bottom of Basin and to Outlet
- Proper Side Slope
- Proper Bottom Width
- Proper Berm Width
- Design of Sand / Loam Mix
- Design of Underdrain
- Removal of Invasive Plants
- Aesthetics

SOIL AND WATER CONSERVATION SOCIETY

CME

Design Strategies to *Reduce Maintenance Costs*

Hydrodynamic Separators

- Depth
- Access Covers
- Confined Space Issues
- Internal Mechanics may block ability to maintain or may break
- Alternate means of maintenance if equipment is unavailable




Design Strategies to Reduce Maintenance Costs

Rain Gardens

- Plantings
- Mulch
- Aesthetics - Free Maintenance?

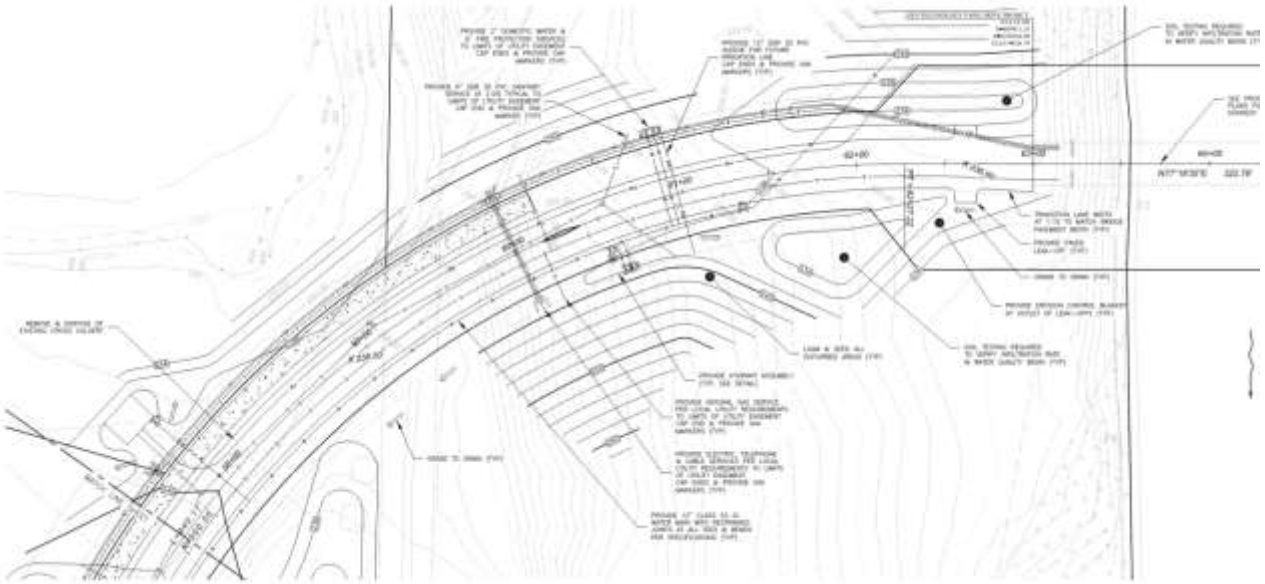
SOIL AND WATER CONSERVATION SOCIETY

CME

Design Strategies to *Reduce Maintenance Costs*

Separation of Public and Private Watersheds

- Employ LID



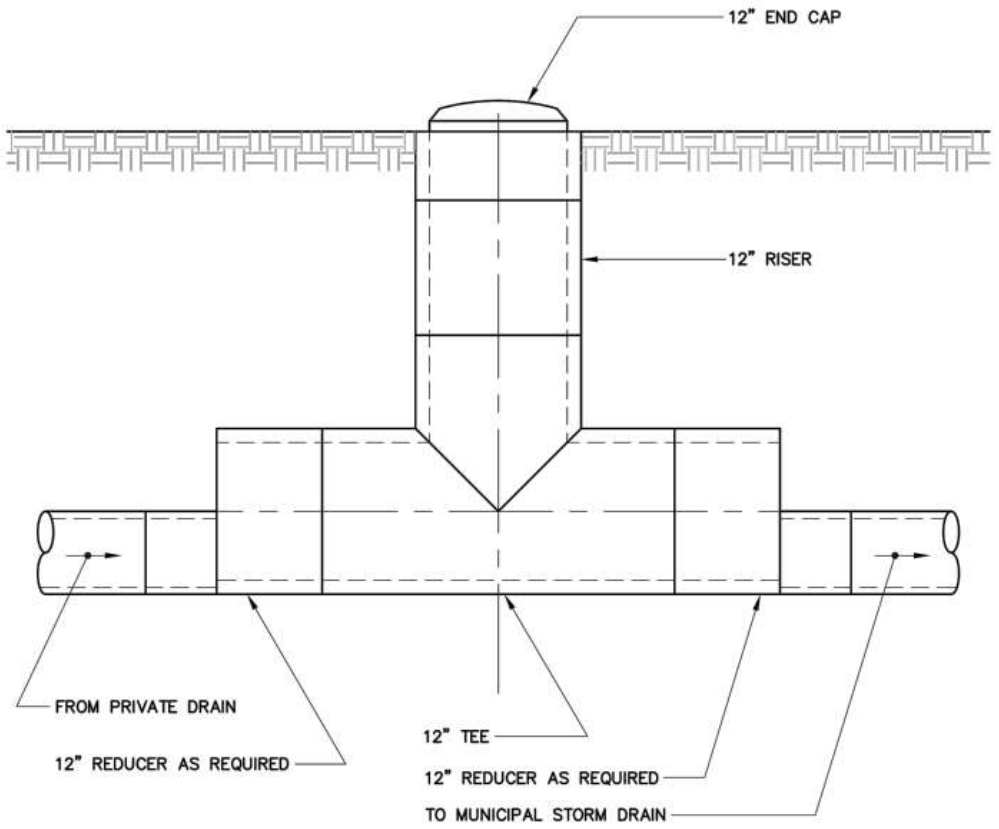
SOIL AND WATER CONSERVATION SOCIETY

CME

Design Strategies to *Reduce Maintenance Costs*

Sampling Structure prior to Connection with Public System

- MS4



SOIL AND WATER CONSERVATION SOCIETY

CME

Costs Associated with Maintenance

SOIL AND WATER CONSERVATION SOCIETY

CME

Costs Associated with Maintenance

	Designed with no input from DPW (maintained once in 10 years)	Designed with DPW in mind (maintained yearly)
Repair Lawn	4 hours	N/A
Construct Access into Basin	2 hour	N/A
Remove Trees & Brush	8 hours	N/A
Mowing	2 hours	30 minutes
Remove Sediment	4 hours	15 minutes
Loam, Seed, E & S	4 hours	N/A




Costs Associated with Maintenance

	Designed with no input from DPW	Designed with DPW in mind
Typical Cost Savings over 10 years	2 employees for 24 hours	2 employees for 45 minutes each year
(manhours only)	48 manhours	15 manhours

70% Reduction in Man Power

SOIL AND WATER CONSERVATION SOCIETY

CME

Design Ordinance

SOIL AND WATER CONSERVATION SOCIETY

CME

Public Works **Design Ordinance**

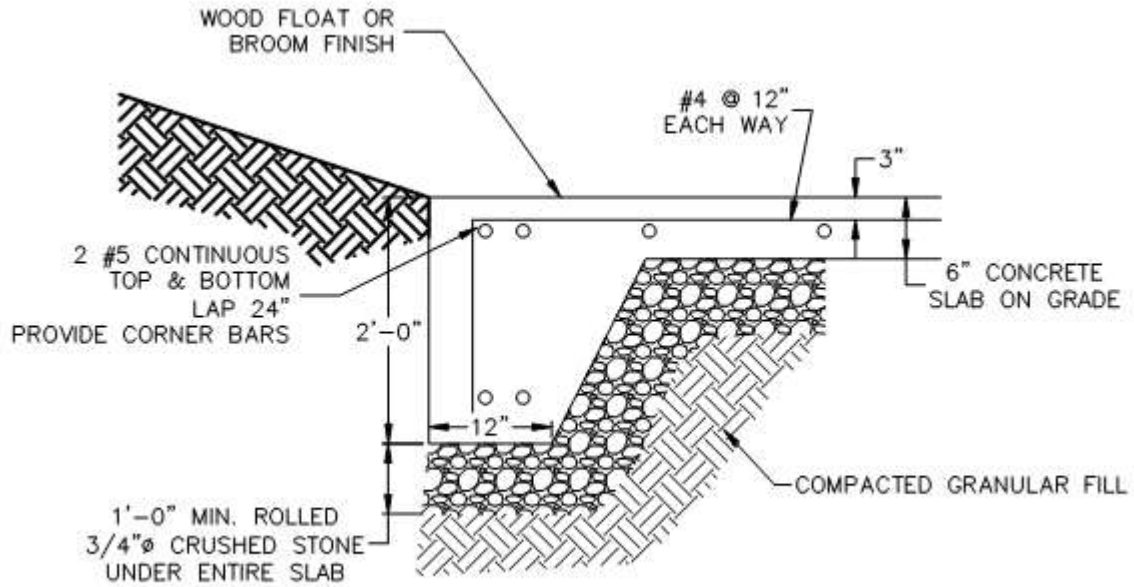
- Overall Design Theory
  - LID/Stormwater Layout, Public vs Private Systems
- Structural Conveyance
  - Catch Basins, Manholes, Pipe, etc.
- Pretreatment (10 to 25% WQV) for Swales / Basins
  - Forebays, Hydrodynamic Separators, Grass Swales, etc.
- Primary Treatment Practices
  - Swales, Basins, etc.
- Maintenance Access
  - Min. 12’ wide, Max. 15% slope
- Special Provisions
  - Infiltration, Erosion Controls, Inspection, Connections, Maintenance, Reporting, Digital Mapping, As-Built/Closeout
- Details

SOIL AND WATER CONSERVATION SOCIETY

CME

Public Works **Design Ordinance**

Concrete Forebay Bottom Detail

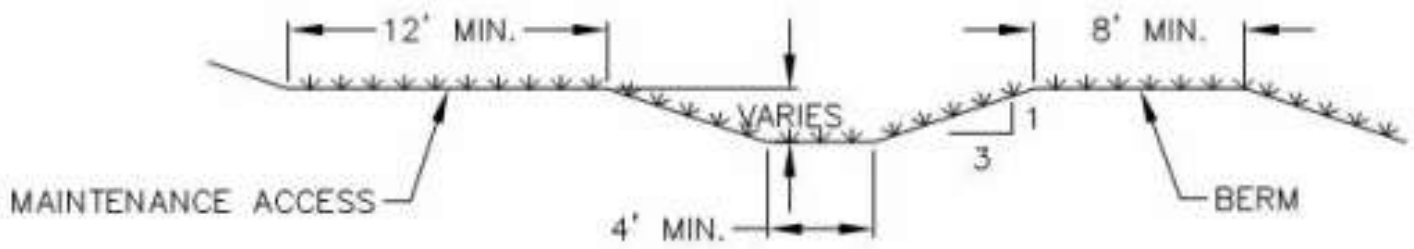


SOIL AND WATER CONSERVATION SOCIETY

CME

Public Works **Design Ordinance**

Typical Basin Cross Section Detail



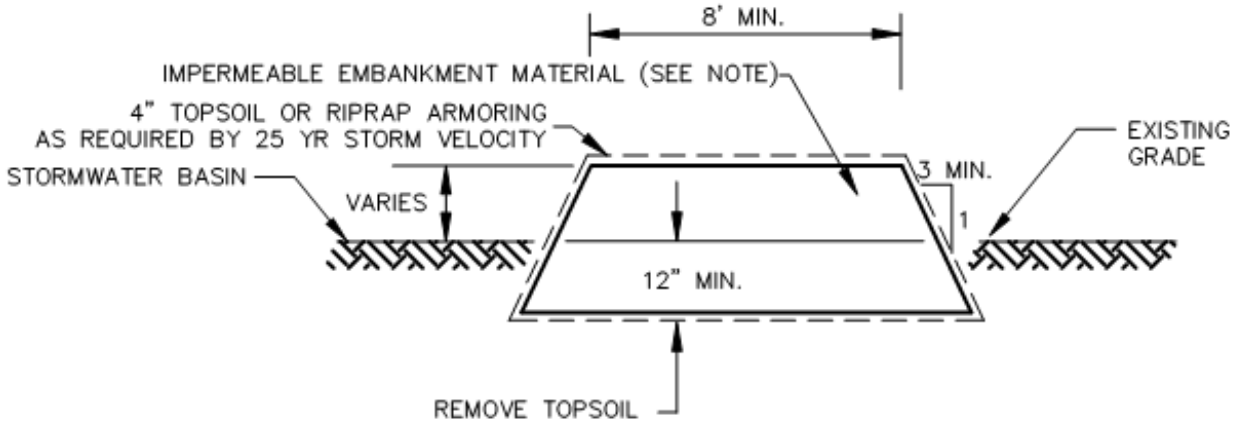
TYPICAL BASIN CROSS SECTION

SOIL AND WATER CONSERVATION SOCIETY

CME

Public Works **Design Ordinance**

Basin Berm Detail



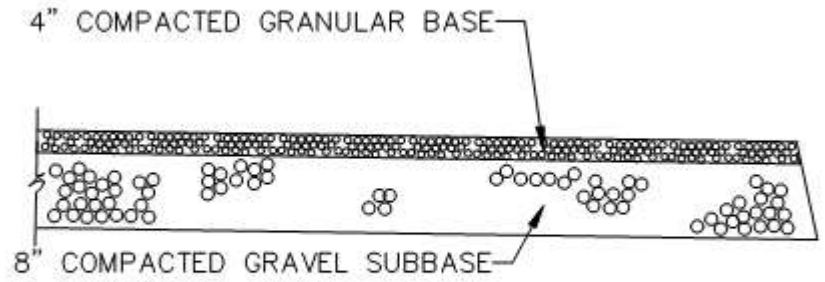
NOTE:
IMPERMEABLE EMBANKMENT MATERIAL SHALL CONTAIN AT LEAST 15% PASSING THE No. 200 SIEVE AND NOT MORE THAN 50% PASSING THE No. 200 SIEVE. NO STONES LARGER THAN 6 INCHES SHALL BE ALLOWED WITHIN THE COMPACTED EMBANKMENT. WITHIN TWO FEET OF ANY STRUCTURE, THE MAXIMUM SIZE SHALL BE 3 INCHES. CONSTRUCTION SHALL NOT TAKE PLACE DURING COLD PERIODS WHERE TEMPERATURES ARE CONSISTENTLY LOWER THAN 40 DEGREES FAHRENHEIT. EMBANKMENT MATERIAL TO BE COMPACTED IN 6" MAXIMUM LIFTS TO 95% MAXIMUM DRY DENSITY.

SOIL AND WATER CONSERVATION SOCIETY

CME

Public Works **Design Ordinance**

Gravel Access Way Detail



NOTES:

1. MAINTENANCE ACCESS WAYS SHALL BE A MINIMUM OF 12' WIDE & SHALL HAVE A MAXIMUM SLOPE OF 15% AND A MAXIMUM CROSS SLOPE OF 4%.
2. ACCESS WAYS SHALL BE PROVIDED TO ALL MAJOR SYSTEM COMPONENTS.

SOIL AND WATER CONSERVATION SOCIETY

CME

Retrofitting Existing BMPs

SOIL AND WATER CONSERVATION SOCIETY

CME

Retrofit of Existing Practices

- **Ensure no downstream harm**
  - Flooding & Erosion
- **Preserve WQV**
- **Ensure easy & cost effective maintenance**

SOIL AND WATER CONSERVATION SOCIETY

CME

Retrofit of Existing Practices: Case Study I

Town Hall Swale

SOIL AND WATER CONSERVATION SOCIETY

CME

Retrofit of Existing Practices: Case Study I

Town Hall Swale

Retrofit of Existing Practices: Case Study I

Town Hall Swale

SOIL AND WATER CONSERVATION SOCIETY

CME

Tips for Successful Construction

SOIL AND WATER CONSERVATION SOCIETY

CME

Tips for Successful BMP Installation

- Implement Design Ordinance
- Proper Design, Coordination and Review
- Proper Construction
  - Install BMP after up gradient watershed is stabilized
  - Ensure proper E & S
  - Inspections
  - Maintenance by Contractor Prior to Acceptance of Ownership
  - Training
  - Preparation and Filing of As Built Plan

SOIL AND WATER CONSERVATION SOCIETY

CME

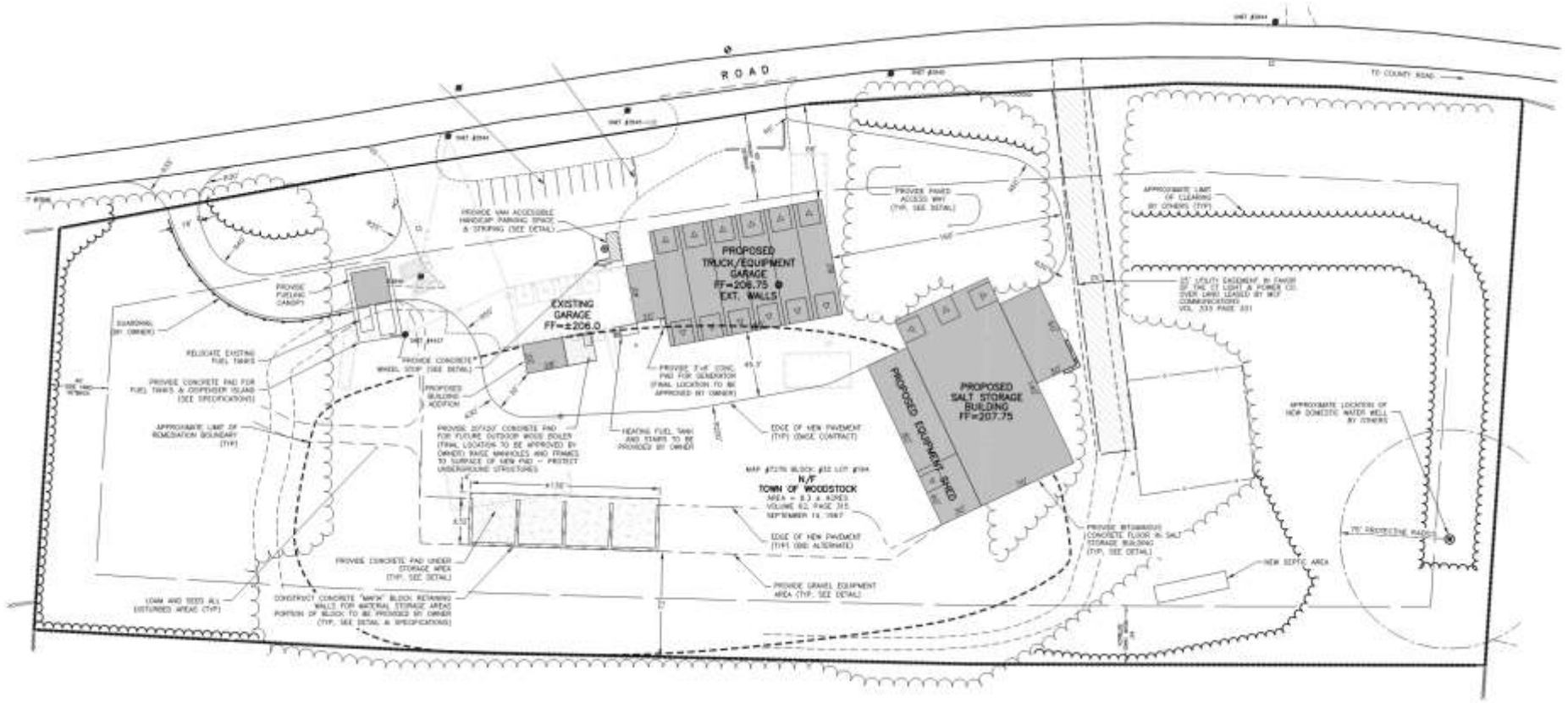
Interactive BMP Design

SOIL AND WATER CONSERVATION SOCIETY

CME

Interactive BMP Design: Case Study I

Public Works Facility

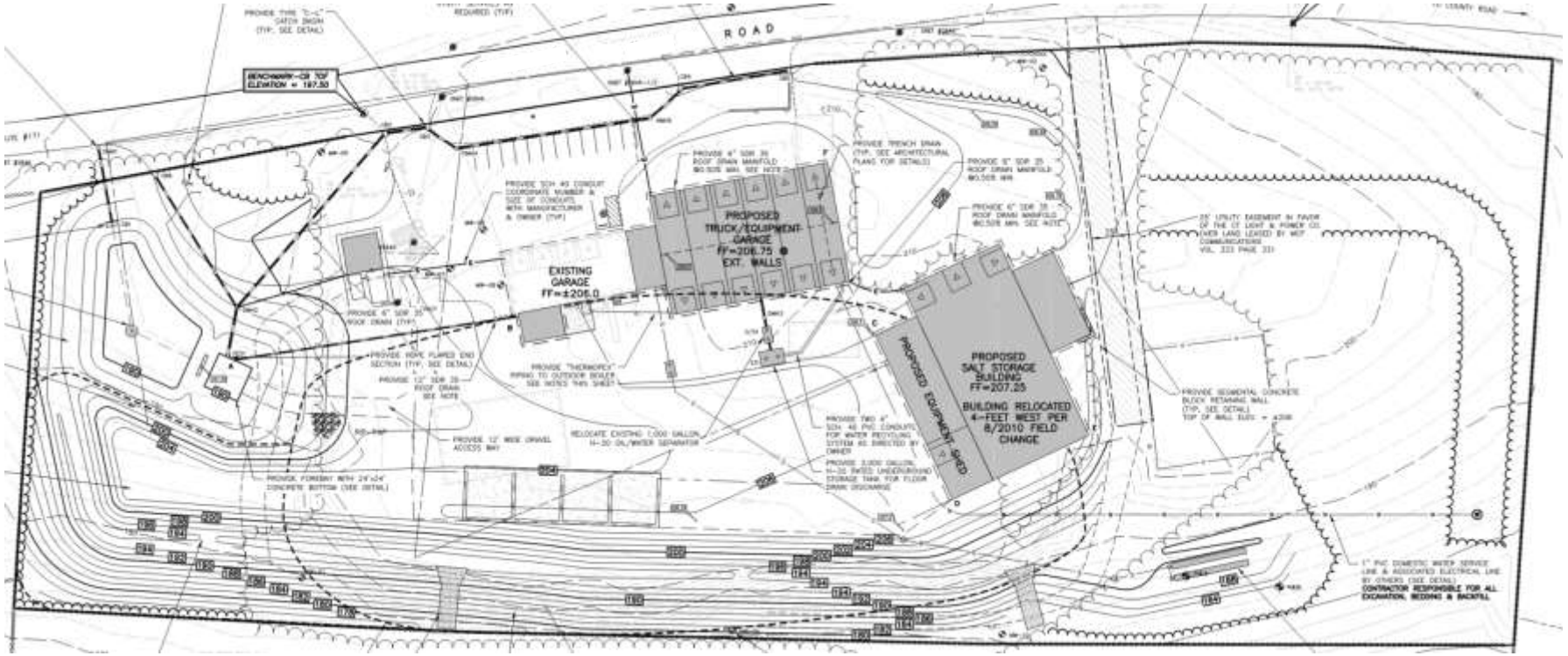


SOIL AND WATER CONSERVATION SOCIETY

CME

Interactive BMP Design: Case Study I

Public Works Facility



SOIL AND WATER CONSERVATION SOCIETY

CME

Interactive BMP Design: Case Study I

Public Works Facility

Improper Install and E&S over Winter




Interactive BMP Design: Case Study I

Public Works Facility

Restoration of Basin




Interactive BMP Design: Case Study I

Public Works Facility

SOIL AND WATER CONSERVATION SOCIETY

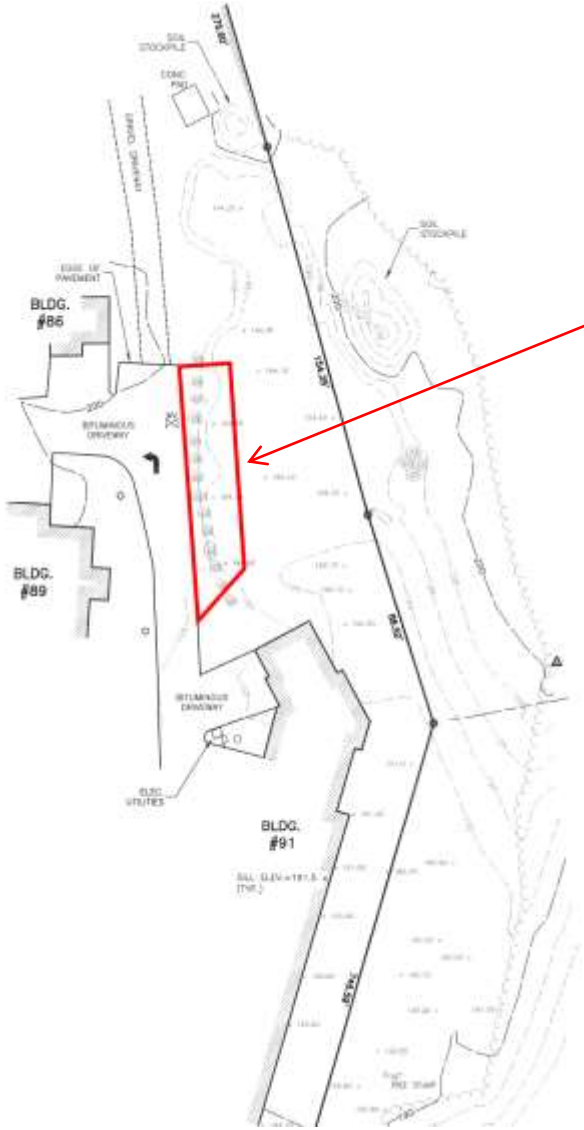
CME

Interactive BMP Design: Case Study I

Public Works Facility

Interactive BMP Design: Case Study II

Parking Lot



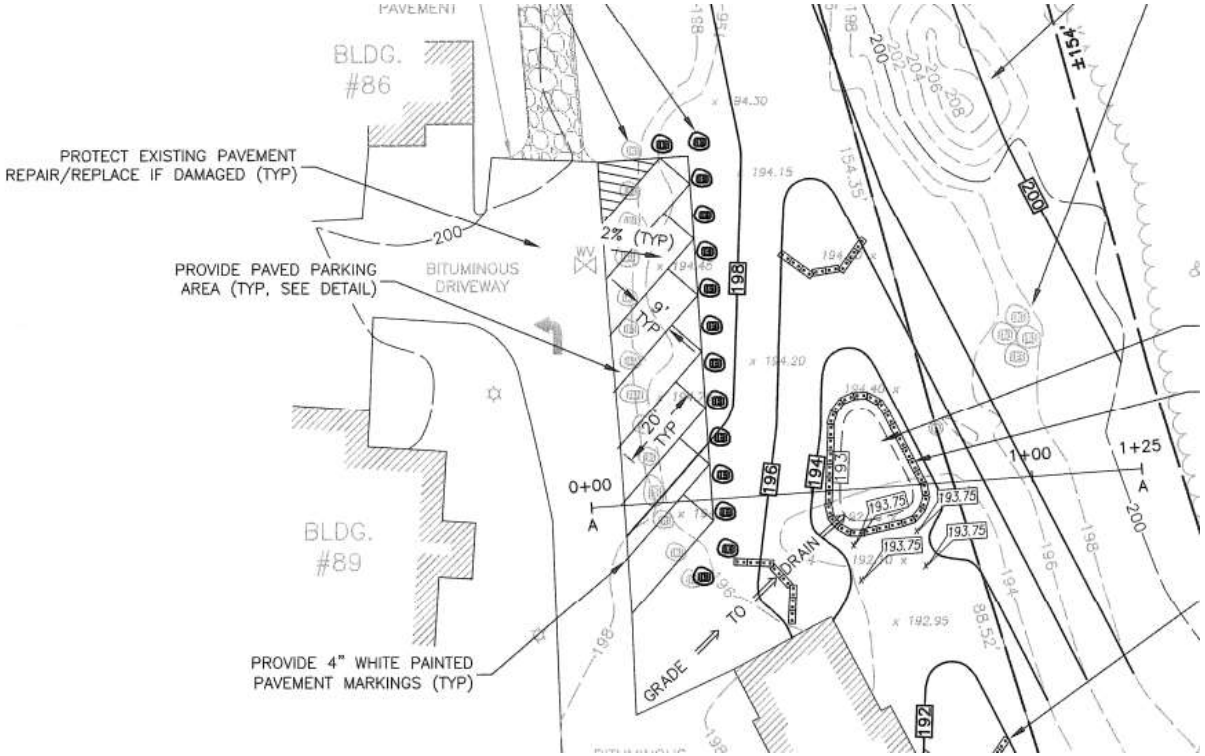
Parking Lot Expansion

SOIL AND WATER CONSERVATION SOCIETY

CME

Interactive BMP Design: Case Study II

Parking Lot



Interactive BMP Design: Case Study II

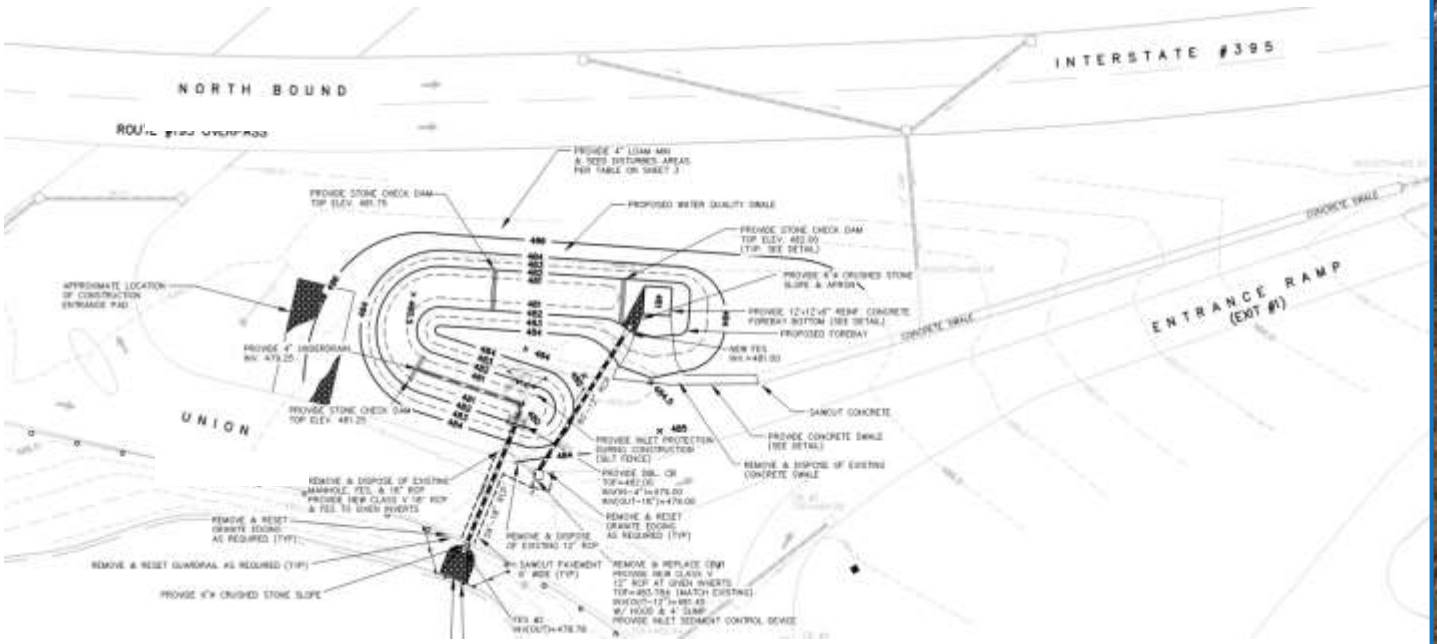
Parking Lot

Interactive BMP Design: Case Study II

Parking Lot

Additional Case Study: Case Study III

Highway Swale



Additional Case Study: Case Study III

Highway Swale



Additional Case Study: Case Study III

Highway Swale

Additional Case Study: Case Study III

Highway Swale

Questions?

Charles Eaton, PE, LEED-AP

Director, Municipal Services
CME Associates, Inc.

1.888.291.3227
ceaton@cmeengineering.com