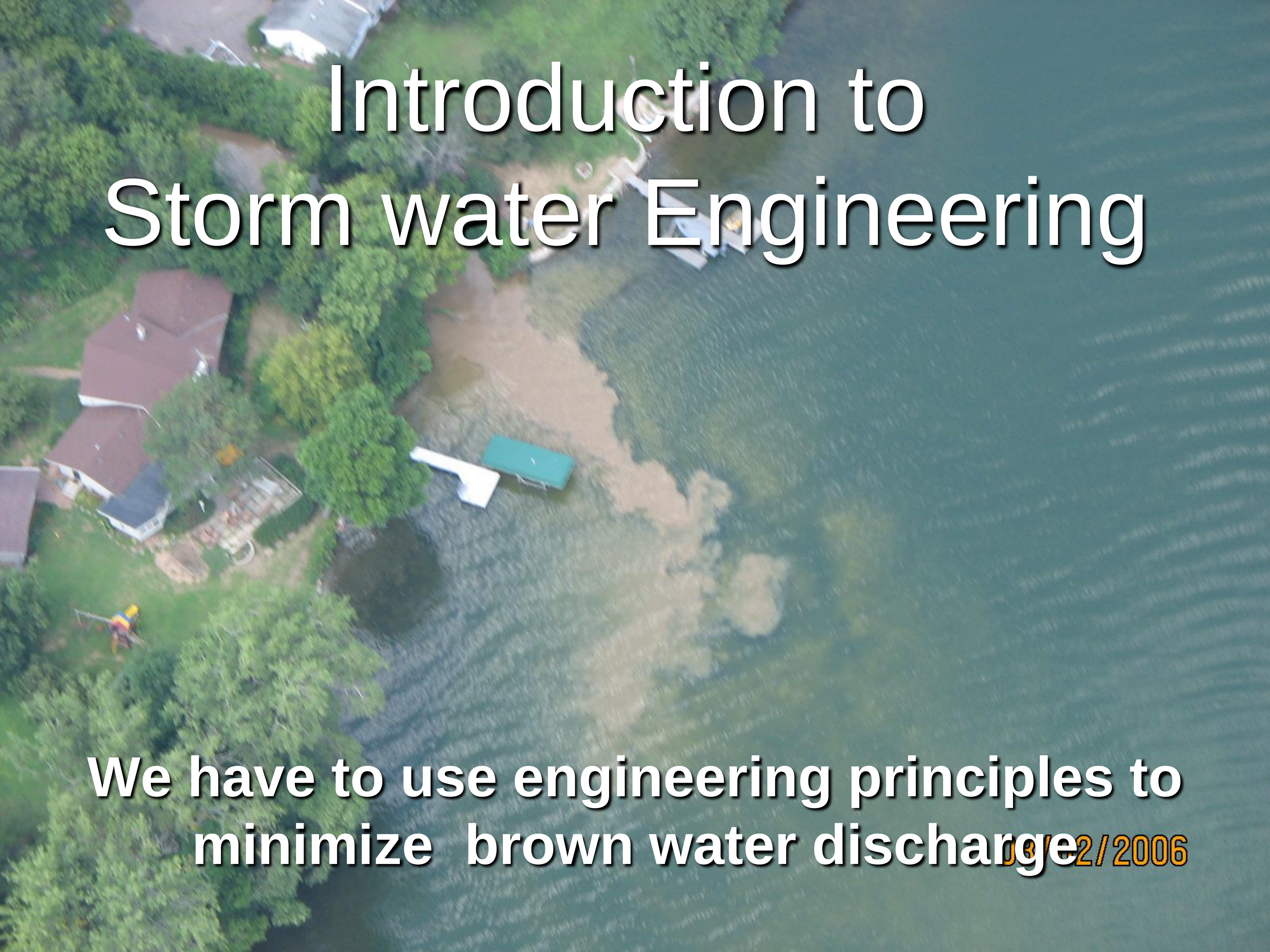
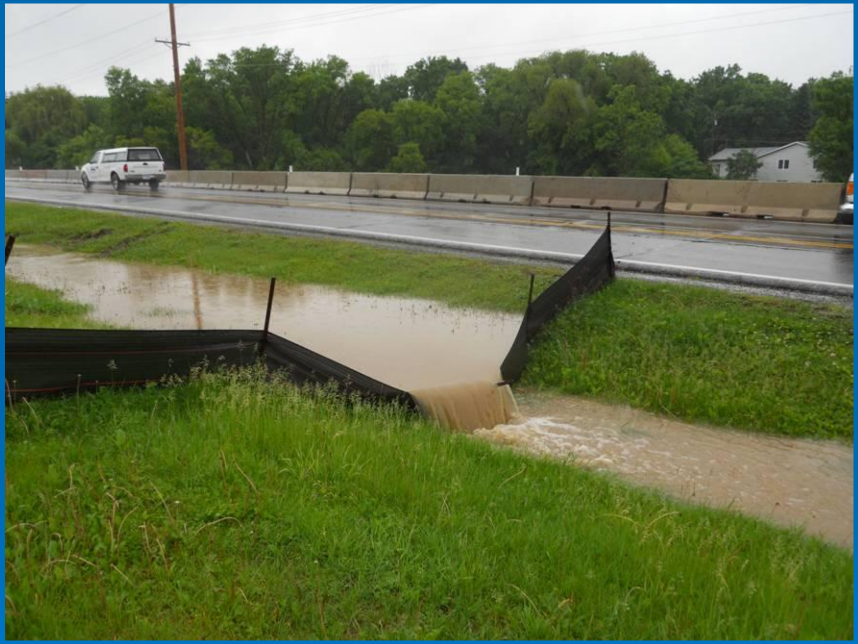
Introduction to Storm water Engineering



We have to use engineering principles to minimize brown water discharge

The future…. Not only limiting soil loss, but turbidity of the runoff water

Silt fence won't reduce the concentration of brown water discharge



Need to capture the runoff and treat it.

Do ponds work?

Use of pond during construction

Brown water… how bad is it?

Use a meter and check the turbidity level

NTU
Nephelometric Turbidity Units

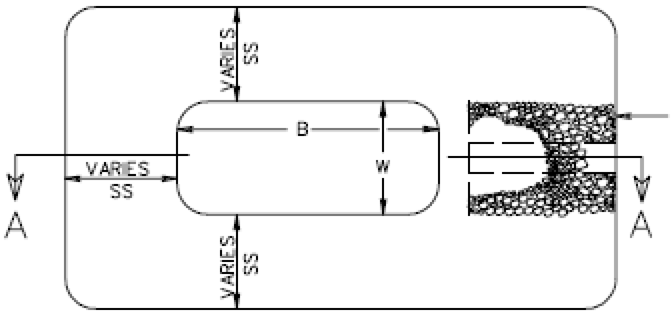
- Ratio of scattered light from the light source

to the reference beam passed through the sample

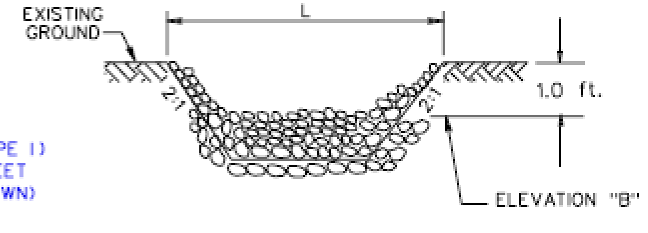
- Ratio is converted to turbidity measure in NTU
- Drinking water typically less than 5 NTU

Comparison of BMPs
Sediment control verses Effluent control

Silt fence	Flocculants
Mulch	Ponds
Blankets	Water treatment dumpsters
Ditch checks	Weepers



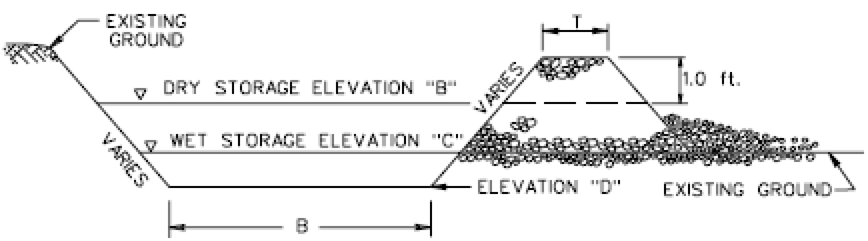
PLAN VIEW OF TEMPORARY SEDIMENT TRAP



TYPICAL SECTION THRU WEIR
(ROCK CHECK DAM TYPE 1)

NOTES:

1. CHECK DAM IS SHOWN FOR ILLUSTRATION ONLY AND IS NOT INCLUDED IN PAYMENT FOR SEDIMENT TRAP.
2. THE SEDIMENT STORAGE VOLUME SHALL BE 134 CUBIC YARDS/ACRE OF TOTAL CONTRIBUTING DRAINAGE AREA AND SHALL CONSIST OF HALF IN THE FORM OF WET STORAGE AND HALF IN THE FORM OF DRY STORAGE.
3. SEE PLANS FOR DIMENSIONS AND ELEVATIONS.



TYPICAL SECTION (A-A) THRU
TEMPORARY SEDIMENT TRAP

Will be designing more sediment traps and rock weepers to use during construction

TYPICAL SEDIMENT TRAP

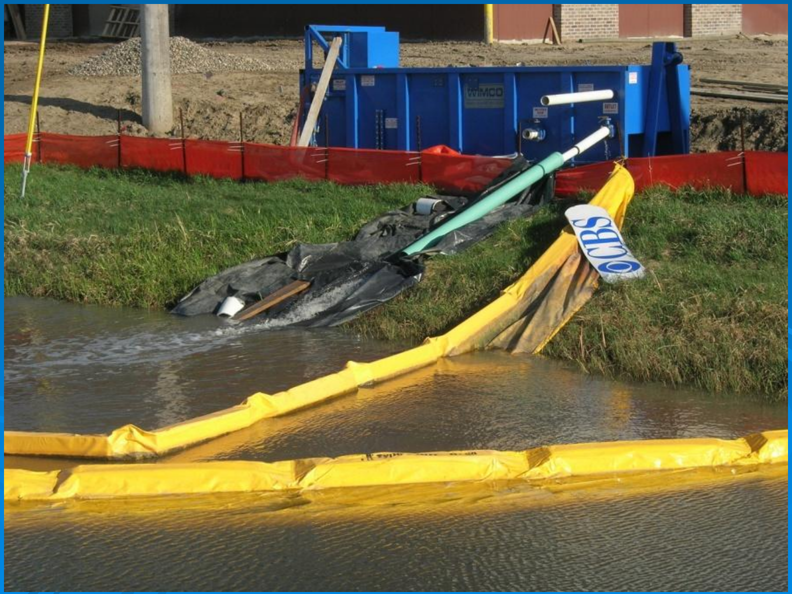
VIRGINIA DEPARTMENT OF TRANSPORTATION

114.08

SPECIFICATION REFERENCE

107
303

Treating brown water with Engineered systems



We have to use engineering to design water treatment methods from projects over the long term

Road Runoff TH 494

Material	Rainfall (ppm)	Snowmelt (ppm
TSS	6-400	100-120
chloride	13-200	300-700
iron	400-13,000	3000-7000
aluminum	150-4000	1500-2500
zinc	20-600	200-400
phosphorus	0.1-1	0.3-0.6
mercury	0.5-6	0.5-1
chromium	1-20	7-13
copper	2-70	20-40

Runoff into storm drains

Salt and sticking agent from parking lots

Storm Water Treatment Methods

- Wet ponds
- Two cell pond /wetland
- Bio-swales
- Dry ponds
- Infiltration areas
  - Pervious pavers
  - Net lawn

- Rain gardens
- Detention swales

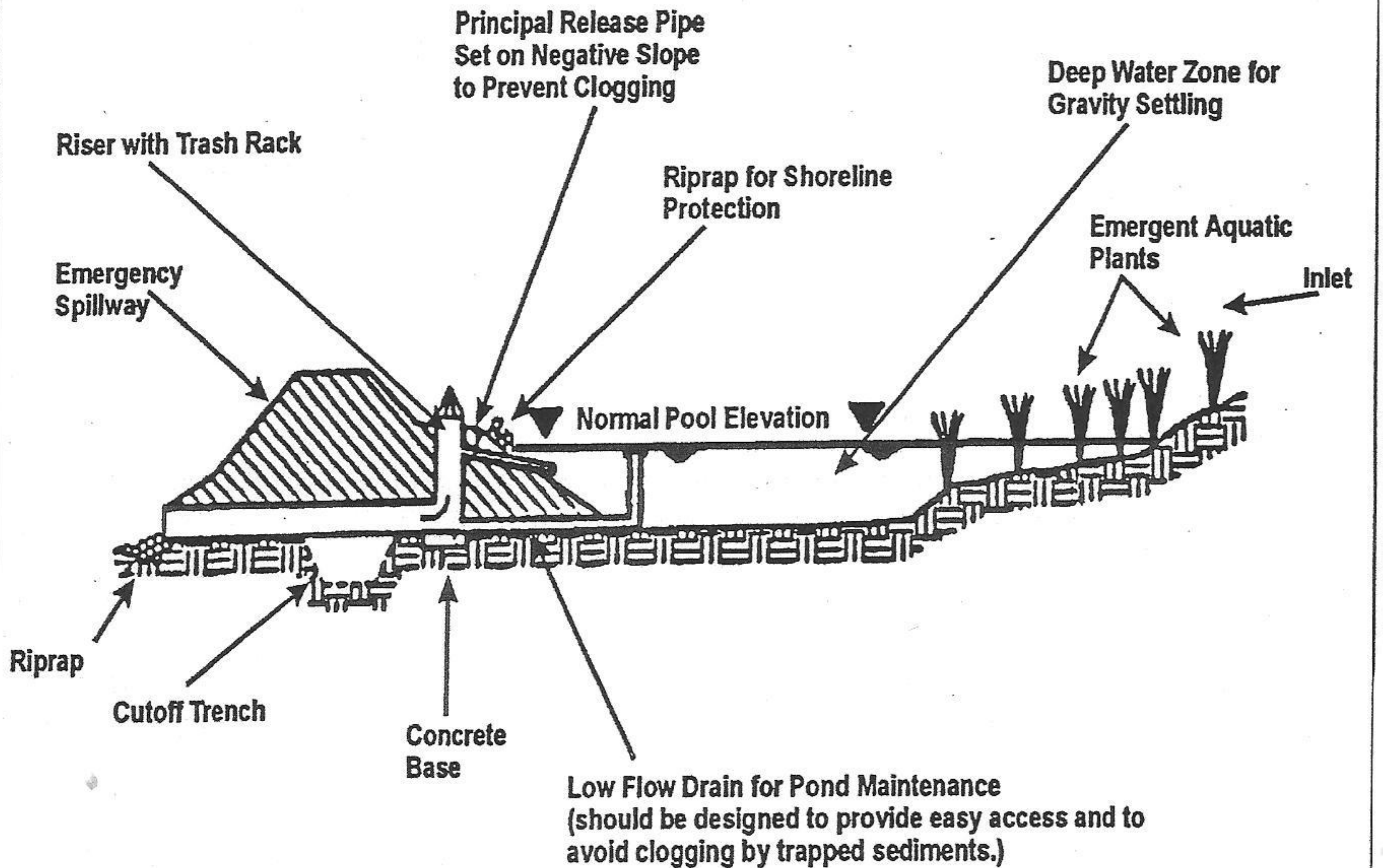


Figure 1: Typical Wet Pond Design

Source: Maryland Department of the Environment, 1986

Naturalize the ponds with site contours

Wet Pond Parameters

- Pond sizing…… 5- 10 year design frequency
- Overflow/outlet……. 10 year design frequency
- 3600 cubic ft of storage /acre drained

Ponds with no buffer vegetation

Ponds large or small depending on the drainage area

TABLE 1 REMOVAL EFFICIENCIES FROM WET DETENTION PONDS

Parameter	Percent Removal	
	Schueler, 1992	Hartigan, 1988
Total Suspended Solid	50-90	80-90
Total Phosphorus	30-90	
Soluble Nutrients	40-80	50-70
Lead	70-80	
Zinc	40-50	
Biochemical Oxygen Demand or Chemical Oxygen Demand	20-40	

1 hydraulic residence time varies
2 hydraulic residence time of 2 weeks

Source: Schueler, 1992 & MD DEQ, 1986.

Design 2

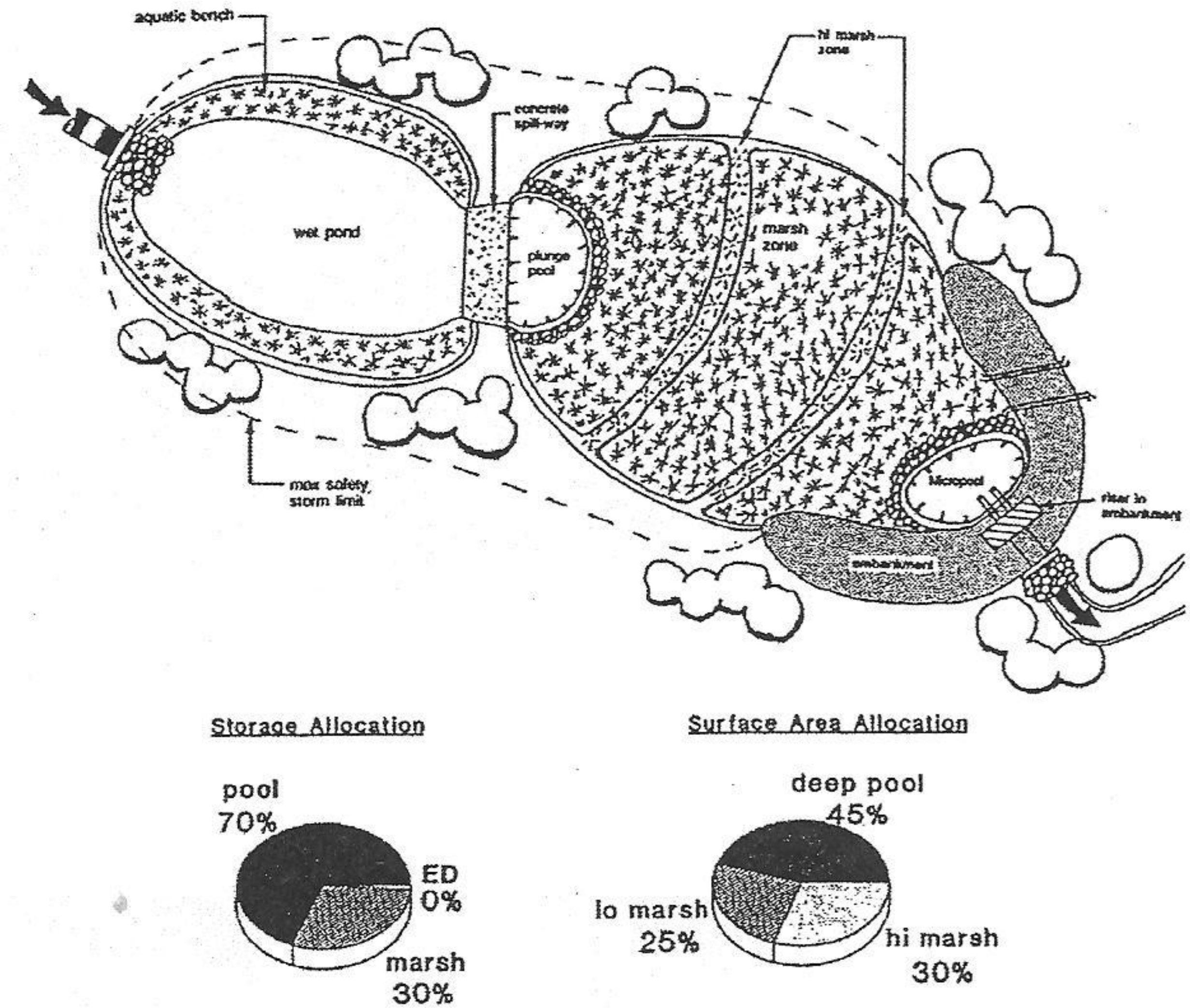
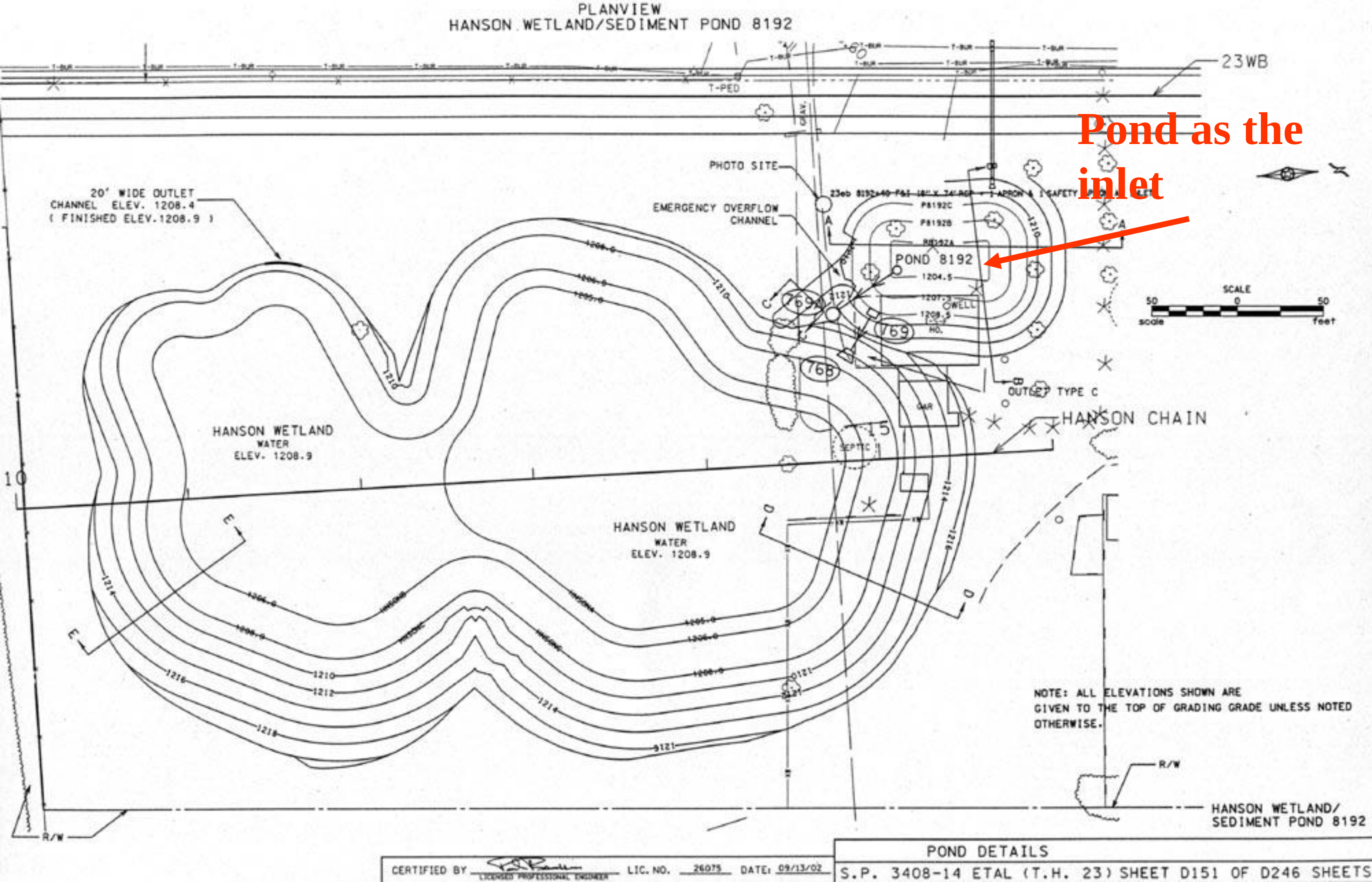


Figure 2. Pond/Wetland System

Source: Schueler, 1992.

Pond/constructed wetland combo



*Performance of Vegetated Storm Water Ponds/Wetlands

Pollutant	Removal Rate (%)
Total Suspended Solids	60-90
Phosphorus	50-90
Nitrogen	30-50
Organic carbon	35-50
Hydrocarbons	80-90
Cadmium	35-50
Copper	40-60
Lead	60-80
Zinc	40-50
Bacteria	70-80

*Modified from U.S EPA Fact sheets

TABLE 2 PERFORMANCE OF STORM WATER WETLANDS

Pollutant	Removal Rate
Total Suspended Solids	67%
Total Phosphorus	49%
Total Nitrogen	28%
Organic Carbon	34%
Petroleum Hydrocarbons	87%
Cadmium	36%
Copper	41%
Lead	62%
Zinc	45%
Bacteria	77%

Source: CWP, 1997.

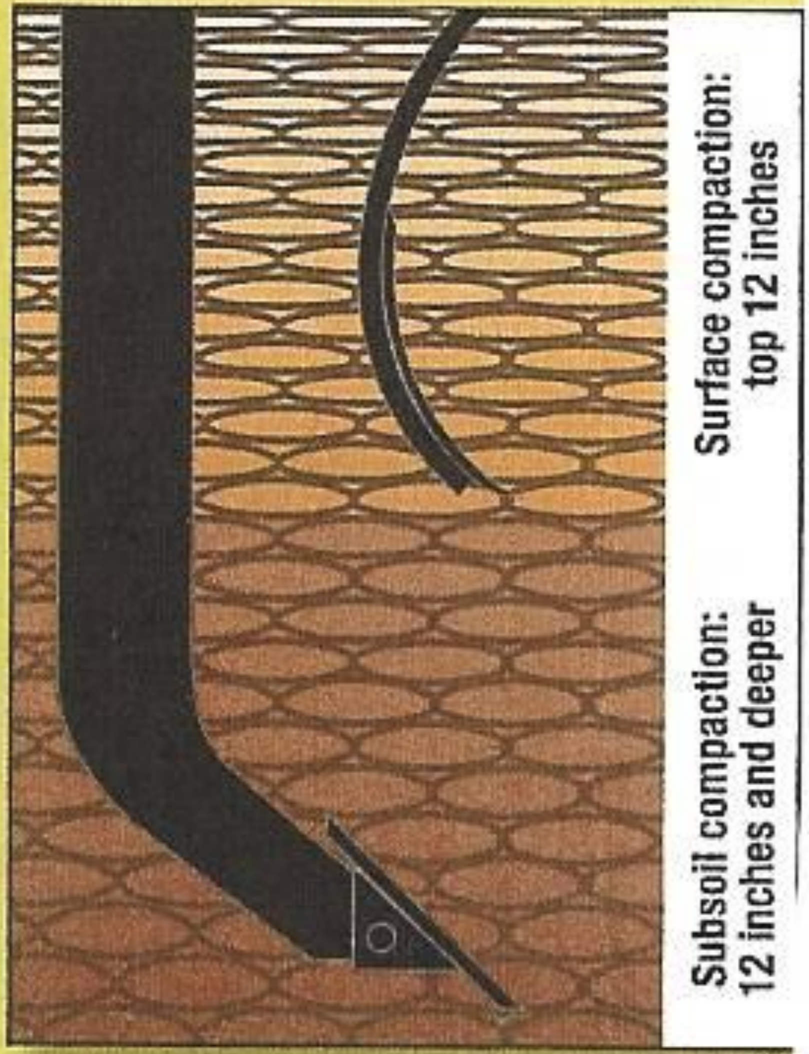
Pond design and vegetation to create bio-swale

Two stage pond/bio-swale

Wet/dry pond on road project


J Chaplin

Subsoil (deep) compaction is determined by total load as well as contact pressure. Axle loads above 10 tons, carried on high pressure tires or on the wrong-sized tires, can cause compaction below the normal tillage zone; loads of 20 tons can compact wet soil as deep as 2 feet.



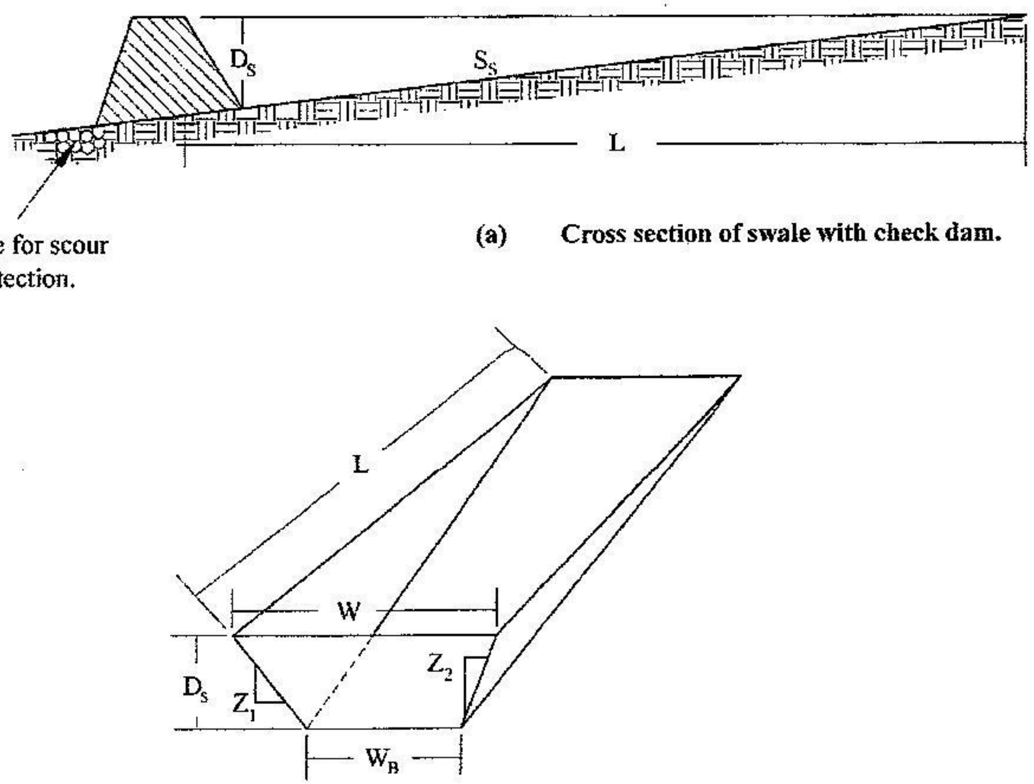

JOHN DEERE

TABLE 1 LABORATORY AND ESTIMATED BIORETENTION

Pollutant	Removal Rate
Total Phosphorus	70%-83% [1]
Metals (Cu, Zn, Pb)	93%-98% [1]
TKN	68%-80% [1]
Total Suspended Solids	90% [2]
Organics	90% [2]
Bacteria	90% [2]

Source: [1]Davis et al. (1998)
[2]PGDER (1993)

Swale and rock weeper in ditch bottoms



Notation:

L = Length of swale impoundment area per check dam (ft)

D_S = Depth of check dam (ft)

S_S = Bottom sipe of swale (ft/ft)

W = Top width of check dam (ft)

W_B = Bottom width of check dam (ft)

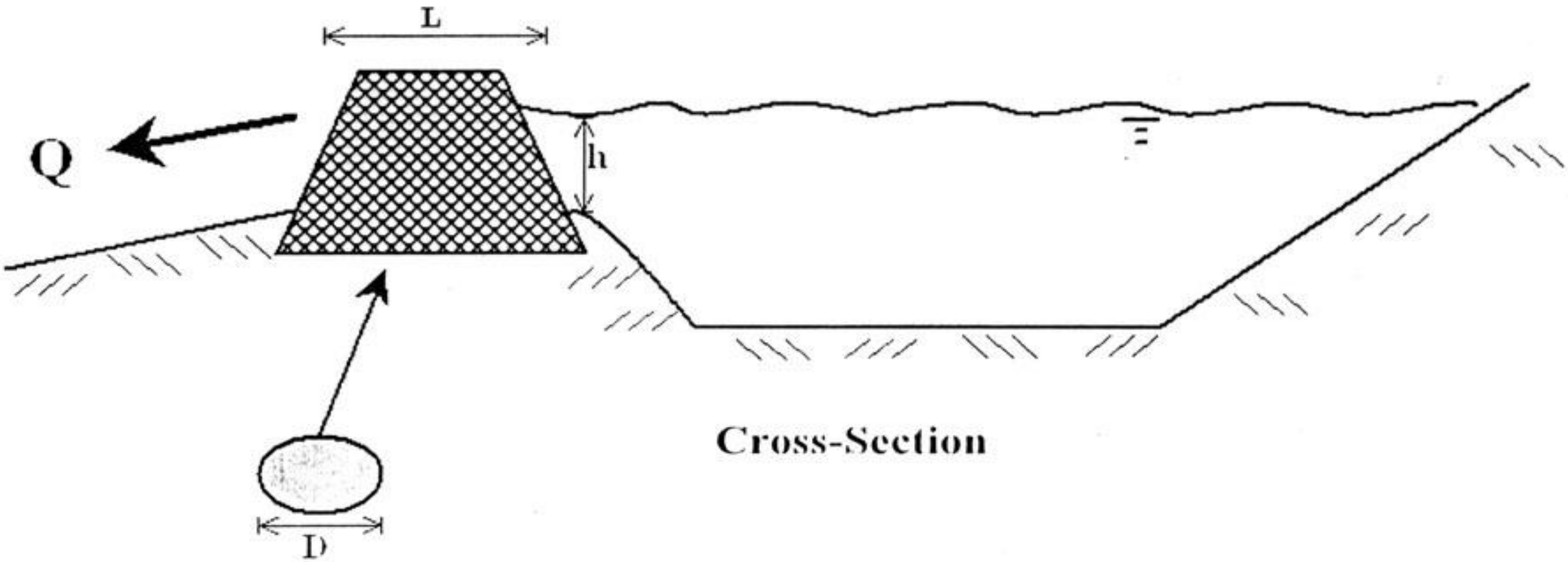
$Z_{1\&2}$ = Ratio of horizontal to vertical change in swale side slope (ft/ft)

(b) Dimensional view of swale impoundment area.

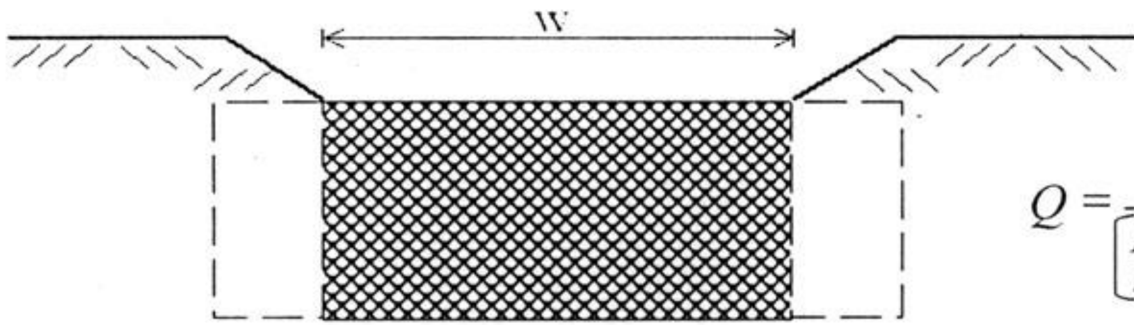
Source: NVPDC, 1996.

FIGURE 1 EXAMPLE OF A VEGETATED SWALE

Calculating Flow through a Rock Dam



Cross-Section



Profile

$$Q = \frac{h^{3/2} W}{\left[L/D + 2.5 + L^2 \right]^{1/2}}$$

Q = total flow through dam (cfs)

h = ponding depth in basin (ft)

W = total length of dam (ft)

L = horizontal flow path length (ft)

D = average rock diameter (ft)

NAHB/NRC Designated Housing Research Center at Penn State University

Flow through rock weeper

- Calculate the Q thru a rock berm,
- Sediment trap average. 2 ft depth
- Berm length, 16 ft
- Ave flow path length thru berm, 8 ft
- D_{50} = 0.75 inches
- $Q = (2^{3/2} * 16)/[8/.0625 + 2.5 + 8^2]^{1/2} =$
- Q = 45.3/13.95 = 3.25 cubic ft /second
- How fast will a pond of capacity 18,000 cubic ft live storage drain?
- 1.54 hours


30

TABLE 1 EFFECTIVENESS OF DESIGN SWALES

Pollutant	Median % Removal
Total Suspended Solids	81
Oxygen Demanding Substances	67
Nitrate	38
Total Phosphorus	9
Hydrocarbons	62
Cadmium	42
Copper	51
Lead	67
Zinc	71

Rain gardens

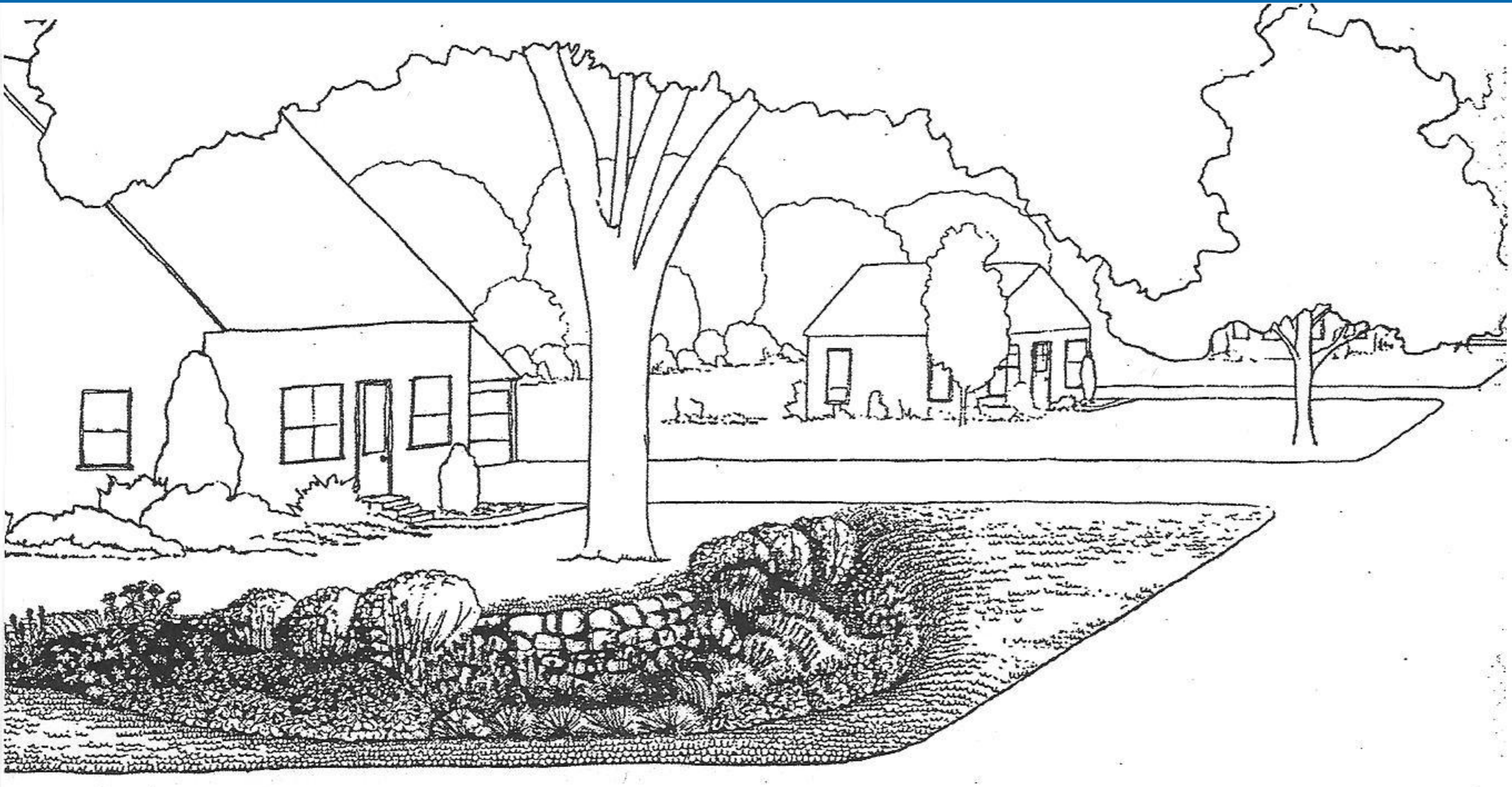


Figure 8: Typical Rainwater Garden Layout

Source: Adapted from Nassauer et al., 1997.

Curb inlet rain garden

Rain garden parameters

- Size…. 5 to 10 percent of contributing area
- Depth 1 to 2 ft
- Planting soil… compost/sand 40/60 ratio typical
- Use Recharga model from Wisconsin

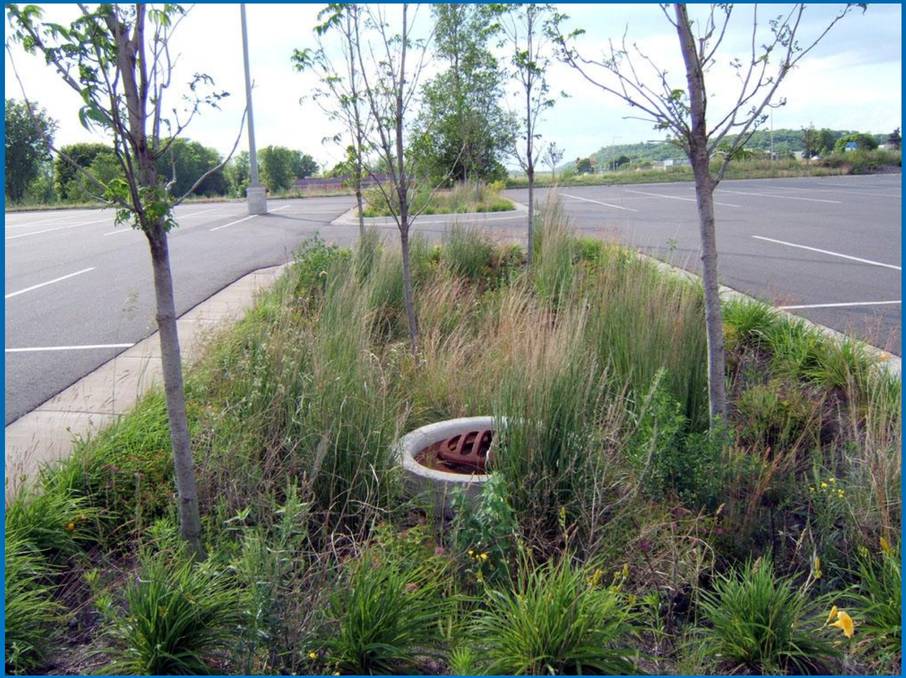
Rain garden under-drain based on soils

Soil Texture	Sat. Hydraulic Conductivity (in/hr)[1]	Typical Design
Sand	3.60	Basic Bioretention
Loamy Sand	1.63	Basic Bioretention
Sandy Loam	0.50	Basic Bioretention
Loam	0.24	Underdrain Recommended[2]
Silt Loam	0.13	Underdrain Required
Sandy Clay Loam	0.11	Underdrain Required
Clay Loam	0.03	Not Recommended for Infiltration[3]
Silty Clay Loam	0.19	Underdrain Required
Sandy Clay	0.04	Not Recommended for Infiltration[3]
Silty Clay	0.07	Not Recommended for Infiltration[3]
Clay	0.07	Not Recommended for Infiltration[3]

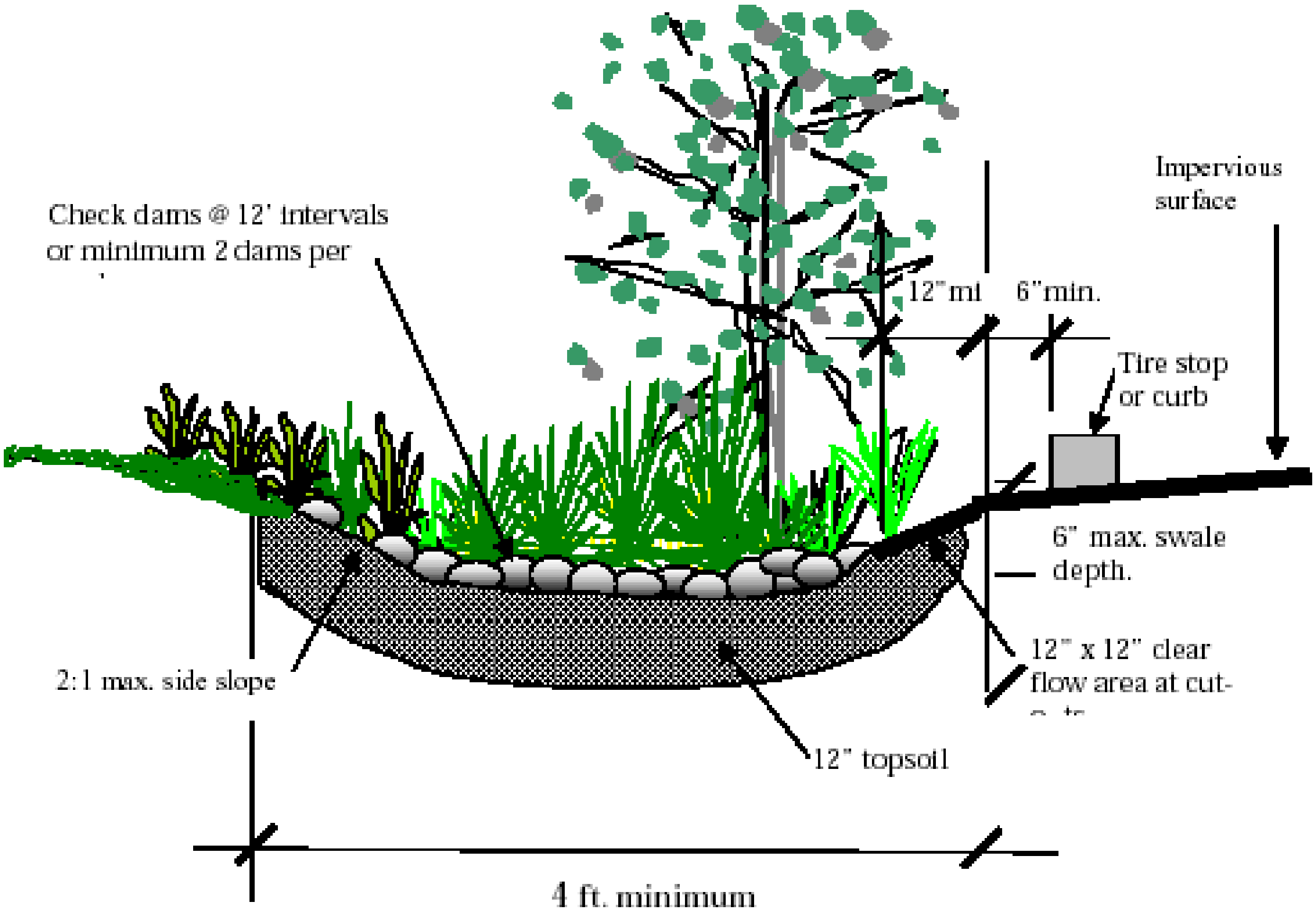
1. Rawls et al. (1998).
2. Underdrain system recommended but may be capped initially; see section 3.6 for details
3. Generally not feasible to meet infiltration goals; however, may be used for water-quality treatment if designed with an underdrain

Rain gardens need permeable soil or an under-drain

Takes time for plants to develop

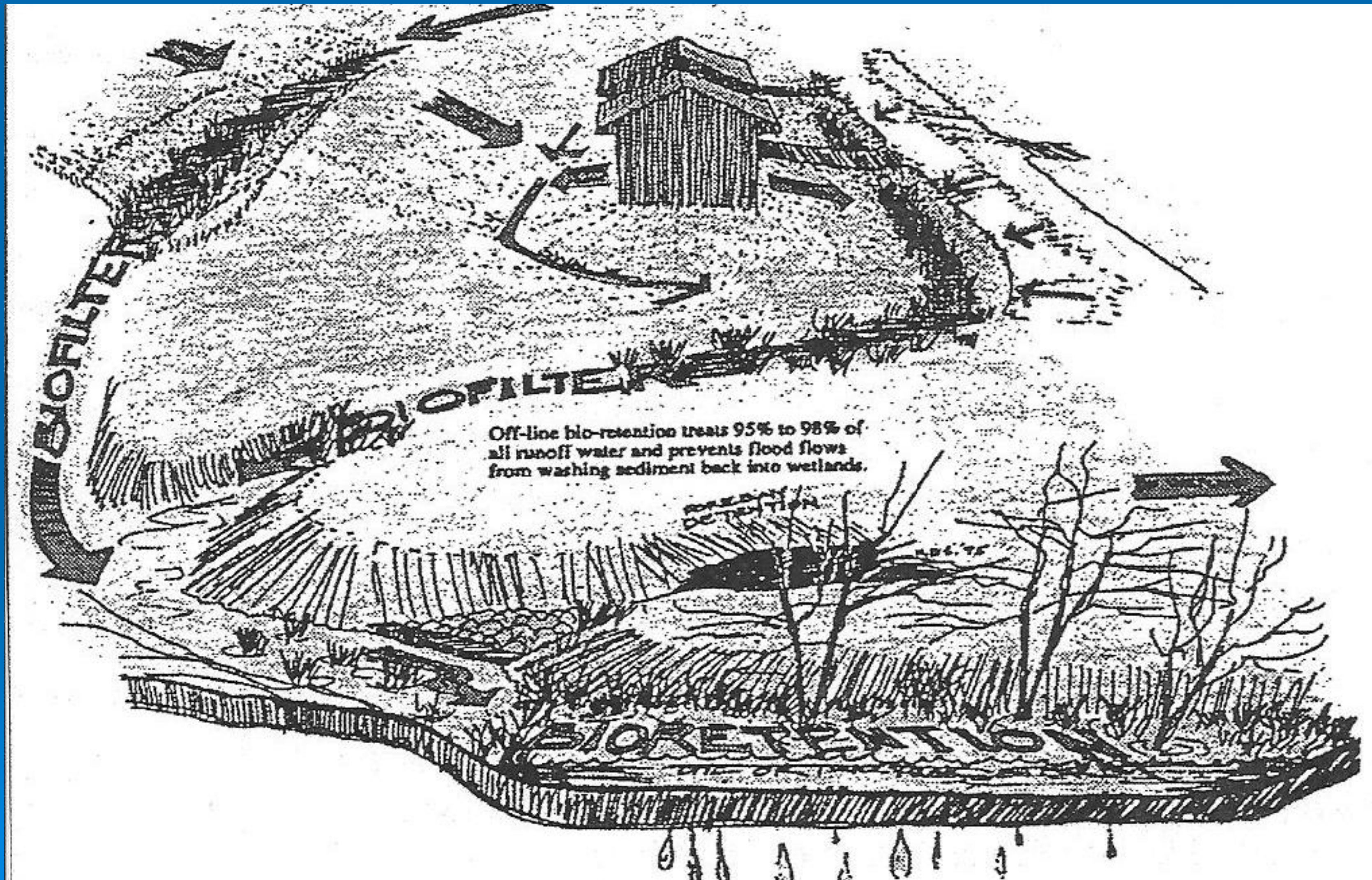


Landscape Swale



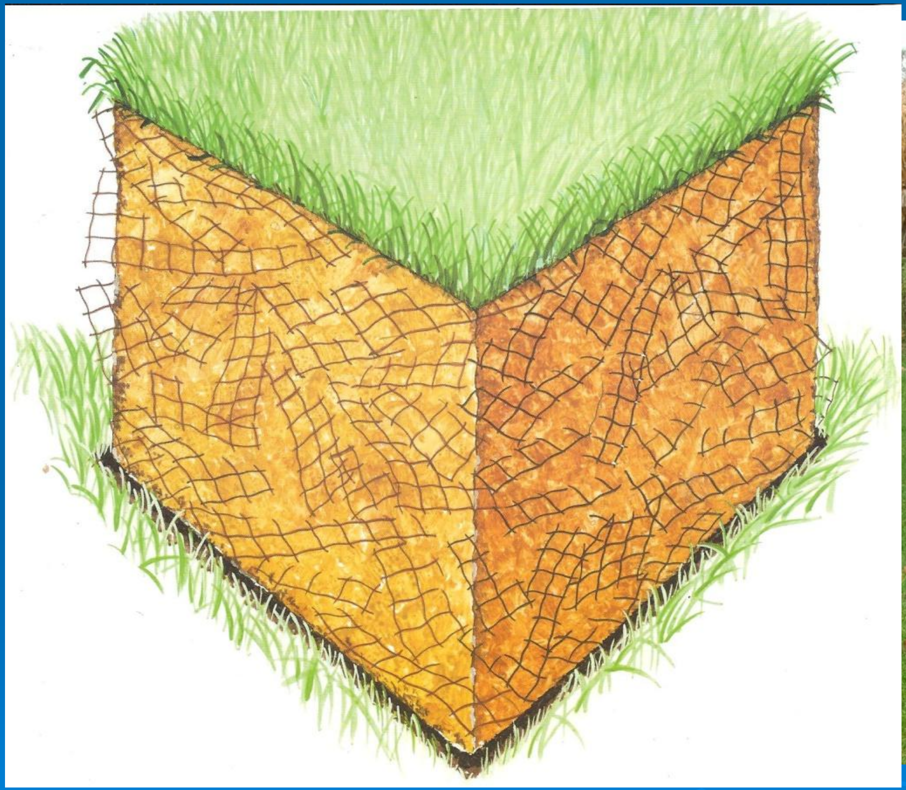
Landscape swales

Storm water management systems approach



Storm water curb appeal

Infiltration parking areas
Net lawn system

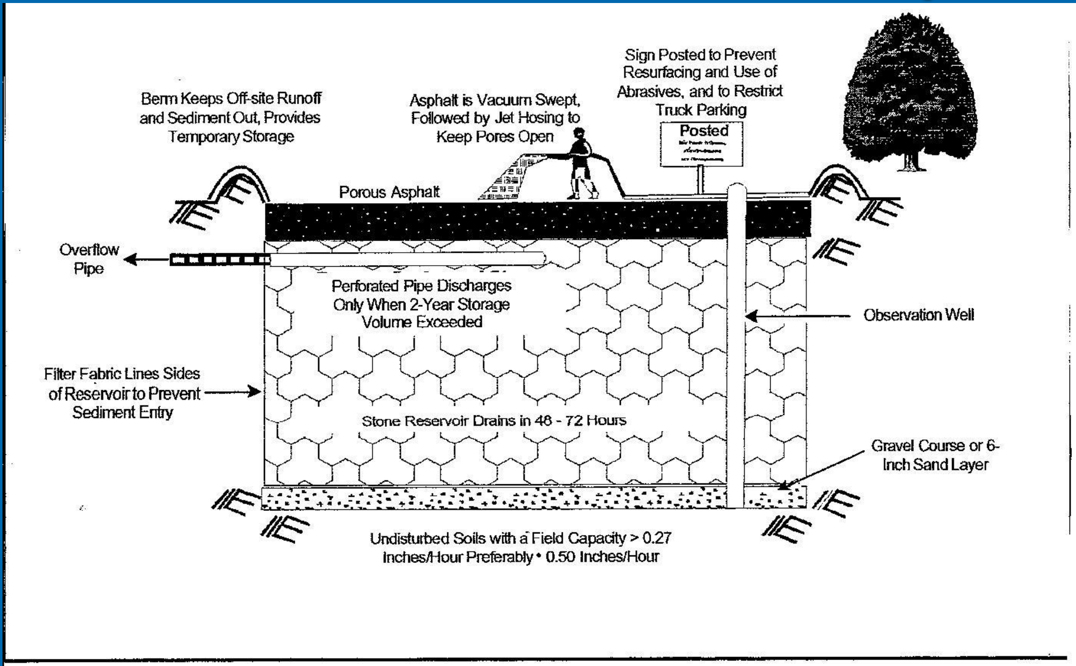


Minimum impact design standards
Rain water treatment for parking lots

- Net lawn and sod

- Rain gardens

Pervious pavements



Source: Modified from MWCOG, 1987.

FIGURE 1 TYPICAL POROUS PAVEMENT INSTALLATION

Do we have results?

No Treatment pond verses treatment pond

Treatment pond

This is the goal for YOUR state