Reservoir Watershed Management for Source Water Protection

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Introduction

- Many drinking water reservoirs are impacted by nonpoint source pollution. Source water protection can save water treatment costs.
- USEPA promotes integrated pollution control, e.g., the TMDL process
- BMP for stormwater control is required
- Performance-based vs. water quality –based BMP design
- Optimal BMP placement in a watershed

Watershed Management Approach- Key Elements

- Problem Identification
- Setting Goals & Finding Solutions
- Implementing Action Plans
- Evaluating Action Plan Effectiveness and Making Necessary Modifications
- Public Participation – Creating Partnerships
- Optimization – Least Cost & Effective

Water Supply Systems in USA (EPA Statistics – 2003)

- ~ 53,400 community water systems
- Serving 273 + million people
- Over 360 very large (>100,000 people) systems
- ~68% of all people served rely on surface water sources
- Many water sources are impacted by developments, etc.

Source Water Protection – Case Example 1

- Manchester, New Hampshire
- Source Water – Lake Massabesic (2,500 acres) and Tower Hill Pond
- Water Quality Problem-Nutrient Loading
- Strategy – Land Use Management, Regulating Traffic, Waste Loads, Biking, Boating & Horseback Riding
- Monitoring Results Show Success

Source Water Protection Case Example 2 – New York City & Seven Upstate Counties

- System serving 9 million people
- Source: 19 surface reservoirs in 7 counties
- Water quality problem: agricultural sources
- In 1997, NYC and 7 counties signed the source water protection agreement, which include upgrading POTWs; payment to the counties; purchasing sensitive lands near the reservoirs, and installing an extensive monitoring program
- Established the Watershed Protection & Partnership Council

Source Water Protection Case Example 3 – Skaneateles Lake Watershed, NY

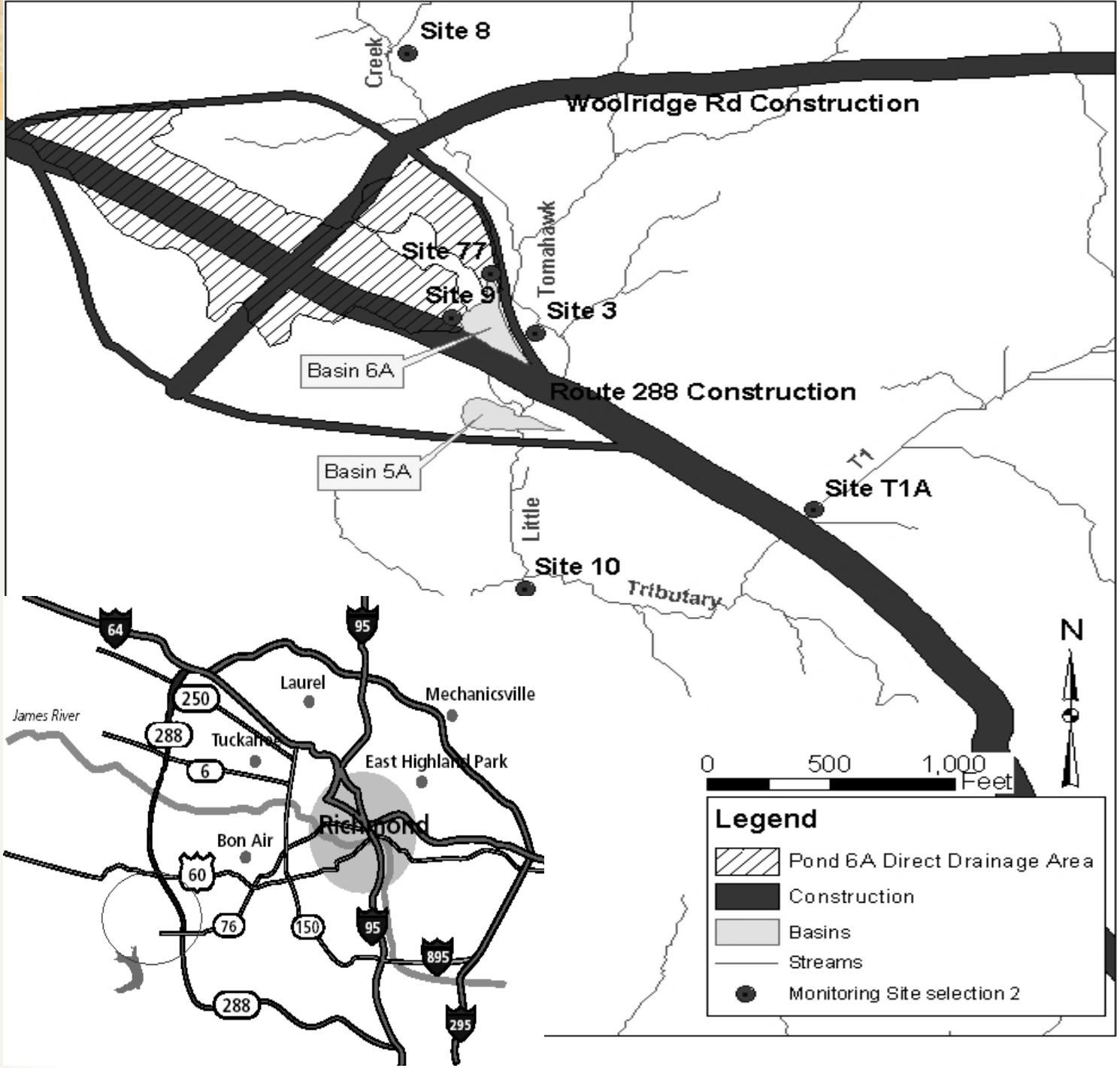
- One of the Finger Lakes
- Serving Syracuse and nearby towns
- Water quality is good, but needs protection
- Established in 1994 the Skaneateles Watershed Agriculture Program (SLWAP)
- BMP implementation
- Assessment is good

Clean Water Act: National Pollutant Discharge Elimination System

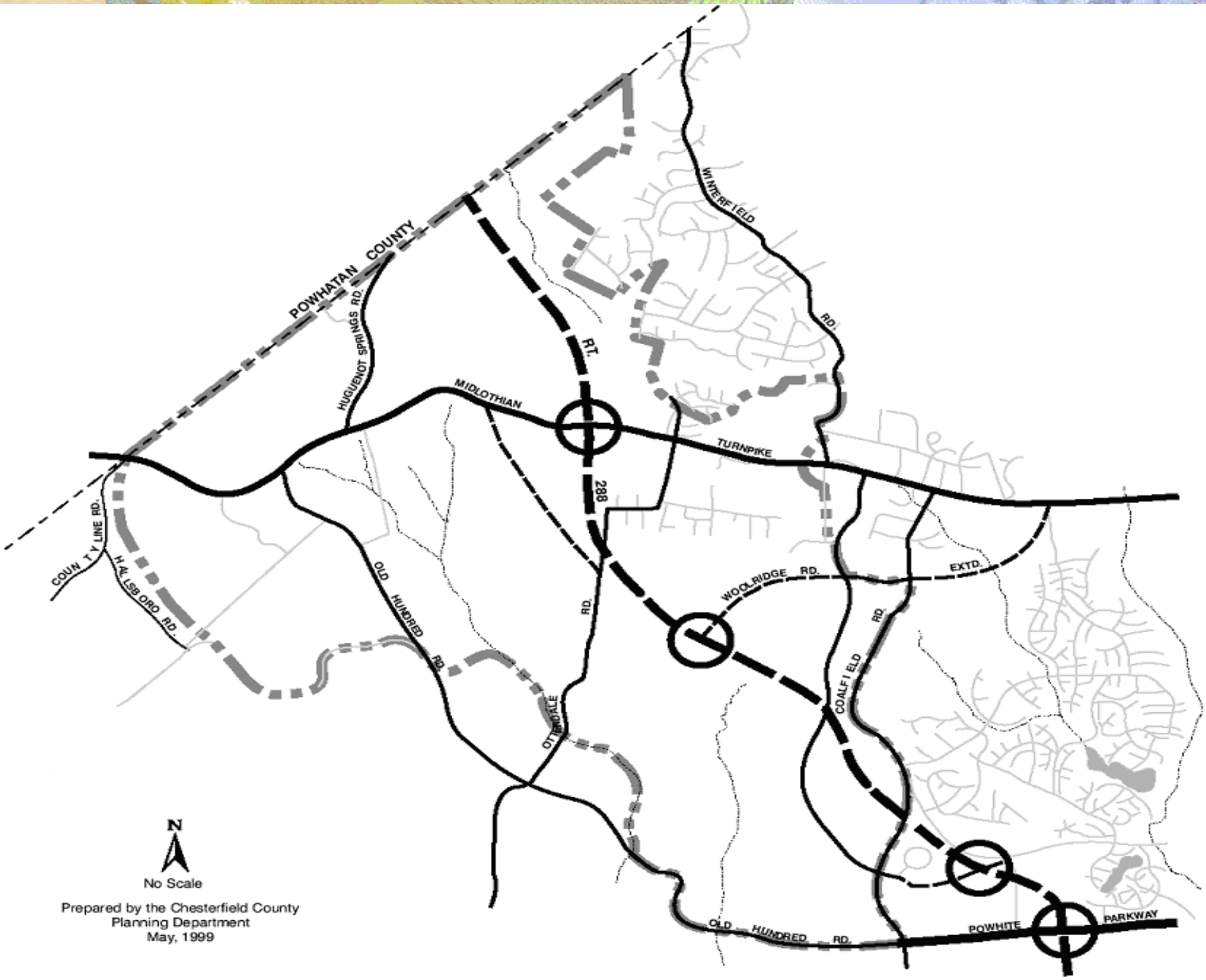
- NPDES Phase I (current)
  - municipalities ≥ 100,000 people
  - construction disturbing ≥ 5 acres
  - some industrial facilities
- NPDES Phase II (in effect 2003)
  - municipalities (approx.) ≥ 10,000 people
  - construction disturbing ≥ 1 acre
  - additional industrial facilities
- Requires BMP implementation

Source Water Protection in Virginia – The Case of Highway Construction

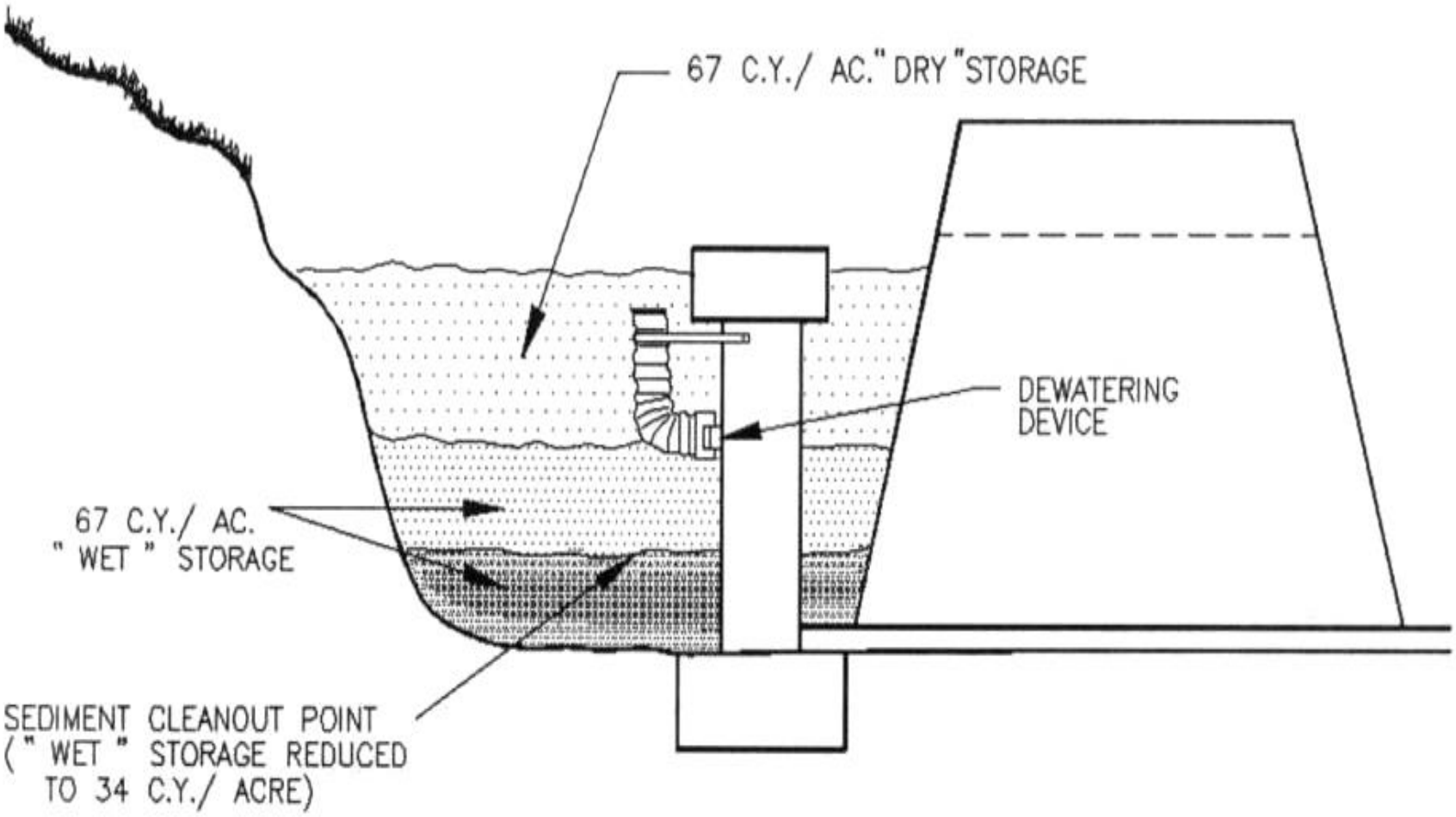
- Rt. 288 construction work near Richmond, Virginia
- Swift Creek Reservoir, a major drinking water source is impacted by Rt.288
- Study conducted by the Univ. of Virginia to determine the effectiveness of erosion & sediment control measures implemented by Virginia Department of Transportation (VDOT)
- 2002-2004 Study


Site 8
Creek
Woolridge Rd Construction
Site 77
Site 9
Tomahawk
Site 3
Basin 6A
Route 288 Construction
Basin 5A
T1
Site T1A
Little
Site 10
Tributary
N
0
500
1,000
Feet
Legend
Pond 6A Direct Drainage Area
Construction
Basins
Streams
Monitoring Site selection 2
64
95
250
288
6
60
76
150
895
295
James River
Laurel
Mechanicsville
Tuckahoe
East Highland Park
Richmond
Bon Air


RT 288 @ Little Tomahawk Creek
John Tyler CC
RT 288 @ Otterdale/ Tomahawk Creek
Charter Colony Rd
Little Tomahawk Creek
The Grove Apartments
Monitoring Station @ Little Tomahawk Creek
Old Hundred Rd
Brandermill Woods
Watermill Pky (new)
Tomahawk Creek
Edgewater at The Reservoir


POWHATAN COUNTY
HUGUENOT SPRINGS RD.
WHITEFIELD
RD.
RT.
MIDLOTHIAN
TURNPIKE
288
COUNTY LINE RD.
HALLSBORO RD.
OLD HUNDRED RD.
RD.
WOOLRIDGE RD.
EXTD.
COALFIELD RD.
OTTERDALE
OLD HUNDRED RD.
POWHITE PARKWAY
N
No Scale
Prepared by the Chesterfield County
Planning Department
May, 1999

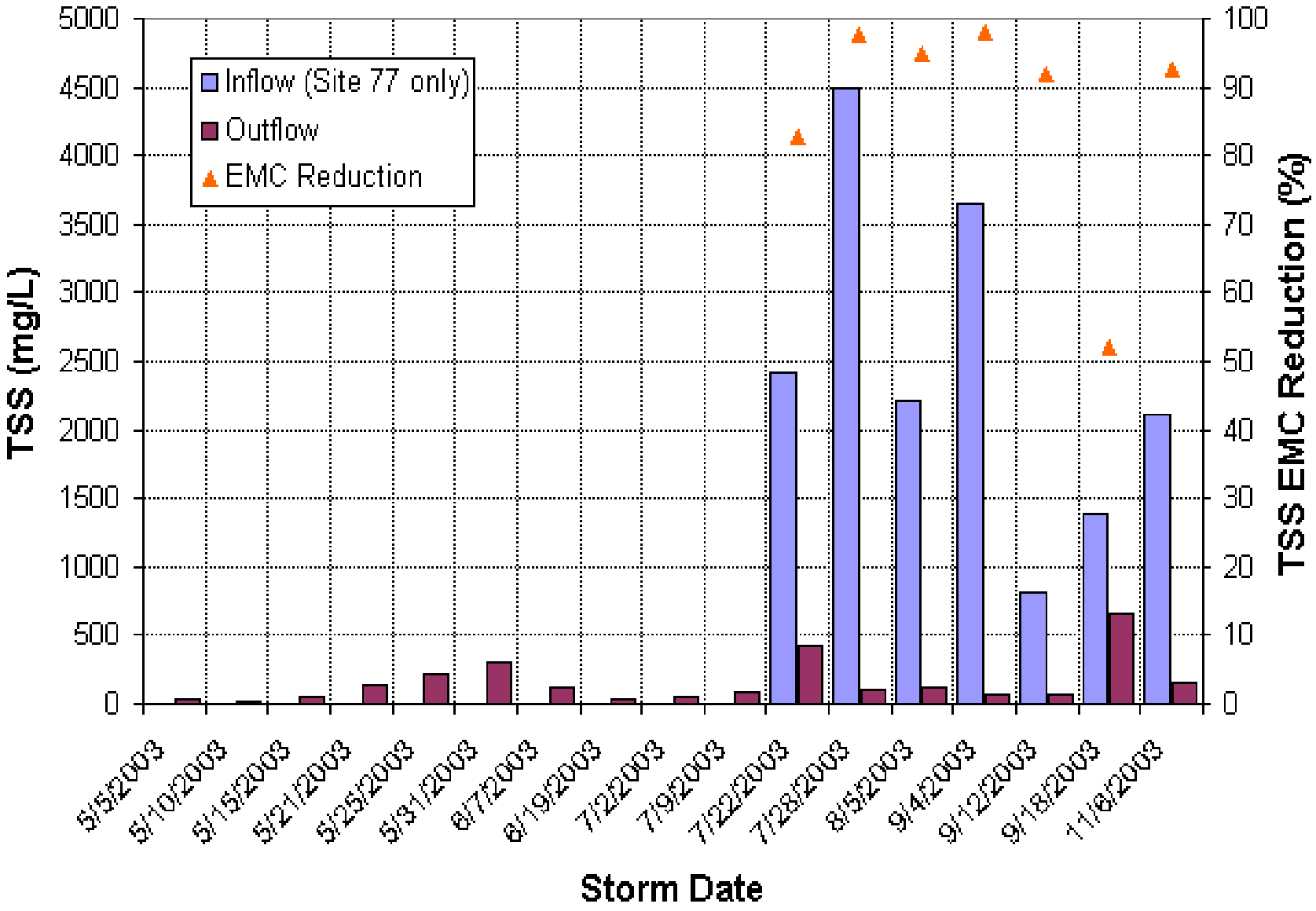
MINIMUM STORAGE VOLUME AND SEDIMENT STORAGE

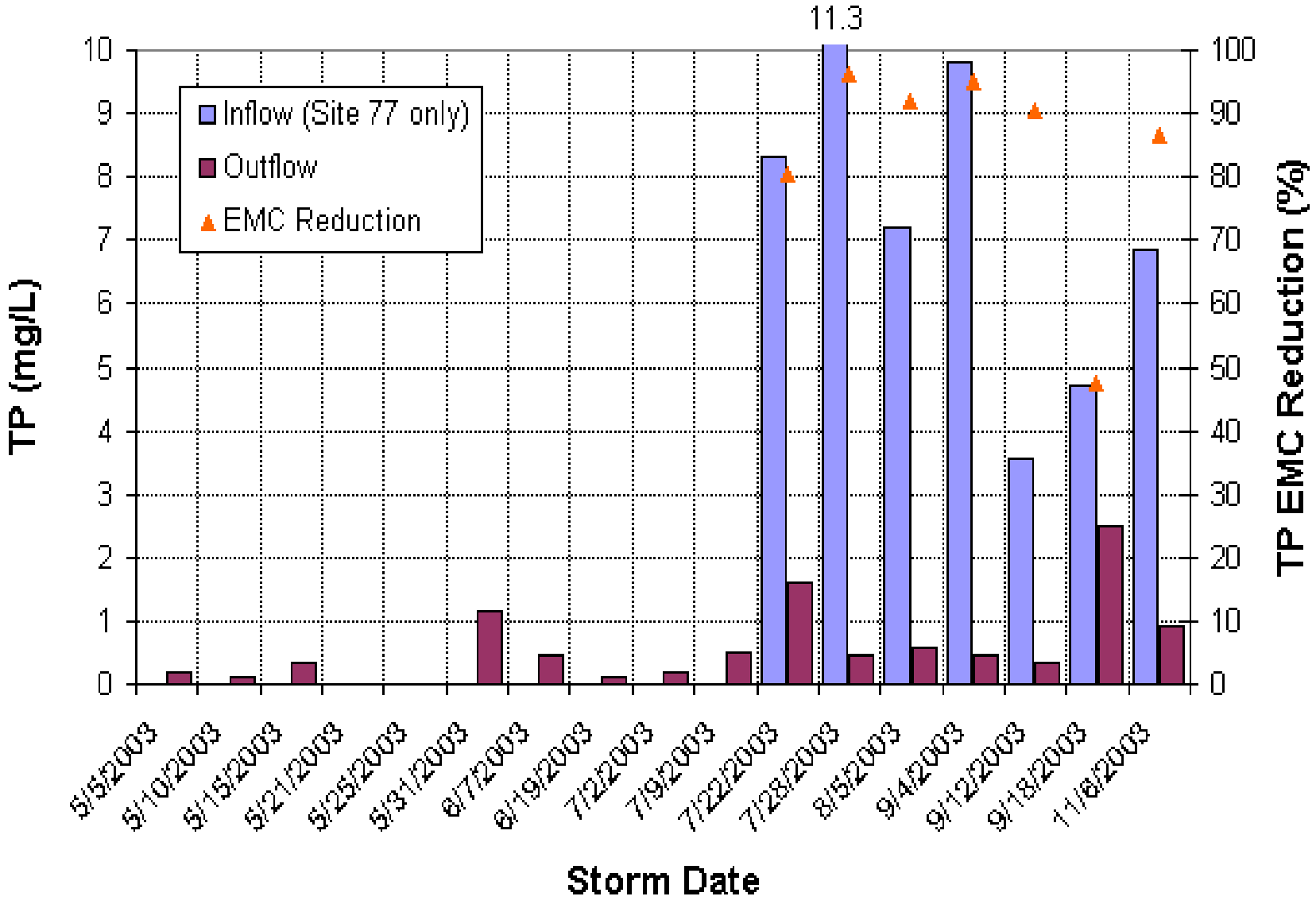


Calculating Pond Efficiency

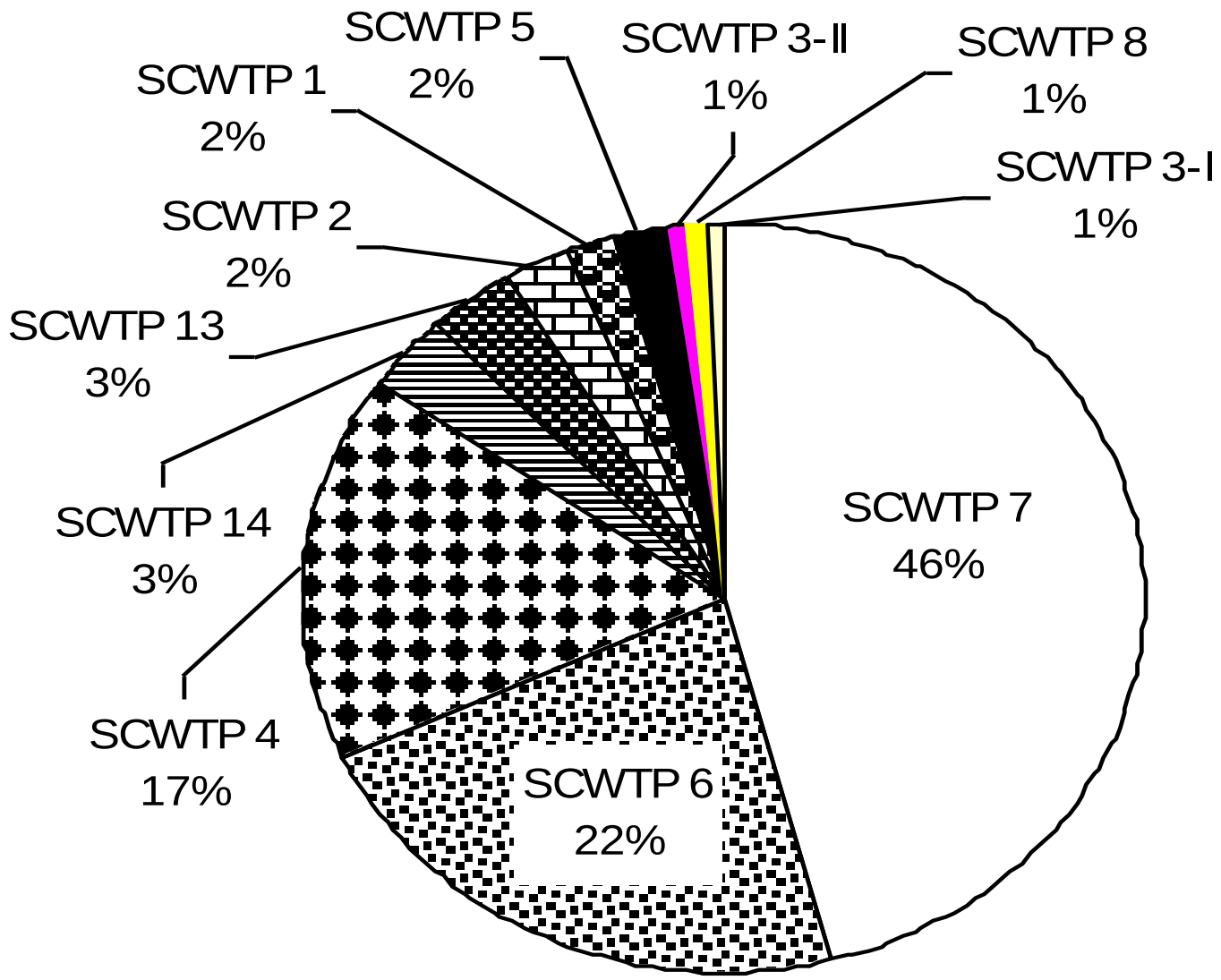
$$EMC = \frac{\sum_{i=1}^{\#\,measurements} (Volume\ during\ period\ i) \times (Avg\ Concentration\ for\ period\ i)}{\sum_{i=1}^{\#\,measurements} (Volume\ during\ period\ i)}$$

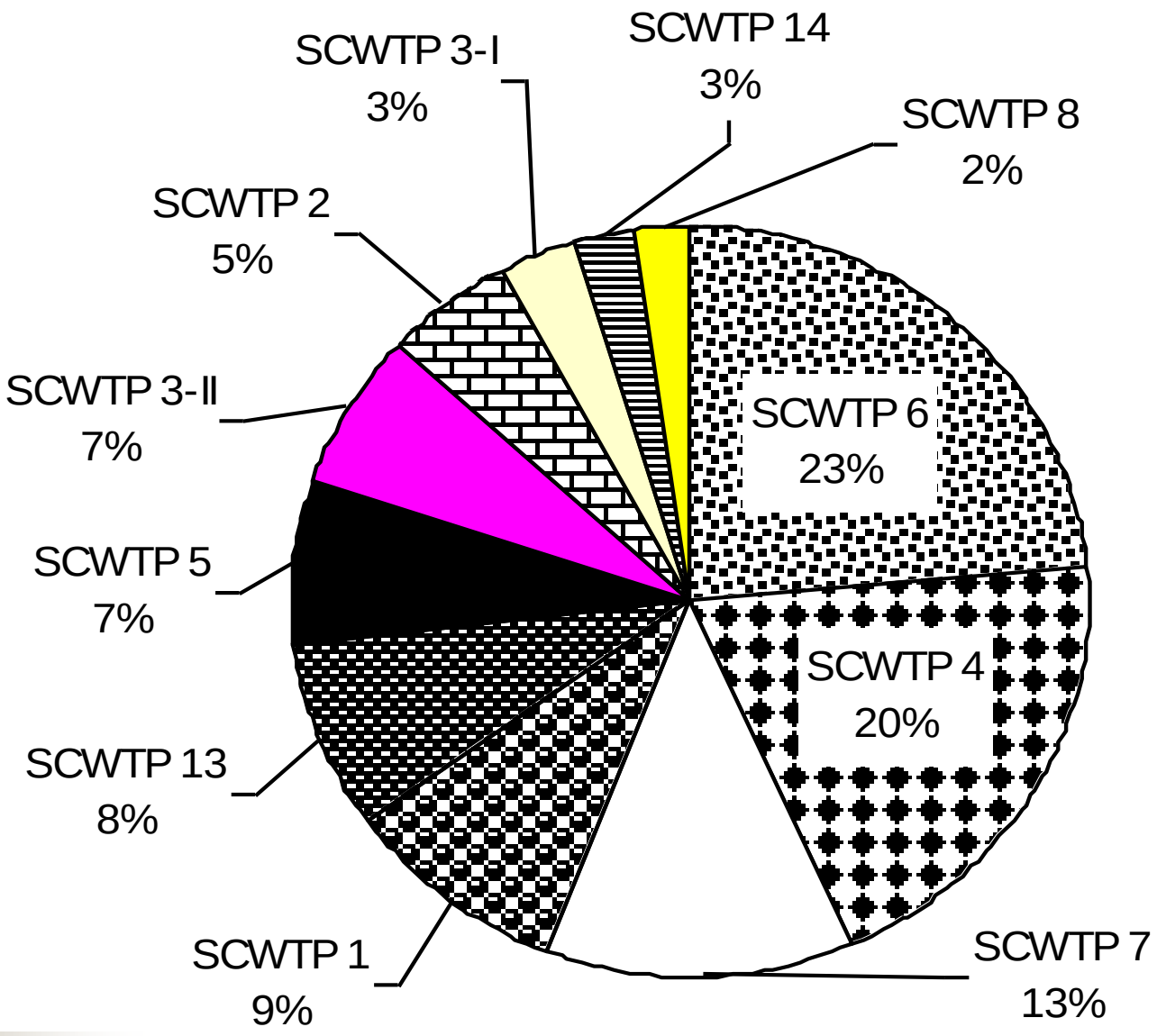
$$EMC\ Efficiency(\%) = \left(1 - \frac{average outlet\ EMC}{average\ inlet\ EMC}\right) \times 100$$

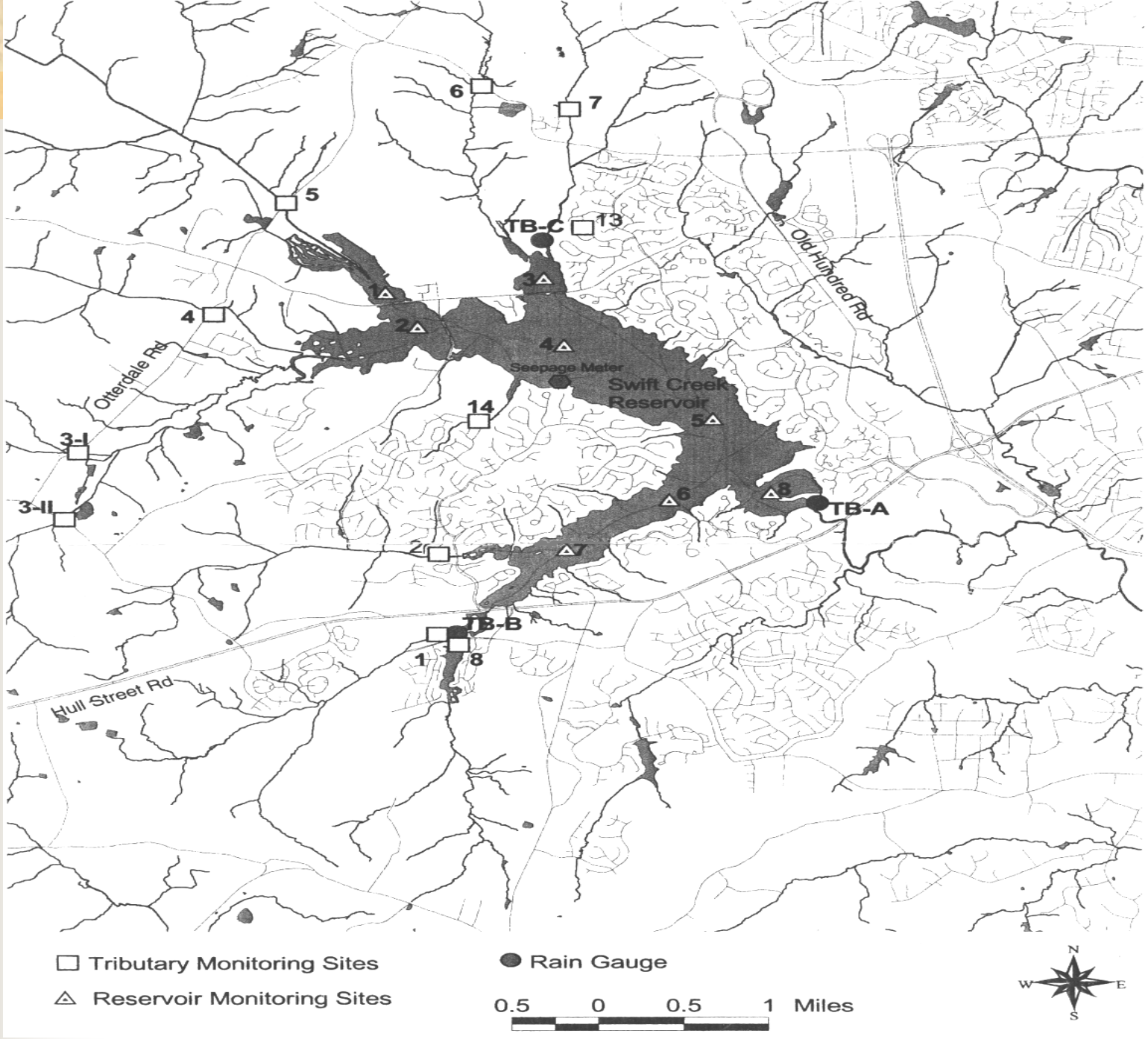

Inflow (Site 77 only)
Outflow
EMC Reduction
TSS (mg/L)
TSS EMC Reduction (%)
Storm Date
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
100
90
80
70
60
50
40
30
20
10
0
5/5/2003
5/10/2003
5/15/2003
5/21/2003
5/25/2003
5/31/2003
6/7/2003
6/19/2003
7/2/2003
7/9/2003
7/22/2003
7/28/2003
8/5/2003
9/4/2003
9/12/2003
9/18/2003
11/6/2003


11.3
Inflow (Site 77 only)
Outflow
EMC Reduction
TP (mg/L)
TP EMC Reduction (%)
Storm Date
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100
5/5/2003
5/10/2003
5/15/2003
5/21/2003
5/25/2003
5/31/2003
6/7/2003
6/19/2003
7/2/2003
7/9/2003
7/22/2003
7/28/2003
8/5/2003
9/4/2003
9/12/2003
9/18/2003
11/8/2003

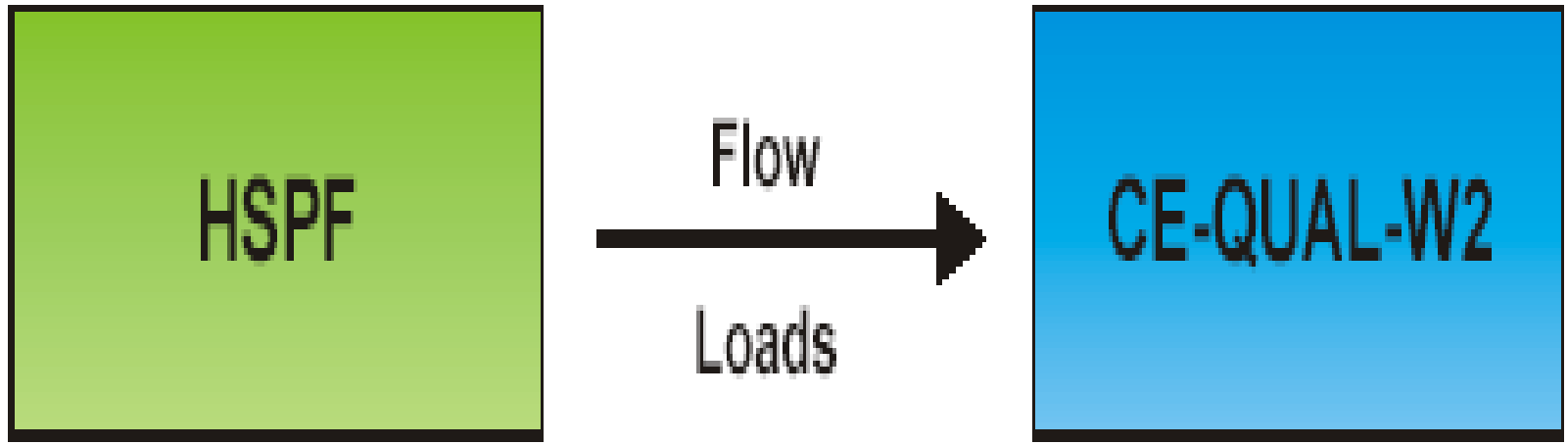

3840
Woolridge Rd

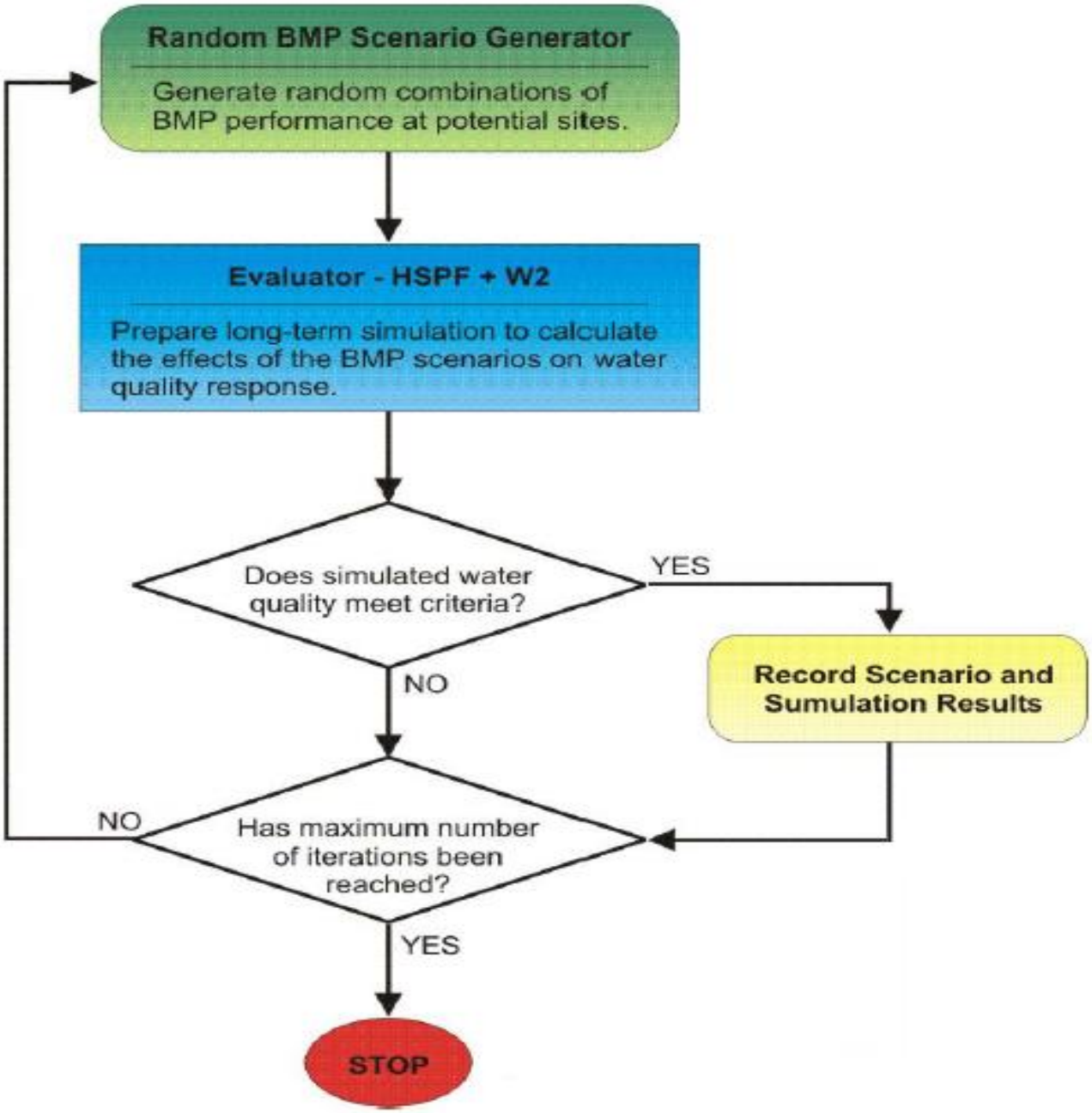

SCWTP 5
2%
SCWTP 3-II
1%
SCWTP 8
1%
SCWTP 1
2%
SCWTP 3-I
1%
SCWTP 2
2%
SCWTP 13
3%
SCWTP 14
3%
SCWTP 7
46%
SCWTP 4
17%
SCWTP 6
22%

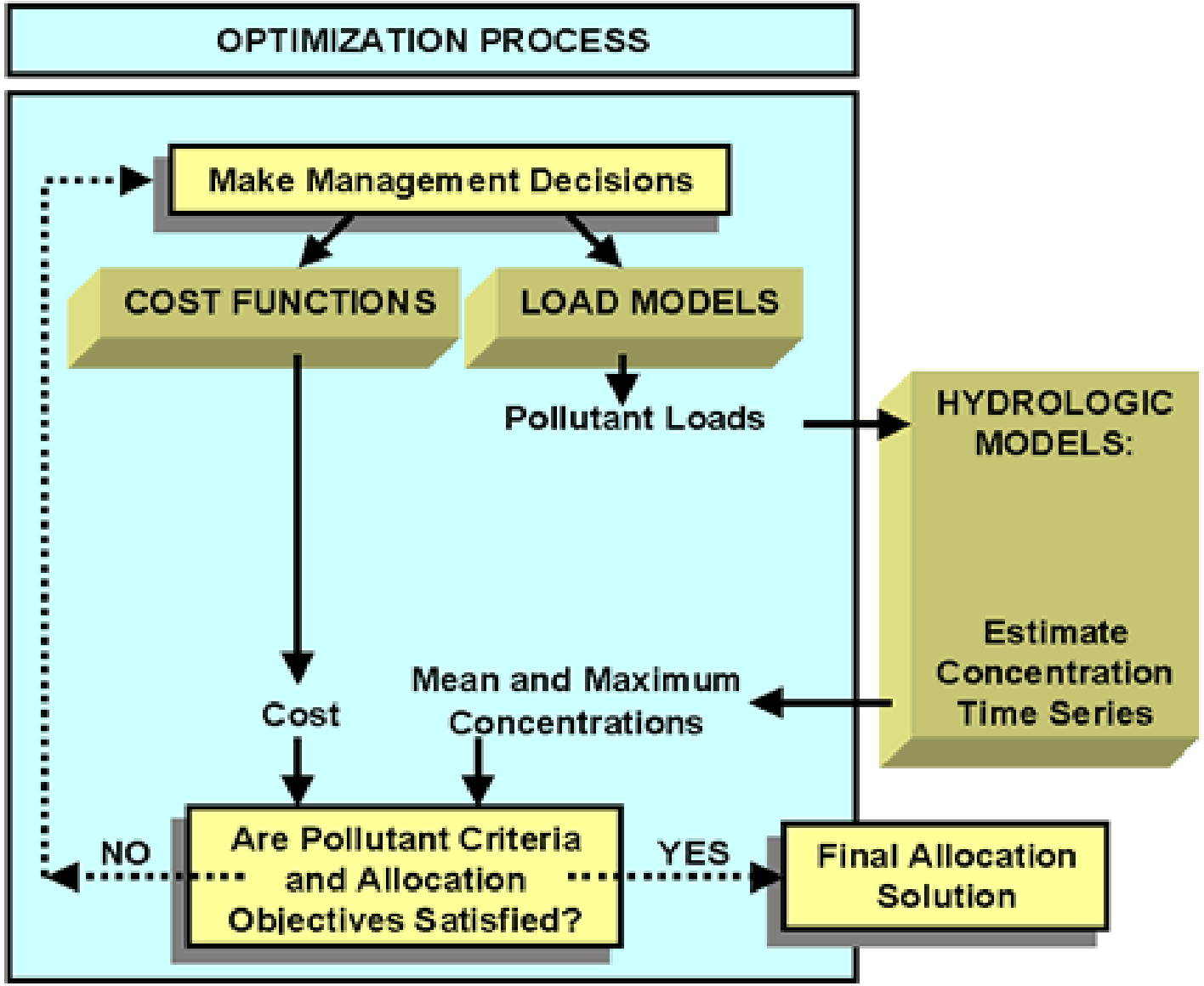

SCWTP 3-I
3%
SCWTP 14
3%
SCWTP 8
2%
SCWTP 2
5%
SCWTP 3-II
7%
SCWTP 6
23%
SCWTP 5
7%
SCWTP 4
20%
SCWTP 13
8%
SCWTP 1
9%
SCWTP 7
13%

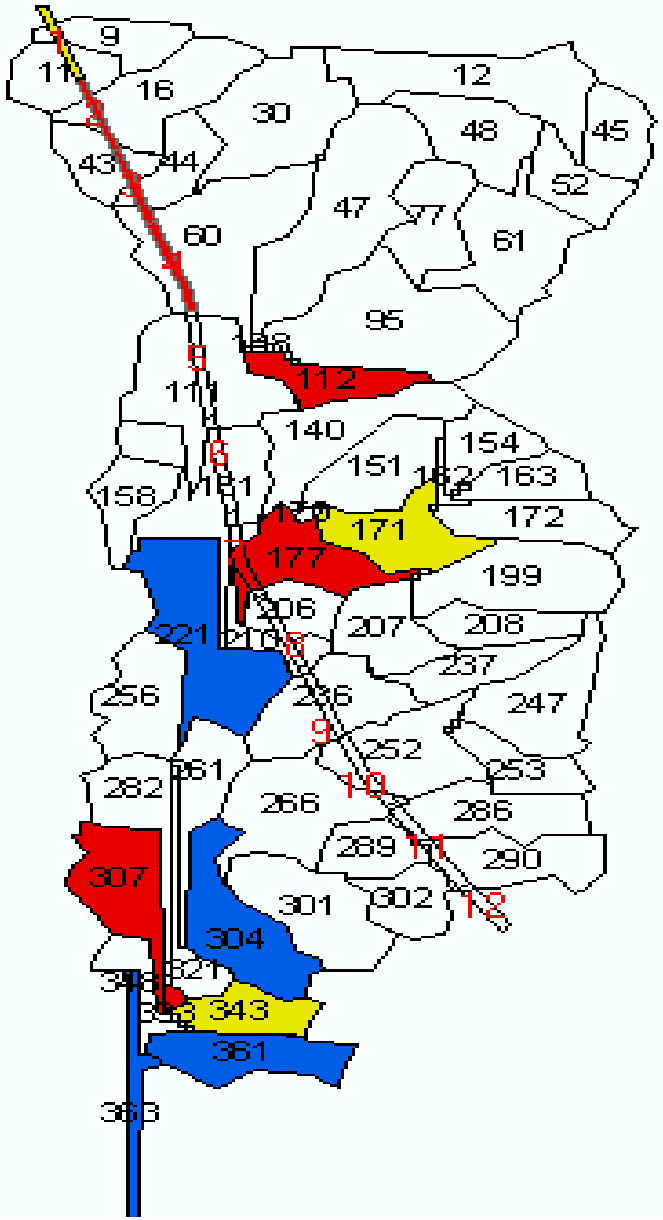

6
7
5
TB-C
13
Old Hundred Rd
1
3
4
2
4
Seepage Meter
Swift Creek
Reservoir
Otterdale Rd
14
5
3-I
3-II
6
8
TB-A
2
7
TB-B
1
8
Hull Street Rd
Tributary Monitoring Sites
Reservoir Monitoring Sites
Rain Gauge
0.5 0 0.5 1 Miles
N
W
E
S

Linking Watershed Model to Reservoir Model




Random BMP Scenario Generator
Generate random combinations of BMP performance at potential sites.
Evaluator - HSPF + W2
Prepare long-term simulation to calculate the effects of the BMP scenarios on water quality response.
Does simulated water quality meet criteria?
YES
NO
Record Scenario and Sumulation Results
NO
Has maximum number of iterations been reached?
YES
STOP


OPTIMIZATION PROCESS
Make Management Decisions
COST FUNCTIONS
LOAD MODELS
Pollutant Loads
HYDROLOGIC MODELS:
Estimate Concentration Time Series
Mean and Maximum Concentrations
Cost
NO
Are Pollutant Criteria and Allocation Objectives Satisfied?
YES
Final Allocation Solution



Blue: Detention Pond;
Yellow: Grassy Swale;
Red: Both;
Hollow: No BMPs;

Figure. The BMPs Placement when TSS removal efficiency=0.7

The total cost is: $452,376.80

U.S. Announces Major Clean Water Act Settlement with Wal-Mart 5/12/04

- $3.1 million Penalty is largest for stormwater violations at construction sites
- Wal-Mart builds 200+ stores each year
- Violations at 24 sites in nine states cited
  - Failure to obtain a permit before construction
  - Failure to develop a plan to control polluted runoff from the construction site
  - Failure to adequately install sediment & erosion control on the sites
  - Failure to protect sensitive ecosystems