Construction Site Storm Water Best Management Practices (BMPs)

Training Seminar

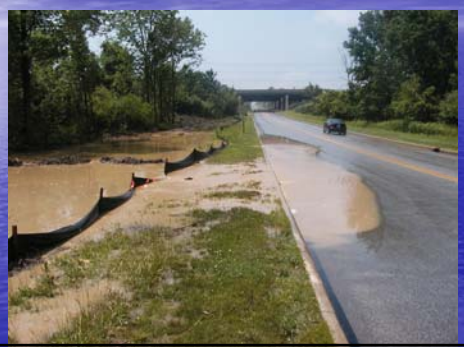
December 5, 2005

Agenda

- The Basics
- Storm Water Pollution Prevention Plans
- BMPs during Development
- Non-Sediment Pollution Controls
- Post-Construction BMPs

Why is storm water runoff from construction sites a problem?

Sediment is a Pollutant



Construction can destroy stream habitat

How Are Sites Regulated?

- Ohio EPA sets minimum requirements
  - NPDES Permit for Construction Activities
  - All "Operators" must obtain NPDES permit
- Small MS4 Communities must develop a local program equivalent to Ohio EPA's program
  - By March 2008 for baseline communities
  - By March 2006 for RDW communities

Which Sites are Regulated?

- Construction Activity is any clearing, grubbing, grading, filling or excavating
  - 1 or more acre disturbed
- Larger Common Plan of Development or Sale
  - Can include parcels < 1 acre
  - "Plan" has broad definition

Who Is an "Operator"?

- Parties with operational control over construction plans including the ability to change them
  - Developer
  - Engineer?
- Parties with day-to-day operational control of activities necessary to comply with permit
  - General Contractor
  - Home Builder

How is NPDES Permit Obtained?

- Notice of Intent
  - Filed by Developer
  - Must be submitted at least 21 days prior to start of construction
  - Cannot start construction until authorized by Ohio EPA
  - Authorizing NOI does not assure that plans comply with NPDES permit

How is NPDES Permit Obtained?

- Co-Permittee Notice of Intent
  - Filed by General Contractor or other "operators"
  - Must be filed prior to working at site
- Individual Lot Notice of Intent
  - Filed when parcel is subdivided and sold to another party
  - Filed by Home Builder or Parcel Purchaser
  - Must be filed at least 7 days prior to starting construction

Basic Requirements

- Develop a Storm Water Pollution Prevention Plan (SWP3)
- Implement the SWP3 per specified timeframes
- Assure compliance with the NPDES permit through regular inspection of BMPs
- Install BMPs capable of treating runoff from the development on a permanent basis
- Restabilize areas disturbed by construction

What is an SWP3?

- Comprehensive document consisting of narrative, blue prints, detail drawings & calculations
  - Sediment & Erosion Control
  - BMPs for Non-Sediment Pollutants during Construction
  - Post-Construction BMPs

Construction Sequence

- Can be described in narrative or presented graphically
- Must be site specific
- Must cover all phases of construction
  - "Before storm sewer" vs. "After storm sewer"
- Assure that perimeter sediment controls and sediment ponds will be installed prior to grading contributing drainage area
  - If permanent ponds are to be sediment ponds during construction, must be installed prior to grading site

Rainwater and Land Development

- All BMPs must be designed and implemented in accordance with the guidelines in this manual
- A revised version should be available in 2005

Sediment & Erosion Controls

- Erosion Controls prevent sediment from becoming suspended in runoff
  - Work by establishing ground cover
  - Stop 90 to 98% of soil loss
- Sediment Controls remove sediment from runoff once it becomes suspended
  - Work by ponding runoff to allow sediment to settle
  - Stop 40 – 80% of soil loss

Erosion Control

Temporary Seeding & Mulching

Matting

Stone Haul Road

Erosion Control

- Temporary Stabilization
  - Required on all areas where soil is disturbed but will be left idle for 21 days or longer
  - Must be initiated within 2 days of last disturbance for areas within 50 feet of a stream
  - Must be initiated within 7 days of last disturbance elsewhere
- Site should be reviewed weekly to determine where temporary stabilization is appropriate

Erosion Control

- Permanent Stabilization
  - Required on all areas that reach final grade
  - Must be initiated within 2 days of reaching final grade on all areas within 50 feet of a stream
  - Must be initiated within 7 days of reaching final grade on all other areas
- May have to temporarily stabilize until permanent stabilization can be properly performed

Sediment Control

Sediment Basin

Inlet Protection

Silt Fence

Sediment Controls

- Required for all areas of the site that will remain disturbed for 14 days or longer
- Must be installed within 7 days of first grubbing
- Must be installed prior to grading the area the BMP will control
- Must be functional throughout earth disturbing activities
- Must pond runoff to be considered functional
  - Perform required maintenance to assure

Selecting Sediment Controls

- Sheet flow vs. Concentrated flow
- Size of drainage area
- Consider the Construction Sequence
  - Different stages may require different methods
  - Has sequence been discussed with contractor?

Sheet Flow vs. Concentrated Flow

Sheet Flow

Concentrated Flow

Typical Non-Sediment Pollutants

- Trash & Debris
- Cement Washwater
- Paint pan or drywall washwater
- Fuel Tanks
- Leaking Fluids from Construction Vehicles
- Dust Control
- Street Sweeping

Post-Construction BMPs

- Are either structural or non-structural
- Are permanent site features
- Function by:
  - Reducing the creation of storm water runoff
  - Capturing and treating storm water runoff
  - Infiltrating storm water runoff

Ohio EPA Requirements

- Required on all construction projects where ≥ 1 acre of land disturbed
  - Larger Common Plan of Development or Sale
  - Must be designed to meet two goals:
    - Remove pollutants from runoff
    - Control hydrologic impacts to receiving stream
- Exceptions
  - Linear projects where no impervious area is created, e.g., pipeline or walking trail
  - Public transportation projects which start construction prior to March 10, 2006

Structural BMPs

- Required for all sites ≥ 5 acres
- Appropriate for all sites
- Must be sized to capture and treat the Water Quality Volume (WQv)
  - WQv = 0.75 * C * A/12
- Must be designed to meet the target draindown time
  - 24 to 48 hours, depending on BMP selected
- Must provide an additional volume = 20% of WQv for storage of accumulated pollutants

Calculating the WQv

- Use "C" value per table at right
- "C" value is specific to the drainage area to the BMP
- If mixed-use, do a weighted average "C" based on land area
- Will allow use of ASCE formula
  - $C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$
  - Check local ordinance to see if permitted

Runoff Coefficients (C)	
Industrial & Commercial	0.8
High Density Residential (> 8 dwellings/acre)	0.5
Medium Density Residential (4 to 8 dwellings/acre)	0.4
Low Density Residential (<4 dwellings/acre)	0.3
Open Space and Recreational Areas	0.2

Draw Down Time

Target Draw Down Time	
BMP	Time (hrs)
Infiltration	24 - 48
Vegetated Swale & Filter Strip	24
Extended Detention Basin (Dry Basin)	48
Retention Basins (Wet Basins)* *Provide both a permanent pool and an extended detention volume above the permanent pool, each sized at 0.75*WQv	24
Constructed Wetlands (above permanent pool)	24
Sand Filters & Bioretention	40

- BMPs listed in this table are approved for general use throughout Ohio
- Any BMP not listed is considered an alternative BMP
- Alternative BMPs are permitted for use on a case-by-case basis by Ohio EPA

Other Ohio EPA Requirements

- Must provide long-term maintenance plan for all BMPs
  - Including identification of responsible party
- For redevelopment projects
  - Reduce impervious area by 20%
  - Provide structural BMPs to treat 20% of WQv
  - Do a combination of first two options to provide same net effect

Requirements for Small Sites

- "Larger Common Plan of Development or Sale" calls for 1 to 5 acres of total cumulative land disturbance
- BMPs <u>are</u> required on these sites!
  - Allow greater flexibility in BMP selection
  - Alternative BMPs may be used
  - However, if selected, structural BMPs are still expected to be designed per the WQv and draindown time requirements of large projects

Non-Structural Post-Construction BMPs

A green parking lot at the Orange Bowl in Miami, Florida (Source: Invisible Structures, no date)

Non-Structural BMPs

- Are encouraged, but no specific requirements
  - Local community to establish via MS4 program
  - 25 foot preservation buffer along streams recommended

Structural Post-Construction BMPs

Extended Detention Ponds

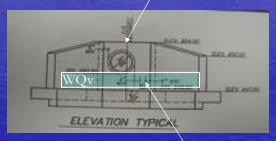
- Three kinds
  - Dry Detention Basins
  - Wet Retention Ponds
  - Constructed Wetlands
- All three must be designed to provide extended detention of the WQv
- Orifice is sized assuming a brimful drawdown of the WQv over the target drawdown time
  - Q_{avg} = WQv/drawdown time
  - $Q_{avg} = CA(2gh_{avg})^{0.5}$; solve for A (area of orifice)

Extended Detention Ponds

- Soils with low permeability are best location for ponds
- Ponds that intercept groundwater have the potential to contaminate groundwater
  - May need lining to prevent contamination
  - However, lined ponds require large drainage areas and may create stagnant water
- Ponds should not be located in floodplains
- Ponds should not be located in wetlands
  - However, Army Corps has final say

Dry Extended Detention Ponds

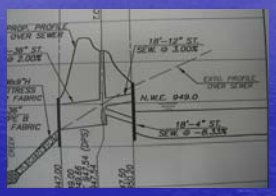
- Storage for the full WQv above the invert of the WQ orifice
- WQ orifice sized for 48-hour drawdown time
- Additional orifice set at top of WQv to control the peak rate of discharge, per local requirements
- Additional 20% of WQv in forebay(s) or micropool



Wet Pond with Extended Detention

Wet Retention Ponds

- Wet pool ≥ 0.95 * WQv
  - 0.75 * WQv per permit
  - 0.20 * WQv for pollutant storage
- WQ orifice at normal waterline elevation
- Extended Detention Volume (EDv) = 0.75*WQv above wet pool
- WQ orifice designed to drawdown EDv in 24 hours

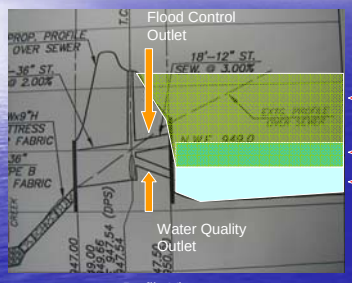


Outlet Structure of Pond

OUTSIDE VIEW

INSIDE VIEW

Wet Pond w/Extended Detention



Profile View

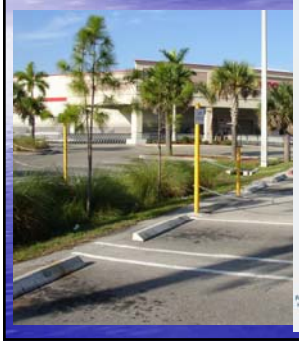
Flood Control Volume (per local requirements)

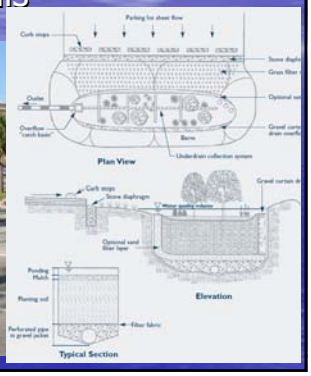
Extended Detention Volume = 0.75 * WQv

Wet Pool = (0.75 * WQv) + (0.20 * WQv)

The WQ Outlet is designed to drain the EDv in 24 hours

Bioretention Cells





Bioretention Cells

- Use of "in situ" soils generally <u>not</u> appropriate
- Optimal filter media is planting soil consisting of sandy loam, loamy sand, or loam texture with a clay content of 10 – 25%
  - Infiltration rate should be 0.5 in/hr
  - pH of 5.5-6.5
  - Organic content of 1.5 – 3%
  - Maximum concentration of soluble salts = 500 ppm

Bioretention Cells

- Depth of filter media is 3 – 5 feet
  - May require "curtain drain" to keep dry if placed in area with high seasonal groundwater levels
  - Need "fall" between inlet and point of storm water outlet to assure drainage
- Maximum drainage area per cell is 5 acres
  - Optimal is 0.5 to 2 acres
- Can be designed without underdrain system if soils are suitable for infiltration

Bioretention Cell

- Runoff volume in excess of WQv is directed to storm sewer system
- Ponding volume above cell = WQv
- Additional 20% of WQv can be provided as additional ponding volume or within pretreatment structures
- Use Darcy's Law to calculate area of filter media
  - A = WQv * d/[k*t(h + d) [=] ft2

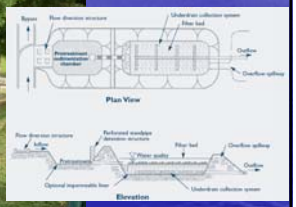
    Where d = depth of filter media [=] ft

    k = hydraulic conductivity of filter media [=] ft/day

    h = average height of WQv above filter media [=] ft

    t = drawdown time = 40 hr

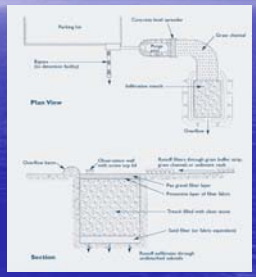
Sand Filters



Sand Filters

- Many design variations, but all consist of
  - Sedimentation Chamber
  - Sand Filter Bed
- Can be built in underground vaults
  - Allows their use in any soil conditions
  - Prevents interaction with groundwater
- For surface sand filters, similar restrictions as with bioretention, except
  - Greater minimum head difference of 5 feet
  - Not feasible where seasonal high groundwater level exists
    - Minimum recommended separation is 3 feet

Infiltration Trenches



Infiltration Trench

- BMP most susceptible to failure if not sited properly
- Underlying soil permeability is key to success
  - Feasible for "A" and "B" Soil Groups

Table 11-P3-1 Minimum Infiltration Rates of NRCS Hydrologic Soil Groups

Group	Soil Texture	Minimum Infiltration Rate (in/hr)
A	Sand, loamy sand, or sandy loam	0.30 – 0.45
B	Silt loam or loam	0.15 – 0.30
C	Sandy clay loam	0.05 – 0.15
D	Clay loam, silty clay loam, sandy clay, silty clay, or clay	0 – 0.05

Note: Tabulated infiltration rates are approximately equal to saturated hydraulic conductivities.
Source: U.S. Soil Conservation Service, 1986.

Infiltration Trench

- Infiltration rates should be determined using an actual field test – not book data
- *Design* infiltration rates should be assumed to be half of the *field-tested* infiltration rate to account for clogging over time
- A field test should be conducted to determine actual depth to groundwater and depth to bedrock if book data indicates ≤ 4 feet
  - Minimum separation between trench bottom and seasonal high groundwater level = 3 feet

Water Quality Swales

Enhanced Dry Swale

Enhanced Wet Swale

- Dry Swales consist of a filter bed of permeable soils over an underdrain system
- Wet Swales are designed to retain water and develop marshy conditions

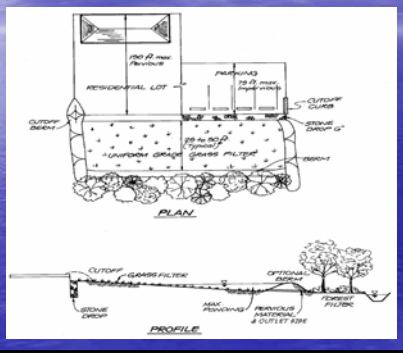
Water Quality Swales

- Channel slopes of 1-2%
- Bottom channel width = 2 – 8 ft
- Maximum ponding depth at the downstream end should be ≤ 18 inches
- Energy dissipation must be provided at inlet end
- Check dams placed in swales to promote infiltration (dry swales) or to create wetland "cells" (wet swales)

Water Quality Swales

- Dry swales are essentially linear bioretention cells
  - Permeable soil layer depth is 30 inches
  - Soil permeability of 1 ft/day (1.5 ft/day maximum)
  - High level of organic material
- Wet swales are essentially linear constructed wetlands
  - Ideal where groundwater level is at or near surface
  - Good in poorly-drained soils

Vegetated Filter Strips



Vegetated Filter Strip

- Soils must support a stand of dense turf grass
- Slope of filter strip should be 2 – 6% maximum
- Treat very small drainage areas
  - Maximum slope length to filter strip
    - 75 feet from impervious areas
    - 150 feet from pervious areas
- Flow must be directed to filter strip as sheet flow

About Swales and Filter Strips

- Ohio EPA intends these practices to be designed to provide 24-hour detention of the WQv
  - *"Enhanced Swales"* and *"Filter Strip with Berm"* in State of Georgia manual
  - *"Water Quality Swales"* in State of Connecticut manual
- Swales and Filter Strips designed using "flow-through" criteria should be considered to be "alternative BMPs"

For More Information

Websites
Ohio EPA
www.epa.state.oh.us/dsw/storm/index.html
USEPA
http://cfpub.epa.gov/npdes/home.cfm?program_id=6

Ohio EPA Northeast District Office
Dan Bogoevski (330) 963-1145
dan.bogoevski@epa.state.oh.us
Kelvin Rogers (330) 963-1117
(Summit & Portage Co.)
kelvin.rogers@epa.state.oh.us
Chris Moody (330) 963-1118
(Medina, Geauga, Trumbull & Ashtabula Co.)
chris.moody@epa.state.oh.us

Ohio EPA Central Office
Mike Joseph (614) 752-0782
John Morrison (614) 644-2259

For More Information

Recommended BMP Manuals
State of Georgia
www.georgiastormwater.com
State of Connecticut
http://www.dep.state.ct.us/wtr/stormwater/strmwtrman.htm
State of California
www.cabmphandbooks.com
State of New York
www.dec.state.ny.us/website/dow/toolbox/swmanual
Urban Small Sites Best Management Practices Manual
www.metrocouncil.org/environment/Watershed/bmp/manual.htm