

Module 2: Selection of Controls and Site Planning for Construction Site Erosion Prevention

Robert Pitt, Ph.D., P.E., BCEE
Emeritus Cudworth Professor of Urban Water Systems
Department of Civil and Environmental Engineering
University of Alabama
Tuscaloosa, AL

1

Recommended Controls for Small Construction Sites (EPA Guidance)

- Best control accomplished through proper planning, installation, and maintenance of controls.
- Non-Structural Controls:
 - Minimize disturbance
 - Preserve natural vegetation
 - Good housekeeping

2

Recommended Controls for Small Construction Sites (cont.)

- Small sites have less space that prevent use of some controls, plus less access to qualified help.
- Structural Controls:
 - Erosion controls (mulch, grass, and stockpile covers)
 - Sediment controls (silt fence, inlet protection, check dams, stabilized construction entrances, and sediment traps)

3

Typical Local Erosion Control Requirements (Storm Water Management Authority, Inc.)

- All surface waters flowing towards construction areas shall be either passed through the site in protected channels or diverted using berms or channels.
- All slope or fill areas which have been graded shall within 14 days of the completion of grading, or the completion of any phase of grading, be planted or otherwise provided with ground cover to retrain erosion.

4

Typical Local Erosion Control Requirements (cont.)

- All upslope and downslope controls must be in place before any on-site construction begins.
- No visible floating scum, oil or other matter allowed in discharge.
- All controls shall be checked and repaired monthly and within 24 hrs after any rainfall at the site of 0.75 inch occurring within 24 hrs.

5

Typical Local Erosion Control Requirements (cont.)

- The control plan must include the size of the disturbed areas and a schedule of the starting and completion dates of land disturbing activities.
- Written descriptions of controls and schedule of their implementation
- Description of procedures for proper storage, handling, and disposal of construction materials.

6

Typical Erosion Control Plan Contents (Storm Water Management Authority, Inc.)

- Present contours and drainage facilities on property
- Drainage facilities on adjacent property
- Proposed contours after development (intervals of 2 ft, or less)
- Description of existing site conditions (erosion characteristics of soils, potential problem areas, soil stabilization specifications)

7

Erosion Controls General Approach

- Divert upland drainage
- Mulch exposed ground
- Control site discharges
- Good housekeeping
- Proper maintenance

8

Erosion Control Manuals

- There are many erosion control manuals that have been produced over the past 10 years, or so and these provide a wealth of information on the selection and construction of erosion controls.
- However, they rarely relate performance and design features.
- The following are lists of control practices listed in 95 recent international guidance manuals for construction site erosion controls.

9

Construction Site Erosion and Sediment Controls Listed in 95 International Guidance Manuals

Erosion and Sediment Control Tool	included in % of 95 reviewed US and international manuals
Erosion Control Blanket/Geotextiles	97
Silt Fence	96
Temporary seeding	92
Mulching	91
Sediment Basin/Trap	91
Diversion/Berm	83
Check Dam	83
Permanent Seeding	81
Construction Entrance/Exit	77

10

Construction Site Erosion and Sediment Controls Listed in 95 International Guidance Manuals (continued)

Erosion and Sediment Control Tool	included in % of 95 reviewed US and international manuals
Temporary Slope Drain	75
Block and Gravel Inlet Protection	73
Grass Swale	71
Riprap-lined Swale	68
Rock Outlet Protection	67
Surface Roughening	64
Sediment Barrier	64
Fabric Drop Inlet Protection	63
Lined Swale	54

11

Construction Site Erosion and Sediment Controls Listed in 95 International Guidance Manuals (continued)

Erosion and Sediment Control Tool	included in % of 95 reviewed US and international manuals
Sodding	52
Temporary Stream Crossing	52
Preserving Natural Vegetation	51
Topsoiling	49
Straw Wattles	45
Excavated Drop Inlet Protection	41
Groundcover Planting	39
Brush/Fabric Barrier	39
Vegetated Buffer Strips	39

12

Construction Site Erosion and Sediment Controls Listed in 95 International Guidance Manuals (continued)

Erosion and Sediment Control Tool	included in % of 95 reviewed US and international manuals
Rock Filter Dam	37
Land Grading	33
Floating Turbidity Barrier	31
Level Spreader	31
Compost Socks and Berms	29
Gravel and Mesh Wire Inlet Protection	28
Subsurface Drain	27
Filter Strip	25
Soil Binders	23

13

Construction Site Erosion and Sediment Controls Listed in 95 International Guidance Manuals (continued)

Erosion and Sediment Control Tool	included in % of 95 reviewed US and international manuals
Sod Drop Inlet Protection	21
Tree Planting	20
Chemical Stabilization (PAM) land application	19
Chemical Stabilization (PAM) water application	19
Drop Structure	9
Straw Bale Sediment Trap	7
Rock Flume	3
Treatment/Coagulation Unit	1

14

Important Considerations for Guidance Manuals

- It is critical that construction site erosion control practice design manuals consider local conditions, especially:
 - Rainfall conditions. Most practices are strongly affected by site hydrologic and hydraulic conditions. Rainfall has a direct effect on the amount of runoff and flow velocities. Devices that can withstand conditions in a generally mild rain area will frequently fail during the severe conditions found elsewhere.

15

Important Considerations for Guidance Manuals (cont.)

- Erosion rates. Maintenance is strongly influenced by the amount of sediment produced. In some areas, these rates can be much greater than in other areas, requiring special considerations for sediment storage and frequent maintenance access.
- Sediment characteristics. Very high concentrations of suspended solids and small particle sizes also require modifications of “standard” designs.

16

Primary Erosion Control Requirements

- Minimize upslope water contributions
 - General diversion structures
 - Temporary diversion structures
 - Permanent diversion structures
 - General channel stabilization
 - Check dams
 - Riprap
 - Waterway drops
 - Stream crossings
 - Grassed waterway
 - Slope down drain structure

17

Erosion Controls Diversion Channels, Berms, and Waterway Drops



18



19

Erosion Controls Protect Channels (Check dams and liners)



20

Primary Erosion Control Requirements (cont.)

- Provide Downslope Controls:
 - General sediment fence
 - Filter fabric fences
 - Straw bale fences
 - Sediment basins
 - Outlet protection

21

Typical Construction Sediment Ponds



22

Erosion Controls Filter fences create small ponding areas



23

Erosion Controls Control Site Discharges

- Filter fencing for small sites (but only for slope lengths less than about 100 ft). Expect about 10 to 50% control of suspended solids.
- Sediment ponds for areas larger than 10 acres. Expect up to 80% control of suspended solids.

24

Primary Erosion Control Requirements (cont.)

- Protect Disturbed Areas:
 - Mulching
 - Local vegetation information
 - General seeding
 - Temporary seeding
 - Permanent seeding
 - Sodding
 - Trees and shrubs
 - Maintenance of vegetation

25

Erosion Controls Slope Protection with Surface Roughening



26

Erosion Controls Slope Protection with Hydroseeding and Blankets



27

Supporting Erosion Control Requirements

- Control wastewater from dewatering operations
 - Dewatering settling basins
- Properly dispose of construction debris
- Control tracking of sediment off-site
 - Entrance controls
 - Site road controls
 - Dust control

28

On-Site Good Housekeeping Controls Gravel Driveways



29

Clean Vehicles before Traveling on Public Roads



30

Supporting Erosion Control Requirements (cont.)

- Protect storm drain inlets
 - Storm drain inlet protection
 - Inlet protection barriers
 - Inlet insert baskets
- Minimize area disturbed
 - Land grading
- Control erosion scour from roof runoff

31

On-Site Good Housekeeping Controls Inlet Protection



32

Special Controls for Working within Waterways



33

Alabama Procedures for Developing Plans for Erosion and Sediment Control

- The following are the minimum components of the plan:
 - Location or vicinity map and a clear and concise narrative describing existing site conditions, along with the proposed sediment and erosion control measures and rationale.
 - Specifications for planned erosion and sediment control measures. Reference standard design manual and describe pre-approved innovative measures.
 - Site plan or treatment map. Site development drawing showing the type and locations of planned conservation practices.

34

Step-by-Step Procedure for Plan Development

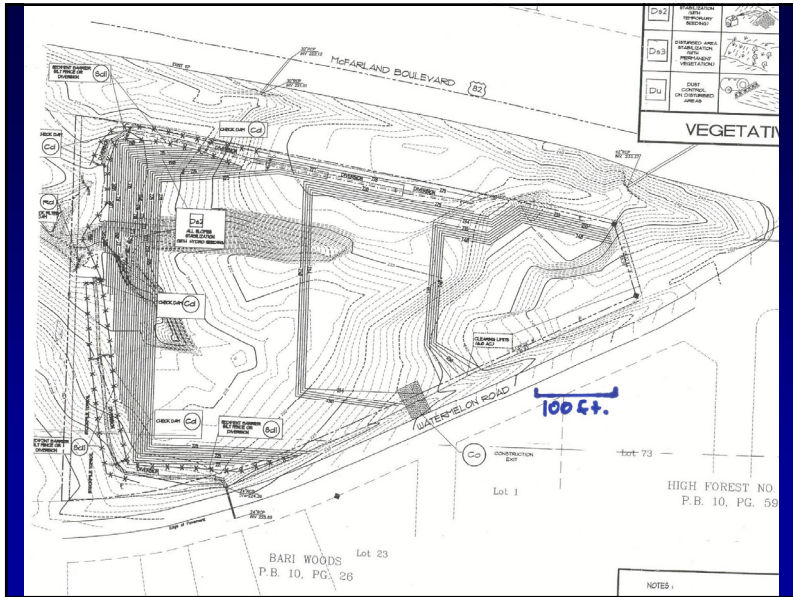
- **Step 1 – Data Collection.** Inventory existing site conditions which will help the planner develop the most effective control plan. The following information should be shown on a map and verbally explained in the plan narrative:
 - Topography (1 to 5 ft contours)
 - Drainage patterns (all existing drainages and swales)
 - Soils (major soil types, especially the soil erodibility factor k and the hydrologic soil type).
 - Ground cover (existing vegetation)
 - Adjacent areas (roads, streams, houses, utilities, etc. should be shown).

35

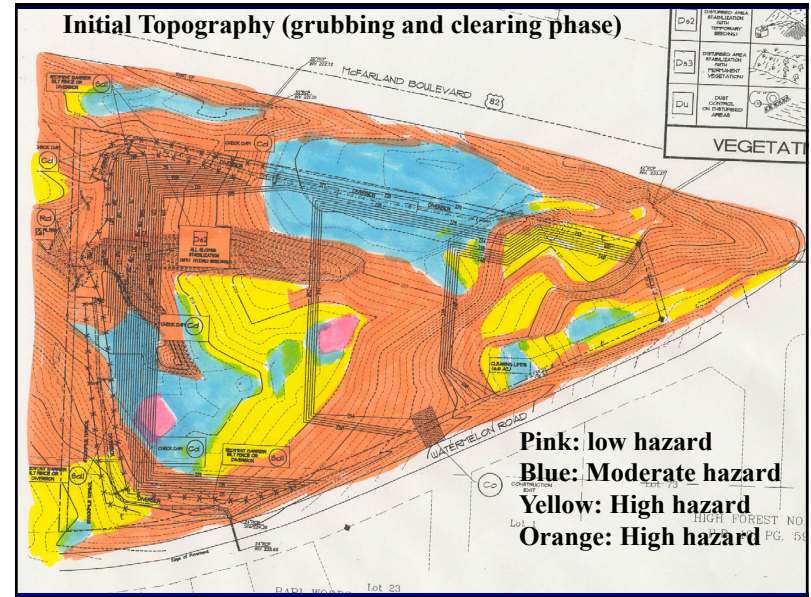
Step-by-Step Procedure for Plan Development (cont.)

- **Step 2 – Data Analysis.** Identify the site potential and limitations and associated critical erosion hazards.
 - A. Topography. Slope steepness and length determine critical hazards associated with topography. If the following are exceeded, the erosion hazard becomes critical:
 - 0 to 2% and 300 feet
 - 2 to 5% and 150 feet
 - Over 5% and 75 feet

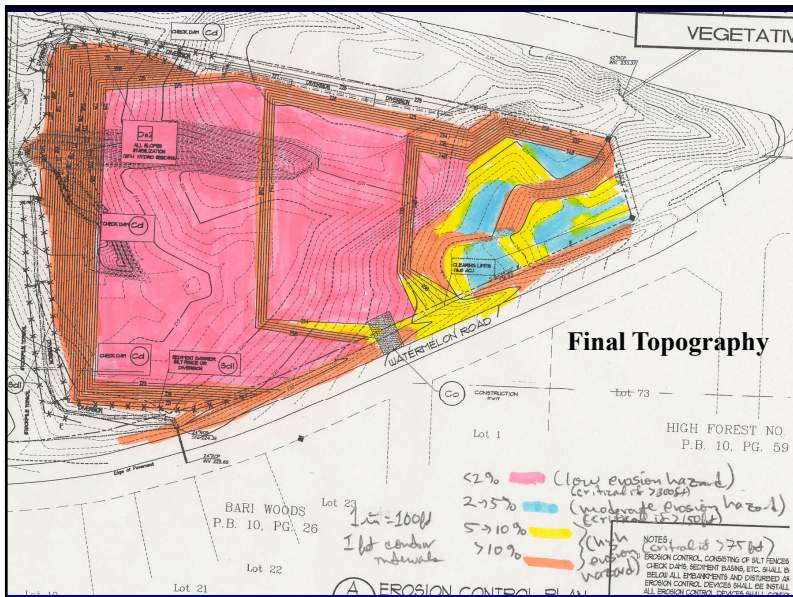
36



37



38



39

Step-by-Step Procedure for Plan Development (cont.)

- Step 2 - Data Analysis (cont.)
 - B. Drainage Patterns. Natural drainage features collect and concentrate water. These need to be identified so they can be avoided by site development. The natural drainages should also be utilized for future site drainage, after proper management.
 - C. Soils. Many soil characteristics affect erosion control. Regional soil maps generally contain general information of interest, especially depth to bedrock, depth to seasonable water table, permeability, shrink-swell potential, texture, hydrologic soil group, and erodibility. If it is likely that critical soil problems exist on the site, then more detailed and site specific soil investigations to supplement the mapped data are warranted.

40

Step-by-Step Procedure for Plan Development (cont.)

- **Step 2 - Data Analysis (cont.)**
 - D. Ground Cover. This is the most important factor in terms of preventing site erosion. Any existing vegetation that can be saved will be a great benefit. In areas where existing vegetation cannot be saved, construction needs to be carefully staged and temporary mulching or vegetation controls will be needed soon after grading operations cease.
 - E. Adjacent Areas. Downslope/downstream areas are the most important. However, upslope areas that contribute flowing water to the construction site also need to be examined and considered. Controls will be needed to divert or safely convey this upslope water, and downslope controls are needed to protect the downstream resources.

41

Step-by-Step Procedure for Plan Development (cont.)

- **Step 3 – Facility Plan Development**. A site plan needs to consider site limitations. Locate buildings, roads, parking areas, etc., to minimize site and downstream problems.
 - A. Fit development to terrain. Existing site conditions need to be considered to minimize land disturbance, erosion hazards, and development costs.
 - B. Confine construction activities to least critical areas.
 - C. Cluster buildings together.
 - D. Minimize impervious areas.
 - E. Utilize the natural drainage system.

42

Step-by-Step Procedure for Plan Development (cont.)

- **Step 4 – Planning for Erosion and Sediment Control**. The following general procedure is recommended for erosion and sediment control planning:
 - A. Divide the site into drainage areas.
 - B. Determine the limits of clearing and grading.
 - C. Select erosion and control measures.
 - Vegetative controls (consider first due to cost-effectiveness, but must carefully consider site conditions)
 - Structural controls (more costly, but can be designed for site specific conditions and desired levels of control)
 - Management controls (sequencing construction, etc.)
 - D. Plan for stormwater management.

43

Step-by-Step Procedure for Plan Development (cont.)

- **Step 5 – Plan Assembly**. This final step is consolidating the pertinent information into the mapping and narrative portions of the plan.

44

Busiest Markets for Single-Family Housing Permits (1999)

Market Area	Single-family Housing Permits (1999)	Percent Change From 1998
Atlanta	25,066	+11%
Phoenix	21,290	+13%
Dallas-Ft. Worth	17,434	+6%
Chicago	14,954	+7%
Washington, DC	14,703	0.07

Source: U.S. Housing Markets, 1999a.

45

Acres Converted from Undeveloped to Developed Uses Typical Large City

Type of Land	Acres Converted to Development 1992-1997 (thousands) Annual Average	Percent Contribution by Type of Land
Cropland	574.8	26.6%
Conservation Reserve Program land	1.5	0.1%
Pastureland	391.2	17.4%
Rangeland	245.9	11.0%
Forest land	939.0	41.9%
Other rural area	89.1	4.0%
Water areas and federal land	1.8	0.1%
Total	2,243.4	100.0%

46

U.S. Estimates of Land Area Developed per Year

Type of Construction		Total NRI Acreage ^a	Acres Waived or not Covered	Adjusted NRI Acreage ^b
Residential	Single-family	546,783	12,905	533,878
	Multifamily	258,616	6,434	252,182
Nonresidential	Commercial ^c	1,377,070	44,594	1,332,476
	Industrial	60,932	3,412	57,523
Total		2,243,400	67,345	2,176,058

47

Example Unit Capital Costs for Construction Site Erosion and Sediment Control Measures

Control	Unit	Typical Unit Cost
Temporary seeding	Sq yard	\$0.15
Mulching	Sq yard	\$0.45
Sodding	Sq yard	\$3.60
Filter fabric fence	foot	\$5.10
Inlet protection device	inlet	\$195.00
3 ft deep diversion swale	100 ft	\$1,200.00
Sediment pond	1 acre	\$73,400.00

48

Quantities of Silt Fencing Needed for Different Developments (at about \$5/ft)

Site size	Feet of Silt Fence			
Acres	Single-family	Multi-family	Commercial	Industrial
1	-	-	-	-
3	621	722	361	361
7.5	1,553	1,143	600	600
25	5,175	3,129	2,087	2,087
70	14,490	5,238	3,492	3,492
200	41,400	8,853	5,902	5,902

49

Summary of Available Controls and Planning Efforts

- Many erosion control guidance manuals exist, but care is needed to ensure they are applicable for local extreme conditions.
- Redundant controls are needed (upslope water diversions, protect exposed soil, downslope controls, and good housekeeping).
- Many options are available for each component. These can be selected (and designed) to fit site conditions.

50