Erosion Control 101 for Puerto Rico
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Erosion & Sediment Control & Puerto Rico

- Needed for General Health & Economic Welfare
- It’s Required – Regulation for the Control of Erosion & Prevention of Sedimentation + EPA Regulations
Puerto Rico is Not Alone!

Implementation is Difficult
Statewide activity
10,000 sites
Approximately 110,000 ac. disturbance

Soil loss @150 tons/ ac/ year
16,500,000 tons
15,670,000 cu. yd.

$738,500,000

State of MD
Effect of Erosion and Sediment Control Measures On Suspended Sediment Concentrations From Piedmont Construction Sites

Storm Median Sediment Concentration (mg/l)

<table>
<thead>
<tr>
<th>Construction Site Condition</th>
<th>Median Concentration (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncontrolled</td>
<td>4,145</td>
</tr>
<tr>
<td>Erosion</td>
<td>680</td>
</tr>
<tr>
<td>Sediment</td>
<td>283</td>
</tr>
<tr>
<td>Urbanized</td>
<td>50</td>
</tr>
<tr>
<td>Natural</td>
<td>25</td>
</tr>
</tbody>
</table>

Uncontrolled = No Erosion or Sediment Control
Erosion = Erosion Control Only
Sediment = Erosion and Sediment Control
Urbanized = Post Construction Sediment Levels (NURP, 1987)
Natural = Predevelopment, Prior to Construction

Source: Schueler and Lugbill, 1990
Erosion Control Implementation?

• Staff & Resources
• Politics (Enforcement)
• Conventional Way of Doing Things
• Agency Coordination
PRIORITY ESC Practices for Puerto Rico:
Not ONLY Practices. . .But Perhaps First Practices

• Fit Island Conditions
• Existing Practice in Handbook
• Simple But Effective
• Good Cost/Benefit
• Ease of Implementation & Enforcement
Priority ESC Practices for Puerto Rico

• #1 – Minimize Site Clearing
• #2 – Construction Phasing
• #3 – Construction Entrance
• #4 – Silt Fence, Properly Installed
• #5 – Rapid Soil Stabilization
• #6 – Traps, Basins & Diversions
• #7 – Your Ideas!
Other ESC Practices in Handbook:
Vegetative, Structural, Runoff Practices

- Construction Sequence
- Topsoiling, Mulching, Matting, Sodding
- Permanent Seeding & Planting
- Filter Strip
- Construction Road Stabilization
- Straw Bales
- Stormwater Conveyance Channel
- Check Dams
- Inlet & Outlet Protection
- Level Spreader
Priority ESC Practice #1

Minimize Site Clearing
1. Minimize Site Clearing

What It Is:

– Clearing Only Area Necessary For Construction
– Buffering Sensitive Features

Techniques:

– Identify Sensitive Features On Plan
– Clearly Mark Limits of Clearing in Field
– Keep Construction Equipment & Traffic Out of Sensitive Areas
Marking Sensitive Resources in Field

TREE PRESERVATION AREA
DO NOT:
- STOCKPILE MATERIALS
- ENTER WITH EQUIPMENT OR VEHICLES
- REMOVE OR RELOCATE FENCE OR OTHER BARRIERS
Silt Fence is Not Adequate Barrier
Silt Fence + Orange Fence: A Little Better

Photo: Delaware Sediment & Stormwater Program
PR Erosion & Sediment Control Handbook

• Sections 2.6 & 2.8 (Erosion Control Plan)
  – Restrict construction to least critical areas
  – Avoid streams, flood plains, steep slopes, erodible soils
  – Physically mark limits of construction

• Section 3.2 (Minimum ESC Practices)
  – More conservative BMPs next to sensitive areas
PR Erosion & Sediment Control Handbook (continued)

- Sections 3.4.1 – Tree Preservation & Protection
- Section 3.4.10 – Riparian Forest Buffer
Implementation Issues

• Identify Sensitive Areas on Site Plan
• Strong Link From Plan to Field
• Education of Contractor & Subcontractors
• Installation & maintenance of fencing or barrier
• $3 - $5/linear foot
Priority ESC Practice #2

Phased Construction
2. Phased Construction

What Is It:

• Only one portion of site is disturbed at any one time
• Subsequent phases are not started until earlier phases are substantially completed
• Reduce soil erosion by minimizing the duration & area of exposed soil
Sequence Of Construction (Part of Phasing)

- Protect existing vegetation
- Stabilized construction access
- Sediment traps and barriers
- Runoff conveyance system
- Clearing and grading
- Building construction
2. Phased Construction

- Can reduce erosion by 40% over traditional mass grading

**Technique:**
- Requires careful planning
- Phasing plan developed early in the project planning and design stage
- Phases should correspond to existing and future drainage boundaries
- Minimum “threshold” size (15 acres)
- “Cut” soil matches “fill” requirement
- Locate temporary stockpiles and construction access
- Establish trigger for completion of each phase
- ID key ESC elements to inspect in each phase
PR Erosion & Sediment Control Handbook

• Section 2.8 (Implementing the Plan)
  – Limit the size of areas exposed at any one time

• Section 3.3 & 3.3.1 (Construction Sequence)
  • Work schedule coordinates timing of construction with installation of ESC practices (sequencing is one component of phasing)
Implementation Issues

• Can be challenging to balance cuts and fills within limited areas
• Certain equipment may need to be mobilized more than once
• Economic consequences?
• Need to coordinate with dry/rainy seasons in terms of stabilization
• Phasing can be hard to enforce

**Cost**: variable – may entail extra costs for mobilization and stockpiling; can also save $ by limiting structural ESC practices, repairs and maintenance
Priority ESC Practice #3

Construction Entrance & Wash Rack
Mud On Roads is Public Safety Issue
P.S. Don’t Wash It Off!

Photo: Albemarle County, Virginia
3. Construction Entrance & Wash Rack

What It Is:

- Clearly Defined & Stabilized Entrance/Exit from Construction Site to Paved Road
- If Needed, Water Available to Wash Tires
- Wash Water Goes to Sediment Trap, Dirt Bag, or Slow Release to Vegetated Area (NOT Wetland)

Techniques:

- 6” Aggregate + Filter Fabric
- At Least 12’ Wide X 50’ Long
Wash Water To Sediment Trap

Photo: Maryland Department of the Environment
Dirt Bag For Wash Water OR Basin Dewatering

Photo: Maryland Department of the Environment
Section 3.2 -- Minimum ESC Practices

Section 3.5.1 – Stabilized Construction Entrance

– Don’t Wash Vehicles Near Waterways
– Define Ingress & Egress From Paved Roads
3. Implementation Issues

- 1st Thing To Do At Site
- Careful Oversight By Contractor & For Subcontractors
- Maintenance Can Be Frequent
- Wash Water Must Be Managed
- Cost: $2 – 3K for paved w/ wash rack
Priority ESC Practice #4

Silt Fence
4. Silt Fence

What It Is:
- Perimeter control that filters runoff before it leaves the site
- Settling is most important sediment removal function

Techniques:
- Silt fence, stakes, trenching
- Super silt fence has wire mesh backing
4. Silt Fence

• Between 65% and 85% TSS removal in field studies.

• Ongoing maintenance can cost as much as original installation over project life

Silt fences are often poorly located, installed or maintained:

Mainland data:
– Only 67% of silt fences on the ESC plan were installed.
– Only 58% were installed correctly.
– Only 34% were adequately maintained
Section 3.5.4 – Silt Fence

- Designed for sheet flow
- DA < 0.25 ac/100lf of fence (max 1 ac.)
- Flow path < 100’
- Slope < 50%
4. Implementation Issues

- Installation issues
- Maintenance chief concern
- Extra time during installation for trenching
- Improper placement (concentrated flow)
- Construction traffic
- Annual maintenance is 100% of installation cost
- **Cost:** Popular practice due to low cost - $5 per linear foot (mainland)
Priority ESC Practice #5

Rapid Soil Stabilization
5. Rapid Soil Stabilization

What It Is:

– Vegetated cover and/or anchored mulch for areas that may or may not be at final grade
– Should be applied when grade will not change for minimum of 14 to 30 days
– Reduces soil erosion by minimizing the amount of time soil is exposed
– Preserves topsoil and reduces need for re-grading b/c of rill and gully formation
– Most effective erosion control
5. Rapid Soil Stabilization

- Techniques:
  - Seeding/Hydroseeding
  - Mulching
  - Erosion control blankets/mats

- Establish grass or mulch cover within one week of soil exposure
- Permanently stabilize disturbed areas at conclusion of construction
- Contingency line item for replacing cover that does not take
- Use native seeds and grasses
Notes on Seeding

• Poor quality of some island soils may require fertilization, liming and other soil amendments
• Take soil test
• Use only warm season grasses, with some annual rye grass to get temporary stabilization
• Grasses vary greatly in tolerance for drought, and shade, and requirements for nitrogen and maintenance
Seeding

- Nearly 100% effective for established grass, 80% for sparse cover
- Best in combination with a mulch or erosion control blanket cover
- Native seedgrass mixes?
Straw Mulch

- Can be up to 95% effective
- Must be anchored to the soil surface
- Best if used in combination with seeding
- Best for slopes flatter than 3:1
- Island Supply?
PR Erosion & Sediment Control Handbook

• Sections 2.6 & 2.8 – Vegetate and mulch denuded areas

• Section 3.3.1. - Construction Sequence
  – Temporary stabilization during extreme weather conditions

• Section 3.4.3 - Mulching
  – Organic mulch (grass hay, wood chips), Inorganic (landscaping fabric – mainly for weed control), hydroseeding w/ mulch. Anchored with tackifiers, emulsions, pinning, netting, crimping, etc.

• Section 3.4.5 - Temporary Seeding
  – Can be used up to 1 year. Species: Ryegrass, Brown Top Millet, Habichuela deterciopela, Velvet bean, Neonotonia wightii
5. Implementation Issues

• Soil compaction/poor soils (need to loosen, amend, scarify)
• Poor germination
• Need for irrigation
• Weed seeds and invasives

**Cost:** Seeding - $1,500/ acres (includes permanent seeding and stabilization)
• Can save $ if need for structural ESC practices is reduced or eliminated
Priority ESC Practice #6

Traps, Basins & Diversions

Photo: Delaware Sediment & Stormwater Program
6. Traps, Basins, Diversions

What It Is:
- Perimeter Controls for Larger Cleared Areas (3 acres)
- Outlet Through Weir or Riser/Barrel
- Used in Conjunction With Diversion Dike to Limit Drainage Area

Techniques:
- Compacted Impoundment
- Outlet Structure
- Sized For Design Storm
Puerto Rican Snow!
Level Weir With Freeboard

Photo: Maryland Department of the Environment
Stabilized Diversion Dike Leading To Trap or Basin

Photo: Maryland Department of the Environment
MAINTENANCE!!!

Photo: Maryland Department of the Environment
Section 2.6 -- Minimum ESC Practices

- Trap Sediment Onsite
- Divide Up Drainage Areas
Section 3.5.2 – Temporary Sediment Trap

- Drainage Area < 5 acres
- Storage = 1,800 cf per acre
- 2-year, 24-hour storm
- 3:1 Length-Width Ratio
- > 20 feet from building foundations
- Embankments < 5 feet
- Clean Out at 1/3 design depth
Section 3.5.3 – Sediment Basin

- Drainage Area: 5 - 100 acres disturbed
- Storage = 1,800 cf per acre (& RUSLE)
- Possible EPA Requirements (more storage)
- Clean Out at 1/2 design volume
- Can be permanent measure
Implementation Issues

- Constructed Prior to Site Disturbance
- Proper Compaction of Embankments
- Access for Maintenance
- Periodic Clean-Out
- Safety/Liability
- Overflow
- $1,000 per acre
Let’s Work Together for Better ESC Implementation
Where Do We Go From Here?