Adapting Erosion & Sediment Control Practices to USVI

A. Kitchell
Center for Watershed Protection
8/15/06

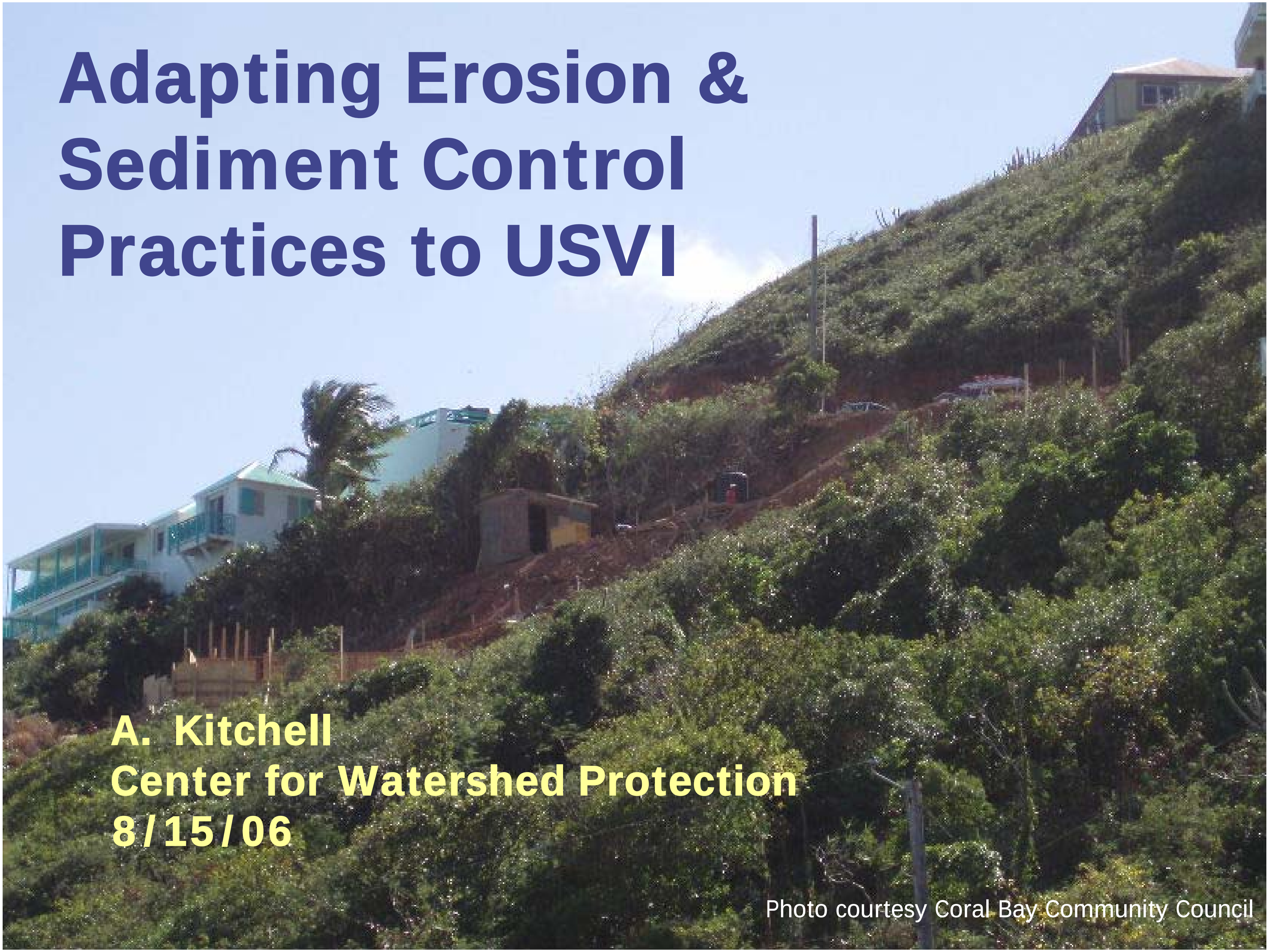
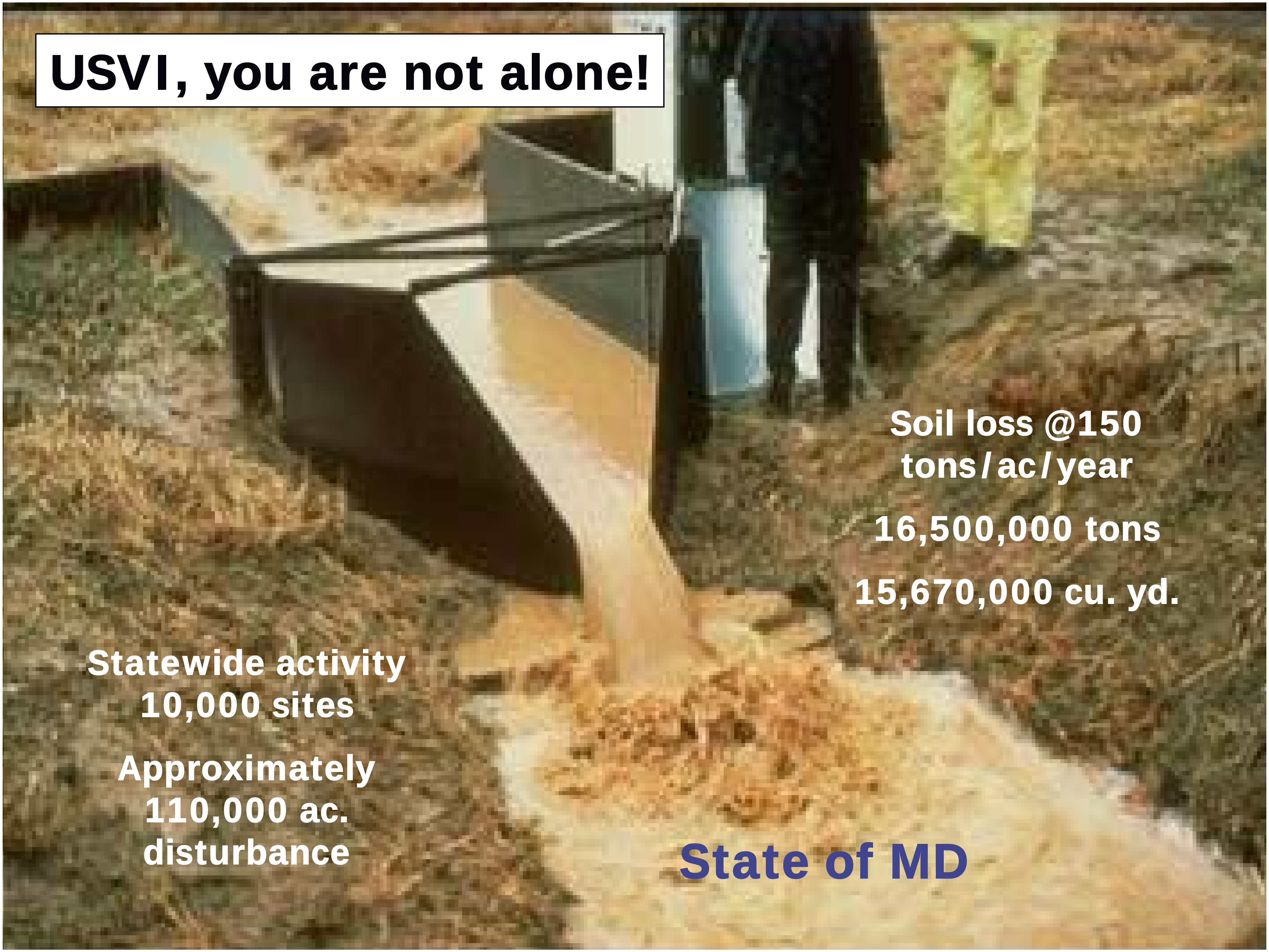


Photo courtesy Coral Bay Community Council

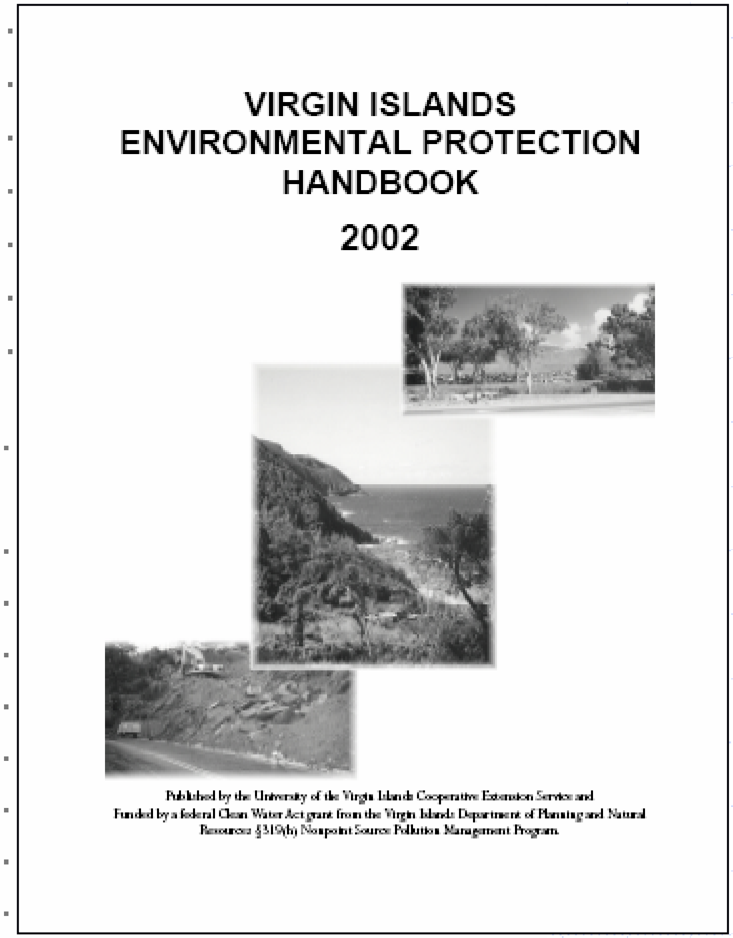

USVI, you are not alone!
Soil loss @150 tons/ac/year
16,500,000 tons
15,670,000 cu. yd.
Statewide activity 10,000 sites
Approximately 110,000 ac. disturbance
State of MD

Objectives

- Review suite of ESC practices
- ID key practices for USVI
  - What it is
  - Techniques
  - Implementation issues
  - Your experience

PRIORITY ESC Practices for USVI

- Fit Island Conditions
- Existing Practice in Handbook
- Simple But Effective
- Good Cost/Benefit
- Ease of Implementation & Enforcement


VIRGIN ISLANDS
ENVIRONMENTAL PROTECTION
HANDBOOK
2002
Published by the University of the Virgin Islands Cooperative Extension Service and
Funded by a federal Clean Water Act grant from the Virgin Islands Department of Planning and Natural
Resources §319(h) Nonpoint Source Pollution Management Program.

Priority ESC Practices for USVI

#1 – Minimize site clearing and grading
#2 – Construction phasing*
#3 – Stabilized construction entrance
#4 – Silt fence, properly installed
#5 – Drainage ways and road design
#6 – Slope stabilization
#7 – Rapid soil stabilization

Others (i.e. traps, basins, inlet protection)

#1 Minimize Clearing & Grading

#1. Minimize Site Clearing

Figure 3.1. Diagram showing site where natural vegetation is preserved around the perimeter (*Toni Thomas, UVI-CES*).

What It Is:

- Clearing only area necessary for construction
- Limit grading to pads, roadways, utilities, septic
- Protect guts, wetlands, other areas

Techniques:

- Consider during site design stage
- Apply clearing restrictions
- Identify sensitive features on ESC plan
- Clearly mark limits of clearing in field
- Keep construction equipment & traffic out of sensitive areas
- Shoot for 1:1 cut to fill ratios

Clearing Restrictions

Areas never cleared or activities sharply restricted:

- Stream buffers
- Wetlands, springs and seeps
- Steep slopes, highly erodible soils
- Drainage ways
- Planned areas for infiltration and bioretention
- Minimum % of Site (10 to 75%, depending on lot size)
- Perimeter setback vegetation
- Outside drip line of trees

ESC plans should clearly show limits of disturbance (LOD)
And means to keep heavy equipment out

Protect Waterways

Objective:

- Protect streams and waterways from sedimentation during construction

Techniques:

- Restrict clearing within 25 feet of waterway
- Special crossings required if work is planned across the waterway
- Clearly flag/post signage in field and on construction plans

Silt Fence + Orange Fence= A Little Better

Photo: Delaware Sediment & Stormwater Program

USVI Erosion & Sediment Control Handbook

- Sections 2.4 (Site Planning) and 3.2 (preservation of natural vegetation)
  - Site fingerprinting
  - Preserve natural drainage channels
  - Limits of disturbance physically marked
  - Temporary and permanent tree protection measures
  - Land grading
- VI Code Title 12 sections 121-125 prohibits cutting or injury to any tree or vegetation within 25 ft of edge or 30 ft of centerline watercourse (including guts)
- Dept of Ag: all trees > 6 inches DBH need to be mapped prior to land disturbance, a permit issued for removals, and replacement plantings undertaken.


What happened to our 25 ft 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

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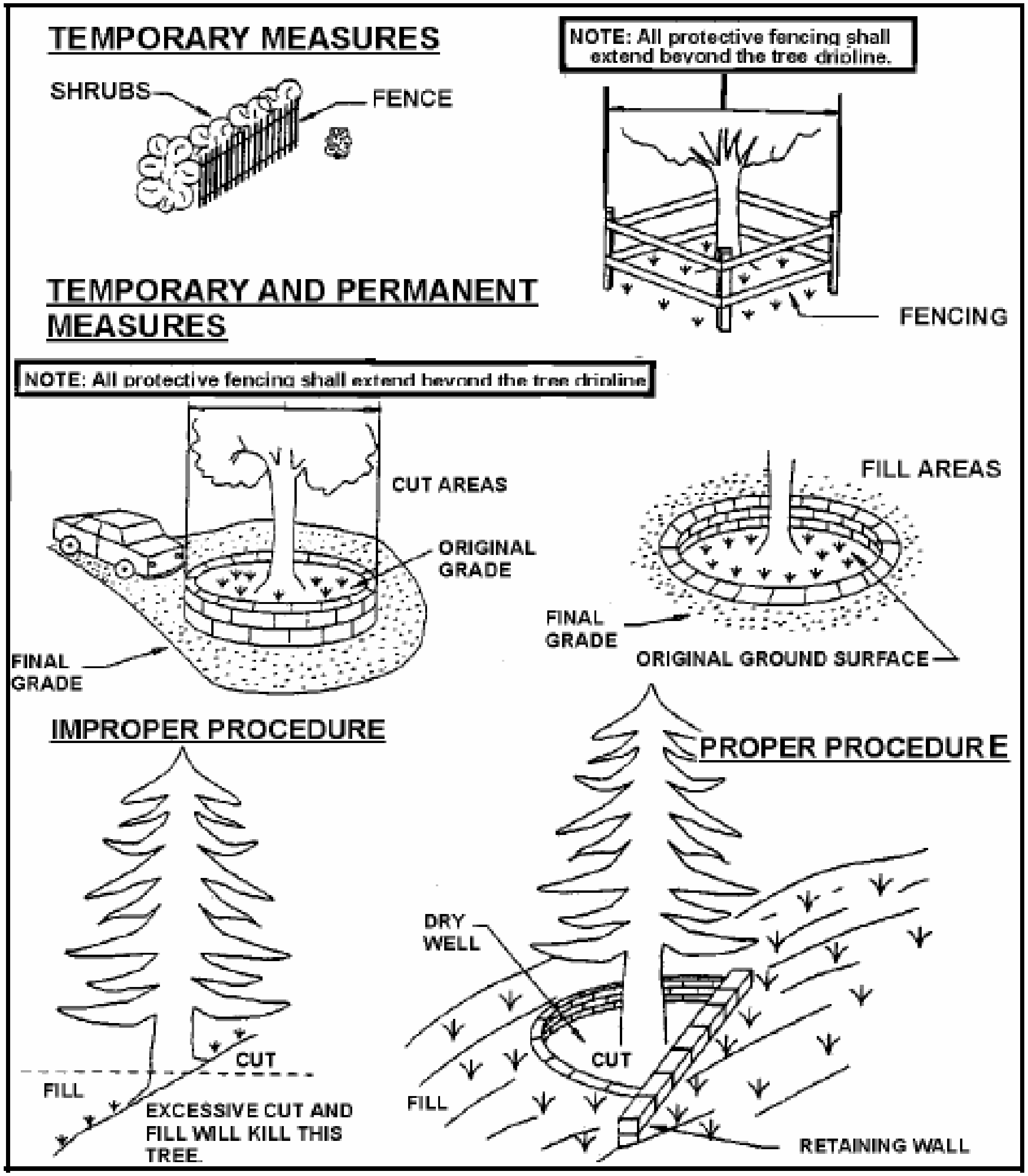
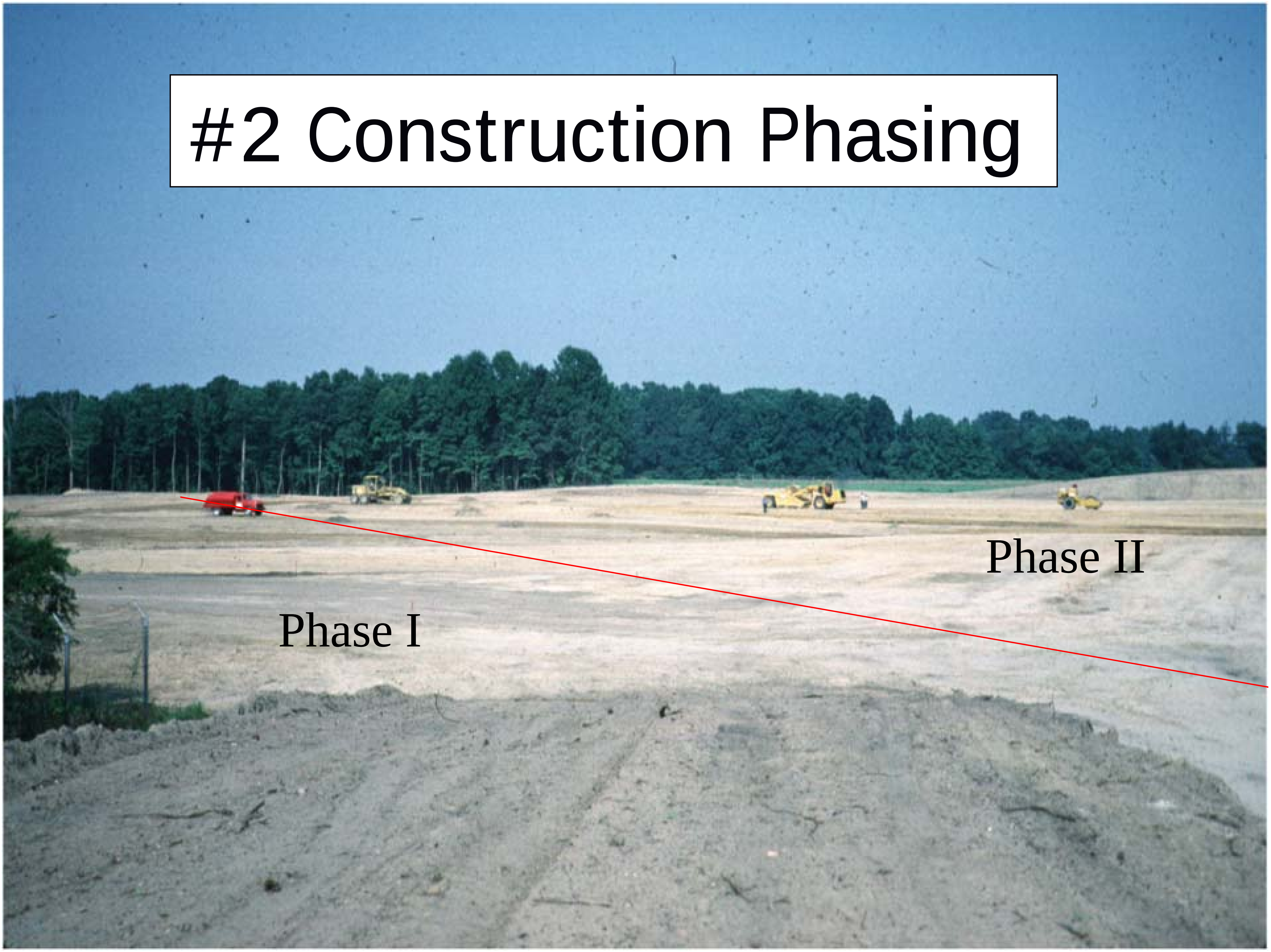


Figure 3.2. Tree protection practices (*Maryland Department of the Environment, 1994*).

#2 Construction Phasing



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
- Can reduce erosion by 40% over traditional mass grading

May not be a big deal in USVI if most sites <5-10 acres...

Technique:

- 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)
- Locate temporary stockpiles and construction access
- Establish trigger for completion of each phase
- ID key ESC elements to inspect in each phase

Roadwork projects provide practice in construction 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

Thoughts on limiting area of disturbance?

- Are clearing and grading restrictions important for USVI?
- How do we better protect waterways?
- Is phased construction applicable?
- If so, how do we best implement?

#3 Stabilized Construction Entrance

3. Construction Entrance

What It Is:

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

Technique:

- Min 50 ft length (30 for single residential lot)
- 10-12 ft min width; flared
- 2-3 in crushed aggregate or recycled concrete; 6 in deep
- Geotextile fabric between ground and stone
- Maintain to prevent tracking onto public roads

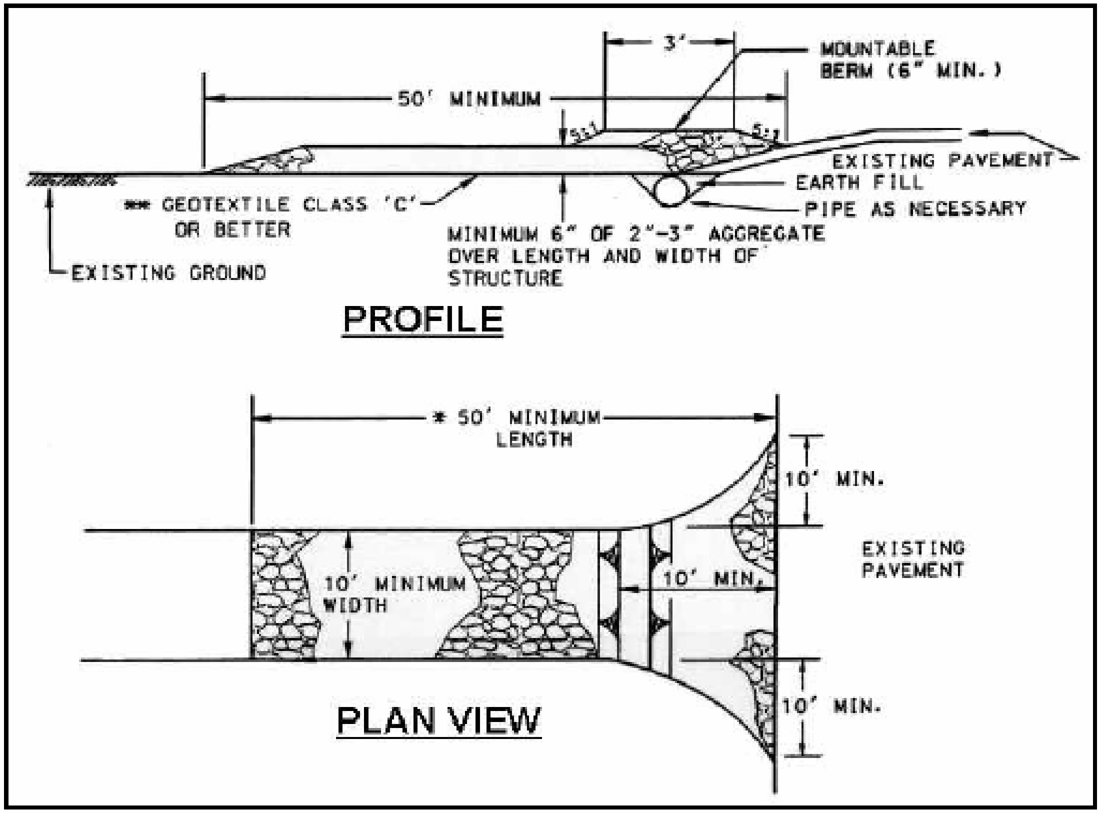


Figure B.30. Stabilized construction entrance details *(Maryland Department of the Environment, 1994)*.

Tracking on STT roadways is a sure sign of poor entrance maintenance...

Photo: Deleware Sediment & Stormwater Program

Dewatering bag

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 – 3 K for paved w/wash rack

Compare two different entrances at the same site...

#4 Silt Fencing

4. Silt Fence

What It Is:

- Perimeter control to slow runoff
- Settling is most important sediment removal function
- 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

Technique

- Install prior to clearing
- Fabric standards
- Trench into soil
- Anchored with steel.
- Post on downhill side
- Designed for sheet flow only
- Reinforced with wire mesh
- DA < 0.25 ac/100lf of fence (max 1 ac.)

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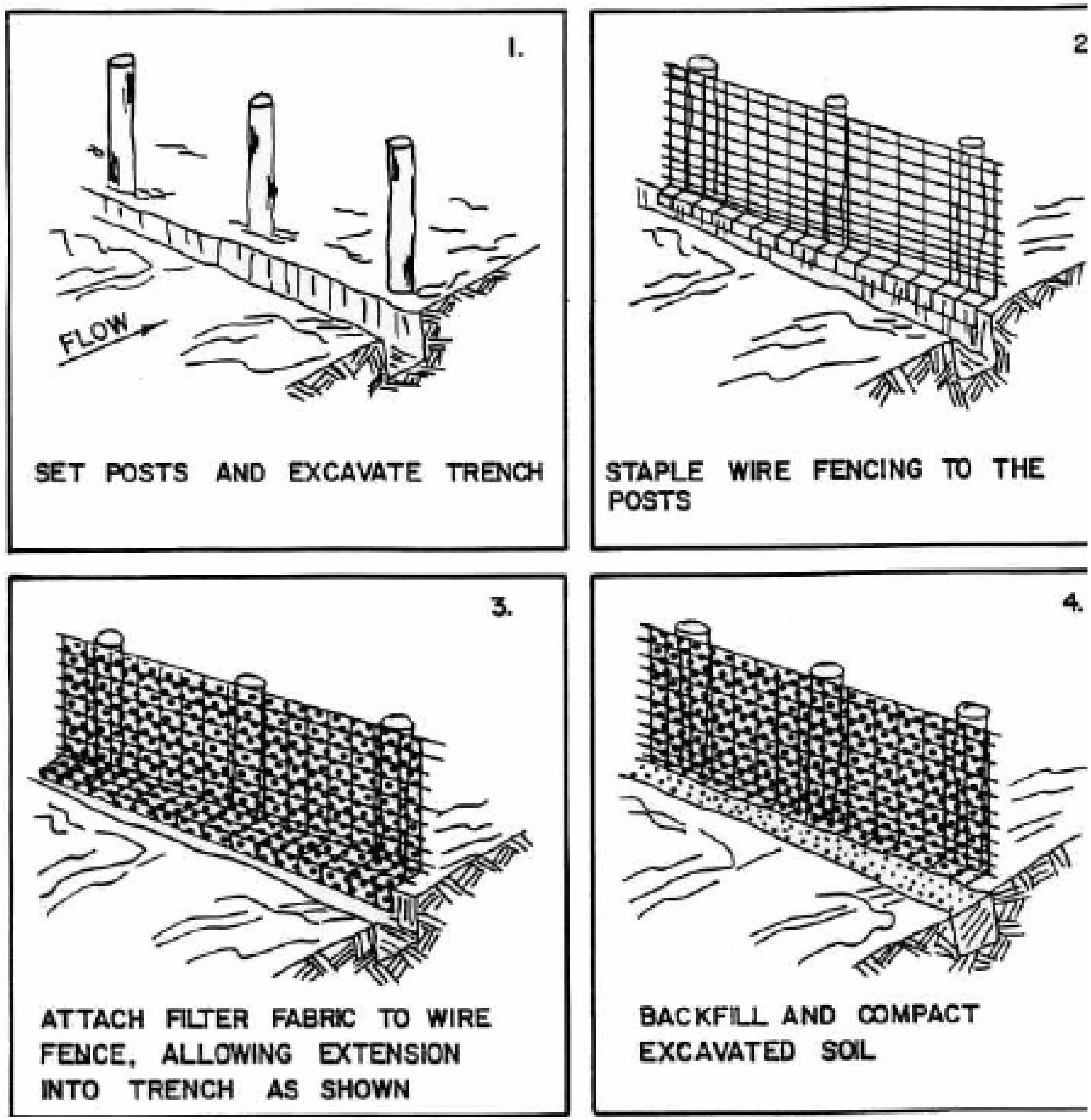
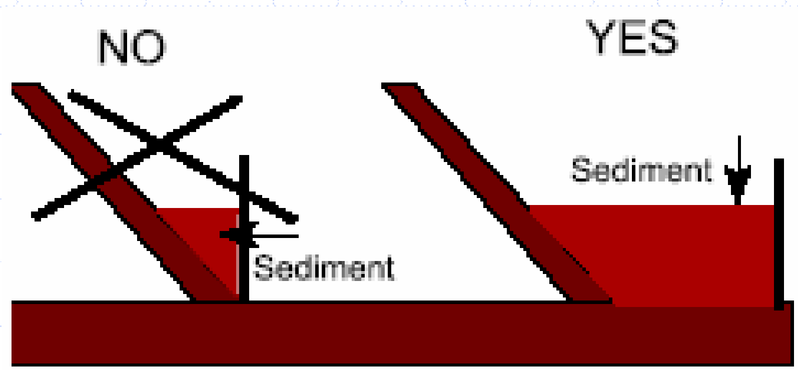


Figure B.29. A step-by-step procedure for building a silt fence (*USDA-SCS, 1993b*).

USVI Erosion & Sediment Control Handbook

Table B.12. Maximum allowable slope lengths contributing runoff to a silt fence (*Empire State Chapter Soil & Water Conservation Society, 1997*).

Slope Steepness	Maximum Slope Length (feet)
2:1	50
3:1	75
4:1	125
5:1	175
Less than 5:1	200



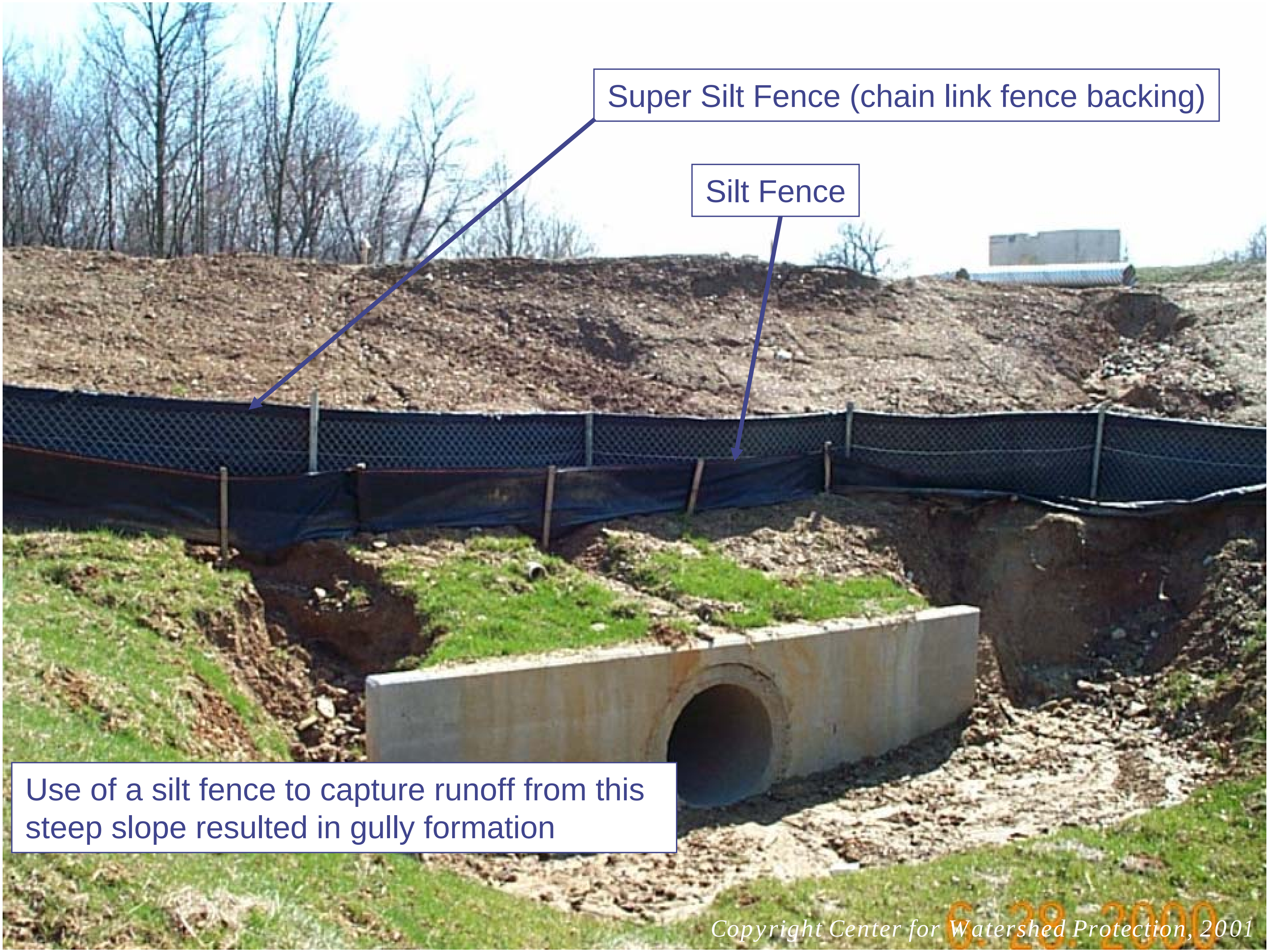


This fencing extended well beyond actual construction site...

Obviously, you can drive over this perimeter control...

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)


Super Silt Fence (chain link fence backing)
Silt Fence
Use of a silt fence to capture runoff from this steep slope resulted in gully formation
6.28.2000

Thoughts on improving perimeter protections?

- How do we encourage better maintenance of practices? Who is the best contractor on the island for this?
- Are those fences for dust control or to block your view?
- How many times can you reuse a silt fence?
- What about alternative technologies?

#5 Stabilize Drainage Ways

What it is:

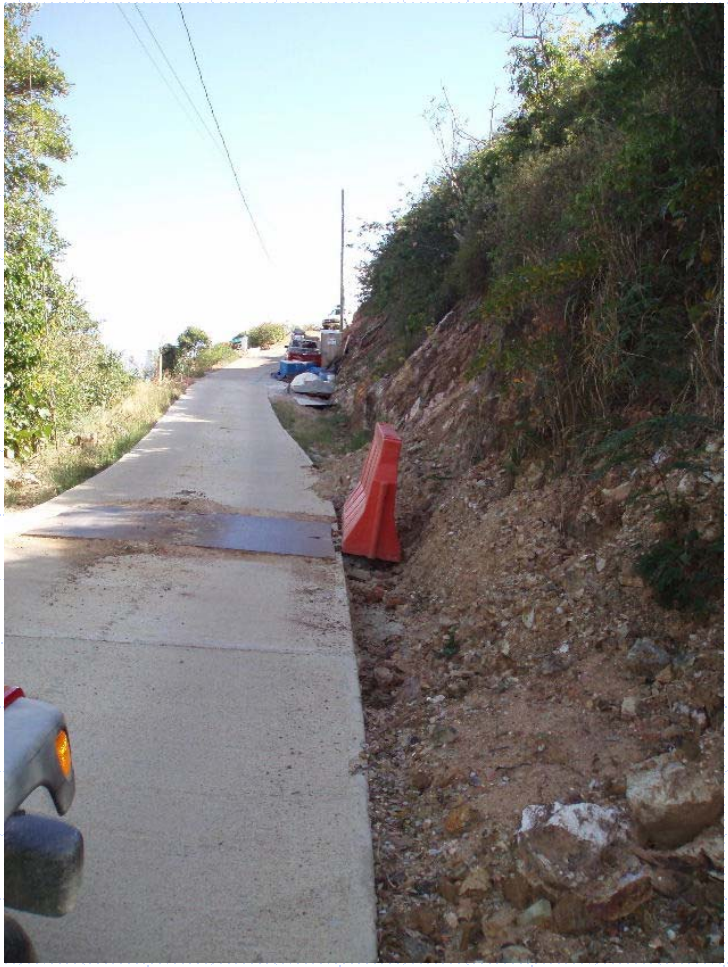
- Structures that prevent erosion in channels
- Ditches draining dirt roads are major source of sediment in most islands
- Road ditches are the most important drainage-way to stabilize

Techniques:

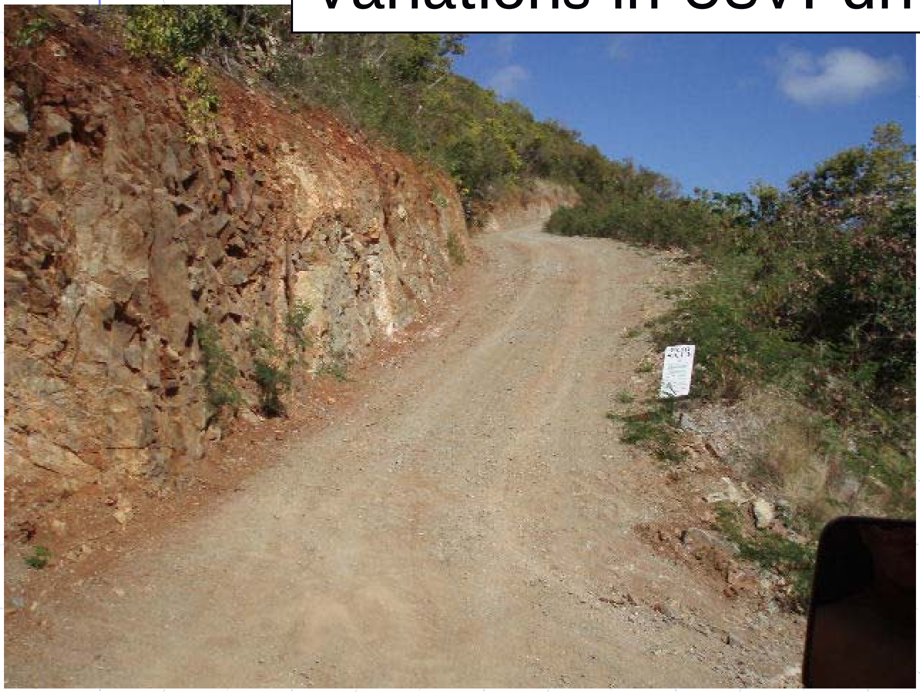
- Checkdams
- Water Bars & Broad-based Dips
- Cross drains and pipe culverts

It starts with good road design

- Maximum grade: 10%
- Gravel cover at key points
- Grass channels for ditches 1 to 5% slopes
- Stable channels with check dams for 5 to 10%
- Non-eroding channels above 10%
- Care taken at stream crossings




Variations in USVI driveway/road designs...




Variations in USVI driveway/road designs (cont)...

Design of check dams

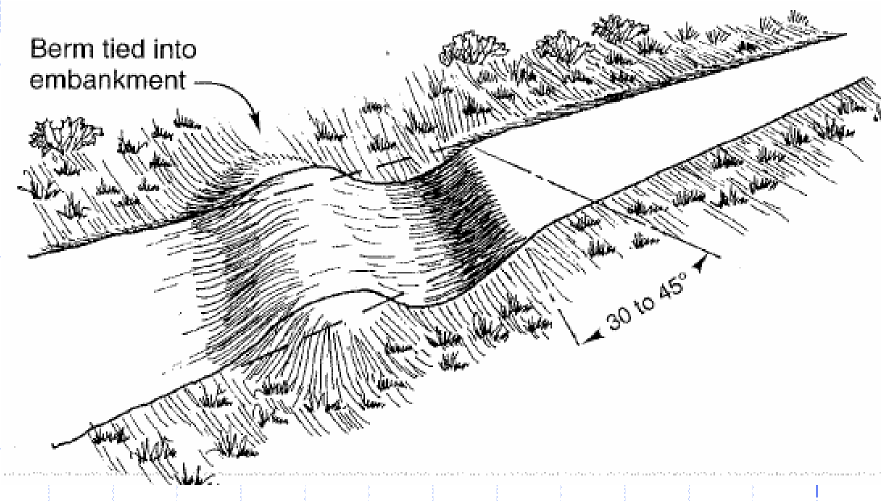
- Stone or coir logs to reduce flow velocities in channels
- Spacing similar to water bars
- Provide limited sediment trapping
- Ineffective on slopes > 10% or if not regularly cleaned out

Table B.14. Standard stone check dam design (*Maryland Department of the Environment, 1994*).

Slope	Spacing (feet)
2% or less	80
2.1% to 4%	40
4.1% to 7%	25
7.1% to 10%	15
over 10%	use lined waterway design

Coir Fiber Log as a Check Dam

Design of Water Bars



- Move shallow concentrated flows across road to safe discharge point
- Divert runoff away from ditches to reduce flow in downstream ditch
- 1 foot mound over 8 to 12 feet
- 30 degree angle
- Spacing of bars based on road grade
- Crushed stone on dip and mound

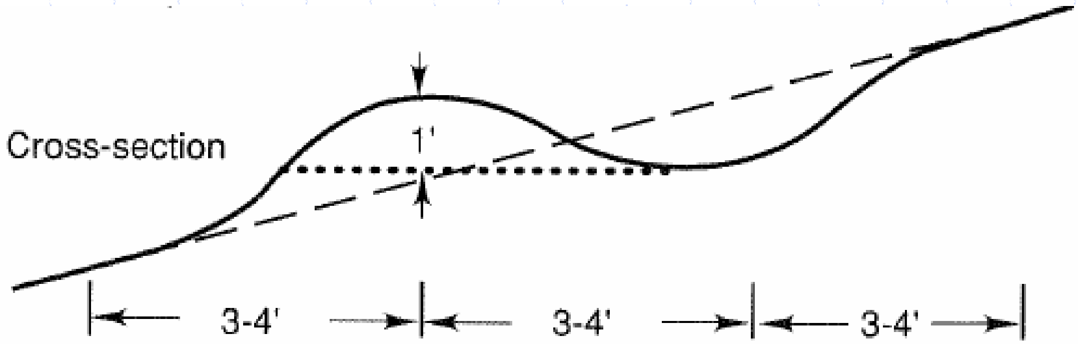
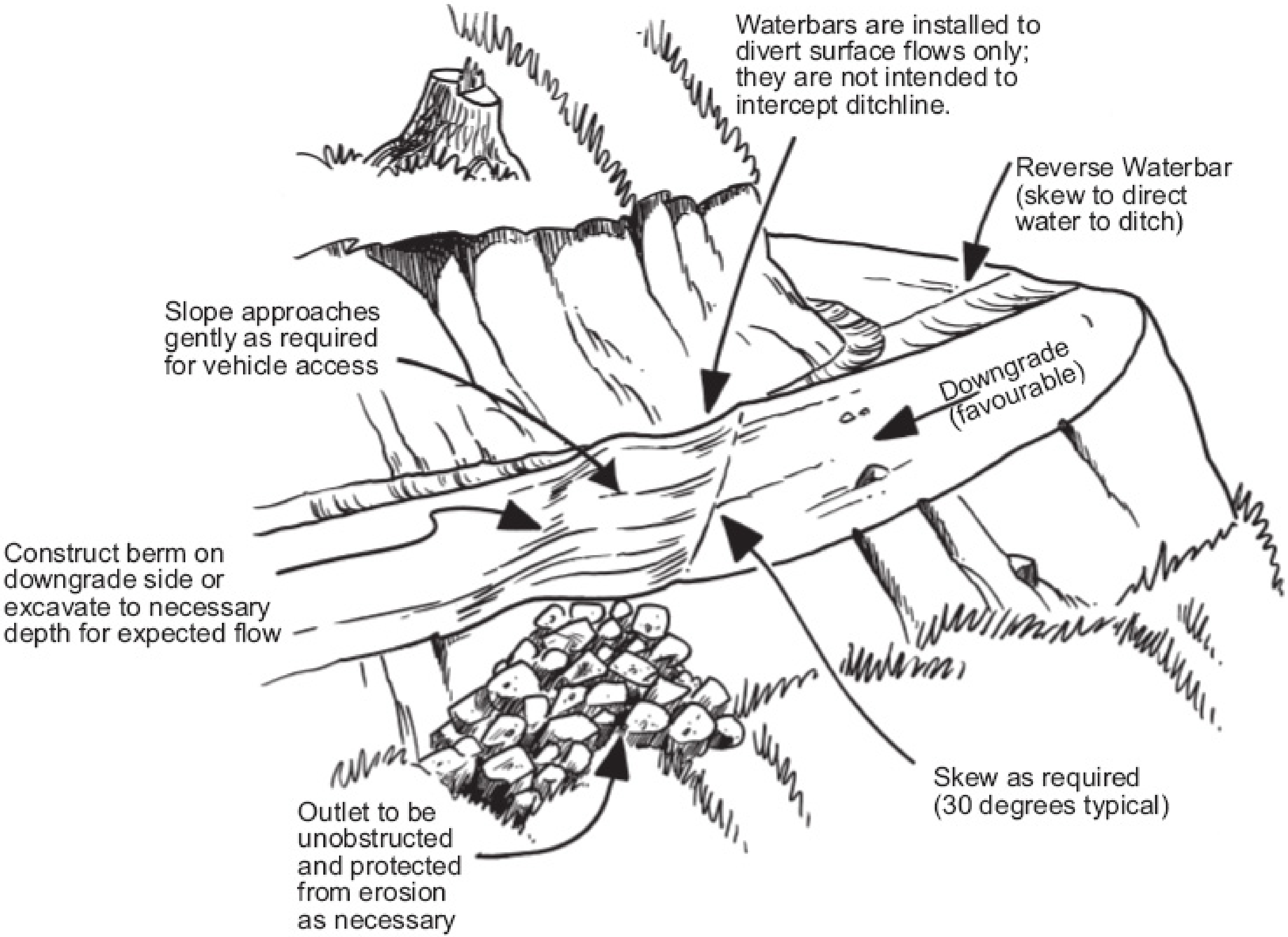


Figure 6-12. Water bar.

WI Forestry Best Management Practices for Water Quality (1995)



Design of Water Bars

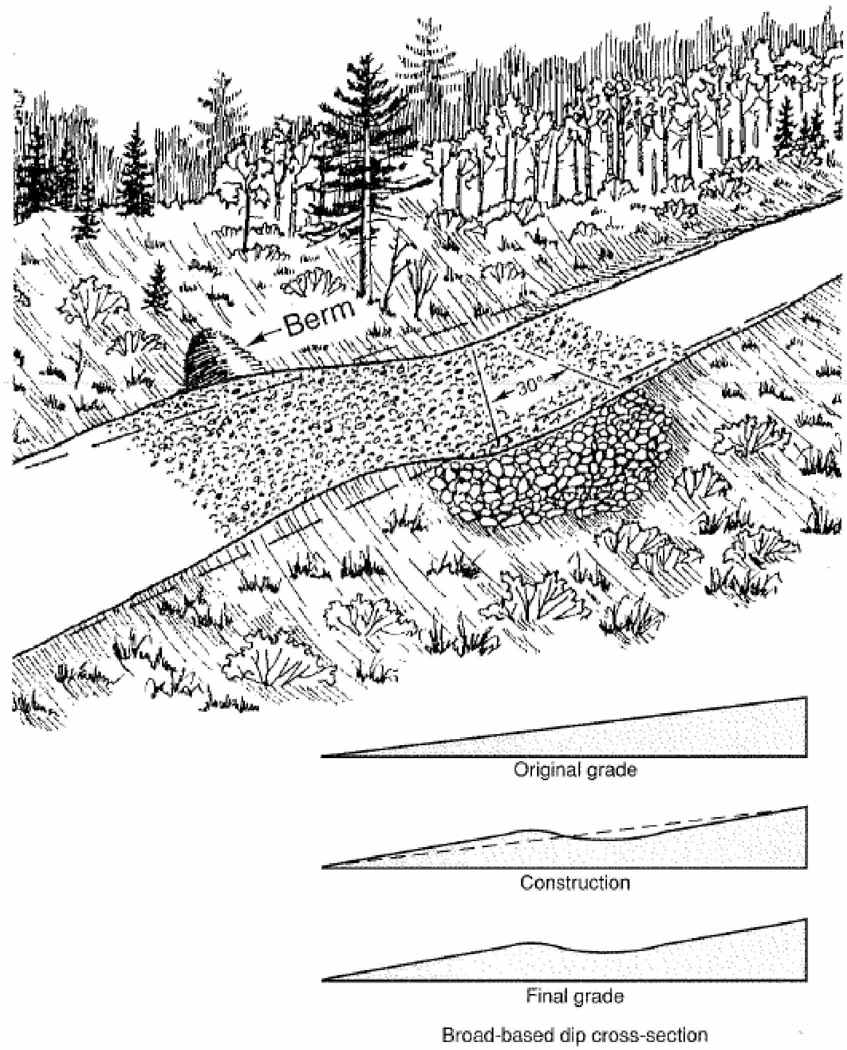
Recommended Spacing Between Water Bars

Grade of Road	Space Between Water Bars
2%	250 ft
5%	135 ft
10%	80 ft
15%	60 ft
20%	45 ft
25%	40 ft
30%	35 ft
40%	30 ft

Source: HI DFW (2003) and VICES (2003)

Design of Broad Based Dips

- Similar to water bars but one foot dip occurs over 20 to 30 feet
- Allows vehicles to pass without jarring
- Dip also has a 30 degree angle
- Tie the hump into up-gradient road cut
- Only works up to 10 to 12% road grades



'igure 6-11. Broad-based dip.

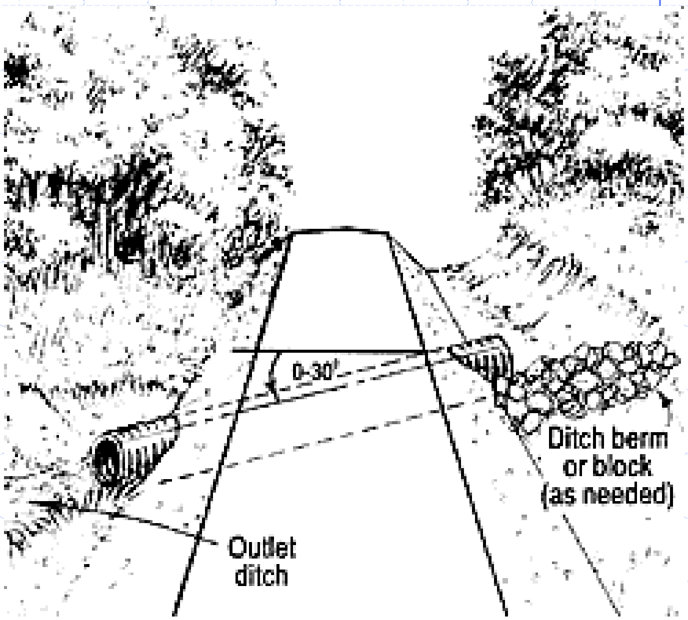
Recommended Spacing for Broad-Based Dips

Grade of Road	Space Between Dips
2%	300 ft
4%	200 ft
5%	180 ft
7%	160 ft
8%	150 ft
10%	140 ft
12%	Do Not Use

Source: HI DFW (2003) and VICES (2003)

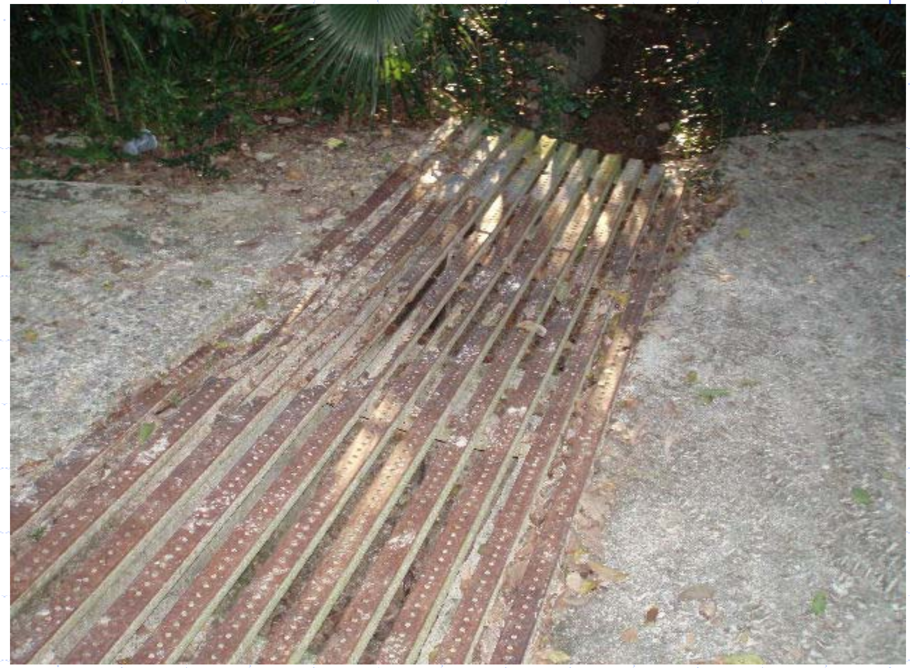
Design of Cross-Drain Culverts

- 12 inch minimum pipe diameter
- Larger pipes may be needed above 2 acre of contributing drainage area
- Pipes angled at 30 to 45%, and have 2% slope
- Armor both the entry and outlet of pipe with stone
- Make sure pipe is covered with fill at last one half its diameter



Angle of culvert placement for low-velocity flows may be less than 30°.

(from University of Minnesota Extension Service)


Implementation Issues

- Development on steeper and steeper slopes
- Requires frequent inspection and maintenance after heavy storms
- Costs to pave are high

Practice	(relative cost)
Water bars	($-$$)
Broad-based dips	($$)
Crowning	($$)
Insloping/outsloping	($$)
Road ditches	($$$)
Open-top culverts	($$$)

(from University of Minnesota Extension Service)

Channel created from uncontrolled runoff from new uphill development in Coral Bay

Thoughts on preventing ditch erosion?

- Is there anywhere you won’t put a road?
- How do you keep up with inlet and culvert cleaning?
- Which practices work best for you?

#6 Slope Stabilization

Source: MDE, 2001

Steep Slope Challenges

Tough planting conditions

- Poor water holding capability
- Exposure to sun and wind
- Thin, nutrient poor soils

Some techniques

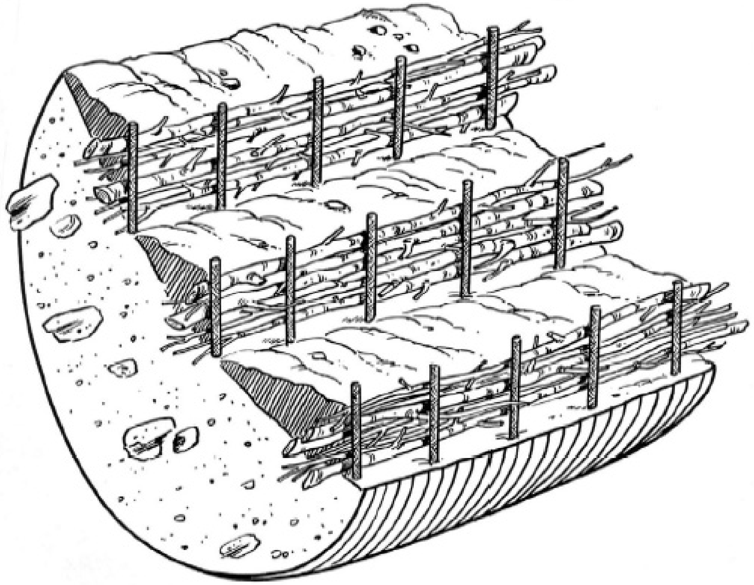
- Pipe slope drains (NOT in Handbook)
- Erosion control fabrics (small slopes)
- Hill Slope Bioengineering
- Better road construction on steep slopes
- Soil binders and tackifiers (have you tried this?)

Pipe Slope Drain

- Cost: $5-6 per linear foot
- Used to convey runoff past steep slopes.
- Limited to <3 acres for each 24” pipe.
- Effective in combination with a sediment trap or basin.
- Requires stable outlet.


Consider for
All cut/fill slopes
15% or more
Coconut, wood fiber or coir
products work better than
Man-made geotextiles

Bioengineering to protect hillslopes from erosion



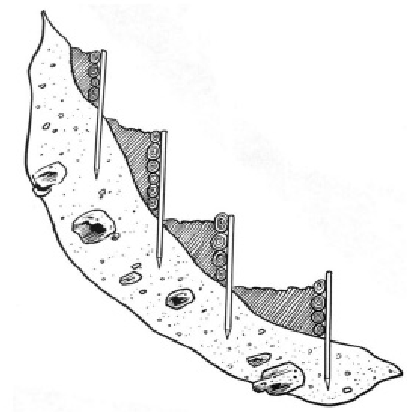


Fig. 6.02 Wattle fences are short retaining walls constructed of li
terraces that ... pen
establishmen ... watt
gradient.

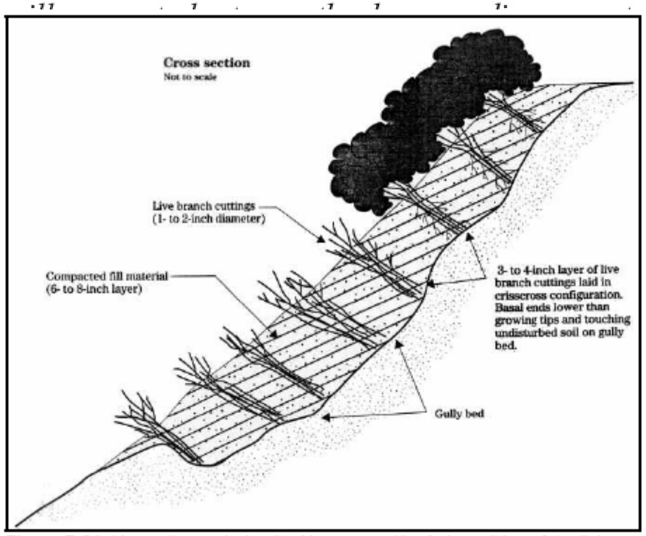
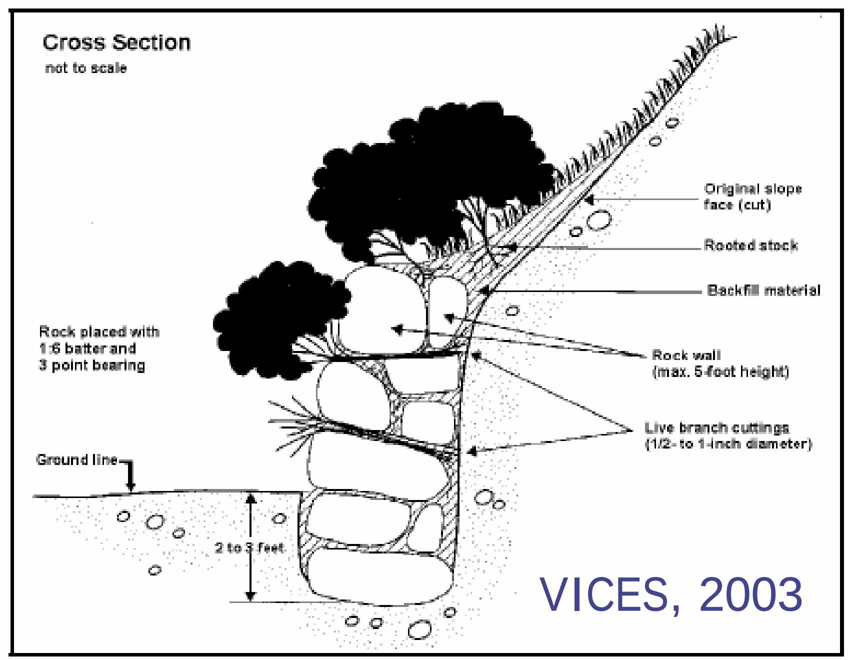


Figure B.21. Live gully repair details; Note: rooted/leafed condition of the living plant material is not representative of the time of installation *(USDA-SCS, 1992)*.



VICES, 2003

Figure B.23. Vegetated rock wall details (*USDA-SCS, 1992*).

#7 Rapid Soil Stabilization

7. 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 21 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

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

- Nearly 100% effective for established grass, 80% for sparse cover
- Best in combination with a mulch or erosion control blanket cover on steep slopes
- 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 ryegrass to get temporary stabilization
- Grasses vary greatly in tolerance for drought, and shade, and requirements for nitrogen and maintenance

Table B.2. Suitable grass species for seeding and planting in the Caribbean *(USDA-SCS, 1990b)*.

Plant Species	Propagation	Adaptation
	-------*Widely Adapted Grasses*-------	
Carpetgrass	8 lbs. per acre	Wet and shaded areas
Common bermuda grass	80 lbs. per acre	Throughout the island
Guinea grass	30 pounds per acre or vegetative	Dry areas & alkaline soils; shady areas; Intolerant to wet and acid soils
Paragrass	Vegetative	Throughout the island, especially wetlands and other wet areas
Pangolagrass	Vegetative	Throughout islands, except dry areas
Vetiver	Vegetative	Especially adapted to granitic soils
	-------*Grasses Especially Adapted to Dry Sites*-------	
Angleton grass	Natural seeding	All dry sites
Buffel grass	4 lbs. per acre	All dry sites
	-------*Grasses Especially Adapted to Saline Sites*-------	
Beach Grass (*Sporobolus virginicus*)	Vegetative	

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?

Implementation Issues

- Soil compaction/ poor soils (need to loosen, amend, scarify)
- Mulch not thick enough
- Poor germination
- Equipment
- 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

Thoughts on stabilizing slopes and exposed soils?

- Does the CES hydro-seed equipment still work?
- What kind of growth success do you get?
- Any luck with non-grass ground cover for permanent cover?


#8. Other?
Photo: Deleware Sediment & Stormwater Program

Advance Settling Devices

- Trap sediment in runoff before it leaves the site
- TSS removal varies between 50% to 90%
- Trapping limited by
  - Difficulty in settling fine-grained soils
  - Simplistic design of existing basins

Techniques:

- Sediment traps
- Sediment basins


Most sites larger than 5 acres should have a trap or basin at downgradient end sized for WQv
Copyright Center for Watershed Protection, 2001

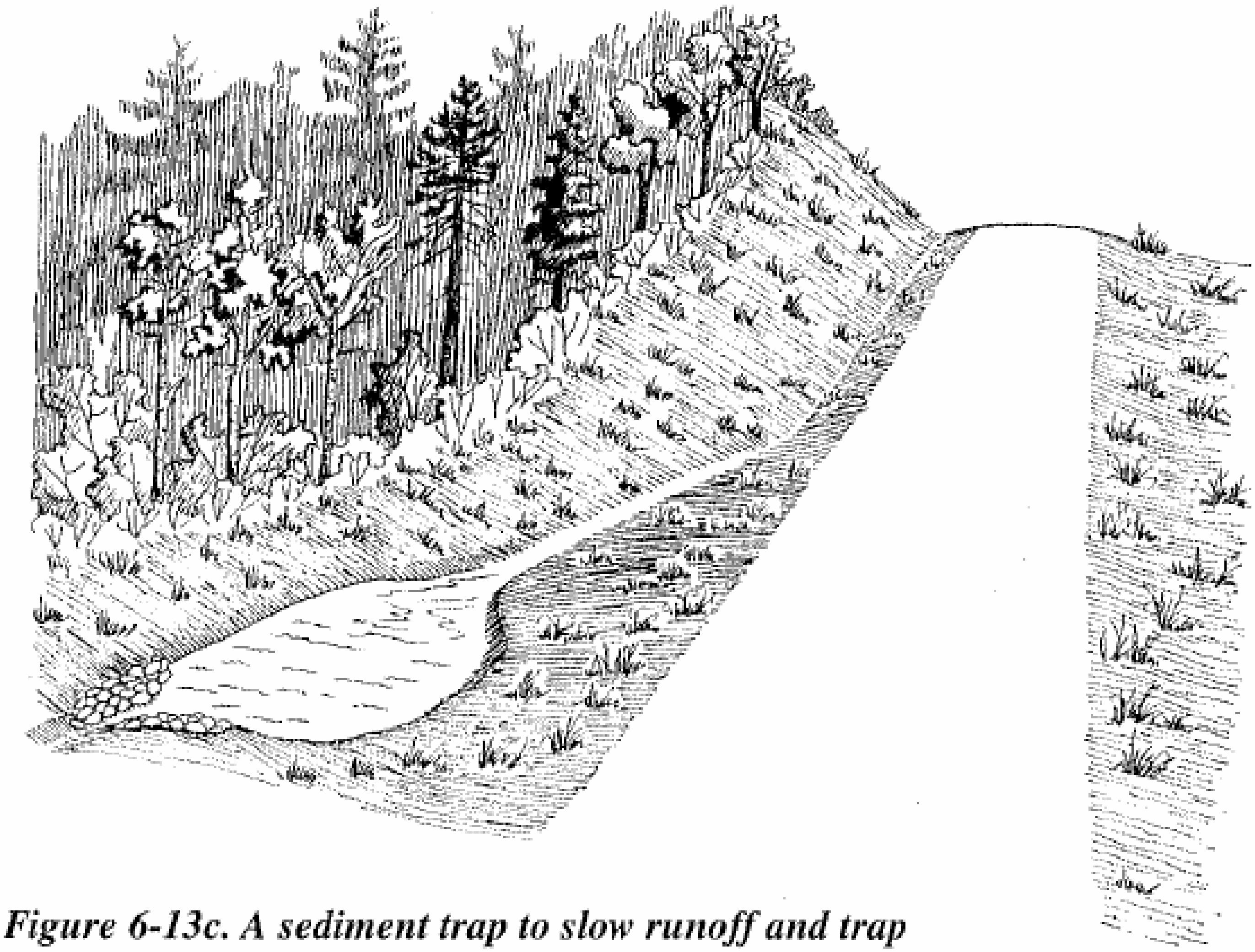


Figure 6-13c. A sediment trap to slow runoff and trap sediment for channelized flow.

http://dnr.wi.gov/org/land/forestry/publications/pdf/FR-093.pdf


Sedimentation basin with standpipe encased in gravel.
Copyright Center for Watershed Protection, 2001


Berm dividing a multiple cell sedimentation basin.
Copyright Center for Watershed Protection, 2001

Implementation Issues

- **Constructed Prior to Site Disturbance**
- **Proper Compaction of Embankments**
- **Maybe converted into stormwater practice**
- **Access for maintenance**
- **Periodic cleanout**
- **Safety/Liability**
- **Overflow**
- **$1,000 per acre**

Local variation on block & gravel inlet protection

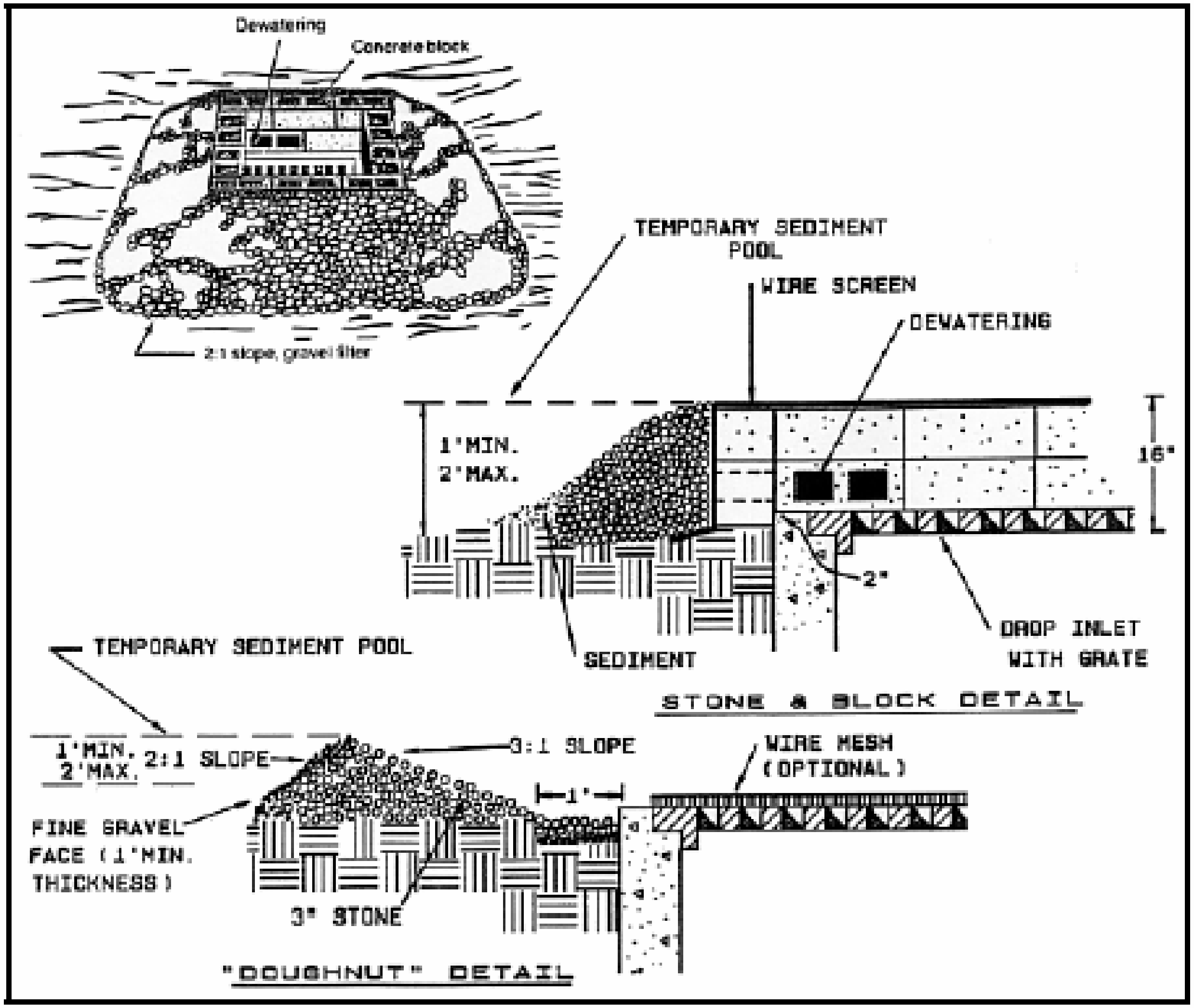


Figure B.59. Stone and block drop inlet protection details (*Empire State Chapter, 1997*)

Your thoughts?

- **#1 – Minimize site clearing and grading**
- **#2 – Construction phasing***
- **#3 – Stabilized construction entrance**
- **#4 – Silt fence, properly installed**
- **#5 – Drainage ways and road design**
- **#6 – Slope stabilization**
- **#7 – Rapid soil stabilization**
- **#8 – Others ??(traps, basins, inlet protection)**