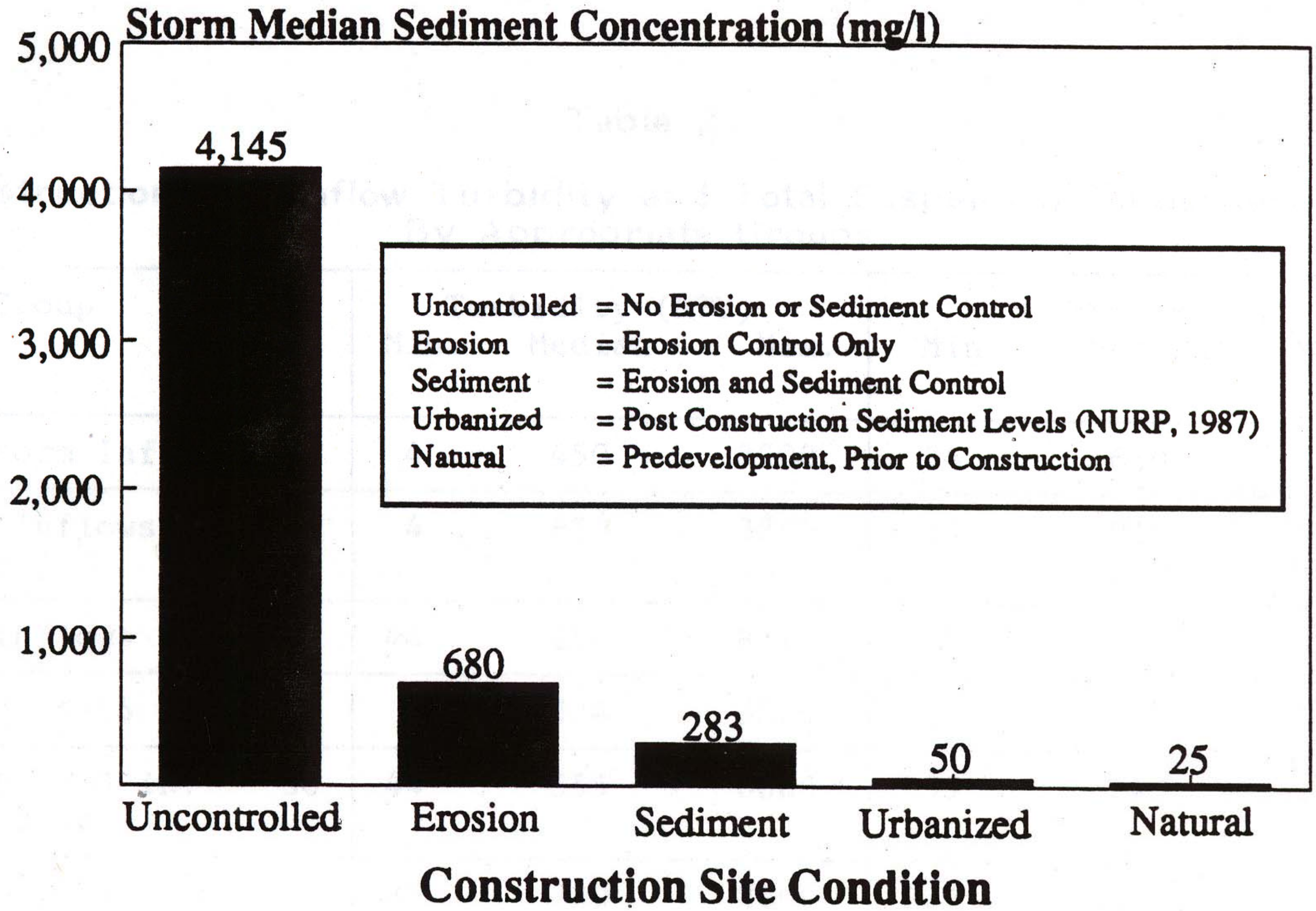
Erosion Control Strategies for Islands

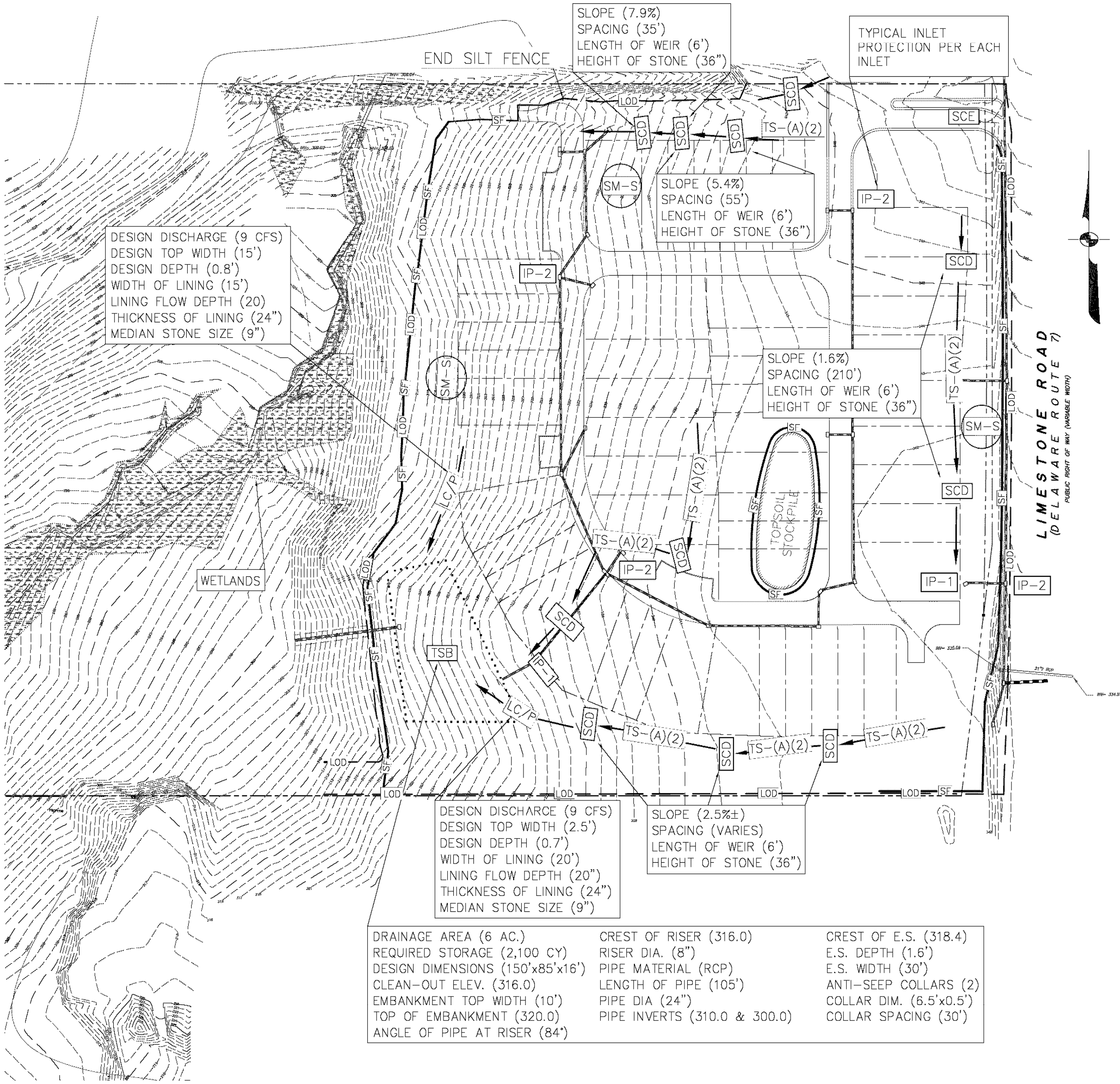

Upland Reforestation
Stabilize Slopes
Control Construction Sites
Reduce Channel Erosion
Sediment Basins
Fish Pond Restoration

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



Source: Schueler and Lugbill, 1990



LEGEND

SM-S	STABILIZATION MATTING – SLOPE
SCD	STONE CHECK DAM
IP-1	STORM INLET PROTECTION (TYPE-1)
IP-2	STORM INLET PROTECTION (TYPE-2)
TSB	TEMPORARY SEDIMENT BASIN
SCE	STABILIZED CONSTRUCT. ENTRANCE
TS-(A)(2)	TEMPORARY SWALE
LC/P	LINED CHANNEL – PARABOLIC
TB-(A)(1)	TEMPORARY EARTH BERM
SF	SILT FENCE
LOD	LIMIT OF DISTURBANCE
	PROPERTY LINE
	WETLANDS
	BASIN AREA
	PROPOSED CONTOUR
	EXISTING CONTOUR

EROSION & SEDIMENT CONTROL SCHEMATIC PLAN POST-DEVELOPED PHASE

ADARE VILLAGE

50 0 25 50 100 200
(IN FEET)
1 inch = 50 ft.

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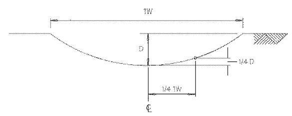
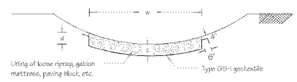
REVISION

Standard Detail & Specifications
Lined Channel - Parabolic



Typical Section (Design)



Typical Section (Lining)

DATA

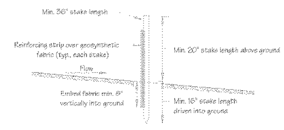
Design discharge (Q)
Design topwidth (TW)
Design depth (D)
Width of lining (w)*
Lining flow depth (d)
Thickness of lining (t)*
Median stone size (d_{50})**

*For gabions & reno mattresses, specify basket dimensions to be used.

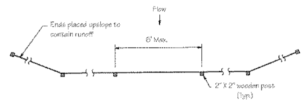
**For paving block, etc., specify size to be used.

Source:	Symbol:	Detail No.
Adapted from VA ESC Manual	LC/P	DE-ESC-3.3.4.1 Sheet 1 of 2 Date: 12/03

Standard Detail & Specifications
Silt Fence



Section

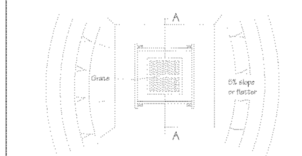


DATA
Max. controlled slope

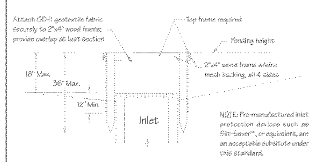
Plan

Source:	Symbol:	Detail No.
Adapted form MD Stds. & Specs. for ESC	SF	DE-ESC-3.1.2.1 Sheet 1 of 2 Date: 12/03

Standard Detail & Specifications
Inlet Protection - Type 1



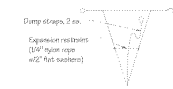
Plan



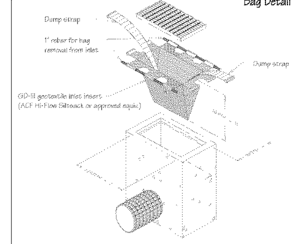
Section A-A

Source:	Symbol:	Detail No.
Adapted from Erosion Draw Manual J. McCullah & Assoc.	IP-1	DE-ESC-3.1.5.1 Sheet 1 of 2 Date: 12/03

Standard Detail & Specifications
Inlet Protection - Type 2



Bag Detail



Perspective

Source:	Symbol:	Detail No.
Adapted from ACF Products, Inc.	IP-2	DE-ESC-3.1.5.2 Sheet 1 of 2 Date: 12/03

Standard Detail & Specifications
Lined Channel - Parabolic

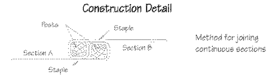
Construction Notes:

1. All trees, brush, stumps, obstructions, and other objectionable material shall be removed and disposed of so as not to interfere with the proper functioning of the waterway.
2. The channel shall be excavated or shaped to line, grade, and cross section as required to meet the criteria specified herein, and be free of bank projections or other irregularities which will impede normal flow.
3. Fills shall be compacted as needed to prevent unequal settlement that would cause damage in the waterway.
4. All earth removed and not needed in construction shall be spread or disposed of so that it will not interfere with the functioning of the waterway.
5. Lining shall be installed to the design dimensions specified on the approved plan. Type GS-I geotextile shall be used on all installations unless specifically approved otherwise. All pre-engineered linings shall be installed in acordance with the manufacturer's recommendations.
6. Lining material shall be as specified on the approved plans with respect to dimension, density, strength, or other criterion so specified.
7. Stabilization shall be done according to the appropriate Standard and Specifications for Vegetative Stabilization.

Source:	Symbol:	Detail No.
Adapted from VA ESC Manual	LC/P	DE-ESC-3.3.4.1 Sheet 2 of 2 Date: 12/03

Standard Detail & Specifications
Silt Fence

Construction Detail



Method for joining continuous sections

Top

Construction Notes:

1. Geosynthetic fabric to be fastened securely to fence posts with wire ties or staples.
2. When two sections of filter cloth adjoin each other they shall be overlapped by six inches and folded.
3. Maintenance shall be performed as needed and material removed when "bulges" develop in the silt fence.

Materials:

1. Stakes: Steel (either T or U) or 2" hardwood
2. Geosynthetic Fabric: Type GD-I
3. Reinforcing strip: Wooden lath, plastic strip or other approved equivalent
4. Prefabricated Unit: Geofab, Envirofence, or approved equivalent

Source:	Symbol:	Detail No.
Adapted from MD Stds. & Specs. for ESC	SF	DE-ESC-3.1.2.1 Sheet 2 of 2 Date: 12/03

Standard Detail & Specifications
Inlet Protection - Type 1

Construction Notes:

1. Excavate completely around inlet to a depth of 18" below grate elevation.
2. Drive 2" x 4" post 1' into ground at four corners of inlet. Place nail strips between posts on ends of inlet. Assemble top portion of 2" x 4" frame using overlap joint shown. Top of frame (weir) must be 6" below edge of roadway adjacent to inlet.
3. Stretch wire mesh tightly around frame and fasten securely. Ends must meet at post.
4. Stretch geotextile fabric tightly over wire mesh, the cloth must extend from top of frame to 18" below inlet grate elevation. Fasten securely to frame. Ends must meet at post, be overlapped and folded, then fastened down.
5. Backfill around inlet in compacted 6" layers until at least 12" of geotextile fabric is buried.
6. If the inlet is not in a low point, construct a compacted earth dike in the ditchline below it. The top of this dike is to be at least 6" higher than the top of frame (weir).
7. This structure must be inspected frequently and the filter fabric replaced when clogged.

Materials:

1. Wooden frame is to be constructed of 2" x 4" construction grade lumber.
2. Wire mesh must be of sufficient strength to support filter fabric with water fully impounded against it.
3. Geotextile fabric: Type GD-II

Source:	Symbol:	Detail No.
Adapted, from Erosion Draw Manual J. McCullah & Assoc.	IP-1	DE-ESC-3.1.5.1 Sheet 2 of 2 Date: 12/03

Standard Detail & Specifications
Inlet Protection - Type 2

Notes:

1. This practice shall only be used in situations in which Inlet Protection - Type 1 cannot be used due to site constraints. These include, but are not limited to partially completed parking areas, streets, roads, etc.
2. It may be necessary to transition from Type 1 to Type 2 Inlet Protection as construction proceeds.
3. For areas where there is a concern for oil run-off or spills, insert shall meet one of the above specifications with an oil-absorbant pillow or shall be made completely from an oil-absorbant material with a woven pillow.

Materials:

The geotextile inlet insert shall meet or exceed the specifications of Type GD-III geotextile in accordance with Appendix A-3 of the Delaware Erosion & Sediment Control Handbook.

Source:	Symbol:	Detail No.
Adapted from ACF Products, Inc.	IP-2	DE-ESC-3.1.5.2 Sheet 2 of 2 Date: 12/03

DETAIL SHEET

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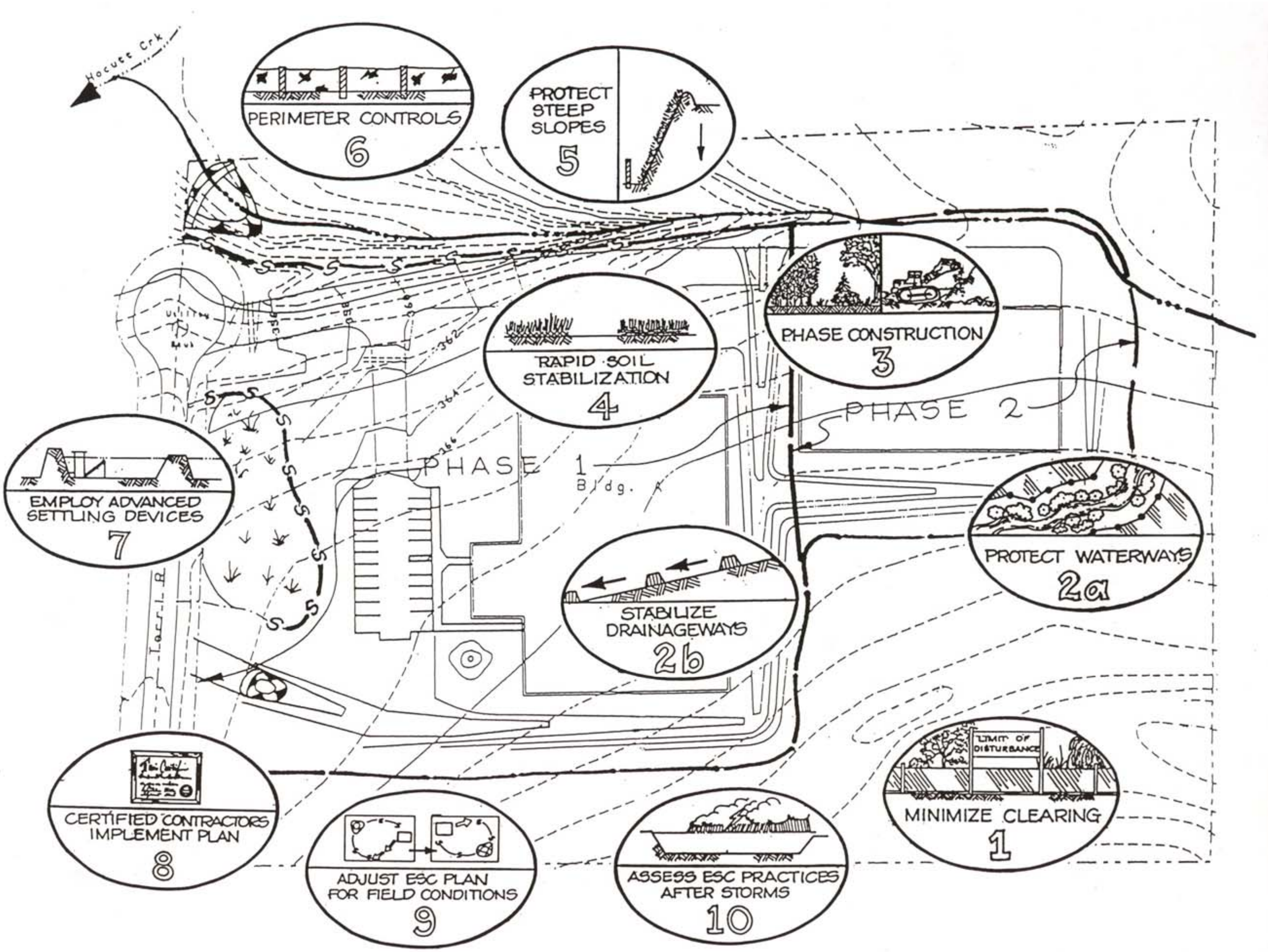
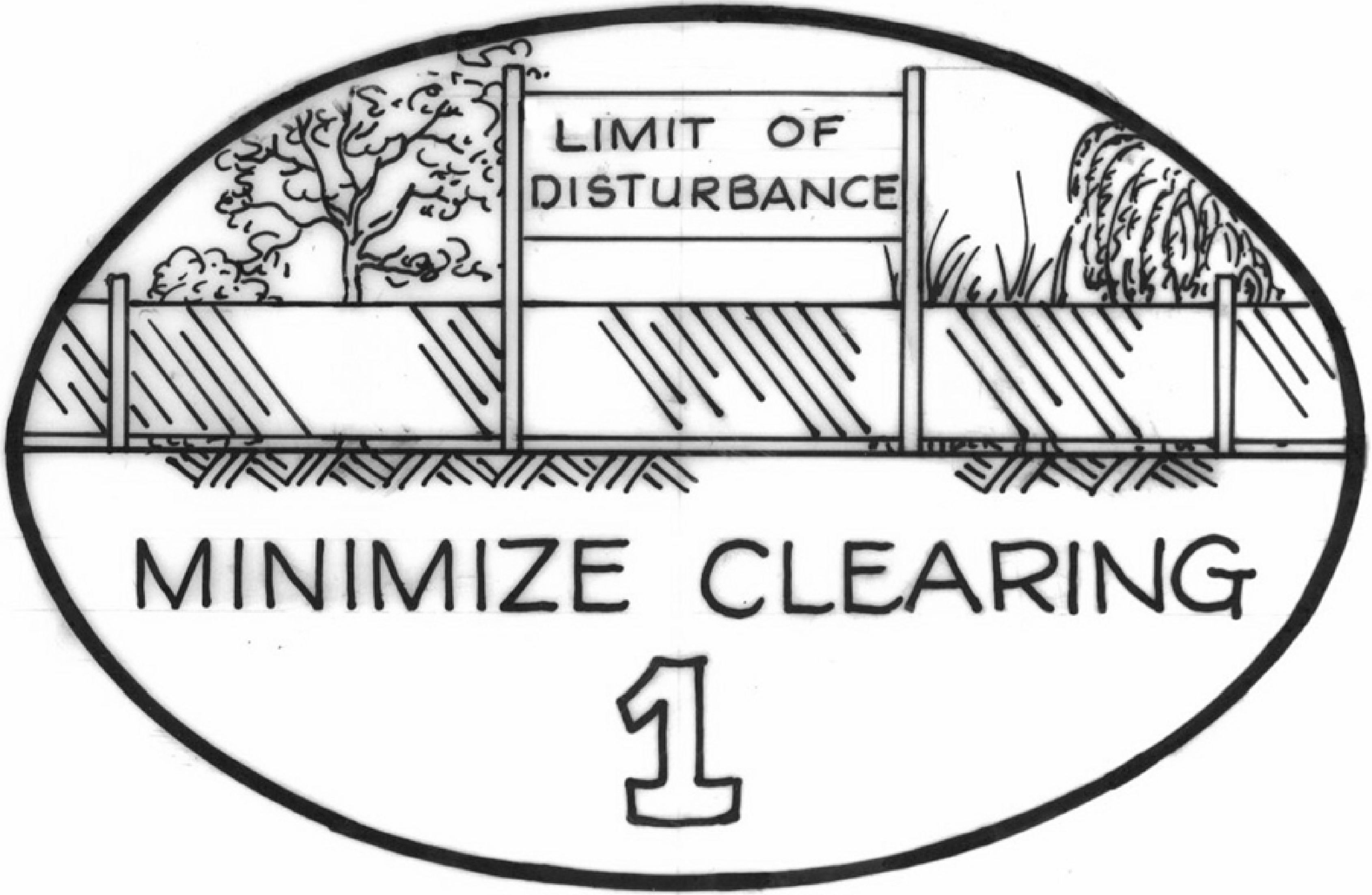
10 Elements of an Effective ESC Plan




LIMIT OF
DISTURBANCE
MINIMIZE CLEARING
1


Copyright Center for Watershed Protection, 2001
6. 28. 2000

1. Minimize Site Clearing

Objectives:

- Prevent erosion by never clearing/grading portions of the work site
- Protect sensitive areas from grading
- Preserve natural vegetation/forest

Techniques:

- Site fingerprinting
- Clearing Restrictions

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)

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


TREE PRESERVATION AREA
DO NOT :
STOCKPILE MATERIALS
ENTER WITH EQUIPMENT OR VEHICLES
REMOVE OR RELOCATE FENCE OR OTHER BARRIERS

Stormwater Haiku

If your Inspectors
Cannot tell brown from green
Dump Infiltration!

Sequencing Stormwater in Construction

OK to install curb, gutters and storm drain and discharge to sediment basin

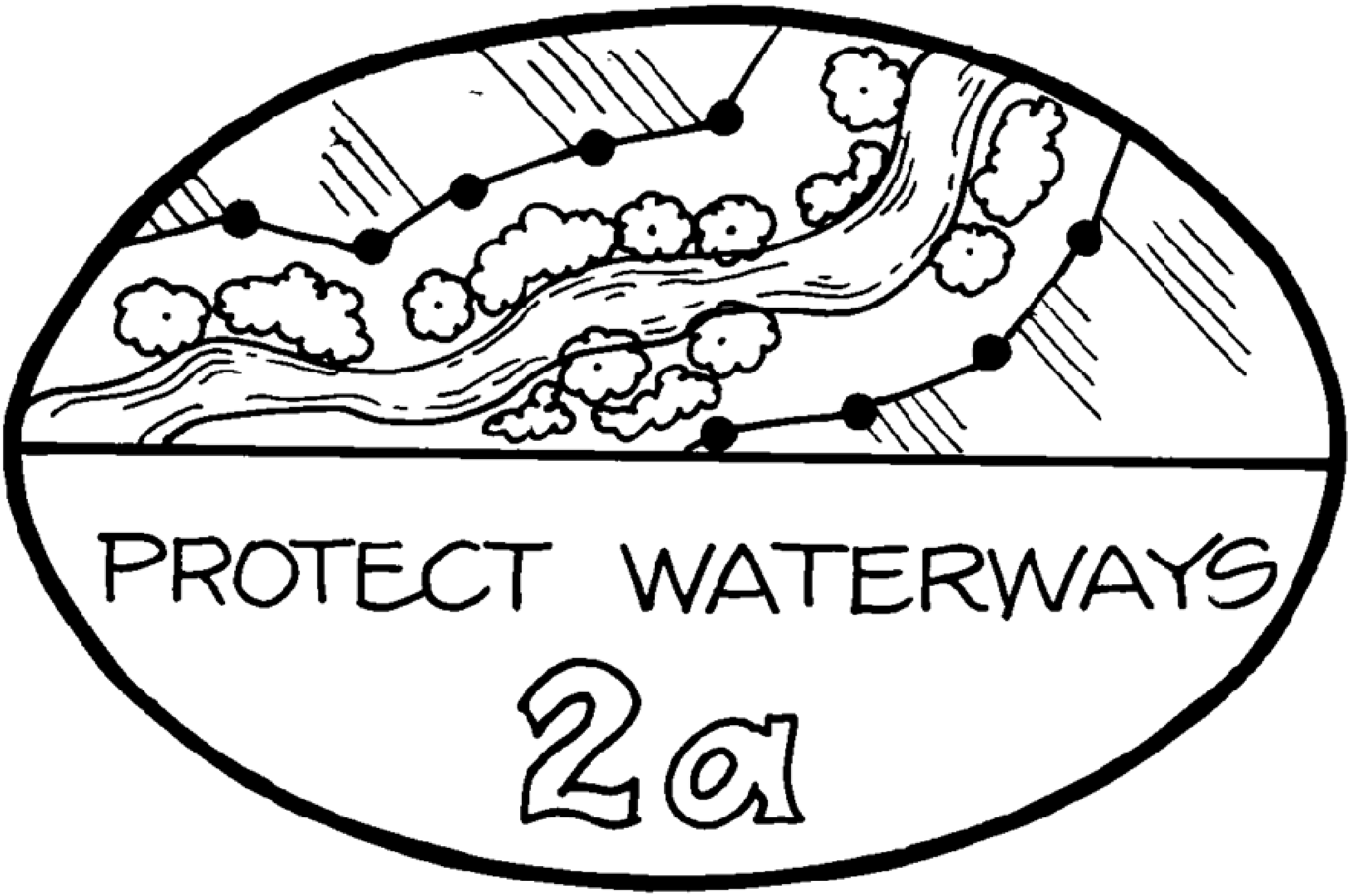
Do not clear locations of stormwater practices (protect them with silt fence– outside LOD

Do not install permanent BMPs (including perforated pipes for peak discharge control) until contributing area is fully stabilized.

Reforestation is proactive erosion and sediment control strategy–link violations to tree planting

Site Fingerprinting

- Reduce grading to building pad, roadway, utilities and septic areas


PROTECT WATERWAYS
2a

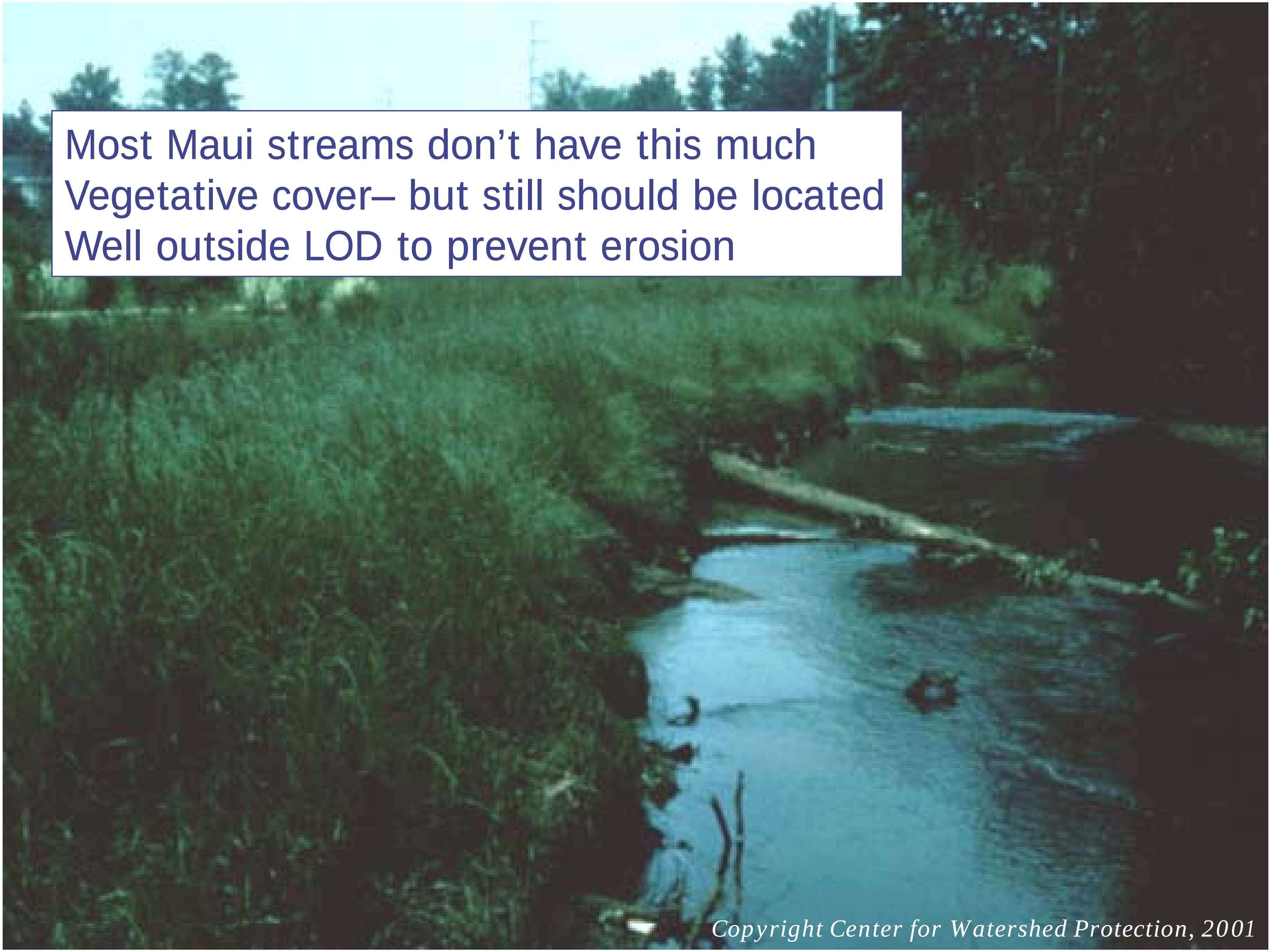
2a. Protect Waterways

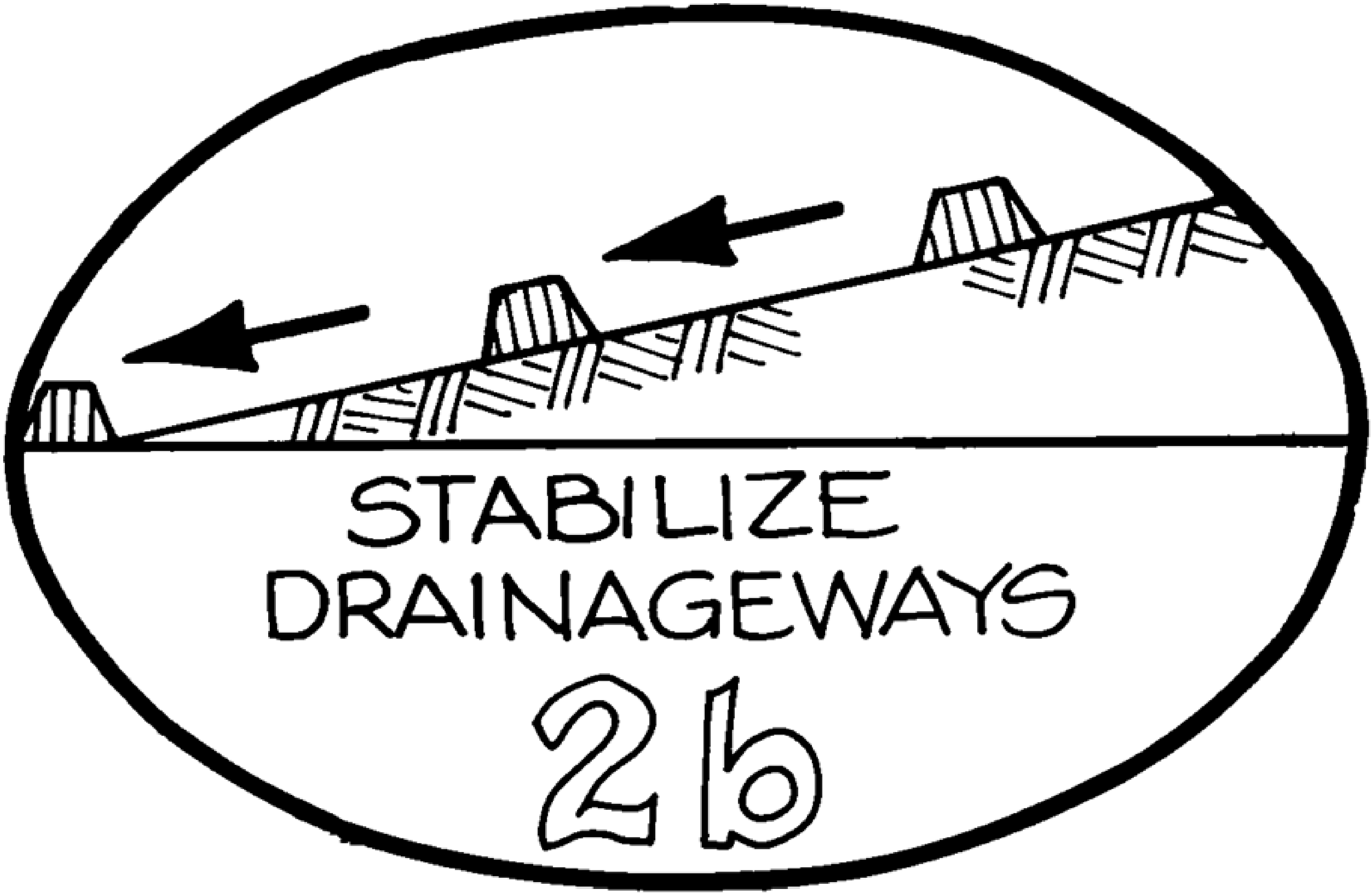
Objective:

- 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


Most Maui streams don’t have this much
Vegetative cover– but still should be located
Well outside LOD to prevent erosion
Copyright Center for Watershed Protection, 2001


STABILIZE
DRAINAGEWAYS
2b

2b. Stabilize Drainage Ways

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

Design of Grass Channels

- Gentle grades and side slopes
- Warm season grasses w/ some perennial rye
- Erosion control fabric
- May need some topsoil, fertilization and liming to get grass started

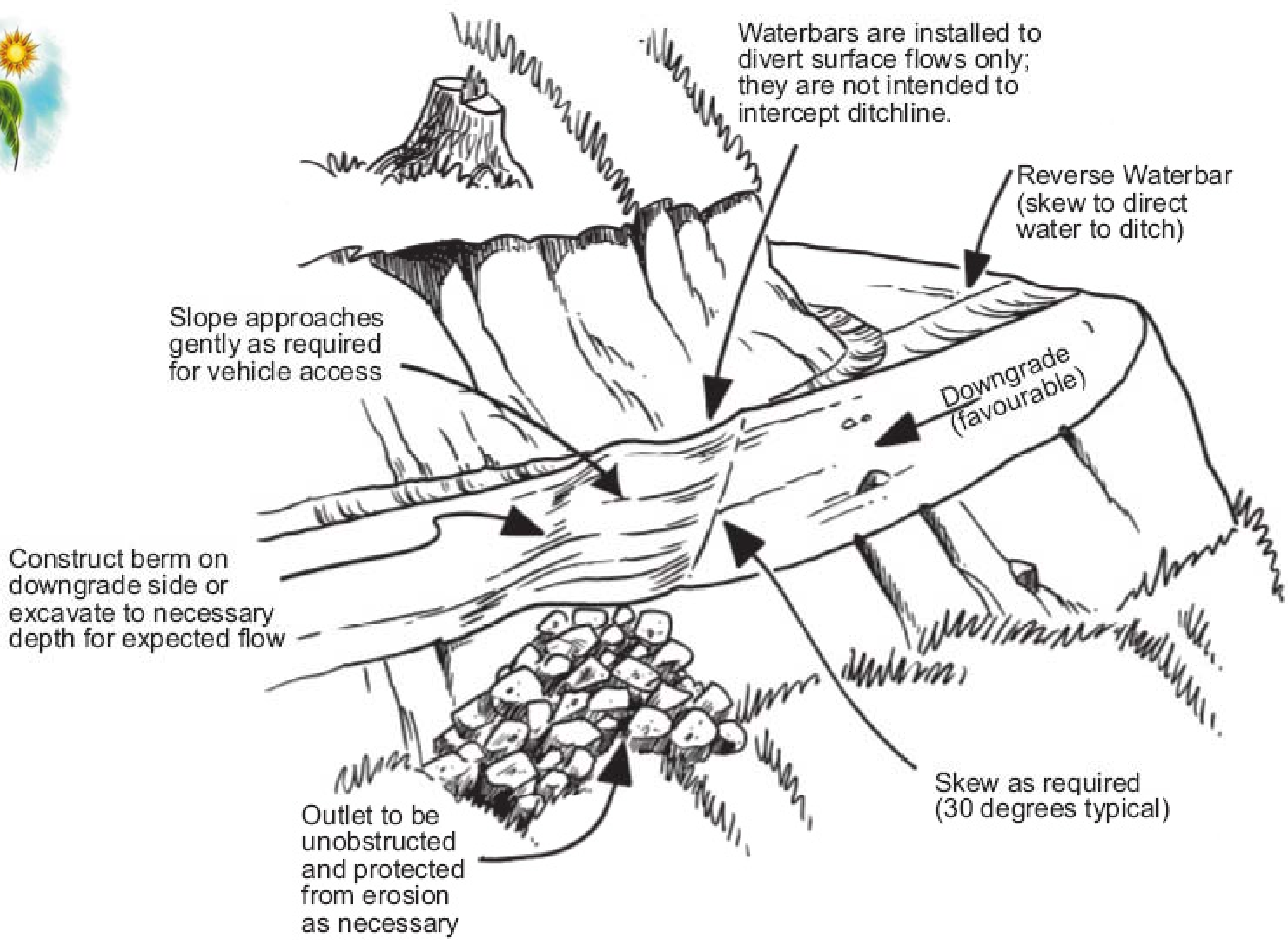
Also may be converted into permanent stormwater practice

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


Direction of Flow
Checkdams
Source: MDE, 2001


Checkdams
Source: MDE, 2001



Design of Water Bars

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

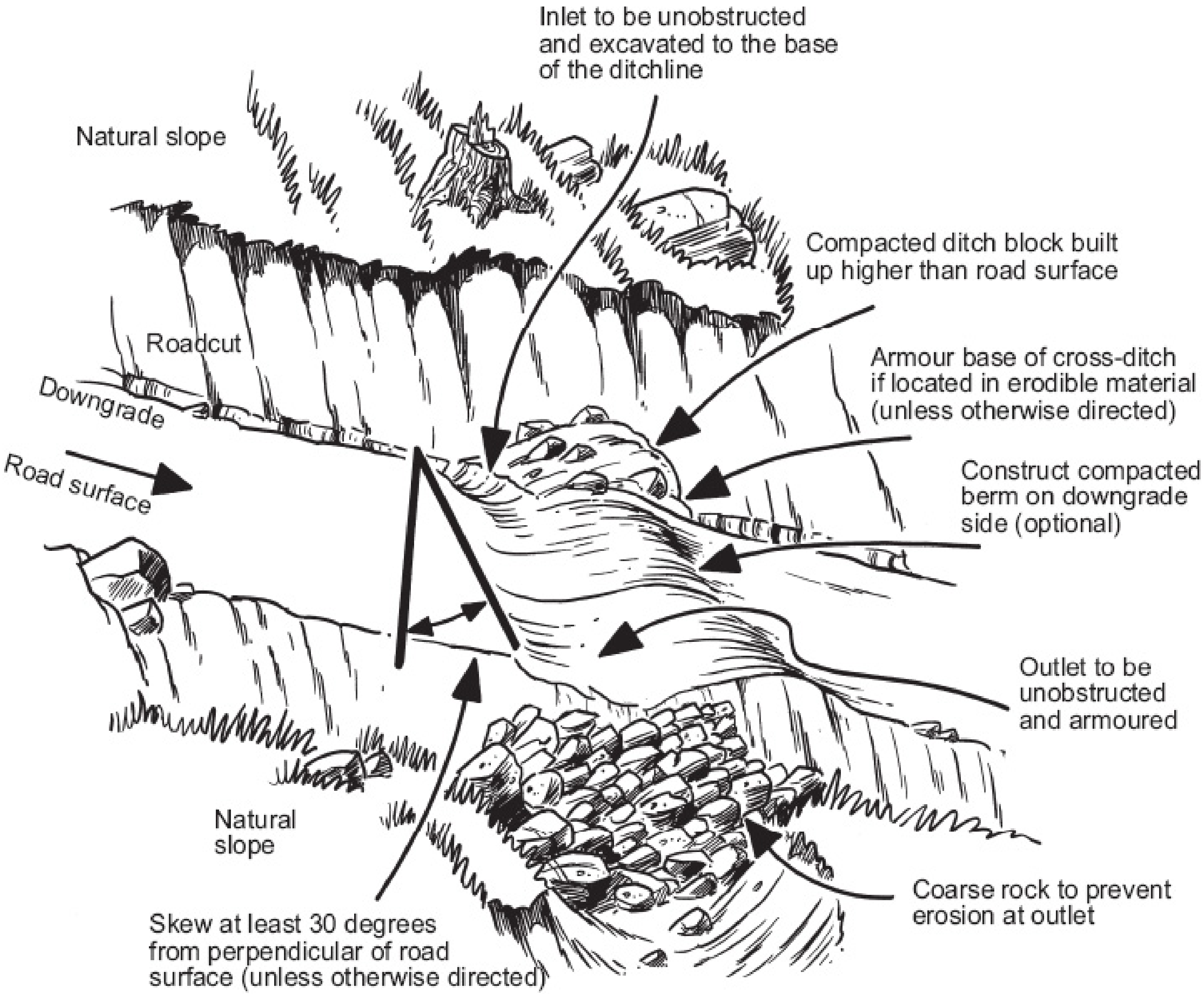
Recommended Spacing Between Water Bars

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 VICS (2003)

Coir Fiber Log as a Check Dam


What island materials cab be used to shape wetland topography (coir fiber log)
Copyright 2000, CWP



Design of Broad-Based Dips

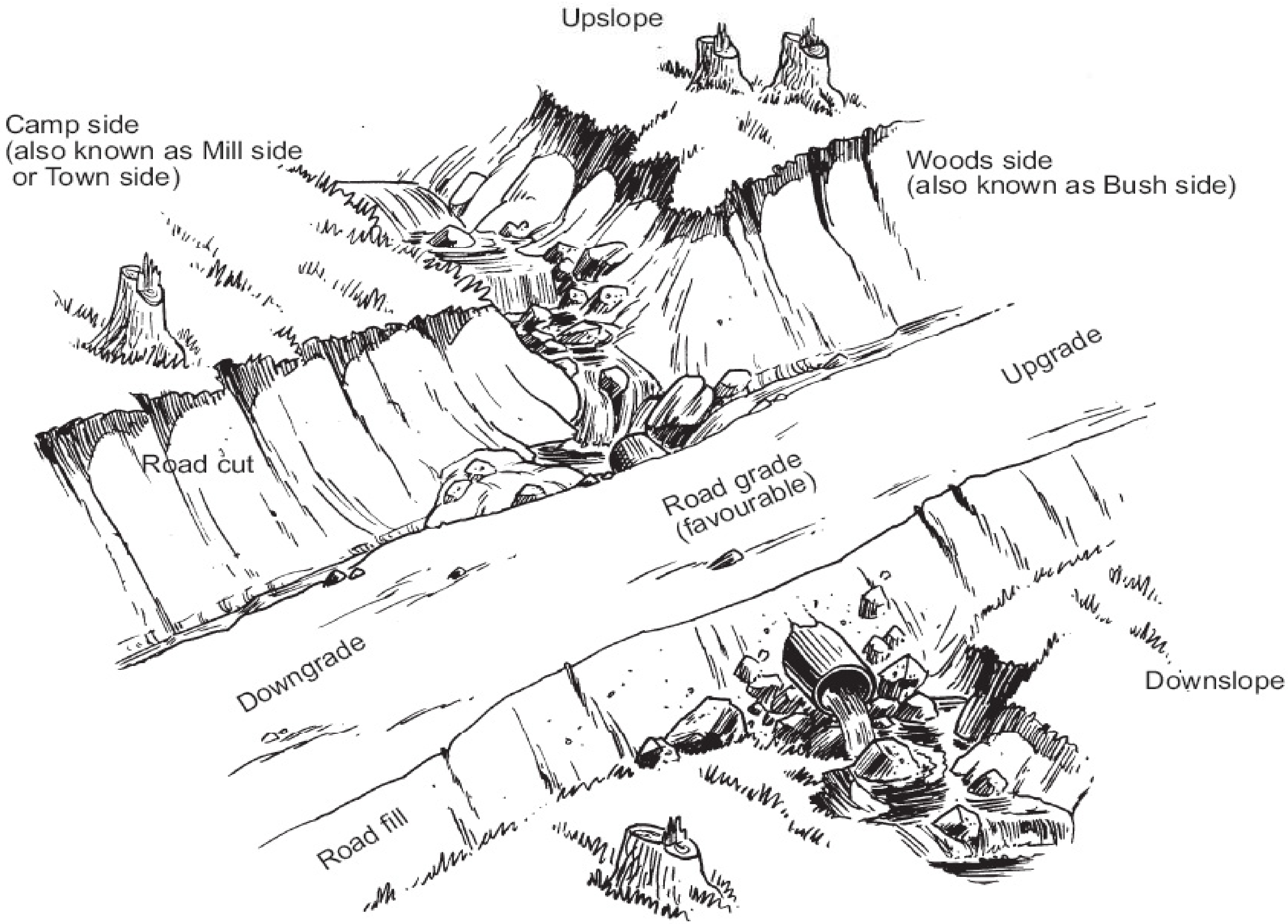
Design of Broad Based Dips

- 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

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

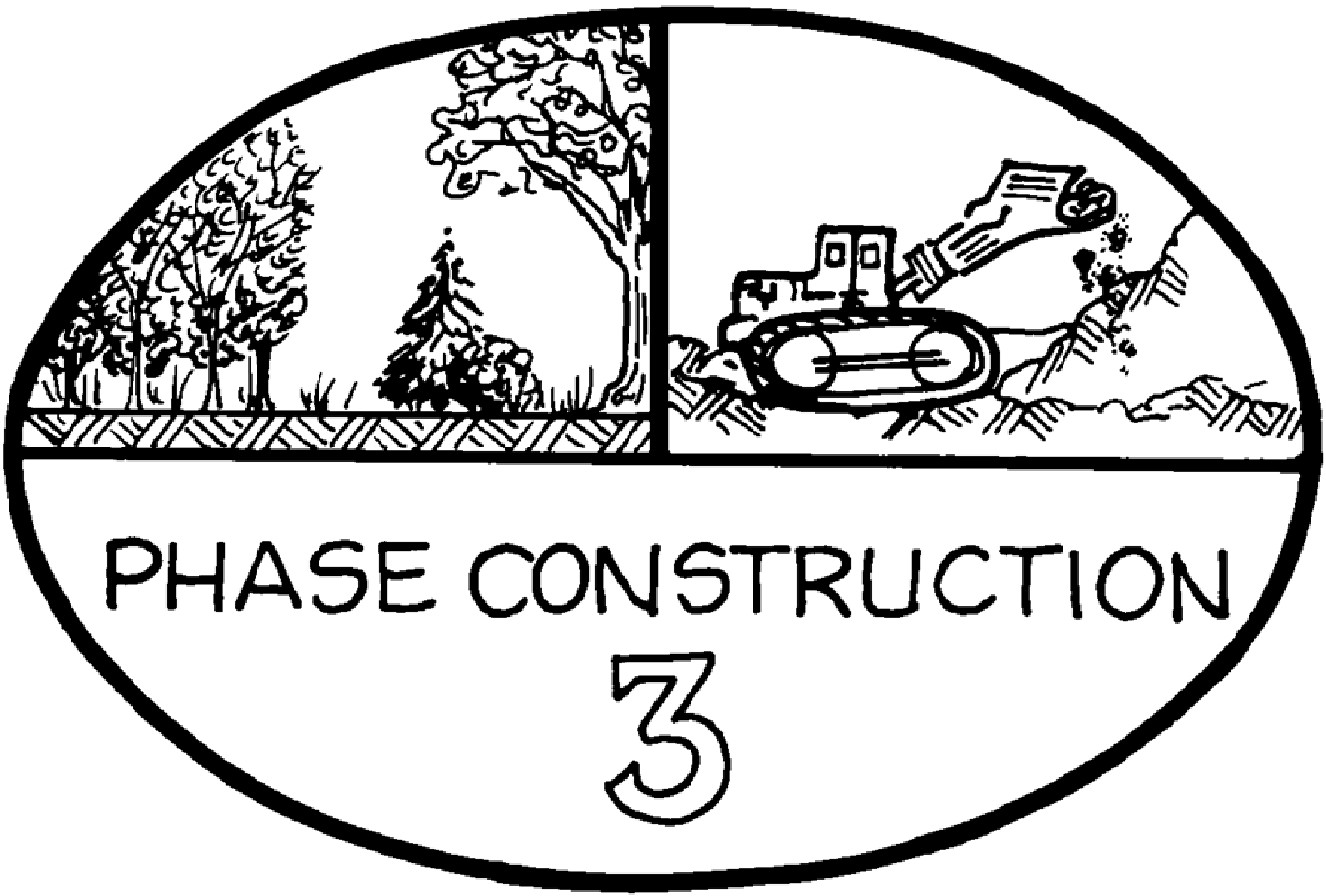
Source: HI DFW (2003) and VICS (2003)



Design of Cross-Drain Culverts

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


PHASE CONSTRUCTION
3

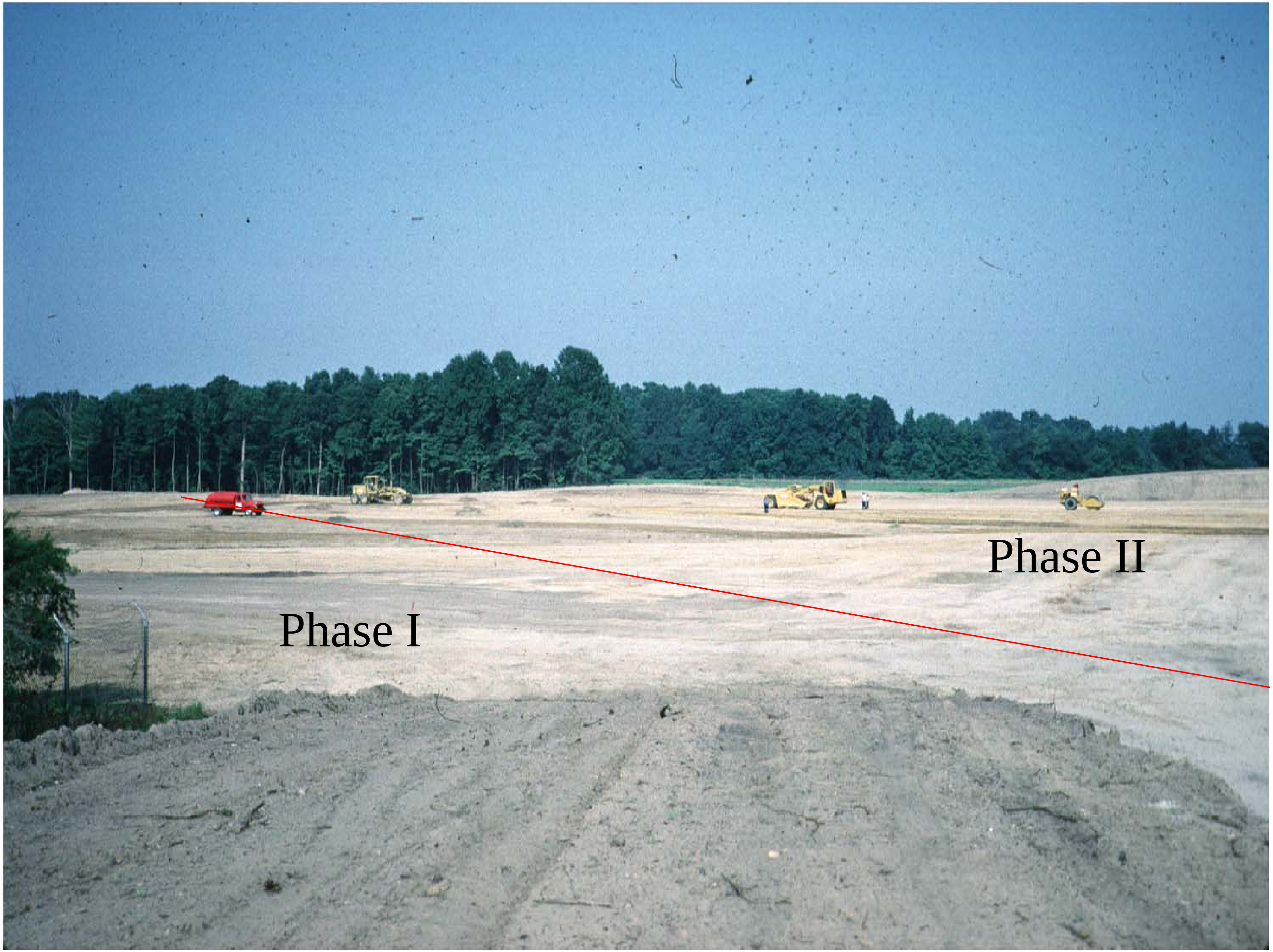
3. Phase Construction

Objective:

Reduce soil erosion by minimizing the amount of time and area of exposed soil

Grade only portion of site where construction is active (“just-in-time” grading)

15 acre threshold for phasing in MC

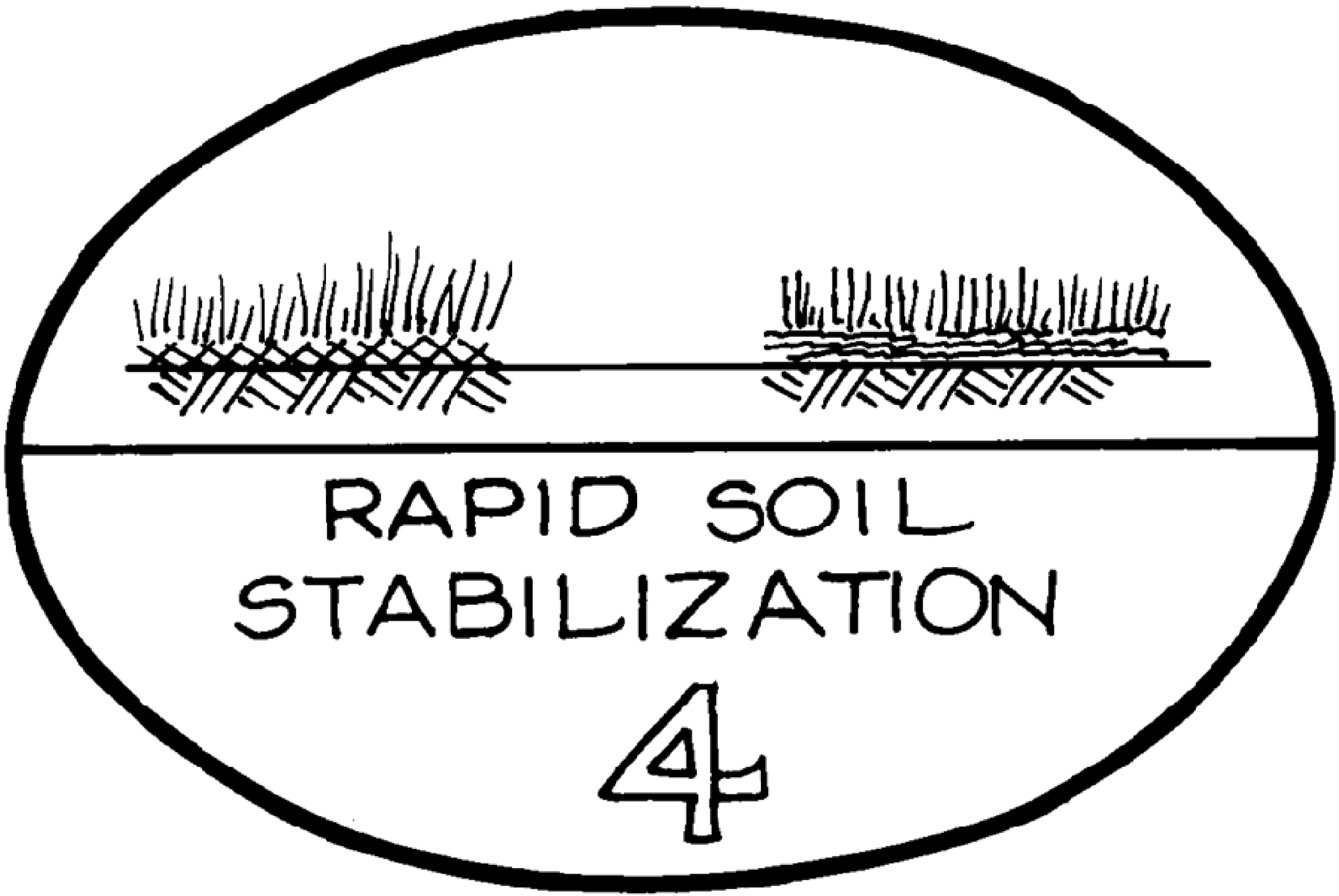

Phase II
Phase I

3. Phase Construction

- Can reduce erosion by 40% over traditional mass grading
- Requires careful planning
  - “Cut” soil matches “fill” requirement
  - temporary stockpiling and construction access
  - Phases should correspond to existing and future drainage boundaries

Be Tough

- Suggest lowering area threshold or increasing temporary stabilization requirements to promote more phasing
- No clearing on phase 2 until phase 1 completed and fully stabilized.
- Tougher ESC requirements the longer a site is open


RAPID SOIL
STABILIZATION
4

4. Rapid Soil Stabilization

Objective:

- Reduce soil erosion by minimizing the amount of time soil is exposed

Techniques:

- Seeding/Hydroseeding
- “straw” mulch
- Wood fiber mulch

4. Rapid Soil Stabilization

- Establish grass or mulch cover within two weeks 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 ryegrass to get temporary stabilization
- Grasses vary greatly in tolerance for drought, and shade, and requirements for nitrogen and maintenance
- See CTHAR Turf Management Note 4.

Seeding

- Cost: $0.10/ square yard
- Nearly 100% effective for established grass, 80% for sparse cover
- Requires temporary irrigation to get cover
- $2200 to 3200 per acre (island)
- Should be considered for sensitive areas

Wood Fiber Mulch

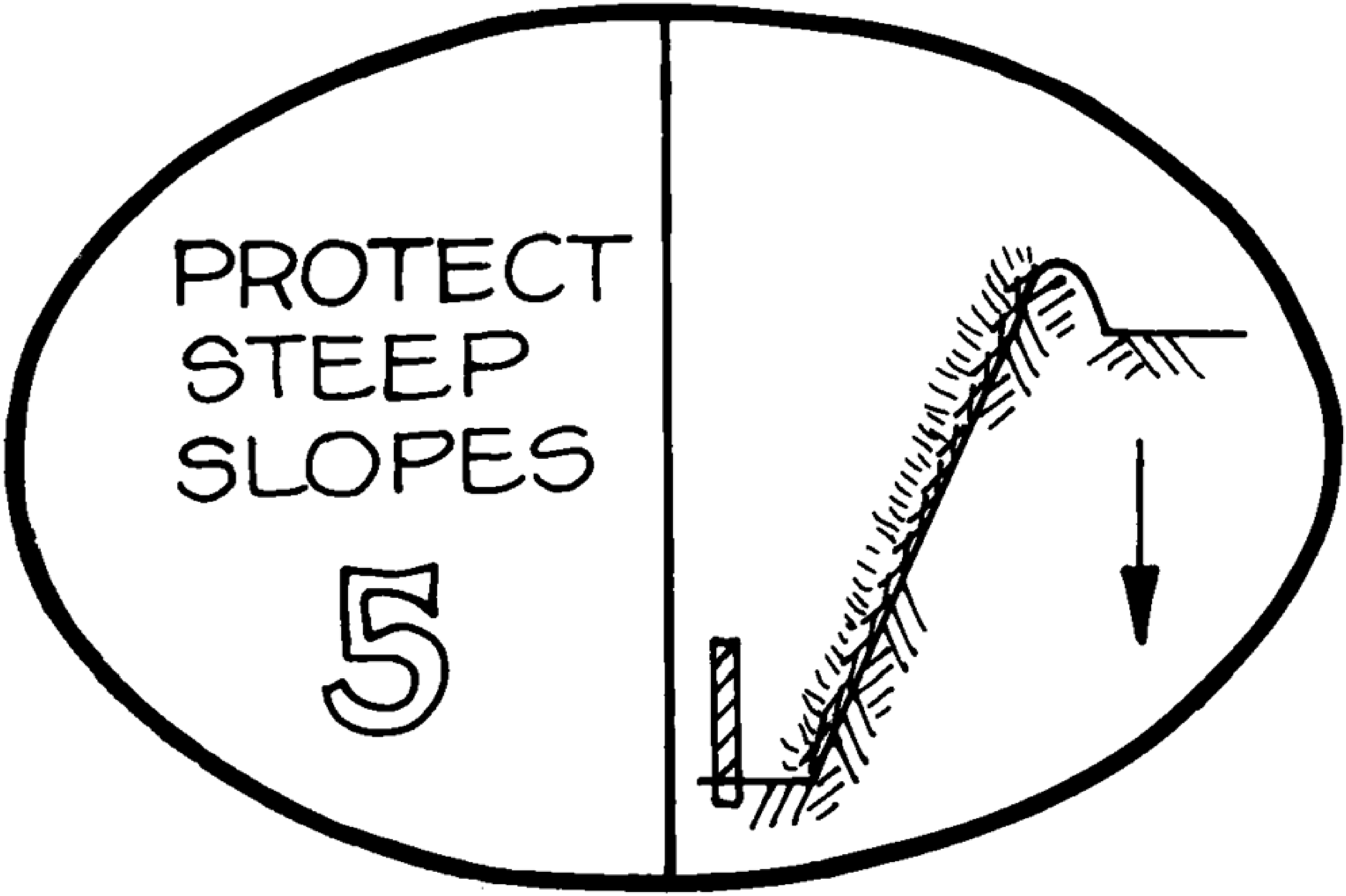
- Cost: $0.25 to 0.50 per square yard
- Can be up to 90% effective
- Typically used in combination with hydroseeding
- Can apply with seeding in one step
- Not appropriate for steep slopes or long time periods

Appears to be too thinly applied on Maui– need an Inspection benchmark


FINN
T90 Hydro Seeder

Organic Mulch

- Shredded Coconut or Cane
- $0.35 per square yard
- 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


PROTECT
STEEP
SLOPES
5

5. Protect Steep Slopes

Objective:

- Reduce erosion from steep slopes

Techniques:

- Limit clearing of steep slopes (25%)
- Divert upland flow using earthen dike, temporary swale or pipe slope drain
- Use upslope line of silt fence
- Erosion control blankets with seed
- Sod (island available?)

Stabilize Steep Slopes

Steeply sloping terrain is poorly vegetated for several thousand feet of elevation

- Source of sediment during extreme rainstorms
- Steep slopes are extremely hard to revegetate

Steep Slope Challenges

Tough planting conditions

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

Steep Slope Solutions

Some strategies

- Erosion control fabrics (small slopes)
- Hill Slope Bioengineering
- Better Design for Road Construction on Steep Slopes

Consider for
All cut/fill slopes
15% or more

Coconut, wood fiber or coir products work better than Man-made geotextiles

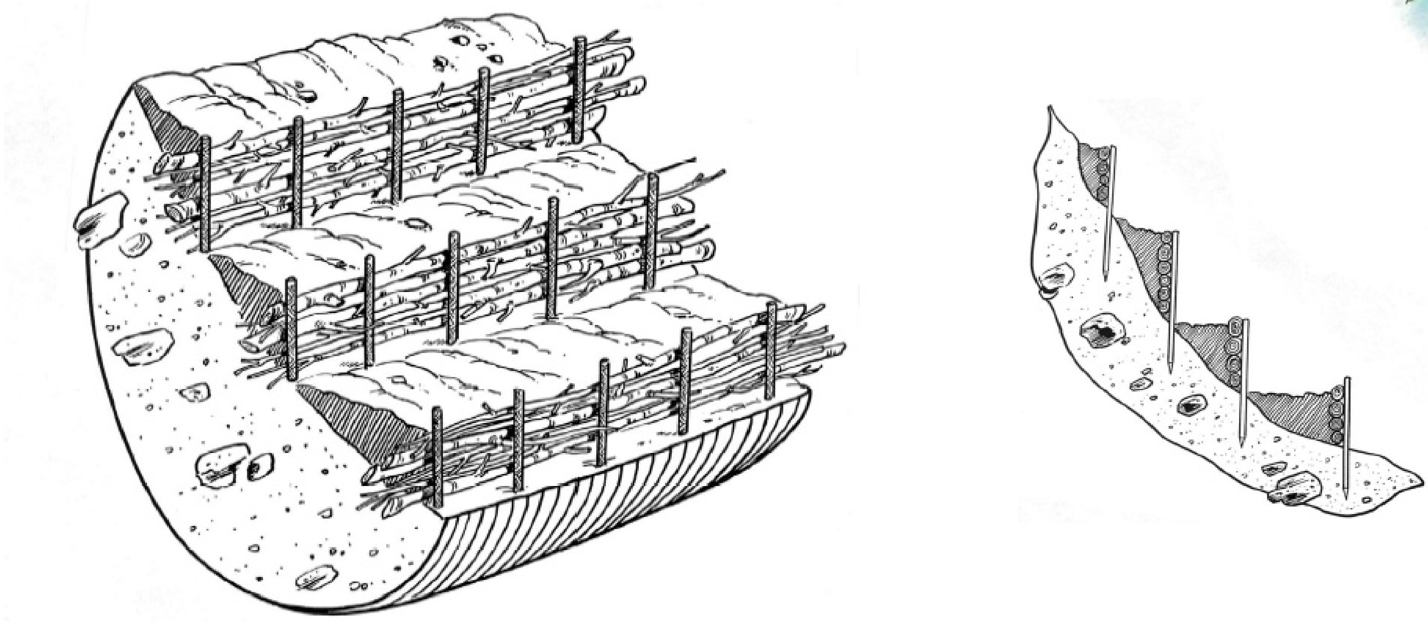


***Fig. 6.02** Wattle fences are short retaining walls constructed of living cuttings. They are used to provide terraces that will support plant growth where eroding oversteepened slopes are limiting plant establishment. The section on the right shows the spacing of wattle fences with increasing slope gradient.*

Bioengineering to protect hillslopes from erosion

Stabilizing steep gullies and guts.

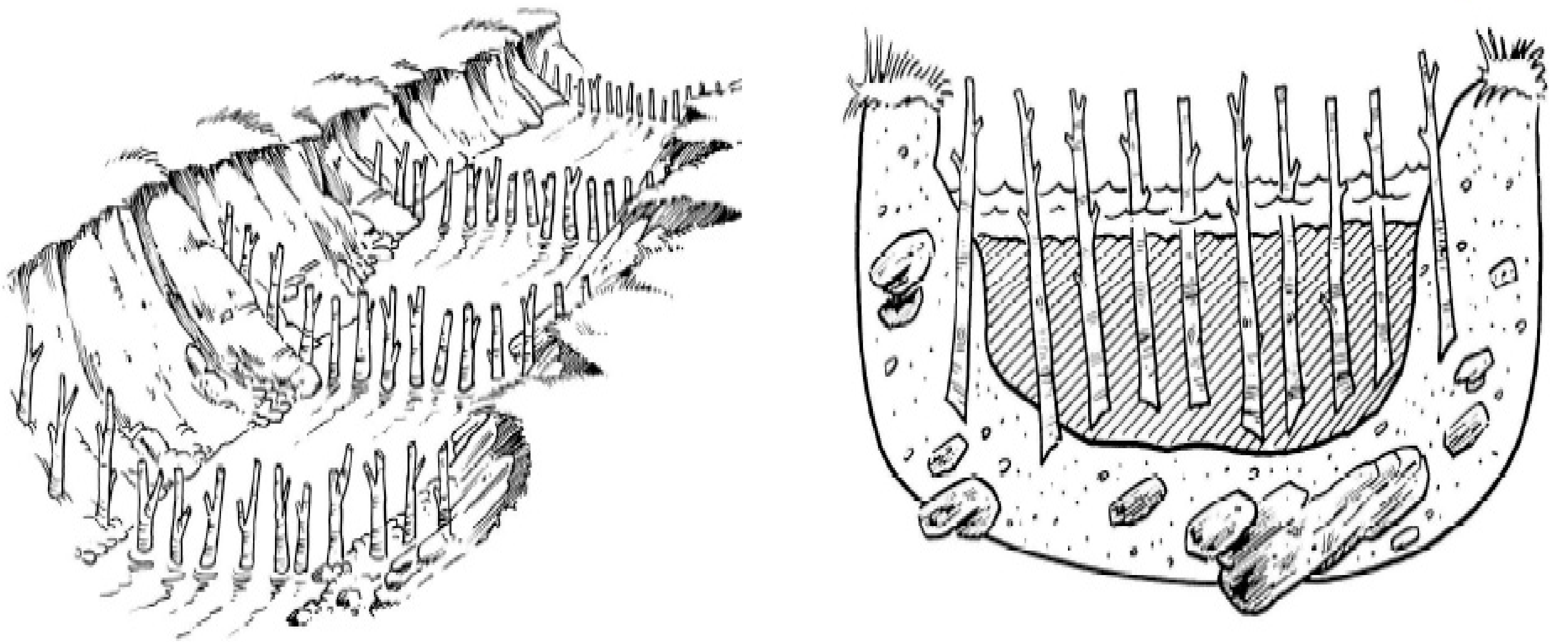


Fig. 6.13 Live silt fences can be used to provide a willow coppice in small streams and ditches. They act by slowing the velocity of the water and allowing sediment to settle out. The cuttings can be either in single rows (as shown) or multiple rows in each fence.


Poor slope drainage control results in the formation of rills and gullies.
Copyright Center for Watershed Protection, 2001

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.


Source: MDE, 2001

Coconut, wood fiber or coir products work better than Man-made geotextiles

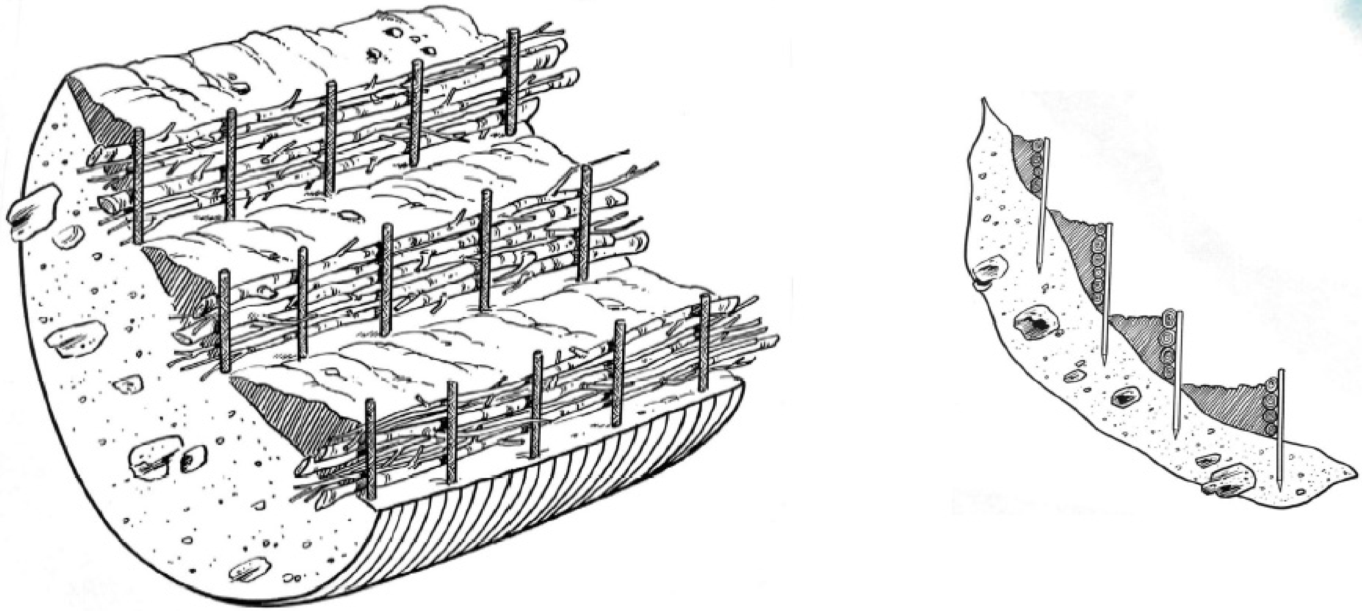
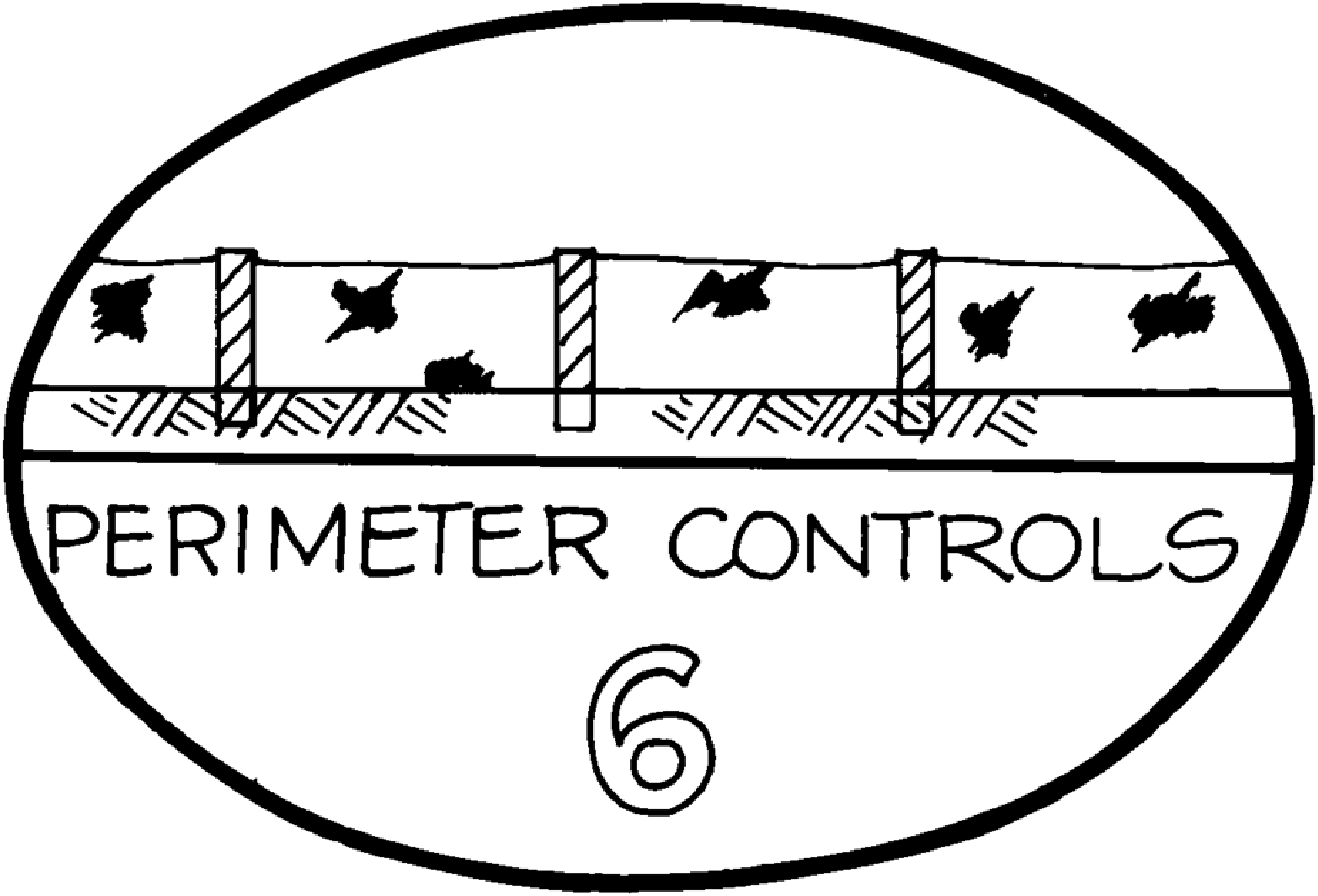


Fig. 6.02 Wattle fences are short retaining walls constructed of living cuttings. They are used to provide terraces that will support plant growth where eroding oversteepened slopes are limiting plant establishment. The section on the right shows the spacing of wattle fences with increasing slope gradient.

Bioengineering to protect hillslopes from erosion


PERIMETER CONTROLS
6

6. Perimeter Controls

Objective:

- Retain or filter runoff before it leaves the site.

Techniques:

- Earth dikes or diversions.
- Silt fences.
- Stabilized construction entrances.

Silt Fences

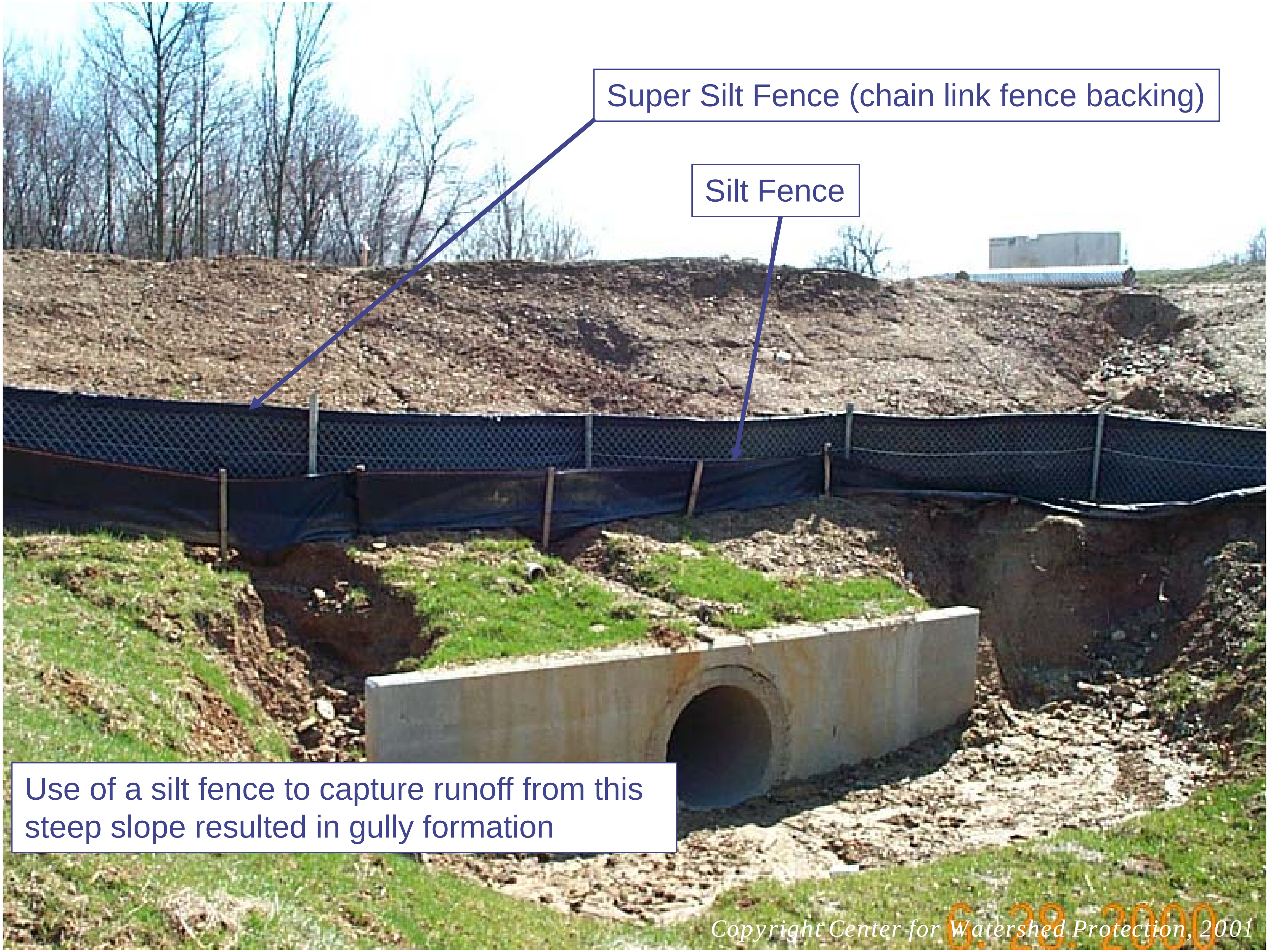
- Popular practice due to low cost: $3.50 per linear foot (mainland).
- Between 65% and 85% TSS removal in field studies.
- Ongoing maintenance can cost as much as original installation over project life

Silt Fences

Silt fences are often poorly located, installed or maintained:

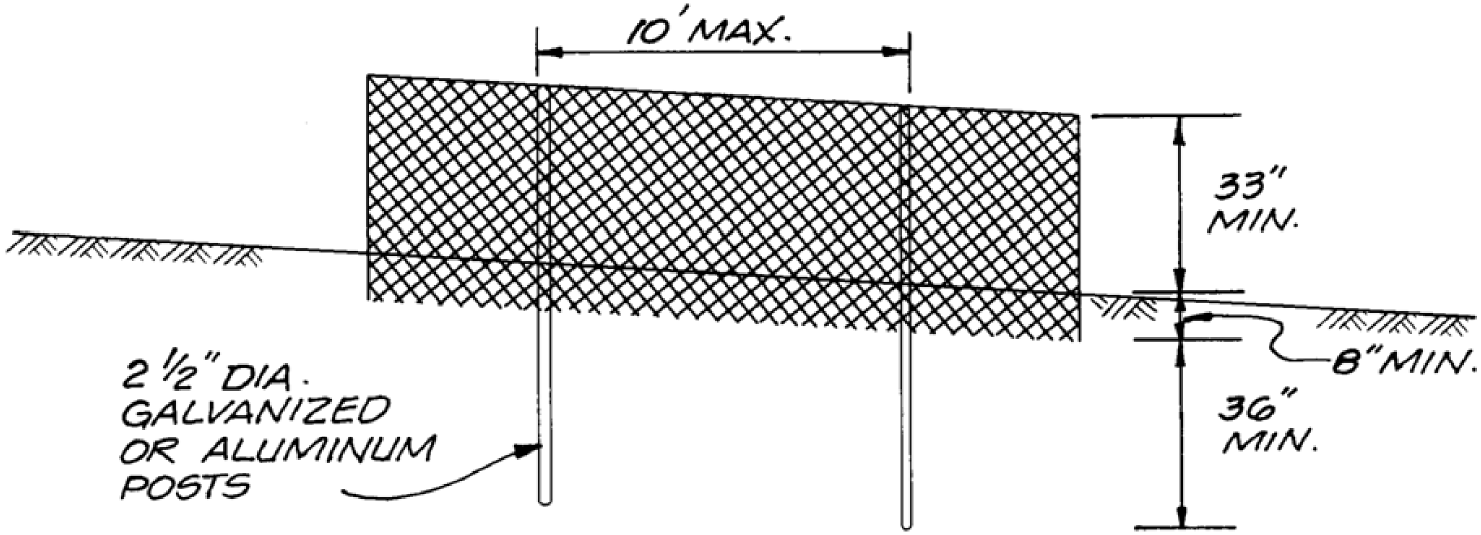
Mainland data:

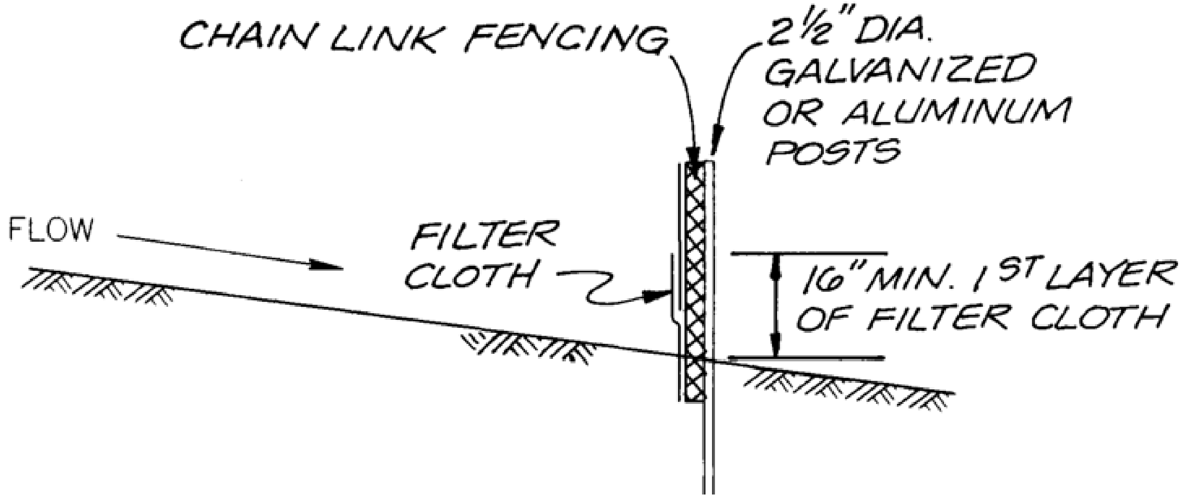
- Only 67% of silt fences on the ESC plan were installed.
- Only 58% were installed correctly.
- Only 34% were adequately maintained.

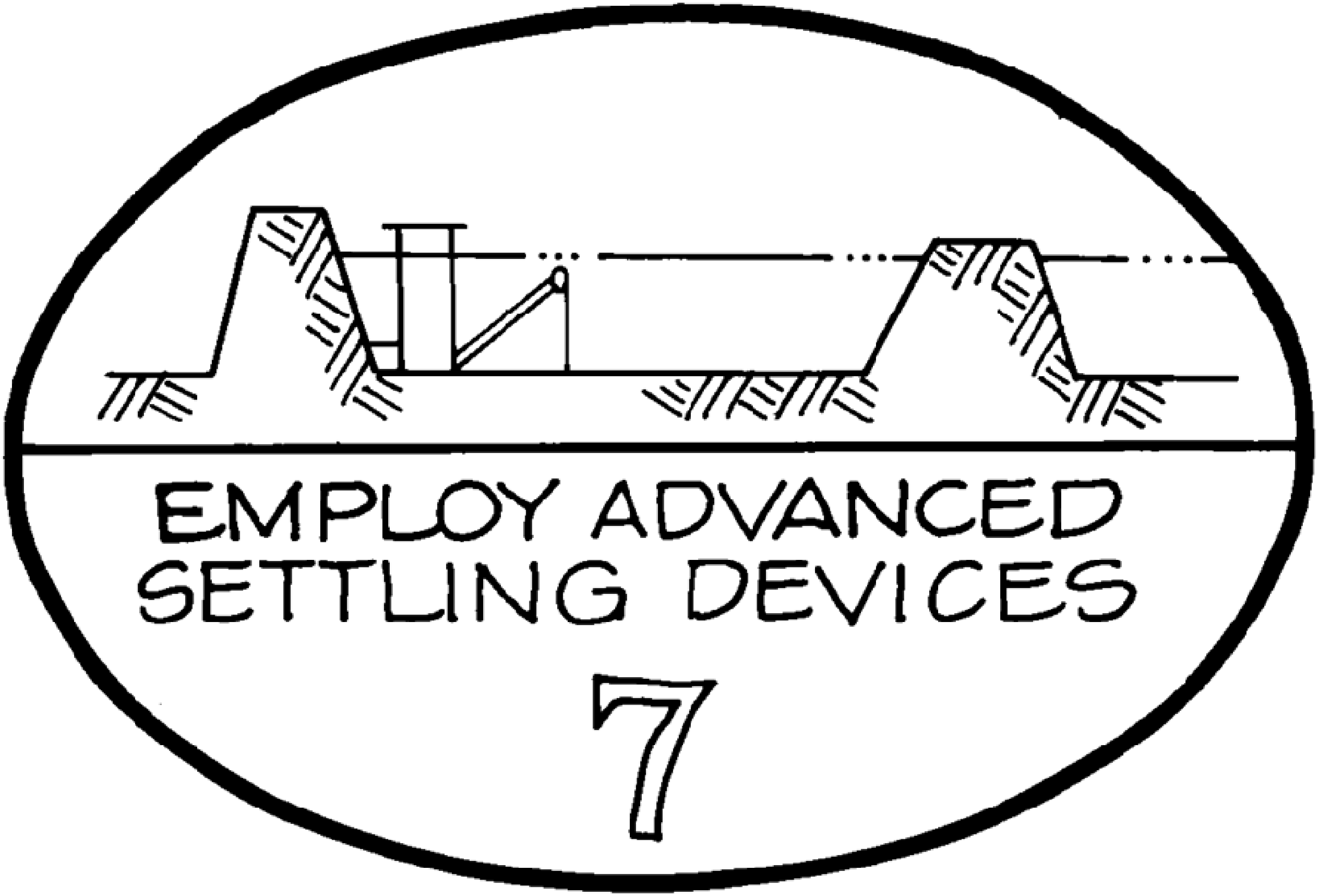

Super Silt Fence (chain link fence backing)
Silt Fence
Use of a silt fence to capture runoff from this steep slope resulted in gully formation
6. 28. 2000


Improper installation below a pipe outlet.

Super Silt Fence






EMPLOY ADVANCED
SETTLING DEVICES
7

7. Employ Advance Settling Devices

Objective:

- Trap sediment in runoff before it leaves the site

Techniques:

- Sediment traps
- Sediment basins

Settling Devices

- TSS removal varies between 50% to 90%
- Trapping limited by
  - Difficulty in settling fine-grained soils
  - Simplistic design of existing 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

Sedimentation basin
with standpipe
encased in gravel.


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

8. Certify Contractors and Inspectors

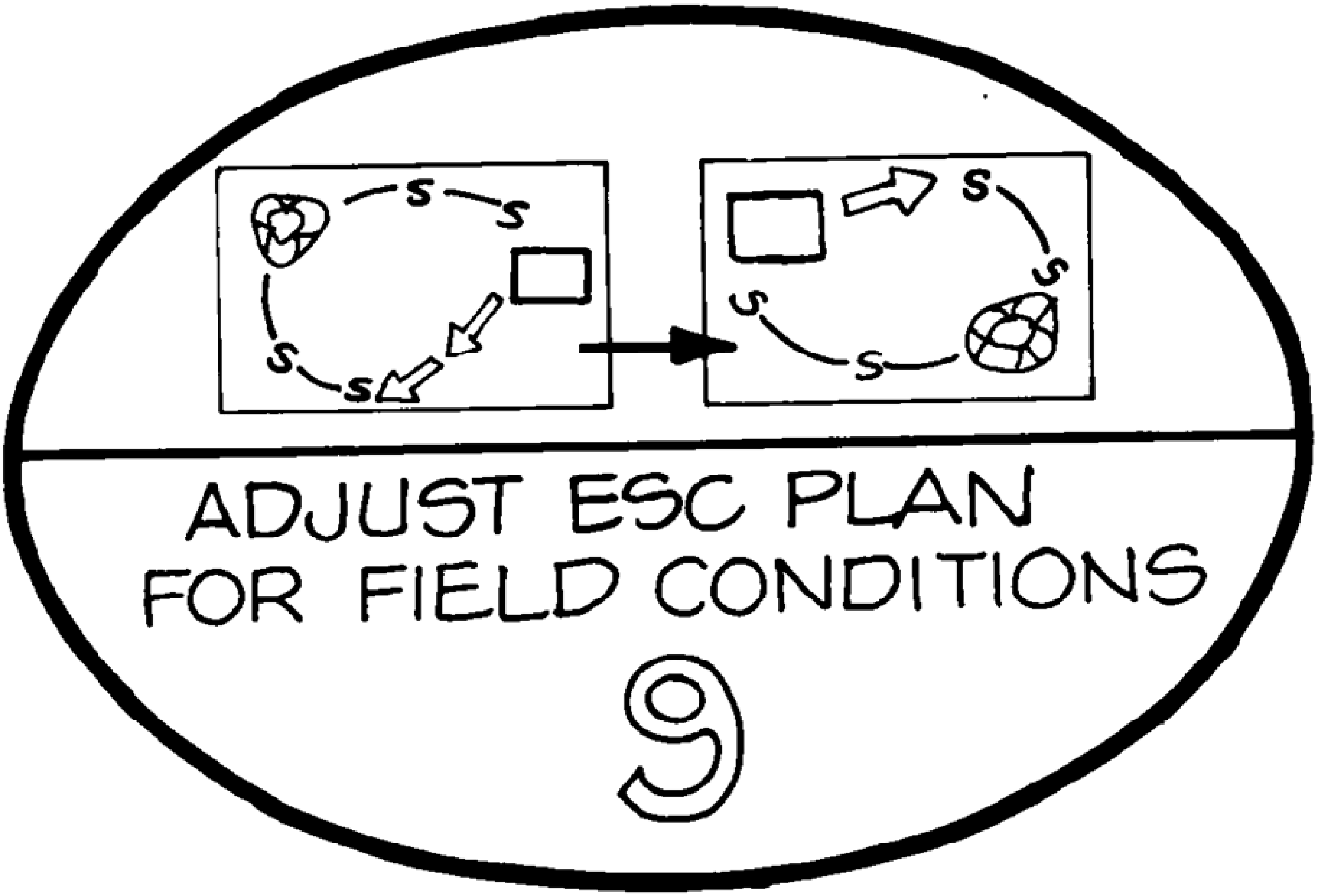
Objectives:

- Ensure proper installation and maintenance.
- Train contractors and inspectors

Techniques:

- mandated ESC training.
- Applies to contractors responsible for installation and maintenance of ESC devices.
- Pre-construction meetings.

Need for greater training for designers and contractors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ADJUST ESC PLAN
FOR FIELD CONDITIONS
9

The Subcontractors Trash My Controls!


ASSESS ESC PRACTICES
AFTER STORMS
10

Maui Recommendations

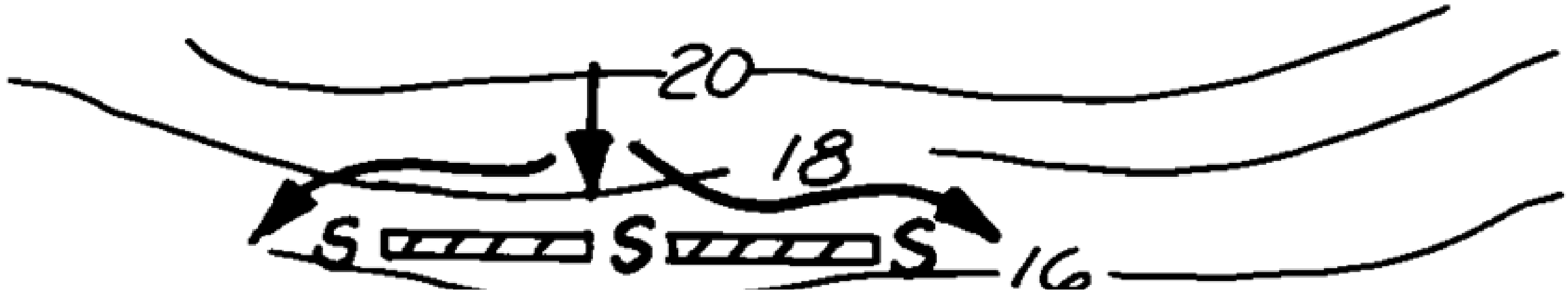
- More Training
- Better Inspection Benchmarks
- Update specs in consultation w/ engineers
- Simple general permits for single lot construction
- Tougher phasing requirements
- Investigate island mulch

Reasons Silt Fences Fail

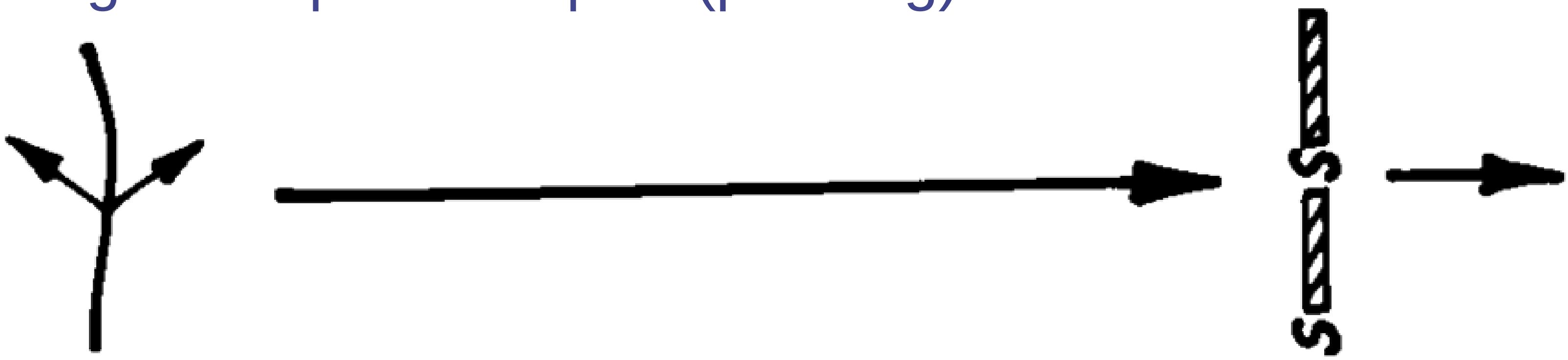
1. Slope to length ratio too high.

2. Installation does not account for construction traffic.

Reasons Silt Fences Fail

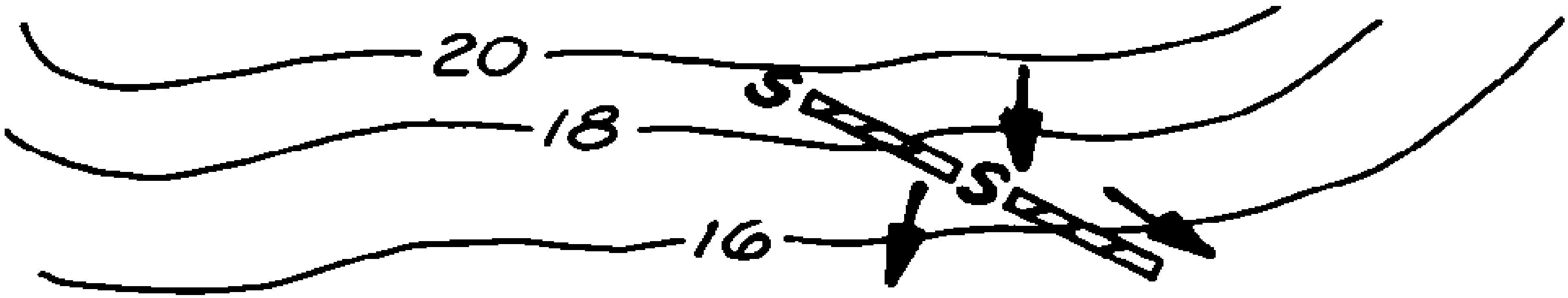


3. Edges not pointed uphill (ponding).

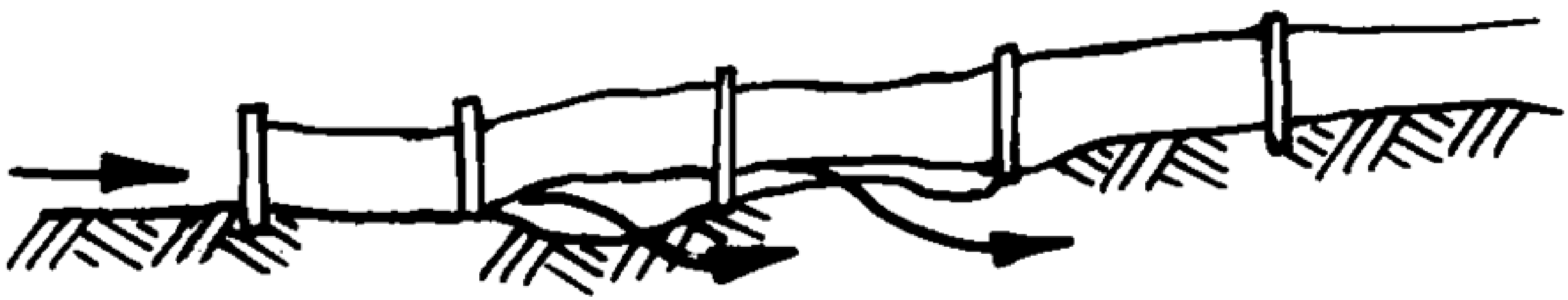


4. Contributing length greater than 100' or placed in concentrated flow location.

Reasons Silt Fences Fail

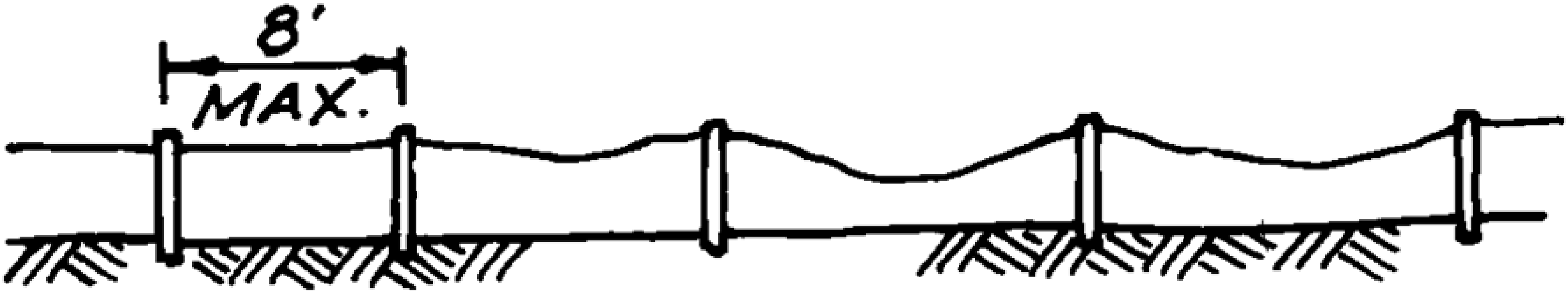


5. Fence is not installed parallel to contours.

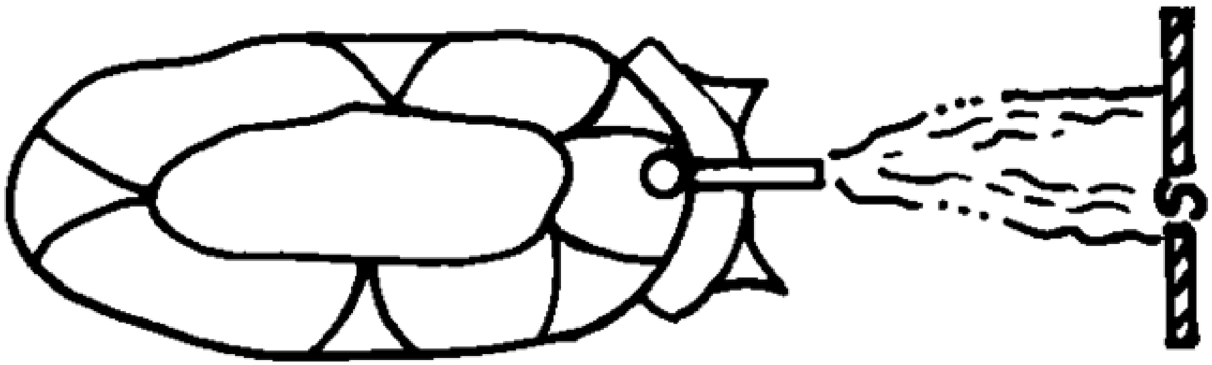


6. Bottom of fabric is not properly entrenched.

Reasons Silt Fences Fail

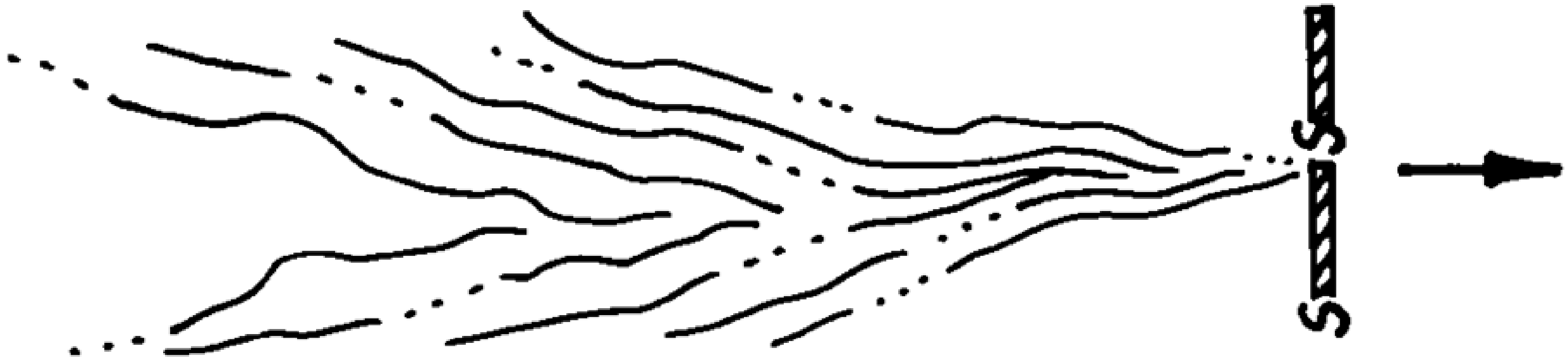


7. Distance between posts > 8'.



8. Silt fence installed below a pipe outlet.

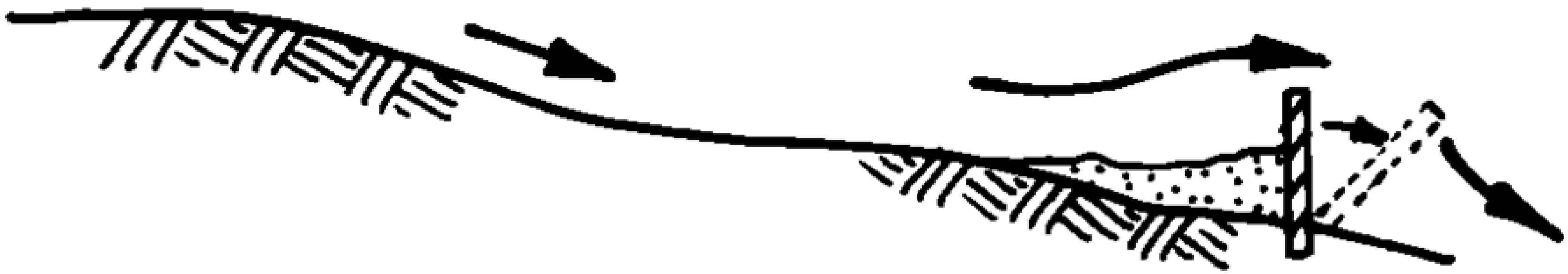
Reasons Silt Fences Fail



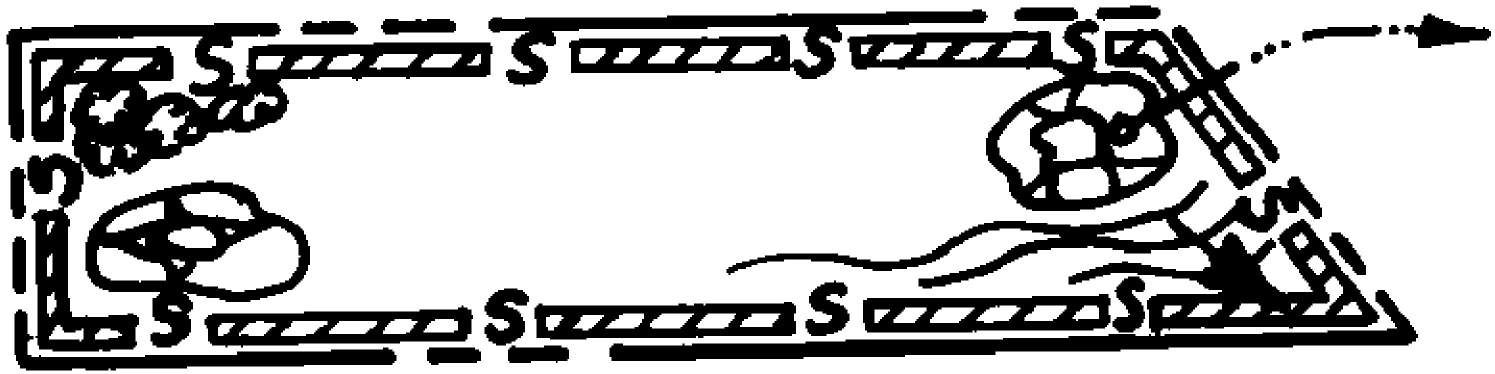
9. Silt fence receives concentrated flow.

10. Silt fence installed uphill of disturbed area.

Reasons Silt Fences Fail



11. Sediment buildup behind fence reduces treatment capacity.



12. Silt fence alignment reflects property line, not ESC needs.


Breached Curb Inlet Protection