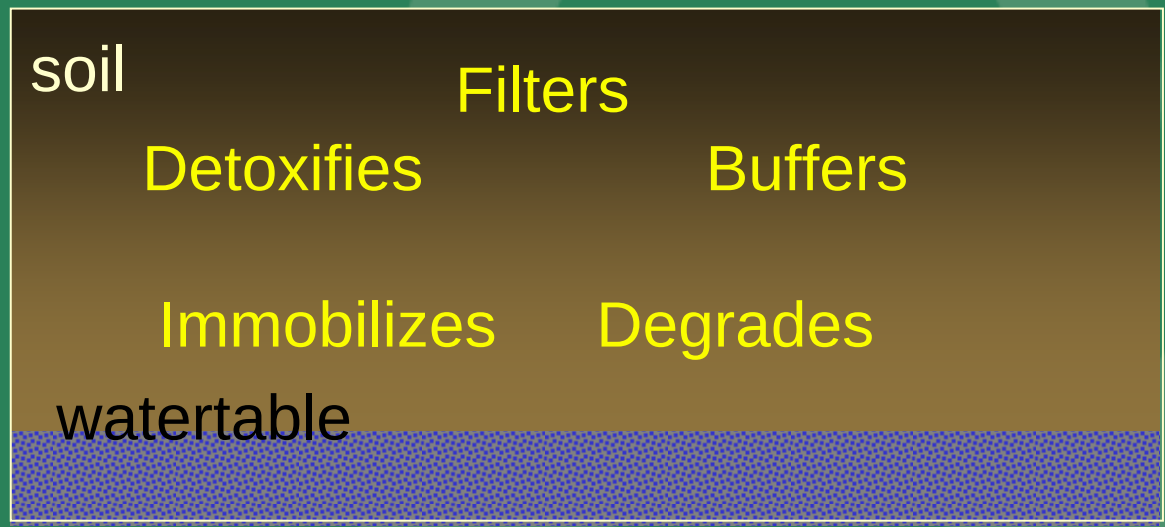
Soil Erosion By Water - Causes and Mitigation

Jerry J. Daigle
State Soil Scientist

Bradley A. Sticker
Asst. State Conservation Engineer

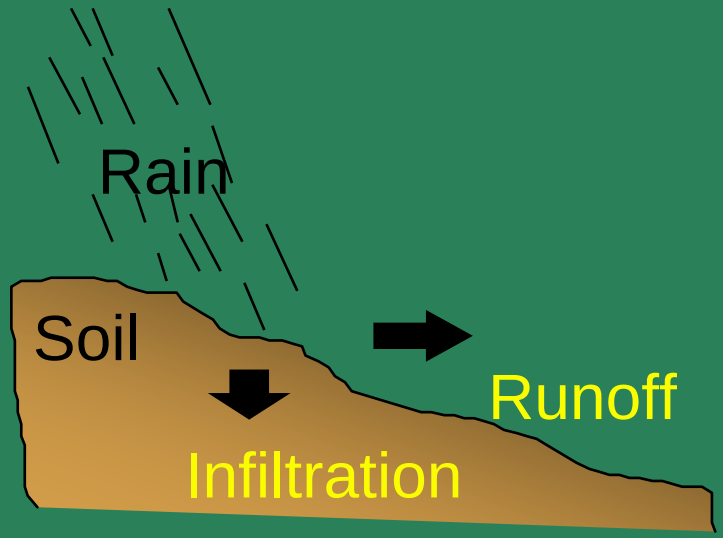
Soil - Ecological and Hydrological Resource

- supports plant growth
- provides water
- provides nutrients
- provides mechanical support
- filters before entering surface water
- filters before entering aquifers



Soil - Controls the fate of precipitation

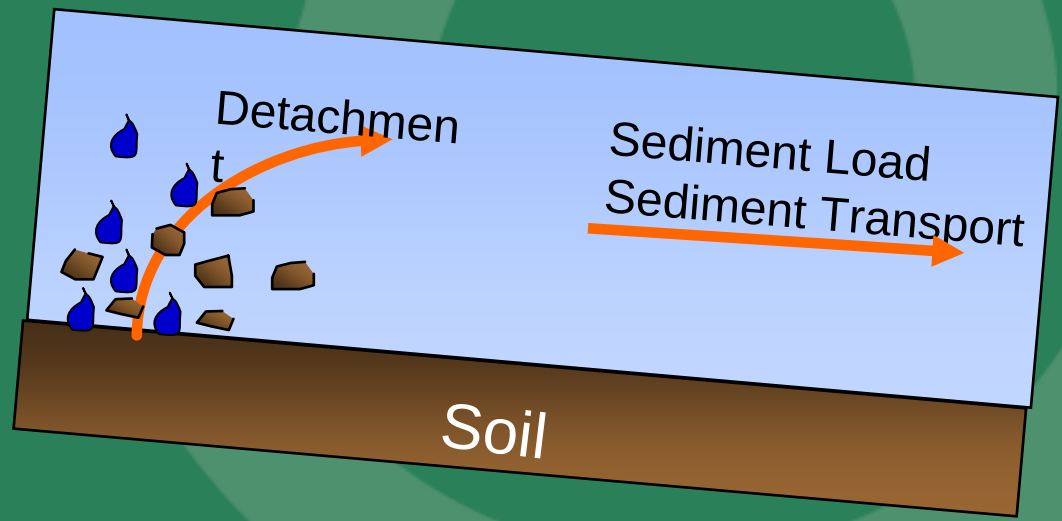
- controls what part infiltrates
- controls what part runs off
- stores water at depths available for plants
- transmits water to underlying materials



- Erosion is a process of detachment and transport of soil particles by erosive agents

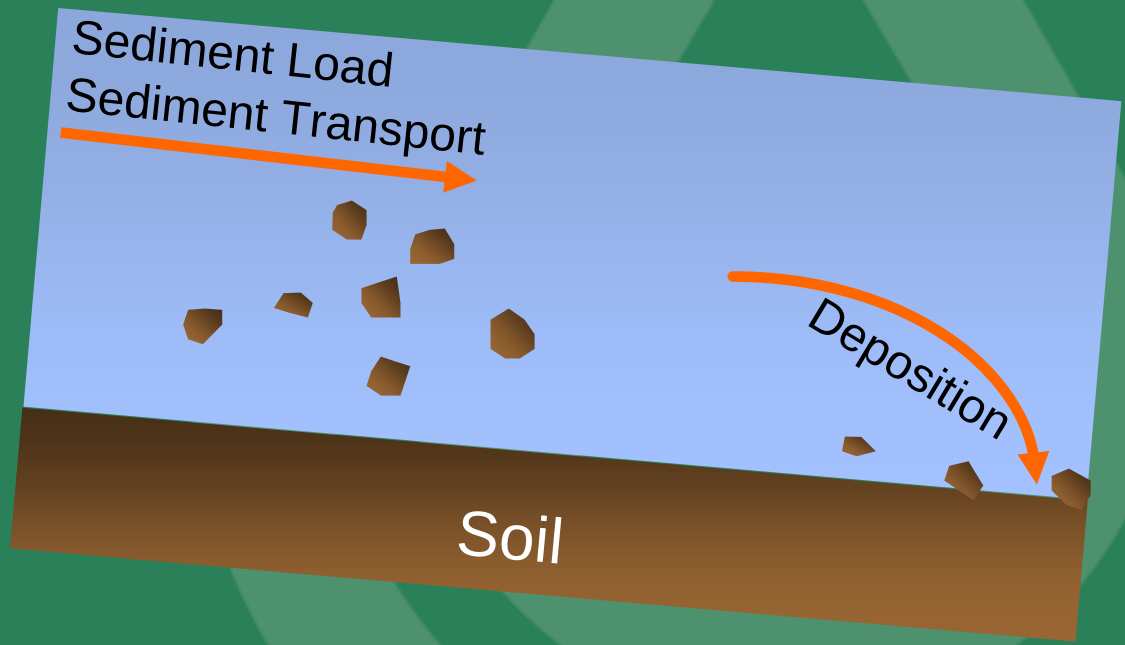
Ellison, 1944

Erosion



Deposition:

- Reduces the sediment load
- Adds to the soil mass
- Local deposition
  - Surface roughness depressions
- Remote deposition
  - Concave slope
  - Strips
  - Terraces



Erosion

- Erosive Agents
  - Raindrop impact
  - Overland flow of surface runoff from rainfall

Erosion is a Concern

- Degrades soil resource
  - Reduces soil productivity
  - Reduces soil organic matter
  - Removes plant nutrients
- Causes downstream sedimentation
- Produces sediment which is a pollutant
- Produces sediment that carries pollutants

Types of Erosion

Nonconformity contact between Pikes Peak Granite (below) and Sawatch Sandstone (above), Manitou Springs, Colorado.

- Geologic
  - natural process
  - humans can accelerate

Types of Erosion

- Raindrop or Splash
  - high detachment capacity
  - low capacity for transport

Types of Erosion

- Interrill (sheet)
  - low detachment capacity
  - higher capacity for transport

Types of Erosion

- Rill
  - small channels <1 foot deep
  - low detachment capacity
  - higher capacity for transport

Types of Erosion

- Gully
  - from concentrated storm water flow
  - removes higher volumes per unit area

Types of Erosion

- Stream Channel
  - high volume peak flows may erode stream banks and channels
  - removes portions of the land surface above and adjacent to the bank
  - can deliver large volumes of sediment directly into the stream

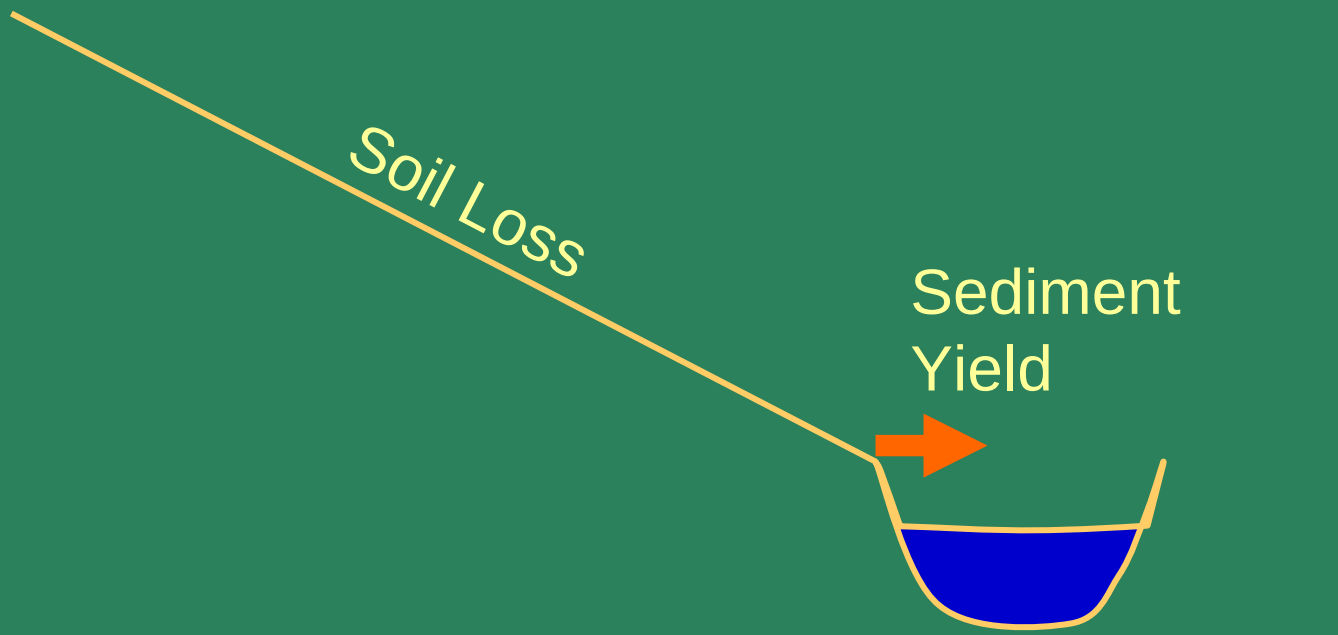
Types of Erosion

- Mass movement (Landslip)
  - slides - shear along specific surfaces
  - flows - viscous, fluid movement

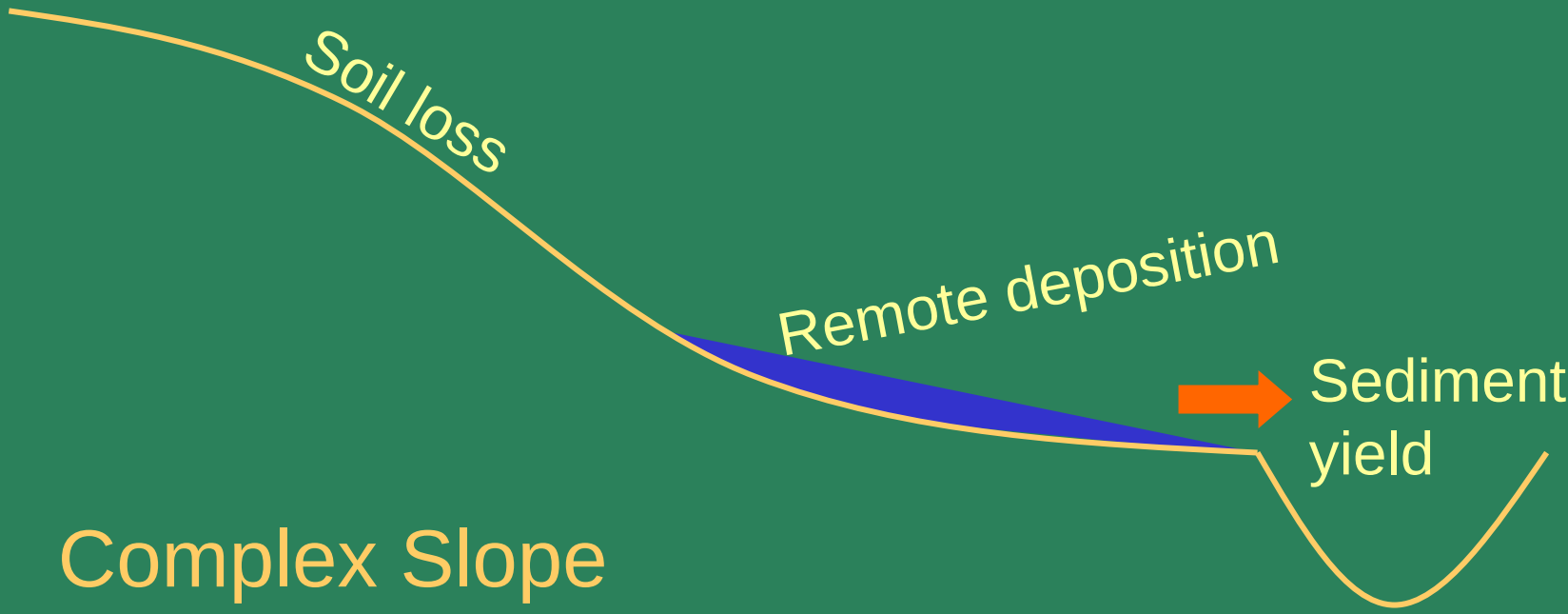
Factors affecting erosion

- Climate
  - rainfall - amount
  - rainfall - intensity
- Soil
  - texture
  - moisture
  - surface roughness
- Topography
  - slope gradient
  - overland flow slope length
  - length of eroding portions
  - slope shape
- Land use
  - cover management
  - supporting practices

Simple Uniform Slope



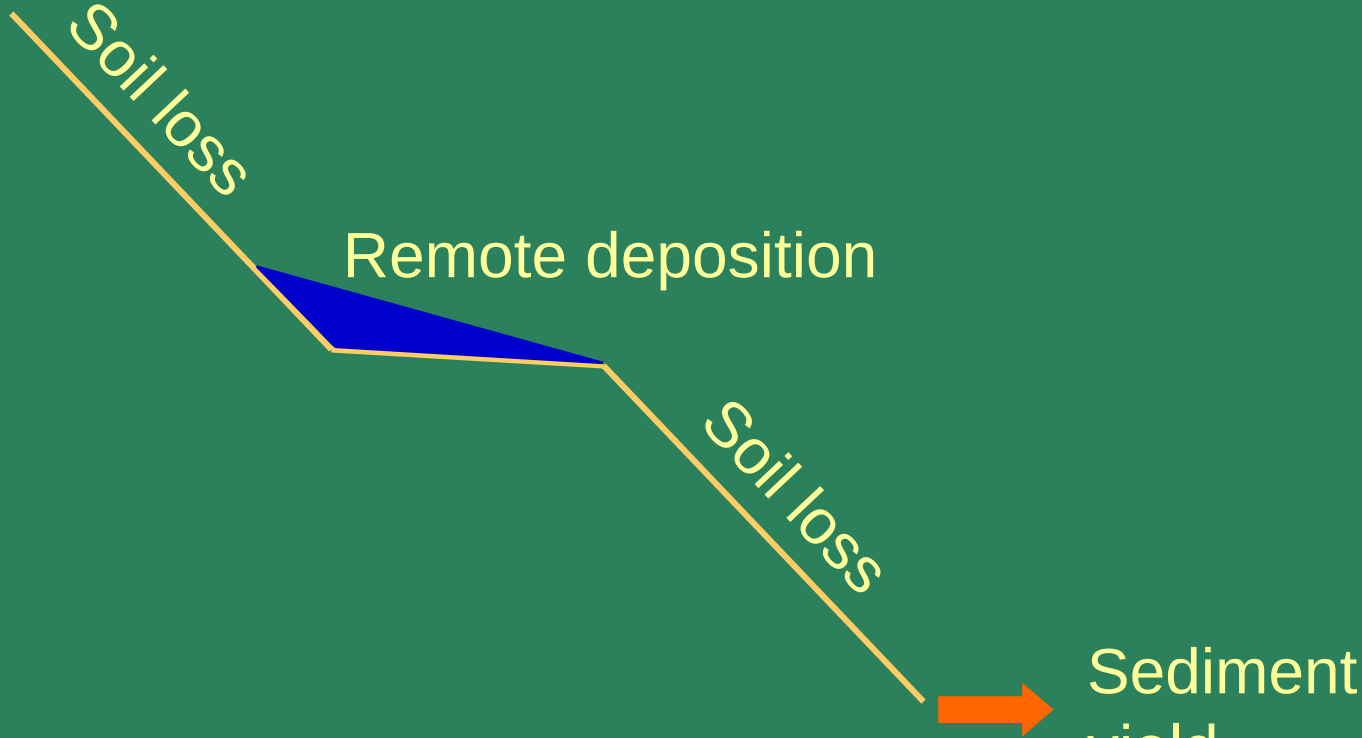
Sediment Yield = Soil Loss



Complex Slope

Sediment Yield = Soil Loss - Deposition

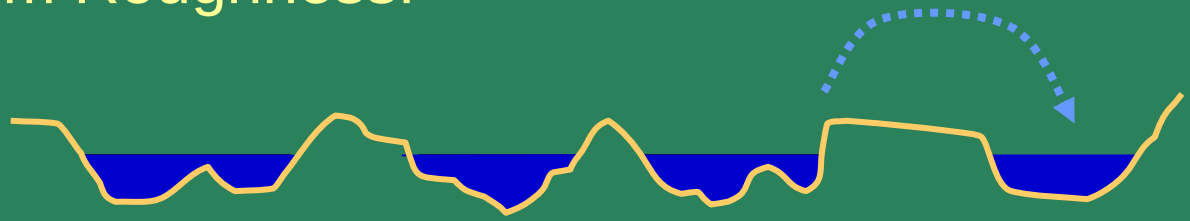
Complex Slope



Sediment Yield = Soil Loss - Deposition

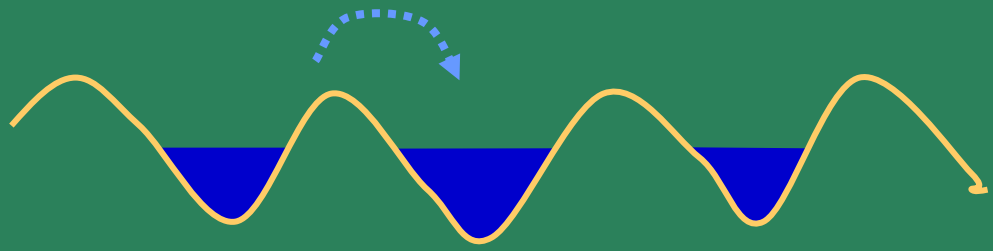
Local Deposition

Random Roughness:

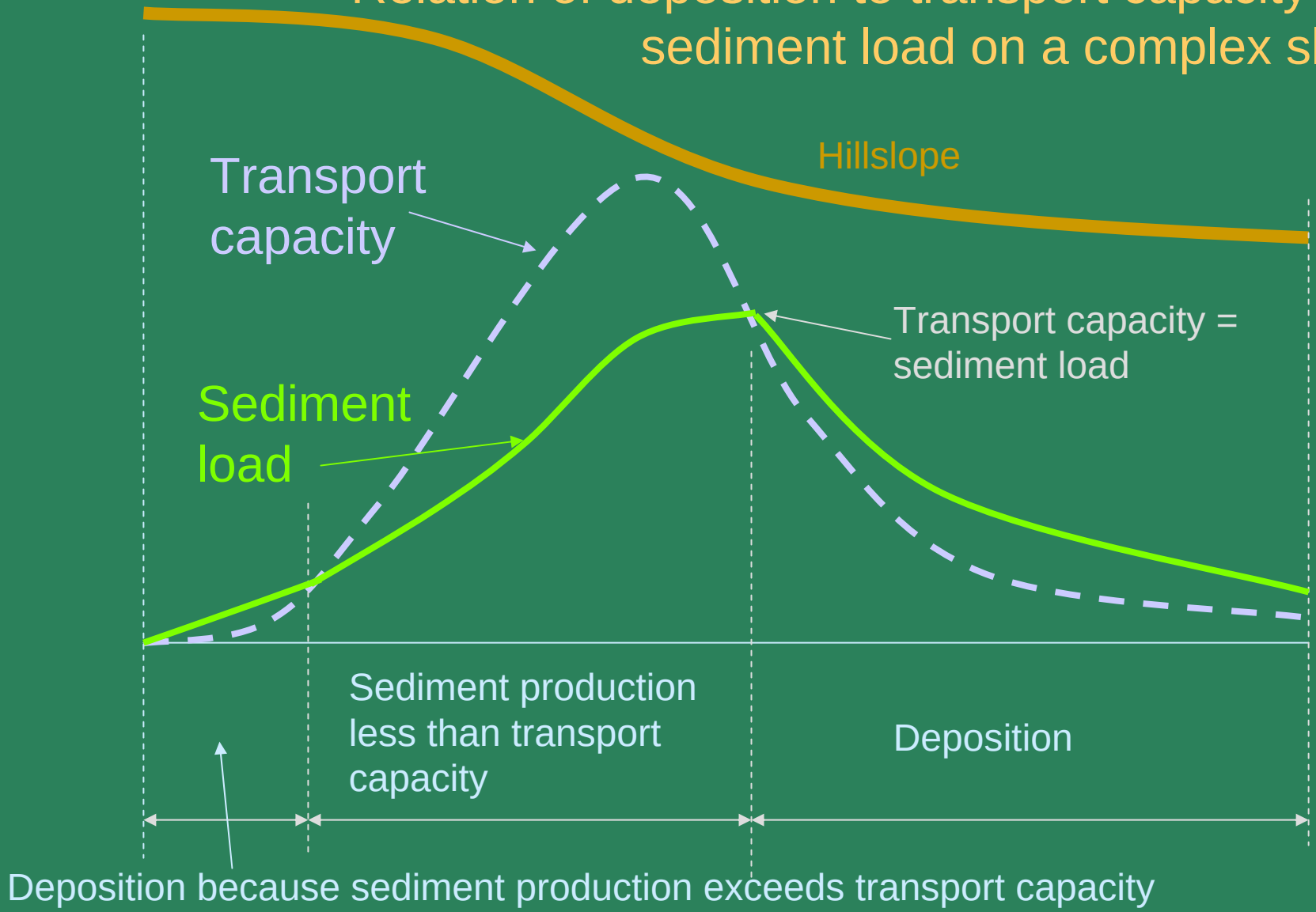


Sediment Yield = Soil Loss - Deposition

Ridges-Furrows:



Relation of deposition to transport capacity and sediment load on a complex slope



How Deposition at a Grass Strip Affects Sediment Characteristics

Particle class	Before (%)	After (%)
Primary clay	5	22
Primary silt	24	58
Small aggreg.	36	14
Large aggreg.	24	5
Primary sand	7	1

SDR = 0.2
Note how deposition enriches sediment in fines

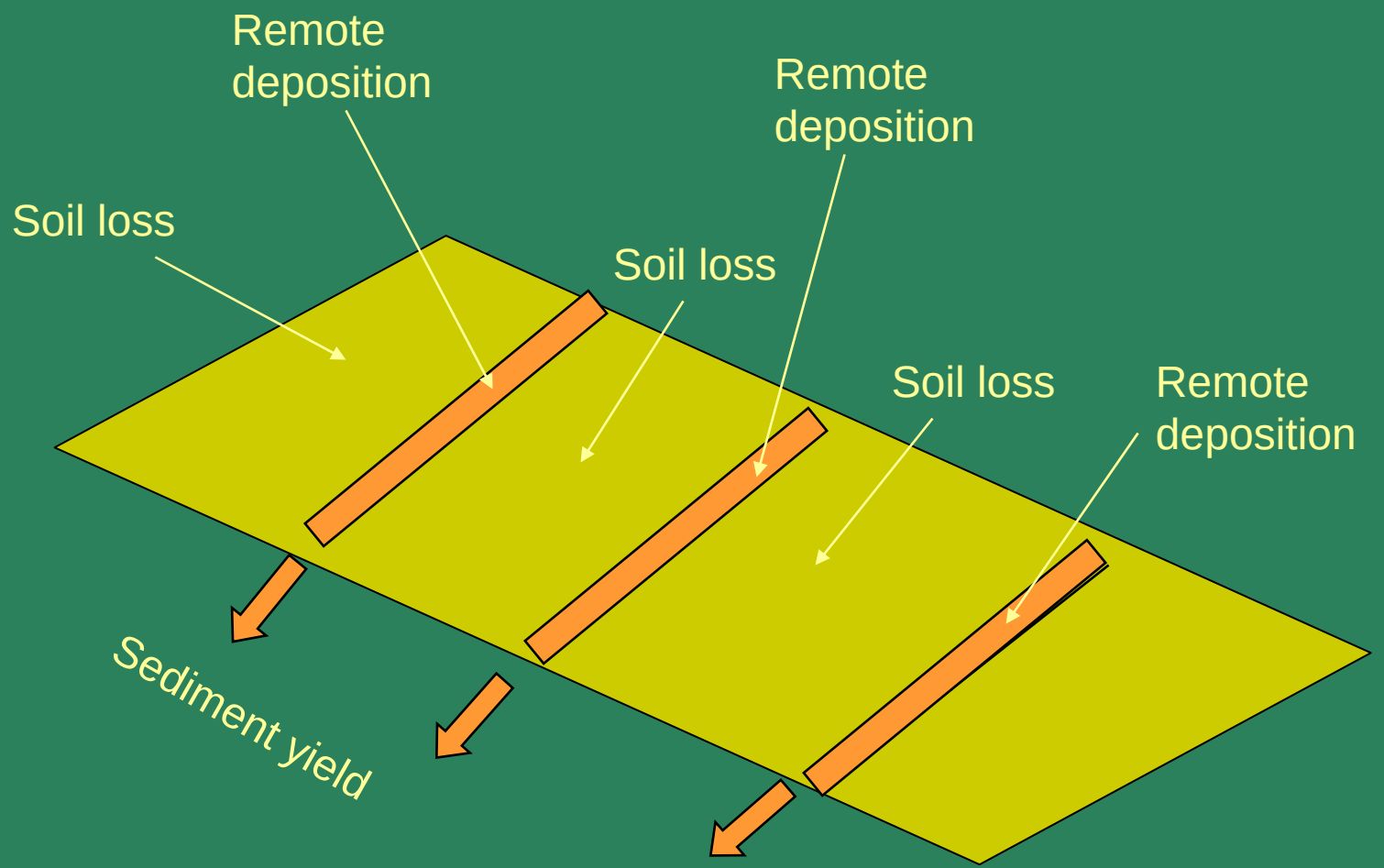
Basic Principles

- Sediment load accumulates along the slope because of detachment
- Transport capacity is function of distance along slope (runoff), steepness at slope location, cover-management, storm severity (10 yr EI)
- Deposition occurs where sediment load becomes greater than transport capacity

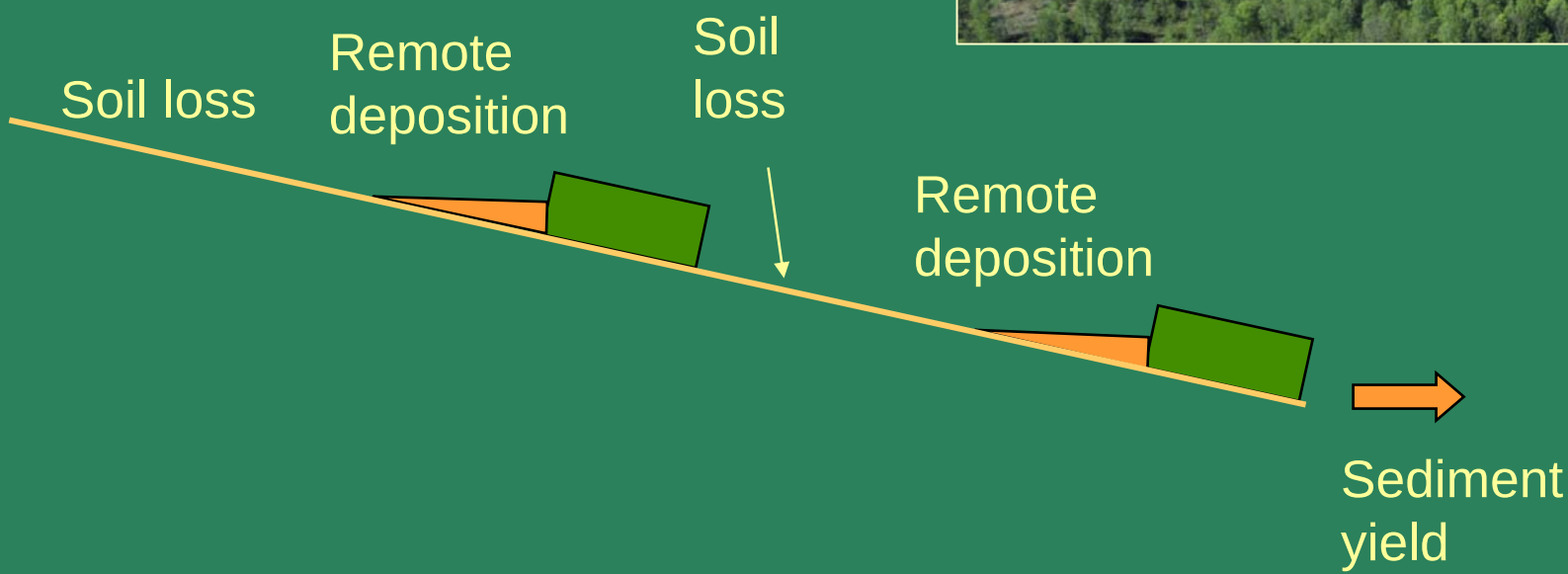
Prevention and Reduction

- fit development to the terrain
- time disturbance to minimize soil erosion
- retain existing vegetation whenever feasible
- vegetate and mulch denuded areas
- divert runoff away from denuded areas
- minimize length and steepness of slopes
- keep runoff velocities low
- prepare drainage ways and outlets to handle flow
- trap sediment on-site
- inspect and maintain control measures

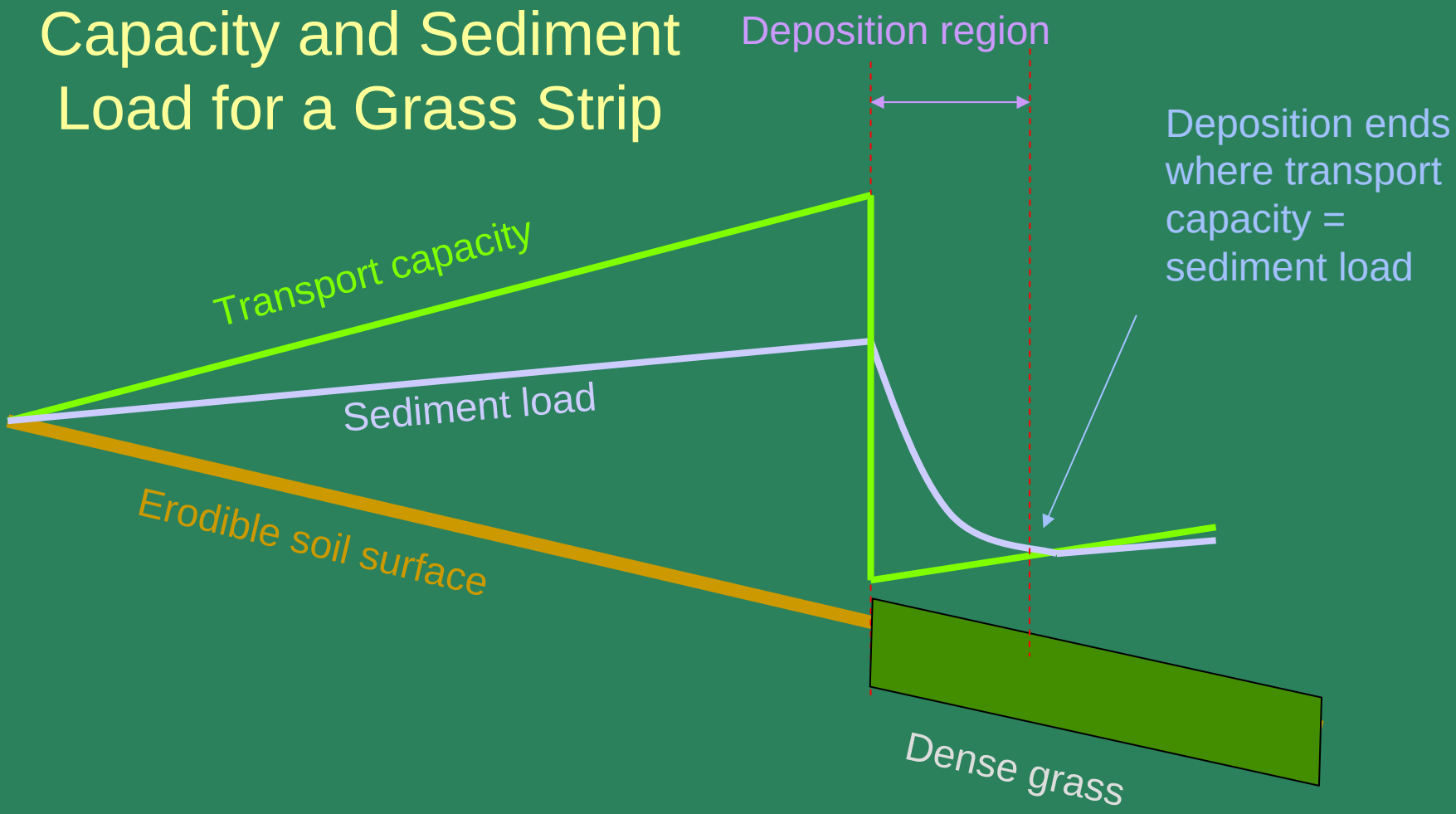
Terraces


Remote deposition
Remote deposition
Soil loss
Soil loss
Soil loss
Remote deposition
Sediment yield

Strips


Soil loss
Remote deposition
Soil loss
Remote deposition
Sediment yield

Relationship of Deposition to Transport Capacity and Sediment Load for a Grass Strip



Why worry about erosion at construction sites?

Sediment Laden Runoff

Sediment in Drainage Channels

Construction Site BMPs

- Need to address soil erosion and sediment transport
- May be structural and/or non-structural
- Should be applied according to a plan developed prior to construction start

Types of Construction Site BMPs

- Erosions control BMPs
  - prevent the detachment of soil particles and subsequent suspension and transportation in runoff water
  - first and best line of defense
- Sediment control BMPs
  - remove a portion of the suspended soil particles from runoff

Erosion Control BMPs

- Minimize disturbed areas and preserve existing vegetation
- Temporary and permanent vegetative establishment of disturbed areas
- Mulching disturbed areas
- Covering stockpiles
- Stabilized construction site entrances
- Divert runoff from disturbed areas
- Various combinations of all of the above

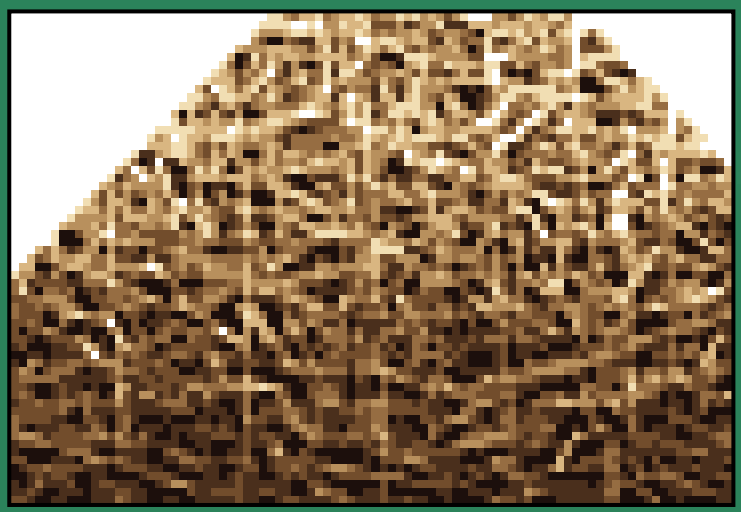
Mulching

- Seed prior to mulching
- Hay or straw @ 1 1/2 to 2 tons per acre
- Mechanically anchor with netting or crimper

Blowing Straw Mulch

Commercial Mulch Matting

- Wide variety of types for various applications
- Apply in accordance with manufacturer's recommendations



Commercial Mulch Matting

Vegetative Establishment

- Establish vegetation as soon as practical after disturbance
- NRCS FOTG Standard - Critical Area Planting (Code 342)
  - Use appropriate seed mix for time of year
  - Test soil
  - Fertilize and lime according to soil test

Vegetative Establishment

Sediment Control BMP's

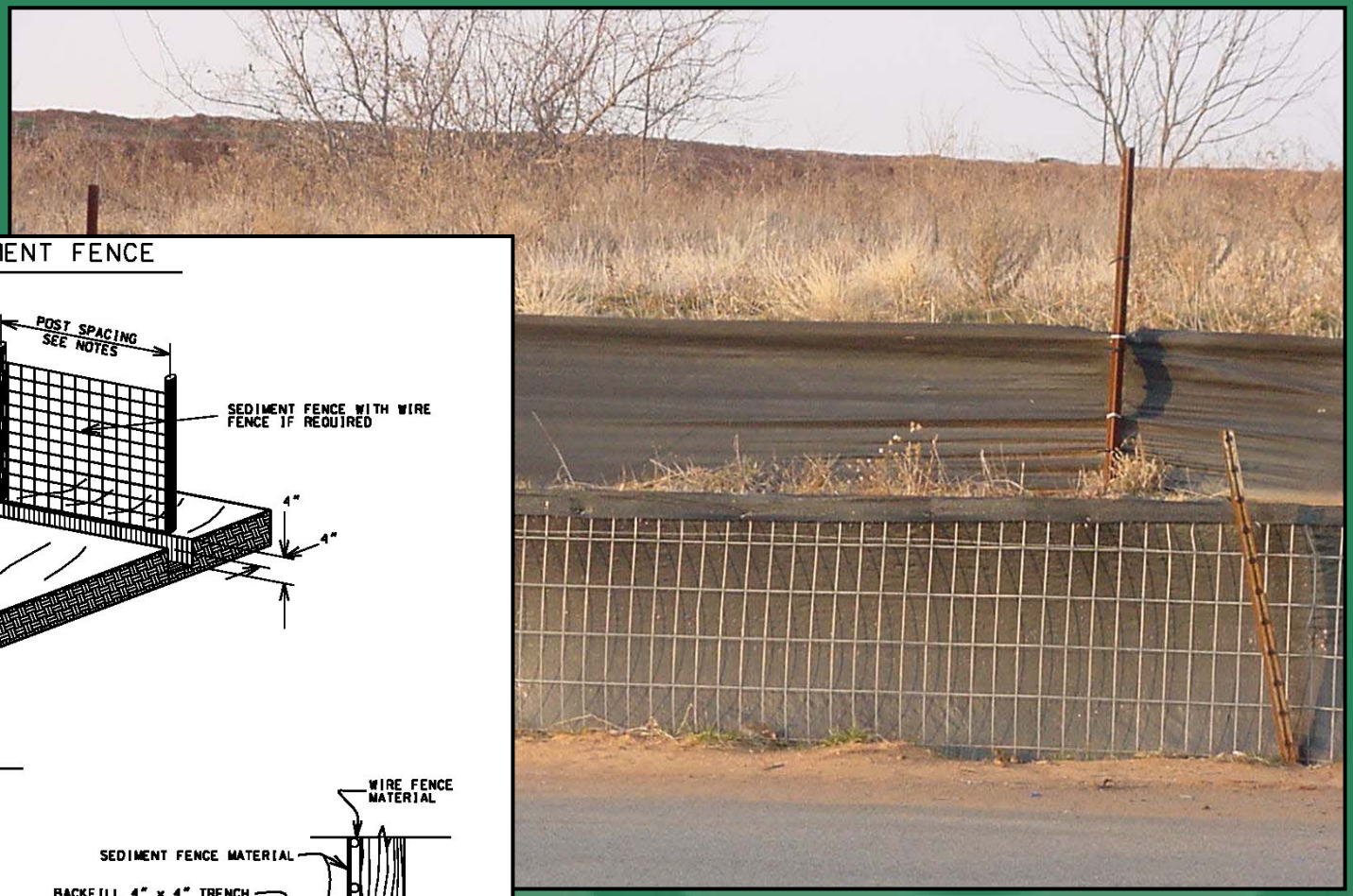
- Second line of defense
- Require proper installation
- Maintenance is crucial through out project life

Sediment Control BMP's

- Silt fences
- Check dams
- Drain inlet protection
- Sediment retention basins
- Other sediment retention devices

Improperly Installed Silt Fences

Properly Installed Silt Fences

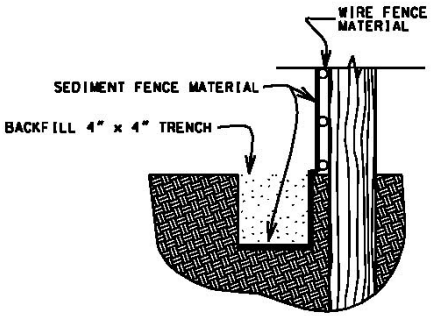


SEDIMENT FENCE

ISOMETRIC VIEW

NOTES:

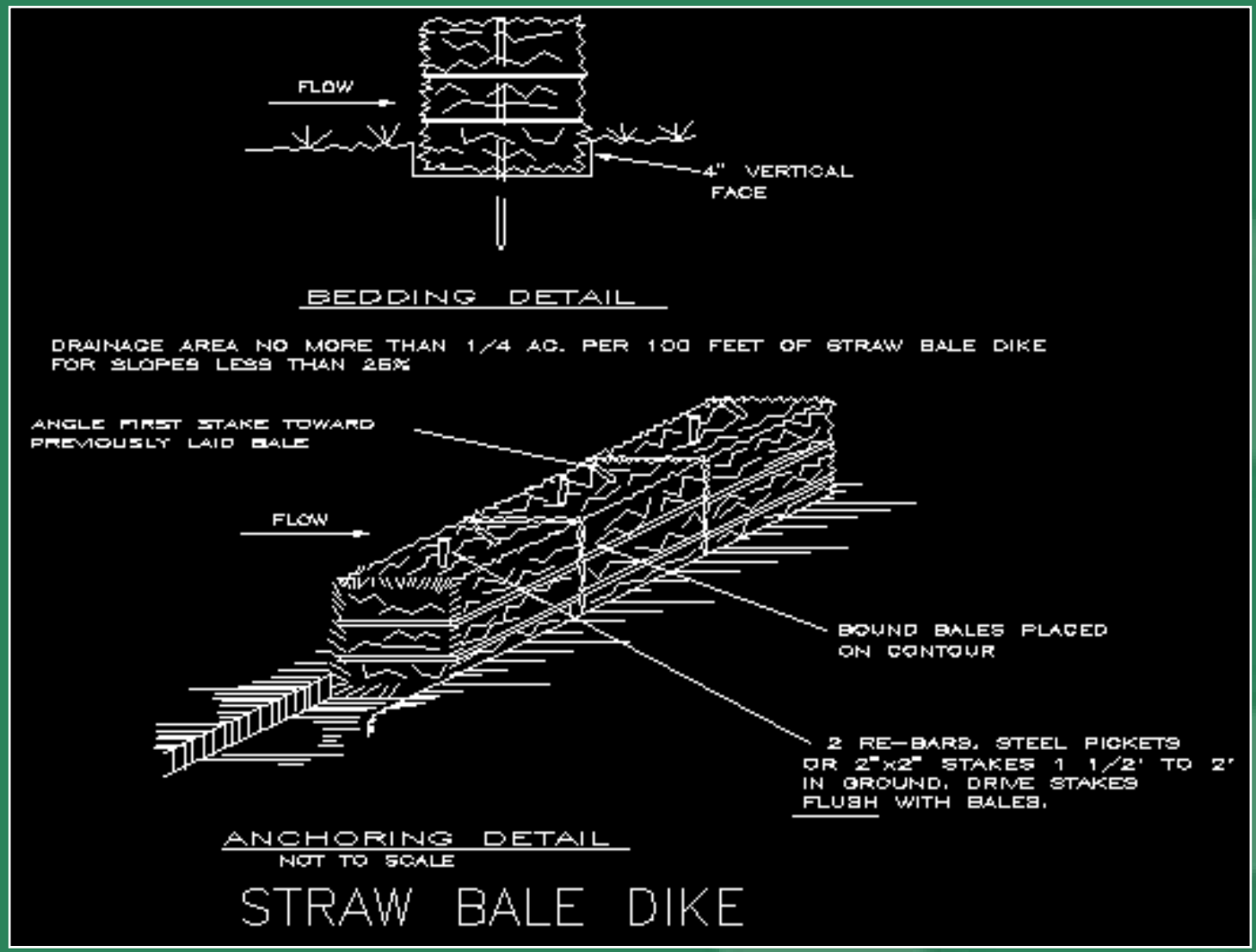
1. A wire fence backing will be required unless sediment fence manufacturer states product is self supporting.
2. Maximum post spacing shall be 10' for wire supported sediment fence and 6' for self supported fence.
3. Sediment fence shall be adequately attached to the posts (and wire support if required).



ANCHOR DETAILS

Open Top Gabion Check Dams

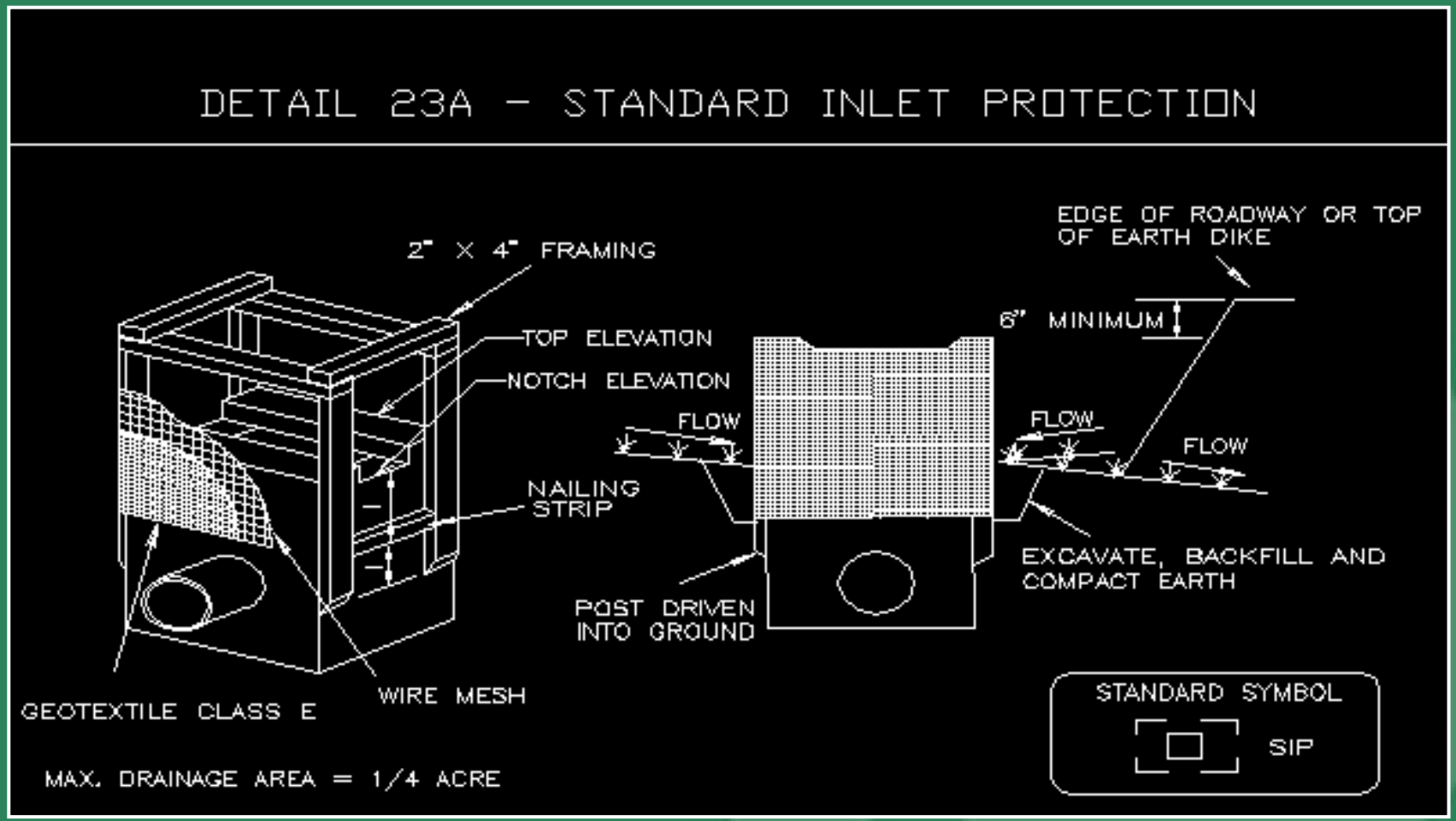
Typical Drawing of Hay Bail Check Dams



Drain Inlet Protection

- Requires monitoring and maintenance

Typical Drawing of Drain Inlet Protection



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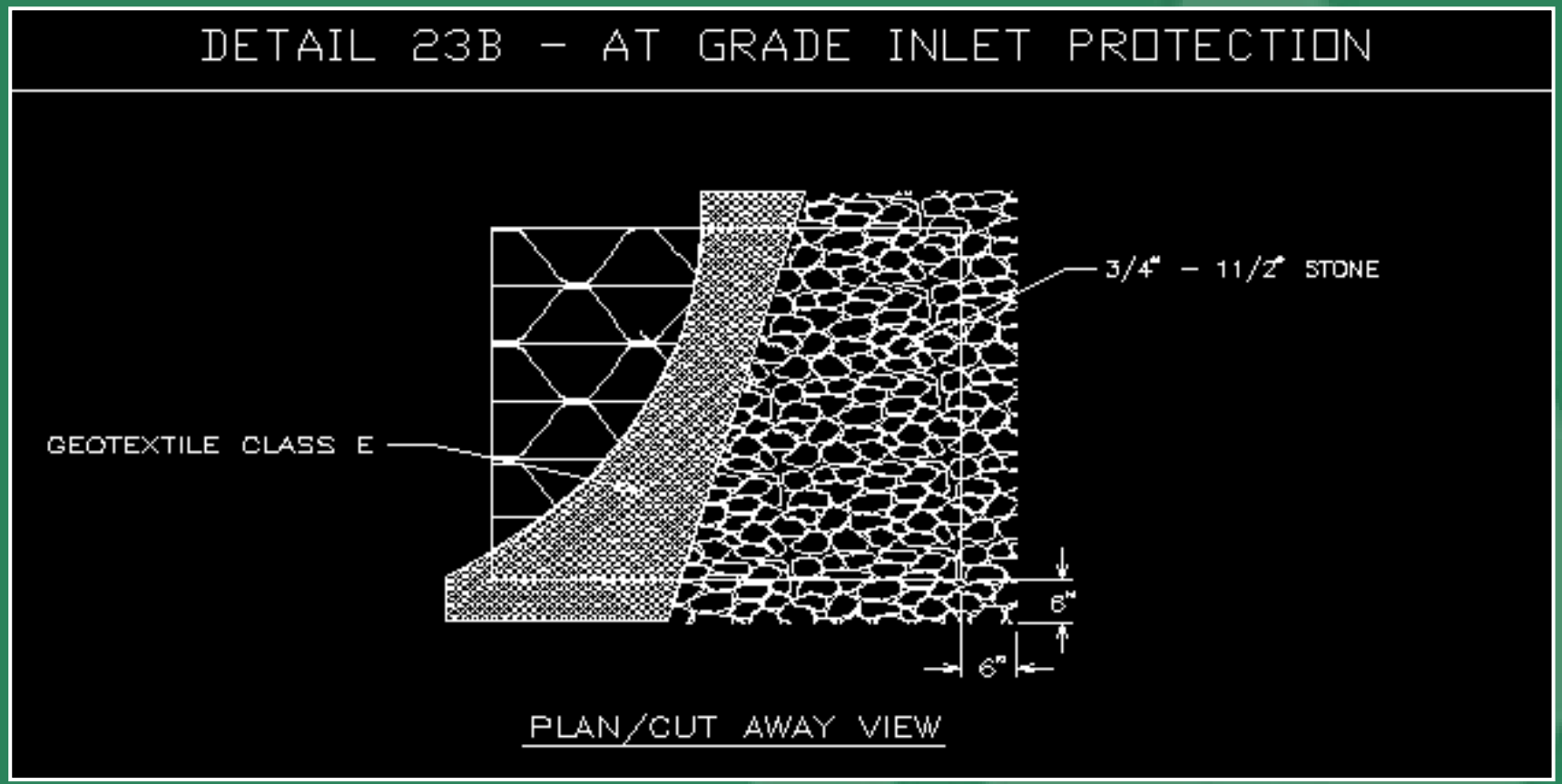
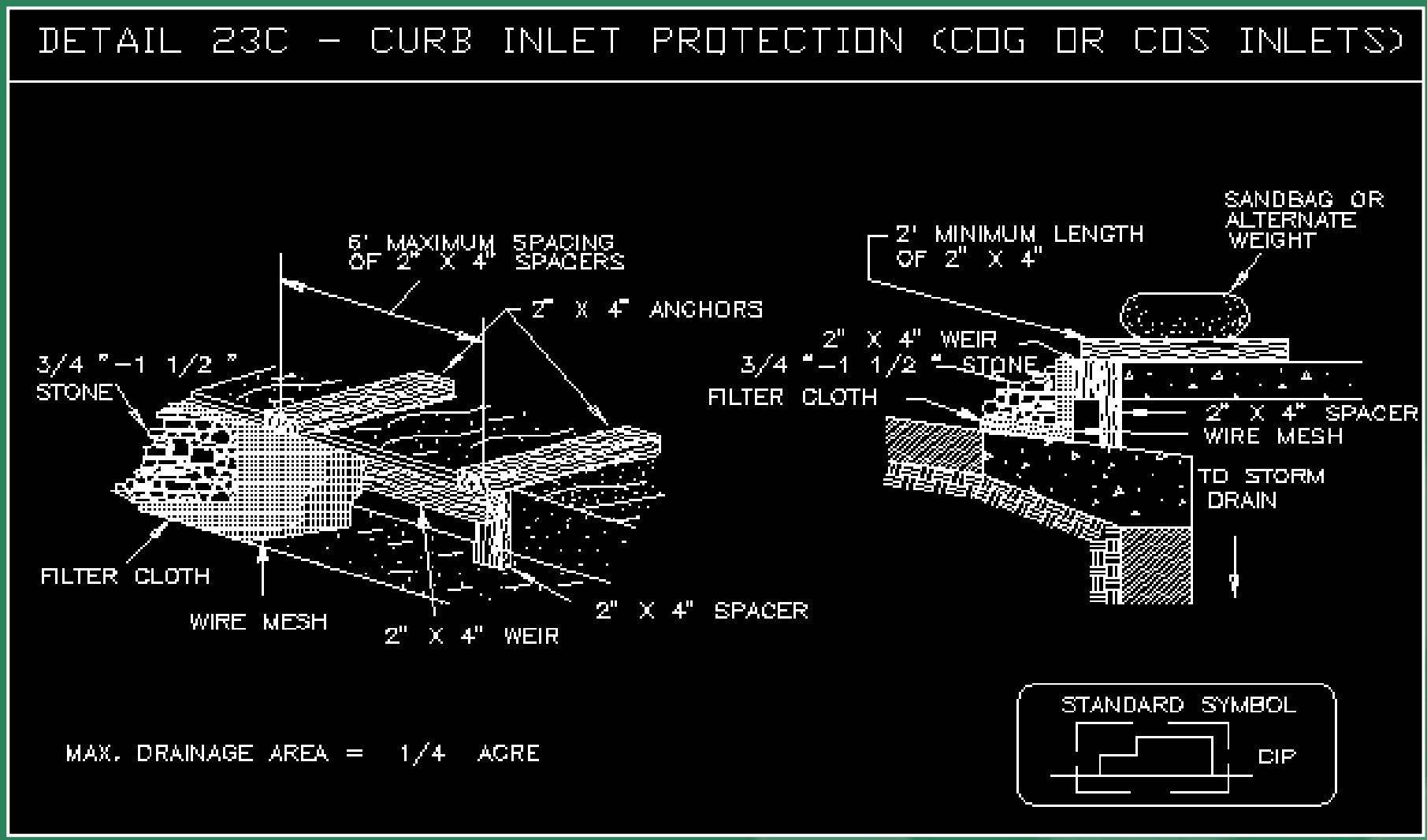


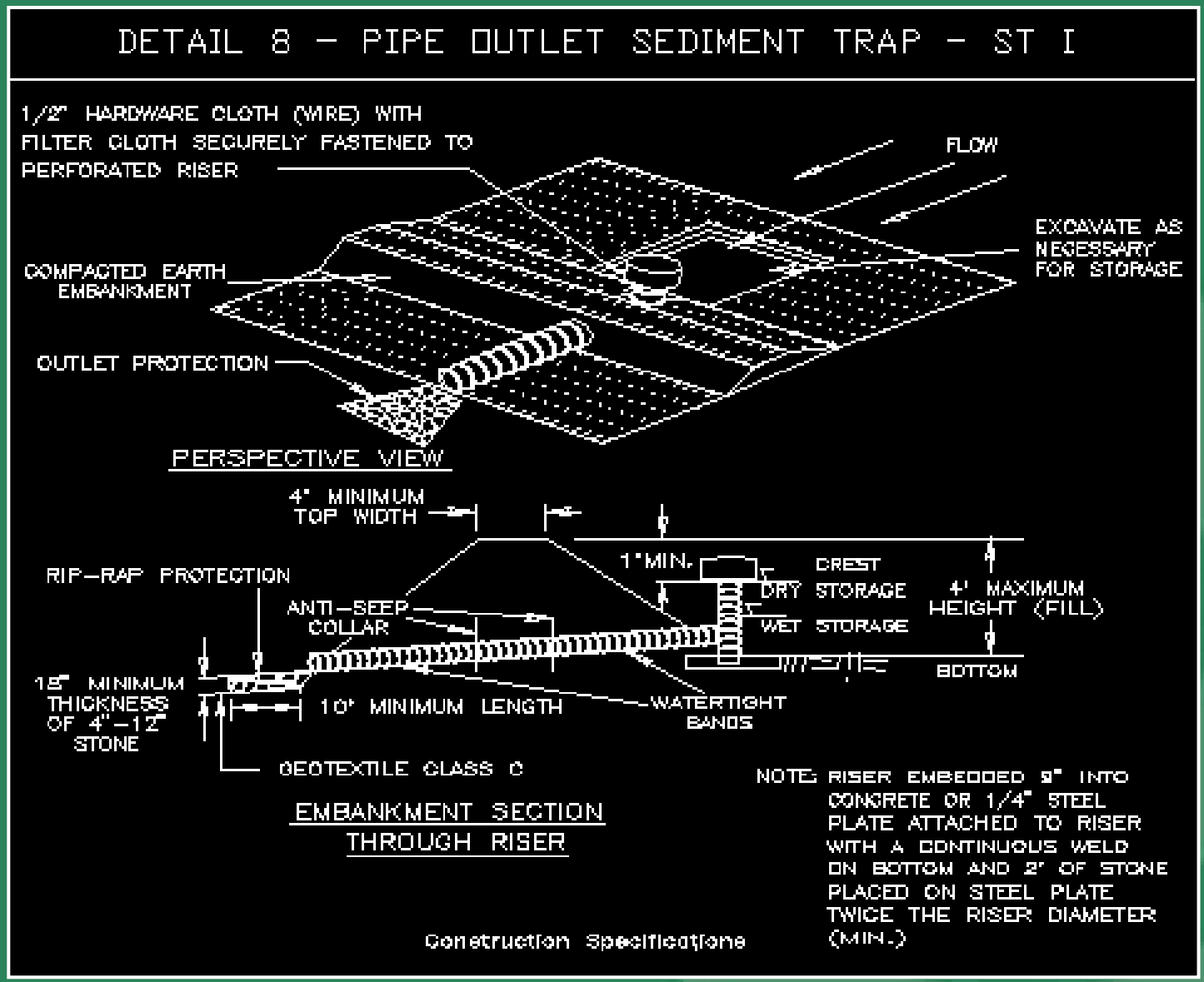
Typical Drawing of Drain Inlet Protection



Sediment Basins

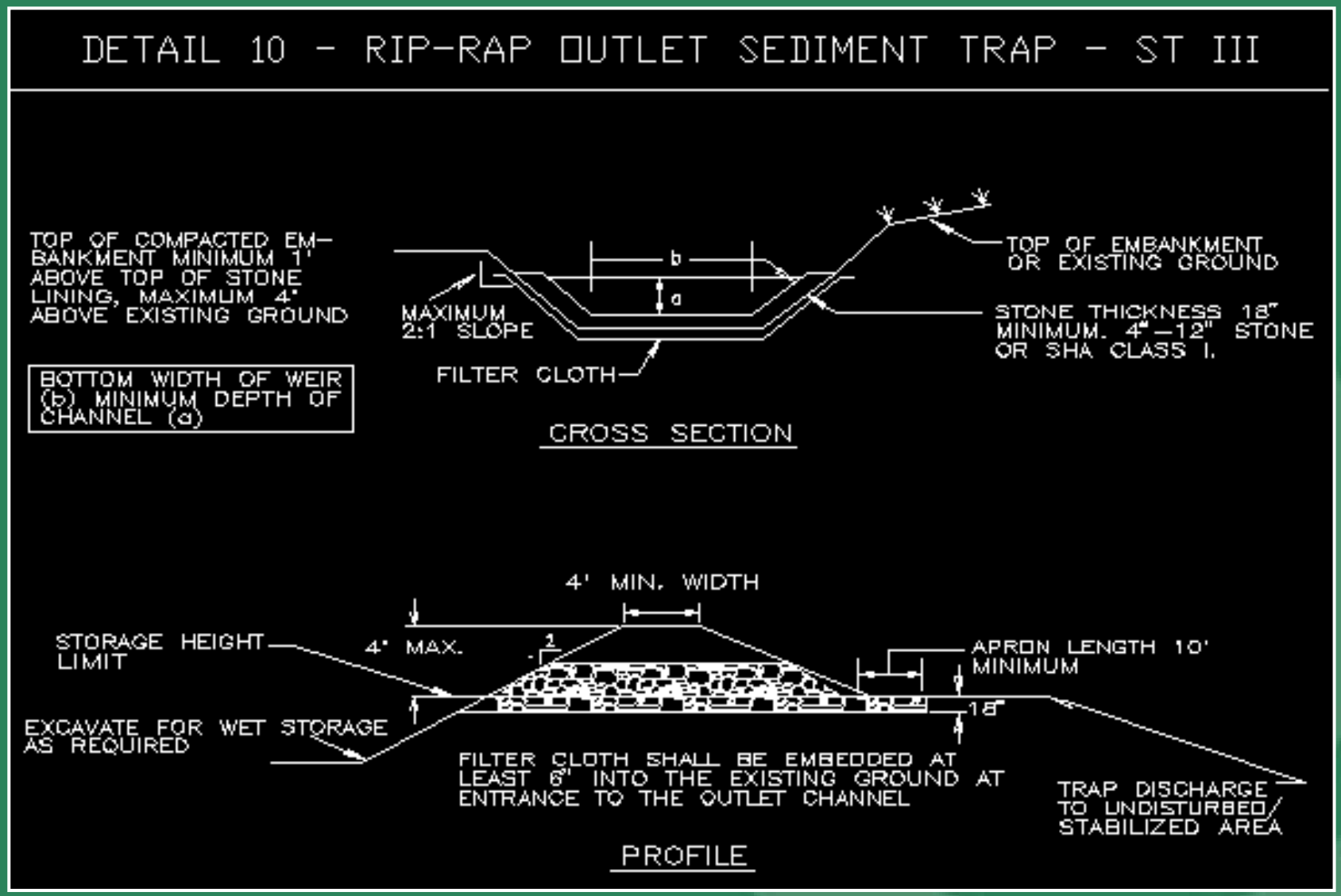
- Drainage area
- Retention time
- Temporary storage volume

Typical Drawing of Sediment Retention Basins



Sediment Retention Basins

Typical Drawing of Sediment Retention Basins



Commercially Available Sediment Retention Devices

Available Resources

- USDA Natural Resources Conservation Service
  - www.usda.nrcs.gov
- International Erosion Control Association
  - www.ieca.org


Our Soil
is
Our Strength