

## Section II

# Best Management Practices (BMP's)

The Good, The Bad, and the Ugly

Andrew Bacon, technical consultant

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produced by

**San Francisco Bay Regional Water  
Quality Control Board**

and

**The San Francisco Estuary Project**

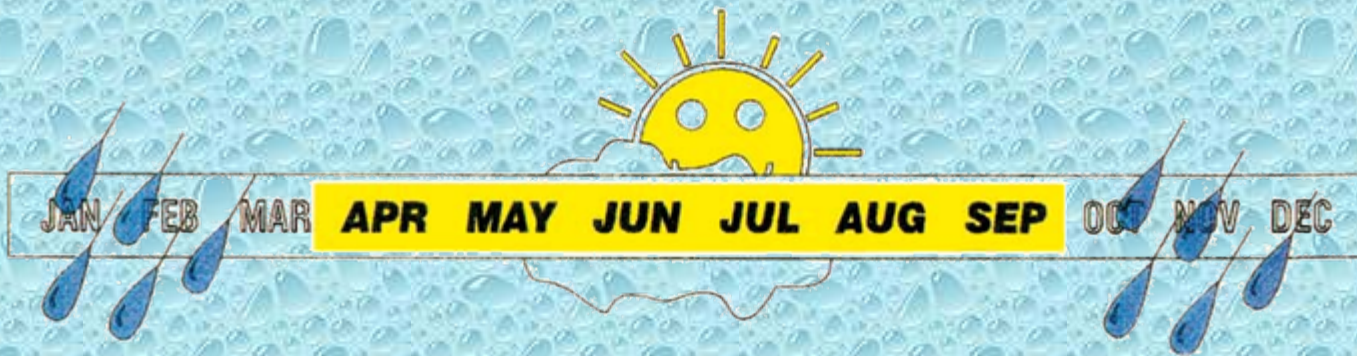
# Part II Objectives

A yellow Caterpillar bulldozer is the central focus of the image, positioned in a construction or industrial setting. The bulldozer is viewed from a side-rear perspective, showing its large rear tires and the operator's cab. The word "CATERPILLAR" is visible on the front grille, and "CAT" is on the side of the engine compartment. The background features a clear blue sky, a white building, and a utility pole. The overall scene is brightly lit, suggesting a sunny day.

Erosion Control

Sediment Control

Non-Storm Water Source Control



# Timing is crucial

Minimize soil exposure

Reduce total area

Protect critical areas

Monitor before and after



# Erosion control vs. Sediment control

Erosion control means:

Source control. By preventing erosion from occurring in the first place, by preserving vegetation, hydroseeding, mulching, mats and other techniques, the biggest problem is prevented.

Sediment control means:

Recovery of particles of soil or pollutants after they have already been dislodged. This is much more difficult and costly than prevention, and must be used in concert with erosion control to be effective.

Erosion control measures and sediment control measures must be implemented simultaneously, prior to the defined wet season to be effective in preventing pollution of storm water runoff!

*Neither method is sufficient without the other.*

# Poor Construction Site Planning



Causes uncontrolled discharges of large volumes of sediments and pollutants into surface waters



Which in turn causes:



Excess sedimentation in drainage channels

Which in turn causes:



Excess erosion of creek banks



Which in turn causes:



Flooding and property damage

Which in turn causes:



Damage to fish spawning areas

# Flood control funds OK'd

■ **Fremont:** Silt in creek to be removed at once.

BY DENNIS AKIZUKI  
*Mercury News Staff Writer*

In an emergency action Tuesday, Alameda County supervisors approved spending \$775,000 to remove silt that experts said is blocking a south Fremont creek and could cause flooding during a heavy rain storm.

WEDNESDAY | JANUARY 6, 1999 | SAN JOSE MERCURY NEWS



# Rates of Erosion

Here are the rates of erosion caused by different industries and land uses.

*As you can see, active surface mines and construction top the list, causing 2,000 times as much erosion as is normally present in a forest .*

## Rates of Erosion from Various Land Users

Land Use	Tons per square mile per year	Relative to Forest = 1
Forest	24	1
Grassland	240	10
Abandoned Surface Mines	2,400	100
Cropland	4,800	200
Harvested Forest	12,000	500
Active Surface Mines	48,000	2,000
Construction	48,000	2,000

## Comparative Rates of Erosion

Area	Yield (ton/sq. mi.)	Factor
Unmined Watershed	28	1
Mined Watershed	1,930	69
Spoil Bank	27,000	968
Haul Road	57,600	2,065

There are four types of erosion we must be aware of:

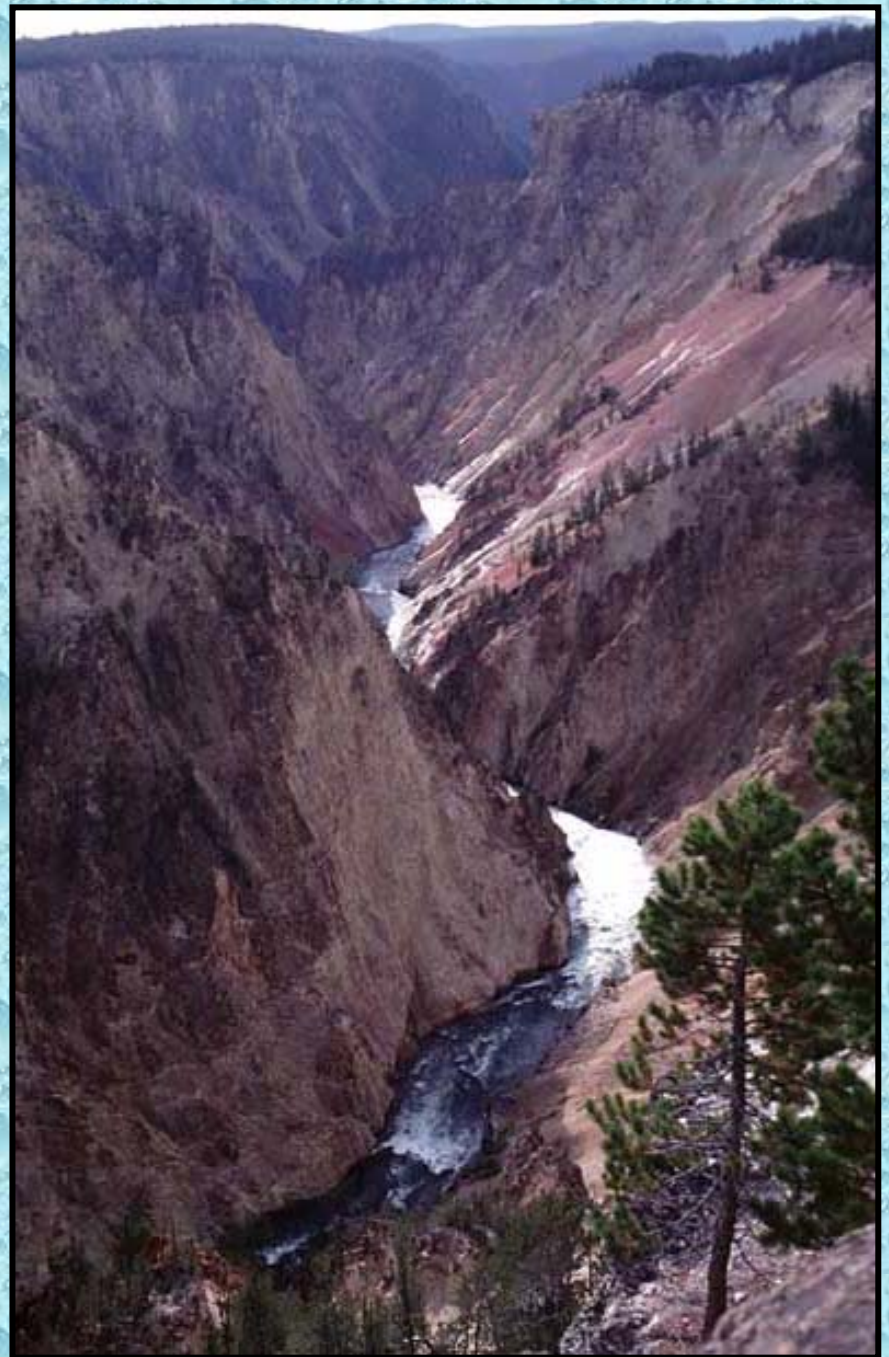
- Natural/Geological Erosion
- Gully Erosion
- Splash Erosion
- Sheet (or rills) Erosion



# Geological Erosion

A natural process which has created many of our current topographical features, geological erosion is tempered by natural forces, and causes very little (if any) irreparable damage, unless assisted by human activity.

This type of erosion is not generally a major concern unless natural conditions are disturbed.





# Gully Erosion

Occurs when a large enough quantity of water streams across a disturbed surface to carve a channel, which allows water to flow even faster, further worsening erosion within the channel.



# Splash Erosion

Each raindrop in a storm event strikes the ground at a speed of over 20 miles per hour, dislodging far greater than its own weight in soil, depending on the type of ground it strikes.



# Sheet Erosion

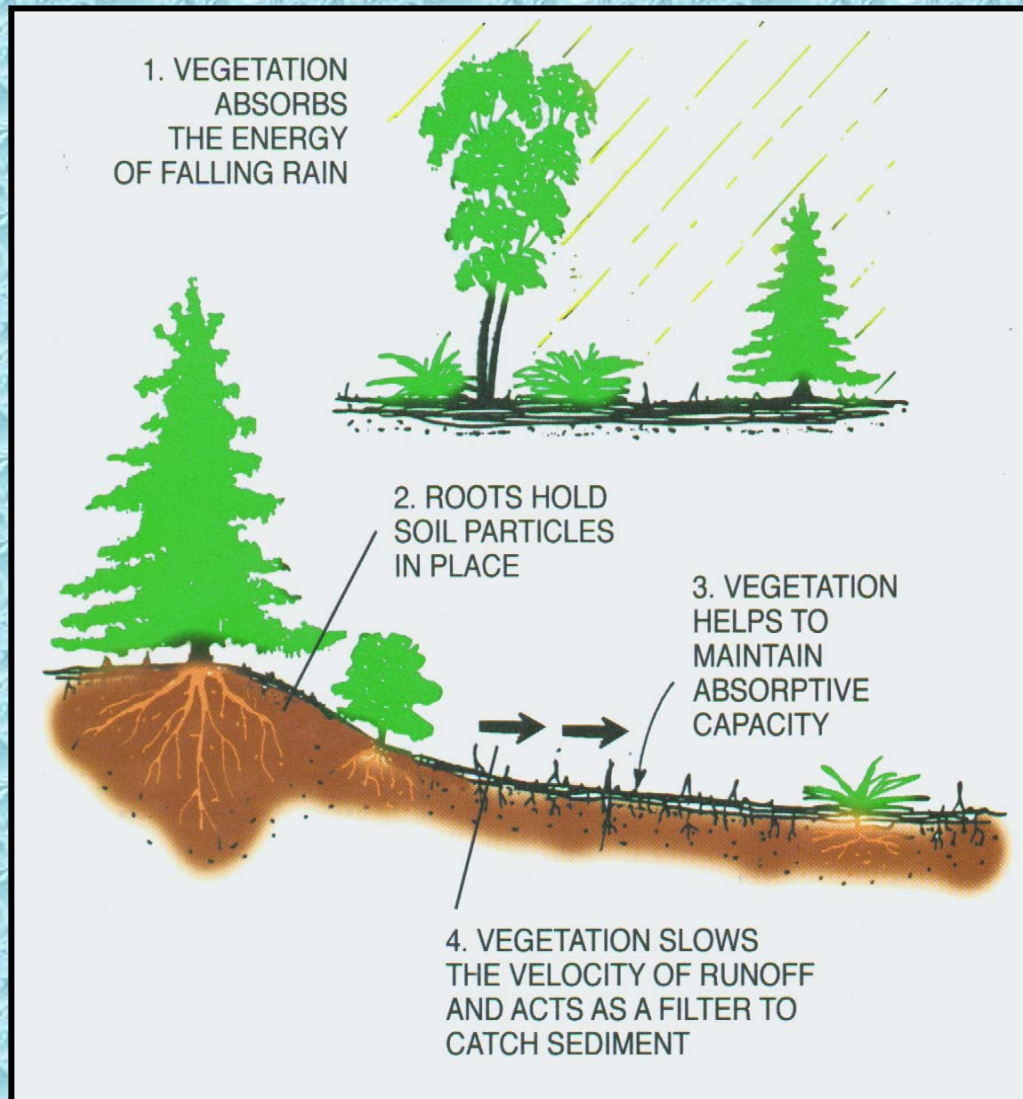
Accounts for 75-80% of the total sediment yield in our streams, and is almost entirely caused by poorly managed construction sites.





# The First Order of Business

## Preserve existing vegetation



Existing vegetation has already stabilized the area it is growing in, to some degree, so if you can leave it in place, do it!

Without plants, we would have lost all our topsoil already. They are uniquely and perfectly suited to prevent erosion in all its forms.

*(Field Manual – Page 19)*

# Preserve Existing Vegetation

This red plastic fencing is a common and effective way to mark the perimeter of a work site, beyond which vegetation is not to be disturbed.



# Divert Clean Water Around Your Site



Any clean water running on to the site must be diverted away from disturbed or denuded areas.



**A good example of clean water diversion.**



You only get one chance to do it right!

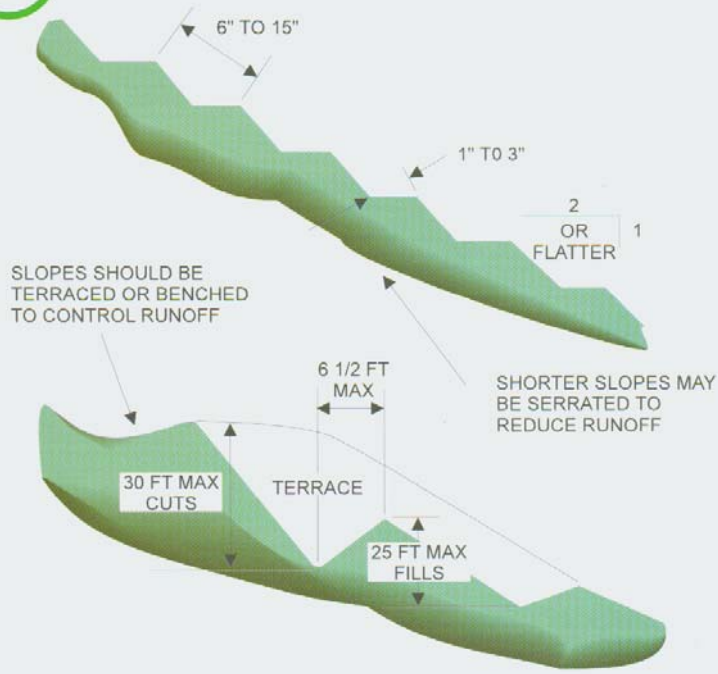
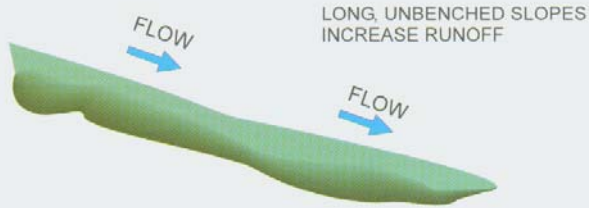


As you can see from this picture, cleaning up after the damage has happened is a lot of work, which is costly and time-consuming.

Once erosion has occurred, it is difficult to remove the soil and pollutants suspended in storm water runoff.

# Erosion Control Measures



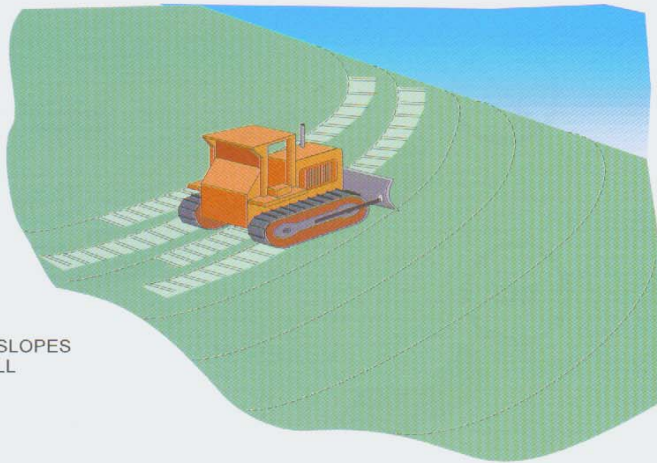


**SLOPE TERRACES**

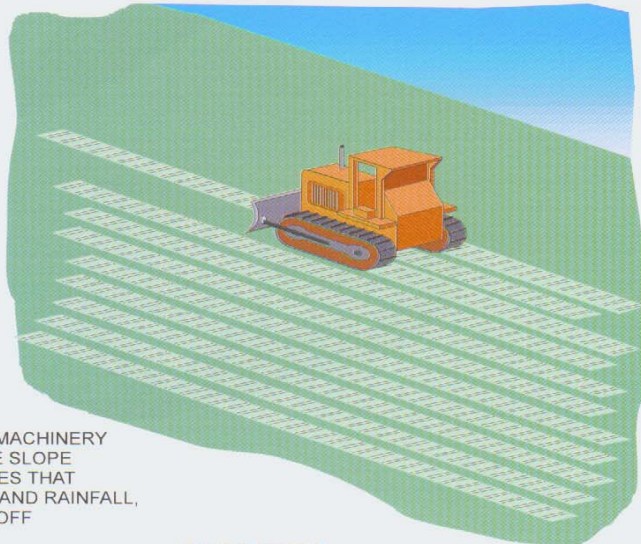
The way a slope is graded can make a big difference in the slope's susceptibility to erosion.

Proper terracing and contouring of graded slopes slows the velocity of running water, and therefore reduces erosion.

*(Field Manual – Page 28)*



DO NOT TRACK SLOPES  
ACROSS THE HILL



"TRACKING" WITH MACHINERY  
UP AND DOWN THE SLOPE  
PROVIDES GROOVES THAT  
WILL CATCH SEED AND RAINFALL,  
AND REDUCE RUNOFF

**TRACKING**

Proper tracking of graded slopes also has a major impact on the erosion of the slope.

Tracking slopes crosswise increases erosion, while tracking up and down the slope creates "mini-terraces", or "serrations" which catches rain drops and slows runoff.

*(Field Manual – Page 27)*

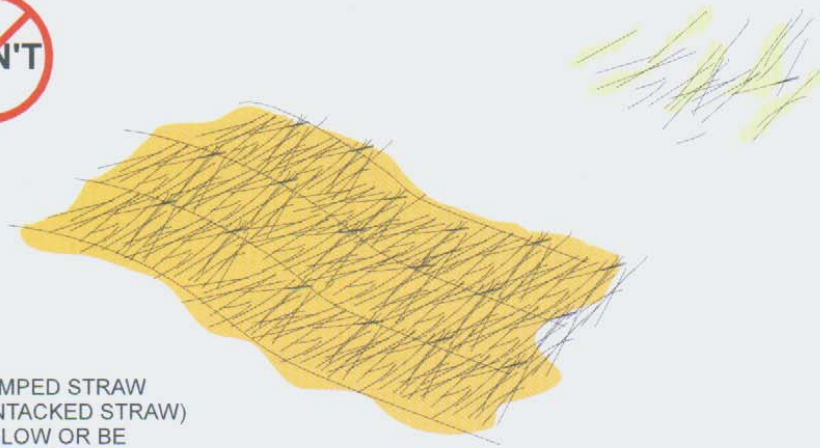


# One Step Hydroseeding

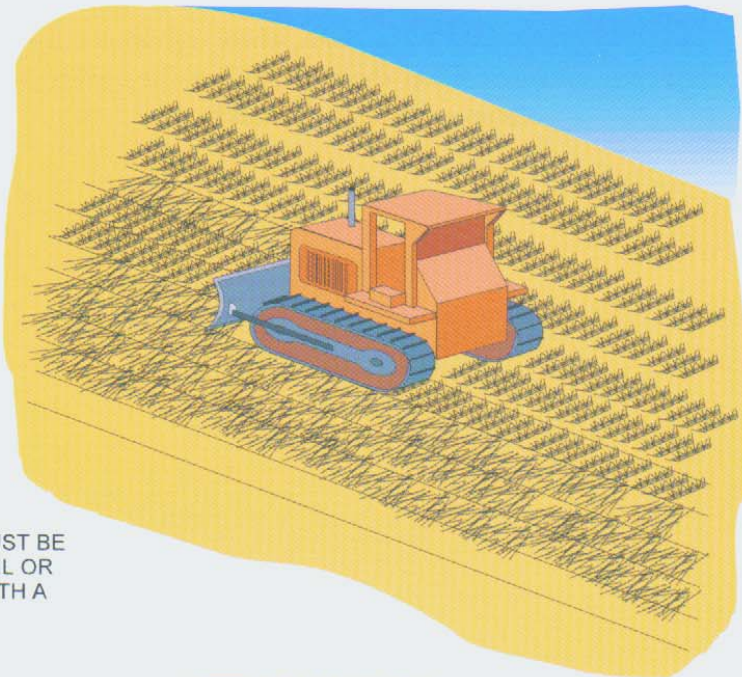


One step hydroseeding (hydroseeding without straw mulch) is generally not effective unless the erosion potential of the area is low, or slopes are irrigated prior to the rainy season.





UNCRIMPED STRAW  
(OR UNTACKED STRAW)  
WILL BLOW OR BE  
WASHED AWAY



STRAW MULCH MUST BE  
CRIMPED INTO SOIL OR  
HELD IN PLACE WITH A  
LIQUID TACKIFIER

**STRAW MULCH**

The solution to the problem in the previous slide is properly crimped or tackified straw mulch.

Even in situations where one-step hydroseeding is appropriate the area must be properly irrigated for the correct amount of time to ensure seed germination prior to rainy season.

*The best erosion control is always plant life.*

# Three step hydroseeding with mulch

Step One: Apply seed and fertilizer

Step Two: Apply mulch (2 tons per acre)

Step Three: Apply tactifier (glue)





# Proper Application

Hydroseeding with mulch and tactifier is the recommended solution for all sites with a slope of less than 2 to 1.





# Proper Slope Stabilization

This crew is uniformly stabilizing this slope using a bonded fiber matrix hydroseeding process with a liquid tackifier in place of straw. In the foreground you can see that they have also serrated the hillside correctly to decrease runoff and allow the seeds to take hold properly.



It is also important to control erosion from small lots prior to rainy season.





Another example of well stabilized small lot with blankets and fiber rolls.





# Here is another good example.

Notice the erosion control (hydroseeding with mulch) on the hillside above, the properly installed and anchored silt fence, at least 2 to 5 feet away from the toe of the slope, and the added hay bales for strength.



No project can be ignored, even a flat finished lot. Mulch is an effective tool.



As you can see, the runoff on this lot is clear. Straw mulch on this flat lot has effectively absorbed the impact of raindrops.





# Erosion Control Blankets

Properly installed erosion control blankets are recommended for more extreme conditions, where the slope is greater than 2 to 1, or for any slope where the soil is sandy or silty.

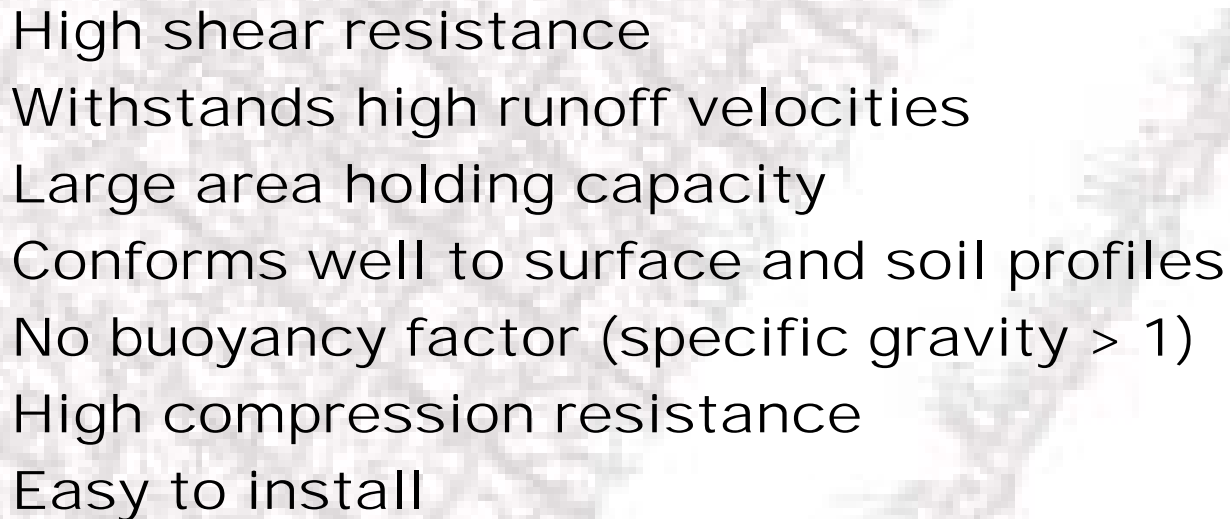




These straw blankets are being used to stabilize the area temporarily before the rainy season and landscaping takes place.



# Permanent Erosion Control blankets have the following characteristics:



- High shear resistance
- Withstands high runoff velocities
- Large area holding capacity
- Conforms well to surface and soil profiles
- No buoyancy factor (specific gravity > 1)
- High compression resistance
- Easy to install

## HOWEVER:

Blankets are not biodegradable, and therefore are not appropriate for all situations, particularly in environmentally sensitive areas. *Be sure to specify the best product for the job!!*



Different types of blankets are better for different applications.



Check the manufacturer's documentation to determine which type of blanket is best for your situation.

Here is an example of properly installed filament erosion control blankets.

These blankets can even be used in place of concrete or rip rap in some situations, although they should not be used in ecologically sensitive areas.





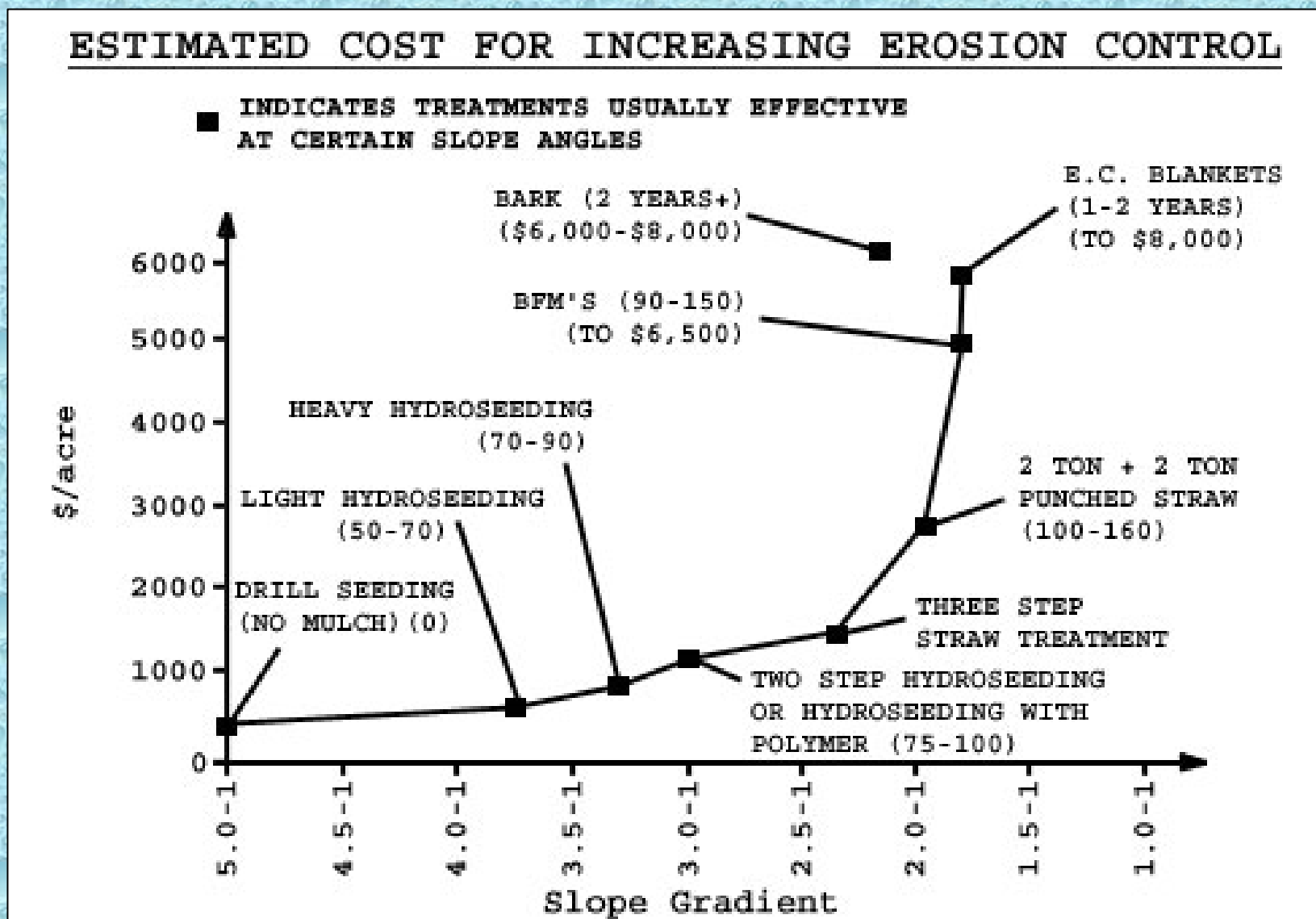
The end result of proper erosion control blanket installation.

This slope was properly seeded, blanketed, and irrigated, and is now completely stabilized.





Estimated cost of erosion control. Costs will vary depending on weather conditions and by area.



# Sediment Control Measures

The most important thing to remember about sediment control:

It doesn't work without erosion control.

It is easy to see that the silt fence at the bottom of this hill has been completely overwhelmed.

This is a disaster.





## Here's another disaster.

The lack of erosion control on this project, coupled with ineffective sediment control measures, has led to uncontrolled sediment discharges.



Token measures do not prevent storm water pollution and result in civil liabilities.



Hay Bales are  
only good for  
one thing:

AND SEDIMENT CONTROL  
ISN'T IT!

This small low-energy  
flow has easily undercut  
these hay bales, and is  
now damaging the  
environment with  
sediment.





# Shred them!

Straw and hay make an excellent mulch for slopes and disturbed flat areas when manually spread and tackified.



Straw and hay can be used in many circumstances to stabilize rills and gullies in moderate conditions.



# Fiber Rolls

Fiber Rolls are alternative to hay bales and silt fences in almost every situation.

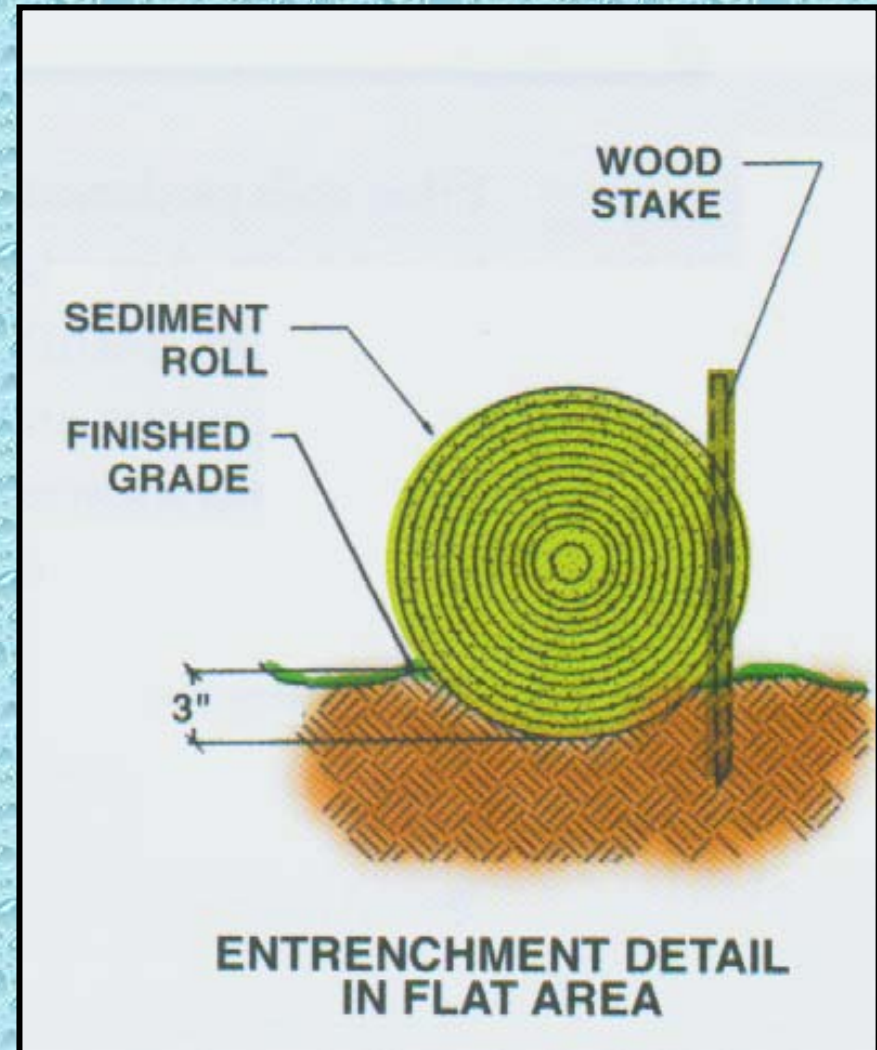
## Installation Instructions:

Place rolls into key trench 3 inches deep

Place excavated soil on uphill or flow side of the roll

Rolls should be abutted at the ends, not overlapped

Alternate stakes on both sides of the roll, every six inches





The fiber rolls with straw mulch on this hillside are an effective sediment control measure.



Fiber rolls installed properly here, and used in conjunction with erosion control measures, have minimized tracking of mud on the paved areas. **This is a successful job site.**





This doesn't mean they're good for everything. Like any BMP, fiber rolls are only effective when used properly.





# Silt fences

Silt fences are widely misused:

- No erosion control on the slope above
- Improper BMP maintenance



# More bad silt fences.

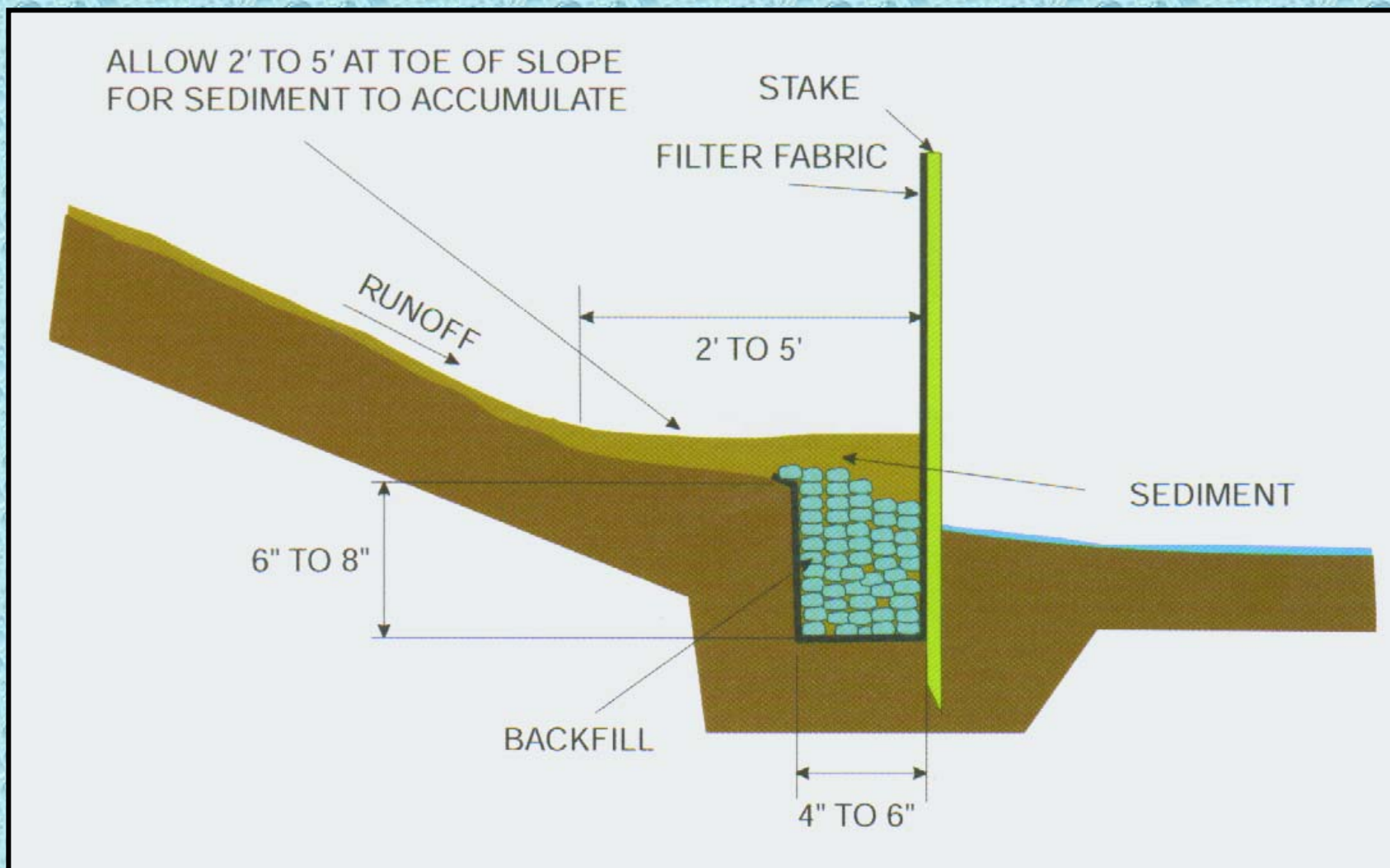
The silt fence running vertically up and down the hill will do absolutely nothing, and is a wonderful example of very expensive tokenism.

The silt fences in the drainage ditch in the foreground should never have been put there in the first place, because silt fences are ineffective in high energy flows.



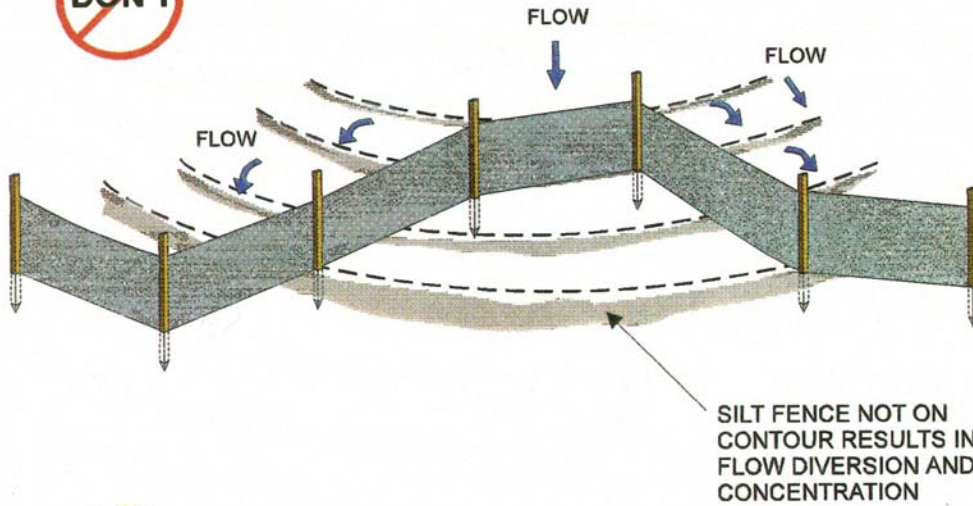
# This is how to do it right.

Key in filter fabric a minimum of 4" below the ground surface and 2 to 5 feet from slope toe, then backfill with dirt or gravel to 6 to 8 inches deep.

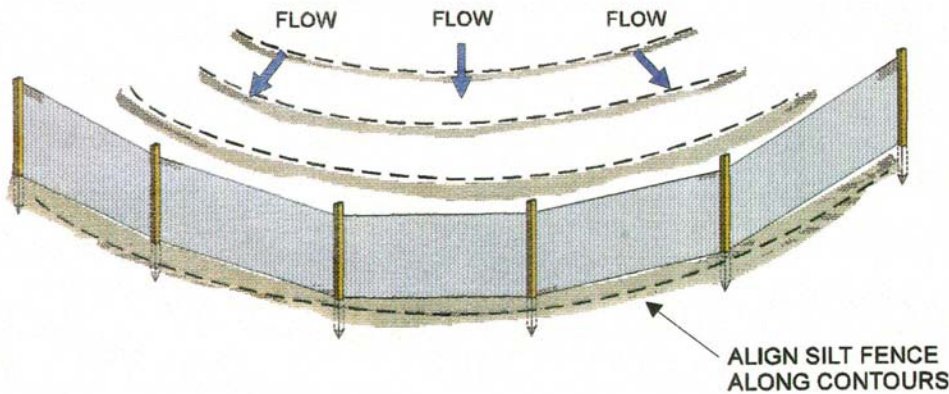




**DON'T**



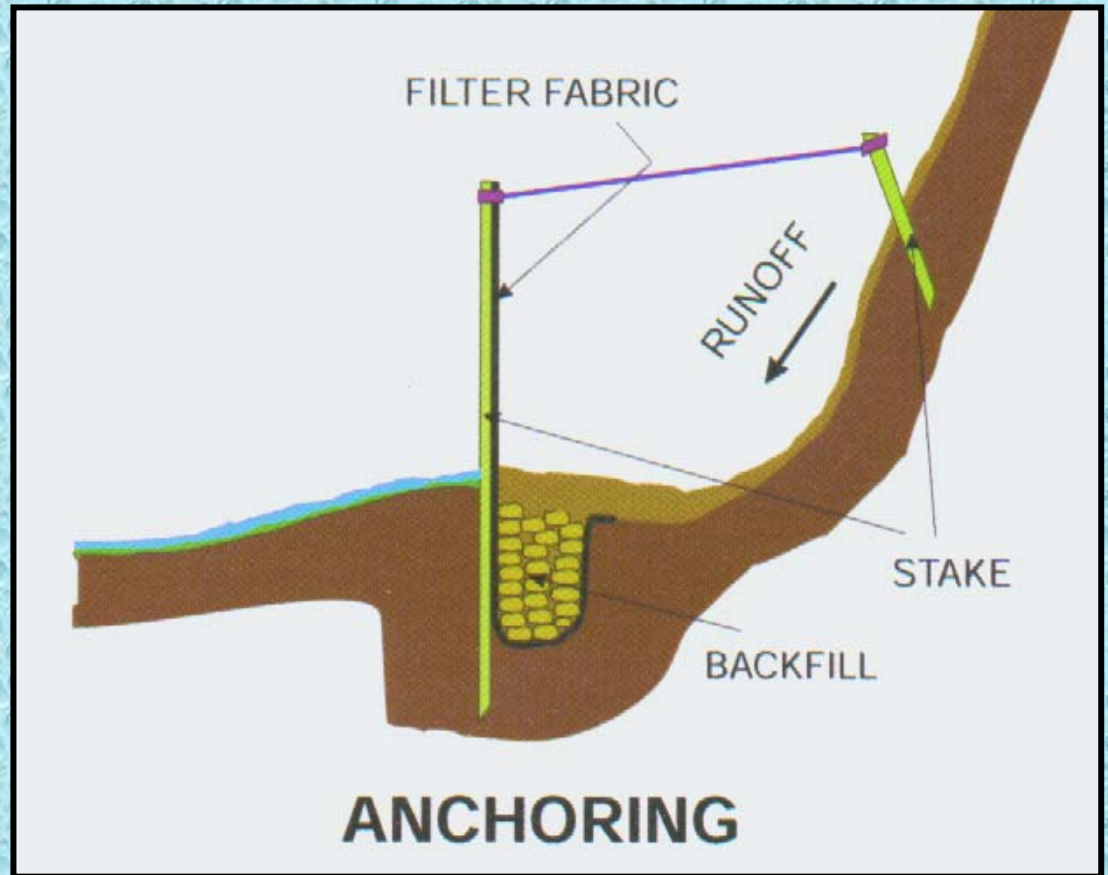
**DO**



**SILT FENCE**

Always align silt fences along the natural contours of slopes. If silt fences divert and concentrate flow, they only make the problem worse. To be effective, silt fences must disrupt the flow of runoff.

In situations where there is less than 2 to 5 feet available at the toe of the slope, this alternative anchoring technique may be used to enhance the effectiveness of the silt fence.



# What's wrong with this picture?

This crew has done a good job in properly anchoring the silt fence with minimal slope toe space.

**HOWEVER ...**

They've left out erosion control on the slope above, so the silt fence will likely fail in a major storm event.





# Good drain inlet protection is easy.

Inlet protection BMP's should always be used in combination (erosion and sediment control)– none of these methods are effective alone.



For this drain inlet, which is not on a paved road, a combination of multiple levels of fiber rolls and gravel beds, in concert with mulch and tackifier, was sufficient to minimize sediment discharges.





**Here is another example of adequate drain protection, using a large gravel bed and gravelbags. Notice, however, that proper erosion control measures have not been taken on the surrounding area (top of slide).**



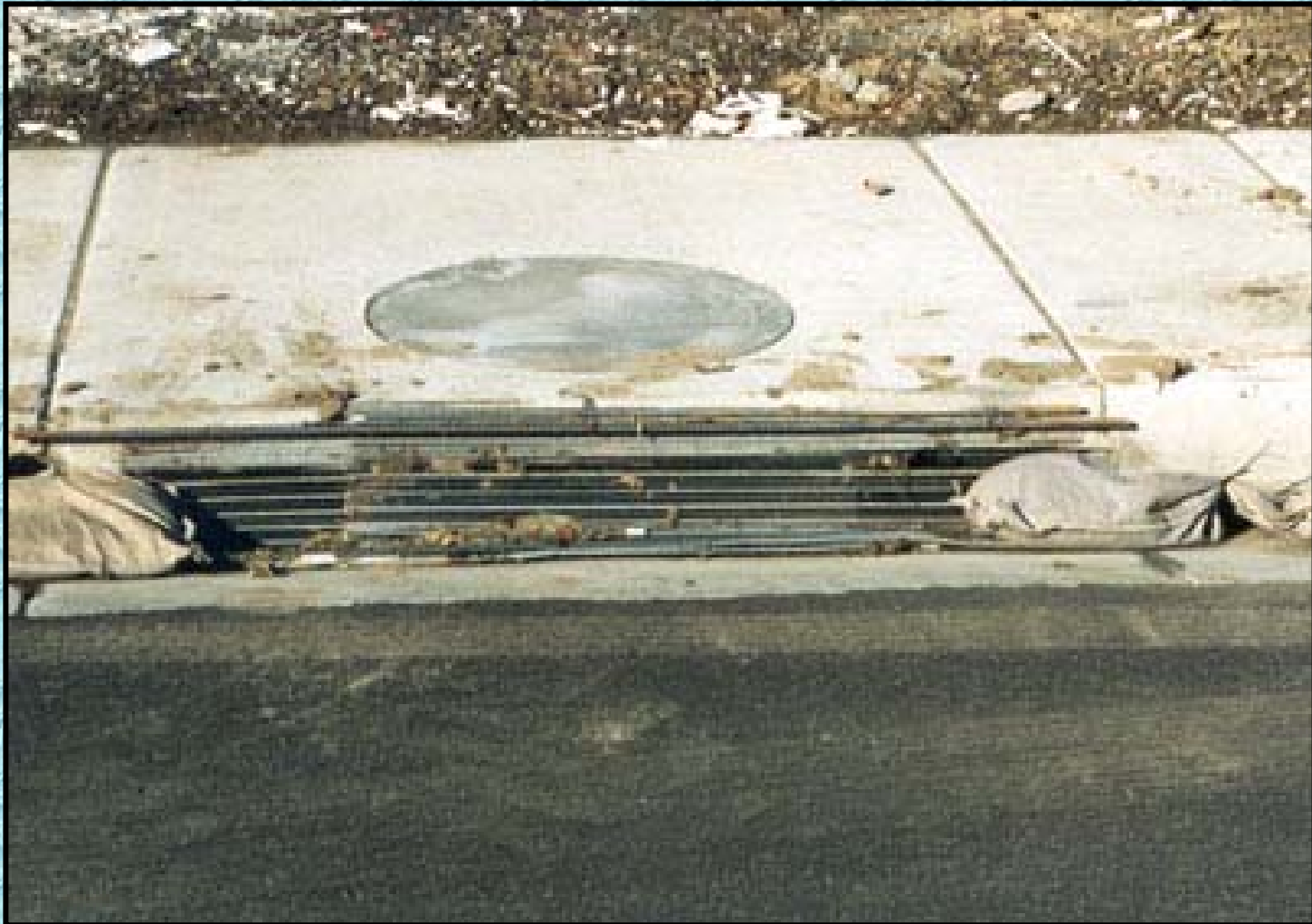


All of these methodologies are acceptable, but only if they are designed and maintained properly.

In this case, not only is the drain inadequately protected, but the sandbags that have been utilized have been torn and are no longer effective.



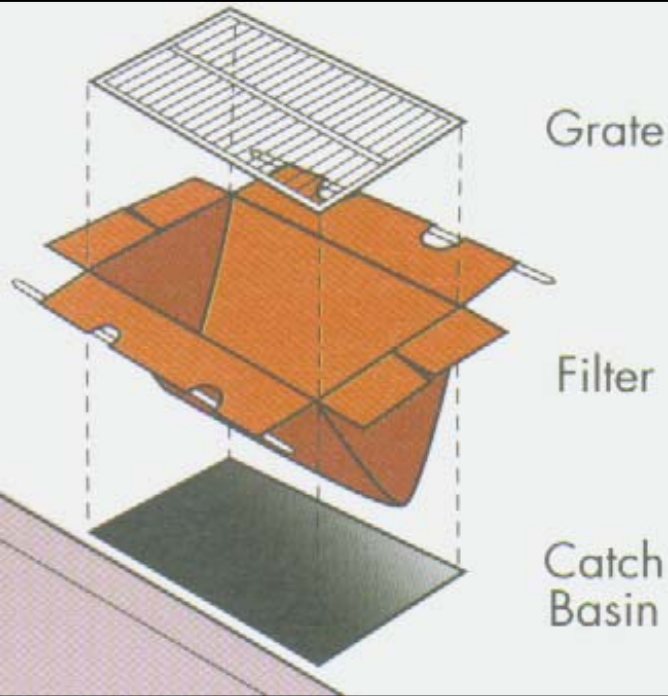
This drain has been protected from dry debris (such as leaves or trash), but this type of inlet protection is ineffective for fine sediments.





# Storm Drain Inlet Filters.....

Such as silt sacks should only be used as a redundant safety feature, and should never be used as a primary sediment control measure. They are not capable of trapping fine sediment ...





# Storm Drain Inlet Filters.....

...and must be monitored and cleaned out frequently.

Silt Sack maintenance guidelines:

1. Empty when one-third full.
2. Properly dispose of trapped sediment.
3. Clean and reuse or discard and replace as necessary.



# Non-Storm Water Control



**Messy sites demonstrate apathy for pollution prevention.**



**DO NOT** wash tracked mud/pollutants directly into stormdrain. First, sweep loose material, then collect and filter all runoff resulting from the washing process.

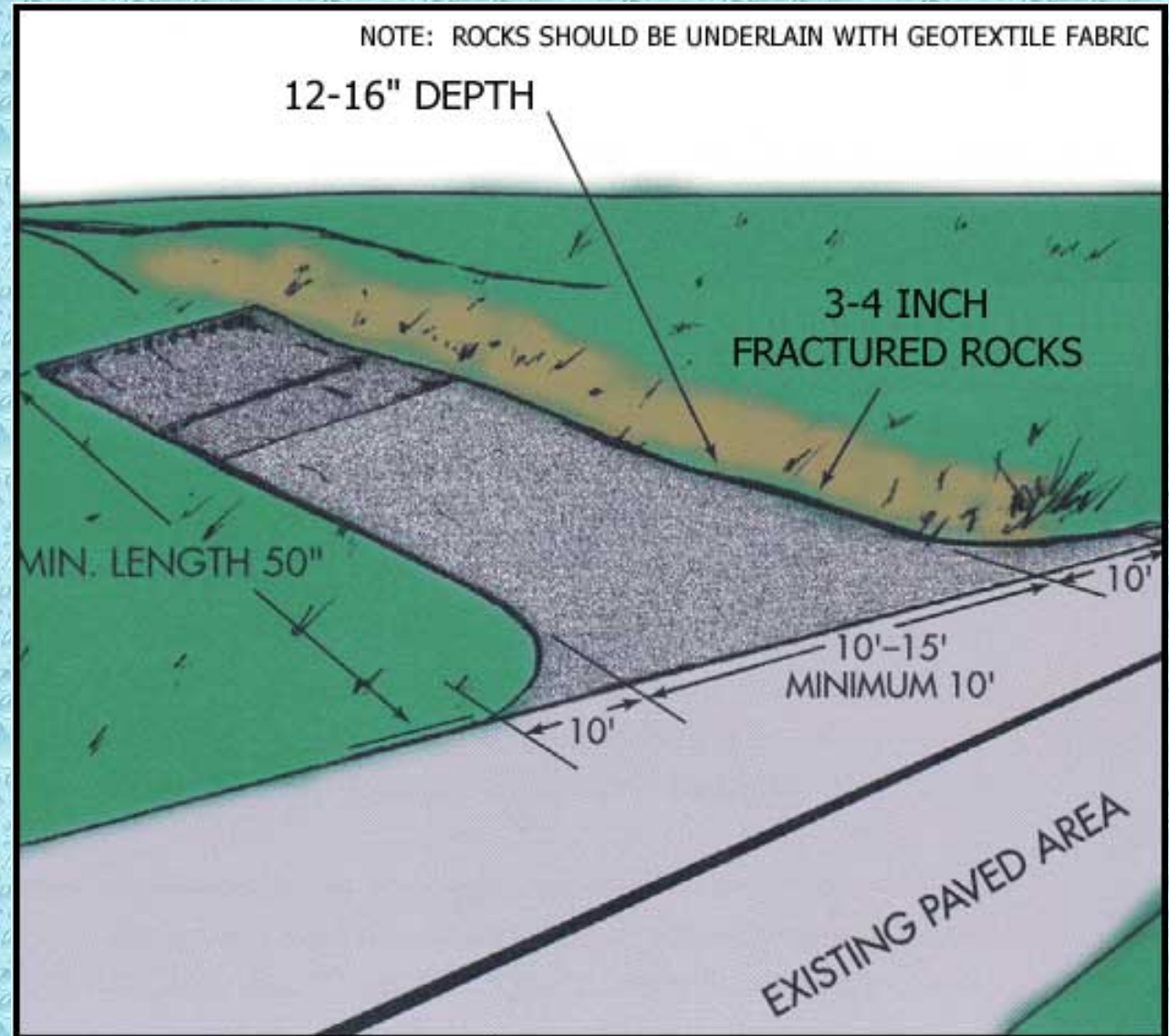




# Construction Entrance Controls

A very significant source of non-storm water pollutants discharge is tracking mud from construction site entrances.

This is very easy to mitigate, as shown to the right.

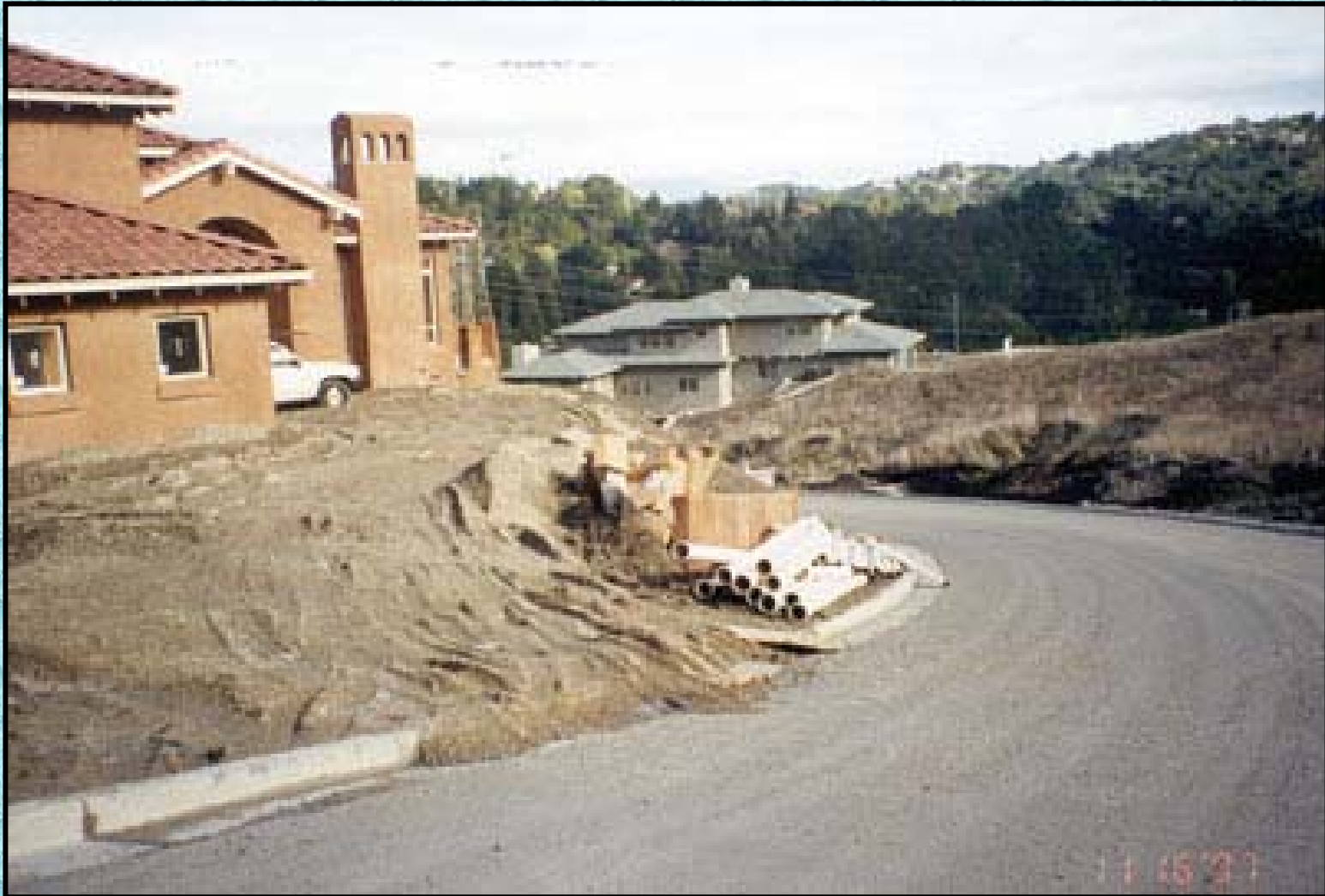


Here is a well designed construction entrance (*using 3 to 4 inch diameter angular rocks*) which shows minimal tracking of sediment outside the job site.





# Improperly designed construction entrances ...



... can cause as much damage as any other kind of violation.





Here is an inadequately protected construction entrance ...

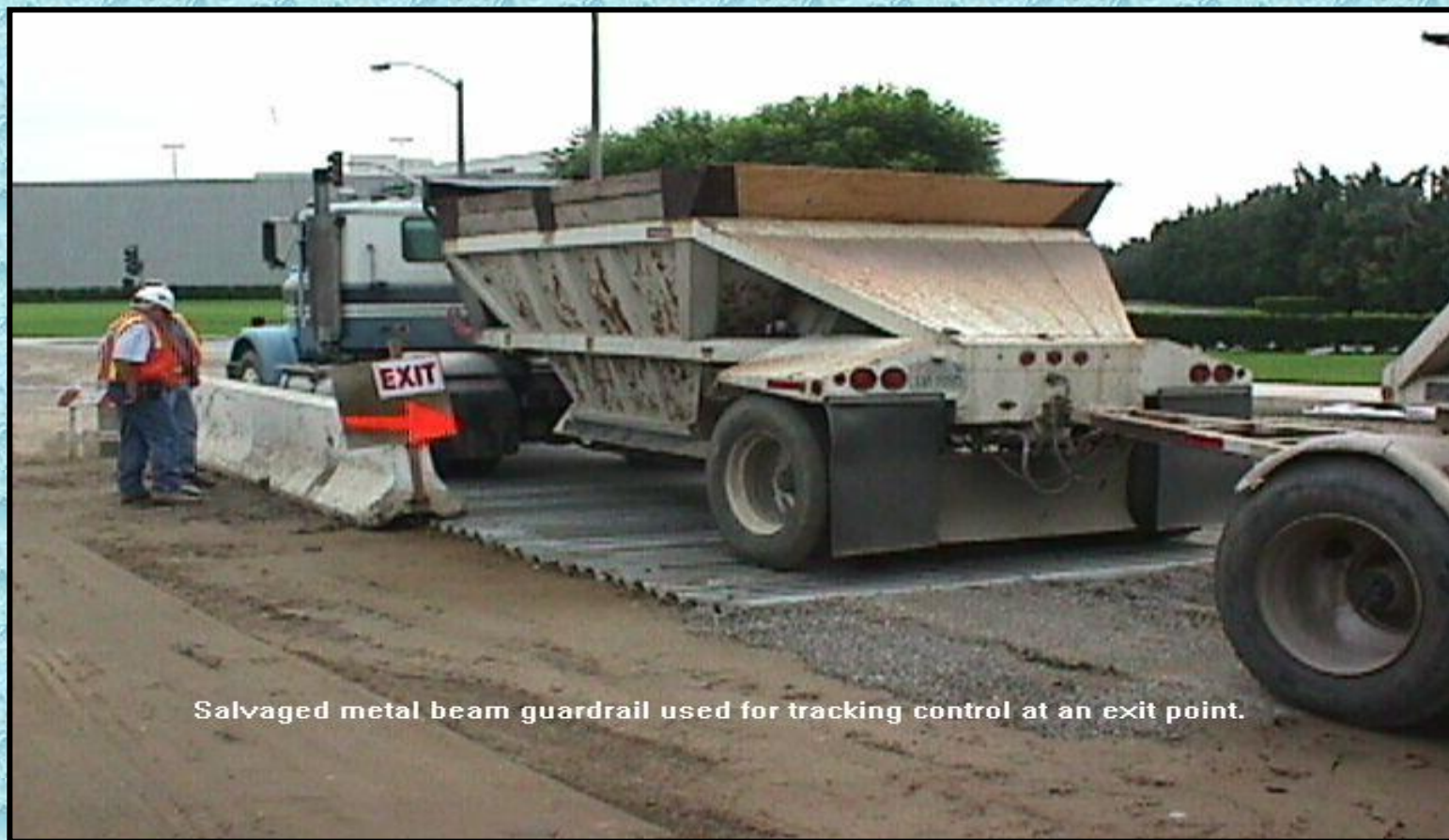


And here it is after the proper application of the BMP's for construction entrances. This entrance is now very stable.





This is another acceptable means of controlling mud, by using available salvaged construction materials. Not everything will work, so proper care must be taken to ensure that the material you choose will be effective.



Salvaged metal beam guardrail used for tracking control at an exit point.

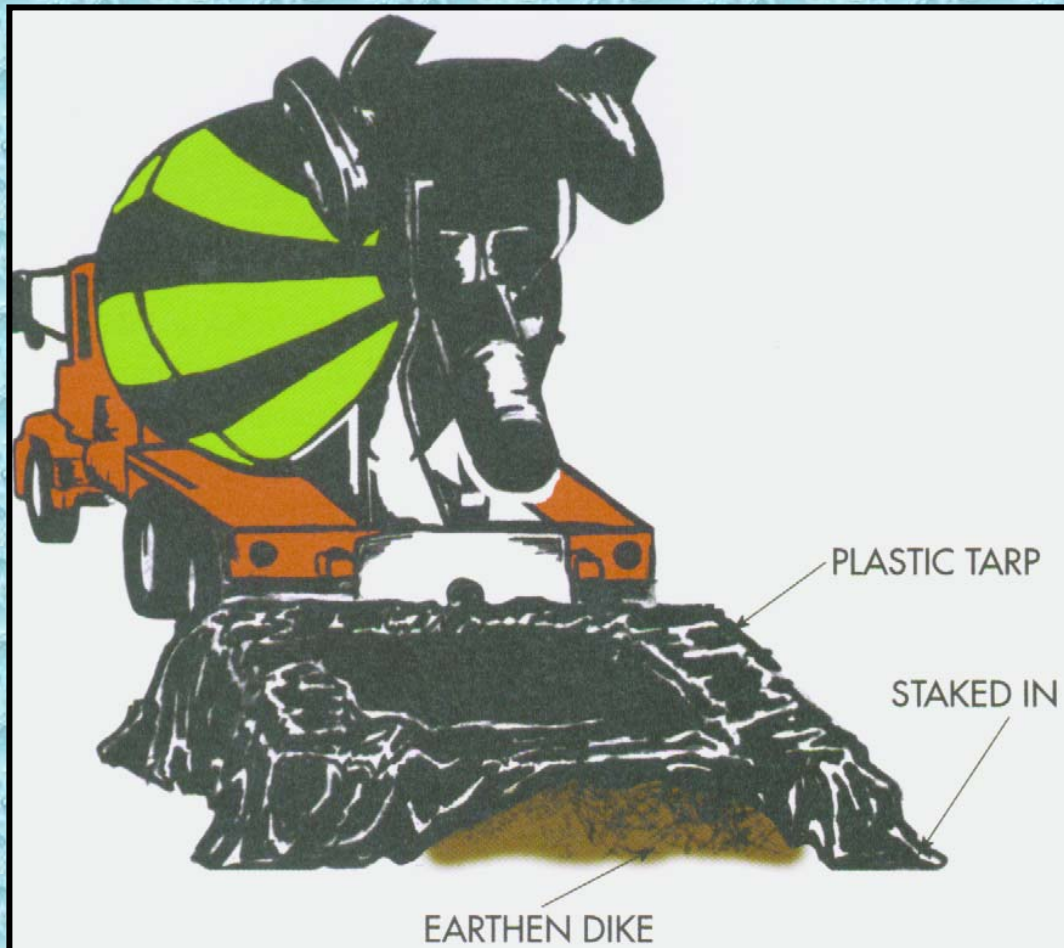


**Alternatively, a tire wash area can be used to avoid tracking mud. This requires a wash at the exit, and a separate entrance.**





Concrete washout locations need to be clearly identified, so that the washed out material is contained and can be disposed of properly.



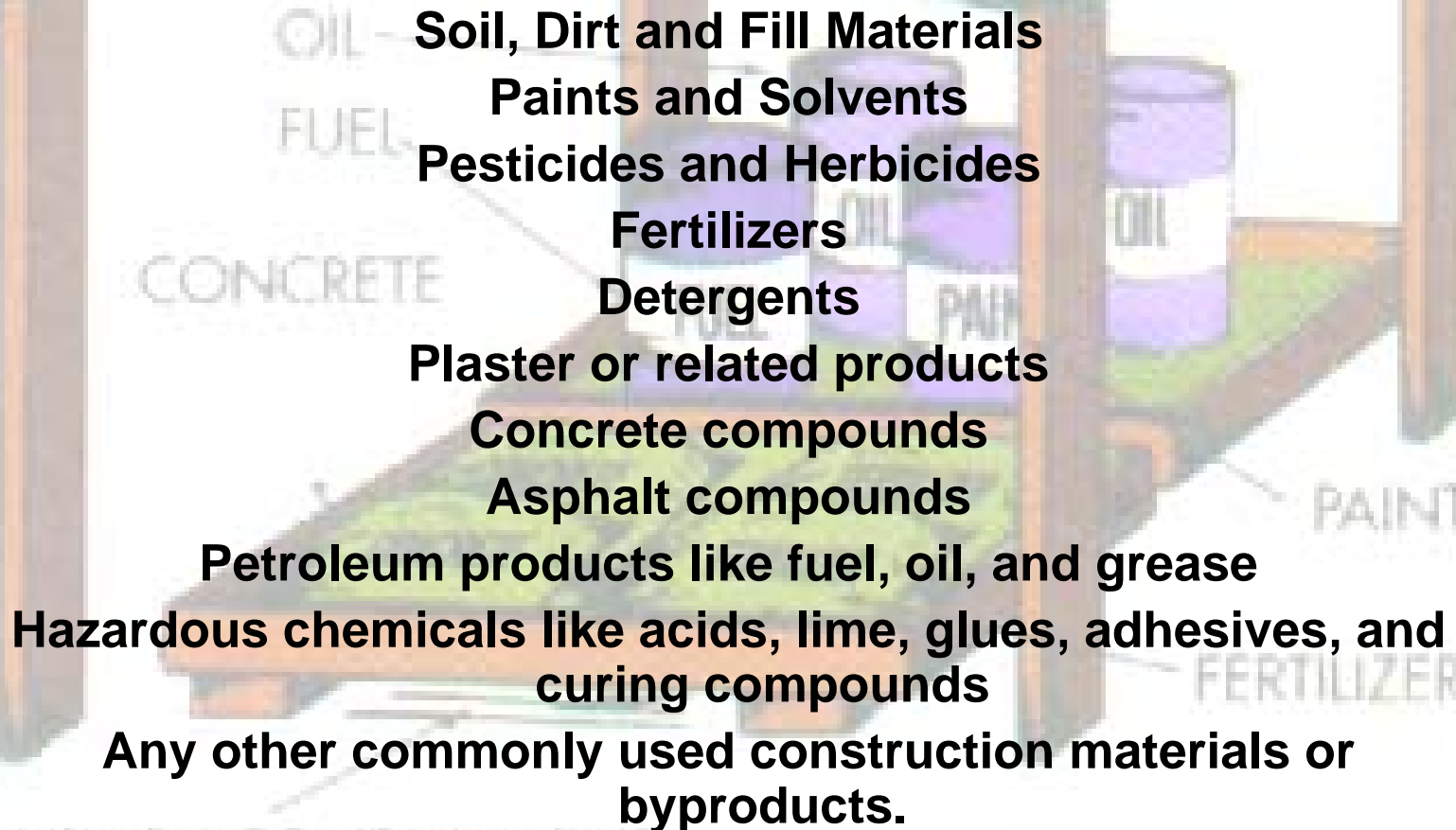
They also must be located well away from storm drains, and drainage ditches.





# Materials Handling and Storage

The following materials must be stored under cover and surrounded by containment berms:

- 
- Soil, Dirt and Fill Materials
  - Paints and Solvents
  - Pesticides and Herbicides
  - Fertilizers
  - Detergents
  - Plaster or related products
  - Concrete compounds
  - Asphalt compounds
  - Petroleum products like fuel, oil, and grease
  - Hazardous chemicals like acids, lime, glues, adhesives, and curing compounds
  - Any other commonly used construction materials or byproducts.

SECONDARY CONTAINMENT

Any chemicals or materials which get outside the containment berm become pollutants.





Proper management of fuel eliminates or minimizes discharge of pollutants and costly cleanup.



Smaller materials storage locations must also be protected; even a small amount of fuel or waste has a large impact on the environment from an accidental spill.



Place all storage areas  
away from stormdrains





# Creek and Drainage Channel Stabilization

Here is a drainage ditch with totally inadequate BMP's, which caused a massive discharge of sediment, clean-up costs and civil liability.

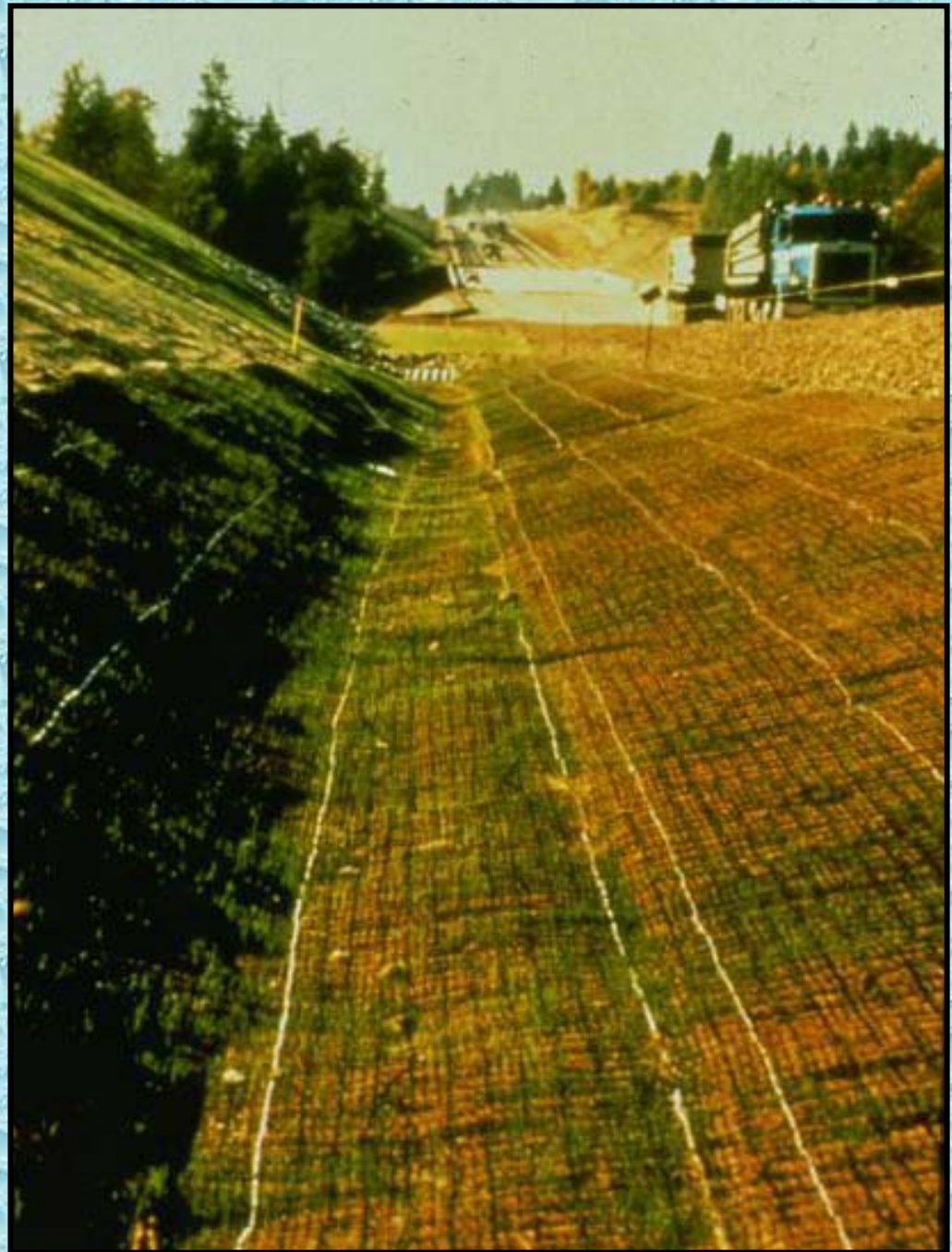




# Swales and Drainage Ditch Protection

Protection of swales and drainage ditches is especially important because they concentrate flow, creating high energy and high potential for sedimentation discharge.

Often all of the methods we have discussed so far are required to adequately protect a drainage ditch.



# Success!!

As you can see here, proper installation of channel blankets on creek banks will reduce erosion.





# Multiple methods for critical situations !!

Here, a combination of nylon erosion control blankets and fiber rolls were used to protect the drainage ditch and the surrounding flat lots.





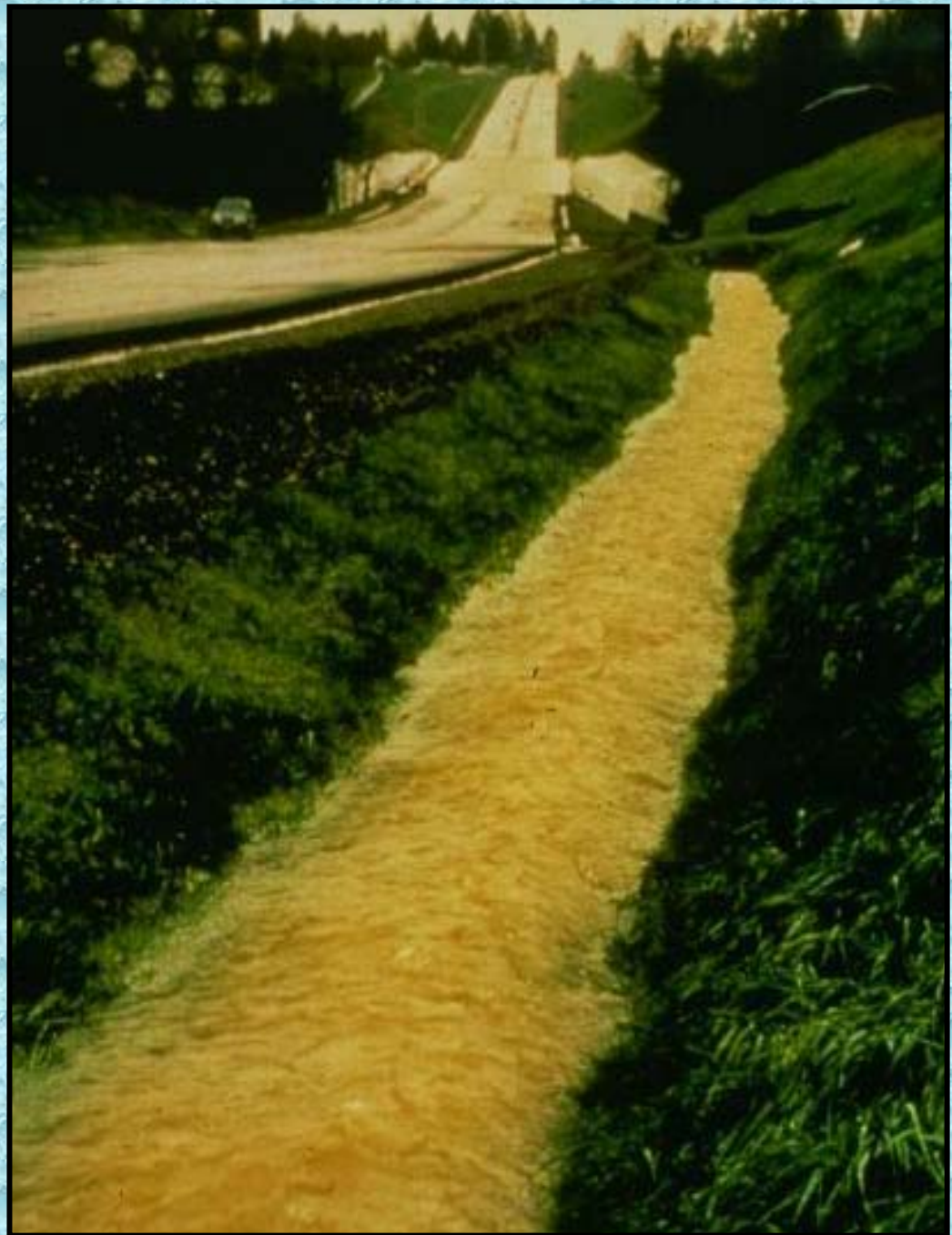
Swale and drainage ditch protection is especially critical, because the function of a drainage ditch is to concentrate flow. This drainage ditch has erosion, sedimentation and outlet controls, all well designed and maintained.





These drainage banks were seeded and stabilized with erosion control blankets.

Vegetation has established through the biodegradable blankets and has minimized erosion of banks.



# Sediment Basins



# Sediment Basins

Sediment basins are the last line of defense, and should never be used as a primary sediment control device.

These basins are designed to work in conjunction with erosion control measures to allow what little fine sediment remains suspended in stormwater to settle out before being discharged.

## Design considerations for sediment basins.

Sediment basins must be large enough for effective sedimentation to occur, based on anticipated water volume, soil particle size and anticipated erosion load.

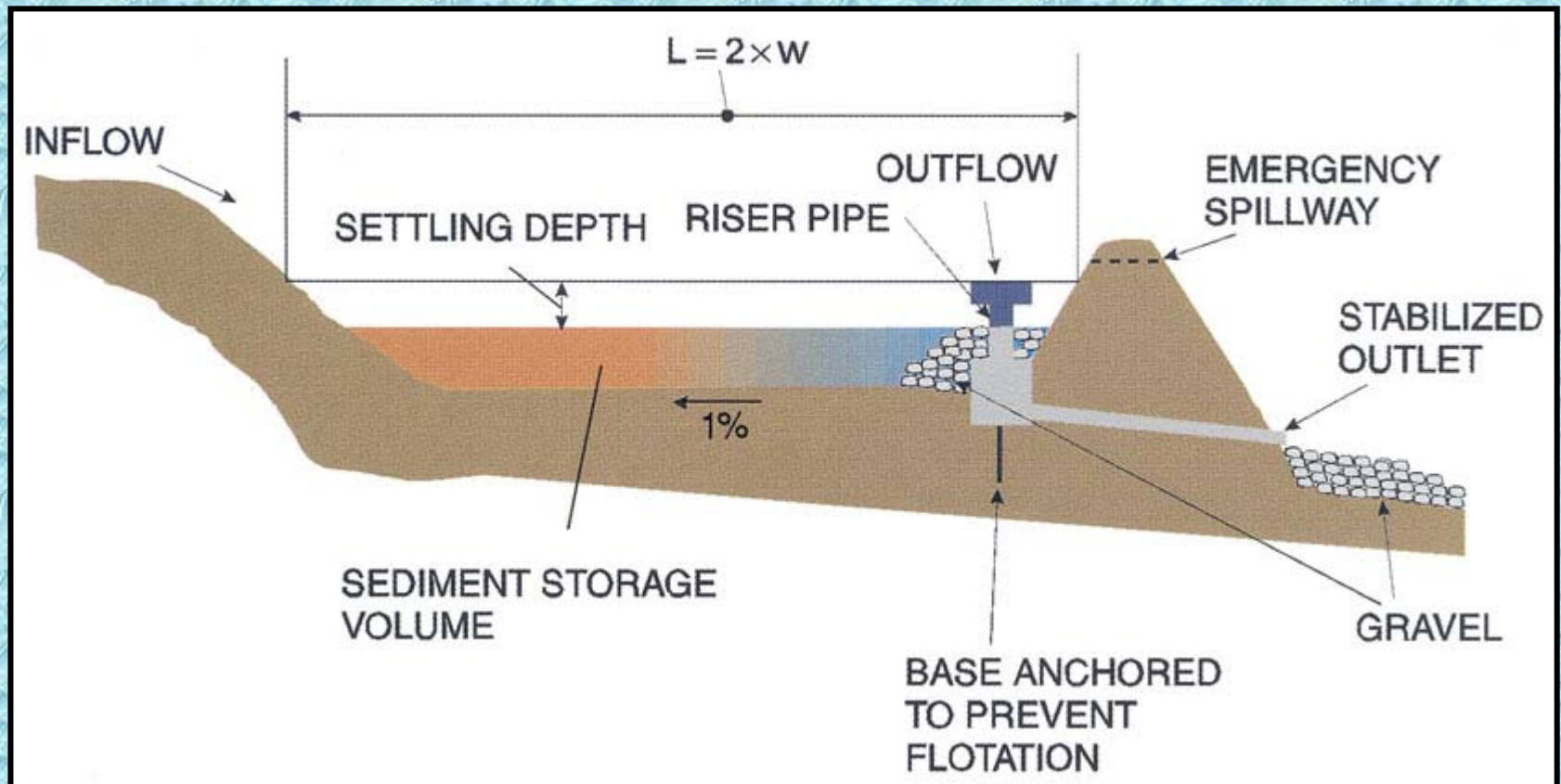
Minimum design calculation should either be based on a 10 year, six hour rain event, or allow for 3,600 cubic feet of reservoir volume per acre disturbed.

Special attention must be paid to the inlet and outlet to avoid secondary erosion.



# Design considerations for sediment basins.

Here are the features of a well-designed sediment basin.



# Design considerations for sediment basins.

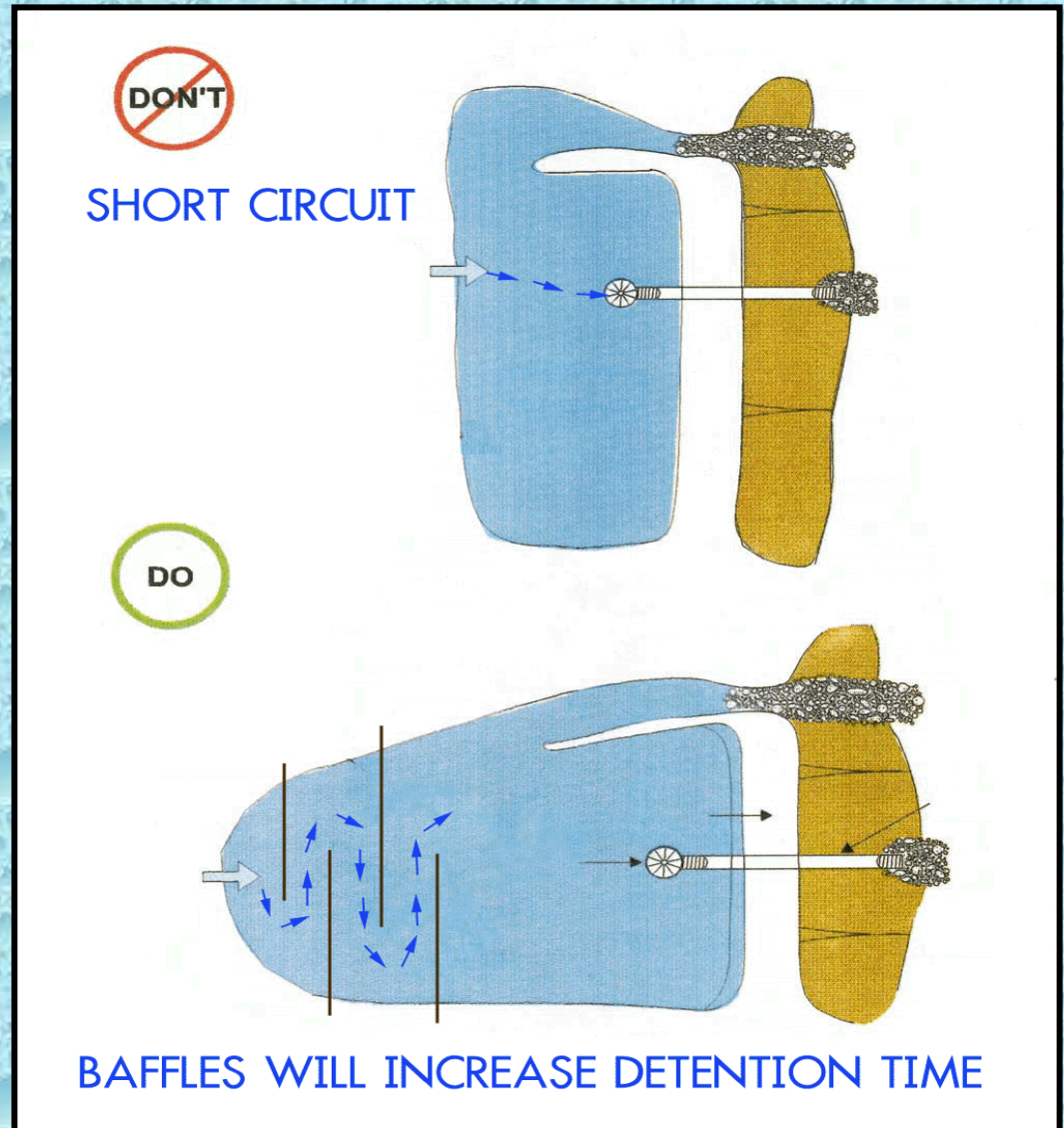
Sediment basins must be large (at least 3,600 cubic feet per disturbed acre) to be effective in allowing sediment to settle.





# Design considerations for sediment basins.

Sedimentation rates can be improved by adding baffles to slow water flow, increasing detention and sedimentation time.



# Design considerations for sediment basins.

Here is an example of a sediment basin design which incorporates a baffle to increase sediment recovery.





# Design considerations for sediment basins.

This outlet looks pretty good, but if you look closely, you'll notice that the rocks below the outlet are not of sufficient size or weight to remain safely in place during a major storm event.



# Design considerations for sediment basins.

Here is a poorly designed sediment basin outlet which is causing erosion at the outlet, defeating the purpose entirely.





# Design considerations for sediment basins.

Here is the same site a few weeks later, with a redesigned outlet in place.



This sediment basin outlet is designed properly.





If a sediment basin fails, it almost always causes a major discharge.



# Dewatering Methods



# Dewatering Methods

## Filtering

Sand and Gravel Bags

Rock Filter Caisson

Filtering Systems

## Sedimentation

Baker Tank

Sediment Basin

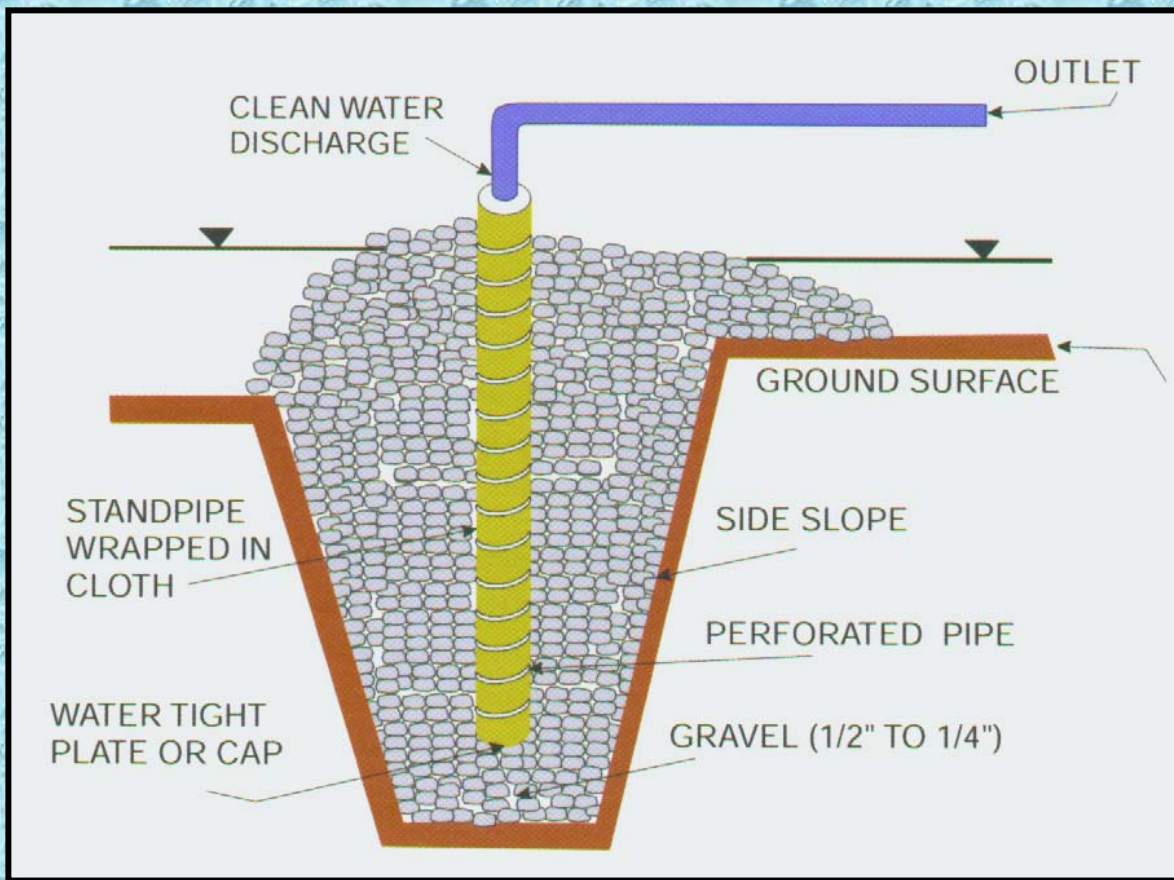
Dewatering an excavation or sediment basin  
without filtration is prohibited!!

# Dewatering

Dewatering can be used to filter sediment laden water to surface waters by using a combination of filtering and sedimentation methods.



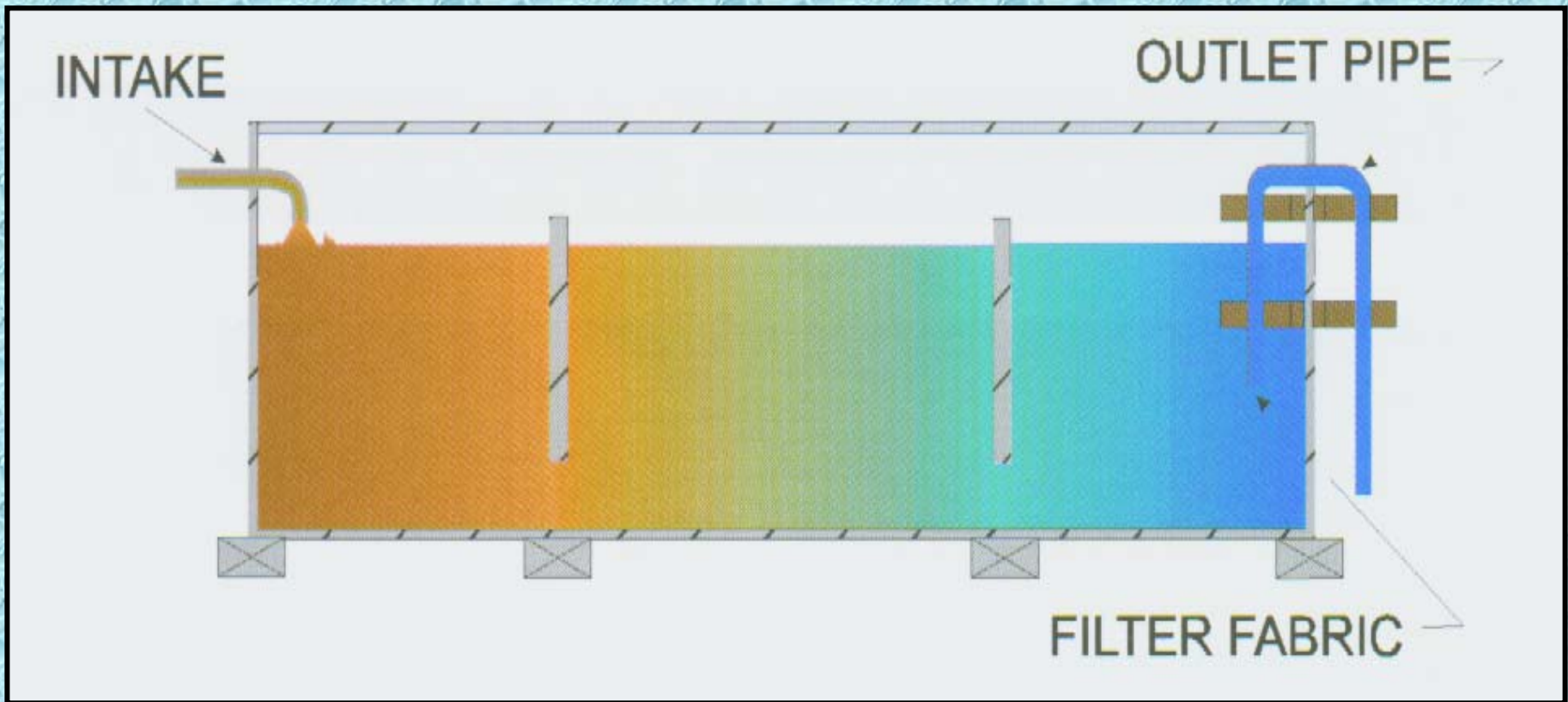




Here is an example of a rock filtering system that addresses the concerns for effective dewatering.

The discharge from all dewatering systems must be monitored to ensure that only clean/filtered water is discharged.

Portable clarifying systems may also be used for dewatering, provided they are maintained and monitored properly.





Here is a two-step filtration unit which uses both a sand filter and a finish filter to remove fine sediments, such as clay soil, from water before releasing it to the environment.

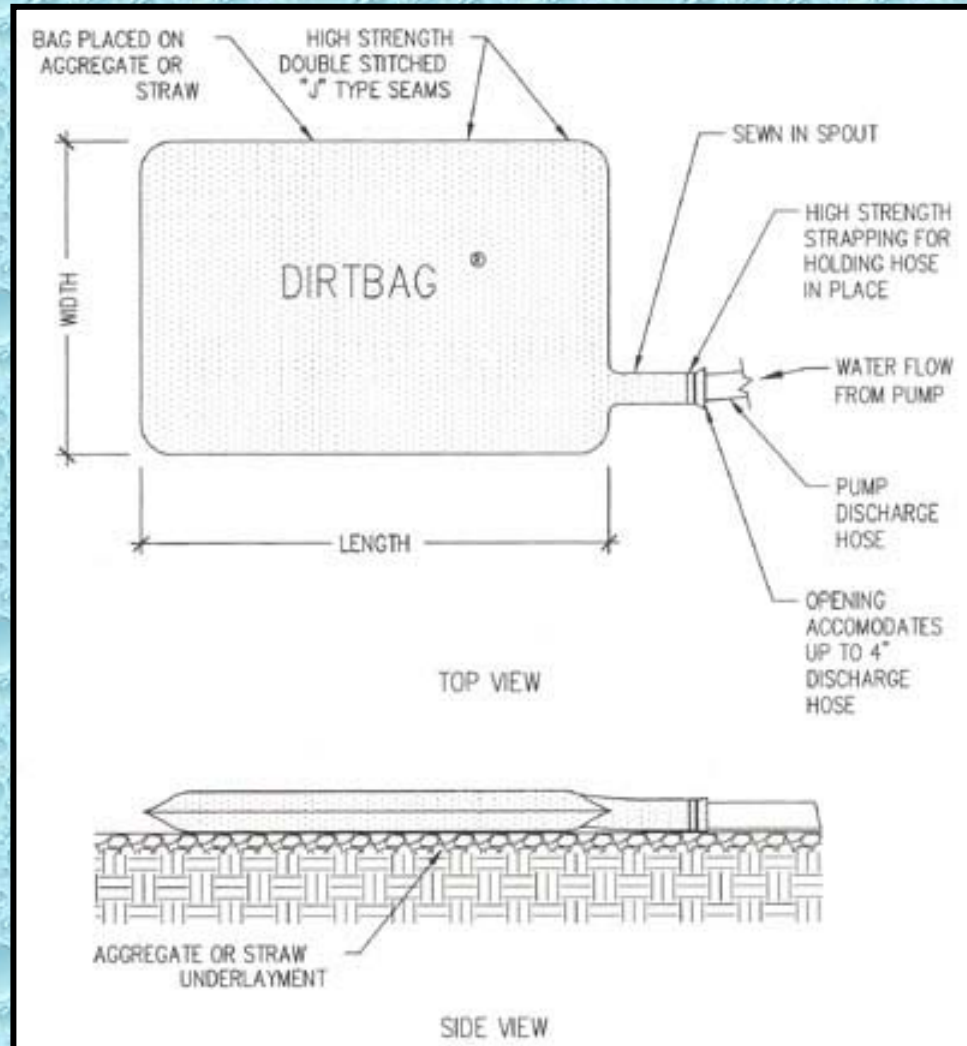


This is another example of a portable two-step filtration unit which can be used to dewater sediment basins or excavations.





Dewatering methods such as dirt bags can be effective and economical in reducing sediment releases during short term dewatering. Dirt bags may not be effective for fine clay soil.



To maximize flow and efficiency, dirt bags should be installed on a straw or aggregate underlayment.





# Stockpile Management and other Pollutants Control BMP's

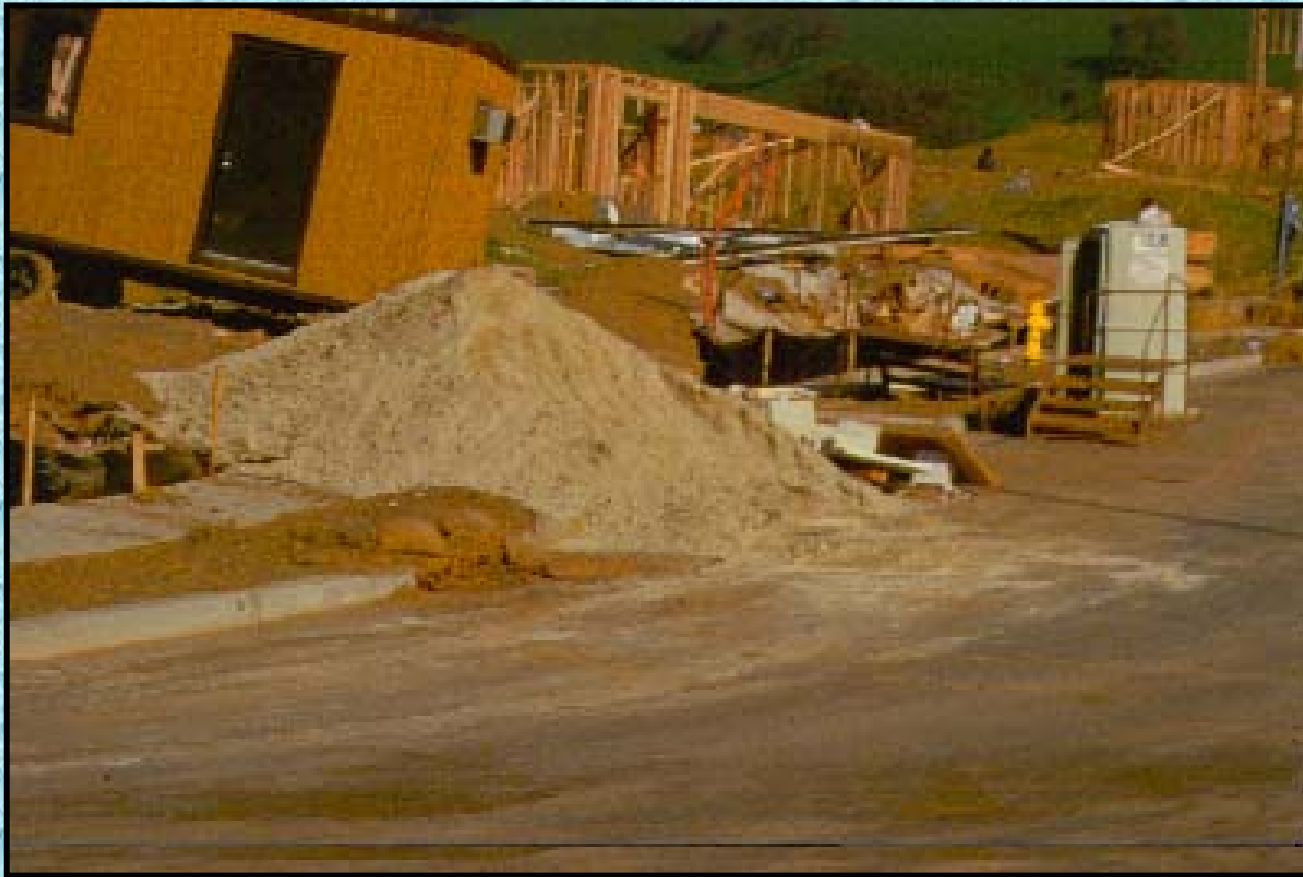
Stockpile management is a very important part of erosion control, and the same care must be taken with an exposed stockpile as with an exposed hillside.

*This is an example of improper stockpile management.*



Another example of poor stockpile management.

If it rained on this site, this entire stockpile of backfill material would be washed into the storm drain.





This stockpile is being properly managed, and will not cause any problems or unnecessary expense, should a storm event occur.



An even better example of good stockpile management.

Erosion control blankets are easier to maintain and more effective than plastic.



Paving operations should only be carried out a minimum of 72 hours prior to a rain event to allow proper curing. Rain on fresh paving will cause petrochemical and solvent releases.





**WRONG !!**

Don't just wash sawcutting debris into the storm drains!!



# Take the time to do it right!

This may not seem like very much pollution, but every effort, even small, will minimize the impact to the environment.





In Summary



# Improper BMP Management ...



# Another example of improper BMP management ...





Still another  
example ...





... which leads to uncontrolled sediment discharges ...



... and financial and legal problems.

**■ Fremont: Silt in creek to be removed at once.**

BY DENNIS AKIZUKI  
Mercury News Staff Writer

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39 | SAN JOSE MERCURY NEWS

# EMPIRE NEWS

Thursday June 8, 2000

## Vineyard owner sentenced to 30 days in jail

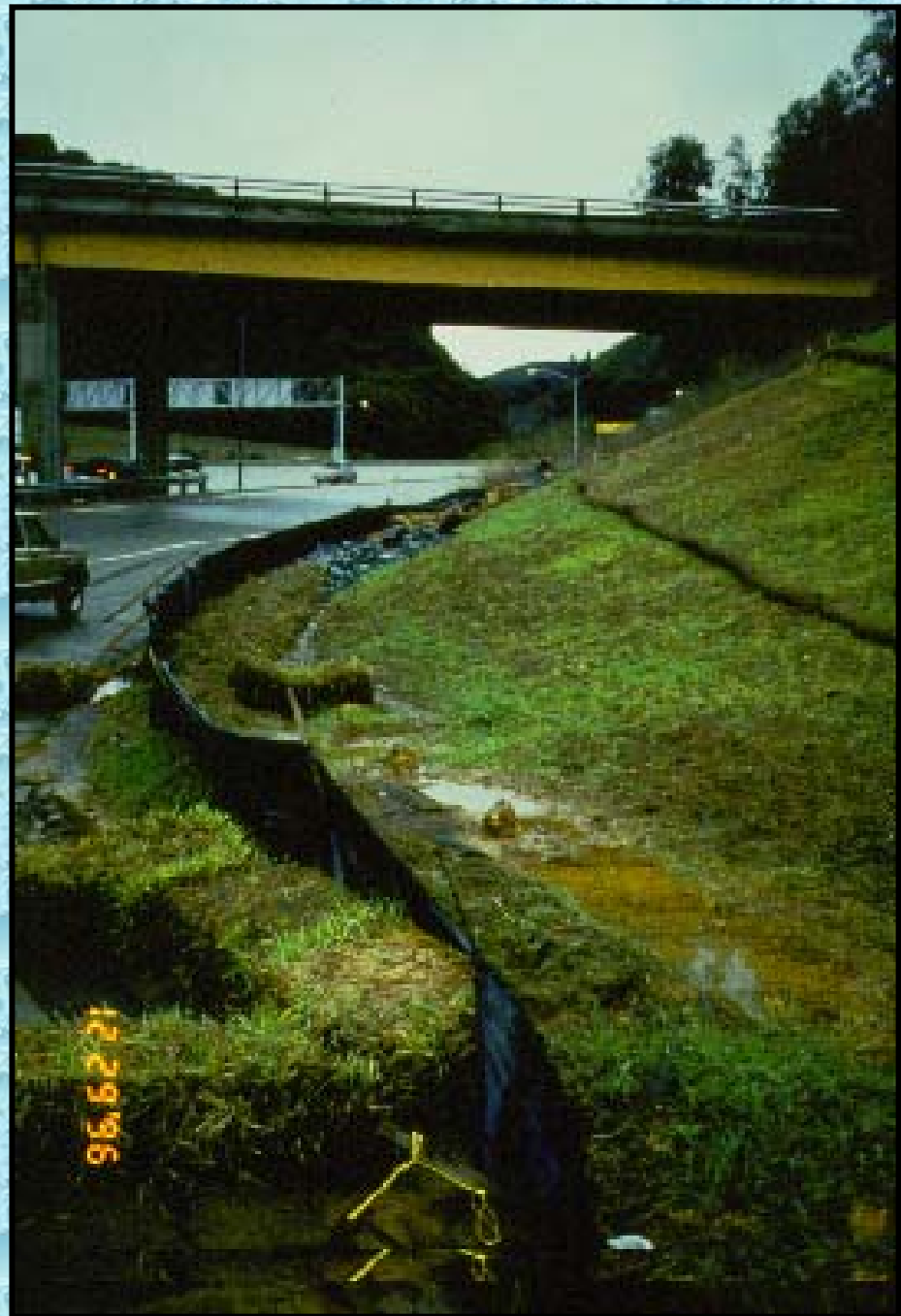
Sebastopol man destroyed vegetation, oak trees

# Proper implementation of Erosion and Sediment Control BMP's ...





... results in  
successful  
erosion and  
sediment  
control.



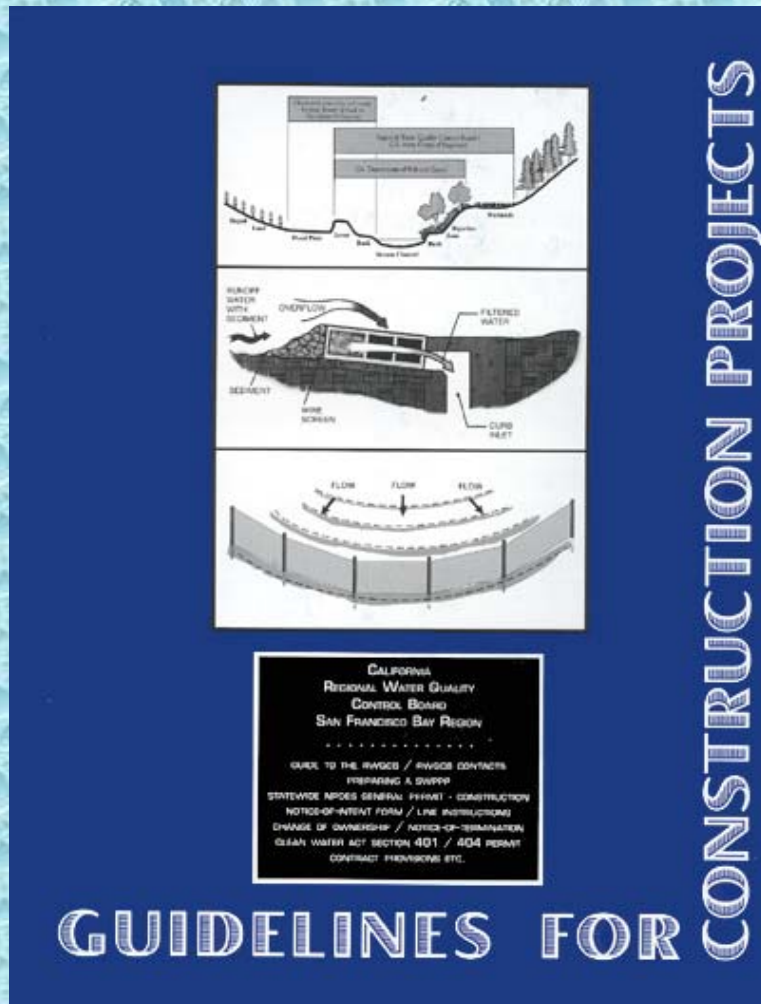
A successful project requires a combination of all these techniques, working together to protect the environment.



# Here is the information you need to stay clean.

These books are available from the Friends of the San Francisco Estuary.

For ordering information call 510-622-2419.

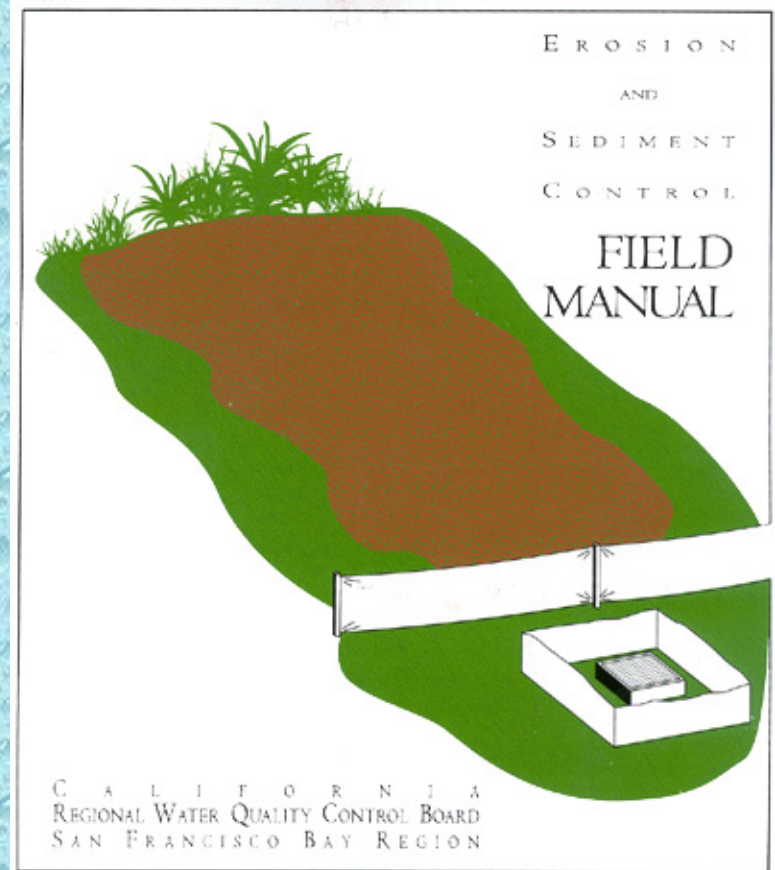


The cover features three diagrams illustrating erosion control techniques: a cross-section of a slope with a check dam, a plan view of a silt trap with labels for 'RUNOFF WATER WITH SEDIMENT', 'SEDIMENT', 'WIRE SCREEN', 'CHOPPED', and 'FILTERED WATER', and a plan view of a silt fence with 'FLOW' arrows. A vertical title 'CONSTRUCTION PROJECTS' is on the right side.

**CALIFORNIA**  
REGIONAL WATER QUALITY  
CONTROL BOARD  
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GUIDE TO THE RWQCB / RWQCB CONTRACTS  
PREPARING A SWPPP  
STATEWIDE NPDES GENERAL PERMIT - CONSTRUCTION  
NOTICE-OF-INTENT FORM / LINE INSTRUCTIONS  
CHANGE OF OWNERSHIP / NOTICE-OF-TERMINATION  
CLEAN WATER ACT SECTION 401 / 404 PERMIT  
CONTRACT PROVISIONS ETC.

**GUIDELINES FOR CONSTRUCTION PROJECTS**



The cover features a cross-section diagram of a slope with green grass on top and brown soil below. A white silt fence is shown at the base of the slope, with a white box containing a silt trap below it. The title 'EROSION AND SEDIMENT CONTROL FIELD MANUAL' is on the right side.

**EROSION  
AND  
SEDIMENT  
CONTROL  
FIELD  
MANUAL**

**CALIFORNIA**  
REGIONAL WATER QUALITY CONTROL BOARD  
SAN FRANCISCO BAY REGION



In Part III, we will discuss Post  
Construction Erosion and Sedimentation  
Control.