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# Polymer Enhanced Best Management Practices (PEBMP) for Erosion, Sediment Control and Stormwater


**Steven R. Iwinski**

**Environmental Scientist**


University of Central Florida Stormwater Management Academy
"Managed Stormwater is Good Water"

**Senior Associate**

University of Central Florida

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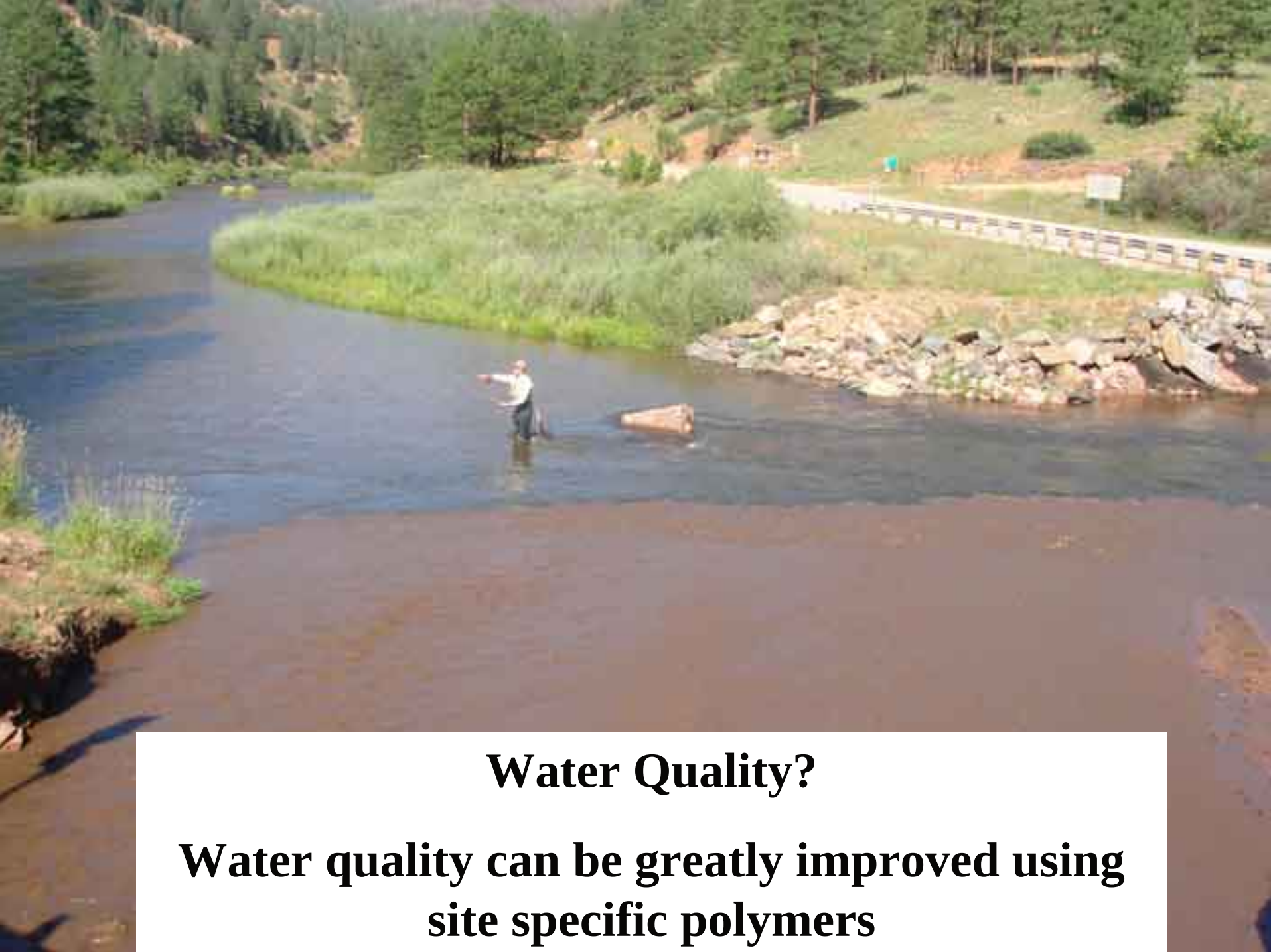
**Ponds and Basins?**

**Sediment loss can be greatly reduced using site specific polymers**



**Water Quality?**

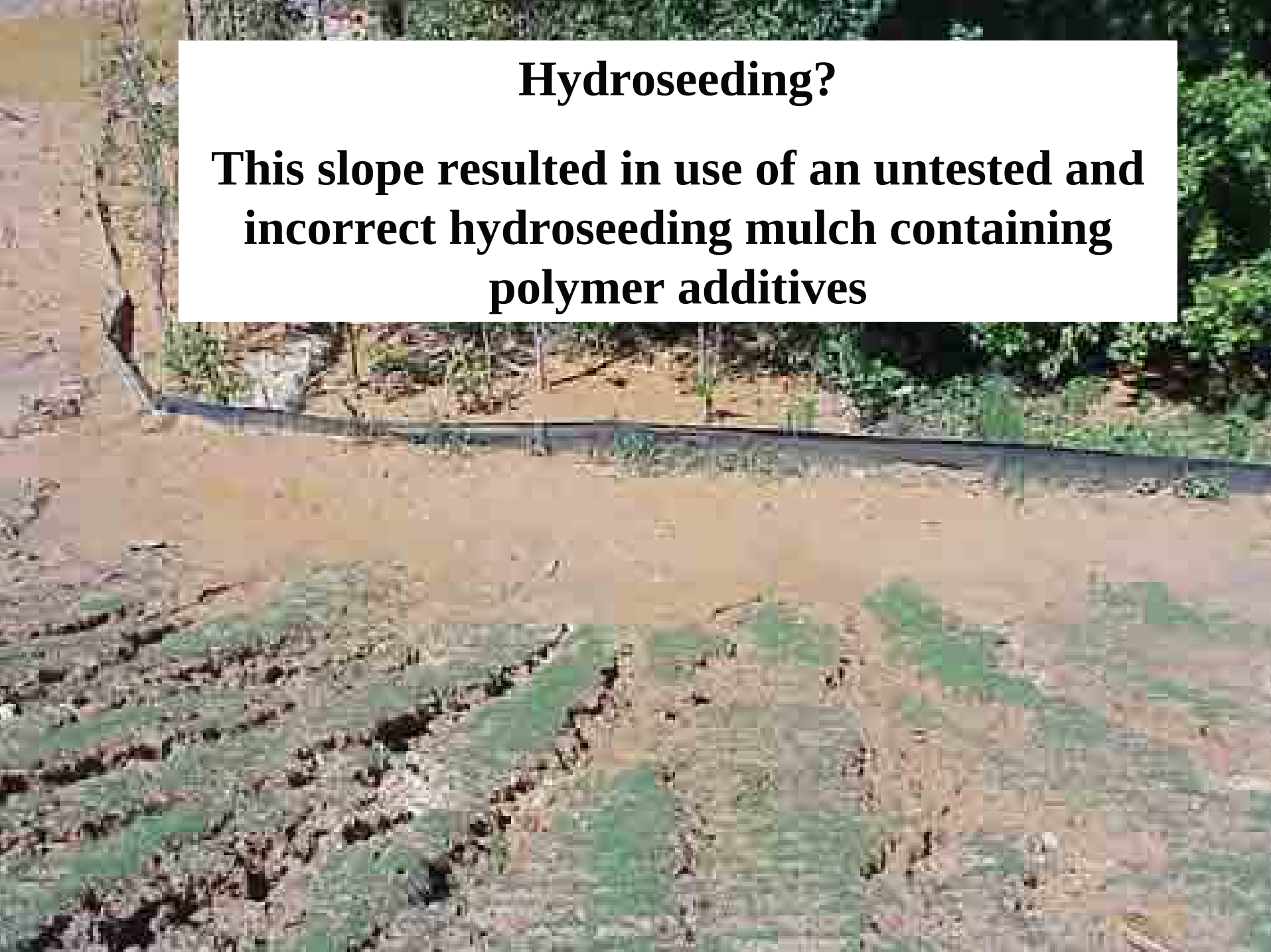
**Water quality can be greatly improved using site specific polymers**

**Silt Fence?**

**Silt fence alone cannot prevent fine sediment loss**

**Site Erosion and Stream Impairment?**

**Erosion repair and clean up is more costly than prevention**



# Hydroseeding?

**This slope resulted in use of an untested and incorrect hydroseeding mulch containing polymer additives**


**Slope Protection?**

**Straw matting alone will not prevent erosion**

**Acid Rock Drainage?**

**Metal, Turbidity and pH**

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# What is Polyacrylamide (PAM)

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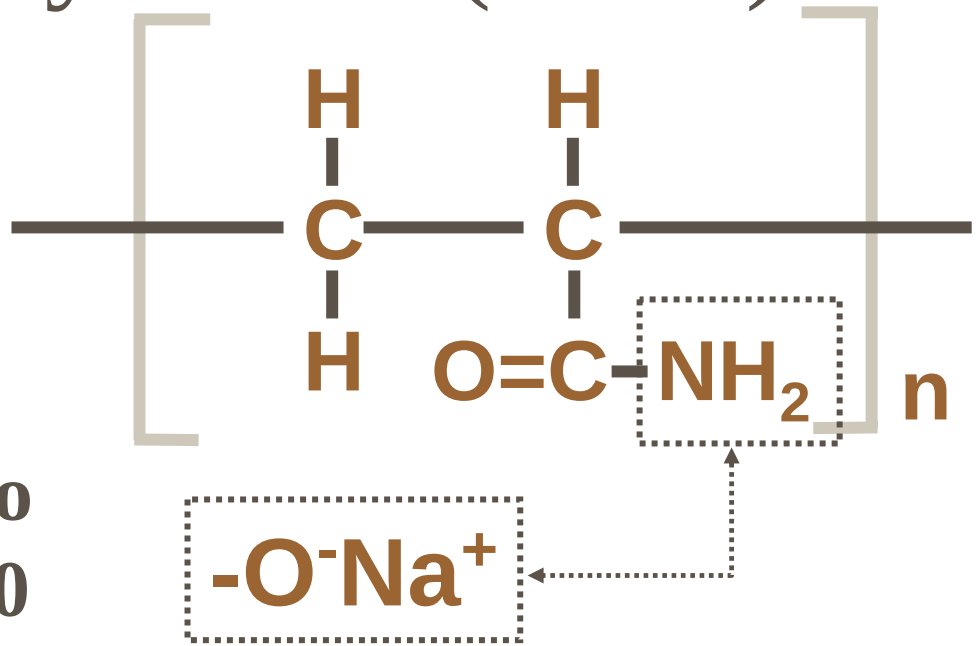
# Anionic Polyacrylamide (PAM)

- **PAM is a polymer of acrylamide (AMD) monomers**
- **Erosion PAMs are 12 to 24 Mg/mole & >150,000 chained monomers/molecule.**
- **Erosion PAMs have <0.05% unreacted AMD**





USDA

ars

NWISRL
Kimberly, ID

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# How Polymer Enhancement Works

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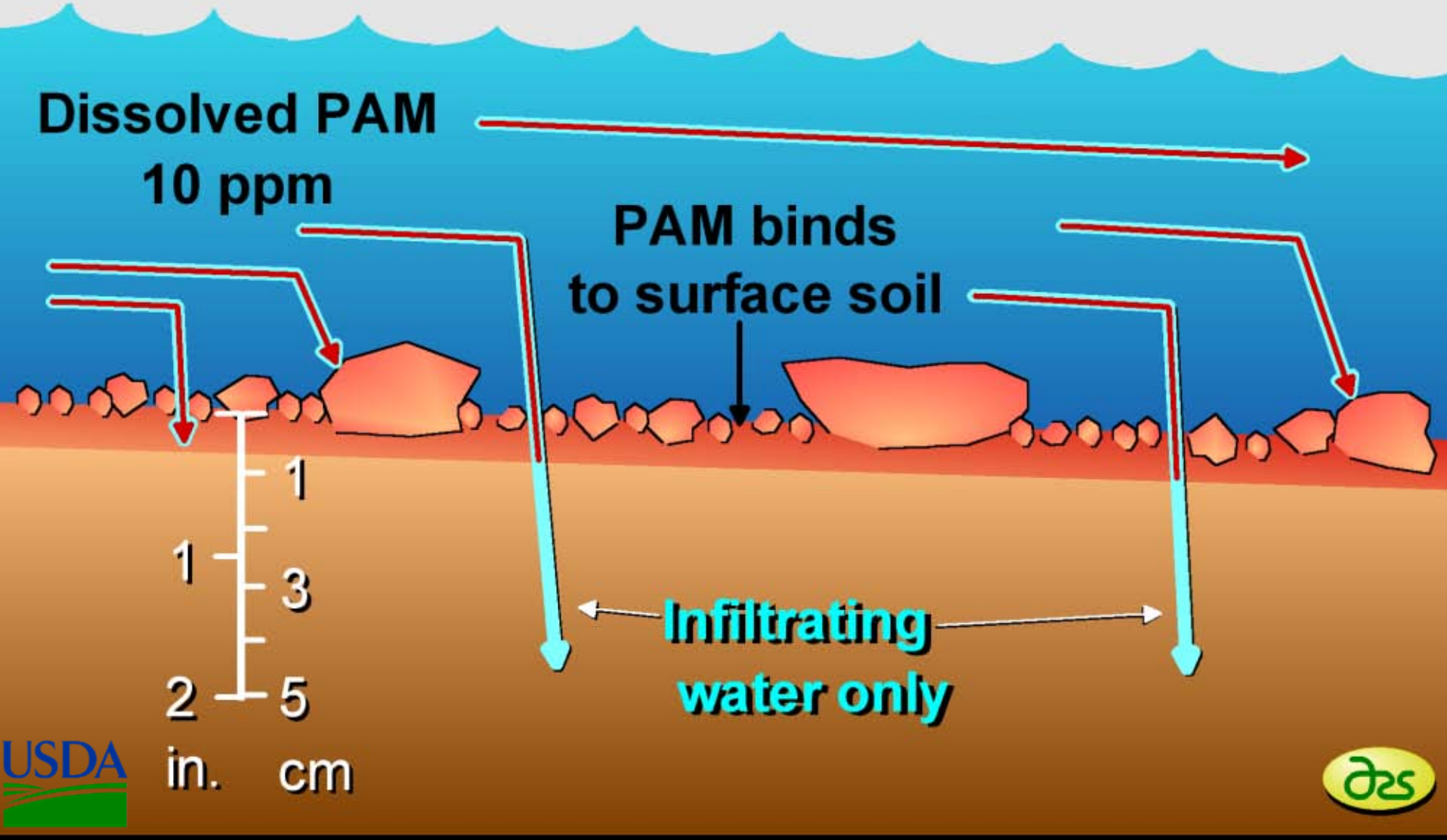
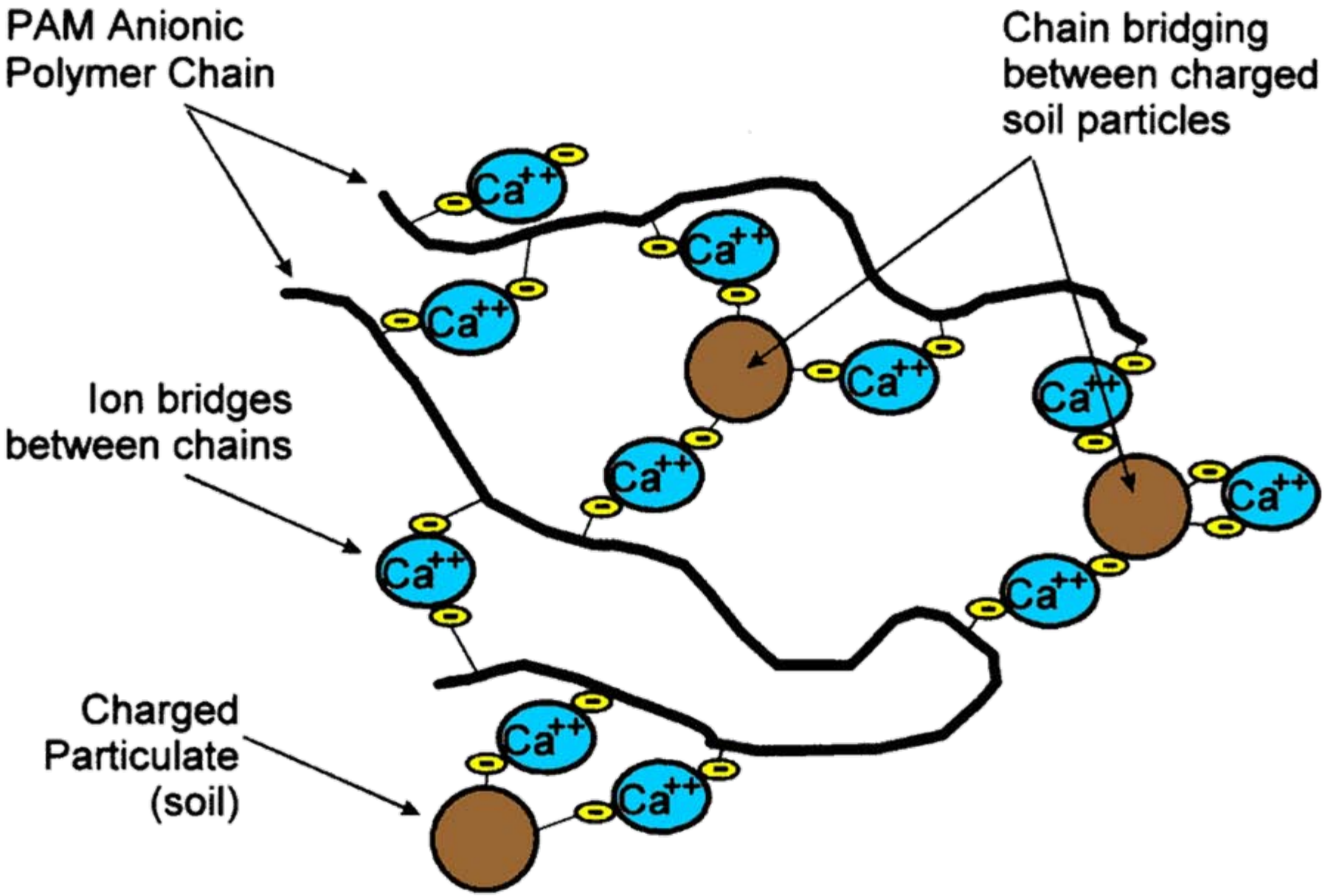
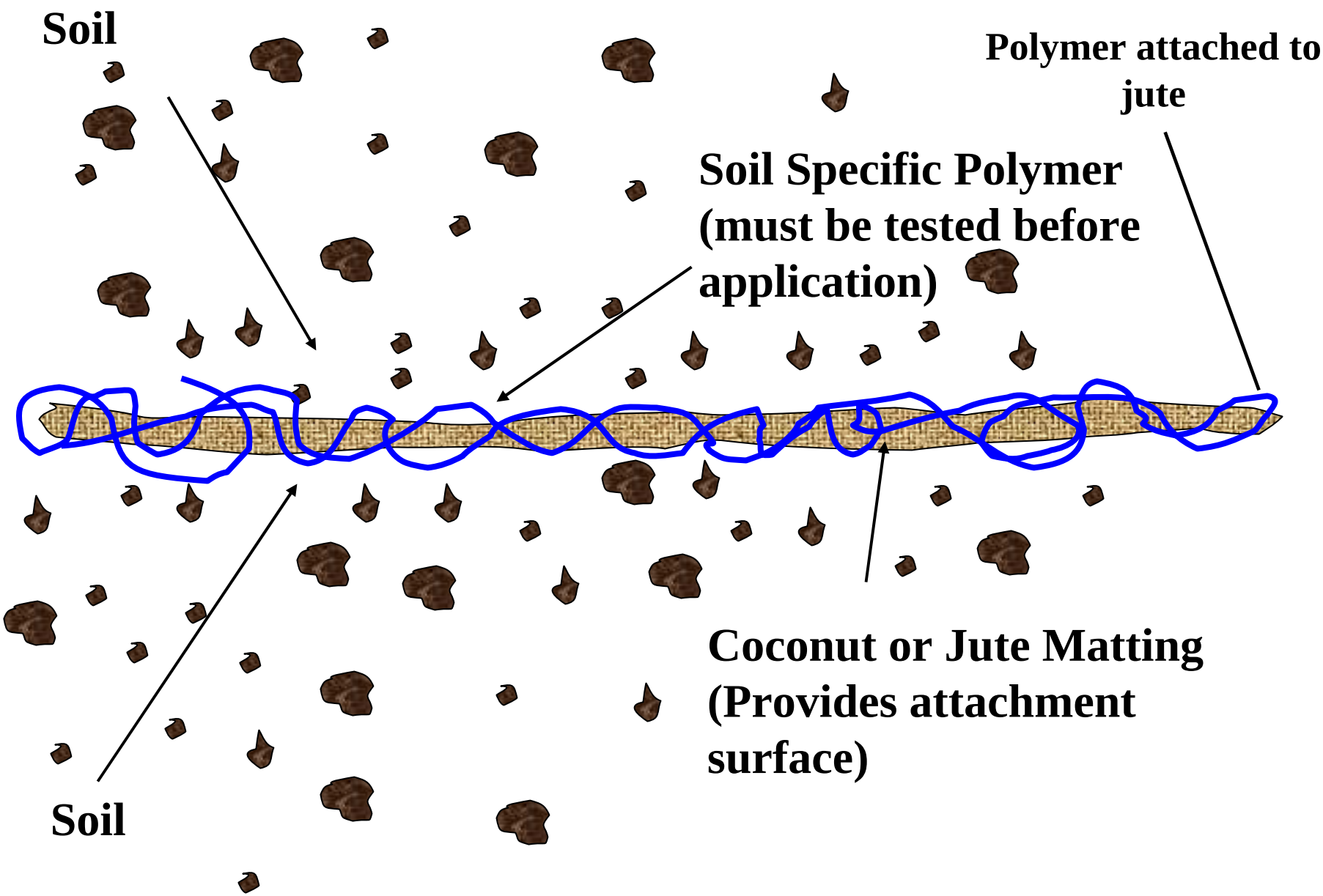
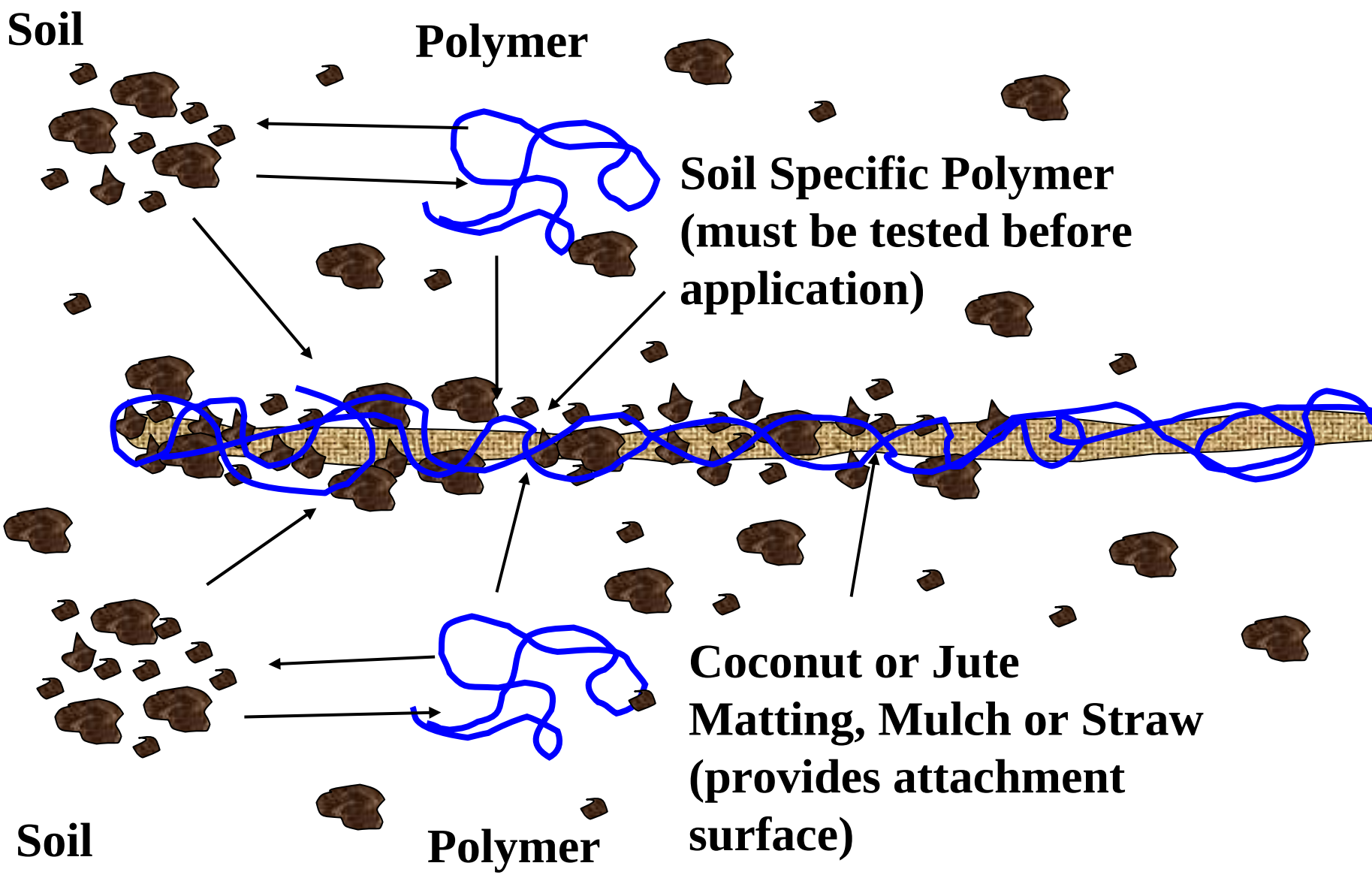
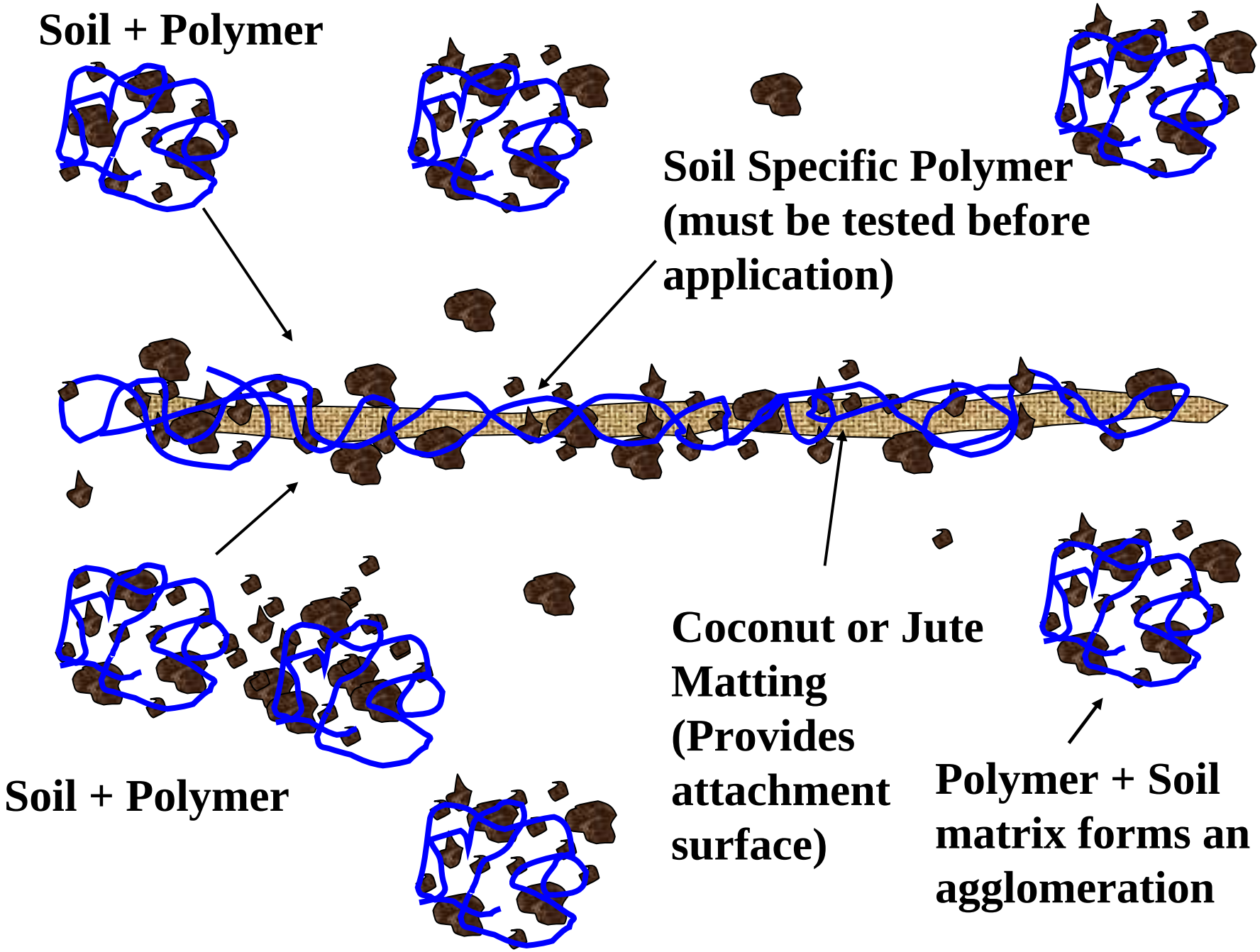
# PAM-Treated Furrow Irrigation



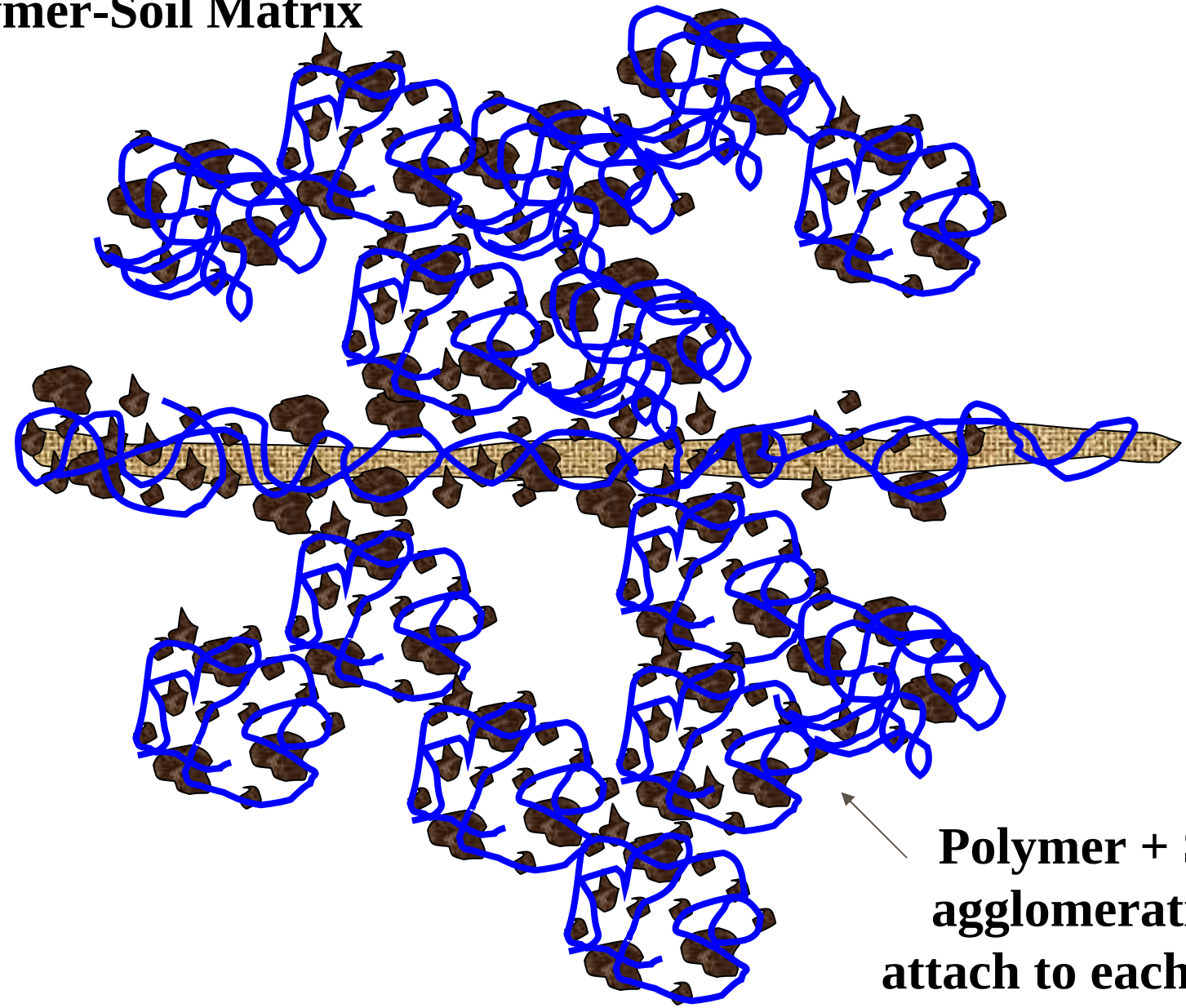

PAM Anionic
Polymer Chain
Chain bridging
between charged
soil particles
Ion bridges
between chains
Charged
Particulate
(soil)
Ca++

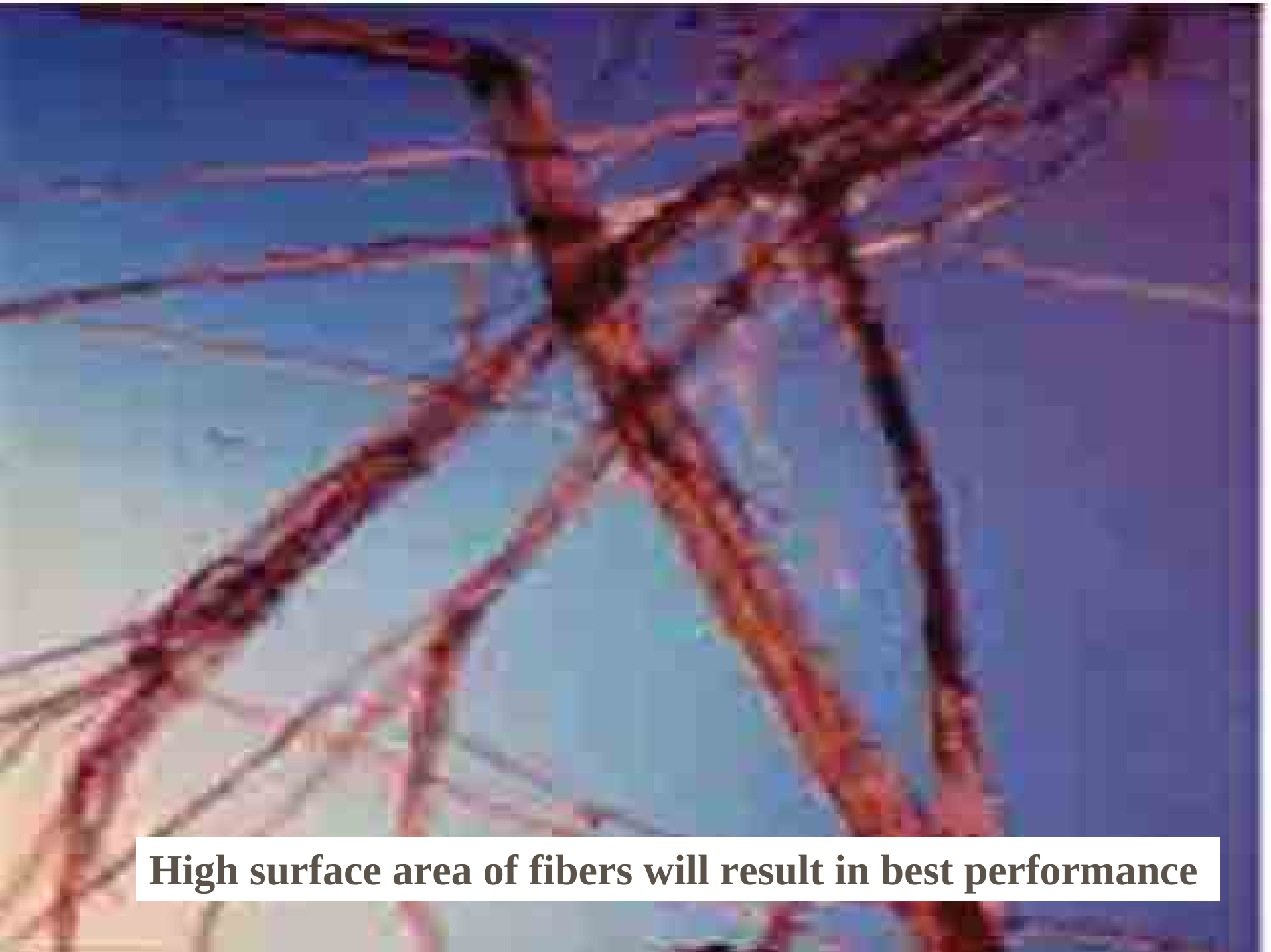

Soil
Polymer attached to jute
Soil Specific Polymer (must be tested before application)
Coconut or Jute Matting (Provides attachment surface)
Soil


Soil
Polymer
Soil Specific Polymer (must be tested before application)
Coconut or Jute Matting, Mulch or Straw (provides attachment surface)
Soil
Polymer

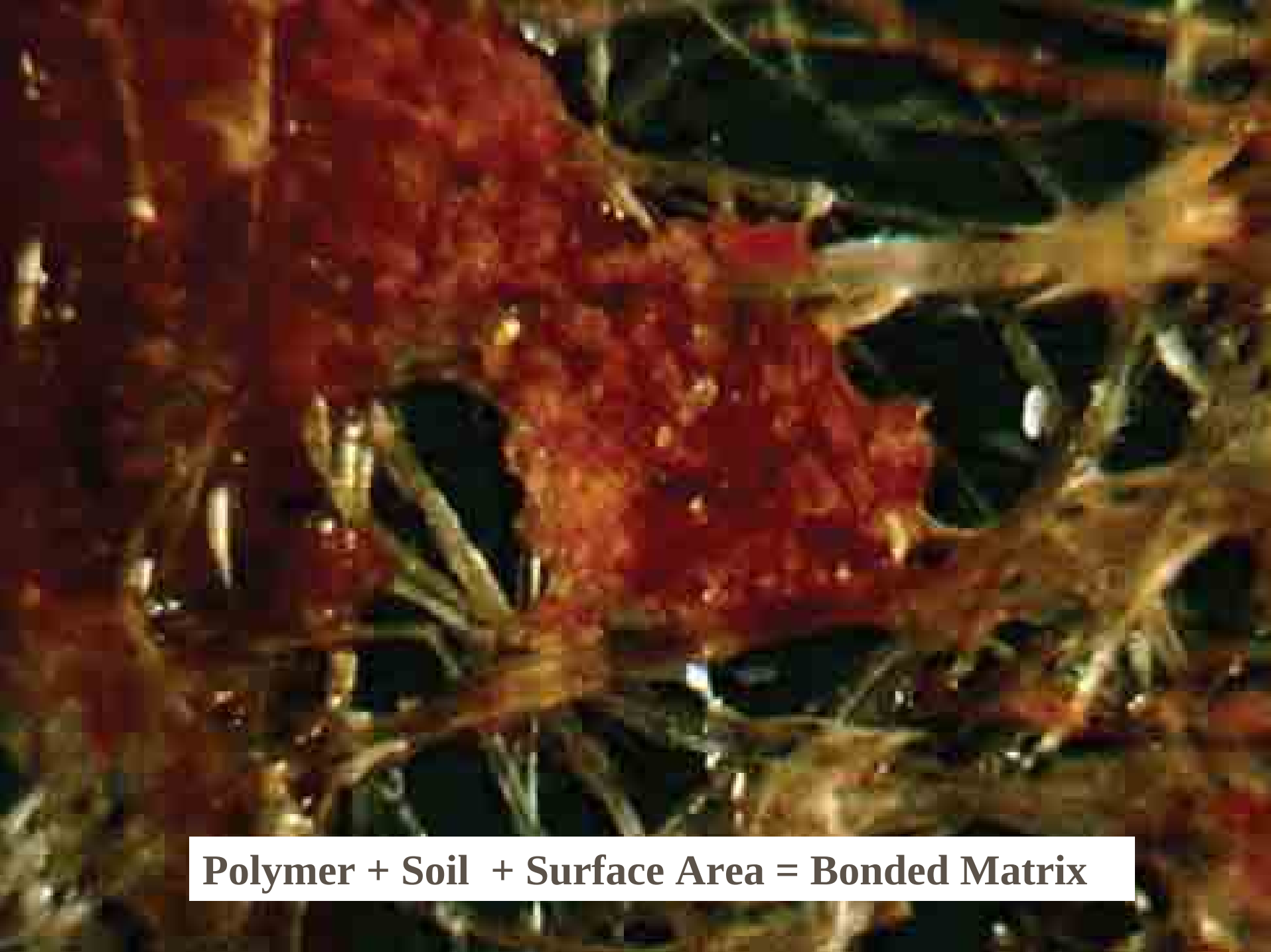

Soil + Polymer
Soil Specific Polymer (must be tested before application)
Coconut or Jute Matting (Provides attachment surface)
Polymer + Soil matrix forms an agglomeration
Soil + Polymer

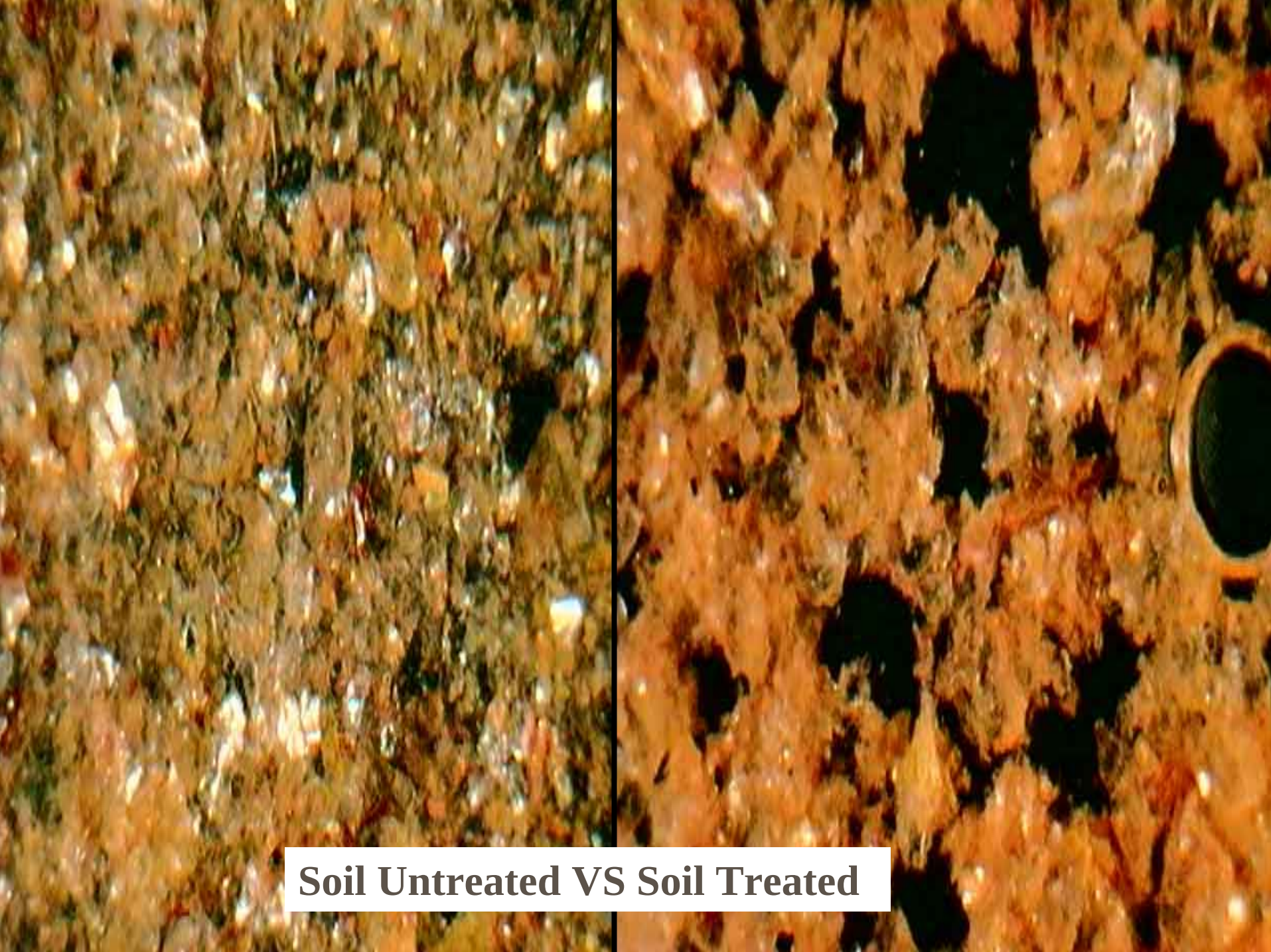
# Polymer-Soil Matrix

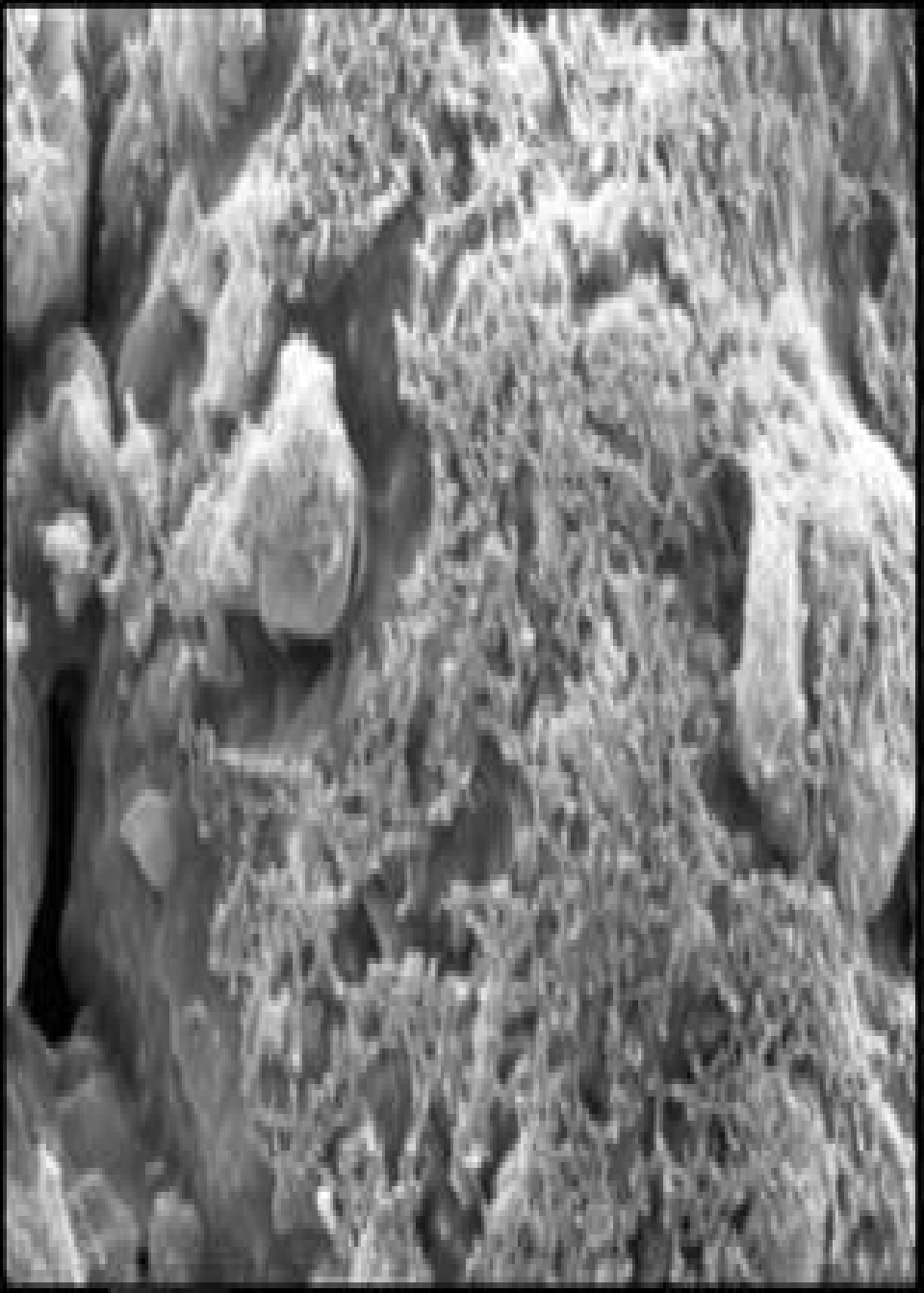


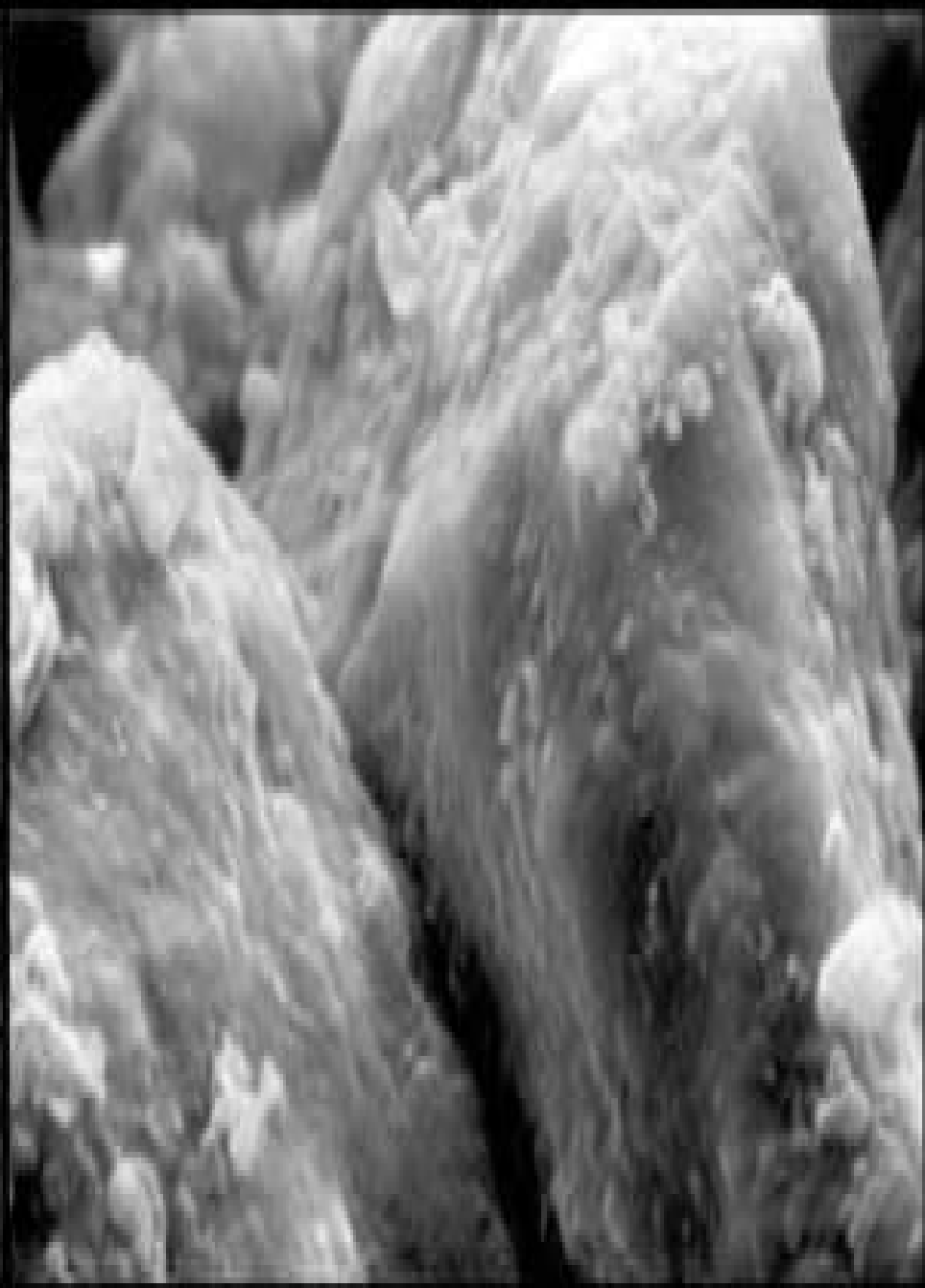


**High surface area of fibers will result in best performance**


Polymer + Soil + Surface Area = Bonded Matrix


Soil Untreated VS Soil Treated


4µM 13KV 3159 6 S


10µM 20KV 3169 2 S

High surface area matting show correct attachment of the matrix

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# Aquatic Toxicity Testing

# and

# Site Specific Testing Report

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**Senior Associate**

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# Alabama Samples

**(Silt Stop and Floc Log applications)**

| Sample | Location | Description | APS Application | Results and Special Instructions |
|---|---|---|---|---|
| | **1/17/07 Analysis by: LBS** | **Soil Type / Sample #** | **Floc Log Type** | **Reaction Time / NTU Reading** |
| | Auburn University | DOT Project | 706b (alone) | 35 sec / 16.0 NTU |
| | Department of Civil Engineering | Soil Sample (fill material) | 703d#3 + 706b (duplex) | 15 sec + 15 sec / 15.0 NTU |
| | 238 harbert Engineering Center | | | |
| | Auburn, AL 36849 | pHi- 6.90 | **Stabilization Type** | |
| | Justin McDonald | NTUi- 600 | | |
| | 334-559-3159 | Hardness- 0 ppm CaCO3 | 705 Silt Stop powder | Dry or spray application (binder / tackifier) |
| | mcdonjs@auburn.edu | (very soft) | 605 emulsion | Hydroseeding additive only |
| | | | 712 Silt Stop powder | Dry application (stormwater clarifier) |

Note: **Mixing / reaction times will be very important when using the Floc Log listed above.** All logs should be placed in a series (one after the other). The dosage rate should be **40-50 GPM flow / Floc Log** placed in a series or row. **The mixing must be continuous for the time stated to obtain the reported results.** Particulate formed may be captured by filtering through silt fence, mulch, straw, particle curtains or jute fabric after the mixing reaction has been completed. **Colder temperatures will increase reaction and mixing times using the Floc Logs stated above.**

The duplex systems require the 703d#3 Floc Log to be placed first in the system followed by the 706b Floc Log. The mixing must be continuous for the time stated to obtain the reported results. **Both logs must be used together to be effective.**

Stabilization of the soil at the source may be obtained by spreading 35-45 # pounds / acre of the 705 Silt Stop powder onto the soil surface, (can be mixed with other additives such as seed, fertilizer, etc.). The 605 emulsion may be used although the powder form of this polymer type will work better on this soil. Once the polymer is applied we suggest covering the soil with straw, mulch or matting especially in areas where water will channel. If hydroseeding, the 705 powder or 605 emulsion may be added as a final additive to the normal mix. This will perform as a stabilizer for reducing clay movement into the runoff water and as a tackifier to hold the soil/organic matrix in place.

**We suggest using both methods to assure best stormwater quality discharges. Areas where high water velocity may occur (ditch lines, swales, etc.) should be "soft armored" by placing "jute" matting flush to the ground surface then spreading the 712 powder (dry) over the jute. This will greatly reduce erosion in these areas. Any areas where water clarity is important can be stabilized using the 712 Silt Stop powder and jute matting or straw.**



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# Cationic Aquatic Toxicity Testing

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## Toxicity Studies for Chitosan (poly-N-acetyl-D-glucosamine)

| Test Species | Scientific Name | Avg Species LC50 | LC50 Std Dev | Number of Studies | Average Species Rating |
|---|---|---|---|---|---|
| Channel Catfish | *Ictalurus punctatus* | 64.5 ug/L **(0.0645 mg/L)** | 27.5 | 2 | Very Highly Toxic |
| Rainbow Trout | *Oncorhynchus mykiss* | 44.0 ug/L **(0.044 mg/L)** | 6.00 | 2 | Very Highly Toxic |

Citation: S. Orme and S. Kegley, *PAN Pestiside Database*, Pestiside Action Network, North America (San Fransisco, CA. 2006), http:www.pestisideinfo.org.

Information found at: http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC34013

Studies:
Bullock, G., V. Blazer, S. Tsukuda, and S. Summerfelt. *Toxicity of Acidified Chitosan for Cultured Rainbow Trout (Oncorfhynchus mykiss)*. Aquaculture 185(3/4): 273-280. Publication year: 2000.

Waller, D.L., J.J. Rach, W.G. Cope, L.L. Marking, S.W. Fisher, and H. Dabrowska. *Toxicity of Candidiate Molluscicides to Zebra Mussels (Dreissena polymorpha) and Selected Nontarget Organisms*. J. Gt. Lakes Res. 19(4): 695-702. Publication year: 1993.

## Comparison of Common Polymers used for Stormwater Applications

| Polymer LC50 Values (mg/L) | | | |
|---|---|---|---|
| **Polymer** | ***D. magna* 48 hr.** | ***O. mykiss* 96 hr.** | ***P. promelas* 96 hr.** |
| $Al_2Cl(OH)_5$ | > 5000 | 390 | 517 |
| DADMAC | 17.5 | 0.49 | 1.65 |
| Mimosa Bark | 258 | No Data | 1.3 |
| Chitosan | 13.7 | 1.1 | 6.4 |
| Note that the Chitosan is considered a hazardous substance according to federal Resource Conservation and Recovery Act (RCRA) standards (due to acidity, at a pH of about 4), while many synthetic polymers such as DADMAC are not RCRA hazardous. | | | |

Citation: Protech General Contracting Services, Inc. *Technical Report July 2004: Polymer Coagulants and Flocculants For Stormwater Applications*. (Napa, CA. 2004)
Information found at: www.protech-services-inc.com

| Polymer LC50 Values (mg/L) | | | |
|---|---|---|---|
| **Polymer** | ***D. magna* 48 hr.** | ***O. mykiss* 96 hr.** | ***P. promelas* 96 hr.** |
| APS 706b Floc Log | > 420 [1] | 637 [1] | > 1680 [1] |
| APS 703d Floc Log | 383 [2] | 1900 [3] | No Data |
| APS 712 powder | 1617 [2] | No Data | > 6720 [2] |

Information available at: http://www.siltstop.com/msds_toxicity_reports.html.
Citation: Third-party acute toxicity testing by certified testing laboratories following appropriate EPA protocol.

1) BioTox Laboratory, LAW Engineering & Environmental Services Inc. Kennesaw, GA.
2) BioTox Laboratory, Mactec Engineering & Consulting Inc. Kennesaw, GA.
3) Maxxam Analytics Inc. Edmonton, Alberta, CANADA.


8 min., 16 sec.
with 0.001% Chitosan

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# Metal and Nutrient Removal using

# Floc Logs®

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University of Central Florida

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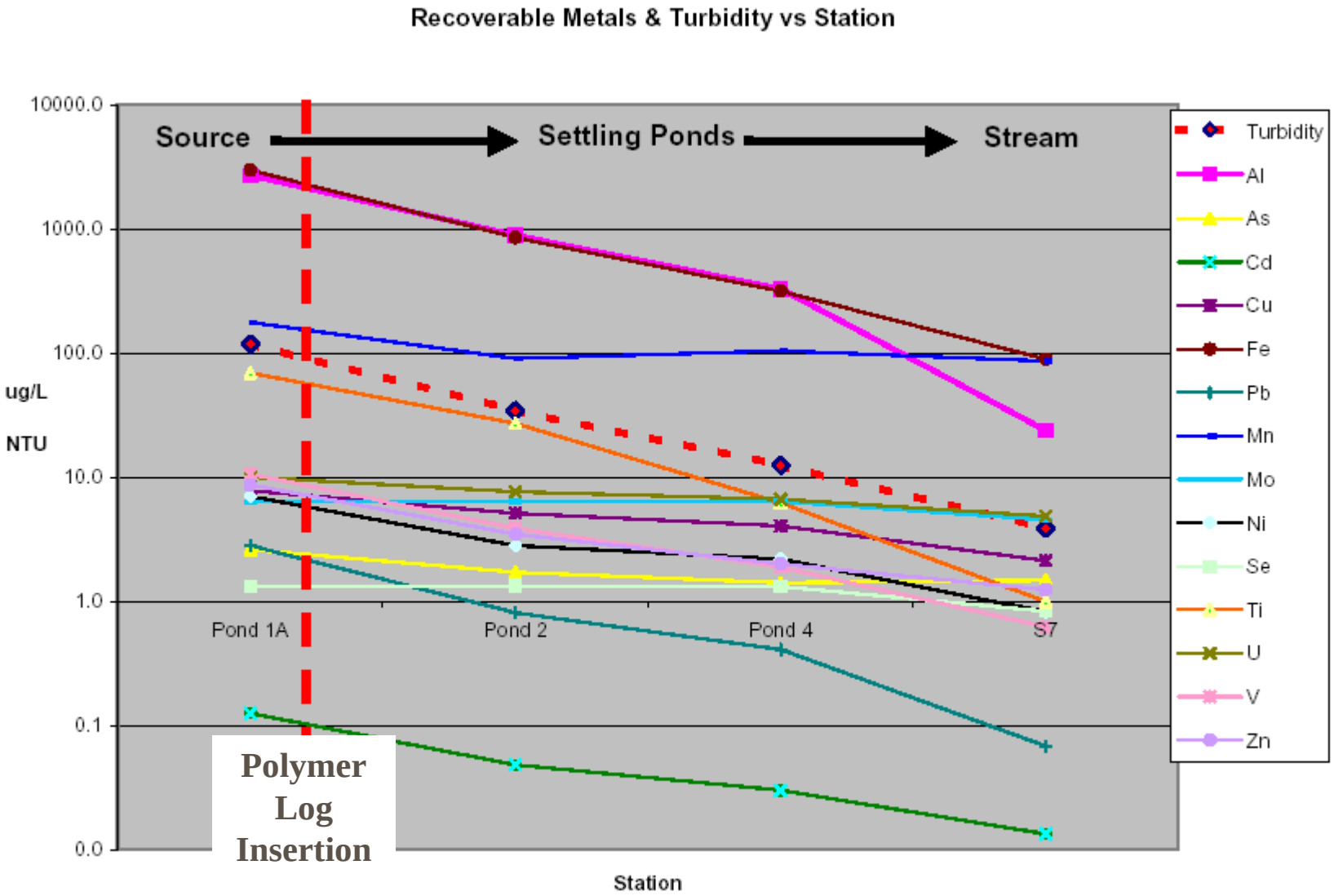
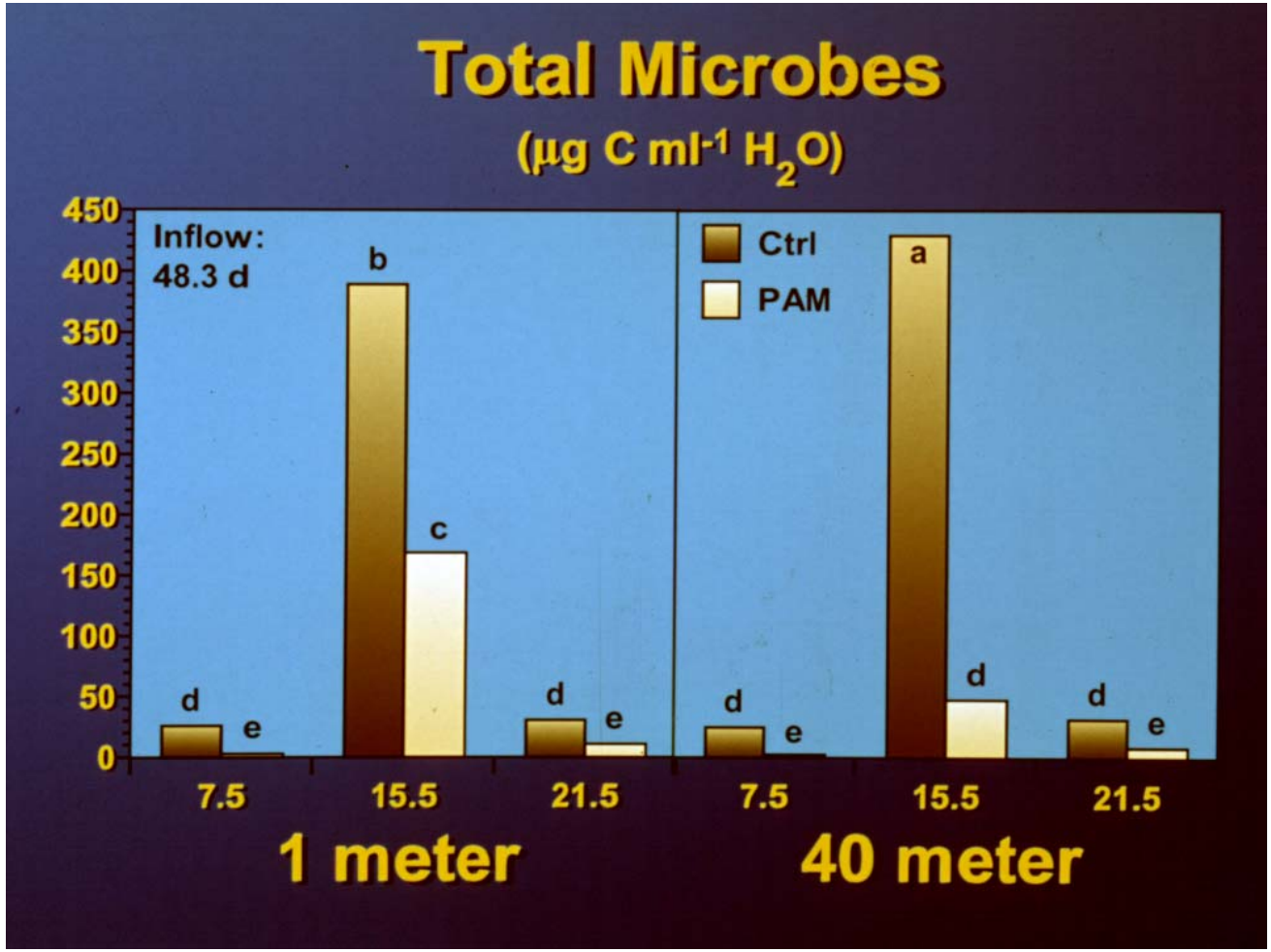


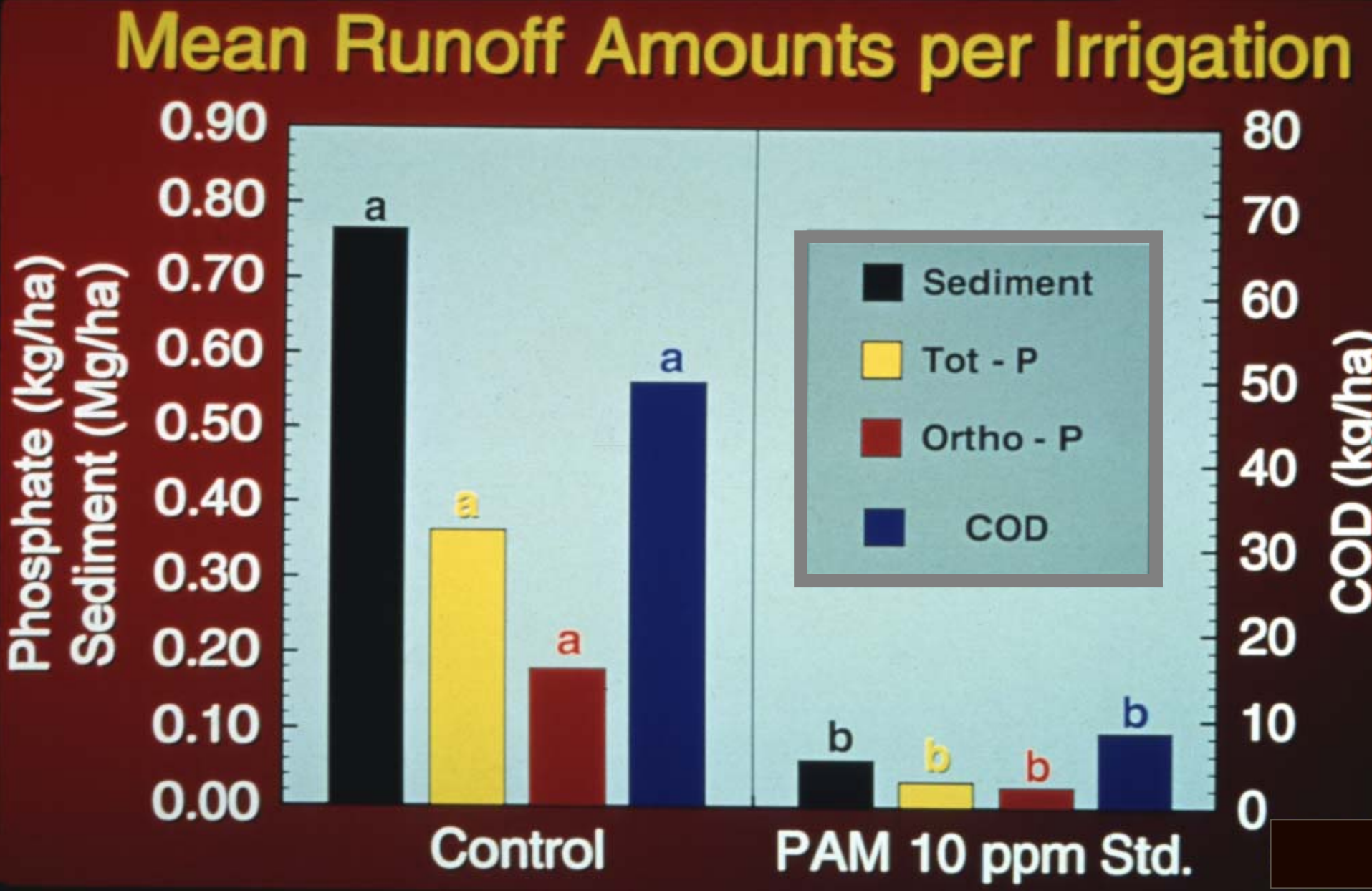

# Floc Log was able to reduce all 14 metals measured

# Implications of Microbe Removal from Runoff

- Soil-borne plant disease epidemiology
  - Less disease spread in your field
  - Less spread downstream in return flows
  - Potentially less need for pesticides




- Manuring less prone to coliform losses
  - -- Reduced hygiene threat to public waters
  - -- Potentially reduced water treatment need




**California & Idaho Research Also Show Reduced Pesticide in Runoff**

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Kimberly, ID

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# Rules of Polymer Use

1) Polymer must be non-toxic to aquatic organisms having EPA certified toxicity reports (whole product WET tests using ASTM guidelines)

2) Each site application must demonstrate 95% or better NTU reduction test reports

3) Each polymer can be unique for each application. One polymer does not work on all soils

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# Polymer Enhanced Hydroseeding

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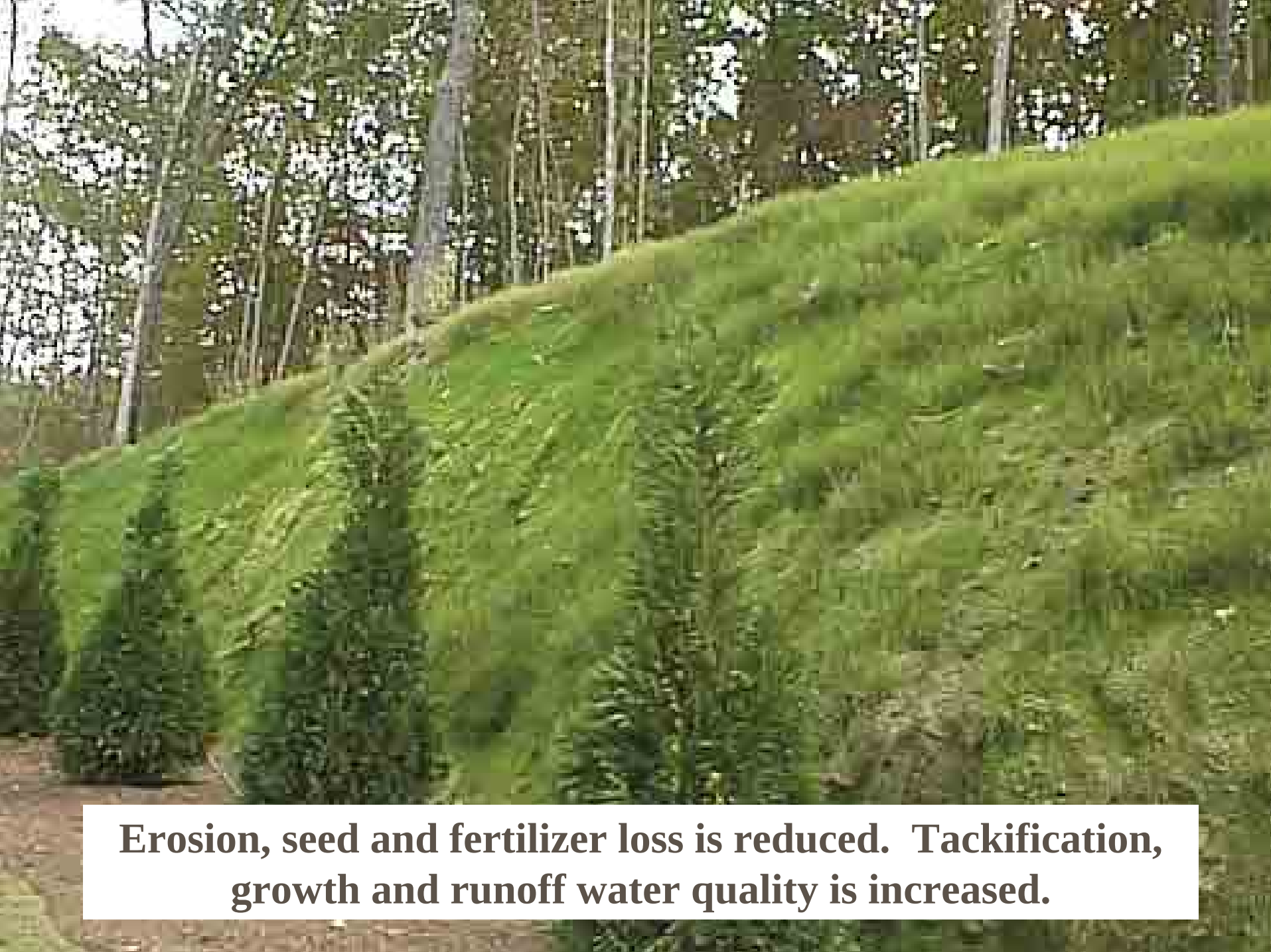
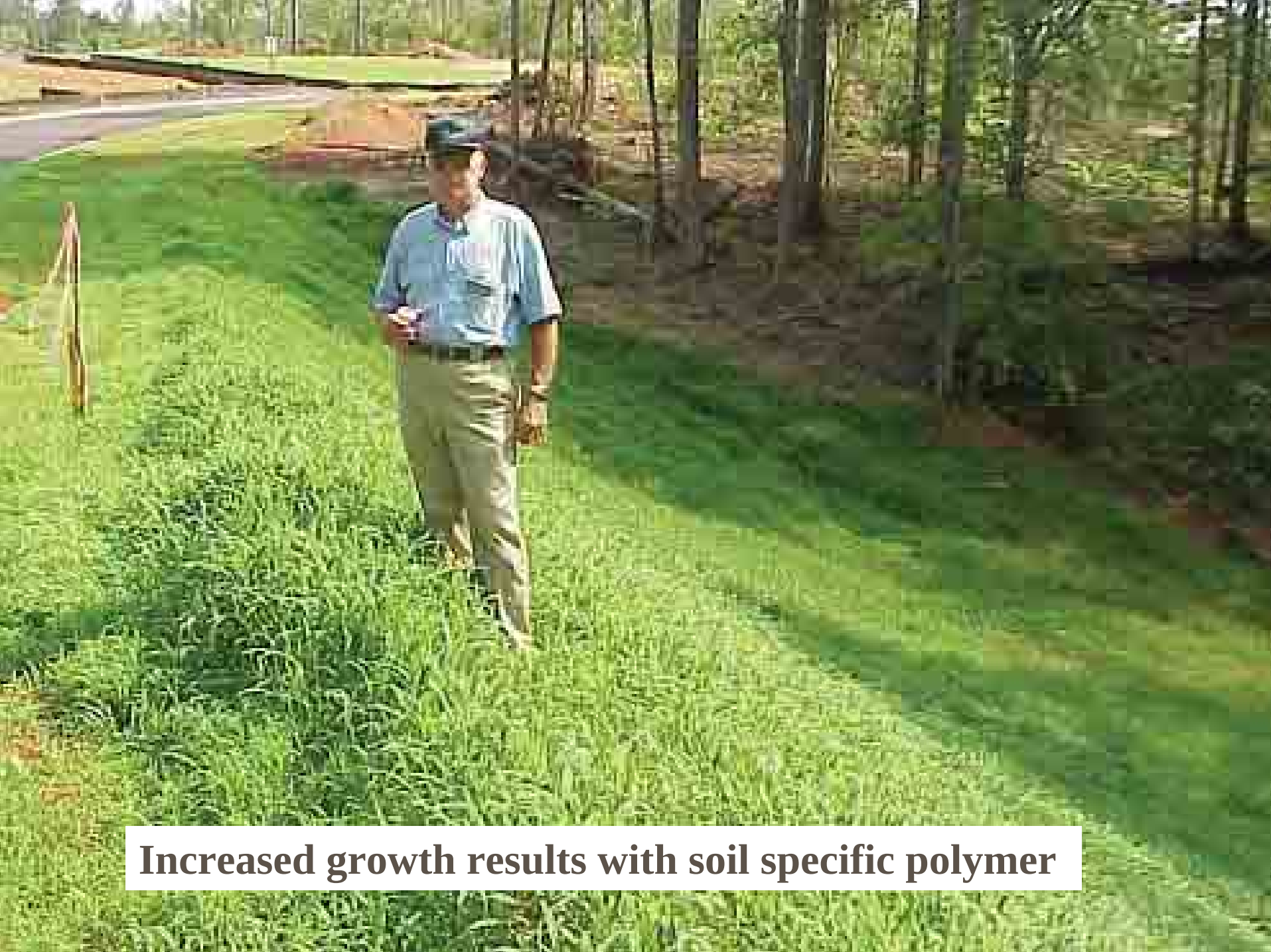
**Simply apply the “correct soil tested” polymer to any hydroseeding mix**

**Apply the hydroseeding mix containing the soil specific polymer to the application**



**Erosion, seed and fertilizer loss is reduced. Tackification, growth and runoff water quality is increased.**



**Increased growth results with soil specific polymer**

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# Polymer Enhanced Soil Stabilization

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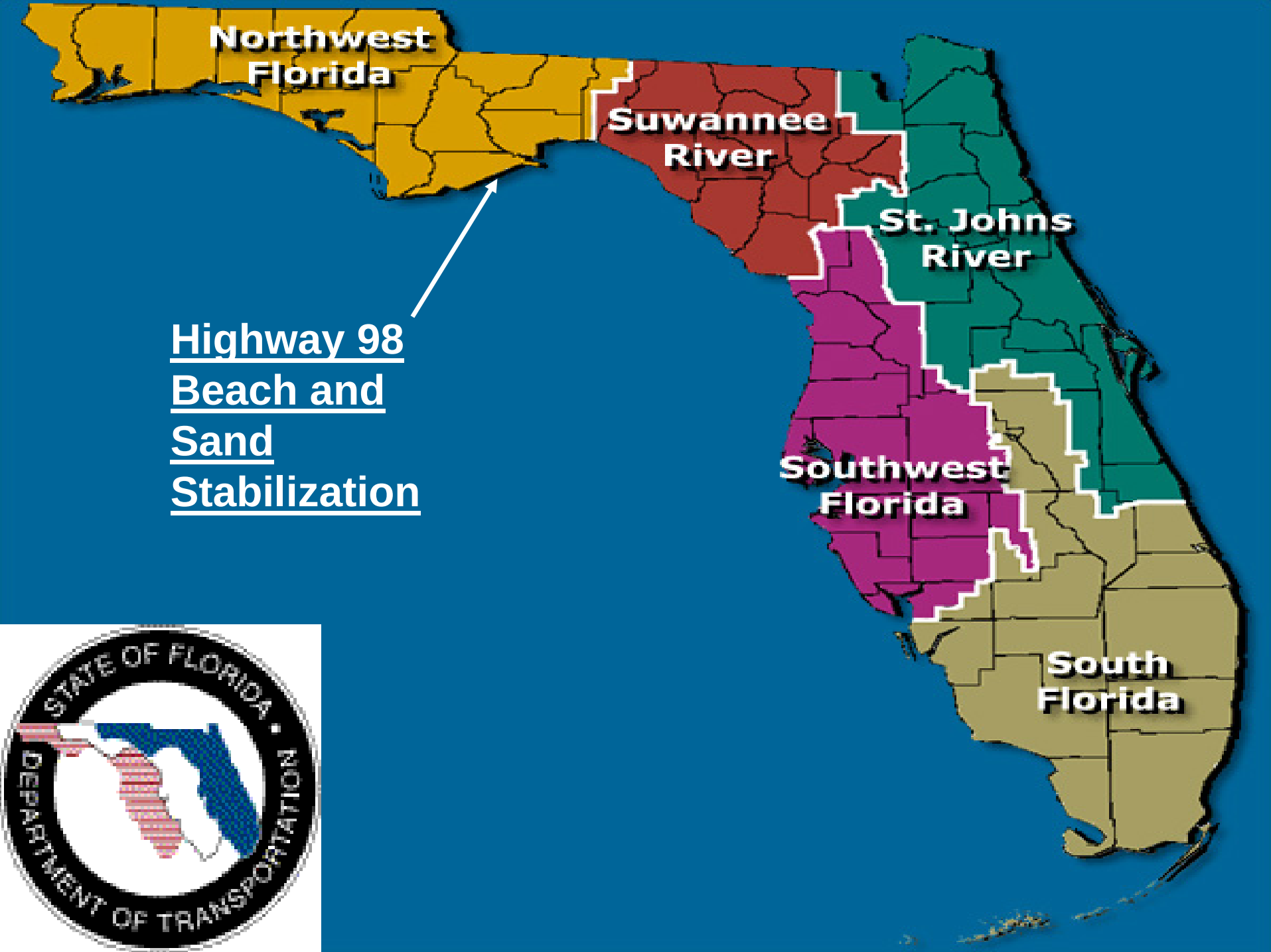
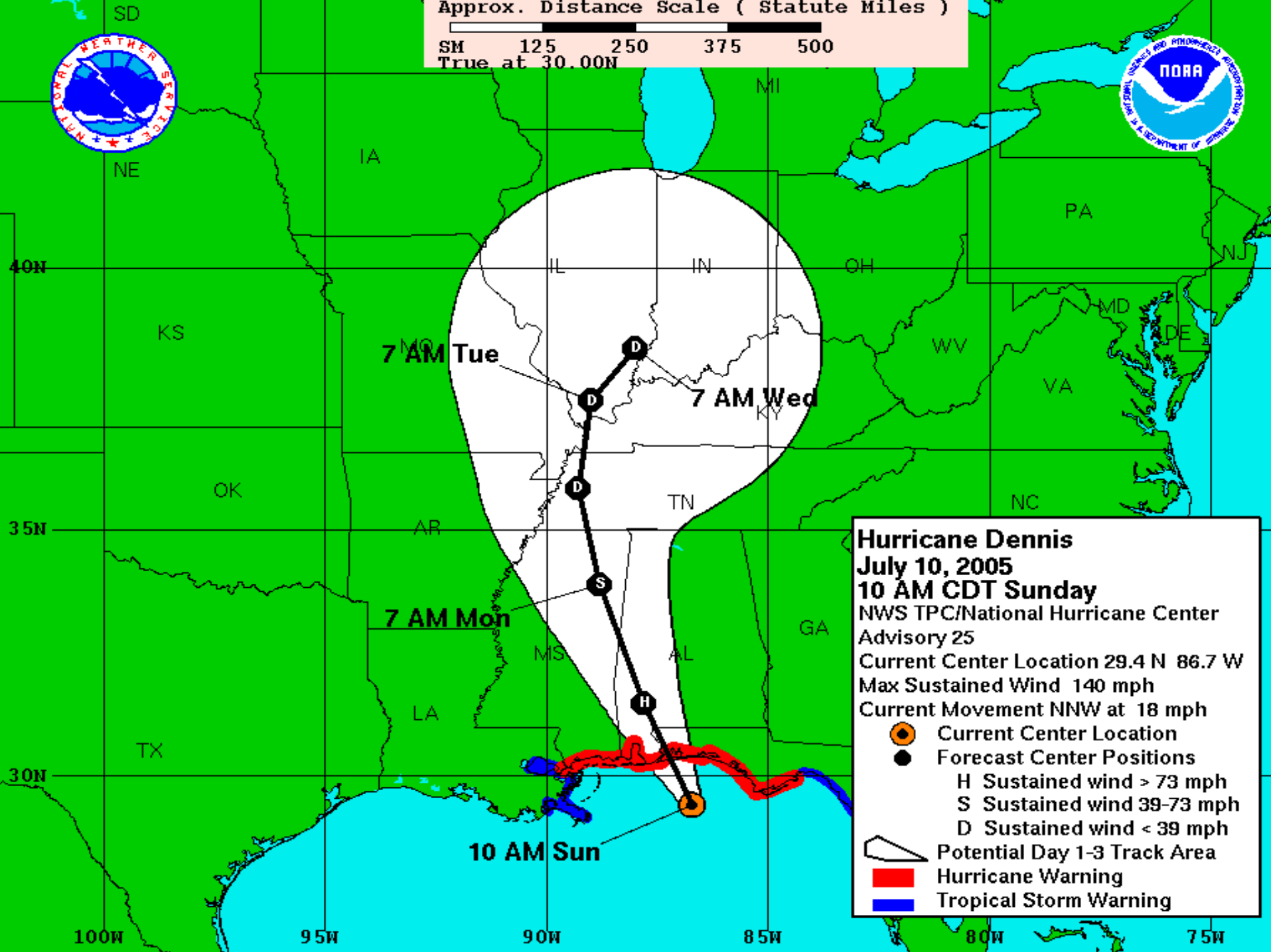
**Inlet protection can be enhanced by use of polymer enhanced soft armor applications**

**Apply jute matting with the correct soil specific polymer to reduce soil movement at the BMP**


VOLVO
05.15.2007


Northwest Florida
Suwannee River
St. Johns River
Southwest Florida
South Florida
Highway 98 Beach and Sand Stabilization
STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

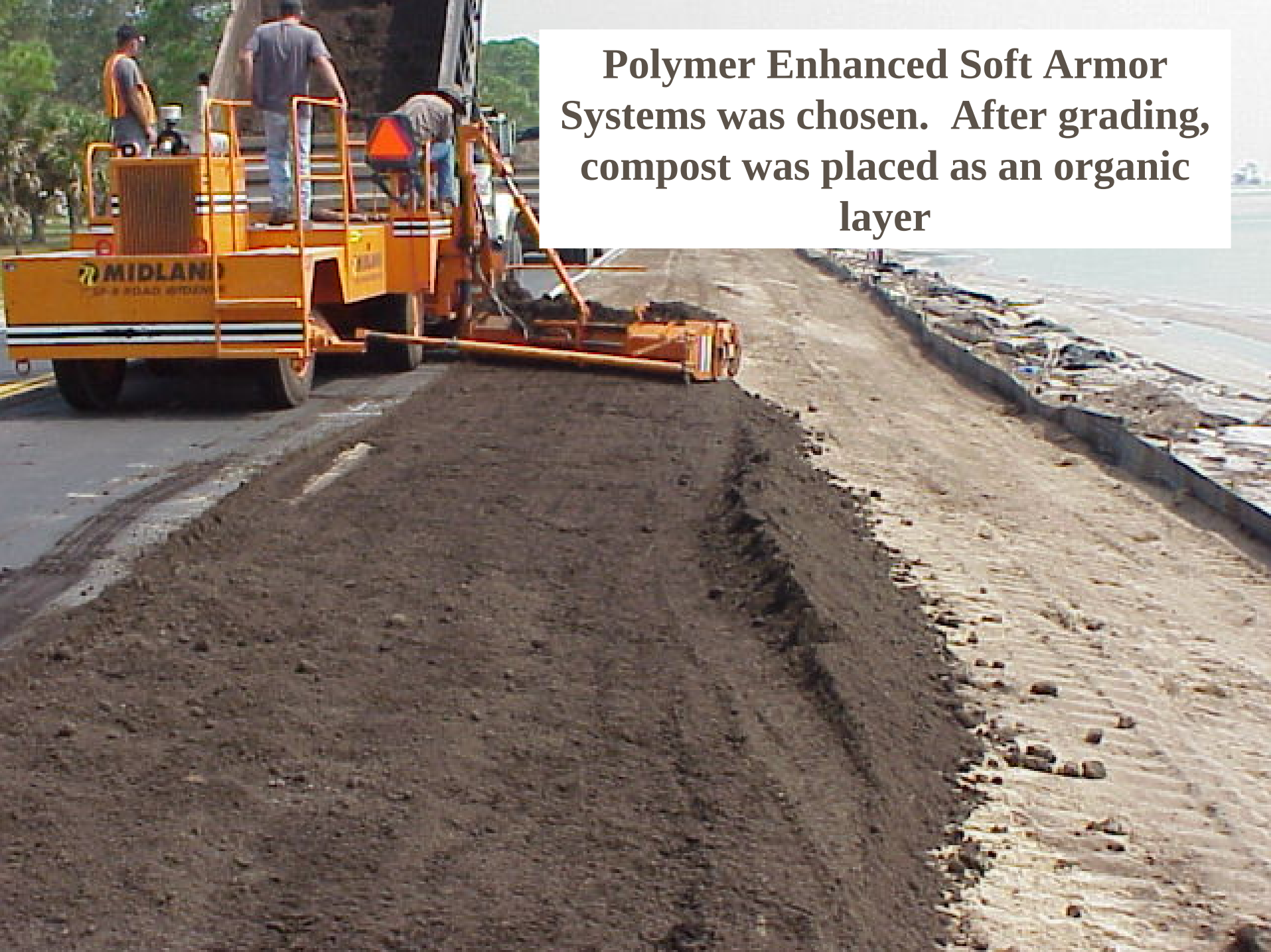

Approx. Distance Scale ( Statute Miles )
SM 125 250 375 500
True at 30.00N
SD
NE
IA
MI
PA
NJ
IL
IN
OH
MD
DE
KS
MO
WV
VA
KY
OK
TN
NC
AR
GA
MS
AL
LA
TX
40N
35N
30N
100W
95W
90W
85W
80W
75W
7 AM Tue
7 AM Wed
7 AM Mon
10 AM Sun
D
D
D
S
H
Hurricane Dennis
July 10, 2005
10 AM CDT Sunday
NWS TPC/National Hurricane Center
Advisory 25
Current Center Location 29.4 N 86.7 W
Max Sustained Wind 140 mph
Current Movement NNW at 18 mph
Current Center Location
Forecast Center Positions
H Sustained wind > 73 mph
S Sustained wind 39-73 mph
D Sustained wind < 39 mph
Potential Day 1-3 Track Area
Hurricane Warning
Tropical Storm Warning

# Highway 98 Damage by Hurricane Dennis

# July 2005 (Carabelle to Eastpoint)

# Highway 98 Repair - Carabelle to Eastpoint

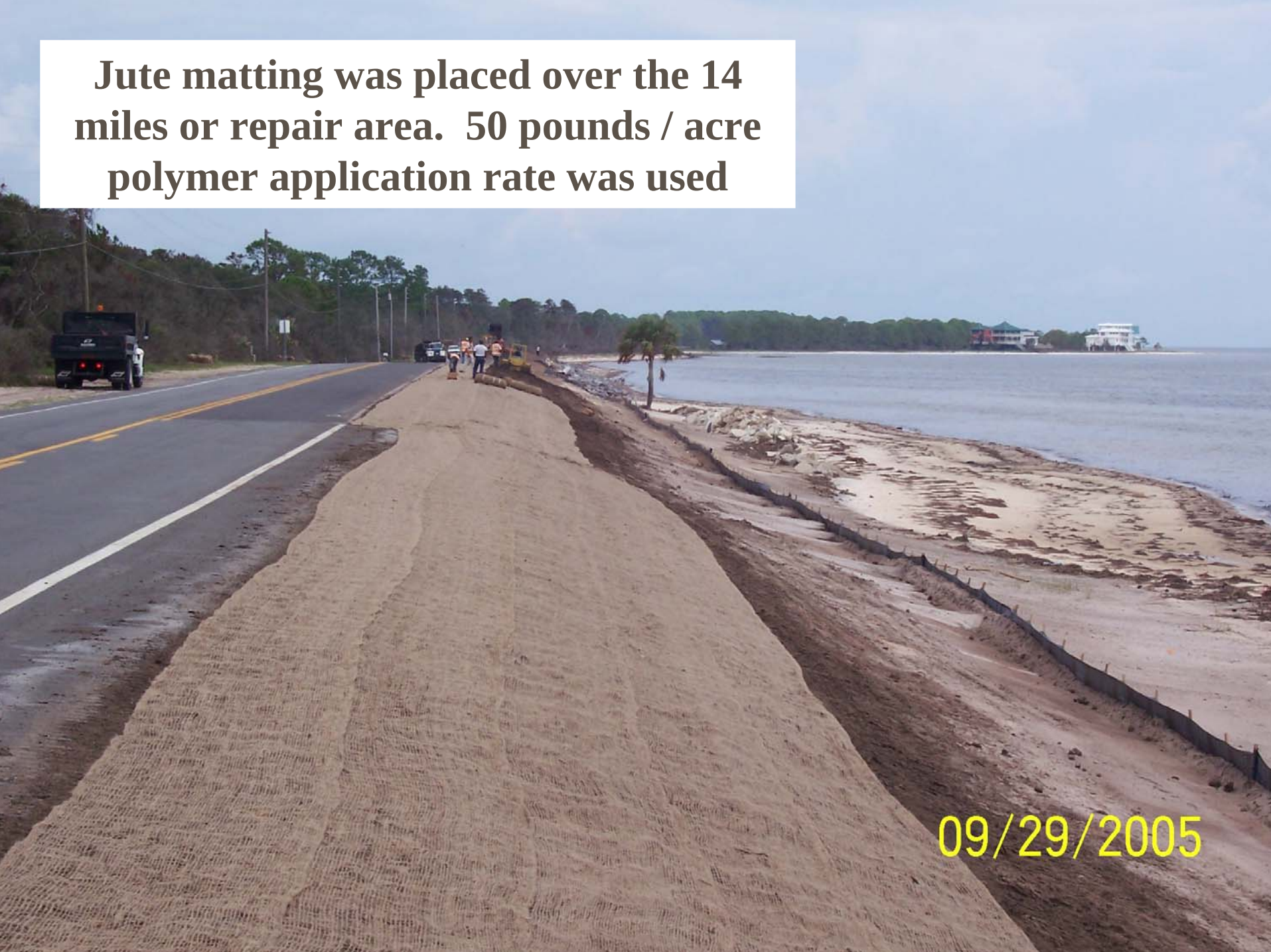
**Erosion after initial repair required an industrial BMP that would work on beach sands**




**Polymer Enhanced Soft Armor Systems was chosen. After grading, compost was placed as an organic layer**

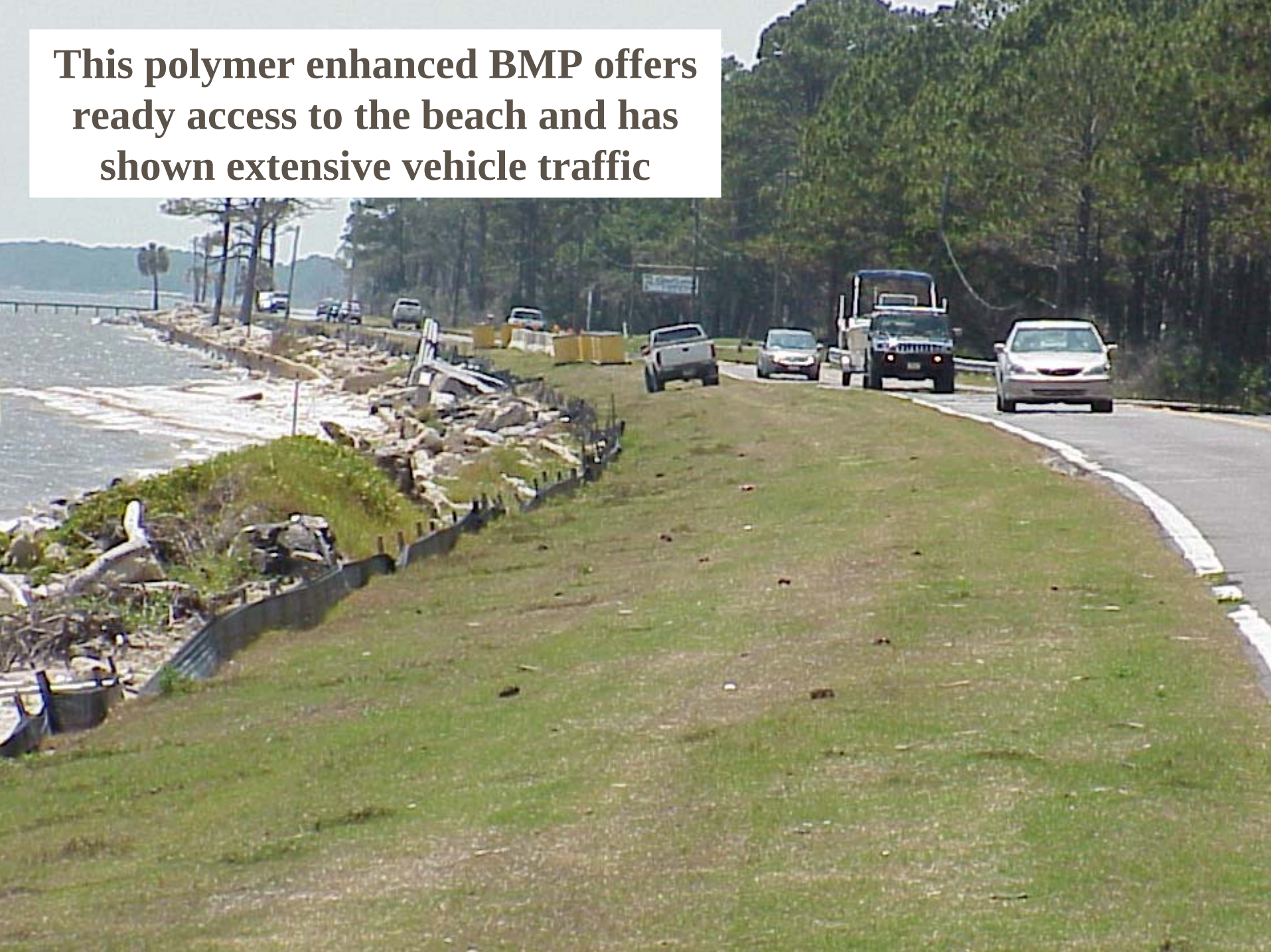
**Jute matting was placed over the organic layer as a binding media for attachment of the polymer, sand and soil**

**Jute matting was placed over the 14 miles or repair area. 50 pounds / acre polymer application rate was used**

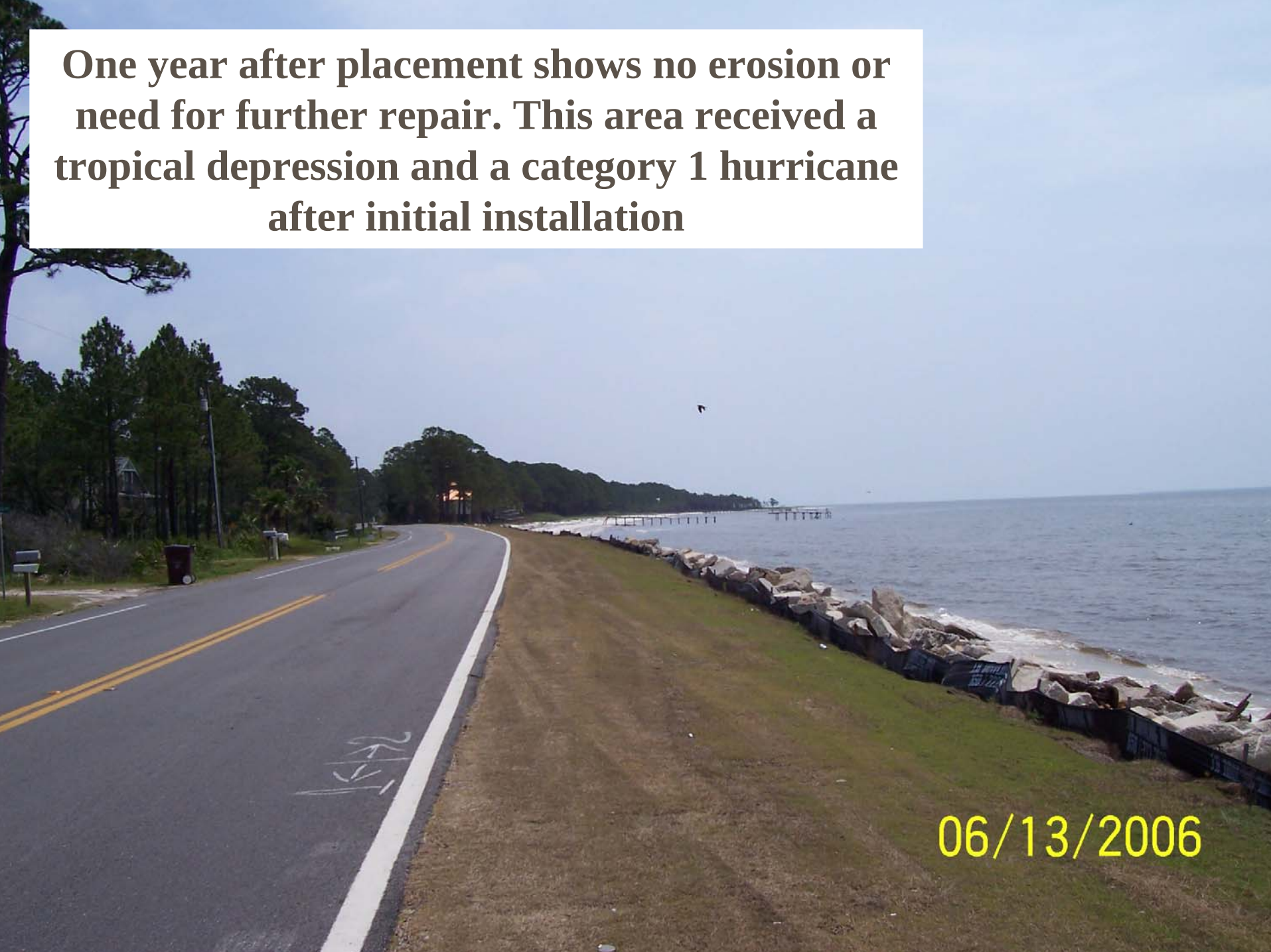


**Application of the correct soil specific polymer to the matting using a seed spreader**

**Sod was placed over the polymer enhanced BMP**


This polymer enhanced BMP offers ready access to the beach and has shown extensive vehicle traffic

**One year after placement shows no erosion or need for further repair. This area received a tropical depression and a category 1 hurricane after initial installation**



**After 16 months, no erosion can be found over the 14 miles showing that beach sands can be stabilized even under hurricane conditions**

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# Polymer Enhanced Rock Check Dams

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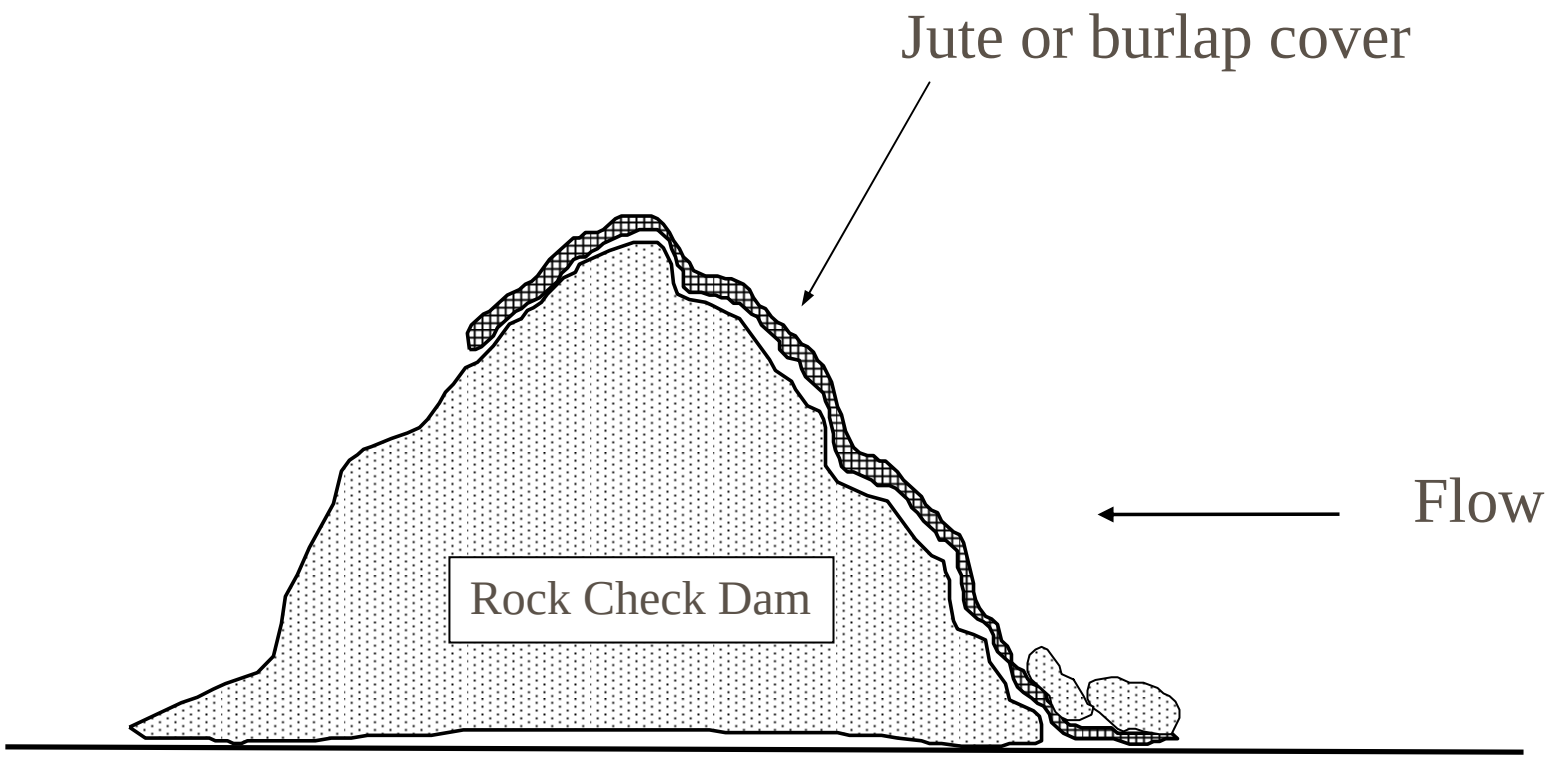
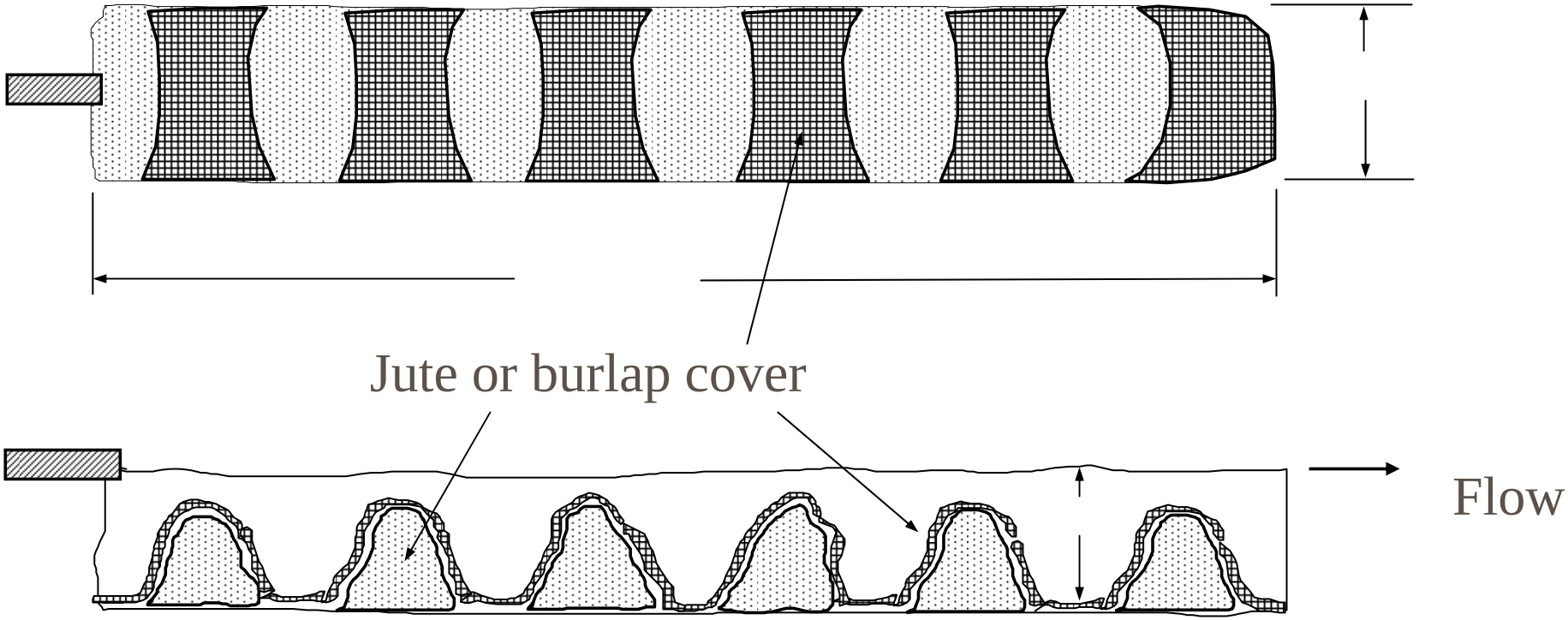



**Apply the correct soil specific polymer to the matting**




**The greater the systems in series the greater the performance and cleaner the water quality**

**Fine sediment and silts move through these BMPs and enter the water ponds or streams**

**Apply jute matting to the rock check. The matting provides a surface area for attachment of soil-polymer matrix**

Apply the correct soil specific polymer to the matting

**Notice how the fine sediments become attached to the matting reducing the impact at the ponds and streams**

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# Silt Fence use during Grading Phase

# Silt fence Retention Barrier (SRB)

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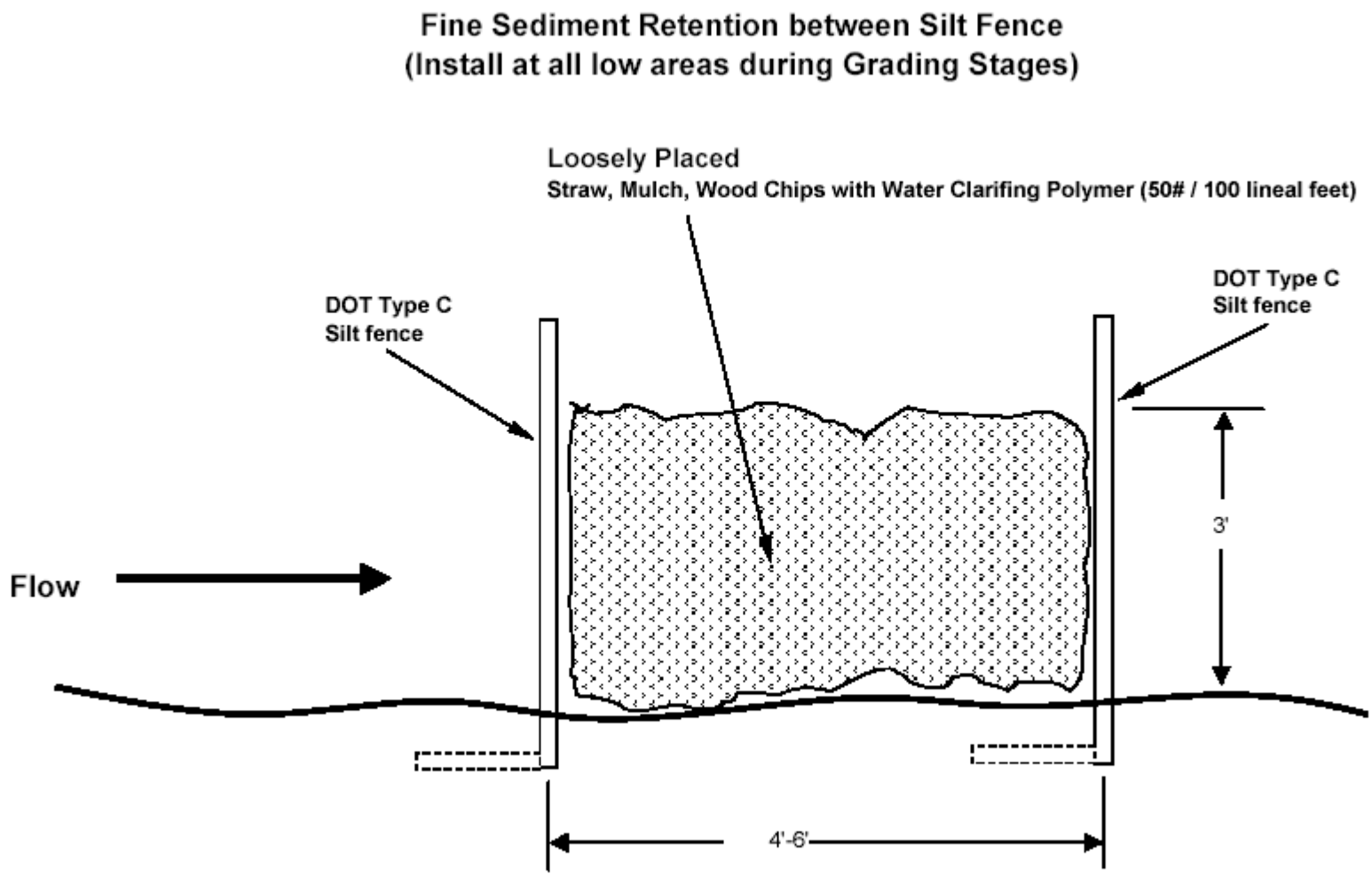
# Silt Fence can easily be used as a water quality device




See SRB applications on the APS web site

Silt fence alone cannot prevent fine sediment loss


05.15.2007


05.15.2007

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# Floc Log® Mixing and Dewatering Systems

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# Floc Logs used in dewatering system for water clarification

**Correct Floc Log placement showing good protection to prevent burying**

# Typical dewatering system showing particle collection and clear water


Dewatering systems can be set up easily

**Simply apply a water proof cover and add the correct Floc Log type**

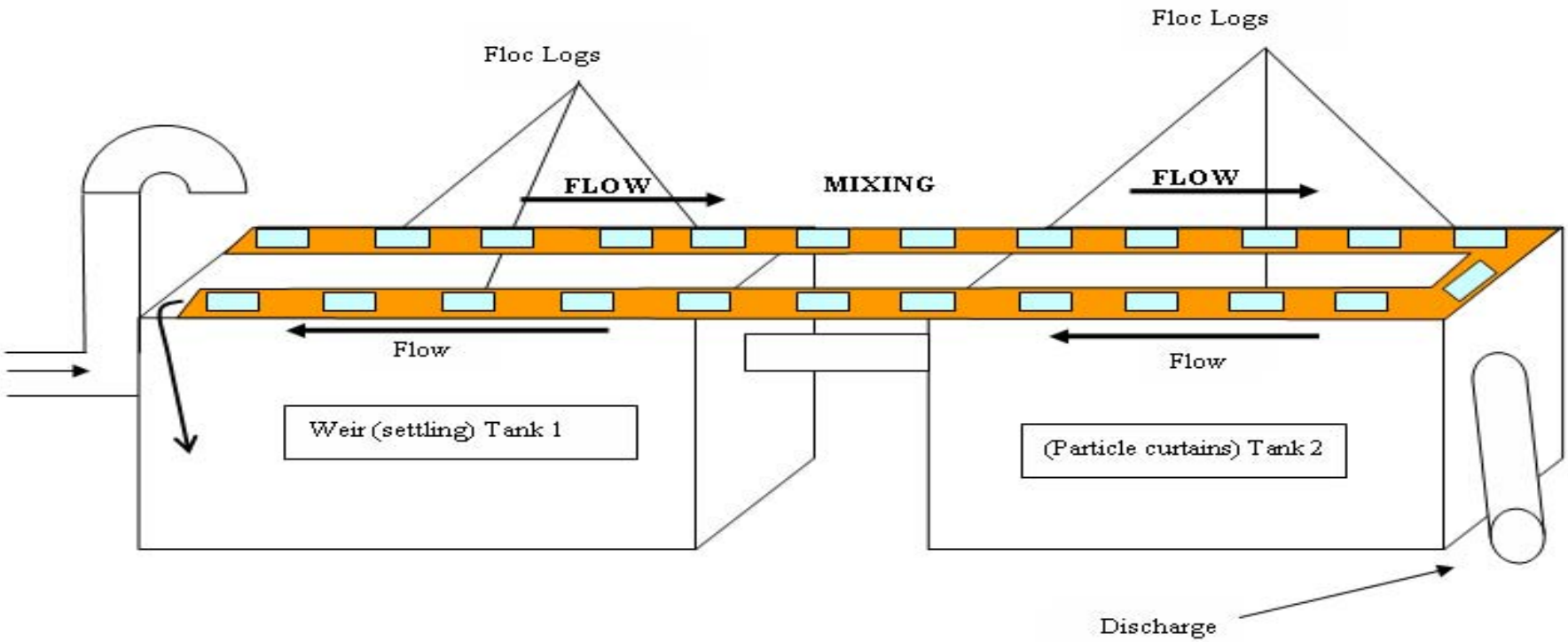
**Apply the particle collection fabric at the end of the treatment system**

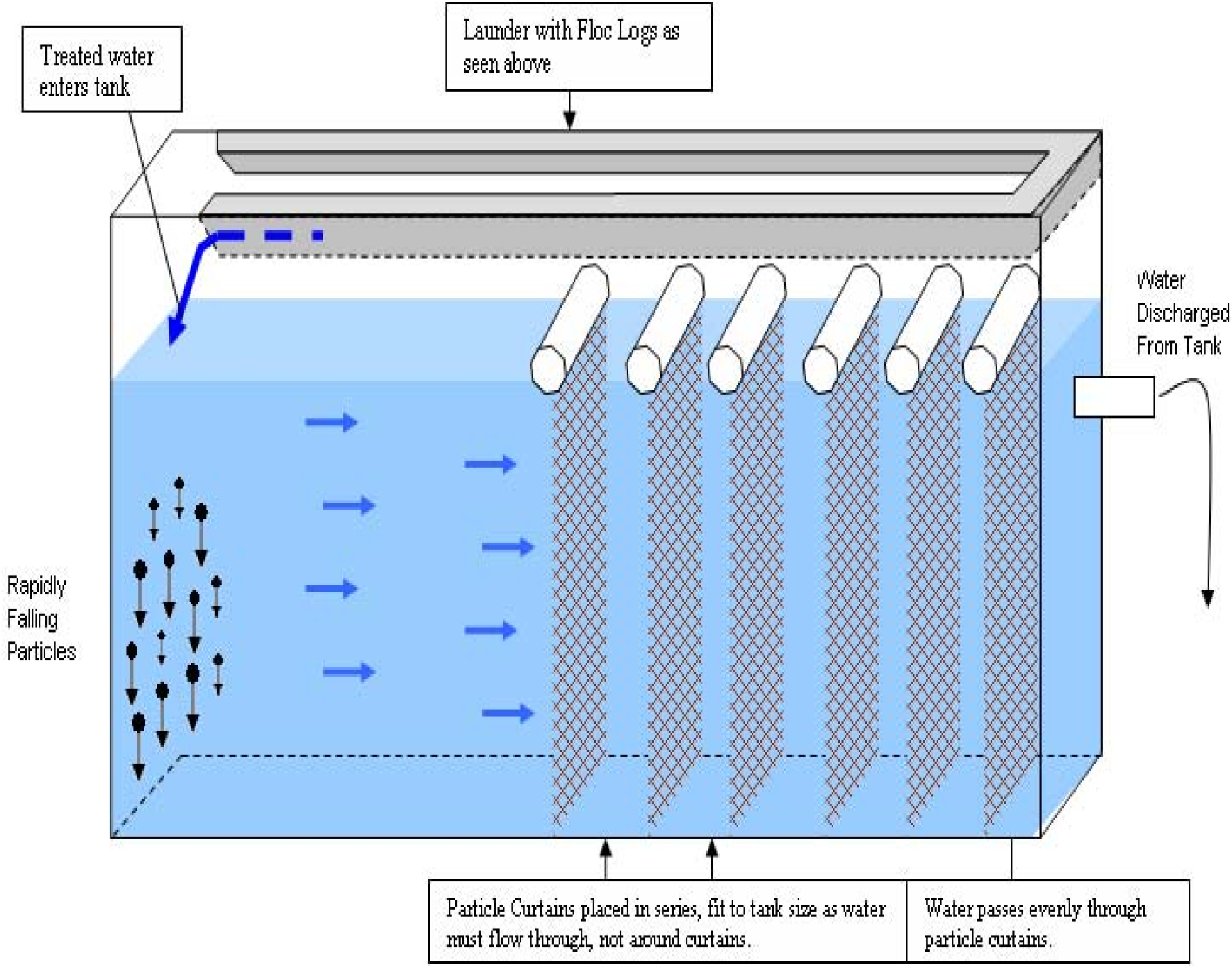

Pump the turbid water into the treatment system

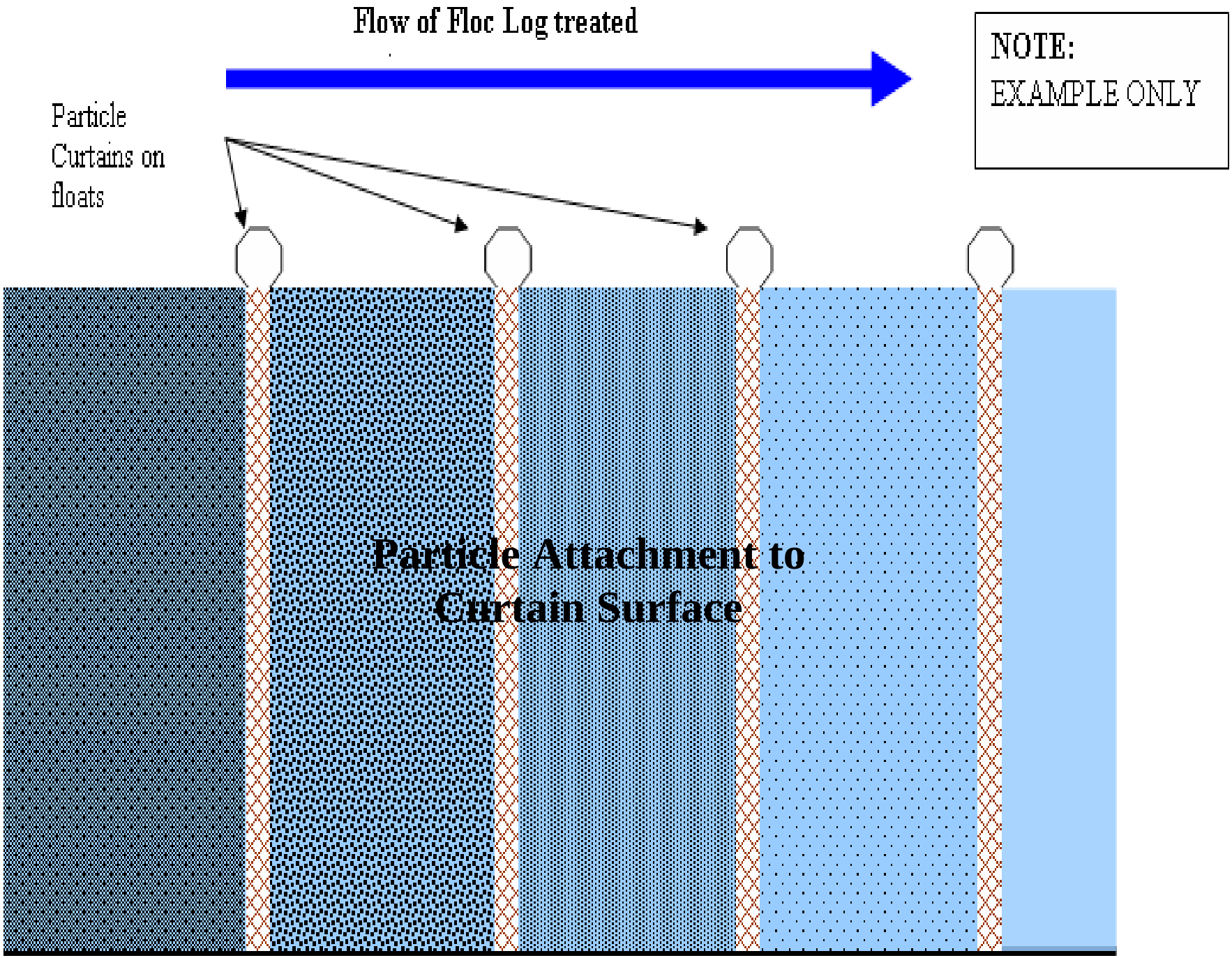
Mixing is required as shown in the narrow portion of the system

Water clarity at the end of the system

**Discharge water here shows 2.1 NTU starting with greater that 800 NTU**


Floc Logs
Floc Logs
FLOW
MIXING
FLOW
Flow
Flow
Weir (settling) Tank 1
(Particle curtains) Tank 2
Discharge


Treated water enters tank
Launder with Floc Logs as seen above
Water Discharged From Tank
Rapidly Falling Particles
Particle Curtains placed in series, fit to tank size as water must flow through, not around curtains.
Water passes evenly through particle curtains.


Flow of Floc Log treated
NOTE:
EXAMPLE ONLY
Particle
Curtains on
floats
Particle Attachment to
Curtain Surface

# Kentucky Lake Project
# Tennessee Valley Authority
# (TVA)

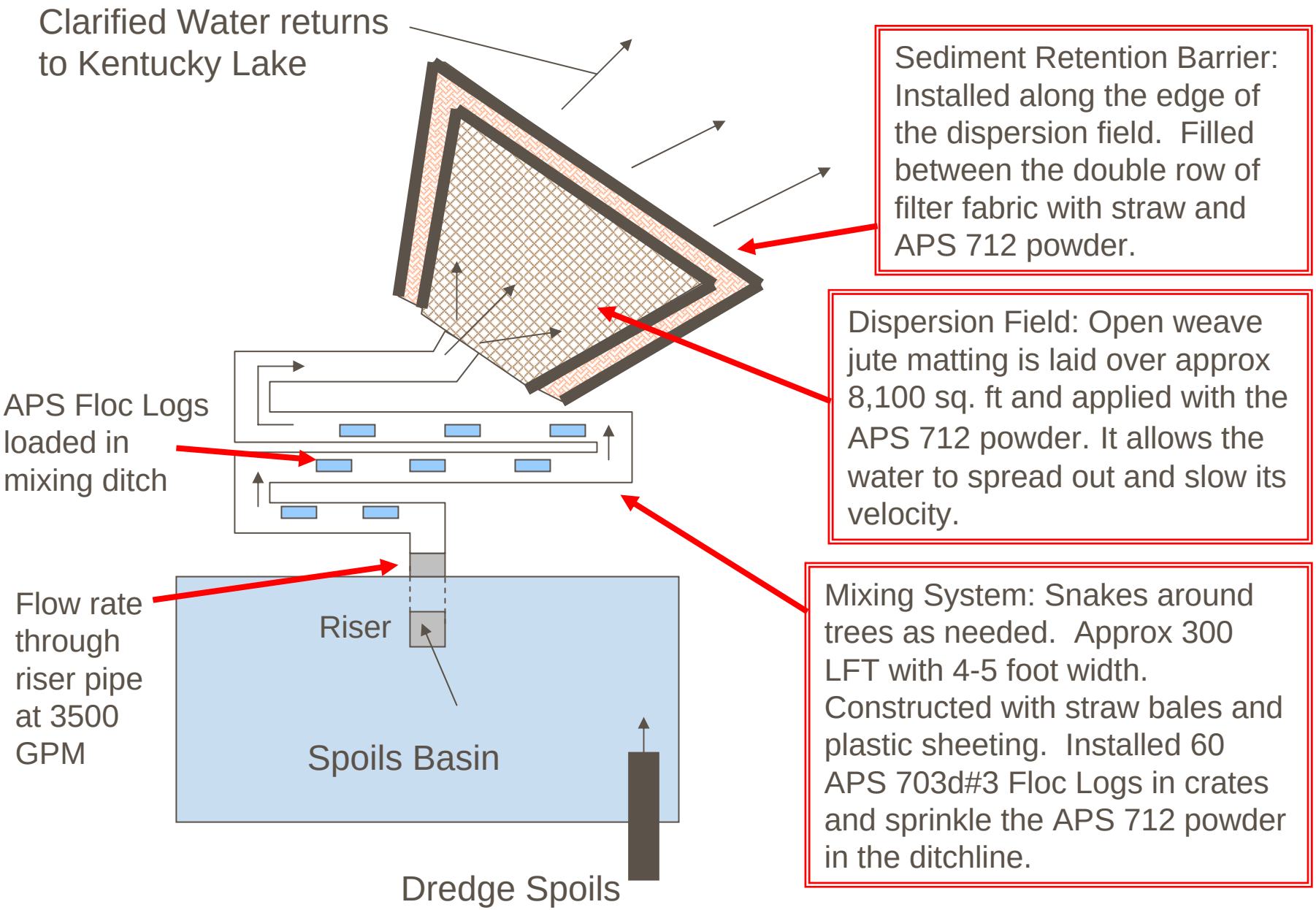
**In Henry County, TN**

**Spring 2007**

**The dredge spoils discharged to a stilling pond which discharged through a flashboard riser.**

**The water discharged from the riser into a wooded wetland area (TVA owned) and eventually back to Kentucky Lake. Complaints of deposits of clay fines in the wetlands and concerns about erosion caused the project to be shut down by TDEC.**

# Kentucky Lake Project, Dewatering Treatment System Diagram



**Straw bales are lined up 4-5 feet apart to build the sides of the mixing ditch.**

**Plastic sheeting is laid over the straw bales to create the mixing ditch.**

**The Sediment Retention Barrier is created using a open weave material that allows the water to flow through it at a rate of 100 GPM/sq. ft.**

**The SRB contains a loose organic fill material (straw) mixed with the APS 712 powder.**

**A layer of open-weave jute matting covers the dispersion field. The matting provides a surface area for the bulk of the particulated sediment to adhere to.**

**The 703d#3 Floc Logs are installed in crates and secured into the mixing ditch.**

**The dredge pump is turned on, and the spoils are discharged into the basin.**

**The water enters the mixing ditch at 3,500 GPM and reacts with the Floc Logs.**

**The turbulence in the mixing ditch allows the dissolving polymer to react with the suspended sediment, causing it to flocculate together into particulate.**

**The water spreads out in the dispersion field which slows the velocity.**

The particulate adheres to the jute matting.

**The water leaving the SRB is clarified.**

Clarified water on its way back to the lake

**Clarified water is returned to the lake with no aquatic toxicity potential**

Cobb County Soil & Water Conservation District

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www.siltstop.com

# Aeration Systems for Turbidity and Nutrient Control

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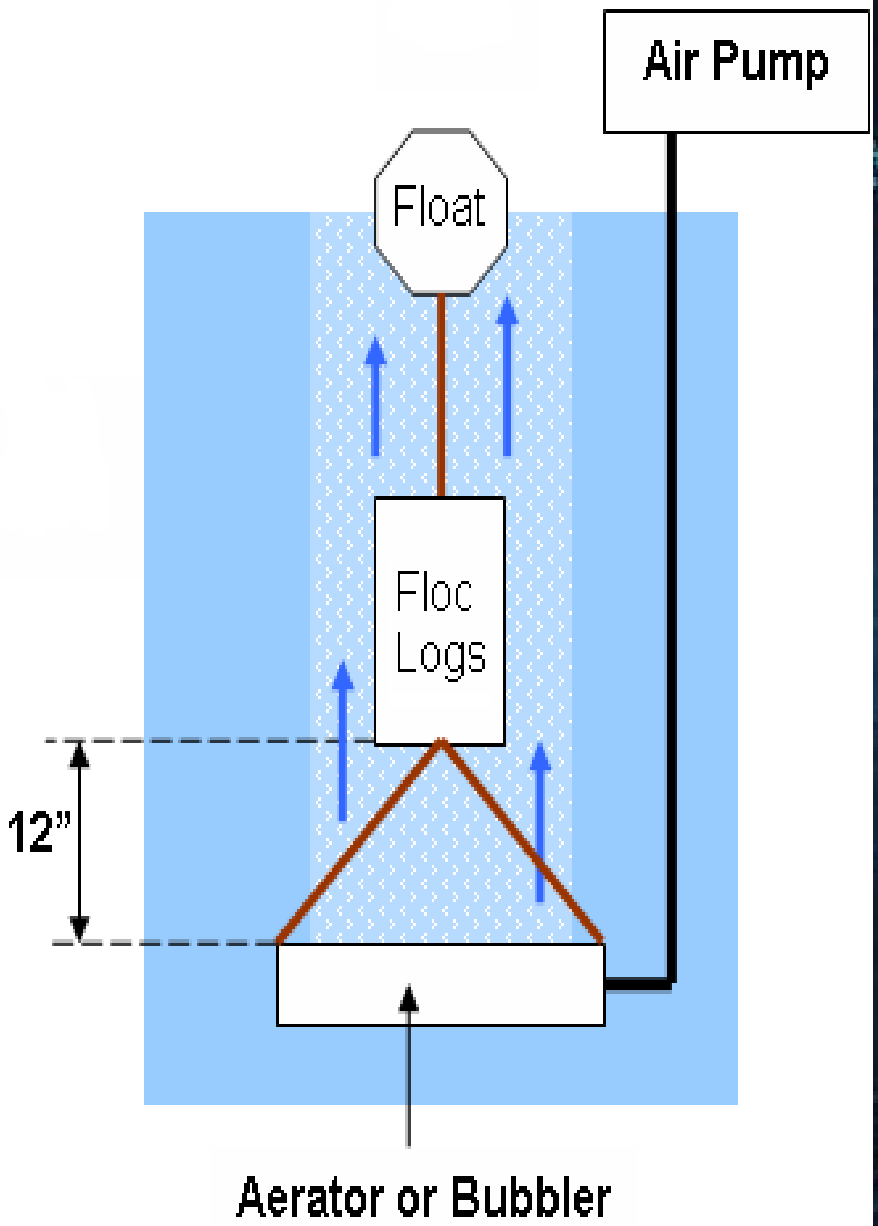
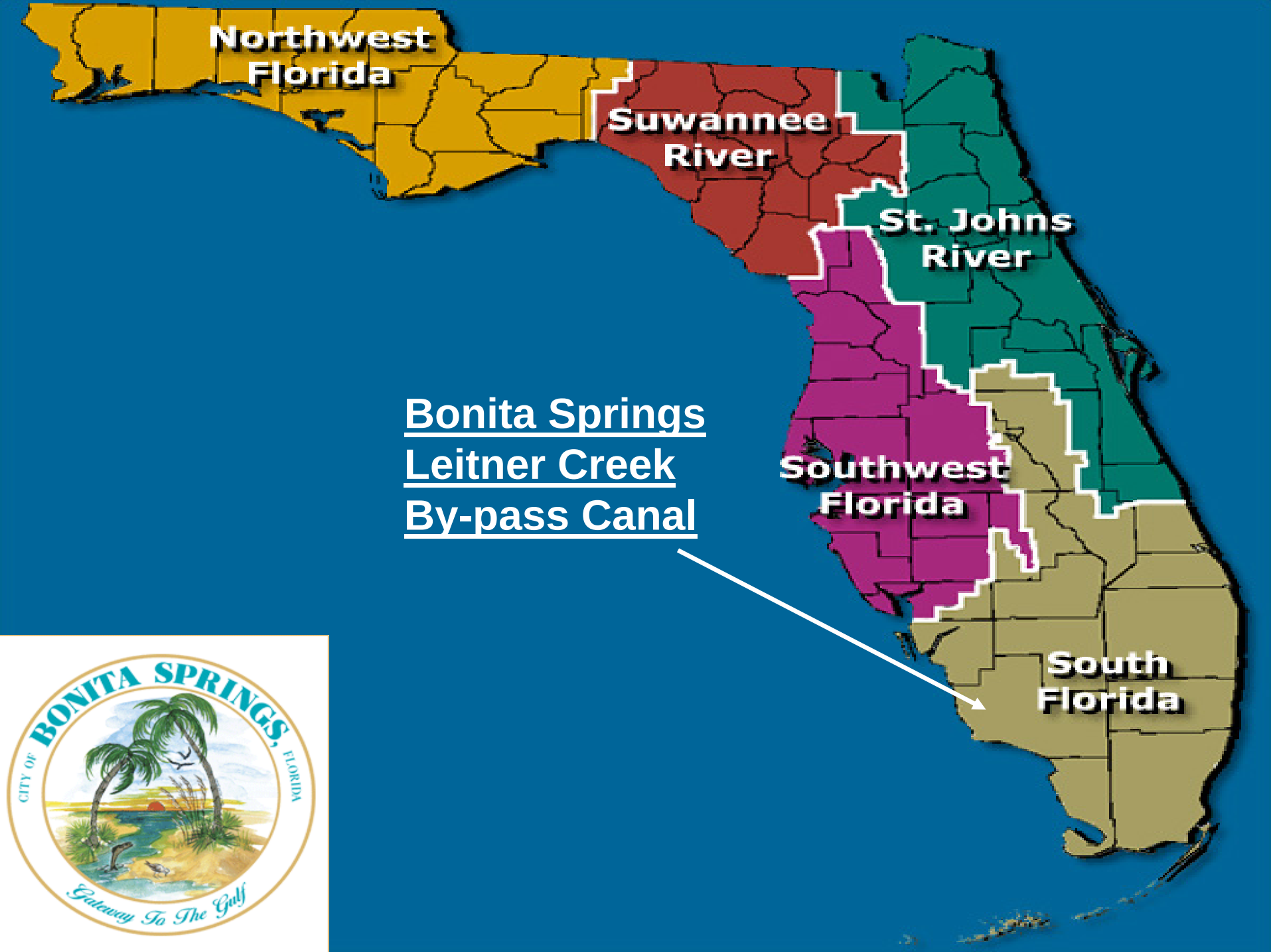
University of Central Florida

**Senior Associate**

H2O4U


Air Pump
Float
Floc
Logs
12"
Aerator or Bubbler

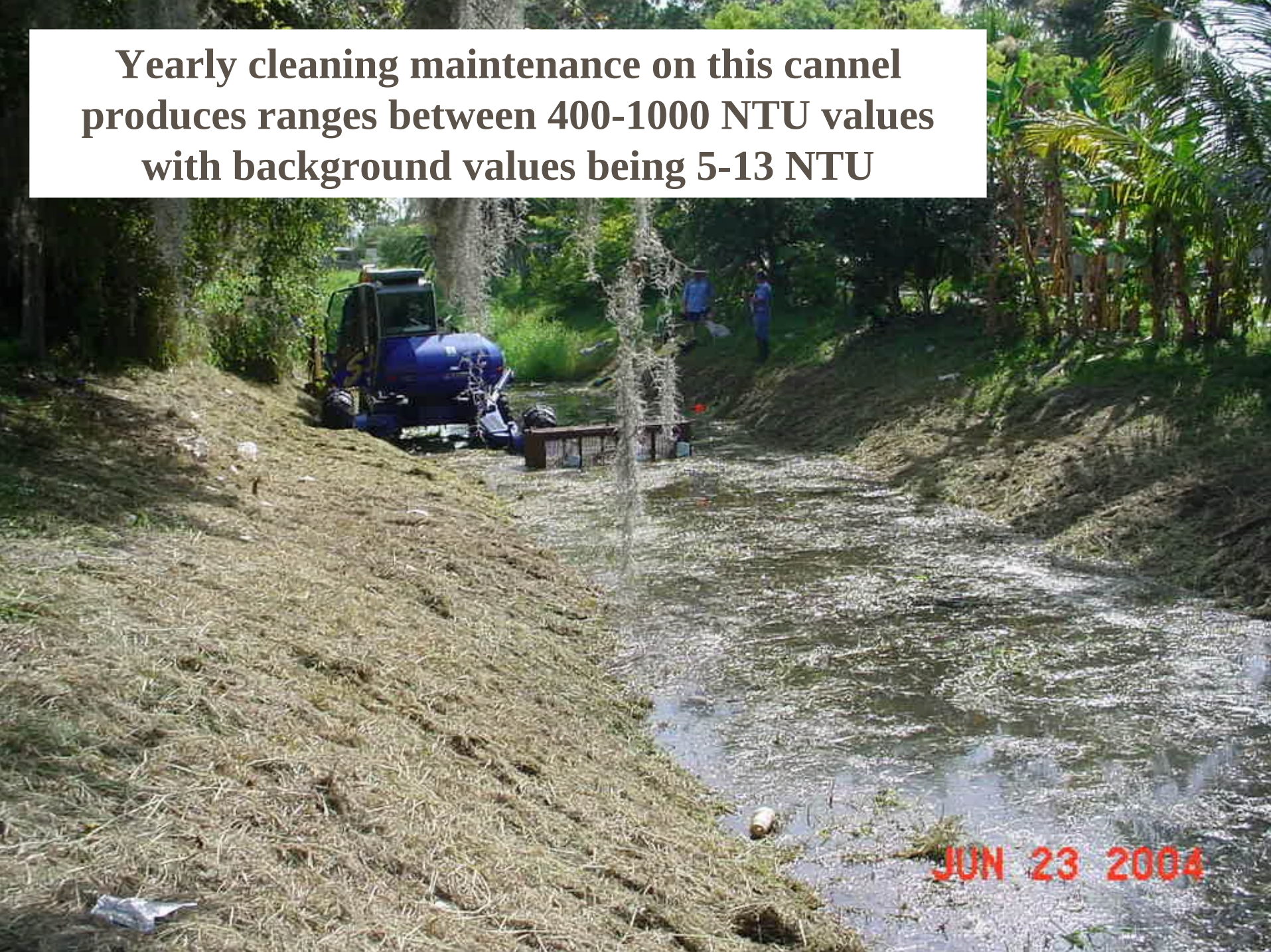

Float
Aerator


Northwest Florida
Suwannee River
St. Johns River
Southwest Florida
South Florida
Bonita Springs
Leitner Creek
By-pass Canal
CITY OF BONITA SPRINGS, FLORIDA
Gateway To The Gulf

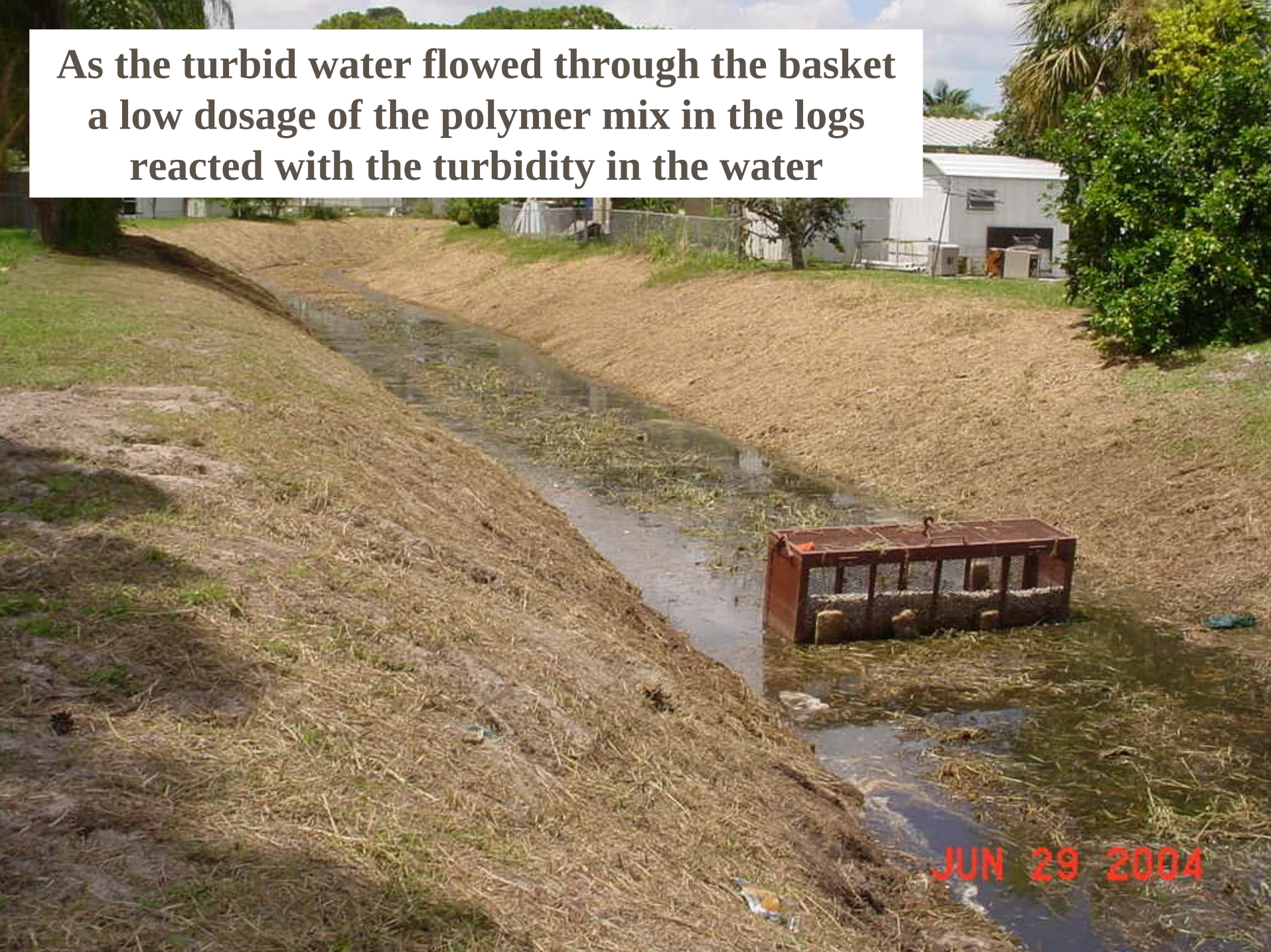

Leitner Creek By-pass Canal 4400’ long discharges to Estero Bay a OFW (Outstanding Florida Waterbody).

# OFWs are the most sensitive waters in the state of Florida requiring very effective BMPs

**Yearly cleaning maintenance on this cannel produces ranges between 400-1000 NTU values with background values being 5-13 NTU**

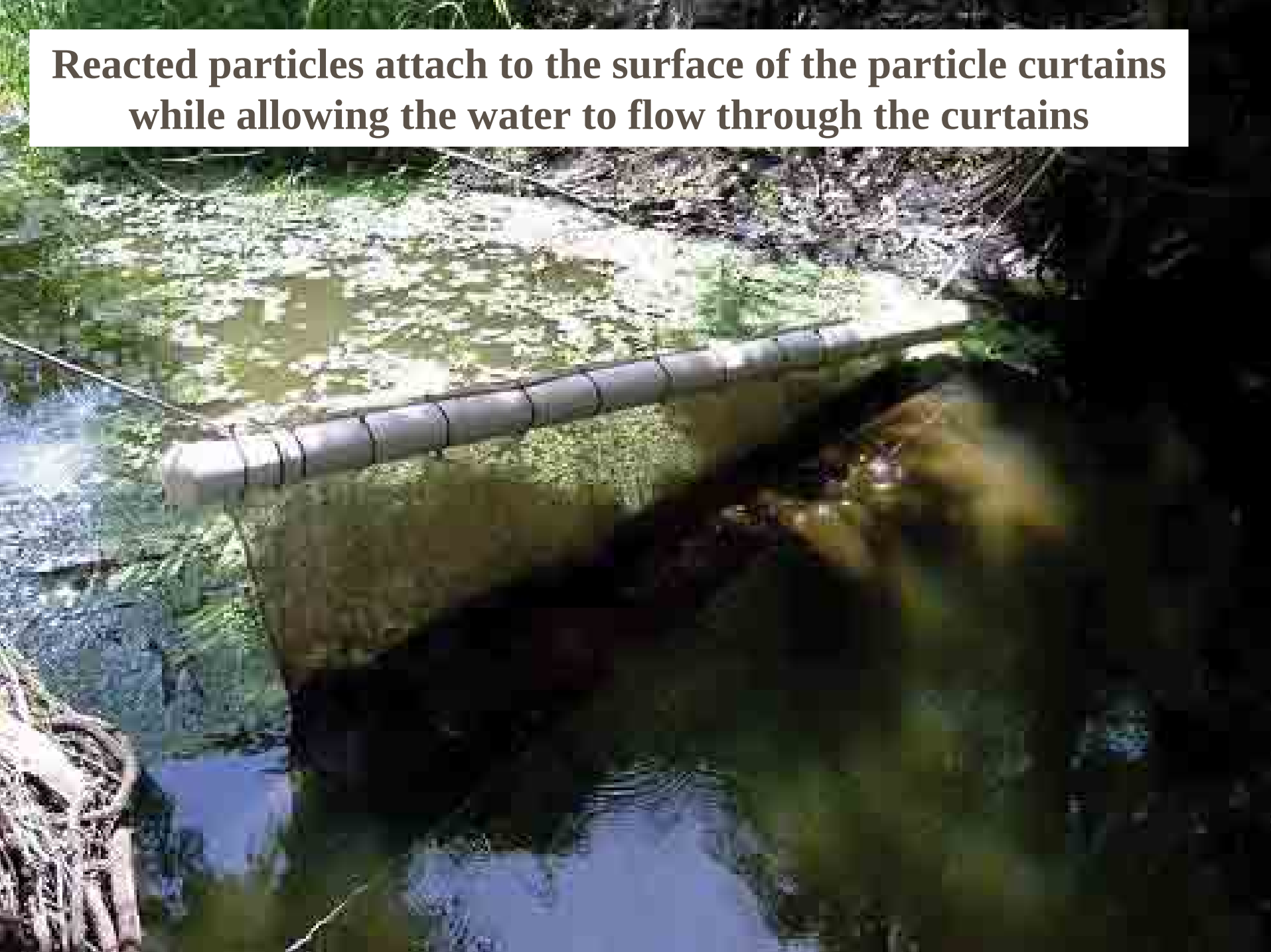


**The basket was placed in the canal downstream from the work area to intercept the turbid water flow**




**As the turbid water flowed through the basket a low dosage of the polymer mix in the logs reacted with the turbidity in the water**

**Reacted particles attach to the surface of the particle curtains while allowing the water to flow through the curtains**



# The polymer enhanced BMP for this project maintained clear water discharges with NTU values within OFW requirements

# Polymer enhanced BMPs significantly reduce odor and increased water clarity resulting in reduced complaints from area residents

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# Demucking and Mixing Systems

# Using Polymer Blends

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**Apply the soil specific polymer to mud surface using a modified leaf blower**


**Mix the mud with the soil specific polymer until thickening occurs**

# The correct polymer can greatly thicken soft mud


**Thickened mud can be used as a growth additive in low nutrient soils and sand**

**High organic polymer treated mud is also very erosion resistant and will hold fertilizer and seed in place**


This system can replace sod at 1/3 the cost
6.29.2000

**Soil specific polymer use can produce results equal or better than the highest cost BMPs on the market today at a fraction the cost**

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# Summary

**PEBMPs must be used in combinations**

**One BMP will usually not produce compliance results**

**Remember the "Rules for Polymer Use"**

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# Questions you should be asking

**Do you have the acute and chronic ASTM-EPA aquatic toxicity reports for the intended polymer?**

**Have you performed site specific jar testing, or lithology testing achieving 95% or better results to show that the polymer will work on the particular site where application is intended?**

**If so, please proceed and help keep our environment clean.**

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# Polymer References

http://kimberly.ars.usda.gov/pampage.shtml

www.stormwater.ucf.edu

www.siltstop.com

**Go to:**

**(Polymer Enhanced BMP Application Guide)**

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