#### E&SC Improvements during the Construction Phase

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# Sediment is single largest pollutant in NC Waterways!

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# Example of Construction Impacts on Streams

 Construction site greatly increases in-stream turbidity during storm events





#### **NC Discharge Regulations**

From an active construction site50 NTUs (nephelometric turbidity units)10 NTUs for Trout waters





#### **New Policy from EPA**



 Need to set Effluent Limit Guidelines (ELGs) and New Source Performance Standards (NSPS)



# EPA Effluent Limitation Guideline Policy

- Construction sites:
  - disturbing <u>ten or more acres</u> at a time would also be required to install <u>sediment basins</u> to treat their stormwater discharges.
  - In addition, if sites <u>30 acres or larger</u> are located in areas of the country with high rainfall intensity and soils with a high clay content, their stormwater discharges would be <u>required</u> to meet a numeric limit on the allowable level of <u>turbidity</u>.



# **Four Options**

- All sites must develop and implement stormwater pollution prevention plans (SWPPPs).
- To establish minimum best management practice (BMP) standards (i.e. sizing criteria and performance standards for sediment basins, as well as other BMPs currently required in EPA's Construction General Permit).
- To establish a numeric standard for designing sediment basins to remove a specified particle size fraction of sediment derived for specific sites based on a multi-variable equation that takes into consideration settling velocity, particle diameter, soil type, etc.
- To establish a numeric standard for turbidity or total suspended solids for discharges from sediment ponds, which most likely would require water from the pond to be pumped to a separate treatment system prior to discharge.



# **Changes Coming!**





#### **Erosion Prevention: First Line of Defense**





#### Erosion: Bare vs. Grass\*



\*50' slope, silt soil, Raleigh weather







# **Straw Mulch Problems**

- Not enough straw applied
- Insufficient tack on mulch
- Too steep or long of slope for straw mulch



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#### Erosion Control: Can Polyacrylamide Help?

PAM







### Polyacrylamide (PAM)

Water soluble synthetic polymer

• Forms: dry powder, solution, emulsion, 'logs'



## Polyacrylamide (PAM)

 Very common for water treatment uses, including drinking water and apple/grape juice clarification



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#### Sedimentation: Size Matters





#### **Flocculation by PAM**

 PAM binds (or flocculates) suspended sediment by attaching to several soil particles forming a larger aggregate or floc.





Flocculation by PAM
The larger (and now heavier) flocs then settle out of suspension.





#### Flocculation

#### What's your next question?



#### **PAM Toxicity?**

- PAM is known to be relatively non-toxic as measured by acute (LD<sub>50</sub>) tests.
- Chronic tests on fish also show low toxicity.
- Chronic effects on smaller species less well known, but toxicity appears to be very low for these as well.





#### Effluent Test: *Ceriodaphnia dubia* 7day chronic reproduction





#### Suspended Sediment Effects Newcombe & McDonald, 1991

#### Review of 120 Studies

Rank	Description of effect
14	>80 to 100% mortality
13	>60 to 80% mortality
12	>40 to 60% mortality, severe habitat degradation
11	>20 to 40% mortality
10	0 to 20% mortality
9	Reduction in growth rates
8	Physiological stress and histological changes
7	Moderate habitat degradation
6	Poor condition of organism
5	Impaired homing
4	Reduction in feeding rates
3	Avoidance response, abandonment of cover
2	Alarm reaction, avoidance reaction
1	Increased coughing rate

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#### Suspended Sediment Effects on Aquatic Organisms



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# Straw Enhanced by PAM





# Hydraulically Applied Mulch

- Currently used as a tackifier for straw mulch
- Under evaluation as ground cover







#### Hydraulically Applied Mulch

Example: bonded fiber matrix – 3,000-4,000 lbs/ac – Slope: 2:1 and steeper

#### Application technique is critical



## **Erosion Studies Conclusions**

- Any ground cover is better than none (90% coverage rule / 21 day requirement).
- Hydromulches and blankets may be more effective than straw (still evaluating this).



### **Does PAM Reduce Erosion?**

- PAM usually reduced erosion rates by 50% or more for typical ground covers.
- Straw + PAM (20 lb/ac or more) can outperform blankets and hydromulch.





#### **Options for Ditch Check Dams**





#### **Other Options for Check Dams**



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#### **Other Options for Check Dams**

#### Triangular Silt Dike™

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# Check Dam Placement/Installation...





#### **Alternative Check Dam System**

#### **Standard Checks/Traps**

#### Coir/Straw Checks, PAM





#### Standard BMPs over time – 5 months after paving



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#### Standard BMPs over time - 5 months after paving



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## Exp BMPs over time – 5 months after paving



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## Exp BMPs over time – 5 months after paving



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## 4,000 NTU

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## 19 NTU!



## **Results through December 2006**





#### Typical tools and products needed for installation







Close up of the mesh



# Wattle Theft!





## Fiber Check with 'flaps' or 'wings'



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# Proper installation required...



# **Cost Estimate Comparison**

Site 1:

411' Standard section\$890 / \$416 to maintain\$2.16 / ft612' Experimental BMPs + PAM\$854 / \$79 to maintain\$1.39 / ft423' Experimental BMPs only\$772 / no maintenance\$1.82 / ft

Site 2:

465' Standard section\$890 / \$416 to maintain\$1.91 / ft447' Experimental BMPs + PAM\$926 / \$76 to maintain\$2.07 / ft

The logs and wattles do not have to be removed either, they can decompose in place.



# **Check Dams as Lawn Art**





# Other Approaches to Improvements

- Sediment Basins/Traps
  - Surface Outlets

- Baffles

- Turbidity Reduction: Chemical Treatment (Polyacrylamide – PAM)
  - Passive and active uses
  - Solid and liquid forms





## **Riser Barrel Outlet**





# Surface Outlet (Faircloth Skimmer)



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# Surface Outlet (skimmers)

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## **Skimmer Basin Functions**

- Skimmer basins back up inflow to create a standing pool
- Pool acts to slow flow and drop sediment
- Basins dewater primarily over emergency spillways during actual storm events
- Skimmer dewaters basin between storms



# **Skimmer Basin**

# Skimmer

## Spillway

### Turbid water still likely...





# Basin Inlet with a Standing Pool

# Skimmer Basin: With and Without PAM in Ditches



# Flashboard Riser Outlet





# Flashboard Riser Outlet

- Adjustable standing pool
- Can empty for sediment removal
- Could be used for stormwater wetlands etc.
- Doesn't automatically dewater
- Could be left open...







#### Porous

#### Silt Fence/Weir





# **Measuring Baffle Effects**





## Effects of Baffles: Particle Distribution



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# Effects of Baffles: Velocity





# Installation Important...



## These baffles not installed well



# Connect high into side slopes or bypass erosion will occur.

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# Do Not Use Jute Alone!





# **Baffles Should Not Be Overtopped!**



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# Work well when installed right...

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# **Protect Inlet!**

4 Tons of Sc





# Simple Inlet Protection





## Sediment Bags are a good 'polishing



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# **Review: Ground Covers**

Failure Rate More Risk

- Straw (\$1500/ac)
- Straw + PAM (\$1800/ac)
- Low end blankets, hydromulch (\$3-4,000/ac)
- Better blankets, hydromulch (\$5-8,000/ac)

Less Risk



# Review: Check Dams/Inlet Protection

#### More Risk

	<ul> <li>Fiber wattles (with poor installation, undercutting)</li> </ul>
	<ul> <li>Rock (poor pooling, erosion)</li> </ul>
	<ul> <li>Fiber wattles (well installed, and</li> </ul>
Less Risk	especially those with 'wings' or 'flaps')




# **Review: Sediment Basin**

More Risk • Any basin w/ steep sides, unprotected inlet

- Rock Outlet Trap (high sediment losses)
- Riser barrel (somewhat high sediment losses)

Skimmer w/ Spillway (very efficient)

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Less Risk





# **Ideal LID design**

 Check dams with PAM placed in ditches feeding basins spaced such that flow goes from pool to pool...



#### Flow enters a skimmer basin with baffles





# Skimmer basin with baffles (top view)

Coir Baffles





## Any Questions?

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