Erosion & Sediment Control Training
September 10-12, 2012
Tumon, Guam
Agenda

Monday, Sept. 10th

8:00-8:30  Registration

8:30-8:45  Welcome and Introductions

8:45-9:15  Why ESC Matters
           What are the economic and environmental impacts of sediment loss from
           construction activities and why should contractors, engineers, and agency staff
           care about good ESC implementation?

9:15-9:45  Regulatory Compliance
           What are the territorial and federal requirements for ESC during new
           development, redevelopment, and military construction activities?

BREAK

10:00-12:00 ESC Practices: Part 1
           Introduction to non-structural practices to avoid erosion and sedimentation
           during construction, as well as temporary sediment barriers; diversions and
           conveyance structures; settling devices; temporary stabilization techniques, and
           inlet/outlet protection.

LUNCH  Provided

1:00-3:00  ESC Practices: Part 2
           A continuation from the previous session.

BREAK

3:15-4:45  Erosion Control Plans (CONCURRENT Sessions)
           Reading an ESC Plan Activity (installers and inspectors)
           In small groups, evaluate an ESC plan, identify practices on the plan, follow
           construction sequencing, and translate installation details.

           ESC Plan Design Activity (designers and plan reviewers)
           In small groups, evaluate and complete the design of an ESC plan for a proposed
           development site.

4:45-5:00  Instructions for Day 2
Tuesday, Sept. 11th

8:00-12:00   Field Demonstrations and Construction Site Visits
Break into groups, review site plans and instructions for day’s activities. Travel to field locations to see how ESC practices are being installed and maintained.

LUNCH Provided

1:00-2:00   Inspecting and Maintaining Practices through Project Closeout
Discuss findings from field trip. Review inspection and maintenance procedures for construction activities and how to properly transition from temporary ESC practices to permanent stormwater management.

2:00-3:00   Top 10 tips for improved compliance on Guam
In small groups, brainstorm ideas for how to improve ESC implementation; report back to full group.

BREAK

3:15-4:00   Certification Exam Review
In small groups, brainstorm ideas for how to improve ESC implementation; report back to full group.

4:00-5:00   Certification Exam (optional)  The exam is open book. There are two options for when you can take the exam.

Wednesday, Sept. 12th

8:00-9:00   Certification Exam (alternative time)

10:00-12:00    Guam ESC Program: Inter-Agency Work Session (Agency Staff)
   10:00-10:30   ESC Program Elements
   10:30-11:00   Recommendations & Debrief from Day 2 Training
   11:00-12:00   Facilitated group discussion on program recommendations

You must bring your own hard hat, safety vest, and boots to go on the field trip.
WORKSHOP EVALUATION FORM

Thank you for attending the Erosion and Sediment Control Training. We would like to get your feedback on the program and ways to improve it in the future. Please take a moment of your time to fill out the following evaluation form.

CLASSROOM TRAINING
How would you rate the classroom training portion of the workshop? (circle number)
1=Poor  2=Fair  3=Adequate  4=Good  5=Excellent

Comments:

READING AN ESC PLAN EXERCISE or DESIGNING AN ESC PLAN EXERCISE (circle one)
How would you rate the group plan exercise?
1=Poor  2=Fair  3=Adequate  4=Good  5=Excellent

Comments:

FIELD DEMONSTRATIONS
How would you rate the usefulness of the hands-on field activities?
1=Poor  2=Fair  3=Adequate  4=Good  5=Excellent

Comments:

LOGISTICS
Venue – The workshop was held at the Marriott. How well did it meet the needs of the training?
1=Poor  2=Fair  3=Adequate  4=Good  5=Excellent

Comments:

EXAM
How would you rate the difficulty of the exam? How well do you think it reflected the training program?
1=Poor  2=Fair  3=Adequate  4=Good  5=Excellent

Comments:

PROGRAM
Time – How satisfied were you with the length of the workshop?
1=Poor  2=Fair  3=Adequate  4=Good  5=Excellent

Comments:

MATERIALS
How satisfied were you with the field guide and training handouts?
1=Poor  2=Fair  3=Adequate  4=Good  5=Excellent

Comments:

OVERALL WORKSHOP
How satisfied were you of the overall workshop?
1=Poor  2=Fair  3=Adequate  4=Good  5=Excellent

Comments:

What is the likelihood that you would attend a future workshop on a similar or related topic?
1=Poor  2=Fair  3=Adequate  4=Good  5=Excellent

Comments:
GENERAL QUESTIONS
How do you plan to apply your training to your work?

Are there any additional Erosion Control Practices you would like more information on?

If you have additional suggestions for improving future workshops, please state them here:

Thank you for your time and your feedback.
Guam Erosion and Sediment Control Training

Additional Resources

Reference Materials

- Guam Soil Erosion and Sediment Control Regulation (22GAR-2 Chapter 10) and associated permits

- 2006 CNMI/Guam Stormwater Management Manual

- 2011 Transportation Stormwater Design Manual

- 2012 Guam Erosion and Sediment Control Field Guide Version 1.0 for Contractors and Inspectors


- NRCS Brochure – Vetiver Grass: The Grass that can protect your land from soil erosion.

- Link to US EPA NPDES Phase II Stormwater Discharges from Construction Sites
  http://cfpub.epa.gov/npdes/stormwater/const.cfm

- Erosion Control Magazine http://www.erosioncontrol.com, free subscriptions

- International Erosion Control Association www.ieca.org

- Erosion Control Technology Council www.ectc.org

Tips for Site Inspectors

- 2008 Delaware Stormwater Inspector's Guidebook

- 2008 Minnesota Stormwater Construction Inspection Guide

Speaker Contact Information

Dave Hirschman, Center for Watershed Protection, 434-293-6355, djh@cwp.org
Anne Kitchell, Horsley Witten Group, 508-833-6600, akitchell@horsleywitten.com
Michelle West, Horsley Witten Group, 508-833-6600, mwest@horsleywitten.com
<table>
<thead>
<tr>
<th>Practice</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sediment Barriers</strong></td>
<td>Temporary practices used mainly as perimeter controls to keep eroded sediment from leaving the site</td>
</tr>
<tr>
<td>Natural Area Protection</td>
<td>Fencing used to mark limits of disturbance and protect natural areas from clearing and grading</td>
</tr>
<tr>
<td>Construction Entrance</td>
<td>Rock pad used to prevent vehicles from tracking sediment off of site and on to public roads or adjacent paved areas</td>
</tr>
<tr>
<td>Silt Fence</td>
<td>Staked fabric fencing to block runoff from leaving the area. Works by ponding water behind fence and allowing sediment to settle out</td>
</tr>
<tr>
<td>Silt Fence Alternatives</td>
<td>Compost filters, silt dikes, or other products used instead of silt fences that slow and filter runoff rather than allowing it to pond behind practice.</td>
</tr>
<tr>
<td>Turbidity Curtain</td>
<td>Flexible floating barrier used to contain suspended sediment along shorelines or within a waterbody</td>
</tr>
<tr>
<td><strong>Diversions/Conveyances</strong></td>
<td>Practices used to move runoff through or around site</td>
</tr>
<tr>
<td>Berms</td>
<td>Mounds of compacted sediment strategically placed to divert runoff to a stable outlet or settling device</td>
</tr>
<tr>
<td>Swales</td>
<td>Channels created to intercept and convey “dirty” runoff to stable outlet or settling device</td>
</tr>
<tr>
<td>Check Dams</td>
<td>Small dams of rock or other durable material placed across a channel to slow runoff and allow sediment to settle out</td>
</tr>
<tr>
<td>Vegetated and Lined Waterways</td>
<td>Permanent channels (grass, rock, concrete) used to convey “clean” runoff from stabilized areas</td>
</tr>
<tr>
<td>Dewatering</td>
<td>Methods for cleaning dirty water pumped from excavations at construction sites</td>
</tr>
<tr>
<td>Temporary Stream Diversion</td>
<td>Pipes, channels, or cofferdams used to temporarily divert natural waterways around stream or shoreline construction projects</td>
</tr>
<tr>
<td><strong>Settling Devices</strong></td>
<td>Practices used to collect and pond runoff that allow sediment to settle out before discharging</td>
</tr>
<tr>
<td>Sediment Trap</td>
<td>Small depressions (excavated or created with an embankment) used to collect/pond runoff and allow sediment to settle out</td>
</tr>
<tr>
<td>Sediment Basin</td>
<td>Similar to traps, but capturing a larger drainage area and having more complex outlet structure and embankments. Can be converted to permanent stormwater practices</td>
</tr>
<tr>
<td><strong>Stabilization Practices</strong></td>
<td>Techniques to protect bare soils and exposed slopes from erosion</td>
</tr>
<tr>
<td>Vegetation, Mulch, Topsoil</td>
<td>Seeding and organic mixes uniformly applied to an area to quickly establish temporary or permanent ground cover</td>
</tr>
<tr>
<td>Surface Roughening</td>
<td>Using equipment to create depressions, steps, and grooves in exposed soils to slow and break up runoff</td>
</tr>
<tr>
<td>Pipe Slope Drains</td>
<td>Pipe used in conjunction with other stabilization practices to convey concentrated flow down a slope</td>
</tr>
<tr>
<td>Erosion Control Blankets</td>
<td>A biodegradable or synthetic matting used to cover exposed area on slopes and in channels to prevent erosion and help establish vegetation</td>
</tr>
<tr>
<td><strong>Inlet Protection</strong></td>
<td>Temporary practices to block sediment from entering storm drains but still allow inflow during construction</td>
</tr>
<tr>
<td><strong>Outlet Protection</strong></td>
<td>Practices used to protect outlet discharge points from erosion by slowing and spreading flow</td>
</tr>
<tr>
<td>Rock Outlet Protection</td>
<td>Rocks used to stabilize outlet pipes and prevent erosion from concentrated discharge</td>
</tr>
<tr>
<td>Level Spreaders</td>
<td>Converts concentrated flow at outlets into non-erosive sheet flow</td>
</tr>
</tbody>
</table>
BREAK
Guam ESC Training 2012

Guam Erosion & Sediment Control (ESC) Training
September 10-12, 2012

Purpose of Workshop
- To provide concurrent training for designers, contractors, reviewers, and inspectors on ESC standards and practices.
- To demonstrate installation procedures for ESC practices.
- To improve on-the-ground success.

Acknowledgements

Additional photos: Guam Environmental Protection Agency, American Samoa Environmental Protection Agency, Palau Environmental Quality Protection Board; CNMI Department of Environmental Quality; Dr. Patrick Colin; Coral Reef Research Foundation; Jon Vogt; Coral Bay Community Council; Center for Watershed Protection; Clemson University; North Carolina State University; NOAA; Carroll County, MD; Albemarle County, VA; Filtrexx; MD Department of Environment; DE Erosion Control Program; University of North Carolina; North Carolina DOT

Schematics adapted from: State of New York, University of Minnesota Extension Service, Wisconsin Department of Natural Resources, British Columbia Ministry of Forests; North Carolina DOT

Course Agenda

Day 1: Classroom training
- Why ESC matters
- Regulatory requirements
- ESC practices
- Reading OR preparing an ESC plan

Day 2: In the field/classroom
- Installations
- Maintaining and closing projects
- Improving implementation
- Exam

Day 3: Classroom
- Exam
- Inter-Agency Work Session

Bring your own hard hat, safety vest, and boots for the field trip!!
Why Erosion and Sediment Control (ESC) Matters

Guam Erosion & Sediment Control Training
September 2012

Topics to Cover

1. Impacts of construction site runoff
2. Regulatory requirements
3. 11 ESC standards
4. Construction sequencing
5. Contractor responsibilities

Why Erosion and Sediment Control Matters

Why do we care about sediment loading?

Sedimentation can impact Guam’s:
- Environmental resources
- Economy
- Function of existing infrastructure
- Abutting properties

Environmental Impacts = Economic Impacts

- Reduces water quality
- Limits photosynthesis
- Reduces oxygen availability
- Clogs fish gills
- Fills spawning grounds
- Increases coral bleaching
- Smothers bottom communities
- Reduces visibility for feeding and predator avoidance
- Costs more to filter drinking water
- Causes sedimentation of reservoirs
- Less fish, hard on fishermen and seafood lovers
- Swimming areas closed, reduced recreation
- Looks bad, fewer tourists

A significant concern across the Pacific Islands is watershed sediment loads. There are many contributors, shown here.
Models estimate that 22% of all coral reefs worldwide are at high or medium threat from inland pollution and soil erosion (Bryant et al. 1998)

Impacts to Infrastructure
- Filling-in of permanent stormwater ponds
- Clogging of infiltration devices/ponding basins
- Smothering of swales and buffers
- Clogging of drain pipes and inlet/outlet structures
- Can contribute to flooding

There are some things, like rainfall, soils, and site location that are out of your control.
Proper use of ESC practices can make a huge difference!!

Sediment Load vs. Rainfall

REALITY: Compliance for Commonly Used ESC Practices (North Carolina >128 ESC plans, >1000 practices)

Caret Bay, USVI
- Nemeth and Nowlis, 2001
- Turbidity sampling during construction process
- Correlation between sediment loading and coral bleaching
- Key problems:
  - Timing of development
  - Failure to maintain ESC practices

When soils are exposed and ESC practice not maintained, expect high sedimentation

Source: Schueler and Lugbill, 1990

% XWVRPHGHFLVLRQVFDQKDYHDVLJQLILFDQWLQIOXHQFH"
2. Relevant Regulations and Standards in Guam

- USEPA National Pollutant Discharge Elimination System (NPDES)
- Guam Soil Erosion and Sediment Control Regulation (22GAR-2 Chapter 10) and associated permits
- 2006 CNMI/Guam Stormwater Management Manual
- 2011 Transportation Stormwater Design Manual

What You Should Know

- New construction and redevelopment sites should meet (some activities are exempted):
  - ESC plan requirements & Guam Regs
    - 11 ESC standards
- All sites over 1 acre of disturbance must:
  - Submit NOI to USEPA and GEPA
  - Prepare and implement a Stormwater Pollution Prevention Plan (SWPPP)
- Measures to convey the 10-yr storm (~10 in.) and trapping devices to retain the 1.5 in. storm.

Which site should meet ESC Standards?

Small  >1 acre, private  >1 acre, public road

ESC Plans (see page 7 of ESC Guide)

- What is included in an ESC plan?
- Do road projects have additional requirements?
- Who develops plan?
- Who reviews plan?
- Are there copies available on site?
- How are plans revised?

3. ESC Standards (see pages 8-9)

1. Minimize clearing and grading
2. Protect waterways (minimum 25’ buffer) and stabilize drainage ways
3. Phase construction to limit soil exposure
4. Stabilize exposed soils immediately (14 days)
5. Protect steep slopes and cuts
6. Install perimeter controls to filter sediments
7. Employ advanced sediment settling devices
8. Certify contractors on ESC plan implementation
9. Conduct a pre-permit site meeting and adjust plan if necessary
10. Schedule construction during dry season (if possible)
11. Maintain ESC throughout construction

ESC #1: Minimize Unnecessary Clearing & Grading

- Only be performed within areas needed to build the project
- Should occur in dry season as possible

Maintaining trees/vegetation is a proactive ESC strategy
ESC #2: Protect Waterways (Minimum 25-ft Buffer) and Stabilize Drainage Ways

- Clearing limited within the 25-ft buffer
- Clearly mark limit of disturbance in field
- Install temporary diversions for activities in waterways
- Conveyance channels should convey flow without erosion

ESC #3: Phase Construction to Limit Soil Exposure

- Limit disturbance to only one area of active construction at a time.
- Future phases not disturbed until construction of prior phases is complete and area is stabilized.

ESC #4: Stabilize Exposed Soils Immediately (14 days)

- Disturbed areas shall be stabilized as soon as possible after construction completed
- In no case longer than 14 days after completion of construction

ESC #5: Protect Steep Slopes and Cuts

- Limit clearing of steep slopes in the first place.
- Prevent runoff from flowing down a steep slope to prevent gully ing.

ESC #6: Install perimeter controls as sediment barriers

- Perimeter controls/barriers shall be applied to trap or retain sediment before it leaves a site.
- Upland runoff should be diverted around excavations

ESC #7: Employ Advanced Sediment Settling Controls

Sediment trapping devices shall be installed to trap/retain suspended sediments and allow time for them to settle out
ESC #8: Certify Contractors on ESC Plan Implementation

All construction site managers should have received adequate ESC training.

ESC #9: Conduct a Pre-permit Site Meeting and Adjust Plan if Necessary

- All construction site managers must participate in a pre-permit meeting.
- All construction site managers must make on-going field adjustments as necessary.

ESC #10: Where Feasible, Minimize Construction During Rainy Season

ESC #11: Maintain ESC Controls Throughout Construction

- Aggressively maintain ESC after installation.
- ESC plans are an enforceable operation and maintenance agreement.

4. Proper Construction Sequencing (see page 10-11)

Mark limits of disturbance and install perimeter fencing BEFORE clearing.
Do not remove temporary practices or switch to permanent stormwater practices until area is stable.

5. Who is Responsible?

- Know ESC standards and practices?
- Correctly size and locate practices?
- Participating in a pre-permit meeting?
- Ensuring proper ESC installation and maintenance?
- Educate operators and site workers on the importance of proper ESC?
- Revising ESC plan if necessary?

For the exam, you should know:

- Why sediment leaving construction sites is a problem
- Which sites need to follow ESC Standards (not just those >1 acre of disturbance)
- The 11 ESC Standards
- Proper sequence of construction
- Who is responsible

...Questions???
BREAK
**ESC Practices Covered**

**Sediment Barriers/Perimeter Controls**
- Natural area protection
- Stabilized construction entrance
- Silt fence
- Alternative “fencing”
- Turbidity curtains

**Diversions & Traps**
- Berms
- Swales
- Check dams
- Vegetated/lined waterways
- Temporary Stream Diversions

**Stabilization**
- Surface roughening
- Vegetation, mulch, soil
- Erosion control blankets
- Pipe slope drains

**Inlet Protection**
- Fabric
- Block and rock
- Wattles
- Inserts

**Outlet Protection**
- Rock outlet protection
- Level spreader

**Additional ESC References**
- Guam Transportation Stormwater Design Manual (2011)

**Sediment Barriers/Perimeter Controls**

Objective: Prevent disturbance and keep sediment from leaving site

**Tree and Buffer Protection:** Visible demarcation with fencing and signage of Limits of Disturbance from construction activities.
**Design**

1. 25 ft min. from waterway
2. Distance from tree:
   - extend to drip line, or
   - allow 1.5 ft for every inch of trunk diameter
3. Select materials based on protection needs

**Alternative Example:**

For a tree with 10-inch trunk

10 X 1.5 ft = 15 ft radius

**Installation**

1. Mark areas to be preserved before clearing
2. Install temporary fencing and/or signage
3. Protect critical root zone during installation
4. Instruct all site workers
5. NO equipment inside fencing
6. Do not remove until end of construction

**Common Problems**

- Not shown on ESC plans
- Not installed on site
- Run over by equipment
- Doesn’t protect buffer
- Doesn’t extend beyond tree drip line
- Fence installed, but materials stored inside

**MAINTENANCE**

- Check daily
- Restore damaged fencing immediately
- Remove sediment and debris if necessary
- Address tree injuries immediately

**Stabilized Construction Entrance:** Rock pad at vehicle entrance/exit used to prevent tracking of mud from tires onto road or adjacent paved area.

- Vehicles cannot bypass entrance
- No tracking of mud on street

**Does this fencing fully protect this tree?**
Adding a tire wash

- Should drain to sediment trapping device

Installation
1. Locate entrance point
2. Place fabric down
3. Use ~1-4 inch diameter rock
4. Spread rock on top (6-inch thick)
5. Full width, flare at street
6. Install barriers to keep traffic on pad

Common Problems
- Does not meet street
- Too short or narrow
- Vehicles drive around it
- No underlying fabric, rock pad gets buried
- Not maintained
**Maintenance**
1. Monitor periodically
2. Wash or add more rock when sediment fills gaps
3. Remove tracked dirt from road

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**Rock pad needs to be washed or replaced.**

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**Slit Fence:** Geotextile supported by posts and trenched in the ground to intercept runoff. Installed along perimeter of disturbed areas. Works by ponding runoff behind fence which allows sediment to settle out.

**Trenched 6-inches deep**

**Works by ponding runoff behind fence and trapping sediment.**

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**Design Features**

**Good installation around stockpile area. Be sure to leave space for material to deposit behind fence and for maintenance.**
**Installation**

1. Dig trench 6-8 inches deep
2. Install sturdy posts 1.5 feet deep
3. Fasten fabric to posts, connect ends
4. Backfill and compact
5. Check it.

**Common Problems**

1. Receives concentrated flow
2. Post spacing too wide
3. Installed perpendicular to slope
4. Installed uphill from flow
5. Flow by-passes ends of fence

**Common Problems (see page 21)**

6. Not properly trenched
7. Follows site boundary only
8. Lack of maintenance
9. Too much drainage area or length of slope

<table>
<thead>
<tr>
<th>Slope Steepness</th>
<th>Max. distance between rows</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:1</td>
<td>25 ft</td>
</tr>
<tr>
<td>3:1</td>
<td>50 ft</td>
</tr>
<tr>
<td>4:1</td>
<td>75 ft</td>
</tr>
<tr>
<td>5:1 or flatter</td>
<td>100 ft</td>
</tr>
</tbody>
</table>

**Poorly trenched fences will not hold back runoff.**

**Do not install across streams unless trying to trap Karabao.**
You can use alternative materials if they work!!

What factors are contributing to this failure?

Maintenance
- Inspect daily
- Repair if sagging or bulging
- Remove sediment when reaches 1/3 height of fence

Silt Fence Alternatives: Practices used as perimeter controls instead of silt fences that filter runoff, trap sediment, that may be easier to install/maintain.

Design & Installation
- Follow manufacturer’s instructions for diameter and mesh material
- Be sure to connect with ground
- Back fill with loose sediment
- Potential for reuse
Fill on site or bring in pallets

Auger attachment

Maintenance
- Check daily and after rain events
- Make sure in contact with ground
- Remove sediment that builds up ½ way behind sock

Use local materials for compost material...

Alternative products are only as good as your installation and maintenance.

Turbidity Curtain: Flexible floating barrier used to trap suspended sediment along shoreline or in waterbody
**Guam ESC Training 2012**

**ESC Practices**

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**Design & Installation**
- Various types, see manufacturer’s instructions
- Use in calm waters
- 1. Remove debris and obstacles
- 2. Firmly anchor in place on shoreline
- 3. Anchor curtain toe if necessary

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**Maintenance**
- Inspect weekly and after wave action
- Check anchors
- Remove debris
- Repair damage immediately
- Remove curtain by slowly pulling to shore
- Remove sediment by hand, deposit in appropriate location

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For the exam, you should know:
- Purpose of sediment barriers is to prevent disturbance or to stop sediment from leaving the site and often are placed around perimeter of site
- How they work
  - Tree protection prevents disturbance
  - Silt fences pond water and allow dirt to settle out
  - Construction entrances clean mud off of tires
  - Compost socks filter water
  - Turbidity curtain contains sediment
- Recognize why they fail
- Basic maintenance requirements
  - Remove sediment when 1/3 filled behind silt fence

...Questions???
Guam Erosion and Sediment Control Training

Objective:

Sediment Barriers,
Diversion, Traps, Stabilization,
Diversions, and Inlet/Outlet Protection

Guam ESC Training

ESC Practices

Sediment Barriers, Diversion, Traps, Stabilization, and Inlet/Outlet Protection

Guam Erosion and Sediment Control Training
September 2012

Diversions & Traps

Objective: Collect “dirty” water & allow time for particles to settle out.

Dewatering Devices

See Field Guide, Chapter 3

Objective: Convey “clean” and “dirty” runoff safely around or through site.

Diversion Berms

Diversion swales

Vegetated/lined waterways

Check dams

Temporary Stream Diversion & Isolation

See Field Guide, Chapter 3

Diversions & Swales: Compacted mounds and/or excavated channels used to direct runoff to stable outlet or trapping device

Diversion swale

Earth Berm Design

Diversion Swale Design
Combined Perimeter Berm/Swale

Vegetated berm diverts runoff from site along perimeter to stabilized outlet. Note stabilization with vegetation and matting.

**Design & Installation**
- Must safely convey the 10-yr storm (~10 inches on Guam)
- Do not construct diversions outside the property boundary
- Berms should be compacted, (except for berm/swale combo)
- Stabilize berms within 1 week
- Outlets should be stabilized

**Common Problems**
- Berms wash out, too much drainage area
- Berms not compacted or stabilized
- Outlets not stabilized

**Maintenance**
- Check full length weekly or after rain events
- Make sure outlets are stable, if not may need to relocate
- If too steep, may need to install matting

**Construction**
- Construction of lined channel to basin. Is this a permanent structure?
Vegetated and Lined Waterways: Permanent grass, rock, or concrete channel used to convey stormwater runoff from stabilized site.

Grass Channels

- Gentle grades and side slopes
- Warm season grasses with some perennial rye (see NRCS)
- Erosion control fabric
- May need some topsoil, fertilization, liming to get grass started
- Becomes permanent conveyance

Installation
1. Clear foundation of stumps, roots, loose rocks
2. Excavate and install as shown on plans
3. May need filter fabric below hard linings
4. Follow manufacturer’s instructions for erosion control matting
5. Stabilize with vegetation according to specifications (see NRCS)
6. Requires stabilized outlet
7. Do not use until fully stabilized

Maintenance
- Maintain lining as built to prevent undermining
- Inspect vegetation establishment/survival
- Inspect for erosion resulting from out-of-bank flows
- May need to install liner along center of channel if scour occurs

Source: Center for Watershed Protection
Permanent concrete channels provide no water quality benefits. When does it make sense?

Check Dams: Ridge of rock or other durable material used in a channel to slow erosive velocities. Often used in series.

Check Dams:

Why are check dams needed?

Design with a smile

Design & Installation

- Anchor with cutoff trench (1½ ft wide x ½ ft deep)
- Rock matrix of 2-9 inches
- Dams less than 2 ft high with lower center
- Tie into banks
- Space according to plan/slope

Albemarle County, VA

Table F.14, Standard slope check dam design (Maryland Department of the Environment, 1986)

<table>
<thead>
<tr>
<th>Slope</th>
<th>Erosion Rate</th>
</tr>
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<tbody>
<tr>
<td>0% or less</td>
<td>60</td>
</tr>
<tr>
<td>2% to 4%</td>
<td>40</td>
</tr>
<tr>
<td>4% to 10%</td>
<td>20</td>
</tr>
<tr>
<td>10% or 10%</td>
<td>15</td>
</tr>
</tbody>
</table>

limited to slopes with < 10% grade

Source: MDE, 1986
Common problems
- Dam doesn’t extend to bank or center of dam too high, allowing by-pass
- Sediment allowed to build up too much behind dam
- Use of non-approved materials

Alternative materials can be used, but require a lot of attention.

Maintenance
- Inspect after rainfall events
- Check for displaced rocks
- Remove sediment behind dams when fills ½ height

Does this work?

What’s wrong here?
Settling Devices (sediment basins & traps): Excavated areas to temporarily pond “dirty” runoff and provide time for sediment to settle out before discharging off site.

### Basins vs. Traps

<table>
<thead>
<tr>
<th></th>
<th>Basins</th>
<th>Traps</th>
</tr>
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<tbody>
<tr>
<td>Max Drainage Area</td>
<td>100 acres</td>
<td>5 acres</td>
</tr>
<tr>
<td>Size</td>
<td>5,500 cubic ft.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(acres of drainage: &gt;2:1 length to width)</td>
<td></td>
</tr>
<tr>
<td>Dam Height</td>
<td>10-15 ft max.</td>
<td>5 ft max.</td>
</tr>
<tr>
<td>Dam Width</td>
<td>8-10 ft min.</td>
<td>4 ft min.</td>
</tr>
<tr>
<td>Dam Side Slopes</td>
<td>2:1 or flatter</td>
<td>2:1 or flatter</td>
</tr>
<tr>
<td>Outlet</td>
<td>River with spillway</td>
<td>River or grass/rock outlet</td>
</tr>
<tr>
<td>Riser Height</td>
<td>2 ft below top of dam, 1 ft below spillway.</td>
<td>1 ½ ft below top of dam</td>
</tr>
<tr>
<td>Status</td>
<td>Temporary or Permanent</td>
<td>Temporary</td>
</tr>
</tbody>
</table>

- Larger excavation
- Can be permanent
- More infrastructure
- Small depression
- Simpler outlet structure
Simple excavated sediment trap with grass outlet and gentle slopes that are stabilized with vegetation.

Sediment Trap:
- rock or pipe outlet

Be sure to construct outlet weir to specifications. The center should be lower than ends to allow water to spill over.

Use smaller diameter rock on inside of dam to help filter sediment.

Sediment basins are structurally more complicated than traps. Should be at least twice as long as wide to maximize flow path.
Sediment basins can be used on highway projects.

Fine sediment removal is limited in basins and traps, advanced designs to enhance effectiveness:

- Baffles to increase length of flow path
- Perforated standpipe encased in rock
- Skimmers
**Installation**

1. Install before major site clearing
2. Locate and construct according to plans
3. Make sure pipe connections are watertight
4. Install water permeable covers on risers and filter fabric over dewatering holes
5. Stabilize outlets, side slopes, and inlets

**Common Problems**

1. Overflow not installed correctly—center not lower than sides causes erosion
2. Not maintained properly
3. Too small
4. Erosion at inlet structures and/or on banks
5. No filter or trash rack on pipe outlet structure

**Maintenance**

1. Remove accumulated sediment when basin volume is reduced by ½
2. Do not dispose of sediment in waterways
3. Check inlets and side slopes for erosion. Stabilize.
4. Check outlets for erosion

**Dewatering devices:** To clean “dirty” water that is pumped out of excavations or from other wet areas on the construction site.

- Sump Pits
- Dewatering Bags
- Containment Areas
- Weir Tanks
§ Sizing should be based on:
  - Expected volumes
  - Pumping rates
  - Type of geotextile bags based on manufacturer recommendations.
  - Discharge to stabilized containment area
  - Follow manufacturer’s instructions for sediment removal or bag replacement
  - Proper disposal
  - Keep an eye on this at all times when pump is running

Bag Filters

Be sure to place bag on stabilized discharge area.

Stabilized Containment Areas
**Design and Installation**

- Size based on expected volumes and pump rates
- Do not use in place of sediment traps
- Locate for ease of cleanout and to minimize interference with construction activities

**Weir Tanks with Baffles**

- Storage is equal to pump discharge (GPM) x 16, assuming 2 hrs of residence time.
- Direct discharge to another ESC practice.
- Be sure to properly dispose of sediment

**For dewatering practices**

**Maintenance**
- Inspect and monitor on an hourly basis while pumps are running
- Ensure final discharge is not causing additional erosion and sedimentation
- Follow manufacturer’s instructions for sediment removal or bag replacement
- Have a plan for proper disposal

**Common Problems**
- Poor sizing of pumps and practice
- Turbid discharge
- Sump pit not filtering well
- Bag explosions

**Temporary Stream Diversion:** To isolate the construction area from surrounding waters and minimize contact of flowing water with exposed soils.

- Cofferdams & impervious dikes
- Piped diversions
- Diversion channels
Existing stream flow should be separated from exposed soils in work area.

Silt fence and earth may not always be reliable

Concrete blocks work well though

**Cofferdams/impervious dikes**

- Sheet piling
- Sand bags
- Gravel bags
- Inflatable bladders

Is this silt fence diversion working?

Water-inflated bladder bag

Sump pit

Hose to dewatering practice
Do not remove coffer dam until work area is stabilized.

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ESC Practices
**Design & Installation**

- Try to work during dry season
- Ensure good seal for coffer dams
- Use appropriate pump size
- Size channels to convey 2-yr storm with 2:1 side slope
- Do not install temp. channels in fill
- Protect channels from erosion
- Ensure coffer dams are working properly
- Minimize amount of disturbance at diversion points
- Avoid earthen dams
- Specify dewatering procedures

**Maintenance**

- Inspect dams daily
- When pumps are being used, inspect hourly
- Check for upstream or downstream erosion
- Check stability of side-slopes on diversion channels

**Common Problems**

- Not sized appropriately
- Erosion of channel and diversion points
- Leaky cofferdams

**For the exam, you should know:**

- Purpose of diversions and settling devices
  - **Diversions**: to convey non-erosive runoff through or around a site
  - **Traps**: to pond runoff and allow sediment to settle out before discharging “clean” water
  - **Dewatering**: to clean “dirty” water that is being pumped from wet construction areas
- How they work and why they fail
- Basic design/installation procedures
  - Swales and channels to convey 10-yr storm
  - Temporary stream diversions 2-yr storm min.
  - Store 1.5 inches of rain
- Basic maintenance requirements for practices
  - Remove sediment from basin ½ full

...Questions???
BREAK
ESC Practices
Sediment Barriers, Diversion, Traps, Stabilization, and Inlet/Outlet Protection

Stabilization Practices
Objective: Protect bare soils and slopes from eroding
- Surface roughening
- Vegetation, mulch, soil
- Erosion control blankets
- Pipe slope drains

Inlet Protection
- Fabric
- Block and rock
- Wattles
- Inserts

Outlet Protection
- Rock outlet protection
- Level spreader

Bare soils should be stabilized within 14 days of exposure

As organized in the Field Guide

Objective: Protect bare soils and slopes from eroding

This grass doesn’t count as stabilization

Rills are an erosion indicator

A lot of dirt came off this site. This gully indicates:
- Lack of stabilization
- Failure to comply with ESC requirements
- Failure to enforce ESC regs.
Surface Roughening: Creation of horizontal depressions, steps, or grooves that run parallel to contour of land and slow runoff.

**Installation**
- Perform as soon as vegetation has been removed
- Combine with seeding/mulch
- Avoid excessive compacting of soil if possible

**Maintenance**
- May need to reapply at end of day or until other stabilization in place
- If rills appear, re-grade and re-seed

**Common Problems**
- Tracking across slope instead of going up and down slope
- Rills appear and no corrective action taken
- Not done frequently

Vegetative, Mulch, or Soil Stabilization: Uniform application of seed and organics to rapidly stabilize exposed soil either temporarily or permanently.
Cover exposed soils with vegetation, mulch, or blankets.

Installation

- Apply grass or mulch cover within 14 days of soil exposure.
- Clear debris.
- Apply native seeds and grasses uniformly with seed spreader or hydroseeder.
- Use appropriate combination of tackifier, mulch, and seed.
- Add fertilizer where needed.
- Permanently stabilize disturbed areas at end of construction.
- Contingency plan for replacing vegetation that does not survive.

Common Problems

- Coverage too thin
- Mulch blows away
- Seed not watered
- Area subject to concentrated flow and erosion
- Soil too compacted

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 rye grass to get temporary stabilization
- Grasses vary greatly in tolerance for drought, and shade, and requirements for nitrogen and maintenance

How can you increase hydoseeding effectiveness on severe slopes?

Stabilization, Inlet & Outlet Protection

Table 4.1 Common Grasses Suitable for Stabilizing/Revegetation on Exposed Soils.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Sod Depth</th>
<th>Tolerance</th>
<th>Mowing Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bermuda Grass</td>
<td>Cynodon dactylon</td>
<td>0.2-0.5</td>
<td>Very Good</td>
<td>3-5”</td>
</tr>
<tr>
<td>Dallis Grass</td>
<td>Cynodon dactylon</td>
<td>0.2-0.5</td>
<td>Very Good</td>
<td>3-5”</td>
</tr>
<tr>
<td>Centipedegrass</td>
<td>Zoysia japonica</td>
<td>0.2-0.5</td>
<td>Good</td>
<td>3-5”</td>
</tr>
<tr>
<td>St. Augustine Grass</td>
<td>Stenotaphrum secundatum</td>
<td>0.2-0.5</td>
<td>Good</td>
<td>3-5”</td>
</tr>
<tr>
<td>Bahiagrass</td>
<td>Paspalum notatum</td>
<td>0.2-0.5</td>
<td>Good</td>
<td>3-5”</td>
</tr>
</tbody>
</table>

1. Sod depth is the average depth of the sod pack. 2. Tolerance is a rating of the level of tolerance to drought, shade, soil compaction, and ease of establishment. 3. Mowing height is the height at which the grass should be mowed to promote healthy growth.

Vetiver is a popular choice to stabilize slopes.
Maintenance

- Irrigate as necessary to establish plants
- Reapply seed mulch or soil as needed
- Maintain other ESC practices until plants fully established

Erosion Control Blankets: Biodegradable or synthetic matting used to cover bare slopes and channels to prevent erosion and help vegetation establish.

Unprotected slope

Protected slope

There are a variety of ECBs types to use depending on slope, flow velocities, durability, and access to supplies.

Consider using on all cut/fill slopes 15% or more.

Installation

1. Grade and compact area first
2. Remove debris (needs ground contact)
3. Amend top 2-3 inches of soil, add fertilizer, seed
4. Install per manufacturer’s instructions
   - Dig anchor trench at top
   - Secure blanket in trench and backfill
   - Install vertically down slope
   - Overlap edges
   - Fasten per instructions
   - DO NOT STRETCH
Combination of blankets with coir logs to establish vegetation on bank.

What is wrong with the installation in this photo?

Maintenance
(not a lot if installed properly)
• Inspect regularly for tears and breaks in fabric
• If slipping, may need to re-stake or re-anchor at top of slope
• Make sure blanket is in contact with the ground to prevent erosion underneath
• Synthetics may degrade in sunlight

Check anchor trench

Displaced mat to be secured or replaced

Pipe Slope Drain: Temporary tubing used to convey runoff safely down a slope. Requires a conversion berm, and should be used in conjunction with other stabilization practices.

Sediment trap
Vegetative stabilization
Berm
Pipe slope drain

Discharge onto a stabilized area
Cutaway to show inlet
Earth berm

Table 4.2: Optimal Pipe Diameter

<table>
<thead>
<tr>
<th>Maximum Drainage Area (acres)</th>
<th>Pipe/Tubing Diameter (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>12</td>
</tr>
<tr>
<td>1.5</td>
<td>18</td>
</tr>
<tr>
<td>2.5</td>
<td>21</td>
</tr>
<tr>
<td>3.5</td>
<td>24</td>
</tr>
<tr>
<td>5.0</td>
<td>30</td>
</tr>
</tbody>
</table>

Design
1. Max drainage is 5 acres
2. Inlet pipe should slope 3% or steeper
3. At least 1-ft of compacted earth on top of pipe inlet
Stabilization, Inlet & Outlet Protection

**Installation**
1. Direct flows with berm to pipe slope inlet
2. Slope inlet to prevent pooling
3. Cover top of inlet
4. Watertight pipe connections
5. Secure to slope with stakes
6. Discharge to stable outlet

**Common Problems**
- Runoff not properly diverted to pipe inlet
- Back up occurs at top of slope
- Slope not stabilized
- No discharge to stable area

**Maintenance**
- Follow up inspection after storm events
- Repair as needed

**Inlet Protection**
Objective: Keep sediment out of inlets, but still let water in

- Fabric
- Block & rock
- Wattles
- Inserts

What features do you notice with this slope drain?
**What inlet protection is occurring here?**

Inlets come in a variety of shapes and sizes, and materials available often determine your creativity! Does this one work?

**Filter Fabric Installation**
1. Use approved fabric
2. Reinforce with wire mesh if necessary
3. Stake as close as possible to inlet
4. Trench fabric and backfill
5. Alternative to add mesh and/or rock filter

**Block and Rock Inlet Protection**

**Excavated Drop Inlet Protection**
Raised inlet and use of filter cloth to block inlet

Filter fabric protection will clog and/or tear if not maintained

Raised ponding height

Install Block/Rock
1. May vary, be creative
2. Place blocks across opening (allow water to pass)
3. Insert wire mesh
4. Pile rock outside mesh (filter)

Install wattles per manufacturer’s instructions. Extend 1 ft beyond either end of inlet opening

Correct
Incorrect in so many ways
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Stabilization, Inlet & Outlet Protection

Common Problems
- Not installed or maintained correctly
- Don’t allow for water overflow
- Filter media not sufficient

Maintenance
1. Check after each rain storm
2. Make repairs as needed
3. Remove sediment when storage is ½ full or accumulation on curb significant
4. Remove when drainage area fully stabilized

Water still needs to be able to overflow into inlet to prevent flooding problems during large rain events.

Outlet Protection
Objective: Prevent erosion at point of discharge by slowing and spreading flow

Rock Outlet Protection: Rocks placed around outlet pipes to stabilize pipe and slow/spread concentrated discharges

Rock apron slows flow and collects sediment

Prevent erosion around pipe

Is this inlet protected?

Unprotected

Protected

Clemson University
Rock outlet protection

Installation
1. Prepare subgrade as directed
2. Use rock riprap of specified size
3. Apply layer of filter fabric between rock and soil
4. Apply rock in one operation carefully to avoid damage to fabric
5. Hand placement for finishing work
6. Apron should be straight and flat

Maintenance
- Generally low
- Inspect after high flows for evidence of scour
- Replace dislodged rocks
- Repair immediately if problem

Sheet flow

Outfall with headwall

Rock aprons should be straight and flat to slow flow and distribute flow uniformly

Outlets without a headwall

Concentrated discharges into highly erodible soil can be a challenge.

Filter fabric should go under rock apron.

Nice use of dissipation pool at outlet.

Probably not enough space to slow/spread flow out at discharge point.
**Level Spreader:** Practice used to change concentrated discharges into non-erosive sheet flow

**Installation**
1. Do not install on fill or above 10% or greater slope
2. Spreader channel should be 6 inches deep or more
3. Lip to be reinforced grass/mat (low flow), timber or concrete (high flow)
4. Discharge to stable low slope area

**Maintenance**
1. Low if properly installed
2. Inspect regularly for sediment removal or erosion at discharge

**Common Problems**
- Flow into level spreader should not have a lot of sediment in it
- Lip needs to be uniform and level
- Used before stabilized

**Do not use until area below spreader has been stabilized**

**Applying ESC Practices to Road Projects**

1. Inlet protection
2. Sediment barriers/perimeter control
3. Outlet protection
4. Traffic management
5. Check dams in roadside ditches
6. Slope stabilization
7. Stockpile management/designated storage
These ESC practices divert road runoff under exposed sediment to discharge in a trap. Adjacent wetlands are protected by silt fence.

How could you apply ESC practices on this project?

For the exam, you should know:

- Purpose of stabilization practices and inlet/outlet protection devices
  - Stabilization – To prevent erosion of bare soils and slopes
  - Inlet protection – To let water pass, but keep sediment out
  - Outlet protection – To prevent erosion at discharge points by slowing and spreading flow
- Timeframe for when you need to stabilize exposed, un-worked soils
- How they work and why they may fail
- Basic installation procedures
- Basic maintenance requirements for practices
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Maintaining and Closing Projects

Outline

1. Inspections and maintenance
2. Managing trash, supplies, and materials
3. Removing temporary ESC practices
4. Permanent stormwater management

1. Inspections and Maintenance

Contractors and inspectors are responsible for ensuring practices are installed, maintained, and operating properly.

Inspector

Contractor

Compliance for Commonly Used ESC Practices

<table>
<thead>
<tr>
<th>Practice</th>
<th>Installed</th>
<th>Properly Maintained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt Fence</td>
<td>67%</td>
<td>34%</td>
</tr>
<tr>
<td>Sediment Trap</td>
<td>86%</td>
<td>58%</td>
</tr>
<tr>
<td>Stable entrance</td>
<td>89%</td>
<td>67%</td>
</tr>
</tbody>
</table>

It helps if you:
- Include ESC maintenance $ in budget
- Designate on-site contractor for maintenance
- Set self-inspection schedule

Relative Maintenance Burden

<table>
<thead>
<tr>
<th>Practice</th>
<th>High</th>
<th>Med</th>
<th>Low</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt fence</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Daily</td>
</tr>
<tr>
<td>Stable entrance</td>
<td>✓</td>
<td></td>
<td></td>
<td>Daily</td>
</tr>
<tr>
<td>Berms/swales</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td>Check dams</td>
<td>✓</td>
<td></td>
<td></td>
<td>After rain event</td>
</tr>
<tr>
<td>Traps/basins</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>When ½ full</td>
</tr>
<tr>
<td>Erosion mats</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inlet protection</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rock outlet</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level spreaders</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Why do you think silt fences have one of the highest maintenance burdens...?
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**Maintaining and Closing Projects**

**Routine maintenance by workers**
- Removing sediment tracked on road
- Repair torn fabrics in fencing, inlet protection, and erosion control matting
- Replace natural area protective fencing
- Replace rocks from entrances, check dams, and outlet protection
- Repair diversions daily if disrupted by construction activities
- Fill gullies and rills
- Irrigate vegetation
- Remove sediment behind sediment barriers, check dams, and in trapping devices

---

**Assess ESC Practices After Storms**

Objectives:
- Repair the damage done during storm events
- Prepare ESC practices for the next storm

Techniques:
- Modify ESC plans
- Reinforce or cleanout existing practices

---

**Inspectors should:**
- Know the ESC plan
- Inspect at required frequency (14 days, after storm events, installation, final)
- Evaluate practice effectiveness
- Identify corrective actions
- Concentrate on areas with highest failure potential:
  - Where sediment can build up
  - Concentrated flow areas
  - Steep cut and fills
  - Around outfalls
- Document conditions and required actions
- Notify/provide report copies to all parties
- Follow up with enforcement

---

**Document with approved inspection report, take photos, describe corrective actions to be taken and timeframe for completion**

---

**Inspectors should follow up on repair jobs...**
**Commonly Observed Problems**

- No ESC plan
- Improper installation and/or substitution of practices
- Lack of proper maintenance — biggest cause of failure!!
- Lack of temporary and permanent stabilization:
  - Proper use of erosion control blankets and vegetation could greatly reduce amount of eroded sediment
  - Most severe on-site erosion takes place at cut and fill slopes, yet these areas tend to be least properly stabilized

---

- Sediment behind check dams should be removed when reaching 1/2 height of check dam
- Sediment behind silt fences should be removed when reaching 1/3 height of fence

---

Which one shows good maintenance?

Good or Bad?
2. Trash, Supplies, and Materials

Goal:
- Keep debris and contaminants out of contact with stormwater
- Improve worker safety
- Save money
- Comply with SWPPP

- Cover waste, stockpiles, supplies to protect from wind and stormwater
- Manage designated wash, fuel, servicing, storage areas
- Store hazardous materials in containment unit
- Have spill response plan
- Recycle or reuse waste materials

Establish designated storage areas

Locating storage areas adjacent to unprotected stream channels is not good.

Once it hits the ground, trash usually never makes it to the dumpster…
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Maintaining and Closing Projects

3. Removing ESC Practices

No site can be closed out until:
- Temporary practices removed
- Permanent stormwater management in place
- Construction waste removed/properly disposed
- Vegetation established on all bare soil areas
- All ditches and slopes are stable
- Final inspection

When removing ESC practices

- Remove accumulated sediments from practices, dispose of properly and use a dewatering practice when necessary
- Fill in, re-grade, re-seed where necessary
- Do not remove inlet protection until drainage area is stable (~30 days) and permanent practices are ready
- Remove perimeter controls
- Clean culverts and inlets
- Stabilize ditch banks and bottoms
- Remove loose or excess erosion control blankets, re-seed bare areas

When converting sediment basins to permanent stormwater practices

- Remove accumulated sediment
- Dispose of sediment properly; if basin is wet, use an appropriate dewatering practice
- Regrade to new post-construction specifications as designed
- Replace/install water quality risers for detention basins
- Add appropriate media, underdrains, media, and vegetation for filtration practices
- Stabilize banks, inlets, and outlets
- Submit “as-built” to approval authority

What needs to be done to this sediment basin before it can be used for post-construction stormwater?
4. Permanent Stormwater Management

- Install permanent practices as designed
- Protect practices from sediment during construction activities
- Maintain drainage paths during final site grading and paving
- Make sure all permanent practices are inspected before temporary practices are removed
- Remove sediment and debris before “turning on” practices

During construction, protect practices from sediment which can clog infiltration devices.

Conversion of sediment basins to permanent ponding basins should be according to approved engineering design.

This basin is accepting stormwater tourists before site has been cleaned, and final vegetative stabilization has been completed.

2 years later...this pond is overgrown...

Make sure you get final grading, paving, and inlet location correct...
These inlets are not located at the low points of this parking lot

Do not "turn on" permanent drainage until site is stabilized and your permanent stormwater practices are in place...

What you should know for exam

- Maintenance requirements for various practices
- Routine maintenance and when to inspect
- Techniques for managing waste materials and construction supplies
- What has to happen before removing ESC practices
- How to go from temporary to permanent stormwater management
BREAK
Guam Erosion and Sediment Control (ESC) Training
Designing an ESC Plan: Group Exercise

Task 1 – Review the site plan and use highlighters to identify the following features:

☐ Use the blue highlighter to outline the stream and stream buffer (100 feet for this site). What is the minimum required stream buffer in Guam? ________________

☐ Locate the **proposed** tree line and highlight with green.

Is this also the limit of disturbance? **Yes** or **No** (circle one)

☐ Identify the highest point on the site and mark it with an “X.”

☐ Locate the proposed storm sewer system and highlight it with orange.

☐ Locate areas of cut and fill slopes, highlighting them with yellow and pink, respectively.

Task 2 – How do you propose to show the limit of disturbance in the field before mass clearing and grading.

______________________________________________

______________________________________________

Task 3 -- Determine the best location for a Stabilized Construction Entrance.

☐ Draw it on the plan to scale, using at least the required minimum dimensions and the appropriate symbol from the ESC legend.

☐ Create a basic cross-section for the practice on the plan in the space provided.

Task 4. Identify and add to the plan an appropriate Materials Stockpile location.

☐ What practices will you use to protect the stockpile? Draw them on the plan.

______________________________________________

______________________________________________
Task 5 – How will you move runoff through the site?

☐ Locate areas up-gradient from the site where “clean” water will flow onto the site during construction. How should this water be handled? Sketch in any ESC practice you recommend to keep this clean water off the construction site and identify on plan using the appropriate symbol from the ESC legend.

☐ The site plan shows two proposed entrances that cross streams. Sketch on the plan how you propose to temporarily divert the stream during construction and create a detail for the practice(s) on the plan in the space provided.

Task 6 – Design a Temporary Settling Device.

☐ The Site Plan shows a post-construction stormwater practice (“Biofilter”) in the bottom left corner. Is this the best place for a temporary settling device? Why or why not?

☐ The drainage area to this practice is 3.04 acres. Would this need to be designed as a Sediment Trap or a Sediment Basin? (circle one)

☐ The volume of this practice as proposed is 20,000 cubic feet. Is this big enough to meet the required volume? Calculate the required volume here:

Yes or No (circle one)

☐ Does this practice meet the required length-to-width ratio? Yes or No (circle one)

☐ How do you propose to convey dirty runoff from the proposed roadway to the temporary settling device before the storm sewer is constructed? Show these measures on the plan using the appropriate symbol(s) from the ESC legend.
Task 7 – How do you propose to stabilize steep slopes?

☐ Determine the method that you would recommend to temporarily stabilize the cut and fill slopes before the permanent storm drain system is in place. Add locations on the plan using the appropriate symbol(s) from the ESC legend.

☐ Determine the method that you would recommend to provide stabilization for the slopes AFTER the storm sewer is installed and functioning (for permanent stabilization).

Task 8 – The permanent stormwater system includes drain inlets in the parking lots. What kind of inlet protection do you propose?

☐ Circle all proposed inlets and draw in arrows that indicate the direction of flow for all storm sewer pipes.

☐ Assuming that these will be curb inlets, what inlet protection practice would you recommend?

Task 9 – Determine the outlet protection practice(s) needed at this site and identify on the plan using the appropriate symbol(s) from the ESC legend.
Task 10 -- Sequence of Construction Scramble

This site is proposed to be constructed in 2 phases. Unscramble the following Sequence of Construction within each phase to show the correct sequence by putting the appropriate sequence number (1, 2, 3, etc).

**Phase 1: Site Access & Preparing for Site Grading**

☐ After road crossing embankment is in place, install outlet structure and grade embankment for permanent stormwater BMP (shown as “Proposed Biofilter” on plan) so that this can function as a temporary sediment basin. Stabilize immediately with seed and straw.

☐ For the construction site, install all temporary diversion dikes and level spreaders to divert upgradient clean water around the construction site and release it in a non-erosive manner.

☐ Create temporary stream diversion channel so that the road crossing of stream can be installed. Install culvert and outlet protection in dry conditions. Direct upstream flow through culvert and remove stream diversion. Grade road crossing embankments and stabilize with erosion control matting.

☐ Install construction entrance at the location shown on the plan.

**Phase 2: Site Grading, Install Storm Sewer System, Stabilization**

☐ Perform necessary grading operations for the site. Seed and apply erosion control matting to all slopes with a 3:1 grade or steeper. BEFORE the storm sewer system is in place, use temporary fill diversions and slope drains for newly graded slopes to convey runoff down the face of graded slopes.

☐ Once the site is adequately stabilized with vegetation, as approved by the erosion and sediment control inspector, complete conversion of temporary sediment basin to permanent biofilter. Remove all temporary erosion and sediment control measures.

☐ After the storm sewer system is in place, complete the remainder of site construction (other than proposed biofilter areas) in accordance with the site development plan.

☐ Install proposed storm sewer system as shown on the plan. Apply inlet protection at each inlet. Construct proposed curbing to ensure conveyance to storm sewer inlets. Remove temporary fill diversions and slope drains as needed.

☐ When all site disturbed areas have been seeded and mulched, conduct grading to convert temporary sediment basin to permanent biofilter. DO NOT INSTALL BIORETENTION UNDERDRAIN OR SOIL MIX.

☐ Stabilize all disturbed areas with permanent seeding and mulch.
Guam ESC Training
Reading an ESC Plan: Group Exercise Handout

Task 1 – Review the Site Plan and use colored highlighters to identify the following items:

- Use the blue highlighter to outline the stream and stream buffer.
- Locate the proposed tree line and highlight with green. What else is located in the same place as the proposed tree line?
- Identify the highest point on the site and mark it with an “X.”
- Locate the proposed storm sewer system and highlight it with orange.
- Locate the following ESC measures and highlight them with yellow:
  - construction entrance
  - materials stockpile area
  - inlet protection
  - pipe slope drain
  - level spreaders
  - diversion and temporary dikes
  - outlet riprap protection
  - sediment basin

Task 2 – How is runoff and stream flow conveyed?

- Draw a flow path from the highest point on the site to the stream. What practices are used to divert this “clean,” offsite runoff around the site?
- What practices convey runoff through the site and into the sediment basin?
- What ESC practices should be used during construction of the new culverts?

Task 3 – Review the construction sequence. Indicate which step in the sequence the following activities belong (for example, “construction entrance” belongs in Step 1 of the sequence):

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<tr>
<th>Sequence Step</th>
<th>Clearing of site</th>
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<td>Removal of all temporary ESC Measures</td>
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Task 4 – Locate and circle the Maintenance section of the notes. When should sediment be removed from behind the silt fences at this site?

Task 5 – Review the Erosion and Sediment Control Notes. According to #6, who is responsible for the installation of any additional ESC measures required at the site?

Task 6 – Review the detail for a diversion dike. What is the minimum height for the dike? Should the dike be compacted? Yes or No (circle one).

Additional Notes:
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Other notes: