LINEAR CONSTRUCTION: Planning and Design of Erosion and Sediment Control

2015 NDWPCC Stormwater Workshop

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Site planning

Planning and designing for erosion and sediment control

- Soil loss prediction
- Hydrologic analysis
- Critical areas

Site visits are important
Critical areas

Identify areas with higher erosion potential

- Slopes
- Soils
- Poor vegetation establishment
Phasing

Amount of disturbed and unprotected ground
  ◦ Weather and seasonal considerations
Natural topography

Fit to current topography as much as possible
  ◦ Minimize cut and fill
Control surface water

Interceptor ditches and berms
Retain natural vegetation
RUSLE & RUSLE2

Soil prediction models
- *USLE* developed in 1965
- *RUSLE* improved several factor estimates
- Rill and interrill erosion

\[ A = RKLSCP \]
**RUSLE & RUSLE2**

R factor: Rainfall-runoff erosivity

- Function of rainfall amount, intensity, and climate
- Splash erosion contributing factor
- Isoerodent maps
RUSLE & RUSLE2

K factor: Soil erodibility
- Soil texture
- Structure
- Permeability
RUSLE & RUSLE2

$LS$ factor: Length-slope factor

- Function of horizontal length of slope and percent slope
- Deposition area
**RUSLE & RUSLE2**

*C factor: Cover management*

- Multiple types of cover can be analyzed
RUSLE & RUSLE2

$P$ factor: Practices

- Vegetated strips, silt fence, sediment basins
RUSLE & RUSLE2

Pre-construction vs. post-construction

Construction phase:
- Changes to topography
- Erosion on bare soil with no protection
- Erosion with combination of control measures
### Initial Clearing and Grubbing

<table>
<thead>
<tr>
<th>Site</th>
<th>Area Description</th>
<th>Land Area (acres)</th>
<th>R for Phase Period (May 1 to June 1)</th>
<th>Soil Factor, $K$</th>
<th>Length Slope Factor, $LS$</th>
<th>Cover Factor, $C$</th>
<th>Calculated Unit Area Soil Loss, $A$ (tons/acre/period)</th>
<th>Calculated Total Area Soil Loss (tons/period)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Undisturbed area (L=100, S=4%)</td>
<td>3.2</td>
<td>2.84</td>
<td>0.15</td>
<td>0.55</td>
<td>0.01</td>
<td>0.002</td>
<td>0.01</td>
</tr>
<tr>
<td>2</td>
<td>Ramp (L=1,000, S=4%)</td>
<td>0.92</td>
<td>2.84</td>
<td>0.32</td>
<td>1.86</td>
<td>0.05</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>3</td>
<td>Main embankment, active construction (L=300, S=10%)</td>
<td>2.1</td>
<td>2.84</td>
<td>0.28</td>
<td>3.09</td>
<td>1.0</td>
<td>2.46</td>
<td>5.2</td>
</tr>
<tr>
<td>4</td>
<td>Side slope (L=50, S=15%)</td>
<td>0.7</td>
<td>2.84</td>
<td>0.21</td>
<td>1.52</td>
<td>0.07</td>
<td>0.06</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total Tons =</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>5.29</strong></td>
<td></td>
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</tbody>
</table>

### Rough Grading

<table>
<thead>
<tr>
<th>Site</th>
<th>Area Description</th>
<th>Land Area (acres)</th>
<th>R for Phase Period (June 1 to Sept 30)</th>
<th>Soil Factor, $K$</th>
<th>Length Slope Factor, $LS$</th>
<th>Cover Factor, $C$</th>
<th>Calculated Unit Area Soil Loss, $A$ (tons/acre/period)</th>
<th>Calculated Total Area Soil Loss (tons/period)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Undisturbed area (L=100, S=4%)</td>
<td>3.2</td>
<td>63.19</td>
<td>0.15</td>
<td>0.55</td>
<td>0.01</td>
<td>0.05</td>
<td>0.17</td>
</tr>
<tr>
<td>2A</td>
<td>Ramp, active construction (L=500, S=5%)</td>
<td>0.46</td>
<td>63.19</td>
<td>0.47</td>
<td>1.71</td>
<td>1.0</td>
<td>50.79</td>
<td>23.36</td>
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<tr>
<td>2B</td>
<td>Ramp (L=250, S=3%)</td>
<td>0.23</td>
<td>63.19</td>
<td>0.39</td>
<td>0.64</td>
<td>0.2</td>
<td>3.15</td>
<td>0.73</td>
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<tr>
<td>2C</td>
<td>Ramp (L=250, S=1%)</td>
<td>0.23</td>
<td>63.19</td>
<td>0.33</td>
<td>0.19</td>
<td>0.2</td>
<td>0.79</td>
<td>0.18</td>
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<tr>
<td>3A</td>
<td>Main embankment, active construction (L=300, S=15%)</td>
<td>1.6</td>
<td>63.19</td>
<td>0.25</td>
<td>5.63</td>
<td>1.0</td>
<td>88.94</td>
<td>142.30</td>
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<tr>
<td>3B</td>
<td>Main embankment (L=100, S=25%)</td>
<td>0.5</td>
<td>63.19</td>
<td>0.22</td>
<td>4.59</td>
<td>0.02</td>
<td>1.28</td>
<td>0.64</td>
</tr>
<tr>
<td>4</td>
<td>Side slope (L=50, S=15%)</td>
<td>0.7</td>
<td>63.19</td>
<td>0.21</td>
<td>1.47</td>
<td>0.06</td>
<td>1.17</td>
<td>0.82</td>
</tr>
<tr>
<td></td>
<td><strong>Total Tons =</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>168.20</strong></td>
<td></td>
</tr>
</tbody>
</table>
RUSLE & GIS

Source: Soo Huey The (2011). Soil erosion modeling using RUSLE and GIS on Cameron Highlands, Malaysia for hydropower development, Master’s Thesis, University of Iceland & University of Akureyri
Design of ESC Measures

Information from site visit and *RUSLE*
  ◦ More detail for critical area (soil samples, etc.)

Manufacturer charts and data are a great place to start but should always consider requirements
  ◦ 2-yr, 24-hr storm event
Increasing Velocity and Shear Stress

Velocity: 7.6 m/s (25 ft/s)
Shear Stress: 480 N/m² (10 psf)
Tensile Strength: 43.8 kN/m (3000 lb/ft)

Velocity: 1.5-1.8 m/s (5-6 ft/s)
Shear Stress: 96 N/m² (2.0 psf)

Image courtesy of:
Western Excelsior Corporation
Design of ESC Measures

Technical resources and testing:
◆ ECTC
◆ USDA
◆ FHWA
◆ AASHTO NTPEP

Software options (from manufacturers):
◆ ECMDS
◆ ErosionWorks
Design of ESC Measures

Avoid “cookie-cutter” plans

Monitor performance of design
  ◦ During and after construction

Communication is key!
Questions?