EROSION AND SEDIMENT CONTROL DESIGN:

Session 3 – Sediment Basins

ENVIRONMENTAL, STORMWATER, AND RIGHT-OF-WAY TRAINING

DECEMBER 10, 2014
Sediment basins

Structures that impound water and allow sedimentation of finer particles

Stormwater quality:

- Total suspended solids (TSS)
- Pollutants (heavy metals, nutrients, chemicals)

Stormwater quantity:

- Slow release of stormwater
<table>
<thead>
<tr>
<th>Particle Diameter (microns)</th>
<th>Settling Velocity</th>
<th>Time to Settle 1 foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel 1.67 – 3.33 ft/sec</td>
<td>0.3 – 0.6 seconds</td>
<td></td>
</tr>
<tr>
<td>Sand 0.008 – 0.33 ft/sec</td>
<td>3 – 120 seconds</td>
<td></td>
</tr>
<tr>
<td>Silt 0.02 – 0.03 ft/min</td>
<td>30 – 60 minutes</td>
<td></td>
</tr>
<tr>
<td>Clay 0.005 – 0.010 ft/day</td>
<td>100 – 200 days</td>
<td></td>
</tr>
<tr>
<td>Colloids 0.02 – 1.6 ft/year</td>
<td>&gt;200 days</td>
<td></td>
</tr>
</tbody>
</table>
Sediment basins

How do sediment basins work?

\[ \nu = \frac{Q_{out}}{A} \]

Where,

\( \nu = \) particle settling velocity (ft/sec)
\( Q_{out} = \) pond outflow rate (ft\(^3\)/sec)
\( A = \) surface area of pond (ft\(^2\))
Sediment basin considerations

Final design based on pre/post development conditions and future use of basin

- Stage-area-storage-discharge relationships

\[ I - O = \frac{\Delta S}{\Delta t} \]

- Receiving waters
Sediment basin considerations

Stage-storage relationship:

![Stage-storage relationship diagram]
Sediment basin considerations

Stage-discharge relationship:

![Graph showing stage-discharge relationship](image-url)
Sediment basins

General design criteria:

- Drainage area: 10 to 100 acres
- Minimum storage capacity: 3,600 ft³/acre of drainage area
- L/W ratio: 2:1 to 6:1
- Primary outlet: Weir or riser
- Emergency outlet: Spillway (capacity for 25-yr, 24-hr storm event)
- Design life: Temporary basin should be 3 years or less
Sediment basins

Parts of a sediment basin:

- Sediment Storage
- Permanent Storage
- Water Quality Storage
- Additional Storage (25-yr, 24-hr storm)
- Freeboard (1 ft minimum)
Primary outlets

Weirs:
- Rectangular
- V-notch
- Vertical risers
Primary outlets

Dewatering devices:

– Skimmers
– Flashboard risers
Basin design

Location of the basin:

- Never locate in natural drainage ways (perennial streams, wetlands, etc.)
- Should be placed to receive the maximum amount of runoff from the site
- Divert run-on to avoid travel through the basin
- Discharge point
Basin design

Sizing of a temporary sediment basin:

- Factors to consider for each part of the basin:
  - Length, width, side slopes, depth
  - Water quality storage should consider outflow rate of primary outlet
  - Emergency spillway and freeboard for safety
Basin design

Permanent pool sizing:

- Provide 3,600 ft$^3$ of storage below the outlet pipe per acre drained to the basin
- Provide storage for runoff from a 2-yr, 24-hr storm event and provide at least 1,800 ft$^3$ of storage for each acre that drains to the basin (minimum)
- Depth of permanent water pool should be at least 3 ft. to prevent re-suspension of settled particles from incoming stormwater
## Basin design

### Water quality storage:

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Clayey soils</th>
<th>Sandy soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paved areas</td>
<td>1.1 in.</td>
<td>1.1 in.</td>
</tr>
<tr>
<td>Undeveloped areas</td>
<td>0.3 in.</td>
<td>0.1 in.</td>
</tr>
<tr>
<td>Construction areas</td>
<td>0.6 in.</td>
<td>0.5 in.</td>
</tr>
</tbody>
</table>

### Basin design

#### Example:

**Water quality storage:**

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Soil Type</th>
<th>Land Area (ac)</th>
<th>Water Quality Factor (in)</th>
<th>WQ Storage (ac-in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paved area</td>
<td>Clayey</td>
<td>1.4 X</td>
<td>1.1</td>
<td>= 1.54</td>
</tr>
<tr>
<td>Undeveloped area</td>
<td>Sandy</td>
<td>0.5 X</td>
<td>0.1</td>
<td>= 0.05</td>
</tr>
<tr>
<td>Construction area</td>
<td>Clayey</td>
<td>15.0 X</td>
<td>0.6</td>
<td>= 9.00</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>= <strong>10.59 ac-in</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>= <strong>0.88 ac-ft</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>= <strong>38,442 ft³</strong></td>
</tr>
</tbody>
</table>
Basin design

Sizing of primary outlet to capture design size particle

Example:

Water quality storage:

- Calculated surface area at top of water quality storage is 0.75 acres
- Depth of 1.5 ft

Select primary outlet for 5µ particle size
5μ particle size settling velocity = 0.000131 ft/sec

Try 60° V-notch weir with 1.5 ft of head

\[ Q_{out} = 1.43H^{2.5} \]
\[ = 1.43(1.5)^{2.5} \]
\[ = 3.941 \text{ ft}^3/s \]

\[ A = \frac{Q_{out}}{v} \]
\[ = \frac{3.941}{0.000131} \]
\[ = 30,081 \text{ ft}^2 \]
\[ = 0.69 \text{ acres} < 0.75 \text{ acres} \]
Basin design

Emergency spillway is sized to safely pass the 25-yr, 24-hr design storm

- Based on $Q_{Peak}$ at the basin location
- Typically a rectangular weir

Freeboard (minimum of 1 ft.) above the 25-yr, 24-hr design storm water level
Basin design

Protection of basin:

- Inlet to the basin and outlet from basin should minimize velocity of water and protect against further erosion
- Embankments should be stabilized with vegetation to prevent erosion
- Emergency spillway typically requires a flexible lining or hard armor
Cleanout

Settled sediment should be removed to maintain capacity of basin

- May be necessary multiple times during the life of the project
- Should design sediment basin to allow access for cleanout
Additional features

Baffles increase the flow length and reduce velocity of flow through basin
Additional features

Forebays create a small detention area before inflow reaches main part of basin
Additional features

Flocculants and coagulants can aid in sedimentation

- Passive vs. active applications