Design of a Silt Fence Alternative

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Customer Need

- Silt fence: reduces sediment leaving disturbed sites
  - Pond runoff
  - Allowing for settling
  - Release effluent
- Significant problems:
  - Incorrect installation
  - Clogging of membrane
  - Downslope erosion/reduced trafficability

Design a comprehensive alternative to current silt fence technology (both product and implementation) that is relatively inexpensive and easy to install while avoiding the major problems of the silt fence.

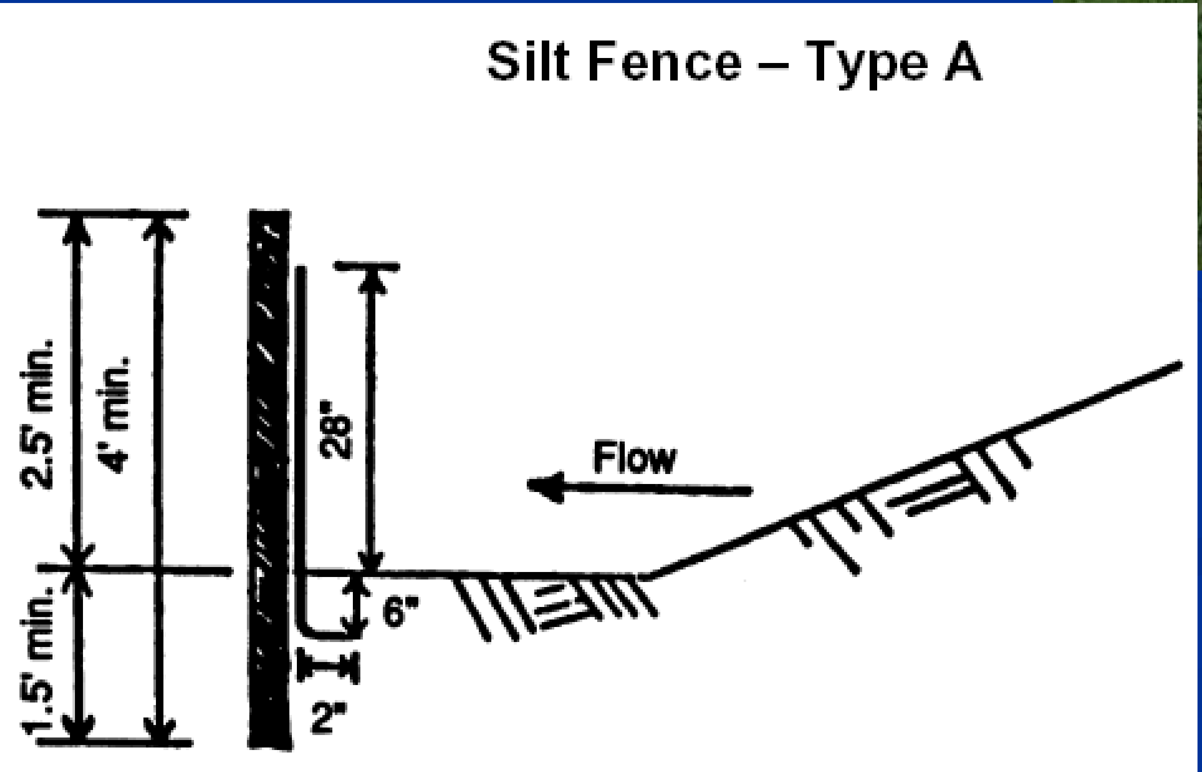
Who Cares?

www.swwrc.wsu.edu/.../images/Sedimentation.jpg

Who Cares?

Silt Fence

- Inexpensive, readily available
- Simple install



Source: TDEC Structural Practices Manual

Silt Fence Problems

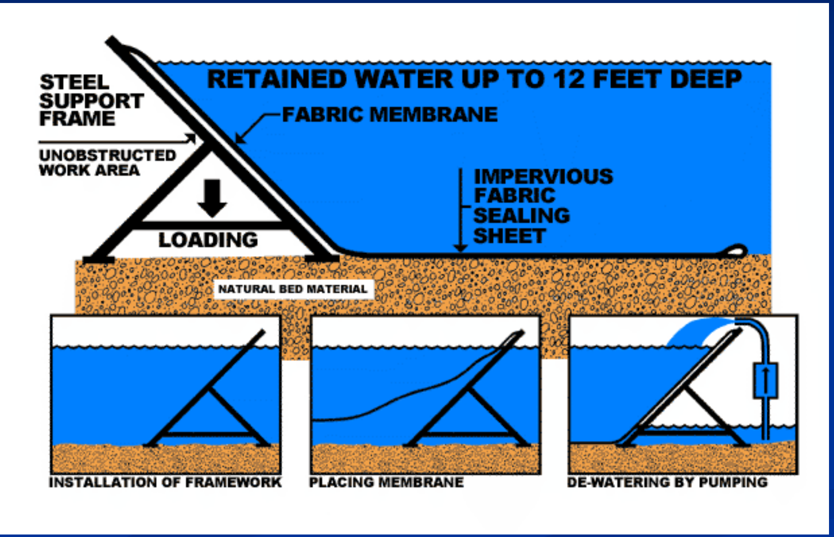
- Ponding, filtering, or diversion?
- Pores of permeable membrane clog
- Contribute to down-slope erosion/reduced trafficability

Performance Criteria

- *Ease of Installation*
- *Sediment Capture Efficiency*
- *Greater Structural Integrity*
- *Required Maintenance between storm events*
- *Reduce Downslope Erosion*
- *Reduce Clogging*
- *Failsafe Overflow Mechanism*
- *Cost-effective*

Conceptual Design

- Comparison of alternatives:
  - Examined flocculants, erosion control blankets, fiber filter tubes, etc
  - Liked settling of basin/skimmer dewatering apparatuses
    - Required on all sites > 10 acres, deemed most effective method
  - Liked *Portadam*/reinforced silt fence
- Hybrid fence/basin apparatus:
  - Reinforced fence structure
  - Impermeable plastic lining
  - Floating skimmer outlet system

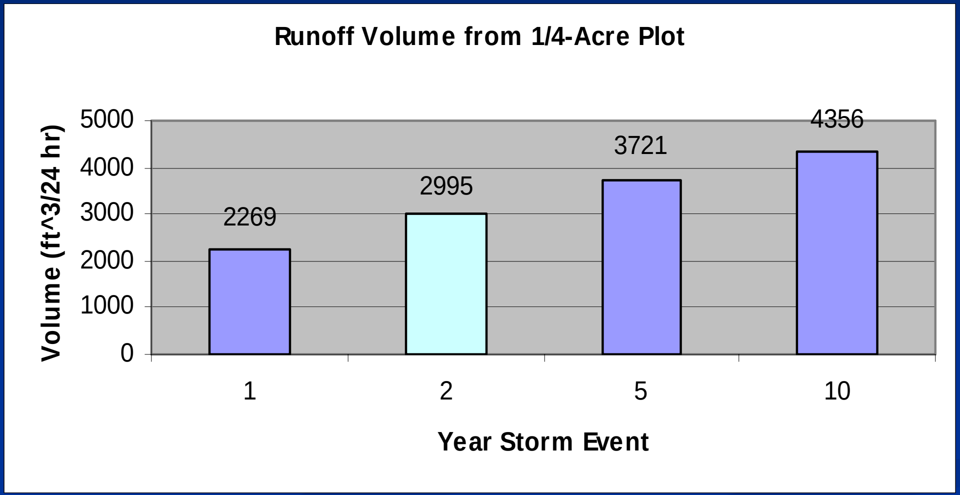


Subsystems

- Runoff detention structure
- Impermeable membrane
- Floating skimmer outlet system
- Emergency overflow

Design Demands

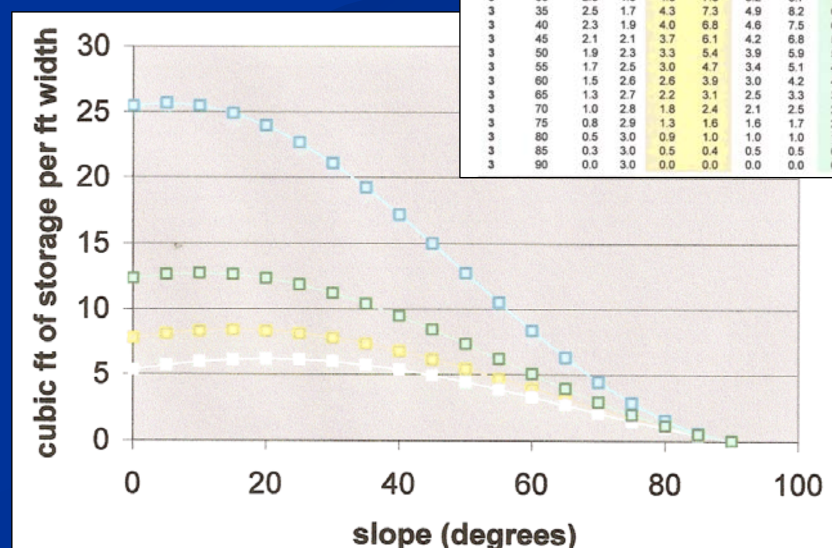
- Knoxville design storm
  - 2 year, 24 hour design storm
  - 2” runoff



City of Knoxville Land Development Manual
Stormwater and Street Ordinance

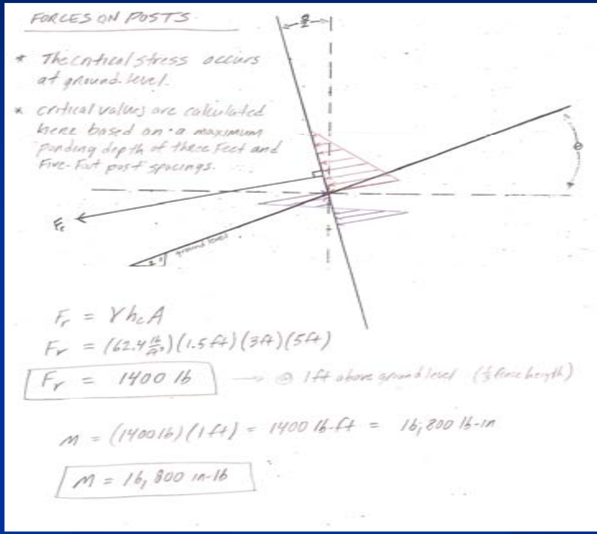
Volumes/Slopes/Spacings

- 100 ft intervals = 25% more work space
- Target Release Rate + Slopes = 3 ft fence



fence section height (ft)	downslope angle from vert (degrees)	water height *h* (ft)	*b* (ft)	***slope 30 degrees*** *a* (ft)	Vol per ft width (ft^3)	***slope 26.56 degrees*** *a* (ft)	Vol per ft width (ft^3)	***slope 20 degrees*** *a* (ft)	Vol per ft width (ft^3)	***slope 10 degrees*** *a* (ft)	Vol per ft width (ft^3)
3	0	3.0	0.0	5.2	7.8	6.0	9.0	8.2	12.4	17.0	25.5
3	5	3.0	0.3	5.2	8.1	6.0	9.3	8.2	12.7	16.9	**25.7**
3	10	3.0	0.5	5.1	8.3	5.9	9.5	8.1	**12.8**	16.8	25.5
3	15	2.9	0.8	5.0	**8.4**	5.8	**9.5**	8.0	12.7	16.4	24.9
3	20	2.8	1.0	4.9	8.3	5.6	9.4	7.7	12.4	16.0	24.0
3	25	2.7	1.3	4.7	8.1	5.4	9.1	7.5	11.9	15.4	22.7
3	30	2.6	1.5	4.5	7.8	5.2	8.7	7.1	11.2	14.7	21.1
3	35	2.5	1.7	4.3	7.3	4.9	8.2	6.8	10.4	13.9	19.2
3	40	2.3	1.9	4.0	6.8	4.6	7.5	6.3	9.5	13.0	17.2
3	45	2.1	2.1	3.7	6.1	4.2	6.8	5.8	8.4	12.0	15.0
3	50	1.9	2.3	3.3	5.4	3.9	5.9	5.3	7.3	10.9	12.8
3	55	1.7	2.5	3.0	4.7	3.4	5.1	4.7	6.2	9.8	10.5
3	60	1.5	2.6	2.6	3.9	3.0	4.2	4.1	5.0	8.5	8.3
3	65	1.3	2.7	2.2	3.1	2.5	3.3	3.5	3.9	7.2	6.3
3	70	1.0	2.8	1.8	2.4	2.1	2.5	2.8	2.9	5.8	4.4
3	75	0.8	2.9	1.3	1.6	1.6	1.7	2.1	2.0	4.4	2.8
3	80	0.5	3.0	0.9	1.0	1.0	1.0	1.4	1.1	3.0	1.5
3	85	0.3	3.0	0.5	0.4	0.5	0.5	0.7	0.5	1.5	0.6
3	90	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Fence Structural Details



Fence Structural Details

Membrane Details

Emergency Spillway

- Spillway:
  - Recommend rectangular weir:
    - 19” x 4”
    - 100 yr, 30 min storm
  - Rip rap

$$Q = C_e \frac{2}{3}\sqrt{2g}(b + K_b)(h + K_h)^{3/2}$$

Floating Skimmer Outlet

Skimmer Flow

- Buoyancy:
  - Water displacement
  - Half as dense as water: floats
- Sized hose using Hazen-Williams formula
  - Outlet 1 ½” below surface when floating
- Flow controlled by outlet or hose?
  - Compared weir/orifice flow with pipe flow calculations
  - Outlet behaves as orifice

Performance Criteria (basis for test tasks)

- *Ease of Installation*
- *Sediment Capture Efficiency*
- *Greater Structural Integrity*
- *Required Maintenance between storm events*
- *Reduce Downslope Erosion*
- *Reduce Clogging*
- *Failsafe Overflow Mechanism*
- *Cost-effective*

Task 1 - Installation

Compare/contrast ease of installation of the SF and OA

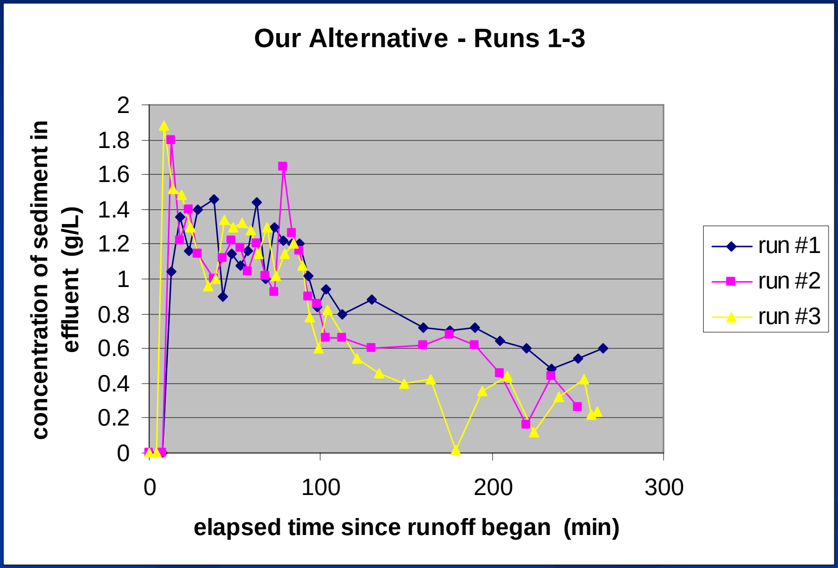
- 2000 ft² Catchment Area
- Installed Manually
  - SF:
    - Trenching difficult
    - Lightweight/few parts
  - OA: *WINNER*
    - Membrane easy to install
    - Bulkier/more complicated

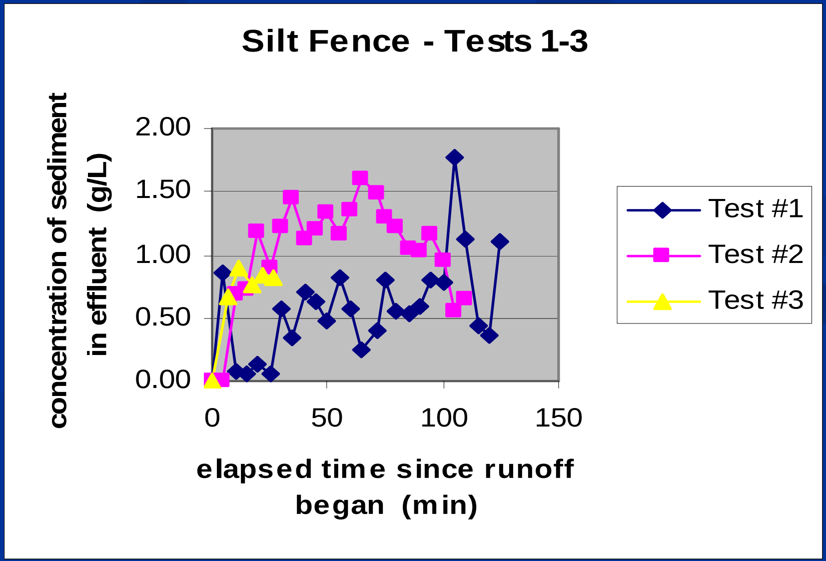
Procedures for Tasks 2-7

- Side by side test (x 3 trials each)
- Document any pertinent observations pertaining to performance criteria
- Simulated 2 yr, 24 hr storm peak runoff period:
  - 48 kg soil
  - 21.5 gpm
- Attempted to keep all storm events for each device as similar as possible

Task 2 – Capture Efficiency

- Average overall capture efficiency
  - OA: 93.0% ***WINNER***
  - SF: 91.5%





Task 3 – Downslope Erosion

Compare the likelihood of the devices causing downslope erosion or poor trafficability

Task 4 - Clogging

Compare the susceptibility of the devices to clogging during sequential events

Task 5 – Structural Integrity

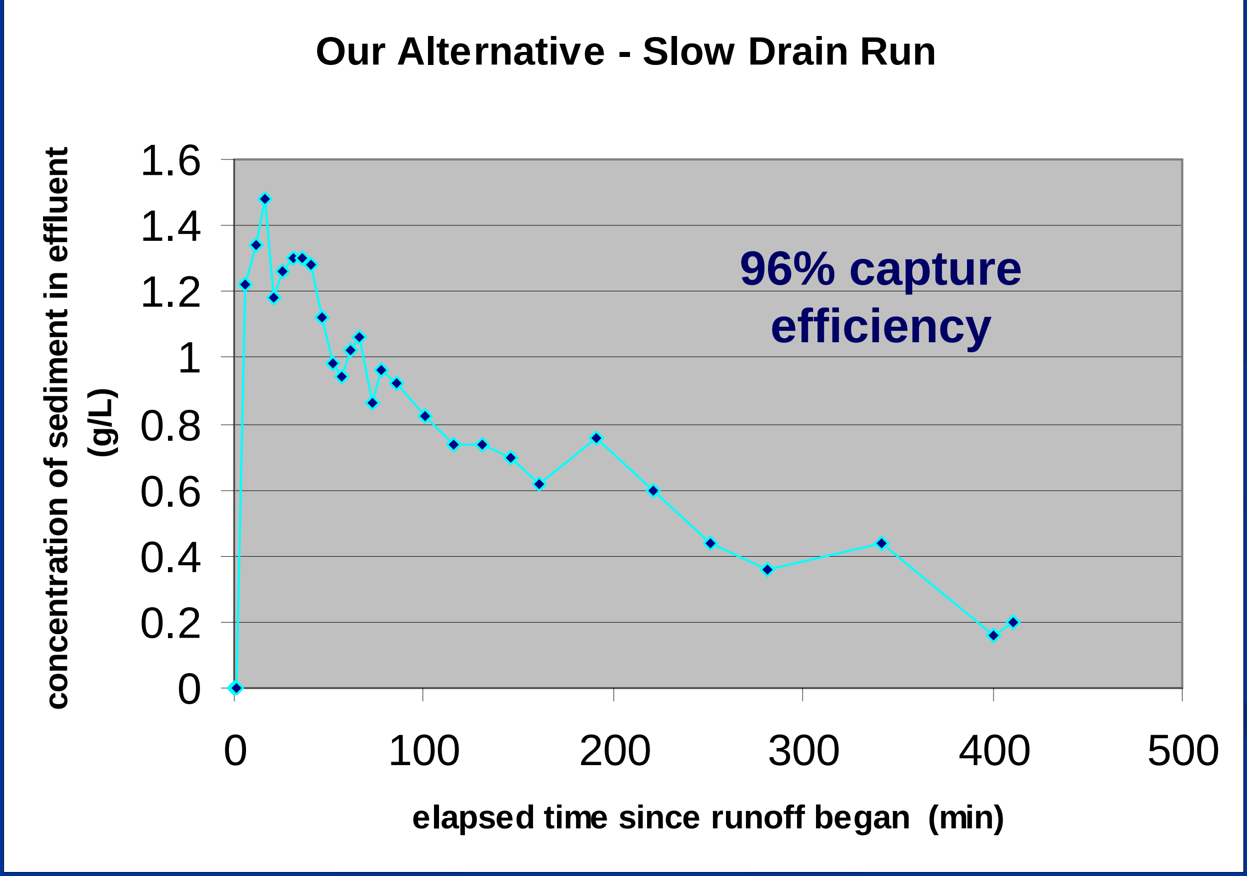
Compare the structural integrity of both devices based on their ability to remain functionally intact over the course of multiple storm events

Task 6 - Maintenance

Compare upkeep and maintenance required between events for each device

Task 7 – Long Detention Run

Obtain a relationship between effluent release rate and capture efficiency for Our Alternative



Task 8 - Economic Analysis

- Cost of materials per 100 ft installation:
  - Assuming installation labor costs equal
    - SF: $30
    - OA: $575

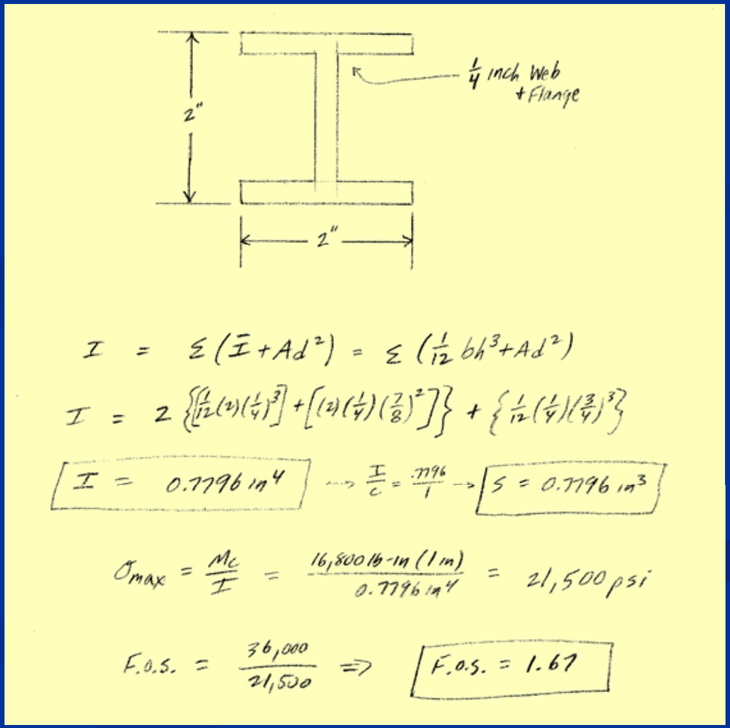
BUT – considering cost of maintenance and materials due to *failures* over the course of a year even when the SF installed correctly, OA an economical alternative

Conclusions

Performance Criteria Winners		
Our Alternative		Silt Fence
✓	*Ease of Installation*	
✓	*Capture Efficiency*	
✓	*Structural Integrity*	
✓	*Maintenance*	
✓	*Downslope Erosion*	
✓	*Reduce Clogging*	
✓	*Overflow Mechanism*	
✓	*Cost Effectiveness*	

2nd Generation Suggestions

- Screen on skimmer to prevent debris from entering outlet
- Custom I-beam
- Longer detention times



Questions?

Our Alternative is Your Alternative.