North Carolina Department of Transportation
Roadside Environmental Unit
Field Operations

NC STATE UNIVERSITY
Bio&Ag ENGINEERING

Level III: Design of Erosion & Sediment Control Plans

- Class materials
  - https://www.bae.ncsu.edu/workshops-conferences/level-iii/
- Certification test (~1.5 hours)
- Test results take 4-7 weeks to get posted

1

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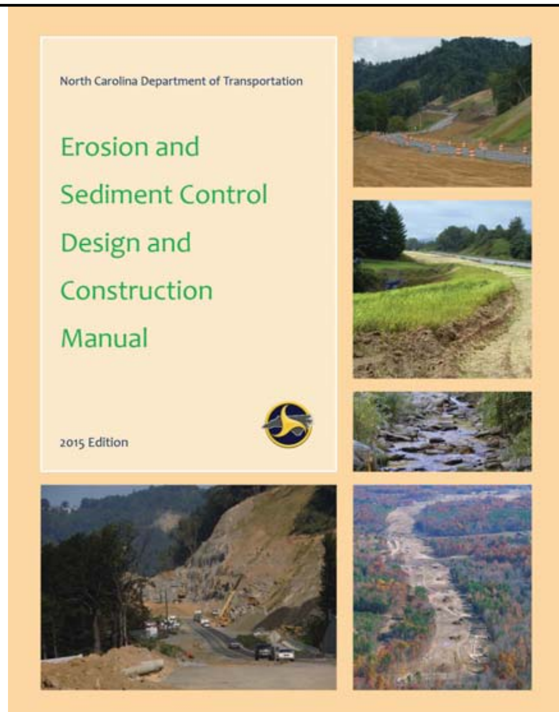
Level III: Erosion & Sediment Certification Design of Erosion & Sediment Control Plans

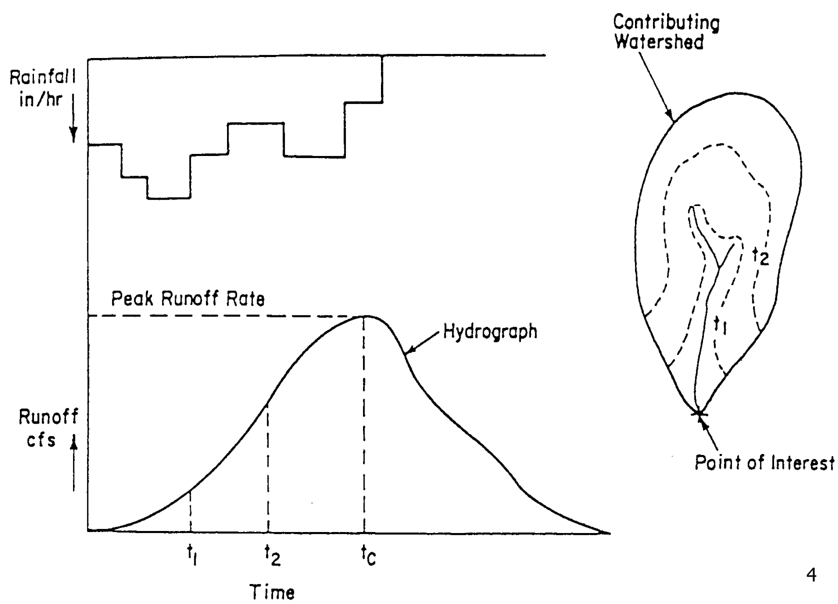
1. Hydrology
2. Erosion
3. Regulatory Issues
4. Open Channel Design
5. Sediment Retention BMPs
6. Below Water Table Borrow Pits

2



3

MODULE 1. Hydrology: Peak Runoff Rate



4

Watershed Definitions

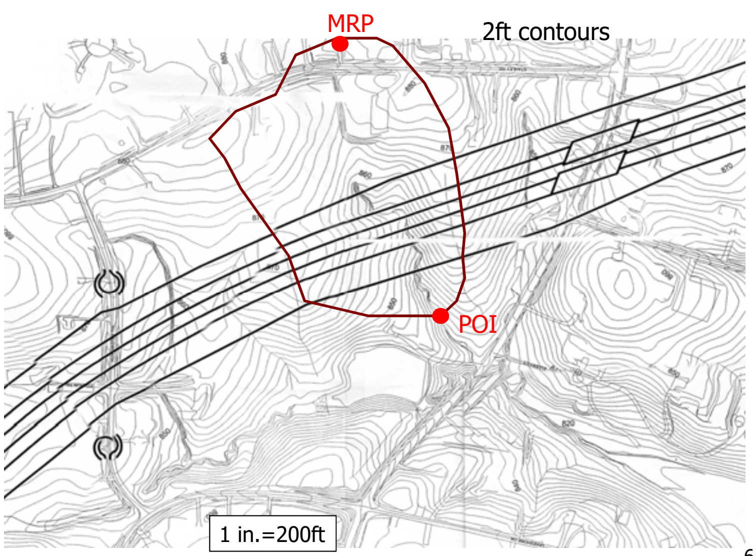
- Water runs down slope and perpendicular to contour lines
- Point of Interest (POI) is the location for which you are computing the runoff/discharge (peak flow for a BMP)
- Most Remote Point (MRP) is the most distant point from the POI
- Watershed drainage area is the total land area that drains to POI (determined from a map)

USGS Topo Maps: topomaps.usgs.gov

ACME Mapper: mapper.acme.com

5

Watershed Delineation



6

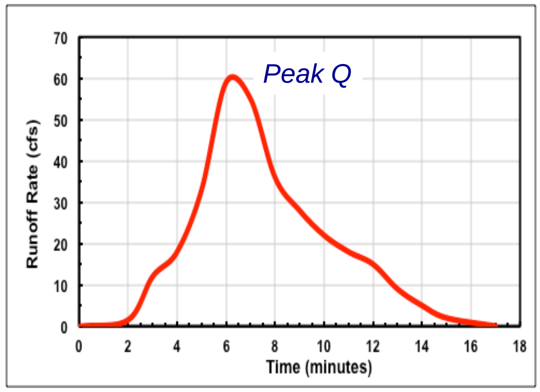
Runoff Hydrograph Estimation Methods

Two common methods:

Rational Method:
Peak Runoff Rate

Soil-Cover-Complex (SCS):
Runoff Volume
Peak Runoff Rate

Runoff Hydrograph



Never combine these methods

7

Rational Method for Estimating Peak Runoff Rate

$$Q = (C)\ (i)\ (A) \qquad \text{(Equation 1.1)}$$

Q = peak runoff or discharge rate in cubic feet per second (cfs),
C = runoff coefficient (decimal ranging from 0 to 1),
i = rainfall intensity (in/hr) for a given return period design storm, and
A = watershed drainage area in acres (ac).

Examples: 10-year peak runoff, Q_{10} = 30 cfs

25-year peak runoff, Q_{25} = 45 cfs

8

Rainfall Intensity

1. Return period for design storm:

$$T = 1 / P \qquad \text{(Equation 1.2)}$$

P = probability of a precipitation event being exceeded in any year,
T = return period for a specific hydrologic event (years).

Example: Return period for a rainfall event that has a 0.10 (10%) probability of being exceeded each year is:

T = 1 / 0.10 = 10-yr return period

2. Duration for design storm:

Equal to time of concentration (Tc)

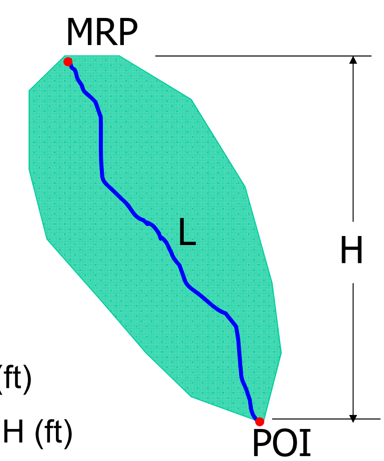
9

Time of Concentration, t_c

Time for water to travel from the Most Remote Point (MRP) to the Point of Interest (POI)

Methods for estimating t_c

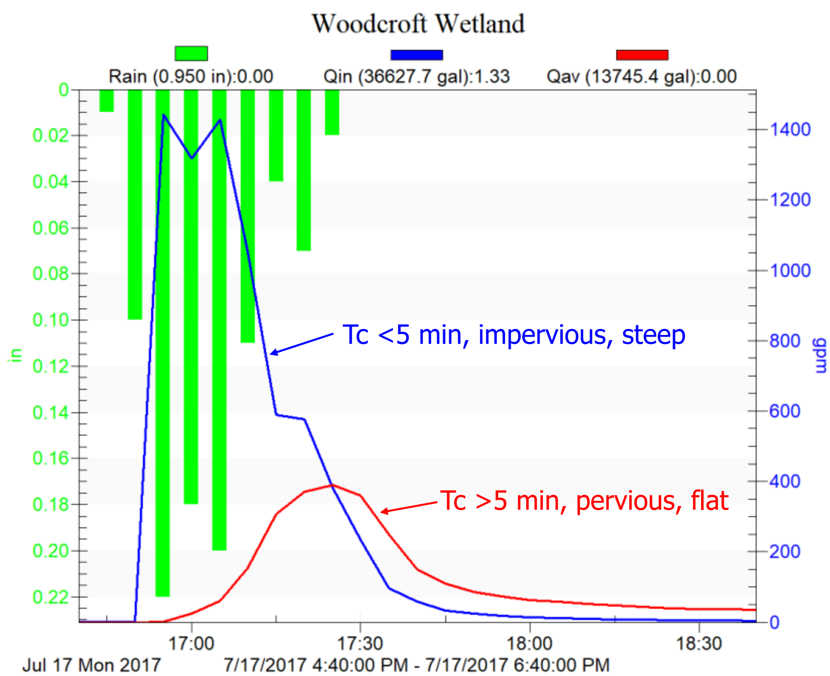
1. Jarrett Shortcut Method
2. Segmental Method (TR-55)



Need to Know:

1. Watershed Area, A (acres)
2. Flow Length from MRP to POI, L (ft)
3. Elevation Drop from MRP to POI, H (ft)
4. Land Use (assume graded, unpaved)

10



Jarrett Shortcut Method: t_c

$$S = H / L_{flow} \qquad \text{(Equation 1.3)}$$

S = average watershed slope (ft/ft),
H = elevation change from most remote point to point of interest (ft), and
L_{flow} = flow length from most remote point to point of interest (ft).

$$A_{Jarrett} = 460\ (S) \qquad \text{(Equation 1.4)}$$

$A_{Jarrett}$ = Jarrett Maximum Area in acres (ac), and
S = average watershed slope (ft/ft).

If the watershed area is less than the Jarrett Maximum Area, then t_c = 5 min

12

Jarrett Shortcut Method: t_c

Example: For a watershed drainage area of 5 acres with an elevation drop of 10 ft over a flow length of 500 ft, what is the average slope and the Jarrett Maximum Area?

Slope, $S = H / L_{flow} = 10 / 500 = 0.02$ ft/ft

Jarrett Max Area, $A_{Jarrett} = 460\ (0.02) = 9.2$ acres

Since the watershed drainage area of 5 acres < 9.2 acres, use $t_c = 5$ min

Example: For a watershed drainage area of 7 acres with an elevation drop of 8 ft over a flow length of 720 ft, what is the average slope and the Jarrett Maximum Area?

Slope, $S = H / L_{flow} = 8 / 720 = 0.011$ ft/ft

Jarrett Max Area, $A_{Jarrett} = 460\ (0.011) = 5.1$ acres

Since the watershed drainage area of 7 acres > 5.1 acres, the Jarrett Shortcut does not apply, and a different method must be used.

13

NRCS Segmental Method (TR-55) Shallow Concentrated Flow

Unpaved Areas: $t_c = 0.001\ (L_{flow}) / S^{0.53}$ (Equation 1.5)

Paved Areas: $t_c = 0.0008\ (L_{flow}) / S^{0.53}$ (Equation 1.6)

t_c = time of concentration in minutes (min),
L_{flow} = flow length from most remote point to point of interest (ft),
S = average watershed slope (ft/ft).

Note: Kirpich (1940) is another method

14

NRCS Segmental Method (TR-55) Shallow Concentrated Flow

Example: For a construction site watershed drainage area of 10 acres with an elevation drop of 12 ft over a flow length of 1000 ft, estimate time of concentration.

Slope, $S = H / L_{flow} = 12 / 1000 = 0.012$ ft/ft

Assume that the area is unpaved, therefore use Equation 1.5:

$t_c = 0.001 (L_{flow}) / S^{0.53} = 0.001 (1000) / 0.012^{0.53} = 10.4$ minutes

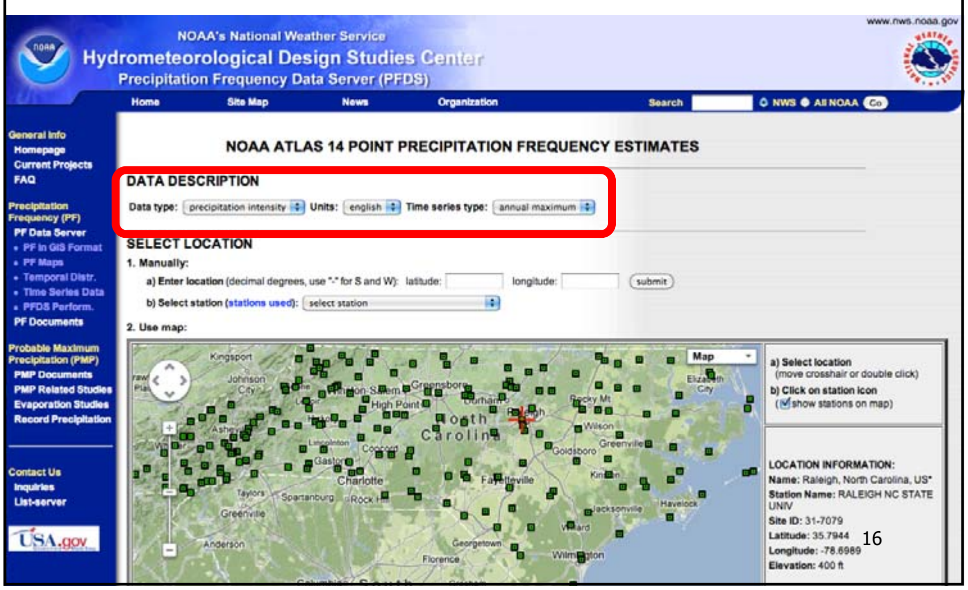
Use $t_c = 10$ minutes

If the elevation drop for this site was 30 ft, the calculated value for t_c would be 6.4 minutes. It that case, use a t_c value of 5 minutes for determining rainfall intensity since the lower t_c produces a higher rainfall intensity and a more conservative estimate of peak runoff rate and basin size.

15

Rainfall Intensity (in/hr): Table 1.1

http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=nc



16

Rainfall Data

Need Intensity by Return Period and Duration

Listed for some locations in Table 1.1

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION

NOAA Atlas 14, Volume 2, Version 3

PF tabular PF graphical Supplementary information Print Pa

AMS-based precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Annual exceedance probability (1/years)							
	1/2	1/5	1/10	1/25	1/50	1/100	1/200	1/500
5-min	5.18 (4.76–5.66)	6.34 (5.83–6.91)	7.14 (6.54–7.76)	7.92 (7.22–8.63)	8.46 (7.68–9.19)	8.94 (8.08–9.72)	9.34 (8.40–10.2)	9.79 (8.74–10.7)
10-min	4.15 (3.82–4.53)	5.08 (4.67–5.54)	5.71 (5.23–6.22)	6.31 (5.76–6.87)	6.73 (6.11–7.33)	7.10 (6.41–7.72)	7.41 (6.66–8.07)	7.75 (6.91–8.45)
15-min	3.48 (3.20–3.80)	4.28 (3.94–4.68)	4.81 (4.41–5.24)	5.33 (4.87–5.81)	5.68 (5.16–6.18)	5.98 (5.40–6.51)	6.23 (5.60–6.79)	6.50 (5.80–7.09)
30-min	2.40 (2.21–2.63)	3.04 (2.80–3.32)	3.49 (3.20–3.80)	3.95 (3.61–4.30)	4.28 (3.89–4.66)	4.58 (4.14–4.98)	4.85 (4.36–5.29)	5.18 (4.61–5.64)
60-min	1.51 (1.39–1.65)	1.95 (1.79–2.13)	2.27 (2.08–2.47)	2.63 (2.40–2.86)	2.90 (2.63–3.16)	3.16 (2.85–3.43)	3.40 (3.06–3.71)	3.71 (3.31–4.05)

17

Runoff Coefficient, C

Table 1.2. Rational Method C for Agricultural Areas. (Taken from Schwab et al., 1971).

Vegetation	Runoff Coefficient, C		
Slope	Sandy Loam	Clay and Silt Loam	Tight Clay
Forest/wooded			
0-5% slope	0.10	0.30	0.40
5-10% slope	0.25	0.35	0.50
10-30% slope	0.30	0.50	0.60
Pasture/grass			
0-5% slope	0.10	0.30	0.40
5-10% slope	0.16	0.36	0.55
10-30% slope	0.22	0.42	0.60
Cultivated/bare soil			
0-5% slope	0.30	0.50	0.60
5-10% slope	0.40	0.60	0.70
10-30% slope	0.52	0.72	0.82

18

Area-Weighted Average C value

Example: Determine the weighted average runoff coefficient, C, for a 4-acre watershed with 1 acre of grassy field on clay soil at 3% slope and 3 acres of active construction on clay soil at 4% slope.

Land Cover	A	C	(A) (C)
Pasture	1	0.40	0.40
Bare Soil	3	0.60	1.80
TOTAL	**sum = 4**		**sum = 2.20**

Weighted C = 2.20 / 4 = 0.55

For this example, estimate Q if rainfall intensity, i = 5.80 in/hr:

Q = (C) (i) (A) = (0.55) (5.80) (4) = 12.8 cfs

19

Example: Rational Method

Determine the 10-year peak runoff rate, Q_{10}, for a 5-acre construction site watershed near Asheville with a flow length = 600 ft and elevation drop = 36 ft. The land uses are shown below:

Land Use	A	C	(A) (C)
Forest, clay (11%)	1	0.60	0.60
Bare soil, clay (7%)	3	0.70	2.10
Grass, clay (3%)	1	0.40	0.40
	sum = 5 ac		sum = 3.10

Weighted Runoff Coefficient: C = 3.10 / 5 = 0.62

Average watershed slope, S = 36 / 600 = 0.06 ft/ft

Jarrett Max Area = 460 (0.06) = 27.6 ac; Since 5 < 27.6, use t_c = 5 min

Rainfall intensity for 10-year storm, i_{10}, is determined from Table 1.1 for a 5-minute rainfall in Asheville: i_{10} = 6.96 in/hr

Peak runoff rate, Q_{10} = (0.62) (6.96) (5) = 21.6 cfs

20

Example: Rational Method

Determine the 25-year peak runoff rate, Q_{25}, for a 4-acre construction site watershed near Charlotte with a flow length = 500 ft and elevation drop = 20 ft. The Runoff Coefficient, C = 0.60 (cultivated tight clay soil)

Average watershed slope, S = 20 / 500 = 0.04 ft/ft

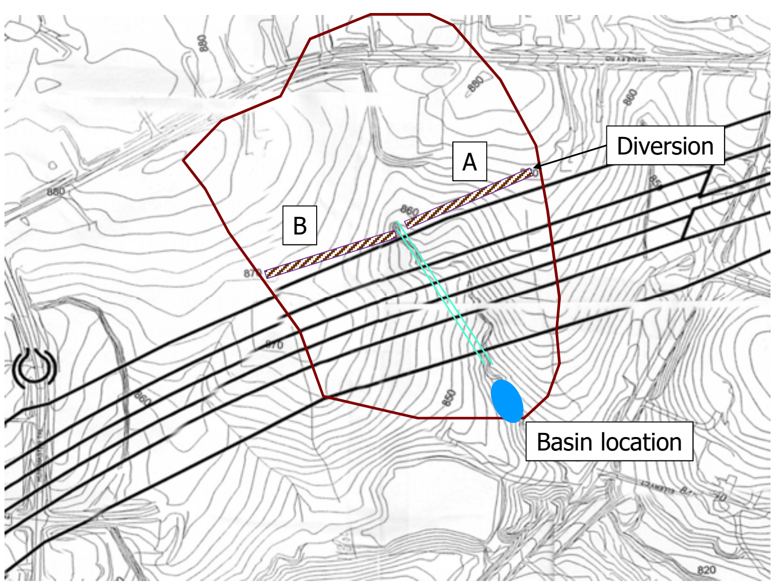
Jarrett Max Area = 460 (0.04) = 18.4 ac; Since 4 < 18.4, use t_c = 5 min

Rainfall intensity for 25-year storm, i_{25}, is determined from Table 1.1 for a 5-minute rainfall in Charlotte: i_{25} = 8.00 in/hr

Peak runoff rate, Q_{25} = (0.60) (8.00) (4) = 19.2 cfs

21

Emphasis on Diverting 'Clean' Runoff



22

Worksheet

1.1 Estimate the 25-year return period peak runoff rate from a watershed near Greensboro that is 5x1.96 inches on a map (scale: 1inch=200ft). The watershed has an average slope of 5.5% and a weighted average runoff coefficient of 0.65.

C = 0.65

A = 9 ac (1000ft x 392 ft)

t_c = 5 min [$A_{Jarrett}$ = 460 (0.055) = 25 which is greater than 9]

i_{25} = 7.46 in/hr

Q_{25} = (C) (i) (A) = (0.65) (7.46 in/hr) (9 ac) = 44 cfs

23

Worksheet

1.2. Estimate the 10-year peak runoff rate, Q_{10}, for a 20-acre construction site watershed near Raleigh with a flow length = 2000 ft and elevation drop = 60 ft. The land uses are half forest and half bare soil. Assume tight clay.

Land Use	A	C	(A) (C)
Forest	10	0.40	4.0
Bare soil	10	0.60	6.0
	sum = 20 ac		sum = 10.0

Weighted Runoff Coefficient: C = 10 / 20 = 0.5

Average watershed slope, S = 60 / 2000 = 0.03 ft/ft

Jarrett Max Area = 460 (0.03) = 13.8 ac; Since 13.8 < 20, use other method

Segmental Method: $t_c = 0.001 (2000) / 0.03^{0.53}$ = 12.8 min; use t_c = 10 min

Rainfall intensity, i_{10} = 5.58 in/hr

Peak runoff rate, Q_{10} = (0.5) (5.58) (20) = 56 cfs

24

MODULE 2. Erosion and Sediment Control

- Erosion Principles
- Erosion Control Planning
  - RUSLE: R, K, LS, CP

25

Erosion Principles: *Detachment and Transport*

Detachment from…
- Rain
- Flowing water
- Tillage
- Earthmoving

Transport from…
- Flowing water
- Wind
- Sloughing of steep slopes

26

Factors Influencing Erosion

- Climate: Precipitation, freezing
- Soil Characteristics:
  - Texture
  - Structure
  - Organic matter
  - Permeability
- Land Shape:
  - Slope
  - Length of Slope
- Land Use:
  - Land cover, BMPs

27

Erosion Planning: USLE / RUSLE

$A_{erosion}$ = (R) (K) (LS) (CP)   (Equation 2.1)

$A_{erosion}$ = longterm annual soil interrill + rill erosion in tons per acre per year (tons/ac-yr),

R = rainfall factor (dimensionless),

K = soil erodibility factor (dimensionless),

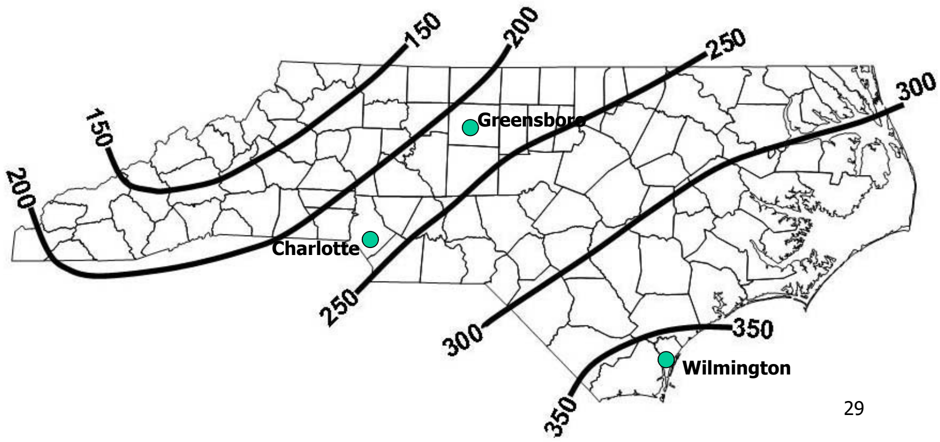
LS = slope-length factor (dimensionless),

CP = conservation practice(s) factor (dimensionless)

28

R, Rainfall Factor

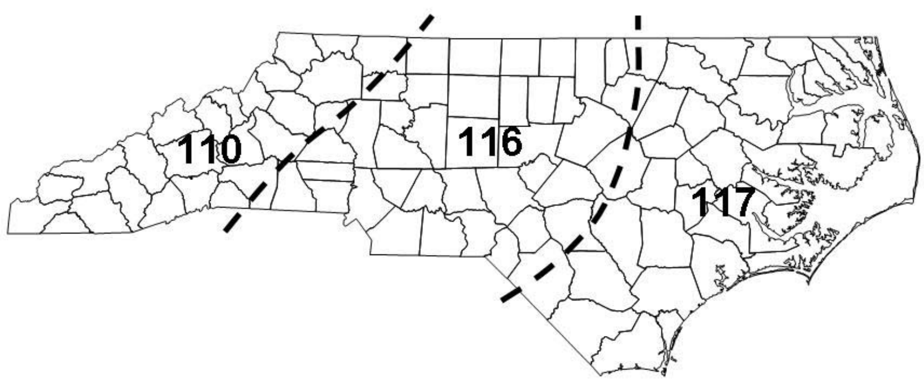
- Represents rainfall energy that causes erosion
- Higher R = higher erosion potential
- Annual R values, Figure 2.1



29

Rainfall Energy Distribution

Varies by location: 3 zones in NC, Figure 2.2



30

Rainfall Energy Distribution

Varies by month due to storm intensity, Table 2.1

Example (Piedmont): April-July (4 months)

Partial-year fraction = 0.06+0.07+0.11+0.20 = 0.49

	Geographic Region, Figure 2.2	
Month	**110 & 116**	**117**
Jan	0.03	0.02
Feb	0.04	0.02
Mar	0.05	0.03
Apr	0.06	0.04
May	0.07	0.06
Jun	0.11	0.14
Jul	0.20	0.23
Aug	0.21	0.20
Sep	0.11	0.15
Oct	0.05	0.06
Nov	0.04	0.03
Dec	0.03	0.02

31

Examples: Rainfall Factor, R

Determine Partial-Year R for Raleigh in March through May:

Figure 2.1: Annual R value for Raleigh is 270

Figure 2.2: Raleigh is located in Region 116

Table 2.1: March-May, fraction R is 0.05 + 0.06 + 0.07 = 0.18

Partial-year R for March-May (3 months) = (0.18) (270) = 49

If the construction period is July-September:

Partial-year R = (0.20 + 0.21 + 0.11) (270) = 140

Determine Partial-Year R for Charlotte in April through July:

Figure 2.1: Annual R value for Charlotte is 230

Figure 2.2: Charlotte is located in Region 116

Table 2.1: Apr-Jul, fraction R is 0.06 + 0.07 + 0.11 + 0.20 = 0.44

Partial-year R for Apr-Jul (4 months) = (0.44) (230) = 101

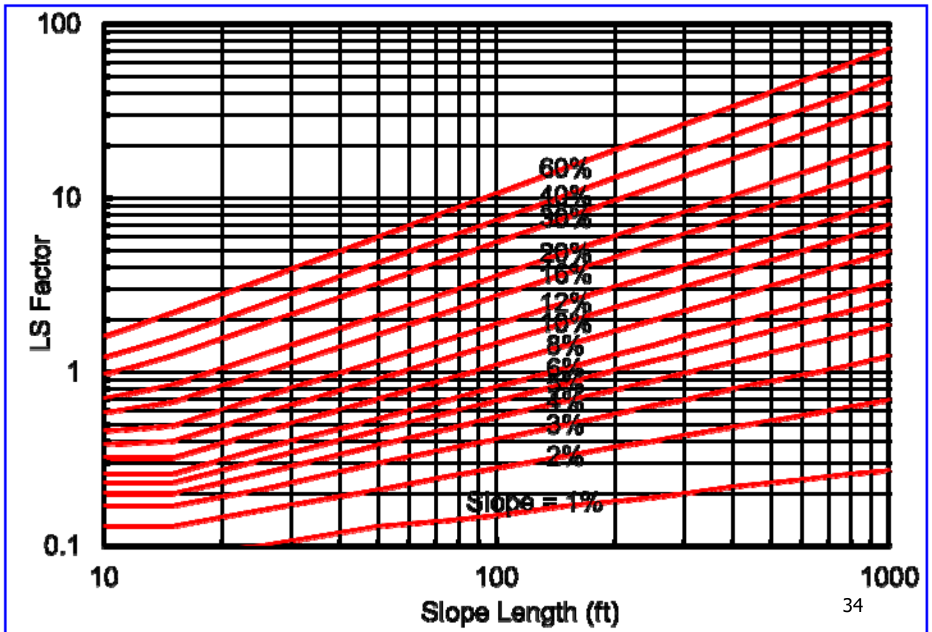
32

K, Soil Erodibility Factor

- Represents soil's tendency to erode
- NRCS tables for most soils (Table 2.2)

Soil		B-Horizon Permeability	RUSLE	RUSLE	RUSLE	RUSLE
Series	HSG	in/hr	T	K(A)	K(B)	K(C)
Ailey	B	0.6 to 2.0	2	0.15	0.24	0.24
Appling	B	0.6 to 2.0	4	0.24	0.28	0.28
Autryville	A	2.0 to 6.0	5	0.10	0.10	0.10
Badin	B	0.6 to 2.0	3	0.15	0.24	0.15
Belhaven	D	0.2 to 6.0	--	--	0.24	0.24
Cecil	B	0.6 to 2.0	4	0.24	0.28	-33

LS, Length Slope Factor (Figure 2.5)



34

CP, Cover-Conservation Practices Factor

Represents the effect of land cover & direction of rills/channels

Table 2.3 lists CP values (use high values)

letters denote references

Bare soil condition	CP
Fill	
Packed, smooth	1.00 a
Fresh disked	0.95 a
Rough (offset disk)	0.85 a
Cut	
Loose to 12 inches, smooth	0.90 b
Loose to 12 inches, rough	0.80 b
Compacted by bulldozer	1.00 b
Compacted by bulldozer and tracked parallel to the contour	0.50 c
Rough, irregular tracked all directions	0.90 b
Surface Condition with No Cover	
Compact and smooth, scraped w/ bulldozer or scraper up / down hill	1.3 d
Compact and smooth, raked w/ bulldozer root rake up and down hill	1.2 d
Compact and smooth, scraped w/bulldozer or scraper across slope	1.2 d
Compact and smooth, raked w/bulldozer root rake across slope	0.9 d
Loose as a disked plow layer	1.0 d

35

Example: Erosion Estimate

Estimate erosion from a 5-acre site in Raleigh during March-May with R = 49. The site is 600 ft long with elevation drop of 48 ft, and soil type is Creedmoor.

Average slope = 48 / 600 = 0.08 ft/ft (8% slope)

Table 2.2: K value is 0.32 (assume B Horizon – subsoil)

Figure 2.3: LS value is 3.5 (slope length = 600 ft; slope = 8%)

Table 2.3: CP value is 1.0 (assume loose surface with no cover)

Erosion per acre = (49) (0.32) (3.5) (1.0) = 54.9 tons/acre (March-May)

Total erosion for 5 acres = (54.9) (5) = 274.5 tons (March-May)

If the construction period is July-September (partial-year R = 140):

Erosion per acre = (140) (0.32) (3.5) (1.0) = 157 tons/acre (Jul-Sep)

Total erosion for 5 acres = (157) (5) = 786 tons (Jul-Sep)

36

Secondary Road Erosion Estimate

$V_{ditch} = (C_{ditch})\ (R)\ (K)\ (S_{ditch})$ (Equation 2.2)

V_{ditch} = secondary road sediment volume expected in cubic feet per acre (ft^3/ac),

C_{ditch} = regression constant for secondary roads dependent on ditch side slopes,

R = Rainfall Factor for the duration of construction,

K = Soil Erodibility Factor (B or C horizon),

S_{ditch} = slope of secondary road ditch (ft/ft).

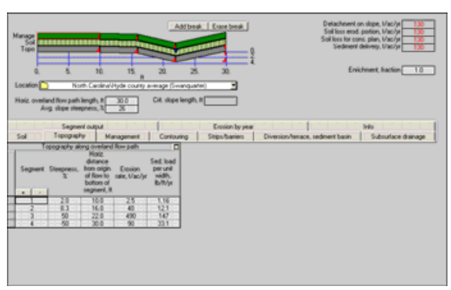
Values of C_S are determined using Table 2.4 depending on road ditch side slope.

Side Slope	**C_{ditch}**
4:1	291
3.5:1	341
3:1	399
2.5:1	467
2:1	549
1.5:1	659
1:1	808
0.75:1	916
0.5:1	1067

37

Secondary Road Erosion Estimate

- Assume 30-ft Right of Way
- Estimate longitudinal slope of road ditch from 0.1 to 5%
- Estimate ditch side slopes of 1:1 to 3:1
- For the site, determine R and K
- Apply Equation 2.2



ERODES Spreadsheet: download software from NCDOT Roadside Field Operations Downloads:

38

www.ncdot.org/doh/operations/dp_chief_eng/roadside/fieldops/downloads

Example: Secondary Road Erosion

Estimate erosion volume from a 2-acre secondary roadway construction during June-July in Carteret County with Goldsboro soil. The road ditch has a slope of 0.05 ft/ft and 2:1 side slopes.

Figures 2.1 and 2.2: Annual R = 340, and Carteret County is in Region 117

Table 2.1: During June-July, partial-year R = (0.14 + 0.23) (340) = 126

Table 2.2: K value is 0.24 (assume B Horizon – subsoil)

Table 2.4: C_{ditch} is 549 for 2:1 ditch side slopes

V_{ditch} = (549) (126) (0.24) (0.05) = 830 ft^3/ac (Jun-Jul)

Total erosion for 2 acres = (830) (2) = 1,660 ft^3 (Jun-Jul)

To convert to cubic yards: Erosion = 1,660 / 27 = 61 cubic yards (Jun-Jul)

39

Example: Secondary Road Erosion

Estimate erosion volume from a 1.5-acre secondary roadway construction during September-October in Halifax County with Rains soil. The road ditch has a slope of 0.02 ft/ft and 3:1 side slopes.

Figures 2.1 and 2.2: Annual R = 270, and Halifax County is in Region 117

Table 2.1: During Sep-Oct, partial-year R = (0.15 + 0.06) (270) = 57

Table 2.2: K value is 0.24 (assume B Horizon – subsoil)

Table 2.4: C_{ditch} is 399 for 3:1 ditch side slopes

V_{ditch} = (399) (57) (0.24) (0.02) = 109 ft^3/ac (Sep-Oct)

Total erosion for 1.5 acres = (109) (1.5) = 164 ft^3 (Sep-Oct)

To convert to cubic yards: Erosion = 164 / 27 = 6.1 cubic yards (Sep-Oct)

40

Worksheet

2.1. Estimate erosion from a 5-acre site in Wilmington during June-October with Cowee soil. The site is 800 ft long with elevation drop of 24 ft.

Average slope = 24 / 800 = 0.03 ft/ft (3% slope)

Figure 2.1 & 2.2: Annual R value is 350 and Region 117

Partial-year R = (0.14+0.23+0.20+0.15+0.06) (350) = 273

Table 2.2: K value is 0.28 (assume B Horizon – subsoil)

Figure 2.3: LS value is 1.1 (slope length = 800 ft; slope = 3%)

Table 2.3: CP value is 1.0 (assume loose surface with no cover)

Erosion per acre = (273) (0.28) (1.1) (1.0) = 84.1 tons/acre (Jun-Oct)

Total erosion for 5 acres = (84.1) (5) = 420 tons (Jun-Oct)

41

Worksheet

2.2. Estimate erosion volume from a 2-acre secondary roadway construction during September-October in Catawba County with Helena soil. The road ditch has a slope of 0.02 ft/ft and 1.5:1 side slopes.

Figures 2.1 & 2.2: Annual R = 180, and Region is 116

Table 2.1: Sep-Oct, partial-year R = (0.11 + 0.05) (180) = 29

Table 2.2: K value is 0.28 (assume B Horizon – subsoil)

Table 2.4: C_{ditch} is 659 for 1.5:1 ditch side slopes

V_{ditch} = (659) (29) (0.28) (0.02) = 107 ft^3/ac (Sep-Oct)

Total erosion for 2 acres = (107) (2) = 214 ft^3 (Sep-Oct)

To convert to cubic yards: Erosion = 214 / 27 = 8 cubic yards (Sep-Oct)

42

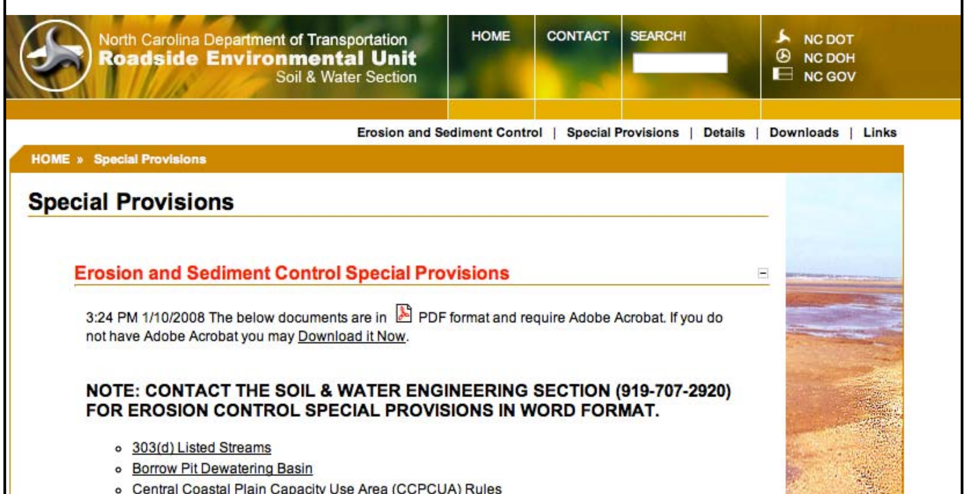
MODULE 3. Regulatory Issues

1. NC Sediment Pollution Control Act (1973)
2. NPDES: NCG01 General Stormwater Permit
3. Jurisdictional Areas - Conditions and Restrictions
   - US Army Corps of Engineers
   - NC DEQ Division of Water Resources
4. Environmentally Sensitive Area (ESA) & Riparian Buffers
5. Reclamation Plans: Staging, Borrow, Waste

43

NCDOT Roadside Environmental Unit Soil and Water Section:

http://ncdot.gov/doh/operations/dp%5Fchief%5Feng/roadside/soil%5Fwater/special_provisions/



44

NC Sediment Pollution Control Act (SPCA) Mandatory Standards

1. E&SC plan must be submitted 30 days prior to disturbance for areas greater than or equal to 1 acre
2. Land disturbing activity must be conducted in accordance with approved E&SC Plan
3. Establish sufficient buffer zone between work zone and water courses
4. Provide groundcover on slopes within 21 calendar days after any phase of grading (NCG-01 takes precedence)
5. The angle of cut and fill slopes shall be no greater than sufficient for proper stabilization

45

NPDES Program: NCG010000 (NCG01)

General Permit for Construction Activities, developed to meet federal NPDES requirements for activities disturbing > 1 acre

NCDEQ, Division of Water Resources delegated by EPA the authority to administer the program in North Carolina

The Erosion and Sedimentation Control plan contains the core requirements of the NPDES permit, but NCG01 has additional requirements.

46

NCG010000 (NCG01)

Site Area Description	Time Frame	Stabilization Time Frame Exceptions
Perimeter dikes, swales, ditches and slopes	7 days	None
High Quality Water (HQW) Zones	7 days	None
Slopes steeper than 3:1	7 days	If slopes are 10 ft or less in length and are not steeper than 2:1, then 14 days are allowed
Slopes 3:1 or flatter	14 days	7-days for slopes greater than 50 feet in length
All other areas with slopes flatter than 4:1	14 days	None (except for perimeters and HQW Zones)

47

NCG010000 (NCG01)

Surface Dewatering Devices

Basins with drainage area 1 acre or larger must utilize a surface dewatering device in basins that discharge from the project

48

Regulated Jurisdictional Areas

- Streams
- Wetlands
- Rivers
- Riparian Buffers
- Lakes
- Reservoirs
- Endangered Species

49

Wetlands and Waterways: US Army Corps of Engineers (USACE)

US Army Corps of Engineers®

- Section 404 of CWA permit require for effects on:
  - Wetlands & Surface waterways
- Practical alternatives
- Mitigation requirements
- Other laws: (e.g. Endangered Species, National Preservation Act)

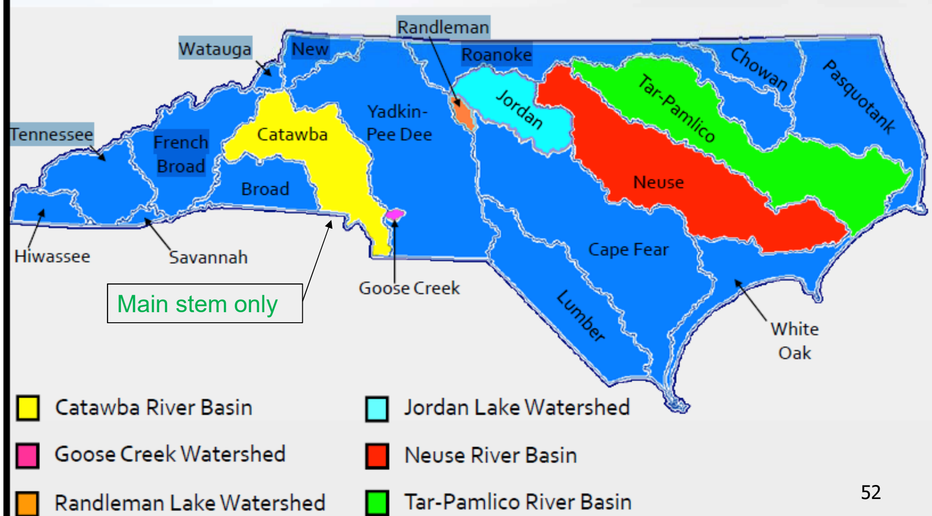
50

Environmentally Sensitive Areas

- Neuse River Basin
- Tar-Pamlico River Basin
- Randleman Dam Watershed
- Main Stem of Catawba River
- Goose Creek Watershed (Yadkin/Pee-Dee Basin)
- Falls Lake (Nutrient Rules)
- Jordan Lake (Buffer Rules)
- High Quality Waters
- Trout Waters
- Others TBD

51

Riparian Buffer Protection Programs



52

Buffer Requirements
(NC DEQ Division of Water Resources)

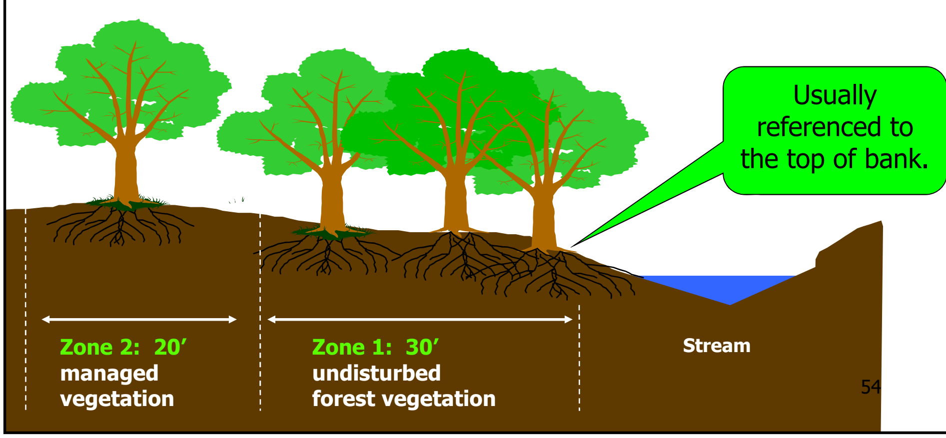
Riparian Buffer: vegetated land at edge of stream or lake
(50 feet or more)

DWR Permits specify:
- Mitigatable Impacts to Zone 1 (closest to stream)
- Mitigatable Impacts to Zone 2
- Allowable Impacts to Zone 1
- Allowable Impacts to Zone 2

53

Riparian Buffer

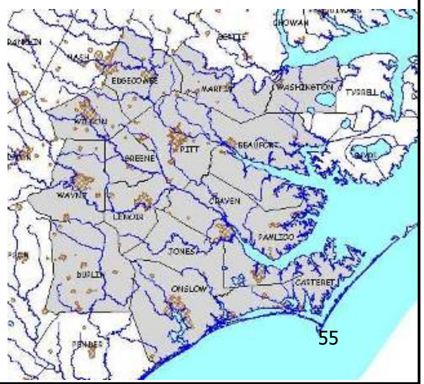
Vegetated land at edge of stream or lake that filters sediment, removes nutrients, and provides habitats



54

Central Coastal Plain Capacity Use Area (CCPCUA)

- Includes 15 Eastern counties: Beaufort, Carteret, Craven, Duplin, Edgecombe, Greene, Jones, Lenoir, Martin, Onslow, Pamlico, Pitt, Washington, Wayne, Wilson
- Annual registration and reporting of withdrawals is required for surface and ground water users of more than <u>10,000 GPD</u>
- Permits are required for ground water users of more than <u>100,000 GPD</u>



55

Reclamation Plans for Offsite Staging, Borrow, Waste Areas

Land disturbing activities associated with project that exceed project limits:

- Staging areas: might not need a plan
- Waste stockpiles (permanent or temporary)
- Borrow sites: newly-created pit must have dewatering basin

56

Staging Areas

Temporary areas, beyond project limits, utilized during the pursuit of a contract, to store equipment, materials, supplies, or other activities related to project

- Require environmental evaluation only if
  - No erodible material
  - No land disturbing activities
- Require full reclamation plan if contain
  - Erodible material (EM)
  - Land disturbing activities (LDA)
- Exempt if no EM & LDA and located at “existing facilities”
  - Unless jurisdiction features are present
- Overnight parking of equipment related to mobile operations are exempt

57

Reclamation Plan

- Reclamation Plan required for all sites regardless of size
- Approved by DOT Lead Engineer
- Elements of a Reclamation Plan:
  - Reclamation Plan form
  - Vicinity Map
  - Signatures
  - Environmental Evaluation
  - State Historical Preservation Office (SHPO) Letter
  - E&SC Plan with adequately designed measures
  - Seeding specifications
  - 1-year post final review

58

Reclamation E&SC Plan for Borrow Pits

- Site visit: Confirm all setbacks & haul road locations
- E&SC Plan:

  Above Water Table: Collect runoff and settle sediment

  < 1 acres: Temporary Rock Sediment Dam - Type B

  up to10 acres: Skimmer Basin

  Below Water Table: Borrow Pit Dewatering Basin
- Closure plan:
  - Establish all final grades
  - Plan to replace all stockpiled topsoil and other overburden
  - Plan to establish permanent vegetation on disturbed areas

59

During Construction

- Delineate buffer zones
- Install EC devices as per approved E&SC Plan
- Excavate/Build slopes in manner that allows for seeding of slopes
- Stage seed slopes
- Monitor the turbidity of Borrow Pit discharge
- Sites are considered “single source”, unless the site has commercial status

60

Turbidity

Measure of water clarity: Higher turbidity tends to occur with more silt & clay particles suspended in water

Measured by passing light through a small sample and measuring the light dispersion

Nephelometric Turbidity Units (NTUs)

No standard for runoff yet

61

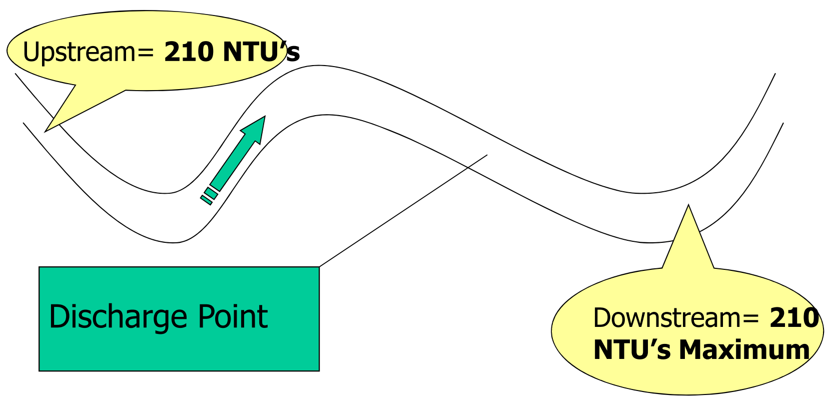
Turbidity Limits

Surface Water Classification	Turbidity Not to Exceed Limit* (NTUs)
Streams	50
Lakes & Reservoirs	25
Trout Waters	10

** If turbidity exceeds these levels due to natural background conditions, the existing turbidity level cannot be increased*

62

Turbidity Limit Example
Non-Trout Water Stream



* *If turbidity exceeds NTU standard due to natural background conditions (upstream sample), the existing turbidity level cannot be increased.*

63

Final Acceptance

- Borrow and Waste Sites must meet all the requirements of the Reclamation Plan
- Permanent stand of vegetation must cover the site
- Property owner will be notified that the site is complete and that inspections and possible repair work may occur during the coming year
- Site will be reviewed after 1 year and released if the site is deemed stable

65

Vegetation

Poor vegetation establishment

Established Vegetation

66

MODULE 4. Open Channel Design

Table 4.1. NCDOT guidelines for selecting channel linings.

Channel Slope (%)	Recommended Channel Lining
< 1.5	Seed and Mulch
1.5 to 4.0	Temporary Liners (RECP)
>4.0	Turf Reinforced Mats or Hard



67

Temporary Liners: Rolled Erosion Control Products

Jute | *Coir* | *Excelsior*






68

Turf Reinforced Mat (TRM)

Enka Mesh w/BFM (bonded fiber matrix)

69

Selecting a Channel Lining

$\tau = (\gamma)\ (d_{chan})\ (S_{chan})$ (Equation 4.1)

τ = average tractive force acting on the channel lining (lbs/ft^2)
γ = unit weight of water, assumed to be 62.4 lbs/ft^3
d_{chan} = depth of flow in the channel (ft)
S_{chan} = slope of the channel (ft/ft)

Select a channel lining that will resist the tractive force.

Example: Select a lining for a ditch with channel slope of 0.02 ft/ft and flow depth of 0.8 ft. NCDOT guidelines (Table 4.1) recommend temporary liner.

τ = (62.4 lb/ft^3) (0.8 ft) (0.02 ft/ft) = 1.0 lb/ft^2

Table 4.3 (pg 23): Select a RECP with allowable tractive force > 1.0 lb/ft^2

70

Examples: Channel Lining

Example: Select a suitable channel liner for a triangular ditch with maximum depth of 1 ft and slope of 1%.

Table 4.1: NCDOT guidelines for 1% slope allow seed and mulch or RECP

Equation 4.1: τ = (62.4 lbs/ft^3) (1 ft) (0.01 ft/ft) = 0.6 lbs/ft^2

Table 4.3: Apply seed and mulch or select a RECP channel lining with a maximum allowable tractive force greater than 0.6 lbs/ft^2.

Example: Select a suitable channel liner for a triangular ditch with maximum depth of 2 ft and slope of 5%.

Table 4.1: NCDOT guidelines for 5% slope require a TRM or hard liner.

Equation 4.1: τ = (62.4 lbs/ft^3) (2 ft) (0.05 ft/ft) = 6.2 lbs/ft^2

Table 4.3: Select a TRM channel lining with a maximum allowable tractive force greater than 6.2 lbs/ft^2.

71

Worksheet

4.1. Select a suitable channel liner for a triangular ditch with maximum depth of 1.2 ft and slope of 4.2%.

Table 4.1: NCDOT guidelines for >4% slope require TRM.

Equation 4.1: τ = (62.4 lbs/ft^3) (1.2 ft) (0.042 ft/ft) = 3.14 lbs/ft^2

Table 4.3: Select a TRM channel lining with a maximum allowable tractive force greater than 3.14 lbs/ft^2 (N. American Green P550)

72

MODULE 5. Sediment Retention BMPs for NCDOT

1. Selection & Design Considerations
2. BMP Design Criteria
3. Example Specs and Calculations

NCDOT Roadside Environmental Unit Soil and Water Section:

http://ncdot.gov/doh/operations/dp%5Fchief%5Feng/roadside/soil%5Fwater/

73

Sediment Retention BMPs

Table 1. BMP Selection

BMP	Location	Catchment	Structure	Sed. Ctl. Stone	Surface Area	Volume	Function
T. Rock Sed. Dam A	Swale/large ditch	< 1 ac.	Class I	Yes	$435Q_{10}$	3600 ft^3/ac	Remove sand
T. Rock Sed. Dam B	Drainage outlet	< 1 ac.	Class B	Yes	$435Q_{10}$	3600 ft^3/ac	Remove sand
Silt Basin B	Drainage outlet/ Adjacent to inlet	< 3 ac.	Earth	No	$435Q_{10}$ ($325Q_{10}$ @ inlets)	3600 ft^3/ac (1800 ft^3/ac @ inlets)	Remove sand
Skimmer Basin	Drainage outlet	< 10 ac.	Earth	No	$325Q_{10}$	1800 ft^3/ac	Remove sand
Infiltration Basin	Drainage outlet	< 10 ac.	Earth	No	$325Q_{10}$	1800 ft^3/ac	Remove sand
Riser Basin(non-perforated riser w/ skimmer)	Drainage outlet	< 100 ac.	Earth	No	$435Q_{10}$	1800 ft^3/ac	Remove silt, clay
Stilling Basin/Pumped	Near Borrow Pit/Culvert	N/A	Earth and Stone	No	2:1 L:W ratio	Based on dewatering	Remove silt, clay
Sp. Stilling Basin(Silt Bag)	Near stream	N/A	Filter Fabric	Yes	N/A	Variable	Remove sand
Rock Pipe Inlet Sed. Trap A	Pipe inlet	< 1 ac.	Class B	Yes	N/A	3600 ft^3/ac	Remove sand
Rock Pipe Inlet Sed. Trap B	Pipe inlet	< 1 ac.	Class A	Yes	N/A	3600 ft^3/ac	Remove sand
Slope Drain w/ Berm	Fill Slopes	< ½ ac.	12-inch pipe	No	N/A	N/A	Convey concentrated runoff
Rock Inlet Sed. Trap A	Stormwater Inlet	< 1 ac.	Class B	Yes	N/A	3600 ft^3/ac	Remove sand
Rock Inlet Sed. Trap B	Stormwater Inlet	< 1 ac.	Class A	Yes	N/A	3600 ft^3/ac	Remove sand
Rock Inlet Sed. Trap C	Stormwater Inlet	< 1 ac.	¼" wire mesh	Yes	N/A	N/A	Remove sand
T. Rock Silt Check A	Drainage outlet	< 1 ac.	Class B	Yes	$435Q_{10}$	3600 ft^3/ac	Remove sand
T. Rock Silt Check B	Channel	< ½ ac.	Class B	No	N/A	N/A	Reduce flow velocity
Temporary Earth Berm	Project perimeter	< 5 ac.	Earth	No	N/A	N/A	Divert offsite runoff
Temporary Silt Fence	Bottom of slope	< ¼ acre per 100 feet <2%*	Silt fence	No	N/A	N/A	Create small basin; Remove sand, silt
Special Sediment Control Fence	Bottom of slope	< ½ ac.	¼" wire mesh	Yes	N/A	N/A	Remove sand
Temporary Silt Ditch	Bottom of slope	< 5 ac.	Earth	No	N/A	N/A	Carry sediment/water
Temporary Diversion	Project & Stream perimeter	< 5 ac.	Earth	No	N/A	N/A	Divert turbid water
Earth Berm		< 5 ac.	Earth	No	N/A	N/A	Divert clean or turbid water
Clean Water Diversion	Project perimeter	<5 ac.	Earth & Fabric	No	N/A	N/A	Divert clean water
Construction Entrance	Exit to road	N/A	Class A	No	N/A	N/A	Clean truck tires
Safety Fence	Permitted Areas	N/A	Orange fence	No	N/A	N/A	Define permitted boundary
Borrow Pit Dewatering Basin	Adjacent to Borrow Pits	N/A	Earth	No	N/A	8.02xQxT	Remove Sand and reduce turbidity
Wattle/Coir Fiber Wattle	Channel	< ½ ac.	Natural Fibers	No	N/A	N/A	Incorporate PAM
Silt Check A with Matting and PAM	Channel	< ½ ac.	Class B	Yes	N/A	N/A	Reduce flow velocity and incorporate PAM

*contributing land slope

74

Structure Sizing

Two Criteria: (see Table 1)

1. Minimum **Volume** (ft^3) based on **disturbed** acres
2. Minimum **Surface Area** (ft^2) based on **total** acres

Use Q_{10} for normal design

Use Q_{25} for Environmentally Sensitive Areas, Upper Neuse River Basin, Jordan Lake

Device Outlet Type	Minimum Volume (ft^3)	Minimum Surface Area (ft^2)
Weir	3600 ft^3/ac	435 Q_{10} or Q_{25}
Surface Outlet	1800 ft^3/ac	325 Q_{10} or Q_{25}
Surface Outlet + Riser	1800 ft^3/ac	435 Q_{10} or Q_{25}

75

Examples: Sizing BMPs

Example: Calculate minimum volume and surface area for a skimmer basin serving a 6-acre construction site (all disturbed) with Q_{10} = 20 cfs.

Volume: $V_{basin} \geq$ 1,800 ft^3 per acre of disturbed land

$V_{basin} \geq$ 1,800 ft^3/ac (6 ac) = 10,800 ft^3

Surface Area: $A_{basin} \geq 325\ Q_{10}$ (skimmer =surface outlet)

$A_{basin} \geq$ 325 (20) = 6,500 ft^2

Example: Calculate minimum volume and surface area for a Temporary Rock Sediment Dam Type B serving a 1-acre construction site (all disturbed) with Q_{10} = 7 cfs.

Volume: $V_{basin} \geq$ 3,600 ft^3 per acre of disturbed land

$V_{basin} \geq$ 3,600 ft^3/ac (1 ac) = 3,600 ft^3

Surface Area: $A_{basin} \geq 435\ Q_{10}$

$A_{basin} \geq$ 435 (7) = 3,045 ft^2

76

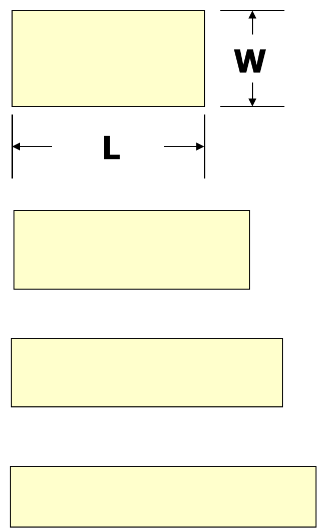
Length to Width (L:W) Ratio

2:1

3:1

4:1

5:1



As L:W ratio increases, basin length increases and width decreases

Equal surface areas are depicted at left

77

Porous Baffle Spacing

Baffles required in Silt Basins at drainage turnouts, Type A and B Temporary Rock Sediment Dams, Skimmer Basins, Stilling Basins:

- <u>3 baffles</u> evenly-spaced if basin length > 20 ft
- <u>2 baffles</u> evenly-spaced if basin length 10 - 20 ft
- <u>1 baffle</u> if basin length ≤ 10 ft (State Forces)

78

Weir Length for Spillway

Skimmers and Infiltration Basins:

Weir Length = Q_{peak} /0.4

Temporary Sediment Dam - Type B:

Minimum 4ft for 1 acre or less

79

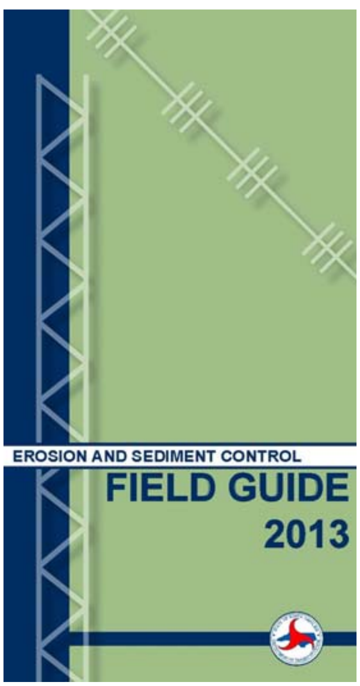


Table of Contents

Click subject to reach page

80

Temporary Rock Sediment Dam, Type B

Drainage area < 1 ac

Surface Area = $435Q_{10}$ or $435Q_{25}$

Volume = 3600 ft^3/ac

Coir Baffles

Minimum Weir Length = 4 ft for 1acre or less

L:W ratio 2:1 to 5:1

12

Temporary Rock Sediment Dam, Type B
1634.02

IS
A small dam with a weir outlet and built-in sediment basin.

USE
At the outlet of a temporary diversion, temporary slope drain, temporary silt ditch, drainage ditch or channel to trap sediment before runoff leaves the project site. Do not use in a live stream.

CONSTRUCT
Of Class B stone lined with sediment control stone. Basin should be 3600 cubic ft. per disturbed acre, and dam weir length variable to the drainage area (minimum 4 ft. for 1 acre or less). Apron length should be approximately equal to the height of the dam, with minimum 2:1 side slope.

81

Skimmer Basin

Drainage area < 10 ac

Surface Area = $325Q_{10}$ or $325Q_{25}$

Volume = 1800 ft^3/ac disturbed

Depth = 3 ft at weir

Coir Baffles (3)

L:W ratio 2:1 to 6:1

Sideslopes 1.5:1 max.

Dam height <= 5 ft

Skimmer Basin

IS
A temporary basin with a trapezoidal spillway lined with filter fabric and equipped with a floating skimmer.

USE
In sensitive watershed areas and in locations where the drainage area is too large for standard rock weir outlet.

CONSTRUCT
Basin with a Faircloth Skimmer at the outlet, a trapezoidal emergency spillway lined with filter fabric, and 3 coir fiber baffles. Storage capacity is 1800 cubic ft. per disturbed acre and surface area must accommodate the 10-year storm runoff. Limit the dam height to 5 ft.

82

BACK TO TABLE OF CONTENTS 15

Faircloth Skimmer (surface outlet)

Designed to captures 90% of fine (silts & clay) sediment when water is held for 24 hours

Rock Pipe Inlet Sediment Trap, Type A

Drainage area < 1 ac

Volume = 3600 ft^3/ac

Pipe inlet no greater than 36 in

Dam height = 18 inches

Class B stone lined with sediment control stone

Locate > 30 ft from travel lane

Rock Pipe Inlet Sediment Trap, Type A
1635.01

IS
A horseshoe-shaped device which prevents sediment from entering a pipe structure.

USE
At a pipe inlet that receives flow from one or more directions and is at least 30 ft. from a vehicular travel lane.

CONSTRUCT
Of Class B stone lined with sediment control stone. Surround the structure with a sediment storage area built to 3600 cubic ft. per disturbed acre. The dam must be a minimum 18 in. high.

84

BACK TO TABLE OF CONTENTS A 13

Check Dam & Wattle Spacing

On NCDOT projects:

Coastal Plain: Spacing = 600 / slope (%)

Example: For 2% slope, space checks 300 ft apart

Piedmont and West: Spacing = 300 / slope (%)

Example: For 3% slope, space checks 100 ft apart

85

Infiltration Basin

Drainage area < 10 ac

Surface Area = $325Q_{10}$ or $325Q_{25}$

Volume = 1800 ft^3/ac

Depth = 3 ft at weir

Coir Baffles (1-3)

L:W ratio 3:1 to 5:1

Must dewater in 3 days or less

Soil permeability must be at least 0.5 in/hr

(from NRCS B or C soil horizon, slowest rate)

86

Guidelines for Infiltration Basins

- Locate in Coastal Plain
- Locate in fill slope with Temporary Silt Ditch bringing runoff
- Do NOT locate in "Soils Prone to Flooding"
- Do not locate in cut ditches

87

Soils Prone to Flooding (Examples)

- Wake
  - Buncombe (BuB)
  - Chewacla (CmA)
  - Congaree (CoA)
  - Congaree (CpA)
  - Wehadkee (WnA)
  - Wehadkee and Bibb (WoA)
  - Wehadkee (WpA)
- Martin
  - Bibb (Bb)
  - Chastain (Ch)
  - Dorovan (Do)
  - Roanoke (Ro)
- Richmond
  - Chewacla (ChA)
  - Johnston (JmA)
- New Hanover
  - Dorovan (Do)
  - Johnston (JO)
  - Pamlico (Pm)
  - Bohicket (TM)
- Hoke
  - Chewacla (Ch)
  - Johnston (JT)
- Dare
  - Carteret (CeA)
  - Currituck (CuA)
  - Hobonny (HoA)

88

Design Steps for Basins, Sediment Dams, & Traps

1. Minimum volume and surface area
2. Width and length at the weir/spillway height based on sideslopes
3. Emergency spillway weir length
4. Baffle spacing

Temporary Rock Sediment Dam, Type B

1634.02

89

Example: Temp Rock Sediment Dam Type B

Disturbed area = 1 ac; Q_{10} = 2.5 cfs

Interior sideslopes = 1.5:1; L:W = 3:1

1. Minimum Volume and Surface Area:

Minimum Volume = 3600 x 1 ac = 3600 ft^3

Minimum Surface Area = 435 Q_{10} = 435 x 2.5 cfs = 1088 ft^2

Depth = Volume / Area = 3600 ft^3 / 1088 ft^2 = 3.3 ft

For DOT projects, Design Depth = 2 to 3 ft

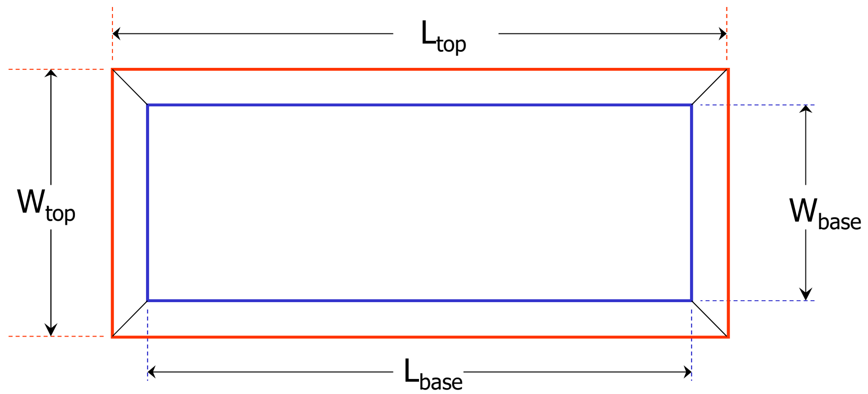
Therefore, use depth = 3 ft

Adjusted Minimum Area = Volume / depth = 3600 / 3 = 1200 ft^2

Surface area must be greater to account for sideslopes

90

Example: Temp Rock Sed Dam Type B



$$\text{Volume} = \frac{d}{3}\left[W_{top}\,L_{top} + W_{base}\,L_{base} + \left(\frac{W_{top}\,L_{base} + W_{base}\,L_{top}}{2}\right)\right]$$

91

Example: Temp Rock Sed Dam Type B

2. Width and depth at top and base (trial & error):

Start with area = 1,200 ft^2 and a 3:1 length to width ratio

$$\text{Trial Width, } W_{top} = \sqrt{\frac{A}{\text{L to W ratio}}} = \sqrt{\frac{1200}{3}} = 20 \text{ ft}$$

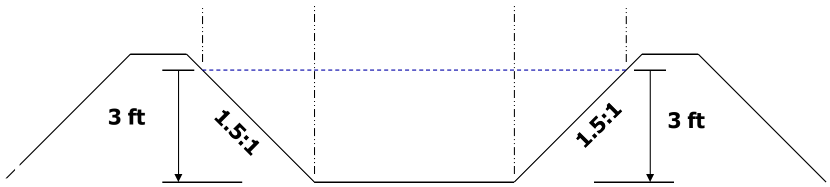
To account for sideslopes, add to top width (try 3 ft):

Trial W_{top} = 20 + 3 = 23 ft

Trial L_{top} = 3 x W_{top} = 3 x 23 = 69 ft

92

Example: Temp Rock Sed Dam Type B



Calculate base width and base length using 1.5 to 1 sideslopes:

$W_{base} = W_{top}$ – (depth x 1.5 x 2 sides) = 23 – (3x1.5x2) = 14 ft

$L_{base} = L_{top}$ – (depth x 1.5 x 2 sides) = 69 – (3x1.5x2) = 60 ft

93

Example: Temp Rock Sed Dam Type B

Calculate volume (minimum required = 3,600 ft^3):

$$\text{Volume} = \frac{d}{3}\left[W_{top}L_{top} + W_{base}L_{base} + \left(\frac{W_{top}L_{base} + W_{base}L_{top}}{2}\right)\right]$$

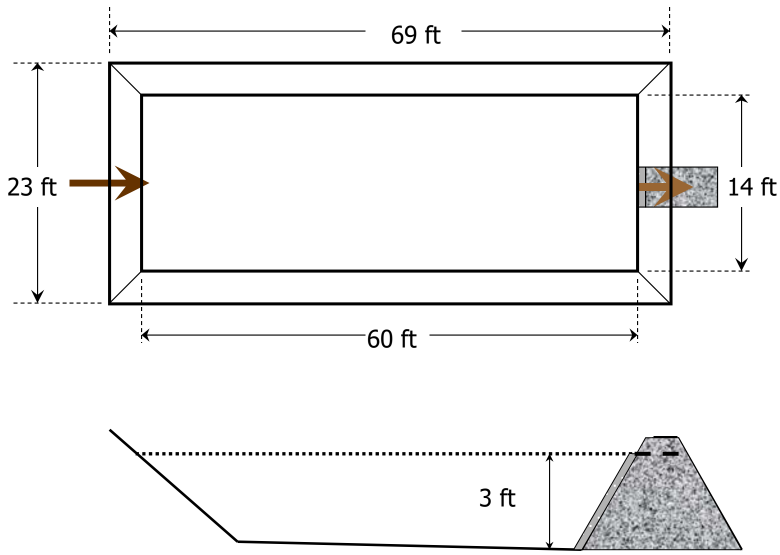
$$\text{Volume} = \frac{3}{3}\left[(23)(69) + (14)(60) + \left(\frac{(23)(60) + (14)(69)}{2}\right)\right]$$

Volume = 3600 ft^3 (meets minimum requirement)

Surface Area (at weir elevation) = 23 x 69 = 1587 ft^2

94

Example: Temp Rock Sed Dam Type B



Not to Scale

95

Example: Temp Rock Sed Dam Type B

Principal spillway:

Water exits the basin via the Class B stone dam covered with sediment control stone

Rock weir:

Weir must be sized according to weir chart based on total drainage area (1 acre)

Weir Length (1 acre) = 4 ft

Baffles:

Since basin is 69 ft long, use 3 baffles spaced evenly. Divided the basin into 4 quarters, each 17 ft long

96

Design Steps: Skimmer Basin with Baffles

1. Minimum volume and surface area
2. Width and length based on sideslopes
3. Dewatering flow rate (top 2 ft in 3 days)
4. Skimmer size and orifice diameter
5. Primary spillway barrel pipe size
6. Emergency spillway weir length
7. Baffle spacing

97

Skimmer Basin

Skimmer Basin on Mitchell Mill Rd

98

Skimmer Basin on Wade Ave.

Example: Skimmer Basin with Baffles

Disturbed area = 9.9 ac; Q_{10} = 17 cfs; Dewater time = 3 days; Interior sideslopes = 1.5:1; L:W = 3:1

1. Minimum Volume and Surface Area:

Minimum Volume = 1800 x 9.9 acres = 17,820 ft^3

Minimum Surface Area = $325Q_{10}$ = 325 x 17 cfs = 5,525 ft^2

Depth = Volume / Area = 17,820 ft^3 / 5,525 ft^2 = 3.2 ft

For DOT projects, <u>Design Depth = 3 ft</u>

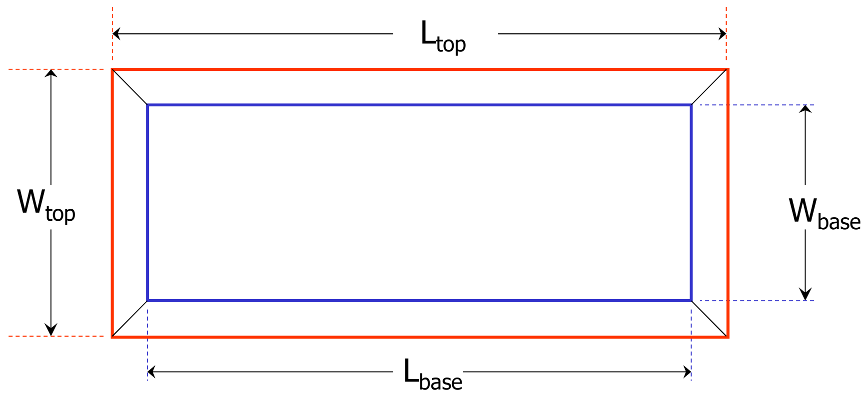
Therefore, adjust minimum surface area up:

$Area_{min}$ = Volume / Design Depth = 17,820 ft^3 / 3 ft = 5,940 ft^2

Surface area must be greater to account for sideslopes

100

Example: Skimmer Basin with Baffles



$$\text{Volume} = \frac{d}{3}\left[W_{top}\,L_{top} + W_{base}\,L_{base} + \left(\frac{W_{top}\,L_{base} + W_{base}\,L_{top}}{2}\right)\right]$$

101

Example: Skimmer Basin with Baffles

2. Width and length at top and base (trial & error):

Start with area = 5,940 ft^2 and a 3 to 1 length to width ratio

$$\text{Trial Width, } W_{top} = \sqrt{\frac{A}{\text{L to W ratio}}} = \sqrt{\frac{5940}{3}} = 45\,\text{ft}$$

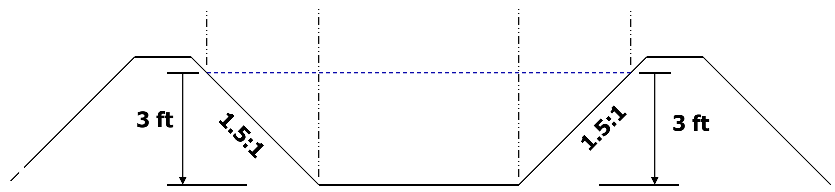
To account for sideslopes, add to top width (try 3 ft):

Trial W_{top} = 45 + 3 = 48 ft

Trial L_{top} = 3 x W_{top} = 3 x 48 = 144 ft

102

Example: Skimmer Basin with Baffles



Calculate base width and base length using 1.5 to 1 sideslopes:

$W_{base} = W_{top}$ – (depth x 1.5 x 2 sides) = 48 – (3x1.5x2) = 39 ft

$L_{base} = L_{top}$ – (depth x 1.5 x 2 sides) = 144 – (3x1.5x2) = 135 ft

103

Example: Skimmer Basin with Baffles

Calculate volume (minimum required = 17,820 ft^3):

$$\text{Volume} = \frac{d}{3}\left[W_{top}L_{top} + W_{base}L_{base} + \left(\frac{W_{top}L_{base} + W_{base}L_{top}}{2}\right)\right]$$

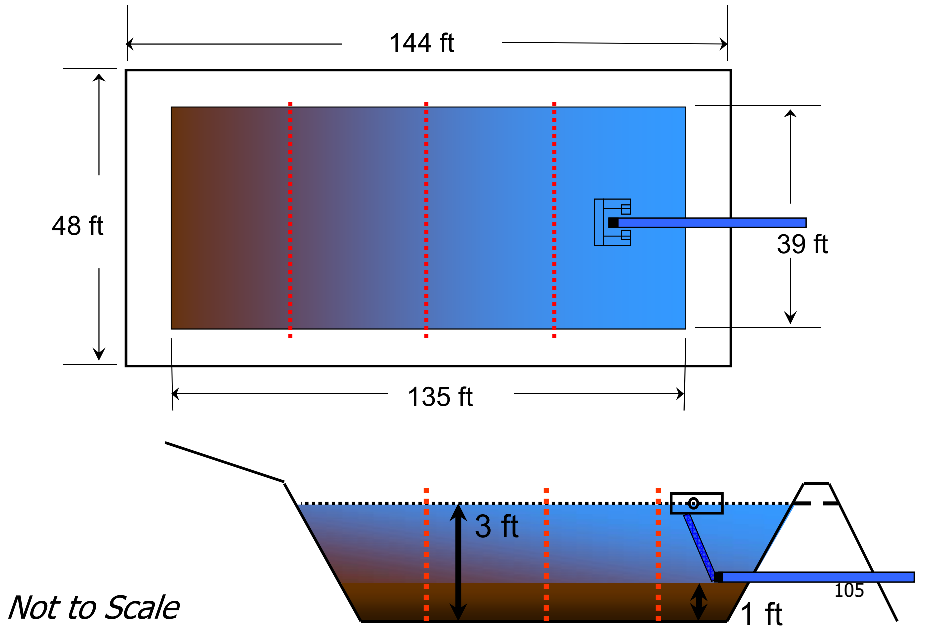
$$\text{Volume} = \frac{3}{3}\left[(48)(144) + (39)(135) + \left(\frac{(48)(135) + (39)(144)}{2}\right)\right]$$

Volume = 18,225 ft^3 (meets minimum requirement)

Surface Area (at weir elevation) = 48 x 144 = 6,912 ft^2

104

Example: Skimmer Basin with Baffles



Example: Skimmer Basin with Baffles

3. Dewatering flow rate (<u>top 2 ft in 3 days)</u>

Calculate width & length at depth =1 ft using 1.5:1 sideslopes:

$W_{1ft} = W_{top} – (\text{depth x 1.5 x 2 sides}) = 48 – (2x1.5x2) = 42$ ft

$L_{1ft} = L_{top} – (\text{depth x 1.5 x 2 sides}) = 144 – (2x1.5x2) = 138$ ft

Calculate volume in the top 2 ft

$$\text{Volume} = \frac{d}{3}\left[W_{top}L_{top} + W_{1ft}L_{1ft} + \left(\frac{W_{top}L_{1ft} + W_{1ft}L_{top}}{2}\right)\right]$$

$$\text{Volume} = \frac{2}{3}\left[(48)(144) + (42)(138) + \left(\frac{(48)(138) + (42)(144)}{2}\right)\right]$$

Volume in top 2 ft = 12,696 ft^3

Example: Skimmer Basin with Baffles

4. Select Faircloth Skimmer to dewater <u>top 2 ft in 3 days</u>

Volume in top 2 ft, V_{skim} = 12,696 ft^3

Dewater Rate, $Q_{skim} = V_{skim} / t_{dewater}$ = 12,696 / 3 = 4,232 ft^3 / day

Select the Skimmer Size to carry <u>at least</u> 4,232 ft^3/day

From Table 5.1, a 2.5-inch skimmer carries 6,234 ft^3/day with driving head, H_{skim} = 0.208 ft

Why not use a 2-inch skimmer?

107

Select skimmer based on flow rate, Table 5.1

Skimmer Diameter (inches)	$Q_{skimmer}$ Max Outflow Rate (ft^3 / day) *	$H_{skimmer}$ Driving Head (ft) *
1.5	1,728	0.125
2.0	3,283	0.167
2.5	6,234	0.208
3.0	9,774	0.250
4.0	20,109	0.333
5.0	32,832	0.333
6.0	51,840	0.417
8.0	97,978	0.500

* *Updated 2007: www.fairclothskimmer.com*

108

Orifice Diameter for Skimmer

$$D_{orifice} = \sqrt{\frac{Q_{skim}}{2310\sqrt{H_{skim}}}} \qquad \text{(Equation 5.2)}$$

$D_{orifice}$ = diameter of the skimmer orifice in inches (in)
$Q_{skimmer}$ = basin outflow rate in cubic feet per day (ft^3/day)
$H_{skimmer}$ = driving head at the skimmer orifice from Table 5.1 in feet (ft)

$$D_{orifice} = \sqrt{\frac{Q_{skim}}{2310\sqrt{H_{skim}}}} = \sqrt{\frac{4{,}232}{2{,}310\sqrt{0.208}}} = 2.0 \textit{ inches}$$

The orifice in the knockout plug is drilled to a 2-inch diameter.

109

Example: Skimmer Basin with Baffles

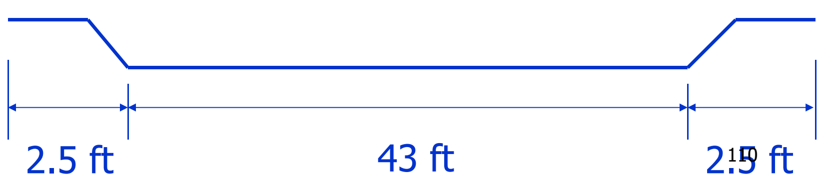
5. Primary spillway barrel pipe size using Q_{skim} = 4,232

NCDOT: Use smooth pipe on 1% slope (minimum 4-inch)

Figure 4.1: At 1% slope, a 4-inch pipe carries up to 100 gpm = 19,300 ft^3/day

6. Emergency spillway weir length:

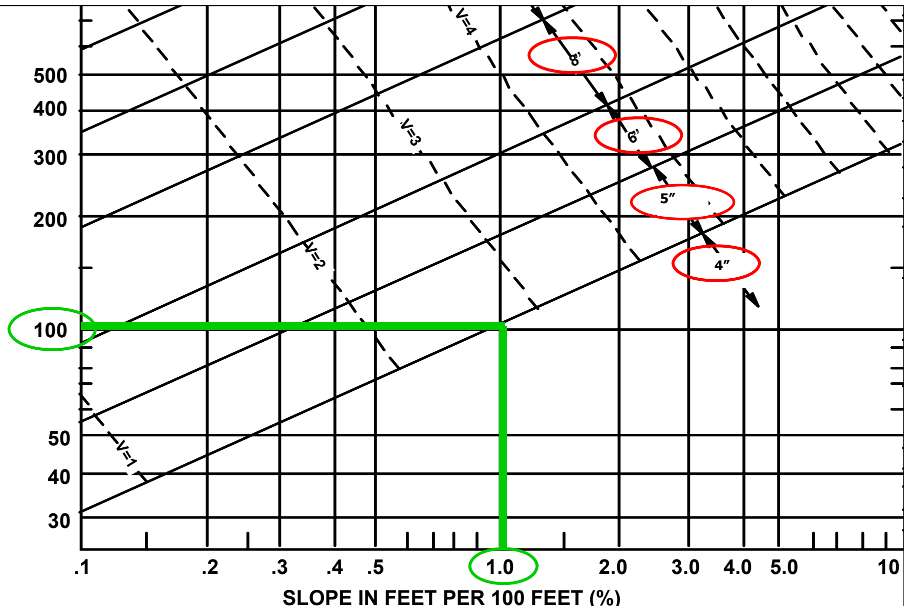
NCDOT: L_{weir} = 17 cfs/0.4 = 42.5 ft or 43 ft



110

Discharge (gpm)

Figure 4.1, pg 28



Based on Manning's n=0.0108

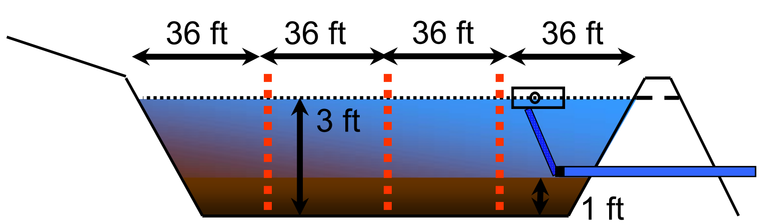
111

Example: Skimmer Basin with Baffles

7. Baffle Spacing:

For L_{top} > 20 ft, use 3 baffles to divide into 4 chambers:

Baffle spacing = L_{top} / 4 = 144 / 4 = 36 ft



Not to Scale

112

Worksheet 5.1. Infiltration Basin

Infiltration basin on Rains soil (permeability= 0.5 in/hr) with drainage area of 8 acres?

Drainage area = 8 ac; permeability = 0.5 in/hr

For NCDOT maximum depth = 3ft

Dewatering time = 3ft x hr/0.5 in x 12 in/ft = 72 hr or 3 days

Design volume = 1800 x 8 = 14,400 ft^3

*NCDOT guidelines: drains in 3 days, drainage area <10ac., soil permeability at least 0.5 in/hr

113

Worksheet 5.2. Temp Rock Sed Dam Type B

Disturbed area = 0.9 ac; Q_{10} = 3 cfs;

Interior sideslopes = 1.5:1; L:W = 3:1

1. Minimum Volume and Surface Area:

Minimum Volume = 3600 x 0.9 ac = 3240 ft^3

Minimum Surface Area = 435 Q_{10} = 435 x 3 cfs = 1305 ft^2

Depth = Volume / Area = 3240 ft^3 / 1305 ft^2 = 2.5 ft

For DOT projects, <u>Design Depth = 2 to 3 ft</u>

Therefore, use depth = 2.5 ft

Surface area must be greater to account for sideslopes

114

Worksheet 5.2. Temp Rock Sed Dam Type B

2. Width and depth at top and base (trial & error):

Start with area = 1305 ft^2 and a 3:1 length to width ratio

$$\text{Trial Width, } W_{top} = \sqrt{\frac{A}{\text{L to W ratio}}} = \sqrt{\frac{1305}{3}} = 21 \text{ ft}$$

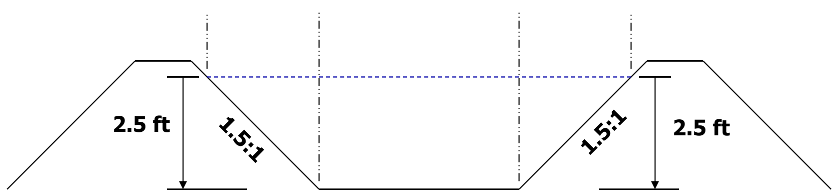
To account for sideslopes, add to top width (try 3 ft):

Trial W_{top} = 21 + 3 = 24 ft

Trial L_{top} = 3 x W_{top} = 3 x 24 = 72 ft

115

Worksheet 5.2. Temp Rock Sed Dam Type B



Calculate base width and base length using 1.5 to 1 sideslopes:

W_{base} = W_{top} – (depth x 1.5 x 2 sides) = 24 – (2.5x1.5x2) = 16.5 ft

L_{base} = L_{top} – (depth x 1.5 x 2 sides) = 72 – (2.5x1.5x2) = 64.5 ft

116

Worksheet 5.2. Temp Rock Sed Dam Type B

Calculate volume (minimum required = 3,240 ft^3):

$$\text{Volume} = \frac{d}{3}\left[W_{top}\,L_{top} + W_{base}\,L_{base} + \left(\frac{W_{top}\,L_{base} + W_{base}\,L_{top}}{2}\right)\right]$$

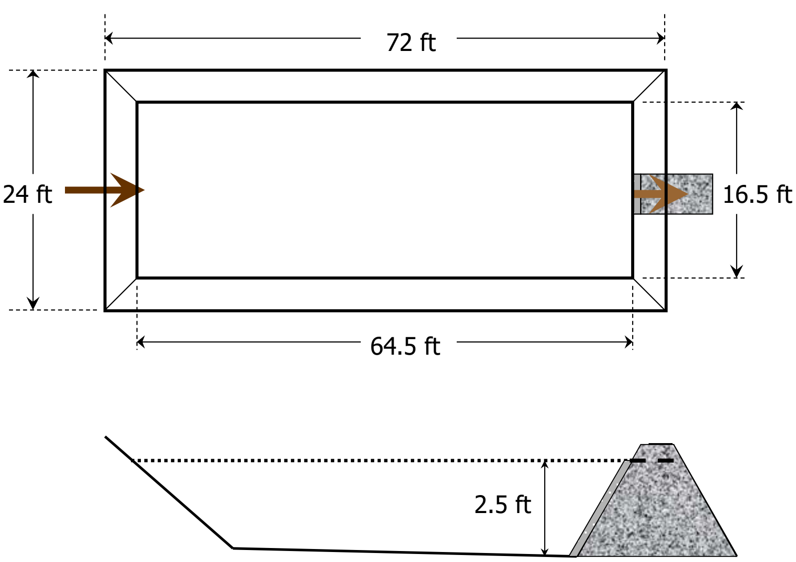
$$\text{Volume} = \frac{2.5}{3}\left[(24)(72) + (16.5)(64.5) + \left(\frac{(24)(64.5) + (16.5)(72)}{2}\right)\right]$$

Volume = 3448 ft^3 (meets minimum requirement)

Surface Area (at weir elevation) = 24 x 72 = 1728 ft^2

117

Worksheet 5.2. Temp Rock Sed Dam Type B



Not to Scale

118

Worksheet 5.2. Temp Rock Sed Dam Type B

Principal spillway:

Water exits the basin via the Class B stone dam covered with sediment control stone

Rock weir:

Weir must be sized according to the weir chart based on total drainage area (1 acre)

Weir Length (1 acre) = 4 ft

Baffles:

Since basin is 72 ft long, use 3 baffles spaced evenly. Divided the basin into 4 quarters, each 18 ft long

119

Worksheet 5.3. Skimmer Basin

Design: For a 5.5-acre construction site with Q_{10} = 12 cfs, design a basin to be dewatered in 3 days. Use 1.5:1 interior sideslopes and 3:1 length:width ratio.

1. Minimum volume and surface area
2. Width and length based on sideslopes
3. Dewatering flow rate (top 2 ft in 3 days)
4. Skimmer size and orifice diameter
5. Primary spillway barrel pipe size
6. Emergency spillway weir length
7. Baffle spacing

120

Worksheet 5.3. Skimmer Basin

Design: For a 5.5-acre construction site with Q_{10} = 12 cfs, design a basin to be dewatered in 3 days. Use 1.5:1 interior sideslopes and 3:1 length:width ratio.

1. Minimum Volume and Surface Area:

Minimum Volume = 1800 x 5.5 acres = 9,900 ft^3

Minimum Surface Area = 325Q_{10} = 325 x 12 cfs = 3,900 ft^2

Depth = Volume / Area = 9,900 ft^3 / 3,900 ft^2 = 2.5 ft

For DOT projects, <u>Design Depth = 3 ft</u>

Surface area must be greater to account for sideslopes

121

Worksheet 5.3. Skimmer Basin

2. Width and Length at top and base (trial & error):

Start with area = 3,900 ft^2 and a 3:1 length:width ratio

$$\text{Trial Width, } W_{top} = \sqrt{\frac{A}{\text{L to W ratio}}} = \sqrt{\frac{3{,}900}{3}} = 36.1\,\text{ft}$$

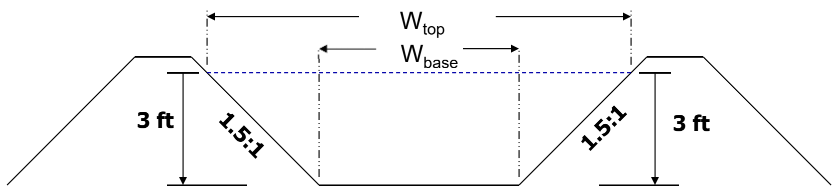
Trial Width, W_{top} = 37 ft round up,   36ft doesn't work

Trial Length, L_{top} = 3 x 37 = 111 ft

Try this width and length with 1.5:1 sideslopes to check if volume > 9,900 ft^3

122

Worksheet 5.3. Skimmer Basin



Calculate base width and base length using 1.5 to 1 sideslopes:

$W_{base} = W_{top}$ – (depth x 1.5 x 2 sides) = 37 – (3x1.5x2) = 28 ft

$L_{base} = L_{top}$ – (depth x 1.5 x 2 sides) = 111 – (3x1.5x2) = 102 ft

For 3ft W_{base} =30ft; W_{top} = 39 ft; L_{top}=117ft; L_{base}= 108 ft

123

Worksheet 5.3. Skimmer Basin

Calculate volume (minimum required = 9,900 ft^3):

$$\text{Volume} = \frac{d}{3}\left[W_{top}\,L_{top} + W_{base}\,L_{base} + \left(\frac{W_{top}\,L_{base} + W_{base}\,L_{top}}{2}\right)\right]$$

$$\text{Volume} = \frac{3}{3}\left[(37)(111) + (28)(102) + \left(\frac{(37)(102) + (28)(111)}{2}\right)\right]$$

Volume = 10,404 ft^3 (meets minimum requirement)

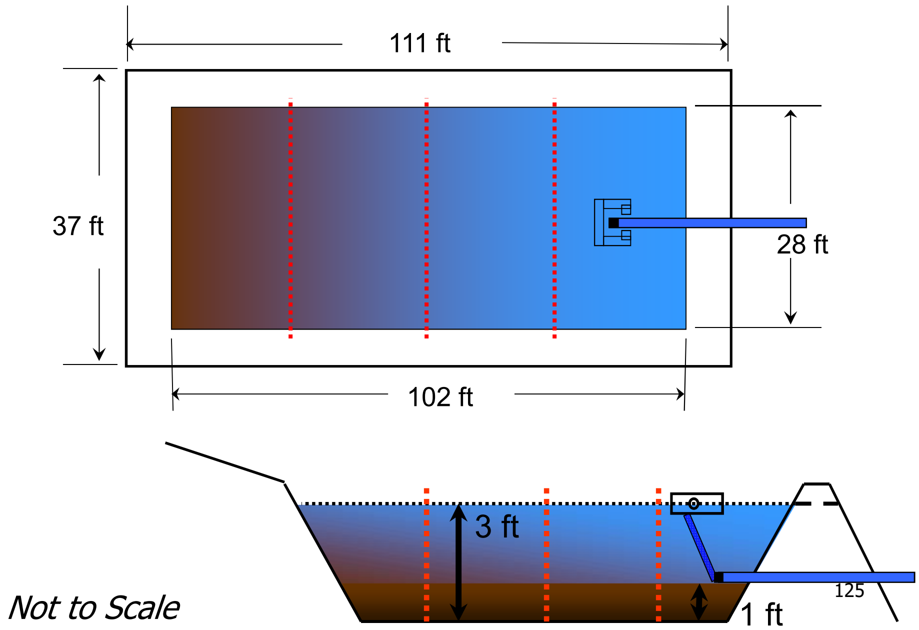
trial add 3ft Vol.= 11,664 ft^3

Surface Area (at weir elevation) = 37 x 111 = 4,107 ft^2

3ft trial Area= 4563 ft^2

124

Worksheet 5.3. Skimmer Basin



125

Worksheet 5.3. Skimmer Basin

3. Dewatering flow rate (<u>top 2 ft in 3 days)</u>

Calculate width & length at depth =1 ft using 1.5:1 sideslopes:

$W_{1ft} = W_{top} – (\text{depth x } 1.5 \text{ x } 2 \text{ sides}) = 37 – (2x1.5x2) = 31$ ft

$L_{1ft} = L_{top} – (\text{depth x } 1.5 \text{ x } 2 \text{ sides}) = 111 – (2x1.5x2) = 105$ ft

Calculate volume in the top 2 ft

$$\text{Volume} = \frac{d}{3}\left[W_{top}L_{top} + W_{1ft}L_{1ft} + \left(\frac{W_{top}L_{1ft} + W_{1ft}L_{top}}{2}\right)\right]$$

$$\text{Volume} = \frac{2}{3}\left[(37)(111) + (31)(105) + \left(\frac{(37)(105) + (31)(111)}{2}\right)\right]$$

Volume in top 2 ft = 7,350 ft^3

126

Worksheet 5.3. Skimmer Basin

4. Select Faircloth Skimmer to dewater top 2 ft in 3 days

Volume in top 2 ft, V_{skim} = 7,350 ft^3

Daily Q_{skim} = 7,350 / 3 = 2,450 ft^3 / day

Select the Skimmer Size to carry at least 2,450 ft^3/day

From Table 5.1, a 2-inch skimmer carries 3,283 ft^3/day with driving head, H_{skim} = 0.167 ft

$$D_{orifice} = \sqrt{\frac{Q_{skim}}{2310\sqrt{H_{skim}}}} = \sqrt{\frac{2{,}450}{2{,}310\sqrt{0.167}}} = 1.6\ \textit{inches}$$

The orifice in the knockout plug is drilled to a 1.6-inch diameter.

127

Select skimmer based on flow rate, Table 5.1

Skimmer Diameter (inches)	$Q_{skimmer}$ Max Outflow Rate (ft^3 / day) *	$H_{skimmer}$ Driving Head (ft) *
1.5	1,728	0.125
2.0	3,283	0.167
2.5	6,234	0.208
3.0	9,774	0.250
4.0	20,109	0.333
5.0	32,832	0.333
6.0	51,840	0.417
8.0	97,978	0.500

* Updated 2007: www.fairclothskimmer.com

128

Worksheet 5.3. Skimmer Basin

5. Primary spillway barrel pipe size using Q_{skim} = 2,450

NCDOT: Use smooth pipe on 1% slope (minimum 4-inch)

Figure 4.1 (Pipe Chart): At 1% slope, a 4-inch pipe carries up to 100 gpm = 19,300 ft^3/day

6. Emergency spillway weir length:

NCDOT: L_{weir} = 12 cfs/0.4 = 30 ft

7. Baffle Spacing:

Baffle spacing = L_{top} / 4 = 111 / 4 = 28 ft

129

MODULE 6: Below Water Table Borrow Pits Dewatering Options

Tier I Methods

- Borrow Pit Dewatering Basin
- Land Application (Irrigation)
- Geotextile Bags
- Alum
- Gypsum
- Polyacrylamide (PAM)

Tier II Methods [rare & unique resources]

- Well Point Pumping
- Impoundments
- Cell Mining
- Sand Media Filtration
- Wet Mining

130

Borrow Pit Dewatering Basin

- Basin at pump outlet to settle sediment
- No area requirement
- Volume = pump rate x detention time:
  - Detention time = 2 hours minimum
  - V_{still} =16(Q_{still}) Q = pump rate in gpm
  - Max pump rate = 1,000 gpm (2.2 cfs)
- Maximum depth = 3 ft
- Earthen embankments are fill above grade
- L:W = 2:1 minimum
- Surface outlet:
  - Non-perforated riser pipe (12-inch)
  - Flashboard riser

131

Turbidity Reduction: PAM at 1 mg/L in stilling basin

<u>Powder:</u> mix 1 pound of PAM per 100 gallons of water

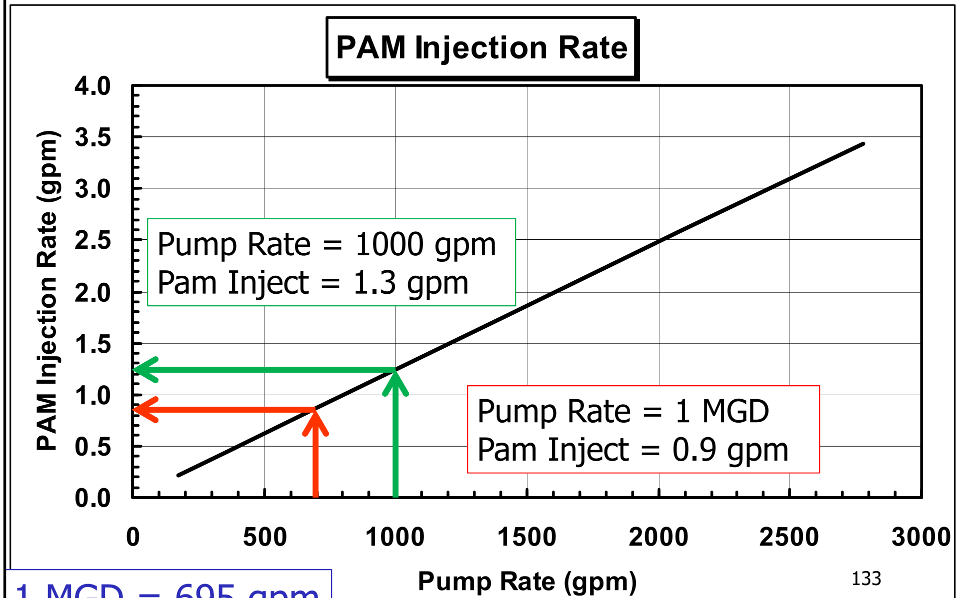
Figure 6.1: At Q_{still} = 1000 gpm, inject liquid PAM mix at 1.3 gpm

Inject mix at pump intake (suction line) or just after water leaves pump

<u>Floc-Log:</u> turbulent flow 60-80 gpm inside corrugated plastic pipe (no inner liner)

132

Figure 6.1. PAM Injection (liquid mix)



1 MGD = 695 gpm

133

Example: Borrow Pit Dewatering Basin

Design a Borrow Pit Dewatering Basin with 2-hour detention time, PAM injection, and pumping rate, Q_{still} = 300 gpm.

Volume: $V_{still} = 16\ (Q_{still})$ (Equation 6.1, pg 34)

$V_{still} = 16\ (300\ \text{gpm}) = 4{,}800\ \text{ft}^3$

For depth = 3 ft, minimum surface area:

Area = Volume/Depth = $4{,}800\ \text{ft}^3 / 3\ \text{ft} = 1{,}600\ \text{ft}^2$

134

Example: Borrow Pit Dewatering Basin

Width and length at top and base (trial & error):

Start with area = 1,600 ft^2 and a 2:1 length to width ratio

$$\text{Trial Width}, W_{top} = \sqrt{\frac{A}{\text{L to W ratio}}} = \sqrt{\frac{1{,}600}{2}} = 29 \text{ ft}$$

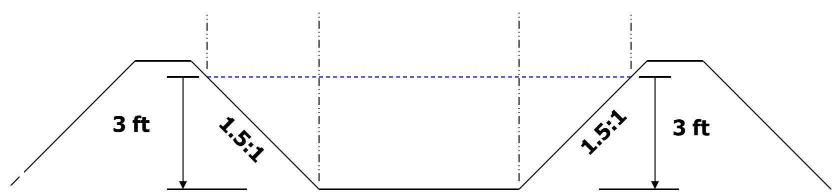
To account for sideslopes, add to top width (try 4 ft):

Trial W_{top} = 29 + 4 = 33 ft

Trial L_{top} = 2 x W_{top} = 2 x 33 = 66 ft

135

Example: Borrow Pit Dewatering Basin



Calculate base width and base length using 1.5 to 1 sideslopes:

W_{base} = W_{top} – (depth x 1.5 x 2 sides) = 33 – (3x1.5x2) = 24 ft

L_{base} = L_{top} – (depth x 1.5 x 2 sides) = 66 – (3x1.5x2) = 57 ft

136

Example: Borrow Pit Dewatering Basin

Calculate volume (minimum required = 4,824 ft^3):

$$\text{Volume} = \frac{d}{3}\left[W_{top}\,L_{top} + W_{base}\,L_{base} + \left(\frac{W_{top}\,L_{base} + W_{base}\,L_{top}}{2}\right)\right]$$

$$\text{Volume} = \frac{3}{3}\left[(33)(66) + (24)(57) + \left(\frac{(33)(57) + (24)(66)}{2}\right)\right]$$

Volume = 5,300 ft^3 (meets minimum requirement)

Surface Area (at weir elevation) = 33 x 66 = 2,200 ft^2

137

Example: Borrow Pit Dewatering Basin

<u>Spillway Options:</u>

- Riser Pipe (12-inch diameter) with invert at 3 ft depth
- Flashboard Riser with invert at 3 ft depth and flow rate of 300 gpm (0.67 cfs)

<u>PAM Injection:</u>

Mix 1 pound of PAM powder per 100 gallons of water

Figure 6.1: Q_{still} = 300 gpm, inject liquid PAM mix at 0.4 gpm

Inject mix at pump intake (suction line) or just after water leaves pump

138

Worksheet 6.1: Borrow Pit Dewatering Basin

Design a Borrow Pit Dewatering Basin with (1.5:1 sideslopes; 2:1 L:W ratio) 2-hour detention, PAM injection, and pumping rate, Q_{still} = 1 MGD = 695 gpm.

Volume: $V_{still} = 16 (Q_{still})$ (Equation 6.1)

$V_{still} = 16 \text{ (695 gpm)} = 11{,}120 \text{ ft}^3$

For depth = 3 ft, minimum surface area:

Area = Volume/Depth = 11,120 ft^3 / 3 ft = 3,700 ft^2

139

Worksheet 6.1: Borrow Pit Dewatering Basin

Width and length at top and base (trial & error):

Start with area = 3,700 ft^2 and a 2:1 length to width ratio

$$\text{Trial Width, } W_{top} = \sqrt{\frac{A}{\text{L to W ratio}}} = \sqrt{\frac{3{,}700}{2}} = 43.0\text{ft}$$

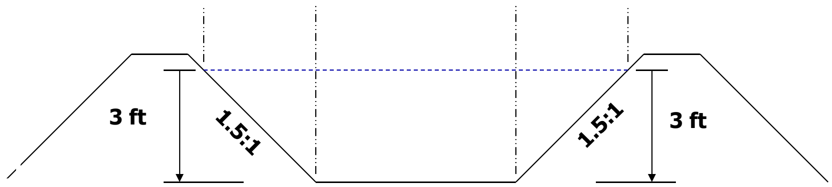
To account for sideslopes, add to top width (try 4 ft):

Trial W_{top} = 43 + 4 = 47 ft

Trial $L_{top} = 2 \times W_{top}$ = 2 x 47 = 94 ft

140

Worksheet 6.1: Borrow Pit Dewatering Basin



Calculate base width and base length using 1.5 to 1 sideslopes:

W_{base} = W_{top} – (depth x 1.5 x 2 sides) = 47 – (3x1.5x2) = 38 ft

L_{base} = L_{top} – (depth x 1.5 x 2 sides) = 94 – (3x1.5x2) = 88 ft

141

Worksheet 6.1: Borrow Pit Dewatering Basin

Calculate volume (minimum required = 11,120 ft^3):

$$\text{Volume} = \frac{d}{3}\left[W_{top}L_{top} + W_{base}L_{base} + \left(\frac{W_{top}L_{base} + W_{base}L_{top}}{2}\right)\right]$$

$$\text{Volume} = \frac{3}{3}\left[(47)(94) + (38)(85) + \left(\frac{(47)(85) + (38)(94)}{2}\right)\right]$$

Volume = 11,432 ft^3 (meets minimum requirement)

Surface Area (at weir elevation) = 47 x 94 = 4,418 ft^2

142

Worksheet 6.1: Borrow Pit Dewatering Basin

Spillway Options:

- Riser Pipe (12-inch diameter) with invert at 3 ft depth
- Flashboard Riser with invert at 3 ft depth and flow rate of 695 gpm (1.6 cfs)

PAM Injection:

Mix 1 pound of PAM powder per 100 gallons of water

Figure 6.1: Q_{still} = 695 gpm, inject liquid PAM mix at 0.9 gpm

Inject mix at pump intake (suction line) or just after water leaves pump

143

Below Water Table Sites: Wetland Protection

Type 1: Flow from wetland to pit

Type 2: Flow from pit to wetland

Does not require Skaggs Method calculations

Minimum 25 ft buffer (setback) from wetland

Minimum 50 ft buffer from stream

Type 3: Flow-through pits: wetland to pit on one side, pit to wetland on other side

For Types 1 & 3 or uncertain flow direction:

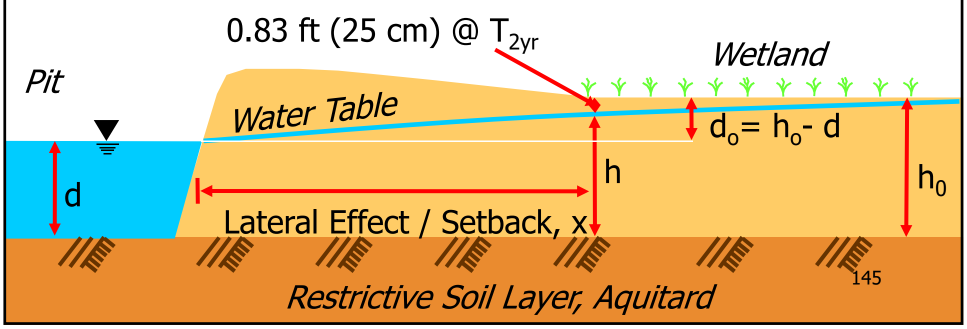
- 400 ft buffer OR
- Skaggs Method calculations

144

Skaggs Method: Determine Setback

Wetland hydrology is defined as an area where the water table is normally within 1.0 ft of the soil surface for a continuous critical duration, defined as 5-12.5% of the growing season. The 5% was used in the Skaggs method.

Calculate "Lateral Effect," or setback, x



145

Skaggs Method: Determine Setback

Soil Characteristics:

- Effective hydraulic conductivity, $\mathbf{K_e}$ (Soil Survey or site investigation)
- Drainable porosity, **f = 0.035 for DOT applications**

Surface Depressional Storage:

1 inch if area is relatively smooth

2 inches if area is rough with shallow depressions

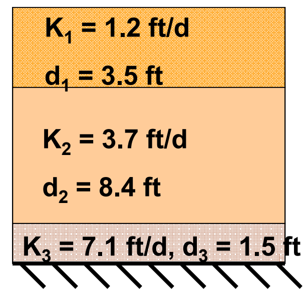
Depth to water table at borrow pit: d_o= 2 ft

Depth of soil profile to restrictive layer: h_o

146

Effective Hydraulic Conductivity

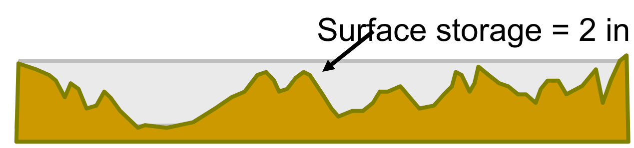
$$K_e = \frac{K_1 d_1 + K_2 d_2 + K_3 d_3}{d_1 + d_2 + d_3}$$



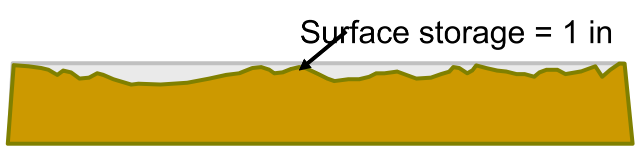
$$K_e = \frac{1.2(3.5) + 3.7(8.4) + 7.1(1.5)}{3.5 + 8.4 + 1.5} = 3.4\, ft/d$$

147

Surface Storage



Natural Forest or Pocosin



Land planed agricultural field

148

Surface storage = 1 in

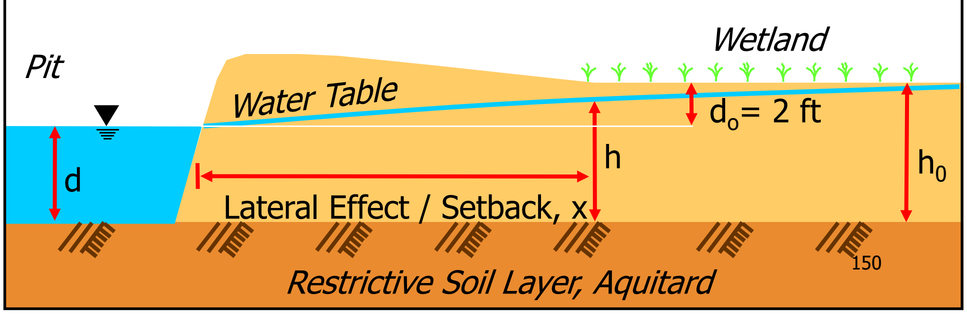
Surface storage = 2 in

Skaggs Method: Determine Setback

h_o = average profile depth to restrictive layer (measured from wetland soil surface)

d_o = 2 ft = depth from wetland soil surface to water in the borrow pit ($d_o = h_o - d$). For NCDOT, d_o = 2 ft

d = depth of pit water to restrictive layer, $d = h_o - 2$ ft



Skaggs Method: Determine Setback

Table 6.1 based on County climate data:

- 30+ years of rainfall data & ET estimates
- DRAINMOD simulates how water table changes during growing season for depressional storage
- Select depressional storage (1 or 2 inches)

For NCDOT, use 2 ft 'depth to water' (d_o = 2 ft)

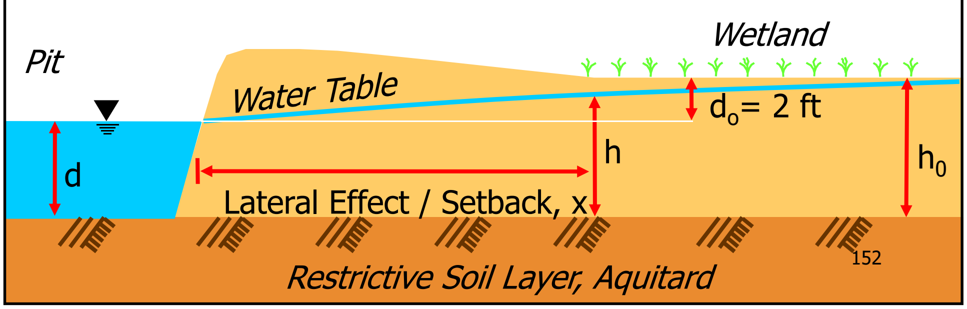
Note: reference section (pg 35) contains details on the method and the background to the method.

151

Skaggs Method: Determine Setback

$$H = h / h_o = (h_o - 0.83) / h_o$$

$$D = d / h_o = (h_o - 2) / h_o$$



152

Skaggs Method Software

www.ncdot.org/doh/Operations/dp_chief_eng/roadside/fieldops/downloads/

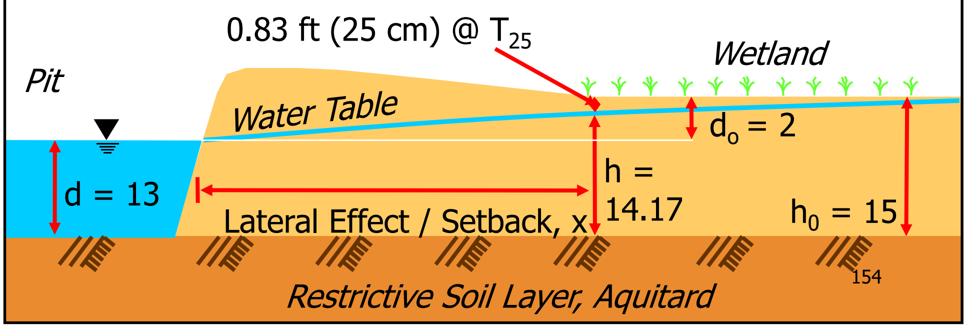
Inputs:

- Soil type (information only)
- County
- Depth from wetland surface to water in pit (d_o = 2 ft, NCDOT)
- Surface depressional storage (1 inch smooth, 2 inches rough)
- Depth from wetland soil surface to restrictive layer, h_o
- Drainable porosity of the soil, f=0.035 for NCDOT
- Effective Hydraulic Conductivity of each soil layer between pit and wetland, K_e, inches per hour

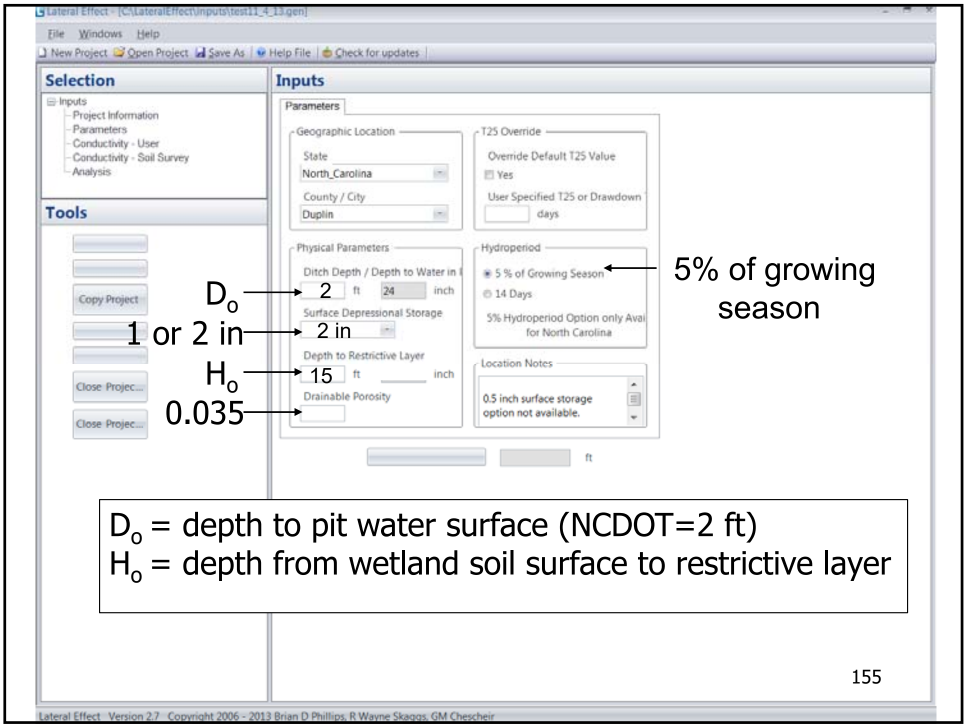
153

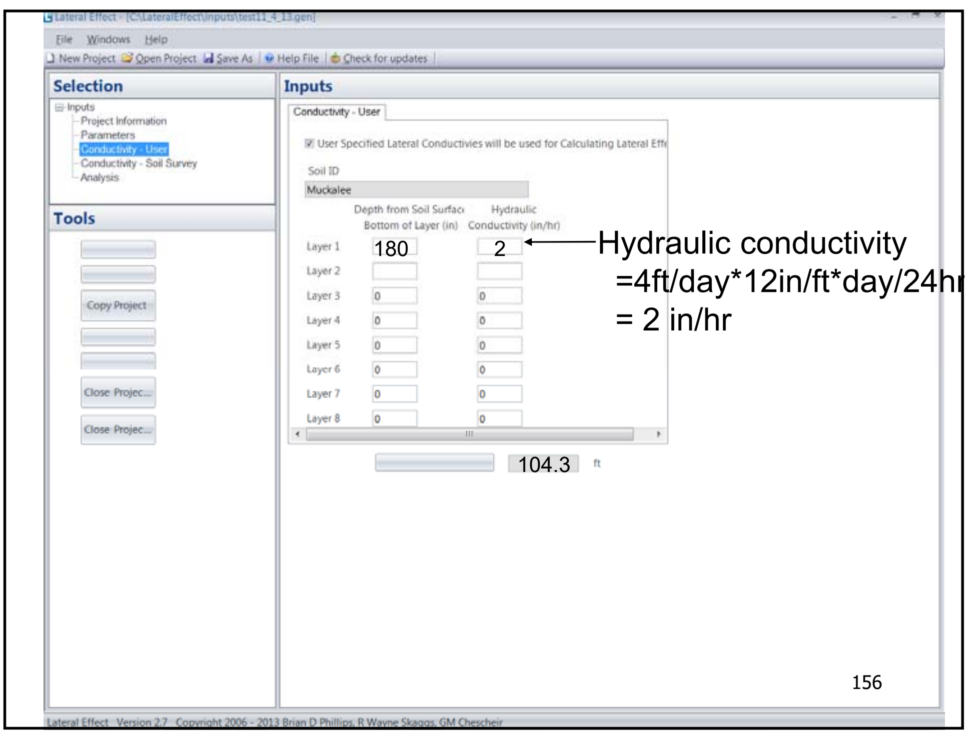
Example: Skaggs Method

The wetland is located in Johnston County on a Rains soil. From wetland soil surface to impermeable/restrictive layer is 15 ft. Soil hydraulic conductivity is 4ft/day. The wetland has a natural rough surface. What is the minimum lateral setback?



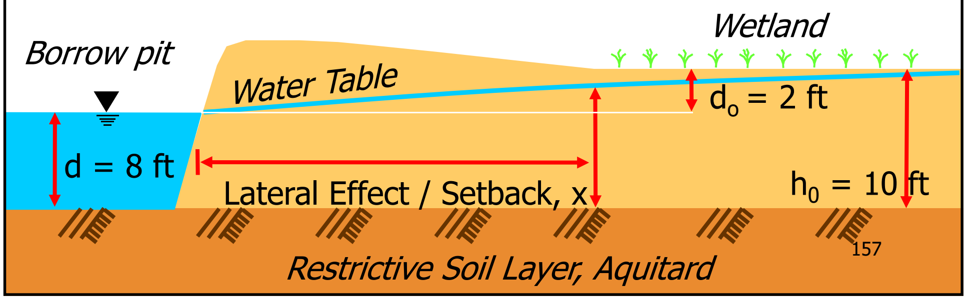
154


Lateral Effect - [C:\LateralEffect\inputs\test11_4_13.gen]
File Windows Help
New Project Open Project Save As Help File Check for updates
Selection
Inputs
Project Information
Parameters
Conductivity - User
Conductivity - Soil Survey
Analysis
Tools
Copy Project
Close Projec...
Inputs
Parameters
Geographic Location
State
North_Carolina
County / City
Duplin
T25 Override
Override Default T25 Value
Yes
User Specified T25 or Drawdown
days
Physical Parameters
Ditch Depth / Depth to Water in
2 ft 24 inch
Surface Depressional Storage
2 in
Depth to Restrictive Layer
15 ft inch
Drainable Porosity
Hydroperiod
5 % of Growing Season
14 Days
5% Hydroperiod Option only Avai for North Carolina
Location Notes
0.5 inch surface storage option not available.
ft
D_o
1 or 2 in
H_o
0.035
5% of growing season
D_o = depth to pit water surface (NCDOT=2 ft)
H_o = depth from wetland soil surface to restrictive layer
155
Lateral Effect Version 2.7 Copyright 2006 - 2013 Brian D Phillips, R Wayne Skaggs, GM Chescheir


Lateral Effect - [C:\LateralEffect\inputs\test11_4_13.gen]
File Windows Help
New Project Open Project Save As Help File Check for updates
Selection
Inputs
Project Information
Parameters
Conductivity - User
Conductivity - Soil Survey
Analysis
Tools
Copy Project
Close Projec...
Inputs
Conductivity - User
User Specified Lateral Conductivies will be used for Calculating Lateral Eff
Soil ID
Muckalee
Depth from Soil Surface Bottom of Layer (in)
Hydraulic Conductivity (in/hr)
Layer 1 180 2
Layer 2
Layer 3 0 0
Layer 4 0 0
Layer 5 0 0
Layer 6 0 0
Layer 7 0 0
Layer 8 0 0
104.3 ft
Hydraulic conductivity
=4ft/day*12in/ft*day/24hr
= 2 in/hr
156
Lateral Effect Version 2.7 Copyright 2006 - 2013 Brian D Phillips, R Wayne Skaggs, GM Chescheir

Worksheet 6.2. Skaggs Method Software Input

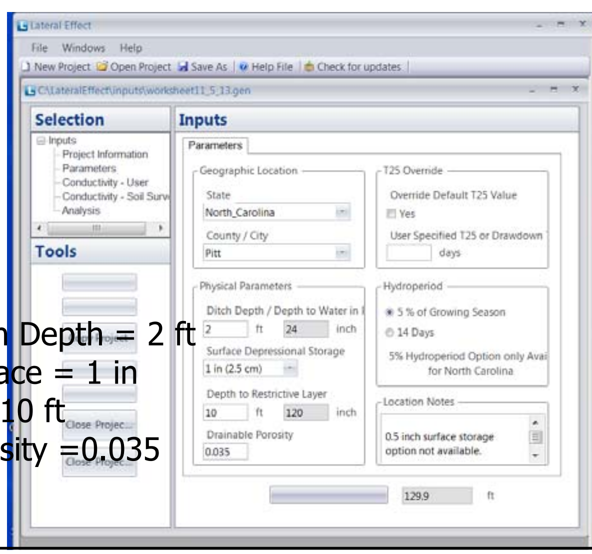
For a borrow pit in Pitt County with Emporia soil (K = 6 ft/day), depth from wetland soil surface to the impermeable layer is 10 ft, ground surface of wetland area is smooth, fill in the inputs for the Skaggs Method software program.



157

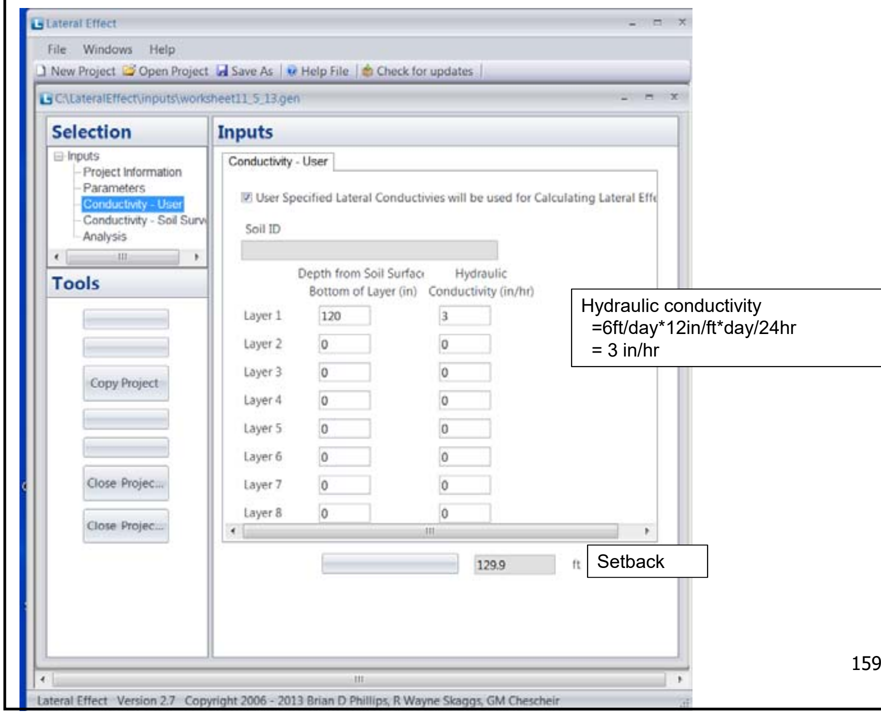
Worksheet 6.2. Skaggs Method Software Input

For a borrow pit in Pitt County with Emporia soil (K = 6 ft/day), depth from wetland soil surface to the impermeable layer is 10 ft, ground surface of wetland area is smooth, fill in the inputs for the Skaggs Method software program.



Ditch Depth = 2 ft
Surface = 1 in
Do=10 ft
Porosity =0.035

158


Lateral Effect
File Windows Help
New Project Open Project Save As Help File Check for updates
C:\LateralEffect\inputs\worksheet11_5_13.gen
Selection
Inputs
Project Information
Parameters
Conductivity - User
Conductivity - Soil Surv
Analysis
Tools
Copy Project
Close Projec...
Close Projec...
Inputs
Conductivity - User
User Specified Lateral Conductivies will be used for Calculating Lateral Effe
Soil ID
Depth from Soil Surface Bottom of Layer (in)
Hydraulic Conductivity (in/hr)
Layer 1 120 3
Layer 2 0 0
Layer 3 0 0
Layer 4 0 0
Layer 5 0 0
Layer 6 0 0
Layer 7 0 0
Layer 8 0 0
129.9 ft
Setback
Hydraulic conductivity
=6ft/day*12in/ft*day/24hr
= 3 in/hr
Lateral Effect Version 2.7 Copyright 2006 - 2013 Brian D Phillips, R Wayne Skaggs, GM Chescheir

159