Erosion Control Design for Stormwater Basins

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Background Information

- Environmental Planning Process Identifies:
  - Locations for Stormwater Basins
  - Type of Stormwater Basin
- Designed by NCDOT Hydraulics Unit
- Final Design Coordinated with Environmental Agencies
- Roadside Environmental Unit Evaluates for Erosion Control

NCDOT Stormwater Basins

- Dry Detention Basin
- Wet Detention Basin
- Hazardous Spill Basin

- For Design Information, visit:
  https://connect.nctdot.gov/resources/hydro/pages/default.aspx

Design Criteria

- Maximum Drainage Area = 100 acres
- Minimum Surface Area (ft^2) = 435 x Q_{10} (or Q_{25})
- Minimum Volume = 1800 ft^3 per Disturbed Acre
- Dewatering Mechanisms: Skimmer + Riser Structure
- Minimum Dewatering Time = 48 hours

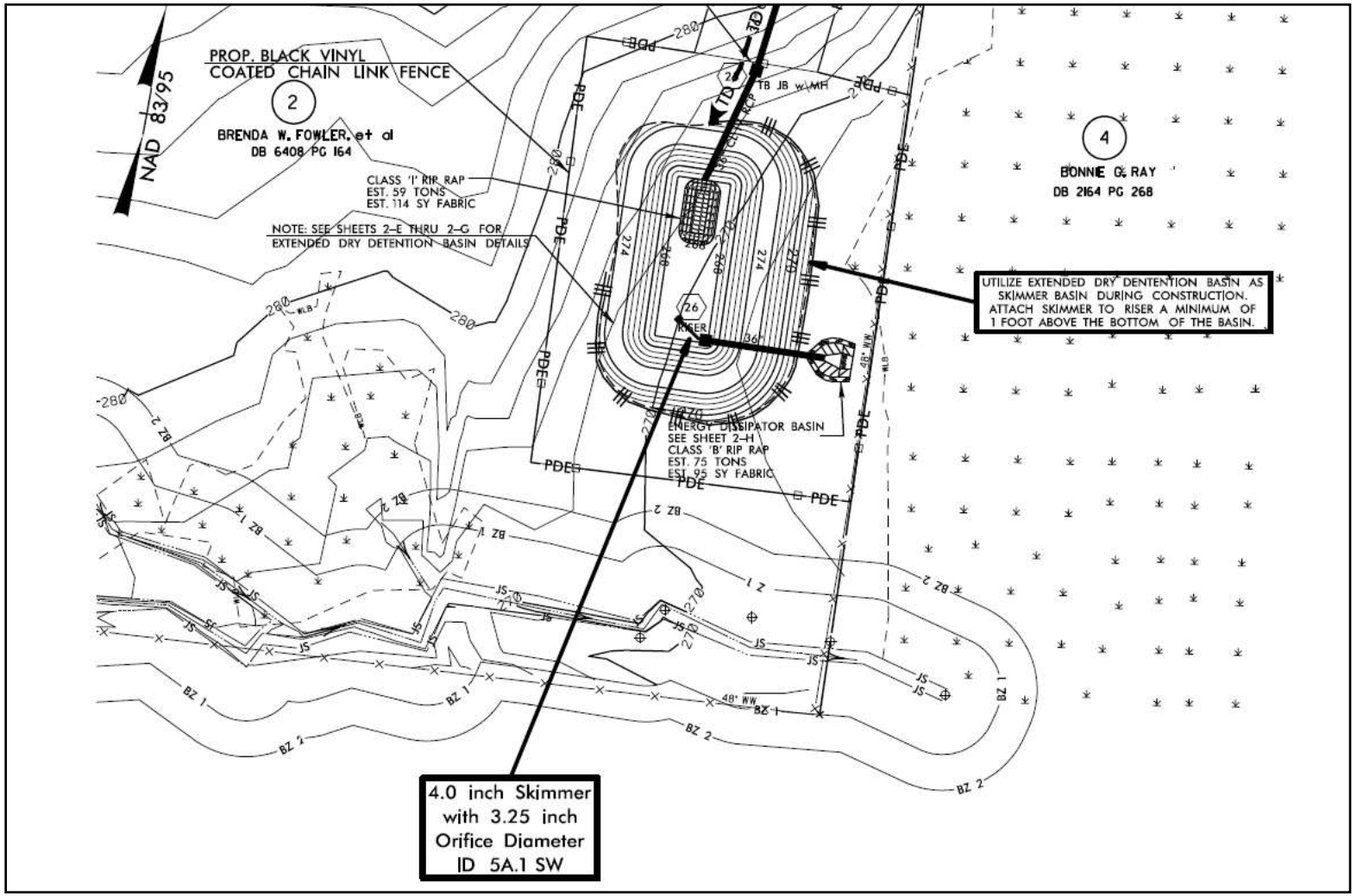
Design Procedure

1. Determine flow (Q) to Basin
2. Determine Disturbed Area Draining to Basin
3. Compute Required Surface Area
4. Compute Required Sediment Storage
5. Compare Requirements to Stormwater Basin Dimensions

Dewatering Analysis

- Size Skimmer Orifice based on Volume of Stormwater Basin
- Use Volume of Stormwater Basin 1 ft. above Basin Bottom
- Choose appropriate size Skimmer
- Check Primary Spillway (Riser) to Convey 2-yr Storm
  - Entire System (Riser + Spillway) must convey 10-yr Storm

Stormwater Basin & EC Plans



Case Study: Timber Drive Project

- Located in Garner, NC
- Length of Project: 1.5 miles
- Construction began in July 2010
- Surrounding Land Use:
  - Shopping Centers
  - Private Home Sites
  - Forests

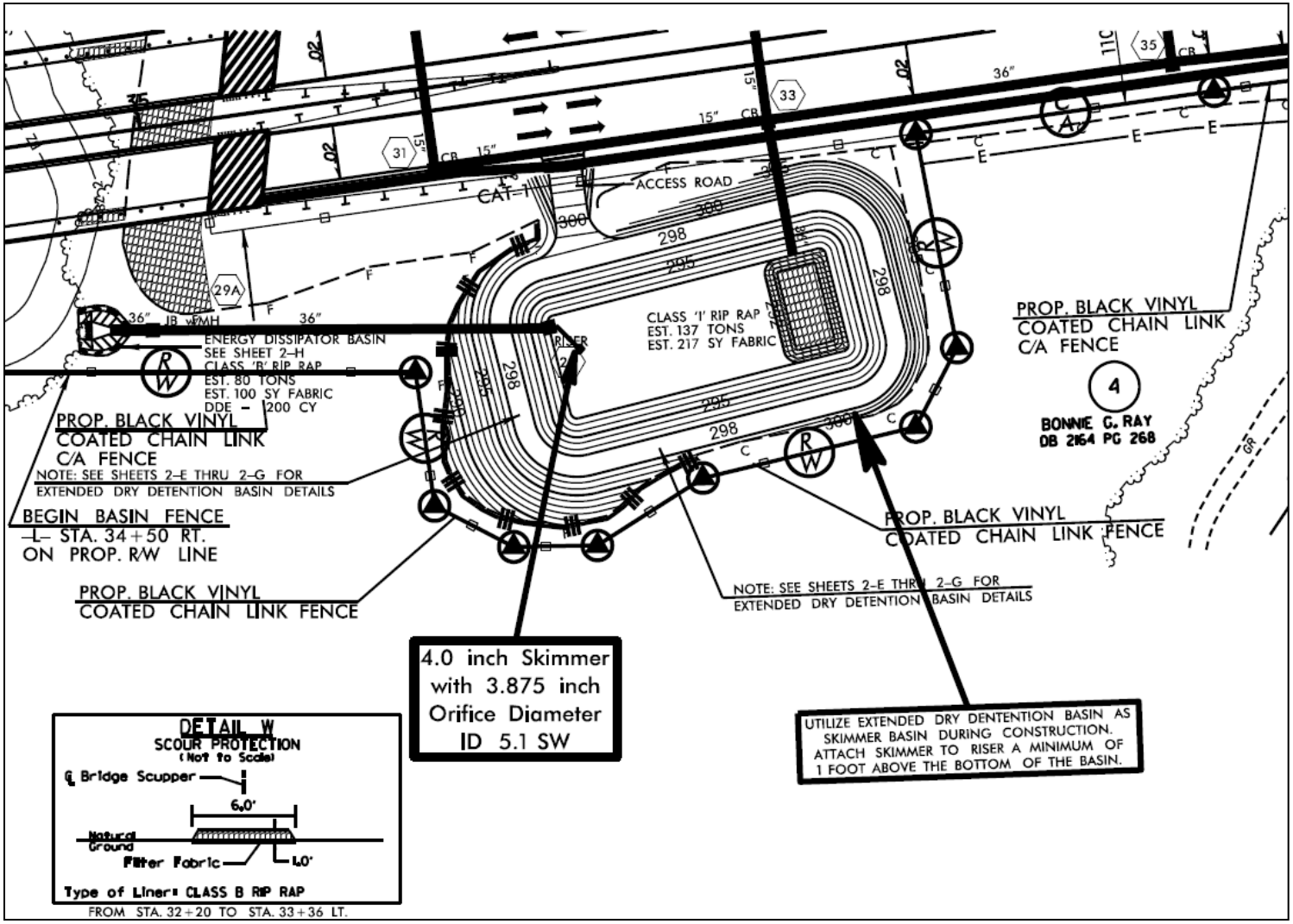
Satellite View of Project

Stormwater Basin Design Info (EC)

- Disturbed Area = 13.3 Acres
- Undisturbed Area = 0.02 Acres
- Q_{25*} = 23.23 ft^3/s

  -*Neuse River Basin

Initial EC Design



Stormwater Basin Design Spreadsheet

	A	B	C	D
1	25-Year Stormwater Basin Design	**TIP No. :**	**X-XXXX**	
2				
3	Construction Sheet #			
4	Closest City	Raleigh		
5	**Design 1**			
6	Basin ID(Sta. No./Const. Line/lt,rt or median)			
7	**Calculate Peak Flow: Q = CIA**			
8	Time of Concentration,Tc (min) =	30	5	5
9	Disturbed Area (Acres)	13.3	0	0
10	Undisturbed Area 1 (Acres)	0.02	0	0
11	Undisturbed Area 2 (Acres)	0	0	0
12	Undisturbed Area 3 (Acres)	0	0	0
13	Total Drainage Area (Acres)	13.32	0.00	0.00
14	Disturbed Area C Factor	0.45	0.00	0.00
15	Undisturbed Area 1 C Factor	0.05	0.00	0.00
16	Undisturbed Area 2 C Factor	0.00	0.00	0.00
17	Undisturbed Area 3 C Factor	0.00	0.00	0.00
18	Total Drainage Area C	0.45	N/A	N/A
19	Rainfall Intensity Factor (in/hr)	3.88	7.78	7.78
20	Peak Flow Rate Q_{25} (ft^3/s)	23.23	N/A	N/A
21	**Required Surface Area and Sediment Storage**			
22	Surface Area (ft^2) = 435 x Q_{25}	**10103**	N/A	N/A
23	Sediment Storage (ft^3) = 1800 ft^3 per Disturbed Acre	23940	N/A	N/A
24	**Suggested Basin Size**			
25	Length (ft)	142	N/A	N/A
26	Width (ft)	71	N/A	N/A
27	**Stormwater Basin Dimensions**			
28	Basin Length (ft)	174		
29	Basin Width (ft)	87		
30	Basin Depth (ft)	6		
31	Basin Sideslope Grade (i.e. 2 for 2:1)	3		
32	**Stormwater Basin Analysis**			
33	Basin Surface Area (ft^2)	15138	N/A	N/A
34	Basin Volume (ft^3)	65232	N/A	N/A
35	Additional Storage Requirement (ft^3)	0	N/A	N/A
36	**Skimmer Sizing**			
37	Orifice Diameter (in.)	3.875	N/A	N/A
38	Skimmer Size (in.)	4	N/A	N/A

Initial Basin Construction

All is well, until THIS happened!

Downstream View!

Cause No. 1 - Granite Rock…

Cause No. 2 – Sandy Soil

Construction Issues

- Rock Layer Close to Surface
- Sandy Loam Material Used for Berm
  - Onsite
- Inadequate Compaction of Soil in Berm

Repair Plan

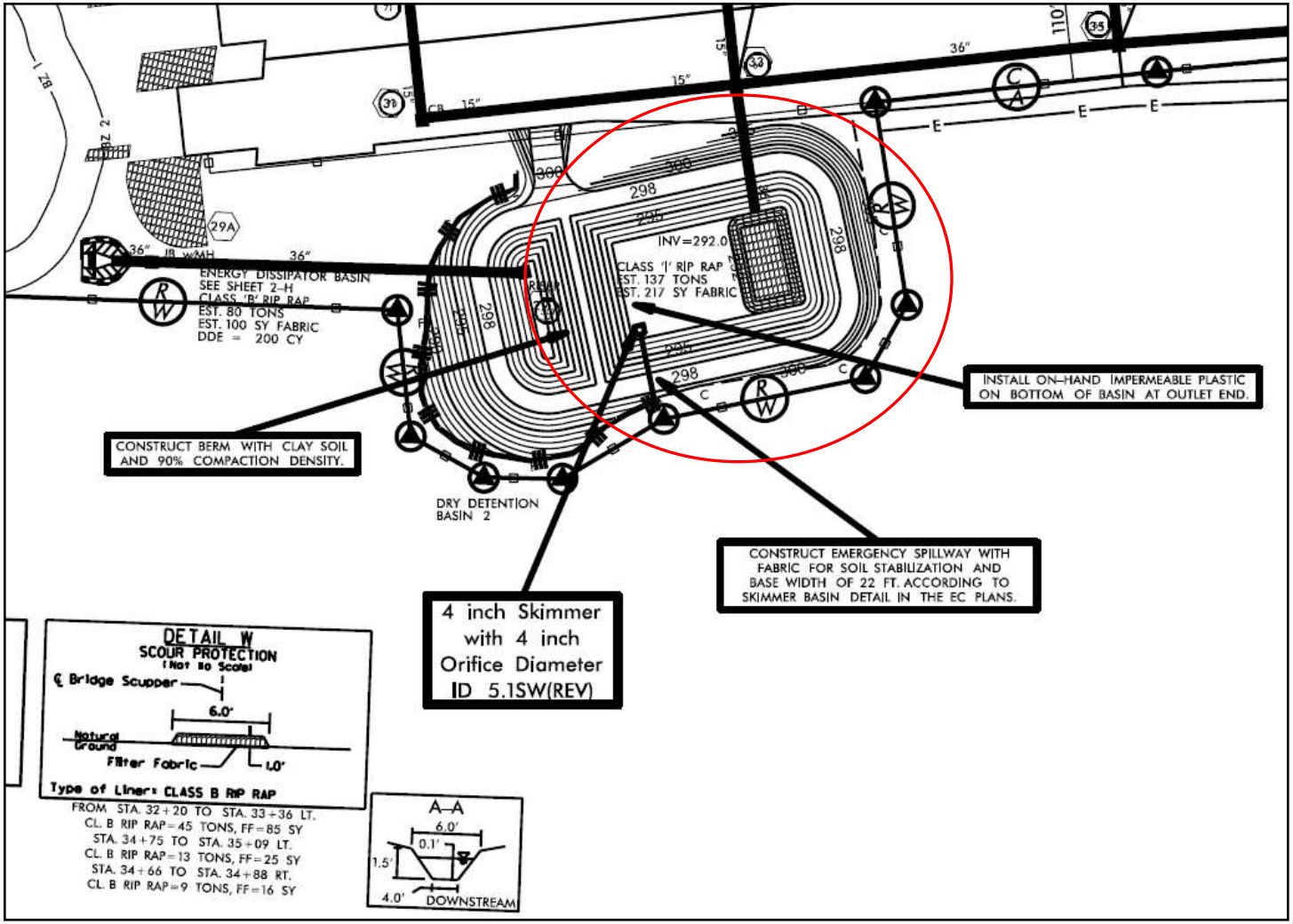
- Interim EC Design with Temporary Berm
- Install Anti-Seep Collar(s) on Barrel Pipe
- Rebuild Embankment with Clay Material
- Achieve 90% Compaction of AASHTO T 99 Test

Intermediate Design Information

- Disturbed Area = 9 Acres
- Undisturbed Area = 1 Acre
- Q_{25*} = 21.75 ft^3/s

  -*Neuse River Basin

Interim EC Design



Reconstruction Methods

- Anti-Seep Collars Installed
  - 2 ft. on 3 sides and extended down to bedrock
  - 7 ft. spacing
- Core Constructed with Onsite Red Silty Clay
- Core Compacted to 90% Density of T99 Test
- Topsail Placed 1-2 ft. of Depth on Core

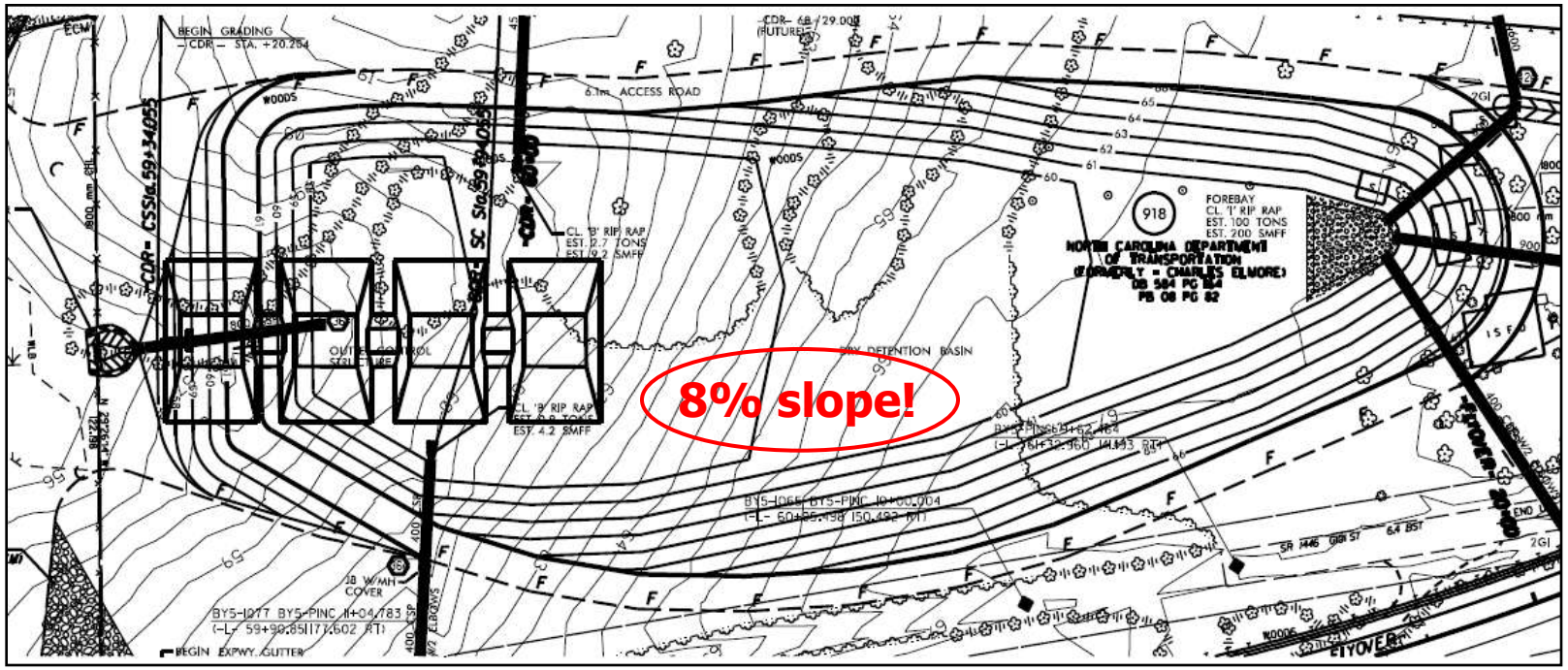
Now a Permanent Stormwater Basin!

General Design Constraints

- Rock Layer Close to Surface
- Soils
- High Water Table
- Topography
- Width of Stormwater Basin

Dry Detention Basin on Slope

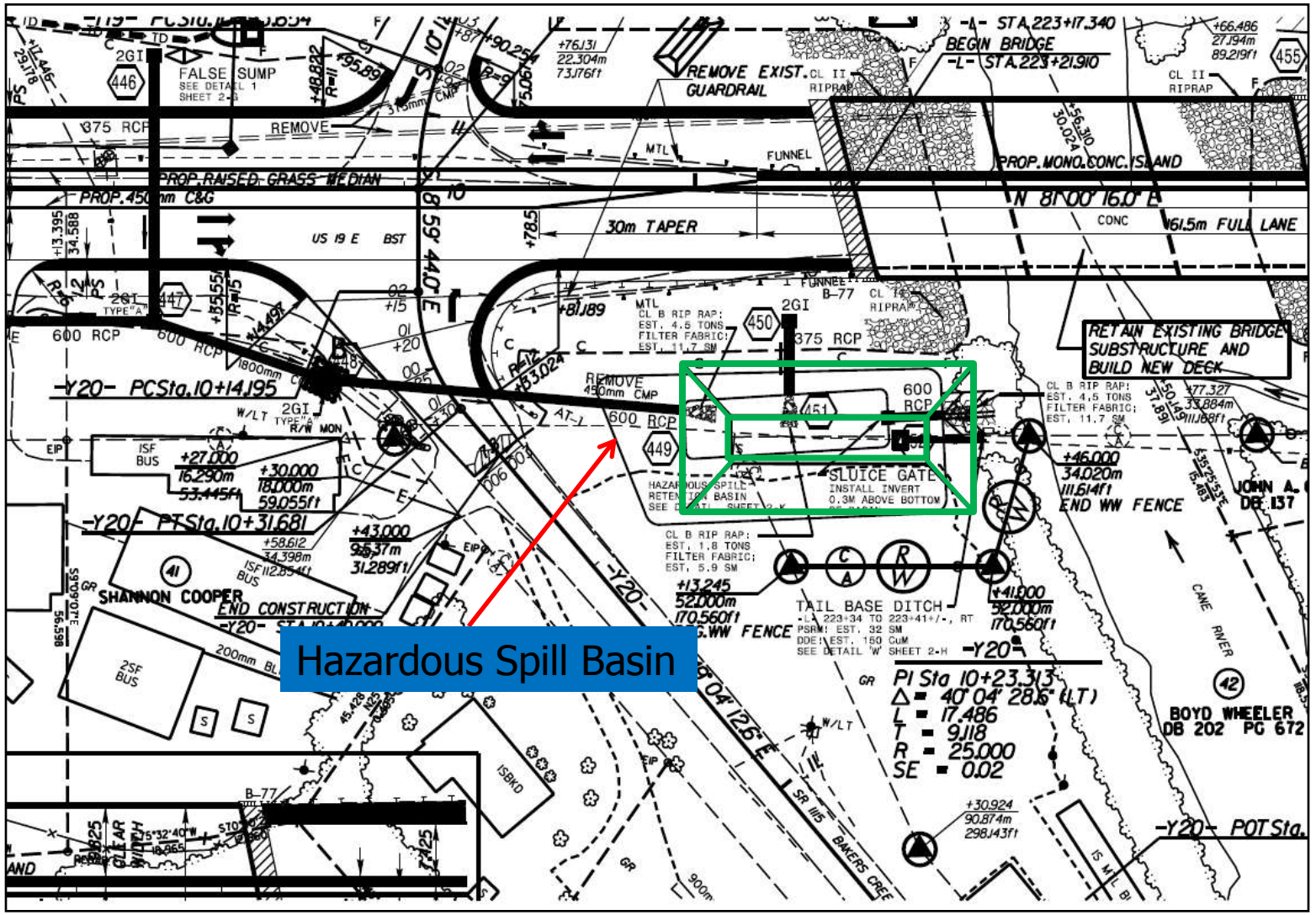
- Width of Stormwater Basin = 240 ft.
- Width of Skimmer Basin = 80 ft.



Dry Detention Basin Constructed

Dry Detention Basin Constructed

Small Hazardous Spill Basin



Basin with Skimmer and Stone Spillway

Hazardous Spill Basin with Skimmer

Hazardous Spill Basin with Pool

Hazardous Spill Basin Dewatering

Detention Basin with Skimmer

Skimmer with Corrugated Steel Pipe

Construction Specifications

- Minimum of 3 Baffles with Equal Spacing
- Anti-Seep Collars
  - ftp://ftp-fc.sc.egov.usda.gov//IL/engineer/supplements/6-36.1.pdf
- Berm Material
  - Construct with Soils Classified as Clays (ch, cl or sc)
  - Compact Embankment to at least 90-95% of AASHTO T 99 Test

Slope Stabilization

- Permanent Seed Mix
- Matting (Excelsior at minimum)
- Permanent Matting (TRM)
- Geotextile (NCDOT Type 4, 8 mil., etc.)
  - Interim
  - Impermeable

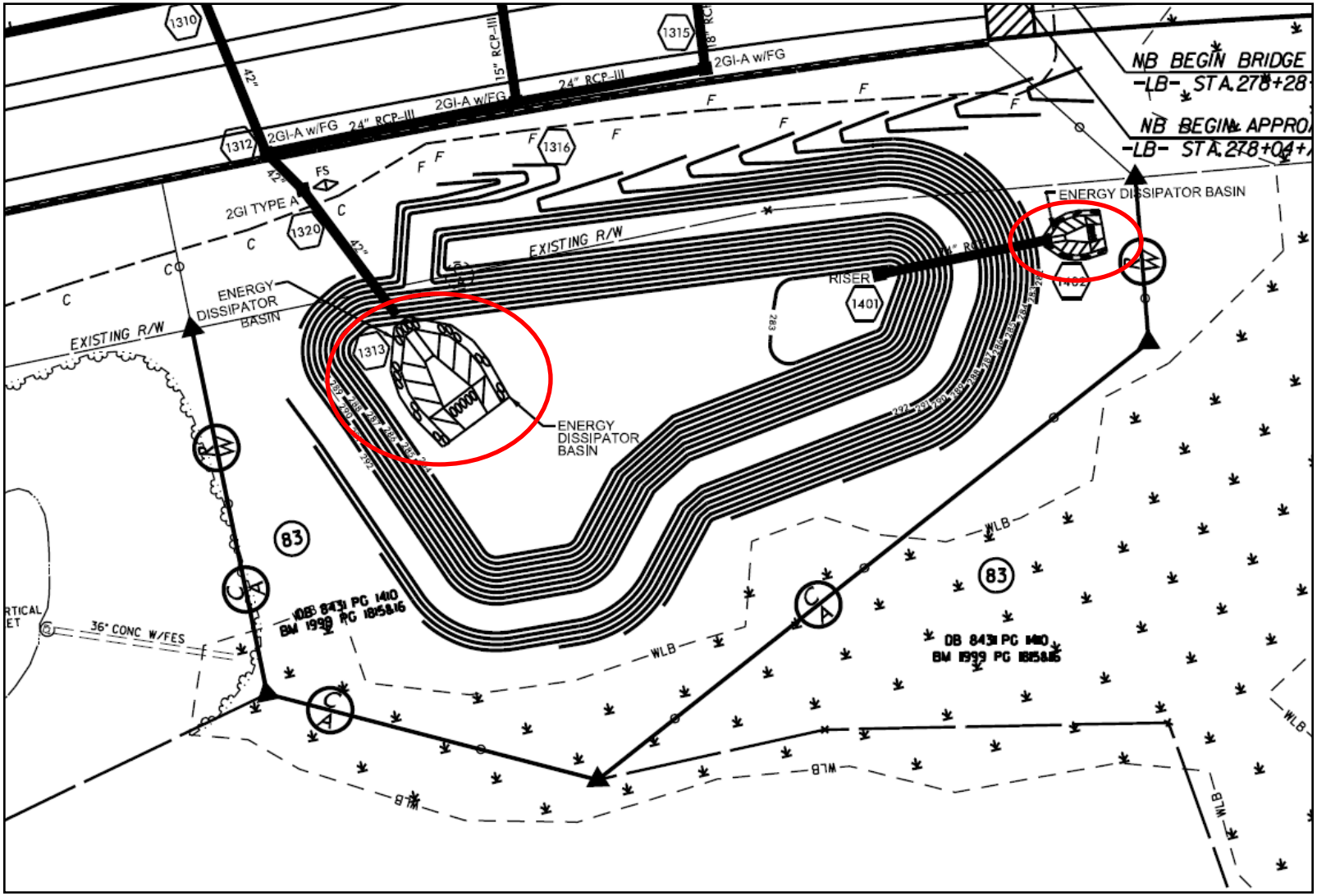
Stormwater Basin Cleanout

Komatsu D155 W Bulldozer In Action

Enhancements to Stormwater Basins

- Forebays / Energy Dissipators
- Incorporation of Flocculants
- Infiltration

Energy Dissipator in Basin



Flocculant in Basin

Permanent Basin with Infiltration

General Design Tips

- Convey Runoff to Basin in Non-erosive Manner
- Remember Volumes for Skimmer Orifice
  - Volume of Stormwater Basin
  - Volume of Basin 1 ft. above bottom
- Include ALL Construction Specifications

Before Basin becomes Permanent…

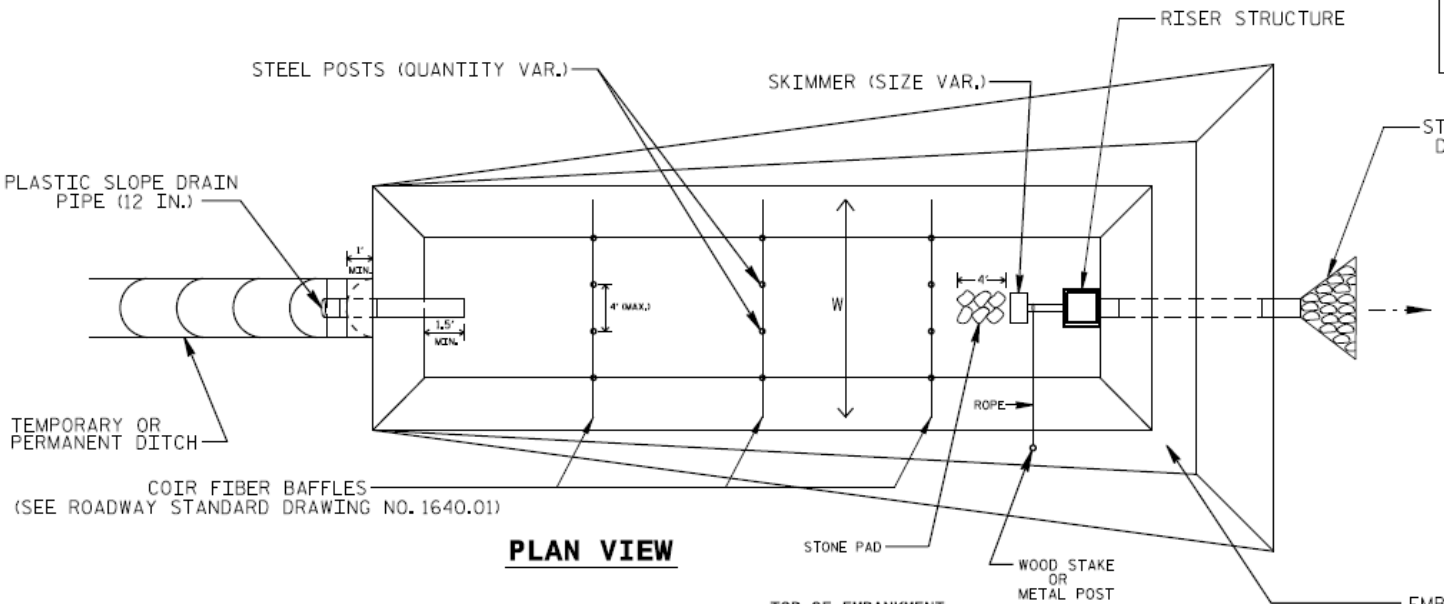
- ALL Drainage Areas to Basin Stabilized
- Drainage System Completely Installed
- Interior Slopes Stabilized
- Sediment in Basin Removed

Detention Basin Needs Maintenance

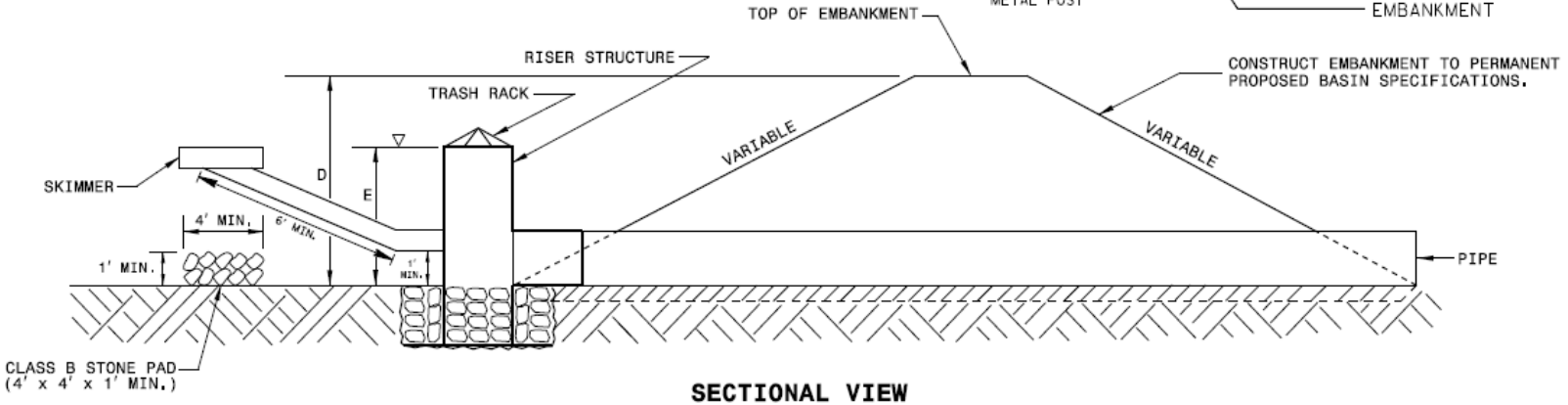
Skimmer in Sediment

PROJECT REFERENCE NO.	SHEET NO.
X-XXXX	EC-2D
RW SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

STORMWATER BASIN WITH SKIMMER



PLAN VIEW



SECTIONAL VIEW

NOTES

1. SEED AND PLACE MATTING FOR EROSION CONTROL ON INTERIOR AND EXTERIOR SIDESLOPES.
2. INSTALL A MINIMUM OF 3 COIR FIBER BAFFLES IN ACCORDANCE WITH ROADWAY STD. DRAWING 1640.01.
3. INSTALL SKIMMER AND COUPLING TO RISER STRUCTURE OR DIRECTLY INTO EMBANKMENT 1 FT. FROM BOTTOM OF BASIN.
4. THE ARM PIPE SHALL HAVE A MINIMUM LENGTH OF 6 FT. BETWEEN THE SKIMMER AND COUPLING.
5. PLASTIC SLOPE DRAIN PIPE AT INLET OF BASIN MAY BE REPLACED BY FILTRATION GEOTEXTILE AS DIRECTED.
6. THE DIFFERENCE BETWEEN LENGTHS "D" AND "E" REPRESENT THE FREEBOARD AND SHOULD BE 1 FT. MINIMUM.

NOT TO SCALE

Reference Web Sites

- Stormwater Basin Design Spreadsheet

http://www.ncdot.gov/doh/operations/dp_chief_eng/roadside/soil_water/erosion_control/downloads.html

- Details

http://www.ncdot.gov/doh/operations/dp_chief_eng/roadside/soil_water/Details/

- Special Provisions

http://www.ncdot.gov/doh/operations/dp_chief_eng/roadside/soil_water/special_provisions/

Questions?