Mitigation Plan
Greensboro Eastern Loop
Guilford County, North Carolina
T.I.P. Number U-2525B
WBS No. 34821.1.1
August 12, 2013

1.0 BASELINE INFORMATION

Transportation Improvement Project (TIP) U-2525B involves the construction of a new section of highway known as the Greensboro Eastern Loop in Guilford County (Appendix A-Figure 1). The proposed construction of U-2525B involves unavoidable impacts to jurisdictional resources within USGS Hydrologic Unit 03030002 of the Cape Fear River Basin. NCDOT proposes to offset a portion of these impacts with on-site mitigation.

TIP U-2525B is located in the Central Piedmont Ecoregion. The topography in the project study area is generally characterized as rolling hills with moderately steep slopes along the drainage ways. Elevations in the study area range from 700 to 750 feet above mean sea level (USGS 1968). The project study area and surrounding area consists of low density rural, residential, commercial, agricultural, and forested areas.

The mitigation site selection and mitigation work plan sections of this plan will refer to the identification labels given the affected jurisdictional resources in the onsite mitigation review.

2.0 OBJECTIVES

The goal of the proposed onsite mitigation is to offset and mitigate for impacts due to U-2525B by relocating and/or restoring adjacent stream systems to their natural conditions through the removal of structures, restoration of channel dimensions and profiles, and establishment of riparian buffer areas. This will be achieved on three individual sites described below on a total of 2055 linear feet of stream.

3.0 SITE SELECTION

All sites are located within the proposed, new right-of-way for U-2525B. Each site was evaluated both internally as well as discussed and reviewed with regulatory personnel during concurrence meetings and field visits. Existing conditions for each site is provided in this section. Additional information on existing conditions, geomorphology parameters, and proposed stream measurements are provided in Appendix D.

SITE 2-UT to South Buffalo Creek-ONEID 041-029

Site 2 (Site 5 in the Permit Drawings) is located approximately from Station 61+50 to 73+70 and scored 59 on the USACE Stream Quality Assessment Worksheet (Appendix G). Site 2 includes the relocation and restoration of 1307 linear feet of UT to South Buffalo Creek. UT to South Buffalo Creek has a NCDWQ Best Usage Classification of WS-V; NSW. Within Site 2, UT to South Buffalo Creek flows from its headwaters toward a confluence with a larger reach through two distinct valley sections (Appendix A-Figure 2A). Within the upper section, the west side (river

right) valley wall is relatively steep. The east side valley wall and surrounding valley of the lower section are relatively flat. The riparian buffer of the upper section has been cleared within the last 5-10 years. The subsequent revegetation has led to a landscape with a high density of scrub-shrub successional species. Within the lower section, the riparian buffer consists of more widely spaced, larger mature woody vegetation. Throughout both valley sections, the channel is incised and entrenched and exhibits signs of instability. These moderately sinuous channels classify as Rosgen B5 streams. Sand materials dominate the channel, but there are also inclusions of gravel and bed rock. The watershed for this UT to South Buffalo Creek is 0.10 square miles at the downstream end of the site. The watershed is approximately 55% forested, 40% agricultural fields, and 5% impervious. Future zoning of the watershed is split between low (3 to 5 dwelling units/acre), interim, and moderate (5 to 12 dwelling units/acre) residential.

SITE 4-UT to North Buffalo Creek- ONEID 041-031

Site 4 (Site 18 in the Permit Drawings) is located approximately from Station 217+00 to 220+10 and scored 52 on the USACE Stream Quality Assessment Worksheet (Appendix G). Site 4 includes restoration of approximately 386 linear feet of UT to North Buffalo Creek. UT to North Buffalo Creek has a best usage classification WS-V; NSW. UT to North Buffalo Creek flows through Site 4 within a broad and gently sloping valley (Appendix A-Figure 2B). The riparian area has been greatly disturbed with some portions remaining cleared of woody vegetation and other areas consisting of scattered large woody vegetation. For most of the stream length, the riparian buffer is densely vegetated with a mix of shrubs and trees. The channel is incised and the upper section is moderately entrenched. The channel appears to have been modified. An earthen dam is located within the bottom third of the reach. This moderately sinuous reach classifies as a Rosgen B5 stream type. An existing 15 foot wide sanitary sewer line is located along the left bank (east side) of the existing channel approximately 25 to 30 feet from the left bank. The watershed is 0.57 square miles at the downstream end of the site. The watershed is 50% forested, 40% agricultural fields, 5% light residential, and 5% impervious. Future zoning of the watershed is primarily low residential (3 to 5 dwelling units/acre) with some moderate residential (5 to 12 dwelling units/acre).

SITE 5-UT to North Buffalo Creek- ONEID 041-032

Site 5 (Site 20 in the Permit Drawings) is located approximately from Station 242+08 to 245+03 and scored 57 on the USACE Stream Quality Assessment Worksheet (Appendix G). Site 5 includes relocation and restoration of approximately 362 linear feet of North Buffalo Creek. UT to North Buffalo Creek has a best usage classification WS-V; NSW. UT to North Buffalo Creek flows within Site 5 from its headwaters to confluence with a larger reach (Appendix A-Figure 2C). The stream valley is relatively broad with a flat down valley slope. The immediate riparian buffer consists of mature woody vegetation and kudzu on portions of the hillside that are located outside of the proposed right of way. The channel is slightly to moderately incised and appears relatively stable with the exception of about 100 feet of channel that is cutting through a meander bend. This moderately sinuous reach classifies as a Rosgen E5 stream type. The channel bed includes a significant amount of artificially introduced large stone. The watershed is 0.51 square miles at the downstream end of the site. The watershed is 50% forested, 5% agricultural fields, 30% light residential, and 15% impervious.

4.0 MITIGATION WORK PLAN

Each mitigation site will be constructed in conjunction with the construction of the roadway project. Following the successful completion of site grading and stabilization, each site will be reforested with a mix of bare-root tree species and live stakes as described in the Streambank Reforestation Specifications in Appendix F. The stream channels will be stabilized by planting live stakes on three foot centers and matting with coir fiber on the banks as necessary. Morphological characteristics of the proposed streams are provided in Appendix D.

In accordance with the guidance and standard procedures of NCDOT's Roadside Environmental Unit (REU), seeding and mulching will be performed on all disturbed areas within the mitigation sites for stabilization purposes. All floodplains and floodplain slopes will be over-excavated 6 inches starting 3 feet from top of stream bank and backfilled with topsoil to final grade (see detail on OSM-2 in design plan sheets). Additionally, per NCDOT's Native Seeding and Mulching Provision, 4000 lbs/acre of lime will be applied and 500 lbs/acre of 10-20-20 fertilizer will be applied. An as-built report will be submitted within 60 days of completion of the project. On sites that have kudzu present within the ROW limits, NCDOT proposes to minimize the potential spread of this species from construction-related activities. NCDOT will attempt to suppress the Kudzu within the ROW of the mitigation sites by herbicide applications prior to reforestation and during the required post construction monitoring period.

The Natural Environment Section shall be contacted to provide construction assistance to ensure that each mitigation area is constructed appropriately.

SITE 2-UT to South Buffalo

This site includes the relocation and restoration of 1307 feet of UT to South Buffalo Creek that is currently located within the footprint of the proposed roadway through a priority II restoration approach. The channel is currently an incised B5 Rosgen stream type channel that will be restored to a stable B5 channel by establishing a lower valley at the bankfull elevation. Proper sinuosity and radius of curvature will be restored to the channel to provide stability. The channel will be elevated to its historic floodplain in some locations where possible, improving its dimension and allowing bankfull and higher flows to access the floodplain. Proper riffle-pool sequencing will also be restored to the channel with corrected pattern and the installation of rock and log structures. The installation of these structures will increase stability of the profile and banks while allowing time for vegetation to establish and natural bed materials to be transported throughout the system.

Special attention was given to the possible change in flow regime in this system as it may be influenced by storm water runoff from the proposed roadway. To account for this change the stream design uses dimensionless ratios that lean toward natural channel systems with a more urban watershed than a rural watershed. For instance, the radius of curvature tends to be on the larger side to ensure that the bends in the stream channel will be gradual enough to accommodate the flashy flows that come with increased impervious area. Additionally, the belt width of the proposed channels were designed slightly more narrow than a system with no development in its watershed and the curvature of floodplains were reduced to account for increased flood flows over time as the watersheds develop. Designing the floodplain to be less sinuous allows for the new system to convey flood flows without excessively increasing shear stress along the edges of the newly constructed floodplain. The buffer for this channel will extend 50 feet from the top of bank

on both sides and totals approximately 3.14 acres, all of which lies within the proposed U-2525B right-of-way.

SITE 4-UT to North Buffalo Creek

This site includes the restoration of 386 linear feet of UT to North Buffalo Creek through a Priority II restoration approach. The appropriate dimension, pattern, and profile will be restored to the channel. The dimension will be corrected by connecting the bankfull stream channel to a floodplain bench. A C5 Rosgen stream type channel is proposed. The pattern will be re-adjusted to return the proper pool to pool spacing and radius of curvature to the channel. This channel is confined along the left bank by the adjacent sanitary sewer line. The right bank is densely wooded. Therefore, it is necessary for the proposed stream channel to cross over the existing channel location several times to create the desired pattern. The profile will be corrected and stabilized by using rock structures. These structures will hold the profile in place and prevent head cuts until the proper bed material has had a chance to be distributed through the stream channel and vegetation has had a chance to stabilize the banks. Proposed design parameters for the proposed stream can be found in the morphological table in Appendix C. The buffer for this channel will extend 50 feet from the top of bank on both sides and totals approximately 1.01 acres, all of which lies within the proposed U-2525B right-of-way. Currently, an existing 15 foot wide sewer easement encroaches on the left side of the 50 foot wide buffer.

SITE 5-UT to North Buffalo Creek

This site includes the relocation and restoration of 362 linear feet of UT to North Buffalo Creek with a Priority II restoration approach. The stream will be relocated outside of the fill slope of the proposed roadway. The appropriate dimension, pattern, and profile will be constructed on the relocated channel. A Rosgen type C5 channel is proposed for this stream. A lower belt width ratio is proposed due to the urbanized watershed with potential for flashy flows. The proposed channel profile will be stabilized by rock structures. The structures will provide stability and allow time for native bed materials to be transported through the newly constructed stream and for vegetation to stabilize the banks. Proposed design parameters for the proposed stream can be found in the morphological table in Appendix D. The buffer for this channel will extend 50 feet from the top of bank on both sides and totals approximately 0.91 acres, all of which lies within the proposed U-2525B right-of-way. An existing 15 foot wide sewer easement will make a perpendicular crossing of the stream near the culvert inlet.

During the "4C" Meeting held on March 21, 2013 there was a discussion about the "potential road" shown on the plans at Site 5 and if NCDOT could acquire right of way between the road and mitigation site. There is a no future road planned at this location. That information was from old plans and has been removed from the plans.

5.0 PERFORMANCE STANDARDS

An As-built will be submitted within 60 days of completion of the project. The As-built will document changes in the dimension, pattern, profile, vegetation plantings, and structures of the constructed channels.

Success for vegetation monitoring within the riparian buffer areas are based on the survival of at least 260 stems of five year old trees at year five. Assessment of channel stability will be based on

the survival of riparian vegetation and visual observation of channel dimensions, pattern or profile as well as inspection of in stream structure.

6.0 MONITORING REQUIREMENTS

All of the mitigation sites will be monitored according to the April 2003 Stream Mitigation Guidelines. The following components of Level 1 monitoring will be performed each year of the 5-year monitoring period: reference photos, plant survival (identification of specific problem areas, estimated causes and proposed/required remedial action); visual inspection of channel stability. Physical measurements of channel stability/morphology will not be performed. A monitoring report will be submitted within 60 days after completing the monitoring.

7.0 OTHER INFORMATION: STREAM REFERENCE RESTORATION STUDIES

A reference reach is a stream segment that represents a stable channel within a particular valley morphology. A stable stream is defined as a stream, which over time and in the present climate transports the flows and sediment produced by its watershed in such a manner that the dimension, pattern, and profile are maintained without either aggrading or degrading (Rosgen, 1996, 1998).

The methodology used for the reference reach analysis consisted of the following tasks: (1) identify reference quality sections of the project reaches that could be used for dimension and/or pattern analysis, (2) identify nearby reference reaches that have been previously located and surveyed and can be used to provide pattern data, (3) survey and classify the stream morphology for the on-site reference reaches, and (4) develop dimensionless ratios based on reference reach data and past project data under similar morphological conditions.

Several locations were identified and surveyed (Appendix C) within the project reaches where stable bankfull features had developed and provided information regarding bankfull dimension. These locations were identified by the presence of a consistent bankfull indicator, typically a well formed bankfull bench, and stable, vegetated stream banks. Cross-section surveys were conducted in these locations to evaluate stream dimension. The bankfull cross-section areas were then plotted versus drainage area and compared to published Rural Piedmont regional curve data, provided by the North Carolina Stream Restoration Institute (SRI) (See Appendix C-Figure 3).

As illustrated in Figure 3, the cross sectional areas surveyed at stable on-site reference reach locations correlates with the Rural Piedmont Regional Curve Data. Also, three of the four off-site reference reach locations correspond with the Rural Piedmont Regional Curve Data. More consideration is given to the cross sectional data gathered at stable reaches on-site because they more accurately reflect the conditions that will provide stability for that particular stream's flow regime. The three off-site reference reaches that correlate with the Rural Piedmont Regional Curve Data have been used previously in other natural channel designs. The stream designs were based on the collected data since this data was verified by the Rural Piedmont Regional Curve Data.

Shear stress calculations were completed for all reaches and are included in Appendix D. The data shows that the shear stresses for the proposed designs will be able to move the bed material of the streams. Shear stress is reduced on Sites 2 and 5, and slightly increased on site 4. Although most reaches have decreases in shear stress, incorporation of in-stream structures for grade control is implemented on all reaches. This is especially important since all restoration/relocation sites

will be excavated on new location and will not immediately have the properly sorted materials transported in from upstream immediately after construction. Constructed riffles and harvesting of existing bed material will be used to the extent feasible to provide this immediate supply of properly sorted bed material.

8.0 DETERMINATION OF CREDITS

NCDOT proposes to supplement mitigation provided by EEP with 2055 feet of onsite stream mitigation. All of the proposed mitigation sites exhibit some form of degradation. Site 2 and Site 5 include relocation of the channels that would be under fill slopes of the original roadway design.

Based on field and meeting discussions with agency representatives and per the NCDOT plans and 401/404 permit application for U-2525B; NCDOT proposes a 1:1 mitigation ratio for a total of 2055 feet of stream credits.

An as-built report will be submitted within 60 days of completion of the each mitigation site to verify actual mitigation areas constructed and planted. The success of the mitigation areas and determination of final credits will be based upon successful completion and closeout of the monitoring period.

8.1 CREDIT RELEASE SCHEDULE

NCDOT proposes immediate, full release of the proposed mitigation to offset the unavoidable impacts associated with U-2525B.

9.0 GEOGRAPHIC SERVICE AREA

The proposed Geographic Service Area (GSA) for the mitigation sites is composed of the 8-digit Hydrologic Cataloging Unit (HUC) 03030002.

10.0 SITE PROTECTION INSTRUMENT

The mitigation areas are within the NCDOT Right-of-Way for the project. They will be managed to prohibit all use inconsistent with their use as mitigation properties, including any activity that would materially alter the biological integrity or functional and educational value of the sites, consistent with the mitigation plan.

The sites will be placed on the Natural Environment Section's (NES) Mitigation GeoDatabase. This database is provided to all NCDOT personnel as a record of mitigation sites and their attributes, including prohibited activities. NCDOT is held by virtue of the permit associated with these mitigation sites and the associated roadway impacts to protect the sites in perpetuity.

11.0 MAINTENANCE PLAN

The mitigation sites will be held by NCDOT and placed on the NES Mitigation GeoDatabase. Once monitoring is completed and the sites are closed out, they will be placed in the NCDOT Stewardship Program for long term maintenance and protection.

If an appropriate third party recipient is identified in the future, then the transfer of the property will include a conservation easement or other measure to protect the natural features and mitigation value of the site in perpetuity.

12.0 LONG TERM ADAPTIVE MANAGEMENT PLAN

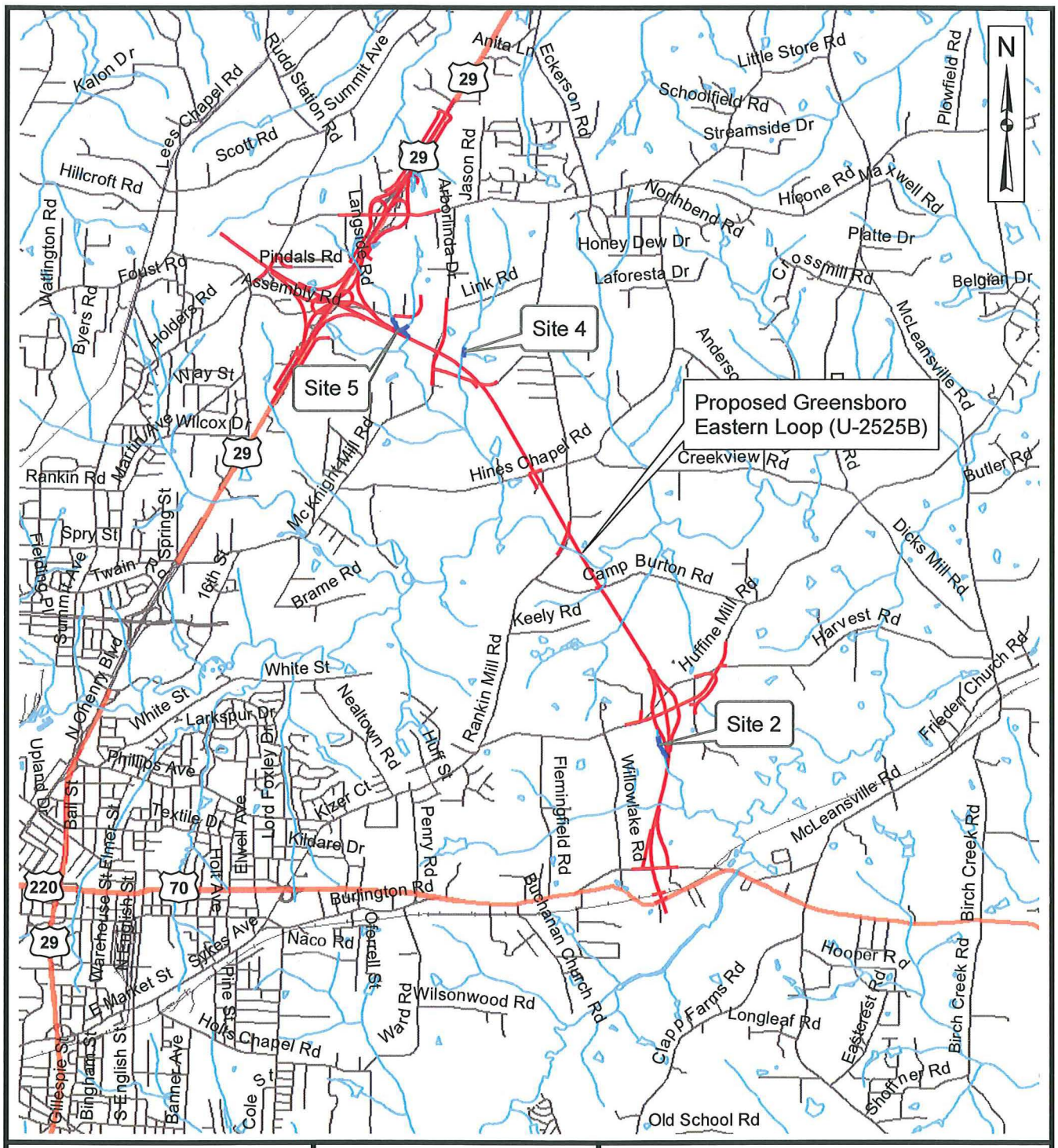
The sites will be managed by NCDOT according to the mitigation plan. Encroachments into the areas will be investigated and appropriate measures taken to minimize any negative effects. In the event that unforeseen issues arise that affect the management of the site, any remediation will be addressed by NCDOT in coordination with the Interagency Review Team.

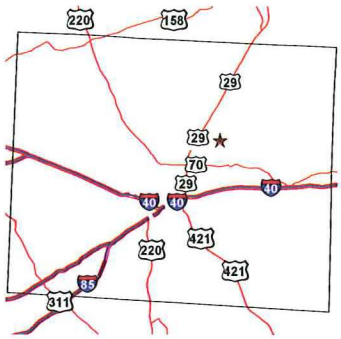
13.0 FINANCIAL ASSURANCES

NCDOT is held by permit conditions associated with U-2525B to construct, monitor, and steward the mitigation sites. NCDOT has established funds for each project and within each Division to monitor mitigation sites and protect them in perpetuity.

APPENDIX A

FIGURES



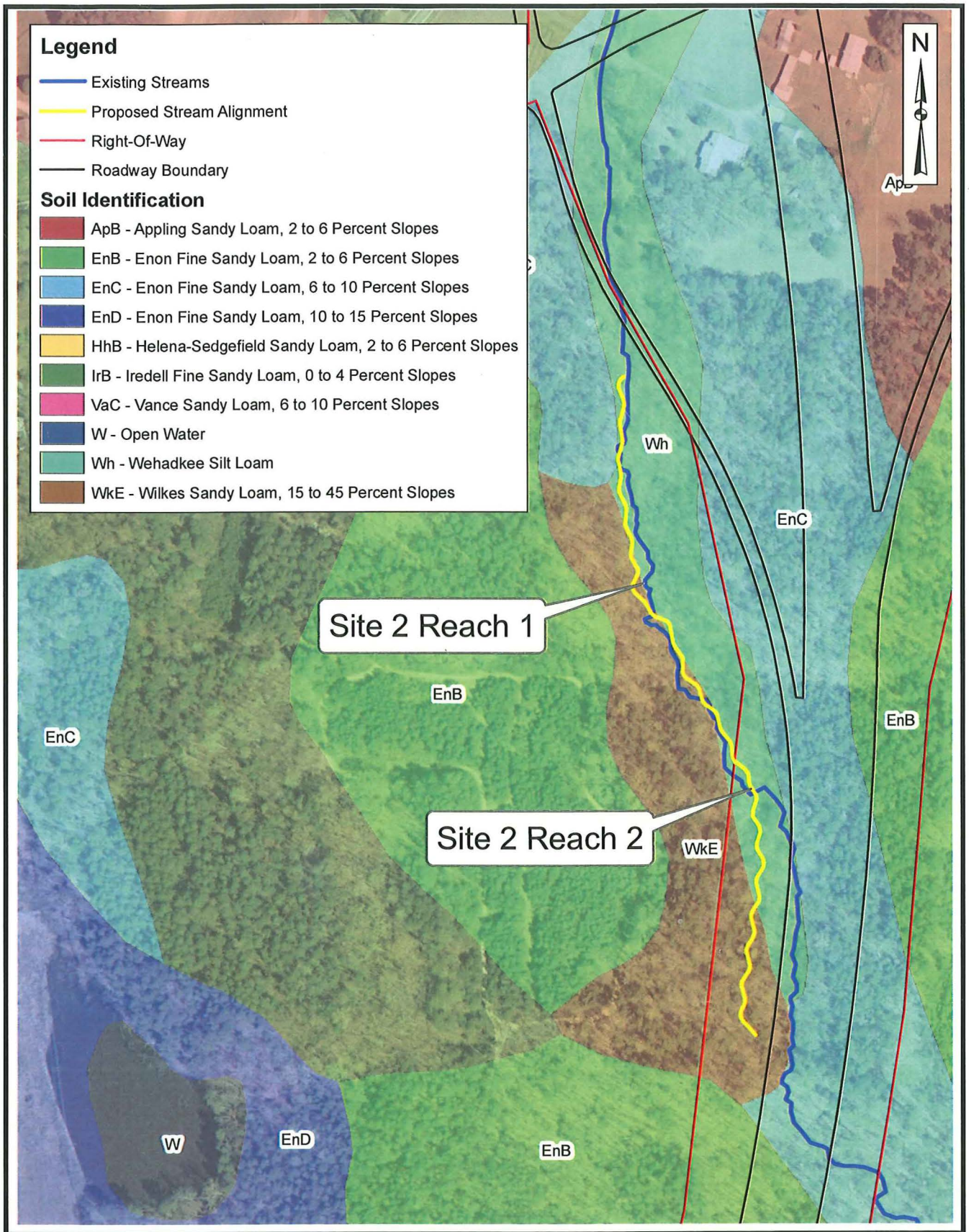


Project Development and Environmental Analysis Branch

Figure 1. Project Vicinity Map
U-2525B

0 1 2 Miles

0 1 2 Kilometers

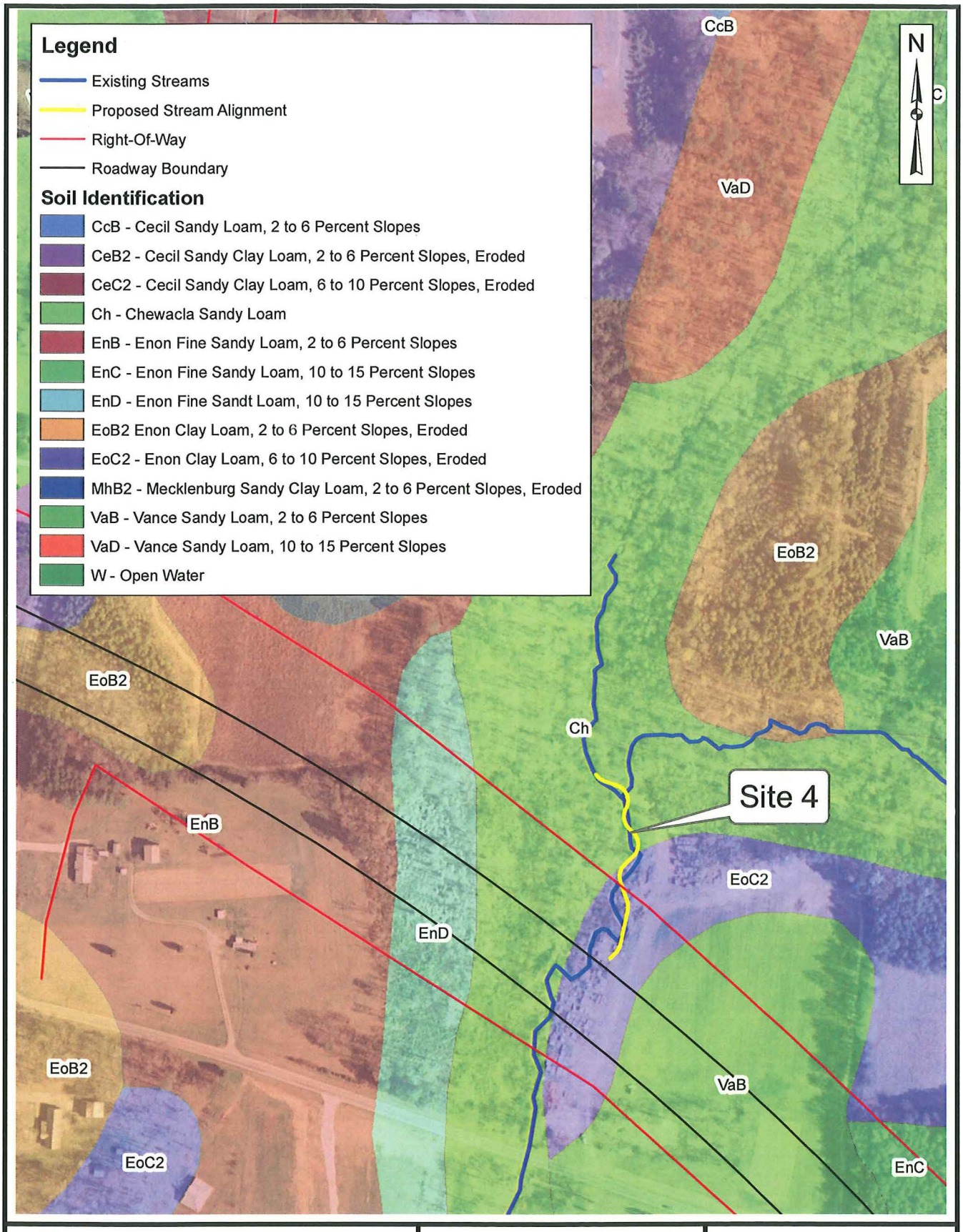


Project Development and Environmental Analysis Branch

0 250 500 Feet

0 50 100 Meters

Figure 2A
Soils Map
U-2525B, Site 2

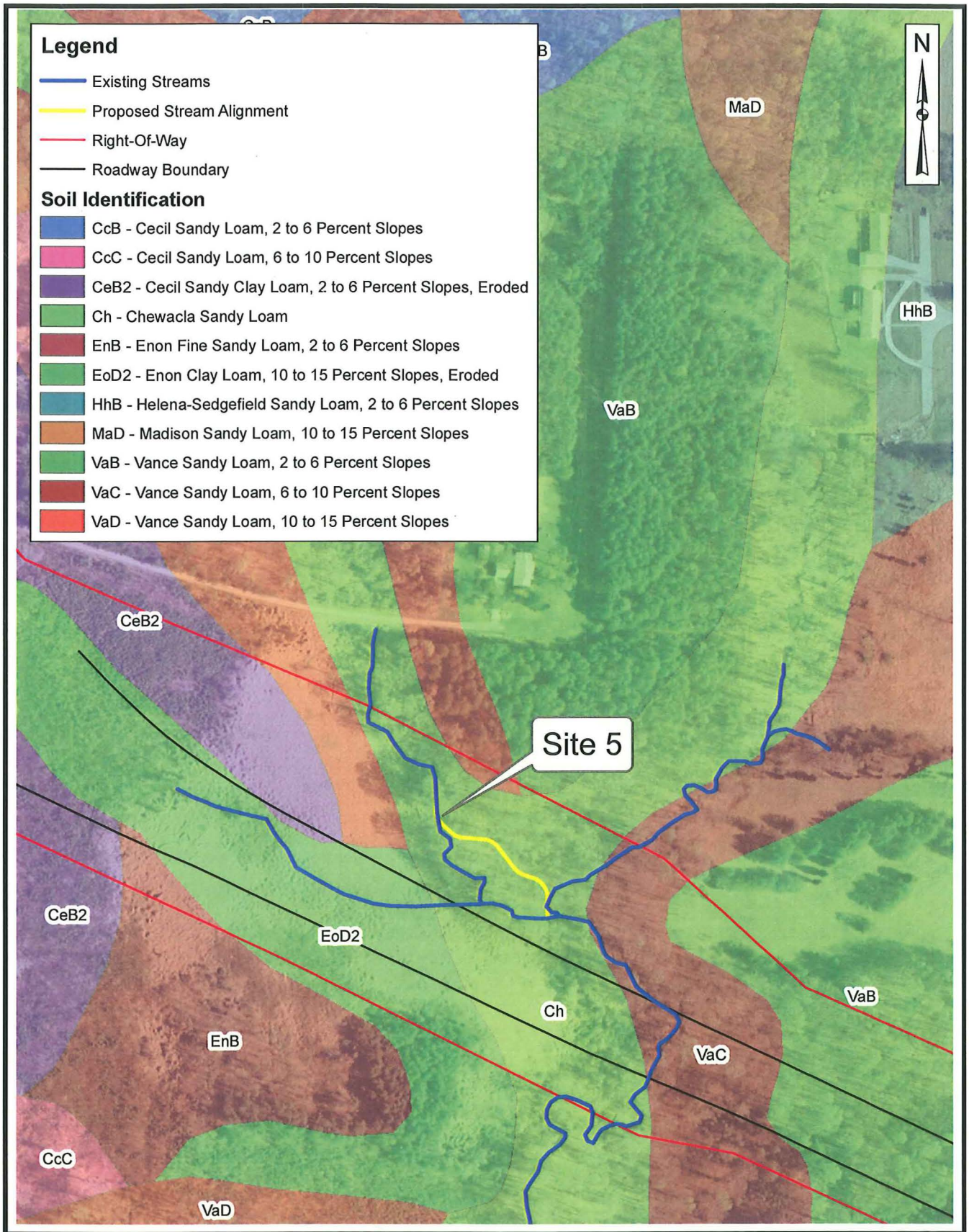


Project Development and Environmental Analysis Branch

0 250 500 Feet

0 50 100 Meters

Figure 2B
Soils Map
U-2525B, Site 4



Project Development and Environmental Analysis Branch

0 250 500 Feet

0 50 100 Meters

Figure 2C
Soils Map
U-2525B, Site 5

APPENDIX B

ONSITE MITIGATION PERMIT DRAWINGS

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

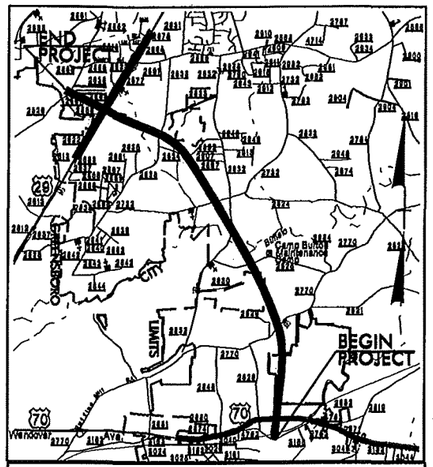
STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	U-2525B	OSM-1	30

STATE PROJ. NO.	F.A. PROJ. NO.	DESCRIPTION
34821.1.3		PE
34821.2.3		ROW

PLAN FOR ON-SITE MITIGATION GUILFORD COUNTY

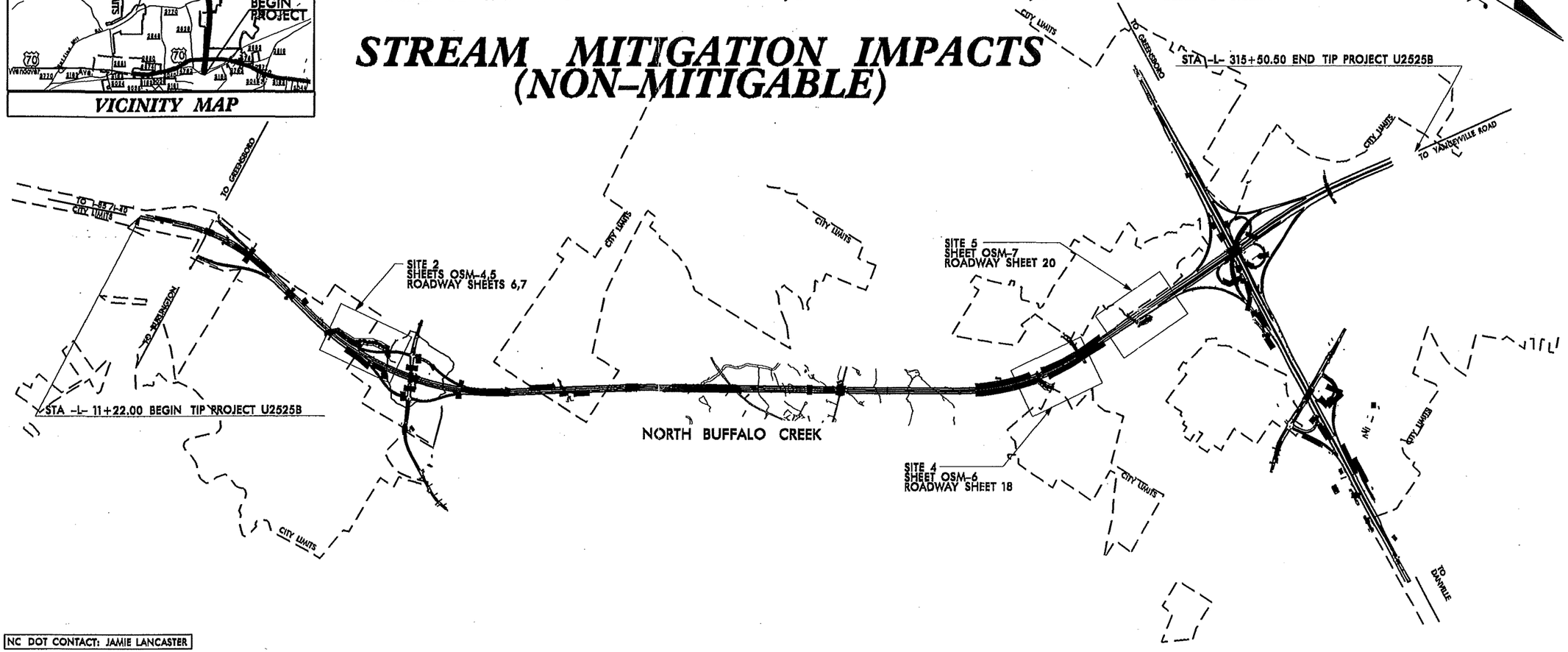
LOCATION: GREENSBORO EASTERN LOOP FROM NORTH OF US 70 TO US 29 NORTH OF GREENSBORO

TYPE OF WORK: STREAM RELOCATION, STREAM RESTORATION, STREAM ENHANCEMENT



VICINITY MAP

STREAM MITIGATION IMPACTS (NON-MITIGABLE)



NC DOT CONTACT: JAMIE LANCASTER

TIP PROJECT: U-2525B

CONTRACT:

GRAPHIC SCALES

30 15 0 30 60
PLANS

30 15 0 30 60
PROFILE (HORIZONTAL)

6 3 0 6 12
PROFILE (VERTICAL)

DESIGN DATA

PROJECT LENGTH

MITIGATION SITE	MITIGATION TYPE	LENGTH
SITE 2	RESTORATION/RELOCATION	1,307LF
SITE 4	RESTORATION	386LF
SITE 5	RELOCATION	362LF

2006 STANDARD SPECIFICATIONS

DESIGN ENGINEER

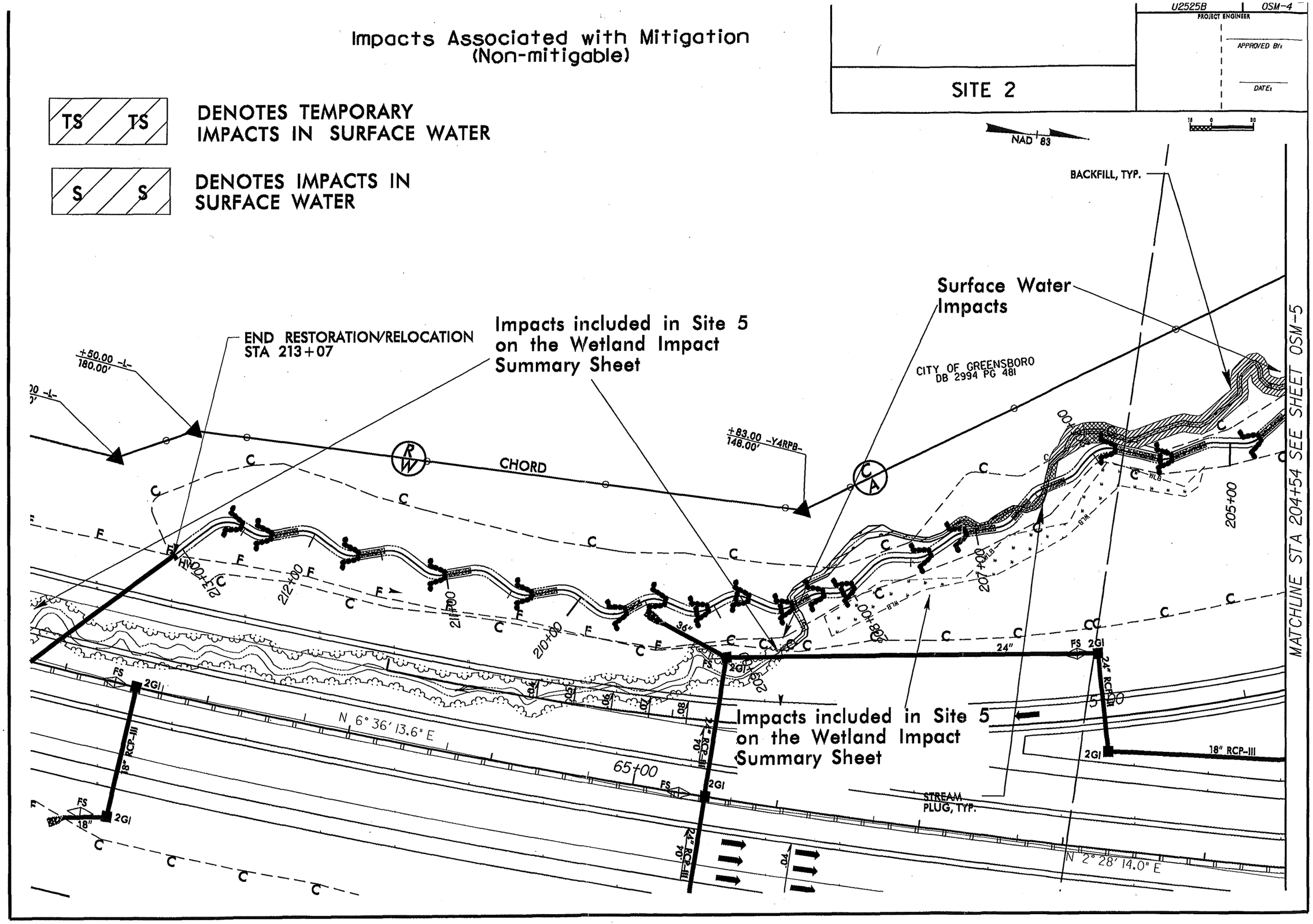
SIGNATURE: P.E.

DIVISION OF HIGHWAYS STATE OF NORTH CAROLINA

STATE DESIGN ENGINEER P.E.

DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION

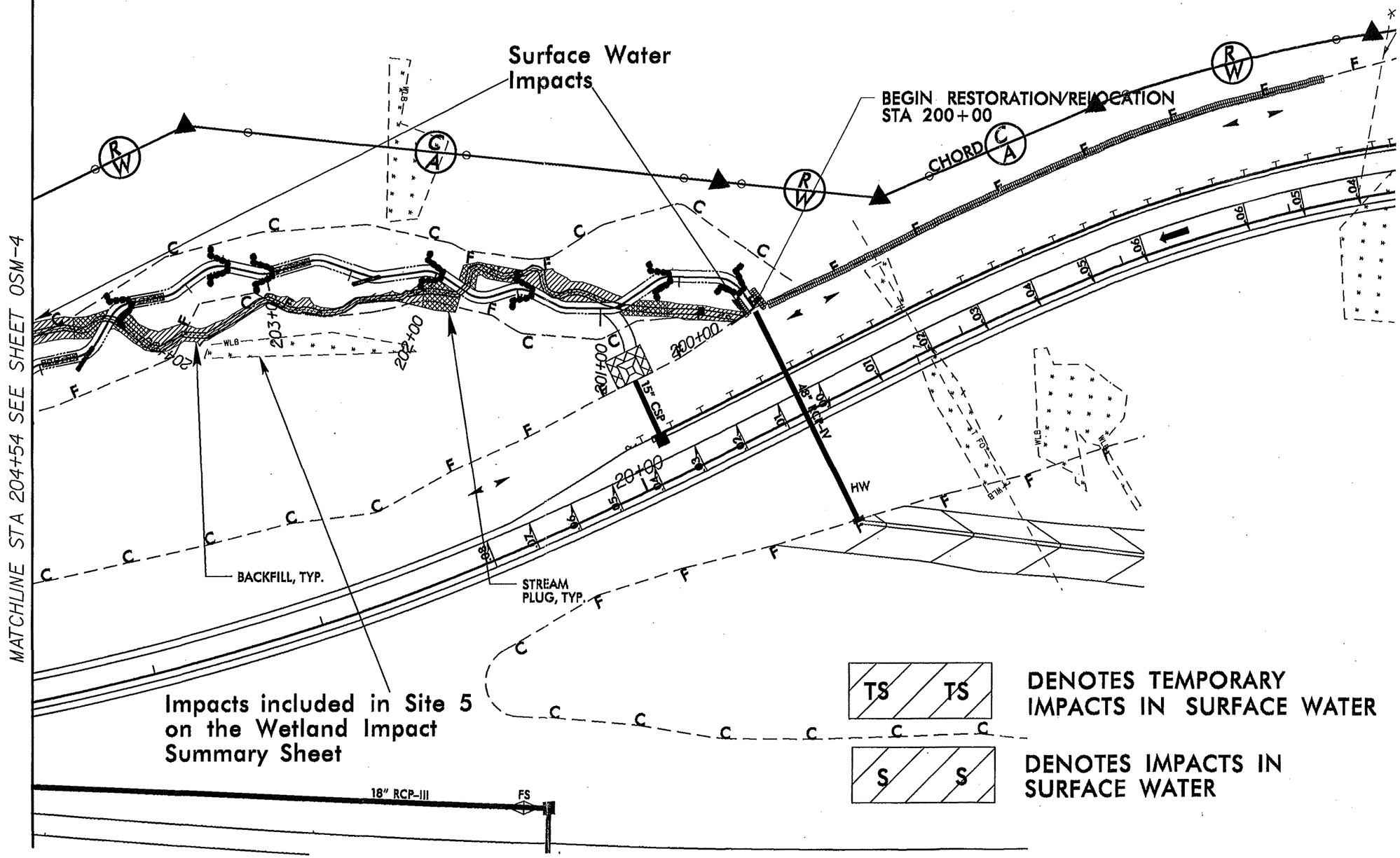
APPROVED
DIVISION ADMINISTRATOR DATE

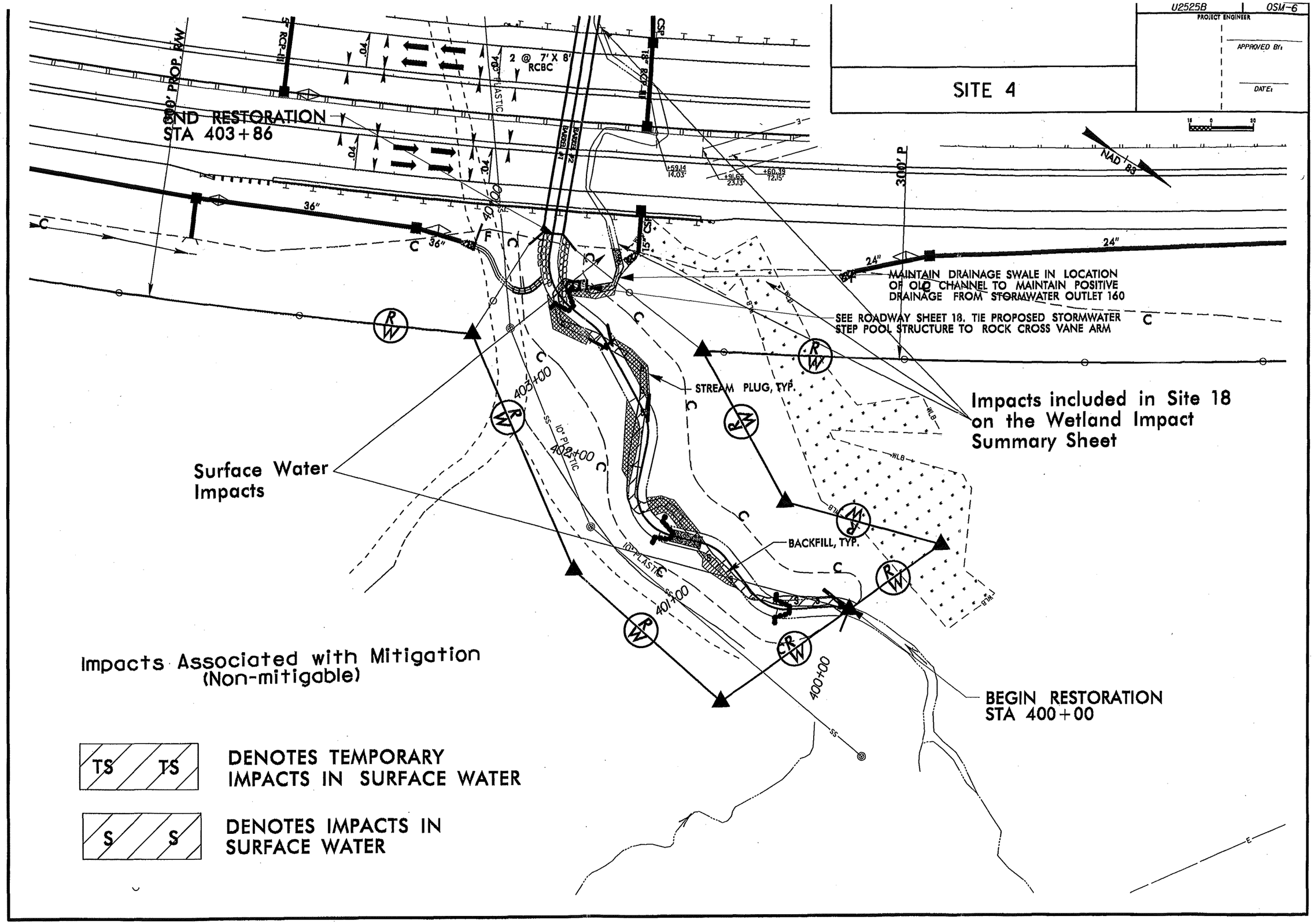

Impacts Associated with Mitigation
(Non-mitigable)
TS TS
DENOTES TEMPORARY IMPACTS IN SURFACE WATER
S S
DENOTES IMPACTS IN SURFACE WATER
U2525B
OSM-4
PROJECT ENGINEER
APPROVED BY:
DATE:
SITE 2
NAD 83
BACKFILL, TYP.
Surface Water Impacts
END RESTORATION/RELOCATION STA 213+07
Impacts included in Site 5 on the Wetland Impact Summary Sheet
CITY OF GREENSBORO DB 2994 PG 481
+50.00 -L-
180.00'
+83.00 -Y4RPB-
148.00'
CHORD
RW
CA
MATCHLINE STA 204+54 SEE SHEET OSM-5
205+00
207+00
208+00
210+00
211+00
212+00
213+00
36"
24"
24" RCP-III
18" RCP-III
FS
2GI
N 6° 36' 13.6" E
65+00
Impacts included in Site 5 on the Wetland Impact Summary Sheet
STREAM PLUG, TYP.
N 2° 28' 14.0" E

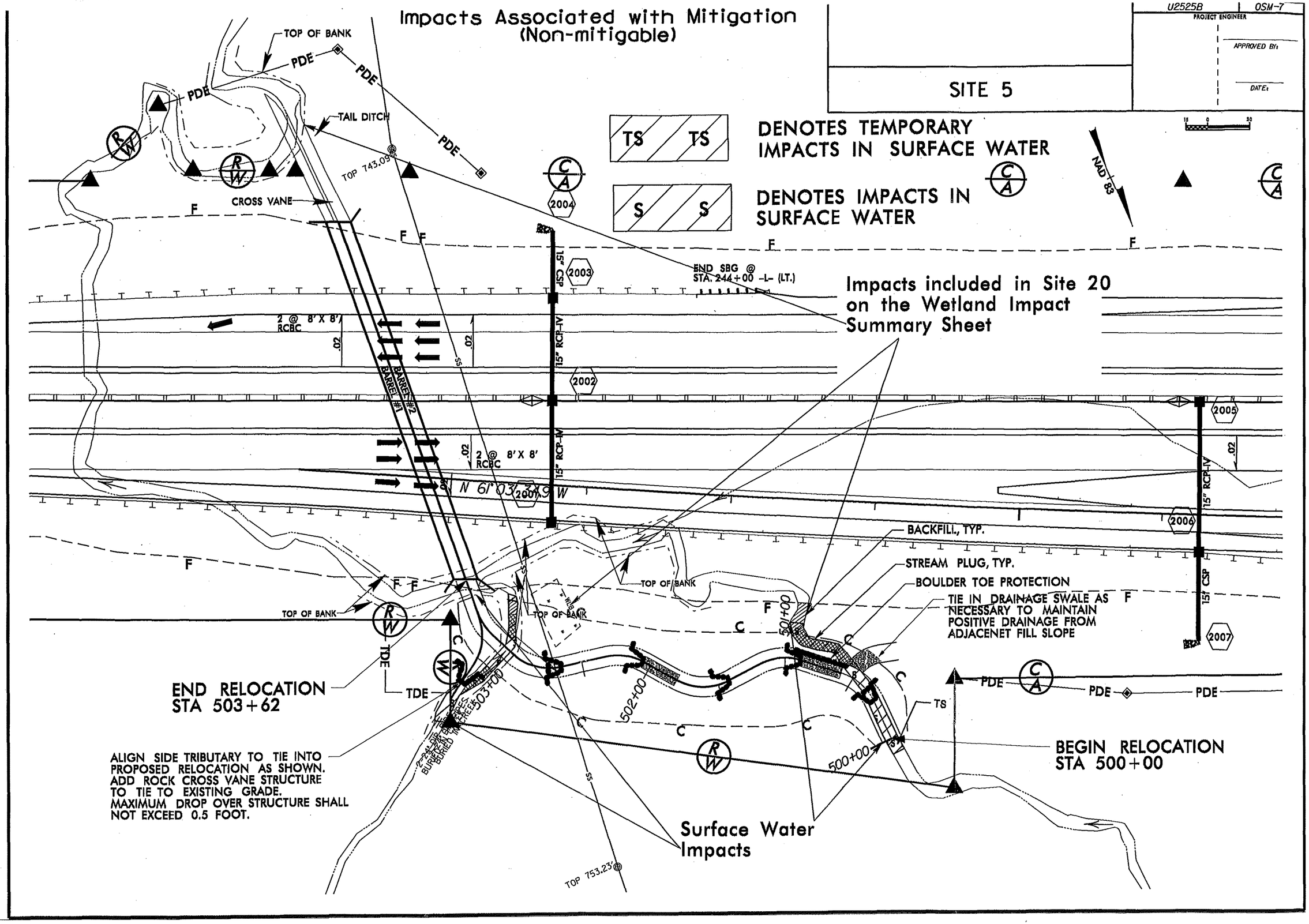
Impacts Associated with Mitigation (Non-mitigable)

U2525B	OSM-5
PROJECT ENGINEER	
APPROVED BY:	
DATE:	

SITE 2




U2525B
OSM-6
PROJECT ENGINEER
APPROVED BY:
DATE:
SITE 4
NAD 83
300' PROP. R/W
END RESTORATION
STA 403+86
2 @ 7' X 8'
RCBC
36"
24"
MAINTAIN DRAINAGE SWALE IN LOCATION OF OLD CHANNEL TO MAINTAIN POSITIVE DRAINAGE FROM STORMWATER OUTLET 160
SEE ROADWAY SHEET 18. TIE PROPOSED STORMWATER STEP POOL STRUCTURE TO ROCK CROSS VANE ARM
STREAM PLUG, TYP.
BACKFILL, TYP.
Impacts included in Site 18 on the Wetland Impact Summary Sheet
Surface Water Impacts
BEGIN RESTORATION
STA 400+00
Impacts Associated with Mitigation (Non-mitigable)
TS
DENOTES TEMPORARY IMPACTS IN SURFACE WATER
S
DENOTES IMPACTS IN SURFACE WATER


Impacts Associated with Mitigation
(Non-mitigable)
U2525B
OSM-7
PROJECT ENGINEER
APPROVED BY:
DATE:
SITE 5
TS TS
DENOTES TEMPORARY IMPACTS IN SURFACE WATER
S S
DENOTES IMPACTS IN SURFACE WATER
NAD 83
TOP OF BANK
PDE
TAIL DITCH
TOP 743.09'
CROSS VANE
F
END SBG @ STA. 244+00 -L- (LT.)
Impacts included in Site 20 on the Wetland Impact Summary Sheet
2 @ 8' X 8' RCBC
.02
BARREL #1
BARREL #2
15" CSP
15" RCP-IV
15" RCP-M
2004
2003
2002
2001
2005
2006
2007
N 61°03'33.9" W
BACKFILL, TYP.
STREAM PLUG, TYP.
BOULDER TOE PROTECTION
TIE IN DRAINAGE SWALE AS NECESSARY TO MAINTAIN POSITIVE DRAINAGE FROM ADJACENET FILL SLOPE
TOP OF BANK
TDE
END RELOCATION
STA 503+62
503+00
502+00
501+00
500+00
TS
BEGIN RELOCATION
STA 500+00
ALIGN SIDE TRIBUTARY TO TIE INTO PROPOSED RELOCATION AS SHOWN. ADD ROCK CROSS VANE STRUCTURE TO TIE TO EXISTING GRADE. MAXIMUM DROP OVER STRUCTURE SHALL NOT EXCEED 0.5 FOOT.
Surface Water Impacts
TOP 753.23'

MITIGATION IMPACT SUMMARY

			WETLAND IMPACTS					SURFACE WATER IMPACTS				
Mitigation Site No.	Mitigation Station Station (From/To)	Mitigation Description	Permanent Fill In Wetlands (ac)	Temp. Fill In Wetlands (ac)	Excavation in Wetlands (ac)	Mechanized Clearing in Wetlands (ac)	Hand Clearing in Wetlands (ac)	Permanent SW impacts (ac)	Temp. SW impacts (ac)	Existing Channel Impacts Permanent (ft)	Existing Channel Impacts Temp. (ft)	Natural Stream Design (ft)
2 (Permit Site #5)	200+00 to 213+07	Restoration/ Relocation								934		1307
4 (Permit Site #18)	400+00 to 403+86	Restoration								431		386
5 (Permit Site #20)	500+00 to 503+62	Relocation								106	10	362
TOTALS:										1471		2055

For impacts associated with the roadway fill slopes, culverts and pipes please see Wetland Impact Summary Sheet for Site 5, Site 18, and Site 20 on U-2525B

NC DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GUILFORD
COUNTY
WBS - 34821.1.3 (U-2525B)

SHEET 1 OF 1 8/12/2013

ATN Revised 3/31/05

APPENDIX C

REFERENCE REACH DATA

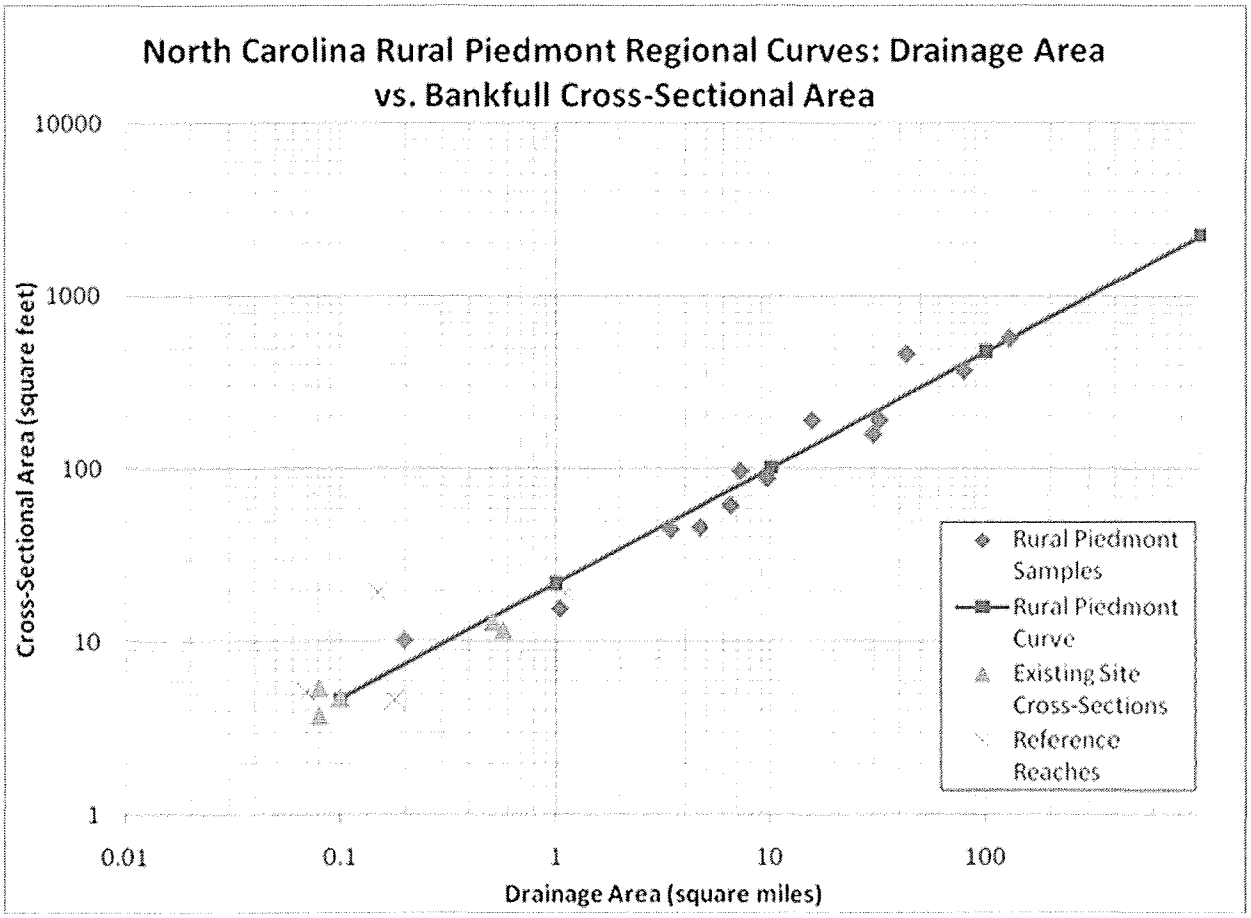


FIGURE 3: COMPARISON OF REGIONAL CURVE INFORMATION FOR PROJECT REACHES

REFERENCE REACH MORPHOLOGICAL MEASUREMENTS TABLE

U-2525 On-Site Mitigation – Tributary to Riddicks Creek (KHA)

	Variables	Reference Reach		
1.	Stream type	C5		
2.	Drainage Area (sq. mi)	0.18		
3.	Bankfull width (ft)	Mean:	7.9	
		Range:	--	--
4.	Bankfull mean depth (ft)	Mean:	0.6	
		Range:	--	--
5.	Width/depth ratio	Mean:	13.5	
		Range:	--	--
6.	Bankfull cross-sectional area (sq. ft)	Mean:	4.6	
		Range:	--	--
7.	Bankfull mean velocity (ft/sec)	Mean:	NA	
		Range:	--	--
8.	Bankfull discharge (cfs)	Mean:	NA	
		Range:	--	--
9.	Bankfull max depth (ft)	Mean:	1.0	
		Range:	--	--
10.	Width of floodprone area (ft)	Mean:	36.0	
		Range:	--	--
11.	Entrenchment ratio	Mean:	4.6	
		Range:	--	--
12.	Meander length (ft)	Mean:	80.5	
		Range:	64.0	97.0
13.	Ratio of meander length to bankfull width	Mean:	10.2	
		Range:	8.1	12.3
14.	Radius of curvature (ft)	Mean:	13.4	
		Range:	8.5	22.0
15.	Ratio of radius of curvature to bankfull width	Mean:	1.7	
		Range:	1.1	2.8
16.	Belt width (ft)	Mean:	34.0	
		Range:	--	--
17.	Meander width ratio	Mean:	4.3	
		Range:	--	--
18.	Sinuosity (stream length/valley length)	Mean:	1.3	
		Range:	--	--
19.	Valley slope (ft/ft)	Mean:	0.0022	
		Range:	--	--
20.	Average slope (ft/ft)	Mean:	0.0017	
		Range:	--	--
21.	Pool slope (ft/ft)	Mean:	0.0002	
		Range:	0.0000	0.0007
22.	Ratio of pool slope to average slope	Mean:	0.1	
		Range:	0.0	0.4
23.	Maximum pool depth (ft)	Mean:	2.0	
		Range:	--	--
24.	Ratio of pool depth to average bankfull depth	Mean:	3.4	
		Range:	--	--
25.	Pool width (ft)	Mean:	11.5	
		Range:	--	--
26.	Ratio of pool width to bankfull width	Mean:	1.5	
		Range:	--	--
27.	Pool to pool spacing (ft)	Mean:	38.3	
		Range:	18	78
28.	Ratio of pool to pool spacing to bankfull width	Mean:	4.8	
		Range:	2.3	9.9

REFERENCE REACH MORPHOLOGICAL MEASUREMENTS TABLE

U-2525 On-Site Mitigation – Riddicks Creek (KHA)

	Variables	Reference Reach		
1.	Stream type	E5		
2.	Drainage Area (sq. mi)	0.07		
3.	Bankfull width (ft)	Mean:	6.6	
		Range:	5.7	7.5
4.	Bankfull mean depth (ft)	Mean:	0.8	
		Range:	0.7	0.8
5.	Width/depth ratio	Mean:	8.7	
		Range:	8.2	9.2
6.	Bankfull cross-sectional area (sq. ft)	Mean:	5.1	
		Range:	4.0	6.1
7.	Bankfull mean velocity (ft/sec)	Mean:	NA	
		Range:	--	--
8.	Bankfull discharge (cfs)	Mean:	NA	
		Range:	--	--
9.	Bankfull max depth (ft)	Mean:	1.5	
		Range:	1.3	1.6
10.	Width of floodprone area (ft)	Mean:	27.4	
		Range:	20.0	34.0
11.	Entrenchment ratio	Mean:	4.2	
		Range:	3.5	4.6
12.	Meander length (ft)	Mean:	32.0	
		Range:	25.0	45.0
13.	Ratio of meander length to bankfull width	Mean:	4.8	
		Range:	3.8	6.8
14.	Radius of curvature (ft)	Mean:	11.3	
		Range:	5.7	18.8
15.	Ratio of radius of curvature to bankfull width	Mean:	1.7	
		Range:	0.9	2.8
16.	Belt width (ft)	Mean:	15.8	
		Range:	10.5	22.0
17.	Meander width ratio	Mean:	2.4	
		Range:	1.6	3.3
18.	Sinuosity (stream length/valley length)	Mean:	1.4	
		Range:	--	--
19.	Valley slope (ft/ft)	Mean:	0.0130	
		Range:	--	--
20.	Average slope (ft/ft)	Mean:	0.0093	
		Range:	--	--
21.	Pool slope (ft/ft)	Mean:	0.0024	
		Range:	0.0000	0.0100
22.	Ratio of pool slope to average slope	Mean:	0.3	
		Range:	0.0	0.6
23.	Maximum pool depth (ft)	Mean:	2.0	
		Range:	--	--
24.	Ratio of pool depth to average bankfull depth	Mean:	2.3	
		Range:	--	--
25.	Pool width (ft)	Mean:	8.1	
		Range:	--	--
26.	Ratio of pool width to bankfull width	Mean:	1.2	
		Range:	--	--
27.	Pool to pool spacing (ft)	Mean:	22.9	
		Range:	8	48
28.	Ratio of pool to pool spacing to bankfull width	Mean:	3.5	
		Range:	1.1	7.3

REFERENCE REACH MORPHOLOGICAL MEASUREMENTS TABLE

U-2525 On-Site Mitigation – Tributary to Lake Jeanette (NCDOT)

	Variables	Reference Reach		
1.	Stream type	E5		
2.	Drainage Area (sq. mi)	0.15		
3.	Bankfull width (ft)	Mean:	12.0	
		Range:	--	--
4.	Bankfull mean depth (ft)	Mean:	1.6	
		Range:	1.4	1.7
5.	Width/depth ratio	Mean:	8.4	
		Range:	7.1	9.6
6.	Bankfull cross-sectional area (sq. ft)	Mean:	19.4	
		Range:	18.8	20.0
7.	Bankfull mean velocity (ft/sec)	Mean:	5.6	
		Range:	5.2	6.2
8.	Bankfull discharge (cfs)	Mean:	109.3	
		Range:	100.7	119.6
9.	Bankfull max depth (ft)	Mean:	2.9	
		Range:	--	--
10.	Width of floodprone area (ft)	Mean:	49.0	
		Range:	--	--
11.	Entrenchment ratio	Mean:	4.4	
		Range:	4.1	4.7
12.	Meander length (ft)	Mean:	22.0	
		Range:	--	--
13.	Ratio of meander length to bankfull width	Mean:	1.8	
		Range:	--	--
14.	Radius of curvature (ft)	Mean:	7.3	
		Range:	--	--
15.	Ratio of radius of curvature to bankfull width	Mean:	0.6	
		Range:	--	--
16.	Belt width (ft)	Mean:	45.0	
		Range:	--	--
17.	Meander width ratio	Mean:	3.8	
		Range:	--	--
18.	Sinuosity (stream length/valley length)	Mean:	NA	
		Range:	--	--
19.	Valley slope (ft/ft)	Mean:	NA	
		Range:	--	--
20.	Average slope (ft/ft)	Mean:	0.0033	
		Range:	--	--
21.	Pool slope (ft/ft)	Mean:	NA	
		Range:	--	--
22.	Ratio of pool slope to average slope	Mean:	NA	
		Range:	--	--
23.	Maximum pool depth (ft)	Mean:	3.1	
		Range:	--	--
24.	Ratio of pool depth to average bankfull depth	Mean:	2.0	
		Range:	--	--
25.	Pool width (ft)	Mean:	19.6	
		Range:	--	--
26.	Ratio of pool width to bankfull width	Mean:	1.6	
		Range:	--	--
27.	Pool to pool spacing (ft)	Mean:	NA	
		Range:	--	--
28.	Ratio of pool to pool spacing to bankfull width	Mean:	NA	
		Range:	--	--

REFERENCE REACH MORPHOLOGICAL MEASUREMENTS TABLE

U-2525 On-Site Mitigation – Tributary to Rich Fork (KHA)

	Variables	Reference Reach		
1.	Stream type	B4		
2.	Drainage Area (sq. mi)	1.12		
3.	Bankfull width (ft)	Mean:	15.2	
		Range:	--	--
4.	Bankfull mean depth (ft)	Mean:	1.2	
		Range:	--	--
5.	Width/depth ratio	Mean:	12.7	
		Range:	--	--
6.	Bankfull cross-sectional area (sq. ft)	Mean:	19.0	
		Range:	--	--
7.	Bankfull mean velocity (ft/sec)	Mean:	5.1	
		Range:	--	--
8.	Bankfull discharge (cfs)	Mean:	96.9	
		Range:	--	--
9.	Bankfull max depth (ft)	Mean:	1.9	
		Range:	--	--
10.	Width of floodprone area (ft)	Mean:	23.3	
		Range:	--	--
11.	Entrenchment ratio	Mean:	1.5	
		Range:	--	--
12.	Meander length (ft)	Mean:	NA	
		Range:	--	--
13.	Ratio of meander length to bankfull width	Mean:	NA	
		Range:	--	--
14.	Radius of curvature (ft)	Mean:	NA	
		Range:	--	--
15.	Ratio of radius of curvature to bankfull width	Mean:	NA	
		Range:	--	--
16.	Belt width (ft)	Mean:	NA	
		Range:	--	--
17.	Meander width ratio	Mean:	NA	
		Range:	--	--
18.	Sinuosity (stream length/valley length)	Mean:	1.07	
		Range:	--	--
19.	Valley slope (ft/ft)	Mean:	0.0168	
		Range:	--	--
20.	Average slope (ft/ft)	Mean:	0.0157	
		Range:	--	--
21.	Pool slope (ft/ft)	Mean:	0.0032	
		Range:	0.0009	0.0065
22.	Ratio of pool slope to average slope	Mean:	0.2	
		Range:	0.1	0.4
23.	Maximum pool depth (ft)	Mean:	3.0	
		Range:	2.3	3.9
24.	Ratio of pool depth to average bankfull depth	Mean:	2.5	
		Range:	1.912	3.28
25.	Pool width (ft)	Mean:	16.3	
		Range:	--	--
26.	Ratio of pool width to bankfull width	Mean:	1.1	
		Range:	--	--
27.	Pool to pool spacing (ft)	Mean:	33.1	
		Range:	20	52
28.	Ratio of pool to pool spacing to bankfull width	Mean:	2.2	
		Range:	1.3	3.4

APPENDIX D

MORPHOLICICAL CHARACTERISTICS OF PROPOSED STREAMS

MORPHOLOGICAL MEASUREMENTS TABLE

U-2525B On-Site Mitigation – Site 2 Reach 1

	Variables	Existing Channel			Proposed Design		
1.	Stream type	Incised B5			B5		
2.	Drainage area (sq. mi)	0.08			0.08		
3.	Bankfull width (ft)	Mean:	7.8		Mean:	7.2	
		Range:	--	--	Range:	--	--
4.	Bankfull mean depth (ft)	Mean:	0.7		Mean:	0.5	
		Range:	--	--	Range:	--	--
5.	Width/depth ratio	Mean:	11.0		Mean:	13.5	
		Range:	--	--	Range:	--	--
6.	Bankfull cross-sectional area (sq. ft)	Mean:	5.5		Mean:	3.8	
		Range:	--	--	Range:	--	--
7.	Bankfull mean velocity (ft/sec)	Mean:	3.4		Mean:	4.9	
		Range:	3.1	3.8	Range:	--	--
8.	Bankfull discharge (cfs)	Mean:	18.6		Mean:	18.6	
		Range:	--	--	Range:	--	--
9.	Bankfull max depth (ft)	Mean:	0.9		Mean:	0.8	
		Range:	--	--	Range:	--	--
10.	Width of floodprone area (ft)	Mean:	12.0		Mean:	14.0	
		Range:	--	--	Range:	--	--
11.	Entrenchment ratio	Mean:	1.5		Mean:	1.9	
		Range:	--	--	Range:	--	--
12.	Meander length (ft)	Mean:	27.9		Mean:	63.0	
		Range:	13.2	51.1	Range:	50.4	75.6
13.	Ratio of meander length to bankfull width	Mean:	3.6		Mean:	8.8	
		Range:	1.7	6.5	Range:	7.0	10.5
14.	Radius of curvature (ft)	Mean:	10.9		Mean:	17.3	
		Range:	7.1	17.1	Range:	15.8	18.9
15.	Ratio of radius of curvature to bankfull width	Mean:	1.4		Mean:	2.4	
		Range:	0.9	2.2	Range:	2.2	2.6
16.	Belt width (ft)	Mean:	12.2		Mean:	12.9	
		Range:	8.1	25.2	Range:	11.3	14.5
17.	Meander width ratio	Mean:	1.6		Mean:	1.8	
		Range:	1.0	3.2	Range:	1.6	2.0
18.	Sinuosity (stream length/valley length)	Mean:	1.15		Mean:	1.07	
		Range:	--	--	Range:	--	--
19.	Valley slope (ft/ft)	Mean:	0.0174		Mean:	0.0110	
		Range:	--	--	Range:	--	--
20.	Average slope (ft/ft)	Mean:	0.0151		Mean:	0.0103	
		Range:	--	--	Range:	--	--
21.	Pool slope (ft/ft)	Mean:	0.0111		Mean:	0.0001	
		Range:	0.0067	0.0165	Range:	0.0001	0.0001
22.	Ratio of pool slope to average slope	Mean:	0.7		Mean:	0.0	
		Range:	0.4	1.1	Range:	0.0	0.0
23.	Maximum pool depth (ft)	Mean:	1.9		Mean:	1.4	
		Range:	1.6	2.1	Range:	--	--
24.	Ratio of pool depth to average bankfull depth	Mean:	2.6		Mean:	2.6	
		Range:	2.2	3.0	Range:	--	--
25.	Pool width (ft)	Mean:	6.7		Mean:	9.8	
		Range:	--	--	Range:	--	--
26.	Ratio of pool width to bankfull width	Mean:	0.9		Mean:	1.4	
		Range:	--	--	Range:	--	--
27.	Pool to pool spacing (ft)	Mean:	20.0		Mean:	31.5	
		Range:	12.6	27.7	Range:	25.2	37.8
28.	Ratio of pool to pool spacing to bankfull width	Mean:	2.6		Mean:	4.4	
		Range:	1.6	3.5	Range:	3.5	5.3

MORPHOLOGICAL MEASUREMENTS TABLE

U-2525B On-Site Mitigation – Site 2 Reach 2

	Variables	Existing Channel			Proposed Design		
1.	Stream type	Incised B5			B5		
2.	Drainage area (sq. mi)	0.10			0.10		
3.	Bankfull width (ft)	Mean:	5.0		Mean:	7.6	
		Range:	--	--	Range:	--	--
4.	Bankfull mean depth (ft)	Mean:	1.0		Mean:	0.5	
		Range:	--	--	Range:	--	--
5.	Width/depth ratio	Mean:	5.2		Mean:	13.9	
		Range:	--	--	Range:	--	--
6.	Bankfull cross-sectional area (sq. ft)	Mean:	4.8		Mean:	4.2	
		Range:	--	--	Range:	--	--
7.	Bankfull mean velocity (ft/sec)	Mean:	4.0		Mean:	4.6	
		Range:	3.6	4.5	Range:	--	--
8.	Bankfull discharge (cfs)	Mean:	19.1		Mean:	19.1	
		Range:	--	--	Range:	--	--
9.	Bankfull max depth (ft)	Mean:	1.3		Mean:	0.8	
		Range:	--	--	Range:	--	--
10.	Width of floodprone area (ft)	Mean:	8.1		Mean:	12.0	
		Range:	--	--	Range:	--	--
11.	Entrenchment ratio	Mean:	1.6		Mean:	1.6	
		Range:	--	--	Range:	--	--
12.	Meander length (ft)	Mean:	42.3		Mean:	65.0	
		Range:	14.2	72.8	Range:	52.0	78.0
13.	Ratio of meander length to bankfull width	Mean:	8.5		Mean:	8.6	
		Range:	2.9	14.7	Range:	6.8	10.3
14.	Radius of curvature (ft)	Mean:	9.4		Mean:	17.9	
		Range:	5.0	16.0	Range:	16.3	19.5
15.	Ratio of radius of curvature to bankfull width	Mean:	1.9		Mean:	2.4	
		Range:	1.0	3.2	Range:	2.1	2.6
16.	Belt width (ft)	Mean:	18.5		Mean:	22.8	
		Range:	9.0	40.7	Range:	16.3	29.3
17.	Meander width ratio	Mean:	3.7		Mean:	3.0	
		Range:	1.8	8.2	Range:	2.1	3.9
18.	Sinuosity (stream length/valley length)	Mean:	1.19		Mean:	1.06	
		Range:	--	--	Range:	--	--
19.	Valley slope (ft/ft)	Mean:	0.0171		Mean:	0.0199	
		Range:	--	--	Range:	--	--
20.	Average slope (ft/ft)	Mean:	0.0144		Mean:	0.0187	
		Range:	--	--	Range:	--	--
21.	Pool slope (ft/ft)	Mean:	0.0040		Mean:	0.0000	
		Range:	0.0027	0.0056	Range:	0.0000	0.0019
22.	Ratio of pool slope to average slope	Mean:	0.3		Mean:	0.0	
		Range:	0.2	0.4	Range:	0.0	0.1
23.	Maximum pool depth (ft)	Mean:	1.8		Mean:	1.5	
		Range:	1.6	2.2	Range:	--	--
24.	Ratio of pool depth to average bankfull depth	Mean:	1.9		Mean:	2.7	
		Range:	1.6	2.3	Range:	--	--
25.	Pool width (ft)	Mean:	5.4		Mean:	10.2	
		Range:	--	--	Range:	--	--
26.	Ratio of pool width to bankfull width	Mean:	1.1		Mean:	1.3	
		Range:	--	--	Range:	--	--
27.	Pool to pool spacing (ft)	Mean:	28.8		Mean:	32.5	
		Range:	24.0	33.7	Range:	29.3	42.3
28.	Ratio of pool to pool spacing to bankfull width	Mean:	5.8		Mean:	4.3	
		Range:	4.8	6.8	Range:	3.9	5.6

MORPHOLOGICAL MEASUREMENTS TABLE

U-2525B On-Site Mitigation – Site 4

	Variables	Existing Channel			Proposed Design		
1.	Stream type	Incised B5			C5		
2.	Drainage area (sq. mi)	0.57			0.57		
3.	Bankfull width (ft)	Mean:	8.9		Mean:	12.7	
		Range:	--	--	Range:	--	--
4.	Bankfull mean depth (ft)	Mean:	1.3		Mean:	0.9	
		Range:	--	--	Range:	--	--
5.	Width/depth ratio	Mean:	6.6		Mean:	13.6	
		Range:	--	--	Range:	--	--
6.	Bankfull cross-sectional area (sq. ft)	Mean:	11.9		Mean:	11.9	
		Range:	--	--	Range:	--	--
7.	Bankfull mean velocity (ft/sec)	Mean:	2.1		Mean:	2.1	
		Range:	1.9	2.3	Range:	--	--
8.	Bankfull discharge (cfs)	Mean:	24.5		Mean:	24.5	
		Range:	--	--	Range:	--	--
9.	Bankfull max depth (ft)	Mean:	2.1		Mean:	1.4	
		Range:	--	--	Range:	--	--
10.	Width of floodprone area (ft)	Mean:	15.1		Mean:	80.0	
		Range:	--	--	Range:	--	--
11.	Entrenchment ratio	Mean:	1.7		Mean:	6.3	
		Range:	--	--	Range:	--	--
12.	Meander length (ft)	Mean:	44.7		Mean:	122.0	
		Range:	25.7	58.3	Range:	97.6	146.4
13.	Ratio of meander length to bankfull width	Mean:	5.0		Mean:	9.6	
		Range:	2.9	6.6	Range:	7.7	11.5
14.	Radius of curvature (ft)	Mean:	33.6		Mean:	33.6	
		Range:	12.0	63.0	Range:	30.5	36.6
15.	Ratio of radius of curvature to bankfull width	Mean:	3.8		Mean:	2.6	
		Range:	1.3	7.1	Range:	2.4	2.9
16.	Belt width (ft)	Mean:	12.3		Mean:	42.7	
		Range:	7.4	17.7	Range:	30.5	54.9
17.	Meander width ratio	Mean:	1.4		Mean:	3.4	
		Range:	0.8	2.0	Range:	2.4	4.3
18.	Sinuosity (stream length/valley length)	Mean:	1.22		Mean:	1.08	
		Range:	--	--	Range:	--	--
19.	Valley slope (ft/ft)	Mean:	0.0029		Mean:	0.0050	
		Range:	--	--	Range:	--	--
20.	Average slope (ft/ft)	Mean:	0.0024		Mean:	0.0046	
		Range:	--	--	Range:	--	--
21.	Pool slope (ft/ft)	Mean:	0.0073		Mean:	0.0000	
		Range:	0.0061	0.0080	Range:	0.0000	0.0005
22.	Ratio of pool slope to average slope	Mean:	3.0		Mean:	0.0	
		Range:	2.5	3.3	Range:	0.0	0.1
23.	Maximum pool depth (ft)	Mean:	2.7		Mean:	2.6	
		Range:	2.5	2.8	Range:	--	--
24.	Ratio of pool depth to average bankfull depth	Mean:	2.0		Mean:	2.8	
		Range:	1.9	2.1	Range:	--	--
25.	Pool width (ft)	Mean:	13.3		Mean:	17.0	
		Range:	--	--	Range:	--	--
26.	Ratio of pool width to bankfull width	Mean:	1.5		Mean:	1.3	
		Range:	--	--	Range:	--	--
27.	Pool to pool spacing (ft)	Mean:	24.4		Mean:	70.2	
		Range:	23.7	25.2	Range:	54.9	85.4
28.	Ratio of pool to pool spacing to bankfull width	Mean:	2.7		Mean:	5.5	
		Range:	2.7	2.8	Range:	4.3	6.7

MORPHOLOGICAL MEASUREMENTS TABLE

U-2525B On-Site Mitigation – Site 5

	Variables	Existing Channel			Proposed Design		
1.	Stream type	E5			C5		
2.	Drainage area (sq. mi)	0.51			0.51		
3.	Bankfull width (ft)	Mean:	11.8		Mean:	13.7	
		Range:	--	--	Range:	--	--
4.	Bankfull mean depth (ft)	Mean:	1.1		Mean:	1.0	
		Range:	--	--	Range:	--	--
5.	Width/depth ratio	Mean:	10.4		Mean:	14.1	
		Range:	--	--	Range:	--	--
6.	Bankfull cross-sectional area (sq. ft)	Mean:	13.3		Mean:	13.3	
		Range:	--	--	Range:	--	--
7.	Bankfull mean velocity (ft/sec)	Mean:	4.3		Mean:	4.3	
		Range:	3.9	4.8	Range:	--	--
8.	Bankfull discharge (cfs)	Mean:	56.5		Mean:	56.5	
		Range:	--	--	Range:	--	--
9.	Bankfull max depth (ft)	Mean:	1.6		Mean:	1.4	
		Range:	--	--	Range:	--	--
10.	Width of floodprone area (ft)	Mean:	147.0		Mean:	147.0	
		Range:	--	--	Range:	--	--
11.	Entrenchment ratio	Mean:	12.5		Mean:	10.7	
		Range:	--	--	Range:	--	--
12.	Meander length (ft)	Mean:	85.2		Mean:	126.0	
		Range:	27.5	138.0	Range:	100.8	151.2
13.	Ratio of meander length to bankfull width	Mean:	7.2		Mean:	9.2	
		Range:	2.3	11.7	Range:	7.4	11.0
14.	Radius of curvature (ft)	Mean:	29.6		Mean:	34.7	
		Range:	6.0	71.0	Range:	31.5	37.8
15.	Ratio of radius of curvature to bankfull width	Mean:	2.5		Mean:	2.5	
		Range:	0.5	6.0	Range:	2.3	2.8
16.	Belt width (ft)	Mean:	33.5		Mean:	36.4	
		Range:	17.6	53.2	Range:	24.6	48.2
17.	Meander width ratio	Mean:	2.8		Mean:	2.7	
		Range:	1.5	4.5	Range:	1.8	3.5
18.	Sinuosity (stream length/valley length)	Mean:	1.16		Mean:	1.13	
		Range:	--	--	Range:	--	--
19.	Valley slope (ft/ft)	Mean:	0.0131		Mean:	0.0118	
		Range:	--	--	Range:	--	--
20.	Average slope (ft/ft)	Mean:	0.0113		Mean:	0.0105	
		Range:	--	--	Range:		
21.	Pool slope (ft/ft)	Mean:	0.0012		Mean:	0.0000	
		Range:	0.0057	0.0017	Range:	0.0000	0.0010
22.	Ratio of pool slope to average slope	Mean:	0.1		Mean:	0.0	
		Range:	0.5	0.1	Range:	0.0	0.1
23.	Maximum pool depth (ft)	Mean:	2.3		Mean:	2.6	
		Range:	1.9	2.6	Range:	--	--
24.	Ratio of pool depth to average bankfull depth	Mean:	2.1		Mean:	2.7	
		Range:	1.7	2.3	Range:	--	--
25.	Pool width (ft)	Mean:	11.8		Mean:	16.0	
		Range:	--	--	Range:	--	--
26.	Ratio of pool width to bankfull width	Mean:	1.0		Mean:	1.2	
		Range:	--	--	Range:	--	--
27.	Pool to pool spacing (ft)	Mean:	32.7		Mean:	72.5	
		Range:	21.3	50.8	Range:	56.7	88.2
28.	Ratio of pool to pool spacing to bankfull width	Mean:	2.8		Mean:	5.3	
		Range:	1.8	4.3	Range:	4.1	6.4

APPENDIX E

SEDIMENT TRANSPORT CALCULATIONS

SHEAR TRANSPORT CALCULATIONS
U-2525B On-Site Mitigation – Site 2 Reach 1

Shear Stress Analysis Data			
Feature		Existing	Proposed
Bankfull Cross-Sectional Area (A_{bkf})	Sq. ft	5.5	3.8
Bankfull Width, (W_{bkf})	ft	7.8	7.2
Width/Depth Ratio (W/D)	ft	11.0	13.5
Wetted Perimeter (WP) WP = W + 2D	ft	9.3	7.5
Hydraulic Radius (R) R = A_{bkf}/WP	ft	0.6	0.51
Average Channel Slope (Se)	ft/ft	0.0151	0.0103
Boundary Shear Stress, (τ)	lb/sq. ft	0.56	0.33
Median Diameter of Pavement (D_{50})	mm	13.75	
Median Diameter of Sub-Pavement ($\hat{D}_{50}$)	mm	1.7	
Critical Dimensionless Shear Stress (τ_{ci})		0.029	
Largest Particle from Sub-Pavement (D_i)	mm	45	
Largest Particle from Sub-Pavement (D_i)	ft	0.15	
Required Mean Bankfull Depth (D_r)	ft	0.47	
Required Mean Bankfull Slope (S_r)	ft/ft	0.0100	

SHEAR TRANSPORT CALCULATIONS
U-2525B On-Site Mitigation – Site 2 Reach 2

Shear Stress Analysis Data			
Feature		Existing	Proposed
Bankfull Cross-Sectional Area (A_{bkf})	Sq. ft	4.8	4.2
Bankfull Width, (W_{bkf})	ft	5	7.6
Width/Depth Ratio (W/D)	ft	5.2	13.9
Wetted Perimeter (WP) WP = W + 2D	ft	6.1	7.9
Hydraulic Radius (R) $R = A_{bkf}/WP$	ft	0.8	0.53
Average Channel Slope (Se)	ft/ft	0.0144	0.0187
Boundary Shear Stress, (τ)	lb/sq. ft	0.71	0.62
Median Diameter of Pavement (D_{50})	mm	13.75	
Median Diameter of Sub-Pavement ($\hat{D}_{50}$)	mm	1.7	
Critical Dimensionless Shear Stress (τ_{ci})		0.029	
Largest Particle from Sub-Pavement (D_i)	mm	45	
Largest Particle from Sub-Pavement (D_i)	ft	0.15	
Required Mean Bankfull Depth (D_r)	ft	0.49	
Required Mean Bankfull Slope (S_r)	ft/ft	0.0071	

SHEAR TRANSPORT CALCULATIONS
U-2525B On-Site Mitigation – Site 4

Shear Stress Analysis Data			
Feature		Existing	Proposed
Bankfull Cross-Sectional Area (A_{bkf})	Sq. ft	11.9	11.9
Bankfull Width, (W_{bkf})	ft	8.9	12.7
Width/Depth Ratio (W/D)	ft	6.6	13.6
Wetted Perimeter (WP) WP = W + 2D	ft	10.7	13.2
Hydraulic Radius (R) $R = A_{bkf}/WP$	ft	1.11	0.90
Average Channel Slope (Se)	ft/ft	0.0024	0.0046
Boundary Shear Stress, (τ)	lb/sq. ft	0.17	0.26
Median Diameter of Pavement (D_{50})	mm	29.41	
Median Diameter of Sub-Pavement ($\hat{D}_{50}$)	mm	8.3	
Critical Dimensionless Shear Stress (τ_{ci})		0.013	
Largest Particle from Sub-Pavement (D_i)	mm	45	
Largest Particle from Sub-Pavement (D_i)	ft	0.15	
Required Mean Bankfull Depth (D_r)	ft	1.31	
Required Mean Bankfull Slope (S_r)	ft/ft	0.0024	

SHEAR TRANSPORT CALCULATIONS
U-2525B On-Site Mitigation – Site 5

Shear Stress Analysis Data			
Feature		Existing	Proposed
Bankfull Cross-Sectional Area (A_{bkf})	Sq. ft	13.3	13.3
Bankfull Width, (W_{bkf})	ft	11.8	13.7
Width/Depth Ratio (W/D)	ft	10.4	14.1
Wetted Perimeter (WP) WP = W + 2D	ft	12.8	14.1
Hydraulic Radius (R) $R = A_{bkf}/WP$	ft	1.04	0.94
Average Channel Slope (Se)	ft/ft	0.0113	0.0105
Boundary Shear Stress, (τ)	lb/sq. ft	0.73	0.61
Median Diameter of Pavement (D_{50})	mm	50	
Median Diameter of Sub-Pavement ($\hat{D}_{50}$)	mm	15.2	
Critical Dimensionless Shear Stress (τ_{ci})		0.021	
Largest Particle from Sub-Pavement (D_i)	mm	50	
Largest Particle from Sub-Pavement (D_i)	ft	0.16	
Required Mean Bankfull Depth (D_r)	ft	0.51	
Required Mean Bankfull Slope (S_r)	ft/ft	0.0052	

APPENDIX F

RIPARIAN PLANTING SPECIFICATIONS

STREAM REFORESTATION:

Description

Stream Reforestation will be planted in areas designated on the plans and as directed. See the Stream Reforestation Detail Sheets.

The entire *Stream Reforestation* operation shall comply with the requirements of Section 1670 of the *Standard Specifications*.

Materials

Live Stakes:

Type I Stream Reforestation shall be live stakes, planted along both streambanks. Live stakes shall be ½"- 2" in diameter. Stakes shall also be 2 ft. - 3 ft. in length.

Live staking plant material shall consist of a random mix made up of the following:

Percent Planted	Common Name	Scientific Name
50%	Buttonbush	*Cephalanthus occidentalis*
50%	Silky Dogwood	*Cornus amomum*

Other species may be substituted upon approval of the Engineer. All plant material shall be harvested locally (within the same physiographic ecoregion and plant hardiness zone) or purchased from a local nursery, with the approval of the Engineer. All live stakes shall be dormant at time of acquisition and planting.

Coir Fiber Matting:

Provide matting that meets the following requirements:

100% coconut fiber (coir) twine woven into high strength matrix

Thickness -	0.30 in. minimum
Tensile Strength	1348 x 626 lb/ft minimum
Elongation	34% x 38% maximum
Flexibility (mg-cm)	65030 x 29590
Flow Velocity	Observed 11 ft/sec
Weight	20 oz/SY
Size	6.6 x 164 ft (120 SY)
"C" Factor	0.002
Open Area (measured)	50%

Staples, stakes, or reinforcement bars shall be used as anchors and shall meet the following requirements:

Wooden Stakes:

Provide hardwood stakes 12"- 24" long with a 2" x 2" nominal square cross section. One end of the stake must be sharpened or beveled to facilitate driving through the coir fiber mat and down into the underlying soil. The other end of the stake needs to have a 1"- 2" long head at the top with a 1"- 2" notch following to catch and secure the coir fiber mat.

Steel Reinforcement Bars:

Provide uncoated #10 steel reinforcement bars 24" nominal length. The bars shall have a 4" diameter bend at one end with a 4" straight section at the tip to catch and secure the coir fiber mat.

Staples:

Provide staples made of 0.125" diameter new steel wire formed into a *u* shape not less than 12" in length with a throat of 1" in width.

Bare Root Seedlings:

Type II Stream Reforestation shall be bare root seedlings 12"-18" tall. Bare root seedlings shall consist of a random mix made up of the following:

Percent Planted	Common Name	Scientific Name
20%	Tulip Poplar	*Liriodendron tulipifera*
20%	Sycamore	*Platanus occidentalis*
20%	Green Ash	*Fraxinus pennsylvanica*
20%	Willow Oak	*Quercus phellos*
20%	River Birch	*Betula nigra*

Other species may be substituted upon approval of the Engineer.

Construction Methods

Coir fiber matting shall be installed on the streambanks where live staking is to be planted as shown on the Stream Reforestation Detail Sheets and in locations as directed. Work includes providing all materials, excavating and backfilling, and placing and securing coir fiber mat.

Provide a smooth soil surface free from stones, clods, or debris that will prevent the contact of the matting with the soil. Place the matting immediately upon final grading. Take care to preserve the required line, grade, and cross section of the area covered.

Unroll the matting and apply without stretching such that it will lie smoothly but loosely on the soil surface. Bury the top slope end of each piece of matting in a narrow trench at least 6" deep and tamp firmly. Where one roll of matting ends and a second roll begins, overlap the end of the upper roll over the buried end of the second roll so there is a 6" overlap. Construct check trenches at least 12" deep every 50 ft. longitudinally along the edges of the matting, or as directed. Fold over and bury matting to the full depth of the trench, close and tamp firmly. Overlap matting at least 6" where 2 or more widths of matting are installed side be side.

Wooden stakes, reinforcement bars, or staples may be used as anchors in accordance with the Stream Reforestation Detail Sheets and as directed. Place anchors across the matting at ends, junctions, and check trenches approximately 1 ft. apart. Place anchors along the outer edges and down the center of each strip of matting 3 ft. apart. Place anchors along all lapped edges 1 ft. apart. Refer to the Stream Reforestation Detail Sheets for anchoring pattern. The Engineer may require adjustments in the trenching or anchoring requirements to fit individual site conditions.

During preparation of the live stakes, the basal ends shall be cleanly cut at an angle to facilitate easy insertion into the soil, while the tops shall be cut square or blunt for tamping. All limbs shall be removed from the sides of the live cutting prior to installation.

Live stakes shall be installed within 48 hours of cutting. Outside storage locations should be continually shaded and protected from wind and direct sunlight. Live cut plant material shall remain moist at all times before planting.

Stakes shall be spaced approximately 4 ft. on center. Live stakes shall be installed according to the configuration presented on the Stream Reforestation Detail Sheets.

Tamp live stakes perpendicularly into the finished bank slope with a dead blow hammer, with buds oriented in an upward direction. Stakes should be tamped until approximately ¾ of the stake length is within the ground. The area around each live stake shall be compacted by foot after the live stake has been installed.

1"- 2" shall be cut cleanly off of the top of each live stake with loppers at an angle of approximately 15 degrees following installation. Any stakes that are split or damaged during installation shall be removed and replaced.

The bare root seedlings shall be planted as soon as practical following permanent *Seeding and Mulching*. The seedlings shall be planted from top of bank out, along both sides of the stream, as designated on the plans.

Root dip: The roots of reforestation seedlings shall be coated with a slurry of water, and either a fine clay (kaolin) or a superabsorbent that is designated as a bare root dip. The type, mixture ratio, method of application, and the time of application shall be submitted to the Engineer for approval.

With the approval of the Engineer, seedlings may be coated before delivery to the job or at the time of planting, but at no time shall the roots of the seedlings be allowed to dry out. The roots shall be moistened immediately prior to planting.

Seasonal Limitations: Stream reforestation shall be planted from November 15 through March 15.

Measurement and Payment

Stream Reforestation will be measured and paid for as the actual number of acres of land measured along the surface of the ground, which has been acceptably planted in accordance with this section.

Payment will be made under:

Pay Item	**Pay Unit**
Stream Reforestation	Acre

APPENDIX G

STREAM QUALITY ASSESEMENT WORKSHEETS

Mitigation Site 2 USACE 2:1 Ratio

Stream CS56

USACE AID#_____ DWQ #_____ Site # SAD (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCDOT

2. Evaluator's name: Atkins / O'Loughlin

3. Date of evaluation: June 11 2012

4. Time of evaluation: 1:10P

5. Name of stream: UT to South Buffalo Creek

6. River basin: Cape Fear 16-11-14-1

7. Approximate drainage area: 110 acres

8. Stream order: 2

9. Length of reach evaluated: 50 feet

10. County: Guilford

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any): N/A

Latitude (ex. 34.872312): 36.10309 Longitude (ex. –77.556611): -79.69732

Method location determined (circle): (GPS) Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): South of Huffine Mill Road and East of Flemingfield Road

14. Proposed channel work (if any): Highway construction

15. Recent weather conditions: Sunny, warm

16. Site conditions at time of visit: Moderate Flow

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters X Nutrient Sensitive Waters ___Water Supply Watershed ___(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES (NO) If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? (YES) NO

20. Does channel appear on USDA Soil Survey? (YES) NO

21. Estimated watershed land use: 35 % Residential ___% Commercial ___% Industrial 15 % Agricultural 50 % Forested ___% Cleared / Logged ___% Other (_____)

22. Bankfull width: 8 feet

23. Bank height (from bed to top of bank): 2 feet

24. Channel slope down center of stream: ___Flat (0 to 2%) X Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ___Straight X Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 59

Comments: Substrate silt, sand, cobble; velocity moderate; clarity turbid

Evaluator's Signature Dave Coughlin **Date** 06/29/12

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	3
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	3
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	3
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	3
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	3
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	3
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	3
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	3
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	3
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	2
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	3
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	4
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	3
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	3
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	1
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	4
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				59

* These characteristics are not assessed in coastal streams.

Mitigation Site 4 USACE 2:1 Ratio

Stream AX01 / CS42

USACE AID#_____ DWQ #_____ Site # SQ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCDOT

2. Evaluator's name: Atkins / O'Loughlin

3. Date of evaluation: May 9, 2012

4. Time of evaluation: 4:35P

5. Name of stream: UT to North Buffalo Creek

6. River basin: Cape Fear 16-11-14-1

7. Approximate drainage area: 318 acres

8. Stream order: 2

9. Length of reach evaluated: 50 feet

10. County: Guilford

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any): N/A

Latitude (ex. 34.872312): 36.13854 Longitude (ex. –77.556611): -79.71996

Method location determined (circle): (GPS) Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): North of Briarmeade Road

14. Proposed channel work (if any): Highway construction

15. Recent weather conditions: Sunny, warm

16. Site conditions at time of visit: Slow Flow

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters X Nutrient Sensitive Waters ___Water Supply Watershed ___(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? (YES) NO If yes, estimate the water surface area: 5 ponds 4.8 ac

19. Does channel appear on USGS quad map? (YES) NO

20. Does channel appear on USDA Soil Survey? (YES) NO

21. Estimated watershed land use: 45 % Residential ___% Commercial 15 % Industrial 10 % Agricultural 30 % Forested ___% Cleared / Logged ___% Other (_____)

22. Bankfull width: 7 feet

23. Bank height (from bed to top of bank): 4 feet

24. Channel slope down center of stream: ___Flat (0 to 2%) X Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ___Straight ___Occasional bends X Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 52 **Comments:** Substrate silt, sand; velocity slow; clarity turbid

Evaluator's Signature ____ **Date** 06/28/12

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	0
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	1
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	2
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	4
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	3
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	2
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	3
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	3
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	2
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	3
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	3
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	1
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				52

* These characteristics are not assessed in coastal streams.

Mitigation Site 5 USACE 2:1 Ratio

Stream AR01 / CS38

USACE AID#_____ DWQ #_____ Site # SL (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCDOT

2. Evaluator's name: Atkins / O'Loughlin

3. Date of evaluation: May 9, 2012

4. Time of evaluation: 2:45P

5. Name of stream: UT to North Buffalo Creek

6. River basin: Cape Fear 16-11-14-1

7. Approximate drainage area: 319 acres

8. Stream order: 3

9. Length of reach evaluated: 50 feet

10. County: Guilford

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any): N/A

Latitude (ex. 34.872312): 36.14196 Longitude (ex. –77.556611): -79.72825

Method location determined (circle): (GPS) Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): North of White Rock Road

14. Proposed channel work (if any): Highway construction

15. Recent weather conditions: Sunny, warm

16. Site conditions at time of visit: Moderate Flow

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters X Nutrient Sensitive Waters ___Water Supply Watershed ___(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? (YES) NO If yes, estimate the water surface area: 0.6 acre

19. Does channel appear on USGS quad map? (YES) NO

20. Does channel appear on USDA Soil Survey? (YES) NO

21. Estimated watershed land use: 25 % Residential ___% Commercial ___% Industrial ___% Agricultural 55 % Forested 20 % Cleared / Logged ___% Other (_____)

22. Bankfull width: 8 feet

23. Bank height (from bed to top of bank): 4 feet

24. Channel slope down center of stream: X Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ___Straight ___Occasional bends X Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 57 **Comments:** Substrate silt, boulder; velocity fast; clarity turbid

Evaluator's Signature _____ **Date** 06/28/12

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

SL

STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	4
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	1
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	3
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	2
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	3
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	3
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	3
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	3
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	3
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	3
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	3
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	3
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	1
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				57

* These characteristics are not assessed in coastal streams.

APPENDIX H

PHOTOGRAPHS

Site 2

Site 2

Site 2

Site 2

Site 4

Site 4

Site 4

Site 4

Site 5

Site 5

Site 5

Site 5

TIP PROJECT: U-2525B

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

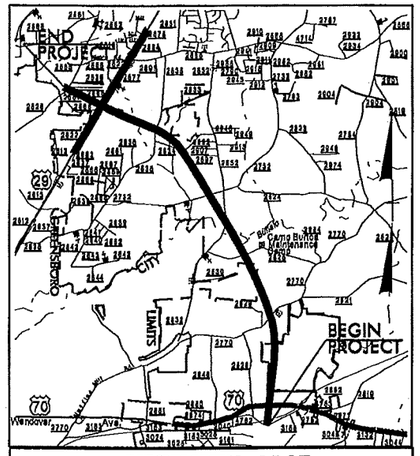
STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	U-2525B	OSM-1	30

STATE PROJ. NO.	F.A. PROJ. NO.	DESCRIPTION
34821.1.3		PE
34821.2.3		ROW
34821.3.6		CONST.

PLAN FOR ON-SITE MITIGATION GUILFORD COUNTY

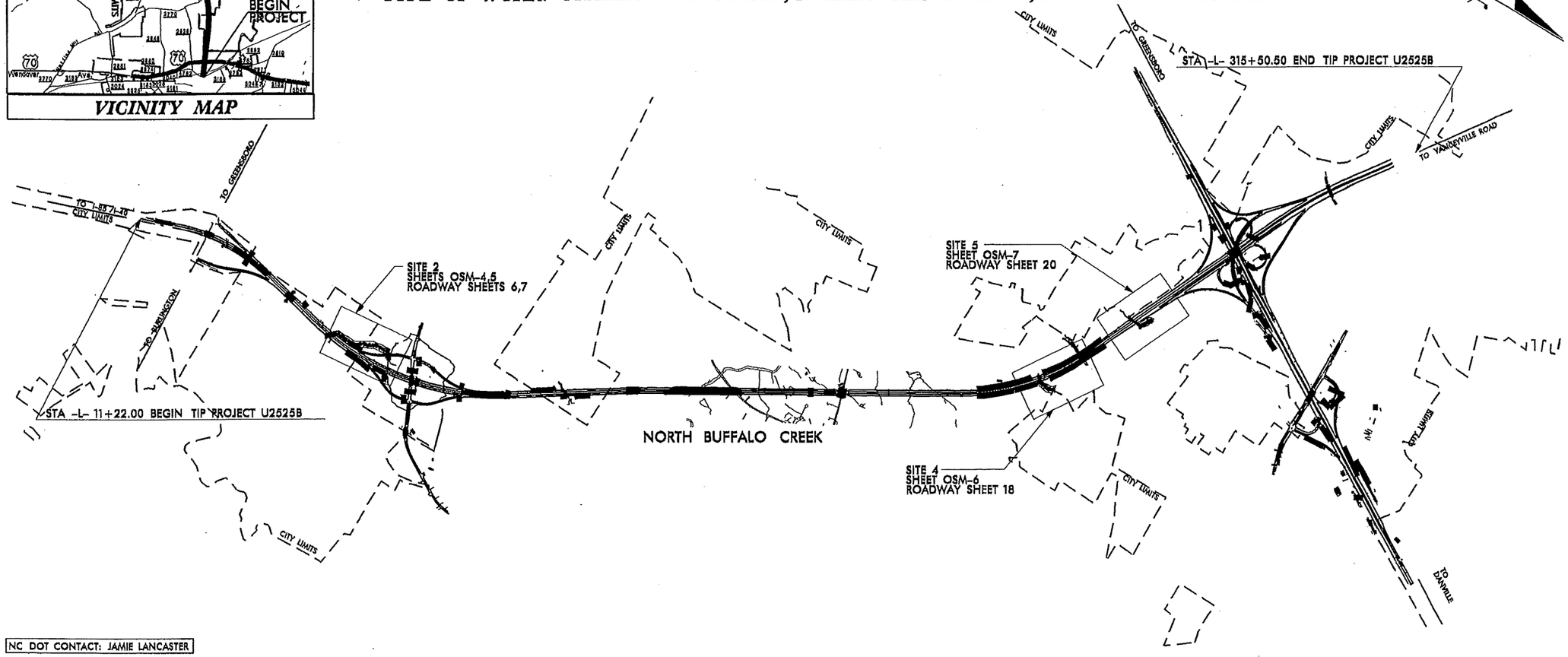
LOCATION: GREENSBORO EASTERN LOOP FROM NORTH OF US 70 TO US 29 NORTH OF GREENSBORO

TYPE OF WORK: STREAM RELOCATION, STREAM RESTORATION, STREAM ENHANCEMENT



VICINITY MAP

NAD 83



NC DOT CONTACT: JAMIE LANCASTER

GRAPHIC SCALES

30 15 0 30 60
PLANS

30 15 0 30 60
PROFILE (HORIZONTAL)

6 3 0 6 12
PROFILE (VERTICAL)

DESIGN DATA

PROJECT LENGTH

MITIGATION SITE	MITIGATION TYPE	LENGTH
SITE 2	RESTORATION/RELOCATION	1,307LF
SITE 4	RESTORATION	386LF
SITE 5	RELOCATION	362LF

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 – RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050
NC License F-0102

2012 STANDARD SPECIFICATIONS

DESIGN ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DAREN M. PAYT

SIGNATURE: P.E.

GENERAL NOTES

ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH THE FOLLOWING STANDARDS:

A) NORTH CAROLINA DEPARTMENT OF TRANSPORTATION 'STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES, DATED JANUARY 2012, AND ANY SUPPLEMENTS THERETO ISSUED PRIOR TO THE DATE OF RECEIPT OF BIDS.

B) NORTH CAROLINA DEPARTMENT OF TRANSPORTATION 'ROADWAY STANDARD DRAWINGS, ENGLISH' DATED JANUARY 2012, AND ANY SUPPLEMENTS ISSUED THERETO PRIOR TO THE DATE OF RECEIPT OF BIDS.

ALL RIGHT OF WAY CORNER MARKERS OR FENCING SHALL BE PLACED BY OTHERS AS NECESSARY.

THE CONTRACTOR IS RESPONSIBLE FOR AVOIDING ANY DISTURBANCE OR DAMAGE TO EXISTING UTILITIES AND SHALL BE RESPONSIBLE FOR IMMEDIATELY REPAIRING ANY DAMAGES AT A COST INCIDENT TO THIS CONTRACT.

ABANDONED SECTIONS OF THE EXISTING CHANNEL SHALL BE FILLED TO THE MAXIMUM EXTENT FEASIBLE WITH MATERIAL EXCAVATED ON-SITE. THIS EXCAVATED MATERIAL SHALL BE STOCKPILED ADJACENT TO THE REACHES OF CHANNEL OR DITCHES TO BE BACKFILLED.

THE CONTRACTOR MAY UTILIZE THE DESIGNATED STAGING AREA AND THE AREA INSIDE THE PROPOSED RIGHT OF WAY FOR STAGING AND STOCKPILING EQUIPMENT AND MATERIALS.

THE STREAM SHALL BE CONSTRUCTED IN ACCORDANCE TO THE TYPICAL SECTIONS.

SUBSURFACE PLANS: NO SUBSURFACE PLANS ARE AVAILABLE ON THE PROJECT. THE CONTRACTOR SHOULD MAKE HIS OWN INVESTIGATION AS TO THE SUBSURFACE CONDITIONS.

ROADWAY STANDARD DRAWINGS

(REV. JANUARY 2012)

THE FOLLOWING ROADWAY STANDARDS AS APPEAR IN 'ROADWAY STANDARD DRAWINGS' - ROADWAY DESIGN UNIT - N.C. DEPARTMENT OF TRANSPORTATION - RALEIGH, N.C., DATED JANUARY 2012 AND THE LATEST REVISION THERETO ARE APPLICABLE TO THIS PROJECT AND BY REFERENCE HEREBY ARE CONSIDERED A PART OF THESE PLANS:

CONSTRUCTION SEQUENCING

THIS STREAM MITIGATION PROJECT CONSISTS OF THREE SITES. ONCE WORK BEGINS ON A STREAM SITE, THE CONTRACTOR MUST COMPLETE THAT SITE BEFORE MOVING WORK CREWS AND EQUIPMENT TO A DIFFERENT SITE, UNLESS APPROVED TO DO SO BY THE ENGINEER.

LAYOUT LOCATION OF THE NEW STREAM CHANNEL, CONSTRUCTION EASEMENT LIMITS, AND GRADE STAKES. THE ENGINEER MUST INSPECT AND APPROVE ALL LAYOUT WORK BEFORE CONSTRUCTION MAY BEGIN.

MOBILIZE EQUIPMENT AND MATERIALS TO THE SITE.

INSTALL CONSTRUCTION ENTRANCE PER EROSION CONTROL PLAN.

ESTABLISH STAGING AREAS AND MARK CONSTRUCTION EQUIPMENT ACCESS LOCATIONS WITH VISIBLE MARKERS. CONSTRUCTION EQUIPMENT SHALL BE CONTAINED WITHIN THE LIMITS OF CONSTRUCTION AS DEPICTED IN THE PLANS OR SPECIFIED BY THE ENGINEER.

INSTALL TEMPORARY EROSION CONTROL MEASURES.

BEGIN FLOODPLAIN GRADING, INCLUDING EXCAVATION OF BANKFULL BENCHES AT LOCATIONS DEPICTED IN THE PLANS AND AS DIRECTED BY THE ENGINEER. STOCKPILE MATERIALS IN AREAS DESIGNATED ON THE PLANS. KEEP TOPSOIL SEPARATE FROM OTHER STOCKPILE MATERIAL. TOPSOIL MATERIAL WILL BE USED LATER ON FLOODPLAIN.

TOPSOIL SHALL BE EXCAVATED AND STOCKPILED SEPARATELY FROM THE WASTE MATERIAL SO THAT IT CAN BE PLACED BACK ON THE FLOODPLAIN ONCE GRADING IS COMPLETE. NO DIRECT PAYMENT WILL BE MADE FOR THIS EXCAVATION. OVER-EXCAVATE FLOODPLAIN AND FLOODPLAIN SLOPES TO A DEPTH OF 6" BELOW FINAL GRADE AND PLACE 6" OF TOPSOIL TO FILL TO FINAL GRADE. OVER-EXCAVATION SHOULD BEGIN 3' FROM TOP OF BANK AND EXTEND TO EXCAVATION LIMITS. SEE TYPICAL SECTIONS FOR DETAIL.
INSTALL IMPERVIOUS DIKES AND PUMP AROUND SYSTEM TO PUMP STREAM DISCHARGE AROUND THE IMMEDIATE WORK AREA AS NECESSARY.

CONSTRUCTION SHALL PROCEED IN SUCCESSIVE REACHES WITH THE UPSTREAM REACH BEING COMPLETED PRIOR TO INITIATING CONSTRUCTION OF THE ADJACENT DOWNSTREAM REACH. EACH REACH SHALL BE LIMITED IN LENGTH TO WORK THAT CAN BE COMPLETED BEFORE ALLOWING WATER TO FLOW THROUGH THAT REACH. COMPLETION OF A REACH SHALL CONSIST OF CHANNEL CONSTRUCTION, FLOODPLAIN GRADING, IN-STREAM STRUCTURE INSTALLATION, BED MATERIAL INSTALLATION, AND EROSION CONTROL MEASURES. CONSTRUCTION SHALL BE DONE IN THE DRY, WITH THE CHANNEL FLOW PUMPED AROUND THE REACH UNDER CONSTRUCTION AS NECESSARY.

AT THE END OF EACH DAY'S CONSTRUCTION WORK, THE CONTRACTOR SHALL SEED ALL DISTURBED AREAS AND COVER THE STREAM BANKS AND BANKFULL BENCHES WITH COIR FIBER MATTING. IN ADDITION, THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ALL TEMPORARY EROSION CONTROL MEASURES ON A DAILY BASIS THROUGHOUT THE CONSTRUCTION PROCESS.

ONCE NEW CHANNEL CONSTRUCTION IS COMPLETE, THE CONTRACTOR SHALL INSTALL STREAM PLUGS TO DIRECT STREAM FLOW INTO THE NEW CHANNEL. THE CONTRACTOR SHALL THEN FILL IN THE ABANDONED SECTIONS OF THE EXISTING CHANNEL TO THE EXTENT FEASIBLE AND AS DIRECTED BY THE ENGINEER. CONTRACTOR WILL ENSURE THAT VEGETATION HAS BEEN ESTABLISHED ALONG THE BANKS OF THE NEW STREAM CHANNEL BEFORE DIRECTING FLOW INTO THE NEW STREAM CHANNEL. FOR NEW STREAM CHANNEL REACHES WHERE THIS IS NOT POSSIBLE, THE CONTRACTOR SHOULD GET APPROVAL FROM THE ENGINEER BEFORE DIRECTING FLOW INTO THE NEW STREAM CHANNEL.

AFTER ALL IN-STREAM WORK IS COMPLETED, THE CONTRACTOR SHALL REMOVE TEMPORARY EROSION CONTROL MEASURES AND TEMPORARY STREAM ACCESS AND SCARIFY ANY COMPACTED AREAS AS DIRECTED BY THE ENGINEER. ALL PORTIONS OF THE SITE SHALL BE STABILIZED WITH TEMPORARY EROSION CONTROL MEASURES.

PREPARED IN THE OFFICE OF:

Kimley-Horn and Associates, Inc.

P.O. BOX 33068 – RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050
NC LICENSE F-0102

PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-1A

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DARREN M. PAIT

APPROVED BY:

DATE:

U-2525B
ON-SITE MITIGATION
GUILFORD COUNTY

INDEX OF SHEETS

OSM-1	TITLE SHEET
OSM-1A	INDEX OF SHEETS, CONSTRUCTION SEQUENCING, GENERAL NOTES
OSM-1B	CONVENTIONAL PLAN SHEET SYMBOLS
OSM-2	TYPICAL SECTIONS
OSM-2A	DETAILS -COIR FIBER MATTING -ROCK CROSS VANE -LOG CROSS VANE -STORMWATER STEP POOL PROTECTION STRUCTURE
OSM-2B	-ROCK A-VANE -CONSTRUCTED RIFFLE -ROOTWAD -BOULDER TOE PROTECTION
OSM-2C	-ROCK VANE -LOG VANE -STREAM PLUG
OSM-2D	-PUMP AROUND OPERATION
OSM-2E-2F	-MORPHOLOGICAL TABLES
OSM-3	SUMMARY OF QUANTITIES EARTHWORK SUMMARY
OSM-4-7	PLAN SHEETS
OSM-8-11	PROFILE SHEETS
OSM-12-22	CROSS SECTIONS

STREAM SYMBOLS

PLAN VIEW SYMBOLS

ROCK VANE

LOG VANE

LOG CROSS VANE

STORMWATER OUTLET STEP POOL

FP FP FLOODPLAIN LINE

BOULDER TOE PROTECTION

ROCK A-VANE

ROCK CROSS VANE

CONSTRUCTED RIFFLE

STREAM PLUG

BACKFILL EXISTING CHANNEL

PROFILE SYMBOLS

EXISTING GROUND ELEVATION

PROPOSED GROUND ELEVATION

PROPOSED BANKFULL

PROPOSED LOG SILL

PROPOSED LOG CROSS VANE

CONSTRUCTED RIFFLE

PROPOSED ROCK CROSS VANE

PROPOSED ROCK A-VANE

PROPOSED STEP POOL STRUCTURE

PLANTING SYMBOLS

TYPE I

TYPE II

PROJECT REFERENCE NO.	SHEET NO.
U-2525B	OSM-1B

Note: Not to Scale

**S.U.E. = Subsurface Utility Engineering*

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

CONVENTIONAL PLAN SHEET SYMBOLS

BOUNDARIES AND PROPERTY:

- State Line
- County Line
- Township Line
- City Line
- Reservation Line
- Property Line
- Existing Iron Pin — EIP
- Property Corner
- Property Monument — ECM
- Parcel/Sequence Number — 123
- Existing Fence Line
- Proposed Woven Wire Fence
- Proposed Chain Link Fence
- Proposed Barbed Wire Fence
- Existing Wetland Boundary — WLB
- Proposed Wetland Boundary — WLB
- Existing Endangered Animal Boundary — EAB
- Existing Endangered Plant Boundary — EPB

BUILDINGS AND OTHER CULTURE:

- Gas Pump Vent or U/G Tank Cap
- Sign — S
- Well — W
- Small Mine
- Foundation
- Area Outline
- Cemetery
- Building
- School
- Church
- Dam

HYDROLOGY:

- Stream or Body of Water
- Hydro, Pool or Reservoir
- Jurisdictional Stream — JS
- Buffer Zone 1 — BZ 1
- Buffer Zone 2 — BZ 2
- Flow Arrow
- Disappearing Stream
- Spring
- Wetland
- Proposed Lateral, Tail, Head Ditch — FLOW
- False Sump

RAILROADS:

- Standard Gauge — CSX TRANSPORTATION
- RR Signal Milepost — MILEPOST 35
- Switch — SWITCH
- RR Abandoned
- RR Dismantled

RIGHT OF WAY:

- Baseline Control Point
- Existing Right of Way Marker
- Existing Right of Way Line
- Proposed Right of Way Line — RW
- Proposed Right of Way Line with Iron Pin and Cap Marker — RW
- Proposed Right of Way Line with Concrete or Granite Marker — RW
- Existing Control of Access — CA
- Proposed Control of Access — CA
- Existing Easement Line — E
- Proposed Temporary Construction Easement — E
- Proposed Temporary Drainage Easement — TDE
- Proposed Permanent Drainage Easement — PDE
- Proposed Permanent Utility Easement — PUE

ROADS AND RELATED FEATURES:

- Existing Edge of Pavement
- Existing Curb
- Proposed Slope Stakes Cut — C
- Proposed Slope Stakes Fill — F
- Proposed Wheel Chair Ramp — WCR
- Existing Metal Guardrail
- Proposed Guardrail
- Existing Cable Guiderail
- Proposed Cable Guiderail
- Equality Symbol
- Pavement Removal

VEGETATION:

- Single Tree
- Single Shrub
- Hedge
- Woods Line
- Orchard
- Vineyard — Vineyard

EXISTING STRUCTURES:

MAJOR:

- Bridge, Tunnel or Box Culvert — CONC
- Bridge Wing Wall, Head Wall and End Wall — CONC WW

MINOR:

- Head and End Wall — CONC HW
- Pipe Culvert
- Footbridge
- Drainage Box: Catch Basin, DI or JB — CB
- Paved Ditch Gutter
- Storm Sewer Manhole — S
- Storm Sewer — S

UTILITIES:

POWER:

- Existing Power Pole
- Proposed Power Pole
- Existing Joint Use Pole
- Proposed Joint Use Pole
- Power Manhole — P
- Power Line Tower
- Power Transformer
- U/G Power Cable Hand Hole — HH
- H-Frame Pole
- Recorded U/G Power Line — P
- Designated U/G Power Line (S.U.E.*) — P

TELEPHONE:

- Existing Telephone Pole
- Proposed Telephone Pole
- Telephone Manhole — T
- Telephone Booth
- Telephone Pedestal — T
- Telephone Cell Tower
- U/G Telephone Cable Hand Hole — HH
- Recorded U/G Telephone Cable — T
- Designated U/G Telephone Cable (S.U.E.*) — T
- Recorded U/G Telephone Conduit — TC
- Designated U/G Telephone Conduit (S.U.E.*) — TC
- Recorded U/G Fiber Optics Cable — T FO
- Designated U/G Fiber Optics Cable (S.U.E.*) — T FO

WATER:

- Water Manhole — W
- Water Meter
- Water Valve
- Water Hydrant
- Recorded U/G Water Line — W
- Designated U/G Water Line (S.U.E.*) — W
- Above Ground Water Line — A/G Water

TV:

- TV Satellite Dish
- TV Pedestal — C
- TV Tower
- U/G TV Cable Hand Hole — HH
- Recorded U/G TV Cable — TV
- Designated U/G TV Cable (S.U.E.*) — TV
- Recorded U/G Fiber Optic Cable — TV FO
- Designated U/G Fiber Optic Cable (S.U.E.*) — TV FO

GAS:

- Gas Valve
- Gas Meter
- Recorded U/G Gas Line — G
- Designated U/G Gas Line (S.U.E.*) — G
- Above Ground Gas Line — A/G Gas

SANITARY SEWER:

- Sanitary Sewer Manhole
- Sanitary Sewer Cleanout
- U/G Sanitary Sewer Line — SS
- Above Ground Sanitary Sewer — A/G Sanitary Sewer
- Recorded SS Forced Main Line — FSS
- Designated SS Forced Main Line (S.U.E.*) — FSS

MISCELLANEOUS:

- Utility Pole
- Utility Pole with Base
- Utility Located Object
- Utility Traffic Signal Box — S
- Utility Unknown U/G Line — ?UTL
- U/G Tank; Water, Gas, Oil
- A/G Tank; Water, Gas, Oil
- U/G Test Hole (S.U.E.*)
- Abandoned According to Utility Records — AATUR
- End of Information — E.O.I.

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PHONE: (919) 677-2000 FAX: (919) 677-2050
NC LICENSE F-0102

PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-2

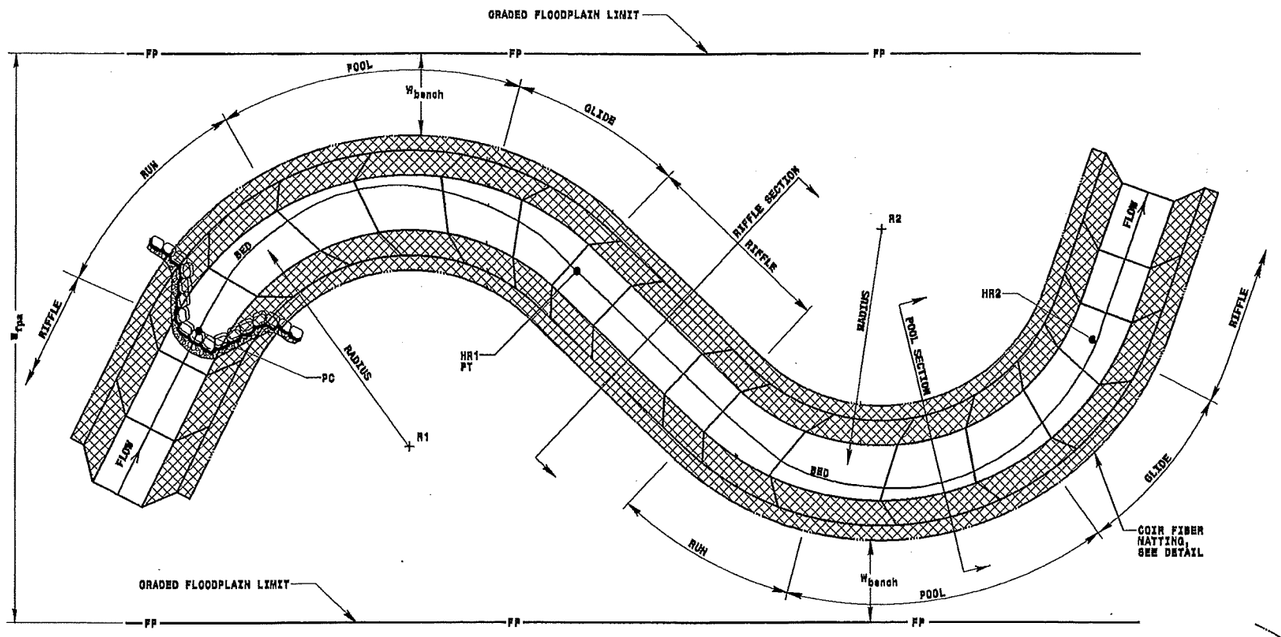
PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DAREN M. PAIT

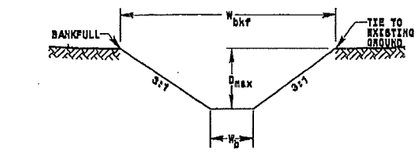
APPROVED BY:

DATE:

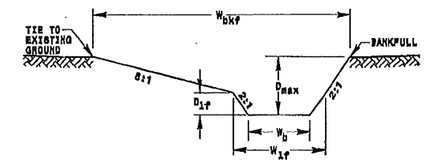
U-2525B ON-SITE MITIGATION GUILFORD COUNTY



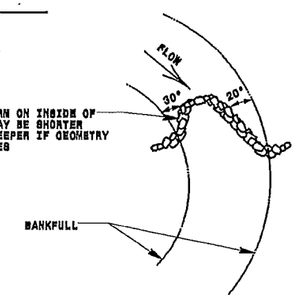
TYPICAL PLAN



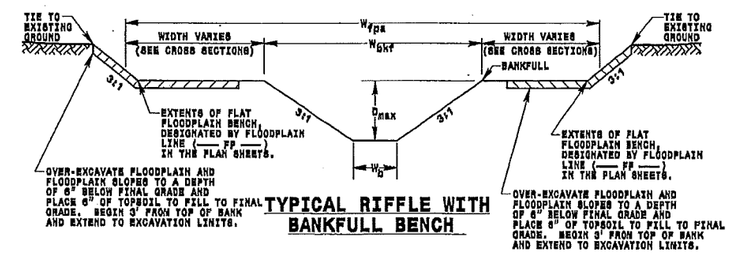
TYPICAL RIFFLE



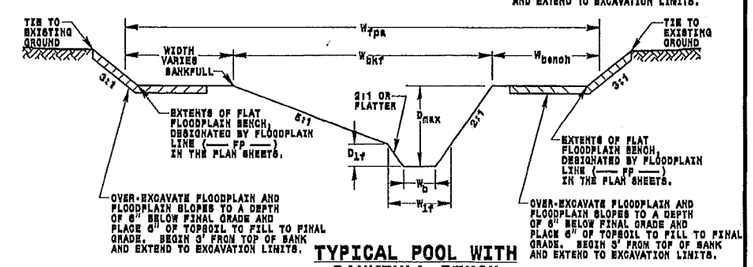
TYPICAL POOL



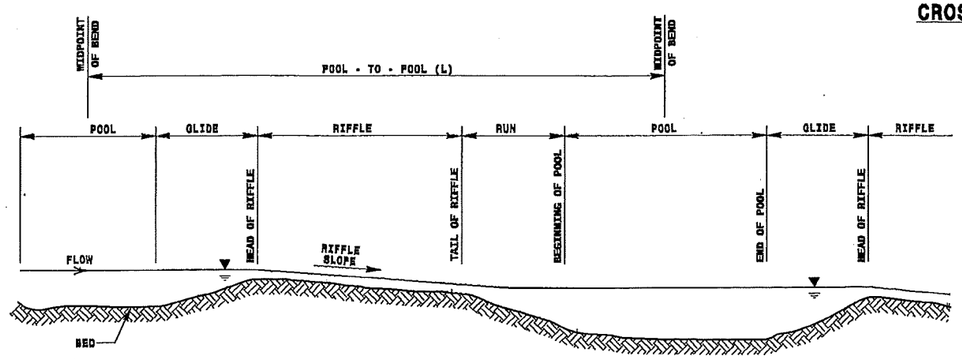
CROSS VANE CONSTRUCTION IN MEANDER-BEND PLAN VIEW



TYPICAL RIFFLE WITH BANKFULL BENCH



TYPICAL POOL WITH BANKFULL BENCH



TYPICAL PROFILE

NOTES:
1. THE COORDINATES FOR EACH CENTER OF RADIUS (EX. "R1", "R2") AND EACH HEAD OF RIFFLE (EX. "HR1", "HR2") ARE INDICATED ON THE PLAN SHEETS.

W_{bkf} = BANKFULL WIDTH
D_{max} = MAXIMUM DEPTH
W_b = BOTTOM WIDTH
W_{fpa} = FLOOD PRONE AREA WIDTH
W_{lf} = LOW FLOW WIDTH
D_{lf} = LOW FLOW DEPTH

CROSS-SECTION DIMENSIONS (IN FEET)

		RIFFLE				POOL							
SITE	REACH	W_{bkf}	D_{max}	W_b	W_{fpa}	W_{bkf}	W_{lf}	D_{lf}	D_{max}	W_b	W_{fpa}	W_{bench}	Width/Depth Ratio
SITE 2	Sta. 200+00 - Sta. 205+00	7.2	0.8	2.4	SEE CROSS SECTIONS	9.8	3.4	0.6	1.4	1.0	SEE CROSS SECTIONS	3.5 MIN.	13.5
SITE 2	Sta. 205+00 - Sta. 213+07	7.8	0.8	2.8	SEE CROSS SECTIONS	10.2	3.6	0.7	1.8	1.0	SEE CROSS SECTIONS	3.5 MIN.	13.9
SITE 4	Sta. 400+00 - Sta. 403+85	12.7	1.4	4.3	SEE CROSS SECTIONS	16.8	4.6	0.9	2.8	1.0	SEE CROSS SECTIONS	6.0 MIN.	13.8
SITE 5	Sta. 500+00 - Sta. 503+22	13.7	1.4	5.3	SEE CROSS SECTIONS	17.0	5.8	1.2	2.8	1.4	SEE CROSS SECTIONS	6.5 MIN.	14.1

CHANNEL TYPICAL DETAIL

NOT TO SCALE

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
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PHONE: (919) 677-2000 FAX: (919) 677-2050
NC LICENSE F-0102

PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-2A

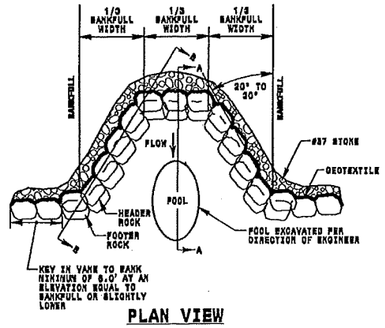
PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DARREN M. PAIT

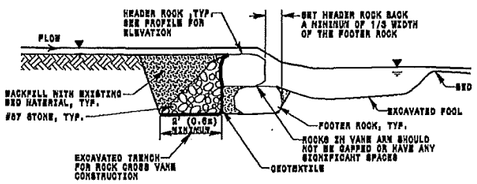
APPROVED BY:

DATE:

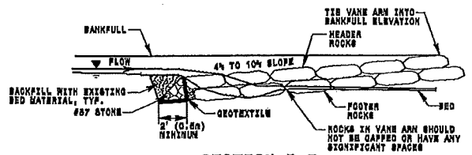
U-2525B ON-SITE MITIGATION GUILFORD COUNTY



PLAN VIEW



SECTION A-A



SECTION B-B

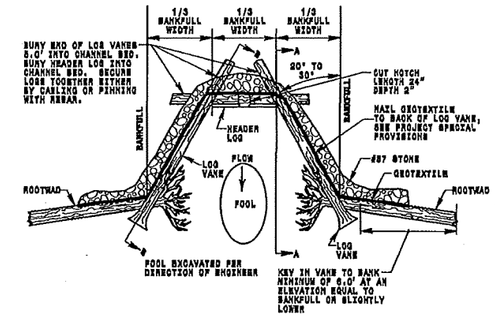
BOULDER SIZE DATA CHART			
REACH	BOULDER DIMENSIONS		
	HEIGHT	WIDTH	LENGTH
SITE 2 REACH 1	2'	3'	4'
SITE 2 REACH 2	2'	3'	4'
SITE 4	2'	3'	4'
SITE 5	2'	3'	4'

NOTE: THESE DIMENSIONS SPECIFY THE MINIMUM BOULDER SIZE

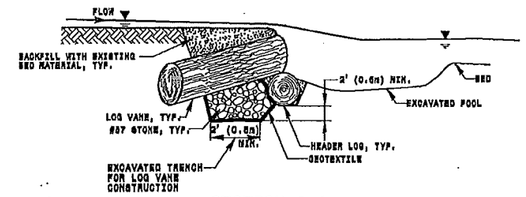
NOTES:
1. DEEPEST PART OF POOL TO BE IN LINE WITH WHERE VANE ARM TIES INTO BANKFULL.
2. DO NOT EXCAVATE POOL TOO CLOSE TO FOOTER BOULDERS.
3. CLASS "A" STONE CAN BE USED TO REDUCE VOIDS BETWEEN HEADERS AND FOOTERS.
4. COMPACT BACKFILL TO EXTENT POSSIBLE OR AT THE DIRECTION OF THE ENGINEER.
5. POOL DEPTH SHOULD BE 2 TO 3 TIMES BANKFULL DEPTH.

ROCK CROSS VANE DETAIL

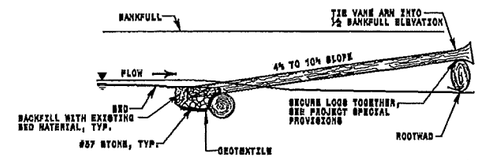
NOT TO SCALE



PLAN VIEW



SECTION A-A

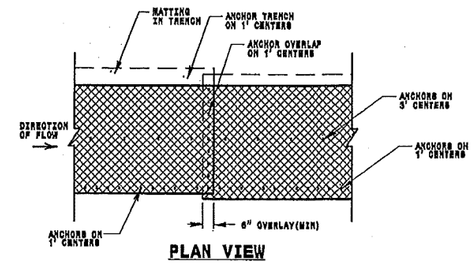


SECTION B-B

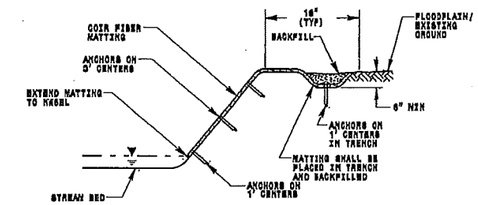
NOTES:
1. DEEPEST PART OF POOL TO BE IN LINE WITH WHERE VANE ARM TIES INTO BANKFULL.
2. DO NOT EXCAVATE POOL TOO CLOSE TO FOOTER BOULDERS.
3. CLASS "A" STONE CAN BE USED TO REDUCE VOIDS BETWEEN HEADERS AND FOOTERS.
4. COMPACT BACKFILL TO EXTENT POSSIBLE OR AT THE DIRECTION OF THE ENGINEER.
5. POOL DEPTH SHOULD BE 2 TO 3 TIMES BANKFULL DEPTH.

LOG CROSS VANE DETAIL

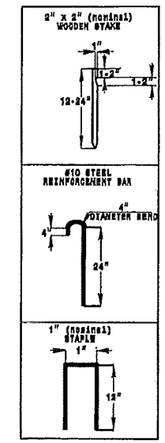
NOT TO SCALE



PLAN VIEW



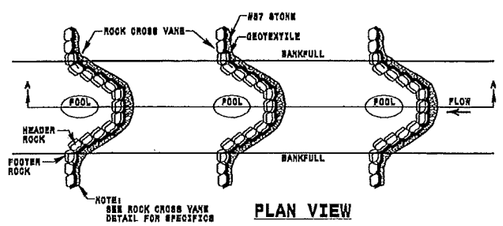
TYPICAL CROSS SECTION



ANCHOR OPTIONS

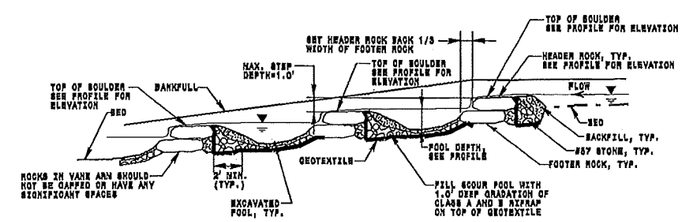
COIR FIBER MATTING DETAIL

NOT TO SCALE



PLAN VIEW

NOTES:
1. STEPS TO BE SHORT, FREQUENT, AND CLOSELY SPACED.
2. POOL SPACING SHALL BE INVERSELY PROPORTIONAL TO STREAM SLOPE. SEE CHANNEL PROFILE FOR SPACING AND ELEVATIONS
3. ADEQUATE NUMBER OF FOOTER BOULDERS TO BE USED IN ORDER TO HOLD UP THE BOULDERS AT HEAD OF STEPS DURING HIGH ENERGY/HIGH FLOW EVENTS.
4. MINIMUM BOULDER SIZE=30"



SECTION A-A

STORMWATER STEP POOL PROTECTION STRUCTURE

NOT TO SCALE

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
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PHONE: (919) 677-2000 FAX: (919) 677-2050
NC LICENSE F-0102

PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-2B

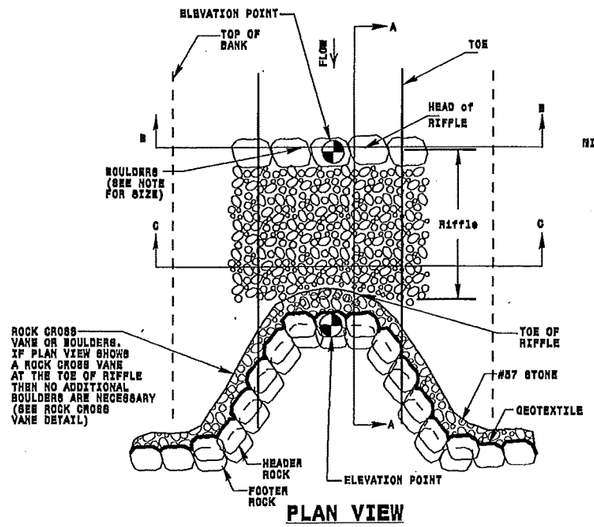
PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DARREN M. PATT

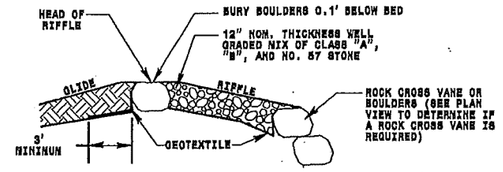
APPROVED BY:

DATE:

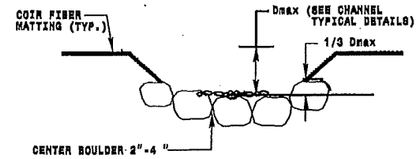
U-2525B ON-SITE MITIGATION GUILFORD COUNTY



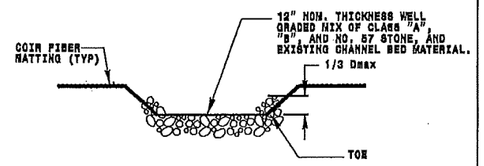
PLAN VIEW



SECTION A-A



SECTION B-B

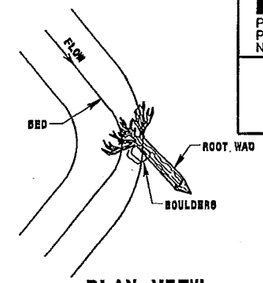


SECTION C-C

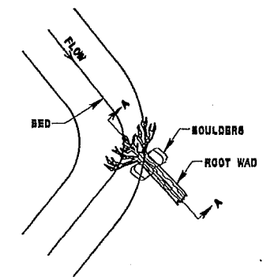
NOTE:
1. BOULDERS SHOULD BE NATIVE STONES OR SHOT ROCK, ANGULAR AND OBLONG, WITH AN AXIS APPROXIMATELY 4'Lx3'Wx2'D
2. NOT ALL CONSTRUCTED RIFFLES REQUIRE A ROCK CROSS VANE ON THE TOE OF RIFFLE.
3. IF NO ROCK CROSS VANE IS PROPOSED AT THE TOE OF RIFFLE, INSTALL BOULDERS AT THE TOE OF RIFFLE TO SECURE CONSTRUCTED RIFFLE MATERIAL.

CONSTRUCTED RIFFLE DETAIL

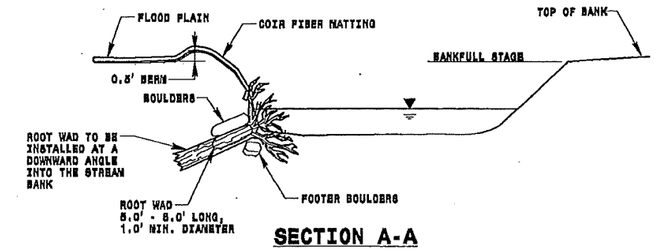
NOT TO SCALE



PLAN VIEW
DRIVE POINT METHOD



PLAN VIEW
TRENCHING METHOD



SECTION A-A

NOTES:

ORIENT ROOT WADS SO THAT THE STREAM FLOW MEETS THE ROOT WAD STRAIGHT ON, DEFLECTING THE WATER AWAY FROM THE BANK.

METHODS OF INSTALLATION:

DRIVE POINT METHOD:

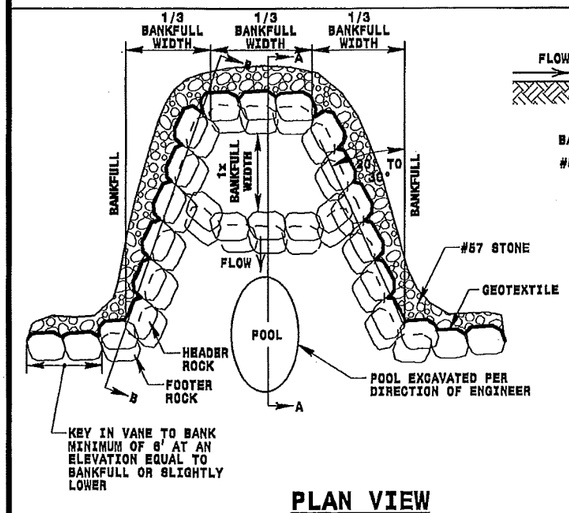
SHARPEN THE END OF THE LOG BEFORE "DRIVING" AT A DOWNWARD ANGLE INTO THE BANK. BOULDER SHOULD BE PLACED ON EACH SIDE OF THE ROOT WAD TO PIN IT IN PLACE. THE BOULDERS SHALL BE APPROXIMATELY 2' X 3' X 4'. ONE-THIRD OF THE ROOT WAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS.

TRENCHING METHOD:

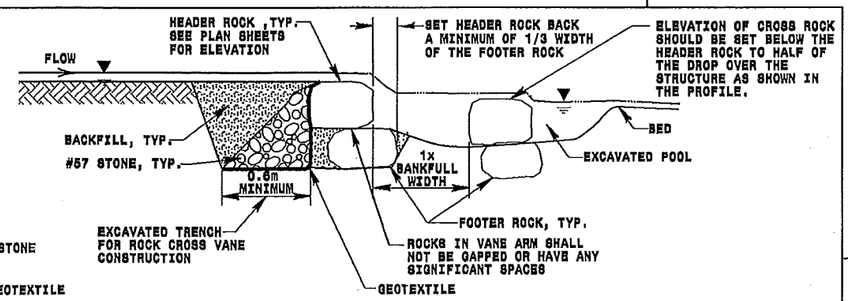
IF THE ROOT WAD CANNOT BE DRIVEN INTO THE BANK OR THE BANK NEEDS TO BE RECONSTRUCTED, THE TRENCHING METHOD SHOULD BE USED. THIS METHOD REQUIRES THAT A TRENCH BE EXCAVATED FOR THE LOG PORTION OF THE ROOT WAD. IN THIS CASE, FOOTER BOULDERS SHOULD BE INSTALLED UNDERNEATH THE ROOT WAD IN A TRENCH EXCAVATED PARALLEL TO THE BANK AND WELL BELOW THE STREAM BED. BOULDERS SHOULD BE PLACED ON EACH SIDE OF THE ROOTWAD TO PIN IT IN PLACE. THE BOULDERS SHOULD BE APPROXIMATELY 2' X 3' X 4'. ONE-THIRD OF THE ROOT WAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS.

ROOT WAD DETAIL

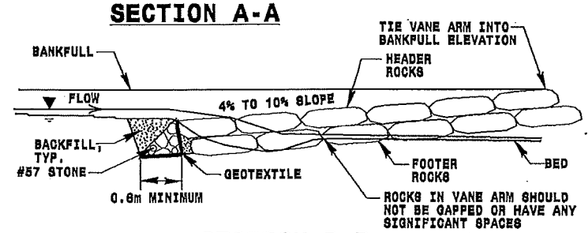
NOT TO SCALE



PLAN VIEW



SECTION A-A



SECTION B-B

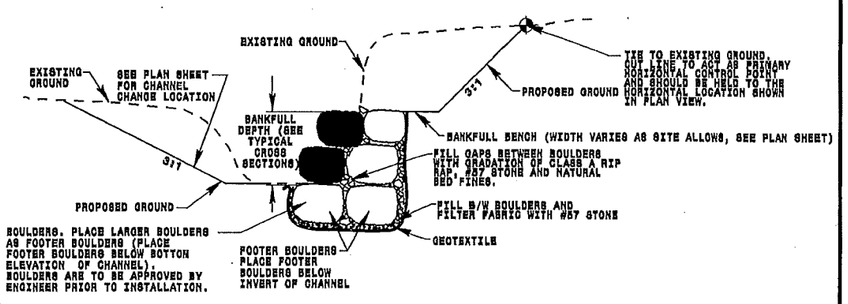
BOULDER SIZE DATA CHART			
REACH	BOULDER DIMENSIONS		
	HEIGHT	WIDTH	LENGTH
SITE 2 REACH 1	2'	3'	4'
SITE 2 REACH 2	2'	3'	4'
SITE 4	2'	3'	4'
SITE 5	2'	3'	4'

NOTE: THESE DIMENSIONS SPECIFY THE MINIMUM BOULDER SIZE

NOTES:
1. DEEPEST PART OF POOL TO BE IN LINE WITH WHERE VANE ARM TIES INTO BANKFULL.
2. DO NOT EXCAVATE POOL TOO CLOSE TO FOOTER BOULDERS.
3. CLASS "A" STONE CAN BE USED TO REDUCE VOIDS BETWEEN HEADERS AND FOOTERS.
4. COMPACT BANKFULL TO EXTENT POSSIBLE OR AT THE DIRECTION OF THE ENGINEER.
5. POOL DEPTH SHOULD BE 2 TO 3 TIMES BANKFULL DEPTH.

ROCK A VANE DETAIL

NOT TO SCALE



BOULDER TOE PROTECTION

NOT TO SCALE

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 – RALEIGH, NORTH CAROLINA 27636-3068
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NC LICENSE F-0102

PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-2C

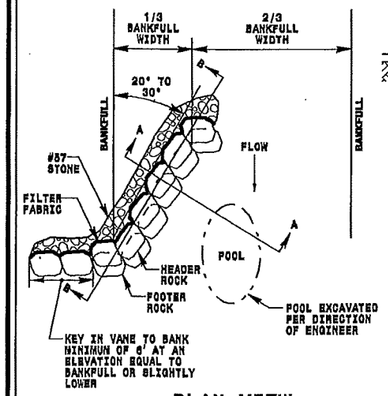
PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DARREN M. PAIT

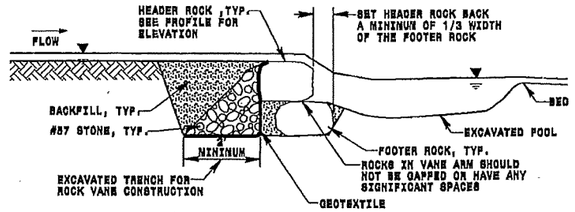
APPROVED BY:

DATE:

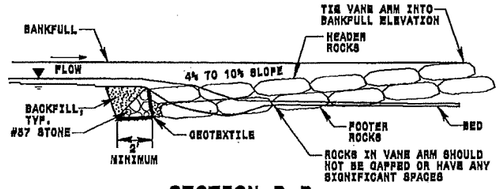
U-2525B ON-SITE MITIGATION GUILFORD COUNTY



PLAN VIEW



SECTION A-A



SECTION B-B

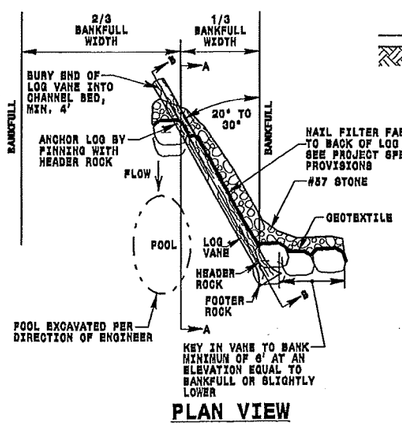
BOULDER SIZE DATA CHART			
REACH	BOULDER DIMENSIONS		
	HEIGHT	WIDTH	LENGTH
SITE 2 REACH 1	2'	3'	4'
SITE 2 REACH 2	2'	3'	4'
SITE 4	2'	3'	4'
SITE 5	2'	3'	4'

NOTE: THESE DIMENSIONS SPECIFY THE MINIMUM BOULDER SIZE

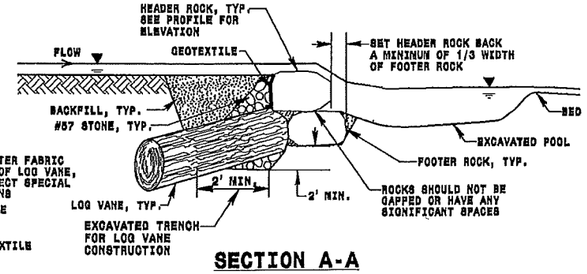
NOTES:
1. DEEPEST PART OF POOL TO BE IN LINE WITH WHERE VANE ARM TIES INTO BANKFULL.
2. DO NOT EXCAVATE POOL TOO CLOSE TO FOOTER BOULDERS.
3. CLASS "A" STONE CAN BE USED TO REDUCE VOIDS BETWEEN HEADERS AND FOOTERS.
4. COMPACT BACKFILL TO EXTENT POSSIBLE OR AT THE DIRECTION OF THE ENGINEER.
5. POOL DEPTH SHOULD BE 2 TO 3 TIMES BANKFULL DEPTH.

ROCK VANE DETAIL

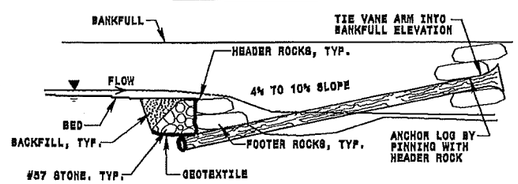
NOT TO SCALE



PLAN VIEW



SECTION A-A



SECTION B-B

BOULDER SIZE DATA CHART			
REACH	BOULDER DIMENSIONS		
	HEIGHT	WIDTH	LENGTH
SITE 2 REACH 1	2'	3'	4'
SITE 2 REACH 2	2'	3'	4'
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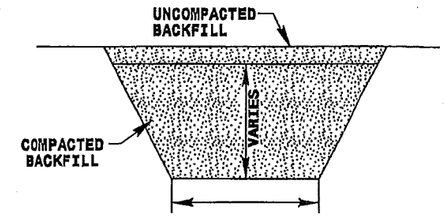
NOTE: THESE DIMENSIONS SPECIFY THE MINIMUM BOULDER SIZE

NOTES:
1. DEEPEST PART OF POOL TO BE IN LINE WITH WHERE VANE ARM TIES INTO BANKFULL.
2. DO NOT EXCAVATE POOL TOO CLOSE TO FOOTER BOULDERS.
3. CLASS "A" STONE CAN BE USED TO REDUCE VOIDS BETWEEN HEADERS AND FOOTERS.
4. COMPACT BACKFILL TO EXTENT POSSIBLE OR AT THE DIRECTION OF THE ENGINEER.
5. POOL DEPTH SHOULD BE 2 TO 3 TIMES BANKFULL DEPTH.

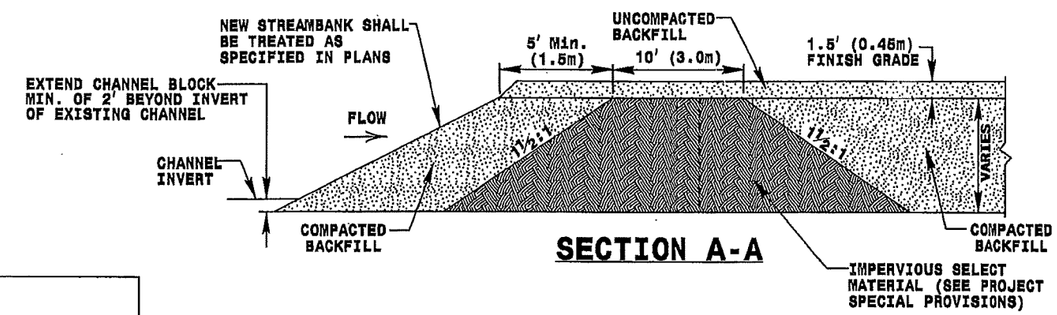
LOG VANE DETAIL

NOT TO SCALE

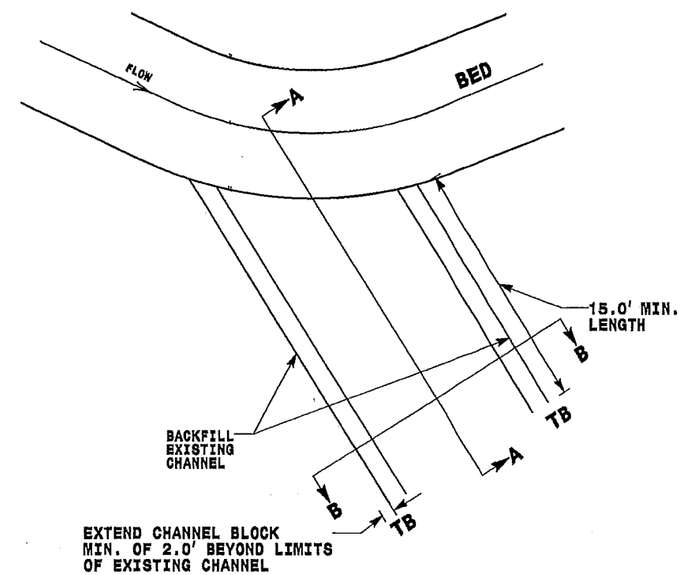
NOTES:
1) CHANNEL BLOCK SHALL BE INSTALLED IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS.
2) BLOCK SHOULD BE INSTALLED AT THE INTERFACE BETWEEN EXISTING CHANNEL AND PROPOSED CHANNEL.
3) BOTTOM OF BLOCK SHOULD BE A MINIMUM OF 2.0' BELOW THE INVERT OF THE EXISTING CHANNEL.
4) BLOCK SHOULD EXTEND A MINIMUM OF 2.0' BEYOND THE LIMITS OF THE EXISTING STREAM CHANNEL.
5) INSTALL EROSION CONTROL MATTING AND SEED IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS IMMEDIATELY AFTER GRADING.
6) COMPACT BACKFILL TO EXTENT POSSIBLE OR AT THE DIRECTION OF THE ENGINEER.



SECTION B-B



SECTION A-A



PLAN VIEW

STREAM PLUG

NOT TO SCALE

PREPARED IN THE OFFICE OF:
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PHONE: (919) 677-2000 FAX: (919) 677-2050
NC LICENSE F-0102

PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-2D

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DAREN M. PATT

APPROVED BY:

DATE:

U-2525B
ON-SITE MITIGATION
GUILFORD COUNTY

NOTES:
1) All excavation shall be performed in only dry or isolated sections of channel.
2) Impervious dikes are to be used to isolate work from stream flow when necessary.
3) All graded areas shall be stabilized within 24 hours.
4) Maintenance of stream flow operations shall be incidental to the work. This includes polyethylene sheeting, diversion pipes, pumps and hoses.
5) Pumps and hoses shall be of sufficient size to dewater the work area.

SEQUENCE OF CONSTRUCTION FOR PUMP AROUND OPERATION

1. INSTALL SPECIAL STILLING BASIN(S).

2. INSTALL UPSTREAM PUMP AND TEMPORARY FLEXIBLE HOSE.

3. PLACE UPSTREAM IMPERVIOUS DIKE AND BEGIN PUMPING OPERATIONS FOR STREAM DIVERSION.

4. PLACE DOWNSTREAM IMPERVIOUS DIKE AND PUMPING APPARATUS. DEWATER ENTRAPPED AREA. AREA TO BE DEWATERED SHALL BE EQUAL TO ONE DAY'S WORK.

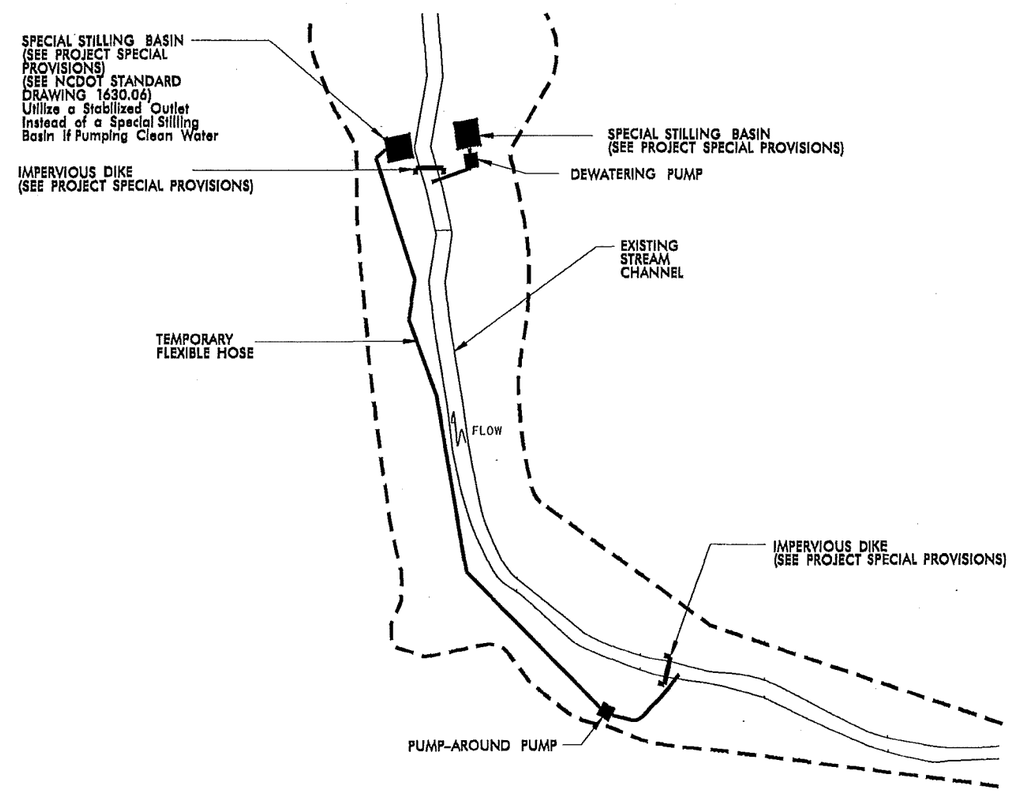
5. PERFORM STREAM RESTORATION WORK IN ACCORDANCE WITH THE PLANS.

6. EXCAVATE ANY ACCUMULATED SILT AND DEWATER BEFORE REMOVAL OF IMPERVIOUS DIKES. REMOVE IMPERVIOUS DIKES, PUMPS, AND TEMPORARY FLEXIBLE HOSE. (DOWNSTREAM IMPERVIOUS DIKES FIRST).

7. ALL GRADING AND STABILIZATION MUST BE COMPLETED IN ONE DAY WITHIN THE PUMP AROUND AREAS BETWEEN THE IMPERVIOUS DIKES. THE IMPERVIOUS DIKE LOCATIONS AS SHOWN ON THIS SHEET ONLY SHOW THE UPPER AND LOWER EXTENT OF WORK FOR EACH STREAM SEGMENT. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE LOCATION OF THE IMPERVIOUS DIKE(S) FOR EACH DAY'S WORK.

8. REMOVE SPECIAL STILLING BASIN(S) AND BACKFILL. STABILIZE DISTURBED AREA WITH SEED AND MULCH.

EXAMPLE OF PUMP-AROUND OPERATION



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U-2525B ON-SITE MITIGATION GUILFORD COUNTY

PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-2E

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DAREN M. PATT

APPROVED BY:

DATE:

VARIABLES	Reference Reach Tributary to Riddicks Creek (KHA)	Reference Reach Riddicks Creek (KHA)	Reference Reach Tributary to Lake Jeanette (NCDOT)	Reference Reach Tributary to Rich Fork (KHA)	Existing Site 2 Reach 1	Regional Curves Piedmont Rural/Rosgen Reference Values	Site 2 Reach 1 Design Reach	Existing Site 2 Reach 2	Regional Curves Piedmont Rural/Rosgen Reference Values	Site 2 Reach 2 Design Reach
STATION	–	–	–	–	–	–	200+00 to 205+00	–	–	205+00 to 213+07
1. Stream Type (Rosgen)	C5	E5	E5	B4	Incised B5	C/E	B5	Incised B5	C/E	B5
2. Drainage Area (sq. mile)	0.18	0.07	0.15	1.12	0.08	0.08	0.08	0.10	0.10	0.10
Bankfull Width (W_{bkf})	Mean: 7.9 Range:	Mean: 6.0 Range: 5.7 – 7.5	Mean: 12.0 Range: 12.0 – 13.5	Mean: 15.2 Range:	Mean: 7.3 Range:	Mean: 4.1 Range:	Mean: 7.2 Range:	Mean: 5.0 Range:	Mean: 4.3 Range:	Mean: 7.5 Range:
4. Bankfull Mean depth (d_{bkf})	Mean: 0.6 Range: – –	Mean: 0.8 Range: 0.7 – 0.8	Mean: 1.6 Range: 1.4 – 1.7	Mean: 1.2 Range: – –	Mean: 0.7 Range: – –	Mean: 0.7 Range: – –	Mean: 0.5 Range: – –	Mean: 1.0 Range: – –	Mean: 0.7 Range: – –	Mean: 0.5 Range: – –
5. Width/Depth Ratio (W_{bkf}/d_{bkf})	Mean: 13.5 Range: – –	Mean: 8.7 Range: 8.2 – 9.2	Mean: 8.4 Range: 7.1 – 9.5	Mean: 12.7 Range: – –	Mean: 11.0 Range:	Mean: 6.0 Range:	Mean: 13.5 Range: – –	Mean: 5.2 Range: – –	Mean: 6.1 Range: – –	Mean: 13.9 Range: – –
6. Bankfull cross-sectional Area (Abkf)	Mean: 4.6 Range: – –	Mean: 5.1 Range: 4.0 – 6.1	Mean: 19.4 Range: 18.8 – 20.0	Mean: 19.0 Range: – –	Mean: 5.5 Range: – –	Mean: 4.0 Range: – –	Mean: 3.8 Range: – –	Mean: 4.8 Range: – –	Mean: 4.3 Range: – –	Mean: 4.2 Range: – –
7. Bankfull Mean Velocity (V_{bkf})	Mean: Not Reported Range: – –	Mean: Not Reported Range: – –	Mean: 5.6 Range: 5.2 – 5.9	Mean: 5.1 Range: – –	Mean: 3.4 Range: 3.1 – 3.8	Mean: 2.8 Range: – –	Mean: 4.9 Range: – –	Mean: 4.0 Range: 4.6 – 4.5	Mean: 3.8 Range: – –	Mean: 4.5 Range: – –
8. Bankfull Discharge, cfs (Q_{bkf})	Mean: Not Reported Range: – –	Mean: Not Reported Range: – –	Mean: 109.3 Range: 100.7 – 119.6	Mean: 95.9 Range: – –	Mean: 18.6 Range: – –	Mean: 15.0 Range: – –	Mean: 18.6 Range: – –	Mean: 19.1 Range: – –	Mean: 16.4 Range: – –	Mean: 19.1 Range: – –
9. Bankfull Maximum Depth (d_{bkf})	Mean: 1.0 Range:	Mean: 1.5 Range: 1.3 – 1.6	Mean: 2.9 Range:	Mean: 1.9 Range:	Mean: 0.9 Range:	Mean: – Range:	Mean: 0.6 Range:	Mean: 1.3 Range:	Mean: – Range:	Mean: 0.8 Range:
10. Max d_{bkf}/d_{bkf} ratio	Mean: 1.7 Range: – –	Mean: 2.0 Range: 1.9 – 2.0	Mean: 2.4 Range: – –	Mean: 1.6 Range: – –	Mean: 1.3 Range: – –	Mean: 1.4 Range: 1.2 – 1.5	Mean: 1.5 Range: – –	Mean: 1.3 Range: – –	Mean: 1.4 Range: 1.2 – 1.5	Mean: 1.5 Range: – –
11. Low Bank Height to max depth	Mean: 1.0 Range: – –	Mean: 1.3 Range: 1.29 – 1.30	Mean: Not Reported Range: – –	Mean: 1.1 Range: – –	Mean: 2.7 Range: 2.48 – 2.90	Mean: Range: – –	Mean: 1.0 Range: – –	Mean: 3.4 Range: 3.10 – 3.40	Mean: Range: – –	Mean: 1.0 Range: – –
12. Width of Flood Prone Area (W_{fpa})	Mean: 36.0 Range: – –	Mean: 27.4 Range: 20.0 – 34.0	Mean: 49.0 Range: – –	Mean: 23.3 Range: – –	Mean: 12.0 Range: – –	Mean: – Range: – –	Mean: 14.0 Range: – –	Mean: 8.1 Range: – –	Mean: – Range: – –	Mean: 12.0 Range: – –
13. Entrenchment Ratio (W_{fpa}/W_{bkf})	Mean: 4.6 Range: 3.5 – 4.6	Mean: 4.2 Range:	Mean: 4.1 Range: 4.1 – 4.7	Mean: 1.5 Range:	Mean: 1.6 Range:	Mean: Range:	Mean: 1.9 Range:	Mean: 1.6 Range:	Mean: Range:	Mean: 1.6 Range:
14. Meander Length (L_m)	Mean: 80.5 Range: 64.0 – 97.0	Mean: 32.0 Range: 25.0 – 45.0	Mean: 22.0 Range: 22.0 – 69.0	Mean: – Range: – –	Mean: 27.9 Range: 13.2 – 51.1	Mean: – Range: – –	Mean: 63.0 Range: 50.4 – 75.6	Mean: 42.3 Range: 14.2 – 72.8	Mean: – Range: – –	Mean: 65.0 Range: 62.0 – 78.0
15. Ratio of Meander Length to Bankfull Width (L_m/W_{bkf})	Mean: 10.2 Range: 8.1 – 12.3	Mean: 5.0 Range: 3.9 – 6.8	Mean: 1.8 Range: 1.0 – 5.8	Mean: – Range: – –	Mean: 3.8 Range: 1.7 – 6.5	Mean: 11.0 Range: 9.0 – 14.0	Mean: 8.6 Range: 7.0 – 10.5	Mean: 8.5 Range: 2.9 – 14.7	Mean: 1.5 Range: 1.0 – 14.0	Mean: 8.8 Range: 5.8 – 10.3
16. Radius of Curvature (R_c)	Mean: 13.4 Range: 8.5 – 22.0	Mean: 11.3 Range: 5.7 – 18.8	Mean: 7.3 Range: 7.3 – 17.3	Mean: – Range: – –	Mean: 10.9 Range: 7.1 – 17.1	Mean: – Range: – –	Mean: 17.3 Range: 15.8 – 18.9	Mean: 9.4 Range: 5.0 – 16.0	Mean: – Range: – –	Mean: 17.9 Range: 16.3 – 19.5
17. Ratio of Radius of Curvature to Bankfull Width (R_c/W_{bkf})	Mean: 1.7 Range: 1.0 – 2.8	Mean: 1.7 Range: 0.9 – 2.9	Mean: 0.6 Range: 0.6 – 1.4	Mean: Range:	Mean: 1.4 Range: 0.9 – 2.2	Mean: 2.5 Range: 2.5 – 3.0	Mean: 2.4 Range: 2.2 – 2.6	Mean: 1.9 Range: 1.0 – 3.2	Mean: 2.8 Range: 2.5 – 3.0	Mean: 2.4 Range: 2.1 – 2.9
18. Belt Width (W_{blt})	Mean: 34.0 Range: – –	Mean: 15.8 Range: 10.5 – 22.0	Mean: 45.0 Range: – –	Mean: – Range: – –	Mean: 12.2 Range: 8.1 – 25.2	Mean: – Range: – –	Mean: 12.9 Range: 11.3 – 14.5	Mean: 18.5 Range: 9.0 – 40.7	Mean: – Range: – –	Mean: 22.8 Range: 18.3 – 29.3
19. Meander Width Ratio (W_{blt}/W_{bkf})	Mean: 4.3 Range: – –	Mean: 2.4 Range: 1.6 – 4.3	Mean: 3.0 Range: – –	Mean: – Range: – –	Mean: 1.5 Range: 1.0 – 2.2	Mean: 1.0 Range: 1.3 – 5.0	Mean: 1.8 Range: 1.6 – 2.0	Mean: 3.7 Range: 1.8 – 8.2	Mean: 4.0 Range: 3.0 – 5.0	Mean: 3.0 Range: 2.1 – 4.9
20. Sinuosity (k) (Stream Length / Valley Length)	Mean: 1.30 Range: – –	Mean: 1.40 Range: – –	Mean: Not Reported Range: – –	Mean: 1.07 Range: – –	Mean: 1.15 Range:	Mean: – Range: – –	Mean: 1.07 Range: – –	Mean: 1.10 Range: – –	Mean: – Range: – –	Mean: 1.06 Range: – –
21. Valley Slope (S_{vlly}) (ft/ft)	Mean: 0.0022 Range: – –	Mean: 0.0195 Range: – –	Mean: Not Reported Range: – –	Mean: 0.0168 Range: – –	Mean: 0.0174 Range:	Mean: Range:	Mean: 0.0110 Range: – –	Mean: 0.0171 Range: – –	Mean: Range: – –	Mean: 0.0190 Range: – –
22. Average Stream Slope (S_{avg}) = (S_{vlly}/k)	Mean: 0.0017 Range: – –	Mean: 0.0093 Range: – –	Mean: 0.0033 Range: – –	Mean: 0.0157 Range: – –	Mean: 0.0151 Range: – –	Mean: – Range: – –	Mean: 0.0103 Range: – –	Mean: 0.0144 Range: – –	Mean: – Range: – –	Mean: 0.0187 Range: – –
23. Riffle Slope (S_{rif})	Mean: 0.0042 Range: 0.0000 – 0.0257	Mean: 0.0540 Range: 0.0180 – 0.0800	Mean: Not Reported Range:	Mean: 0.0522 Range: 0.0077 – 0.0961	Mean: 0.0490 Range: 0.0158 – 0.0940	Mean: Range:	Mean: 0.0185 Range: 0.0088 – 0.0215	Mean: 0.0200 Range: 0.0067 – 0.0303	Mean: Range:	Mean: 0.0328 Range: 0.0281 – 0.0374
24. Ratio of Riffle Slope to Avg. Slope (S_{rif}/S_{avg})	Mean: 2.9 Range: 0.0 – 15.3	Mean: 5.8 Range: 0.6 – 4.5	Mean: – Range: – –	Mean: 3.3 Range: – –	Mean: 2.9 Range: 1.1 – 4.2	Mean: 1.8 Range: 1.5 – 2.0	Mean: 1.5 Range: 0.8 – 2.1	Mean: 1.4 Range: 0.5 – 2.1	Mean: 1.8 Range: 1.5 – 2.0	Mean: 1.8 Range: 1.5 – 2.0
25. Pool Slope (S_{pool})	Mean: 0.0092 Range: 0.0001 – 0.0072	Mean: 0.0024 Range: 0.0000 – 0.0100	Mean: Not Reported Range: – –	Mean: 0.0012 Range: 0.0009 – 0.0015	Mean: 0.0111 Range: 0.0047 – 0.0185	Mean: Range: – –	Mean: 0.0001 Range: 0.0031 – 0.0001	Mean: 0.0040 Range: 0.0007 – 0.0016	Mean: Range: – –	Mean: 0.0001 Range: 0.0000 – 0.0018
26. Ratio of Pool Slope to Avg. Slope (S_{pool}/S_{avg})	Mean: 0.1 Range: 0.0 – 0.4	Mean: 0.3 Range: 0.0 – 0.6	Mean: – Range: – –	Mean: 0.2 Range: 0.1 – 0.4	Mean: 0.7 Range: 0.4 – 1.1	Mean: 0.0 Range: 0.0 – 0.1	Mean: 0.0 Range: 0.0 – 0.0	Mean: 0.3 Range: 0.2 – 0.4	Mean: 0.0 Range: 0.0 – 0.1	Mean: 0.0 Range: 0.0 – 0.1
27. Maximum Pool Depth (d_{pool})	Mean: 2.0 Range:	Mean: 2.0 Range:	Mean: 3.1 Range:	Mean: 3.0 Range: 2.3 – 3.9	Mean: 1.9 Range: 1.5 – 2.1	Mean: Range:	Mean: 1.4 Range:	Mean: 1.8 Range: 1.6 – 2.2	Mean: Range:	Mean: 1.5 Range:
28. Ratio of Pool Depth to Avg. Depth (d_{pool}/d_{bkf})	Mean: 3.4 Range: – –	Mean: 2.3 Range: – –	Mean: 2.0 Range: – –	Mean: 2.5 Range: 1.9167 – 3.2833	Mean: 2.6 Range: 2.2 – 3.0	Mean: 3.0 Range: 2.5 – 3.5	Mean: 2.6 Range: – –	Mean: 1.9 Range: 1.6 – 2.3	Mean: 3.0 Range: 2.5 – 3.5	Mean: 2.7 Range: – –
29. Pool Width (W_{pool})	Mean: 11.5 Range: – –	Mean: 8.1 Range: – –	Mean: 13.8 Range: – –	Mean: 16.1 Range: – –	Mean: 8.7 Range: – –	Mean: Range:	Mean: 9.8 Range: – –	Mean: 5.4 Range: – –	Mean: – Range: – –	Mean: 10.2 Range: – –
30. Ratio of Pool Width to Bankfull Width (W_{pool}/W_{bkf})	Mean: 1.5 Range: – –	Mean: 1.2 Range: – –	Mean: 1.6 Range: – –	Mean: 1.1 Range: – –	Mean: 0.9 Range: – –	Mean: 1.5 Range: 1.3 – 1.7	Mean: 1.4 Range: – –	Mean: 1.1 Range: – –	Mean: 1.5 Range: 1.3 – 1.7	Mean: 1.3 Range: – –
31. Pool Area (A_{pool})	Mean: Not Reported Range: – –	Mean: Not Reported Range: – –	Mean: 27.9 Range: – –	Mean: 22.7 Range: – –	Mean: 5.5 Range: – –	Mean: Range:	Mean: 5.5 Range: – –	Mean: 5.8 Range: – –	Mean: Range: – –	Mean: 7.3 Range: – –
32. Ratio of Pool Area to Bankfull Area (A_{pool}/A_{bkf})	Mean: – Range: – –	Mean: – Range: – –	Mean: 1.4 Range: – –	Mean: 1.2 Range: – –	Mean: 1.0 Range: – –	Mean: – Range: – –	Mean: 1.7 Range: – –	Mean: 1.2 Range: – –	Mean: – Range: – –	Mean: 1.8 Range: – –
33. Pool to Pool Spacing (p-p)	Mean: 38.0 Range: 18 – 78	Mean: 22.9 Range: 8 – 48	Mean: Not Reported Range:	Mean: 39.1 Range: 20 – 52	Mean: 21.0 Range: 12.8 – 27.7	Mean: Range:	Mean: 31.5 Range: 25.2 – 37.8	Mean: 28.8 Range: 24.0 – 33.7	Mean: Range:	Mean: 32.5 Range: 29.3 – 42.3
34. Ratio of Pool to Pool Spacing to Bankfull Width (p-p/Wbkf)	Mean: 4.8 Range: 2.3 – 9.9	Mean: 3.5 Range: 1.1 – 7.3	Mean: – Range: – –	Mean: 2.2 Range: 1.3 – 3.4	Mean: 2.6 Range: 1.6 – 3.5	Mean: 4.5 Range: 4.0 – 5.0	Mean: 4.4 Range: 3.5 – 5.3	Mean: 5.8 Range: 4.8 – 6.8	Mean: 4.5 Range: 4.0 – 5.0	Mean: 4.3 Range: 3.9 – 5.6

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PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-2F

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DAREN M. PAIT

APPROVED BY:

DATE:

U-2525B
ON-SITE MITIGATION
GUILFORD COUNTY

VARIABLES		Reference Reach Tributary to Riddicks Creek (KHA)	Reference Reach Riddicks Creek (KHA)	Reference Reach Tributary to Lake Jeanette (NCDOT)	Reference Reach Tributary to Rich Fork (KHA)	Existing Site 4	Regional Curves Piedmont Rural/Rosgen Reference Values	Site 4 Design Reach	Existing Site 5	Regional Curves Piedmont Rural/Rosgen Reference Values	Site 5 Design Reach
STATION		–	–	–	–	–	–	400+00 to 403+86	–	–	500+00 to 503+62
1. Stream Type (Rosgen)		C5	E5	E5	B4	Incised B5	C/E	C5	E5	C/E	C5
2. Drainage Area (sq. mile)		0.18	0.07	0.15	1.12	0.57	0.57	0.57	0.51	0.51	0.51
3. Bankfull Width	Mean:	7.9	6.6	12.0	15.2	8.9	9.3	12.7	11.8	8.9	13.7
(W_{bkf})	Range:		5.7 – 7.5	12.0 – 13.5							
4. Bankfull Mean	Mean:	0.6	0.8	1.6	1.2	1.3	1.3	0.9	1.1	1.2	1.0
depth (d_{bkf})	Range:	– –	0.7 – 0.8	1.4 – 1.7	-- --	– –	– --	-- –	– –	– –	-- –
5. Width/Depth Ratio	Mean:	13.5	8.7	11.4	12.7	6.8	7.5	13.6	10.4	7.4	14.1
(W_{bkf}/d_{bkf})	Range:		8.2 – 9.2	7.1 – 9.6							
6. Bankfull cross-sectional	Mean:	4.6	5.1	19.4	19.0	11.9	14.6	11.9	13.3	13.6	13.3
Area (Abkf)	Range:	– –	4.0 – 6.1	18.8 – 20.0	– --	– –	– --	-- –	– --	– --	-- –
7. Bankfull Mean Velocity	Mean:	Not Reported	Not Reported	5.8	5.1	2.1	4.1	2.1	4.3	4.0	4.3
(V_{bkf})	Range:			5.2 – 6.2		1.9 – 2.3			3.9 – 4.8		
8. Bankfull Discharge, cfs	Mean:	Not Reported	Not Reported	109.3	96.9	24.5	59.4	24.5	56.5	54.8	56.5
(Q_{bkf})	Range:	-- –	– –	100.7 – 119.6	-- –	-- –	-- --	-- --		– --	-- --
9. Bankfull Maximum Depth	Mean:	1.0	1.5	2.9	1.9	2.1	–	1.4	1.8	–	1.4
(d_{mbkf})	Range:	– –	1.3 – 1.8	– –	– –	– –	– –	– –	– –	– –	– –
10. Max d_{mbkf}/d_{bkf}	Mean:	1.7	2.0	2.4	1.6	1.5	1.4	1.5	1.4	1.4	1.4
ratio	Range:	– –	1.9 – 2.0	– –	– –	– –	1.2 – 1.5	-- –	-- --	1.2 – 1.5	– --
11. Low Bank Height to max	Mean:	1.0	1.3	Not Reported	1.1	3.1		1.0	2.5		1.0
d_{bkf} ratio	Range:		1.20 – 2.50			2.86 – 3.19			2.42 – 2.62		
12. Width of Flood Prone	Mean:	36.0	27.4	49.0	23.3	15.1	–	80.0	147.0	–	147.0
Area (W_{fpa})	Range:	– –	20.0 – 34.0	– –	– –	– –	– –	-- –	– –	– –	-- –
13. Entrenchment Ratio	Mean:	4.5	4.2	4.4	1.5	1.7		6.3	12.5		10.7
(W_{fpa}/W_{bkf})	Range:		3.5 – 4.5	4.1 – 4.7							
14. Meander Length	Mean:	80.5	32.0	22.0	--	44.7	--	122.0	85.2	--	126.0
(L_m)	Range:	64.0 – 97.0	25.0 – 45.0	22.0 – 69.0	– --	25.7 – 58.3	-- --	97.6 – 146.4	27.5 – 138.0	– --	100.8 – 151.2
15. Ratio of Meander Length to	Mean:	10.2	4.8	1.8	–	5.0	11.5	9.6	7.2	11.5	9.2
Bankfull Width (L_m/W_{bkf})	Range:	8.1 – 12.3	3.8 – 6.8	1.8 – 5.8	– –	2.9 – 6.6	9.0 – 14.0	7.7 – 11.5	2.3 – 11.7	9.0 – 14.0	7.4 – 11.0
16. Radius of Curvature	Mean:	13.4	11.3	7.3	--	33.6	--	33.6	29.6	–	34.7
(R_c)	Range:	8.5 – 22.0	5.7 – 18.8	7.3 – 17.3	-- –	12.0 – 63.0	-- –	30.5 – 36.6	6.0 – 71.0	– –	31.5 – 37.8
17. Ratio of Radius of Curvature	Mean:	1.7	1.7	0.8	–	3.8	2.8	2.8	2.5	2.0	2.5
to Bankfull Width (R_c/W_{bkf})	Range:	1.1 – 2.0	0.9 – 2.8	0.6 – 1.4	– –	1.3 – 7.1	2.5 – 3.0	2.4 – 2.9	0.5 – 6.0	2.5 – 3.0	2.3 – 2.8
18. Belt Width	Mean:	34.0	15.8	45.0	–	12.3	–	42.7	33.5	–	38.4
(W_{blt})	Range:	-- –	10.5 – 22.0	– –	-- –	7.4 – 17.7	-- –	30.5 – 54.9	17.0 – 53.2	– --	24.6 – 48.2
19. Meander Width Ratio	Mean:	4.3	2.4	3.8		1.4	4.0	3.4	2.8	4.0	2.7
(W_{blt}/W_{bkf})	Range:		1.5 – 3.3			0.8 – 2.0	3.0 – 5.0	2.4 – 4.3	1.5 – 4.5	3.0 – 5.0	1.8 – 3.5
20. Sinuosity (K)	Mean:	1.30	1.40	Not Reported	1.07	1.22	–	1.08	1.16	–	1.13
(Stream Length / Valley Length)	Range:	– –	– –	– –	– --	– –	– --	-- –	– --	– --	-- –
21. Valley Slope (S_{valley})	Mean:	0.0022	0.0130	Not Reported	0.0168	0.0029		0.0050	0.0131		0.0118
(ft/ft)	Range:										
22. Average Stream Slope	Mean:	0.0017	0.0093	0.0033	0.0157	0.0024	–	0.0046	0.0113	–	0.0105
(S_{avg}) = (S_{valley}/K)	Range:	– –	– –	– –	– –	– –	– --	-- –	– --	– --	-- –
23. Riffle Slope	Mean:	0.0049	0.0540	Not Reported	0.0522	0.0380	–	0.0081	0.0217	–	0.0185
(S_{riffle})	Range:	0.0010 – 0.0257	0.0100 – 0.0800	– –	0.0077 – 0.0381	0.0129 – 0.0774	– –	0.0080 – 0.0092	0.0238 – 0.0396	– –	0.0157 – 0.0210
24. Ratio of Riffle Slope to Avg.	Mean:	2.9	5.8	--	3.3	15.8	1.8	1.8	2.5	1.8	1.8
Slope (S_{riffle}/S_{avg})	Range:	0.0 – 15.3	0.6 – 4.5	– –	-- –	5.3 – 32.1	1.5 – 2.0	1.5 – 2.0	2.1 – 3.5	1.5 – 2.0	1.5 – 2.0
25. Pool Slope	Mean:	0.0002	0.0024	Not Reported	0.0032	0.0073	–	0.000	0.0012		0.000
(S_{pool})	Range:	0.0000 – 0.0007	0.0005 – 0.0100		0.0009 – 0.0065	0.0061 – 0.0080	–	0.0000 – 0.0005	0.0057 – 0.0017		0.0000 – 0.0010
26. Ratio of Pool Slope to Avg.	Mean:	0.1	0.3	--	0.2	3.0	0.0	0.0	0.1	0.0	0.0
Slope (S_{pool}/S_{avg})	Range:	0.0 – 0.4	0.0 – 0.6	-- –	0.1 – 0.4	2.5 – 3.3	0.0 – 0.1	0.0 – 0.1	0.5 – 0.1	0.0 – 0.1	0.0 – 0.1
27. Maximum Pool	Mean:	2.0	2.0	3.1	3.0	2.7		2.5	2.3		2.6
Depth (d_{pool})	Range:				2.3 – 3.9	2.5 – 2.8			1.9 – 2.6		
28. Ratio of Pool Depth to Avg.	Mean:	3.4	2.3	2.0	2.5	2.0	3.0	2.8	2.1	3.0	2.7
Depth (d_{pool}/d_{bkf})	Range:	– –	– --	– –	1.9167 – 3.2833	1.9 – 2.1	2.5 – 3.5	-- –	1.7 – 2.3	2.5 – 3.5	-- –
29. Pool Width	Mean:	11.5	8.1	19.8	16.3	13.1	–	17.0	11.8	–	16.0
(W_{pool})	Range:	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
30. Ratio of Pool Width to	Mean:	1.5	1.2	1.6	1.1	1.5	1.5	1.3	1.0	1.5	1.2
Bankfull Width (W_{pool}/W_{bkf})	Range:	-- –	– --	-- –	-- –	– –	1.3 – 1.7	– --	-- --	1.3 – 1.7	– --
31. Pool Area	Mean:	Not Reported	Not Reported	27.0	22.7	28.4	–	20.0	13.3	–	20.1
(A_{pool})	Range:	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
32. Ratio of Pool Area to	Mean:	–	--	1.4	1.2	2.4	–	1.7	1.0	–	1.5
Bankfull Area (A_{pool}/A_{bkf})	Range:	-- –	– --	– –	-- –	– –	-- –	– --	-- –	– –	– --
33. Pool to Pool Spacing	Mean:	38.3	22.9	Not Reported	33.1	24.4		70.2	32.7		72.5
(p-p)	Range:	18 – 78	8 – 48		20 – 52	23.7 – 25.2		54.9 – 85.4	21.3 – 50.8		56.7 – 88.2
34. Ratio of Pool to Pool Spacing	Mean:	4.8	3.5	--	2.2	2.7	6.0	5.5	2.8	6.0	5.3
to Bankfull Width (p-p/Wbkf)	Range:	2.3 – 9.9	1.1 – 7.3	– –	1.3 – 3.4	2.7 – 2.8	5.0 – 7.0	4.3 – 6.7	1.8 – 4.3	5.0 – 7.0	4.1 – 6.4

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 – RALEIGH, NORTH CAROLINA 27636–3068
PHONE: (919) 677–2000 FAX: (919) 677–2050
NC LICENSE F–0102

U-2525B
ON-SITE MITIGATION
GUILFORD COUNTY

PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-3

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DARREN M. PAIT

APPROVED BY:

DATE:

SUMMARY OF QUANTITIES

DESCRIPTION	SECTION	QUANTITIY	UNIT	ITEM DESCRIPTION
6133000000-N	SP	1	LS	CONSTRUCTION SURVEYING FOR MITIGATION
6133000000-N	SP	1	LS	GRADING FOR MITIGATION
1077000000-E	SP	600	TON	#57 STONE
3656000000-E	876	1,250	SY	FILTER FABRIC FOR DRAINAGE
3651000000-E	SP	975	TON	BOULDER
3642000000-E	876	60	TON	PLAIN RIP RAP, CLASS A
3649000000-E	876	50	TON	PLAIN RIP RAP, CLASS B
6133000000-N	SP	1	LS	DIVERSION PUMPING FOR MITIGATION
6132000000-N	SP	6	EA	LOGS
6132000000-N	SP	2	EA	ROOTWADS

SUMMARY OF EARTHWORK FOR MITIGATION

LOCATION	MITIGATION UNCLASSIFIED EXCAV. (CU.YD.)	MITIGATION EMBANKMENT	MITIGATION BORROW (CU.YD.)	MITIGATION WASTE (CU.YD.)
SITE 2	7,304	785	0	6,519
SITE 4	1,369	235	0	1,134
SITE 5	1,810	31	0	1,779
SUBTOTAL	10,483	1,051	0	9,432

APPROXIMATE QUANTITIES ONLY, MITIGATION UNCLASSIFIED EXCAVATION, MITIGATION BORROW EXCAVATION, MITIGATION FINE GRADING AND MITIGATION CLEARING AND GRUBBING WILL BE PAID FOR AT THE CONTRACT LUMP SUM PRICE FOR "GRADING FOR MITIGATION".

DESC.	STATION	NORTHING	EASTING	ELEV.	RADIUS	DESC.	STATION	NORTHING	EASTING	ELEV.	RADIUS	DESC.	STATION	NORTHING	EASTING	ELEV.	RADIUS
HR16	204+56.3	856586.17	1794087.12	733.77		HR25	207+68.2	856337.99	1794206.44	728.58		HR34	210+17.7	856094.69	1794269.29	721.32	
RCV8	204+78.9	856570.54	1794108.38	733.84		TR13	207+60.4	856325.83	1794207.22	728.40		RCV15	210+35.8	856076.88	1794253.80	721.45	
R16		856559.01	1794092.29		16	R25		856327.28	1794229.97		22.8	R34		856072.04	1794236.91		19.5
HR17	204+90.7	856560.00	1794108.25	733.14		HR26	207+78.8	856309.86	1794215.27	728.43		HR35	210+51.5	856061.51	1794251.32	721.15	
TR9	205+11.2	856539.54	1794109.53	732.88		RAV2	207+95.9	856298.80	1794228.37	728.09		TR15	210+66.7	856049.04	1794243.32	721.03	
R17		856540.54	1794125.50		16	R26		856283.90	1794218.78		19.5	R35		856038.51	1794259.74		19.5
HR18	205+17.6	856533.46	1794111.15	732.88		HR27	208+11.7	856285.15	1794235.24	727.29		HR36	210+82.7	856033.67	1794240.85	721.08	
RAV1	205+43.0	856510.62	1794122.41	732.43		RCV12	208+19.0	856277.82	1794235.71	727.20		RCV16	211+01.0	856015.89	1794245.40	720.56	
R18		856508.11	1794107.17		17	R27		856278.84	1794255.19		19.5	R36		856011.06	1794226.51		19.5
HR19	205+53.2	856500.79	1794124.01	731.42		HR28	208+29.5	856268.01	1794238.97	726.70		HR37	211+17.1	856000.52	1794242.92	720.27	
RCV9	205+82.7	856470.99	179411.92	730.91		RAV3	208+42.3	856257.30	1794246.12	726.46		TR16	211+31.5	855988.39	1794235.14	720.15	
R19		856468.34	1794139.23		19.5	R28		856246.86	1794229.65		19.5	R37		855977.86	1794251.56		19.5
HR20	206+05.4	856451.94	1794128.69	730.53		HR29	208+59.6	856240.72	1794248.16	725.46		HR38	211+47.5	855973.03	1794232.67	720.15	
TR10	206+16.1	856445.73	1794137.44	730.44		RAV4	208+74.3	856226.79	1794243.53	725.31		RCV17	211+65.8	855955.27	1794237.21	719.68	
R20		856428.60	1794125.80		21	R29		856220.65	1794261.04		19.5	R38		855950.43	1794218.32		19.5
HR21	206+26.5	856437.87	1794144.14	730.44		HR30	208+92.0	856209.82	1794245.83	724.31		HR39	211+81.8	855939.91	1794234.74	719.49	
TR11	206+44.2	856422.05	1794151.92	730.05		RAV5	209+04.2	856199.71	1794252.57	724.25		TR17	211+96.5	855927.59	1794226.83	719.26	
R21		856430.66	1794169.42		19.5	R30		856188.88	1794236.36		19.5	R39		855917.06	1794243.25		19.5
HR22	206+56.5	856413.49	1794160.53	730.05		HR31	209+21.9	856182.74	1794254.87	723.25		HR40	212+12.5	855912.22	1794224.36	719.26	
TR12	206+72.7	856403.94	1794173.54	729.67		RCV18	209+35.6	856169.75	1794250.55	723.14		RCV18	212+30.7	855894.57	1794228.88	718.80	
R22		856388.22	1794162.00		19.5	R31		856163.57	1794269.06		19.5	R40		855889.78	1794209.99		19.5
HR23	206+86.7	856392.45	1794181.04	729.67		HR32	209+53.8	856152.74	1794252.83	722.64		HR41	212+44.4	855881.20	1794227.52	718.60	
RCV10	207+07.3	856372.31	1794185.51	729.24		RCV14	209+64.9	856143.13	1794259.23	722.42		RCV19	212+52.8	855873.67	1794223.86	718.50	
R23		856376.54	1794204.54		19.5	R32		856132.88	1794243.02		19.5	R41		855865.14	1794241.40		19.5
HR24	207+16.6	856364.08	1794189.58	729.04		HR33	209+87.5	856121.80	1794259.43	722.12		HR42	212+75.7	855852.24	1794226.78	718.10	
RCV11	207+35.9	856349.27	1794201.94	728.88		TR14	210+01.7	856109.86	1794251.77	721.92		TIE IN	213+07.2	855828.61	1794247.62	718.00	
R24		856336.69	1794187.05		19.5	R33		856099.33	1794268.18		19.5						

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PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-4

PROJECT ENGINEER

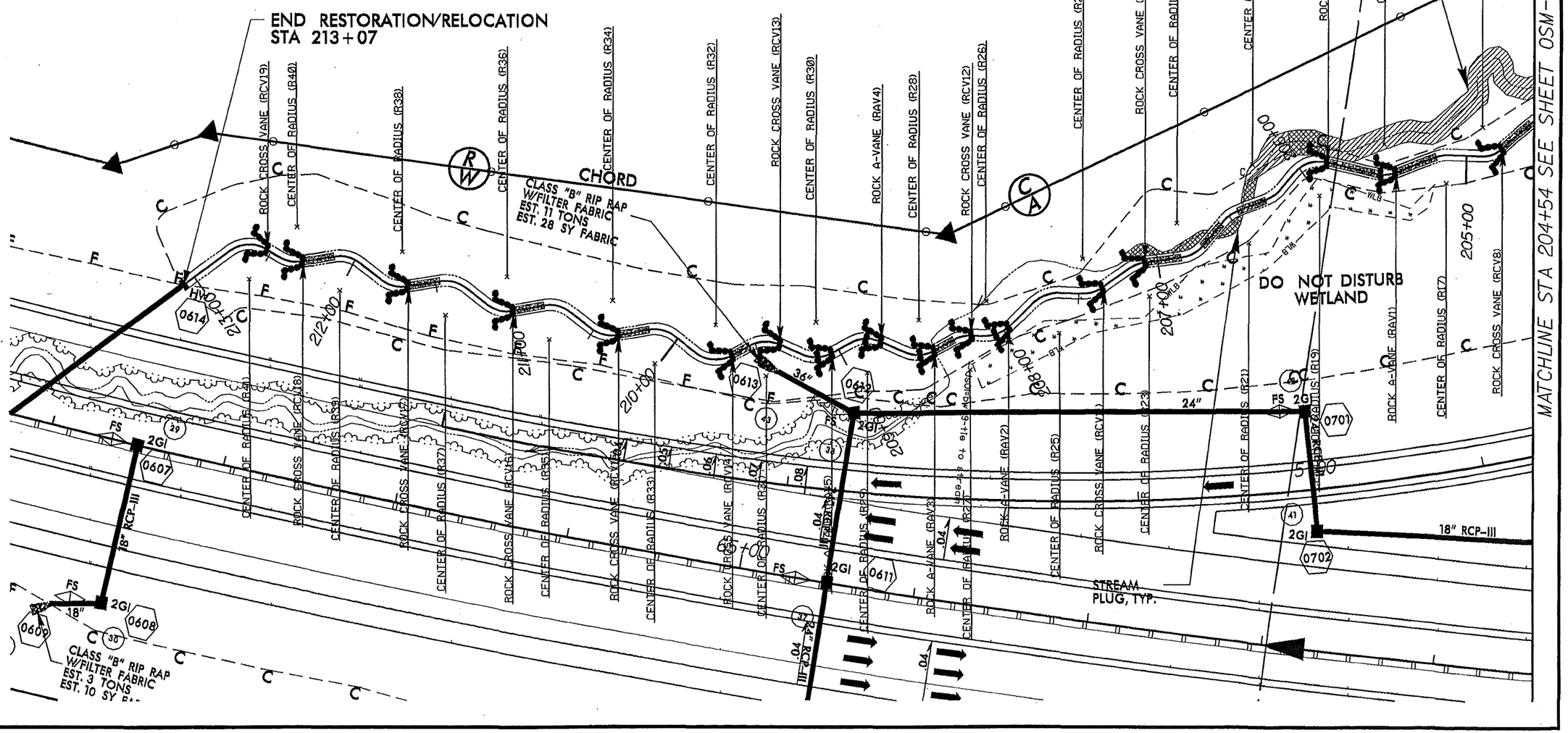
NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DAREN M. PATT

APPROVED BY:

DATE:

SITE 2

NAD 83



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Kimley-Horn and Associates, Inc.

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PHONE: (919) 677-2000 FAX: (919) 677-2050

PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-5

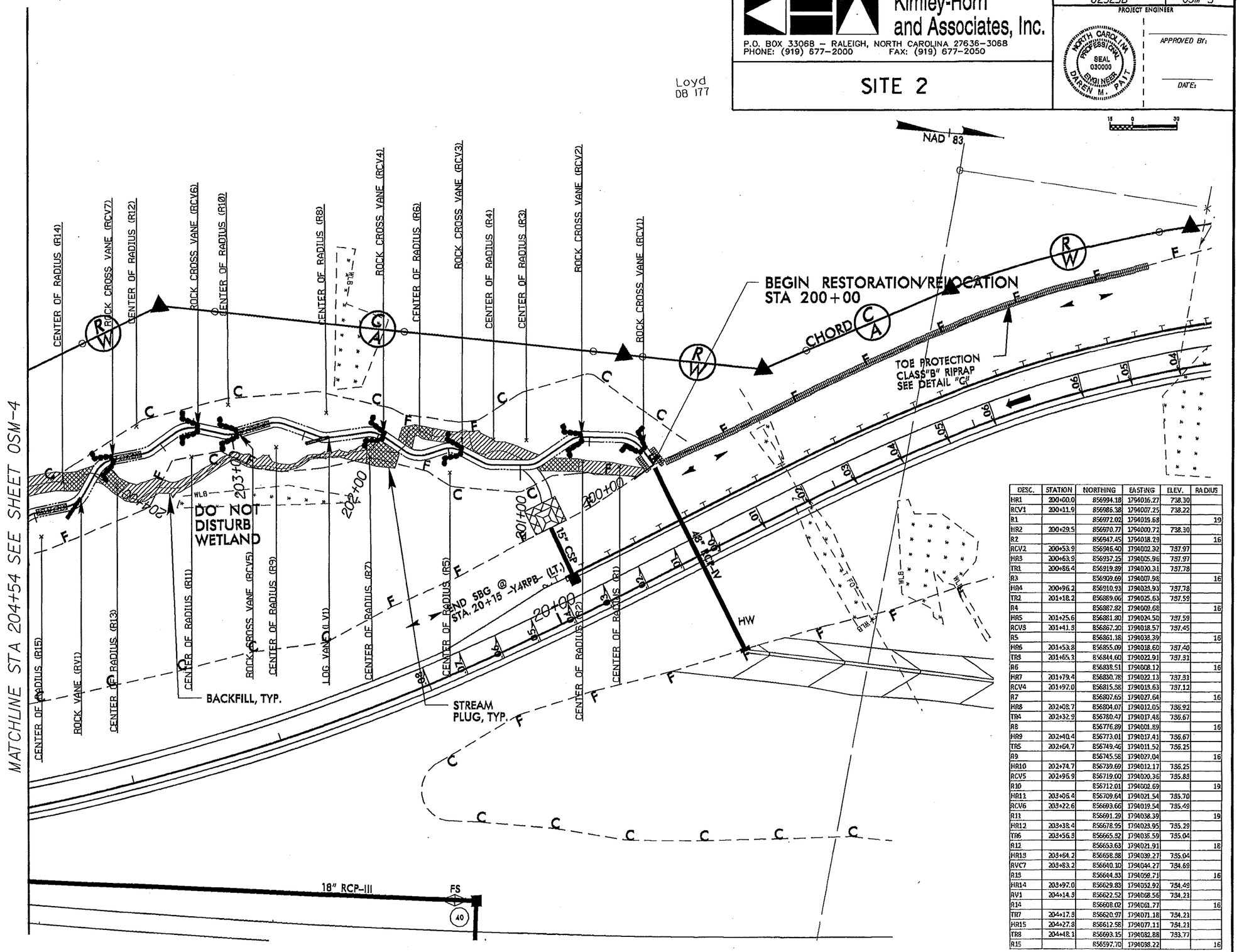
PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DAREN M. PATT

APPROVED BY:

DATE:

SITE 2



DESC.	STATION	NORTHING	EASTING	ELEV.	RADIUS
HR1	200+00.0	856994.18	1794016.27	738.30	
RCV1	200+11.9	856986.38	1794007.25	738.22	
R1		856972.02	1794019.68		19
HR2	200+29.5	856970.77	1794000.72	738.30	
R2		856947.45	1794018.29		16
RCV2	200+53.9	856946.40	1794002.32	737.97	
HR3	200+63.9	856937.25	1793995.96	737.97	
TR1	200+86.4	856919.89	1794020.31	737.78	
R3		856909.69	1794007.98		16
HR4	200+96.2	856910.93	1794023.93	737.78	
TR2	201+18.2	856889.06	1794025.63	737.59	
R4		856887.82	1794009.68		16
HR5	201+25.6	856881.80	1794024.50	737.59	
RCV3	201+41.8	856867.20	1794018.57	737.45	
R5		856861.18	1794038.39		16
HR6	201+53.8	856855.09	1794018.60	737.40	
TR3	201+65.3	856844.60	1794022.91	737.31	
R6		856838.51	1794008.12		16
HR7	201+79.4	856830.78	1794022.13	737.31	
RCV4	201+97.0	856815.58	1794019.63	737.12	
R7		856807.65	1794027.64		16
HR8	202+08.7	856804.07	1794012.05	736.92	
TR4	202+32.9	856780.47	1794017.48	736.67	
R8		856776.89	1794001.89		16
HR9	202+40.4	856773.01	1794017.41	736.67	
TR5	202+64.7	856749.46	1794011.52	736.25	
R9		856745.58	1794027.04		16
HR10	202+74.7	856739.69	1794012.17	736.25	
RCV5	202+95.9	856719.00	1794020.36	735.88	
R10		856712.01	1794002.69		19
HR11	203+05.4	856709.64	1794021.54	735.70	
RCV6	203+22.6	856693.66	1794019.54	735.49	
R11		856691.29	1794038.39		19
HR12	203+38.4	856678.95	1794023.95	735.29	
TR6	203+56.9	856665.92	1794035.59	735.04	
R12		856653.63	1794021.91		18
HR13	203+64.2	856658.88	1794039.27	735.04	
RVC7	203+83.2	856640.10	1794044.27	734.69	
R13		856644.33	1794059.71		16
HR14	203+97.0	856629.83	1794052.92	734.49	
RV1	204+14.3	856622.52	1794068.56	734.21	
R14		856608.02	1794061.77		16
TR7	204+17.9	856620.97	1794071.18	734.21	
HR15	204+27.8	856612.58	1794077.11	734.21	
TR8	204+48.1	856593.35	1794082.88	733.77	
R15		856597.70	1794098.22		16

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PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-6

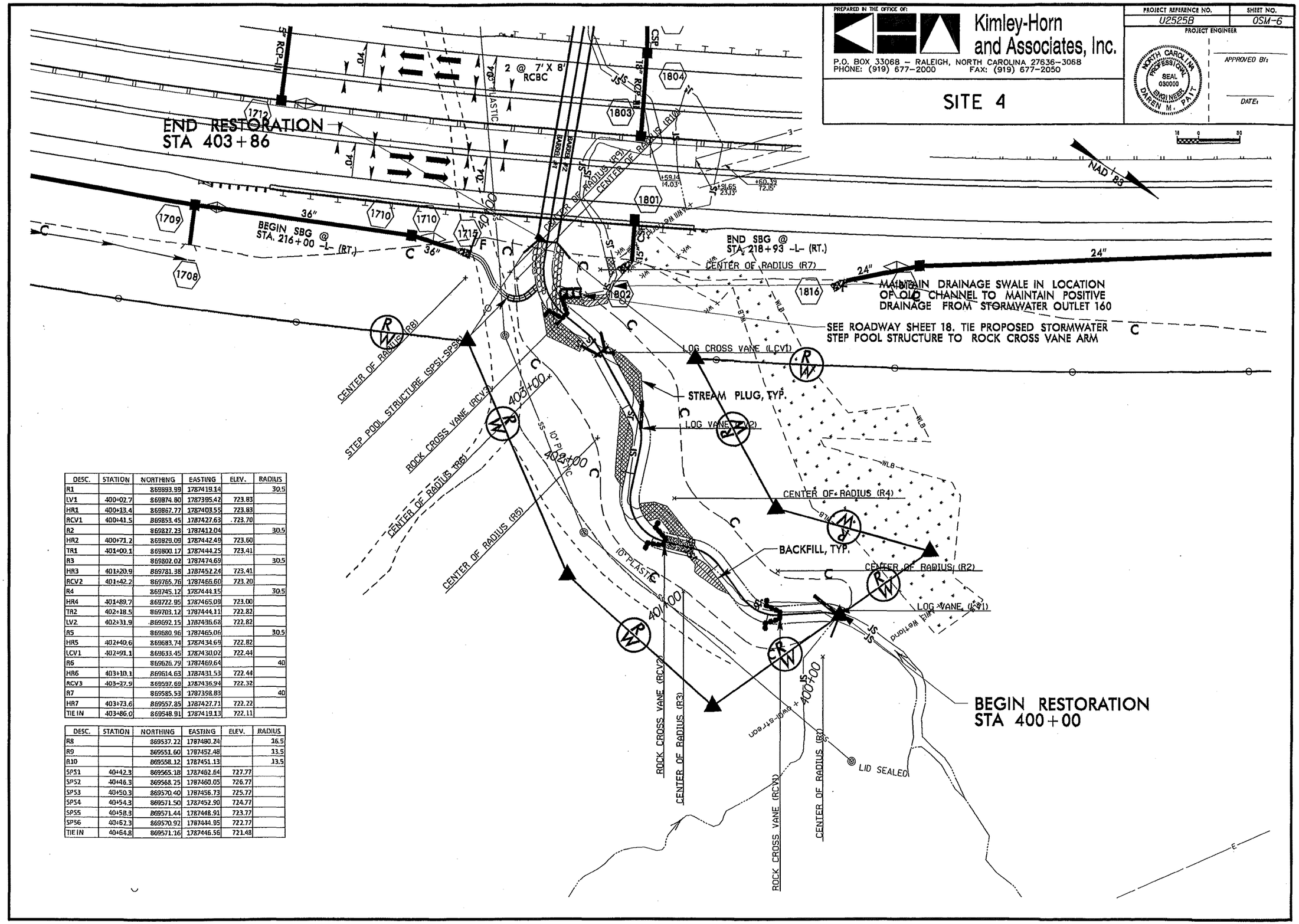
PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DARREN M. PAIT

APPROVED BY:

DATE:

SITE 4



DESC.	STATION	NORTHING	EASTING	ELEV.	RADIUS
R1		869893.99	1787419.14		30.5
LV1	400+02.7	869874.80	1787395.42	723.83	
HR1	400+13.4	869867.77	1787403.55	723.83	
RCV1	400+41.5	869853.45	1787427.63	723.70	
R2		869827.23	1787412.04		30.5
HR2	400+71.2	869829.09	1787442.49	723.60	
TR1	401+00.1	869800.17	1787444.25	723.41	
R3		869802.02	1787474.69		30.5
HR3	401+20.9	869781.38	1787452.24	723.41	
RCV2	401+42.2	869765.76	1787466.60	723.20	
R4		869745.12	1787444.15		30.5
HR4	401+89.7	869722.95	1787465.09	723.00	
TR2	402+18.5	869703.12	1787444.11	722.82	
LV2	402+31.9	869692.15	1787436.68	722.82	
R5		869680.96	1787465.06		30.5
HR5	402+40.6	869683.74	1787434.69	722.82	
LCV1	402+91.1	869633.45	1787430.02	722.44	
R6		869626.79	1787469.64		40
HR6	403+10.1	869614.63	1787431.53	722.44	
RCV3	403+27.9	869597.69	1787436.94	722.32	
R7		869585.53	1787398.83		40
HR7	403+73.6	869557.85	1787427.71	722.22	
TIE IN	403+86.0	869548.91	1787419.13	722.11	

DESC.	STATION	NORTHING	EASTING	ELEV.	RADIUS
R8		869537.22	1787480.24		16.5
R9		869551.60	1787452.48		13.5
R10		869558.12	1787451.13		13.5
SPS1	40+42.3	869565.18	1787462.64	727.77	
SPS2	40+46.3	869568.25	1787460.05	726.77	
SPS3	40+50.3	869570.40	1787456.73	725.77	
SPS4	40+54.3	869571.50	1787452.90	724.77	
SPS5	40+58.3	869571.44	1787448.91	723.77	
SPS6	40+62.3	869570.92	1787444.95	722.77	
TIE IN	40+64.8	869571.16	1787446.56	721.48	

DESC.	STATION	NORTHING	EASTING	ELEV.	RADIUS
HR1	500+00.	870989.41	1785058.05	734.69	
RAV1	500+27.9	870961.72	1785058.07	734.66	
R1		870961.75	1785095.87		37.8
HR2	500+58.7	870984.09	1785070.11	734.44	
RCV1	500+88.6	870913.68	1785092.02	734.04	
R2		870941.84	1785117.79		37.8
HR3	501+18.8	870903.58	1785119.62	733.79	
RCV2	501+47.1	870904.71	1785142.86	733.49	
R3		870866.95	1785144.69		37.8
HR4	501+79.5	870869.21	1785175.24	732.99	
RCV3	502+05.5	870868.20	1785190.56	732.85	
R4		870890.46	1785211.11		37.8
HR5	502+32.7	870858.59	1785212.76	732.35	
RAV2	502+64.7	870846.52	1785244.03	732.24	
R5		870809.65	1785235.66		37.8
HR6	503+01.9	870823.09	1785270.99	731.74	
R6		870791.21	1785242.09		37.8
TIE IN	503+62.	870764.74	1785278.27	731.25	

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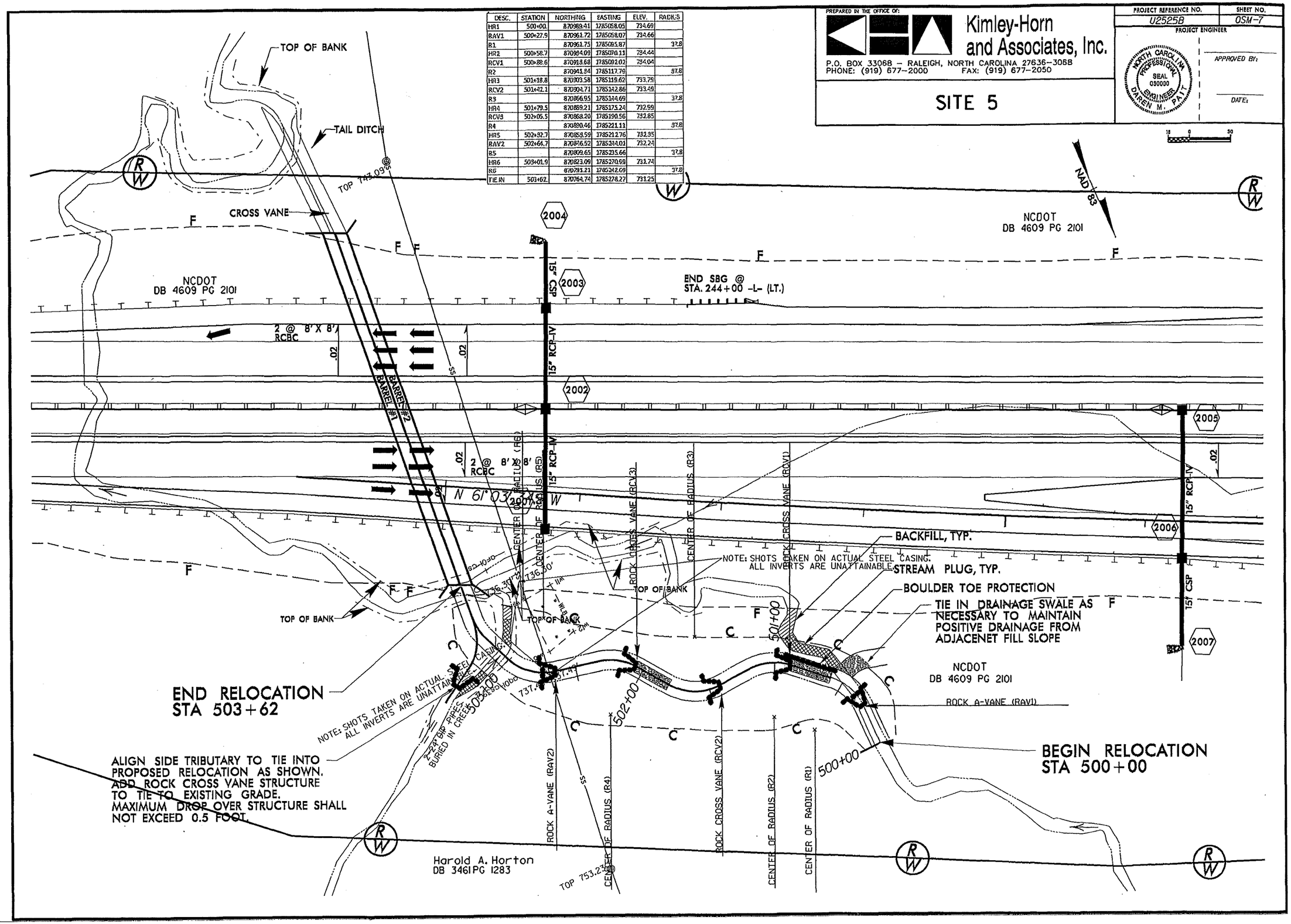
SITE 5

PROJECT REFERENCE NO.	SHEET NO.
U2525B	OSM-7

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 030000 ENGINEER DAREN M. PAIT

APPROVED BY:

DATE:

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