STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

PAT L. MCCRORY
GOVERNOR

ANTHONY J. TATA
SECRETARY

July 18, 2013

Ms. Amy Euliss
N.C. Dept. of Environment and Natural Resources
Division of Water Quality
585 Waughtontown Street
Winston-Salem, NC, 27107

Mr. Andy Williams
US Army Corps of Engineers
Regulatory Field Office
6508 Falls of Neuse Road, Suite 120
Raleigh, NC 27615

Dear Ma'm/Sir:

Subject: **Additional Information in Response to the N.C. Division of Water Quality's and USACE's Email Questions** for the proposed new location facility from SR 2011 (Edgefield Road) to the Haw River at US 220 in Greensboro, Guilford County; Division 7; TIP No. R-2413 A & B; WBS Element No. 34429.1.1

Reference: 1) Application for Section 404 Individual Permit, Section 401 Individual Water Quality Certification, and Randleman Lake Buffer Authorization, May 14, 2013.
2) NCDWQ/USACE Emails, dated June 4, 11, and 13, 2013.

NCDOT received several emails regarding questions concerning project construction as well as onsite mitigation. Original questions from your emails (in italics) as well as our responses are provided below for those questions relating to the permit application.

R-2413B

1) *Permit site 8 (mitigation site 5) shows 2 ditches on the upstream portion that are not in the mitigation plans. Please update the plans, so they are the same. If the mitigation*

MAILING ADDRESS:
NC DEPARTMENT OF TRANSPORTATION
PROJECT DEVELOPMENT AND ENVIRONMENTAL ANALYSIS UNIT
1598 MAIL SERVICE CENTER
RALEIGH NC 27699-1598

TELEPHONE: 919-707-6000
FAX: 919-212-5785
WEBSITE: NCDOT.GOV

LOCATION:
CENTURY CENTER, BUILDING B
1020 BIRCH RIDGE DRIVE
RALEIGH NC 27610

site plans need to have the ditches added, include a statement that the mitigation design accounts for the stormwater input.

Mitigation plans have been updated to reflect the same information.

R-2413A

2) *The stormwater plan needs to include a list of grassed swales that are providing treatment, as you have done in the stormwater management plan for R2413B.*

   There is one grass swale on R-2413 B section that was used. There are no grass swales used on R-2413 A. The project is not subject to the buffer rules. Therefore grass swales were not designed for project. Ditches were designed with non-erosive velocities.

3) *Permit site 3: There location survey lines showing a stream and a pond at permit site 3. The stream line has impacts. Have these features been deemed non-jurisdictional?*

   The area below Site 3 you are referring to is not within the right-of-way (ROW) for NCDOT. The stream impacts for Site 3 ends near the cut/fill line and inside the NCDOT ROW. There are JS lines depicted outside the ROW, but they are just depicting top of bank. Also, the flow line at the bottom of Permit Drawing 10 of 81 is not a jurisdictional stream.

4) *Permit site 4: There are mechanized clearing impacts listed at site 4. There are no mechanized clearing impacts shown on the plans. Also the 4C meeting minutes state that there are no mechanized clearing impacts at site 4. Please update.*

   There is mechanized clearing at Site 4 (Permit Sheet 74). The comment made during the 4C meeting must have been made while looking at the Site 4 impacts on Permit Sheet 13. Site 4 is depicted on two permit sheets.

5) *Permit site 8: Adjacent to permit site 8, an energy dissipater pad is shown discharging into a channel. Is this jurisdictional channel? Can it handle the additional flow?*

   The channel is not jurisdictional. The existing channel will be able to handle the flow after it is dissipated.

6) *Permit site 9: How will the pond bed be stabilized once it is drained?*

   Standard BMPs for Sediment and Erosion Control Methods will be used. Erosion Control Matting maybe utilized, as well as seeding/planting with riparian seed mix and bare root seedling trees. However, plans will be finalized at the Preconstruction conference. See attached Pond Drainage Plan for more details.

7) *Permit site 13: The permit drawings show the relocated stream in both a lateral base ditch and a restored stream. Please remove the lateral base ditch, if its function is to carry the relocated stream.*

The lateral ditch has to remain to drain the cut ditch for the roadway.

8) *Permit site 19: The channel change is coming into the existing channel at 90 degrees. Can it be shifted? If not, will the bank need to be armored at the tie in?*

The channel change is acutally tying into the existing channel at about 30 degrees and not 90.

9) *Permit site 20. Please explain why the impacts don't continue to the tie in of the 36" pipe. Also the plans should show the dissipater tying into the existing stream.*

The impacts do not continue because the stream does not continue out of the wetland. The dissipater is not a pad, but a box. Flow exits the box via a ditch that connects to the stream. See Detail M on Roadway Plans.

10) *Roadway plans sheet 33: At approximately sta no. 17+ 46, there is a PDE that's tied to a jurisdictional stream. Are there stream impacts associated with the PDE? If so, this should be a permit site.*

There are no direct impacts to the stream since the stream starts below the end of ditch and just above PDE line. There maybe temporary impacts with the construction in this area. A new site, Site 23, has been added to reflect these temporary impacts.

<u>Mitigation Questions</u>

Mitigation site 3

11) *On the upstream side where the two channels are being relocated because of the road project, these are mitigable impacts and should be considered impacts from the project not the stream mitigation. Your justification of slope stake lines doesn't make sense, because the channels have to be moved for the road and pipe alignment. Further, the purpose of the mitigation on the upstream site appears to be for the primary purpose of dropping grade, not based on a reference reach. Finally on the downstream side, the mitigation is for 26 feet, and not providing any real uplift to the system. Please be advised that in order to be in compliance with the permit, the downstream end will need to be stable, and if a cross vein is necessary for stability, then it will be required regardless of the stream restoration. Since that leaves very little linear footage for on-site mitigation, I don't believe this site is an appropriate candidate.*

NCDOT and DWQ could not come to an agreement with Mitigation Site 3. Mitgation Site 3 was removed. Any additional impacts that occur at this site has been accounted for on the permit impact summary sheet at Site 14A and 14B.

Mitigation site 5

12) In my comments on the mitigation plan following the 4C meeting, I stated that the upstream impacts should be treated as restoration, while the downstream impacts should be treated as relocation. This is not how its presented in the permit application. Based on the pipe alignment, the entire downstream portion needs to be relocated, and, therefore, the impacts are mitigable impacts that should be listed as impacts from the road fill and the pipe.

The permit stream impacts for Mitigation Site 5 have been adjusted to reflect additional stream impacts at Site 8g and 8d. Site 8g now has permanent impacts, whereas previously it did not. DWQ and USACE did not agree with NCDOT's account of where mitigation impacts started and where project impacts started.

In addition to the above information, 44 feet of temporary impacts have been added to Site 18 (R-2413 A) to incorporate a crossing necessary to construct bent three. Impacts have been added to Table 1 and to permit summary sheet.

Revised permit drawing sheets 13-16 and 31 for R-2413 B and 44-46, 53-55, 66A-66C (new site), and 80 - 81 for R-2413 A are included with this letter. A document entitled " R-2413 A & B Update Information" is attached. This document updates the Surface Waters and Compensatory Mitigation Sections and Tables 1, 2, 5, and 6 of the Permit Application. Changed information in the tables is reflected by a strike through and /or italics. Also attached are the Pond Drainage Plan and the EEP Request Form. The EEP acceptance letter will be submitted under separate cover.

We believe that all of DWQ's and USACE concerns have been addressed and request that both agencies continue to process our application. If you have any further questions or need additional information, please contact Deanna Riffey at 919-707-6151 or driffey@ncdot.gov.

Sincerely,

E.L. Lusk

for Gregory J. Thorpe, Ph.D., Manager
Project Development and Environmental Analysis Unit

cc:
Colin Mellor, NES, NCDOT
Steve Morgan, Hydraulics Unit, NCDOT
Randy Henegar, Hydraulics, NCDOT

R-2413 A & B Application Update Information (7/10/13)

Correction Notes: New impact numbers are listed beside of old impact numbers. Old numbers have a strikethrough the number. Sites that changed are in italics.

Surface Waters

R-2413A

Surface water impacts for R-2413A are ~~8,917~~ 9,093 linear feet of permanent stream impacts and ~~866~~ 942 linear feet of temporary stream impacts. There are also 0.60 acres of surface water impacts for the installation of a corrugated steel pipe (CSP) in pond 4 (P4) ~~along with 0.29 acres of temporary surface water impacts for installation of pipes, a culvert, and bents of the bridge at Reedy Fork Creek~~. The jurisdictional stream impacts are summarized below in Table 1.

R-2413B

Surface water impacts for R-2413B are ~~3,441~~ 3,819 linear feet of permanent stream impacts and 197 linear feet of temporary stream impacts. ~~There are also 0.03 acres of temporary surface water impacts for three UTs to Reedy Fork and five UTs to the Haw River~~. The jurisdictional stream impacts are summarized below in Table 2.

Table 1. R-2413A Surface Water Impacts (Revised 7/10/13)

Site	Stream JD ID	Classification	Impact Type	Permanent Impacts (ft.)	Impacts Requiring USACE Mitigation (ft.)	USACE Proposed Mitigation Ratio	Impacts Requiring NCDWQ Mitigation (ft.)	Temporary Impacts (ft.)
1	S73A	Perennial	Fill	699	699	2:1	699	22
			BS[2]	20	0	0[1]	20	
2A	S68	Perennial	Fill	60	60	2:1	0	18
2B	S70	Perennial	Fill	44	44	2:1	0	7
2C	S67	Perennial	Fill	366	366	2:1	366	22
			BS[2]	20	0	0[1]	20	
3	S65	Perennial	Fill	212	212	2:1	212	36
			BS[2]	32	0	0[1]	32	
4	S63	Perennial	Fill	523	523	2:1	523	42
			BS[2]	30	0	0[1]	30	
5	S56	Perennial	Fill	408	408	2:1	408	33
			BS[2]	20	0	0[1]	20	
6	S53	Perennial	Fill	409	409	2:1	409	21
			BS[2]	23	0	0[1]	23	
7A	S51	Perennial	Fill	379	379	2:1	379	21
			BS[2]	45	0	0[1]	45	
Impacts Subtotal:				**3,290**	**3,100**		**3,186**	**222**

[1] Mitigation for bank stabilization not required by USACE. [2]BS = Bank Stabilization

Table 1. R-2413A Surface Water Impacts (continued) (Revised 7/10/13)

Site	Stream JD ID	Classification	Impact Type	Permanent Impacts (ft.)	Impacts Requiring USACE Mitigation (ft.)	USACE Proposed Mitigation Ratio	Impacts Requiring NCDWQ Mitigation (ft.)	Temporary Impacts (ft.)
7B	S50	Perennial	Fill	26	26	2:1	0	10
7C	S49	Perennial	Fill	31	31	2:1	0	
8A	S46	Perennial	Fill	654	654	2:1	654	50
			BS[2]	21	0	0[1]	21	
8B	S47	Perennial	Fill	50	50	2:1	0	
8C	S45	Perennial	Fill	34	34	2:1	0	
10A	S40	Perennial	Fill	426	426	2:1	426	41
			BS[2]	20	0	0[1]	20	
10B	S42	Perennial	Fill	49	49	2:1	0	
10C	S41	Perennial	Fill	116	116	2:1	0	
11	S39A	Perennial	Fill	47	47	2:1	0	17
12A	S37A	Perennial	Fill	299	299	2:1	299	
12B	S37C	Perennial	Fill	131	131	1:1	0	
13A	S35	Perennial	Fill	525	525	2:1	525	10
13B	S36	Perennial	Fill	106	106	2:1	0	
Impacts Subtotal:				**2,535**	**2,494**		**1,945**	**128**

[1] Mitigation for bank stabilization not required by USACE. [2]BS = Bank Stabilization

Table 1. R-2413A Surface Water Impacts (continued) (Revised 7/16/13)

Site	Stream JD ID	Classification	Impact Type	Permanent Impacts(ft.)	Impacts Requiring USACE Mitigation (ft.)	USACE Proposed Mitigation Ratio	Impacts Requiring NCDWQ Mitigation (ft.)	Temporary Impacts (ft.)
14A	*S31*	*Perennial*	Fill	~~486~~ 551	~~486~~ 551	2:1	~~486~~ 551	20
			BS[2]	25	0	0[1]	25	
14B	*S32*	*Perennial*	Fill	~~172~~ 258	~~172~~ 258	2:1	~~172~~ 258	10
15A	S29A	Perennial	Fill	513	513	2:1	513	41
			BS[2]	20	0	0[1]	20	
15B	S30	Perennial	Fill	46	46	2:1	0	
16A	S27	Perennial	Fill	342	342	2:1	342	29
			BS[2]	20	0	0[1]	20	
16B	S28	Perennial	Fill	33	33	2:1	0	
18	*S25*	Perennial	Fill					*172*
19	S23B	Perennial	Fill	507	507	2:1	507	34
20	S34	Perennial	Fill	240	240	2:1	240	
21A	S22A/B 22B	Perennial	Fill	288	288	2:1	288	262
21B	S22.5	Perennial	Fill	149	149	2:1	0	
22	S62	Perennial	Fill	256	256	2:1	256	22
			BS[2]	20	0	0[1]	20	
23	*S23A*	*Perennial*	Fill	0	0		0	12
Impacts Subtotal:				~~3,092~~ 3,268	~~3,032~~ 3,183		~~2,864~~ 3,040	~~516~~ 592
Total Impacts:			**Fill**	**~~8,626~~ 8,777**	**~~8,626~~ 8,777**		**~~7,704~~ 7,855**	**~~866~~ 942**
			BS[2]	**~~291~~ 316**	**0**		**~~291~~ 316**	
			Total	**~~8,917~~ 9,093**	**~~8,626~~ 8,777**		**~~7,995~~ 8,171**	**~~866~~ 942**

[1] Mitigation for bank stabilization not required by USACE. [2]BS = Bank Stabilization

Table 2. R-2413B Surface Water Impacts (7/10/13)

Site	Stream JD ID	Classification	Impact Type	Permanent Impacts (ft.)	Impacts Requiring USACE Mitigation (ft.)	USACE Proposed Mitigation Ratio	Impacts Requiring NCDWQ Mitigation (ft.)	Temporary Impacts (ft.)
1	S22	Perennial	Fill	260	260	2:1	260	45
			BS[2]	24	0	0[1]	24	
2	S17	Perennial	Fill	235	235	2:1	235	15
			BS[2]	11	0	0[1]	11	
3	S13	Perennial	Fill	726	726	2:1	726	30
4	S12	Intermittent	Fill	39	39	2:1	0	15
			BS[2]	11	0	0[1]	0	
5	S10	Perennial	Fill	554	554	2:1	554	24
			BS[2]	11	0	0[1]	11	
5A	S11	Perennial	Fill	146	146	2:1	0	17
6	S9B	Perennial	Fill		0	0	0	21
7	S6A	Perennial	Fill	411	411	2:1	411	30
8	S3A	Perennial	Fill	645	645	2:1	645	
8d	*S3A*	*Perennial*	Fill	~~339~~ 464	~~339~~ 464	1:1	~~339~~ 464	
8e	S5	Perennial	Fill	29	29	2:1	0	
8g	*S3A*	*Perennial*	Fill	253	253	1:1	253	
Total Impacts:			**Fill**	**~~3,384~~ 3,762**	**~~3,384~~ 3,762**		**~~3,159~~ 3,537**	**197**
			BS[2]	**57**	**0**		**57**	
			Total	**~~3,441~~ 3,819**	**~~3,384~~ 3,762**		**~~3,216~~ 3,594**	**197**

[1] Mitigation for bank stabilization not required by USACE. [2]BS = Bank Stabilization

Compensatory Mitigation (Revised 7/10/13)

R-2413A

Compensatory mitigation requirements for R-2413A are summarized below in Table 5. Section A will permanently impact ~~8,917~~ 9,093 feet of warm water streams. Of these ~~8,917~~ 9,093 feet, there are ~~291~~ 316 feet of bank stabilization that do not require mitigation by the USACE, resulting in ~~8,626~~ 8,777 feet of stream impacts requiring USACE mitigation.

The USACE is requiring 2:1 mitigation for ~~8,495~~ 8,646 feet and requiring 1:1 mitigation for 131 feet of stream impacts. NCDWQ is requiring mitigation for ~~7,995~~ 8,171 feet at 1:1. Therefore, the total USACE mitigation requirement exceeds the NCDWQ requirement. NCDOT is providing onsite mitigation of ~~2,732~~ 2,390 feet of warm water stream by enhancing, relocating, or restoring streams at ~~four~~ three sites. See Table 1 of the attached On-site Mitigation Plan Document for further information. The remaining mitigation requirements for ~~5,894~~ 6,387 feet of permanent warm water stream impacts will be provided by the NCEEP for R-2413A (Table 5).

NCEEP will also provide mitigation for the 3.32 acres (2:1 ratio) of permanent riparian wetland impacts resulting from roadway fill, excavation, and mechanized clearing.

Table 5. R-2413A Required Compensatory Mitigation Summary

	Stream Impacts in Length (ft.)	Riparian Wetland Impacts (ac.)
Impacts Requiring Mitigation	~~8,626~~ 8,777*	3.32
Onsite Mitigation Credits	~~2,732~~ 2,390	
Total Mitigable Impacts Less Onsite Mitigation	~~5,894~~ 6,387	3.32
Required EEP Mitigation	~~5,763~~ 6,256@ 2:1 131 @ 1:1	3.32 @ 2:1
Total EEP Mitigation	**~~11,657~~ 12,643**	**6.64**

*Does not include the 316 feet of bank stabilization.

R-2413B

Compensatory mitigation requirements for R-2413B are summarized below in Table 6. Section B will permanently impact ~~3,441~~ 3,819 feet of warm water streams. Of these ~~3,441~~ 3,819 feet, there are 57 feet of bank stabilization that do not require mitigation by the USACE, resulting in ~~3,384~~ 3,762 feet of stream impacts requiring USACE mitigation.

The USACE is requiring 2:1 mitigation for 3,045 feet and requiring 1:1 mitigation for ~~339~~ 717 feet of stream impacts. NCDWQ is requiring mitigation for ~~3,216~~ 3,594 feet at 1:1. Therefore, the total USACE mitigation requirement exceeds the NCDWQ requirement. NCDOT is providing onsite mitigation of 765 feet of warm water stream by relocating and restoring one stream at site five. See Table 1 of the attached On-site Mitigation Plan Document for further information. The remaining mitigation requirements of ~~2,619~~ 2,997 feet of permanent warm water stream impacts will be provided by the NCEEP for R-2413B (Table 6).

NCEEP will also provide mitigation for the 2.15 acres (2:1 ratio) of permanent riparian wetland impacts resulting from roadway fill, excavation, and mechanized clearing.

Table 6. R-2413B Required Compensatory Mitigation Summary (Revised 7/10/13)

	Stream Impacts in Length (ft.)	Riparian Wetland Impacts (ac.)
Impacts Requiring Mitigation	~~3,384~~ 3,762*	2.15
Onsite Mitigation Credits	765	
Mitigable Impacts Less Onsite Mitigation	~~2,619~~ 2,997	2.15
Required Mitigation	~~2,619~~ 2,280@ 2:1 *717@1:1*	2.15 @ 2:1
Total EEP Mitigation	**~~5,238~~ 5,277**	**4.30**

*Does not include the 57 feet of bank stabilization.

POND DRAINAGE PLAN REQUIREMENT:

The Contractor shall develop a Pond Drainage Plan for all ponds that are required to be drained for the construction of this project and submit the plan to the Engineer at the preconstruction conference for approval. The Pond Drainage Plan shall include but not be limited to procedures and rate of water drawdown, sediment control measures, water quality monitoring, fish and wildlife relocation plan, shall address procedures avoiding the inundation of a receiving body of water with deoxygenated or nutrient rich water resulting in impacts to aquatic life or algae bloom and procedures for maintaining downstream channel stability. If such ponds to be drained are on the DENR Dam Safety Inventory List, all NC DENR Dam Safety procedures must be followed.

Any erosion control devices or permanent seeding and mulching in areas where ponds have been drained will be paid for at the contract unit price for the item required. All additional erosion and sediment control practices not included in the contract documents that may be required on a pond drainage site will be done at the Contractor's expense.

No direct payment will be made for developing or implementing the Pond Drainage Plan as the cost of such shall be included in the lump sum price bid for *Clearing and Grubbing*.

MITIGATION REQUEST FORM
TRI-PARTY MOA (NCDOT)

Revised 3/24/2008

Fill in requested information, print out the form, sign and date, and either mail to EEP, 1652 Mail Service Center, Raleigh, NC 27699-1652, or fax to 919-715-2219. Attachments are acceptable for clarification purposes.

Electronic submissions are permissable; however, an acceptance letter cannot be sent until the original signed form has been received.

NCDOT CONTACT INFORMATION		REGULATORY CONTACT INFORMATION	
Agency/Division	NCDOT-Highways	**USACE Office**	Regulatory Field Office
Branch	PDEA-NEU	**USACE Contact**	Mr. Andy Williams
Mailing Address	1598 Mail Service Center	**Mailing Address**	3331 Heritage Trade Drive, Ste 105
City, State, Zip	Raleigh, NC 27699-1598	**City, State, Zip**	Wake Forest, NC 27587-4346
Project Manager	Deanna Riffey	**USACE Fax Number**	(919) 562-0421
Telephone Number	(919) 707-6000	**NCDWQ Contact**	
E-Mail Address	driffey@dot.state.nc.us	**Mailing Address**	
Supervisor	Rachelle Beauregard	**City, State, Zip**	
Telephone Number	(919) 707-6000	**NCDWQ Fax Number**	

PROJECT LOCATION INFORMATION AND IMPACTS

TIP Number(s)		R-2413 A		
TIP Description		NC 68 CONNECTOR - US 220 FROM EXISTING 4 LANES AT SR 2011		
Current Let Date		4/15/14		
NCDOT Highway Division		Division 7		
County(ies)		Guilford		
EEP Ecoregion(s)		Central Piedmont		
River Basin(s)		Cape Fear		
Cataloging Unit(s) (8-digit)		03030002		
Total Stream (feet)	**Warm**	9,384		
	Cool			
	Cold			
	TOTAL	9,384		
Total Riparian Wetland Impact (acres)		5.47		
Total Non-Riparian Wetland Impact (acres)				
Total Coastal Marsh Impact (acres)				
Total Buffer Impact	**Zone 1 (square feet)**			
	Zone 2 (square feet)			

OTHER INFORMATION

USACE Action ID Number (if known)	
NCDWQ Project Number (if known)	
NCDCM Project Number (if known)	

Comments:

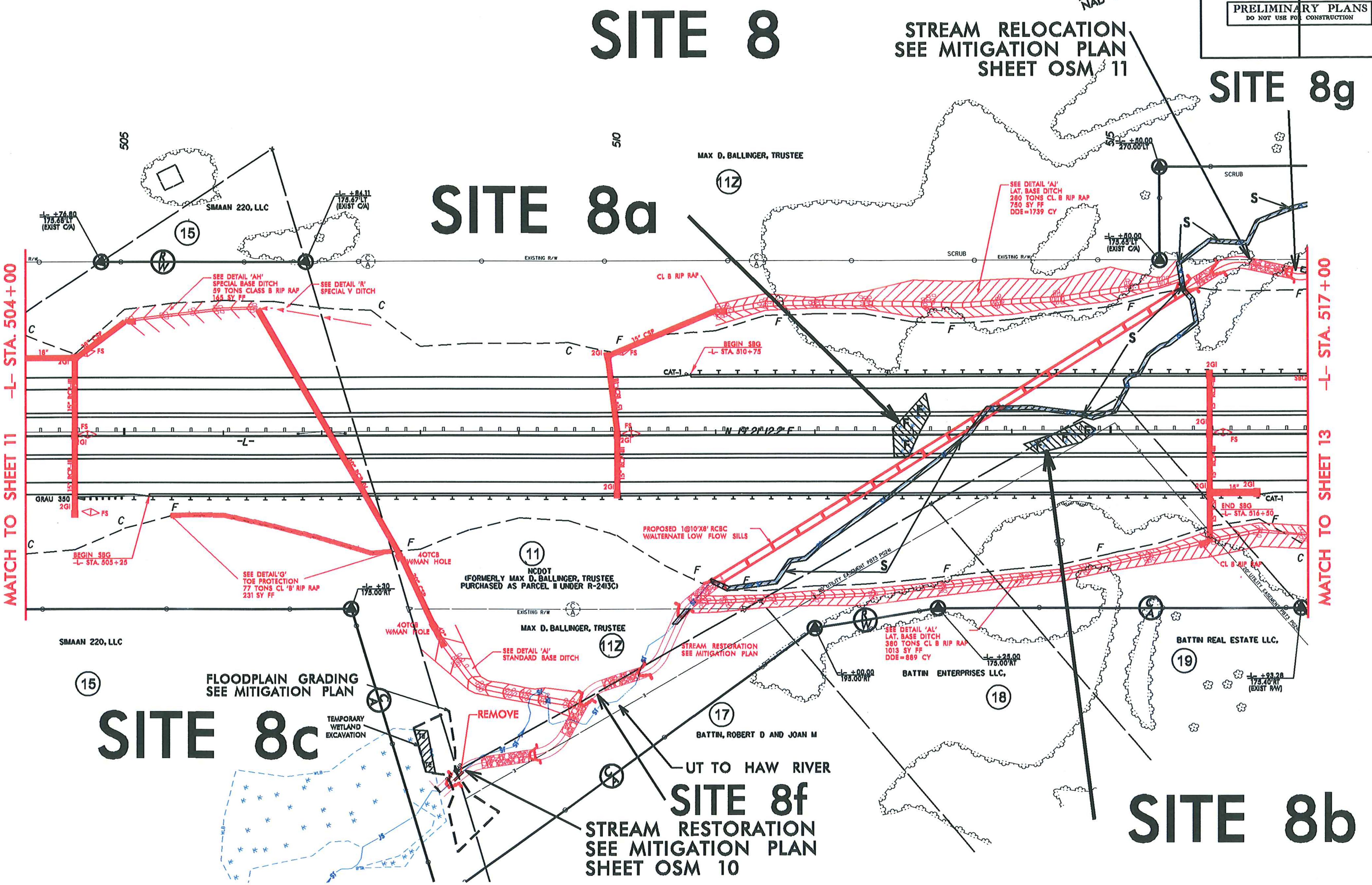
Impacts for R-2413 A & B
Streams: 8,536 feet @ 2:1
848 feet @ 1:1
S:\ProjMgmt\Central Region\Riffey\Rural\R-2413 Guilford\Permit

IMPORTANT	Signature of Applicant or Agent:
Check below if this request is a:	
New Mitigation Request	
X Revision to a current acceptance	Date:

PROJECT REFERENCE NO.	SHEET NO.
R-2413B	12
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Permit Drawing Sheet 13 of 31
Revised 7/1/13



DENOTES TEMPORARY EXCAVATION IN WETLAND

DENOTES IMPACTS IN SURFACE WATER

GRAPHIC SCALE 50' 0' 50' 100' 150'

PROJECT REFERENCE NO.	SHEET NO.
R-2413B	12
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Permit Drawing
Sheet 14 of 31
Revised 7/1/13

NAD 83/NSRS 2007

8/17/99

REVISIONS

SITE 8

SITE 8a

SITE 8g

STREAM RELOCATION
SEE MITIGATION PLAN
SHEET OSM 11

MAX D. BALLINGER, TRUSTEE
11Z

SMAAN 220, LLC
15

SCRUB

EXISTING R/W

SEE DETAIL 'AH'
SPECIAL BASE DITCH
59 TONS CLASS B RIP RAP
145 SY FF

SEE DETAIL 'R'
SPECIAL V DITCH

SEE DETAIL 'AI'
LAT. BASE DITCH
280 TONS CL. B RIP RAP
780 SY FF
DDE=1739 CY

CL B RIP RAP

BEGIN SBG
-L- STA. 510+75

END SBG
-L- STA. 516+80

CAT-1

PROPOSED 1@10'X8' RCBC
W/ALTERNATE LOW FLOW SILLS

SEE DETAIL 'G'
TOE PROTECTION
77 TONS CL 'B' RIP RAP
231 SY FF

BEGIN SBG
-L- STA. 503+25

NCDOT
(FORMERLY MAX D. BALLINGER, TRUSTEE
PURCHASED AS PARCEL 11 UNDER R-2413C)
11

SEE DETAIL 'AI'
STANDARD BASE DITCH

STREAM RESTORATION
SEE MITIGATION PLAN

SEE DETAIL 'AI'
LAT. BASE DITCH
380 TONS CL B RIP RAP
1013 SY FF
DDE=889 CY

BATTIN REAL ESTATE LLC.
19

BATTIN ENTERPRISES LLC.
18

BATTIN, ROBERT D AND JOAN M
17

FLOODPLAIN GRADING
SEE MITIGATION PLAN

TEMPORARY
WETLAND
EXCAVATION

REMOVE

EXCAVATION

UT TO HAW RIVER

SITE 8c

SITE 8f

STREAM RESTORATION
SEE MITIGATION PLAN
SHEET OSM 10

SITE 8b

MATCH TO SHEET 11 -L- STA. 504+00

MATCH TO SHEET 13 -L- STA. 517+00

TE TE DENOTES TEMPORARY EXCAVATION IN WETLAND

S S DENOTES IMPACTS IN SURFACE WATER

50' 0' 50' 100' 150'
GRAPHIC SCALE

$$$$$$SYSTIME$$$$$$
$$$$$$USERNAME$$$$$$
$$$$$$ICERNAME$$$$$$

8/17/99

PROJECT REFERENCE NO.	SHEET NO.
R-2413B	13
RW SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Permit Drawing
Sheet 13 of 31
Revised
7/1/13
NAD 83/NSRS 2007

STREAM RELOCATION
SEE MITIGATION PLAN
SHEET OSM 11

NOTE: STREAM MITIGATION
SEE OSM SHEET 11

SEE DETAIL 'AA'
CHANNEL RELOCATION

SITE 8e

SITE 8d

SEE DETAIL 'G'
TOE PROTECTION
35 TONS CL B RIP RAP
105 SY FF

END SBG
-L- STA. 520+00

GRAU 350

-L- +00.00
270.00' LT

-L- +00.00
175.44' LT
(EXIST C/A)
TIE FENCE TO R-2413C

-L- +22.80
175.44' LT
(EXIST C/A)

EXISTING R/W

(112)
MAX D. BALLINGER, TRUSTEE
DB 3561 PG 1460

-L- POT Sta. 521+22.80
END CONSTRUCTION

END TIP PROJECT R-2413B -L- Sta. 520+00.81

BEGIN TIP PROJECT R-2413C -L REV- Sta. 18+30.000
TIE MEDIAN GUIDERAIL TO TIP PROJECT R-2413C

(11)
NCDOT
(FORMERLY MAX D. BALLINGER, TRUSTEE
PURCHASED AS PARCEL 11 UNDER R-2413C)

-L- +47.35
175.41' RT
(EXIST C/A)

(112)
BALLINGER TRUSTEE, MAX D.
DB 3561 PG 1460

CONC. 2

US 220 25 BST

50' 0' 50' 100' 150'
GRAPHIC SCALE

SYSTIMESTAMP
SYSDATE
PENAMEL

8/17/99

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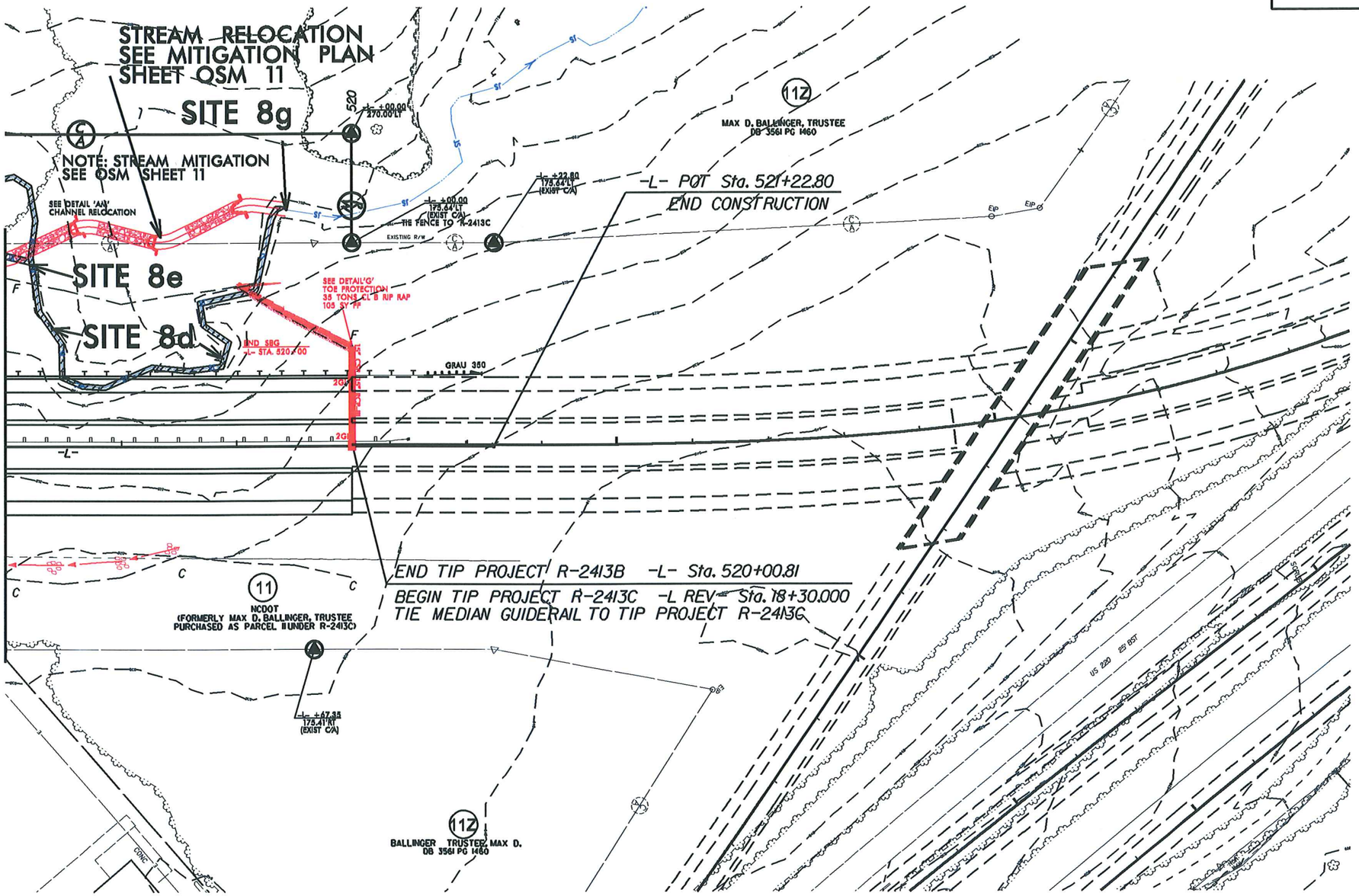
PROJECT REFERENCE NO.	SHEET NO.
R-2413B	13
RW SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION



DENOTES IMPACTS IN SURFACE WATER

50' 0' 50' 100' 150'
GRAPHIC SCALE

$$$$$SYSTIME$$$$$
$$$$$USERNAME$$$$$

WETLAND PERMIT IMPACT SUMMARY

Site No.	Station (From/To)	Structure Size / Type	WETLAND IMPACTS: Permanent Fill In Wetlands (ac)	WETLAND IMPACTS: Temp. Fill In Wetlands (ac)	WETLAND IMPACTS: Temp. Excavation in Wetlands (ac)	WETLAND IMPACTS: Mechanized Clearing in Wetlands (ac)	WETLAND IMPACTS: Hand Clearing in Wetlands (ac)	SURFACE WATER IMPACTS: Permanent SW impacts (ac)	SURFACE WATER IMPACTS: Temp. SW impacts (ac)	SURFACE WATER IMPACTS: Existing Channel Impacts Permanent (ft)	SURFACE WATER IMPACTS: Existing Channel Impacts Temp. (ft)	SURFACE WATER IMPACTS: Natural Stream Design (ft)
8	513+00 -L-	10' X 8' RCBC						0.06		645		
8a		Roadway Fill	0.02									
8b		Roadway Fill	0.03									
8c		Flood Plain Exc.			0.01							
8f	508+20 to 511+00 -L- Rt.	Stream Restoration										373
8d	517+25 to 519+11 -L- Lt.	Roadway Fill						0.03		464		
8g	515+75 to 519+43 -L- Lt.	Stream Relocation								253		392
8e	516+94 to 517+23 -L- Rt.	Roadway Fill						<0.01		29		
SUBTOTALS:			0.05		0.01			0.09		1391		765
TOTALS:			1.92		0.01	0.23		0.47	0.03	3819	197	765

NOTES:

NC DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS

GUILFORD COUNTY
WBS - 34429.1.1 (R-2413B)

7/1/2013

Revised 7/1/13

PROJECT REFERENCE NO.	SHEET NO.
R-2413A	20
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

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8/17/99

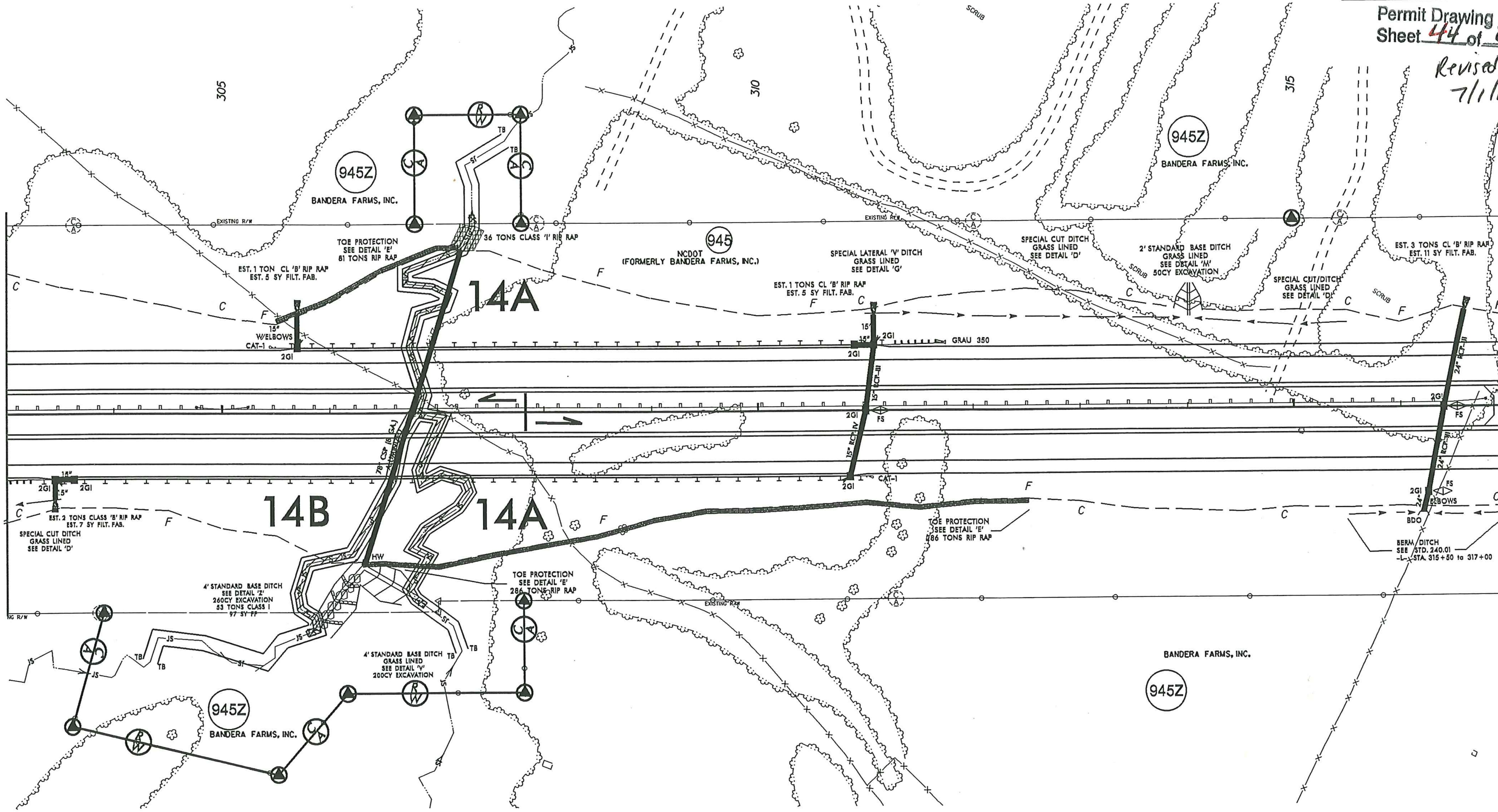
REVISIONS

S S DENOTES IMPACTS IN SURFACE WATER

TS TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER

SITE 14

NAD 83/NSRS 2007



GRAPHIC SCALE

100 50 0 100 200

PLANS

$$$$$$$SYSTIME$$$$$$ $$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$ $$$$$$USERNAME$$$$$

8/17/99

REVISIONS

DENOTES IMPACTS IN SURFACE WATER

DENOTES TEMPORARY IMPACTS IN SURFACE WATER

SITE 14

PROJECT REFERENCE NO.	SHEET NO.
R-2413A	20
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

NAD 83/NSRS 2007

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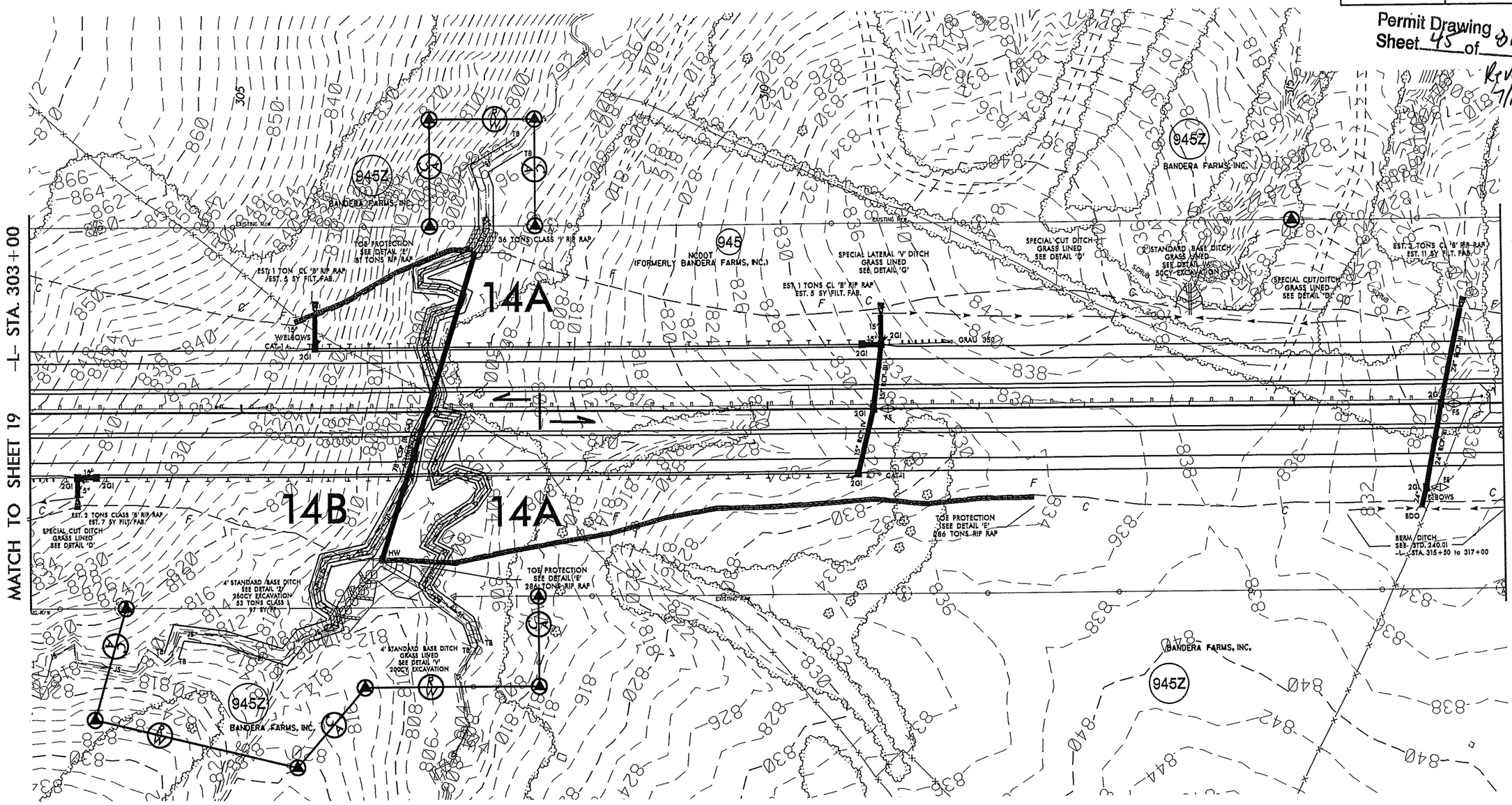
Revised 7/11/16



GRAPHIC SCALE

100 50 0 100 200

PLANS

R-2413A	20
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

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REVISIONS

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945Z
BANDERA FARMS, INC.

945
NCDOT
(FORMERLY BANDERA FARMS, INC.)

EXISTING R/W

TOE PROTECTION
SEE DETAIL 'E'
81 TONS RIP RAP

36 TONS CLASS 'I' RIP RAP

EST. 1 TON CL 'B' RIP RAP
EST. 5 SY FILT. FAB.

15"
W/ELBOWS
CAT-1

2GI

14A

14B

78" CSP (8 GA.)
ALUMINIZED

HW

4' STANDARD BASE DITCH
SEE DETAIL 'Z'
260CY EXCAVATION
53 TONS CLASS I
97 SY FF

4' STANDARD BASE DITCH
GRASS LINED
SEE DETAIL 'V'

TOE PROTECTION
SEE DETAIL 'E'
286 TONS RIP RAP

TB
SF
JS
C
F

SITE 14

TS TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER

S S DENOTES IMPACTS IN SURFACE WATER

100' 0' 100'

SCALE: 1"= 100'

$$$$$$$SYSTIME$$$$$$$
$$$$$$$FILENAME$$$$$$$

8/17/99

REVISIONS

R/W REVISION: PARCEL NUMBER 45 HAS BEEN CHANGED TO PARCEL NUMBER 47. CEH 2/27/13.

GRAPHIC SCALE

100 50 0 100 200

PLANS

PROJECT REFERENCE NO.	SHEET NO.
R-2413A	22
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

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SITE 17

CITY OF GREENSBORO

ROY LEE HEDRICK AND BARBARA HEDRICK

OLLIE T. HARRELL AND RHUMELL M. HARRELL

HARRELL, OLLIE T AND RHUMELL M

ARTHUR M. IHRIG AND ANN S. IHRIG

PAUL R. MOUNCE

MATCH TO SHEET 21 -L- STA. 331+00

-L- STA. 344+00 MATCH TO SHEET 23

PSH SEE DETAIL 'AP'

ELBOWS

ATTENUATOR

SMOOTH WALL

3' STANDARD BASE DITCH SEE DETAIL 'N' 46 TONS CLASS 'B' RIP RAP 123 SY FF 40 CY DDE

3' LATERAL BASE DITCH SEE DETAIL 'AA' 92 TONS CLASS 'B' RIP RAP 243 SY FF

CLASS II RIP RAP (STRUCTURE PAY ITEM)

HC HC DENOTES HAND CLEARING

F F DENOTES FILL IN WETLAND

DENOTES MECHANIZED CLEARING

TS TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER

T T DENOTES TEMPORARY FILL IN WETLAND

SITE 18

PROJECT REFERENCE NO.	SHEET NO.
R-2413A	22
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

GRAPHIC SCALE
100 50 0 100 200
PLANS

REVISIONS
R/W REVISION: PARCEL NUMBER 45 HAS BEEN CHANGED TO PARCEL NUMBER 47. PARCEL 45 HAS BEEN COMBINED WITH PARCEL 47. CEH 2/27/13.

8/17/99

Permit Drawing
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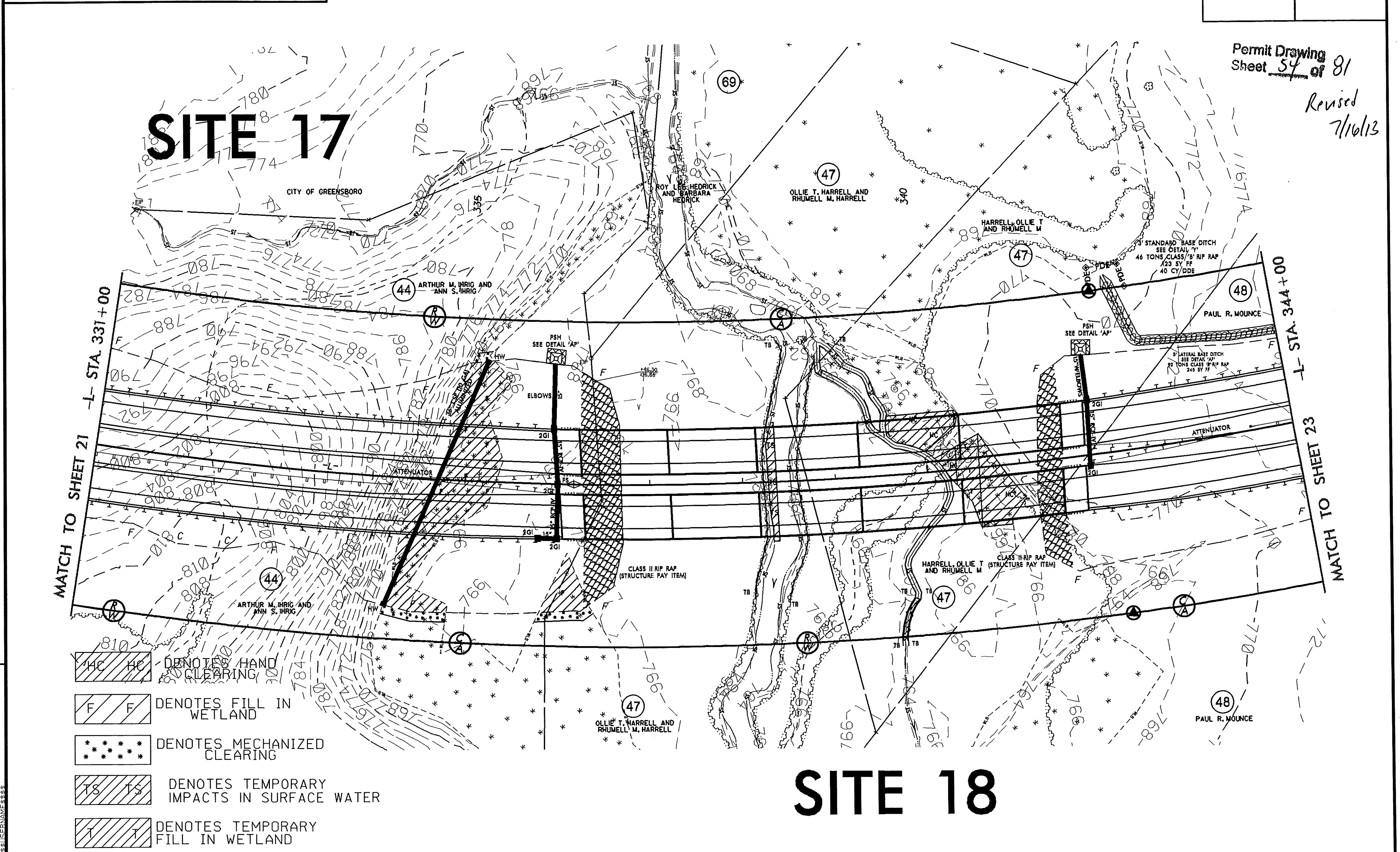

PROJECT REFERENCE NO.	SHEET NO.
R-2413A	22
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

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8/17/99

REVISIONS

SITE 17

SITE 18

44 ARTHUR M. IHRIG AND ANN S. IHRIG

HC HC DENOTES HAND CLEARING

F F DENOTES FILL IN WETLAND

DENOTES MECHANIZED CLEARING

TS +46.30 / 136.88 TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER

T T DENOTES TEMPORARY FILL IN WETLAND

PSH
SEE DETAIL 'AP'

EIP

HW

36" CSP (10 GA) ALUMINIZED

ELBOWS

15"

15" RCP-IV

2GI

FS

ATTENUATOR

CLASS II RIP RAP
(STRUCTURE PAY ITEM)

HARRELL, OLLIE T (STRUCTURE
AND RHUMELL M

47

100' 0' 100'

SCALE: 1"= 100'

$$$$$$$SYSTIME$$$$$$$
$$$$$$$USERNAME$$$$$$$

R-2413A	33
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

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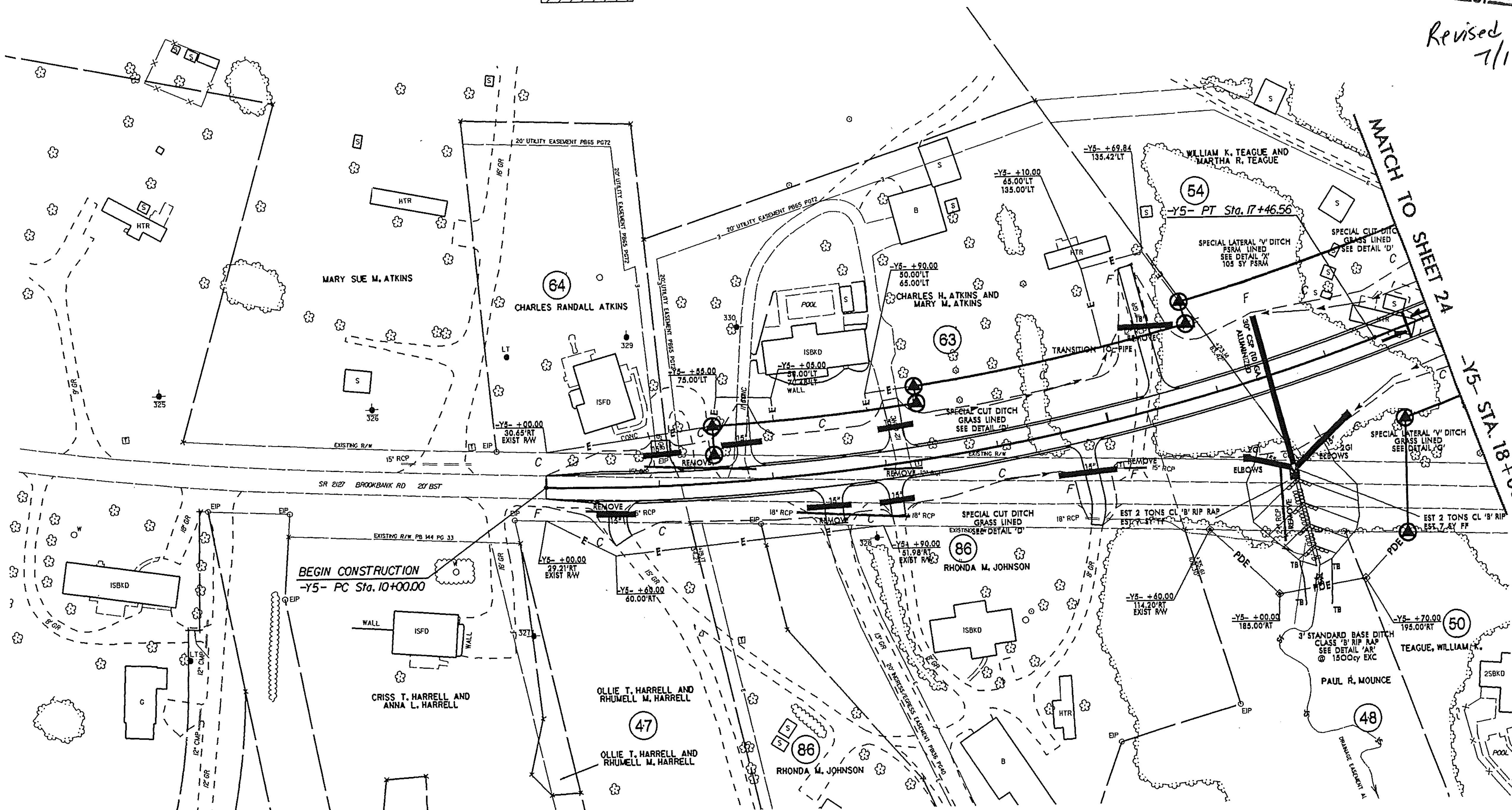
SITE 23

TS TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER



PAVEMENT REMOVAL

FOR -Y5- PROFILE, SEE SHEET NO. 61

DRIVEWAY RADII ARE 15', UNLESS NOTED

FOR DITCH DETAILS, SEE SHEET NO. 2-W & 2-X

REVISIONS

DESIGN REVISION: THE VERTICAL ALIGNMENT FOR -Y5- HAS BEEN REVISED. JLT 1/28/2013

R/W REVISION: PARCEL NUMBER 87 HAS BEEN CHANGED TO PARCEL 86. PARCEL 87 HAS BEEN COMBINED WITH PARCEL 86. CEH 2/27/13.

8/17/99

PROJECT REFERENCE NO.	SHEET NO.
R-2413A	33
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

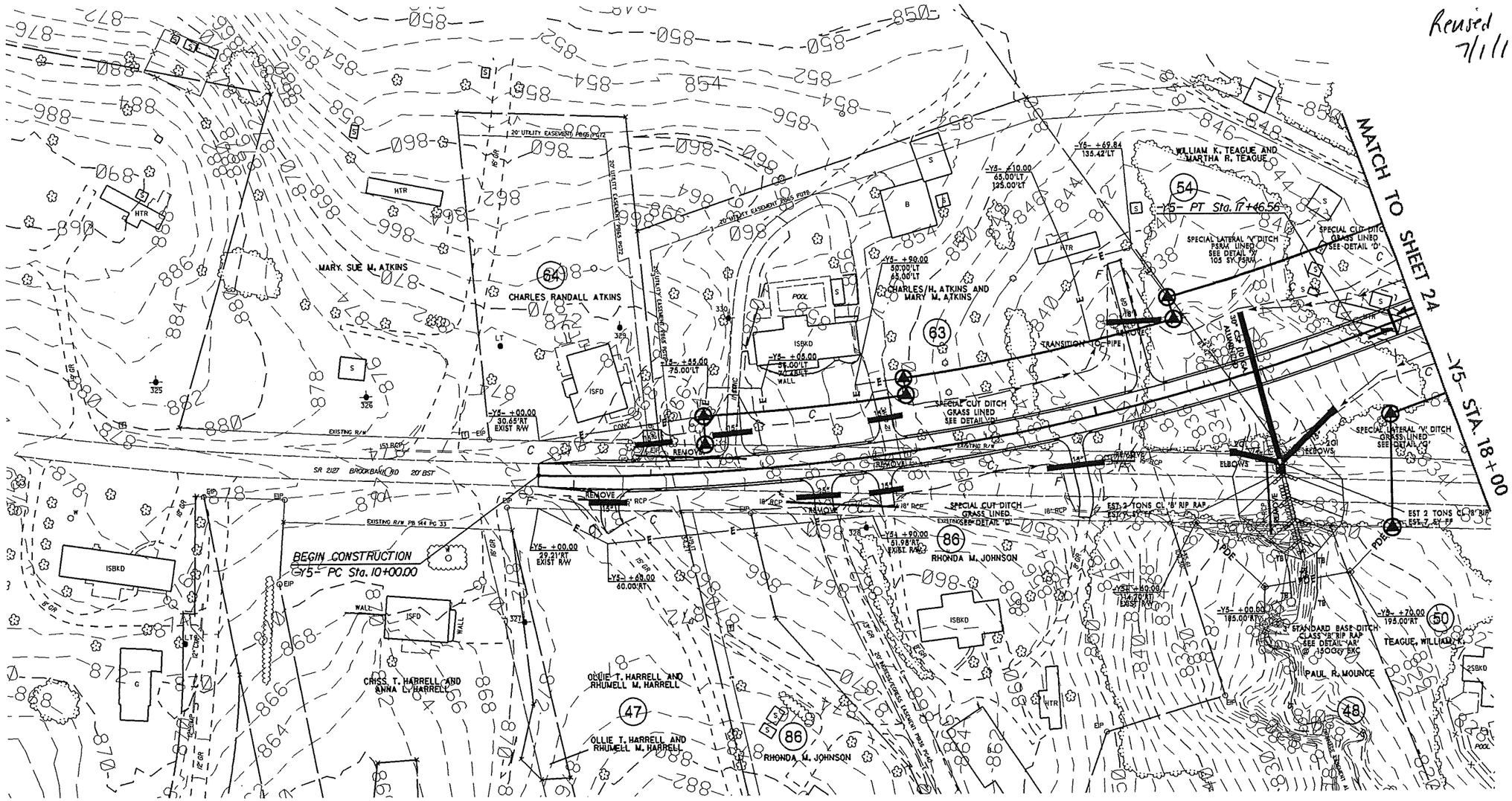
NAD 83/NSRS 2007

Permit Drawing
Sheet 66B of 91

Revised
7/1/13

SITE 23

TS TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER



PAVEMENT REMOVAL

FOR -Y5- PROFILE, SEE SHEET NO. 61

DRIVEWAY RADII ARE 15', UNLESS NOTED

FOR DITCH DETAILS, SEE SHEET NO. 2-W & 2-X

REVISIONS

DESIGN REVISION: THE VERTICAL ALIGNMENT FOR -Y5- HAS BEEN REVISED. JLT 1/28/2013

R/W REVISION: PARCEL NUMBER 87 HAS BEEN CHANGED TO PARCEL 86. CEH 2/27/13.

8/17/99

$$$$$$$$$$TIME$$$$$$$$$$

$$$$$$$$$$DGN$$$$$$$$$$

$$$$$$$$$$USERNAME$$$$$$$$$$

PROJECT REFERENCE NO.	SHEET NO.
R-2413A	33
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

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REVISIONS

100' 0' 100'

SCALE: 1"= 100'

NAD 83/NSRS 2007

SPECIAL LATERAL 'V' DITCH
PSRM LINED
SEE DETAIL 'X'
105 SY PSRM

SPECIAL CUT DITCH
GRASS LINED
SEE DETAIL 'D'

HTR

INS AND
KINS

18" RCP
REMOVE

TRANSITION TO PIPE

+23+14
85.42' RT

30" CSP [10 GA.]
ALUMINIZED

15"

GRAU 350

EASEMENT NO RECORD FOUND

15"

HTR

3/32

AL CUT DITCH
ASS LINED
DETAIL 'D'

EXISTING R/W

15" REMOVE 15" RCP

2GI ELBOWS

15" 2GI ELBOWS

SPECIAL LATERAL 'V' DITCH
GRASS LINED
SEE DETAIL 'G'

-Y5- +55.00
75.00'RT

RETAIN

12" RCP

15"

ECIAL CUT DITCH
GRASS LINED
SEE DETAIL 'D'

18" RCP

EST 2 TONS CL 'B' RIP RAP
EST 7 SY FF

24" RCP REMOVE

EST 2 TONS CL 'B' RIP RAP
EST 7 SY FF

-Y5- +52.02
1.00'RT

331

WALL

RETAIN

A M. JOHNSON

8" GR

+35.61
108.30' RT

PDE

TB

PDE

TB

PDE

-Y5- +60.00
114.20'RT
EXIST R/W

-Y5- +00.00
185.00'RT

-Y5- +70.00
195.00'RT

50

3' STANDARD BASE DITCH
CLASS 'B' RIP RAP
SEE DETAIL 'AR'
@ 1500cy EXC

TEAGUE, WILLIAM K.

PAUL R. MOUNCE

HTR

EIP

EIP

48

SITE 23

TS TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER

WETLAND PERMIT IMPACT SUMMARY

Site No.	Station (From/To)	Structure Size / Type	WETLAND IMPACTS: Permanent Fill In Wetlands (ac)	Temp. Fill In Wetlands (ac)	Excavation in Wetlands (ac)	Mechanized Clearing in Wetlands (ac)	Hand Clearing in Wetlands (ac)	SURFACE WATER IMPACTS: Permanent SW impacts (ac)	Temp. SW impacts (ac)	Existing Channel Impacts Permanent (ft)	Existing Channel Impacts Temp. (ft)	Natural Stream Design (ft)
12	269+50 -L-	72" CSP										
12a.								0.03		299		1163*
12b.								0.01		131		
13	277+00 to 281+00 -L-	54" RCP										
13a.								0.04	<0.01	525	10	977*
13b.								0.01		106		
14	307+00 -L-	78" CSP										
14a.								0.07		551	20	
14b.								0.02		258	10	
		Bank Stabilization								25		
15	322+50 to 326+00 -L-	54" CSP										
15a.			0.01					0.04	<0.01	513	41	
		Bank Stabilization								20		
15b.								<0.01		46		
16	327+50 to 329+50 -L-	72" CSP										
16a.			0.15					0.02	<0.01	342	29	
		Bank Stabilization								20		
16b.								<0.01		33		
SUBTOTALS:			0.16					0.21	0.03	2,869	110	2,140

* See Plan for On-Site Mitigation

NC DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GUILFORD
COUNTY
WBS - 34429.1.1 (R-2413A)

ATN Revised 3/31/05

WETLAND PERMIT IMPACT SUMMARY

Site No.	Station (From/To)	Structure Size / Type	WETLAND IMPACTS: Permanent Fill In Wetlands (ac)	Temp. Fill In Wetlands (ac)	Excavation in Wetlands (ac)	Mechanized Clearing in Wetlands (ac)	Hand Clearing in Wetlands (ac)	SURFACE WATER IMPACTS: Permanent SW impacts (ac)	Temp. SW impacts (ac)	Existing Channel Impacts Permanent (ft)	Existing Channel Impacts Temp. (ft)	Natural Stream Design (ft)
17	334+00 to 336+50 -L-	36" CSP	0.35			0.03						
18	338+00 to 340+50 -L-	Bridge		0.04			0.13		0.03		172	
19	348+00 to 353+00 -L-	60" RCP						0.03	<.01	507	34	
20	17+50 to 19+00 -Y4-	36" CSP	0.11					0.02		240		
21	29+00 to 36+00 -Y5-	1 @ 12' X 12' RCBC										
21a.			2.11			0.13		0.06	0.09	288	262	250*
21b.		Road Fill						0.01		149		
22	24+50 -Y1C-	48" CSP						0.02	<.01	256	22	
		Bank Stabilization								20		
23	16+50-Y1C-	30" CSP/PDE							<.01		12	
SUBTOTALS:			2.57	0.04	<0.01	0.13	0.13	0.14	0.15	1,460	502	250
TOTALS:			3.13	0.04	<0.01	0.19	0.13	1.45	0.31	9,093	922	2,390

* See Plan for On-Site Mitigation

NC DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GUILFORD
COUNTY
WBS - 34429.1.1 (R-2413A)

On-Site Stream Mitigation Plan

R-2413 A&B NC 68 Connector from SR 2011 to the Haw River

Guilford County, North Carolina

T.I.P. Number R-2413 A&B

WBS No's: 34429.1.1, 34429.2.2, 34429.2.3

JUNE 25, 2013

The North Carolina Department of Transportation (NCDOT) plans to use on-site stream mitigation to offset unavoidable impacts to existing streams from the construction of the proposed NC 68 Connector corridor (R-2413A&B) in Guilford County. Five potential stream mitigation sites associated with the R-2413 A&B project were assessed in December 2010. This mitigation project will provide approximately 2,945 linear feet of stream mitigation credits in the Cape Fear River Basin. The sites are located along the proposed R-2413 A corridor in Guilford County between SR 2011 (Edgefield Road) and SR 2127(Brookbank Road) and along the proposed R-2413 B corridor in Guilford County between SR 2127 (Brookbank Road) and the Haw River.

Field reviews confirmed that all five stream reaches are perennial. The combined existing length of the stream reaches is approximately 3,080 linear feet. The combined proposed length of the stream reaches is approximately 3,155 linear feet. A summary of the stream locations, mitigation approaches, and lengths are provided in Table 1. More detailed descriptions of the existing and proposed conditions of each site are presented in the following sections.

TABLE 1. STREAM INFORMATION

Mitigation Site	JD Stream No.	Roadway Plan Sheet	Roadway Station	Existing Length (ft.)	Mitigation Type	Proposed Length (ft.)
Site 1	S37a/ 38	17 (R-2413A)	269+00 to 271+50	1,300	Enhancement	350
					Restoration	813
Site 2	S35/ 36	18 (R-2413A)	274+50 to 282+50	1,000	Relocation/ Restoration	906
					Enhancement	71
Site 3	Mitigation Site 3 has been removed.					
Site 4	S22a/ 22b	34 (R-2413A)	-Y5-Sta. 30+50 to -Y5 Sta. 32+10	170	Restoration	250
Site 5	S3a	12 (R-2413B)	508+30 to 511+20	610	Restoration/ Relocation	765
		13 (R-2413B)	517+10 to 519+30			

1.0 BASELINE

The R-2413 A&B mitigation sites are located in Guilford County between State Route 2011 (Edgefield Road) and State Route 2127 (Brookbank Road) and between State Route 2127 (Brookbank Road) and the Haw River. See Figures 1 and 2A – 2D at the end of this report. The eight digit USGS Hydrologic Unit Code (HUC) for all five sites is 03030002 (Cape Fear Basin). Sites 1 through 4 lie within the 11 digit USGS HUC 03030002010, and the North Carolina Division of Water Quality (NCDWQ) sub-basin number for these four sites is 03-06-02. Site 5 lies within the 11 digit USGS HUC 03030002020 and the NCDWQ sub-basin number is 03-06-01. All sites are designated by the North Carolina Division of Water Quality (NCDWQ) as Nutrient Sensitive Waters. All stream Sites, 1 through 5, were classified as perennial in NCDOT's 2009 State EA/FONSI Reevaluation. Table 2 provides NCDWQ Stream Classifications of the proposed mitigation reaches.

TABLE 2. SITE LOCATION INFORMATION

Mitigation Site	Roadway Station	Stream Name	Stream Classification	Stream Index Number
Site 1 WM 041-034	269+00 to 271+50	UT to Reedy Creek	WS-III; NSW	16-11-(1)
Site 2 WM 041-035	274+50 to 282+50	UT to Reedy Creek	WS-III; NSW	16-11-(1)
Site 3 WM 041-036	Mitigation Site 3 has been removed.			
Site 4 WM 041-037	-Y5-Sta. 30+50 to -Y5 Sta. 32+10	UT to Reedy Creek	WS-III; NSW	16-11-(1)
Site 5 WM 041-038	508+30 to 511+20			
	517+10 to 519+30	UT to Haw River	WS-V; NSW	16-(1)

WS-III = Water Supply III - Moderately Developed; WS-V = Water Supply V - Upstream; NSW Nutrient Sensitive Waters

2.0 SITE SELECTION

A discussion of the watershed information and existing conditions for each project stream site is provided in the sections that follow. Existing condition geomorphology parameters and measurements are provided in Appendix B.

GENERAL WATERSHED INFORMATION

The watersheds for the project reaches are primarily rural, ranging from low density residential to agricultural land uses. The watersheds are estimated to range from 5 to 50 percent low density residential and commercial development with the remainder agriculture and forest. Future zoning for most of the watersheds is primarily low to moderate density residential so changes in land use are expected over the next 10 years. Watershed drainage areas are summarized in Table 3 for the project sites.

TABLE 3. DRAINAGE AREAS FOR PROJECT REACHES

Mitigation Site	Stream Name	Drainage Area (square miles)
Site 1	UT to Reedy Creek	0.13
Site 2	UT to Reedy Creek	0.09
Site 4	UT to Reedy Creek	3.04
Site 5	UT to Haw River	0.41

SITE 1 (WM 041-034)

An unnamed tributary (UT) to Reedy Fork flows approximately 2,700 feet from its headwaters to its confluence with Reedy Creek (Figure 2A). The stream is shown on the USGS topographic quadrangle as an intermittent stream. Observations during field investigations indicate that the upper portion of the stream is likely intermittent and the lower portion appears to be perennial. The UT flows through two distinct valley sections. The upper valley section has a relatively steep down valley slope with a tighter cross valley slope. The lower valley becomes less steep down valley and the cross valley slope becomes broader as the stream approaches its confluence with Reedy Creek. Much of the stream within the upper valley is entrenched and the stream within the lower valley is deeply incised. Both portions of the stream show signs of instability. A riparian buffer surrounds the stream with early successional woody vegetation adjacent to the stream banks. Based on a review of available aerial photography, the riparian areas appear to have been logged between 1999 and 2002. The channel materials are primarily sands with intermixed gravel-sized material. The upper and lower portions of the existing stream channel are classified as Rosgen G5 stream types. The watershed for this UT to Reedy Creek is approximately 0.13 square miles at its confluence with the larger stream at the downstream end of the site. The watershed is approximately 70% wooded and 30% agricultural or light residential. According to Guilford County Geographic Information System (GIS) data, future land use of the watershed is low residential (1 to 2 dwelling units/acre).

SITE 2 (WM 041-035)

This UT to Reedy Creek flows within Site 2 from its headwaters approximately 2,500 feet toward a confluence with the Site 1 UT to Reedy Creek (Figure 2B). This upper portion of the UT is not shown on the USGS topographic quadrangle as a blue line stream. Similar to Site 1, observations during field investigations indicate that the upper portion of the stream is likely intermittent and the lower portion appears to be perennial. The Site 2 UT to Reedy Creek has a relatively steep down valley slope within the upper reach with a tight cross valley slope. The lower reach valley becomes less steep and the cross valley slope becomes broader as the stream approaches its confluence with the Site 1 UT to Reedy Creek. The upper reach of this existing channel near the proposed area of impact is relatively stable and classifies as a Rosgen E5 channel. The lower portion of Site 2 varies from an E5 to G5 channel and has a severe headcut that is gradually moving up through the system. The UT is moderately sinuous. Sand materials with inclusions of gravel material dominate the upper channel and gravel materials dominate the lower channel. A riparian buffer surrounds the stream with early successional woody vegetation adjacent to the stream banks. As with Site 1, based on a review of available aerial photography, the riparian areas appear to have been logged between 1999 and 2002. Kudzu has invaded an adjacent hill side in the upper portion of the reach. The watershed for this UT to Reedy Creek is 0.09 square miles at the downstream end of the site. The watershed is approximately 70% forested and 30% agricultural or light residential. According to Guilford County GIS data, future land use of the watershed is low residential (1 to 2 dwelling units/acre).

SITE 3 (WM 041-036)

Mitigation Site 3 has been removed.

SITE 4 (WM 041-037)

A UT to Reedy Creek flows through Site 4 within a broad and gently sloping valley (Figure 2D). The UT is depicted as perennial on the USGS topographic quadrangle and observations during the field investigations confirmed that the reach is perennial. The channel within Site 4 appears to have frequent access to its floodplain and has an entrenchment ratio of 5.4. The UT has a low sinuosity within the project reach and classifies as a Rosgen E5 stream type. The channel flows through an existing culvert under Brookbank Road. The riparian area upstream of Brookbank Road consists of mature woody vegetation and the riparian area downstream of Brookbank Road appeared to be impacted by Kudzu during the site visit. The watershed is approximately 3.04 square miles at the downstream end of the site. The watershed is 40% forested and the remainder is residential or agricultural.

SITE 5 (WM 041-038)

Site 5 consists of a UT to Haw River (Figure 2E). The stream valley is relatively broad with a flat down valley slope. The lower portion of the UT is depicted as perennial on the USGS topographic quadrangle. An instream pond is depicted on the USGS topographic quadrangle between the lower and upper portions. Site investigations revealed that the pond is no longer

present because the stream has routed around the East side of the old dam resulting in significant bank erosion. The lower cross valley slope becomes broader as the stream approaches its confluence with Haw River. The riparian buffer consists of mature woody vegetation. The channel is incised and straightened and shows signs of instability. Within the upper reach the stream classifies as an E5 channel but is slightly entrenched and is trying to re-establish pattern by eroding the existing banks. The watershed is 0.41 square miles at the downstream end of the site. The watershed is 60% forested and 40% residential or agricultural.

3.0 SITE PROTECTION INSTRUMENT

The mitigation areas are presently located within or will be located within the NCDOT Right-of-Way for the project. The sites are designated on the plan sheets as a mitigation area and will placed on the Natural Environment Section's 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 this mitigation site and the associated roadway impacts to protect the site in perpetuity.

4.0 OBJECTIVES

The goals for these projects are to restore/relocate 2,734 linear feet of stream and enhance 421 linear feet of stream. This will be achieved by: improving floodplain function by matching floodplain elevation with bankfull stage; establishing native stream bank and floodplain vegetation; improving water quality in the Cape Fear River watershed by reducing sediment and nutrient inputs; and improving aquatic and riparian habitat by creating deeper pools and areas of re-aeration, planting a riparian buffer, and reducing bank erosion.

5.0 MITIGATION WORK PLAN

The stream mitigation plan for each of the four project sites is described in the sections that follow. Detailed plan sheets have been provided to NCDOT with the submittal of this mitigation plan narrative.

SITE 1 (WM 041-034)

A combination of Priority II and Priority I restoration is proposed for the upper reach of the Site 1 stream channel. A portion of the upper reach of Site 1 will only require enhancement measures with occasional log vanes, some boulder toe protection, and minor bank grading (see OSM-4, -12 and XS-01, -02). The channel is currently an incised G5 Rosgen stream type channel that will be restored to a stable C5 channel by establishing a lower valley at the bankfull elevation for the upstream portion then gradually elevating the stream channel to allow bankfull and higher flows access to the existing floodplain prior to flowing into the proposed 72" culvert under the new roadway alignment. Priority I restoration is proposed for the lower reach of Site 1. The existing channel classifies as an incised G5 Rosgen stream type that will also be restored to a stable C5 channel. As channel flow exits the 72" culvert under the proposed roadway it will flow into a

stream channel that will be elevated to allow proper floodplain access at the bankfull elevation on new location. The stream channel will be relocated back to the center of the existing valley.

Proper sinuosity and radius of curvature will be restored to both the upper and lower stream reaches to provide stability. Proper riffle-pool sequencing will also be returned to the channels along with in-stream rock and log structures to provide immediate grade control of the newly excavated channels. 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 must also be given to the possible change in flow regime in this system as it may be influenced by storm water runoff from the proposed roadway. The proposed stream channel design anticipates the increased impervious area and increased flashy flows from contributing adjacent roadway stormwater runoff. This is achieved by maximizing radii of curvature to ensure that bends in the stream channel are gradual enough to accommodate flashy flows. Similarly, the belt width of the proposed stream channel is narrowed, slightly straightening the flood plain to convey flood flows without excessively increasing shear stress along the edges of the newly constructed floodplain.

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.

The proposed riparian buffer for Site 1 upper extends a minimum of 50 feet from the top of bank from both sides of the stream channel and totals approximately 1.97 acres. The required buffer will be included within proposed right-of-way. The proposed riparian buffer for Site 1 lower will extend a minimum of 50 feet from the top of bank on both sides and would require a minimum of 1.27 acres. Due to the fact that Site 1 lower and Site 2 lower are located adjacent to each other on the north side of the proposed roadway, the proposed right-of-way will include Site 1 lower, Site 2 lower, their respective riparian buffers and the forested drainage area between the two. Design parameters for the proposed stream can be found in the morphological table in Appendix B.

SITE 2 (WM 041-035)

The upper reach of the existing stream channel on Site 2 will be relocated away from the toe of fill material using a Priority I restoration approach. The existing channel in this location is fairly stable but will be directly impacted by the fill slope as shown in the on-site mitigation construction drawings. The existing upper reach channel transitions from a B5 at the upper extent of the project to an E5 where the channel will be impacted by the future roadway work. The relocated channel will be designed as a C5 channel with gradual 3:1 side slopes that will be

planted and will eventually transition to an E5 channel over time as the channel narrows. The lower reach of Site 2 Classifies as an E5 channel that transitions to a G5 channel downstream of a large 4.0 foot head cut that is moving up through the system. This lower reach begins at the outlet of the proposed 54 inch culvert and it is anticipated that the roadway drainage would expedite the upstream progression of the existing head cut. The proposed restored lower reach channel will also be designed as a C5 channel with gradual 3:1 side slopes that will be planted and eventually transition to an E5 channel as the channel narrows over time.

Appropriate sinuosity and radius of curvature will be restored to both the upstream and downstream reach channels to provide stability. The channels will be elevated to their historic floodplain in some locations where possible, improving their cross sectional dimension and allowing bankfull and higher flows to access the floodplain. Proper riffle-pool sequencing will also be returned to the channels with corrected pattern and the installation of rock and log structures. The installation of these in-stream 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 must also be given to the possible change in flow regime in this system as it may be influenced by storm water runoff from the proposed roadway. The proposed stream channel design anticipates the increased impervious area and increased flashy flows from contributing adjacent roadway stormwater runoff. This is achieved by maximizing radii of curvature to ensure that bends in the stream channel are gradual enough to accommodate flashy flows. Similarly, the belt width of the proposed stream channel is narrowed, slightly straightening the flood plain to convey flood flows without excessively increasing shear stress along the edges of the newly constructed floodplain.

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.

The proposed riparian buffer for Site 2 upper extends a minimum of 50 feet from the top of bank from both sides and would require approximately 1.33 acres. The required buffer will be included within proposed right-of-way. The proposed riparian buffer for Site 2 lower will extend a minimum of 50 feet from the top of bank on both sides and would require a minimum of 1.48 acres. Due to the fact that Site 1 lower and Site 2 lower are located adjacent to each other on the north side of the proposed roadway, the proposed right-of-way will include Site 1 lower, Site 2 lower, their respective riparian buffers and the forested drainage area between the two. Design parameters for the proposed stream can be found in the morphological table in Appendix B.

Some Kudzu is present adjacent to the very upper reaches of Site 2. NCDOT proposes to minimize the potential spread of this species from construction-related activities. NCDOT will also 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.

SITE 3 (WM 041-036)
Mitigation Site 3 has been removed.

SITE 4 (WM 041-037)
A Priority II restoration approach is proposed for the stream reach at Site 4. The current channel classifies as a Rosgen E5 stream channel and flows through an existing culvert under Brookbank Road. The proposed restoration of this reach will consist of excavating a new stream channel and floodplain through the existing Brookbank Road fill material. This road will be abandoned with the proposed improvements associated with R-2413A&B and presents an opportunity to re-connect the upstream floodplain with the floodplain downstream of the existing roadway fill. The proposed channel through this reach will be a C5 channel. Banks and floodplain will be planted with native species and the channel is expected to narrow over time to an E5 channel. The proposed reach is not long enough to establish pattern within the restored reach, but in-stream log cross vanes will be installed to provide profile stabilization and in-stream habitat. Preliminary design parameters for the proposed stream can be found in the morphological table in Appendix B.

Presently, Kudzu grows in areas adjacent to this site. NCDOT proposes to minimize the potential spread of this species from construction-related activities. NCDOT will also 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 proposed riparian buffer for this channel would extend 50 feet from the top of bank from both sides and would total approximately 1.01 acres. The revised right-of-way encompasses the required easement area.

SITE 5 (WM 041-038)
The upper reach of Site 5 will be restored using Priority I restoration. At the upstream end of the proposed restoration a pipe and causeway will be removed and floodplain connectivity restored to both the right and left floodplains. Causeway removal and grading will result in 0.01 acres of temporary wetland impacts. Downstream, the existing channel will be relocated to the center of the existing floodplain and elevated so that bankfull and higher flows can access the existing floodplain. The lower reach of Site 5 will be relocated by re-establishing a natural stream channel and proper floodplain through the existing dam. The existing stream channel breached the dam along the east side of the floodplain and is therefore currently eroding the toe of the existing floodplain and the fill material of the old dam. The channel will be relocated back to the center of the existing floodplain and a significant portion of the dam will be removed to ensure

the upstream floodplain is hydraulically connected to the lower floodplain. The existing channels at Site 5 classify as incised E5 channels that are actively eroding in an effort to re-establish appropriate pattern and dimension. The appropriate dimension, pattern, and profile will be restored to the relocated channels in both the upper and lower reaches.

Special attention will be given to the change in flow regime that could occur from the storm water runoff of the proposed roadway. The proposed stream channel design anticipates the increased impervious area and increased flashy flows from contributing adjacent roadway stormwater runoff. This is achieved by maximizing radii of curvature to ensure that bends in the stream channel are gradual enough to accommodate flashy flows. Similarly, the belt width of the proposed stream channel is narrowed, slightly straightening the flood plain to convey flood flows without excessively increasing shear stress along the edges of the newly constructed floodplain.

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.

A Rosgen type C5 channel is proposed for both the upstream and downstream reaches. Rock and log in-stream structures will be installed along the restored reaches to ensure that the newly constructed stream channels remain stable until mature vegetation is established on the banks and native bed material is transported into the relocated channels. Preliminary design parameters for the proposed stream can be found in the morphological table in Appendix B. The proposed riparian buffer for this channel would extend 50 feet from the top of bank from both sides and would total approximately 2.18 acres. The required buffer will be included within proposed right-of-way in order to provide easements along proposed cut lines associated with the proposed stream restoration and to ensure a 50 foot minimum riparian buffer is provided on all stream reaches.

6.0 PERFORMANCE STANDARDS

Success for vegetation monitoring within the riparian buffer and wetland areas is based on the survival of at least 320 stems at year three and 260 stems of five year old trees at year five. Assessment of channel stability will be based on the survival of riparian vegetation and lack of significant bank erosion, channel widening or down-cutting.

7.0 MONITORING REQUIREMENTS

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.

The following components of Level 1 monitoring will be performed each year of the 5-year monitoring period: Reference photos, plant survival (i.e., identify specific problem areas (missing, stressed, damaged or dead plantings), 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.

8.0 OTHER INFORMATION

STREAM REFERENCE RESTORATION STUDIES

A reference reach is a stream segment that represents a stable channel within 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.

Reference data collected during field investigations for on-site mitigation work for U-2525B were utilized as regional reference reaches. U-2525B is the Greensboro Eastern Loop project located in Guilford County between US Highway 70 and US Highway 29. These stable reference sections were identified 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 Figure on next page).

As illustrated in Figure labeled "Regional Curve Information Used for Design" on the following page, the cross sectional areas surveyed at stable reference reach locations correlates with the Rural Piedmont Regional Curve Data. Also, three of the four off-site reference reach locations agree with the Rural Piedmont Regional Curve Data. The stream designs were based on the collected data since this data was verified by the Rural Piedmont Regional Curve Data.

The majority of the work proposed for this project will consist of restoration or relocation approaches, with the exception of approximately 350 linear feet of Site 1 and 71 linear feet of Site 2 which will be enhancement. All of the sites will be designed as type "C" channels to provide for stable banks during construction and floodplain connectivity. With time the "C" channel will adjust to a stable "E" channel as vegetation establishes on the banks and width/depth ratios decrease. The enhancement work will consist of installing in-stream structures, along with limited channel grading, and planting the banks and riparian buffer. The in-stream structures will stabilize channel banks and halt progression of head cuts, and provide increased habitat.

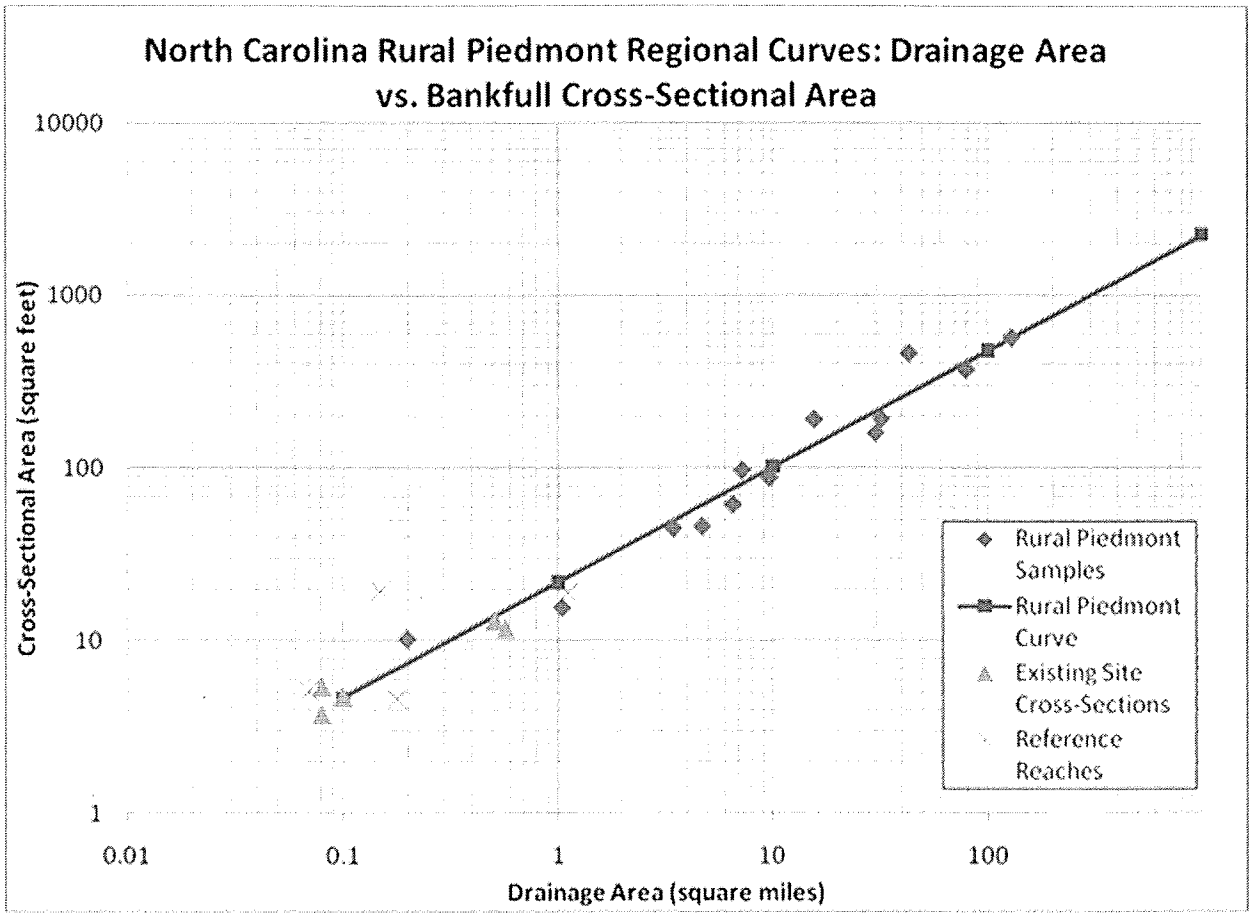


FIGURE: REGIONAL CURVE INFORMATION USED FOR DESIGN

Shear stress calculations were completed for all reaches and are included in Appendix C. The data show that the shear stresses for the proposed designs will generally be kept approximately the same or slightly increased with a few exceptions. Site 1 Lower shear stress will be increased to ensure proper sediment transport. Site 2 shear stress will be greatly increased from the existing conditions. This is because a significant 4.0 foot headcut exists in the current channel

resulting in abnormally flat reaches upstream and downstream of the headcut. The proposed conditions for Site 2 will distribute this drop over several grade control structures. Shear stress for Site 4 is increased to an appropriate level for sediment transport as compared to the very low existing conditions shear stress which currently does not provide proper sediment transport. Although most reaches do not have significant increases 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. 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.

9.0 DETERMINATION OF CREDITS

NCDOT has made an effort to restore/relocate and enhance approximately 3,155 feet of streams adjacent to the R-2413A&B project to meet mitigation requirements. The streams are being purchased as right-of-way for the roadway project. These sites will have controlled access to ensure they are protected from local landowner encroachment. Also, placing these streams and riparian buffers into right-of-way guarantees that no future impacts will occur directly to these channels due to commercial or residential development along the corridor.

Sites 1 and 2 are both first order streams that drain directly into Reedy Creek, an NCDWQ classified NSW, and WS-III, that flows into Lake Brandt, part of Greensboro's water supply. USACE stream quality assessments scored 47 and 43 for Sites 1 and 2 respectively. By performing the restoration and enhancement measures outlined in this mitigation plan, NCDOT is providing quality in-kind stream mitigation immediately upstream and downstream of the proposed impact site.

Site 4 is a third order stream also draining into Reedy Creek. This UT scored 60 on the USACE stream quality assessments. The existing culvert and roadway embankment of Brookbank Road significantly constrict the floodplain of this stream. The removal of the existing culvert and roadway embankment daylights 70+ feet stream and restores floodplain connectivity and capacity, immediately downstream of the proposed impact.

The UT to the Haw River to be restored/relocated at Site 5 scored 63 on the USACE stream quality assessment. However, this evaluation was completed on a section of the stream downstream of the proposed mitigation work. The proposed mitigation work will take place on a section of stream that has been altered by the construction of an earth dam. The breaching/failure of this dam caused a huge slope failure at the lower end of Site 5, and in turn is resulting in significant channel incision and head cutting at the upstream end of Site 5. UT's within the proposed mitigation work area (JD streams S4 and S5) scored only 40 points on the

USACE stream quality assessment. Further, significant timber logging has taken place at the upstream end of Site 5 since the assessments were performed. NCDOT's proposed mitigation will restore this stream and its buffer to function at its "pre-dam" level. This in-kind mitigation is located immediately upstream and downstream of the proposed impact and will ultimately help improve water quality flowing into the Haw River, NCDWQ classification WS-V; NSW.

NCDOT proposes to restore/relocate and enhance approximately 2,945 feet of streams and associated buffer adjacent to the R-2413A&B project, in partial fulfillment of mitigation requirements. The planned stream mitigation will restore significant lengths of degraded headwater streams that drain directly into water supply and nutrient sensitive streams. The proposed stream designs also take into account potential future watershed conditions. By placing the mitigation projects within right-of-way NCDOT has protected these sites for the future. NCDOT has considerable experience and a history of success with the design and construction of on-site stream mitigation projects. There are presently no known in lieu fee or mitigation bank sites within the 14-digit HUC of the proposed mitigation sites. Existing in lieu fee and mitigation bank sites within the same 8-digit HUC are all located downstream of Greensboro's water supply reservoirs.

Based on the factors outlined above, NCDOT proposes the credit ratios shown below in Table 4. All remaining unavoidable stream impacts will be offset by compensatory mitigation provided by the Ecosystem Enhancement Program (EEP).

MITIGATION SUMMARY

TABLE 4. MITIGATION IMPACT SUMMARY AND PROPOSED CREDITS*

Mitigation Site No.	Mitigation Description	Existing Channel Impacts Permanent (ft)	Existing Channel Impacts Temp. (ft)	Natural Stream Design (ft)	Credit Ratio	Proposed Credit (ft)
1 Upper	Enhancement		350	350	2:1	175
	Restoration	368		304	1:1	304
1 Lower	Restoration	505	53	509	1:1	509
2 Upper	Relocation	308		424	1:1	424
2 Lower	Restoration	513		482	1:1	482
	Enhancement		87	71	2:1	36
4	Restoration		**	250	1:1	250
5 Upper***	Restoration	403	20	373	1:1	373
5 Lower	Restoration/ Relocation	746		392	1:1	392
TOTALS		2843	510	3155		2945

Table 4. notes:

* Impacts associated roadway fill slopes, culverts, and pipes are listed on the Wetland Impact Summary Sheet for Sites 12, 13, 14, and 21 on R-2413A and Site 8 for R-2413B.

** Impacts for Mitigation Site 4 are included in the impact summary sheet for R-2413A, Site 21

*** Temporary wetland impacts associated with Mitigation Site 5 Upper are included in the Wetland Impact Summary Sheet for R-2413B, Site 8c.

9.1 CREDIT RELEASE SCHEDULE

NCDOT proposes immediate, full release of the proposed stream mitigation as outlined above as on-site mitigation for unavoidable stream impacts associated with R-2413 A&B.

10.0 GEOGRAPHIC SERVICE AREA

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

11.0 MAINTENANCE PLAN

The mitigation site will be held by NCDOT and placed on the NES mitigation geodatabase. Once monitoring is completed and the site is closed out, it will be placed in the NCDOT Stewardship Program for long term maintenance and protection.

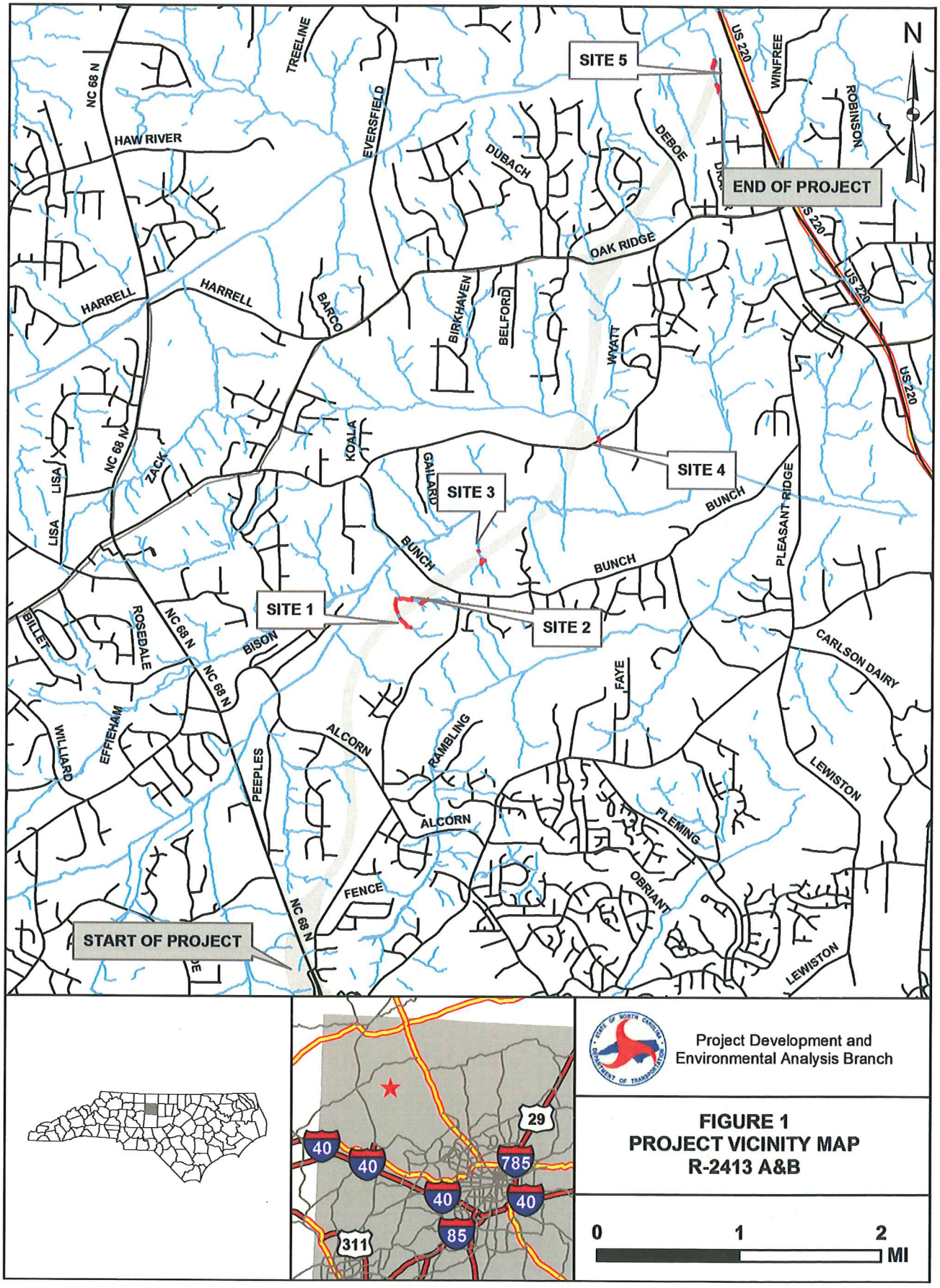
If an appropriate third party recipient is identified in the future, then the transfer of the property will include a conservation easement or other measure to protect the natural features and mitigation value of the site in perpetuity.

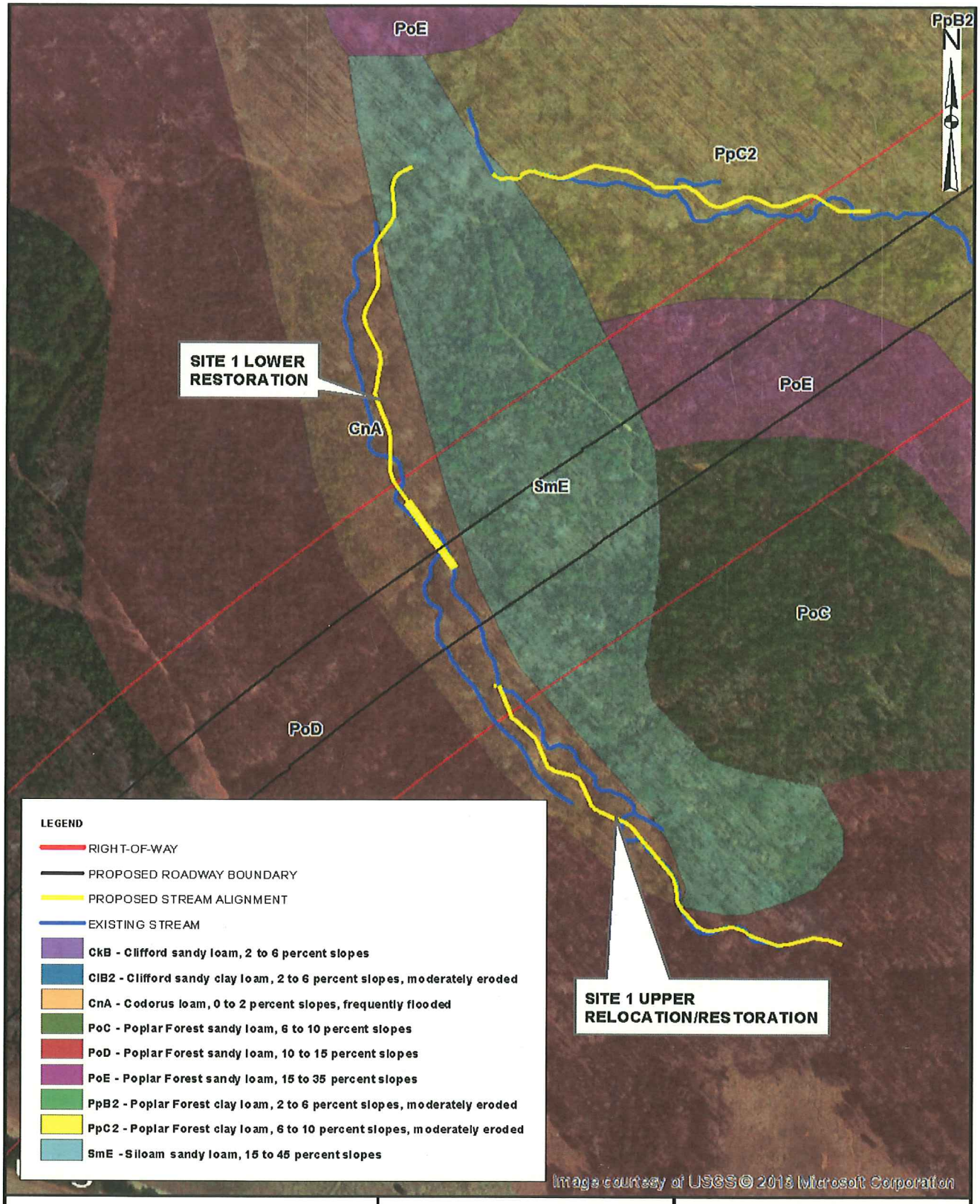
12.0 LONG TERM ADAPTIVE MANAGEMENT PLAN

The sites will be managed by the NCDOT according to the mitigation plan. Beaver management will be instituted during the monitoring period. Encroachments into the area 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 R-2413 A&B to preserve the stream restoration and enhancement areas. NCDOT has established funds for each project and within each Division to monitor the mitigation site and to protect it in perpetuity.

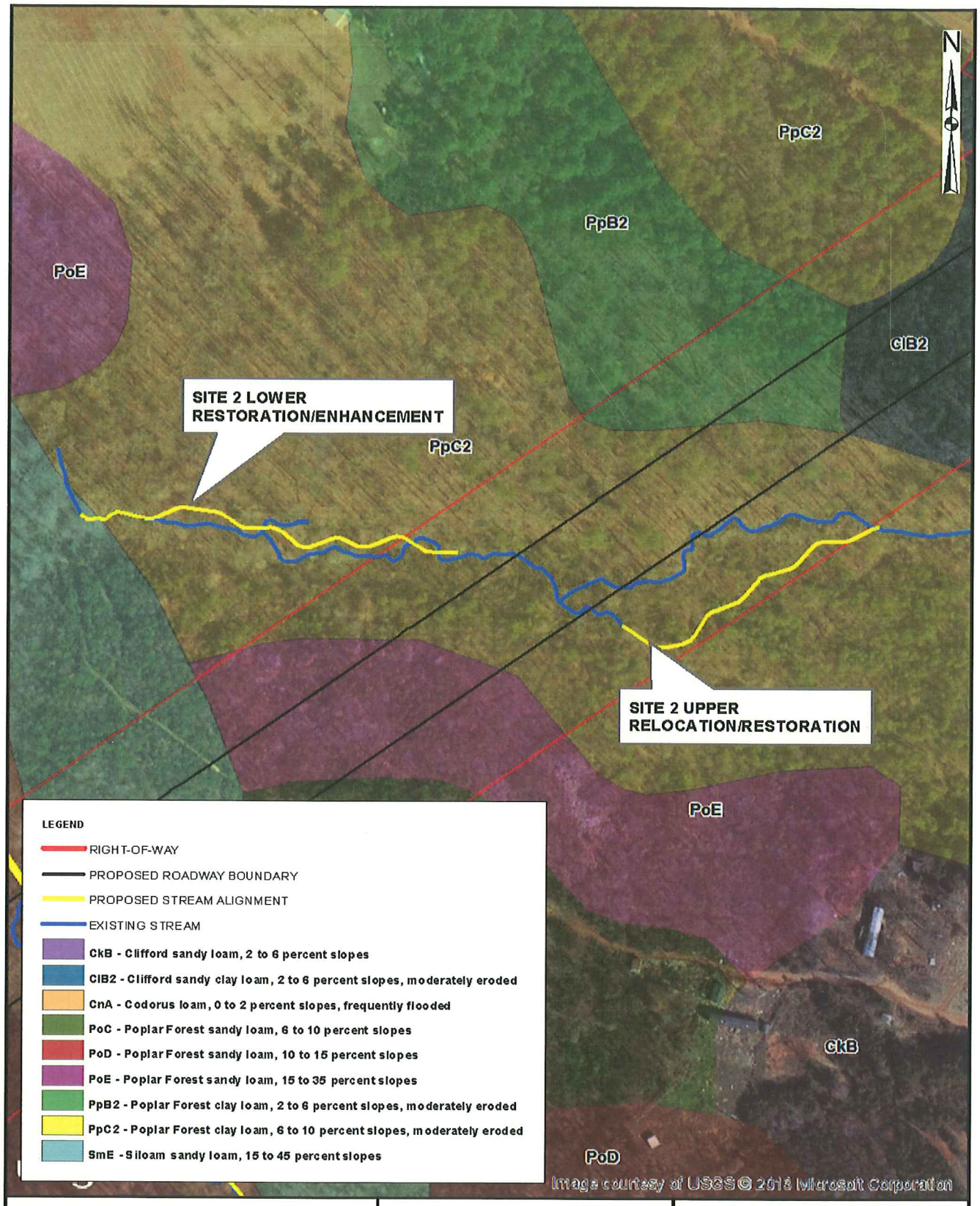

N
SITE 5
END OF PROJECT
SITE 4
SITE 3
SITE 1
SITE 2
START OF PROJECT
US 220
WINFREE
ROBINSON
DEBOE
DUBACH
EVERSFIELD
TREELINE
NC 68 N
HAW RIVER
HARRELL
BARCO
OAK RIDGE
BIRKHAVEN
BELFORD
WYATT
KOALA
GAILARD
BUNCH
PLEASANT RIDGE
LISA
ZACK
ROSEDALE
BISON
SILLETT
WILLIARD
EFFIRHAM
PEEPLES
ALCORN
RAMBLING
FAYE
CARLSON DAIRY
LEWISTON
FLEMING
OBRIANT
FENCE
Project Development and Environmental Analysis Branch
FIGURE 1
PROJECT VICINITY MAP
R-2413 A&B
0
1
2
MI
29
40
785
85
311

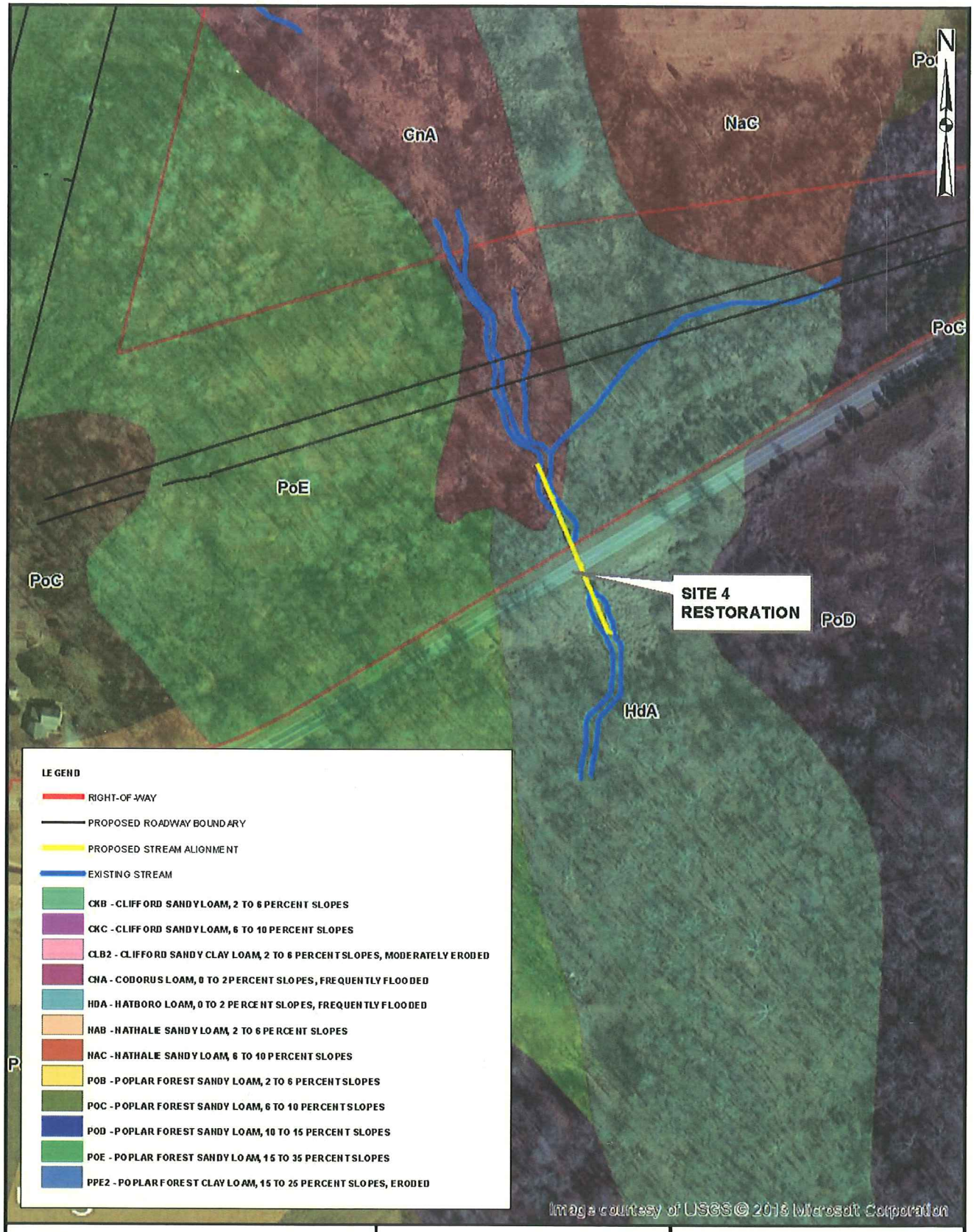


Project Development and Environmental Analysis Branch

0 100 200 Feet

FIGURE 2A
SOILS MAP
R-2413 A&B, SITE 1

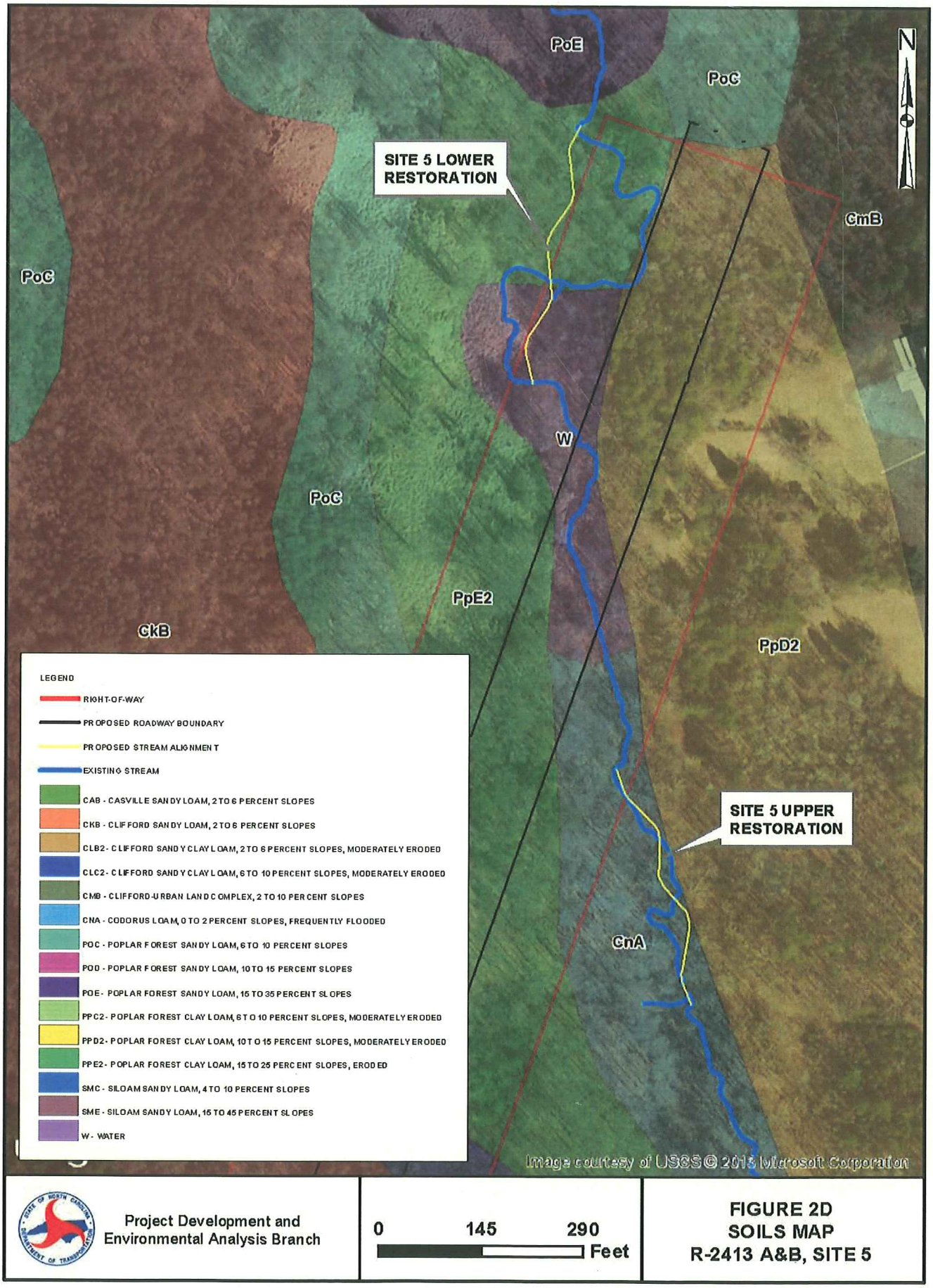

N
PpC2
PpB2
PoE
CIB2
SITE 2 LOWER
RESTORATION/ENHANCEMENT
PpC2
SITE 2 UPPER
RELOCATION/RESTORATION
PoE
CkB
PoD
LEGEND
RIGHT-OF-WAY
PROPOSED ROADWAY BOUNDARY
PROPOSED STREAM ALIGNMENT
EXISTING STREAM
CkB - Clifford sandy loam, 2 to 6 percent slopes
CIB2 - Clifford sandy clay loam, 2 to 6 percent slopes, moderately eroded
CnA - Codorus loam, 0 to 2 percent slopes, frequently flooded
PoC - Poplar Forest sandy loam, 6 to 10 percent slopes
PoD - Poplar Forest sandy loam, 10 to 15 percent slopes
PoE - Poplar Forest sandy loam, 15 to 35 percent slopes
PpB2 - Poplar Forest clay loam, 2 to 6 percent slopes, moderately eroded
PpC2 - Poplar Forest clay loam, 6 to 10 percent slopes, moderately eroded
SmE - Siloam sandy loam, 15 to 45 percent slopes
Image courtesy of USGS © 2013 Microsoft Corporation
Project Development and
Environmental Analysis Branch
0 100 200
Feet
FIGURE 2B
SOILS MAP
R-2413 A&B, SITE 2



Project Development and Environmental Analysis Branch

0 137.5 275 Feet

FIGURE 2C
SOILS MAP
R-2413 A&B, SITE 4



Project Development and Environmental Analysis Branch

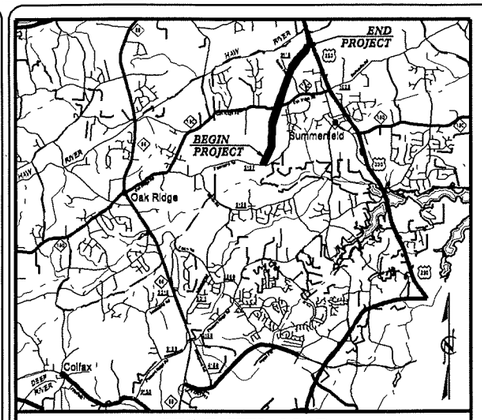
0 145 290 Feet

FIGURE 2D
SOILS MAP
R-2413 A&B, SITE 5

09/26/11

TIP PROJECT: R-2413 A&B

CONTRACT:



STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

PLAN FOR ON-SITE MITIGATION GUILFORD COUNTY

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	R-2413A&B	OSM-1	52

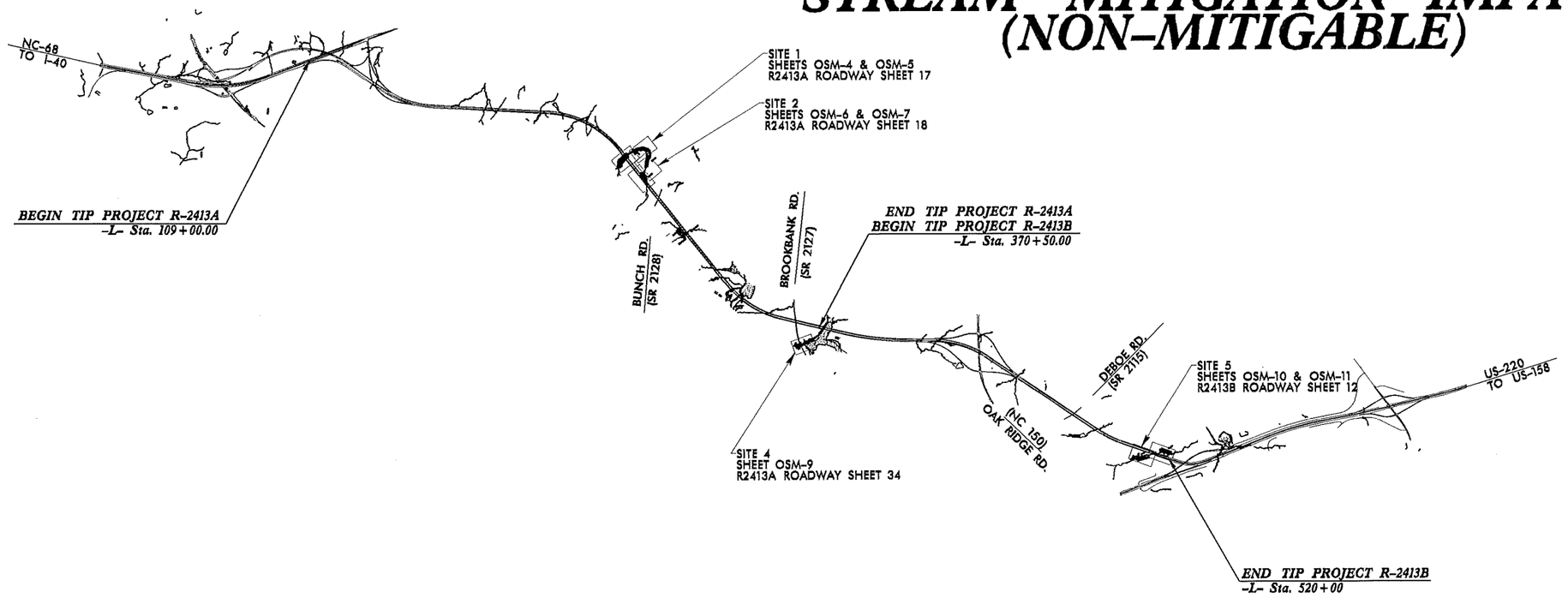
STATE PROJ. NO.	F. A. PROJ. NO.	DESCRIPTION
		PE
		ROW

NAD 83

LOCATION: NC 68 CONNECTOR – FROM SR 2011 (EDGEFIELD ROAD) TO HAW RIVER

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

STREAM MITIGATION IMPACTS (NON-MITIGABLE)



REV. 07/02/2013

NC DOT CONTACT: PETE ALLEN

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

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 1	RESTORATION/ENHANCEMENT	870LF
SITE 2	RELOCATION/RESTORATION/ENHANCEMENT	900LF
SITE 4	RESTORATION	250LF
SITE 5	RESTORATION/RELOCATION	760LF

2012 STANDARD SPECIFICATIONS

DESIGN ENGINEER

P.E.
SIGNATURE:

DIVISION OF HIGHWAYS
STATE OF NORTH CAROLINA

P.E.
STATE DESIGN ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED
DIVISION ADMINISTRATOR DATE

09/26/11

Impacts Associated with Mitigation (Non-mitigable)

S S — DENOTES IMPACTS IN SURFACE WATER

TS TS — DENOTES TEMPORARY IMPACTS IN SURFACE WATER

Rev. 07/01/2013

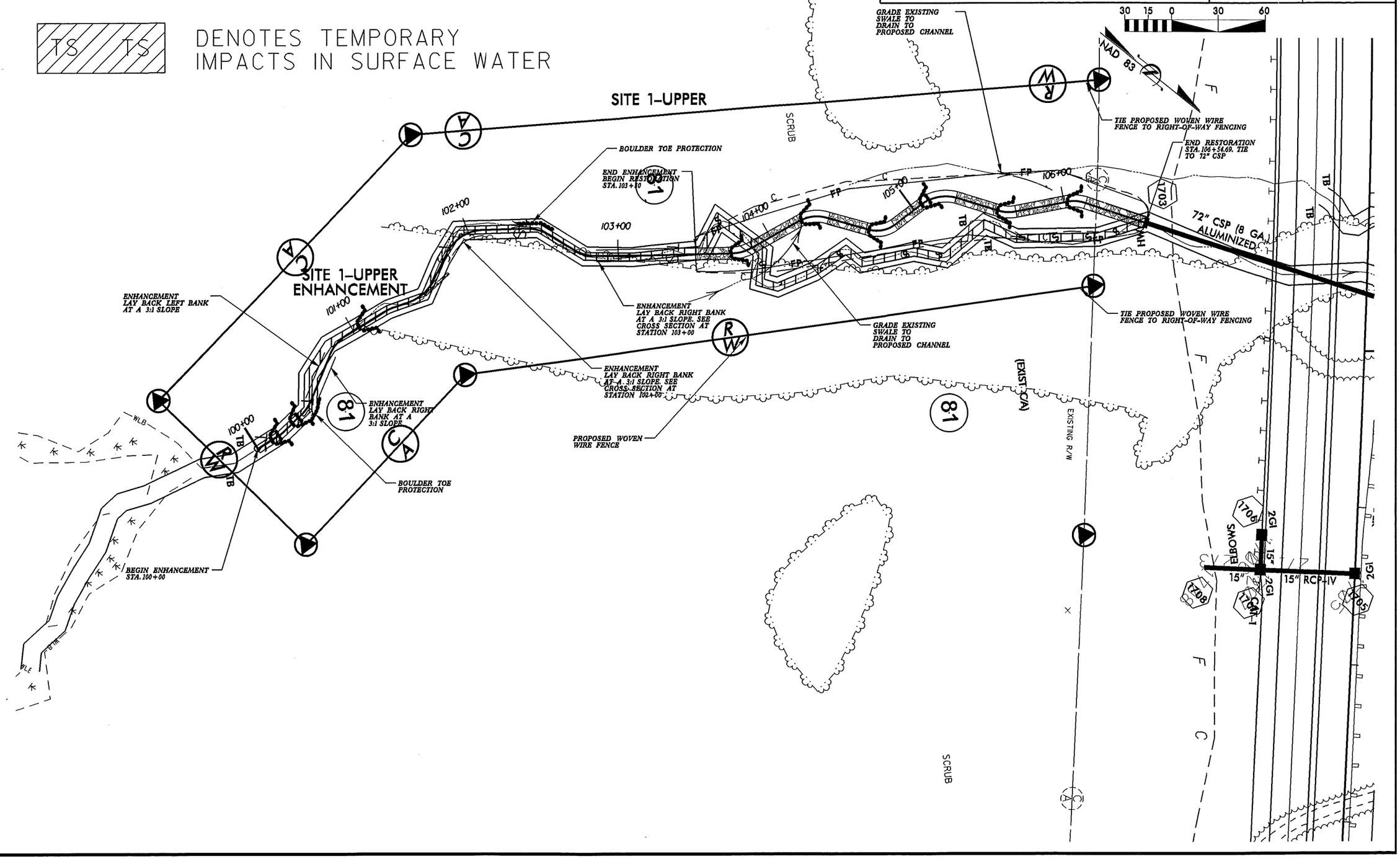
PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-4

PROJECT ENGINEER

APPROVED BY:

DATE:

SITE 1-UPPER PLAN



Impacts Associated with Mitigation (Non-mitigable)

Rev. 07/01/2013

PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-5

PROJECT ENGINEER

APPROVED BY:

DATE:

SITE 1- LOWER PLAN

30 15 0 30 60

NAD 83

S S DENOTES IMPACTS IN SURFACE WATER

TS TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER

CHORD

RW

CA

+20 174.59'LT (EXIST C/A)

+30.00 440.00' RT

+35.00 600.00' LT

BEGIN RESTORATION STA.150+00. TIE TO PROPOSED 72" CSP

TIE PROPOSED WOVEN WIRE FENCE TO RIGHT-OF-WAY FENCING

72" CSP (8 GA.) ALUMINIZED

PROPOSED 72" CSP

ELBOW

MATCHLINE SEE SHEET OSM-4

16:1 TAPER

RCP-IV

2GI

15"

ELBOW

CLASS 'B' RIP RAP

SPECIAL CUT DITCH GRASS LINED SEE DETAIL 'D'

GRAU 350

SITE 1 LOWER

SCRUB

END RESTORATION STA.155+09. TIE TO EXISTING CHANNEL

MATCHLINE SEE SHEET OSM-7

Impacts Associated with Mitigation
(Non-mitigable)

Rev. 07/01/2013

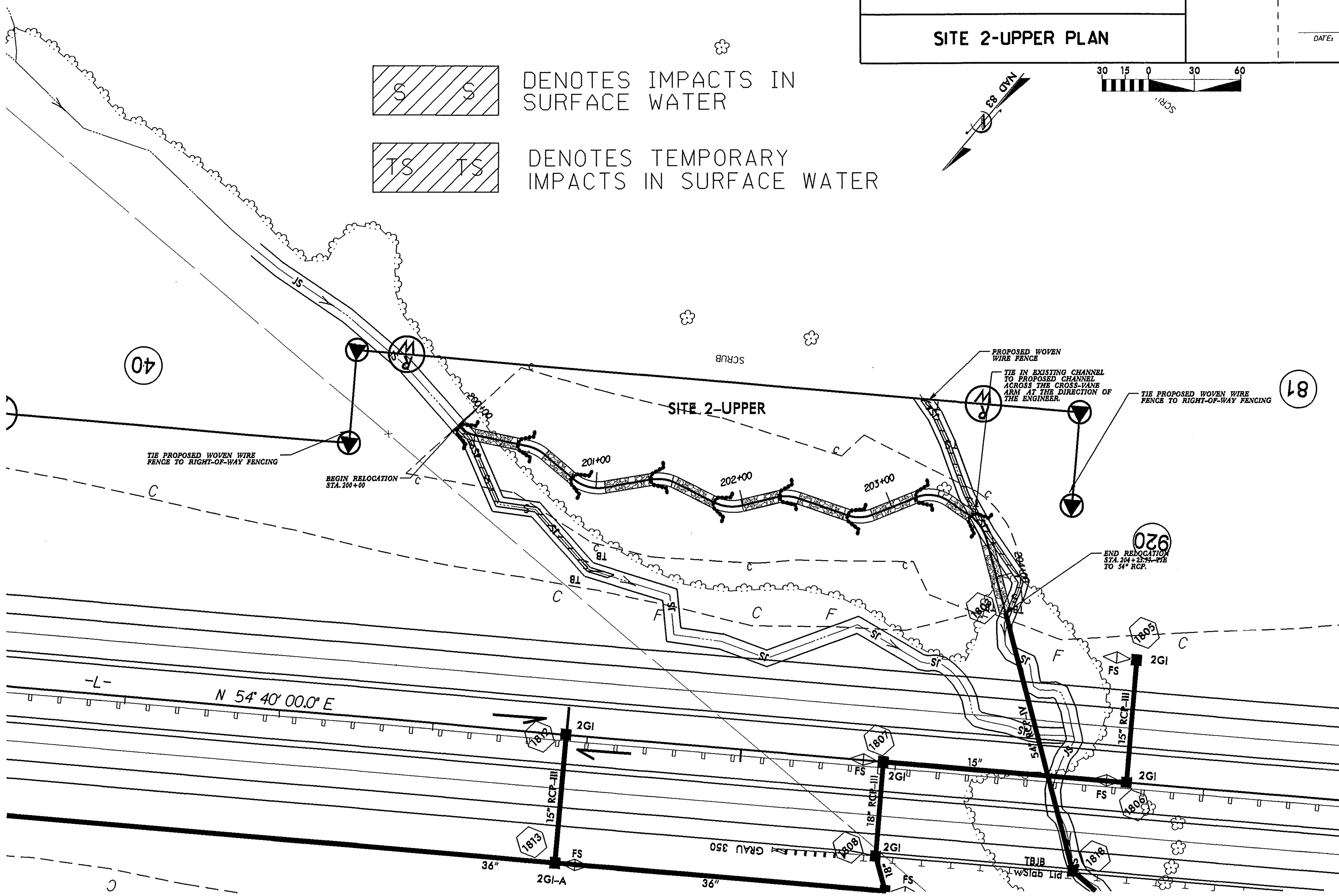
SITE 2-UPPER PLAN

PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-6

PROJECT ENGINEER

APPROVED BY:

DATE:



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R-2413A\Mitigation Permit Drawings\R2413_NEU_OSM-06_PSH_impacts.dgn

09/26/11

PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-7

PROJECT ENGINEER

APPROVED BY:

DATE:

Rev. 07/01/2013

SITE 2-LOWER PLAN

MATCHLINE SEE SHEET OSM-6

BEGIN RESTORATION STA. 250+00, TIE TO 54" RCP.

CLASS 'I' RIP RAP SEE DETAIL 'AJ'

CLASS 'B' RIP RAP

TIE PROPOSED WOVEN WIRE FENCE TO RIGHT-OF-WAY FENCING

-L- +27.44 175.27' LT (EXIST CA)

PROPOSED WOVEN WIRE FENCE

-L- +00.00 282.00' LT

GRADE TO DRAIN INTO PROPOSED CHANNEL NEAR STATION 253+00

SITE 2-LOWER

END RESTORATION
BEGIN ENHANCEMENT
STA. 254+22.4, TIE
TO EXISTING CHANNEL

END ENHANCEMENT
STA. 255+53.89

-L- +25.00 530.00' RT

MATCHLINE SEE SHEET OSM-5

30 15 0 30 60

NAD 83

Impacts Associated with Mitigation
(Non-mitigable)

S S DENOTES IMPACTS IN SURFACE WATER

TS TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER

09/26/11

Impacts Associated with Mitigation (Non-mitigable)

PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-08

PROJECT ENGINEER

APPROVED BY:

DATE:

Rev. 07/01/2013

SITE 4 PLAN

30 15 0 30 60

S S DENOTES IMPACTS IN SURFACE WATER

TS TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER

NAD 83

N 73° 00' 00.0" E

-Y5-

SCRUB

SR 2127 BROOKBANK RD

WLB

F

72

54

SITE 4

BEGIN RESTORATION STA. 400+00

END RESTORATION STA. 402+50

TES

TB

C

400+00

401+00

402+00

1@ 12'x12' RCBC

REMOVE

9.7' HIGH X 16.8' WIDE GRAVEL CWT

TS

2' FDPS

24"

2GI

02

15"

3403

3401

ELBOWS

CLASS 'B' RIP RAP

4' LATERAL BASE DITCH CLASS 'B' RIP RAP LINED SEE DETAIL 'L'

340

25-JUN-2013 06:57
R-2413A_01_BRP530_Permits Drawings\R2413_NEU_OSM-09_PSH_impacts.dgn

PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-9

PROJECT ENGINEER

APPROVED BY:

DATE:

Rev. 07/01/2013

SITE 5-UPPER PLAN

Impacts Associated with Mitigation (Non-mitigable)

30 15 0 30 60

SCALE: 1" = 30'

MATCHLINE SEE SHEET OSM-11

PROPOSED 1@10'X8' RCBC W/ALTERNATE LOW FLOW SILLS (BY OTHERS)

END RESTORATION STA. 503+72.77 TIE TO PROPOSED 10'x8' RCBC

SITE 5-UPPER

30" CSP

42" CSP

1217

1207

HATCHED AREA TO BE GRADED DOWN TO APPROXIMATELEY 6 INCHES ABOVE THE ADJACENT VALLEY IN AN EFFORT TO PROVIDE FLOODPLAIN CONNECTIVITY, WHILE MAINTAINING WETLAND HYDROLOGY. TARGET ELEVATION IS 795.7

TEMPORARY WETLAND EXCAVATION

TEMPORARY STREAM IMPACTS

BEGIN RESTORATION STA. 500+00

503+00

502+00

501+00

500+00

WLB

BTW

F

C

EP

EW

RW

S S DENOTES IMPACTS IN SURFACE WATER

TS TS DENOTES TEMPORARY IMPACTS IN SURFACE WATER

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\R-2413A Division Permit Drawings\R2413_NEU_OSM-10_PSH_impacts.dgn

09/26/11

Rev. 07/01/2013

PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-10

PROJECT ENGINEER

APPROVED BY:

DATE:

SITE 5-LOWER PLAN

NAD 83

30 15 0 30 60

5/5

520

SEE DETAIL 'AJ'
LAT. BASE DITCH
280 TONS CL. B RIP RAP
750 SY FF
DDE=1739 CY

SITE 5-LOWER

SEE DETAIL 'AM'
CHANNEL RELOCATION
FS=0 DDE=5000 CY

551+00

553+00

EXISTING R/W

END RESTORATION
STA. 553+91.59

SEE DETAIL'G'
TOE PROTECTION
35 TONS CL B RIP RAP
105 SY FF

BEGIN RESTORATION
STA. 550+00
TIE TO PROPOSED
10" RCDD

1212 2GI

15" RCP-III

2GI 1213 FS

15" RCP-III

2GI 1214 SP

15" 2GI 1215

15" CSP 1303

2GI 15" RCP-III 1301

2GI 1302

26-JUN-2013 07:49
R-2413A\Hydro\Design Permit Drawings\R2413_NEU_OSM-11_PSH_impacts.dgn

MITIGATION IMPACT SUMMARY

Mitigation Site No.	Mitigation Station Station (From/To)	Mitigation Description	WETLAND IMPACTS					SURFACE WATER IMPACTS				
			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)
1 Upper	100+00 to 103+50	Enhancement									350	350
	103+50 to 106+55	Restoration								368		304
1 Lower	150+00 to 155+09	Restoration								505	53	509
2 Upper	200+00 to 204+24	Relocation								225	83	424
2 Lower	250+00 to 255+54	Restoration								513		482
		Enhancement									87	71
4	400+00 to 402+50	Restoration									*	250
5 Upper	500+00 to 503+73	Restoration								403	20	373
5 Lower	550+00 to 553+92	Restoration/ Relocation								**		392
TOTALS:										2014	593	3155

* - Impacts for Site 4 are included in the impact summary table for R-2413A Site 21

** - Impacts for Site 5 Lower are included in the impact summary table for R-2413B Site 8

For impacts associated with the roadway fill slopes, culverts and pipes please see Wetland Impact Summary Sheet for Site 12, Site 13 and Site 21 on R-2413A and Site 8 for R-2413B

Temporary Wetland Impacts associated with Site 5 Upper are shown in the Wetland Impact Summary Sheet for R-2413B Site 8

NC DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GUILFORD
COUNTY
WBS - 34429.1.1 (R-2413A & B)

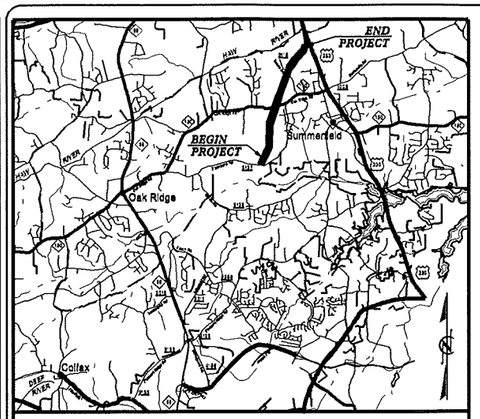
ATN Revised 3/31/05

SHEET 1 OF 1 6/25/2013

09/26/11

TIP PROJECT: R-2413 A&B

CONTRACT:



VICINITY MAP

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

PLAN FOR ON-SITE MITIGATION GUILFORD COUNTY

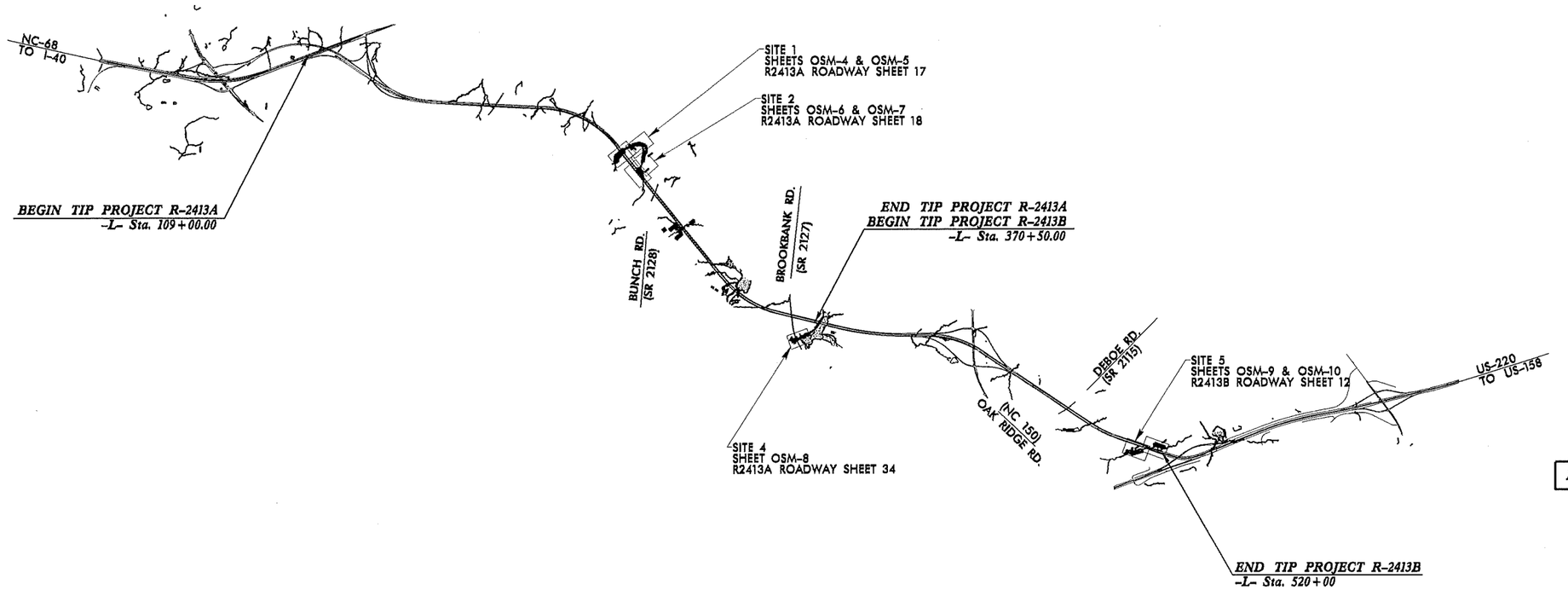
STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	R-2413A&B	OSM-1	53

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

NAD 83

LOCATION: *NC 68 CONNECTOR – FROM SR 2011 (EDGEFIELD ROAD) TO HAW RIVER*

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



REV. 07/01/2013

NC DOT CONTACT: PETE ALLEN

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

GRAPHIC SCALES

PLANS: 30 15 0 30 60

PROFILE (HORIZONTAL): 30 15 0 30 60

PROFILE (VERTICAL): 6 3 0 6 12

DESIGN DATA

PROJECT LENGTH

MITIGATION SITE	MITIGATION TYPE	LENGTH
SITE 1	RESTORATION/ENHANCEMENT	870LF
SITE 2	RELOCATION/RESTORATION/ENHANCEMENT	900LF
SITE 4	RESTORATION	250LF
SITE 5	RESTORATION/RELOCATION	760LF

PREPARED IN THE OFFICE OF:
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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

P.E.
SIGNATURE:

DIVISION OF HIGHWAYS
STATE OF NORTH CAROLINA

P.E.
STATE DESIGN ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED
DIVISION ADMINISTRATOR *DATE*

Rev. 07-01-2013

09/26/11

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 INCIDENTAL 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 WITH 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 FIVE 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 IN THE 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 DAYS 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.

$$$$SYSTIME$$$$
$$$$USERNAME$$$$
$$$$DGN$$$$

PREPARED IN THE OFFICE OF:
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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.
R-2413A&B	OSM-1A

PROJECT ENGINEER

APPROVED BY:

DATE:

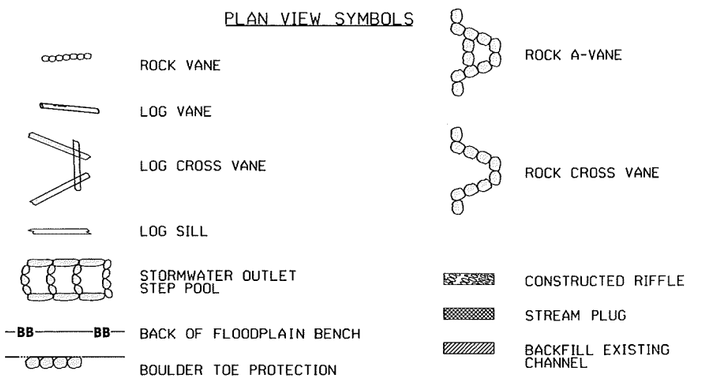
INDEX OF SHEETS, CONSTRUCTION SEQUENCING, AND GENERAL NOTES

INDEX OF SHEETS

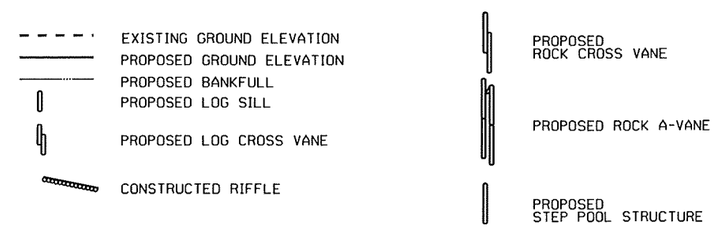
REFORESTATION NOTES, DETAILS, AND PLANS WILL BE INCLUDED IN REU PLANS

STREAM SYMBOLS

PLAN VIEW SYMBOLS



PROFILE SYMBOLS



Rev-07-01-2013

09/26/09

PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	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 — IP
- 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 Drainage / Utility Easement — DUE
- Proposed Permanent Utility Easement — PUE
- Proposed Temporary Utility Easement — TUE
- Proposed Permanent Easement with Iron Pin and Cap Marker

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 — PH
- 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 — PH
- 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:

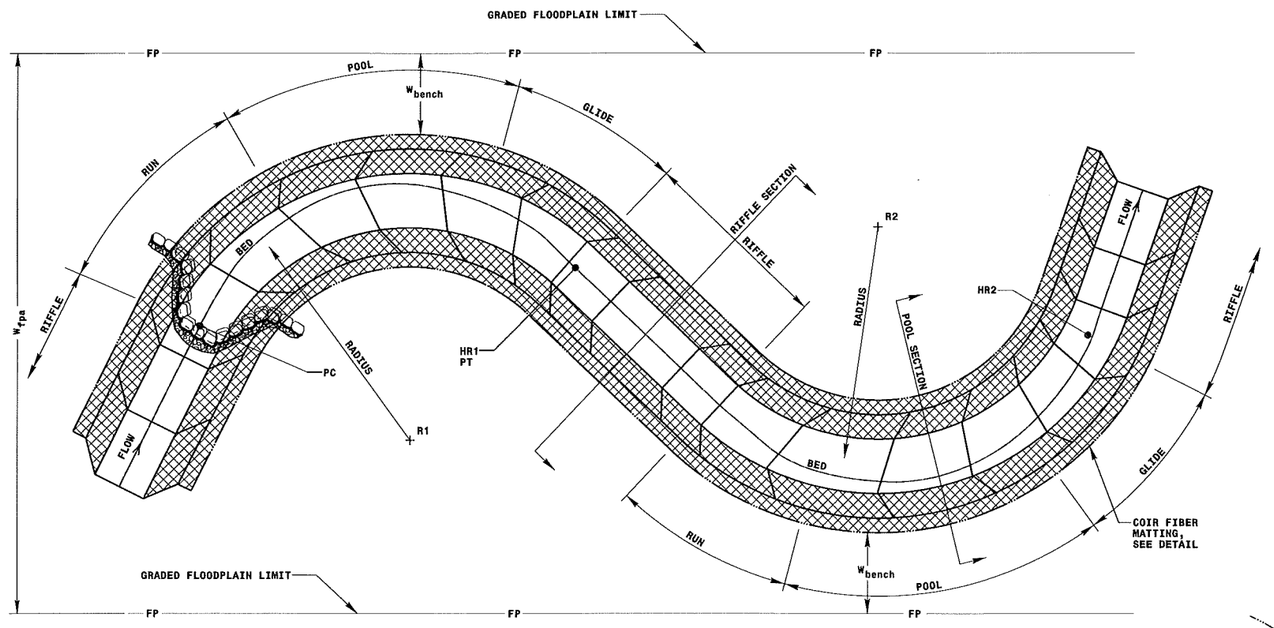
- Sanitary Sewer Manhole
- Sanitary Sewer Cleanout
- U/G Sanitary Sewer Line — SS
- Above Ground Sanitary Sewer — A/G Sanitary Sewer
- Recorded SS Forced Main Line — FSS
- Designated SS Forced Main Line (S.U.E.*) — FSS

MISCELLANEOUS:

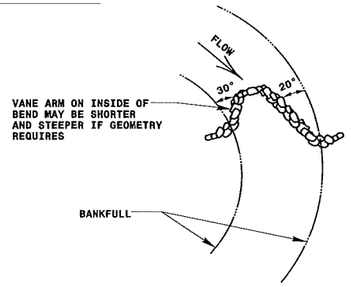
- Utility Pole
- Utility Pole with Base
- Utility Located Object
- Utility Traffic Signal Box — S
- Utility Unknown U/G Line — ?UTL
- U/G Tank; Water, Gas, Oil
- A/G Tank; Water, Gas, Oil
- U/G Test Hole (S.U.E.*)
- Abandoned According to Utility Records — AATUR
- End of Information — E.O.I.

Rev-07-01-13

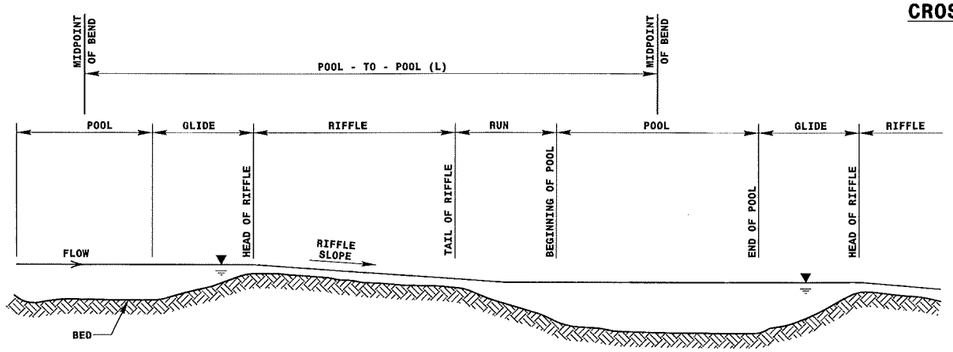
09/26/11



TYPICAL PLAN



CROSS VANE CONSTRUCTION IN MEANDER-BEND PLAN VIEW



TYPICAL PROFILE

CHANNEL TYPICAL DETAIL

NOT TO SCALE

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

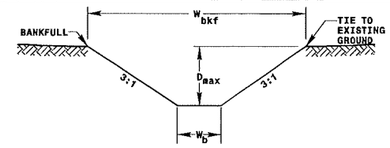
PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-2

PROJECT ENGINEER

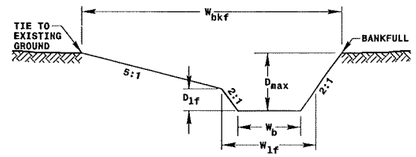
APPROVED BY:

DATE:

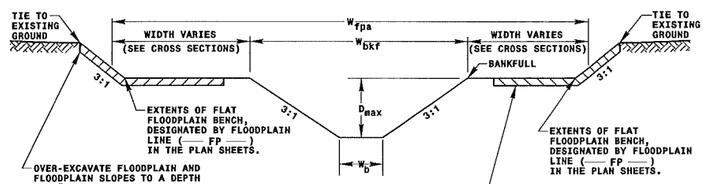
TYPICAL SECTIONS



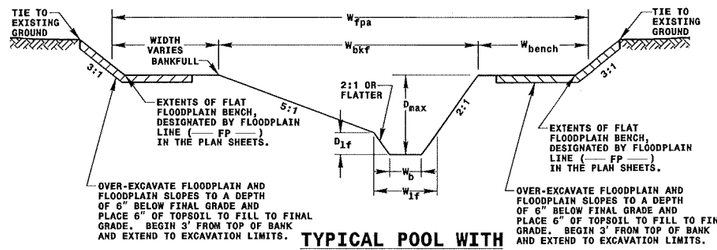
TYPICAL RIFFLE



TYPICAL POOL



TYPICAL RIFFLE WITH BANKFULL BENCH



TYPICAL POOL WITH BANKFULL BENCH

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 1-UPPER	SEE PLAN SHEETS FOR DRAFT STATIONS	7.6	0.8	2.8	SEE CROSS SECTIONS	9.4	3.8	0.7	1.5	1.0	SEE CROSS SECTIONS	3.8 MIN.	13.9
SITE 1-LOWER	SEE PLAN SHEETS FOR DRAFT STATIONS	8.4	0.9	3.0	SEE CROSS SECTIONS	10.6	4.3	0.7	1.6	1.5	SEE CROSS SECTIONS	4.2 MIN.	13.8
SITE 2	SEE PLAN SHEETS FOR DRAFT STATIONS	7.6	0.8	2.8	SEE CROSS SECTIONS	9.4	3.8	0.7	1.5	1.0	SEE CROSS SECTIONS	3.8 MIN.	13.9
SITE 3	SEE PLAN SHEETS FOR DRAFT STATIONS	7.3	0.8	2.5	SEE CROSS SECTIONS	9.4	3.8	0.7	1.5	1.0	SEE CROSS SECTIONS	3.7 MIN.	13.6
SITE 4	SEE PLAN SHEETS FOR DRAFT STATIONS	25.0	2.5	10.0	SEE CROSS SECTIONS	30.5	13.0	2.0	4.5	5.0	SEE CROSS SECTIONS	12.5 MIN.	14.3
SITE 5	SEE PLAN SHEETS FOR DRAFT STATIONS	11.7	1.2	4.5	SEE CROSS SECTIONS	14.4	6.0	1.0	2.2	2.0	SEE CROSS SECTIONS	5.9 MIN.	14.1

$$$$SYSTIME$$$$
$$$$USERNAME$$$$
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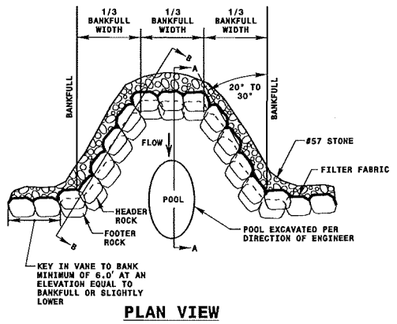
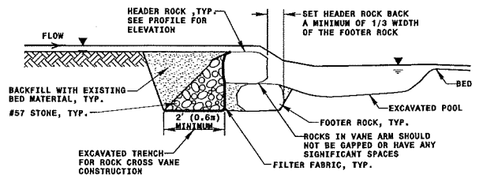
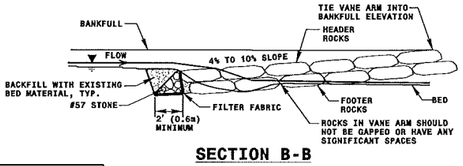


PLAN VIEW



SECTION A-A



SECTION B-B

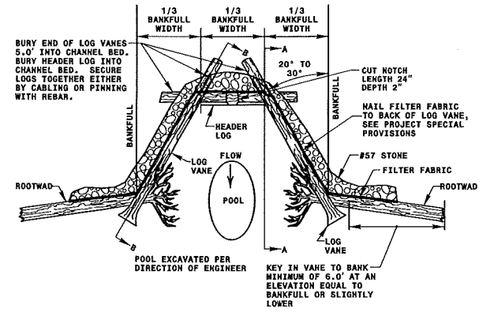
BOULDER SIZE DATA CHART			
REACH	BOULDER DIMENSIONS HEIGHT	WIDTH	LENGTH
SITE 1	2'	3'	4'
SITE 2	2'	3'	4'
SITE 3	2'	3'	4'
SITE 4	2'	3'	4'
SITE 5	2'	3'	4'

NOTE: THESE DIMENSIONS SPECIFY THE MINIMUM BOULDER SIZE

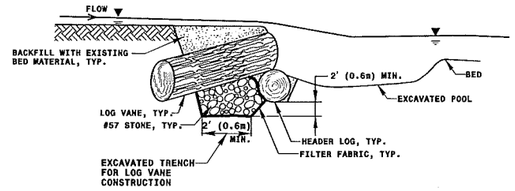
NOTES:
1. DEEPEST PART OF POOL TO BE IN LINE WITH WHERE VANE ARM TIES INTO BANKFULL.
2. DO NOT EXCAVATE POOL TOO CLOSE TO FOOTER BOULDERS.
3. CLASS "A" STONE CAN BE USED TO REDUCE VOIDS BETWEEN HEADERS AND FOOTERS.
4. COMPACT BACKFILL TO EXTENT POSSIBLE OR AT THE DIRECTION OF THE ENGINEER.
5. POOL DEPTH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

ROCK CROSS VANE DETAIL

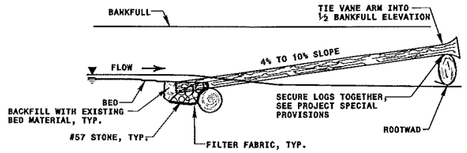
NOT TO SCALE



PLAN VIEW



SECTION A-A

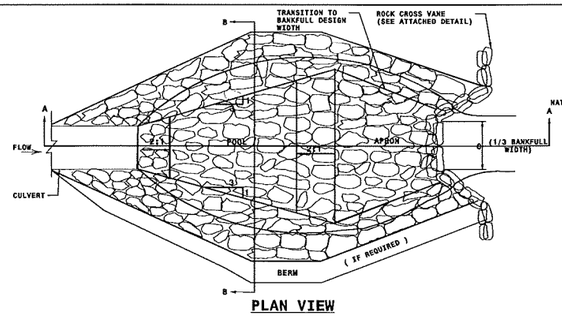


SECTION B-B

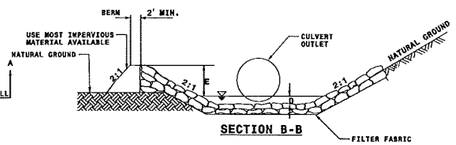
NOTES:
1. DEEPEST PART OF POOL TO BE IN LINE WITH WHERE VANE ARM TIES INTO BANKFULL.
2. DO NOT EXCAVATE POOL TOO CLOSE TO FOOTER BOULDERS.
3. CLASS "A" STONE CAN BE USED TO REDUCE VOIDS BETWEEN HEADERS AND FOOTERS.
4. COMPACT BACKFILL TO EXTENT POSSIBLE OR AT THE DIRECTION OF THE ENGINEER.
5. POOL DEPTH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

LOG CROSS VANE DETAIL

NOT TO SCALE



PLAN VIEW

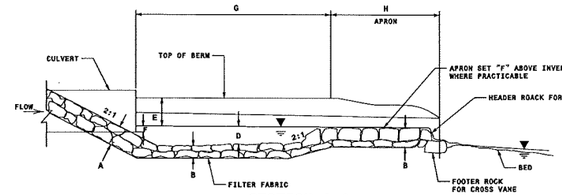


SECTION B-B

SITE NUMBER	STREAM STATION	CULVERT SIZE	RIP RAP BASIN A	B	C	D	E	F	G	H
2	250+02	54" RCP	2.5	2.0	4.0	2.0	3.0	0.3	20	10

ALL DIMENSIONS APPROXIMATE IN FEET

NOTE: DISSIPATOR ROCKS SHOULD BE NATIVE STONE OR SHOT ROCK, ANGULAR AND OBLONG WITH AN APPROXIMATE d50 SIZE OF CLASS I.



SECTION A-A

NATURAL ROCK ENERGY DISSIPATOR DETAIL

NOT TO SCALE

$$$$SYSTIME$$$$
$$$$USERNAME$$$$

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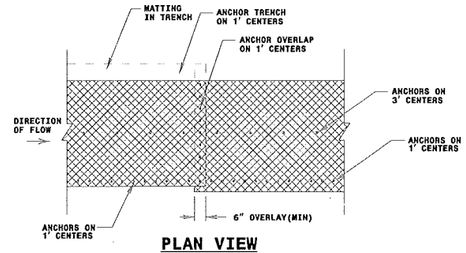
R-2413A&B	OSM-2A

PROJECT ENGINEER

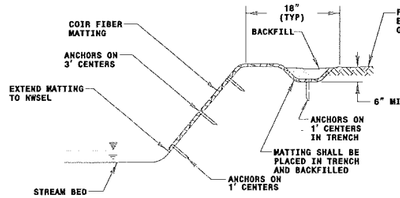
APPROVED BY:

DATE:

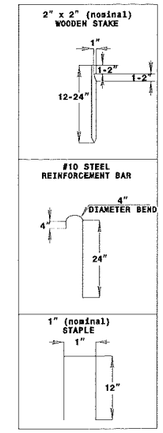
DETAILS 1 OF 4



PLAN VIEW



TYPICAL CROSS SECTION



ANCHOR OPTIONS

COIR FIBER MATTING DETAIL

NOT TO SCALE

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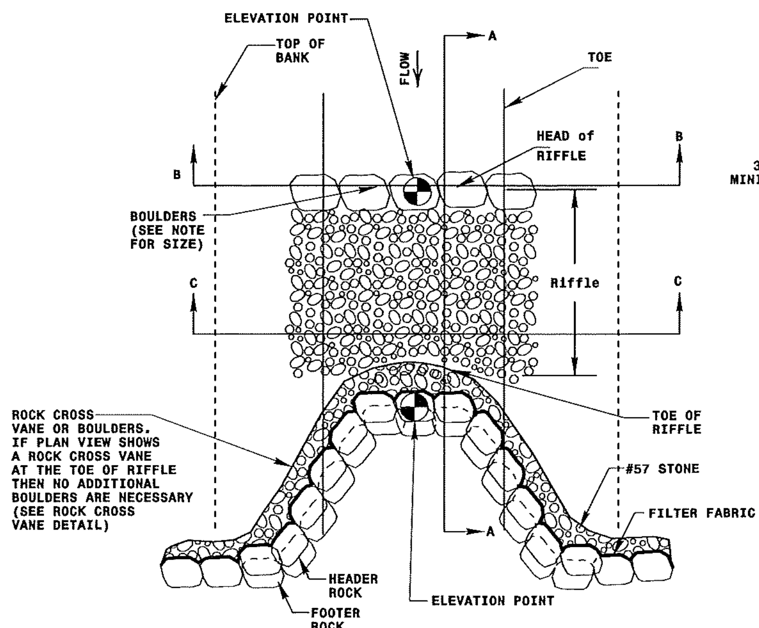
PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-2B

PROJECT ENGINEER

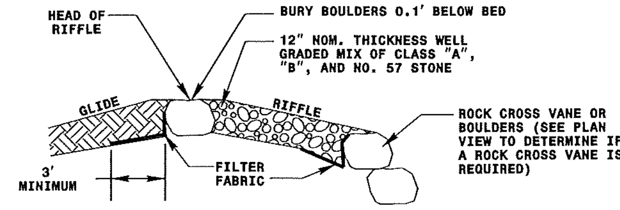
APPROVED BY:

DATE:

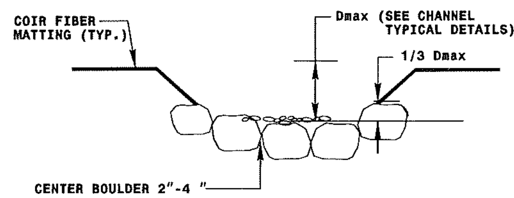
DETAILS 2 OF 4



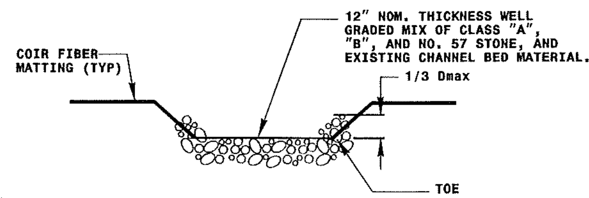
PLAN VIEW



SECTION A-A



SECTION B-B

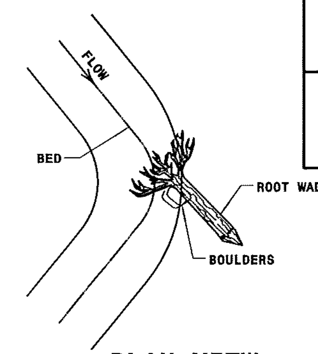


SECTION C-C

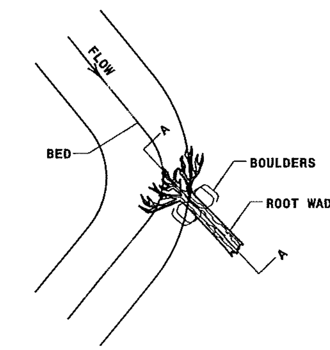
NOTE:
1. BOULDERS SHOULD BE NATIVE STONES OR SHOT ROCK, ANGULAR AND OBLONG, WITH AN AXIS APPROXIMATELY 4'Lx3'Wx2'D
2. NOT ALL CONSTRUCTED RIFFLES REQUIRE A ROCK CROSS VANE ON THE TOE OF RIFFLE.
3. IF NO ROCK CROSS VANE IS PROPOSED AT THE TOE OF RIFFLE, INSTALL BOULDERS AT THE TOE OF RIFFLE TO SECURE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

CONSTRUCTED RIFFLE DETAIL

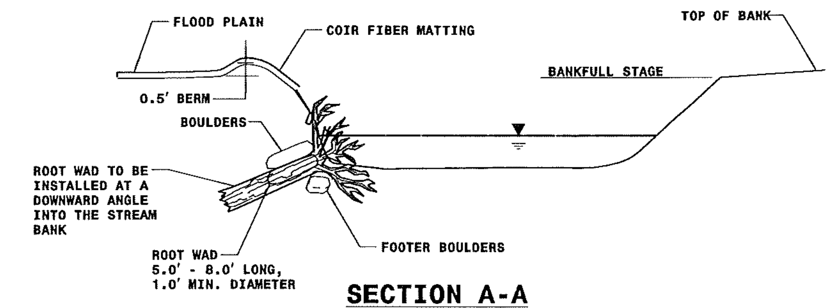
NOT TO SCALE



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:

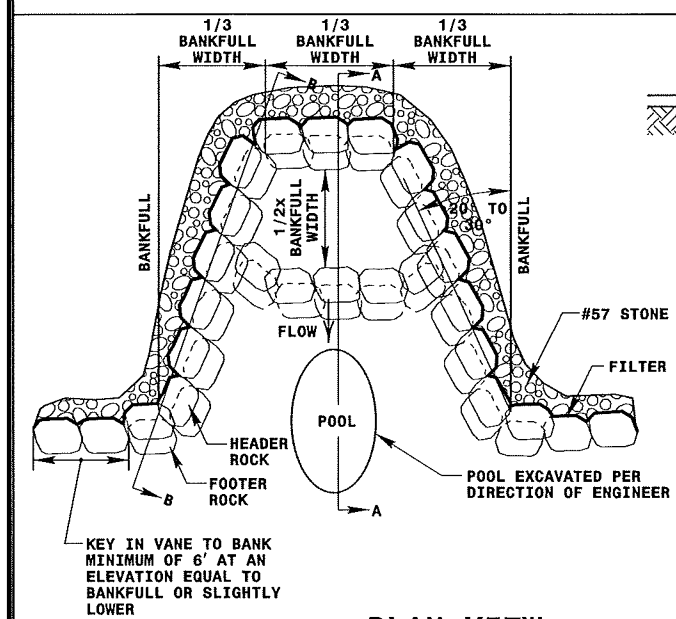
SHARPEN THE END OF THE LOG BEFORE "DRIVING" AT A DOWNWARD ANGLE INTO THE BANK. BOULDER SHOULD BE PLACED ON EACH SIDE OF THE ROOT WAD TO PIN IT IN PLACE. THE BOULDERS SHALL BE APPROXIMATELY 2' X 3' X 4'. ONE-THIRD OF THE ROOT WAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS.

TRENCHING METHOD:

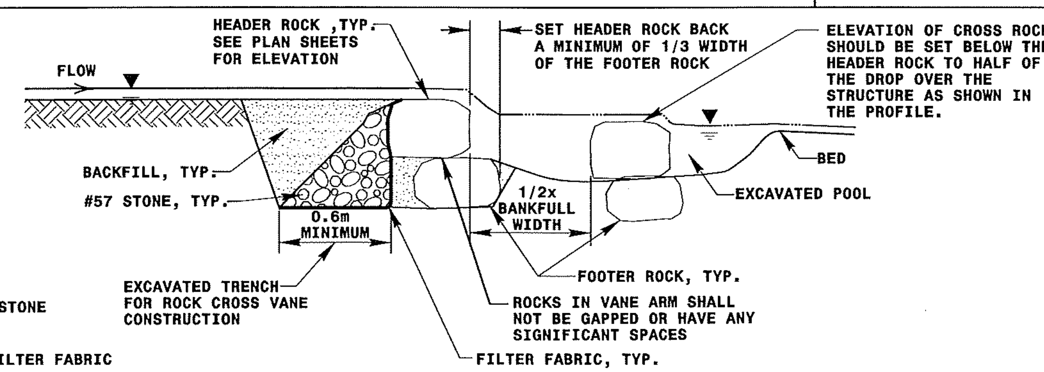
IF THE ROOT WAD CANNOT BE DRIVEN INTO THE BANK OR THE BANK NEEDS TO BE RECONSTRUCTED, THE TRENCHING METHOD SHOULD BE USED. THIS METHOD REQUIRES THAT A TRENCH BE EXCAVATED FOR THE LOG PORTION OF THE ROOT WAD. IN THIS CASE, FOOTER BOUDERS SHOULD BE INSTALLED UNDERNEATH THE ROOT WAD IN A TRENCH EXCAVATED 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

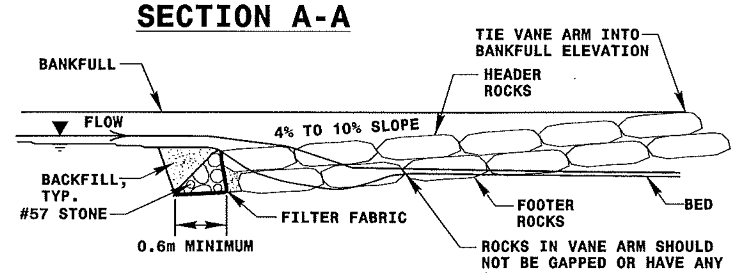
NOT TO SCALE



PLAN VIEW



SECTION A-A



SECTION B-B

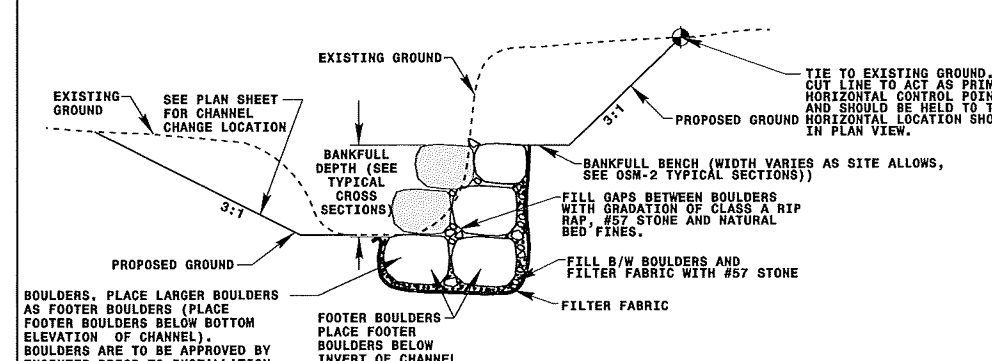
BOULDER SIZE DATA CHART			
REACH	BOULDER DIMENSIONS		
	HEIGHT	WIDTH	LENGTH
SITE 1	2'	3'	4'
SITE 2	2'	3'	4'
SITE 3	2'	3'	4'
SITE 4	2'	3'	4'
SITE 5	2'	3'	4'

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

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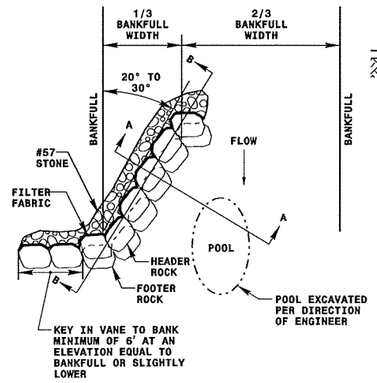
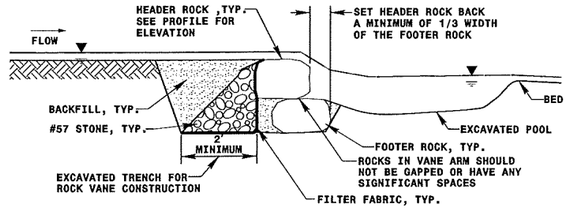
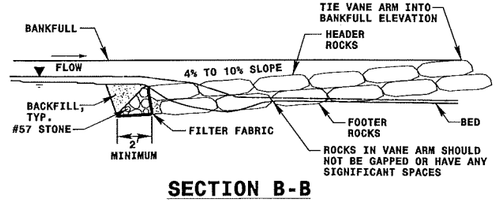


PLAN VIEW



SECTION A-A



SECTION B-B

BOULDER SIZE DATA CHART			
REACH	BOULDER DIMENSIONS HEIGHT	WIDTH	LENGTH
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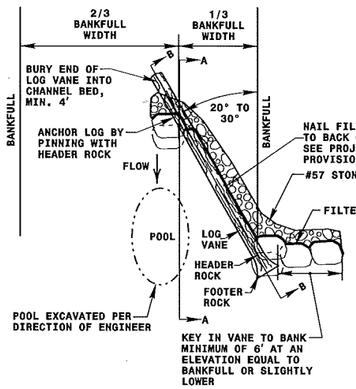
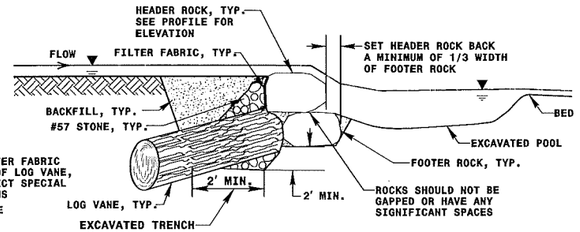
ROCK VANE DETAIL

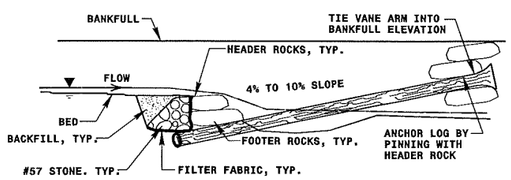
NOT TO SCALE



PLAN VIEW



SECTION A-A



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BOULDER SIZE DATA CHART			
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SITE 1	2'	3'	4'
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NOTES:
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5. POOL DEPTH SHOULD BE 2 TO 3 TIMES BANKFULL DEPTH.

LOG VANE DETAIL

NOT TO SCALE

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PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-2C

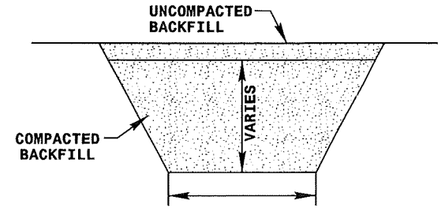
PROJECT ENGINEER

APPROVED BY:

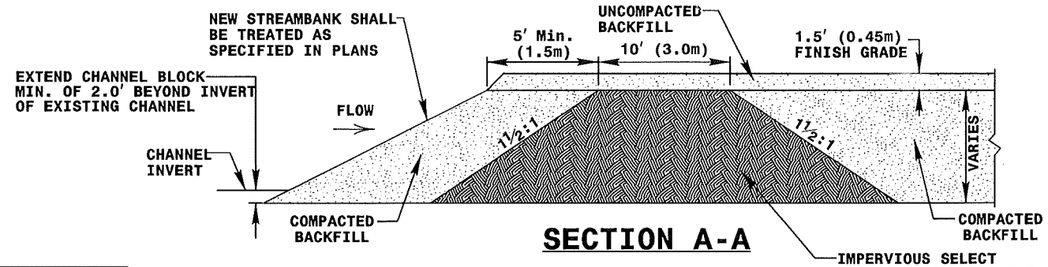
DATE:

DETAILS 3 OF 4

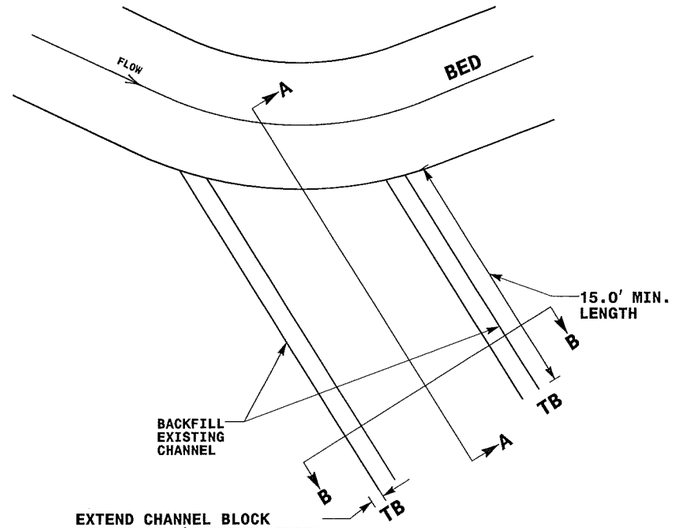
NOTES:
1) CHANNEL BLOCK SHALL BE INSTALLED IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS.
2) BLOCK SHOULD BE INSTALLED AT THE INTERFACE BETWEEN EXISTING CHANNEL AND PROPOSED CHANNEL.
3) BOTTOM OF BLOCK SHOULD BE A MINIMUM OF 2.0' BELOW THE INVERT OF THE EXISTING CHANNEL.
4) BLOCK SHOULD EXTEND A MINIMUM 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



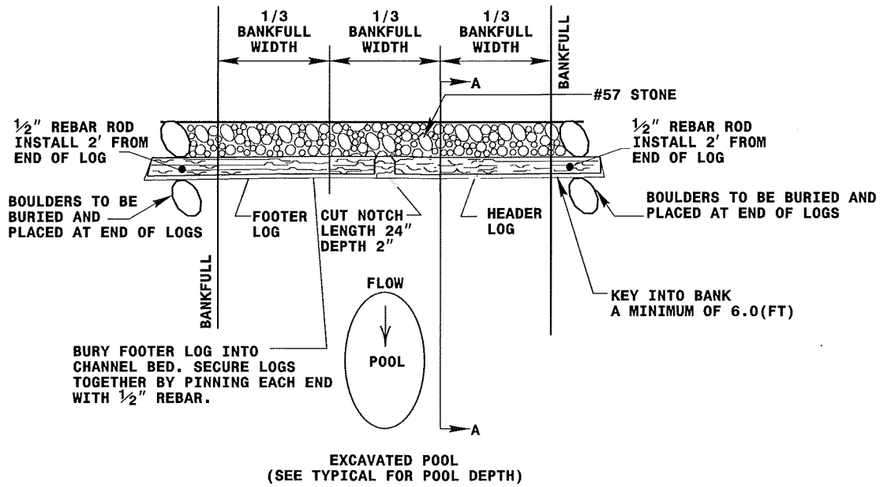
PLAN VIEW

STREAM PLUG

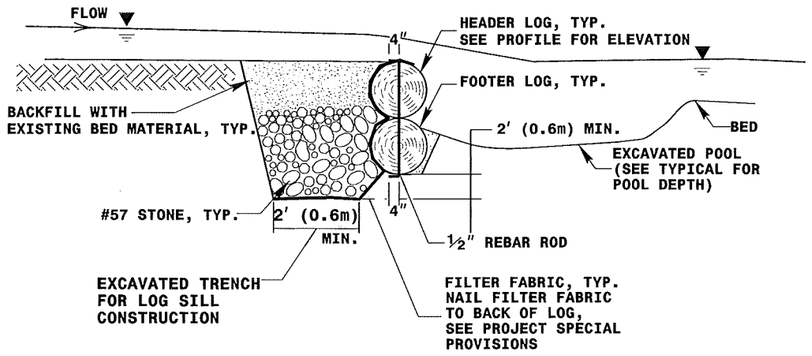
NOT TO SCALE

Rev. 07-01-13

09/26/11



PLAN VIEW



SECTION A-A

NOTES:

1. DO NOT EXCAVATE POOL CLOSE TO FOOTER LOG.
2. CLASS "A" STONE CAN BE USED TO REDUCE VOIDS BETWEEN HEADERS AND FOOTERS.
3. COMPACT BACKFILL TO EXTENT POSSIBLE OR AT THE DIRECTION OF THE ENGINEER.
4. POOL DEPTH SHOULD BE 2 TO 3 TIMES BANKFULL DEPTH.
5. BOULDERS TO BE 2'x3'x4' MIN.

LOG SILL DETAIL

NOT TO SCALE

SYSTIME=9:52:05 PLOTDATE=9/26/2011 PLOTSCALE=1.000000

PREPARED IN THE OFFICE OF:

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NC LICENSE F-0102

PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-2D

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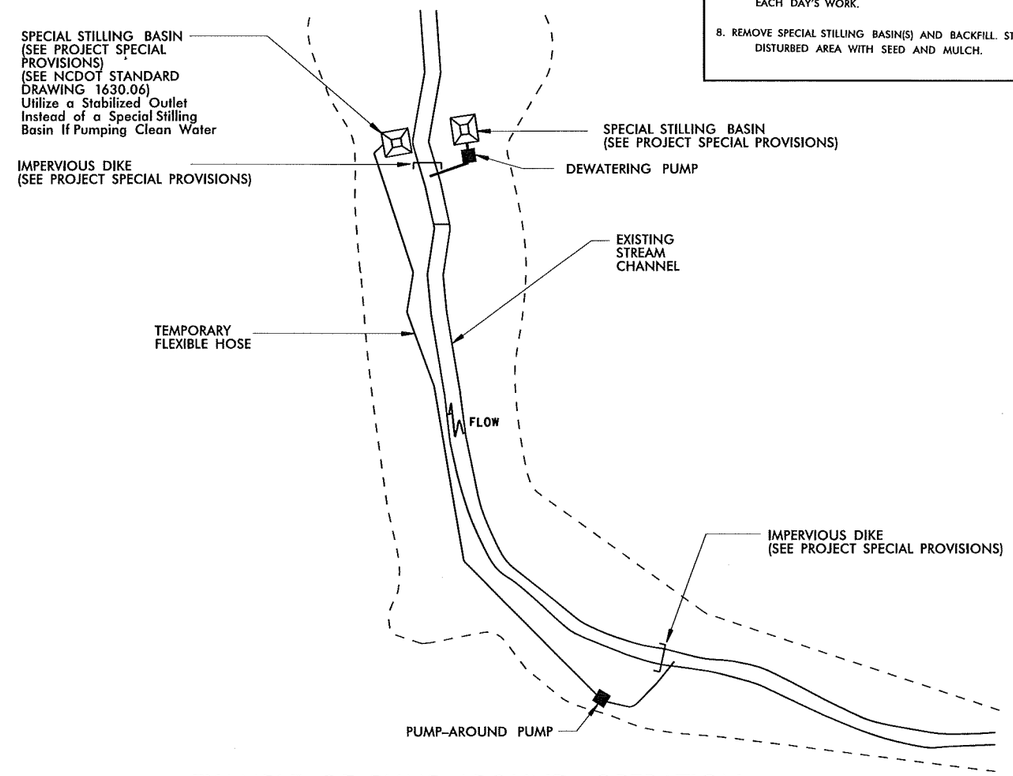
DETAILS 4 OF 4

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 sufficicient 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

NOT TO SCALE

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MORPHOLOGICAL TABLE

No.	VARIABLES	Stat	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)		SITE 1 UPPER EXISTING	
	STATION		–		–		–		–		–	
1.	Stream Type (Rosgen)		C5		E5		E5		B4		G5	
2.	Drainage Area (sq. mile)		0.18		0.07		0.15		1.12		0.13	
3.	Bankfull Width	Mean:	7.9		6.6		12.0		15.2		5.9	
	(W_{bkf})	Range:	–	–	5.7	7.5	12.0	13.5	–	–	–	–
4.	Bankfull Mean	Mean:	0.6		0.8		1.6		1.2		1.18	
	depth (d_{bkf})	Range:	–	–	0.7	0.8	1.4	1.7	–	–	–	–
5.	Width/Depth Ratio	Mean:	13.5		8.7		8.4		12.7		5.0	
	(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		4.0	
	Area (Abkf)	Range:	–	–	4.0	6.1	18.8	20.0	–	–	–	–
7.	Bankfull Mean Velocity	Mean:	Not Reported		Not Reported		5.6		5.1		4.3	
	(V_{bkf})	Range:	–	–	–	–	5.2	6.2	–	–	4.0	4.7
8.	Bankfull Discharge, cfs	Mean:	Not Reported		Not Reported		109.3		96.9		17.4	
	(Q_{bkf})	Range:	–	–	–	–	100.7	119.6	–	–	16.2	19.0
9.	Bankfull Maximum Depth	Mean:	1.0		1.5		2.9		1.9		1.4	
	(d_{max})	Range:	–	–	1.3	1.6	–	–	–	–	–	–
10.	Max d_{max}/d_{bkf}	Mean:	1.7		2.0		2.4		1.6		1.2	
	ratio	Range:	–	–	1.9	2.0	–	–	–	–	–	–
11.	Low Bank Height to max	Mean:	1.0		1.3		Not Reported		1.1		3.5	
	d_{bkf} ratio	Range:	–	–	1.20	2.50	–	–	–	–	–	–
12.	Width of Flood Prone	Mean:	36.0		27.4		49.0		23.3		8.0	
	Area (W_{fpa})	Range:	–	–	20.0	34.0	–	–	–	–	–	–
13.	Entrenchment Ratio	Mean:	4.6		4.2		4.4		1.5		1.4	
	(W_{fpa}/W_{bkf})	Range:	–	–	3.5	4.6	4.1	4.7	–	–	–	–
14.	Meander Length	Mean:	80.5		32.0		22.0		–		73.5	
	(L_m)	Range:	64.0	97.0	25.0	45.0	22.0	69.0	–	–	43.0	104.0
15.	Ratio of Meander Length to	Mean:	10.2		4.8		1.8		–		12.5	
	Bankfull Width (L_m/W_{bkf})	Range:	8.1	12.3	3.8	6.8	1.8	5.8	–	–	7.3	17.7
16.	Radius of Curvature	Mean:	13.4		11.3		7.3		–		29.0	
	(R_c)	Range:	8.5	22.0	5.7	18.8	7.3	17.3	–	–	18.0	40.0
17.	Ratio of Radius of Curvature	Mean:	1.7		1.7		0.6		–		4.9	
	to Bankfull Width (R_c/W_{bkf})	Range:	1.1	2.8	0.9	2.8	0.6	1.4	–	–	3.1	6.8
18.	Belt Width	Mean:	34.0		15.8		45.0		–		20.6	
	(W_{blt})	Range:	–	–	10.5	22.0	–	–	–	–	13.1	28.1
19.	Meander Width Ratio	Mean:	4.3		2.4		3.8		–		3.5	
	(W_{blt}/W_{bkf})	Range:	–	–	1.6	3.3	–	–	–	–	2.2	4.8
20.	Sinuosity (k)	Mean:	1.30		1.40		Not Reported		1.07		1.15	
	(Stream Length / Valley Length)	Range:	–	–	–	–	–	–	–	–		
21.	Valley Slope (Sv_{alley})	Mean:	0.0022		0.0130		Not Reported		0.0168		0.0175	
	(ft/ft)	Range:	–	–	–	–	–	–	–	–		
22.	Average Stream Slope	Mean:	0.0017		0.0093		0.0033		0.0157		0.0152	
	(S_{avg}) = (S_{valley}/k)	Range:	–	–	–	–	–	–	–	–	–	–
23.	Riffle Slope	Mean:	0.0049		0.0540		Not Reported		0.0522		0.0154	
	(S_{riff})	Range:	0.0000	0.0257	0.0100	0.0800	–	–	0.0077	0.0961	0.0138	0.0170
24.	Ratio of Riffle Slope to Avg.	Mean:	2.9		5.8		–		3.3		1.0	
	Slope (S_{riffle}/S_{avg})	Range:	0.0	15.3	0.6	4.5	–	–	–	–	0.9	1.1
25.	Pool Slope	Mean:	0.0002		0.0024		Not Reported		0.0032		0.0054	
	(S_{pool})	Range:	0.0000	0.0007	0.0000	0.0100	–	–	0.0009	0.0065	0.0043	0.0060
26.	Ratio of Pool Slope to Avg.	Mean:	0.1		0.3		–		0.2		0.4	
	Slope (S_{pool}/S_{avg})	Range:	0.0	0.4	0.0	0.6	–	–	0.1	0.4	0.3	0.4
27.	Maximum Pool	Mean:	2.0		2.0		3.1		3.0		1.5	
	Depth (d_{pool})	Range:	–	–	–	–	–	–	2.3	3.9	–	–
28.	Ratio of Pool Depth to Avg.	Mean:	3.4		2.3		2.0		2.5		1.3	
	Depth (d_{pool}/d_{bkf})	Range:	–	–	–	–	–	–	1.9167	3.2833	–	–
29.	Pool Width	Mean:	11.5		8.1		19.6		16.3		6.3	
	(W_{pool})	Range:	–	–	–	–	–	–	–	–	–	–
30.	Ratio of Pool Width to	Mean:	1.5		1.2		1.6		1.1		1.1	
	Bankfull Width (W_{pool}/W_{bkf})	Range:	–	–	–	–	–	–	–	–	–	–
31.	Pool Area	Mean:	Not Reported		Not Reported		27.0		22.7		7.6	
	(A_{pool})	Range:	–	–	–	–	–	–	–	–	–	–
32.	Ratio of Pool Area to	Mean:	–		–		1.4		1.2		1.9	
	Bankfull Area (A_{pool}/A_{bkf})	Range:	–	–	–	–	–	–	–	–	–	–
33.	Pool to Pool Spacing	Mean:	38.3		22.9		Not Reported		33.1		38.0	
	(p - p)	Range:	18	78	8	48	–	–	20	52	32.0	56.0
34.	Ratio of Pool to Pool Spacing	Mean:	4.8		3.5		–		2.2		6.5	
	to Bankfull Width (p-p/Wbkf)	Range:	2.3	9.9	1.1	7.3	–	–	1.3	3.4	5.4	9.5

No.	VARIABLES	Stat	Regional Curves Peidmont Rural/Rosgen Reference Values		SITE 1 UPPER DESIGN		SITE 1 LOWER EXISTING		Regional Curves Peidmont Rural/Rosgen Reference Values		SITE 1 LOWER DESIGN	
	STATION		–		–		–		–		–	
1.	Stream Type (Rosgen)		C/E		C5		G5		C/E		C5	
2.	Drainage Area (sq. mile)		0.13		0.13		0.13		0.13		0.13	
3.	Bankfull Width	Mean:	5.0		7.6		6.8		5.0		8.4	
	(W_{bkf})	Range:	–	–	–	–	–	–	–	–	–	–
4.	Bankfull Mean	Mean:	0.8		0.5		1.78		0.8		0.6	
	depth (d_{bkf})	Range:	–	–	–	–	–	–	–	–	–	–
5.	Width/Depth Ratio	Mean:	6.3		13.9		3.8		6.3		13.8	
	(W_{bkf}/d_{bkf})	Range:	–	–	–	–	–	–	–	–	–	–
6.	Bankfull cross-sectional	Mean:	5.4		4.2		12.0		5.4		5.1	
	Area (Abkf)	Range:	–	–	–	–	–	–	–	–	–	–
7.	Bankfull Mean Velocity	Mean:	3.8		4.2		2.5		3.8		5.9	
	(V_{bkf})	Range:	–	–	3.9	4.6	2.4	2.8	–	–	5.5	6.5
8.	Bankfull Discharge, cfs	Mean:	20.8		17.4		30.2		20.8		30.2	
	(Q_{bkf})	Range:	–	–	16.2	19.0	28.2	33.4	–	–	28.2	33.4
9.	Bankfull Maximum Depth	Mean:	–		0.8		1.8		–		0.9	
	(d_{max})	Range:	–	–	–	–	–	–	–	–	–	–
10.	Max d_{max}/d_{bkf}	Mean:	1.4		1.5		1.0		1.4		1.5	
	ratio	Range:	1.2	1.5	–	–	–	–	1.2	1.5	–	–
11.	Low Bank Height to max	Mean:	–		1.0		2.1		–		1.0	
	d_{bkf} ratio	Range:	–	–	–	–	–	–	–	–	–	–
12.	Width of Flood Prone	Mean:	–		80.0		9.0		–		84.0	
	Area (W_{fpa})	Range:	–	–			–	–	–	–	–	–
13.	Entrenchment Ratio	Mean:	–		10.5		1.3		–		10.0	
	(W_{fpa}/W_{bkf})	Range:	–	–	–	–	–	–	–	–	–	–
14.	Meander Length	Mean:	–		85.0		79.5		–		103.0	
	(L_m)	Range:	–	–	68.4	106.4	75.0	84.0	–	–	89.0	117.0
15.	Ratio of Meander Length to	Mean:	11.5		11.2		11.6		11.5		12.3	
	Bankfull Width (L_m/W_{bkf})	Range:	9.0	14.0	9.0	14.0	11.0	12.3	9.0	14.0	9.0	14.0
16.	Radius of Curvature	Mean:	–		22.8		31.0		–		25.2	
	(R_c)	Range:	–	–	19.0	26.6	20.0	42.0	–	–	21.0	29.4
17.	Ratio of Radius of Curvature	Mean:	2.8		3.0		4.5		2.8		3.0	
	to Bankfull Width (R_c/W_{bkf})	Range:	2.5	3.0	2.5	3.5	2.9	6.1	2.5	3.0	2.5	3.5
18.	Belt Width	Mean:	–		24.4		30.5		–		23.1	
	(W_{blt})	Range:	–	–	19.0	25.1	25.0	36.0	–	–	21.0	25.2
19.	Meander Width Ratio	Mean:	4.0		3.2		4.5		4.0		2.8	
	(W_{blt}/W_{bkf})	Range:	3.0	5.0	2.5	3.3	3.7	5.3	3.0	5.0	2.5	3.0
20.	Sinuosity (k)	Mean:	–		1.11		1.24		–		1.14	
	(Stream Length / Valley Length)	Range:	–	–	–	–			–	–		
21.	Valley Slope (Sv_{alley})	Mean:	–		0.0175		0.0205		–		0.0205	
	(ft/ft)	Range:	–	–					–	–		
22.	Average Stream Slope	Mean:	–		0.0150		0.0053		–		0.0185	
	(S_{avg}) = (S_{valley}/k)	Range:	–	–	–	–	–	–	–	–	–	–
23.	Riffle Slope	Mean:	–		0.0162		0.0200		–		0.0193	
	(S_{riff})	Range:	–	–	0.0101	0.0224	0.0125	0.0275	–	–	0.0102	0.0284
24.	Ratio of Riffle Slope to Avg.	Mean:	1.8		1.1		3.8		1.8		1.0	
	Slope (S_{riffle}/S_{avg})	Range:	1.5	2.0	0.7	1.5	2.4	5.2	1.5	2.0	0.6	1.5
25.	Pool Slope	Mean:	–		0.0001		0.0001		–		0.0001	
	(S_{pool})	Range:	–	–	0.0001	0.0015	0.0001	0.0010	–	–	0.0001	0.0015
26.	Ratio of Pool Slope to Avg.	Mean:	0.0		0.0		0.0		0.0		0.0	
	Slope (S_{pool}/S_{avg})	Range:	0.0	0.1	0.0	0.1	0.0	0.2	0.0	0.1	0.0	0.1
27.	Maximum Pool	Mean:	–		1.5		1.3		–		1.6	
	Depth (d_{pool})	Range:	–	–	–	–	–	–	–	–	–	–
28.	Ratio of Pool Depth to Avg.	Mean:	3.0		2.7		0.7		3.0		2.6	
	Depth (d_{pool}/d_{bkf})	Range:	2.5	3.5	–	–	–	–	2.5	3.5	–	–
29.	Pool Width	Mean:	–		9.4		7.9		–		10.6	
	(W_{pool})	Range:	–	–	–	–	–	–	–	–	–	–
30.	Ratio of Pool Width to	Mean:	1.5		1.2		1.2		1.5		1.3	
	Bankfull Width (W_{pool}/W_{bkf})	Range:	1.3	1.7	–	–	–	–	1.3	1.7	–	–
31.	Pool Area	Mean:	–		7.0		8.0		–		8.8	
	(A_{pool})	Range:	–	–	–	–	–	–	–	–	–	–
32.	Ratio of Pool Area to	Mean:	–		1.7		0.7		–		1.7	
	Bankfull Area (A_{pool}/A_{bkf})	Range:	–	–	–	–	–	–	–	–	–	–
33.	Pool to Pool Spacing	Mean:	–		46.0		32.7		–		52.5	
	(p - p)	Range:	–	–	38.0	53.2	25.0	37.0	–	–	44.0	61.0
34.	Ratio of Pool to Pool Spacing	Mean:	6.0		6.1		4.8		6.0		6.3	
	to Bankfull Width (p-p/Wbkf)	Range:	5.0	7.0	5.0	7.0	3.7	5.4	5.0	7.0	5.0	7.0

1. Geomorphic feature was not visibly present due to channelization and/or urban impacts to stream channel.
2. Feature was not measured as part of the project field effort

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DATE:

MORPHOLOGICAL TABLE

	VARIABLES	SITE 2 EXISTING			Regional Curves Peidmont Rural/Rosgen Reference Values			SITE 2 DESIGN		
	STATION	--			–			–		
1.	Stream Type (Rosgen)	E5			C/E			C5		
2.	Drainage Area (sq. mile)	0.09			0.09			0.09		
3.	Bankfull Width	Mean:	6.2		Mean:	4.3		Mean:	7.6	
	(W_{bkf})	Range:	--	--	Range:	–	–	Range:	–	–
4.	Bankfull Mean	Mean:	0.62		Mean:	0.7		Mean:	0.5	
	depth (d_{bkf})	Range:	--	--	Range:	–	–	Range:	–	–
5.	Width/Depth Ratio	Mean:	10.0		Mean:	6.1		Mean:	13.9	
	(W_{bkf}/d_{bkf})	Range:	--	--	Range:	–	–	Range:	–	–
6.	Bankfull cross-sectional	Mean:	3.9		Mean:	4.3		Mean:	4.2	
	Area (Abkf)	Range:	--	--	Range:	–	–	Range:	–	–
7.	Bankfull Mean Velocity	Mean:	4.4		Mean:	3.8		Mean:	4.0	
	(V_{bkf})	Range:	4.1	4.8	Range:	–	–	Range:	3.8	4.5
8.	Bankfull Discharge, cfs	Mean:	16.8		Mean:	16.3		Mean:	16.8	
	(Q_{bkf})	Range:	15.7	18.6	Range:	–	–	Range:	15.7	18.6
9.	Bankfull Maximum Depth	Mean:	1.1		Mean:	–		Mean:	0.8	
	(d_{max})	Range:	--	--	Range:	–	–	Range:	–	–
10.	Max d_{max}/d_{bkf}	Mean:	1.8		Mean:	1.4		Mean:	1.5	
	ratio	Range:	--	--	Range:	1.2	1.5	Range:	–	–
11.	Low Bank Height to max	Mean:	1.0		Mean:	–		Mean:	1.0	
	d_{bkf} ratio	Range:	–	–	Range:	–	–	Range:	–	–
12.	Width of Flood Prone	Mean:	15.9		Mean:	–		Mean:	34.0	
	Area (W_{fpa})	Range:	--	--	Range:	–	–	Range:	25.0	38
13.	Entrenchment Ratio	Mean:	2.6		Mean:	–		Mean:	4.5	
	(W_{fpa}/W_{bkf})	Range:	--	--	Range:	–	–	Range:	3.3	5.0
14.	Meander Length	Mean:	77.5		Mean:	–		Mean:	89.0	
	(L_m)	Range:	75.0	80.0	Range:	–	–	Range:	72.0	100.0
15.	Ratio of Meander Length to	Mean:	12.4		Mean:	11.5		Mean:	11.7	
	Bankfull Width (L_m/W_{bkf})	Range:	12.0	12.8	Range:	9.0	14.0	Range:	9.0	14.0
16.	Radius of Curvature	Mean:	28.0		Mean:	–		Mean:	22.8	
	(R_c)	Range:	18.0	38.0	Range:	–	–	Range:	19.0	26.6
17.	Ratio of Radius of Curvature	Mean:	4.5		Mean:	3.0		Mean:	3.0	
	to Bankfull Width (R_c/W_{bkf})	Range:	2.9	6.1	Range:	2.5	3.5	Range:	2.5	3.5
18.	Belt Width	Mean:	21.8		Mean:	–		Mean:	23.4	
	(W_{blt})	Range:	6.5	37.0	Range:	–	–	Range:	19.0	25.1
19.	Meander Width Ratio	Mean:	3.5		Mean:	4.0		Mean:	3.1	
	(W_{blt}/W_{bkf})	Range:	1.0	5.9	Range:	3.0	5.0	Range:	2.5	3.3
20.	Sinuosity (k)	Mean:	1.16		Mean:	–		Mean:	1.18	
	(Stream Length / Valley Length)	Range:			Range:	–	--	Range:		
21.	Valley Slope (Sv_{alley})	Mean:	0.0506		Mean:	–		Mean:	0.0506	
	(ft/ft)	Range:			Range:	–	–	Range:		
22.	Average Stream Slope	Mean:	0.0158		Mean:	–		Mean:	0.0257	
	(S_{avg}) = (S_{valley}/k)	Range:	0.0054	0.0158	Range:	–	–	Range:	--	--
23.	Riffle Slope	Mean:	0.0295		Mean:	–		Mean:	0.0288	
	(S_{riff})	Range:	0.0090	0.0500	Range:	–	–	Range:	0.0106	0.0469
24.	Ratio of Riffle Slope to Avg.	Mean:	1.9		Mean:	1.8		Mean:	1.1	
	Slope (S_{riffle}/S_{avg})	Range:	0.6	3.2	Range:	1.5	2.0	Range:	0.4	1.8
25.	Pool Slope	Mean:	0.0001		Mean:	–		Mean:	0.0001	
	(S_{pool})	Range:	0.0001	0.0010	Range:	–	–	Range:	0.0001	0.0015
26.	Ratio of Pool Slope to Avg.	Mean:	0.0		Mean:	0.0		Mean:	0.0	
	Slope (S_{pool}/S_{avg})	Range:	0.0	0.1	Range:	0.0	0.1	Range:	0.0	0.1
27.	Maximum Pool	Mean:	1.5		Mean:	–		Mean:	1.5	
	Depth (d_{pool})	Range:	–	--	Range:	–	–	Range:	--	--
28.	Ratio of Pool Depth to Avg.	Mean:	2.4		Mean:	3.0		Mean:	2.7	
	Depth (d_{pool}/d_{bkf})	Range:	--	--	Range:	2.5	3.5	Range:	–	--
29.	Pool Width	Mean:	5.9		Mean:	–		Mean:	9.4	
	(W_{pool})	Range:	--	–	Range:	–	–	Range:	–	–
30.	Ratio of Pool Width to	Mean:	0.9		Mean:	1.5		Mean:	1.2	
	Bankfull Width (W_{pool}/W_{bkf})	Range:	--	--	Range:	1.3	1.7	Range:	–	–
31.	Pool Area	Mean:	5.0		Mean:	–		Mean:	7.0	
	(A_{pool})	Range:	–	--	Range:	–	–	Range:	–	–
32.	Ratio of Pool Area to	Mean:	1.3		Mean:	--		Mean:	1.7	
	Bankfull Area (A_{pool}/A_{bkf})	Range:	--	--	Range:	–	–	Range:	–	--
33.	Pool to Pool Spacing	Mean:	23.5		Mean:	–		Mean:	46.5	
	(p - p)	Range:	18.0	29.0	Range:	–	–	Range:	39.0	54.0
34.	Ratio of Pool to Pool Spacing	Mean:	3.8		Mean:	6.0		Mean:	6.1	
	to Bankfull Width (p-p/Wbkf)	Range:	2.9	4.7	Range:	5.0	7.0	Range:	5.0	7.0

1. Geomorphic feature was not visibly present due to channelization and/or urban impacts to stream channel.
2. Feature was not measured as part of the project field effort

09/26/11

$$$$$SYSTIME$$$$$ $$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$$$$ $$$$$USERNAME$$$$$

Rev. 07-01-13

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.
R-2413A&B	OSM-2G

PROJECT ENGINEER

APPROVED BY:

DATE:

MORPHOLOGICAL TABLE

No.	VARIABLES	SITE 4 EXISTING			Regional Curves Peidmont Rural/Rosgen Reference Values			SITE 4 DESIGN			SITE 5 EXISTING			Regional Curves Peidmont Rural/Rosgen Reference Values			SITE 5 DESIGN		
	STATION	–			–			–			–			–			–		
1.	Stream Type (Rosgen)	E5			C/E			C5			E5 --> F5			C/E			C5		
2.	Drainage Area (sq. mile)	3.04			3.04			3.04			0.41			0.41			0.41		
3.	Bankfull Width	Mean:	15.7		Mean:	19.2		Mean:	25.0		Mean:	6.6		Mean:	8.1		Mean:	11.7	
	(W_{bkf})	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
4.	Bankfull Mean	Mean:	2.06		Mean:	2.1		Mean:	1.8		Mean:	0.98		Mean:	1.1		Mean:	0.8	
	depth (d_{bkf})	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
5.	Width/Depth Ratio	Mean:	7.6		Mean:	9.0		Mean:	14.3		Mean:	6.8		Mean:	7.2		Mean:	14.1	
	(W_{bkf}/d_{bkf})	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
6.	Bankfull cross-sectional	Mean:	32.4		Mean:	45.6		Mean:	43.8		Mean:	6.6		Mean:	11.7		Mean:	9.7	
	Area (Abkf)	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
7.	Bankfull Mean Velocity	Mean:	1.5		Mean:	4.3		Mean:	1.1		Mean:	3.4		Mean:	4.0		Mean:	2.3	
	(V_{bkf})	Range:	1.4	1.7	Range:	–	–	Range:	1.0	1.2	Range:	3.2	3.8	Range:	–	–	Range:	2.2	2.6
8.	Bankfull Discharge, cfs	Mean:	49.0		Mean:	198.3		Mean:	49.0		Mean:	22.6		Mean:	46.9		Mean:	22.6	
	(Q_{bkf})	Range:	45.7	54.1	Range:	–	–	Range:	45.7	54.1	Range:	21.1	25.0	Range:	–	–	Range:	21.1	25.0
9.	Bankfull Maximum Depth	Mean:	2.85		Mean:	–		Mean:	2.5		Mean:	1.4		Mean:	–		Mean:	1.2	
	(d_{max})	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
10.	Max d_{max}/d_{bkf}	Mean:	1.4		Mean:	1.4		Mean:	1.4		Mean:	1.4		Mean:	1.4		Mean:	1.4	
	ratio	Range:	–	–	Range:	1.2	1.5	Range:	–	–	Range:	–	–	Range:	1.2	1.5	Range:	–	–
11.	Low Bank Height to max	Mean:	1.1		Mean:	–		Mean:	1.0		Mean:	2.0		Mean:	–		Mean:	1.0	
	d_{bkf} ratio	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
12.	Width of Flood Prone	Mean:	85.0		Mean:	–		Mean:	85.0		Mean:	14.5		Mean:	–		Mean:	80.0	
	Area (W_{fpa})	Range:	–	–	Range:	–	–	Range:			Range:	–	–	Range:	–	–	Range:		
13.	Entrenchment Ratio	Mean:	5.4		Mean:	–		Mean:	3.4		Mean:	2.2		Mean:	–		Mean:	6.8	
	(W_{fpa}/W_{bkf})	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
14.	Meander Length	Mean:	101.0		Mean:	–		Mean:	180.0		Mean:	70.0		Mean:	–		Mean:	140.5	
	(L_m)	Range:	94.0	108.0	Range:	–	–	Range:	–	–	Range:	37.5	115.0	Range:	–	–	Range:	112.0	169.0
15.	Ratio of Meander Length to	Mean:	6.4		Mean:	11.5		Mean:	7.2		Mean:	10.6		Mean:	11.5		Mean:	12.0	
	Bankfull Width (L_m/W_{bkf})	Range:	6.0	6.9	Range:	9.0	14.0	Range:	–	–	Range:	5.7	17.3	Range:	9.0	14.0	Range:	9.0	14.0
16.	Radius of Curvature	Mean:	78.0		Mean:	–		Mean:	75.0		Mean:	35.0		Mean:	–		Mean:	35.1	
	(R_c)	Range:	56.0	100.0	Range:	–	–	Range:	62.5	87.5	Range:	18.0	52.0	Range:	–	–	Range:	29.3	41.0
17.	Ratio of Radius of Curvature	Mean:	5.0		Mean:	2.8		Mean:	3.0		Mean:	5.3		Mean:	2.8		Mean:	3.0	
	to Bankfull Width (R_c/W_{bkf})	Range:	3.6	6.4	Range:	2.5	3.0	Range:	2.5	3.5	Range:	2.7	7.8	Range:	2.5	3.0	Range:	2.5	3.5
18.	Belt Width	Mean:	39.8		Mean:	–		Mean:	28.0		Mean:	26.0		Mean:	–		Mean:	32.0	
	(W_{blt})	Range:	37.5	42.0	Range:	–	–	Range:	25.0	75.0	Range:	17.0	35.0	Range:	–	–	Range:	29.0	35.0
19.	Meander Width Ratio	Mean:	2.5		Mean:	4.0		Mean:	1.1		Mean:	3.9		Mean:	4.0		Mean:	2.7	
	(W_{blt}/W_{bkf})	Range:	2.4	2.7	Range:	3.0	5.0	Range:	1.0	3.0	Range:	2.6	5.3	Range:	3.0	5.0	Range:	2.5	3.0
20.	Sinuosity (k)	Mean:	1.02		Mean:	–		Mean:	1.00		Mean:	1.14		Mean:	–		Mean:	1.15	
	(Stream Length / Valley Length)	Range:			Range:	–	–	Range:			Range:	–	–	Range:	–	–	Range:		
21.	Valley Slope (Sv_{alley})	Mean:	0.0200		Mean:	–		Mean:	0.0200		Mean:	0.0155		Mean:	–		Mean:	0.0155	
	(ft/ft)	Range:			Range:	–	–	Range:			Range:	–	–	Range:	–	–	Range:		
22.	Average Stream Slope	Mean:	0.0019		Mean:	–		Mean:	0.0020		Mean:	0.0097		Mean:	–		Mean:	0.0138	
	(S_{avg}) = (S_{valley}/k)	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
23.	Riffle Slope	Mean:	0.0012		Mean:	–		Mean:	0.0027		Mean:	0.0103		Mean:	–		Mean:	0.0158	
	(S_{riff})	Range:	0.0005	0.0019	Range:	–	–	Range:	0.0021	0.0033	Range:	–	–	Range:	–	–	Range:	0.0126	0.0189
24.	Ratio of Riffle Slope to Avg.	Mean:	0.6		Mean:	1.8		Mean:	1.4		Mean:	1.1		Mean:	1.8		Mean:	1.2	
	Slope (S_{riffle}/S_{avg})	Range:	0.3	1.0	Range:	1.5	2.0	Range:	1.1	1.7	Range:	–	–	Range:	1.5	2.0	Range:	0.91	1.4
25.	Pool Slope	Mean:	0.0001		Mean:	–		Mean:	0.0001		Mean:	0.00010		Mean:	–		Mean:	0.0001	
	(S_{pool})	Range:	0.0001	0.0010	Range:	–	–	Range:	0.0001	0.0015	Range:	0.0001	0.0010	Range:	–	–	Range:	0.0001	0.0015
26.	Ratio of Pool Slope to Avg.	Mean:	0.1		Mean:	0.0		Mean:	0.1		Mean:	0.0		Mean:	0.0		Mean:	0.0	
	Slope (S_{pool}/S_{avg})	Range:	0.1	0.5	Range:	0.0	0.1	Range:	0.0	0.1	Range:	0.0	0.1	Range:	0.0	0.1	Range:	0.0	0.1
27.	Maximum Pool	Mean:	2.4		Mean:	–		Mean:	4.5		Mean:	1.6		Mean:	–		Mean:	2.2	
	Depth (d_{pool})	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
28.	Ratio of Pool Depth to Avg.	Mean:	1.1		Mean:	3.0		Mean:	2.6		Mean:	1.6		Mean:	3.0		Mean:	2.6	
	Depth (d_{pool}/d_{bkf})	Range:	–	–	Range:	2.5	3.5	Range:	–	–	Range:	–	–	Range:	2.5	3.5	Range:	–	–
29.	Pool Width	Mean:	16.2		Mean:	–		Mean:	30.5		Mean:	8.7		Mean:	–		Mean:	14.4	
	(W_{pool})	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
30.	Ratio of Pool Width to	Mean:	1.0		Mean:	1.5		Mean:	1.2		Mean:	1.3		Mean:	1.5		Mean:	1.2	
	Bankfull Width (W_{pool}/W_{bkf})	Range:	–	–	Range:	1.3	1.7	Range:	–	–	Range:	–	–	Range:	1.3	1.7	Range:	–	–
31.	Pool Area	Mean:	36.8		Mean:	–		Mean:	72.4		Mean:	8.8		Mean:	–		Mean:	16.2	
	(A_{pool})	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
32.	Ratio of Pool Area to	Mean:	1.1		Mean:	–		Mean:	1.7		Mean:	1.3		Mean:	–		Mean:	1.7	
	Bankfull Area (A_{pool}/A_{bkf})	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–	Range:	–	–
33.	Pool to Pool Spacing	Mean:	78.5		Mean:	–		Mean:	97.0		Mean:	43.0		Mean:	–		Mean:	78.0	
	(p - p)	Range:	50.0	107.0	Range:	–	–	Range:	58.0	136.0	Range:	26.0	60.0	Range:	–	–	Range:	60.0	90.0
34.	Ratio of Pool to Pool Spacing	Mean:	5.0		Mean:	6.0		Mean:	3.9		Mean:	6.5		Mean:	6.0		Mean:	6.7	
	to Bankfull Width (p-p/Wbkf)	Range:	3.2	6.8	Range:	5.0	7.0	Range:	2.3	5.5	Range:	3.9	9.0	Range:	5.0	7.0	Range:	5.0	7.0

1. Geomorphic feature was not visibly present due to channelization and/or urban impacts to stream channel.
2. Feature was not measured as part of the project field effort

09/26/11

$$$$$SYSTIME$$$$
$$$$$DGN$$$$$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$

Rev 07-01-13

09/26/11

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.
R-2413A&B	OSM-3

PROJECT ENGINEER

APPROVED BY:

DATE:

SUMMARY OF QUANTITIES,
SUMMARY OF EARTHWORK
FOR MITIGATION

SUMMARY OF QUANTITIES

DESCRIPTION	SECTION	QUANTITIY	UNIT	ITEM DESCRIPTION
0000400000-N	SP	1	LS	CONSTRUCTION SURVEYING FOR MITIGATION
0043000000-N	SP	1	LS	GRADING FOR MITIGATION
1077000000-M	1610	670	TON	#57 STONE
3656000000-M	1042	2,100	SY	FILTER FABRIC FOR DRAINAGE
3651000000-M	SP	2,800	TON	BOULDER
3642000000-M	SP	270	TON	PLAIN RIP RAP, CLASS A
3649000000-M	SP	250	TON	PLAIN RIP RAP, CLASS B
3628000000-M	SP	170	TON	PLAIN RIP RAP, CLASS I
6133000000-N	SP	1	LS	DIVERSION PUMPING FOR MITIGATION
6133000000-N	SP	8	EA	LOGS
6133000000-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 1	1,359	1,083	0	276
SITE 2	8,056	692	0	7,364
SITE 4	5,038	196	0	4,842
SITE 5	3,413	1,279	0	2,134
SUBTOTAL	17,866	3,250	0	14,616

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".

$$$$SYSTIME$$$$
$$$$SYSLEVEL$$$$
$$$$USERNAME$$$$
$$$$DGN$$$$$$$$$$$$$$$$$$$$

Rev. 07-01-13

PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-4

PROJECT ENGINEER

APPROVED BY:

DATE:

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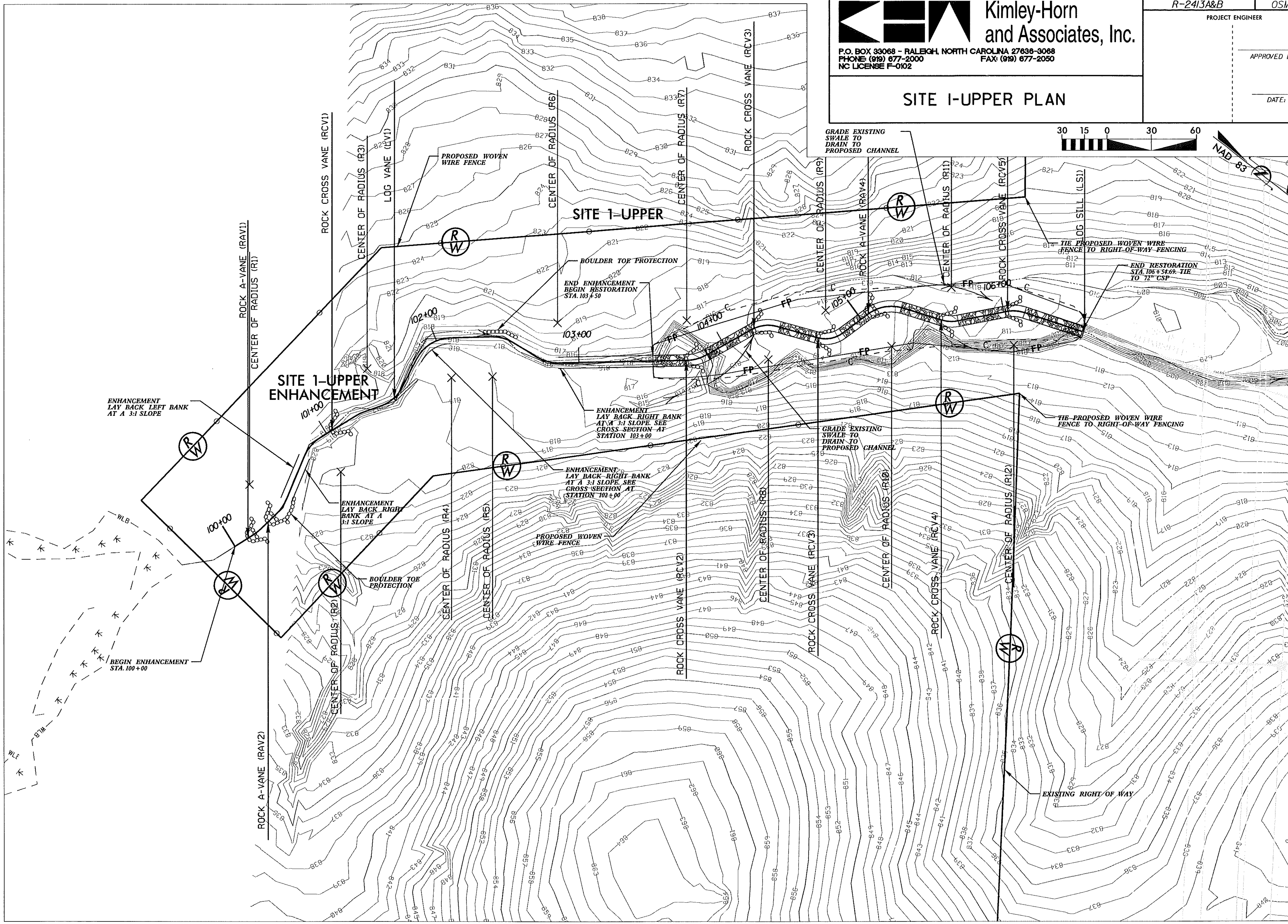
SITE 1-UPPER PLAN



09/26/11

Rev. 07-01-13

09/26/11

PREPARED IN THE OFFICE OF:	PROJECT REFERENCE NO.	SHEET NO.
Kimley-Horn and Associates, Inc.	R-2413A&B	OSM-5
P.O. BOX 33068 - RALEIGH, NORTH CAROLINA 27636-3068 PHONE: (919) 677-2000 FAX: (919) 677-2050 NC LICENSE F-0102	PROJECT ENGINEER APPROVED BY: DATE:	

SITE 1- LOWER PLAN

30 15 0 30 60

NAD 83

EXISTING CONTROLLED ACCESS LINE

BEGIN RESTORATION STA.150+00. ENSURE INVERT OF ROCK CROSS VANE (RCV1) IS PLACED 1.0' HIGHER THAN OUTLET INVERT OF PROPOSED 72" CSP

PROPOSED 72" CSP

TIE PROPOSED WOVEN WIRE FENCE TO RIGHT-OF-WAY FENCING

PROPOSED WOVEN WIRE FENCE

END RESTORATION STA. 155+09. TIE TO EXISTING CHANNEL

ROCK CROSS VANE (RCV1)
ROCK CROSS VANE (RCV2)
ROCK CROSS VANE (RCV3)
ROCK CROSS VANE (RCV4)
ROCK CROSS VANE (RCV5)
ROCK CROSS VANE (RCV6)
ROCK CROSS VANE (RCV7)
ROCK CROSS VANE (RCV8)
ROCK CROSS VANE (RCV9)
ROCK A-VANE (RAV1)

CENTER OF RADIUS (R1)
CENTER OF RADIUS (R2)
CENTER OF RADIUS (R3)
CENTER OF RADIUS (R4)
CENTER OF RADIUS (R5)
CENTER OF RADIUS (R6)
CENTER OF RADIUS (R7)
CENTER OF RADIUS (R8)
CENTER OF RADIUS (R9)

150+00
151+00
152+00
153+00
154+00
155+00

FP

SITE 1-LOWER

MATCHLINE SEE SHEET OSM-4

MATCHLINE SEE SHEET OSM-7

$$$$FILENAME$$$$ $$$$SYSTIME$$$$ $$$$DGN$$$$

Rev-07-01-13

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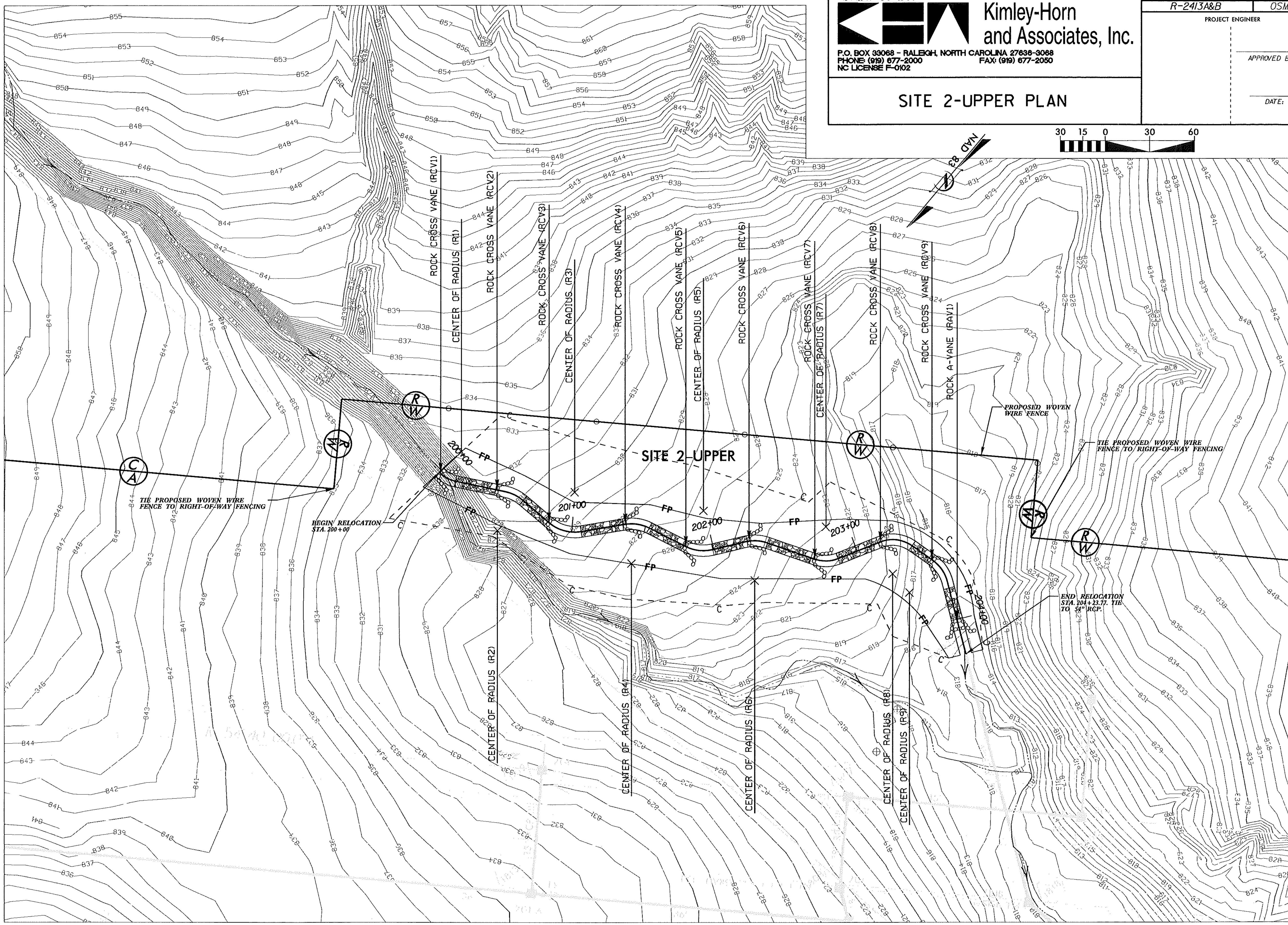
PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-6

PROJECT ENGINEER

APPROVED BY:

DATE:

SITE 2-UPPER PLAN



Rev-07-01-13

09/26/11

MATCHLINE SEE SHEET OSM-6

BEGIN RESTORATION STA.250+00. ENSURE INVERT OF ROCK CROSS VANE (RCV1) IS PLACED 1.0' HIGHER THAN OUTLET INVERT OF PROPOSED 54" RCP

NATURAL ROCK ENERGY DISSIPATER

ROCK A-VANE (RAV1)

CENTER OF RADIUS (R1)

ROCK A-VANE (RAV2)

ROCK A-VANE (RAV3)

TIE PROPOSED WOVEN WIRE FENCE TO RIGHT-OF-WAY FENCING

CENTER OF RADIUS (R3)

ROCK A-VANE (RAV4)

ROCK A-VANE (RAV5)

CENTER OF RADIUS (R5)

ROCK A-VANE (RAV6)

ROCK A-VANE (RAV7)

PROPOSED WOVEN WIRE FENCE

CENTER OF RADIUS (R7)

ROCK A-VANE (RAV8)

ROCK A-VANE (RAV9)

ROCK A-VANE (RAV10)

CENTER OF RADIUS (R10)

CENTER OF RADIUS (R2)

CENTER OF RADIUS (R4)

GRADE TO DRAIN INTO PROPOSED CHANNEL NEAR STATION 253+00

CENTER OF RADIUS (R6)

CENTER OF RADIUS (R8)

CENTER OF RADIUS (R9)

END RESTORATION BEGIN ENHANCEMENT STA 254+82.4. TIE TO EXISTING CHANNEL

END ENHANCMENT STA. 255+53.89

250+00

251+00

252+00

253+00

254+00

255+00

FP

C

SITE 2-LOWER

MATCHLINE SEE SHEET OSM-5

30 15 0 30 60

NAD 83

N

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PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-7

PROJECT ENGINEER

APPROVED BY:

DATE:

SITE 2-LOWER PLAN

$$$$$$SYSTIME$$$$$$
$$$$$$LEVELS$$$$$$

Rev. 07-01-13

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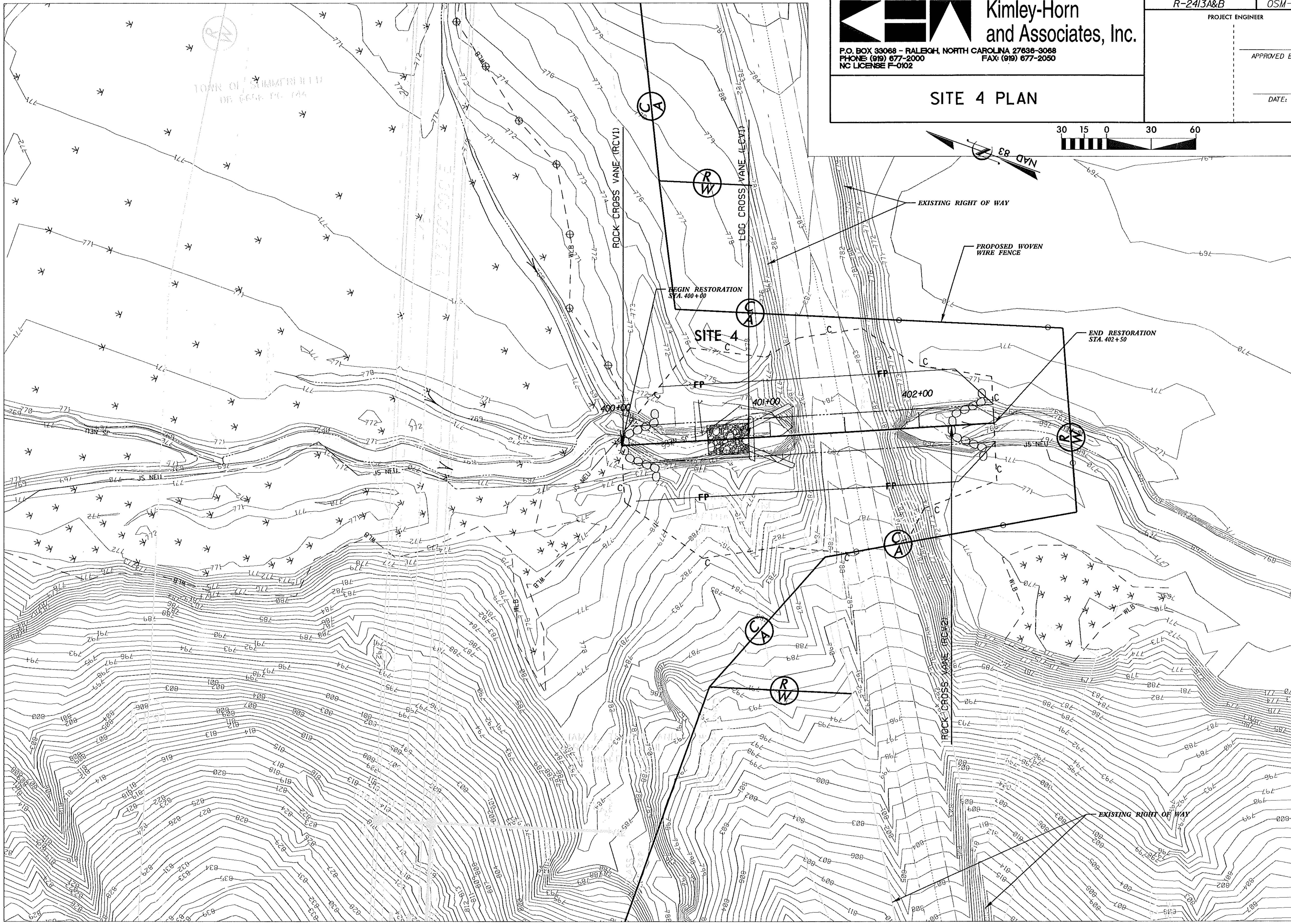
PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-08

PROJECT ENGINEER

APPROVED BY:

DATE:

SITE 4 PLAN



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Rev. 07-01-13

09/26/11

PREPARED IN THE OFFICE OF:

Kimley-Horn and Associates, Inc.
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PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-9

PROJECT ENGINEER

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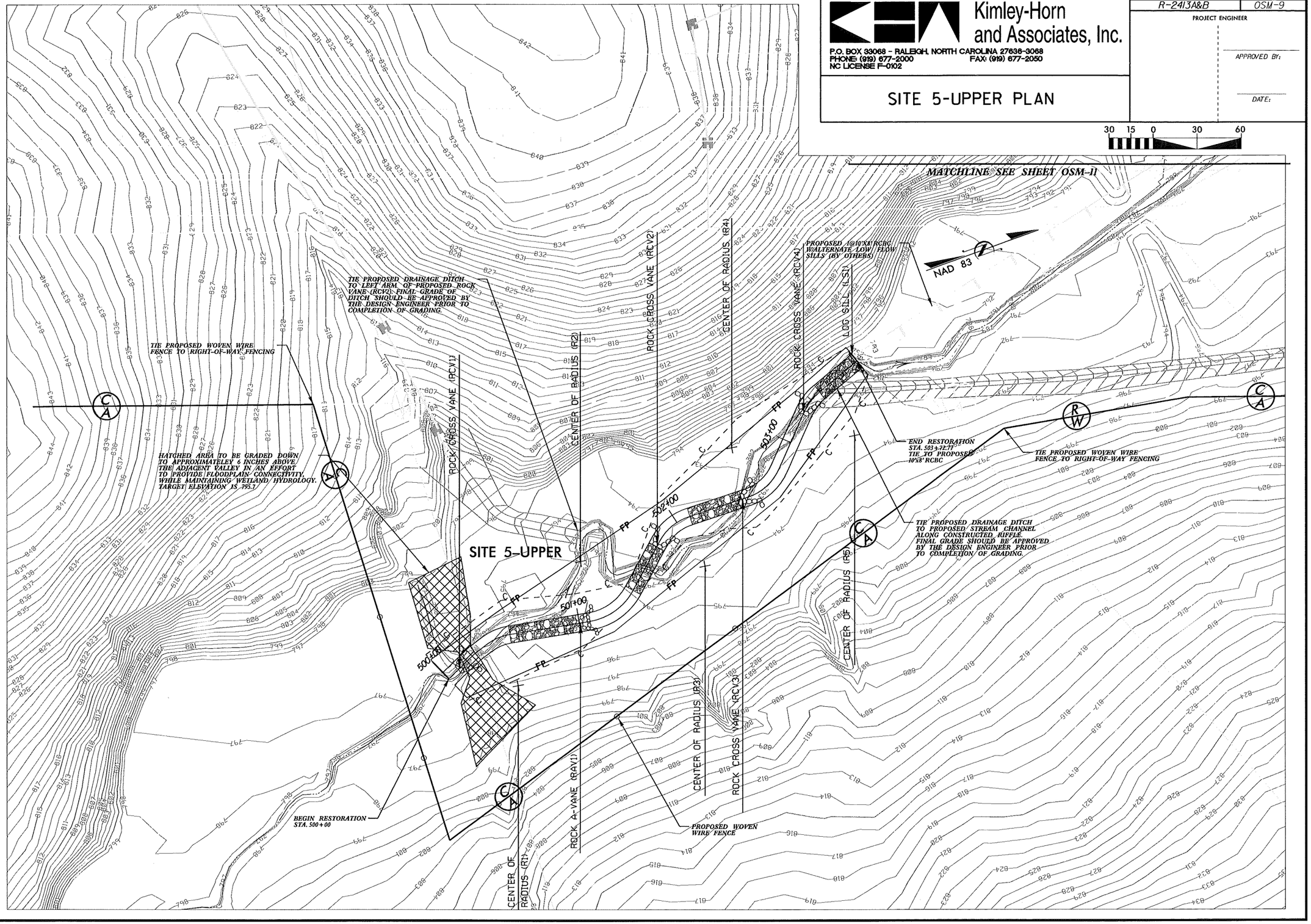
DATE:

SITE 5-UPPER PLAN

30 15 0 30 60



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Rev. 07-01-13

PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-10

PROJECT ENGINEER

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DATE:

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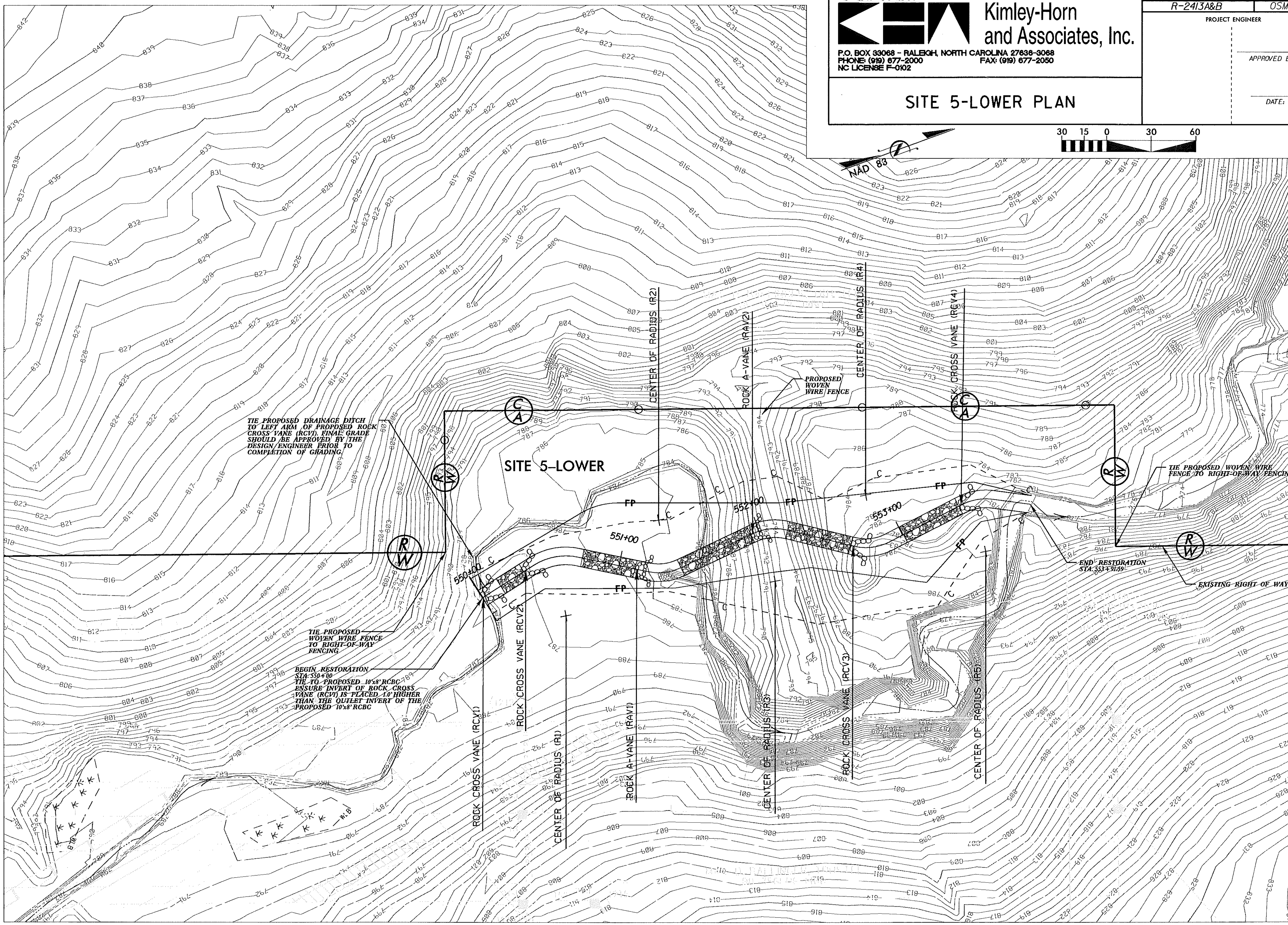
SITE 5-LOWER PLAN



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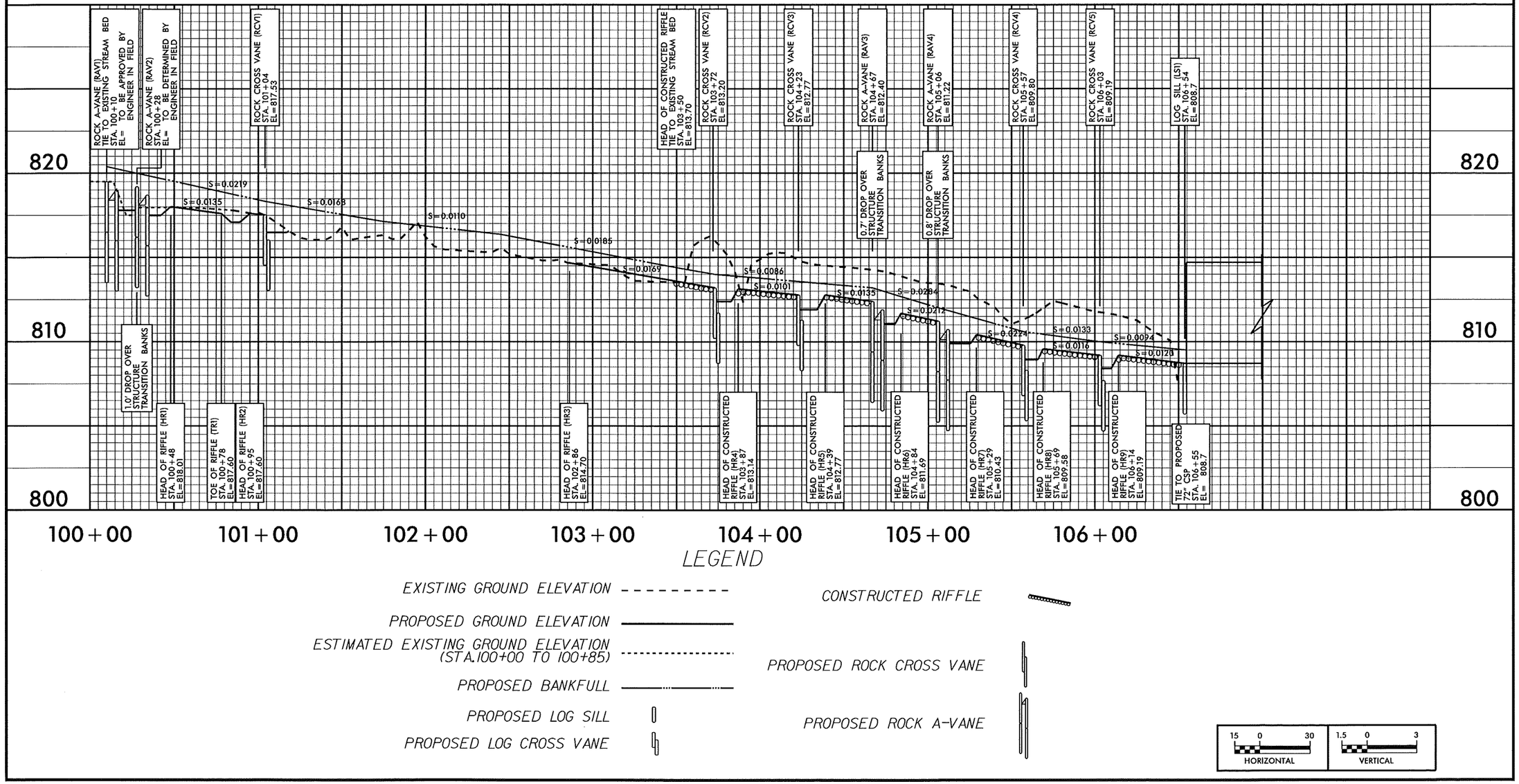
PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-11

PROJECT ENGINEER

APPROVED BY:

DATE:

SITE I UPPER PROFILE



LEGEND

- EXISTING GROUND ELEVATION
- PROPOSED GROUND ELEVATION
- ESTIMATED EXISTING GROUND ELEVATION (STA.100+00 TO 100+85)
- PROPOSED BANKFULL
- PROPOSED LOG SILL
- PROPOSED LOG CROSS VANE
- CONSTRUCTED RIFFLE
- PROPOSED ROCK CROSS VANE
- PROPOSED ROCK A-VANE

HORIZONTAL 15 0 30

VERTICAL 1.5 0 3

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PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-12

PROJECT ENGINEER

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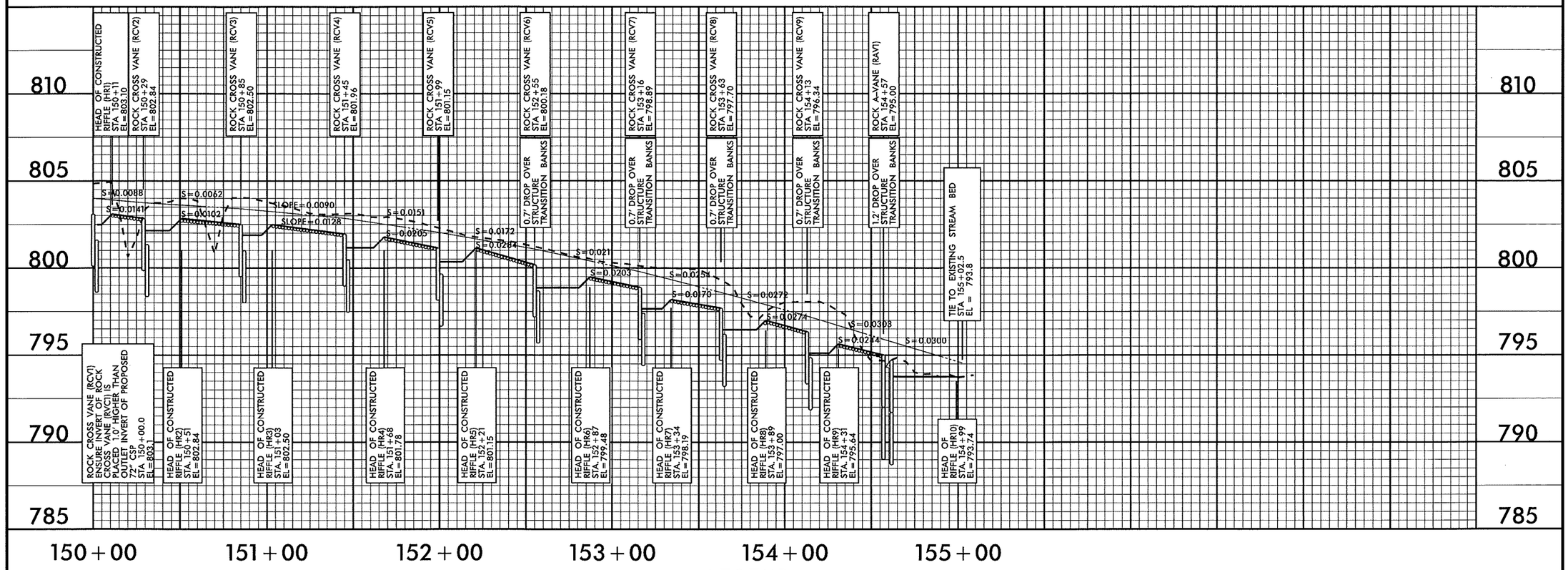
DATE:

SITE I LOWER PROFILE

SITE 1 LOWER



LEGEND

- 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

HORIZONTAL 15 0 30

VERTICAL 1.5 0 3

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PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-13

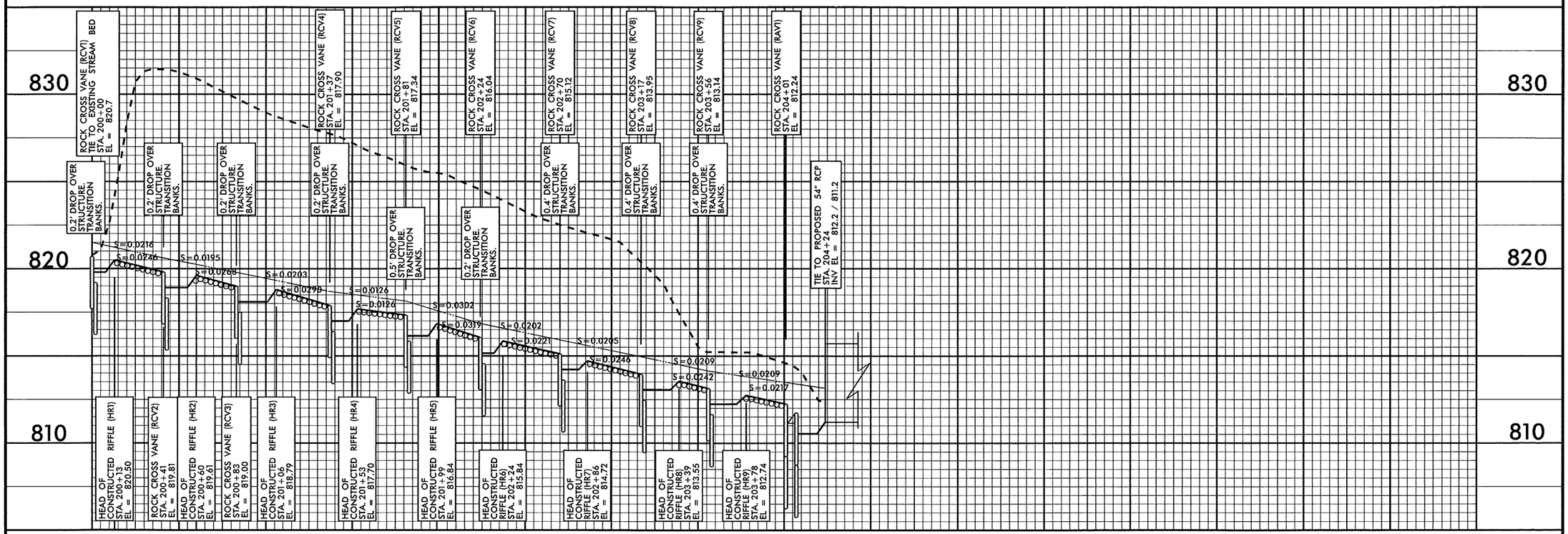
PROJECT ENGINEER

APPROVED BY:

DATE:

SITE 2 UPPER PROFILE

SITE 2 UPPER



LEGEND

- 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

HORIZONTAL 15 0 30

VERTICAL 1.5 0 3

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PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-14

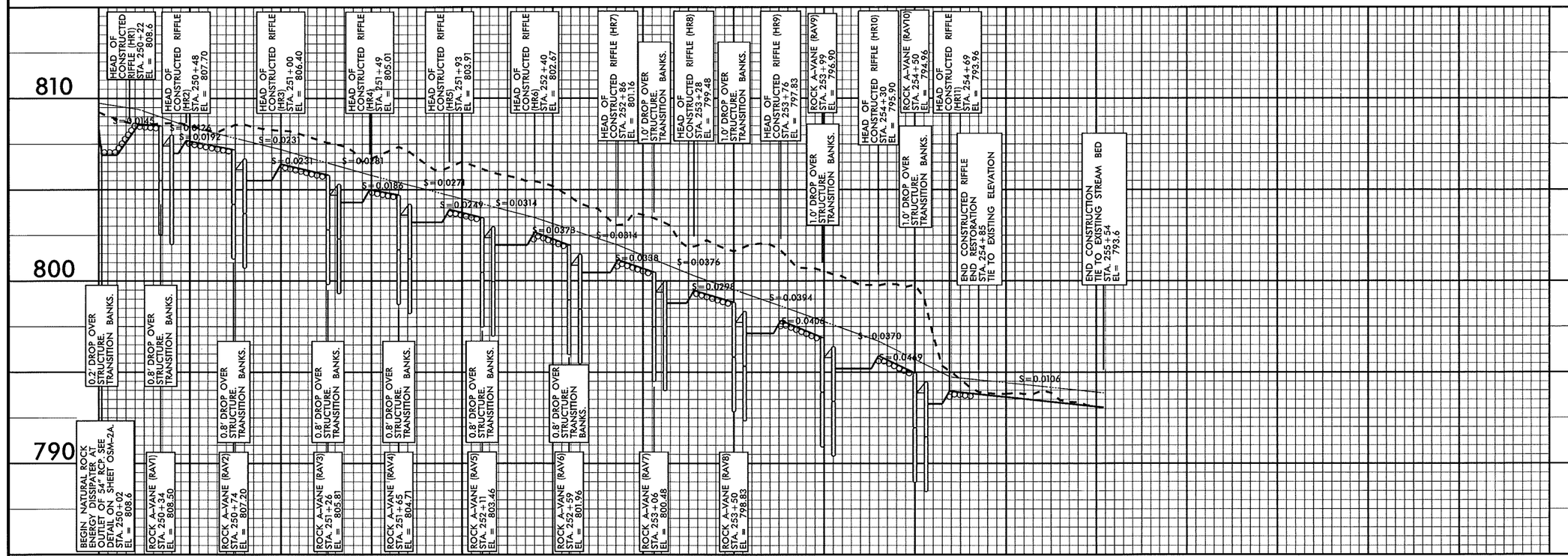
PROJECT ENGINEER

APPROVED BY:

DATE:

SITE 2 LOWER PROFILE

SITE 2 LOWER



LEGEND

- 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

HORIZONTAL 15 0 30

VERTICAL 1.5 0 3

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PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-15

PROJECT ENGINEER

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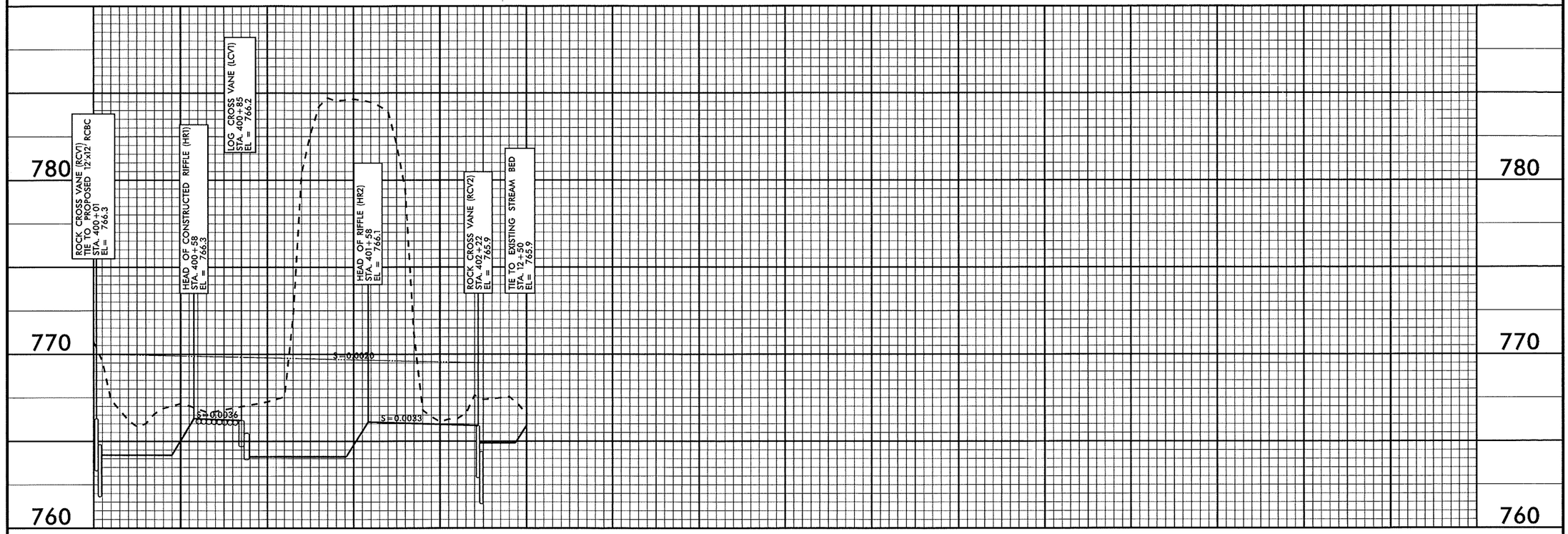
DATE:

SITE 4 PROFILE



LEGEND

- 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

15 0 30 HORIZONTAL

1.5 0 3 VERTICAL

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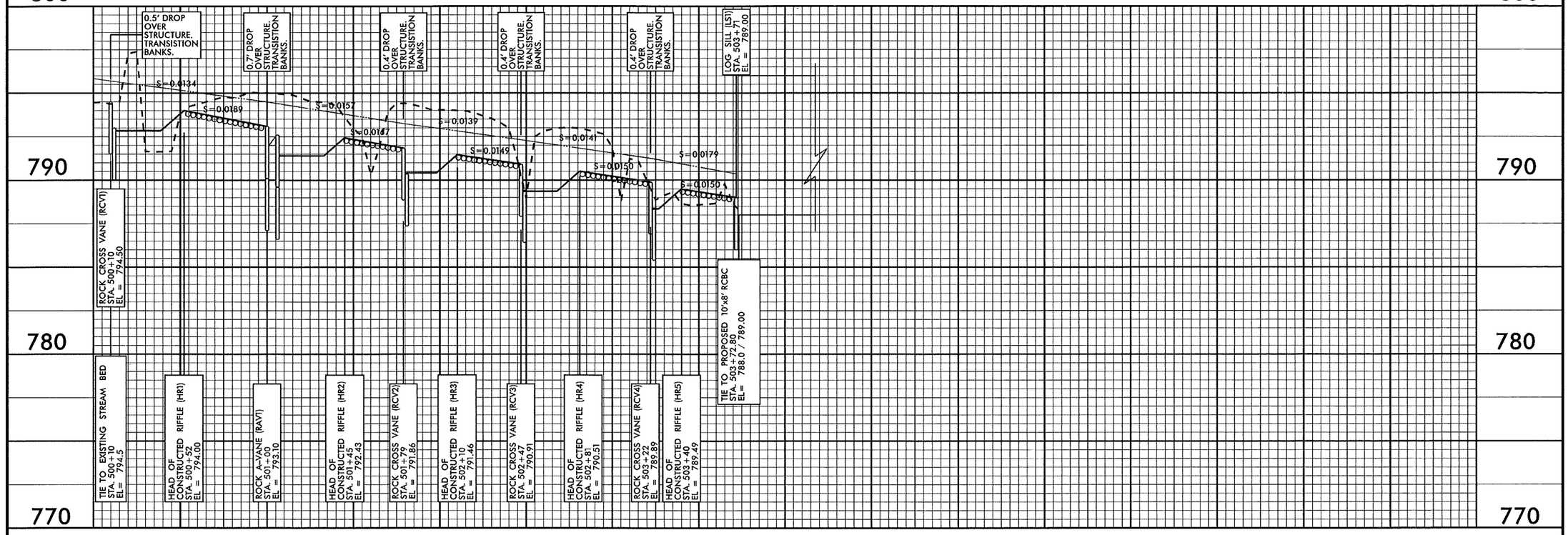
PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-16

PROJECT ENGINEER

APPROVED BY:

DATE:

SITE 5 UPPER PROFILE



LEGEND

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

15 0 30 HORIZONTAL

1.5 0 3 VERTICAL

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09/26/11

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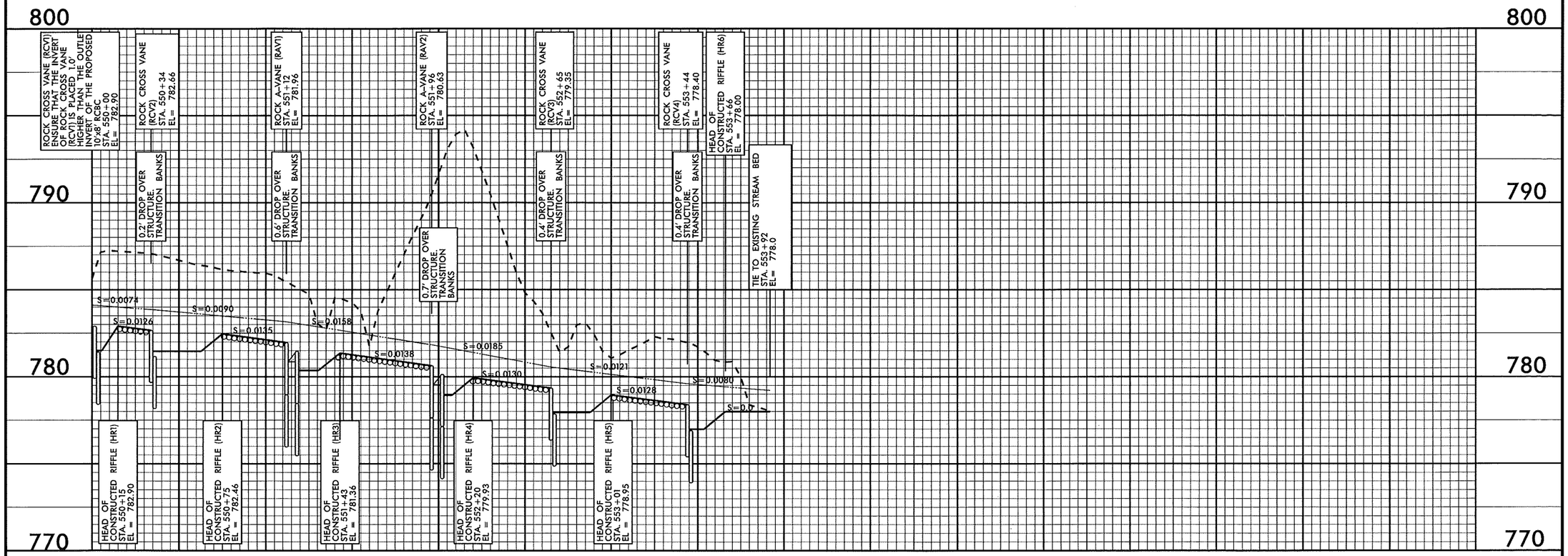
PROJECT REFERENCE NO.	SHEET NO.
R-2413A&B	OSM-17

PROJECT ENGINEER

APPROVED BY:

DATE:

SITE 5 LOWER PROFILE



LEGEND

- 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

15 0 30 HORIZONTAL

1.5 0 3 VERTICAL

Rev. 07-01-13

04/03/12

0 5 10	PROJ. REFERENCE NO.	SHEET NO.
		XS-01

840
835
830
825
820
815
810
805

EXCAVATE BANKFULL BENCH FOR ENHANCEMENT OF EXISTING CHANNEL

102+00.00

840
835
830
825
820
815
810
805

EXCAVATE BANKFULL BENCH FOR ENHANCEMENT OF EXISTING CHANNEL

101+50.00

830
825
820
815
810

EXCAVATE BANKFULL BENCH FOR ENHANCEMENT OF EXISTING CHANNEL

101+00.00

830
825
820
815
810

NOTE:
EXISTING CONDITIONS SURVEY DOES NOT INCLUDE THE STREAM CHANNEL IN THIS LOCATION. PER PLAN VIEW NOTES STABILIZE THE BANKS IN THIS LOCATION BY GRADING THEM BACK AT A 3:1 SLOPE TO MATCH PROPOSED TYPICAL CROSS SECTION AS CLOSELY AS POSSIBLE WITHOUT DAMAGING TREES LARGER THAN 12" IN DIAMETER AT BREAST HEIGHT.

100+50.00

140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140

$$$$$$SYSTIME$$$$$$
$$$$$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$$$
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Rev. 07-01-13

04/03/12

0 5 10

PROJ. REFERENCE NO.	SHEET NO.
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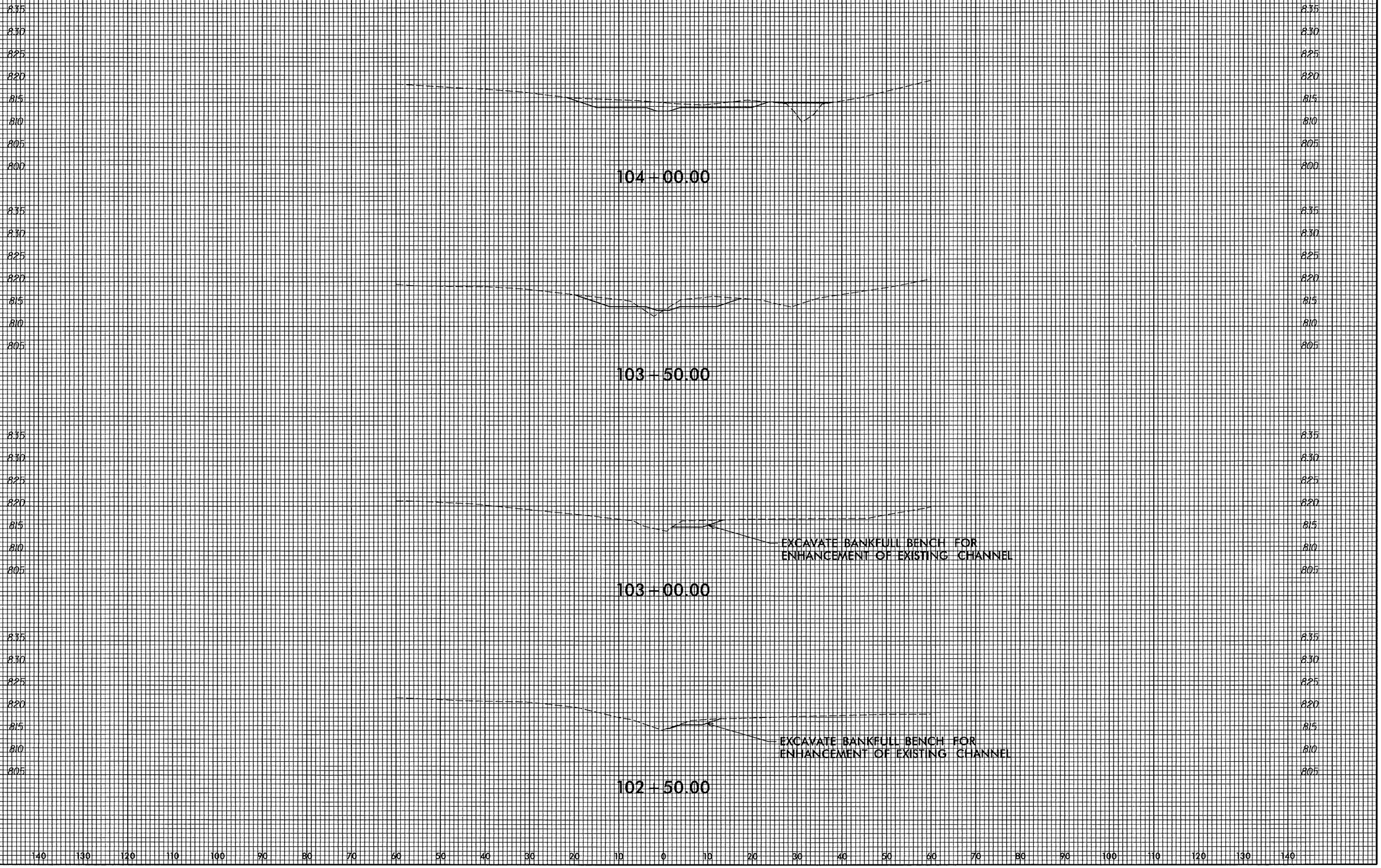

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Rev. 07-01-13

PROJ. REFERENCE NO.	SHEET NO.
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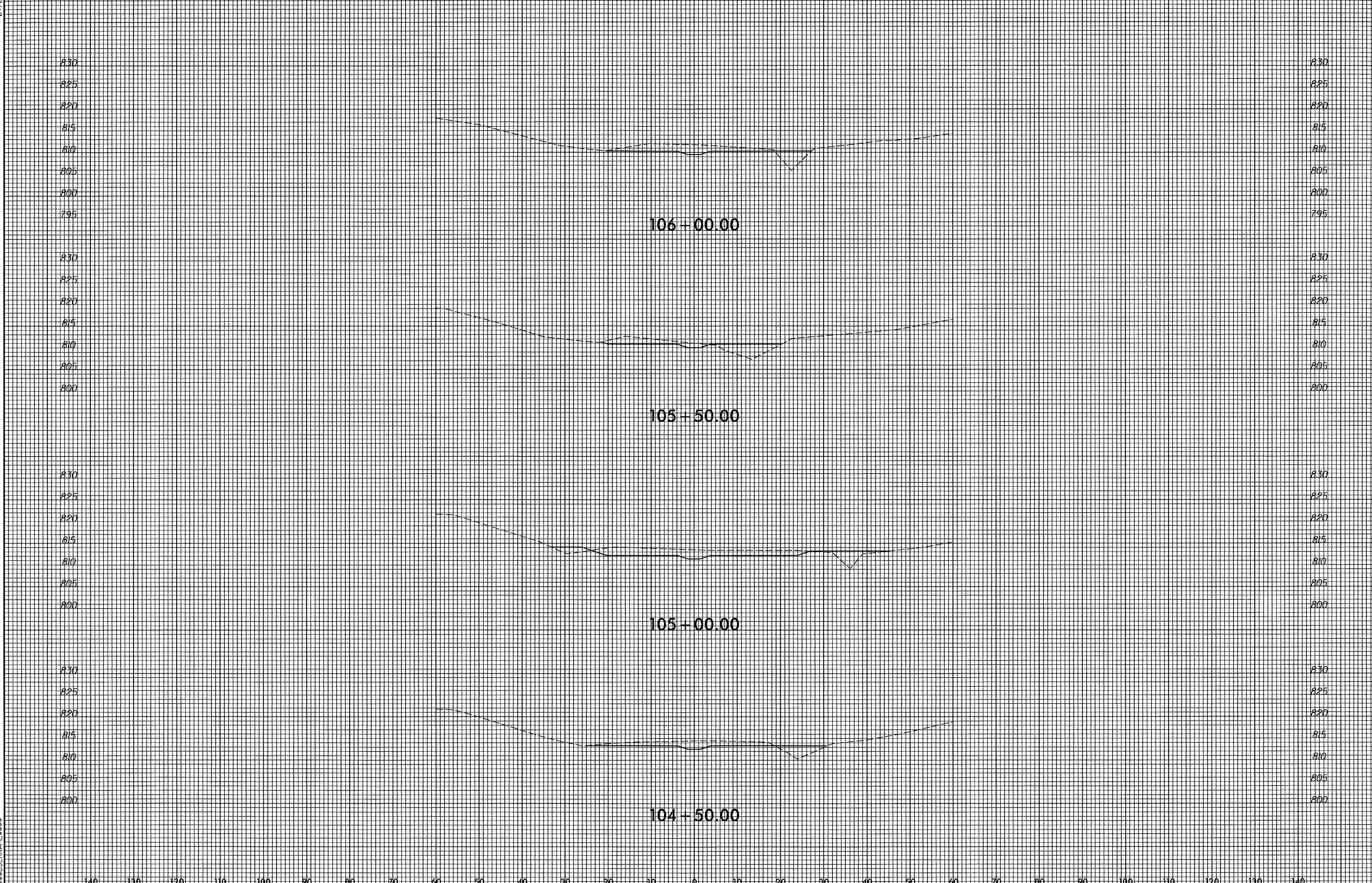
04/03/12



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Rev. 07-01-13

04/03/12

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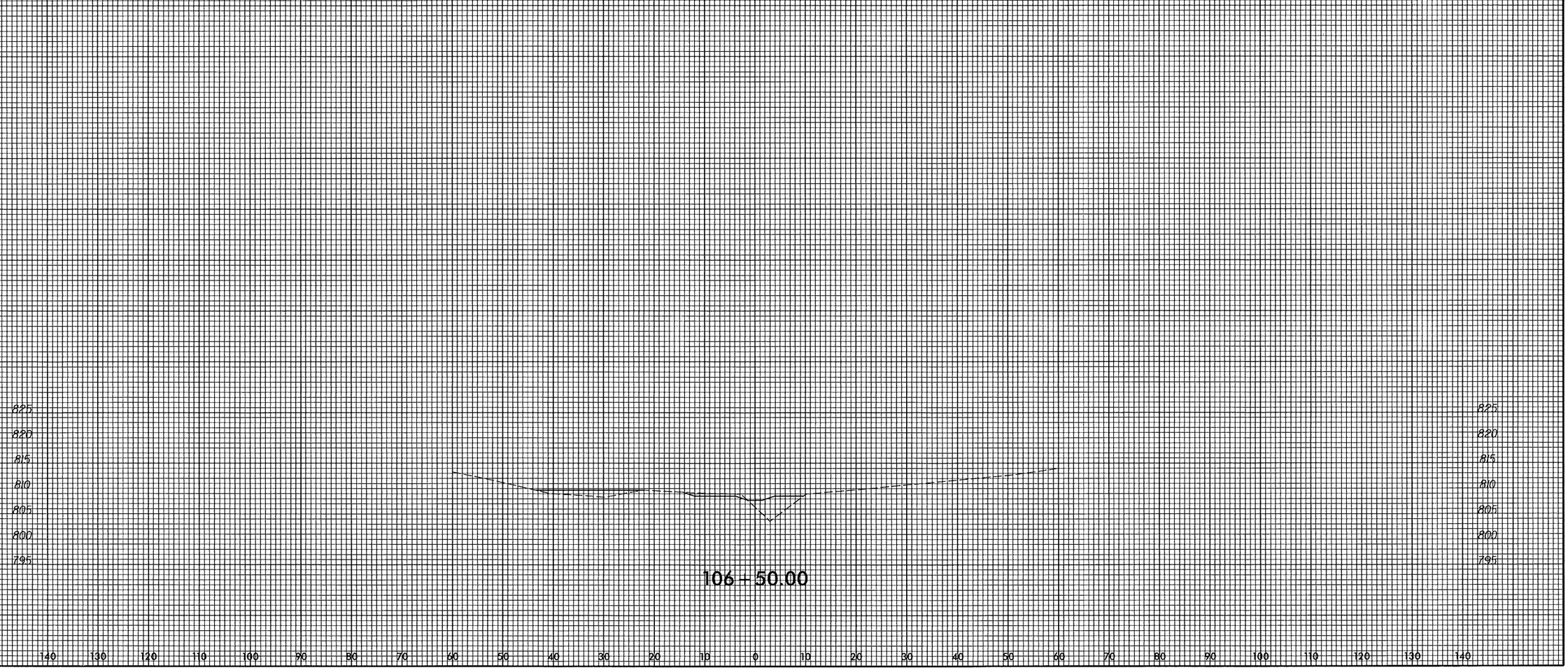

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Rev. 07-01-13.

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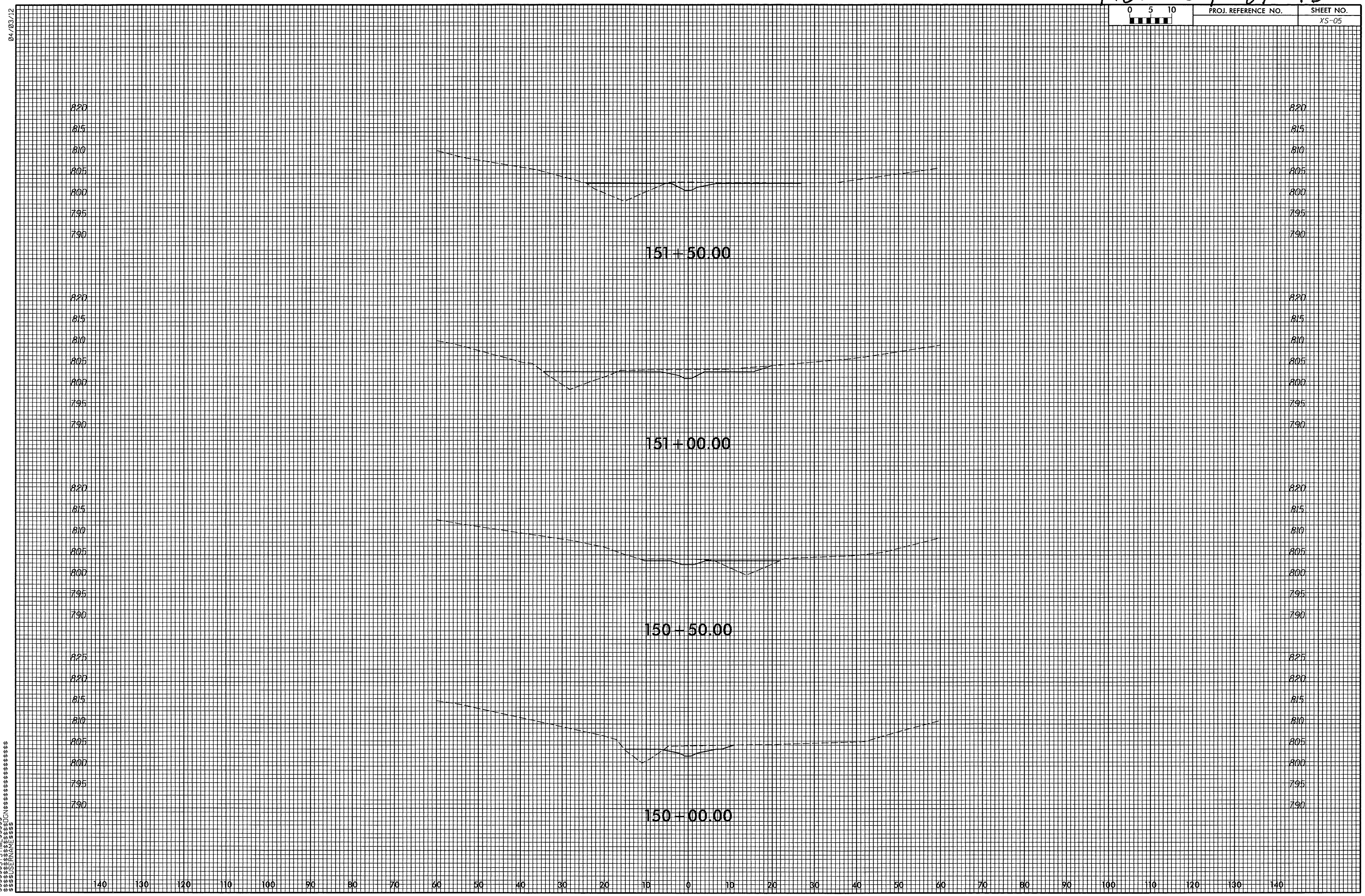
04/03/12



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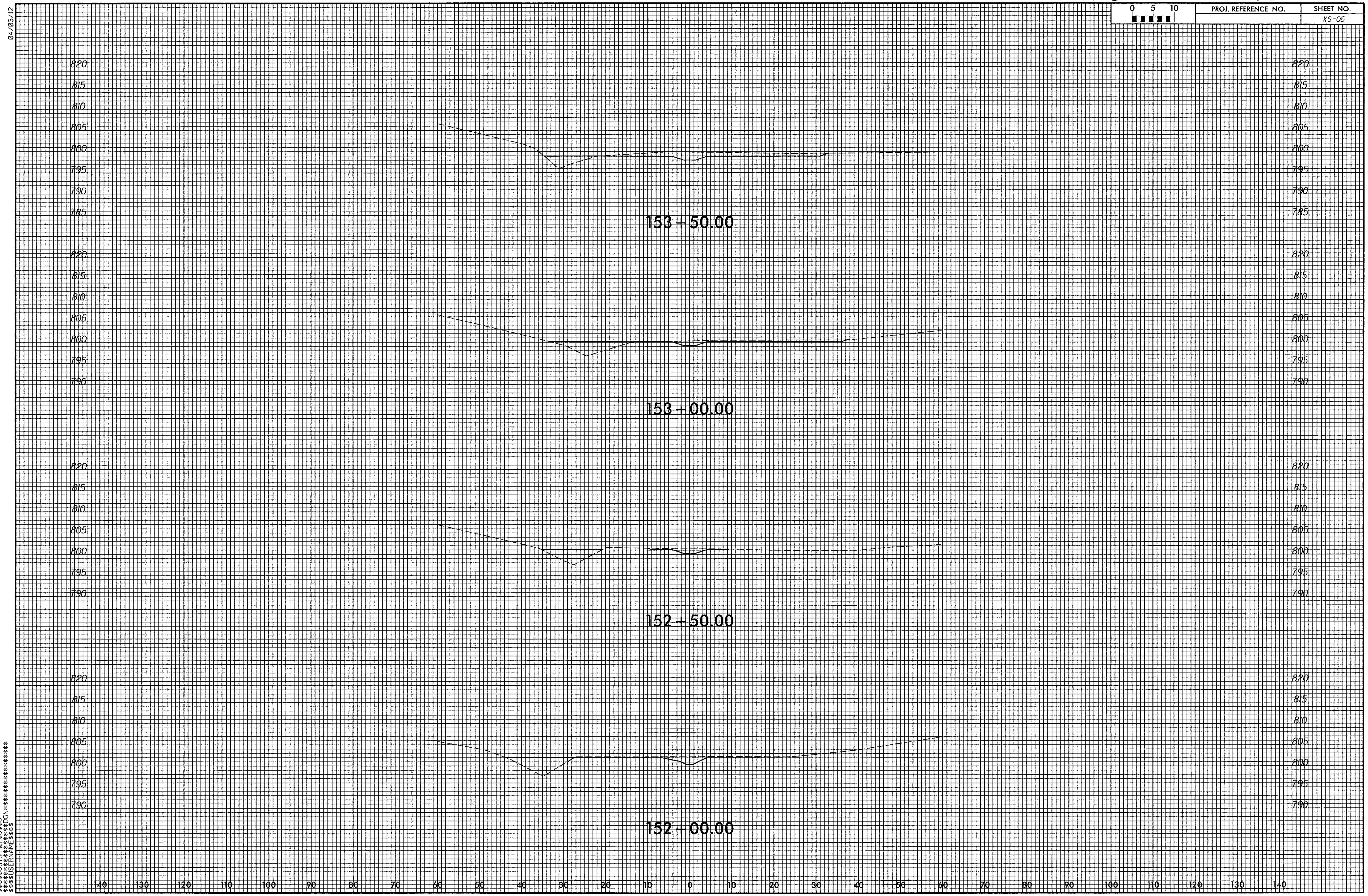
Rev. 07-01-13



04/03/12

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Rev. 07-01-13.

04/03/12

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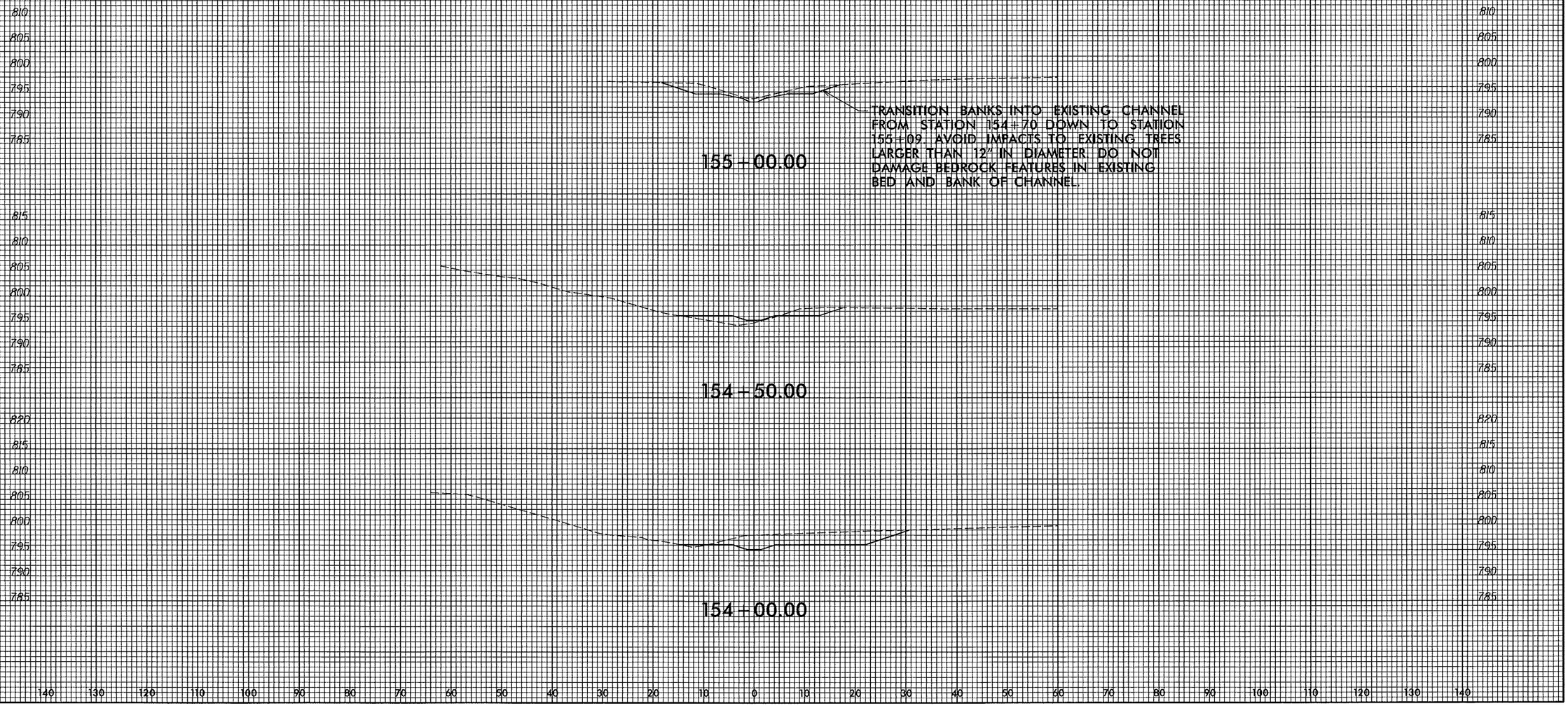

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Rev. 07-01-13

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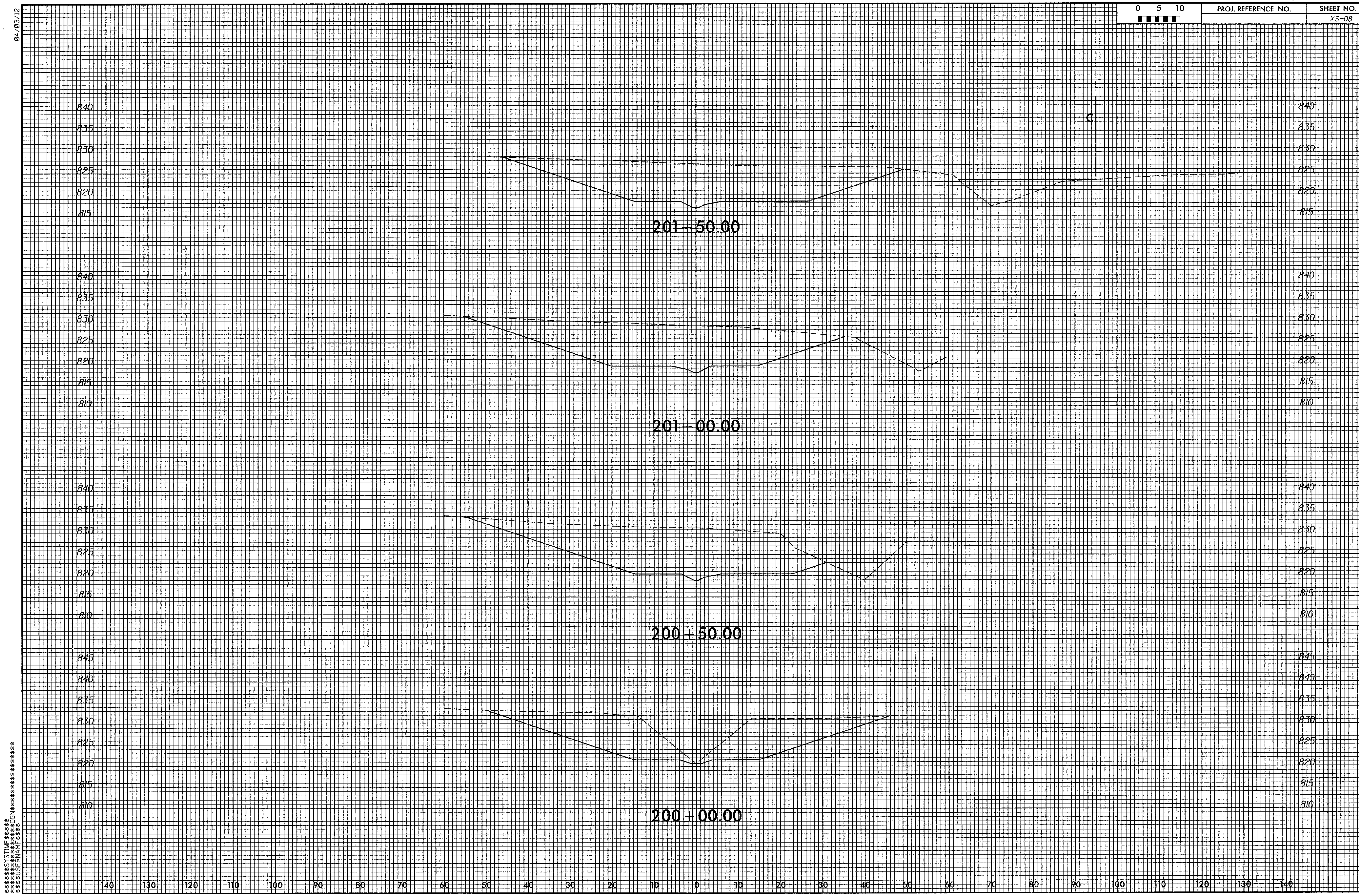

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04/03/12

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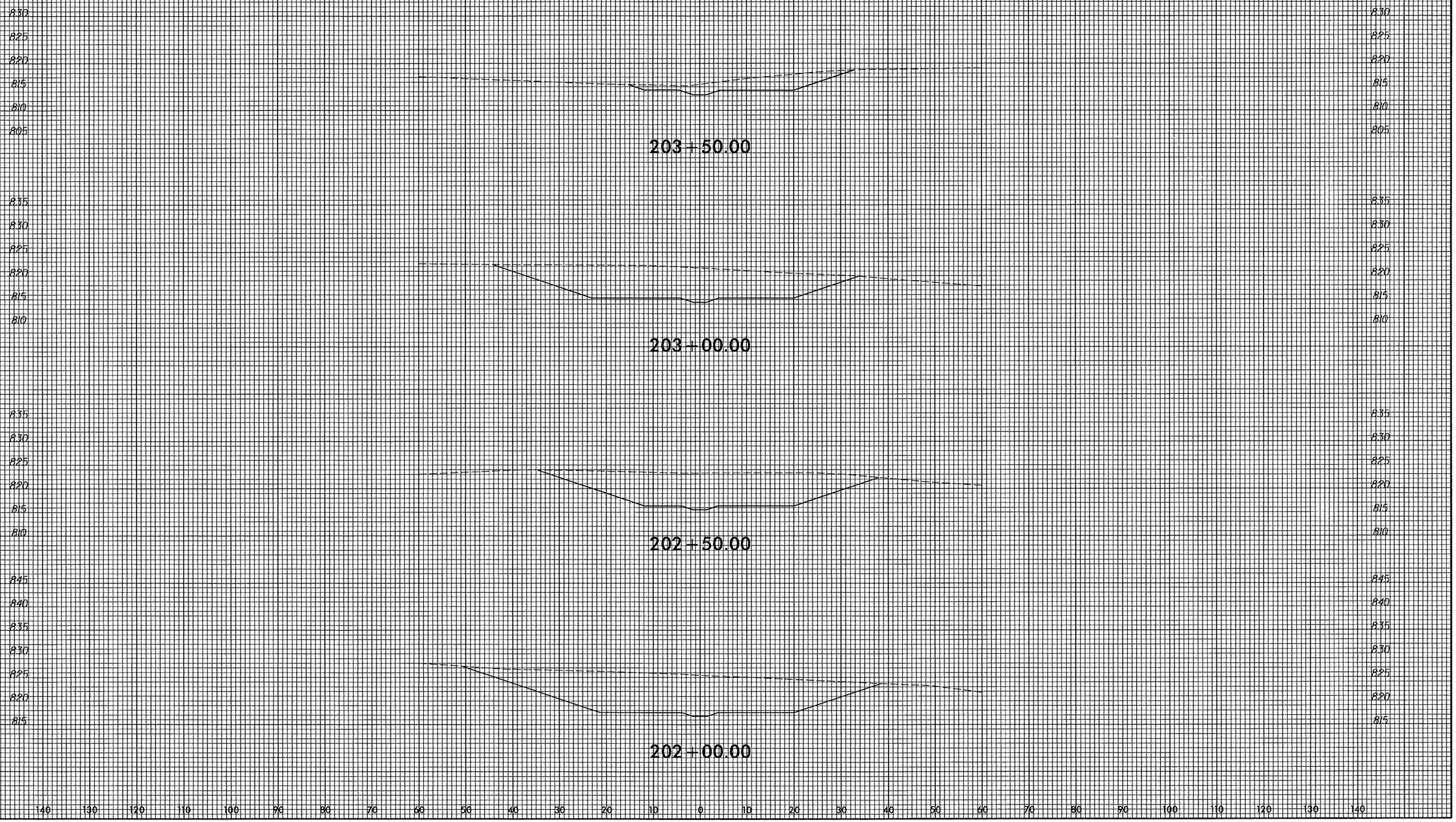

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Rev. 07-01-13

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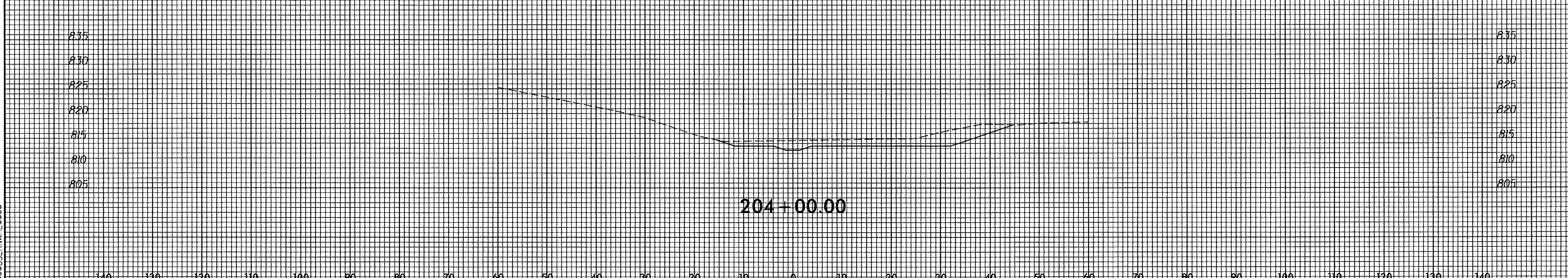
04/03/12



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Rev. 07-01-13

04/03/12

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PROJ. REFERENCE NO.	SHEET NO.
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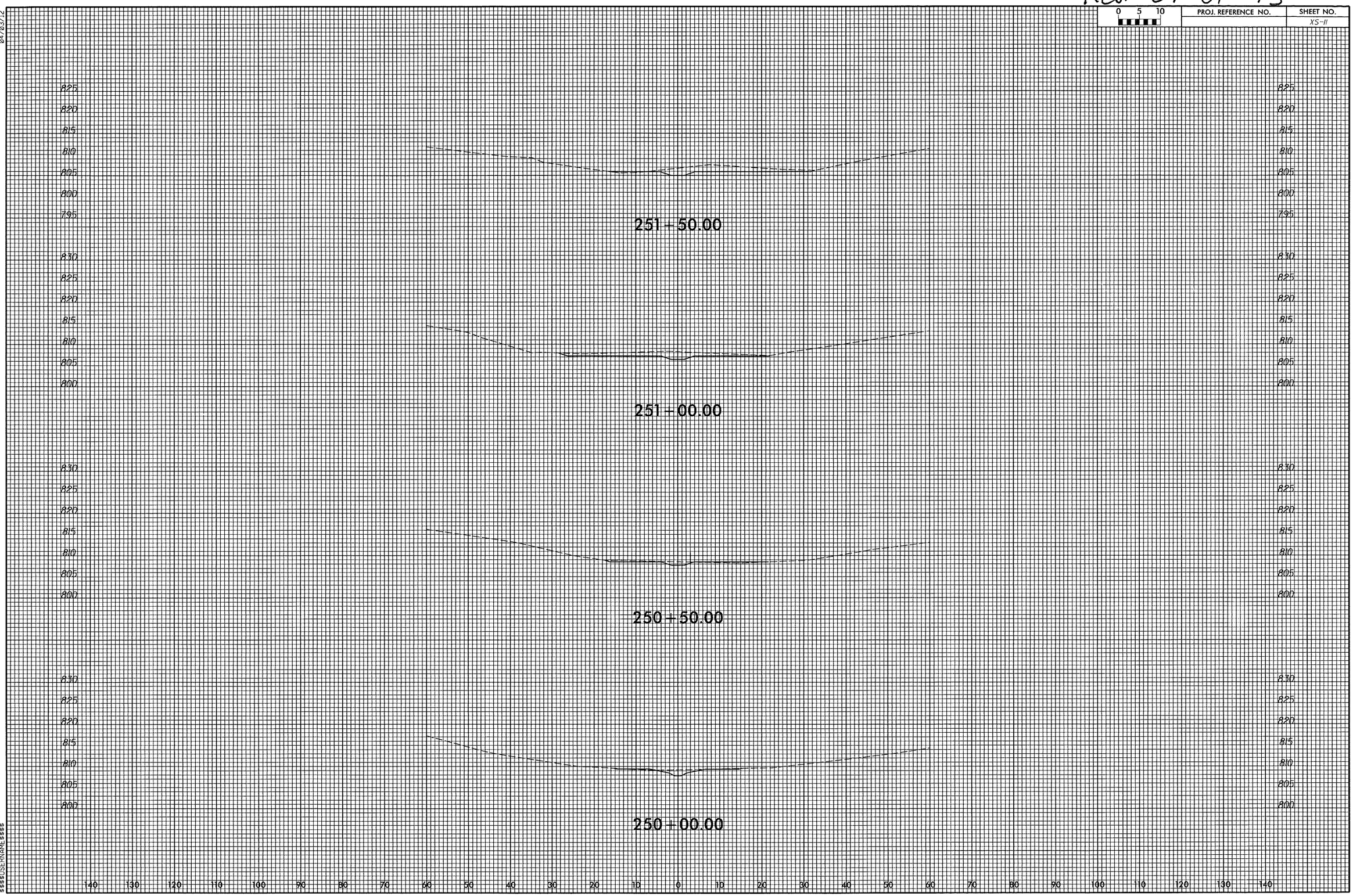

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Rev. 07-01-13

04/03/12

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PROJ. REFERENCE NO.	SHEET NO.
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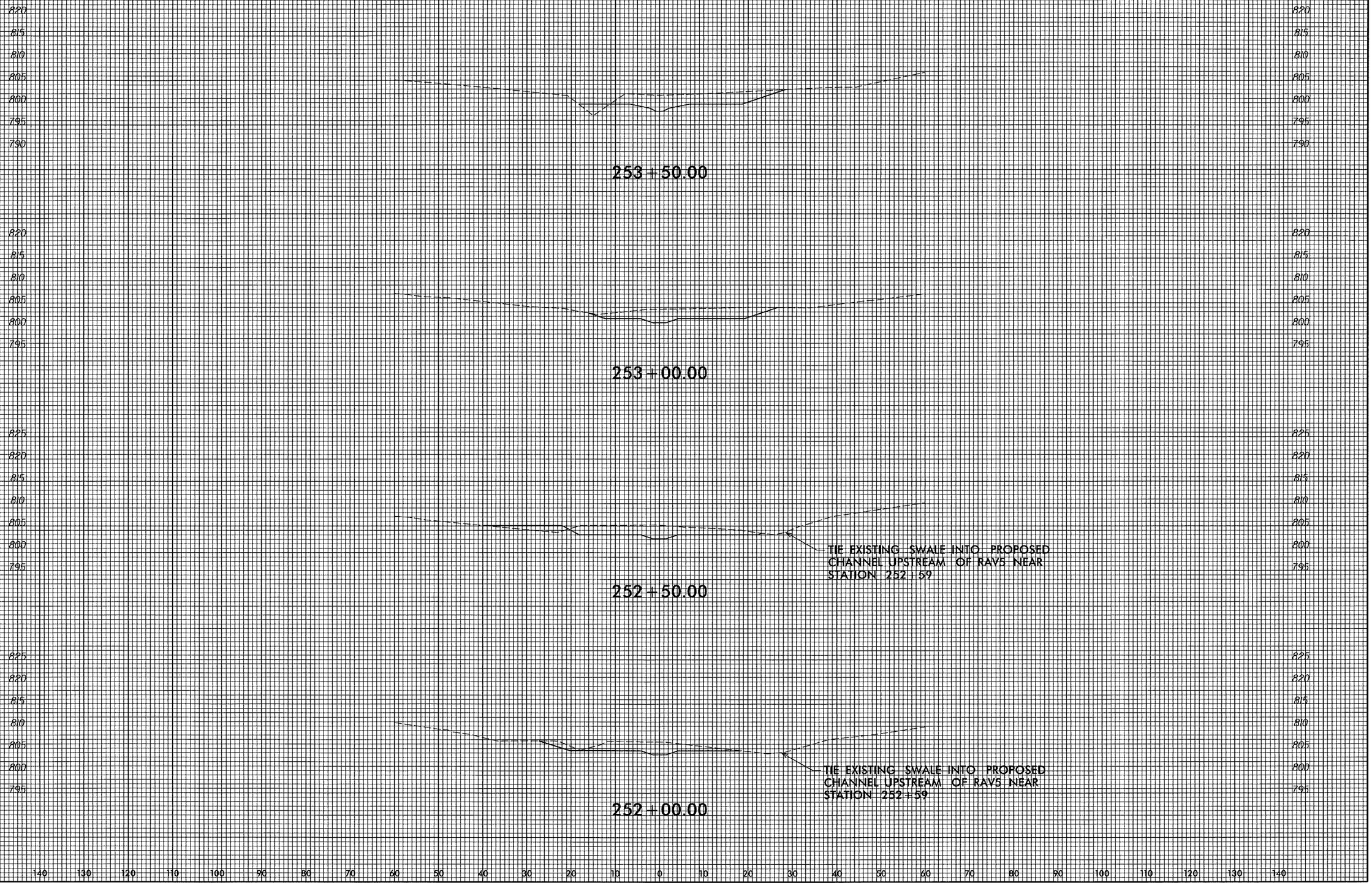

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Rev. 07-01-13

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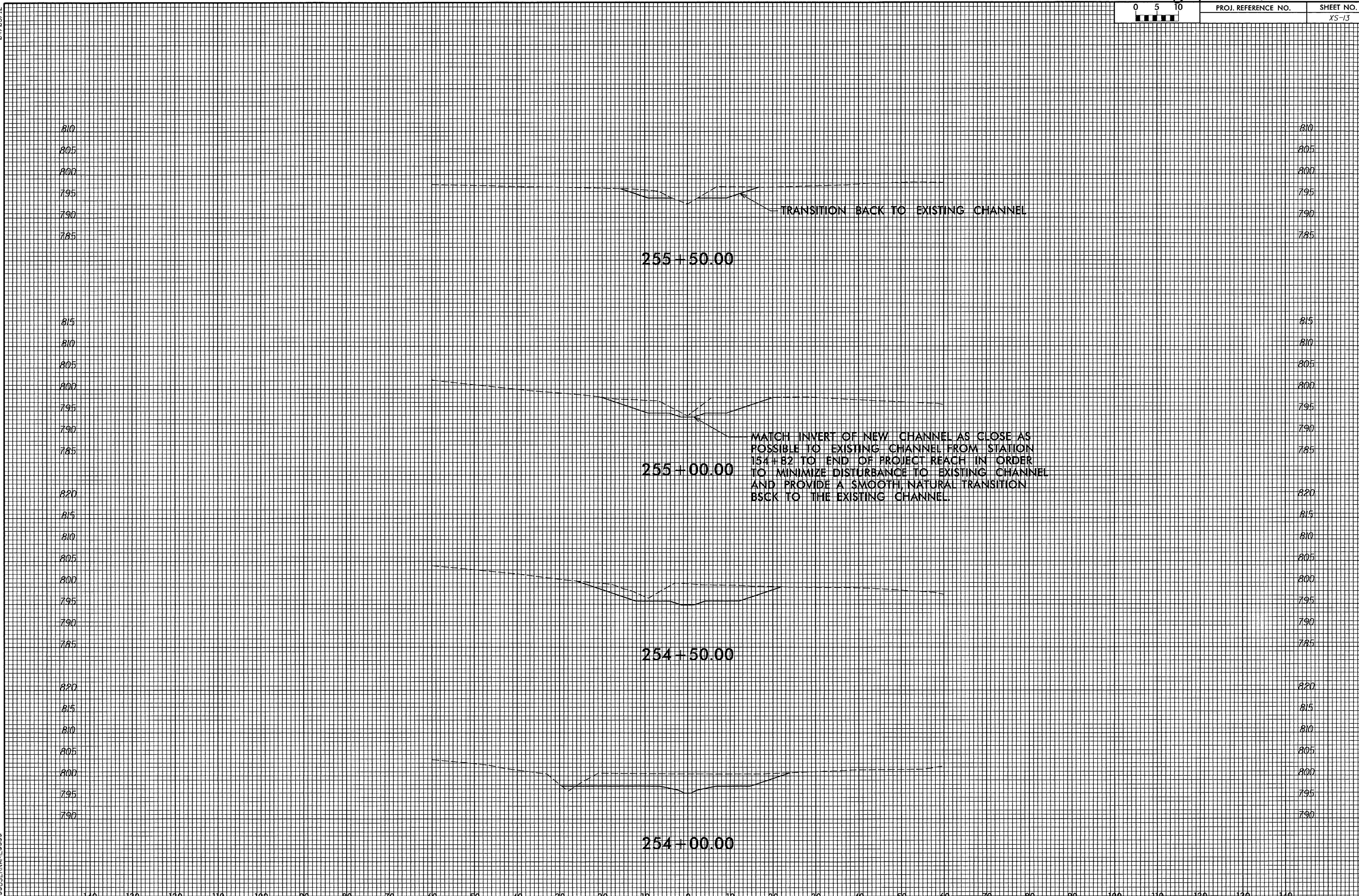
04/03/12



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Rev. 07-01-13

04/03/12

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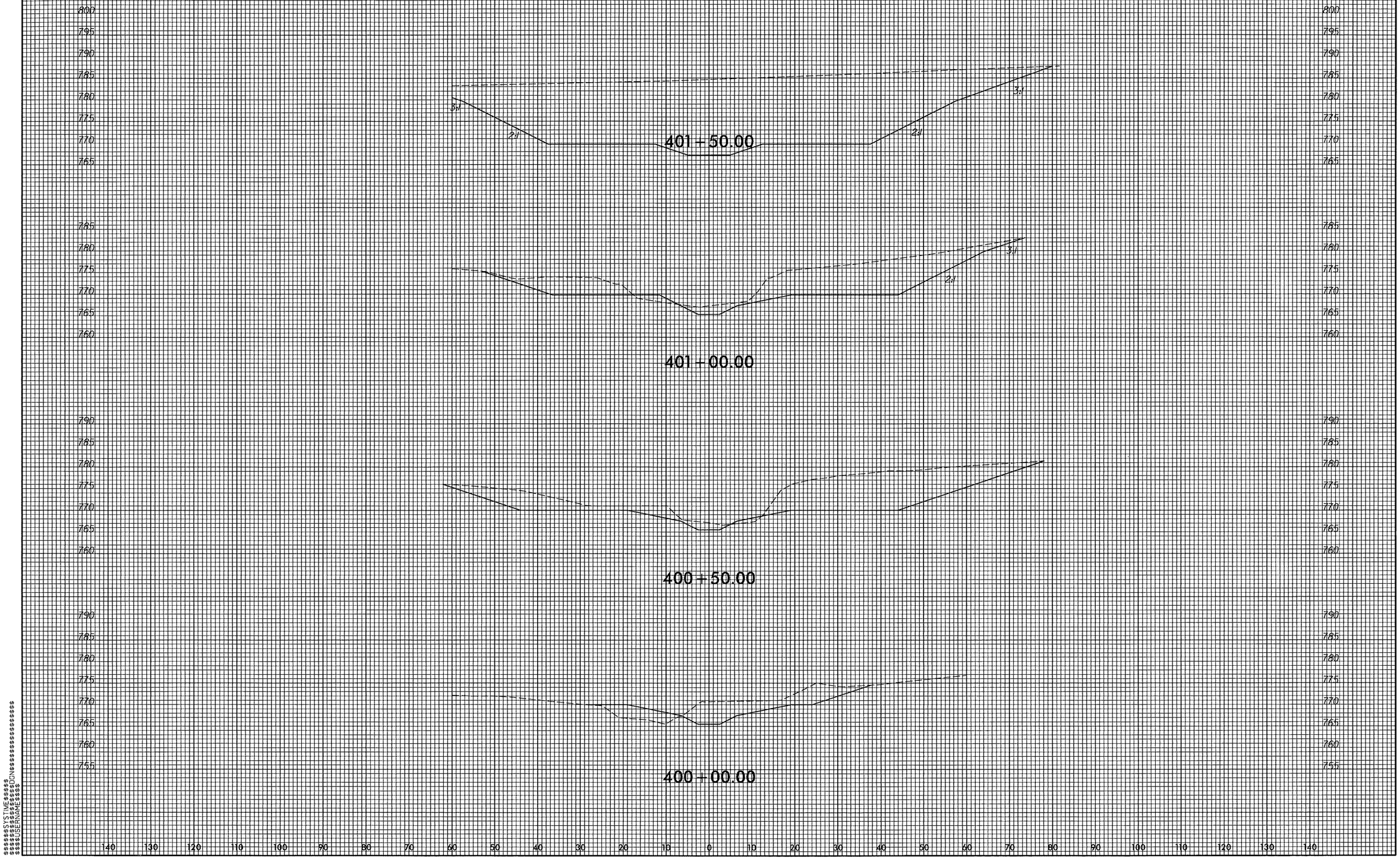

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Rev. 07-01-13

04/03/12

0 5 10

PROJ. REFERENCE NO.	SHEET NO.
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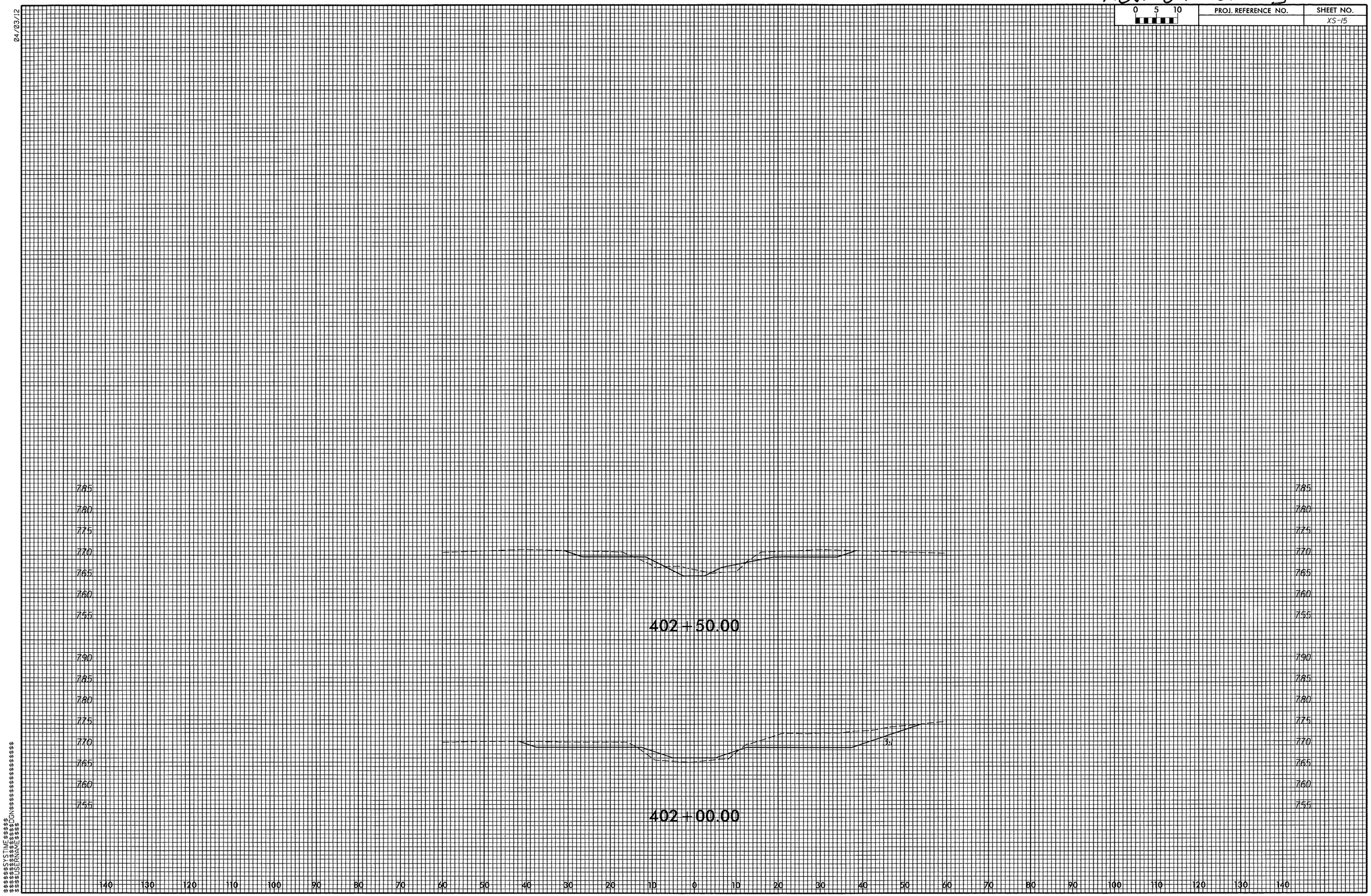

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Rev. 07-01-13

04/03/12

0 5 10

PROJ. REFERENCE NO.	SHEET NO.
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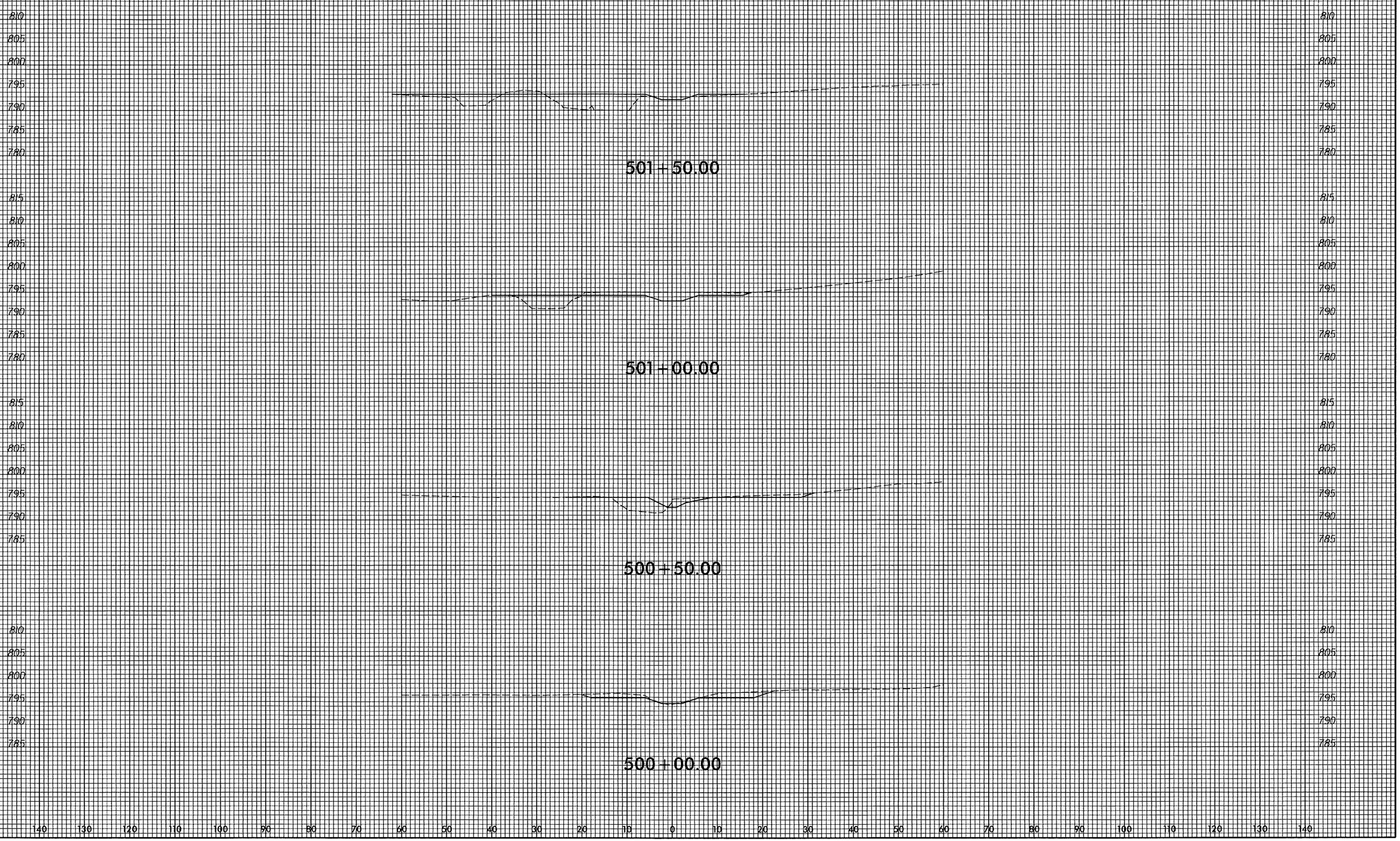

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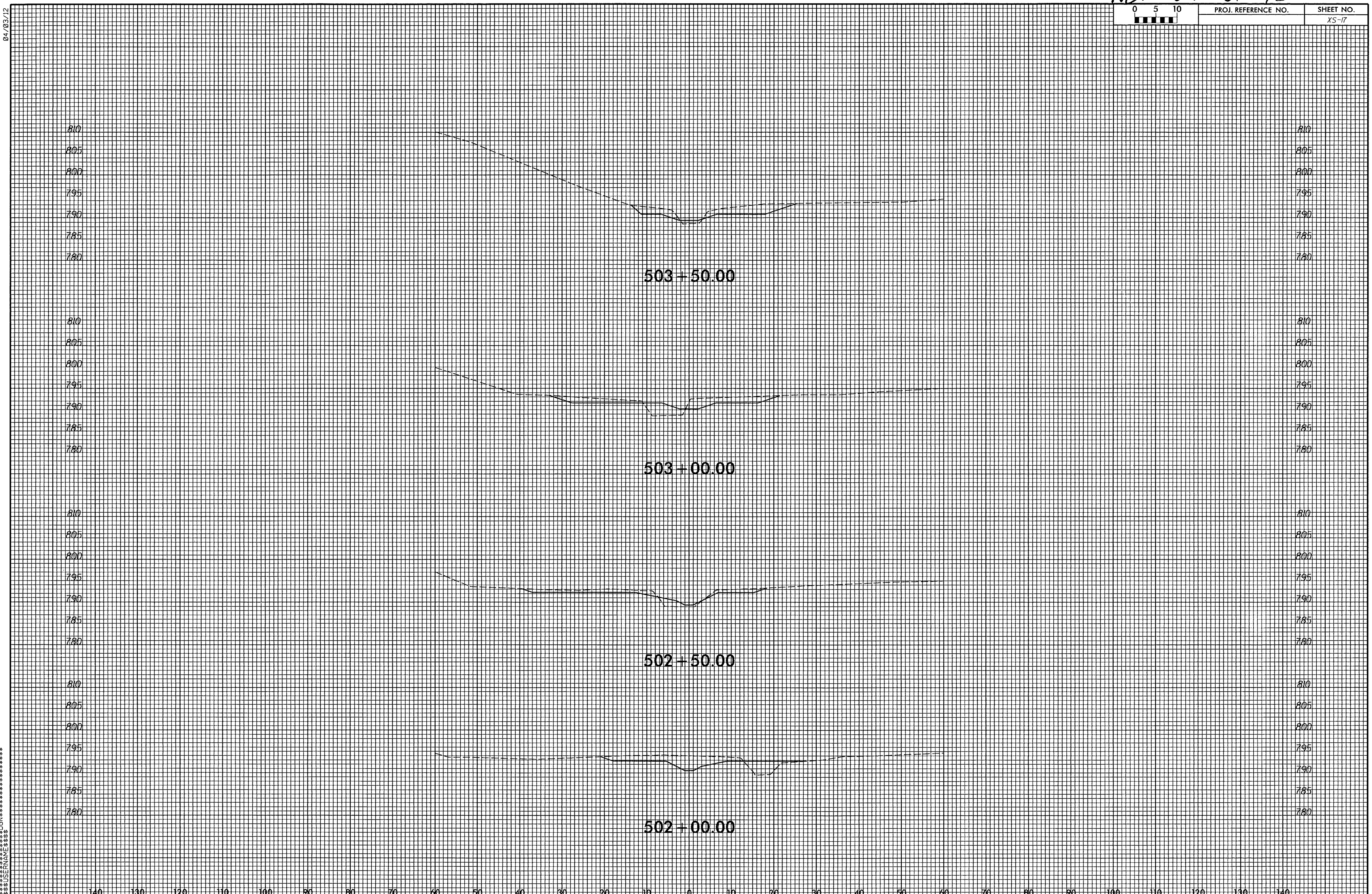
Rev. 07-01-13

04/03/12



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Rev. 07-01-13

04/03/12

0 5 10

PROJ. REFERENCE NO.	SHEET NO.
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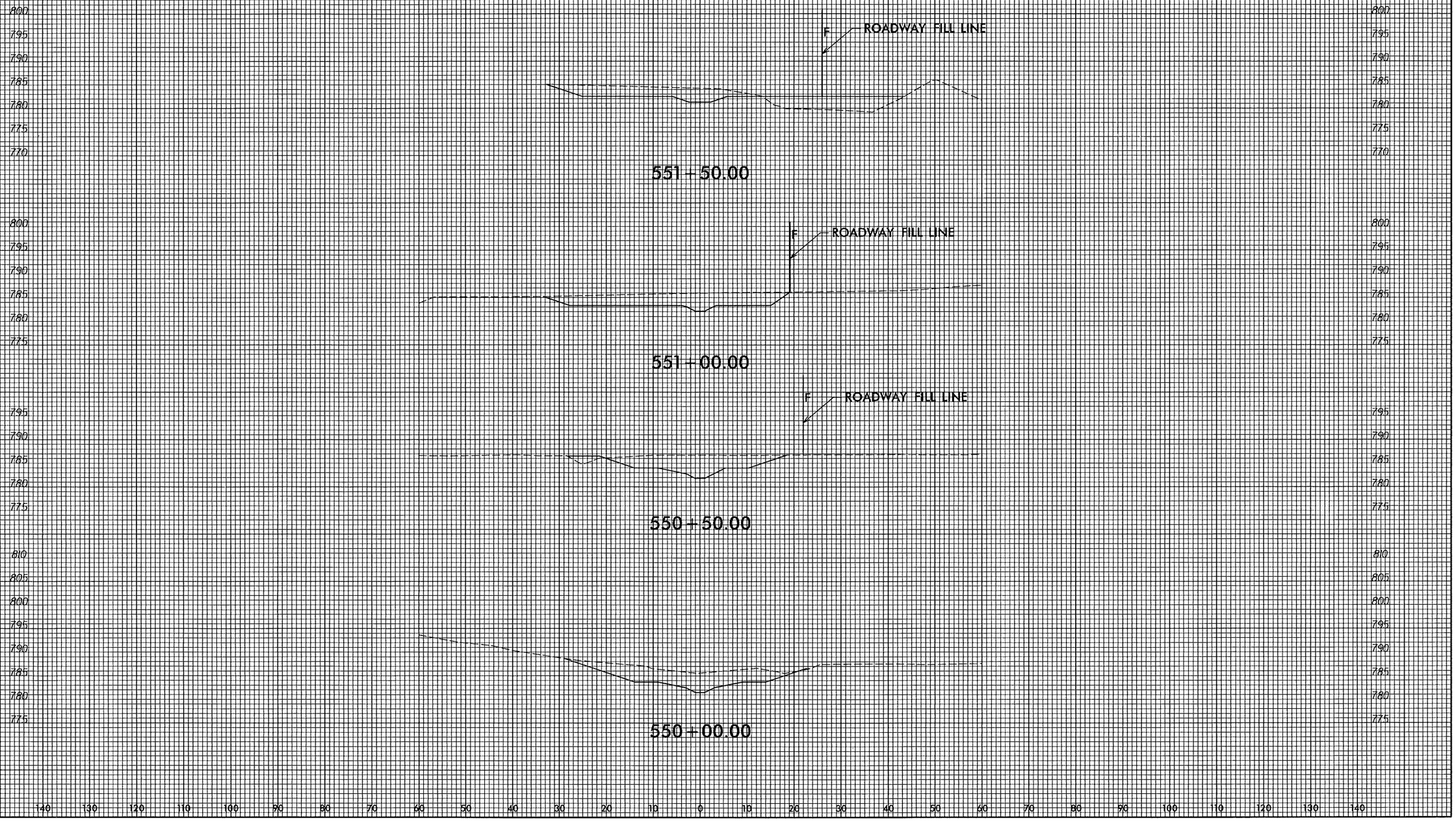

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Rev. 07·01-13

PROJ. REFERENCE NO.	SHEET NO.
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