Culvert Foundation Recommendation Letter
Aluminum Arch Culvert @ -L- Sta. 13+58.00 over Richland Swamp
Robeson County, North Carolina
NCDOT Project No.: BP6.R005
S&ME Project No. 213634A

PREPARED FOR:
CDM Smith, Inc.
5400 Glenwood Ave, Suite 400
Raleigh, North Carolina 27612

PREPARED BY:
S&ME, Inc.
9751 Southern Pine Boulevard
Charlotte, North Carolina 28273

October 11, 2022

October 11, 2022

CDM Smith, Inc.
5400 Glenwood Ave, Suite 400
Raleigh, North Carolina 27612

Attention: Adam Conrad, P.E.
Project Manager

Reference: **Culvert Foundation Recommendation Letter**
Aluminum Arch Culvert @ -L- Sta. 13+58.00 over Richland Swamp

NCDOT Project Number:	BP6.R005
County:	Robeson
S&ME Project No.:	213634A
NC PE Firm License No.:	F-0176

Dear Mr. Conrad:

S&ME, Inc. (S&ME) has completed the authorized culvert foundation recommendation report for the above-referenced project. Our services were performed in general accordance with the Agreement for Professional Services contract between CDM Smith, Inc and S&ME, dated February 17, 2022.

Project and Recommendations

We understand that existing pipe culvert, crossing Old Red Springs Road (SR 1303), is to be replaced with a 117-inch x 79-inch Arch Culvert. The proposed culvert replacement will be approximately 51 feet long with a centerline invert elevation of 176.47 feet and slope of 1.78 percent.

Based on our subsurface exploration, the proposed culvert is planned to bear in alluvial soils. The Arch Culvert should be installed to bear on a minimum of 12 inches of foundation conditioning material in accordance with NCDOT Standard Specifications Section 414. A total of 49 tons of foundation conditioning material is anticipated.

Less than 0.1 inches of total settlement is expected. Therefore, no camber is required.

Recommended Plan Notes

BACKFILL WITH SELECT MATERIAL, CLASS VI MEETING THE REQUIREMENTS OF SECTION 1016 OF THE STANDARD SPECIFICATIONS.

Closing

S&ME appreciates the opportunity to provide our services on this project. Please contact us if you have any questions regarding this report or if we may be of further assistance.

Sincerely,

S&ME, Inc.

DocuSigned by:
Thomas J. Daily
F29CA6BB83F449F...

NORTH CAROLINA PROFESSIONAL SEAL 045672 ENGINEER THOMAS J. DAILY

Thomas J. Daily, P.E.
Project Manager
NC Registration No. 045672 10/13/2022

Ali Salehian

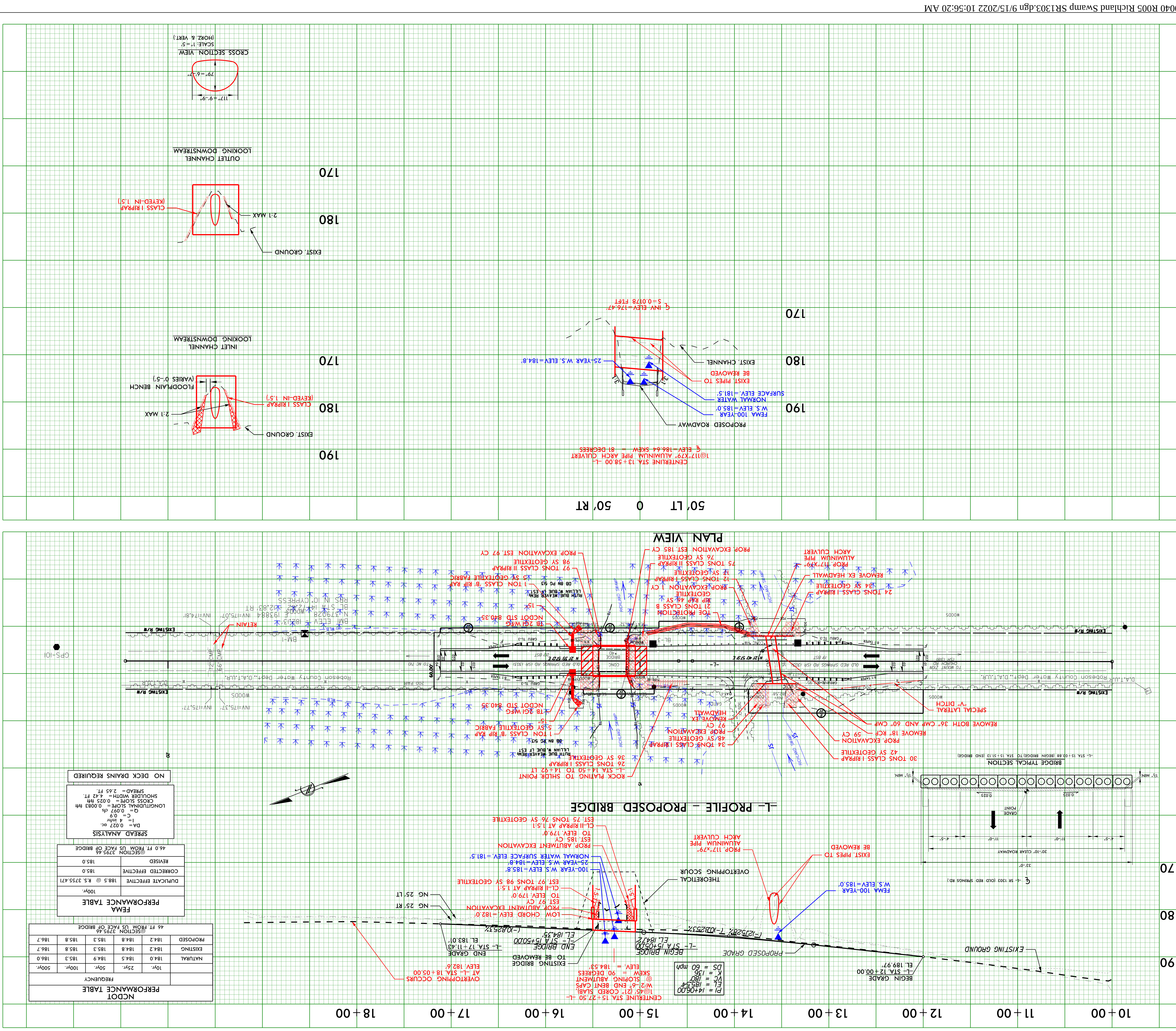
Ali Salehian, P.E.
Project Engineer
NC Registration No. 046104

Senior Review By: Kristen H. Hill, P.E., P.G.

Attachments

Culvert Survey & Hydraulic Design Report
CDM Smith 85% Draft Culvert Plans
FCM Quantity Calculations
Settlement Calculations

Attachments



NCDOT PERFORMANCE TABLE

	10yr.	25yr.	50yr.	100yr.	500yr.
NATURAL	184.0	184.5	184.9	185.3	186.0
EXISTING	184.2	184.8	185.3	185.8	186.7
PROPOSED	184.2	184.8	185.3	185.8	186.7

@SECTION 3795.46
46 FT. FROM US FACE OF BRIDGE

FEMA PERFORMANCE TABLE

	100yr.
DUPLICATE EFFECTIVE	188.5 @ R.S. 3755.471
CORRECTED EFFECTIVE	185.0
REVISED	185.0

@SECTION 3795.46
46.0 FT. FROM US FACE OF BRIDGE

SPREAD ANALYSIS

DA= 0.027 ac.
I= 4 in/hr
C= 0.9
Q= 0.097 cfs
LONGITUDINAL SLOPE= 0.0083 ft/ft
CROSS SLOPE= 0.025 ft/ft
SHOULDER WIDTH= 4.42 FT.
SPREAD= 2.65 FT.

NO DECK DRAINS REQUIRED

INFORMATION TO BE SHOWN ON PLANS

WS EL. Taken @ River Station 3795.46

Design: Discharge 1160 c.f.s. Frequency 25 yr. Elev. 184.8 ft.
Base Flood: Discharge 1740 c.f.s. Frequency 100 yr. Elev. 185.8 ft.
Overtopping: Discharge 320 c.f.s. Frequency 2 yr. Elev. 182.6 ft.
OVERTOPPING OCCURS @ -L- STA. 18+05.00 PROPOSED ROADWAY ℄

ADDITIONAL INFORMATION AND COMPUTATIONS

NOTE: BANKS ARE SUBMERGED WETLANDS, VEGETATED, WIDE AND STABLE

RURAL COASTAL PLAIN SIR 2009-5158 — FEMA FLOW

Q_{10} = 174 $(DA)^{0.617}$ = 843 CFS SAY 840 CFS
Q_{25} = 245 $(DA)^{0.606}$ = 1,154 CFS SAY 1,160 CFS
Q_{50} = 309 $(DA)^{0.600}$ = 1,433 CFS SAY 1,430 CFS
Q_{100} = 380 $(DA)^{0.594}$ = 1736 CFS SAY 1,740 CFS — Q_{100} = 1,189 CFS
Q_{500} = 550 $(DA)^{0.583}$ = 2,443 CFS SAY 2,440 CFS

THE DESIGN DISCHARGES WERE USED FOR DESIGN AND FEMA 100 YR DISCHARGE FOR FEMA COMPLIANCE.

CONTRACTION SCOUR:

$Y_2 = Y_1 [Q_2 / Q_1]^{6/7} [W_1 / W_2]^{k1}$ — OT FLOW: Y_2 = 5.8 $[126.2/65.3]^{6/7} [45.0/44.4]^{0.69}$
Ys = Y_2–Yo — OT FLOW: Ys = 10.3–4.6 = 5.7 ft. SAY = 6'

ABUTMENT SCOUR: OT FLOW (NCHRP 24-20 EQUATION)

$Y_{MAX} = \alpha(Y_c) = \alpha[Y_1(q_2/q_1)^{6/7}]$ — $Y_{MAX} = \alpha(Y_c) = 1.21[5.8(2.8/1.5)^{6/7}]$ — ALPHA FROM FIGURE 8.9 (HEC-18) = 1.21
$Y_s = Y_{MAX} - Y_o$ — Y_s = 12.0–4.6 = 7.4 ft. SAY = 7'

* ACCORDING TO THE INFORMATION RECEIVED FROM STEVEN BLANTON, NCDOT BRIDGE MAINTENANCE SUPERVISOR THE STRUCTURE 770040 DID NOT GO UNDER WATER BUT ROAD BEYOND THE BRIDGE DID HAVE SOME WATER OVERTOPPING THE LOW POINT.

NO INSURABLE STRUCTURES AT THE TIME OF THE PROJECT WILL BE ADVERSELY IMPACTED BY THIS PROJECT.

** WATERWAY OPENING AREA IN PROPOSE CONDITION INCLUDES PROP. 45' BRIDGE, PROP. 117"X79" PIPE ARCH CULVERT AND EXIST. 72" CMP & 66" CMP.

SITE DATA

Drainage Area 12.9 SQ. MI. Source USGS – STREAMSTATS
River Basin LUMBER RIVER Character SWAMPY, RURAL
Stream Classification (Such as Trout, High Quality Water, etc.) C;SW
Data on Existing Structure 1 @ 30' OF 18" PRESTRESSED CONCRETE CHANNELS BEAM ON TIMBER PILES (OAL = 30') WITH 60" CMP & 36" CMP ON SOUTH OF BRIDGE & 72" CMP & 66" CMP ON NORTH OF THE BRIDGE Total Waterway Opening 156 s.f.
Waterway Opening Below 100yr. WS EL. 156 s.f.
Debris Potential: Low X Moderate ___ High ___
Data on Structures Up and Down Stream U/S 3 BARRELS @ 9'X7' RCBC
D/S 4 BARRELS @ 11'X8' RCBC
Design Control Elev. 184.8 ft. (25yr), 185.0 ft. (100 yr) (MAINTAIN OR IMPROVE 25YR AND FEMA 100 YR WSEL @ RS 3795.46)
Gage Station No. N/A Period of Records N/A yrs.
Max. Discharge N/A c.f.s. Date N/A Frequency N/A

Historical Flood Information:
Date – Elev. – ft. Est. Freq. – yr. Source STEVEN BLANTON, NCDOT BRIDGE MAINTENANCE SUPERVISOR * Period of Knowledge – yrs.
Date ___ Elev. ___ ft. Est. Freq. ___ yr. Source ___ Period of Knowledge ___ yrs.
Date ___ Elev. ___ ft. Est. Freq. ___ yr. Source ___ Period of Knowledge ___ yrs.
Historical Scour Info. : General N/A ft. Contraction N/A ft. Local N/A ft.
Channel Slope 0.015 ft/ft Source DETAILED SURVEY Normal Water Surface Elev. 181.5 ft.
Manning's n: Left O.B. 0.115 Channel 0.05 Right O.B. 0.122 Source FEMA /FIELD OBSERVATION
Flood Study /Status LIMITED DETAILED (ROBESON CO. FIS PANEL 9326) Non-Encroachment Established? YES
Flood Study 100yr. Discharge 1189 c.f.s. WS Elev.: With Non-Encroachment 188.5 ft. Without Non-Encroachment 185.0 ft. @ River Station 3795.46

DESIGN DATA

Hydrological Method RURAL FLOOD-FREQ. EQUATIONS (USGS SIR 2009-5158); COASTAL PLAINS REGION
Hydraulic Design Method HEC-RAS 5.0.7

Floods Evaluated: @ River Station 3795.46

	Freq. (yr.)	Q (c.f.s)	Elev. (ft.)	Backwater (ft.)	Bridge Opening Velocity (f.p.s.)
	10	840	184.2	0.2	0.8
DESIGN	25	1160	184.8	0.3	1.1
	50	1430	185.3	0.4	1.0
	100	1740	185.8	0.5	0.7
	500	2440	186.7	0.7	0.7

Waterway Opening Provided Below:Design W.S. Elev. 250** s.f., 100yr W.S. Elev. 250** s.f., Total 250** s.f.,
Average Channel Velocity (Design) 0.6 f.p.s. Average Overbank Velocity (Design) 0.2 f.p.s.
Computed Scour : General N/A ft. Contraction 6 ft. Local N/A ft.
Is a Floodway Revision Required? NO, MOA TYPE 1

BRIDGE SURVEY & HYDRAULIC DESIGN REPORT

N. C. DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
HYDRAULICS UNIT
RALEIGH, N. C.

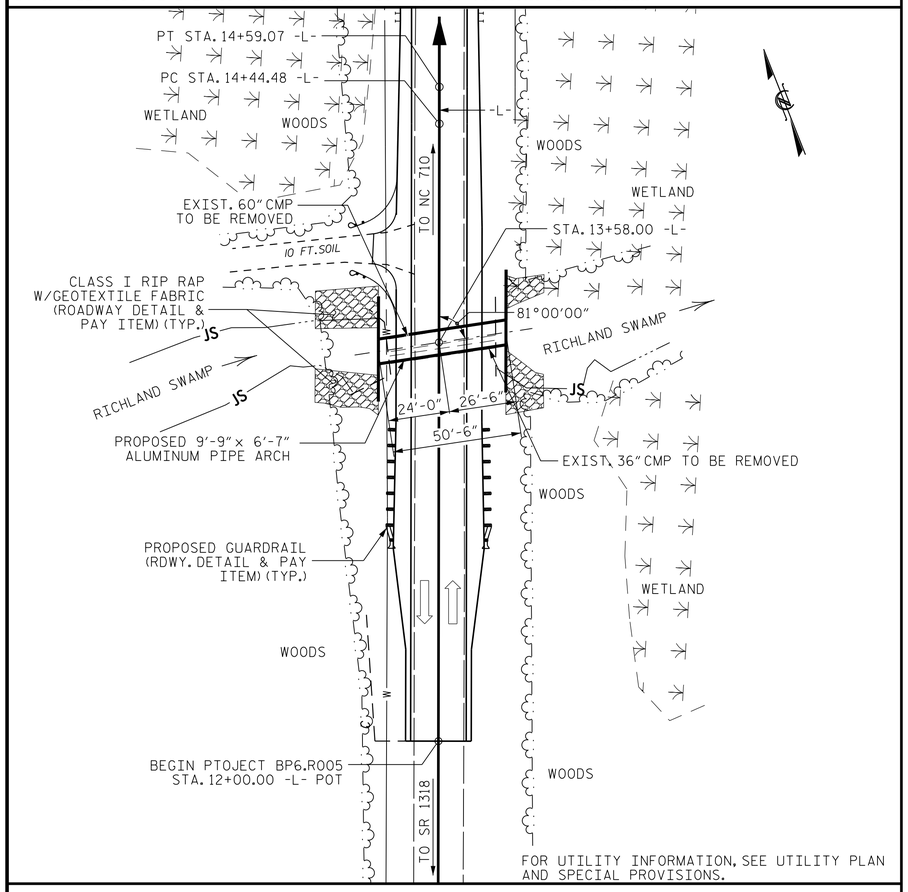
I.D. No. SF-770040 Project No. BP6.R005 Proj. Station 15+27.50
County ROBESON Bridge Over RICHLAND SWAMP Bridge Inv. No. 770040
On Highway SR 1303 (OLD RED SPRINGS RD) Between NC 710 and SR 1318 (MOUNT ZION CHURCH RD)
Recommended Structures 1@45' (21" CORED SLAB), W/2'-6" E.B. CAPS
117"X79" ALUMINUM PIPE ARCH CULVERT
Recommended Width of Roadway 30'-10" CLEAR ROADWAY Skew 90 DEGREE
Recommended Location is (Up, At, Down) Stream from Existing Crossing. AT
Latitude 34.79047 Longitude -79.20421
Statewide Tier ☐ Regional Tier ☐ Sub-Regional Tier ☒
Bench Mark is BM-1, STA 18+55.11, 28.90' RT,
Northing 379028.1349 Easting 193884l.1435 Elev. 182.13' ft. Datum: NAVD 88
Temporary Crossing OFFSITE DETOUR

Stream RICHLAND SWAMP Struc. Inv. No. 770040 I.D. No. SF-770040 Project No. BP6.R005 PDF File 770040 R005 RICHLAND SWAMP SR 1303.pdf

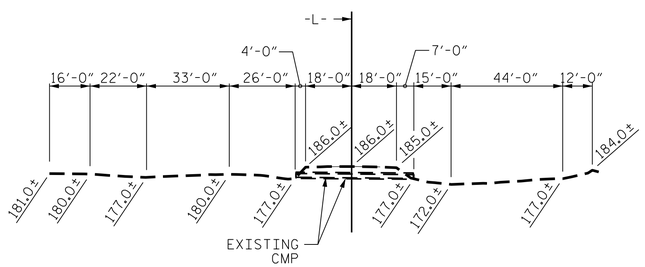
CDM Smith

Designed by: HEATHER HARKENRIDER, PE
Assisted by: PRABHASH JOSHI, EI
Project Engineer ADAM CONRAD, P.E.
Reviewed by: Craig J. Lee
Date 9/15/2022

NORTH CAROLINA PROFESSIONAL SEAL 035021 HEATHER M. HARKENRIDER



LOCATION SKETCH



PROFILE ALONG ℄ CULVERT

ROADWAY DATA

GRADE PT. EL. @ STA. 13+58.00 -L-	= 186.64'
BED ELEV. @ STA. 13+58.00 -L-	= 176.47'
ROADWAY SLOPE	= 3:1

HORIZONTAL CURVE DATA

P.I. STA. = 14+51.77 -L-
Δ = 0°-05'-00.9" (LT.)
D = 0°-34'-22.6"
L = 14.59'
T = 7.29'
R = 10,000.00'

HYDRAULIC DATA

DESIGN DISCHARGE	= 1160 CFS
FREQUENCY OF DESIGN FLOOD	= 25 YRS.
DESIGN HIGH WATER ELEVATION	= 184.8'
DRAINAGE AREA	= 12.9 SQ. MI.
BASE DISCHARGE (Q100)	= 1740 CFS
BASE HIGH WATER ELEVATION	= 185.8'

OVERTOPPING FLOOD DATA

OVERTOPPING DISCHARGE	= 320 CFS
FREQUENCY OF OVERTOPPING FLOOD	= 2 YRS.
OVERTOPPING FLOOD ELEVATION	= 182.6' ✳

✳ OVERTOPPING OCCURS AT ℄ AT STA. 18+05.00 -L-

TOTAL STRUCTURE QUANTITIES

REMOVAL OF EXISTING STRUCTURE	LUMP SUM
CULVERT EXCAVATION	LUMP SUM
FOUNDATION CONDITIONNING MATERIAL	97 TONS
ALUMINUM PIPE ARCH	LUMP SUM
FLOWABLE FILL	26.6 C.Y.

NOTES

ASSUMED LIVE LOAD ---------HL-93 OR ALTERNATE LOADING

PIPE ARCH CULVERT IS TO BE DESIGNED FOR A MINIMUM FILL DEPTH OF 2'-3" AND A MAXIMUM OF 3'-5".

3" Ø WEEP HOLES INDICATED TO BE IN ACCORDANCE WITH THE SPECIFICATIONS.

THE CONTRACTOR SHALL CHECK THE LENGTH AND ELEVATION OF THE PIPE ARCH CULVERT BEFORE STAKING IT OUT TO MAKE CERTAIN THAT IT WILL PROPERLY TAKE CARE OF THE FILL.

ALL MATERIALS SHALL MEET THE REQUIREMENTS OF THE NCDOT STANDARDS SPECIFICATIONS FOR ROADS AND STRUCTURES DATED JANUARY 2018.

THE DETAILS SHOWN ARE FOR GENERAL LAYOUT ONLY. THE SUPPLIER SHALL PROVIDE DETAILS, DESIGN AND RATING SHEET FOR REVIEW AND APPROVAL THAT MEET THE REQUIREMENTS OF AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12, AND ARE SEALED BY A NORTH CAROLINA REGISTERED PROFESSIONAL ENGINEER.

UNLESS OTHERWISE INDICATED, THE SUPPLIER SHALL DETAIL, DESIGN, AND FURNISH ALL STRUCTURAL ELEMENTS AND HARDWARE.

GUARDRAIL POST LOCATIONS SHALL BE DETERMINED IN THE FIELD BY THE ENGINEER TO ENSURE ADEQUATE COVER AND INSTALLATION. FOR CULVERT 25 FT OR LESS, SEE ROADWAY DETAIL DRAWING 862D01 AS OPTIONAL GUARDRAIL PLACEMENT.

EXCAVATE 1 FOOT BELOW PIPE ARCH CULVERT AND REPLACE WITH FOUNDATION CONDITIONING MATERIAL IN ACCORDANCE WITH SECTION 414 OF THE STANDARD SPECIFICATIONS.

BACKFILL CULVERT IN ACCORDANCE WITH SECTION 414 OF THE STANDARD SPECIFICATIONS OR AS RECOMMENDED BY ALUMINUM PIPE ARCH CULVERT MANUFACTURER.

FOR ALUMINUM PIPE ARCH CULVERT, SEE ALUMINUM PIPE ARCH CULVERT AT STATION 13+58.00 -L- SPECIAL PROVISIONS.

FOR SUBMITTAL OF WORKING DRAWINGS, SEE SPECIAL PROVISIONS.

FOR CONSTRUCTION SEQUENCE SEE EROSION CONTROL PLANS.

FOR FALSEWORK AND FORMWORK, SEE SPECIAL PROVISIONS.

FOR CRANE SAFETY, SEE SPECIAL PROVISIONS.

NO PRECAST REINFORCED BOX CULVERT OPTION WILL BE ALLOWED.

FOUNDATION NOTE

THE ALUMINUM BOX CULVERT SHALL BE CONSTRUCTED WITH 12 INCHES OF FOUNDATION CONDITIONING MATERIAL PLACED BELOW THE BOTTOM OF CULVERT.

PROJECT NO. BP6.R005
ROBESON COUNTY
STATION: 13+58.00 -L-

SHEET 1 OF 3

DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED

CDM Smith
CDM SMITH
5400 Glenwood Avenue, Suite 400
Raleigh, NC 27612-3228
NC COA No. F-1255

DRAWN BY : JJR DATE : 5/22
CHECKED BY : THF DATE : 6/22
DESIGN ENGINEER : THF DATE : 7/22

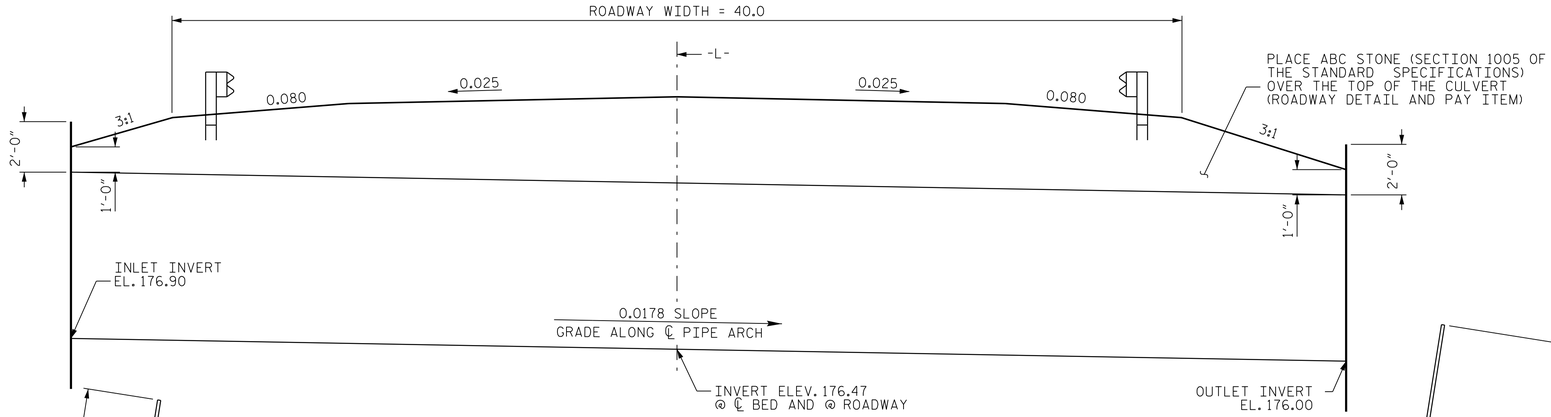
DWG. No.

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

SINGLE 9'-9" X 6'-7" ALUMINUM PIPE ARCH

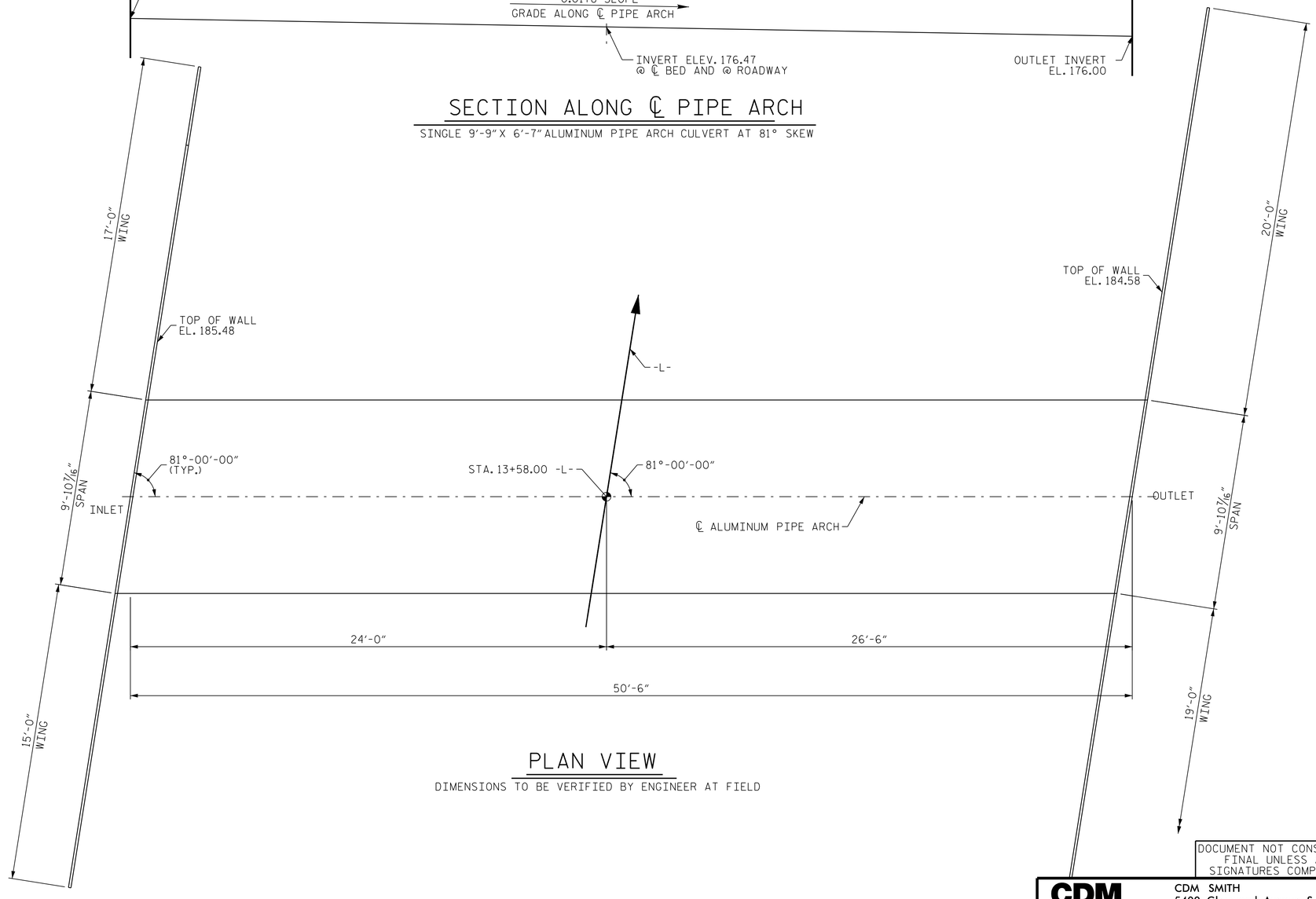
81° SKEW

REVISIONS						SHEET NO.
NO.	BY:	DATE:	NO.	BY:	DATE:	C-1
1			3			TOTAL SHEETS
2			4			3



SECTION ALONG ℄ PIPE ARCH

SINGLE 9'-9" X 6'-7" ALUMINUM PIPE ARCH CULVERT AT 81° SKEW



PLAN VIEW

DIMENSIONS TO BE VERIFIED BY ENGINEER AT FIELD

NOTES:

MINIMUM EMBEDMENT ALONG THE BASE OF WALL SHALL BE 3'-0", INCLUDING 2'-0" OF FLOWABLE FILL SEE DETAIL SHEET C-3.

CONTRACTOR MUST SUBMIT SEALED SHOP DRAWINGS FOR ALUMINUM PIPE ARCH & HEADWALLS TO NCDOT FOR APPROVAL PRIOR TO CONSTRUCTION.

BACKFILL WITH NATIVE MATERIAL TO SILL HEIGHT IN THE CULVERT. NATIVE MATERIAL BETWEEN SILLS IN THE CULVERT SHALL PROVIDE A CONTINUOUS FLOW CHANNEL.

NATIVE MATERIAL CONSISTS OF MATERIAL THAT IS EXCAVATED FROM THE STREAM OR FLOODPLAIN AT THE PROJECT SITE DURING CONSTRUCTION. ONLY MATERIAL THAT IS EXCAVATED FROM THE STREAM BED MAY BE USED TO LINE CULVERT.

RIP RAP MAY BE USED TO SUPPLEMENT THE NATIVE MATERIAL IN THE CULVERT. IF RIP RAP IS USED TO LINE THE FLOW CULVERT BARREL. NATIVE MATERIAL SHOULD BE PLACED ON TOP TO FILL VOIDS AND PROVIDE A FLAT SURFACE FOR ANIMAL PASSAGE.

NATIVE MATERIAL IS SUBJECT TO APPROVAL BY THE ENGINEER AND MAY BE SUBJECT TO PERMIT CONDITIONS.

PROJECT NO. BP6.R005

ROBESON COUNTY

STATION: 13+58.00 -L-

SHEET 2 OF 3

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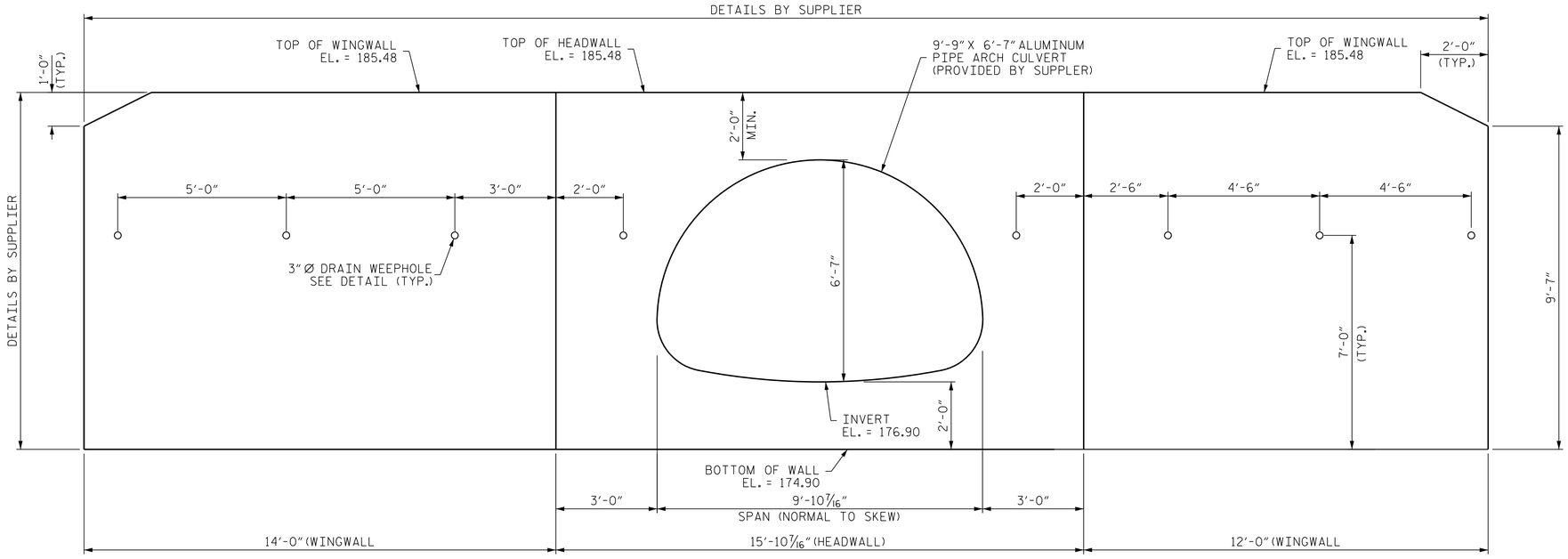
SINGLE 9'-9" X 6'-7" ALUMINUM PIPE ARCH

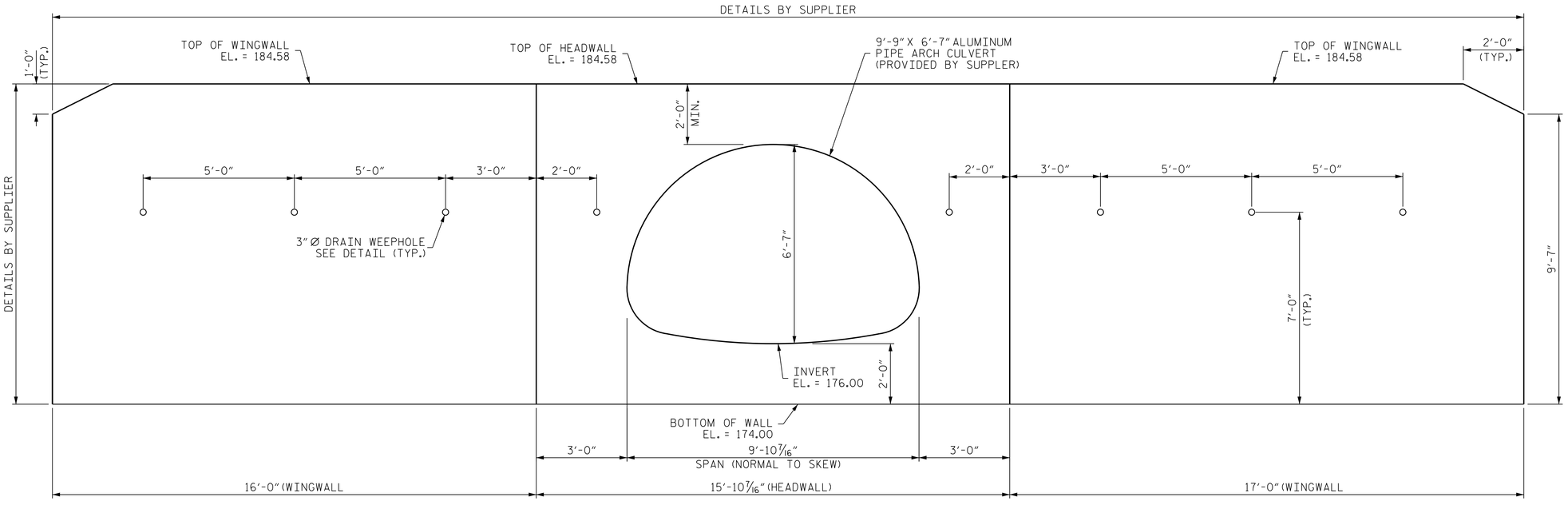
81° SKEW

REVISIONS						SHEET NO.
NO.	BY:	DATE:	NO.	BY:	DATE:	C-2
1			3			TOTAL SHEETS
2			4			3



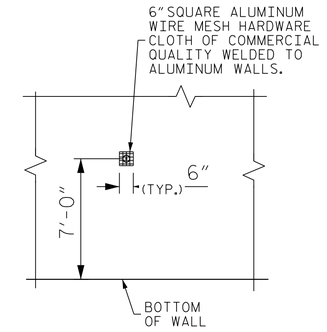
INLET HEADWALL ELEVATION - LOOKING DOWNSTREAM

DIMENSIONS TO BE VERIFIED BY ENGINEER IN THE FIELD.
BOTTOM OF WINGWALLS AND HEADWALL TO BE EMBEDDED AND CAST IN FLOWABLE FILL. SEE DETAILS.

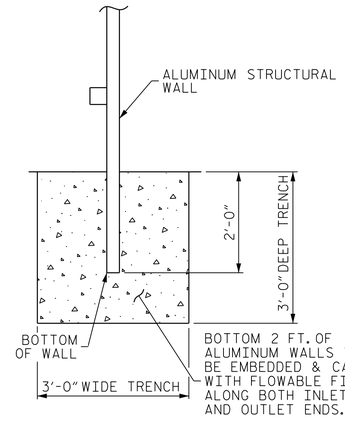


OUTLET HEADWALL ELEVATION - LOOKING UPSTREAM

DIMENSIONS TO BE VERIFIED BY ENGINEER IN THE FIELD.
BOTTOM OF WINGWALLS AND HEADWALL TO BE EMBEDDED AND CAST IN FLOWABLE FILL. SEE DETAILS.



WEEPHOLE DETAIL



FLOWABLE FILL DETAIL

PROJECT NO. BP6.R005
ROBESON COUNTY
STATION: 13+58.00 -L-

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STATE OF NORTH CAROLINA
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SINGLE 9'-9" X 6'-7" ALUMINUM PIPE ARCH

81° SKEW

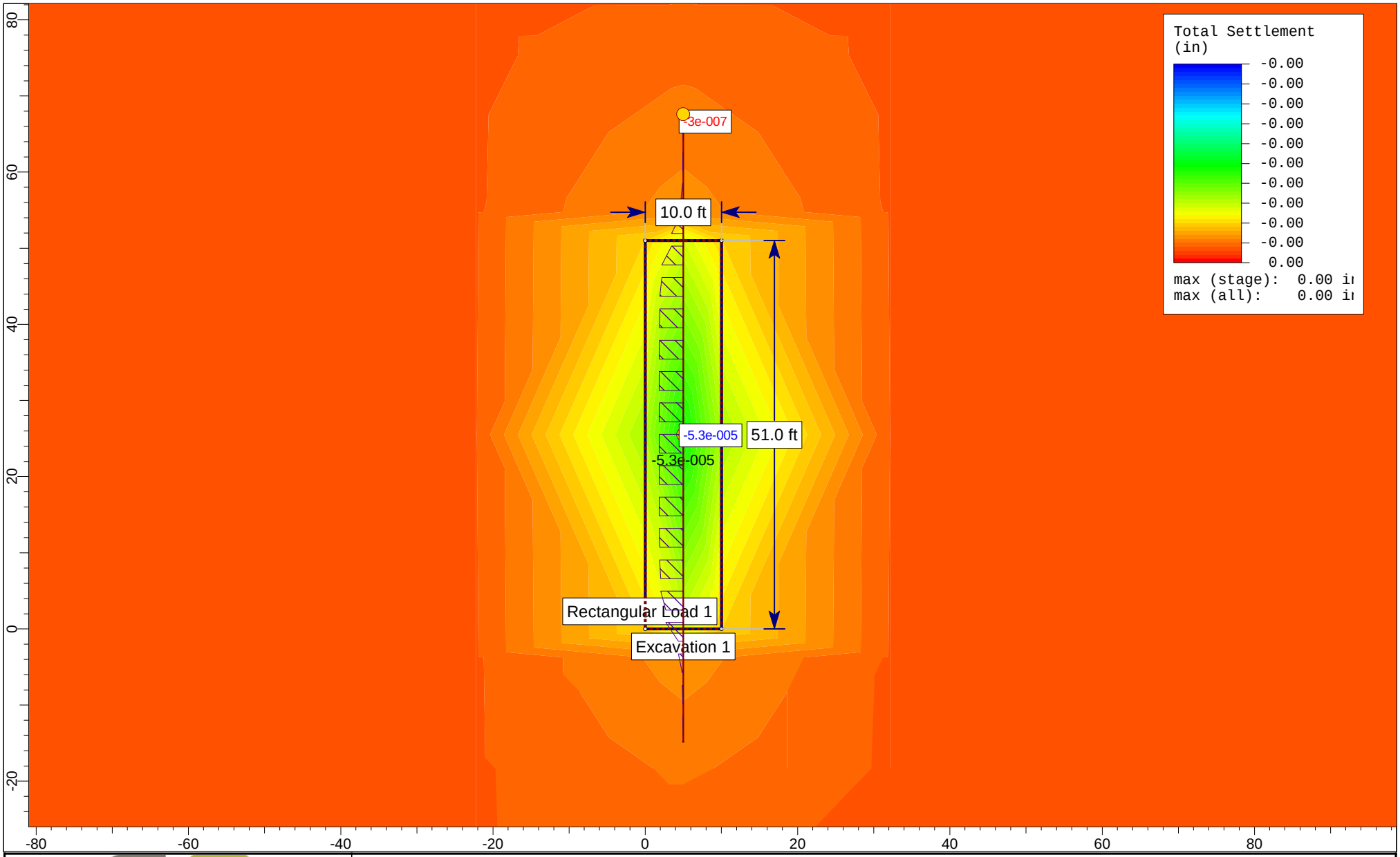
REVISIONS						SHEET NO.
NO.	BY:	DATE:	NO.	BY:	DATE:	C3
1			3			TOTAL SHEETS
2			4			3

Culvert Undercut Quantities
Box Culvert over Richland Swap

Alluminum Pipe Arch Culvert (1 @ 117" x 79")

Foundation Conditioning Material Beneath Culvert Footprint	
Single Culvert Inside Width	9.75
Number of Culverts	1
Number of Culvert Outside Walls	2
Number of Culvert Internal Divisions	*0*
Thickness of Walls & Divisions	*N/A*
Total Culvert(s) Outside Width	*9.75*
Culvert(s) Length (ft)	51
Per Structure Memo, UC to Outer + 4 feet	
UC Outside Width (ft)	*13.75*
UC depth (ft)	1
volume beneath culvert (ft^3)	*701.25*
volume beneath culvert (cy)	*25.97*
Reqd. Foundation Conditioning Material for Culvert(s) (tons)	***49.5***
Reqd. Foundation Conditioning Material for Culvert(s) (tons)	***49***
Per Structure Memo, 1.904 tons/cy	1.904

Per Structure Memo, do not include FCM quantity for standard turned-back wings



SETTLE3 5.001	*Project*	Bridge 40 BP6.R005	
	Analysis Description	Culvert Settlement	
	Drawn By	AS	*Company* S&ME Inc.
	Date	10/10/2022	*File Name* Bridge 40 Culvert Settlement.s3z

Settle3 Analysis Information
Bridge 40 BP6.R005

Project Settings

Document Name	Bridge 40 Culvert Settlement.s3z
Project Title	Bridge 40 BP6.R005
Analysis	Culvert Settlement
Author	AS
Company	S&ME Inc.
Date Created	10/10/2022
Stress Computation Method	Boussinesq
Minimum settlement ratio for subgrade modulus	0.9

Use average properties to calculate layered stresses

Improve consolidation accuracy

Ignore negative effective stresses in settlement calculations

Stage Settings

Stage #	Name
1	Excavate
2	Culvert
3	Traffic

Results

Time taken to compute: 0.0356957 seconds

Stage: Excavate

Data Type	Minimum	Maximum
Total Settlement [in]	-0.000113616	1.60535e-007
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	-0.000113616	1.60535e-007
Loading Stress ZZ [ksf]	-1.03	1.2027e-006
Loading Stress XX [ksf]	-0.953823	0.0362252
Loading Stress YY [ksf]	-0.678299	0.285732
Effective Stress ZZ [ksf]	-2.22045e-016	2.18599
Effective Stress XX [ksf]	-0.298423	1.28202
Effective Stress YY [ksf]	-0.0228991	1.30948
Total Stress ZZ [ksf]	-2.22045e-016	3.98
Total Stress XX [ksf]	-0.298423	2.97324
Total Stress YY [ksf]	-0.0228991	2.99428
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-1.67135e-006	4.7661e-009
Pore Water Pressure [ksf]	0	1.9656
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.00605	2.18317
Over-consolidation Ratio	1	133.508
Void Ratio	0	0
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	-0.0124414	4.8108e-008

Stage: Culvert

Data Type	Minimum	Maximum
Total Settlement [in]	-5.29471e-005	1.60702e-007
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	-5.29471e-005	1.60702e-007
Loading Stress ZZ [ksf]	-0.48	1.2027e-006
Loading Stress XX [ksf]	-0.4445	0.0168816
Loading Stress YY [ksf]	-0.316101	0.133157
Effective Stress ZZ [ksf]	0	2.24431
Effective Stress XX [ksf]	0	1.28522
Effective Stress YY [ksf]	0	1.29801
Total Stress ZZ [ksf]	0	3.98
Total Stress XX [ksf]	0	2.973
Total Stress YY [ksf]	0	2.98281
Modulus of Subgrade Reaction (Total) [ksf/ft]	-172221	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	-172221	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-7.78883e-007	4.7661e-009
Pore Water Pressure [ksf]	0	1.9656
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.00605	2.24159
Over-consolidation Ratio	1	1.36511
Void Ratio	0	0
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	-0.0128745	4.8108e-008

Stage: Traffic

Data Type	Minimum	Maximum
Total Settlement [in]	-5.29471e-005	1.60702e-007
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	-5.29471e-005	1.60702e-007
Loading Stress ZZ [ksf]	-0.48	1.2027e-006
Loading Stress XX [ksf]	-0.4445	0.0168816
Loading Stress YY [ksf]	-0.316101	0.133157
Effective Stress ZZ [ksf]	0	2.24431
Effective Stress XX [ksf]	0	1.28522
Effective Stress YY [ksf]	0	1.29801
Total Stress ZZ [ksf]	0	3.98
Total Stress XX [ksf]	0	2.973
Total Stress YY [ksf]	0	2.98281
Modulus of Subgrade Reaction (Total) [ksf/ft]	-172221	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	-172221	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-7.78883e-007	4.7661e-009
Pore Water Pressure [ksf]	0	1.9656
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.00605	2.24159
Over-consolidation Ratio	1	1.36511
Void Ratio	0	0
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	-0.0128745	4.8108e-008

Loads

1. Rectangular Load: "Rectangular Load 1"

Length	10 ft
Width	51 ft
Rotation angle	0 degrees
Load Type	Flexible
Area of Load	510 ft^2
Load	0.55 ksf
Depth	10 ft
Installation Stage	Culvert

Coordinates

X [ft]	Y [ft]
2.66454e-015	7.10543e-015
10	7.10543e-015
10	51
2.66454e-015	51

Excavations

1. Excavation: "Excavation 1"

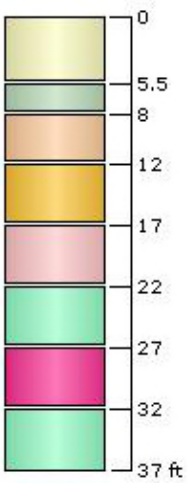
Depth	10 ft
Installation Stage	Excavate

Coordinates

X [ft]	Y [ft]
10	4.26326e-014
10	51
2.66454e-015	51
2.66454e-015	4.26326e-014

Soil Layers

Layer #	Type	Thickness [ft]	Depth [ft]
1	A-2-4 (Fill)	5.5	0
2	A-7-5 (Alluv)	2.5	5.5
3	A-3 (Alluv)	4	8
4	A-2-4 (Alluv)	5	12
5	A-6 (CP)	5	17
6	A-2-4 (CP)	5	22
7	A-7-6 (CP)	5	27
8	A-2-4 (CP)	5	32



Soil Properties

Property	A-2-4 (Fill)	A-7-5 (Alluv)	A-3 (Alluv)	A-2-4 (Alluv)
Color				
Unit Weight [kips/ft^3]	0.11	0.09	0.1	0.12
Saturated Unit Weight [kips/ft^3]	0.11	0.09	0.1	0.12
K0	0.5	0.5	0.5	0.5
Immediate Settlement	Disabled	Disabled	Enabled	Enabled
Es [ksf]	-	-	250	600
Esur [ksf]	-	-	2.5e+007	600000
Undrained Su A [kips/ft2]	0	0	0	0
Undrained Su S	0.2	0.2	0.2	0.2
Undrained Su m	0.8	0.8	0.8	0.8
Piezo Line ID	1	1	1	1

Property	A-6 (CP)	A-2-4 (CP)	A-7-6 (CP)
Color			
Unit Weight [kips/ft^3]	0.105	0.115	0.095
Saturated Unit Weight [kips/ft^3]	0.105	0.115	0.095
K0	0.5	0.5	0.5
Immediate Settlement	Enabled	Enabled	Enabled
Es [ksf]	150	250	40
Esur [ksf]	1.5e+006	2.5e+007	4e+007
Undrained Su A [kips/ft2]	0	0	0
Undrained Su S	0.2	0.2	0.2
Undrained Su m	0.8	0.8	0.8
Piezo Line ID	1	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft^3

Piezometric Line Entities

ID	Depth (ft)
1	5.5 ft

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
1	Query Point 1	5, 25.5	Auto: 79

Query Lines

Line #	Query Line Name	Start Location	End Location	Horizontal Divisions	Vertical Divisions
1	Query Line 1	5, 67.5892	5, -14.8398	20	Auto: 77

Field Point Grid

Number of points	307
Expansion Factor	2

Grid Coordinates

X [ft]	Y [ft]
305	201
305	-150
-295	-150
-295	201