WEST LUMBERTON FLOOD GATE AT VFW ROAD AND RAILROAD UNDERPASS

EARLY NOTICE FLOODPLAIN AND WETLANDS MAPS

- **Proposed Project Location Maps, Robeson County Parcel Data, and Site Plans**
- **FEMA FIRMette, NEPAssist FEMA FIRMs, PFIRMs, NFIP Community Status Book, and Hydrologic and Hydraulic Analysis**
- **USFWS National Wetlands Inventory (NWI) Map, Total Wetlands Area Map, and USACE Correspondence**

- **Proposed Project Location Maps**
- **Robeson County Parcel Data**
- **Site Plans**

West Lumberton Flood Gate - Aerial Map

December 1, 2023

- WLFG Project Action Area
- 550 VFW Rd #938189443052
- 2306 W 5th St #938189201500
- 2400 Cox Rd #938179684407
- 2460 Cox Rd #938179143700
- VFW & Hackett #938280300700
- Railroads

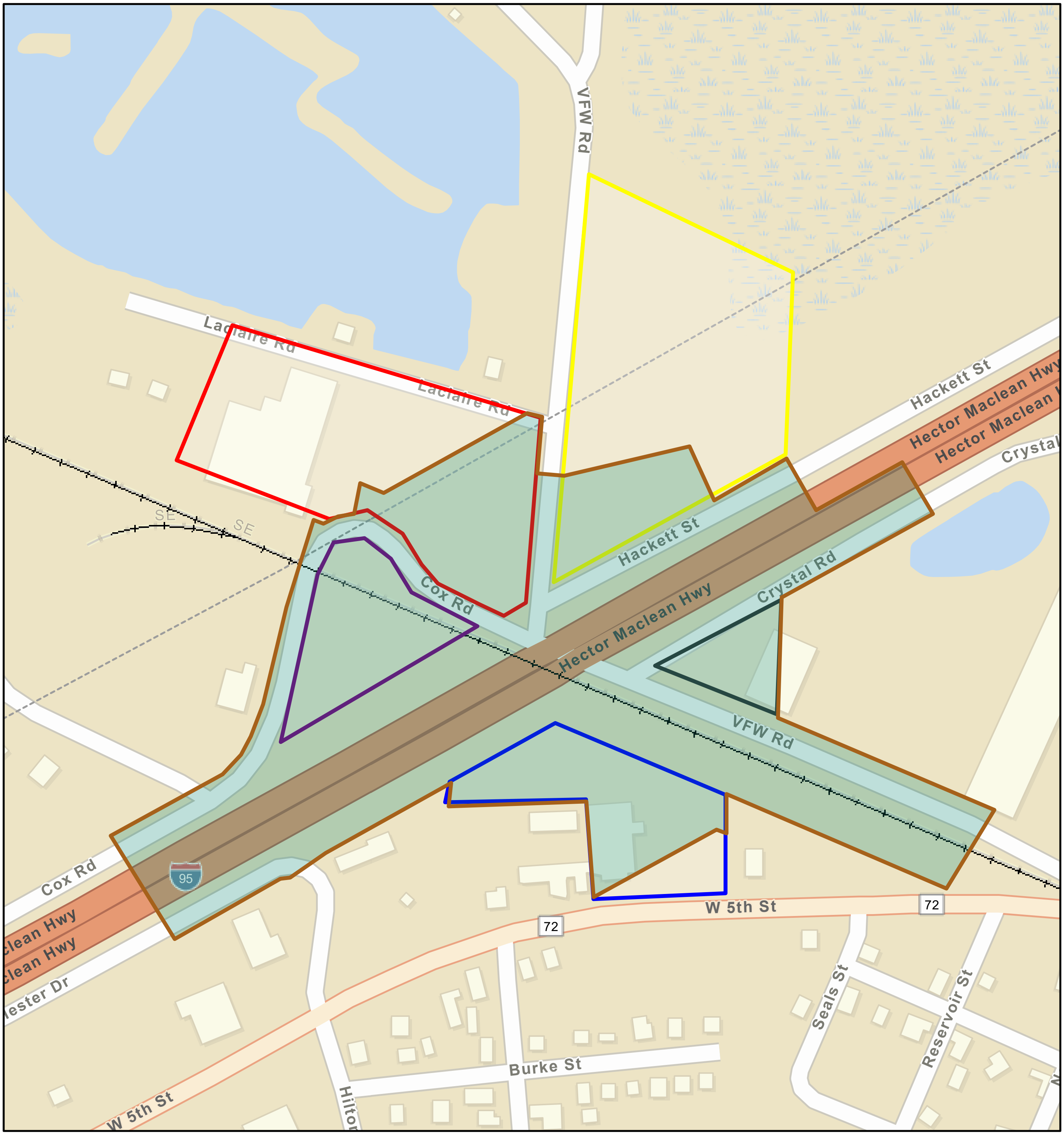
1:4,514

0 0.03 0.06 0.12 mi

0 0.05 0.1 0.2 km

NC CGIA, Maxar, Esri Community Maps Contributors, State of North Carolina DOT, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, EPA OEI

West Lumberton Flood Gate - Street Map



December 1, 2023

- WLFG Project Action Area
- 550 VFW Rd #938189443052
- 2306 W 5th St #938189201500
- 2400 Cox Rd #938179684407
- 2460 Cox Rd #938179143700
- VFW & Hackett #938280300700
- Railroads

1:4,514

0 0.03 0.06 0.12 mi

0 0.05 0.1 0.2 km

Esri Community Maps Contributors, State of North Carolina DOT, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, EPA OEI

West Lumberton Flood Gate - Topographic Map

December 1, 2023

- WLFG Project Action Area
- 550 VFW Rd #938189443052
- 2306 W 5th St #938189201500
- 2400 Cox Rd #938179684407
- 2460 Cox Rd #938179143700
- VFW & Hackett #938280300700
- Railroads

1:4,514

0 0.03 0.06 0.12 mi

0 0.05 0.1 0.2 km

County of Robeson, NC

MAPNO	101102012
PIN_NUMBER	938280300700
PARCELTYPE	Base Parcel
CONFLICTNOTATION	
DEEDEDACRES	7.71000004
OWNERTYPE	null
STATUS	null
OLDMAPNO	1011-02-012
NUMMOD	null
LOT	null
NBHD_CODE	32C27
TAX_YEAR	2023
PAR_CODE	
MAP	9382
SUBMAP	
BLOCK	80
PARCEL	3007
SUBPARCEL	00
PHYLOCAT	56700
CITYCODE	
ROUTENUM	0
OWNERID	8543007
CUROWNID	8543007

OWNAM1	FREEMAN INVESTMENTS INC
OWNAM2	
OWNAM3	
OWADR1	P O BOX 162
OWADR2	
OWADR3	
OWADR4	
OWCITY	LUMBERTON
OWSTATE	NC
OWZIP	283590000
STNUM	0
STSUFFIX	
STDIR	
STNAME	VFW & HACKETT
STTYPE	RD
STDIRSUF	
UNITNO	
DEEDACRE	7.16
MAPACRE	7.16
DISTCODE	27
TOWNCODE	10
PARDESC3	J62
PARDESC1	I-00
NBHCLASS	
NBHCODE	32C27
EXEMCODE	
DEEDBOOK	
DEEDPAGE	
DEEDYEAR	1989
PLATBOOK	
PLATPAGE	
DATESOLD	0
LEGDESC1	A JC BENNETT BORROW PIT
LEGDESC2	
LEGDESC3	
PARDESC4	
GROUPPAR	938280300700
REQREVIEW	
PHYSTRADR	VFW & HACKETT RD
SCHCODE	0
AREACODE	1
LNDASVCUR	19800
IMPASVCUR	0
QUALCODE	

RECTYPE	null
SALEAMT	0
SALEINST	
DEEDSTMP	0

Robeson County Government
PROPERTY REPORT - PRINT

Property Owner	Owner's Mailing Address	Property Location Address
FREEMAN INVESTMENTS INC	P O BOX 162 LUMBERTON , NC 283590000	VFW & HACKETT RD

Administrative Data

Parcel Ref No.	**101102012**
PIN	**938280300700**
Account No.	**8543007**
Tax District	**RAFT SWAMP FIRE**
Land Use Code	**I-00**
Land Use Desc	**INDUSTRIAL VACANT**
Subdiv Code	
Subdiv Desc	
Neighborhood	**32C27**

Administrative Data

Legal Desc	**A JC BENNETT BORROW PIT**
Deed Bk/Pg	**00691 / 0078**
Plat Bk/Pg	**/**

Sales Information

Grantor	
Sold Date	**0--0**
Sold Amount $	**0**

Valuation Information

Market Value $	**19,800**

Market Value - Land and all permanent improvements, if any, effective January 1, 2010, date of County's most recent General Reappraisal

Assessed Value $	**19,800**

If Assessed Value not equal Market Value then subject parcel designated as a special class -agricultural, horticultural, or forestland and thereby eligible for taxation on basis of Present-Use and/or reduction from a formal appeal procedure

Land Supplemental

Map Acres	**7.16**
Tax District Note	**JACOB SWAMP MAINTENANCE**
Present-Use Info	

Improvement Detail

(1st Major Improvement on Subject Parcel)

Year Built	**0**
Built Use/Style	
Current Use	/
* Percent Complete	**0**
Heated Area (S/F)	**0**
** Bathroom(s)	**0 Full Bath(s) 0 Half Bath(s)**
** Bedroom(s)	**0**
Fireplace (Y/N)	**N**
Basement (Y/N)	**N**
Attached Garage (Y/N)	**N**
*** Multiple Improvements	**000**

* Note - As of January 1
* * Note - Bathroom(s), Bedroom(s), shown for description only
* * * Note - If multiple improvements equal "MLT" then parcel includes additional major improvements

Improvement Valuation (1st Major Improvement on Subject Parcel)

* Improvement Market Value $	** Improvement Assessed Value $
0	**0**

* Note - Market Value effective Date equal January 1, 2010, date of County's most recent General Reappraisal
** Note - If Assessed Value not equal Market Value then variance resulting from formal appeal procedure

Land Value Detail (Effective Date January 1, 2010, date of County's most recent General Reappraisal)

Land Market Value (LMV) $	Land Present-Use Value (PUV) $ **	Land Total Assessed Value $
19,800	**19,800**	**19,800**

** Note: If PUV equal LMV then parcel ***has not*** qualified for present use program

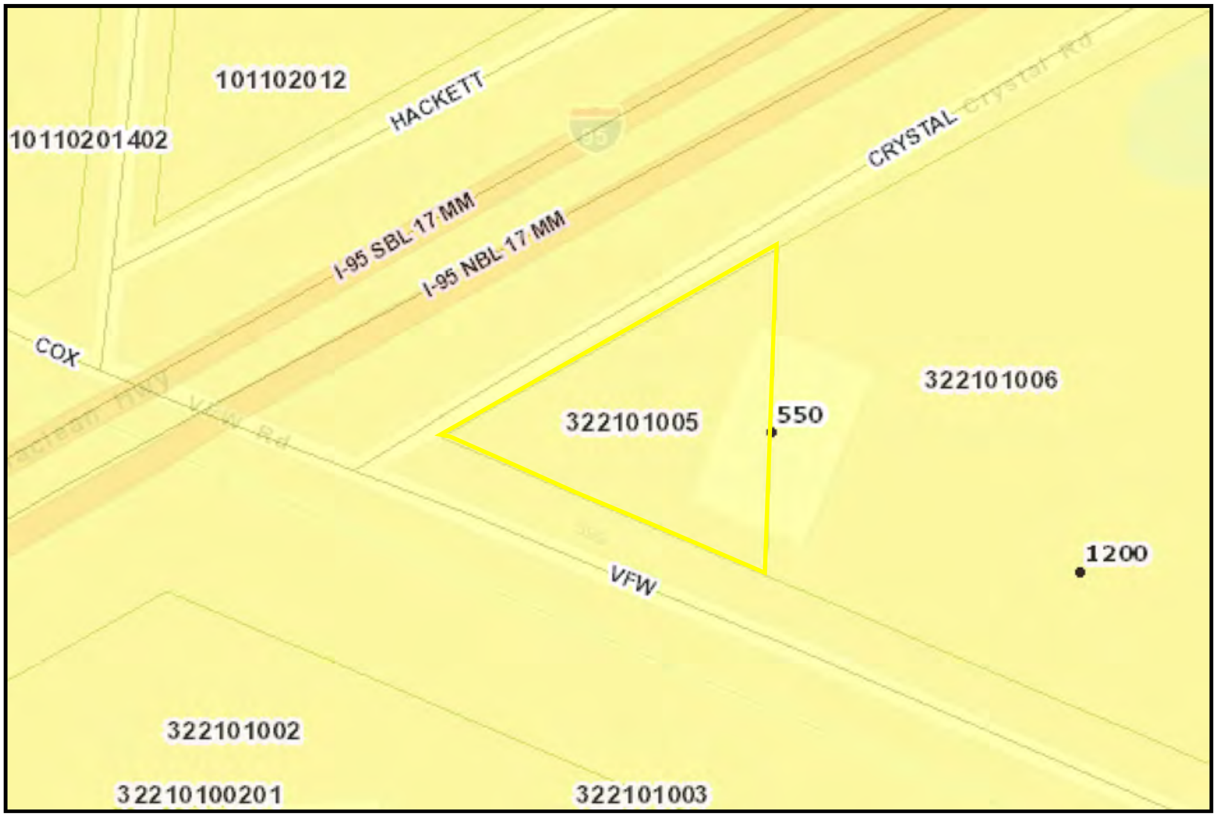
Parcel Sketch:

No Sketch Available

Parcel Photo:

No Photo Available

County of Robeson, NC



MAPNO	322101005
PIN_NUMBER	938189443052
PARCELTYPE	Base Parcel
CONFLICTNOTATION	null
DEEDEDACRES	null
OWNERTYPE	Private
STATUS	null
OLDMAPNO	3221-01-005
NUMMOD	null
LOT	null
NBHD_CODE	000000
TAX_YEAR	2023
PAR_CODE	
MAP	9381
SUBMAP	
BLOCK	89
PARCEL	4420
SUBPARCEL	00
PHYLOCAT	36171
CITYCODE	
ROUTENUM	0
OWNERID	8543000
CUROWNID	8543000

OWNAM1	FREEMAN INVESTMENTS INC
OWNAM2	
OWNAM3	
OWADR1	P O BOX 162
OWADR2	
OWADR3	
OWADR4	
OWCITY	LUMBERTON
OWSTATE	NC
OWZIP	283590000
STNUM	550
STSUFFIX	
STDIR	
STNAME	V. W. F.
STTYPE	RD
STDIRSUF	
UNITNO	
DEEDACRE	0.83
MAPACRE	0.83
DISTCODE	52
TOWNCODE	32
PARDESC3	
PARDESC1	C-80
NBHCLASS	
NBHCODE	32C25
EXEMCODE	
DEEDBOOK	
DEEDPAGE	
DEEDYEAR	1989
PLATBOOK	
PLATPAGE	
DATESOLD	0
LEGDESC1	LT JC BENNETT S/S I 95 OF
LEGDESC2	B1 IS HOUSING FOR A/C UNI
LEGDESC3	T ATTACHED TO REAR OF BLD
PARDESC4	
GROUPPAR	938189442000
REQREVIEW	
PHYSTRADR	550 V. W. F. RD
SCHCODE	0
AREACODE	1
LNDASVCUR	18700
IMPASVCUR	226500
QUALCODE	

RECTYPE	null
SALEAMT	0
SALEINST	
DEEDSTMP	0

Robeson County Government
PROPERTY REPORT - PRINT

Property Owner	Owner's Mailing Address	Property Location Address
FREEMAN INVESTMENTS INC	P O BOX 162	550 V. W. F. RD
	LUMBERTON , NC 283590000	

Administrative Data

Parcel Ref No.	322101005
PIN	938189442000
Account No.	8543000
Tax District	TOWN LUMBERTON
Land Use Code	C-80
Land Use Desc	WAREHOUSES
Subdiv Code	
Subdiv Desc	
Neighborhood	32C25

Administrative Data

Legal Desc	LT JC BENNETT S/S I 95 OF B1 IS HOUSING FOR A/C UNI
Deed Bk/Pg	00691 / 0078
Plat Bk/Pg	/

Sales Information

Grantor	
Sold Date	0--0
Sold Amount $	0

Valuation Information

Market Value $	245,200

Market Value - Land and all permanent improvements, if any, effective January 1, 2010, date of County's most recent General Reappraisal

Assessed Value $	245,200

If Assessed Value not equal Market Value then subject parcel designated as a special class -agricultural, horticultural, or forestland and thereby eligible for taxation on basis of Present-Use and/or reduction from a formal appeal procedure

Land Supplemental

Map Acres	0.83
Tax District Note	
Present-Use Info	

Improvement Detail

(1st Major Improvement on Subject Parcel)

Year Built	1990
Built Use/Style	WAREHOUSE
Current Use	C /
* Percent Complete	100
Heated Area (S/F)	17,000
** Bathroom(s)	0 Full Bath(s) 0 Half Bath(s)
** Bedroom(s)	0
Fireplace (Y/N)	N
Basement (Y/N)	N
Attached Garage (Y/N)	N
*** Multiple Improvements	001

* Note - As of January 1
* * Note - Bathroom(s), Bedroom(s), shown for description only
* * * Note - If multiple improvements equal "MLT" then parcel includes additional major improvements

Improvement Valuation (1st Major Improvement on Subject Parcel)

* Improvement Market Value $	** Improvement Assessed Value $
226,500	226,500

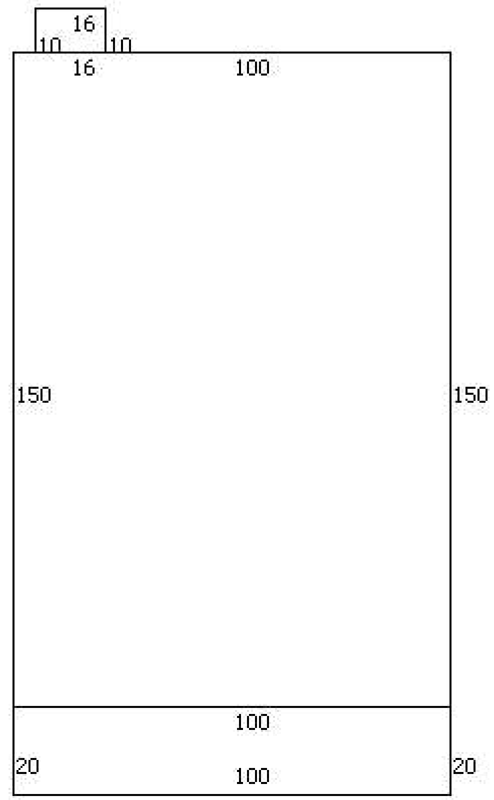
* Note - Market Value effective Date equal January 1, 2010, date of County's most recent General Reappraisal
** Note - If Assessed Value not equal Market Value then variance resulting from formal appeal procedure

Land Value Detail (Effective Date January 1, 2010, date of County's most recent General Reappraisal)

Land Market Value (LMV) $	Land Present-Use Value (PUV) $ **	Land Total Assessed Value $
18,700	18,700	18,700

** Note: If PUV equal LMV then parcel ***has not*** qualified for present use program

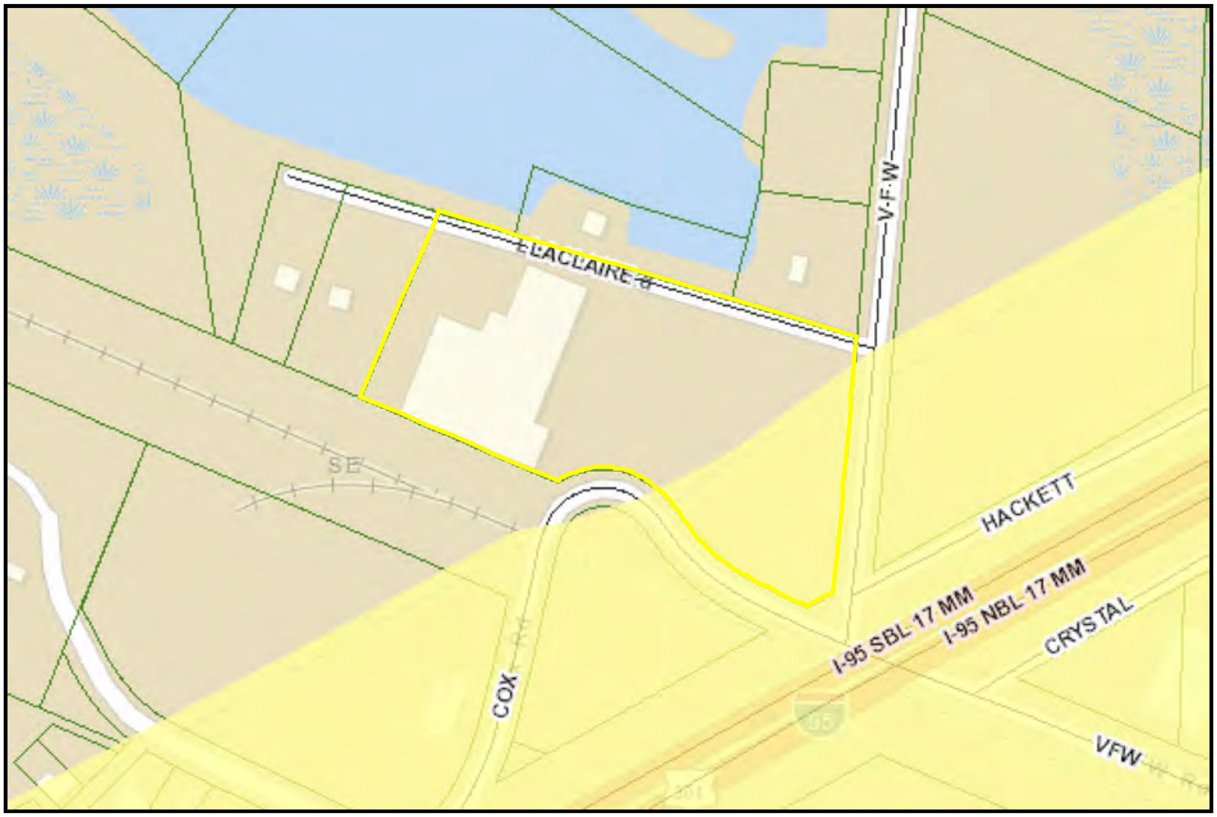
Parcel Sketch:



Parcel Photo:

No Photo Available

County of Robeson, NC



MAPNO	10110201402
PIN_NUMBER	938179684407
PARCELTYPE	Base Parcel
CONFLICTNOTATION	
DEEDEDACRES	6.3
OWNERTYPE	null
STATUS	null
OLDMAPNO	1011-02-01402
NUMMOD	null
LOT	null
NBHD_CODE	32C27
TAX_YEAR	2023
PAR_CODE	
MAP	9381
SUBMAP	
BLOCK	79
PARCEL	6844
SUBPARCEL	07
PHYLOCAT	13183
CITYCODE	
ROUTENUM	0
OWNERID	1073076
CUROWNID	1226876

OWNAM1	FIRST INDUSTRIAL B&L LLC
OWNAM2	
OWNAM3	
OWADR1	101 S TRYON STREET SUITE 2420
OWADR2	
OWADR3	
OWADR4	
OWCITY	CHARLOTTE
OWSTATE	NC
OWZIP	28202
STNUM	2400
STSUFFIX	
STDIR	
STNAME	COX
STTYPE	RD
STDIRSUF	
UNITNO	
DEEDACRE	6.3
MAPACRE	6.3
DISTCODE	27
TOWNCODE	10
PARDESC3	
PARDESC1	I-20
NBHCLASS	
NBHCODE	32C27
EXEMCODE	
DEEDBOOK	null
DEEDPAGE	null
DEEDYEAR	null
PLATBOOK	null
PLATPAGE	null
DATESOLD	null
LEGDESC1	A N/S SR1598
LEGDESC2	TITAN FLOW CONTROL
LEGDESC3	
PARDESC4	
GROUPPAR	938179684407
REQREVIEW	
PHYSTRADR	2400 COX RD
SCHCODE	0
AREACODE	1
LNDASVCUR	115000
IMPASVCUR	435700
QUALCODE	null

RECTYPE	null
SALEAMT	null
SALEINST	null
DEEDSTMP	null

Robeson County Government
PROPERTY REPORT - PRINT

Property Owner	Owner's Mailing Address	Property Location Address
SPARTAN LLC	290 CORPORATE DR	2400 COX RD
	LUMBERTON , NC 28358	

Administrative Data

Parcel Ref No.	**10110201402**
PIN	**938179684407**
Account No.	**1073076**
Tax District	**RAFT SWAMP FIRE**
Land Use Code	**I-20**
Land Use Desc	**LIGHT INDUSTRIAL**
Subdiv Code	
Subdiv Desc	
Neighborhood	**32C27**

Administrative Data

Legal Desc	**A N/S SR1598**
	TITAN FLOW CONTROL
Deed Bk/Pg	**01637 / 0232**
Plat Bk/Pg	**/**

Sales Information

Grantor	**SPARTAN LLC**
Sold Date	**2023-04-26**
Sold Amount $	**50,000**

Valuation Information

Market Value $	**550,700**

Market Value - Land and all permanent improvements, if any, effective January 1, 2010, date of County's most recent General Reappraisal

Assessed Value $	**550,700**

If Assessed Value not equal Market Value then subject parcel designated as a special class -agricultural, horticultural, or forestland and thereby eligible for taxation on basis of Present-Use and/or reduction from a formal appeal procedure

Land Supplemental

Map Acres	**6.3**
Tax District Note	
Present-Use Info	

Improvement Detail

(1st Major Improvement on Subject Parcel)

Year Built	**1977**
Built Use/Style	**MFG/PROCESSING**
Current Use	**C /**
* Percent Complete	**100**
Heated Area (S/F)	**49,972**
** Bathroom(s)	**0 Full Bath(s) 0 Half Bath(s)**
** Bedroom(s)	**0**
Fireplace (Y/N)	**N**
Basement (Y/N)	**N**
Attached Garage (Y/N)	**N**
*** Multiple Improvements	**001**

* Note - As of January 1
* * Note - Bathroom(s), Bedroom(s), shown for description only
* * * Note - If multiple improvements equal "MLT" then parcel includes additional major improvements

Improvement Valuation (1st Major Improvement on Subject Parcel)

* Improvement Market Value $	** Improvement Assessed Value $
435,700	**435,700**

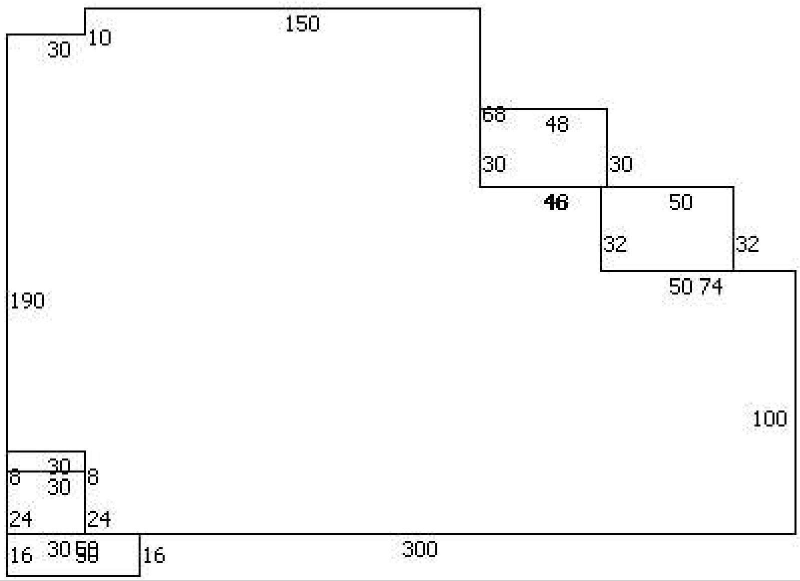
* Note - Market Value effective Date equal January 1, 2010, date of County's most recent General Reappraisal
** Note - If Assessed Value not equal Market Value then variance resulting from formal appeal procedure

Land Value Detail (Effective Date January 1, 2010, date of County's most recent General Reappraisal)

Land Market Value (LMV) $	Land Present-Use Value (PUV) $ **	Land Total Assessed Value $
115,000	**115,000**	**115,000**

** Note: If PUV equal LMV then parcel ***has not*** qualified for present use program

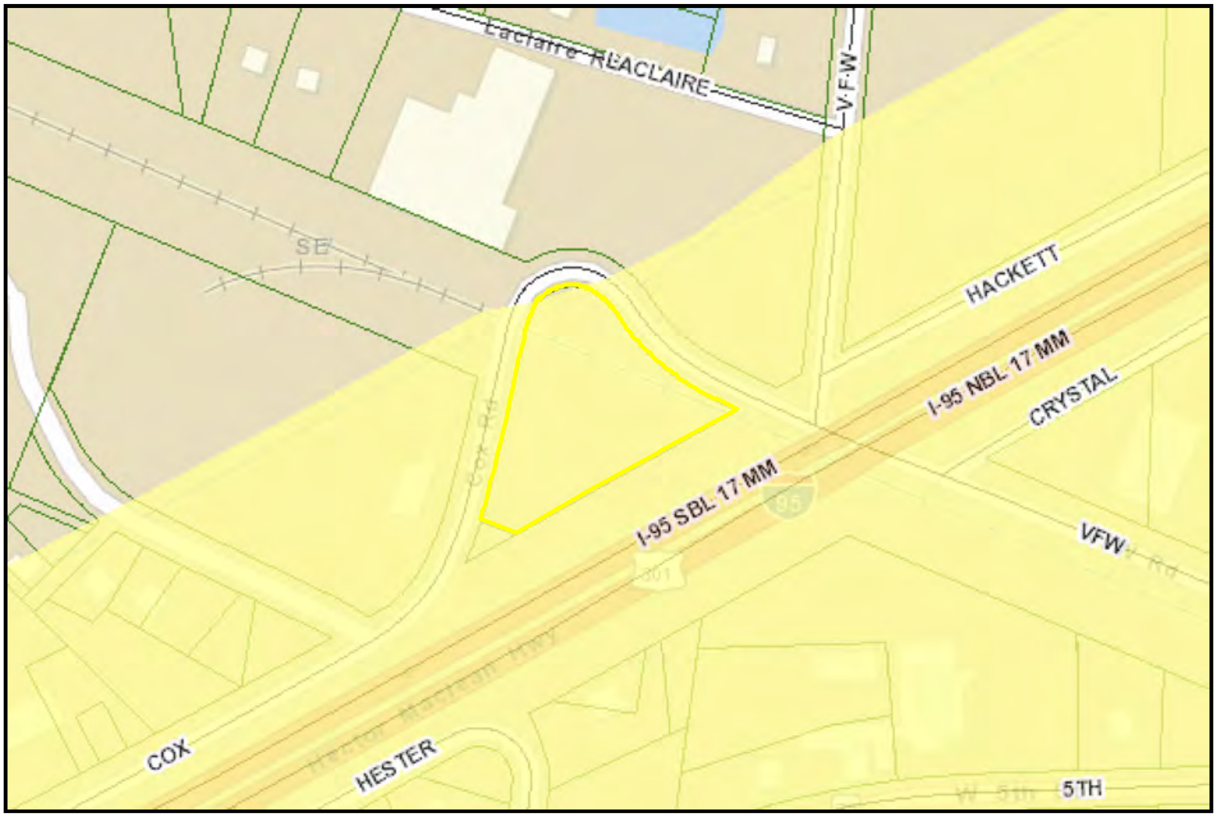
Parcel Sketch:



Parcel Photo:

No Photo Available

County of Robeson, NC



MAPNO	101103010
PIN_NUMBER	938179143700
PARCELTYPE	Base Parcel
CONFLICTNOTATION	
DEEDEDACRES	6.73000002
OWNERTYPE	Private
STATUS	null
OLDMAPNO	1011-03-010
NUMMOD	null
LOT	null
NBHD_CODE	32C27
TAX_YEAR	2023
PAR_CODE	
MAP	9381
SUBMAP	
BLOCK	79
PARCEL	1437
SUBPARCEL	00
PHYLOCAT	13200
CITYCODE	
ROUTENUM	0
OWNERID	1004662001
CUROWNID	1004662001

OWNAM1	OMNISOURCE SOUTHEAST LLC
OWNAM2	
OWNAM3	
OWADR1	7575 W JEFFERSON BLVD
OWADR2	
OWADR3	
OWADR4	
OWCITY	FORT WAYNE
OWSTATE	IN
OWZIP	46508-4131
STNUM	2460
STSUFFIX	
STDIR	
STNAME	COX
STTYPE	RD
STDIRSUF	
UNITNO	
DEEDACRE	6.34
MAPACRE	6.34
DISTCODE	52
TOWNCODE	10
PARDESC3	
PARDESC1	C-80
NBHCLASS	
NBHCODE	32C27
EXEMCODE	
DEEDBOOK	null
DEEDPAGE	null
DEEDYEAR	null
PLATBOOK	null
PLATPAGE	null
DATESOLD	null
LEGDESC1	AC CHARLES STEVENS DIV LU
LEGDESC2	MBERTON RECYCLING CO
LEGDESC3	
PARDESC4	
GROUPPAR	938179143700
REQREVIEW	
PHYSTRADR	2460 COX RD
SCHCODE	0
AREACODE	1
LNDASVCUR	58600
IMPASVCUR	35000
QUALCODE	null

RECTYPE	null
SALEAMT	null
SALEINST	null
DEEDSTMP	null

Robeson County Government
PROPERTY REPORT - PRINT

Property Owner
OMNISOURCE SOUTHEAST LLC

Owner's Mailing Address
7575 W JEFFERSON BLVD
FORT WAYNE , IN 46508-4131

Property Location Address
2460 COX RD

Administrative Data

Parcel Ref No.	**101103010**
PIN	**938179143700**
Account No.	**1004662001**
Tax District	**TOWN LUMBERTON**
Land Use Code	**C-80**
Land Use Desc	**WAREHOUSES**
Subdiv Code	
Subdiv Desc	
Neighborhood	**32C27**

Administrative Data

Legal Desc	**AC CHARLES STEVENS DIV LU**
	MBERTON RECYCLING CO
Deed Bk/Pg	**01994 / 0786**
Plat Bk/Pg	**/**

Sales Information

Grantor	**LUMBERTON RECYCLING CO INC**
	C/O OMINSOURCE SOUTHEAST
Sold Date	**2015-05-29**
Sold Amount $	**0**

Valuation Information

Market Value $	**93,600**

Market Value - Land and all permanent improvements, if any, effective January 1, 2010, date of County's most recent General Reappraisal

Assessed Value $	**93,600**

If Assessed Value not equal Market Value then subject parcel designated as a special class -agricultural, horticultural, or forestland and thereby eligible for taxation on basis of Present-Use and/or reduction from a formal appeal procedure

Land Supplemental

Map Acres	**6.34**
Tax District Note	
Present-Use Info	

Improvement Detail
(1st Major Improvement on Subject Parcel)

Year Built	**1981**
Built Use/Style	**WAREHOUSE**
Current Use	**C /**
* Percent Complete	**100**
Heated Area (S/F)	**4,600**
** Bathroom(s)	**0 Full Bath(s) 0 Half Bath(s)**
** Bedroom(s)	**0**
Fireplace (Y/N)	**N**
Basement (Y/N)	**N**
Attached Garage (Y/N)	**N**
*** Multiple Improvements	**001**

* Note - As of January 1
* * Note - Bathroom(s), Bedroom(s), shown for description only
* * * Note - If multiple improvements equal "MLT" then parcel includes additional major improvements

Improvement Valuation (1st Major Improvement on Subject Parcel)

* Improvement Market Value $	** Improvement Assessed Value $
35,000	**35,000**

* Note - Market Value effective Date equal January 1, 2010, date of County's most recent General Reappraisal
** Note - If Assessed Value not equal Market Value then variance resulting from formal appeal procedure

Land Value Detail (Effective Date January 1, 2010, date of County's most recent General Reappraisal)

Land Market Value (LMV) $	Land Present-Use Value (PUV) $ **	Land Total Assessed Value $
58,600	**58,600**	**58,600**

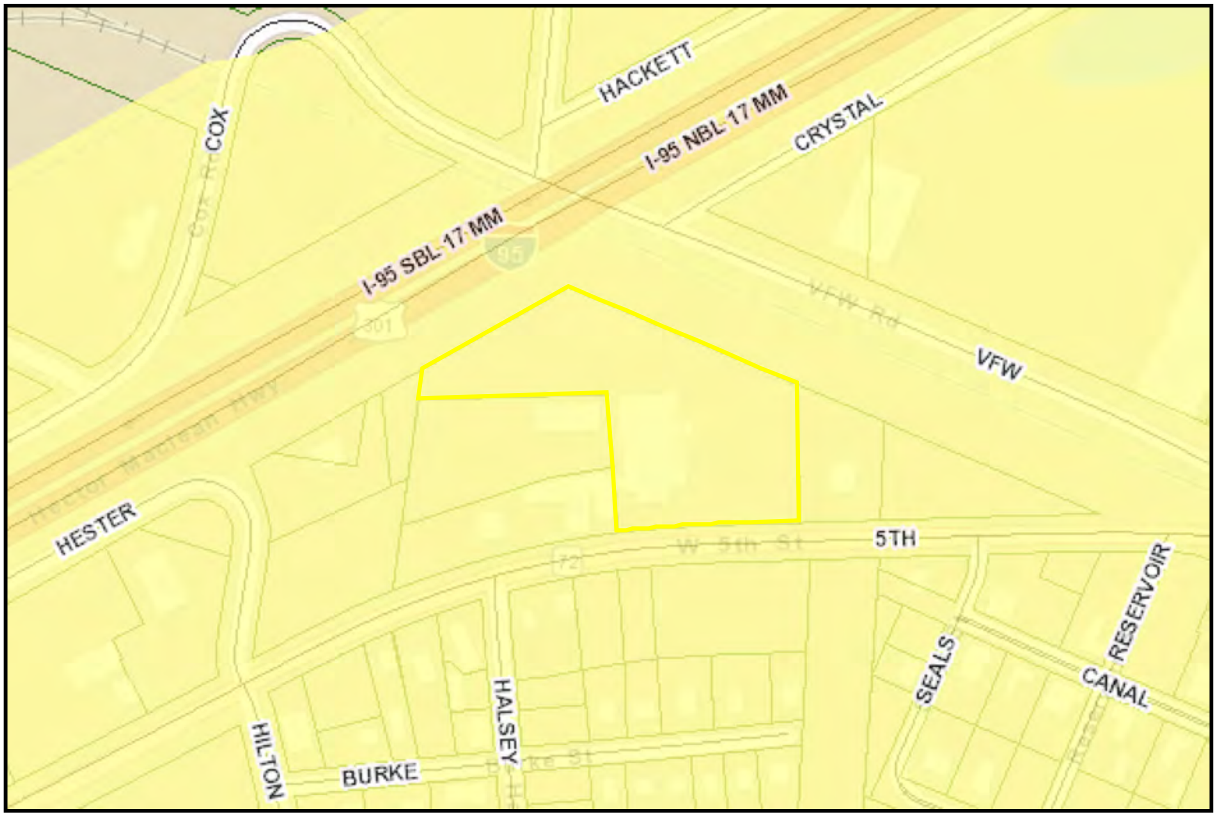
** Note: If PUV equal LMV then parcel ***has not*** qualified for present use program

Parcel Sketch:

Parcel Photo:

No Photo Available

County of Robeson, NC



MAPNO	322101002
PIN_NUMBER	938189201500
PARCELTYPE	Base Parcel
CONFLICTNOTATION	
DEEDEDACRES	2.81999993
OWNERTYPE	null
STATUS	null
OLDMAPNO	3221-01-002
NUMMOD	null
LOT	null
NBHD_CODE	32080
TAX_YEAR	2023
PAR_CODE	
MAP	9381
SUBMAP	
BLOCK	89
PARCEL	2015
SUBPARCEL	00
PHYLOCAT	36168
CITYCODE	LUMB
ROUTENUM	0
OWNERID	47029000
CUROWNID	47029000

OWNAM1	WEST LUMBERTON BAPTIST CHURCH
OWNAM2	
OWNAM3	
OWADR1	2320 W 5TH STREET
OWADR2	
OWADR3	
OWADR4	
OWCITY	LUMBERTON
OWSTATE	NC
OWZIP	283580000
STNUM	2306
STSUFFIX	
STDIR	
STNAME	5TH
STTYPE	ST
STDIRSUF	
UNITNO	
DEEDACRE	2.8
MAPACRE	2.8
DISTCODE	52
TOWNCODE	32
PARDESC3	
PARDESC1	E-10
NBHCLASS	
NBHCODE	32080
EXEMCODE	E10
DEEDBOOK	01160
DEEDPAGE	0884
DEEDYEAR	2001
PLATBOOK	
PLATPAGE	
DATESOLD	0
LEGDESC1	A N/S W 5TH STREET BENNET
LEGDESC2	T S GARAGE
LEGDESC3	
PARDESC4	
GROUPPAR	938189201500
REQREVIEW	
PHYSTRADR	2306 5TH ST
SCHCODE	0
AREACODE	1
LNDASVCUR	176200
IMPASVCUR	2005300
QUALCODE	

RECTYPE	null
SALEAMT	0
SALEINST	
DEEDSTMP	0

Robeson County Government
PROPERTY REPORT - PRINT

Property Owner	Owner's Mailing Address	Property Location Address
WEST LUMBERTON BAPTIST CHURCH	2320 W 5TH STREET	2306 5TH ST
	LUMBERTON , NC 283580000	

Administrative Data

Parcel Ref No.	**322101002**
PIN	**938189201500**
Account No.	**47029000**
Tax District	**TOWN LUMBERTON**
Land Use Code	**E-10**
Land Use Desc	**RP CHURCHES**
Subdiv Code	
Subdiv Desc	
Neighborhood	**32080**

Administrative Data

Legal Desc	**A N/S W 5TH STREET BENNET**
	T S GARAGE
Deed Bk/Pg	**01160 / 0884**
Plat Bk/Pg	**/**

Sales Information

Grantor	
Sold Date	**0--0**
Sold Amount $	**0**

Valuation Information

Market Value $	**2,181,500**

Market Value - Land and all permanent improvements, if any, effective January 1, 2010, date of County's most recent General Reappraisal

Assessed Value $	**2,181,500**

If Assessed Value not equal Market Value then subject parcel designated as a special class -agricultural, horticultural, or forestland and thereby eligible for taxation on basis of Present-Use and/or reduction from a formal appeal procedure

Land Supplemental

Map Acres	**2.8**
Tax District Note	
Present-Use Info	

Improvement Detail

(1st Major Improvement on Subject Parcel)

Year Built	**2005**
Built Use/Style	**RELIGIOUS**
Current Use	**B /**
* Percent Complete	**100**
Heated Area (S/F)	**18,000**
** Bathroom(s)	**0 Full Bath(s) 0 Half Bath(s)**
** Bedroom(s)	**0**
Fireplace (Y/N)	**N**
Basement (Y/N)	**N**
Attached Garage (Y/N)	**N**
*** Multiple Improvements	**001**

* Note - As of January 1
* * Note - Bathroom(s), Bedroom(s), shown for description only
* * * Note - If multiple improvements equal "MLT" then parcel includes additional major improvements

Improvement Valuation (1st Major Improvement on Subject Parcel)

* Improvement Market Value $	** Improvement Assessed Value $
2,005,300	**2,005,300**

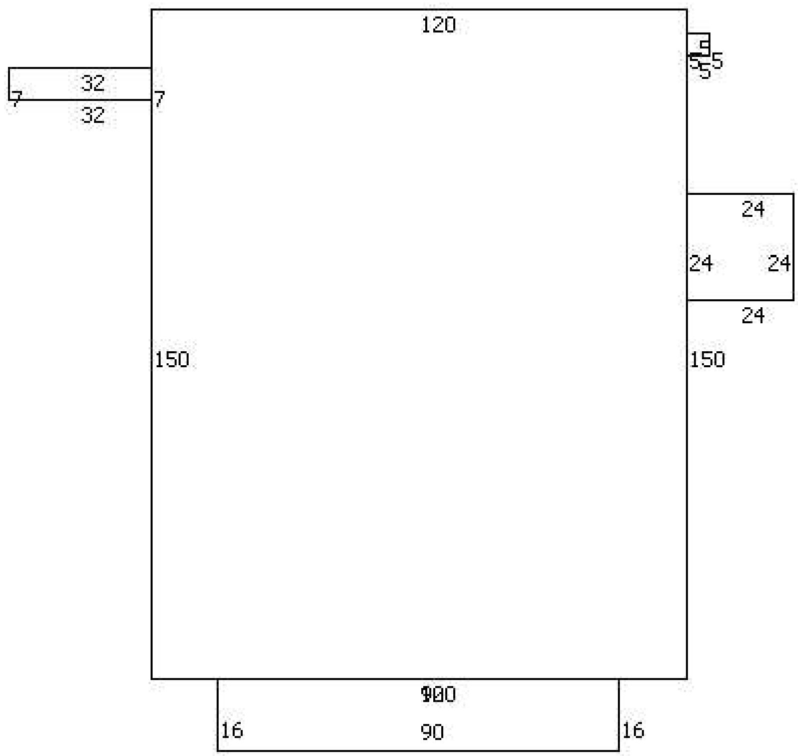
* Note - Market Value effective Date equal January 1, 2010, date of County's most recent General Reappraisal
** Note - If Assessed Value not equal Market Value then variance resulting from formal appeal procedure

Land Value Detail (Effective Date January 1, 2010, date of County's most recent General Reappraisal)

Land Market Value (LMV) $	Land Present-Use Value (PUV) $ **	Land Total Assessed Value $
176,200	**176,200**	**176,200**

** Note: If PUV equal LMV then parcel ***has not*** qualified for present use program

Parcel Sketch:



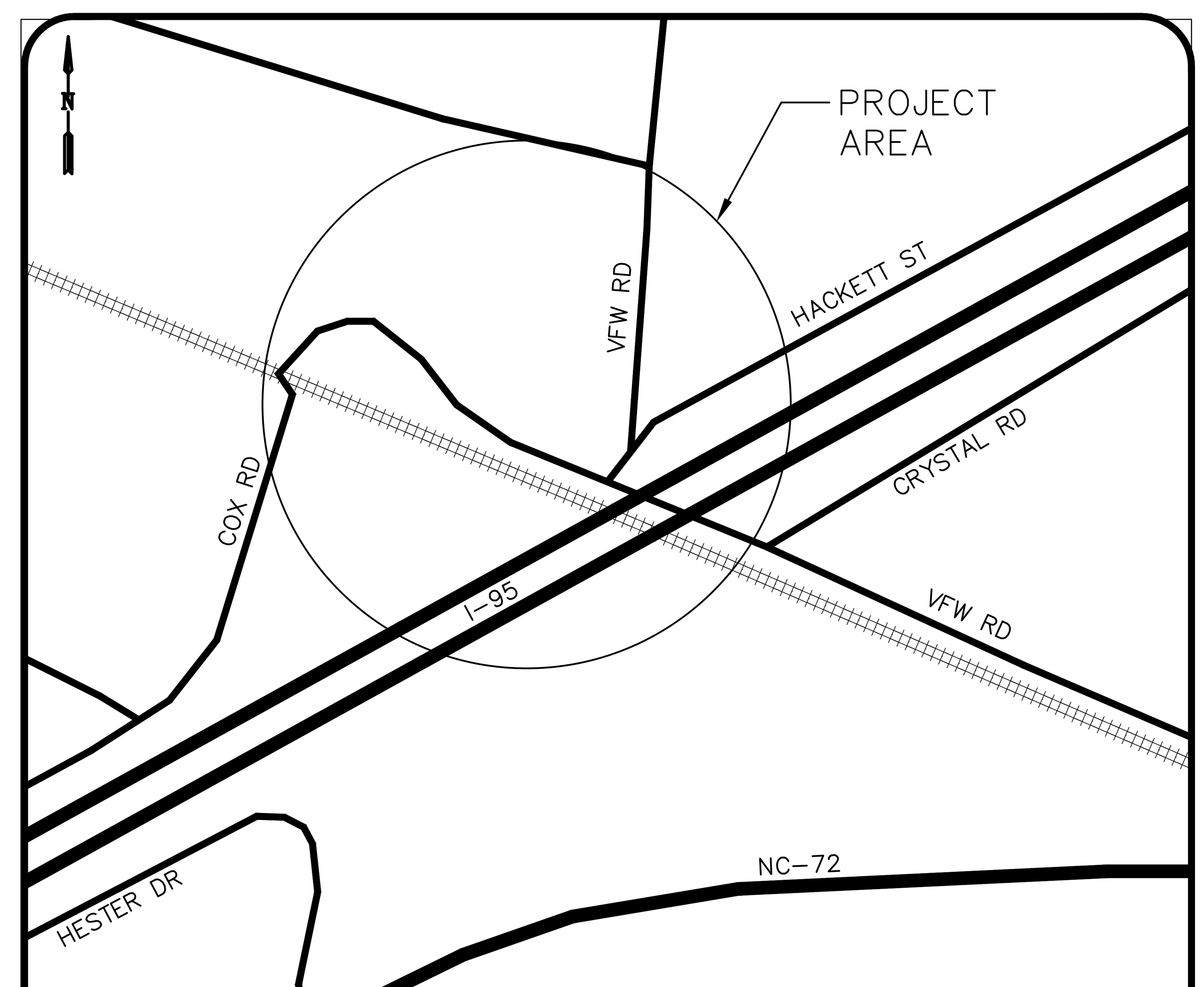
Parcel Photo:

No Photo Available

WEST LUMBERTON FLOODGATE
AT VFW ROAD AND RAILROAD UNDERPASS

CITY OF LUMBERTON

ROBESON COUNTY, NORTH CAROLINA



VICINITY MAP

ATKINS
Member of the SNC-Lavalin Group

1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

ENGINEERS ARCHITECTS SURVEYORS
LINFIELD, HUNTER & JUNIUS, INC.

3608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.LHJunius.com

mcgill

5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

95% SUBMITTAL
- FOR REVIEW PURPOSES ONLY -
DO NOT USE FOR
CONSTRUCTION

APRIL 2023

City of LUMBERTON North Carolina

P:\2019\19.03004-ATKINSNORA-WEST LUMBERTON FLOOD GATE\DRAWINGS\SHEETS\G-001 COVER.DWG PLOT DATE 6/16/2023 4:05 PM CAROLINE HEATHCOAT

SCHEDULE OF DRAWINGS

G-001	Cover
G-002	Schedule of Drawings
CG-003	Notes and Legend
CG-004	NCDEQ NCG01 General Permit Notes
CG-005	NCDEQ NCG01 General Permit Notes
C-101	Existing Conditions (Pre- I-95 Construction)
C-102	Existing Conditions (Post- I-95 Construction)
C-201	Site Plan
C-202	Erosion Control
C-301	Cross Sections
C-501	Details 1 of 2
C-502	Details 2 of 2
STRUCTURAL SHEETS	
SG-001	Structural General Notes
SG-002	Structural General Notes
SG-003	Sheet Index
S-101	Overall Foundation Plan View (1 of 2)
S-102	Overall Foundation Plan View (2 of 2)
S-103	Monolith 1 Plan View
S-104	Monolith 2 Plan View
S-105	Monolith 3 Plan View
S-106	Monolith 4 Plan View
S-107	Monolith 5 Plan View
S-108	Monolith 6 Plan View
S-109	Monolith 7 Plan View
S-110	Monolith 8 Plan View
S-111	Monolith 9 Plan View
S-112	Monolith 10 Plan View
S-113	I-Wall 1 Plan View
S-114	I-Wall 2 Plan View
S-115	Railroad Plan View
S-116	Slope Protection (1 of 2)
S-117	Slope Protection (2 of 2)
S-301	Monolith 1 Section
S-302	Monolith 2 Section
S-303	Monolith 3 Section
S-304	Monolith 4 Section
S-305	Monolith 5 Section
S-306	Monolith 6 Section
S-307	Monolith 7 Section
S-308	Monolith 8 Section
S-309	Monolith 9 Section
S-310	Monolith 10 Section
S-311	Gate Column Section
S-312	I-Wall 1 Section
S-313	I-Wall 2 Section

S-501	Gate Elevation
S-502	Swing Gate Detail (1 of 3)
S-503	Swing Gate Detail (2 of 3)
S-504	Swing Gate Detail (3 of 3)
S-505	Swing Gate Lower Hinge Detail (1 of 6)
S-506	Swing Gate Lower Hinge Detail (2 of 6)
S-507	Swing Gate Lower Hinge Detail (3 of 6)
S-508	Swing Gate Lower Hinge Detail (4 of 6)
S-509	Swing Gate Lower Hinge Detail (5 of 6)
S-510	Swing Gate Lower Hinge Detail (6 of 6)
S-511	Swing Gate Upper Hinge Detail (1 of 3)
S-512	Swing Gate Upper Hinge Detail (2 of 3)
S-513	Swing Gate Upper Hinge Detail (3 of 3)
S-514	Seal Plate and Corner Angle Detail
S-515	Rails and Component Part Detail (1 of 2)
S-516	Rails and Component Part Detail (2 of 2)
S-517	Swing Gate Seal Detail (1 of 2)
S-518	Swing Gate Seal Detail (2 of 2)
S-519	Swing Gate Latching Detail
S-520	Latching Detail (1 of 2)
S-521	Latching Detail (2 of 2)
S-522	Ladder Detail (1 of 3)
S-523	Ladder Detail (2 of 3)
S-524	Ladder Detail (3 of 3)
S-525	Miscellaneous Details
S-526	Settlement Details
S-527	Scour Protection Detail (1 of 2)
S-528	Scour Protection Detail (2 of 2)
S-529	Drainage and Utility Details
S-530	Typical Joint Details (1 of 4)
S-531	Typical Joint Details (2 of 4)
S-532	Typical Joint Details (3 of 4)
S-533	Typical Joint Details (4 of 4)
S-534	Typical Pile Detail
S-535	Pile Load Test
CS-100	Railroad TRS (1 of 5)
CS-101	Railroad TRS (2 of 5)
CS-102	Railroad TRS (3 of 5)
CS-103	Railroad TRS (4 of 5)
CS-104	Railroad TRS (5 of 5)

95% SUBMITTAL
- FOR REVIEW PURPOSES ONLY -
DO NOT USE FOR
CONSTRUCTION

811 Know what's below. Call before you dig.
Dial 811.
North Carolina 811, Inc.

NOT TO SCALE

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status
FOR INFORMATION
Suitability
S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client
City of LUMBERTON North Carolina

Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
SCHEDULE OF DRAWINGS

Scale	Designed	Drawn	Checked	Authorized
NTS	CH	CH	DS	MH
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number
100068207-G-002
Revision
000

LEGEND

TEL PED	TELEPHONE PEDESTAL
ELEC PED	ELECTRIC PEDESTAL
CATV PED	CABLE TV PEDESTAL
SIGN	SIGN
CATV	UNDERGROUND CABLE TV SIGN
UG FOC	UNDERGROUND FIBER OPTIC CABLE SIGN
UG TCS	UNDERGROUND TELEPHONE CABLE SIGN
UG GAS	UNDERGROUND GAS LINE SIGN
UG ELEC	UNDERGROUND ELECTRIC LINE SIGN
LP	LIGHT POLE
UP	UTILITY POLE
	NCDOT UTILITY POLE
	GUY WIRE ANCHOR
TSP	TRAFFIC SIGNAL POLE
R X R	RAILROAD CROSSING SIGNAL
MH	MANHOLE
SSMH	SANITARY SEWER MANHOLE
SDMH	STORM DRAIN MANHOLE
COMMH	COMMUNICATION MANHOLE
ELMH	ELECTRICAL MANHOLE
J.B.	JUNCTION BOX
SPIGOT	SPIGOT/YARD HYDRANT
C.O.	SEWER CLEAN-OUT
E.SS	ELECTRIC SERVICE STUB-OUT
G.SS	GAS SERVICE STUB-OUT
CB	CATCH BASIN
CI	CURB INLET
WM	WATER METER
FH	FIRE HYDRANT
WV	WATER VALVE
BLOWOFF VALVE	BLOW OFF VALVE
G/M	GAS METER
G/V	GAS VALVE
ICV	IRRIGATION CONTROL VALVE
PIV	POST INDICATOR VALVE
E.JUNC	ELECTRIC JUNCTION BOX OR OUTLET
SIG BOX	TRAFFIC SIGNAL BOX

	CALCULATED POINT
IPS	1/2" REBAR SET WITH CAP
	CONCRETE MONUMENT
CM-R/W	RIGHT-OF-WAY MONUMENT
DOT MON	D.O.T. CONTROL POINT
RBF	REBAR FOUND
RRSPIKE	RAILROAD SPIKE
PK NL	PK NAIL FOUND / SET
SPINDLE	SPINDLE FOUND / SET
CPHUB	HUB & TACK SET
CP/NL GPS	CONTROL POINT NAIL SET / FOUND
CP/NL	CONTROL POINT/NAIL SET GPS
CP/TEMP	CONTROL POINT TEMPORARY MARK
NGS METAL ROD	NATIONAL GEODETIC SURVEY METAL ROD
NGS CM	NATIONAL GEODETIC SURVEY CONCRETE MONUMENT
	TEMPORARY CONTROL POINT SET
	NETWORK TRIANGULATION POINT
STAKE	STAKE FOUND
40	INTERSTATE HIGHWAY
66	U.S. HIGHWAY
FFE ELEVATION	FINISHED FLOOR ELEVATION
MW	MONITORING WELL
PZ	PIEZOMETER
	LANDFILL GAS MONITORING PROBE
	SURFACE WATER SAMPLING LOCATION
	LANDFILL GAS VENT
	LANDFILL GAS COLLECTION WELLHEAD
W	POTABLE WATER WELL
MB	MAILBOX OR PAPER BOX
PB	POSTAL DROP BOX
SAT DISH	SATELLITE DISH
YARD ORNAMENT	STATUE, BIRD BATHS, ETC.
	TREES
	SHRUBS / BUSHES

(H) HORIZONTAL GROUND DISTANCE
(G) NC STATE PLANE GRID DISTANCE

	CULVERT
X	FENCE
	SILT FENCE
	GUARD RAIL
FM	APPROXIMATE LOCATION OF EXISTING SEWER FORCE MAIN LINES
W	APPROXIMATE LOCATION OF EXISTING WATER LINES
G	APPROXIMATE LOCATION OF EXISTING GAS LINES
	TOP OF SLOPE
	TOE OF SLOPE
DL	DITCH LINES
CTV	APPROXIMATE LOCATION OF UNDERGROUND CABLE TV LINE
CTV	APPROXIMATE LOCATION OF OVERHEAD CABLE TV LINE
FOC	APPROXIMATE LOCATION OF UNDERGROUND FIBER OPTIC CABLE LINE
E	APPROXIMATE LOCATION OF UNDERGROUND ELECTRIC LINE
E	APPROXIMATE LOCATION OF OVERHEAD ELECTRIC LINE
T	APPROXIMATE LOCATION OF UNDERGROUND TELEPHONE LINES
T	APPROXIMATE LOCATION OF OVERHEAD TELEPHONE LINES
ROW	EXISTING RIGHT-OF-WAY
RR ROW	EXISTING RAILROAD RIGHT-OF-WAY
	TREELINE
	SHRUBLINE
	PROPERTY LINE NOT SURVEYED
	ROCKLINE
	STREAM LINE
	CENTERLINE
℄	CENTERLINE VARIANT
	SWAMPLINE/WETLANDS
U	APPROXIMATE LOCATION OF OVERHEAD UTILITY LINE
	TEMPORARY EASEMENT
	PERMANENT EASEMENT
	RIPRAP (AT GRADE)
	FLOW LINE

IPS	IRON PIN SET	CPP	CORRUGATED PLASTIC PIPE
CMU	CONCRETE MASONRY UNIT	DIP	DUCTILE IRON PIPE
R/W	RIGHT OF WAY	E&T	ELECTRIC & TELEPHONE
℄	CENTERLINE	FOC	FIBER OPTIC CABLE
C	CURVE (SEE CURVE TABLE)	GIP	GALVANIZED IRON PIPE
POB	POINT OF BEGINNING	O/H	OVERHEAD
CP	CALCULATED POINT	RCP	REINFORCED CONCRETE PIPE
PB	PLAT BOOK	U/G	UNDERGROUND
DB	DEED BOOK	VCP	VITRIFIED CLAY PIPE
L	LINE (SEE LINE TABLE)	PVC	POLYVINYL CHLORIDE PIPE
BLDG	BUILDING	FFE	FINISHED FLOOR ELEVATION
CIP	CAST IRON PIPE	PG	PAGE
CMP	CORRUGATED METAL PIPE	REF	REFERENCE
CONC	CONCRETE	DOT	DEPARTMENT OF TRANSPORTATION
PROP	PROPOSED	NGS	NATIONAL GEODETIC SYRVEY
EX/EXIST	EXISTING	NCSP	NORTH CAROLINA STATE PLANE
		MTR BOX	METER BOX
		EL	ELEVATION

GENERAL CONSTRUCTION NOTES

1. SURVEY IS REFERENCED TO HORIZ: NAD83, STATE PLANE (FEET) NORTH CAROLINA (FIFS 3200) VERTICAL: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) BY MCGILL ASSOCIATES.
2. CONSTRUCTION OF THE FLOODGATE PROJECT IS ANTICIPATED TO PRECEDE THE CONSTRUCTION OF THE I-95 CONSTRUCTION PROJECT BY OTHERS. THE DESIGN OF THE FLOODGATE IS BASED ON BEST AVAILABLE DATA OF ANTICIPATED FIELD CONDITIONS BASED ON DESIGN DRAWINGS FOR THE I-95 PROJECT PROVIDED BY OTHERS. CONTRACTOR SHALL VERIFY THAT BUILT CONDITIONS MATCH THE DESIGN AS SHOWN ON SHEET C-201 PRIOR TO BID. NO CHANGE ORDER IS ALLOWED FOR DIFFERING FIELD CONDITIONS.
3. CONTRACTOR SHALL VERIFY ALL ELEVATIONS BEFORE INSTALLATION OF FACILITIES.
4. NOT ALL UTILITIES ARE SHOWN. CONTRACTOR IS RESPONSIBLE FOR VERIFYING THE EXISTING UTILITIES AND UTILITY INFORMATION PRESENTED ON THESE DRAWINGS. ANY DISCREPANCIES SHALL BE ADDRESSED TO THE ENGINEER IN WRITING. THE CONTRACTOR IS RESPONSIBLE OF NOTIFYING AND COORDINATING WORK WITH THE AFFECTED UTILITY COMPANIES WHETHER THE CONTRACTOR PERFORMS THE WORK OR A UTILITY COMPANY PERFORMS THE WORK. ANY DAMAGE DONE TO EXISTING UTILITIES (SHOWN OR NOT SHOWN ON PLANS) SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR. THE CONTRACTOR SHALL CONTACT NC ONE CALL AT 1-800-632-4949 AT LEAST THREE WORKING DAYS PRIOR TO CONSTRUCTION. NON-SUBSCRIBERS SHALL BE CONTACTED DIRECTLY.
5. UNLESS OTHERWISE STATED, ALL FILL AREAS SHALL BE CONSTRUCTED IN LAYERS OF 8" MAXIMUM THICKNESS, WITH WATER ADDED OR SOIL CONDITIONED TO THE OPTIMUM MOISTURE CONTENT AS DETERMINED BY THE ENGINEER AND COMPACTED WITH A SHEEP'S FOOT ROLLER TO A COMPACTION EQUAL TO OR GREATER THAN 95% OF THE DENSITY OBTAINED BY COMPACTING A SAMPLE OF THE MATERIAL IN ACCORDANCE WITH THE STANDARD PROCTOR METHOD OF MOISTURE-DENSITY RELATIONSHIP TEST, ASTM D696 OR AASHTO-99 UNLESS SPECIFIED IN OTHER SPECIFICATIONS. MATERIAL AND COMPACTION REQUIREMENTS FOR LEVEE AND LEVEE TIE-IN ARE INCLUDED IN GEOTECHNICAL SPECIFICATIONS.
6. ALL PUBLIC ROADWAYS SHALL REMAIN OPEN AT ALL TIMES. IT IS THE CONTRACTOR'S RESPONSIBILITY TO MAINTAIN ROAD SURFACES CLEAN AND FREE OF CONSTRUCTION SEDIMENT AND DEBRIS AT ALL TIMES.
7. ALL WORK SHALL BE PREFORMED IN ACCORDANCE WITH APPLICABLE LOCAL CITY, STATE, AND FEDERAL REGULATIONS AND PERMIT REQUIREMENTS.
8. CONTRACTOR SHALL OBTAIN AND PROVIDE TO THE OWNER TEMPORARY STREET AND DRIVEWAY ACCESS PERMIT FOR CONSTRUCTION ENTRANCES PRIOR TO ANY CONSTRUCTION ACTIVITY.
9. ALL DISTURBED ARES SHALL BE SEEDED AND MULCHED OR SODDED UPON COMPLETION OF CONSTRUCTION UNLESS OTHERWISE SPECIFIED.

GENERAL EROSION CONTROL NOTES

1. ENTIRE AREA TO BE GRADED SHALL BE CLEARED AND GRUBBED. NO FILL SHALL BE PLACED ON ANY AREA NOT CLEARED AND GRUBBED.
2. ALL DISTURBED NATURAL GROUND SHALL BE SEEDED.
3. ALL SOIL EROSION CONTROL MEASURES REQUIRED BY THE GRADING PLAN SHALL BE PERFORMED PRIOR TO GRADING, CLEARING, OR GRUBBING. ALL EROSION CONTROL DEVICES SUCH AS SILT FENCES, ETC. SHALL BE MAINTAINED IN WORKABLE CONDITION FOR THE LIFE OF THE PROJECT AND SHALL BE REMOVED AT THE COMPLETION OF THE PROJECT ONLY ON THE ENGINEER'S APPROVAL. PAYMENT SHALL BE CONSIDERED INCIDENTAL TO CLEARING AND GRUBBING. IF DURING THE LIFE OF THE PROJECT A STORM CAUSES SOIL EROSION WHICH CHANGES FINISH GRADES OR CREATES "GULLIES" AND "WASHED AREAS," THESE SHALL BE REPAIRED AT NO EXTRA COST, AND ALL SILT WASHED OFF OF THE PROJECT SITE ONTO ADJACENT PROPERTY SHALL BE REMOVED AS DIRECTED BY THE ENGINEER AT NO EXTRA COST. THE CONTRACTOR SHALL ADHERE TO ANY APPROVED EROSION CONTROL PLANS WHETHER INDICATED IN THE CONSTRUCTION PLANS OR UNDER SEPARATE COVER.
4. DISPOSABLE MATERIAL
   - 4.1. CLEARING AND GRUBBING WASTES SHALL BE REMOVED FROM THE SITE AND PROPERLY DISPOSED OF BY THE CONTRACTOR AT HIS EXPENSE, UNLESS OTHERWISE SPECIFIED.
   - 4.2. THE CONTRACTOR SHALL REMOVE SOLID WASTE FROM THE SITE AND PROPERLY DISPOSE OF IT AT HIS EXPENSE.
   - 4.3. ON SITE BURNING IS NOT ACCEPTABLE.
5. ALL DEVICES SHALL BE MAINTAINED ON ALL CONSTRUCTION SITES, BORROW SITES, AND WASTE PILE (SPOIL) SITES, INCLUDING CONTRACTOR OWNED OR LEASED BORROW PITS ASSOCIATED WITH THE PROJECT. SUFFICIENT MATERIALS REQUIRED FOR STABILIZATION AND/OR REPAIR OF EROSION CONTROL MEASURES AND STORMWATER ROUTING AND TREATMENT SHALL BE ON-SITE AT ALL TIMES.
6. AN NPDES CONSTRUCTION STORMWATER PERMIT (NCG010000) IS REQUIRED FOR CONSTRUCTION PROJECTS THAT DISTURB ONE OR MORE ACRES OF LAND. THE NCG010000 PERMIT ALLOWS STORMWATER TO BE DISCHARGED DURING LAND DISTURBING CONSTRUCTION ACTIVITIES AS STIPULATED IN THE CONDITIONS OF THE PERMIT. IF THE PROJECT IS COVERED BY THE PERMITS, FULL COMPLIANCE WITH PERMIT CONDITIONS INCLUDING THE EROSION AND SEDIMENTATION CONTROL PLAN, INSPECTIONS AND MAINTENANCE, SELF-MONITORING, RECORD KEEPING AND REPORTING REQUIREMENTS IS REQUIRED.
7. ALL PROPOSED AND APPROVED TEMPORARY FILL AND CULVERTS MUST BE REMOVED AND THE IMPACTED AREA RETURNED TO NATURAL CONDITIONS WITHIN 60 CALENDAR DAYS AFTER THE TEMPORARY IMPACT IS NO LONGER NECESSARY. THE IMPACTED AREAS WILL BE RETURNED TO ORIGINAL GRADE, INCLUDING EACH STREAM'S ORIGINAL CROSS SECTIONAL DIMENSIONS, PLANFORM PATTERN, AND LONGITUDINAL BED PROFILE. ALL TEMPORARY IMPACTS SHOULD BE RESTORED AND STABILIZED WITH NATIVE VEGETATION.
8. THE CONTRACTOR OR OTHER RESPONSIBLE ENTITY WILL REPORT ANY PETROLEUM SPILL OF 25 GALLONS OR MORE; ANY SPILL REGARDLESS OF AMOUNT THAT CAUSES A SHEEN ON SURFACE WATERS; ANY PETROLEUM SPILL REGARDLESS OF SIZE THAT OCCURS WITHIN 100-FEET OF SURFACE WATER; AND ANY PETROLEUM SPILL LASS THAN 25 GALLONS THAT CANNOT BE CLEANED UP WITHIN 24 HOURS.

NORTH CAROLINA LAND QUALITY SECTION EROSION CONTROL NOTES

GENERAL: ALL EROSION CONTROL MEASURES ARE TO BE PERFORMED IN STRICT ACCORDANCE WITH REQUIREMENTS OF THE NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY (NCDEQ), DIVISION OF ENERGY, MINERAL, AND LAND RESOURCES (DEMLR), LAND QUALITY SECTION. THE FOLLOWING CONSTRUCTION SEQUENCE SHALL BE COMPLIED WITH FOR ALL WORK.

1. INSTALL ALL EROSION CONTROL MEASURES AS REQUIRED BY THE NCDEQ.
2. PROCEED WITH GRADING, CLEARING, AND GRUBBING. NO OFF SITE DISPOSAL OF MATERIAL IS ALLOWED UNLESS THE DISPOSAL SITE HAS AN APPROVED EROSION CONTROL PLAN.
3. SEED AND MULCH DENUDED AREA WITHIN TIME FRAME SPECIFIED (SEE TABLE). SEED AND SOIL AMENDMENTS SHALL BE PLACED ON A PREPARED SEEDBED AT THE FOLLOWING RATES PER ACRE. STRAW MULCH SHALL BE TACKED WITH TACKING AGENT APPLIED BY HYDROSEEDER.

CREEPING RED FESCUE	100 LBS (NATURAL AREAS AND STREAMBANKS)
STRAW MULCH	60-80 BALES

FOR SUMMER ADD TO THE ABOVE:

GERMAN MILLET (SETARIA ITALICA)	40 LBS
SMALL-STEMMED SUDAN GRASS (SORGHUM BICOLOR)	50 LBS

FOR WINTER SEEDING ADD TO THE ABOVE:

RYE GRAIN (SECALE CEREALE)	120 LBS

IF HYDROSEEDING, WOOD CELLULOSE MAY BE USED IN ADDITION TO STRAW MULCH AT THE RATE OF 1000 LBS PER ACRE.

ALL SEEDING SHALL BE MAINTAINED, WATERED, ETC., UNTIL A PERMANENT VEGETATIVE GROUND COVER IS ESTABLISHED OVER ALL DISTURBED AREAS. FOR ALL SLOPES 2:1 OR STEEPER, ADD TO THE ABOVE:

PURGE LIVE SEED SWITCHGRASS	4 LBS
BROWNTOP MILLET OR PEARL MILLET (PENNISETUM GLAUCUM)	8 LBS
GRAIN SORGHUM (SORGHUM BICOLOR (L.) MOENCH SSP. BICOLOR)	2 LBS

ALL SLOPES 2:1 OR STEEPER SHALL BE COVERED BY EROSION CONTROL MATTING.

CSX GENERAL NOTES

FOR ALL WORK WITHIN THE CSX RAILROAD, CONTRACTOR SHALL ABIDE WITH THE FOLLOWING:

1. ANY SOIL REMOVAL WILL COMPLY WITH CSX SOIL AND WATER MANAGEMENT POLICY. CSX REQUIRES THAT SOILS GENERATED FROM ITS PROPERTY BE EITHER PROPERLY DISPOSED OF IN A CSX APPROVED DISPOSAL FACILITY OR REUSED ON CSX PROPERTY. THE MANAGEMENT OF SOILS GENERATED FROM CSX PROPERTY SHOULD BE PLANNED FOR AND PROPERLY PERMITTED (IF APPLICABLE) PRIOR TO INITIATING ANY WORK ON CSX PROPERTY.
2. IN THE EVENT SOILS CANNOT BE REUSED ON CSX PROPERTY, THE CSX ENVIRONMENTAL DEPARTMENT WILL HANDLE WASTE CHARACTERIZATION AND PROFILING INTO AN APPROVED DISPOSAL FACILITY. AN ESTIMATED QUANTITY OF WASTE TO BE REMOVED FROM THE PROJECT AREA WILL BE PROVIDED TO CSX BY THE CONTRACTOR.
3. ANY PETROLEUM SPILL OR RELEASE OF HAZARDOUS SUBSTANCES WITHIN A CSX RIGHT-OF-WAY SHALL BE REPORTED TO CSX'S PSCC NUMBER AT (904) 359-7551 OR (800) 232-0144 IMMEDIATELY.

95% SUBMITTAL
- FOR REVIEW PURPOSES ONLY -
DO NOT USE FOR
CONSTRUCTION

811 Know what's below. Call before you dig.
Dial 811.
North Carolina 811, Inc.

NOT TO SCALE

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION — Suitability: SO

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: NOTES AND LEGEND

Scale	Designed	Drawn	Checked	Authorized
NTS	CH	CH	DS	MH
Original Size: 22x34	Date: --/--/--	Date: --/--/--	Date: --/--/--	Date: --/--/--

Drawing Number: 100068207-CG-003 — Revision: 000

GROUND STABILIZATION AND MATERIALS HANDLING PRACTICES FOR COMPLIANCE WITH THE NCG01 CONSTRUCTION GENERAL PERMIT

Implementing the details and specifications on this plan sheet will result in the construction activity being considered compliant with the Ground Stabilization and Materials Handling sections of the NCG01 Construction General Permit (Sections E and F, respectively). The permittee shall comply with the Erosion and Sediment Control plan approved by the delegated authority having jurisdiction. All details and specifications shown on this sheet may not apply depending on site conditions and the delegated authority having jurisdiction.

SECTION E: GROUND STABILIZATION

Required Ground Stabilization Timeframes

Site Area Description	Stabilize within this many calendar days after ceasing land disturbance	Timeframe variations
(a) Perimeter dikes, swales, ditches, and perimeter slopes	7	None
(b) High Quality Water (HQW) Zones	7	None
(c) Slopes steeper than 3:1	7	If slopes are 10' or less in length and are not steeper than 2:1, 14 days are allowed
(d) Slopes 3:1 to 4:1	14	-7 days for slopes greater than 50' in length and with slopes steeper than 4:1 -7 days for perimeter dikes, swales, ditches, perimeter slopes and HQW Zones -10 days for Falls Lake Watershed
(e) Areas with slopes flatter than 4:1	14	-7 days for perimeter dikes, swales, ditches, perimeter slopes and HQW Zones -10 days for Falls Lake Watershed unless there is zero slope

Note: After the permanent cessation of construction activities, any areas with temporary ground stabilization shall be converted to permanent ground stabilization as soon as practicable but in no case longer than 90 calendar days after the last land disturbing activity. Temporary ground stabilization shall be maintained in a manner to render the surface stable against accelerated erosion until permanent ground stabilization is achieved.

GROUND STABILIZATION SPECIFICATION

Stabilize the ground sufficiently so that rain will not dislodge the soil. Use one of the techniques in the table below:

Temporary Stabilization	Permanent Stabilization
• Temporary grass seed covered with straw or other mulches and tackifiers • Hydroseeding • Rolled erosion control products with or without temporary grass seed • Appropriately applied straw or other mulch • Plastic sheeting	• Permanent grass seed covered with straw or other mulches and tackifiers • Geotextile fabrics such as permanent soil reinforcement matting • Hydroseeding • Shrubs or other permanent plantings covered with mulch • Uniform and evenly distributed ground cover sufficient to restrain erosion • Structural methods such as concrete, asphalt or retaining walls • Rolled erosion control products with grass seed

POLYACRYLAMIDES (PAMS) AND FLOCCULANTS

1. Select flocculants that are appropriate for the soils being exposed during construction, selecting from the *NC DWR List of Approved PAMS/Flocculants*.
2. Apply flocculants at or before the inlets to Erosion and Sediment Control Measures.
3. Apply flocculants at the concentrations specified in the *NC DWR List of Approved PAMS/Flocculants* and in accordance with the manufacturer's instructions.
4. Provide ponding area for containment of treated Stormwater before discharging offsite.
5. Store flocculants in leak-proof containers that are kept under storm-resistant cover or surrounded by secondary containment structures.

EQUIPMENT AND VEHICLE MAINTENANCE

1. Maintain vehicles and equipment to prevent discharge of fluids.
2. Provide drip pans under any stored equipment.
3. Identify leaks and repair as soon as feasible, or remove leaking equipment from the project.
4. Collect all spent fluids, store in separate containers and properly dispose as hazardous waste (recycle when possible).
5. Remove leaking vehicles and construction equipment from service until the problem has been corrected.
6. Bring used fuels, lubricants, coolants, hydraulic fluids and other petroleum products to a recycling or disposal center that handles these materials.

LITTER, BUILDING MATERIAL AND LAND CLEARING WASTE

1. Never bury or burn waste. Place litter and debris in approved waste containers.
2. Provide a sufficient number and size of waste containers (e.g dumpster, trash receptacle) on site to contain construction and domestic wastes.
3. Locate waste containers at least 50 feet away from storm drain inlets and surface waters unless no other alternatives are reasonably available.
4. Locate waste containers on areas that do not receive substantial amounts of runoff from upland areas and does not drain directly to a storm drain, stream or wetland.
5. Cover waste containers at the end of each workday and before storm events or provide secondary containment. Repair or replace damaged waste containers.
6. Anchor all lightweight items in waste containers during times of high winds.
7. Empty waste containers as needed to prevent overflow. Clean up immediately if containers overflow.
8. Dispose waste off-site at an approved disposal facility.
9. On business days, clean up and dispose of waste in designated waste containers.

PAINT AND OTHER LIQUID WASTE

1. Do not dump paint and other liquid waste into storm drains, streams or wetlands.
2. Locate paint washouts at least 50 feet away from storm drain inlets and surface waters unless no other alternatives are reasonably available.
3. Contain liquid wastes in a controlled area.
4. Containment must be labeled, sized and placed appropriately for the needs of site.
5. Prevent the discharge of soaps, solvents, detergents and other liquid wastes from construction sites.

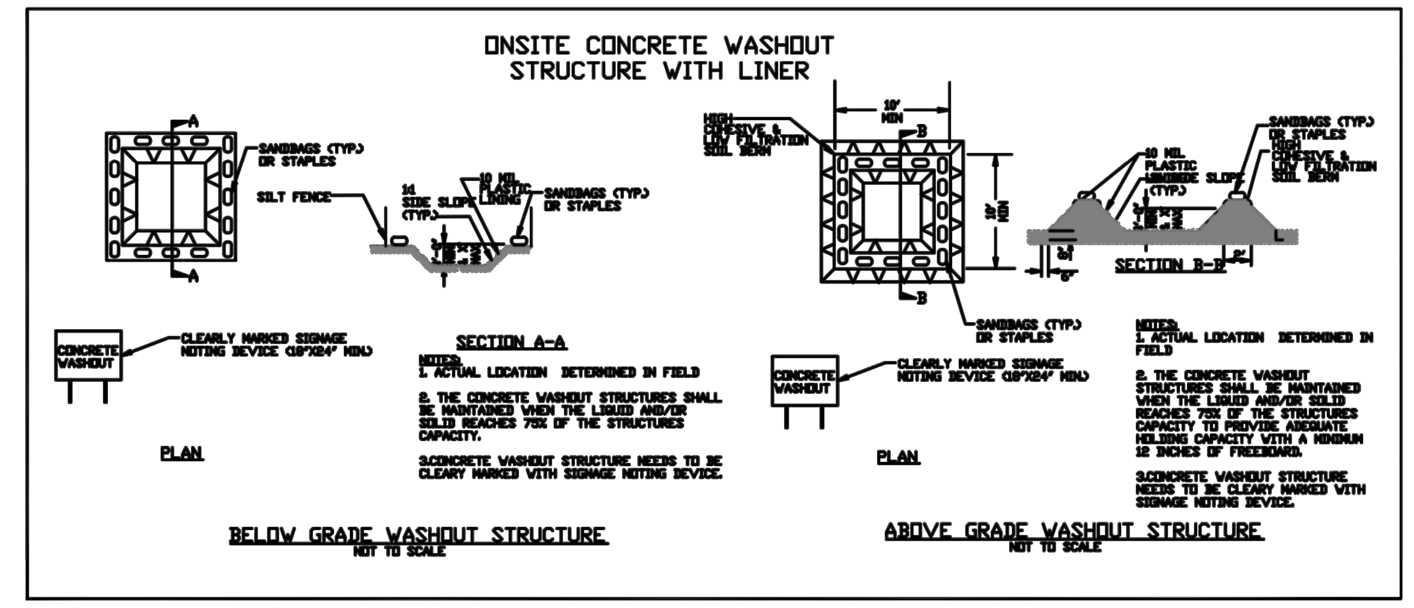
PORTABLE TOILETS

1. Install portable toilets on level ground, at least 50 feet away from storm drains, streams or wetlands unless there is no alternative reasonably available. If 50 foot offset is not attainable, provide relocation of portable toilet behind silt fence or place on a gravel pad and surround with sand bags.
2. Provide staking or anchoring of portable toilets during periods of high winds or in high foot traffic areas.
3. Monitor portable toilets for leaking and properly dispose of any leaked material. Utilize a licensed sanitary waste hauler to remove leaking portable toilets and replace with properly operating unit.

EARTHEN STOCKPILE MANAGEMENT

1. Show stockpile locations on plans. Locate earthen-material stockpile areas at least 50 feet away from storm drain inlets, sediment basins, perimeter sediment controls and surface waters unless it can be shown no other alternatives are reasonably available.
2. Protect stockpile with silt fence installed along toe of slope with a minimum offset of five feet from the toe of stockpile.
3. Provide stable stone access point when feasible.
4. Stabilize stockpile within the timeframes provided on this sheet and in accordance with the approved plan and any additional requirements. Soil stabilization is defined as vegetative, physical or chemical coverage techniques that will restrain accelerated erosion on disturbed soils for temporary or permanent control needs.

NORTH CAROLINA Environmental Quality



CONCRETE WASHOUTS

1. Do not discharge concrete or cement slurry from the site.
2. Dispose of, or recycle settled, hardened concrete residue in accordance with local and state solid waste regulations and at an approved facility.
3. Manage washout from mortar mixers in accordance with the above item and in addition place the mixer and associated materials on impervious barrier and within lot perimeter silt fence.
4. Install temporary concrete washouts per local requirements, where applicable. If an alternate method or product is to be used, contact your approval authority for review and approval. If local standard details are not available, use one of the two types of temporary concrete washouts provided on this detail.
5. Do not use concrete washouts for dewatering or storing defective curb or sidewalk sections. Stormwater accumulated within the washout may not be pumped into or discharged to the storm drain system or receiving surface waters. Liquid waste must be pumped out and removed from project.
6. Locate washouts at least 50 feet from storm drain inlets and surface waters unless it can be shown that no other alternatives are reasonably available. At a minimum, install protection of storm drain inlet(s) closest to the washout which could receive spills or overflow.
7. Locate washouts in an easily accessible area, on level ground and install a stone entrance pad in front of the washout. Additional controls may be required by the approving authority.
8. Install at least one sign directing concrete trucks to the washout within the project limits. Post signage on the washout itself to identify this location.
9. Remove leavings from the washout when at approximately 75% capacity to limit overflow events. Replace the tarp, sand bags or other temporary structural components when no longer functional. When utilizing alternative or proprietary products, follow manufacturer's instructions.
10. At the completion of the concrete work, remove remaining leavings and dispose of in an approved disposal facility. Fill pit, if applicable, and stabilize any disturbance caused by removal of washout.

HERBICIDES, PESTICIDES AND RODENTICIDES

1. Store and apply herbicides, pesticides and rodenticides in accordance with label restrictions.
2. Store herbicides, pesticides and rodenticides in their original containers with the label, which lists directions for use, ingredients and first aid steps in case of accidental poisoning.
3. Do not store herbicides, pesticides and rodenticides in areas where flooding is possible or where they may spill or leak into wells, stormwater drains, ground water or surface water. If a spill occurs, clean area immediately.
4. Do not stockpile these materials onsite.

HAZARDOUS AND TOXIC WASTE

1. Create designated hazardous waste collection areas on-site.
2. Place hazardous waste containers under cover or in secondary containment.
3. Do not store hazardous chemicals, drums or bagged materials directly on the ground.

NCG01 GROUND STABILIZATION AND MATERIALS HANDLING

EFFECTIVE: 04/01/19

95% SUBMITTAL
- FOR REVIEW PURPOSES ONLY-
DO NOT USE FOR CONSTRUCTION

811 Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

NOT TO SCALE

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION | SO

ATKINS Member of the SNC-Lavalin Group
1616 East Millbrook Road, Suite 160, Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
3608 18th Street, Suite 200, Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.LHJunius.com

mcgill
5400 Trinity Road, Suite 107, Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of Lumberton North Carolina

Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: NCDEQ NCG01 GENERAL PERMIT NOTES

Scale	Designed	Drawn	Checked	Authorized
NTS	CH	CH	DS	MH
Original Size: 22x34	Date: --/--/--	Date: --/--/--	Date: --/--/--	Date: --/--/--

Drawing Number: 100068207-CG-004 | Revision: 000

PART III
SELF-INSPECTION, RECORDKEEPING AND REPORTING

SECTION A: SELF-INSPECTION

Self-inspections are required during normal business hours in accordance with the table below. When adverse weather or site conditions would cause the safety of the inspection personnel to be in jeopardy, the inspection may be delayed until the next business day on which it is safe to perform the inspection. In addition, when a storm event of equal to or greater than 1.0 inch occurs outside of normal business hours, the self-inspection shall be performed upon the commencement of the next business day. Any time when inspections were delayed shall be noted in the Inspection Record.

Inspect	Frequency (during normal business hours)	Inspection records must include:
(1) Rain gauge maintained in good working order	Daily	Daily rainfall amounts. If no daily rain gauge observations are made during weekend or holiday periods, and no individual-day rainfall information is available, record the cumulative rain measurement for those un-attended days (and this will determine if a site inspection is needed). Days on which no rainfall occurred shall be recorded as "zero." The permittee may use another rain-monitoring device approved by the Division.
(2) E&SC Measures	At least once per 7 calendar days and within 24 hours of a rain event ≥ 1.0 inch in 24 hours	1. Identification of the measures inspected, 2. Date and time of the inspection, 3. Name of the person performing the inspection, 4. Indication of whether the measures were operating properly, 5. Description of maintenance needs for the measure, 6. Description, evidence, and date of corrective actions taken.
(3) Stormwater discharge outfalls (SDOs)	At least once per 7 calendar days and within 24 hours of a rain event ≥ 1.0 inch in 24 hours	1. Identification of the discharge outfalls inspected, 2. Date and time of the inspection, 3. Name of the person performing the inspection, 4. Evidence of indicators of stormwater pollution such as oil sheen, floating or suspended solids or discoloration, 5. Indication of visible sediment leaving the site, 6. Description, evidence, and date of corrective actions taken.
(4) Perimeter of site	At least once per 7 calendar days and within 24 hours of a rain event ≥ 1.0 inch in 24 hours	If visible sedimentation is found outside site limits, then a record of the following shall be made: 1. Actions taken to clean up or stabilize the sediment that has left the site limits, 2. Description, evidence, and date of corrective actions taken, and 3. An explanation as to the actions taken to control future releases.
(5) Streams or wetlands onsite or offsite (where accessible)	At least once per 7 calendar days and within 24 hours of a rain event ≥ 1.0 inch in 24 hours	If the stream or wetland has increased visible sedimentation or a stream has visible increased turbidity from the construction activity, then a record of the following shall be made: 1. Description, evidence and date of corrective actions taken, and 2. Records of the required reports to the appropriate Division Regional Office per Part III, Section C, Item (2)(a) of this permit of this permit.
(6) Ground stabilization measures	After each phase of grading	1. The phase of grading (installation of perimeter E&SC measures, clearing and grubbing, installation of storm drainage facilities, completion of all land-disturbing activity, construction or redevelopment, permanent ground cover). 2. Documentation that the required ground stabilization measures have been provided within the required timeframe or an assurance that they will be provided as soon as possible.

NOTE: The rain inspection resets the required 7 calendar day inspection requirement.

PART III
SELF-INSPECTION, RECORDKEEPING AND REPORTING

SECTION B: RECORDKEEPING

1. E&SC Plan Documentation

The approved E&SC plan as well as any approved deviation shall be kept on the site. The approved E&SC plan must be kept up-to-date throughout the coverage under this permit. The following items pertaining to the E&SC plan shall be documented in the manner described:

Item to Document	Documentation Requirements
(a) Each E&SC Measure has been installed and does not significantly deviate from the locations, dimensions and relative elevations shown on the approved E&SC Plan.	Initial and date each E&SC Measure on a copy of the approved E&SC Plan or complete, date and sign an inspection report that lists each E&SC Measure shown on the approved E&SC Plan. This documentation is required upon the initial installation of the E&SC Measures or if the E&SC Measures are modified after initial installation.
(b) A phase of grading has been completed.	Initial and date a copy of the approved E&SC Plan or complete, date and sign an inspection report to indicate completion of the construction phase.
(c) Ground cover is located and installed in accordance with the approved E&SC Plan.	Initial and date a copy of the approved E&SC Plan or complete, date and sign an inspection report to indicate compliance with approved ground cover specifications.
(d) The maintenance and repair requirements for all E&SC Measures have been performed.	Complete, date and sign an inspection report.
(e) Corrective actions have been taken to E&SC Measures.	Initial and date a copy of the approved E&SC Plan or complete, date and sign an inspection report to indicate the completion of the corrective action.

2. Additional Documentation

In addition to the E&SC Plan documents above, the following items shall be kept on the site
and available for agency inspectors at all times during normal business hours, unless the Division provides a site-specific exemption based on unique site conditions that make this requirement not practical:

(a) This general permit as well as the certificate of coverage, after it is received.

(b) Records of inspections made during the previous 30 days. The permittee shall record the required observations on the Inspection Record Form provided by the Division or a similar inspection form that includes all the required elements. Use of electronically-available records in lieu of the required paper copies will be allowed if shown to provide equal access and utility as the hard-copy records.

(c) All data used to complete the Notice of Intent and older inspection records shall be maintained for a period of three years after project completion and made available upon request. [40 CFR 122.41]

PART III
SELF-INSPECTION, RECORDKEEPING AND REPORTING

SECTION C: REPORTING

1. Occurrences that must be reported

Permittees shall report the following occurrences:

(a) Visible sediment deposition in a stream or wetland.

(b) Oil spills if:
- They are 25 gallons or more,
- They are less than 25 gallons but cannot be cleaned up within 24 hours,
- They cause sheen on surface waters (regardless of volume), or
- They are within 100 feet of surface waters (regardless of volume).

(a) Releases of hazardous substances in excess of reportable quantities under Section 311 of the Clean Water Act (Ref: 40 CFR 110.3 and 40 CFR 117.3) or Section 102 of CERCLA (Ref: 40 CFR 302.4) or G.S. 143-215.85.

(b) Anticipated bypasses and unanticipated bypasses.

(c) Noncompliance with the conditions of this permit that may endanger health or the environment.

2. Reporting Timeframes and Other Requirements

After a permittee becomes aware of an occurrence that must be reported, he shall contact the appropriate Division regional office within the timeframes and in accordance with the other requirements listed below. Occurrences outside normal business hours may also be reported to the Division's Emergency Response personnel at (800) 662-7956, (800) 858-0368 or (919) 733-3300.

Occurrence	Reporting Timeframes (After Discovery) and Other Requirements
(a) Visible sediment deposition in a stream or wetland	• ***Within 24 hours***, an oral or electronic notification. • ***Within 7 calendar days***, a report that contains a description of the sediment and actions taken to address the cause of the deposition. Division staff may waive the requirement for a written report on a case-by-case basis. • If the stream is named on the NC 303(d) list as impaired for sediment-related causes, the permittee may be required to perform additional monitoring, inspections or apply more stringent practices if staff determine that additional requirements are needed to assure compliance with the federal or state impaired-waters conditions.
(b) Oil spills and release of hazardous substances per Item 1(b)-(c) above	• ***Within 24 hours***, an oral or electronic notification. The notification shall include information about the date, time, nature, volume and location of the spill or release.
(c) Anticipated bypasses [40 CFR 122.41(m)(3)]	• ***A report at least ten days before the date of the bypass, if possible***. The report shall include an evaluation of the anticipated quality and effect of the bypass.
(d) Unanticipated bypasses [40 CFR 122.41(m)(3)]	• ***Within 24 hours***, an oral or electronic notification. • ***Within 7 calendar days,*** a report that includes an evaluation of the quality and effect of the bypass.
(e) Noncompliance with the conditions of this permit that may endanger health or the environment[40 CFR 122.41(l)(7)]	• ***Within 24 hours***, an oral or electronic notification. • ***Within 7 calendar days***, a report that contains a description of the noncompliance, and its causes; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time noncompliance is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. [40 CFR 122.41(l)(6). • Division staff may waive the requirement for a written report on a case-by-case basis.

NORTH CAROLINA Environmental Quality

NCG01 SELF-INSPECTION, RECORDKEEPING AND REPORTING

EFFECTIVE: 04/01/19

NOT TO SCALE

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION | SO

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
3608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.LHJunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

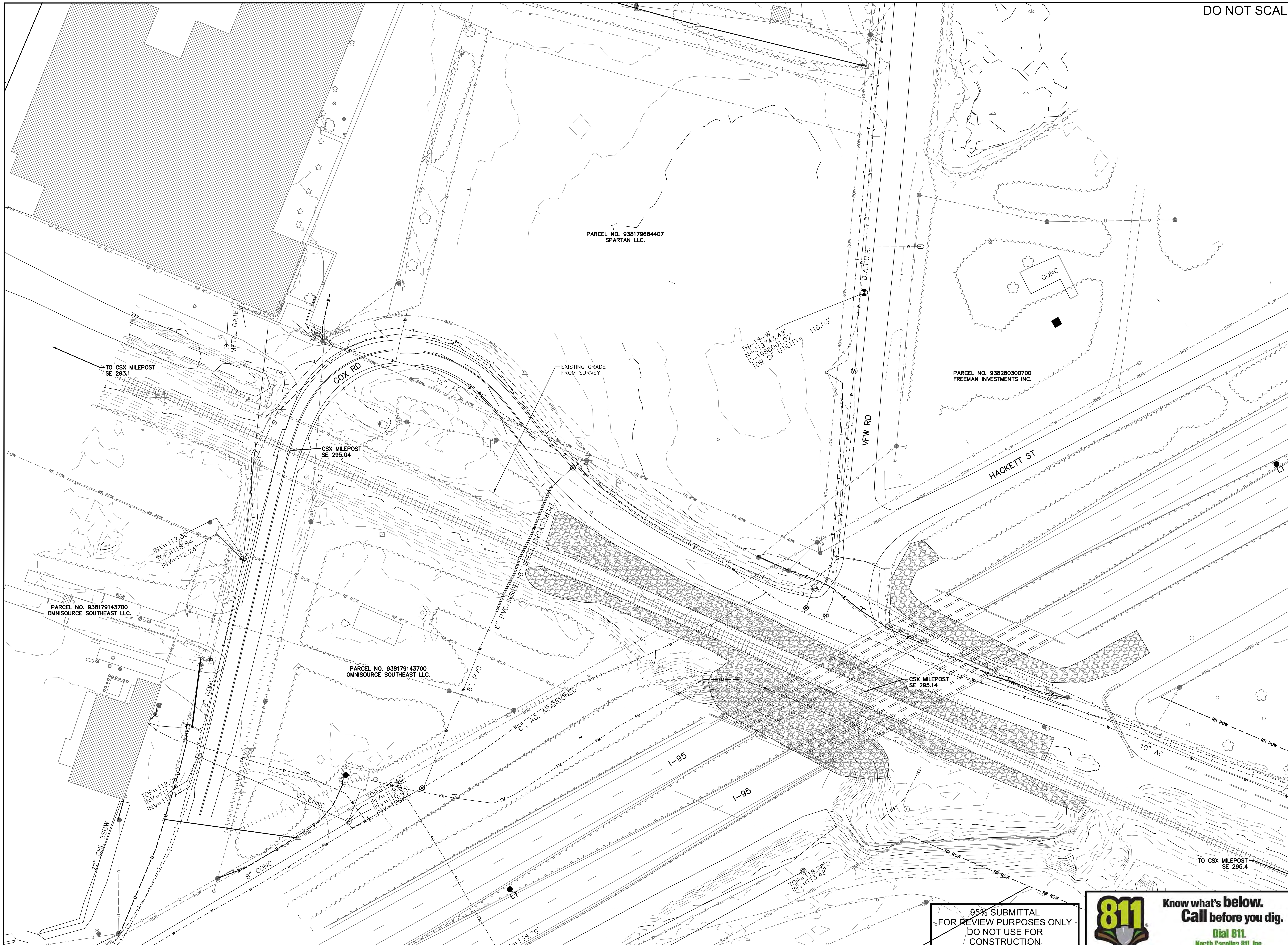
Drawing Title: NCDEQ NCG01 GENERAL PERMIT NOTES

Scale	Designed	Drawn	Checked	Authorized
NTS	CH	CH	DS	MH
Original Size: 22x34	Date: --/--/--	Date: --/--/--	Date: --/--/--	Date: --/--/--

Drawing Number: 100068207-CG-005 | Revision: 000

95% SUBMITTAL
- FOR REVIEW PURPOSES ONLY-
DO NOT USE FOR
CONSTRUCTION

DO NOT SCALE



95% SUBMITTAL
FOR REVIEW PURPOSES ONLY -
DO NOT USE FOR
CONSTRUCTION

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: SO

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title:
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

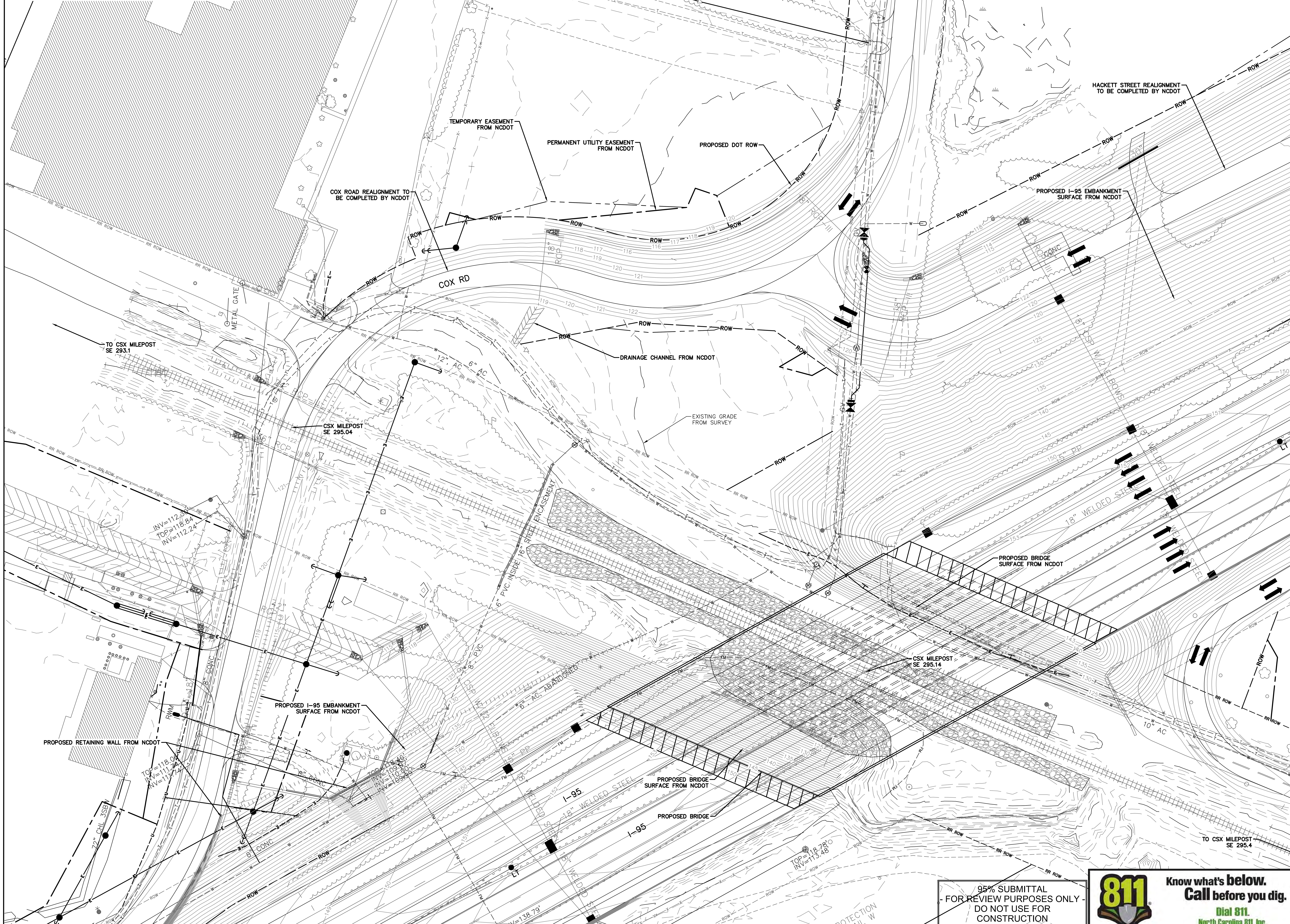
Drawing Title:
EXISTING CONDITIONS
(PRE- I-95 CONSTRUCTION)

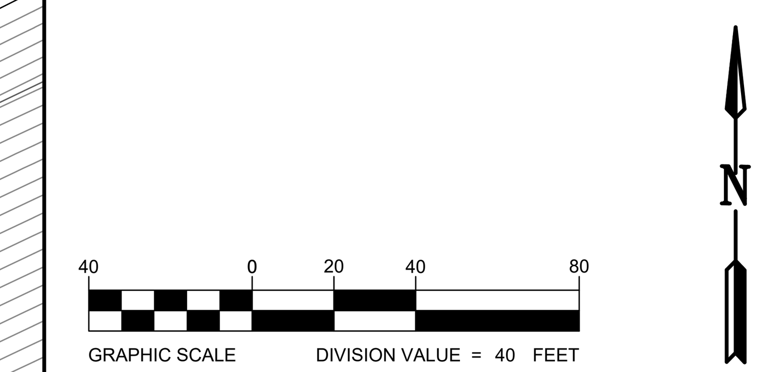
Scale	Designed	Drawn	Checked	Authorized
1"=40'	CH	CH	DS	MH
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number: 100068207-C-101
Revision: 000

THIS SHEET REPRESENTS THE SITE CONDITIONS ANTICIPATED UPON COMPLETION OF THE I-95 CONSTRUCTION PROJECT BY NCDOT. I-95 CONSTRUCTION WILL BE COMPLETED PRIOR TO BEGINNING WORK ON LUMBERTON FLOODGATE.

DO NOT SCALE





95% SUBMITTAL
- FOR REVIEW PURPOSES ONLY -
DO NOT USE FOR CONSTRUCTION

811 Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION | Suitability: SO

ATKINS — Member of the SNC-Lavalin Group
1616 East Millbrook Road, Suite 160, Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC. — ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street, Suite 200, Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road, Suite 107, Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: EXISTING CONDITIONS (POST- I-95 CONSTRUCTION)

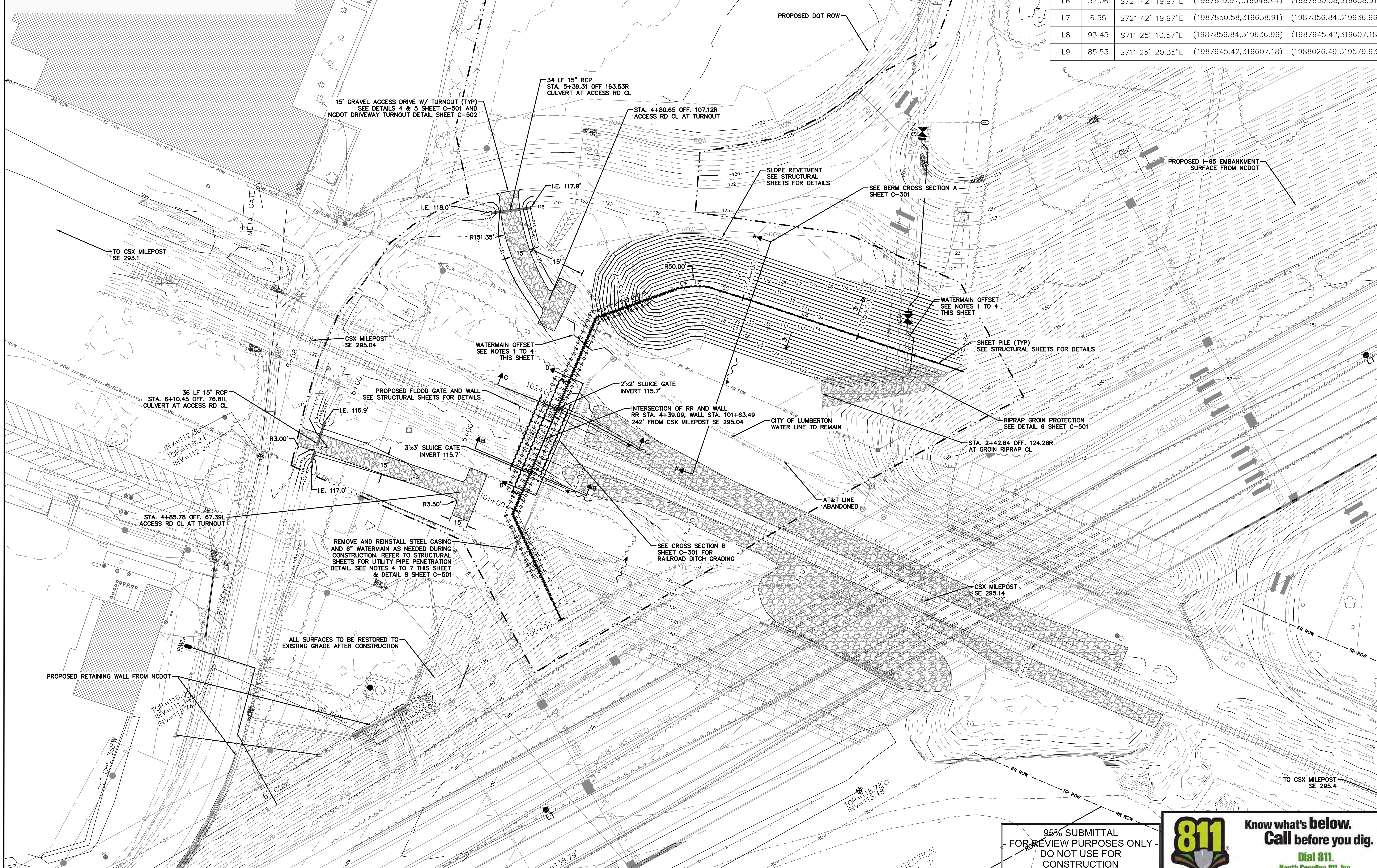
Scale	Designed	Drawn	Checked	Authorized
1"=40'	CH	CH	DS	MH
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-C-102 | Revision: 000

NOTES:
1. OFFSET WATERLINE AS NEEDED DURING CONSTRUCTION TO MINIMIZE INTERRUPTION OF SERVICE. MAXIMUM ALLOWABLE INTERRUPTION OF SERVICE IS 4 HOURS. REFER TO DETAIL 3 SHEET C-301.
2. WATERLINE OFFSET CAN BE USED AS TEMPORARY OF FINAL LOCATION OF PIPE. FINAL PIPE PENETRATION THROUGH WALL SHALL BE PER DETAIL PROVIDED IN STRUCTURAL SHEETS.
3. ALL PIPES SHALL BE DUCTILE IRON.
4. PROVIDE CITY OF LUMBERTON AT LEAST TWO WEEKS NOTICE AHEAD OF INTERRUPTION OF SERVICE AND COORDINATE WITH CITY ON LOCATION AND OPERATION OF CUTOFF VALVES.
5. STEEL CASINGS, SPACERS, AND CARRIER PIPE SHALL BE RESTORED AS EXISTING, IN SAME LOCATION. NO OFFSET IS OLLOWED.
6. STEEL CASING SHALLE BE WELDED AT CUT LOCATIONS. MECHANICAL JOINTS SHALL BE USED TO RESTRAIN CARRIER PIPE.
7. MAXIMUM ALLOWABLE INTERRUPTION OF SERVICE FOR WATERLINE INSIDE STEEL CASING IS TWO WEEKS.

Line Table: Wall CL Alignment

Line #	Length	Direction	Start Point	End Point
L1	96.11	N24° 40' 09.23"W	(1987700.15,319372.56)	(1987660.03,319459.90)
L2	176.53	N23° 00' 27.04"E	(1987660.03,319459.90)	(1987729.03,319622.38)
L3	71.84	N70° 13' 43.98"E	(1987729.03,319622.38)	(1987796.64,319646.68)
L4	10.52	N81° 12' 28.78"E	(1987796.64,319646.68)	(1987807.03,319648.29)
L5	12.94	N89° 20' 58.14"E	(1987807.03,319648.29)	(1987819.97,319648.44)
L6	32.06	S72° 42' 19.97"E	(1987819.97,319648.44)	(1987850.58,319638.91)
L7	6.55	S72° 42' 19.97"E	(1987850.58,319638.91)	(1987856.84,319636.96)
L8	93.45	S71° 25' 10.57"E	(1987856.84,319636.96)	(1987945.42,319607.18)
L9	85.53	S71° 25' 20.35"E	(1987945.42,319607.18)	(1988026.49,319579.93)



95% SUBMITTAL
- FOR REVIEW PURPOSES ONLY -
DO NOT USE FOR CONSTRUCTION

811 Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

DO NOT SCALE

GRAPHIC SCALE 40 0 20 40 80 DIVISION VALUE = 40 FEET

N

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: SO

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

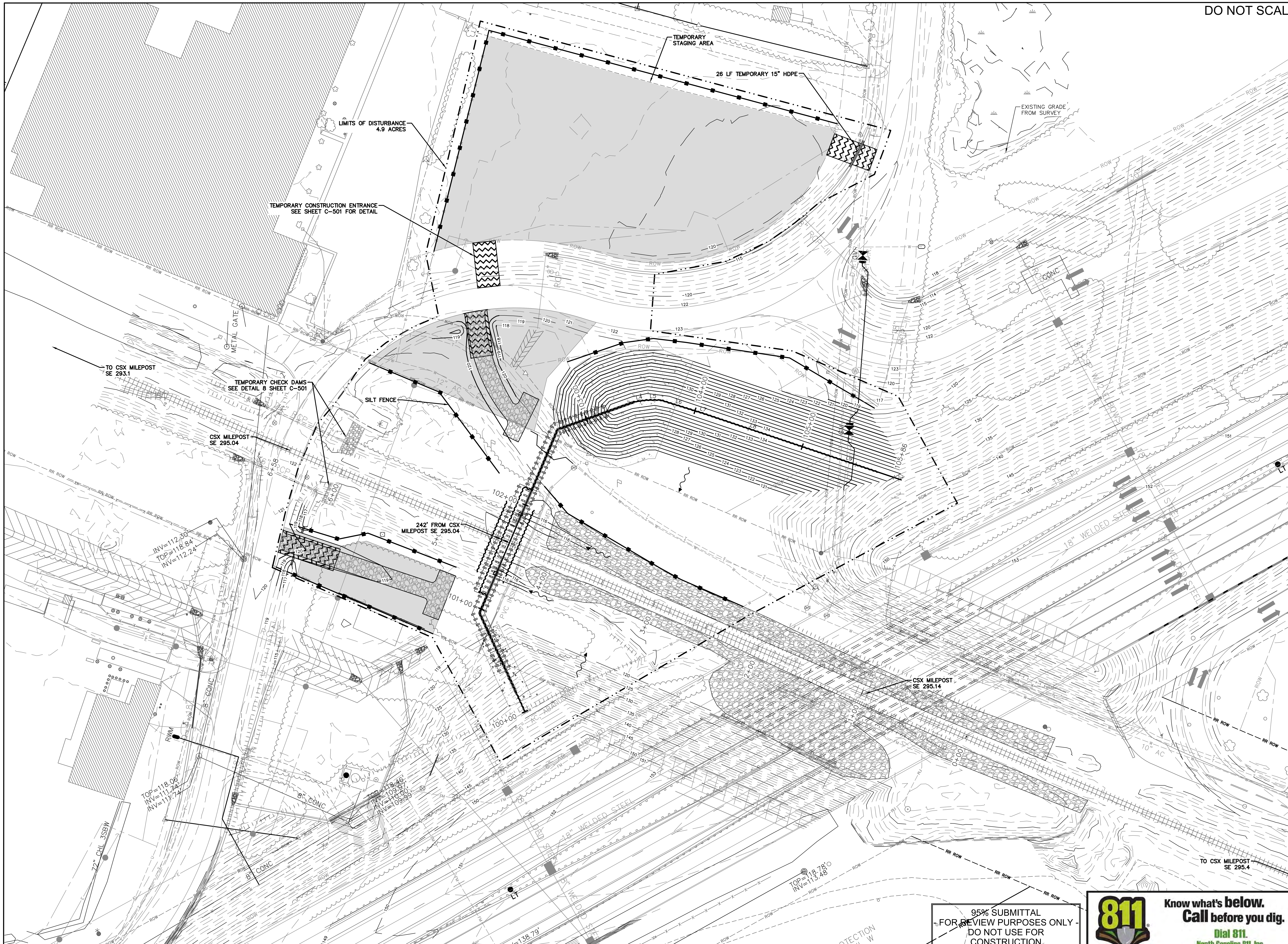
Client: City of LUMBERTON North Carolina

Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
SITE PLAN

Scale	Designed	Drawn	Checked	Authorized
1"=40'	CH	CH	DS	MH
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-C-201
Revision: 000



95% SUBMITTAL
FOR REVIEW PURPOSES ONLY -
DO NOT USE FOR
CONSTRUCTION

Know what's below.
Call before you dig.
Dial 811.
North Carolina 811, Inc.

GRAPHIC SCALE 40 0 20 40 80
DIVISION VALUE = 40 FEET

N

Seal	Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of Lumberton North Carolina

Project Title:
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title:
EROSION CONTROL PLAN

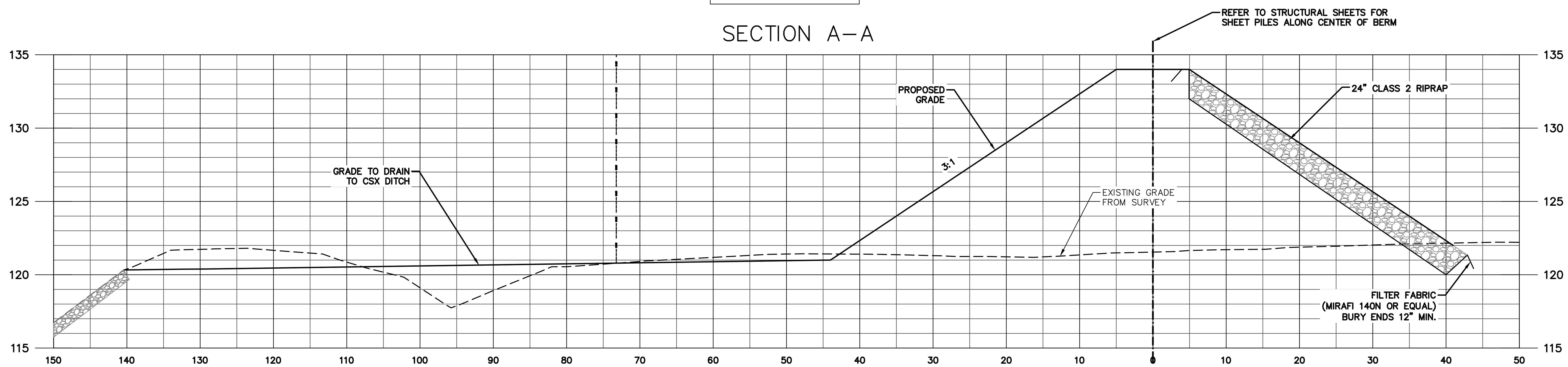
Scale	Designed	Drawn	Checked	Authorized
1"=40'	CH	CH	DS	MH
Original Size: 22x34	Date: --/--/--	Date: --/--/--	Date: --/--/--	Date: --/--/--

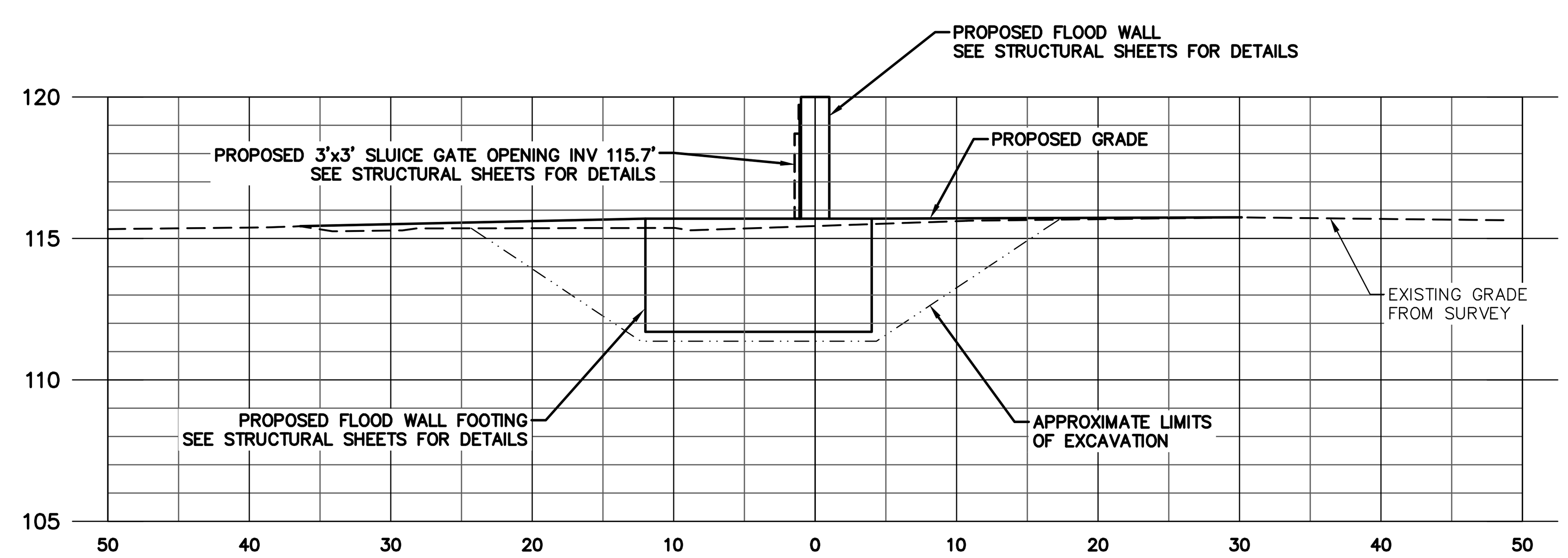
Drawing Number: 100068207-C-202
Revision: 000

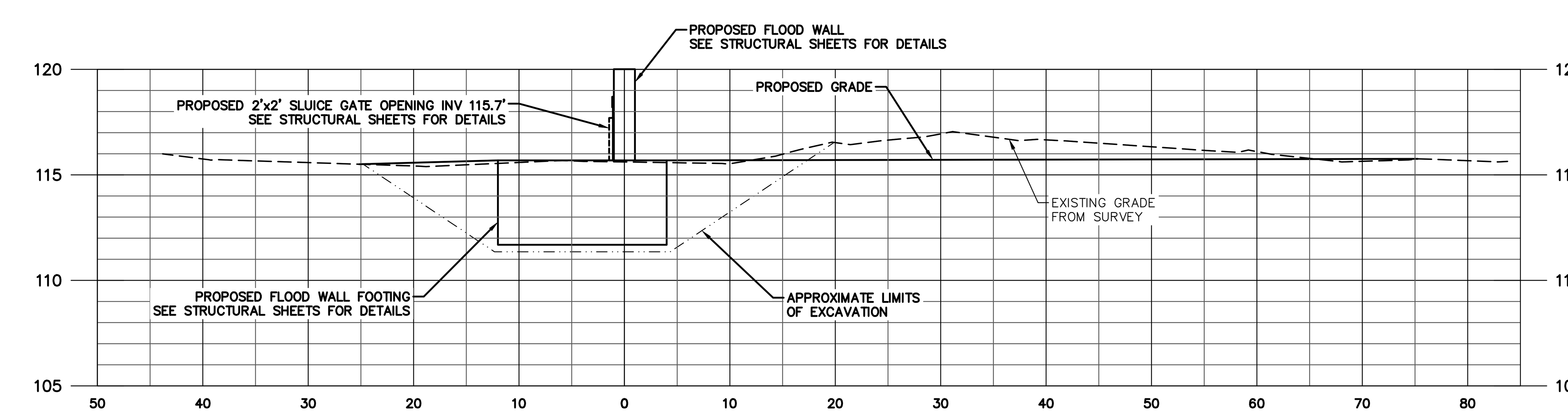
DO NOT SCALE

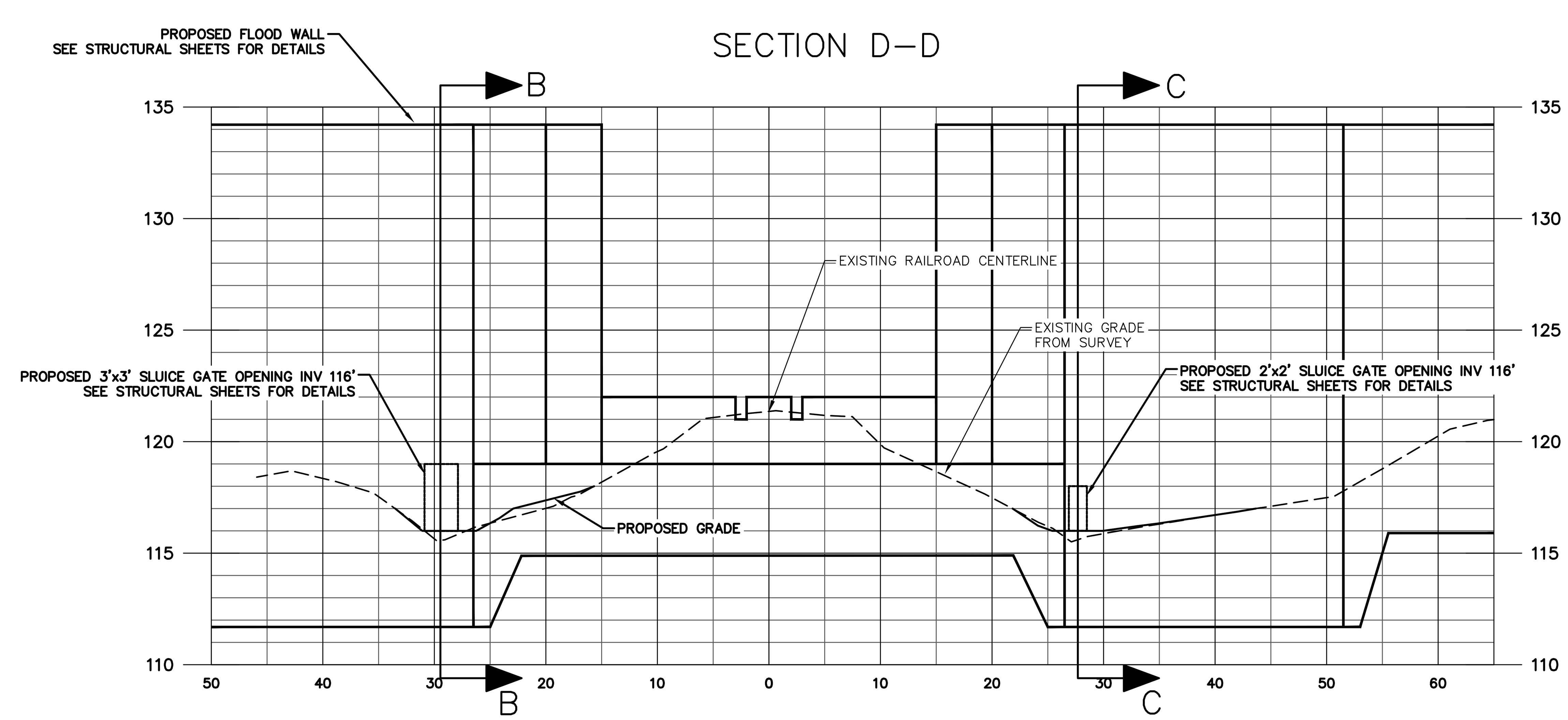
SECTION

SCALE: HORIZ. 1"= 40'
VERT. 1"= 20'









NOTE:

SLUICE GATES SHALL BE SELF–CONTAINED STAINLESS STEEL SLIDE GATES BY RODNEY HUNT OR EQUIVALENT WITH A WALL THIMBLE OFFSET SUFFICIENT TO ACCOMMODATE HANDWHEEL OPERATION

95% SUBMITTAL
- FOR REVIEW PURPOSES ONLY -
DO NOT USE FOR CONSTRUCTION

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

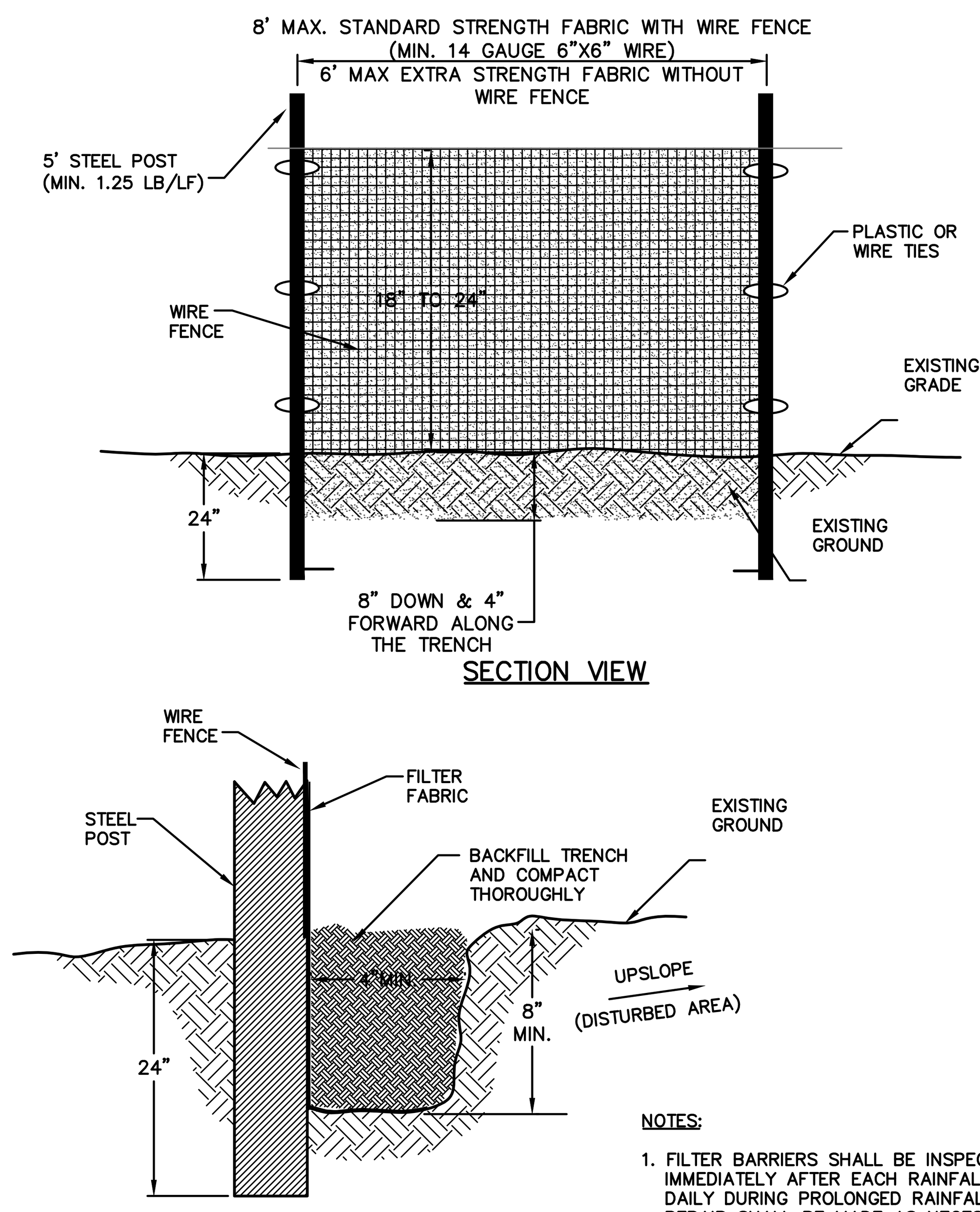
Client: City of LUMBERTON North Carolina

Project Title:
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title:
CROSS SECTIONS

Scale	Designed	Drawn	Checked	Authorized
	CH	CH	DS	MH
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-C-301
Revision: 000



NOTES:

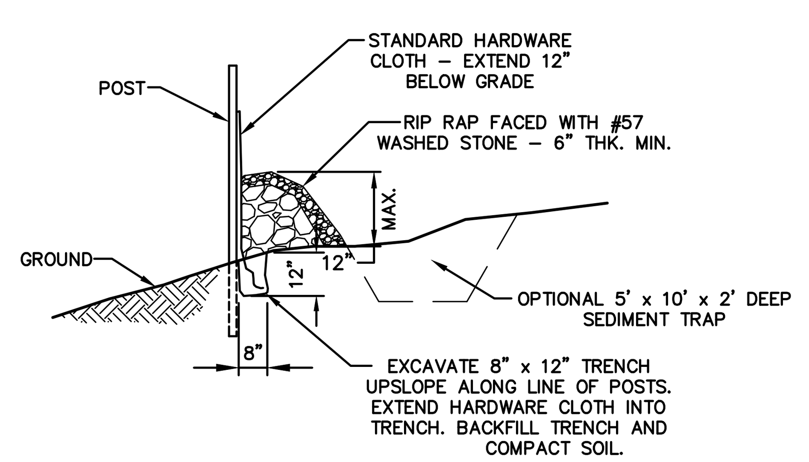
1. FILTER BARRIERS SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL AND DAILY DURING PROLONGED RAINFALL. REPAIR SHALL BE MADE AS NECESSARY.
2. FABRIC SHALL BE REPLACED PROMPTLY IF FOUND TO BE IN DISREPAIR.
3. SEDIMENT DEPOSITS SHALL BE REMOVED AFTER EACH STORM EVENT AND WHEN DEPOSITS REACH APPROXIMATELY 1/3 HEIGHT OF BARRIER.
4. REFERENCE NCDEQ LAND QUALITY SECTION DESIGN MANUAL: 6.62.

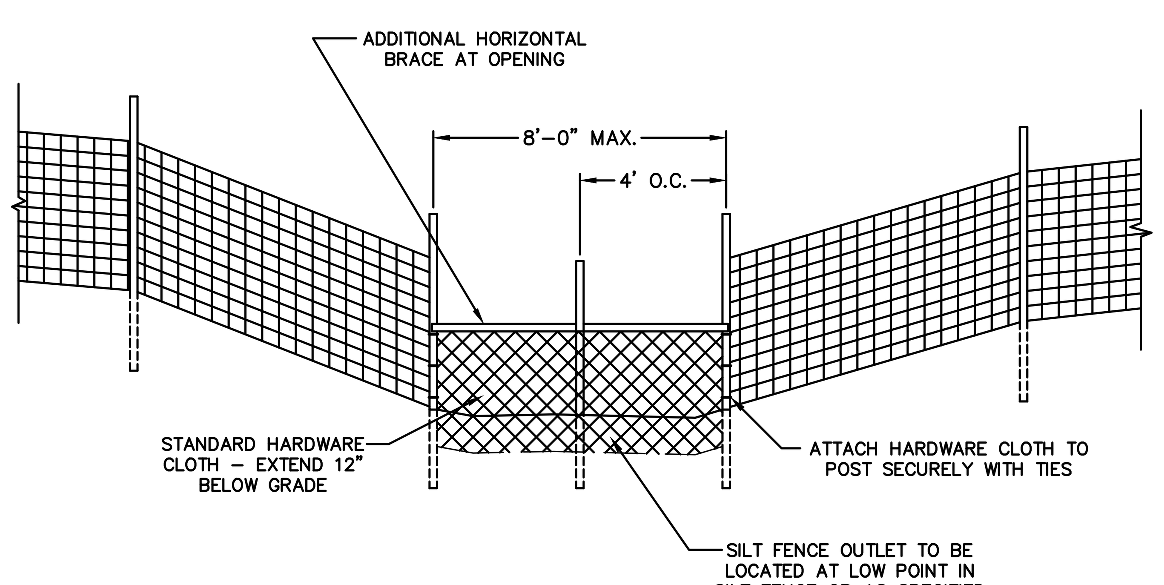
SLOPE	SLOPE LENGTH(FT)	MAXIMUM AREA(SQFT)
<2%	100	10,000
2 TO 5%	75	7,500
5 TO 10%	50	5,000
10 TO 20%	25	2,500
>20%	15	1,500

PLAN SYMBOL

1 SILT FENCE

NOT TO SCALE



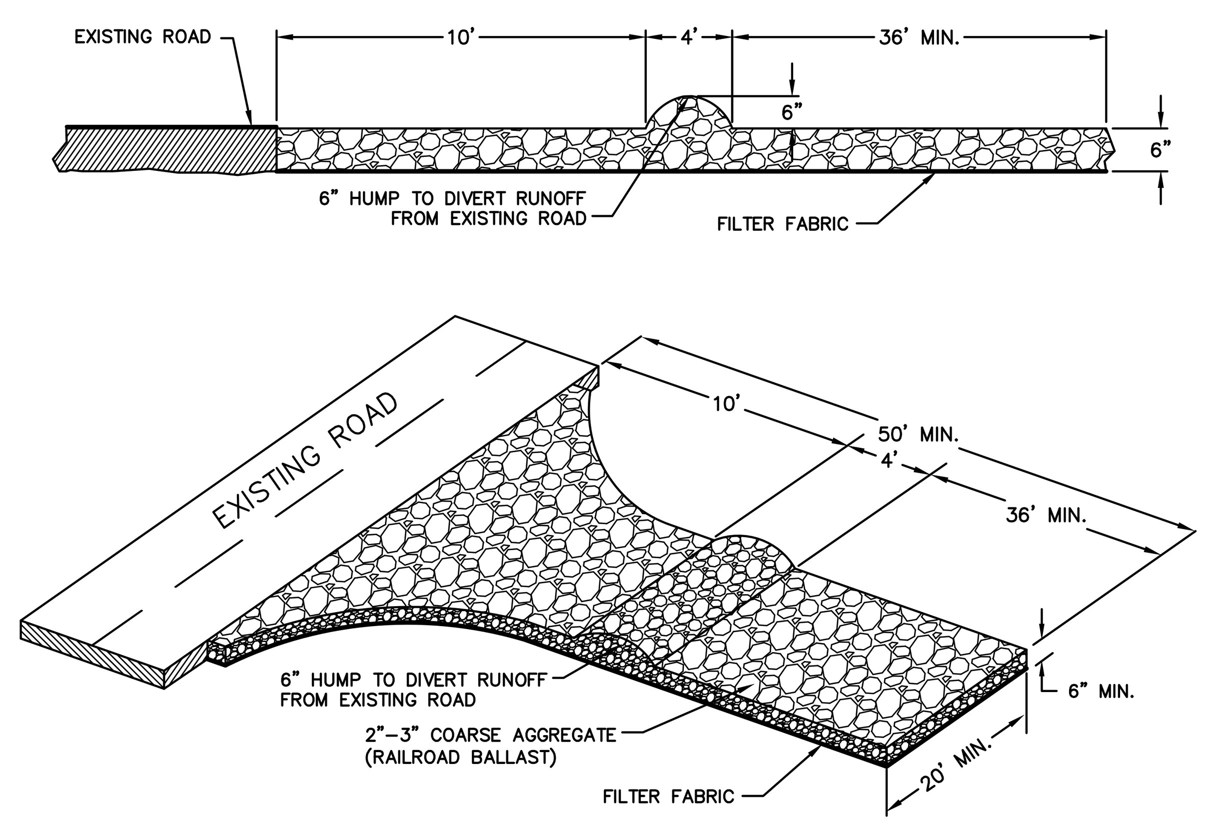


NOTES:

1. FILTER BARRIERS SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL AND DAILY DURING PROLONGED RAINFALL. REPAIR SHALL BE MADE AS NECESSARY.
2. FABRIC SHALL BE REPLACED PROMPTLY IF FOUND TO BE IN DISREPAIR.
3. SEDIMENT DEPOSITS SHALL BE REMOVED AFTER EACH STORM EVENT AND WHEN DEPOSITS REACH APPROXIMATELY 1/3 HEIGHT OF BARRIER.
4. SILT FENCE OUTLETS SHALL BE LOCATED AT LOW POINTS IN CONTINUOUS RUNS OF SILT FENCE.

2 SILT FENCE - OUTLET

NOT TO SCALE

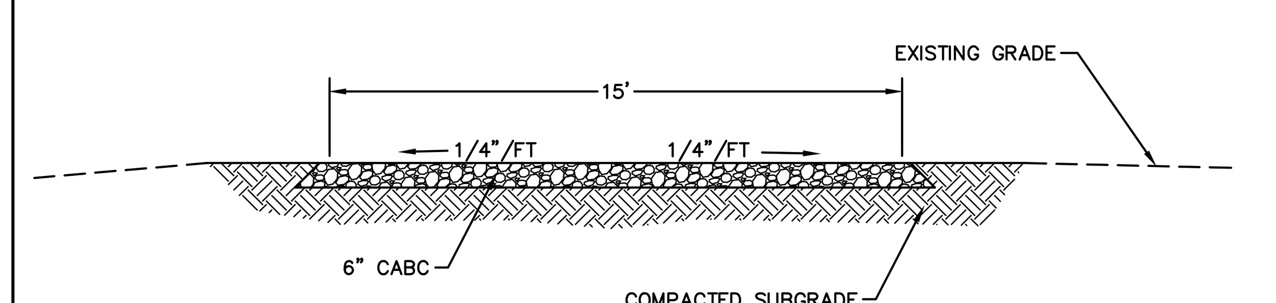


NOTES:

1. A STABILIZED PAD OF CRUSHED STONE SHALL BE LOCATED WHERE TRAFFIC WILL BE ENTERING OR LEAVING A CONSTRUCTION SITE TO OR FROM AN EXISTING ROAD.
2. STONE TO BE 2 – 3 INCH WASHED STONE RAILROAD BALLAST.
3. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC STREETS OR EXISTING PAVEMENT. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT.
4. ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC STREETS MUST BE REMOVED IMMEDIATELY.
5. WHEN NECESSARY WHEELS MUST BE CLEANED TO REMOVE SEDIMENT PRIOR TO ENTERING A PUBLIC STREET, WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH CRUSHED STONE WHICH DRAINS INTO AN APPROVED SEDIMENT BASIN.
6. REFERENCE NCDEQ LAND QUALITY SECTION DESIGN MANUAL: 6.06.

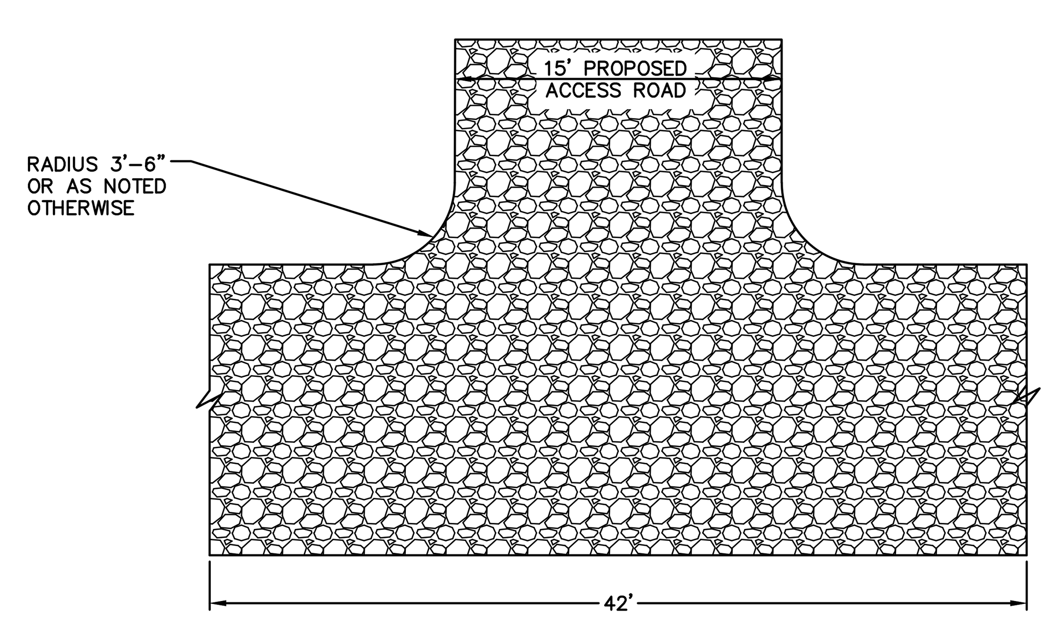
3 TEMPORARY CONSTRUCTION ENTRANCE

NOT TO SCALE



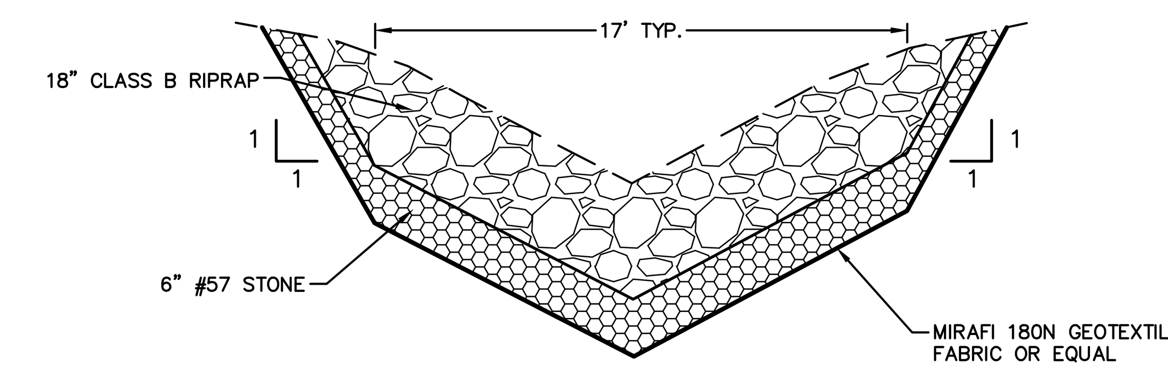
4 TYPICAL GRAVEL ACCESS ROAD CROSS-SECTION

NOT TO SCALE



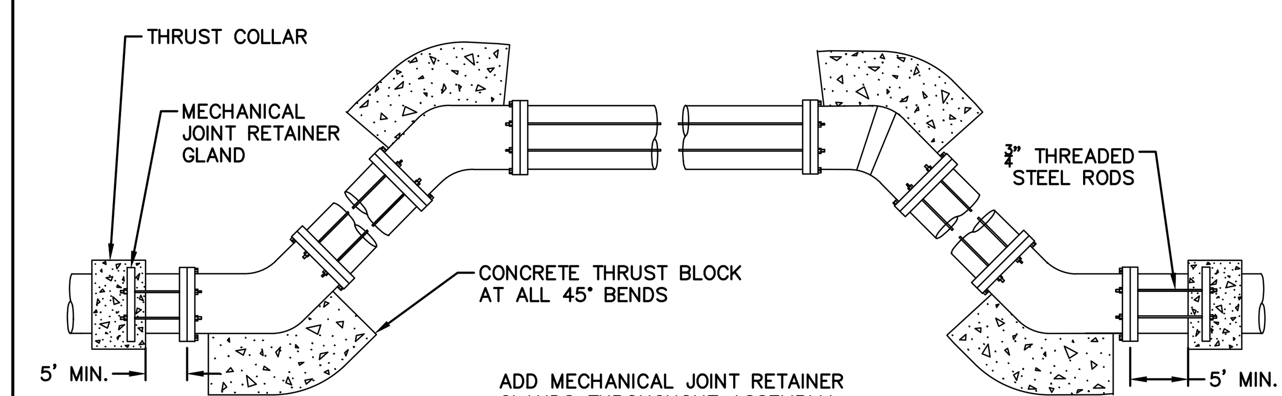
5 GRAVEL ROAD TURNOUT

NOT TO SCALE



6 GROIN PROTECTION RIPRAP

NOT TO SCALE

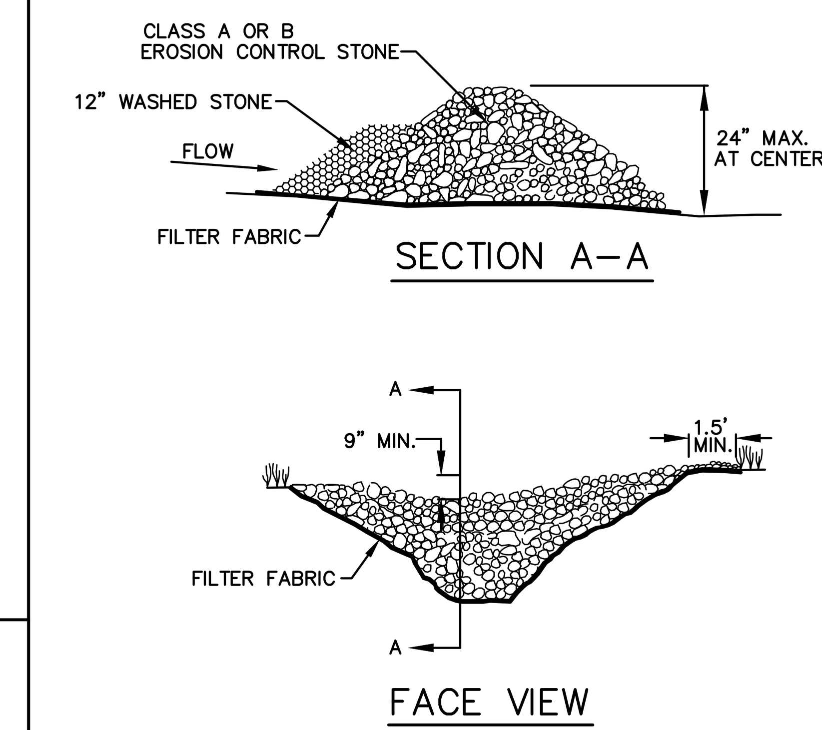


NOTES:

1. FITTING JOINTS SHALL NOT BE POURED IN CONCRETE OR HAVE CONCRETE SPILLED ON THE BOLTS OR NUTS. THE FITTING SHALL BE WRAPPED IN A LAYER OF POLYETHYLENE PLASTIC PRIOR TO POURING THE THRUST BLOCK.
2. ROD AND EYE BOLT DIAMETER SHALL BE A MINIMUM OF 3/4" AND SHALL MATCH THE SIZE OF THE BOLT PROVIDED WITH THE FITTING.
3. CONTRACTOR SHALL REPLACE FITTING BOLTS WITH THREADED ROD FOR 1/2 OF THE BOLTS SUPPLIED WITH EACH FITTING. RODS SHALL BE EQUALLY SPACED.

7 WATER MAIN OFFSET

NOT TO SCALE



STONE CHECK DAM:

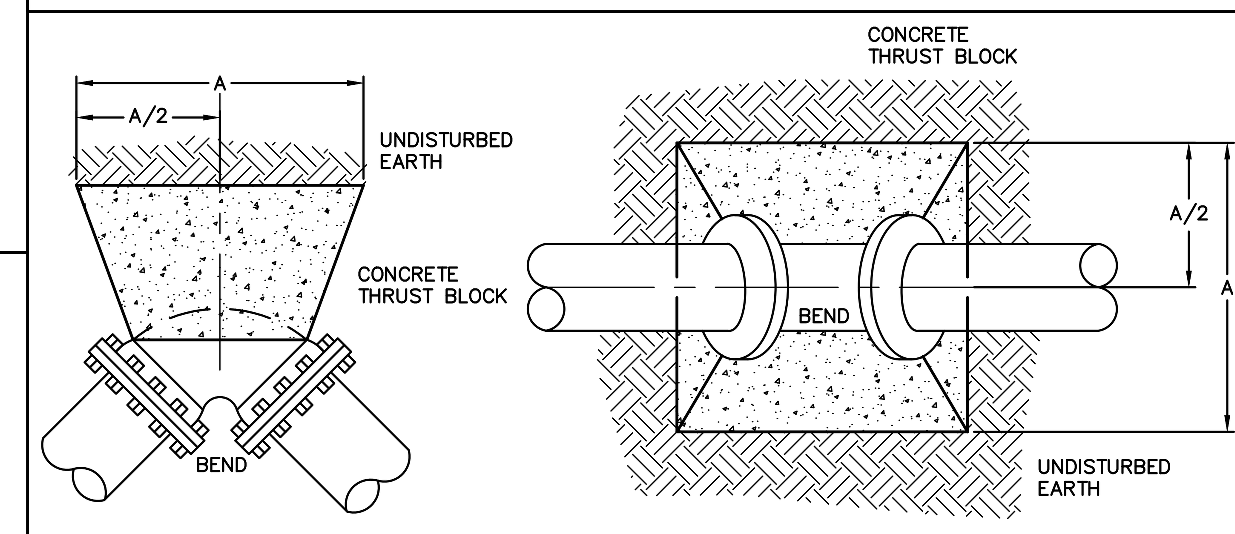
STONE SHOULD BE PLACED OVER THE CHANNEL BANKS TO KEEP WATER FROM CUTTING AROUND THE DAM. L = THE DISTANCE SUCH THAT POINTS A AND B ARE OF EQUAL ELEVATION

THE FOLLOWING CRITERIA SHOULD BE USED WHEN DESIGNING A CHECK DAM:

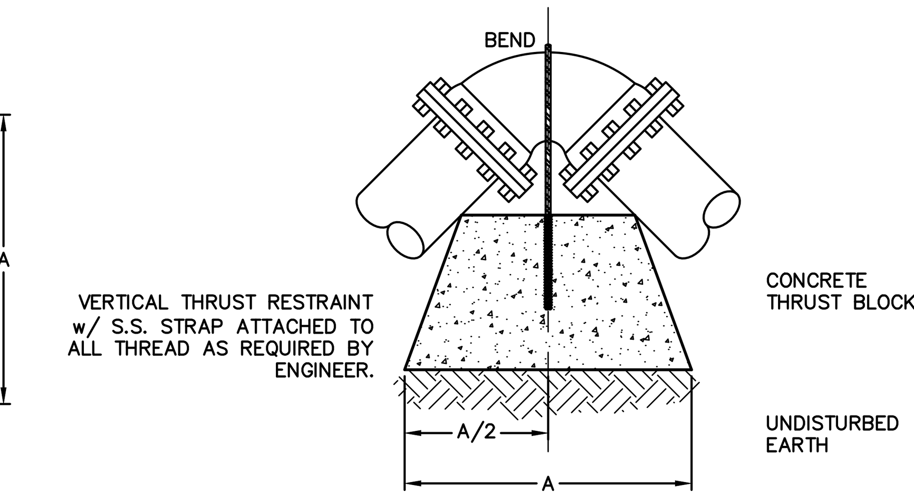
- ENSURE THAT THE DRAINAGE AREA ABOVE THE CHECK DAM DOES NOT EXCEED 2 ACRES.
- KEEP THE MAXIMUM HEIGHT AT 2 FT AT THE CENTER OF THE DAM.
- KEEP THE CENTER OF THE CHECK DAM AT LEAST 9 INCHES LOWER THAN THE OUTER EDGES AT NATURAL GROUND ELEVATION.
- KEEP THE SIDE SLOPES OF THE DAM AT 2:1 OR FLATTER.
- STABILIZE OVERFLOW AREAS ALONG THE CHANNEL TO RESIST EROSION CAUSED BY CHECK DAMS.

8 RIP RAP CHECK DAM

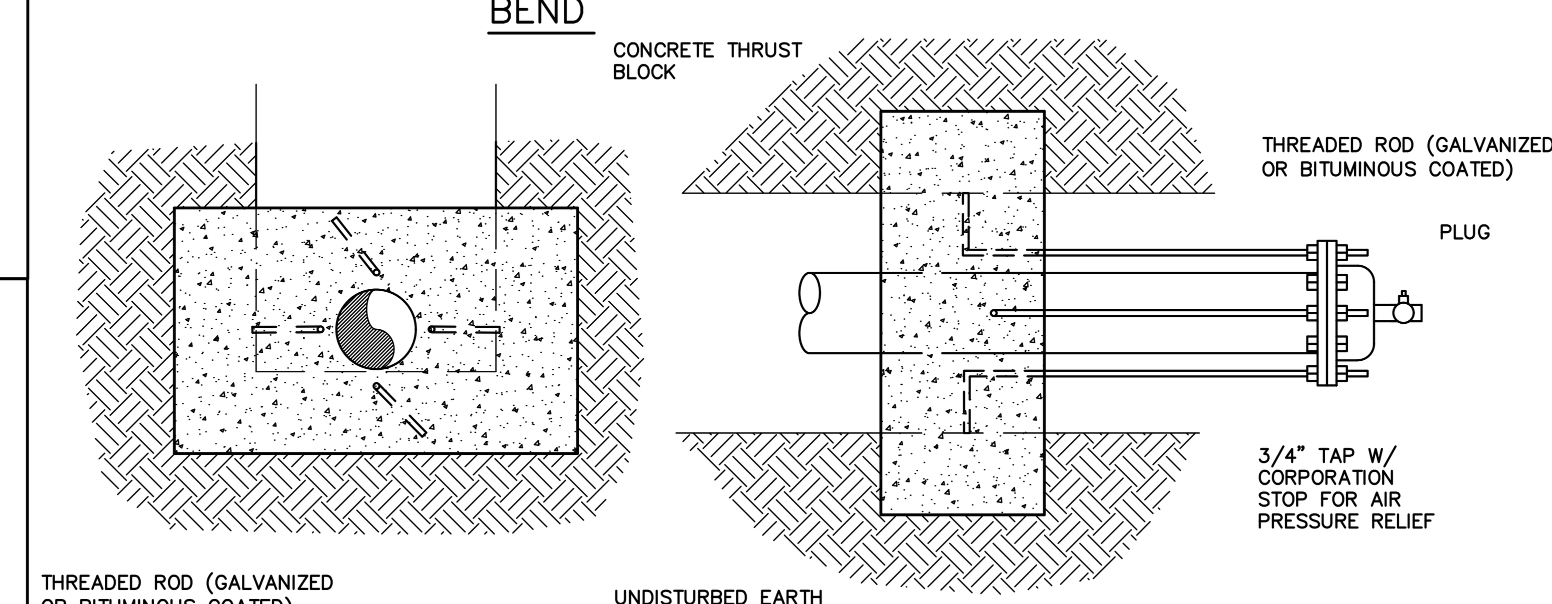
NOT TO SCALE



BEND



VERTICAL



PLUGS

NOTES:

1. FITTING JOINTS SHALL NOT BE POURED IN CONCRETE OR HAVE CONCRETE SPILLED ON THE BOLTS OR NUTS. THE FITTING SHALL BE WRAPPED IN A LAYER OF POLYETHYLENE PLASTIC PRIOR TO POURING THE THRUST BLOCK.
2. ROD AND EYE BOLT DIAMETER SHALL BE A MINIMUM OF 3/4" AND SHALL MATCH THE SIZE OF THE BOLT PROVIDED WITH THE FITTING.
3. CONTRACTOR SHALL REPLACE FITTING BOLTS WITH THREADED ROD FOR 1/2 OF THE BOLTS SUPPLIED WITH EACH FITTING. RODS SHALL BE EQUALLY SPACED.
4. ALL DIMENSIONS SHOWN ARE IN INCHES.

SIZE	TYPE: 11-1/4° BEND	22-1/2° BEND	45° BEND	90° BEND	TEE	PLUG
2-6	12	12	12	16	16	14
8	12	12	16	22	22	18
10	12	14	20	28	28	22
12	12	18	24	32	32	28
14	14	20	28	38	38	32
16	16	22	32	42	42	36
18	18	26	36	48	48	40
20	20	28	40	52	52	44
24	24	34	46	64	64	54
30	30	42	58	78	78	66
36	36	50	70	94	94	80
42	40	58	80	108	108	92
48	46	66	90	124	124	104

THRUST BLOCK DIMENSION "A"

9 TYPICAL THRUST BLOCKS

NOT TO SCALE

95% SUBMITTAL
- FOR REVIEW PURPOSES ONLY -
DO NOT USE FOR CONSTRUCTION

NOT TO SCALE

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: SO

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

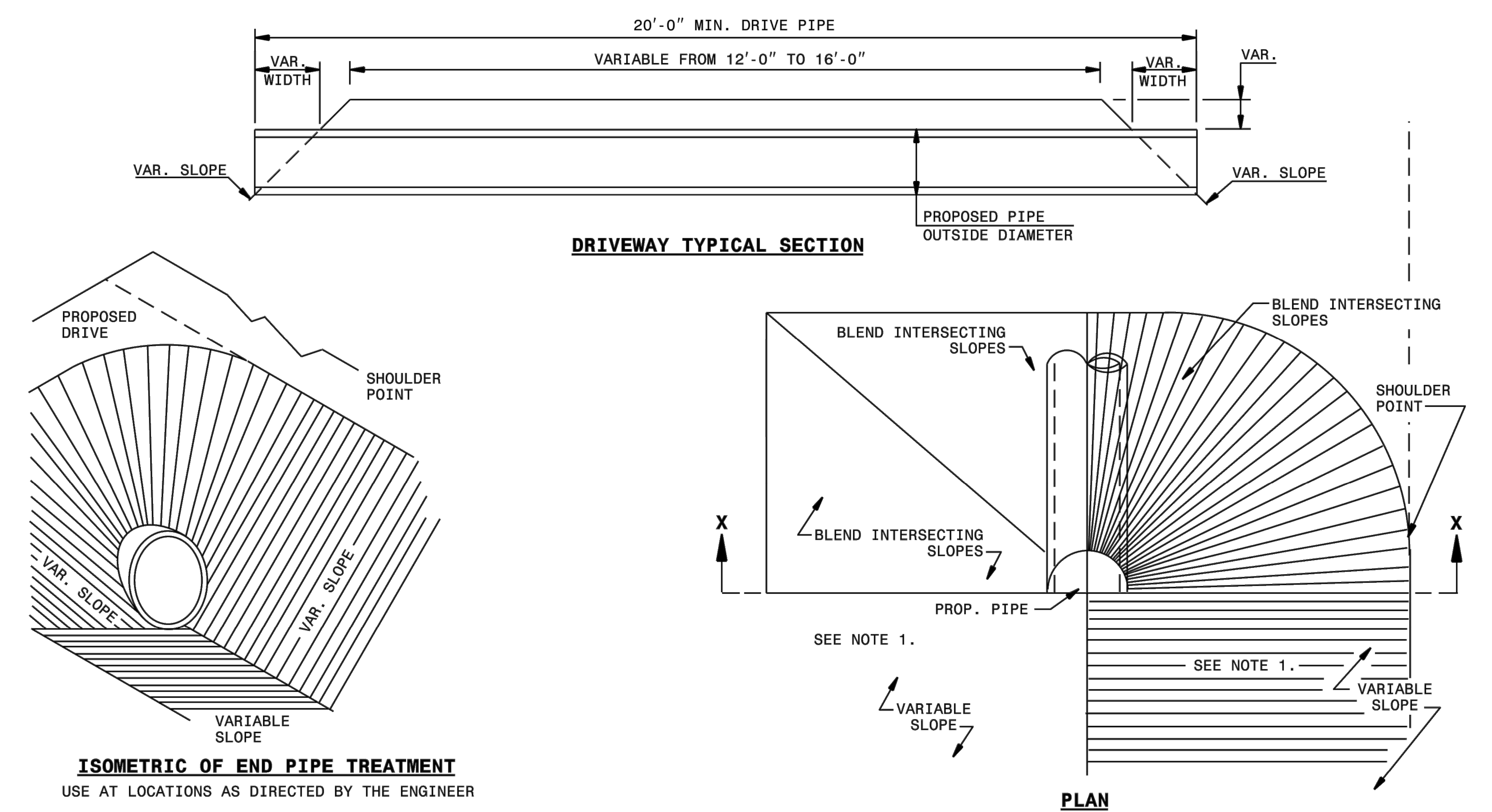
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: DETAILS 1 OF 2

Scale	Designed	Drawn	Checked	Authorized
NTS	CH	CH	DS	MH
Original Size: 22x34	Date: --/--/--	Date: --/--/--	Date: --/--/--	Date: --/--/--

Drawing Number: 100068207-C-501

Revision: 000



ISOMETRIC OF END PIPE TREATMENT

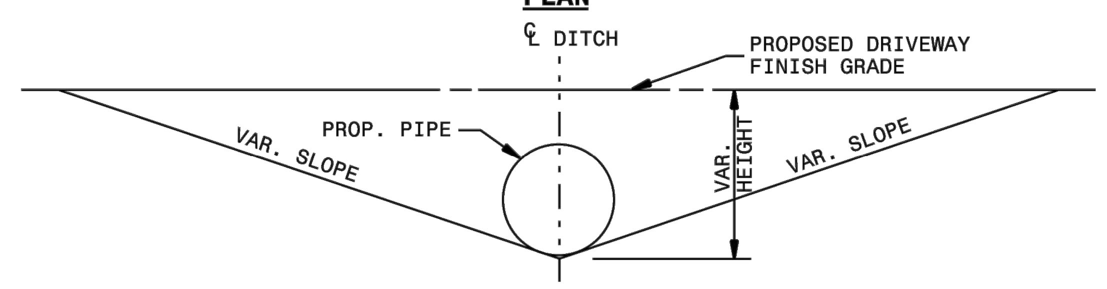
USE AT LOCATIONS AS DIRECTED BY THE ENGINEER

GENERAL NOTES:

ALL DIMENSIONS GIVEN ARE FOR MINIMUM CONDITIONS. PROPER ENGINEERING JUDGEMENT MUST BE USED IN DETERMINING DRIVEWAY LOCATIONS, WIDTHS, AND PIPE LENGTHS.

FACTORS SUCH AS VEHICLE TURNING RADIUS, TRAFFIC VOLUMES, DRIVEWAY SKEW, OFFSET DISTANCE OF PIPE FROM EDGE OF PAVEMENT, PIPE DEPTHS, AND DESIGN SPEED SHOULD BE CONSIDERED IN DETERMINING DRIVEWAY WIDTHS.

NOTE:
1. THESE AREAS ARE TO BE USED TO BLEND THE INTERSECTING SLOPES TO THE PROPOSED DITCH.



SECTION X-X

STATE OF NORTH CAROLINA DEPT. OF TRANSPORTATION DIVISION OF HIGHWAYS RALEIGH, N.C.

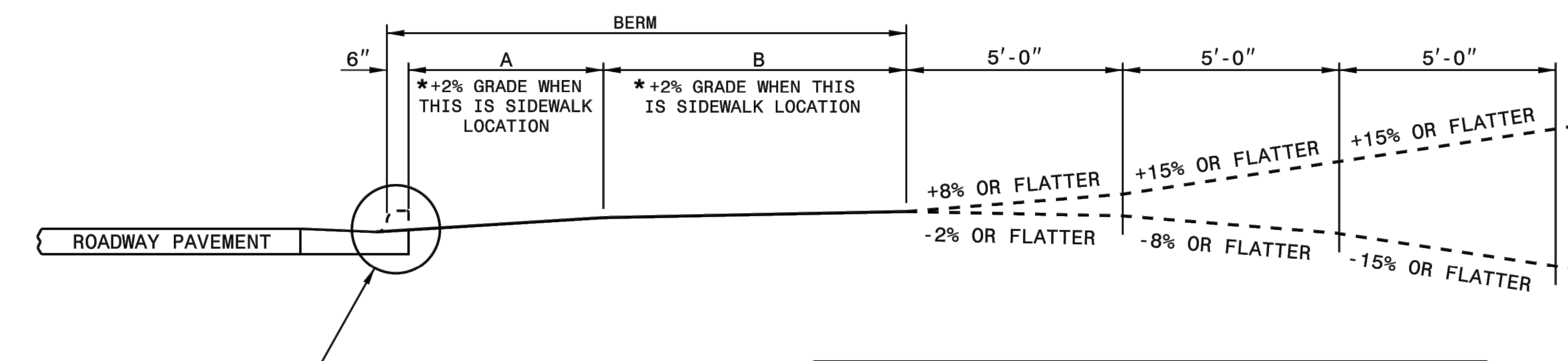
1-18

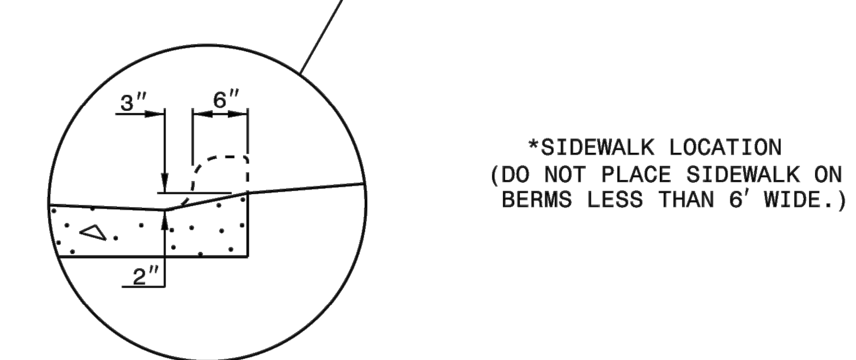
ROADWAY STANDARD DRAWING FOR
DRIVEWAY PIPE CONSTRUCTION
USING NO SPECIAL END SECTIONS

SHEET 1 OF 1

310.10

DESIRABLE DRIVEWAY GRADES

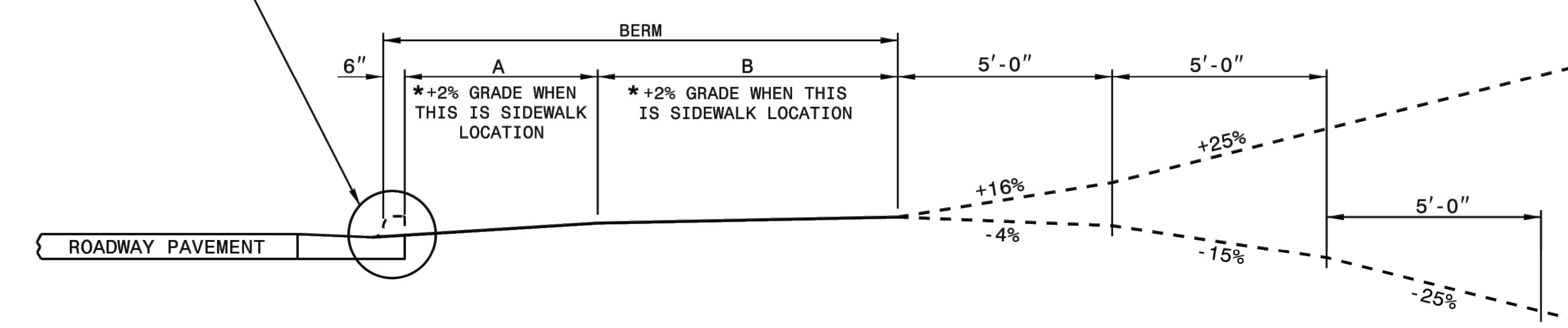




*SIDEWALK LOCATION
(DO NOT PLACE SIDEWALK ON BERMS LESS THAN 6' WIDE.)

DESIRABLE OR MAXIMUM DRIVEWAY GRADES				
BERM WIDTH	A		B	
	DIST.	GRADE	DIST.	GRADE
8' OR LESS	5'-0"	+2%*	2'-6"	+5%
8' OR LESS	2'-0"	+6%	5'-6"	+2%*
10'	4'-0"	+4%	5'-6"	+2%*
12' & OVER	4'-6"	+4%	7'-0"	+2%*

MAXIMUM DRIVEWAY GRADES



STATE OF NORTH CAROLINA DEPT. OF TRANSPORTATION DIVISION OF HIGHWAYS RALEIGH, N.C.

1-18

ROADWAY STANDARD DRAWING FOR
DRIVEWAY TURNOUT
DRIVEWAY GRADES

SHEET 2 OF 2

848.02

NOT TO SCALE

Seal

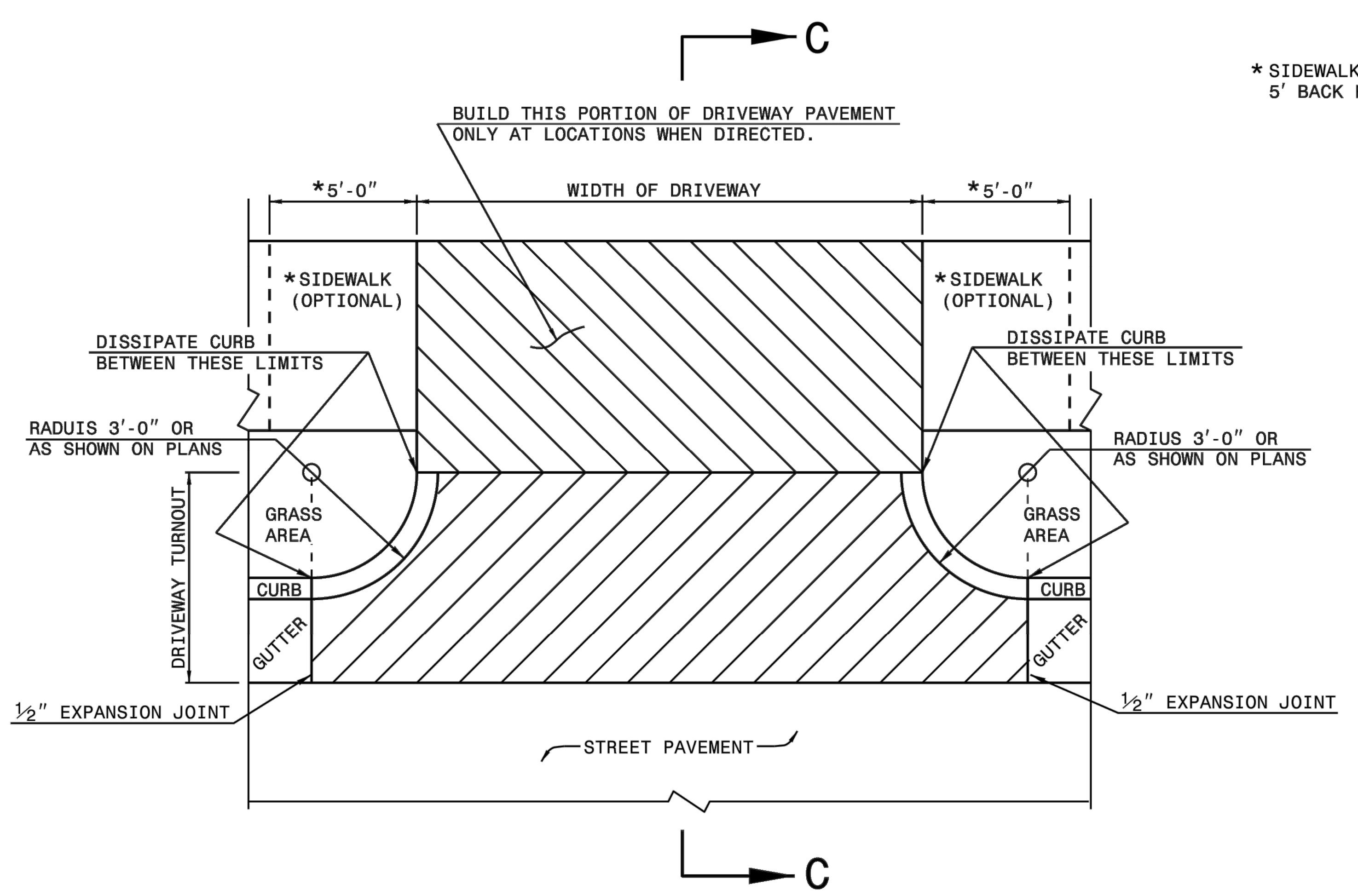
Seal

Rev.	Date	Description	By	Chk'd	App'd

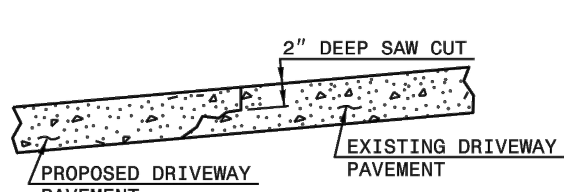
Drawing Status
FOR INFORMATION

Suitability
S0

* SIDEWALK TAPERS DOWN 5' BACK FROM DRIVEWAY.

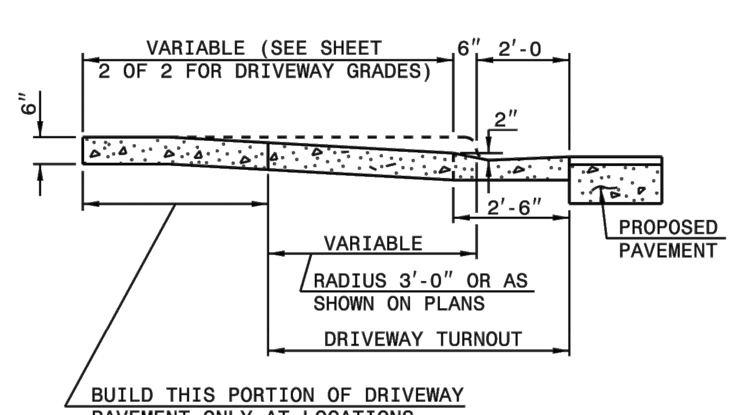


PLAN
DETAIL OF DRIVEWAY



METHOD OF TIE IN

WHEN EXISTING DRIVEWAY PAVEMENT IS CONCRETE, SAW CUT 2" DEEP JOINT AT THE POINT OF TIE-IN. SAW JOINT PERPENDICULAR TO EDGE OF EXISTING DRIVEWAY PAVEMENT.



SECTION C-C

STATE OF NORTH CAROLINA DEPT. OF TRANSPORTATION DIVISION OF HIGHWAYS RALEIGH, N.C.

1-18

ROADWAY STANDARD DRAWING FOR
DRIVEWAY TURNOUT
RADIUS TYPE

SHEET 1 OF 2

848.02

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client
City of LUMBERTON North Carolina

Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
DETAILS 2 OF 2

95% SUBMITTAL
- FOR REVIEW PURPOSES ONLY -
DO NOT USE FOR CONSTRUCTION

Scale	Designed	Drawn	Checked	Authorized
NTS	CH	CH	DS	MH
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number
100068207-C-502

Revision
000

DO NOT SCALE

STEEL NOTES:

1. ALL WELDING SHALL BE ELECTRIC WELDING. WORKMANSHIP AND TECHNIQUE, WHERE APPLICABLE, SHALL CONFORM TO THE AMERICAN WELDING SOCIETY (SEE SPECS.) STRUCTURAL WELDING CODE.
2. WELDING SYMBOLS SHOWN ARE THOSE ADOPTED BY THE AMERICAN WELDING SOCIETY AND INDICATE ONLY SIZE AND TYPE OF WELDS REQUIRED. DETAILED INFORMATION SHALL BE SHOWN ON THE SHOP DRAWINGS AND SUBMITTED BY THE CONTRACTOR FOR APPROVAL.
3. DIMENSIONS SHOWN OR CALLED FOR ARE THE FINAL DIMENSIONS; ALLOWANCES MUST BE MADE FOR MACHINING.
4. ITEMS MARKED C.R.S. SHALL BE CORROSION RESISTANT STEEL (STAINLESS STEEL), SEE SPECIFICATIONS.
5. STEEL SHEET PILING SHALL CONFORM TO ASTM A572, GRADE 50.
6. STEEL H-PILES SHALL CONFORM TO ASTM A572, GRADE 50.

CONCRETE NOTES:

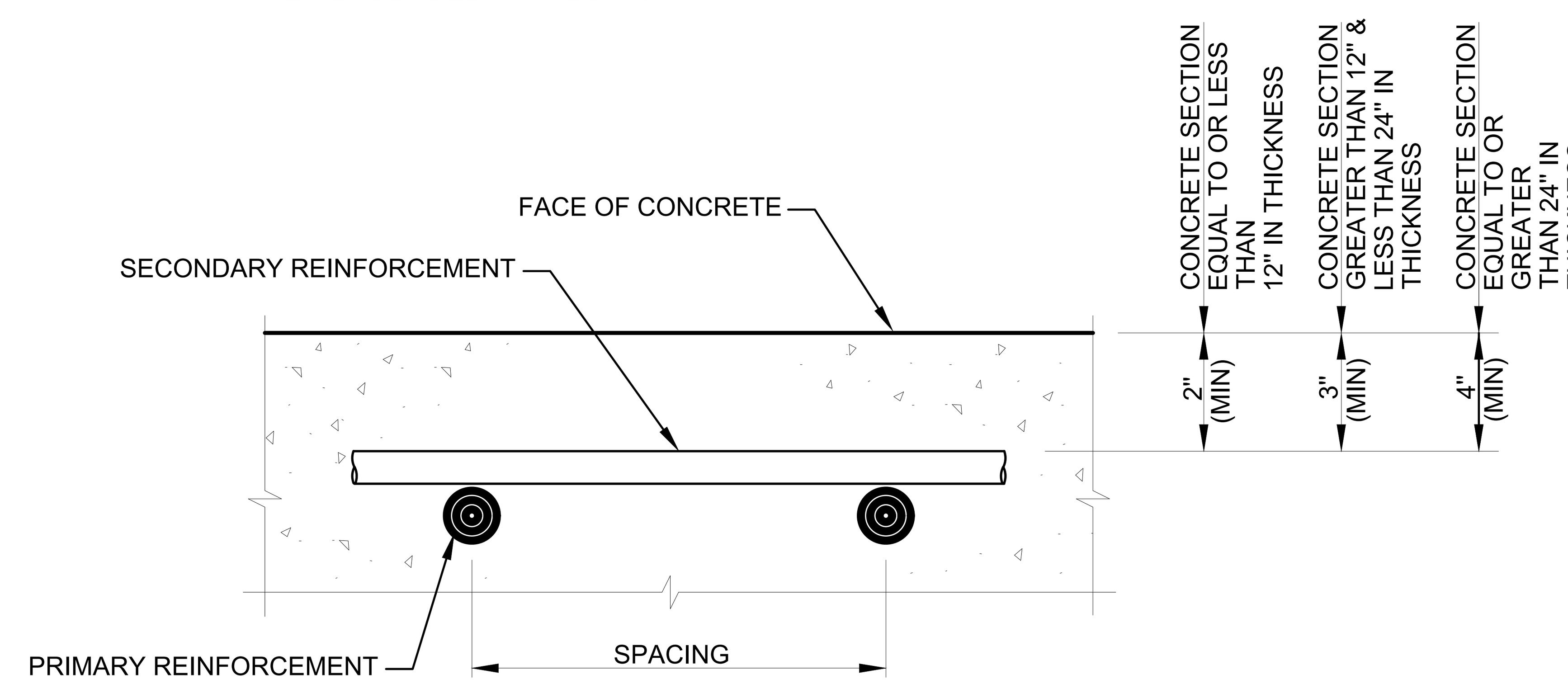
1. CONCRETE SHALL HAVE A COMPRESSIVE STRENGTH (F'c) OF 4000 PSI AT 28 DAYS (90 DAYS IF POZZOLAN IS USED), UNLESS OTHERWISE NOTED.
2. STABILIZATION SLAB CONCRETE SHALL HAVE A COMPRESSIVE STRENGTH (F'c) OF 2500 PSI AT 28 DAYS (90 DAYS IF POZZOLAN IS USED).
3. REINFORCING STEEL SHALL HAVE A MINIMUM YIELD STRENGTH (Fy) OF 60,000 PSI.
4. CONSTRUCTION JOINTS SHALL BE PROVIDED WHERE SHOWN. WHERE NOT SHOWN, CONSTRUCTION JOINTS SHALL BE PLACED AT LOCATIONS LEAST LIKELY TO IMPAIR THE INTEGRITY OF THE CONCRETE STRUCTURE. CONSTRUCTION JOINT LOCATIONS NOT OTHERWISE SHOWN ON THE PLANS SHALL BE APPROVED BY THE CONTRACTING OFFICER.
5. UNLESS OTHERWISE NOTED, PROVIDE 3/4" CHAMFER AT ALL EXPOSED JOINTS, EDGES, EXTERNAL CORNERS, AND VERTICAL EXPANSION JOINTS.
6. UNLESS NOTED OTHERWISE, CLEAR COVER SHALL BE:
   2" FOR SECTIONS EQUAL TO OR LESS THAN 12" THICK
   3" FOR SECTIONS GREATER THAN 12" AND LESS THAN 24" THICK
   4" FOR SECTIONS GREATER THAN 24" THICK
7. ALL BENDS OF REINFORCEMENT AND ALL BAR SPACERS AND SUPPORTS SHALL BE IN ACCORDANCE WITH SP-66, AMERICAN CONCRETE INSTITUTE DETAILING MANUAL - 2004.
8. REINFORCING BAR DESIGNATION NUMBERS CONFORM TO THE NUMBERING SYSTEM OF THE CONCRETE REINFORCING STEEL INSTITUTE.
9. REINFORCING BARS SHALL BE CONTINUOUS AT ALL CORNERS UNLESS OTHERWISE NOTED.
10. REINFORCEMENT, WHERE NECESSARY TO AVOID OPENINGS, PIPES, EMBEDDED ITEMS AND OTHER OBSTRUCTIONS, SHALL BE BENT OR SHIFTED AS DIRECTED BY THE CONTRACTING OFFICER.
11. THE EMBEDMENT AND SPLICE TABLE SHALL BE USED IN DETERMINING LAP SPLICES AND EMBEDMENT LENGTHS WHERE LENGTHS ARE NOT OTHERWISE INDICATED. SPLICE LENGTHS SHALL BE BASED ON THE SMALLER BAR BEING LAPPED. THE CONTRACTOR WILL BE ALLOWED TO MAKE SPLICES IN ADDITION TO THOSE INDICATED IN THE DRAWINGS, WHERE ESSENTIAL TO CONSTRUCTIBILITY, SUBJECT TO APPROVAL BY THE CONTRACTING OFFICER. SPLICES OTHER THAN THOSE SHOWN ON THE DRAWINGS AND OTHER THAN ANY ADDITIONAL SPLICES REQUIRED BY THE CONTRACTING OFFICER, WILL BE AT THE CONTRACTOR'S EXPENSE.
12. ALL EXTERIOR FORMED SURFACES NOT COVERED BY BACK FILL SHALL BE CLASS "A" FINISH AND SURFACES COVERED BY BACK FILL SHALL BE CLASS "D" FINISH, UNLESS OTHERWISE NOTED.
13. FOR "T-WALL" STEMS, CONCRETE PLACEMENT SHALL BE BY PUMP / TREMIE OR THE CONTRACTOR SHALL EMPLOY TEMPORARY "WINDOWS" IN THE FORMS TO FACILITATE CONCRETE PLACEMENT AND CONSOLIDATION.

REINFORCEMENT EMBEDMENT AND SPLICE TABLES - 4000 PSI

BAR SIZE	BASIC TABLE				ALTERNATE TABLE			
	MINIMUM EMBEDMENT LENGTH, INCHES		MINIMUM LAP LENGTH INCHES		MINIMUM EMBEDMENT LENGTH, INCHES		MINIMUM LAP LENGTH INCHES	
	TOP	OTHER	TOP	OTHER	TOP	OTHER	TOP	OTHER
3	18	14	24	18	12	12	14	12
4	25	19	32	25	15	12	19	15
5	31	24	40	31	18	14	24	18
6	37	28	48	37	22	17	29	22
7	54	42	70	54	32	25	42	32
8	62	47	80	62	37	28	48	37
9	69	53	90	69	42	32	54	42
10	77	59	100	77	46	36	60	46
11	85	65	110	85	51	39	66	51

NOTES:

1. USE THE BASIC TABLE IF ALL OF THE FOLLOWING CONDITIONS ARE MET:
   A) CENTER TO CENTER BAR SPACING LATERALLY IS AT LEAST 4 BAR DIAMETERS
   B) CONCRETE COVER IS AT LEAST 2 BAR DIAMETERS, AND
   C) EDGE DISTANCE TO THE FIRST BAR IN A LAYER IS AT LEAST 2 BAR DIAMETERS.
2. THE ALTERNATE TABLE MAY BE USED IF ALL OF THE FOLLOWING CONDITIONS ARE MET:
   A) CENTER TO CENTER BAR SPACING LATERALLY IS AT LEAST 6 BAR DIAMETERS
   B) CONCRETE COVER IS AT LEAST 2 BAR DIAMETERS, AND
   C) EDGE DISTANCE TO THE FIRST BAR IN A LAYER IS AT LEAST 2.5 BAR DIAMETERS.
3. IF CONCRETE COVER OR EDGE DISTANCE IS LESS THAN 2 BAR DIAMETERS OR THE CENTER TO CENTER BAR SPACING LATERALLY IS LESS THAN 4 DIAMETERS, SEE ACI 318 FOR APPROPRIATE GUIDANCE.
4. TOP BARS ARE HORIZONTAL BARS AND BARS INCLINED LESS THAN 45 DEGREES WITH RESPECT TO A HORIZONTAL PLANE WHICH ARE PLACED SUCH THAT MORE THAN 12 INCHES OF CONCRETE IS CAST IN THE MEMBER BELOW THE BAR.



REINFORCEMENT CLEARANCE DETAIL

NTS

ABBREVIATIONS

* UNLESS OTHERWISE NOTED ON EACH SHEET

APP.	APPARENT	FES	FLARED END SECTION	SPEC	SPECIFICATIONS
APPROX	APPROXIMATE	GALV	GALVANIZED	SST	STAINLESS STEEL
ALT W/	ALTERNATE WITH	HT	HEIGHT	SURV	SURVEY
ALUM	ALUMINUM	IF	INSIDE FACE	T&B	TOP AND BOTTOM
B/L	BASELINE	LG	LONG	T.O.C.	TOP OF CASTING
BITUM	BITUMINOUS	L/W	LANDWARD	TYP	TYPICAL
BOT	BOTTOM	MAX	MAXIMUM	UNO	UNLESS NOTED OTHERWISE
C/L	CENTER LINE	MIN	MINIMUM	UGND	UNDERGROUND
C&G	CURB & GUTTER	MIRR	MIRRORED	W/	WITH
CLR	CLEAR	MISC	MISCELLANEOUS	W/L	WALL LINE
CJ	CONSTRUCTION JOINT	N/S	NORFOLK SOUTHERN	WM	WATER MAIN
CMP	CORRUGATED METAL PIPE	NF	NEAR FACE		
CONC	CONCRETE	NO	NUMBER		
DIA., Ø	DIAMETER	OF	OUTSIDE FACE		
DWG.	DRAWING	OC	ON CENTER		
E.F.	EACH FACE	PROJ	PROJECT		
EJ	EXPANSION JOINT	R/W	RIGHT OF WAY		
ELEV.	ELEVATION	RCP	REINFORCED CONCRETE PIPE		
E.W.	EACH WAY	REQ'D	REQUIRED		
EXIST.	EXISTING	R.R.	RAILROAD		
EQ.	EQUAL	SP	SPACE		
FTG	FOOTING	S/W	SIDEWALK		
FF	FAR FACE	SAN	SANITARY		

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: SO

ATKINS Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC. ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title: WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title: GENERAL NOTES

Scale	Designed	Drawn	Checked	Authorized
--	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number: 100068207-G-001
Revision: 000

DO NOT SCALE

SHEET NO.	SHEET TITLE	
G	GENERAL	
G-001	GENERAL NOTES	
G-002	SHEET INDEX	
S	STRUCTURAL - GATE BAY AND T-WALLS	
S-101	OVERALL FOUNDATION PLAN AND PROFILE VIEW (1 OF 2)	
S-102	OVERALL FOUNDATION PLAN AND PROFILE VIEW (2 OF 2)	
S-103	MONOLITH 1 PLAN VIEW	
S-104	MONOLITH 2 PLAN VIEW	
S-105	MONOLITH 3 PLAN VIEW	
S-106	MONOLITH 4 PLAN VIEW	
S-107	MONOLITH 5 PLAN VIEW	
S-108	MONOLITH 6 PLAN VIEW	
S-109	MONOLITH 7 PLAN VIEW	
S-110	MONOLITH 8 PLAN VIEW	
S-111	MONOLITH 9 PLAN VIEW	
S-112	MONOLITH 10 PLAN VIEW	
S-113	I-WALL 1 PLAN VIEW	
S-114	I-WALL 2 PLAN VIEW	
S-115	RAILROAD PLAN VIEW	
S-301	MONOLITH 1 SECTION	
S-302	MONOLITH 2 SECTION	
S-303	MONOLITH 3 SECTION	
S-304	MONOLITH 4 SECTION	
S-305	MONOLITH 5 SECTION	
S-306	MONOLITH 6 SECTION	
S-307	MONOLITH 7 SECTION	
S-308	MONOLITH 8 SECTION	
S-309	MONOLITH 9 SECTION	
S-310	MONOLITH 10 SECTION	
S-311	I-WALL 1 SECTION	
S-312	I-WALL 2 SECTION	
S-501	GATE ELEVATION	
S-502	SWING GATE DETAIL (1 OF 3)	-NOT INCLUDED IN SET
S-503	SWING GATE DETAIL (2 OF 3)	-NOT INCLUDED IN SET
S-504	SWING GATE DETAIL (3 OF 3)	-NOT INCLUDED IN SET
S-505	SWING GATE LOWER HINGE DETAIL (1 OF 6)	-NOT INCLUDED IN SET
S-506	SWING GATE LOWER HINGE DETAIL (2 OF 6)	-NOT INCLUDED IN SET
S-507	SWING GATE LOWER HINGE DETAIL (3 OF 6)	-NOT INCLUDED IN SET
S-508	SWING GATE LOWER HINGE DETAIL (4 OF 6)	-NOT INCLUDED IN SET
S-509	SWING GATE LOWER HINGE DETAIL (5 OF 6)	-NOT INCLUDED IN SET
S-510	SWING GATE LOWER HINGE DETAIL (6 OF 6)	-NOT INCLUDED IN SET
S-511	SWING GATE UPPER HINGE DETAIL	-NOT INCLUDED IN SET
S-512	SWING GATE LATCHING DETAIL	
S-513	LATCHING DETAIL (1 OF 2)	-NOT INCLUDED IN SET
S-514	LATCHING DETAIL (2 OF 2)	-NOT INCLUDED IN SET
S-515	LADDER DETAIL (1 OF 3)	
S-516	LADDER DETAIL (2 OF 3)	
S-517	LADDER DETAIL (3 OF 3)	
S-518	MISCELLANEOUS DETAILS	-NOT INCLUDED IN SET
S-519	SETTLEMENT DETAILS	-NOT INCLUDED IN SET
S-520	SWING GATE SEAL DETAILS (1 OF 2)	
S-521	SWING GATE SEAL DETAILS (2 OF 2)	
S-522	SCOUR PROTECTION DETAIL (1 OF 2)	
S-523	SCOUR PROTECTION DETAIL (2 OF 2)	
S-524	DRAINAGE AND UTILITY DETAILS	
S-525	T-WALL JOINT DETAILS	-NOT INCLUDED IN SET
S-526	RAILS AND COMPONENT PART DETAIL (1 OF 2)	
S-527	RAILS AND COMPONENT PART DETAIL (2 OF 2)	
S-528	TYPICAL PILE DETAIL	
CS	RAILROAD TRS	
CS-100	RAILROAD TRS (1 OF 6)	
CS-101	RAILROAD TRS (2 OF 6)	
CS-102	RAILROAD TRS (3 OF 6)	
CS-103	RAILROAD TRS (4 OF 6)	
CS-104	RAILROAD TRS (5 OF 6)	
CS-105	RAILROAD TRS (6 OF 6)	

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: SO

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

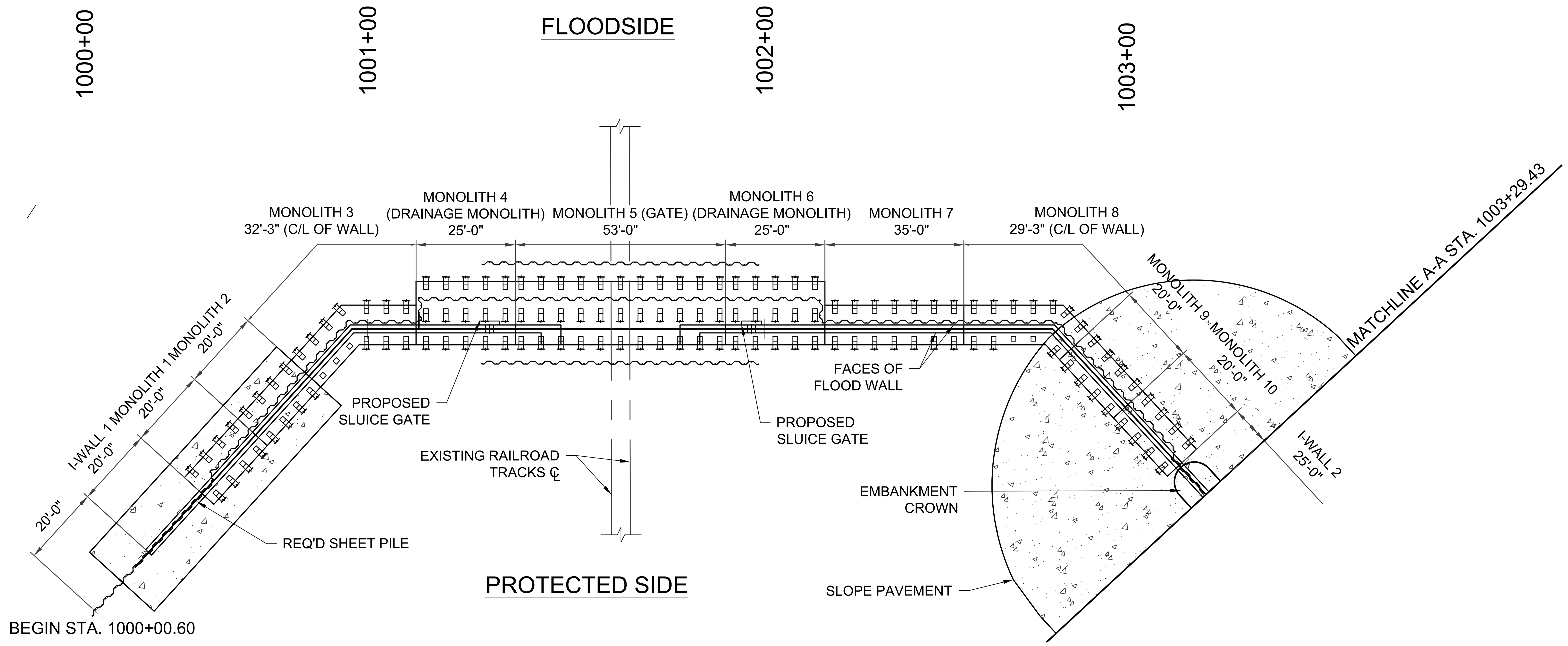
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
SHEET INDEX

Scale	Designed	Drawn	Checked	Authorized
--	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

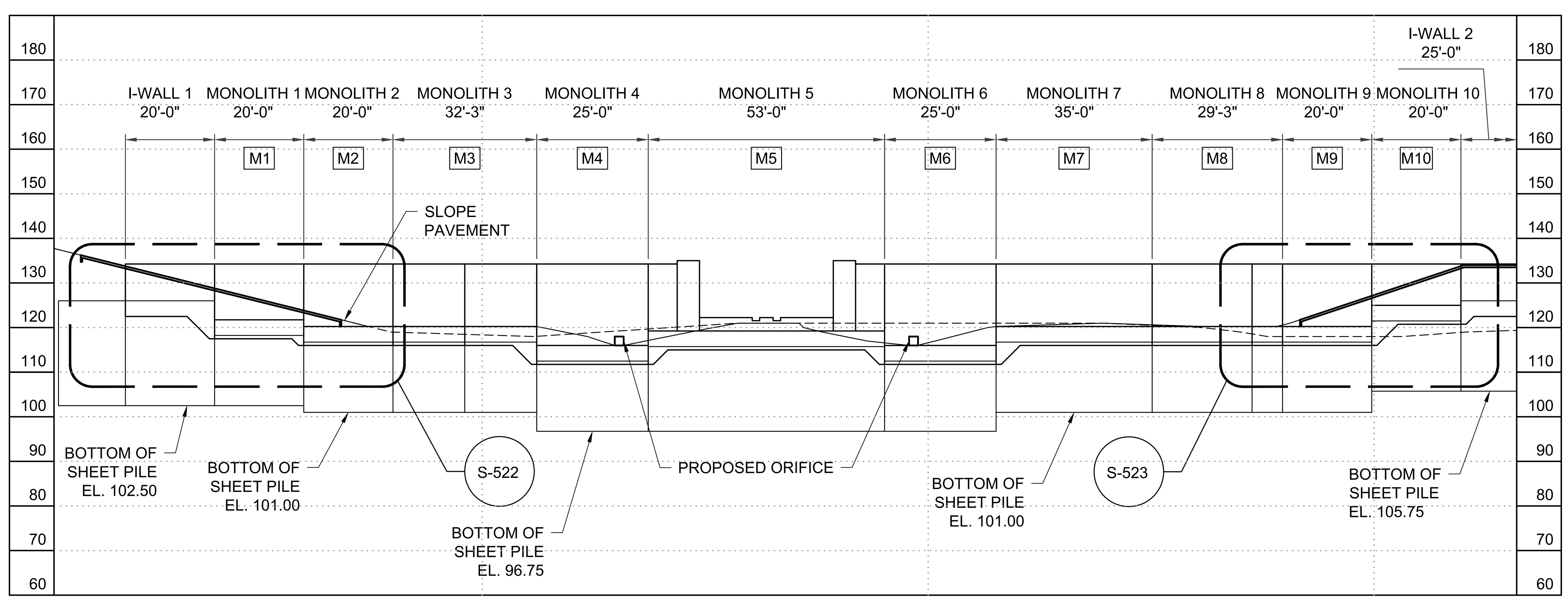
Drawing Number: 100068207-G-002
Revision: 000

DO NOT SCALE



PLAN VIEW

SCALE: 1"=20'



PROFILE VIEW

SCALE: 1"=20'

0 10 20 40 60

(IN FEET)
1 inch = 20 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

811 Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION — Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

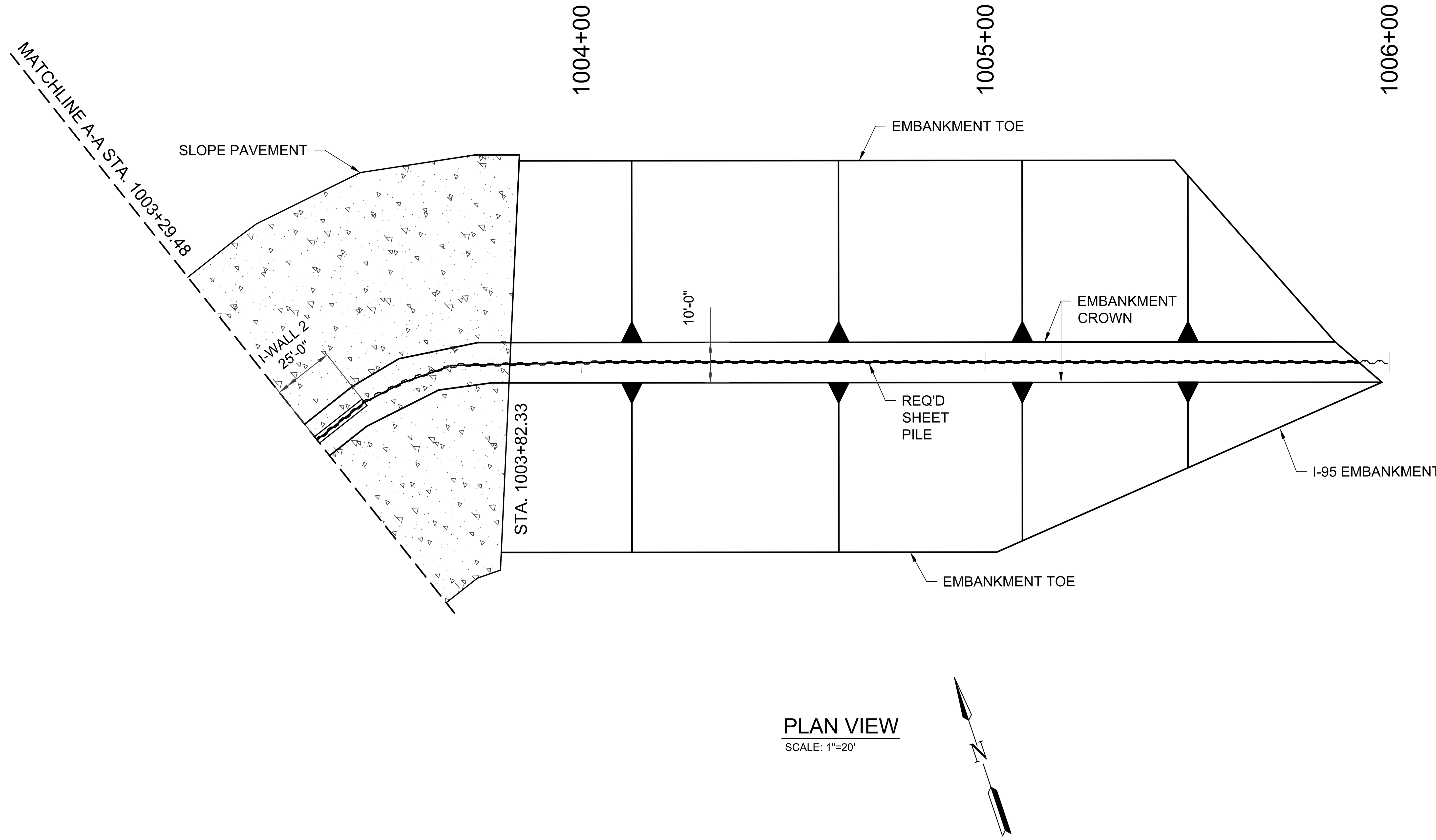
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
OVERALL FOUNDATION
PLAN VIEW (1 OF 2)

Scale	Designed	Drawn	Checked	Authorized
1"=20'	--	--	--	--
Original Size: 22x34	Date: --/--/--	Date: --/--/--	Date: --/--/--	Date: --/--/--

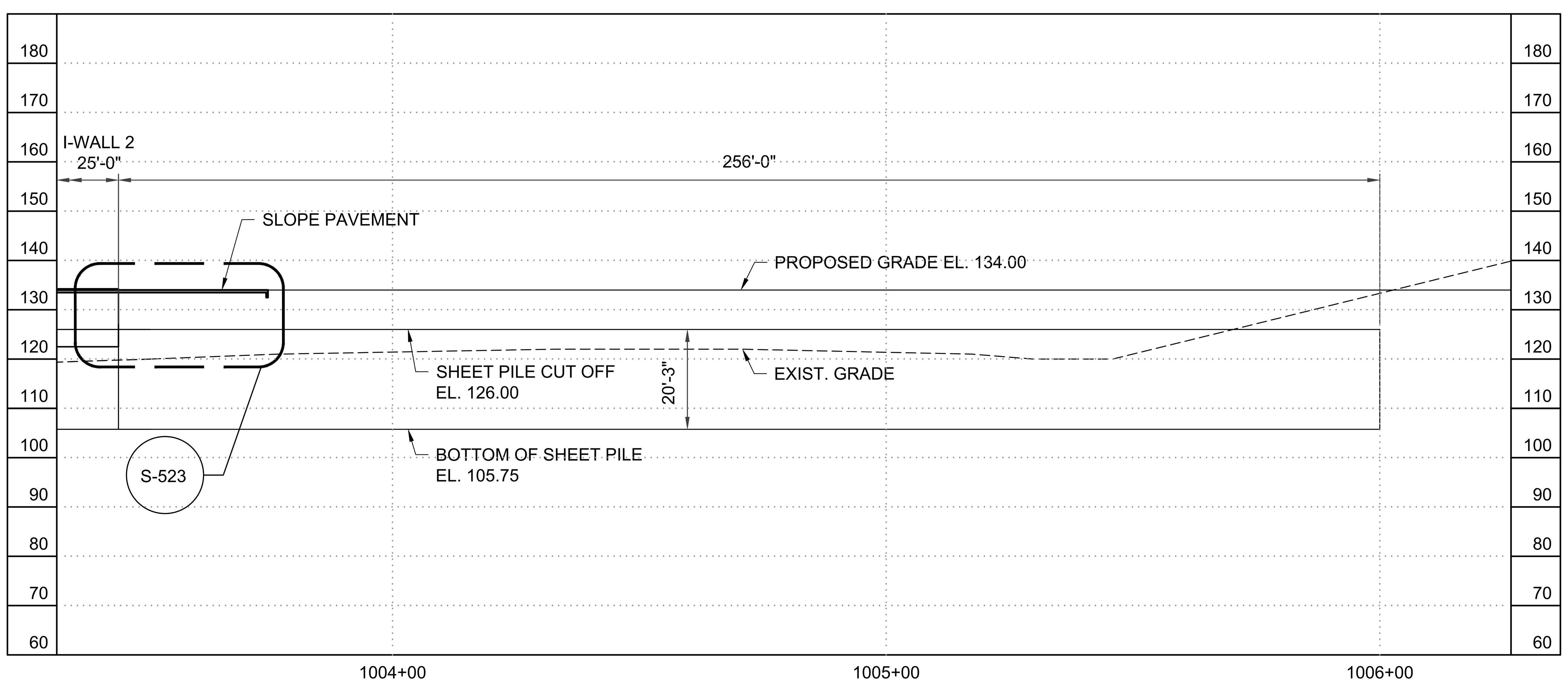
Drawing Number: 100068207-S-101 — Revision: 000

DO NOT SCALE



PLAN VIEW

SCALE: 1"=20'



PROFILE VIEW

SCALE: 1"=20'

0 10 20 40 60

(IN FEET)
1 inch = 20 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

811 Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title:
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

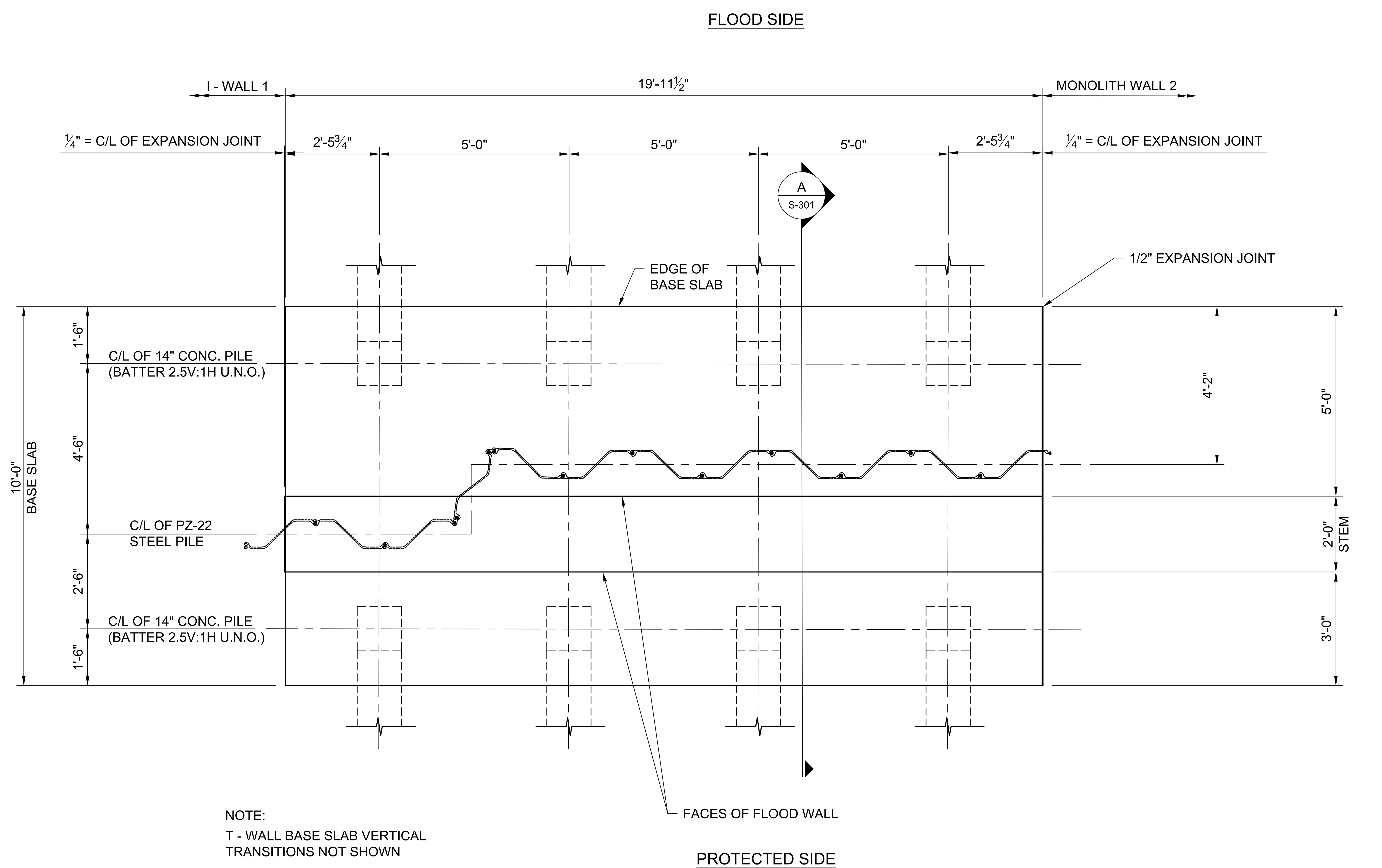
Drawing Title:
OVERALL FOUNDATION
PLAN VIEW (2 OF 2)

Scale	Designed	Drawn	Checked	Authorized
1"=20'	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number: 100068207-S-102

Revision: 000

DO NOT SCALE



NOTE:
T - WALL BASE SLAB VERTICAL TRANSITIONS NOT SHOWN

MONOLITH 1 PLAN VIEW
SCALE: 1/2"=1'

0 1 2 4 6
(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION | Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

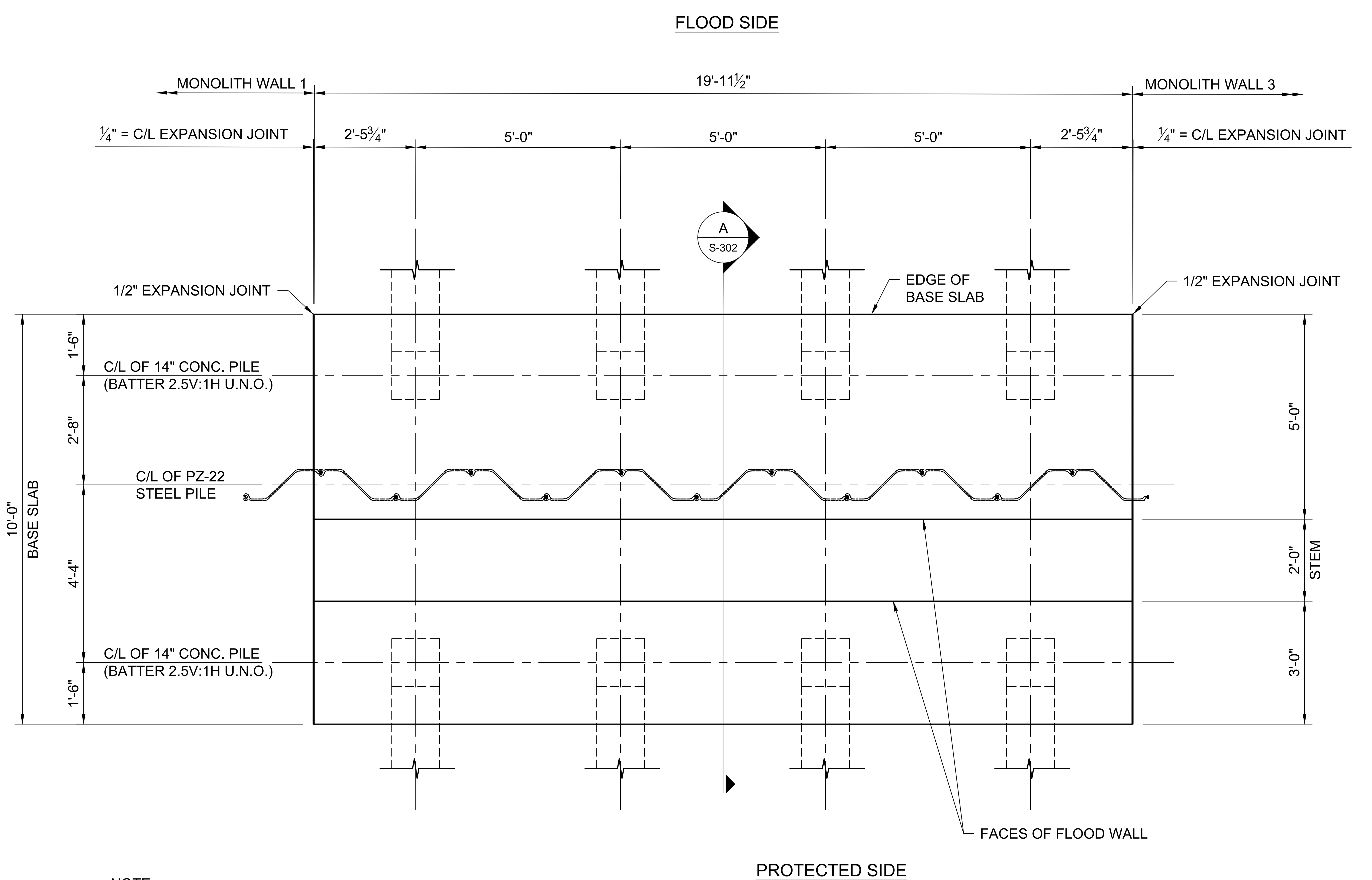
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
MONOLITH 1
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

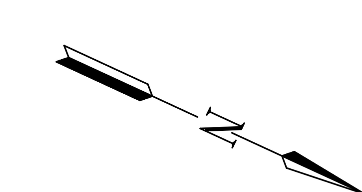
Drawing Number: 100068207-S-103 | Revision: 000

DO NOT SCALE



NOTE:
T - WALL BASE SLAB VERTICAL
TRANSITIONS NOT SHOWN

MONOLITH 2 PLAN VIEW
SCALE: 1/2"=1'



0 1 2 4 6
(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

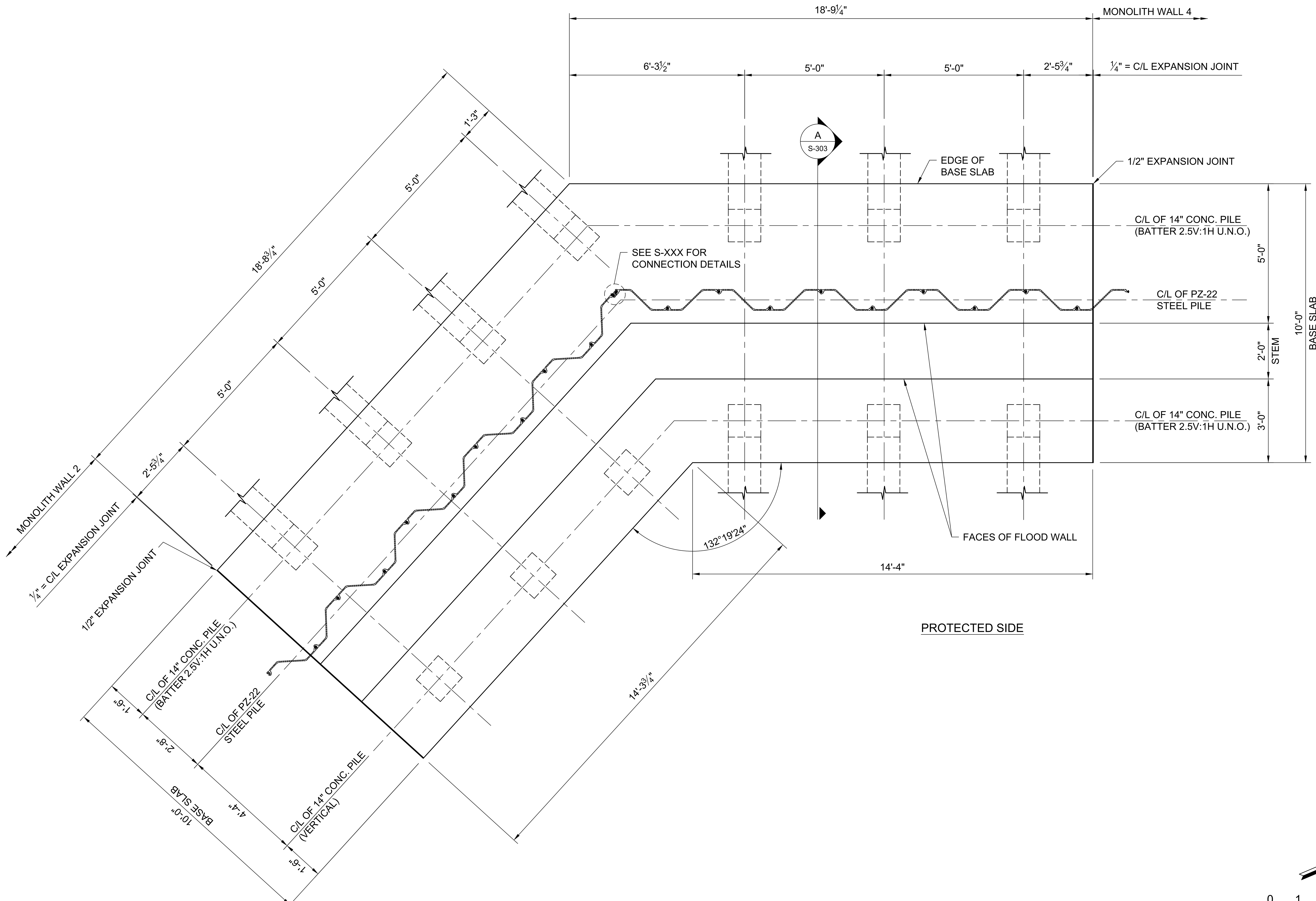
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
MONOLITH 2
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-104
Revision: 000

DO NOT SCALE



NOTE:
T - WALL BASE SLAB VERTICAL TRANSITIONS NOT SHOWN

MONOLITH 3 PLAN VIEW

SCALE: 1/2"=1'

0 1 2 4 6
(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: SO

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

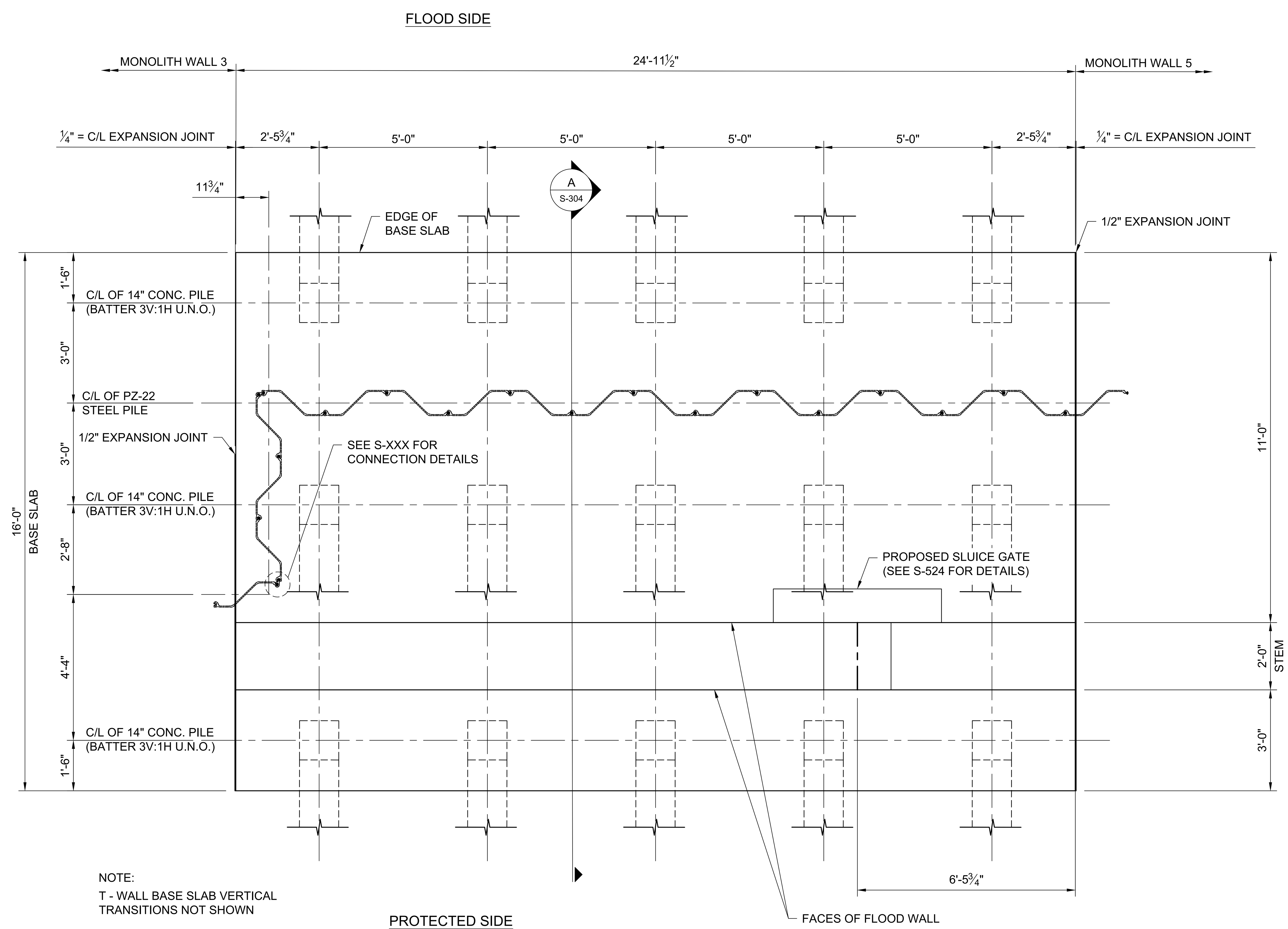
Project Title:
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title:
MONOLITH 3
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

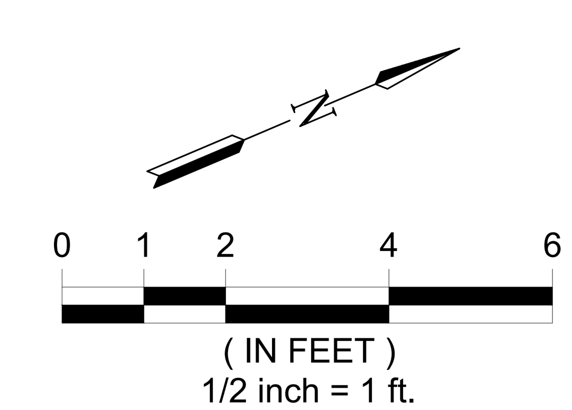
Drawing Number: 100068207-S-105
Revision: 000

DO NOT SCALE



DRAINAGE MONOLITH 4 PLAN VIEW

SCALE: 1/2"=1'



PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of Lumberton North Carolina

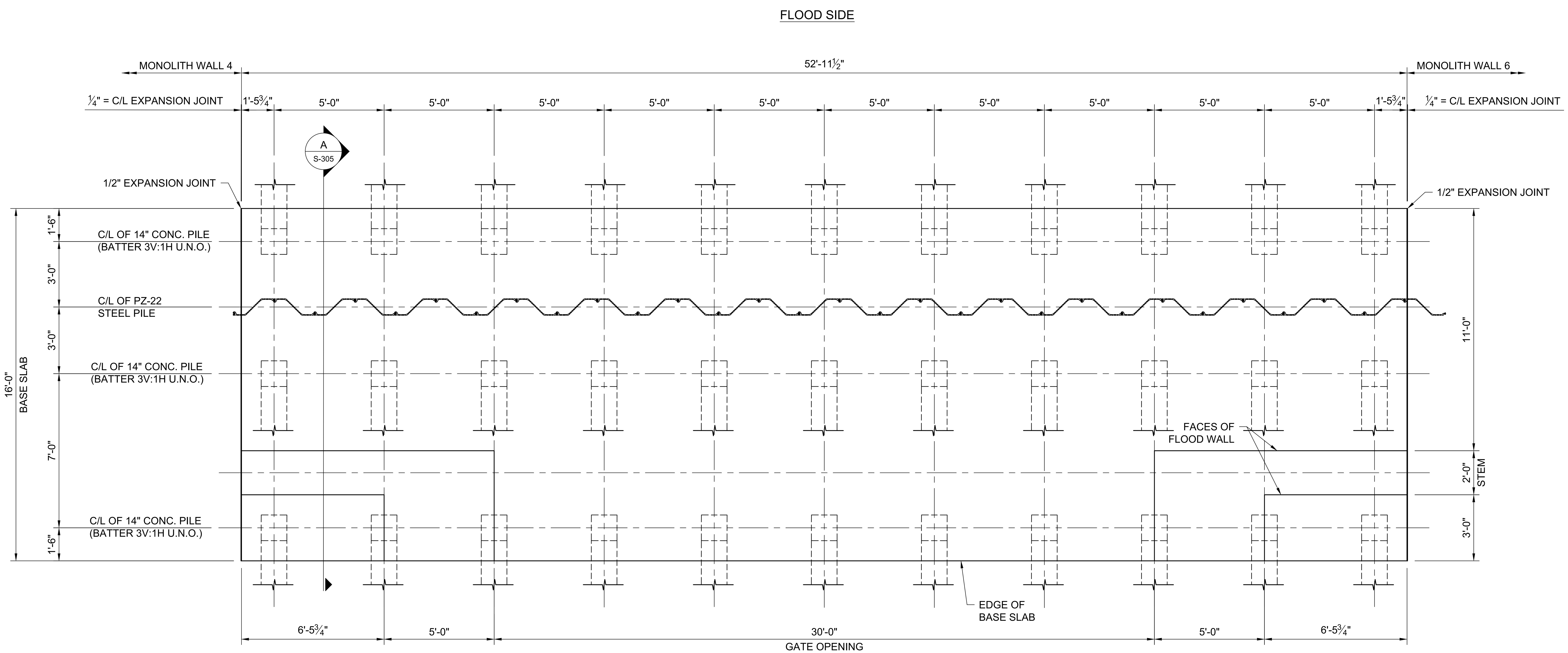
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
MONOLITH 4
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-106
Revision: 000

DO NOT SCALE



NOTE:
T - WALL BASE SLAB VERTICAL TRANSITIONS NOT SHOWN

MONOLITH 5 (GATE) PLAN VIEW

SCALE: 3/8"=1'

0 1 2 4 8
(IN FEET)
3/8 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

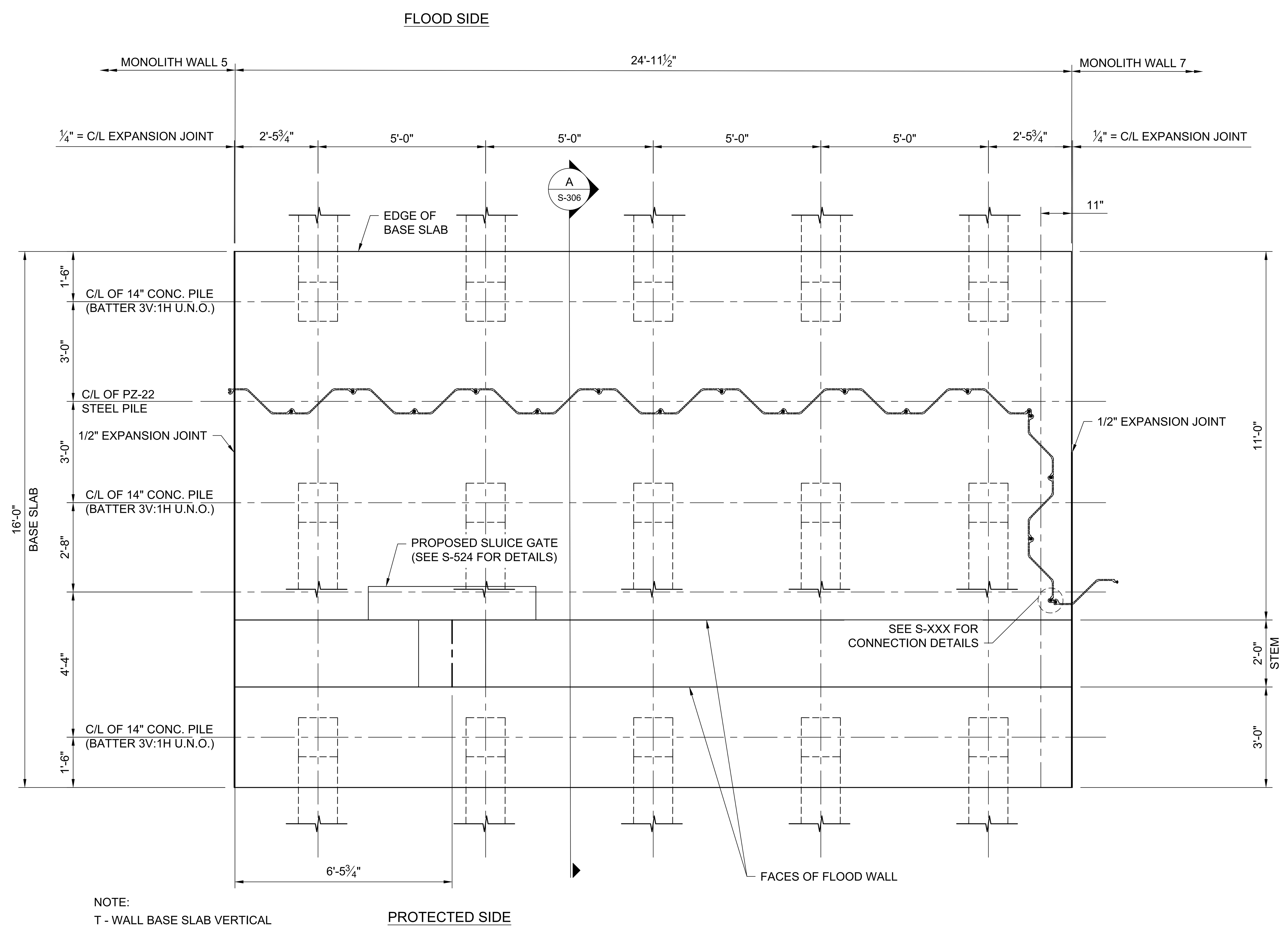
Project Title: WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title: MONOLITH 5
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
3/8"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-107
Revision: 000

DO NOT SCALE



NOTE:
T - WALL BASE SLAB VERTICAL TRANSITIONS NOT SHOWN

DRAINAGE MONOLITH 6 PLAN VIEW

SCALE: 1/2"=1'

0 1 2 4 6
(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client
City of LUMBERTON North Carolina

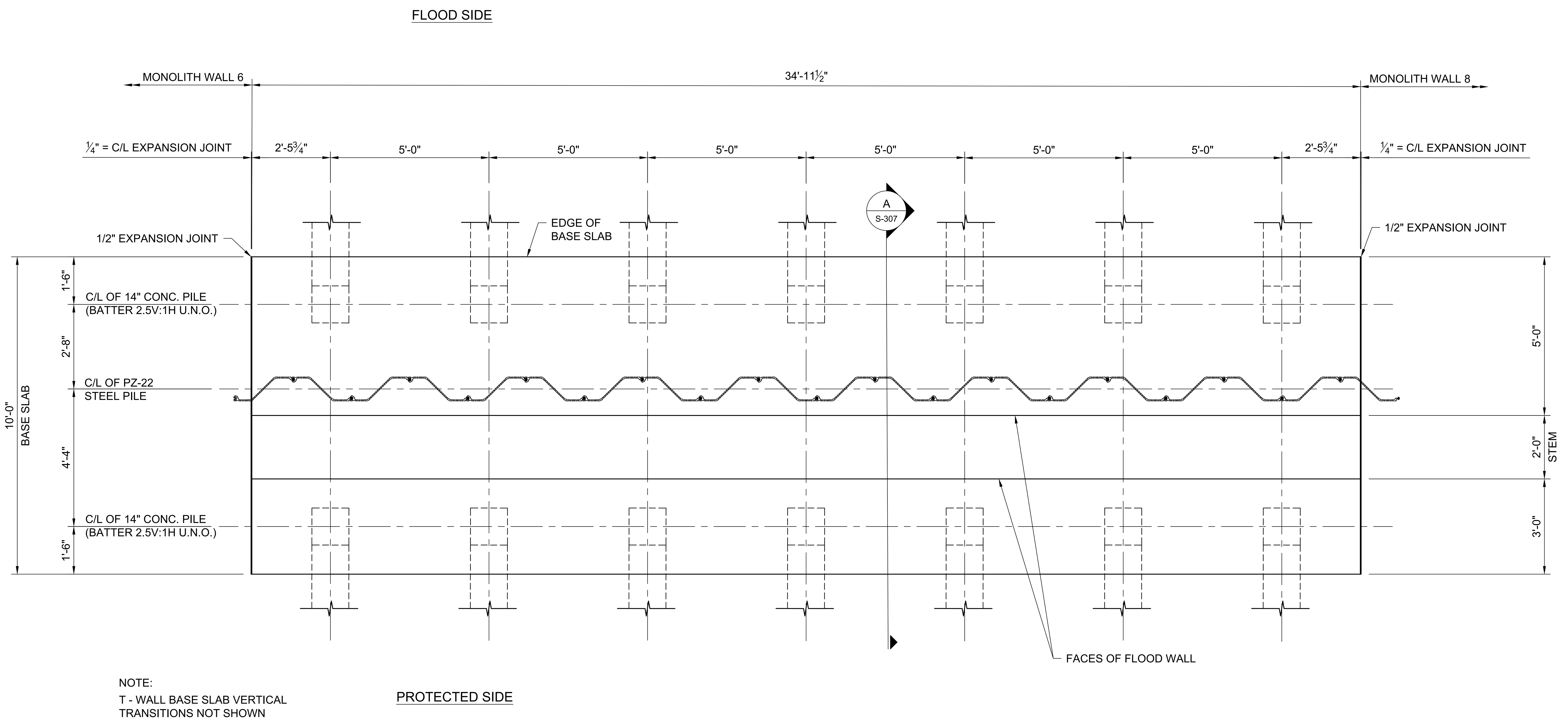
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
MONOLITH 6
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

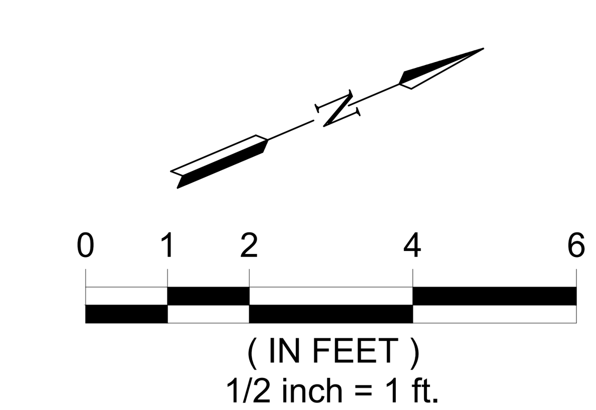
Drawing Number: 100068207-S-108
Revision: 000

DO NOT SCALE



NOTE:
T - WALL BASE SLAB VERTICAL
TRANSITIONS NOT SHOWN

MONOLITH 7 PLAN VIEW
SCALE: 1/2"=1'



PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION,
CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

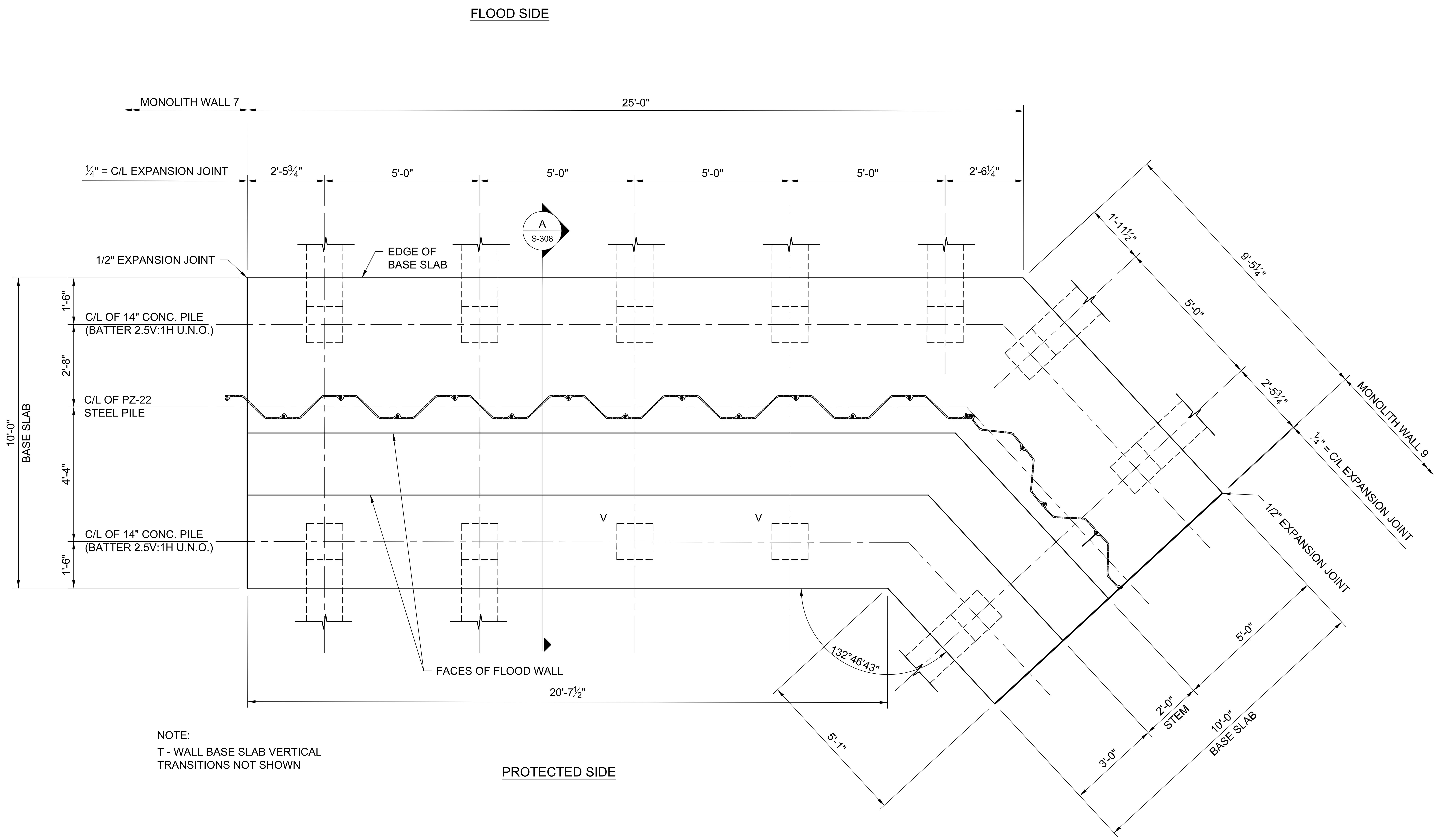
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
MONOLITH 7
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number: 100068207-S-109
Revision: 000

DO NOT SCALE



MONOLITH 8 PLAN VIEW

SCALE: 1/2"=1'

N

0 1 2 4 6

(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

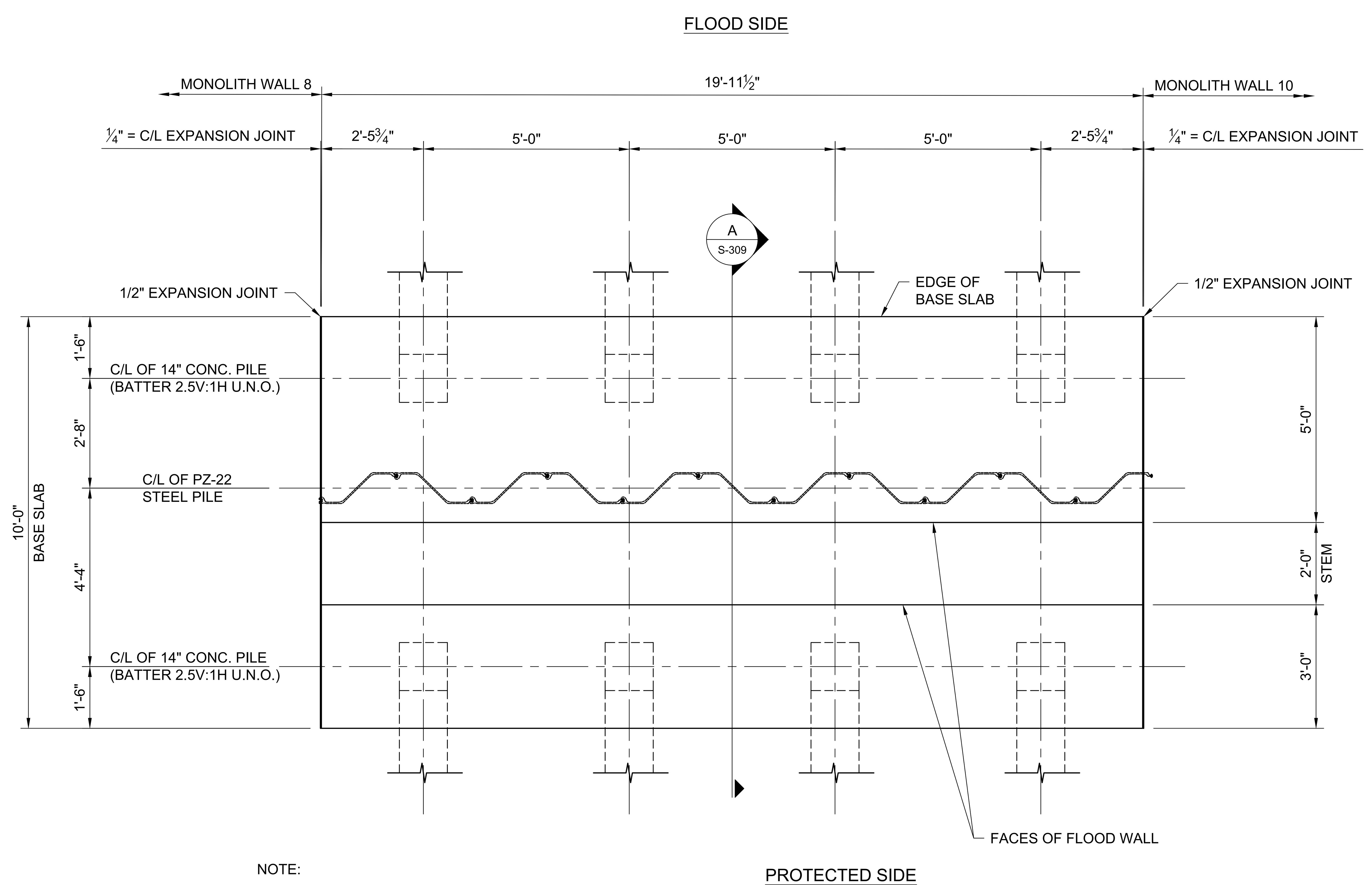
Project Title: WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title: MONOLITH 8
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-110
Revision: 000

DO NOT SCALE



NOTE:
T - WALL BASE SLAB VERTICAL TRANSITIONS NOT SHOWN

MONOLITH 9 PLAN VIEW
SCALE: 1/2"=1'

0 1 2 4 6
(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

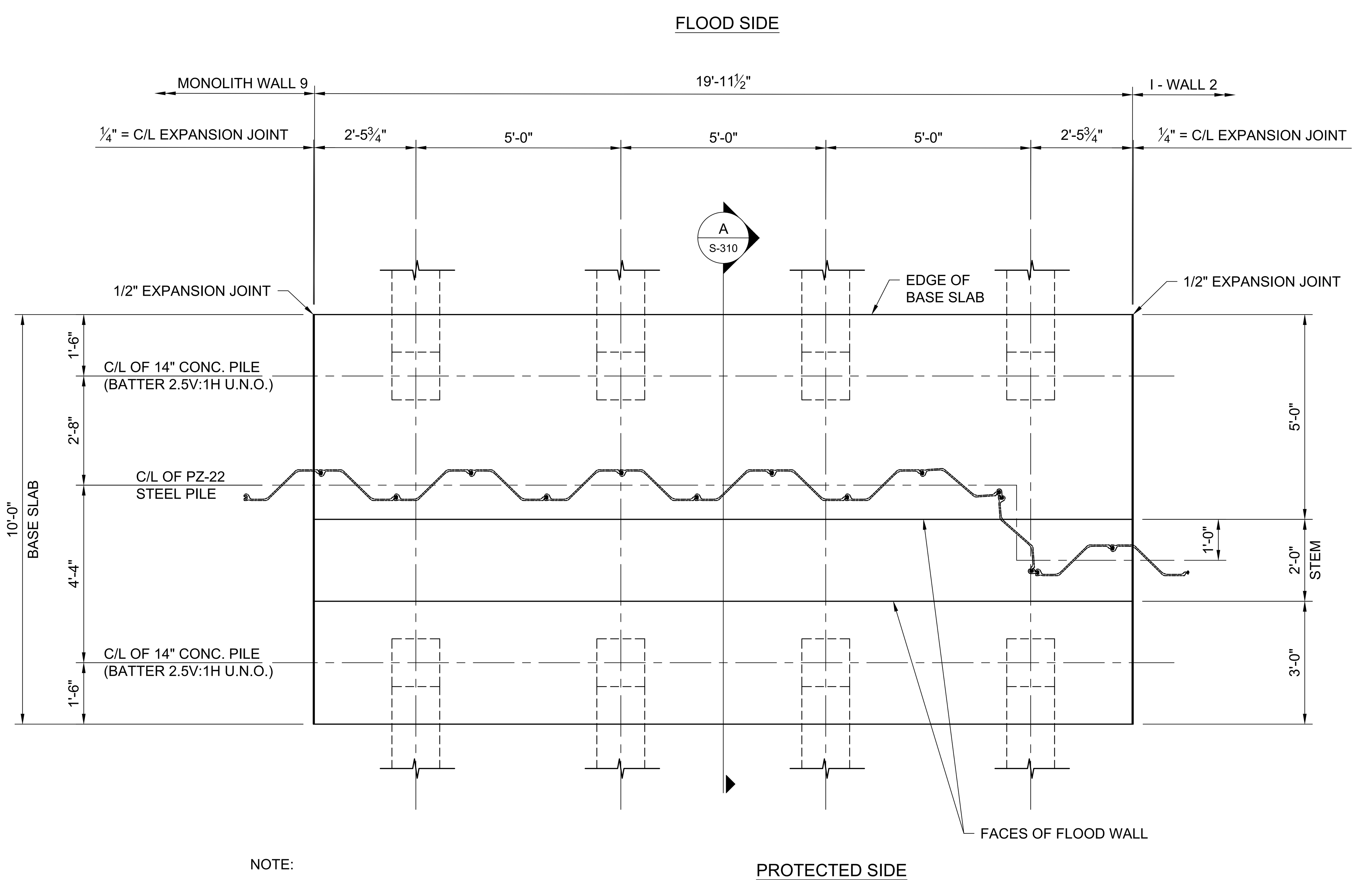
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: MONOLITH 9 PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-111
Revision: 000

DO NOT SCALE



NOTE:
T - WALL BASE SLAB VERTICAL TRANSITIONS NOT SHOWN

MONOLITH 10 PLAN VIEW
SCALE: 1/2"=1'

0 1 2 4 6
(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

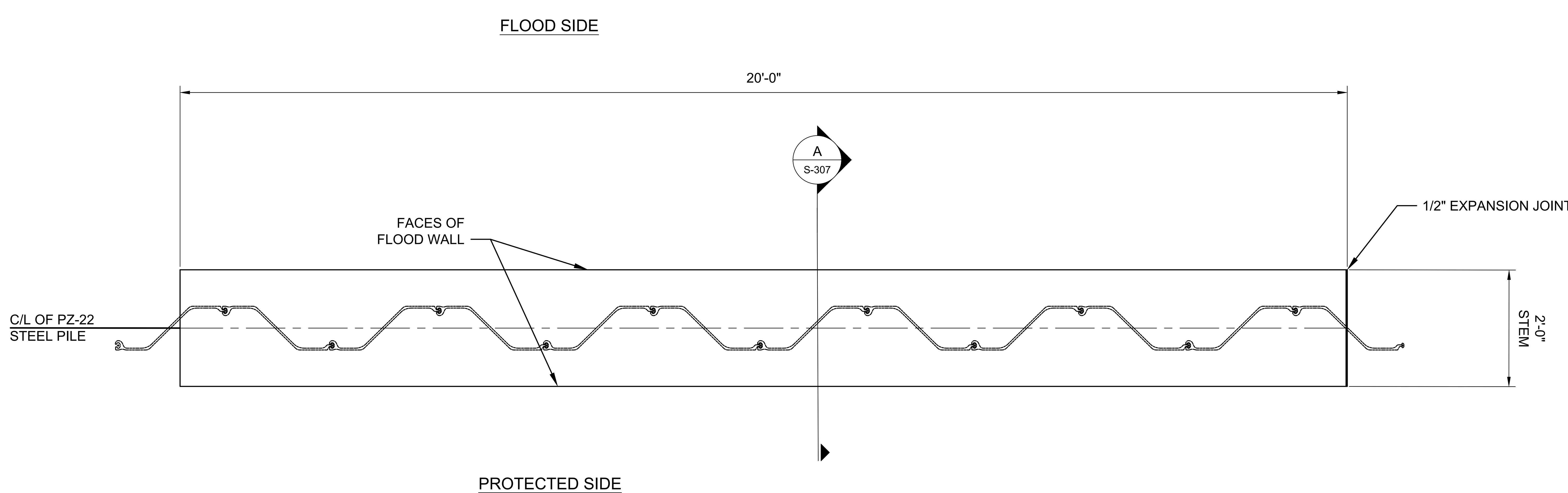
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
MONOLITH 10
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

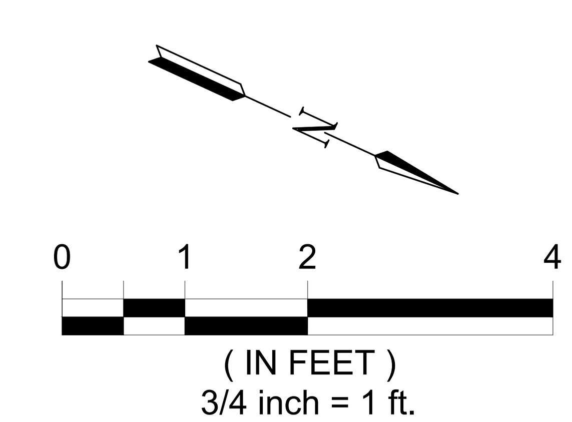
Drawing Number: 100068207-S-112
Revision: 000

DO NOT SCALE



I-WALL 1 PLAN VIEW

SCALE: 3/4"=1'



PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION | Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

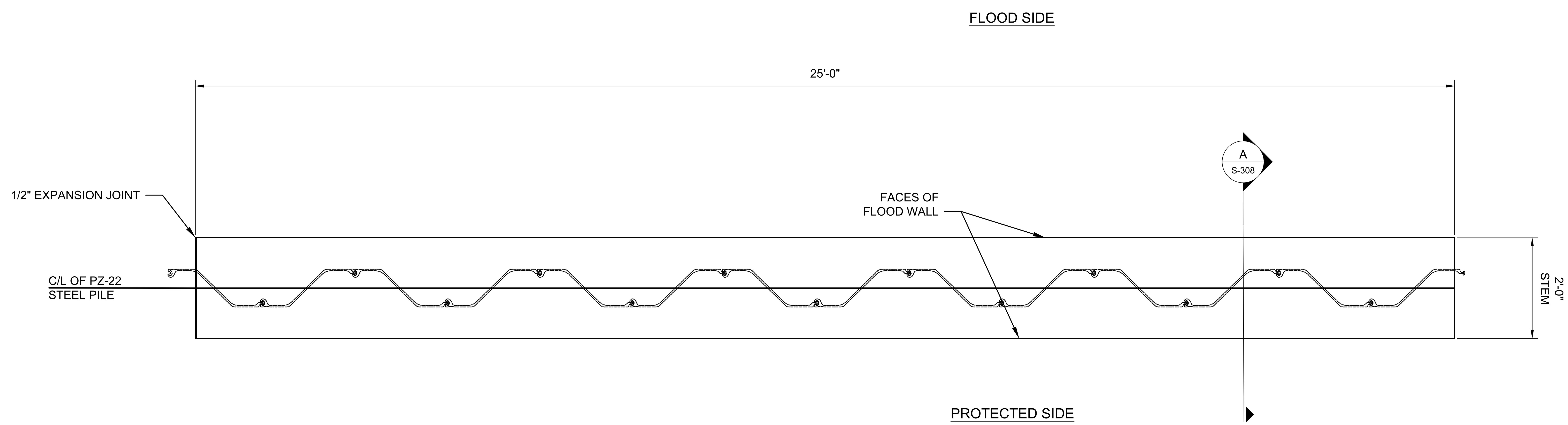
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
I-WALL 1
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
3/4"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

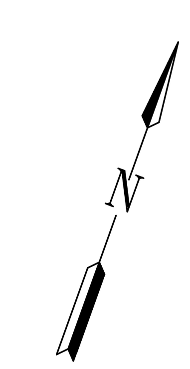
Drawing Number: 100068207-S-113 | Revision: 000

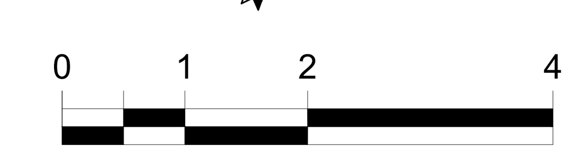
DO NOT SCALE



I-WALL 2 PLAN VIEW

SCALE: 3/4"=1'





PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title

WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title

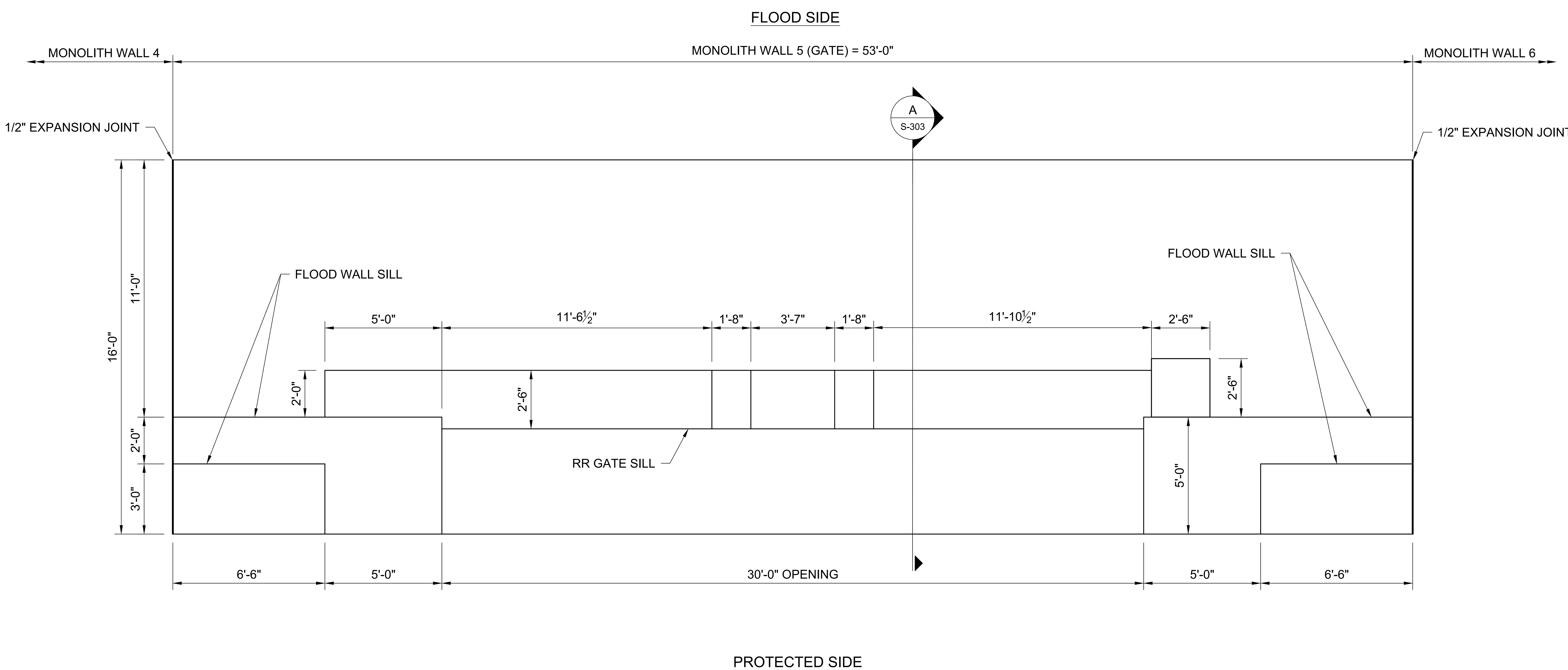
I-WALL 2
PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
3/4"= 1'	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number: 100068207-S-114

Revision: 000

DO NOT SCALE



RAILROAD PLAN VIEW

SCALE: 3/8"=1'

0 1 2 4 8

(IN FEET)

3/8 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION | Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

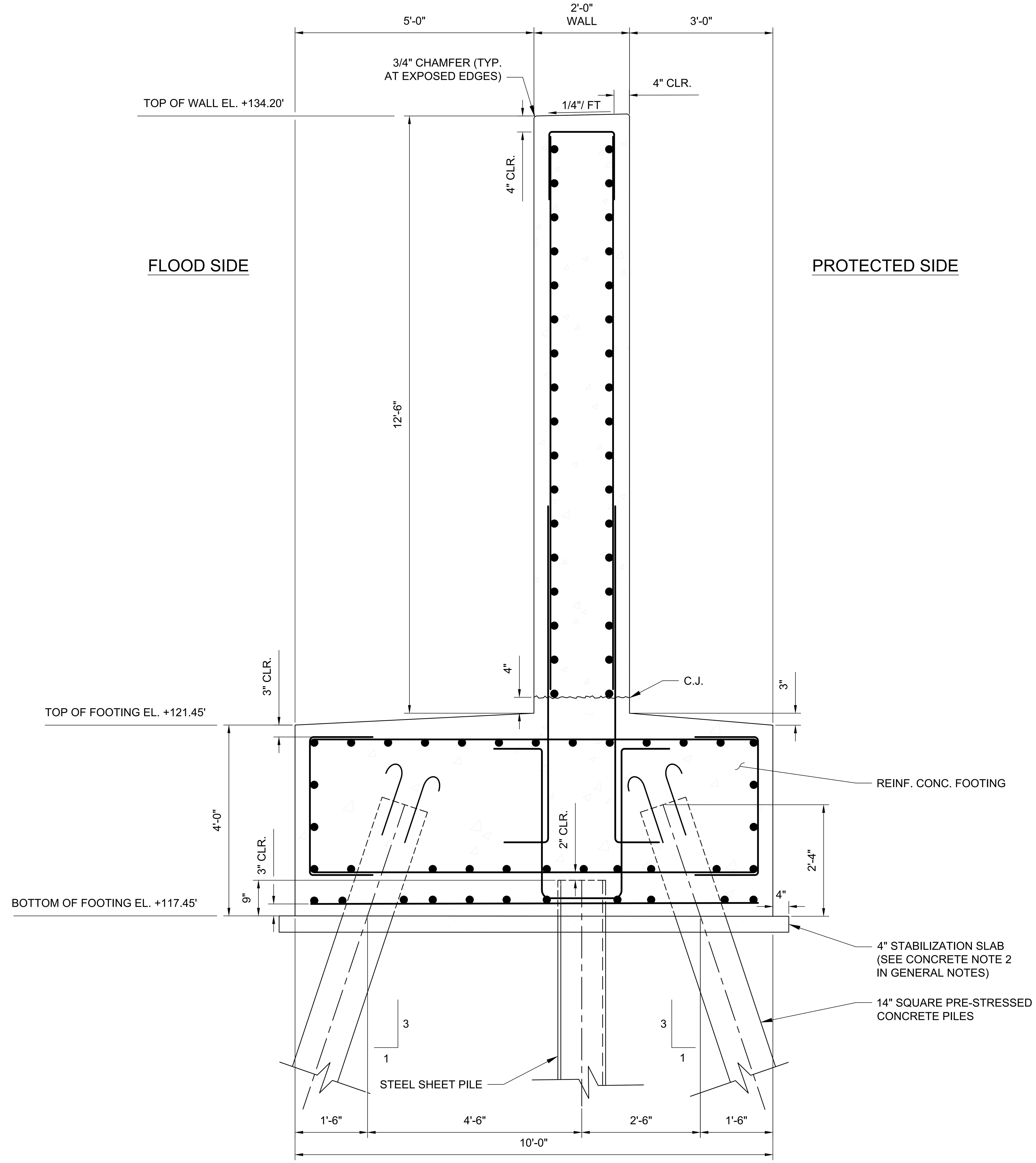
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: RAIL ROAD PLAN VIEW

Scale	Designed	Drawn	Checked	Authorized
3/8"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-115 | Revision: 000

DO NOT SCALE



MONOLITH 1 SECTION

SCALE: 3/4"=1'

0 1 2 4

(IN FEET)

3/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title:
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

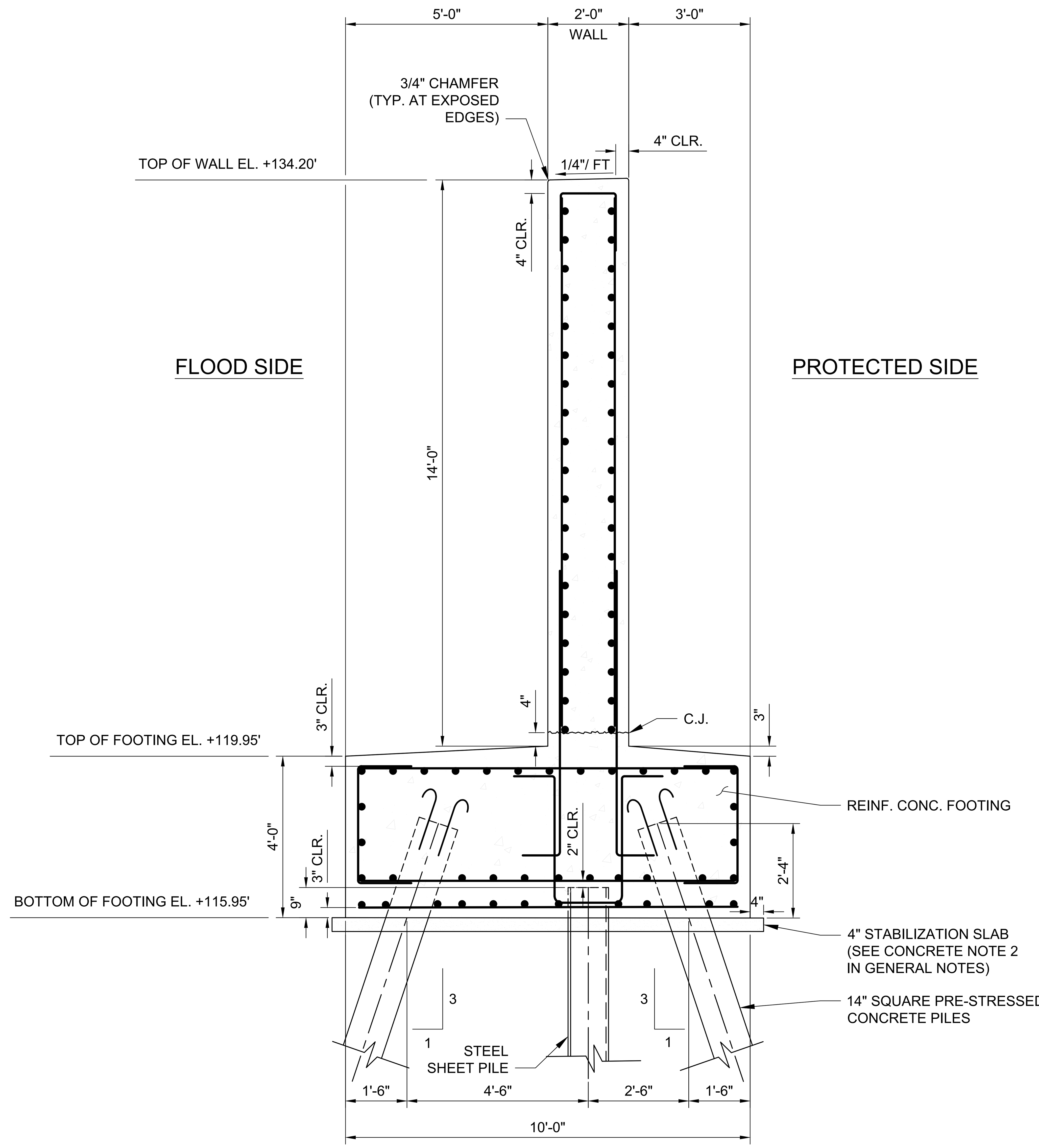
Drawing Title:
MONOLITH 1
SECTION

Scale	Designed	Drawn	Checked	Authorized
3/4"= 1'	--	--	--	--
Original Size: 22x34	Date: --/--/--	Date: --/--/--	Date: --/--/--	Date: --/--/--

Drawing Number: 100068207-S-301

Revision: 000

DO NOT SCALE



MONOLITH 2 SECTION

SCALE: 1/2"=1'

0 1 2 4 6

(IN FEET)

1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION | Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

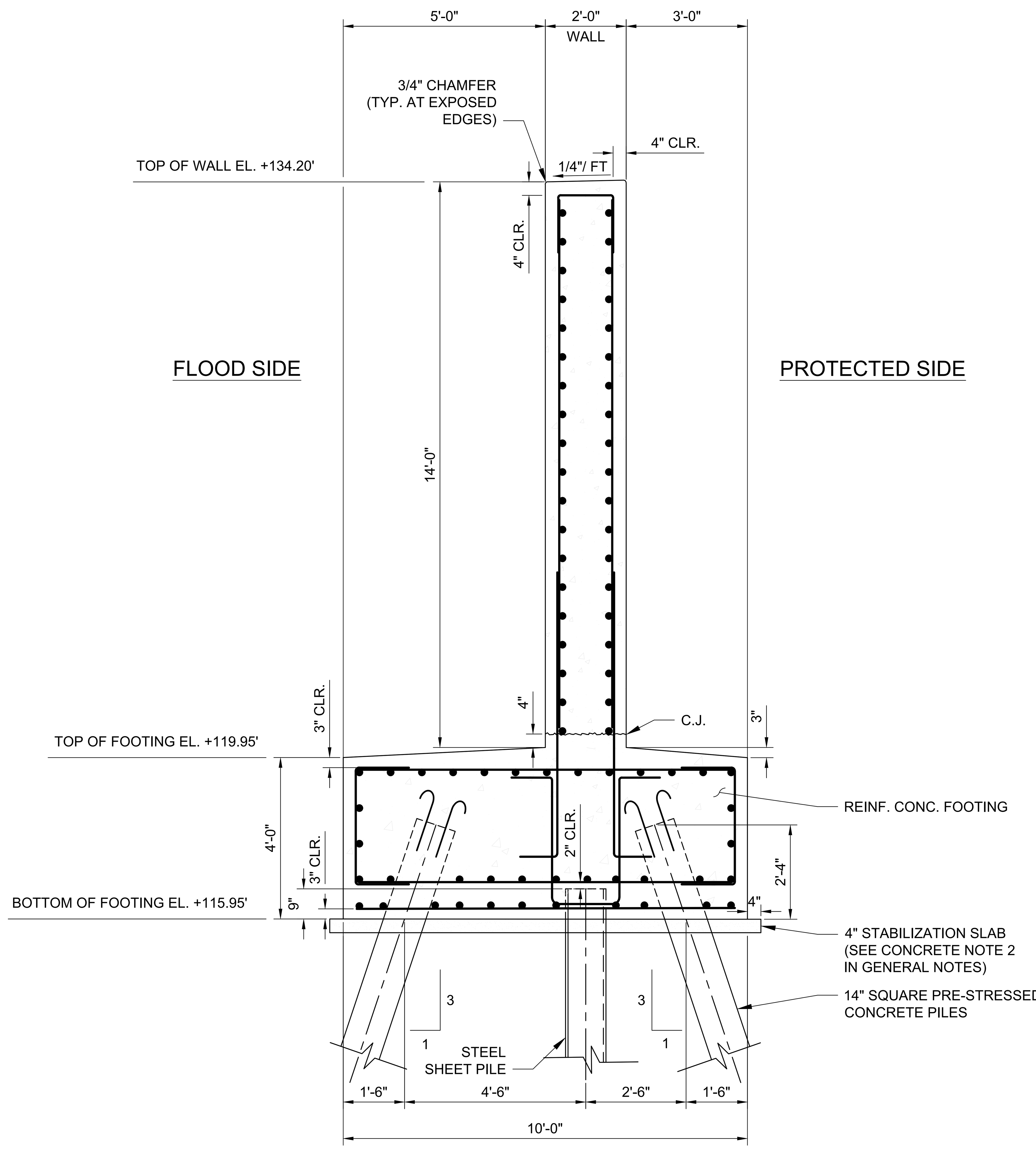
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: MONOLITH 2 SECTION

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-302 | Revision: 000

DO NOT SCALE



MONOLITH 3 SECTION

SCALE: 1/2"=1'

0 1 2 4 6

(IN FEET)

1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

811 Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title

WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title

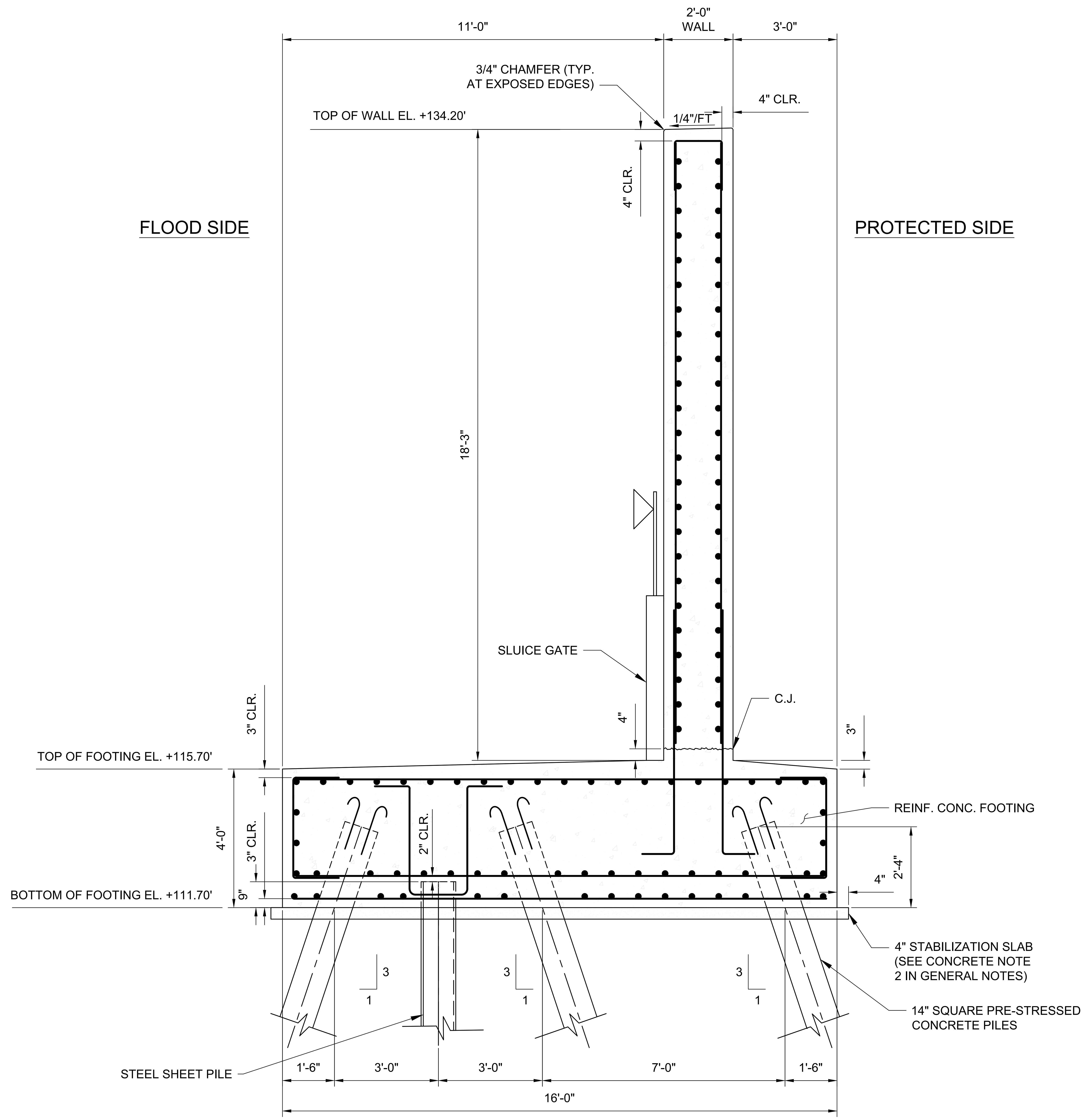
MONOLITH 3
SECTION

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size: 22x34	Date: --/--/--	Date: --/--/--	Date: --/--/--	Date: --/--/--

Drawing Number: 100068207-S-303

Revision: 000

DO NOT SCALE



MONOLITH 4 (DRAINAGE) SECTION

SCALE: 1/2"=1'

0 1 2 4 6

(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION,
CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

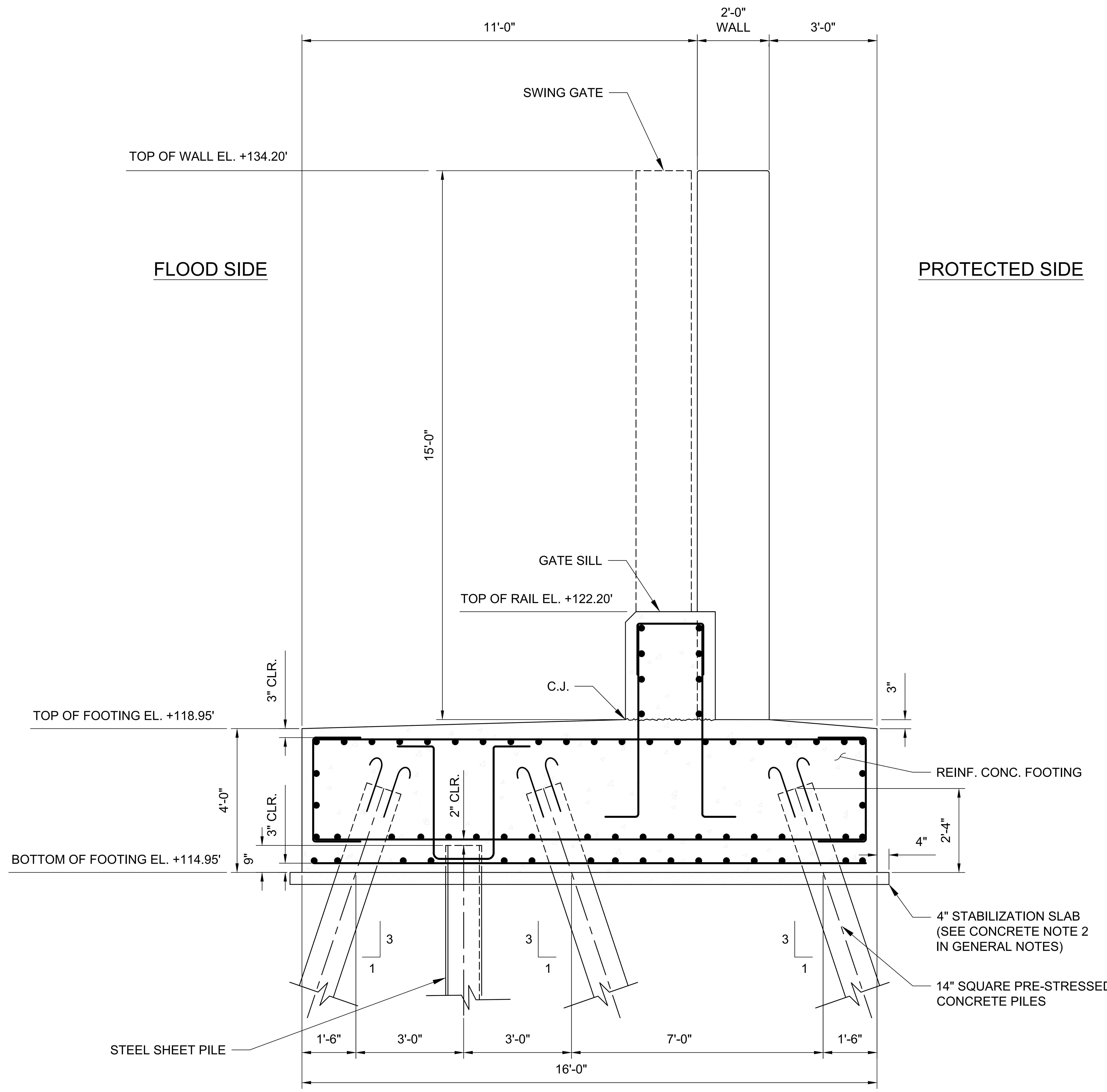
Drawing Title
MONOLITH 4
SECTION

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-304

Revision: 000

DO NOT SCALE



MONOLITH 5 (GATE) SECTION

SCALE: 1/2"=1'

0 1 2 4 6

(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA NORTH CAROLINA P.E.LIC. NO. 051021 LINFIELD, HUNTER & JUNIUS, INC.

811 Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of Lumberton North Carolina

Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

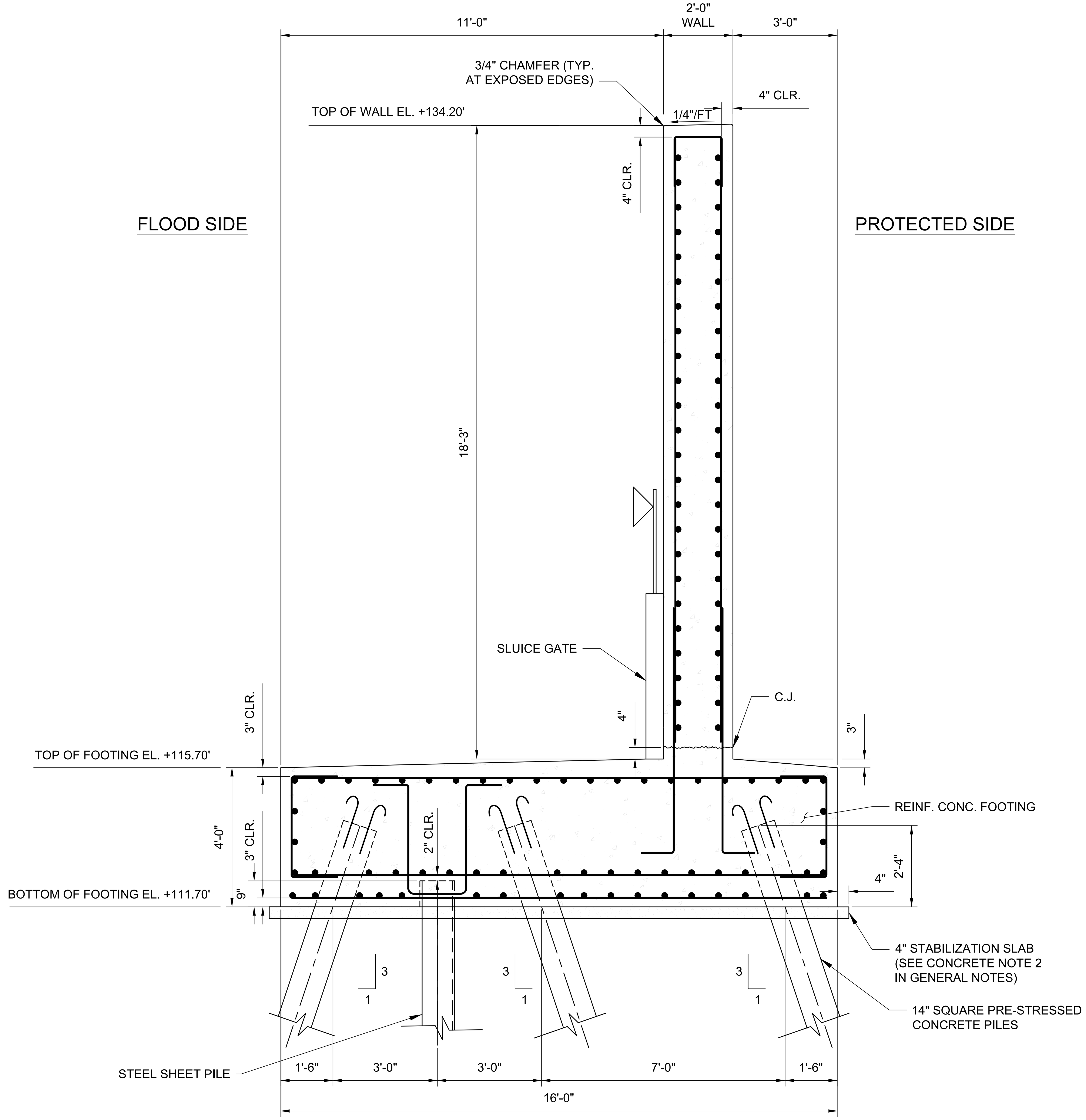
Drawing Title: MONOLITH 5 SECTION

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-305

Revision: 000

DO NOT SCALE



MONOLITH 6 (DRAINAGE) SECTION

SCALE: 1/2"=1'

0 1 2 4 6

(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION,
CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title:
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

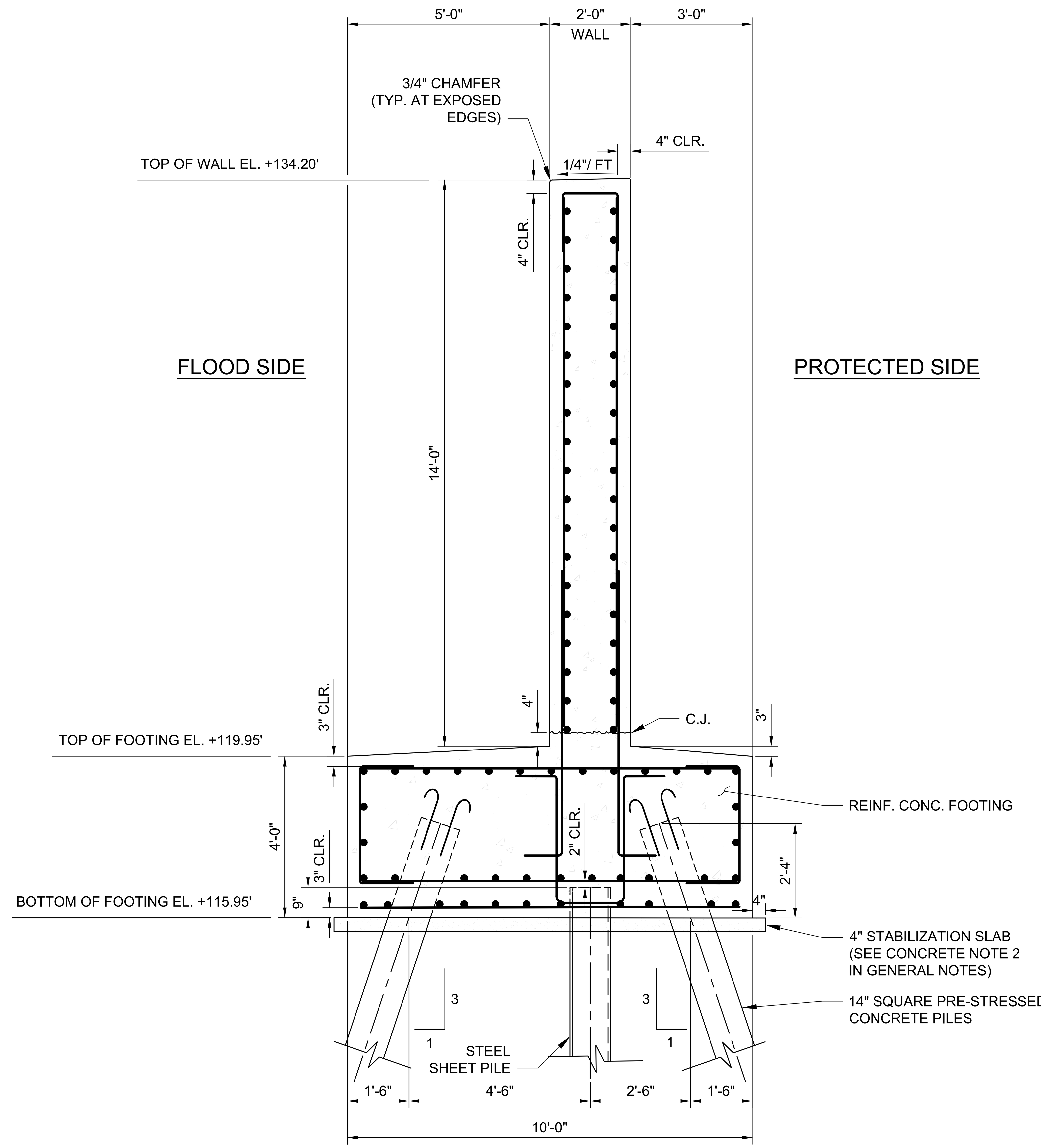
Drawing Title:
MONOLITH 6
SECTION

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number: 100068207-S-306

Revision: 000

DO NOT SCALE



MONOLITH 7 SECTION

SCALE: 1/2"=1'

0 1 2 4 6

(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

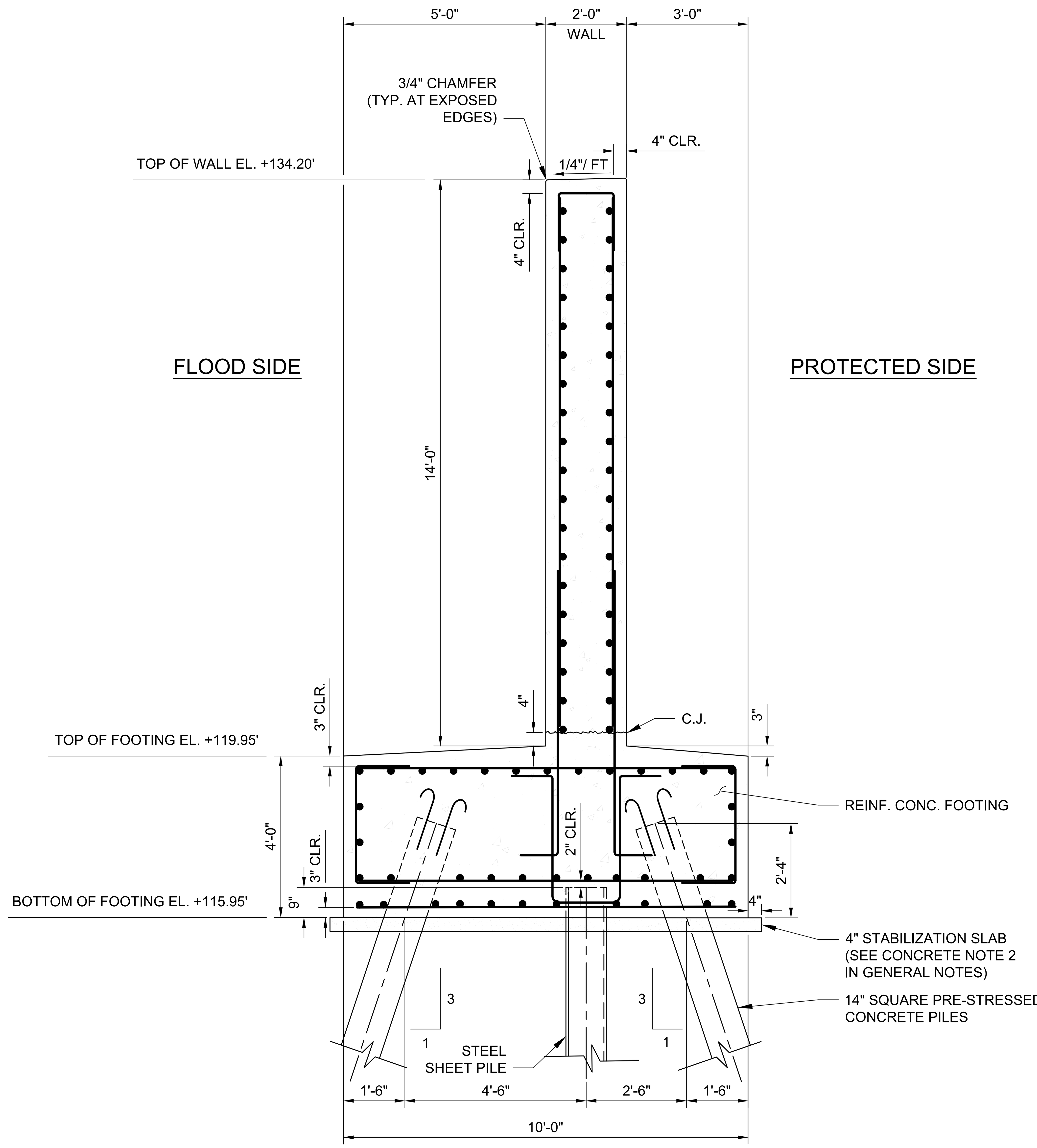
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
MONOLITH 7
SECTION

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-307
Revision: 000

DO NOT SCALE



MONOLITH 8 SECTION

SCALE: 1/2"=1'

0 1 2 4 6

(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION,
CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

811 Know what's below. Call before you dig.
Dial 811.
North Carolina 811, Inc.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
Copyright © Atkins Limited (2020)

1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS

13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill

5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client
City of LUMBERTON North Carolina

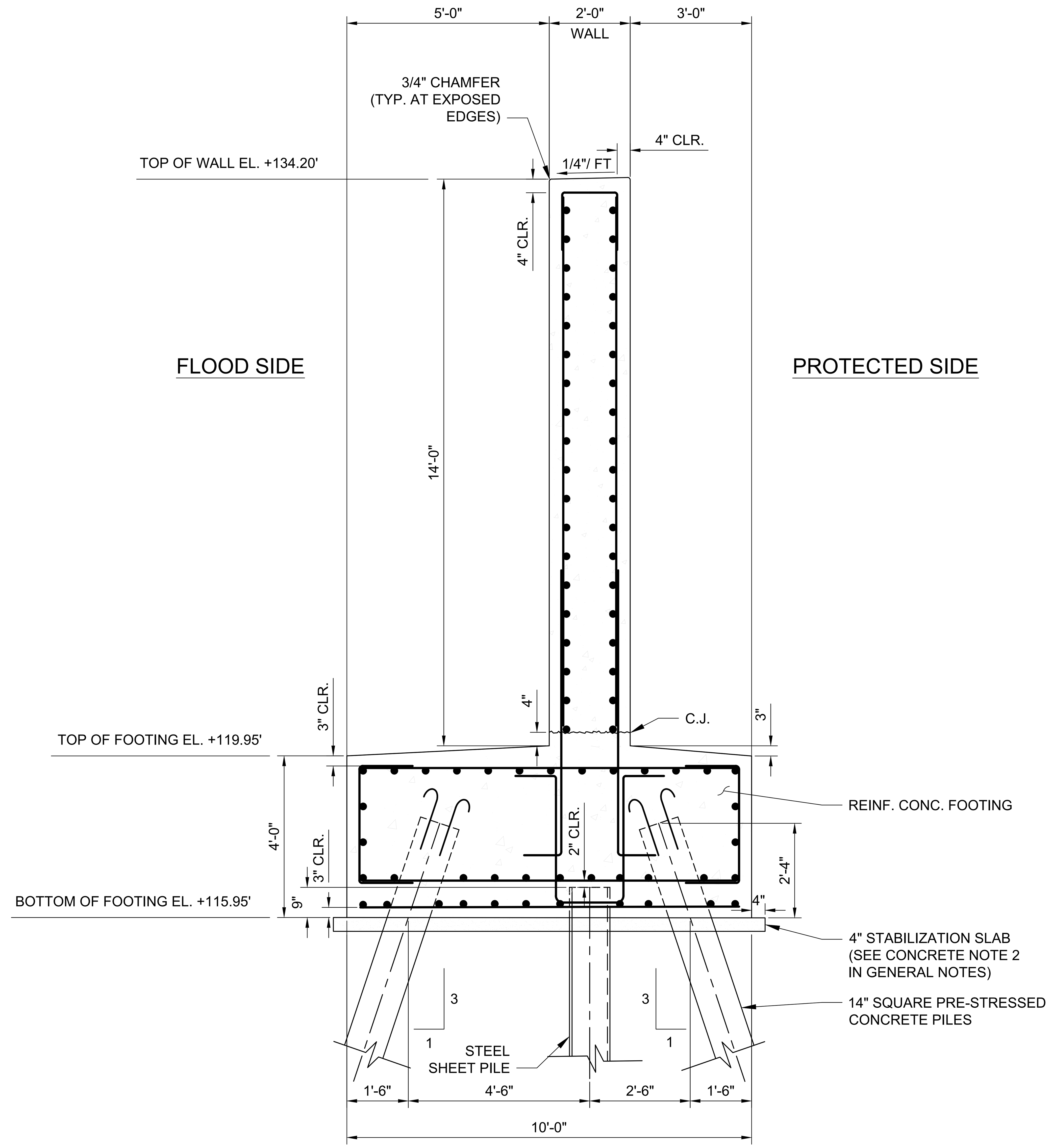
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
MONOLITH 8
SECTION

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

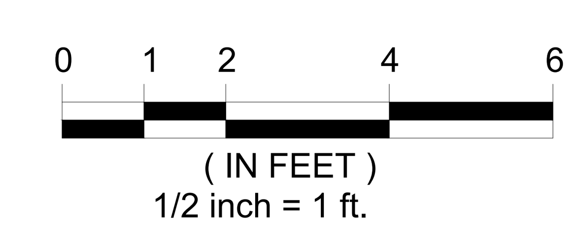
Drawing Number: 100068207-S-308
Revision: 000

DO NOT SCALE



MONOLITH 9 SECTION

SCALE: 1/2"=1'



PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION,
CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Know what's below. Call before you dig.
Dial 811.
North Carolina 811, Inc.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

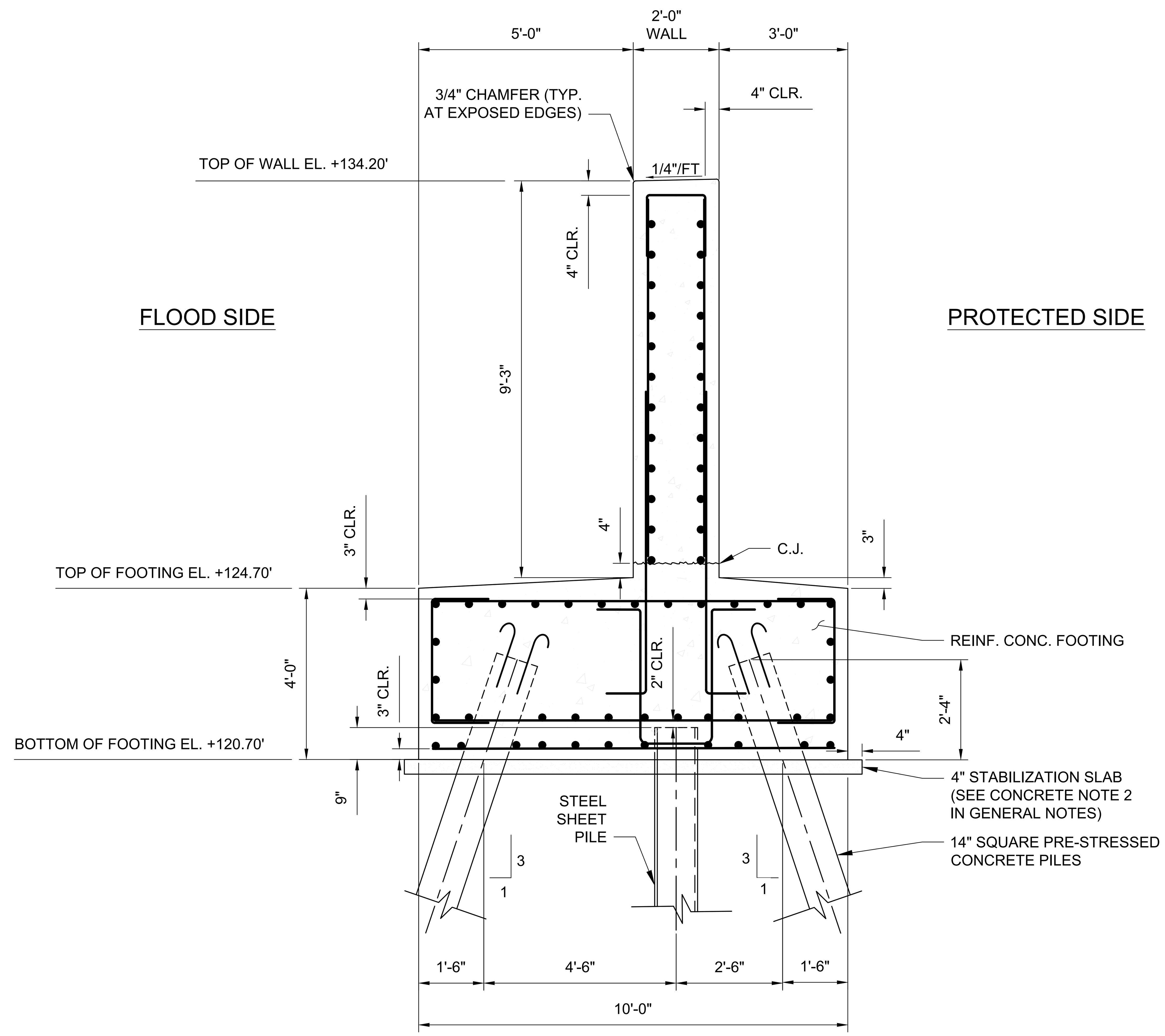
Drawing Title
MONOLITH 9
SECTION

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number	Revision
100068207-S-309	000

Inches 0 ½ 1 4

DO NOT SCALE



MONOLITH 10 SECTION

SCALE: 1/2"=1'

0 1 2 4 6

(IN FEET)

1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

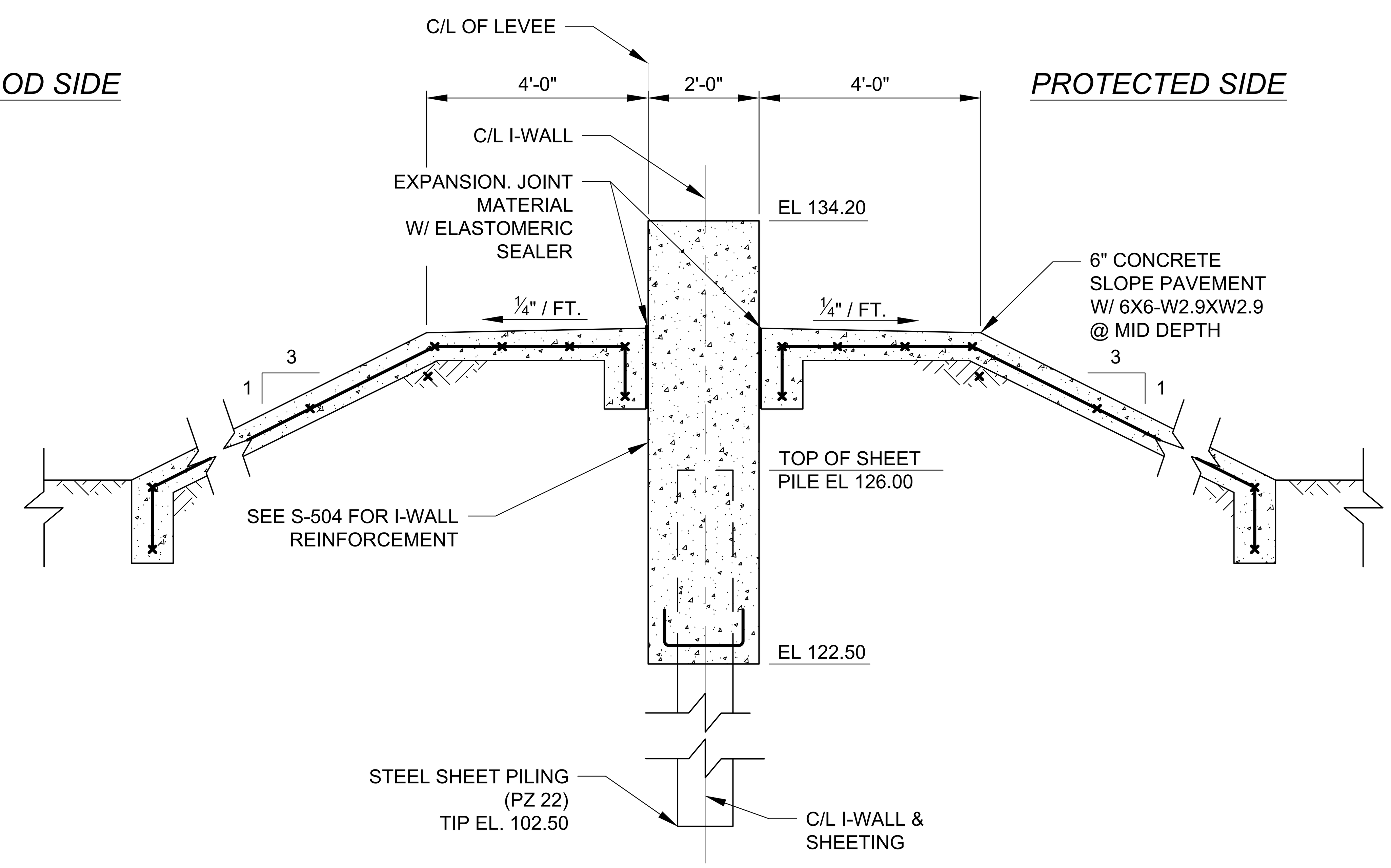
Drawing Title: MONOLITH 10 SECTION

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-310

Revision: 000

DO NOT SCALE



I WALL 1 SECTION

SCALE: 3/4"=1'

0 1 2 4

(IN FEET)

3/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title

WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title

I-WALL 1
SECTION

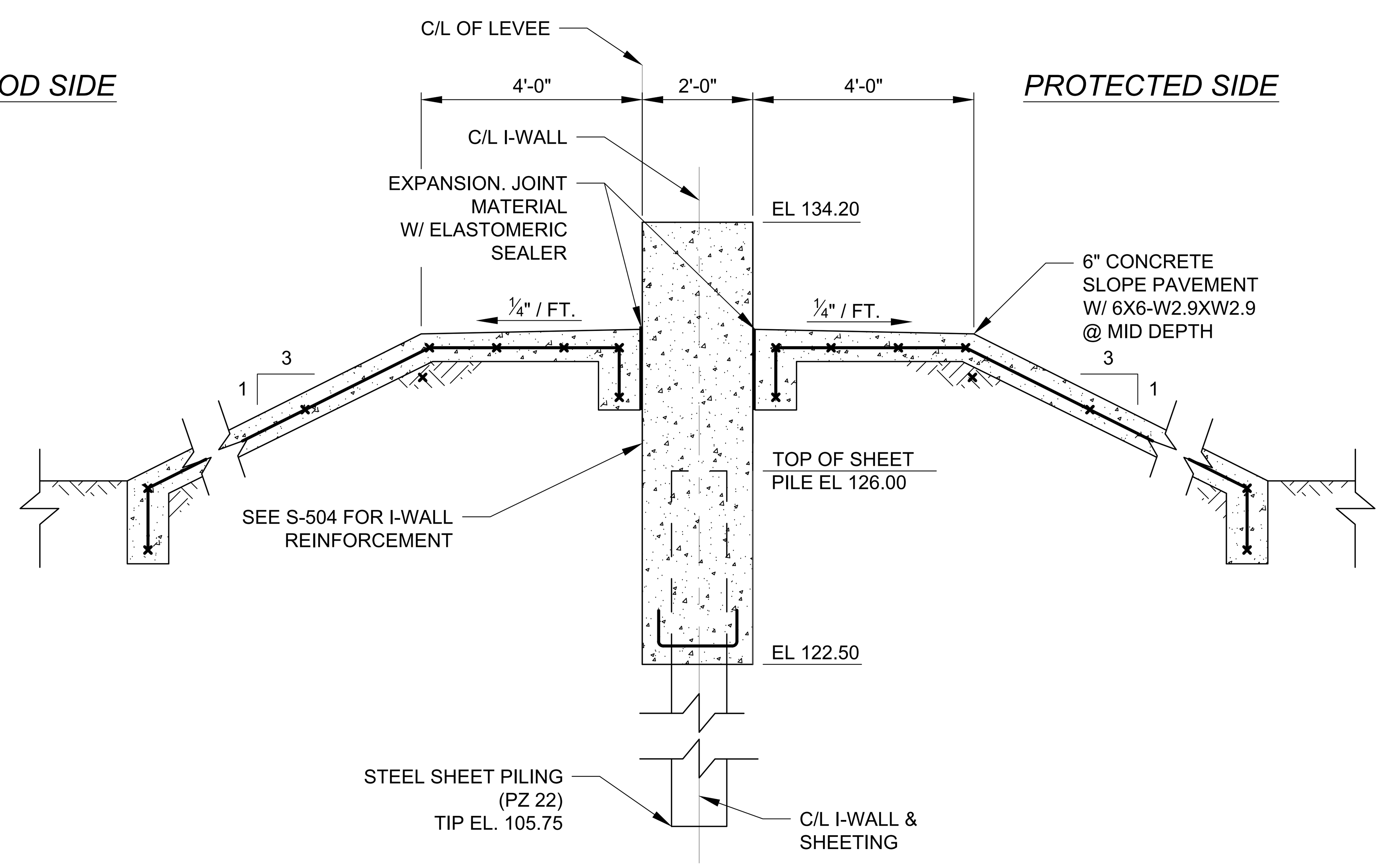
Scale	Designed	Drawn	Checked	Authorized
3/4"= 1'	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number	Revision
100068207-S-311	000

DO NOT SCALE

FLOOD SIDE

PROTECTED SIDE



I WALL 2 SECTION
SCALE: 3/4"=1'

0 1 2 4
(IN FEET)
3/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

811 Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION | Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of Lumberton North Carolina

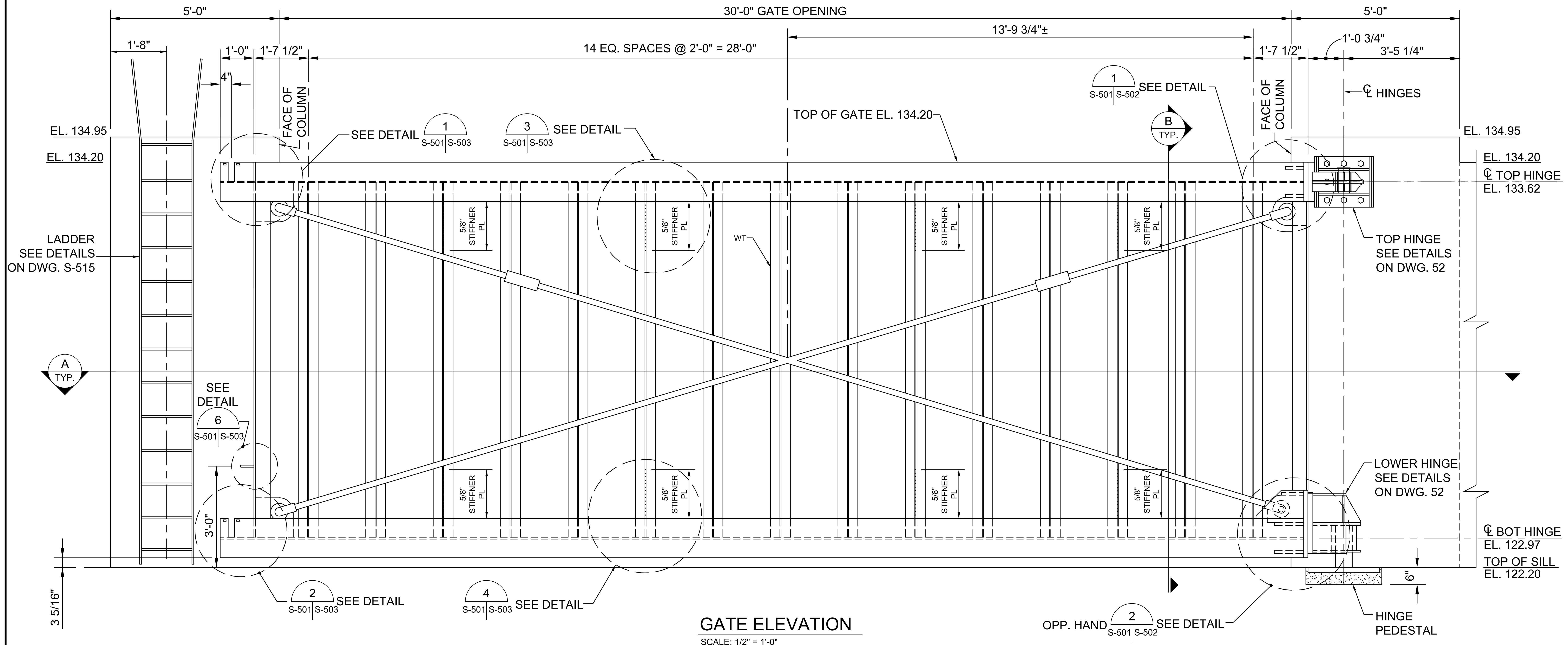
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
I-WALL 2
SECTION

Scale	Designed	Drawn	Checked	Authorized
3/4"= 1'	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

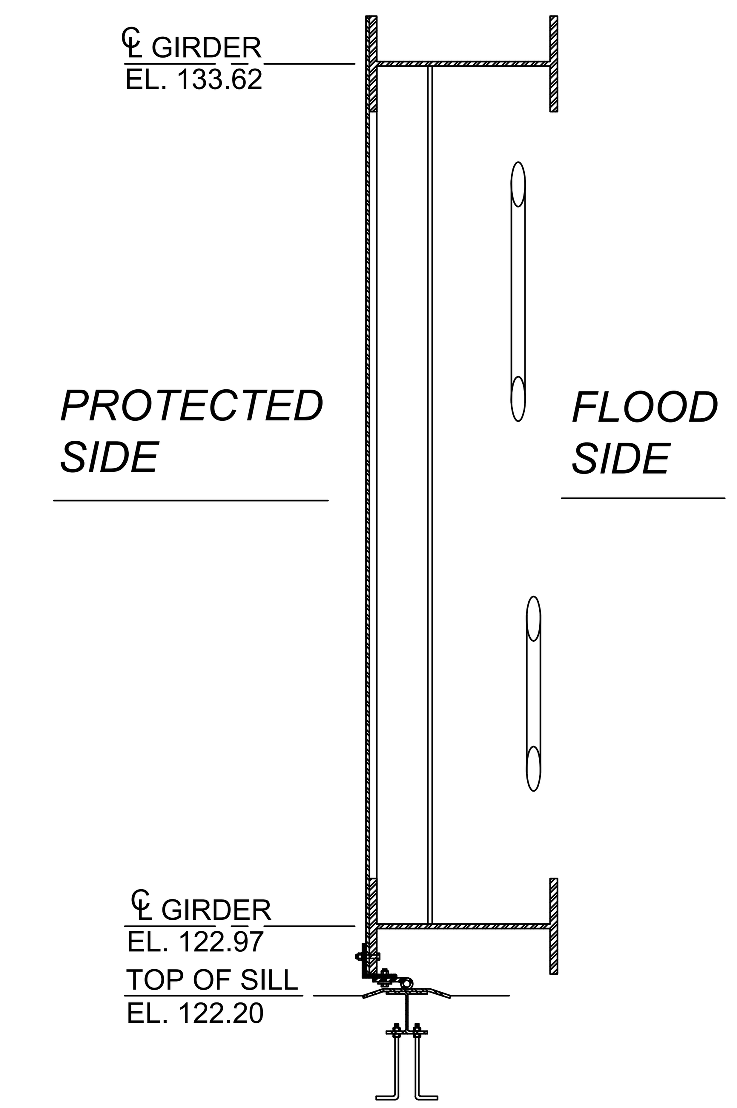
Drawing Number: 100068207-S-312 | Revision: 000

DO NOT SCALE



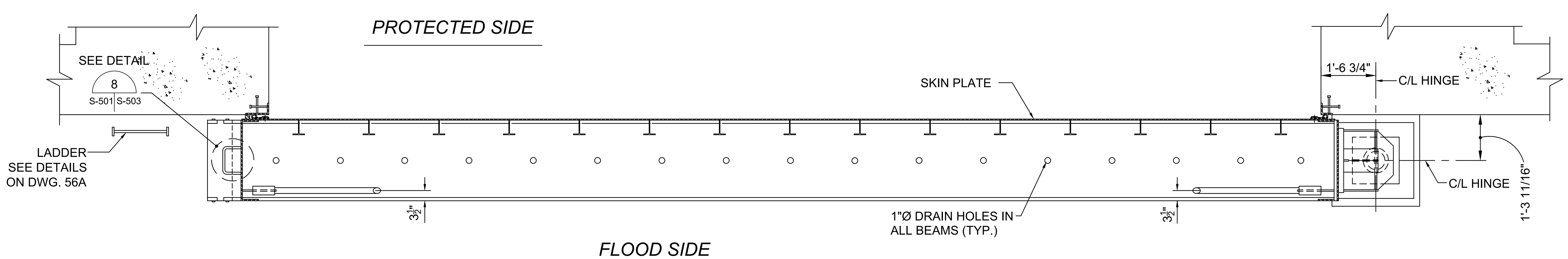
GATE ELEVATION

SCALE: 1/2" = 1'-0"



B SECTION

TYP. TYP. SCALE: 1/2"= 1'-0"



A SECTION

TYP. TYP. SCALE: 1/2"= 1'-0"

0 1 2 4 6

(IN FEET)
1/2 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax:+1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax:+1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

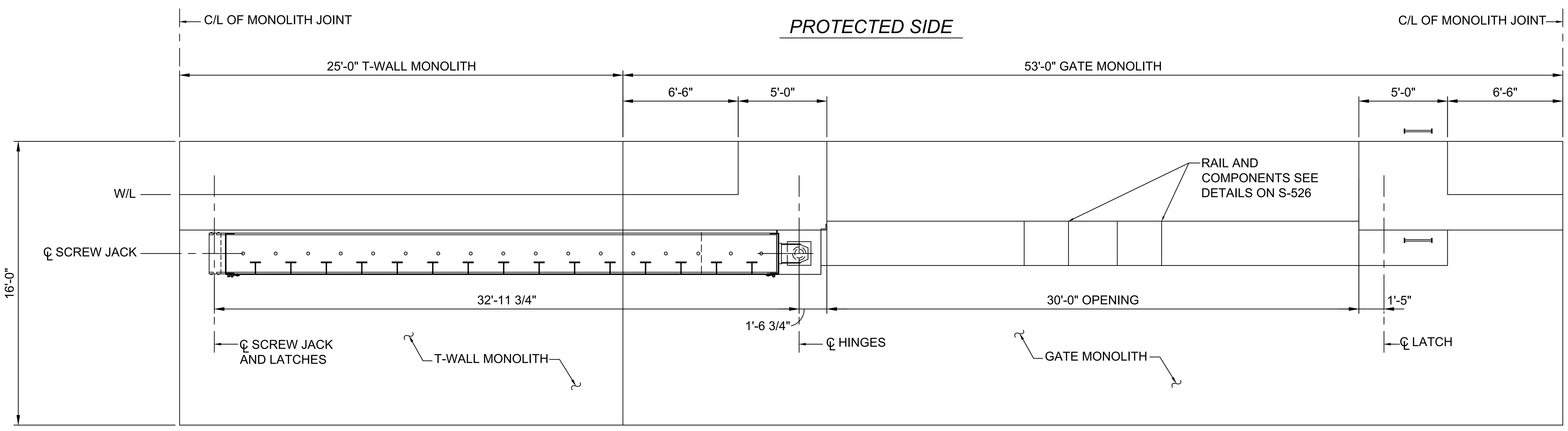
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
GATE ELEVATION

Scale	Designed	Drawn	Checked	Authorized
1/2"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

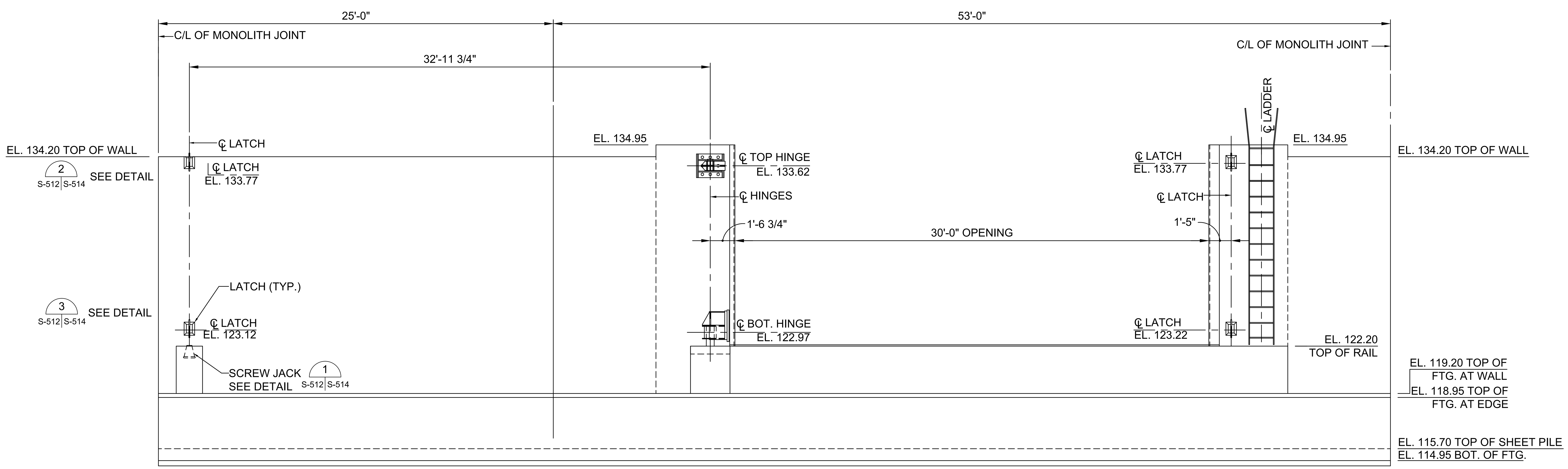
Drawing Number: 100068207-S-501
Revision: 000

DO NOT SCALE



GATE MONOLITH 5 PLAN
(GATE IN OPEN POSITION)

SCALE: 1/4" = 1'-0"



FLOOD SIDE ELEVATION

SCALE: 1/4" = 1'-0"

0 2 4 8 12
(IN FEET)
1/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title: WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

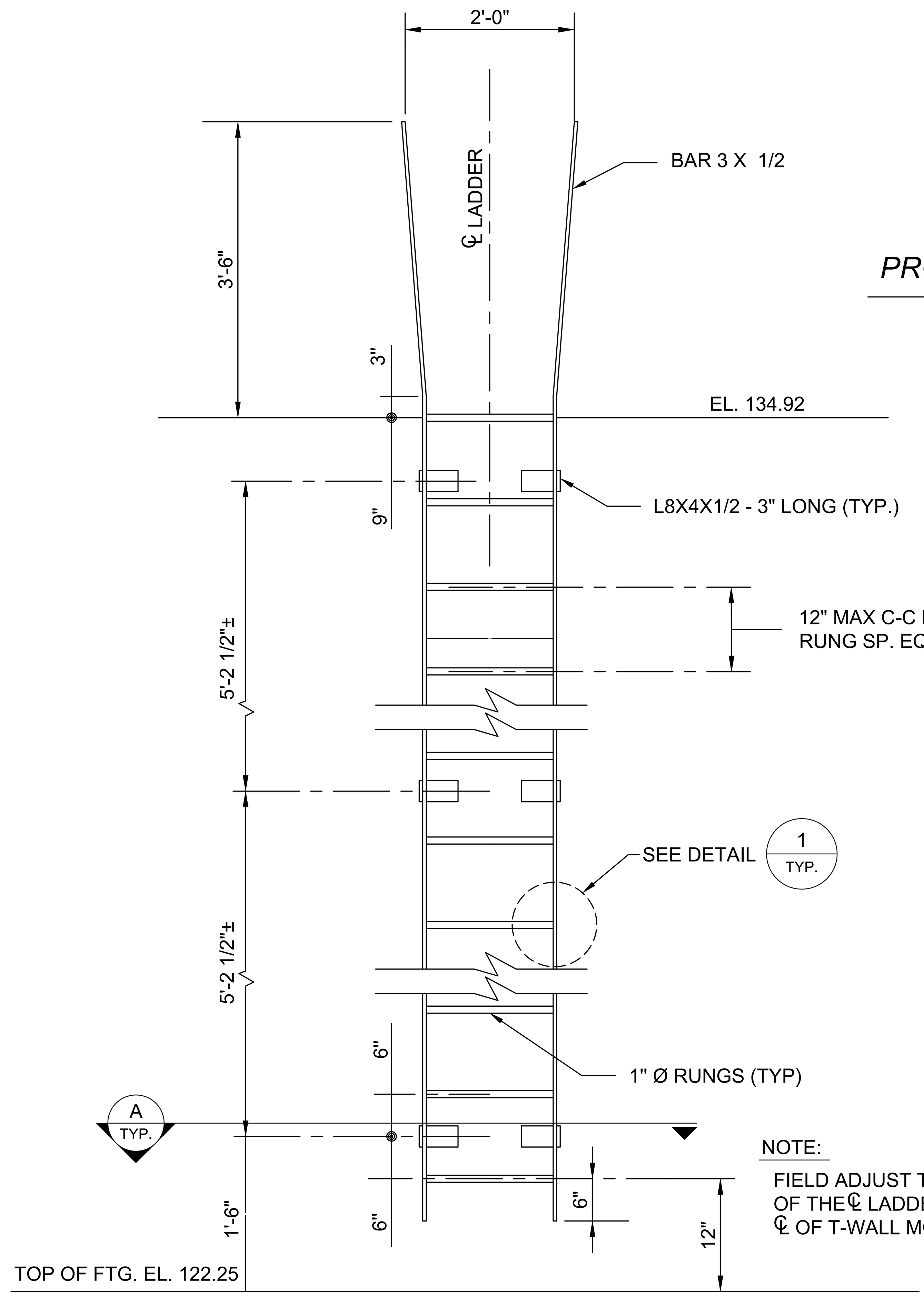
Drawing Title: SWING GATE
LATCHING DETAIL

Scale	Designed	Drawn	Checked	Authorized
1/4"= 1'	--	--	--	--

Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

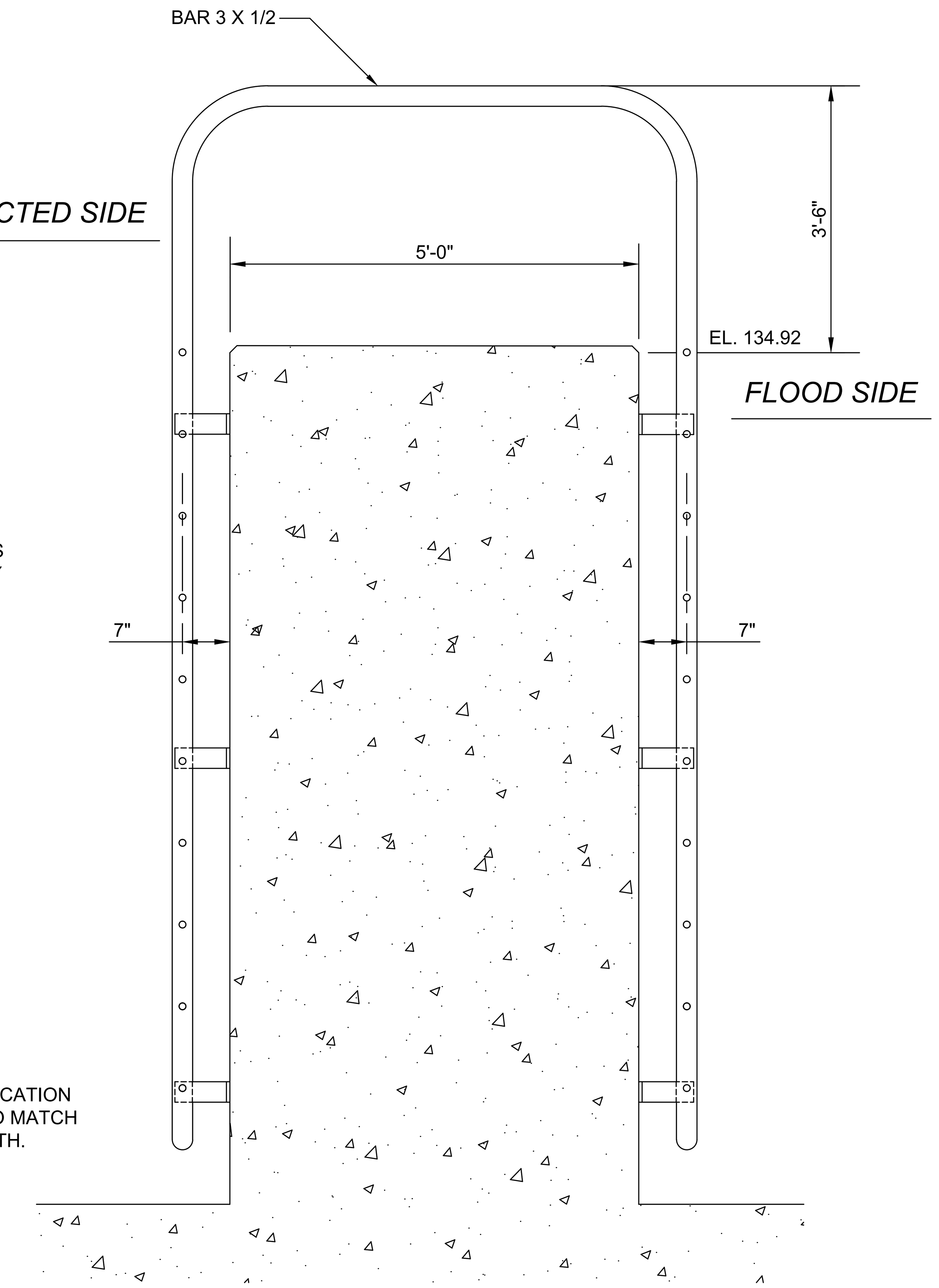
Drawing Number: 100068207-S-512
Revision: 000

DO NOT SCALE



NOTE:
FIELD ADJUST THE LOCATION OF THE ℄ LADDERS TO MATCH ℄ OF T-WALL MONOLITH.

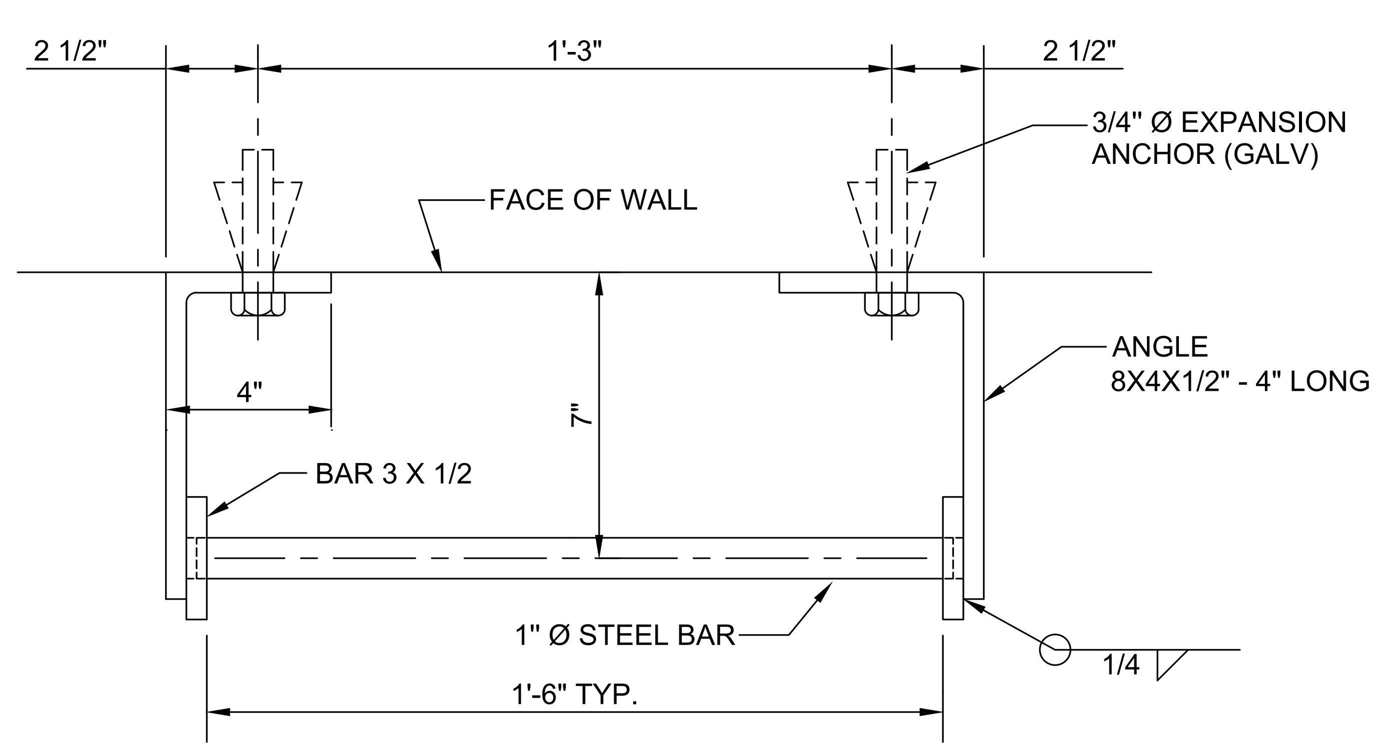
PROTECTED SIDE ELEVATION



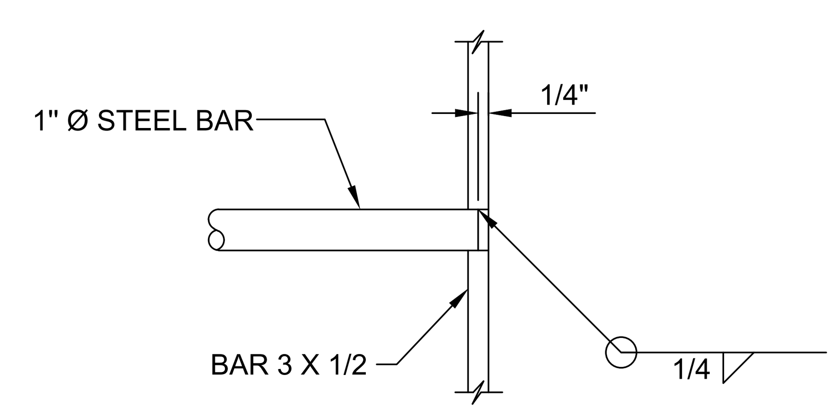
SECTION

NOTE:
ALL LADDERS SHALL BE HOT-DIPPED GALVANIZED AFTER FABRICATION.

LADDER DETAILS
SCALE: 3/4" = 1'-0"



A TYP. TYP. SECTION
SCALE: 3"= 1'-0"



1 TYP. TYP. DETAIL
SCALE: 3"= 1'-0"

0 1/2 1 2 4
(IN FEET)
3/4 inch = 1 ft.

0 3 6 12
(IN INCHES)
3 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

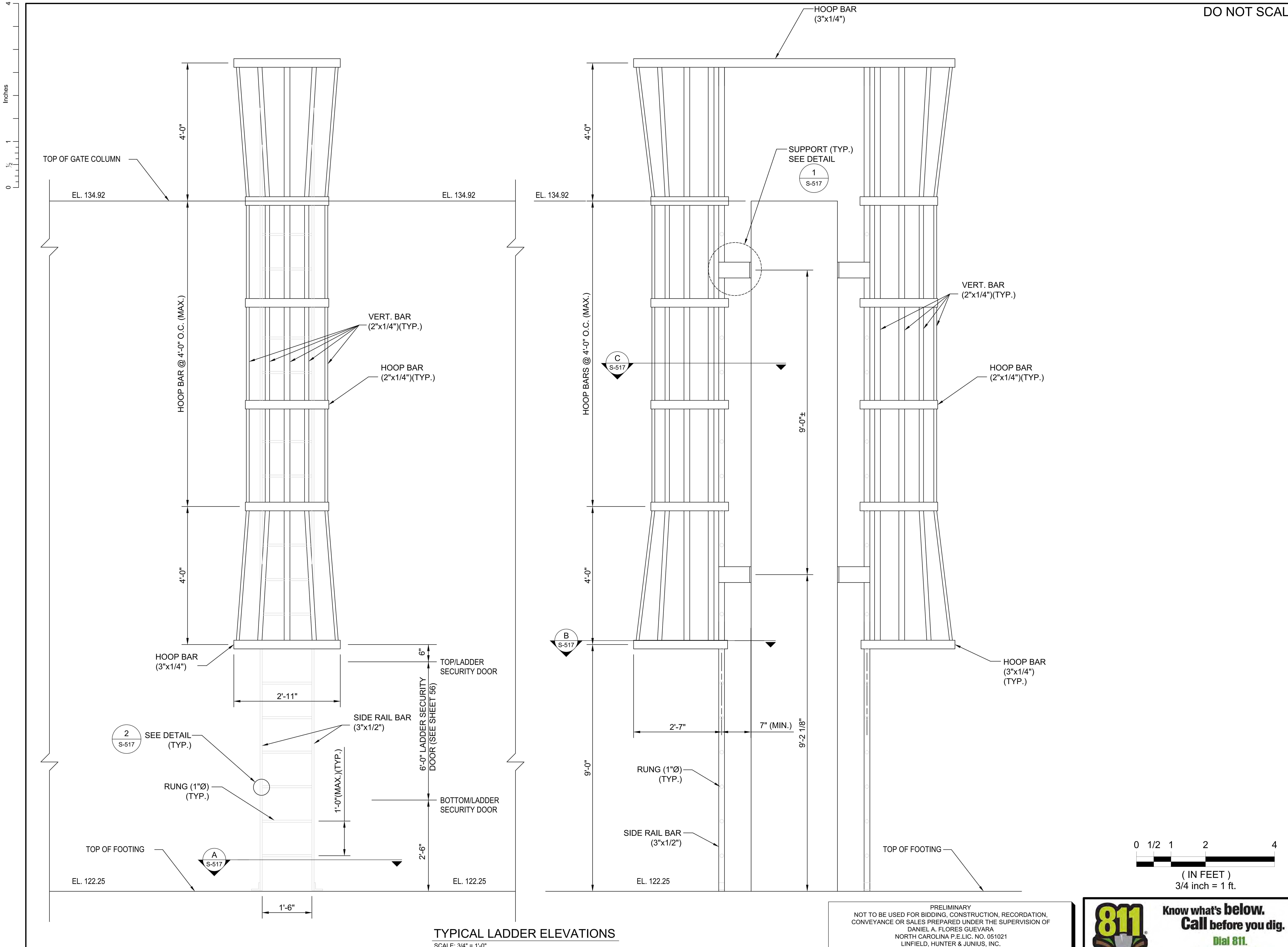
Client: City of LUMBERTON North Carolina

Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
LADDER DETAIL (1 OF 3)

Scale	Designed	Drawn	Checked	Authorized
SEE DWG.	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number	Revision
100068207-S-515	000



TYPICAL LADDER ELEVATIONS
SCALE: 3/4" = 1'-0"

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client
City of LUMBERTON North Carolina

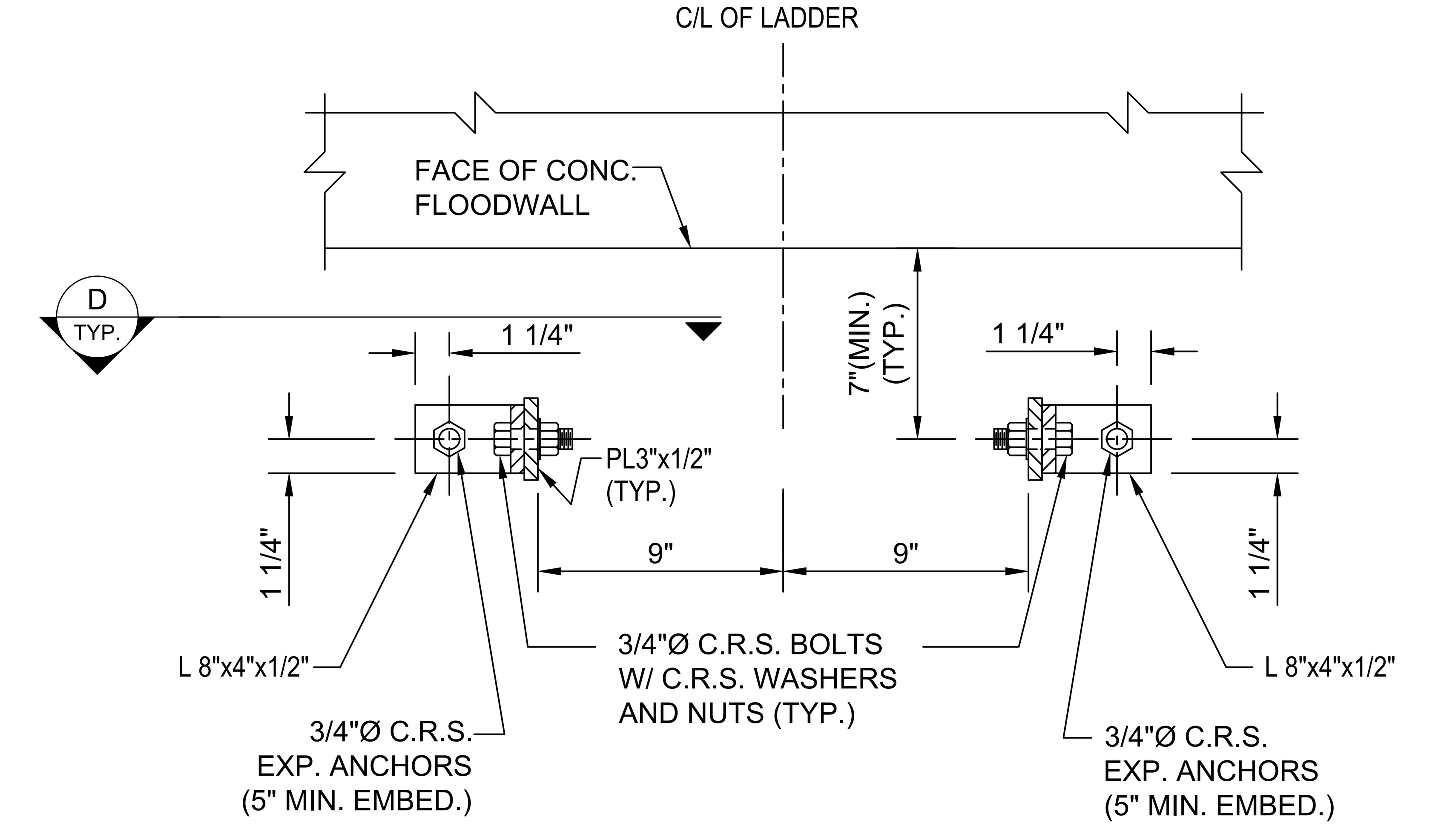
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
LADDER DETAIL (2 OF 3)

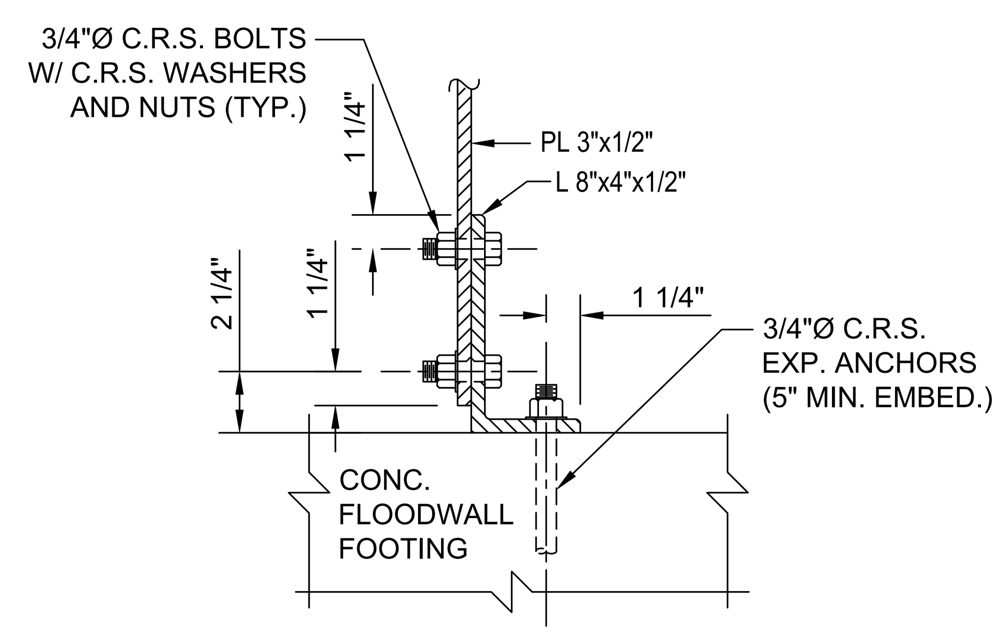
Scale	Designed	Drawn	Checked	Authorized
3/4" = 1'-0"	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-516
Revision: 000

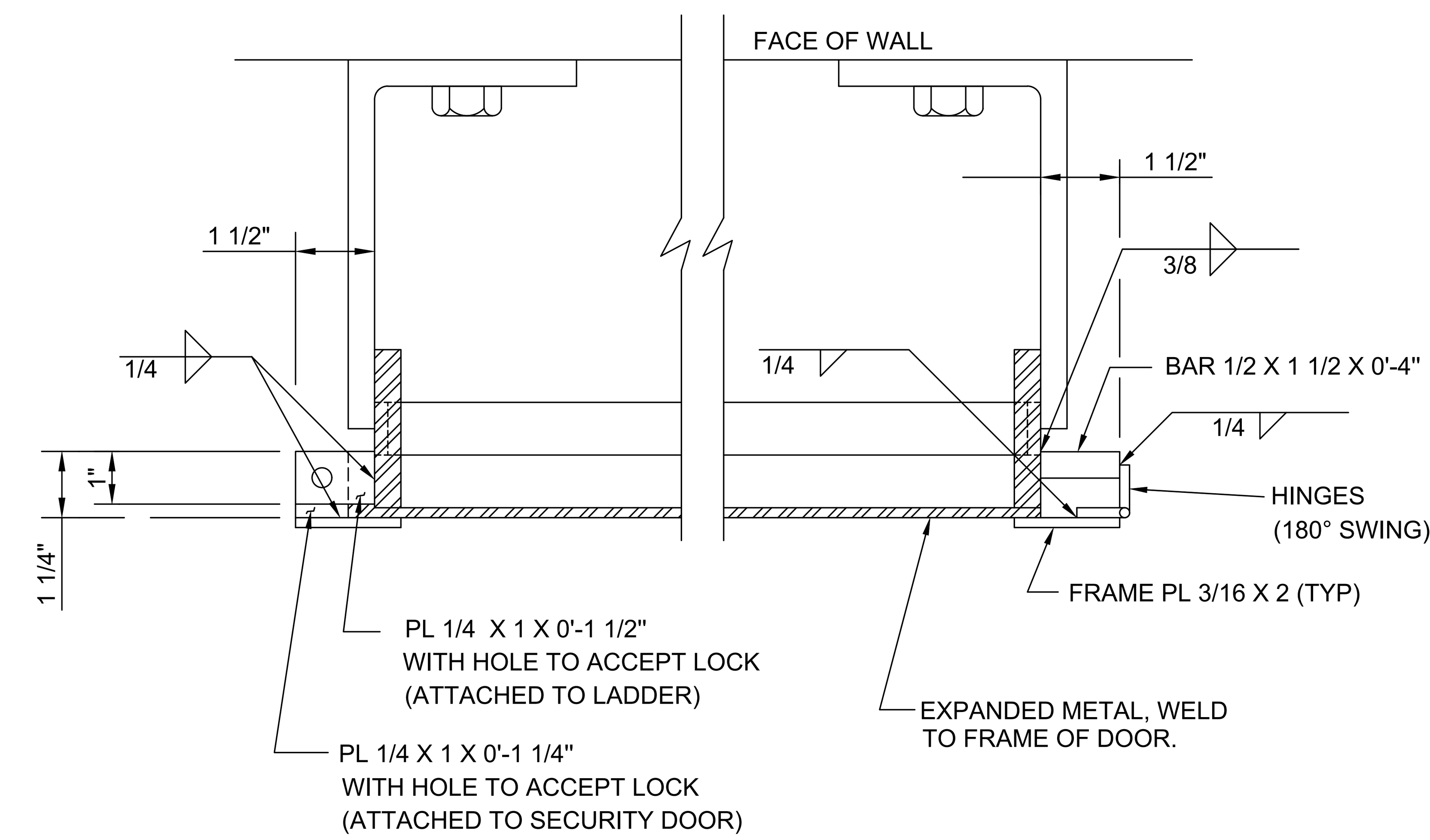
DO NOT SCALE



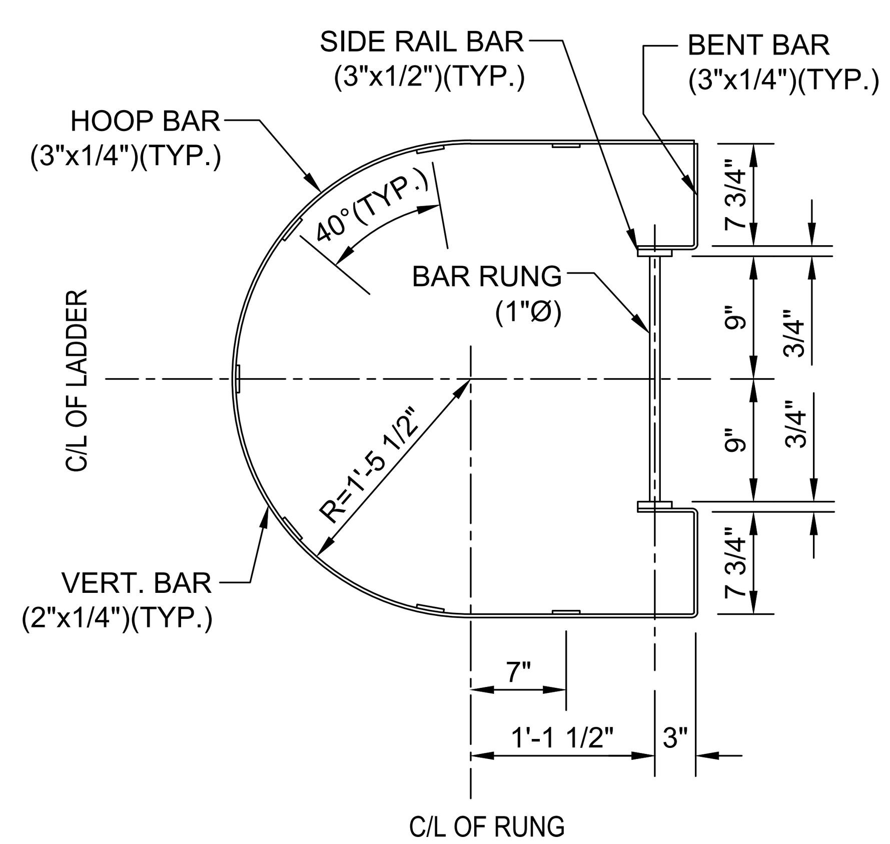
SECTION A (S-516 | S-517) SCALE: 2"= 1'-0"



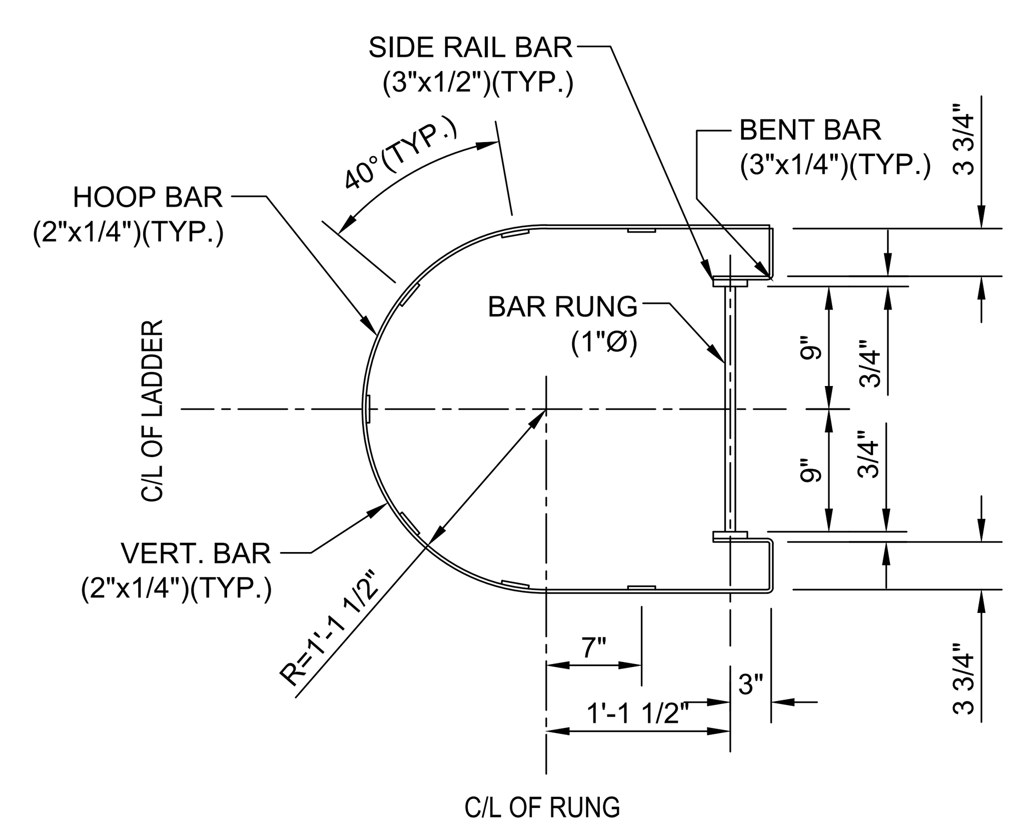
SECTION D (TYP. | TYP.) SCALE: 2"= 1'-0"



PLAN
SCALE: 3/8" = 1"

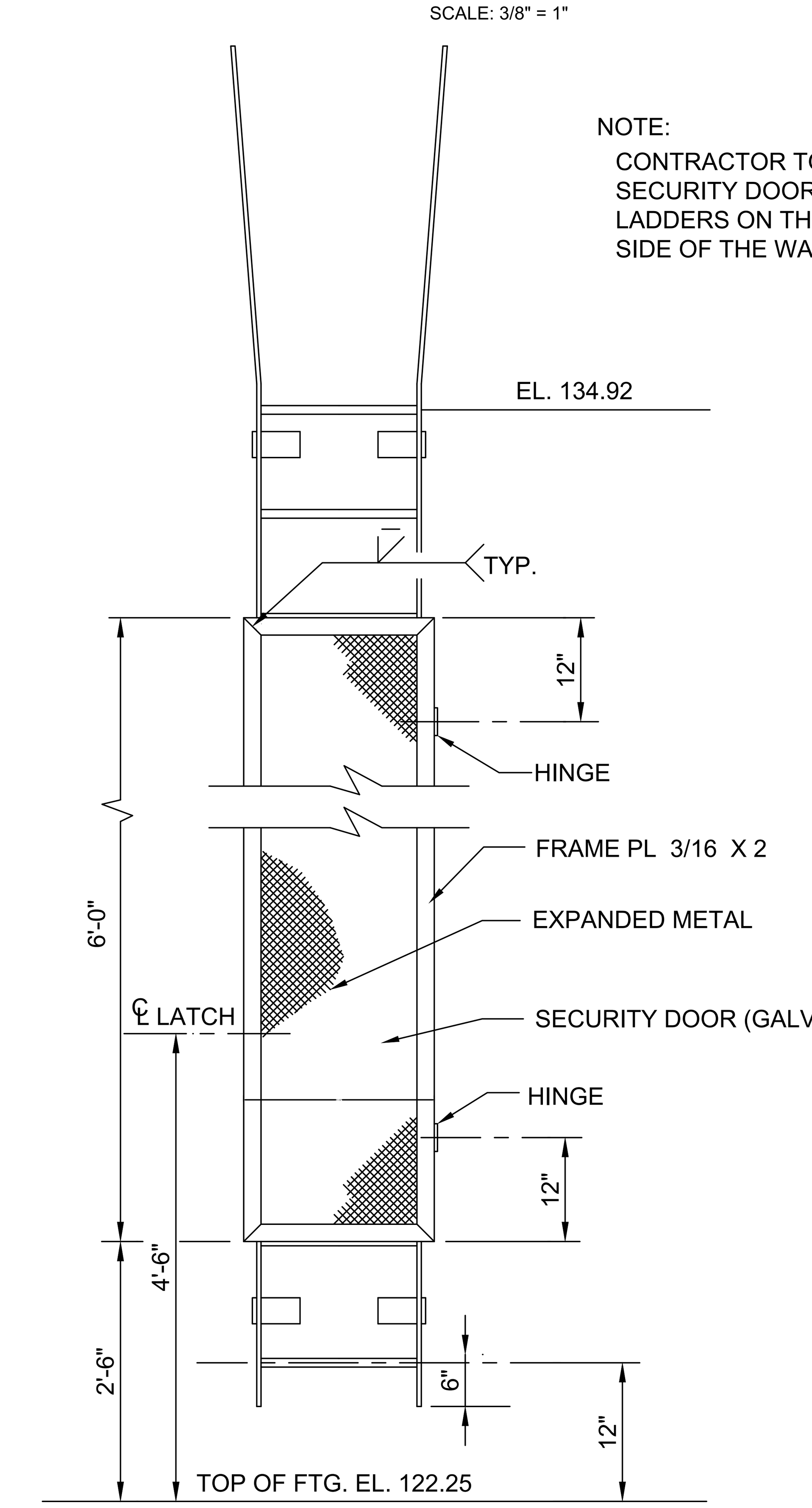


SECTION B (S-516 | S-517) SCALE: 1"= 1'-0"



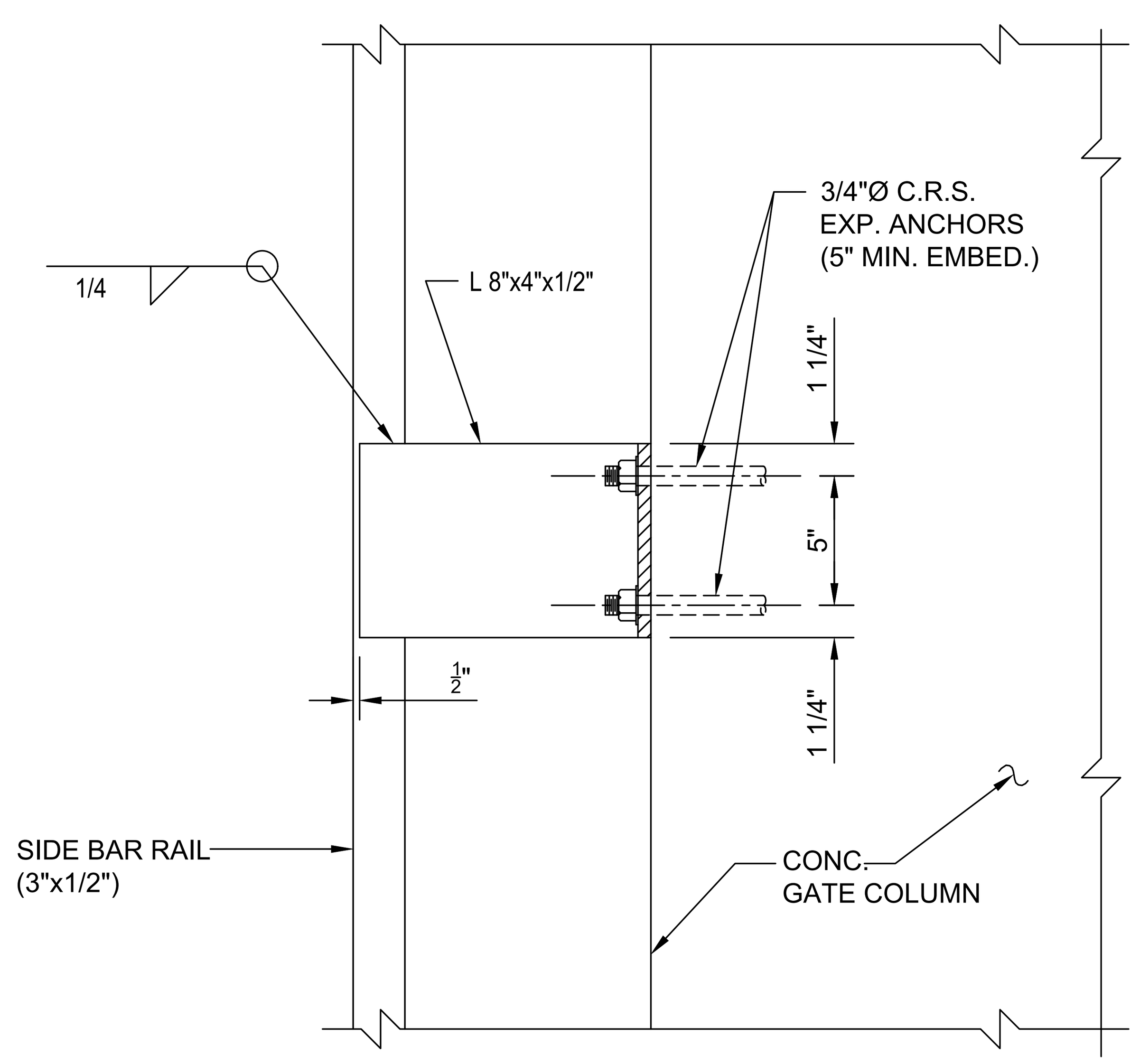
SECTION C (S-516 | S-517) SCALE: 1"= 1'-0"

NOTE:
CONTRACTOR TO PROVIDE A SECURITY DOOR FOR ALL LADDERS ON THE PROTECTED SIDE OF THE WALL ONLY

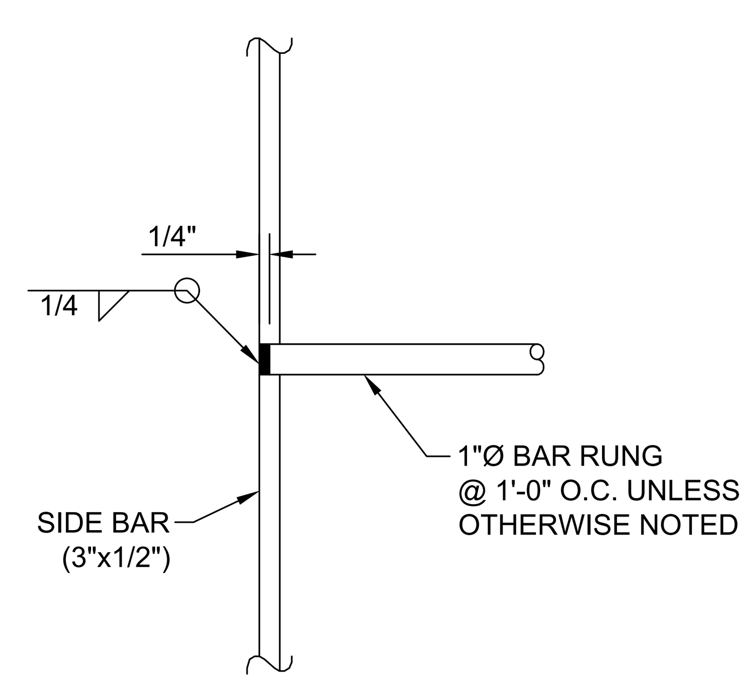


PROTECTED SIDE ELEVATION
SCALE: 3/4" = 1'-0"

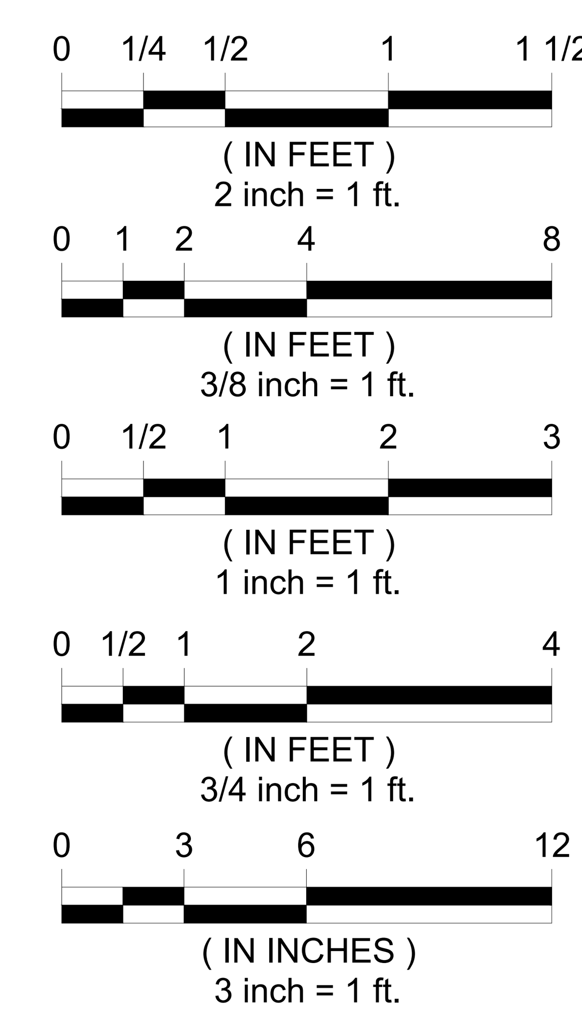
LADDER SECURITY DOOR DETAILS



DETAIL 1 (S-516 | S-517) SCALE: 2"= 1'-0"



DETAIL 2 (S-516 | S-517) SCALE: 3"= 1'-0"



PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA NORTH CAROLINA P.E.LIC. NO. 051021 LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: SO

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road Suite 160 Raleigh, NC 27519
Tel: +1 (919) 876-6888 Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
13608 18th Street Suite 200 Metairie, LA 70002
Tel: +1 (504) 833-5300 Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road Suite 107 Raleigh, NC 27607
Tel: +1 (919) 378-9111 NC Firm License # C-0459
mcgillassociates.com

Client: City of Lumberton North Carolina

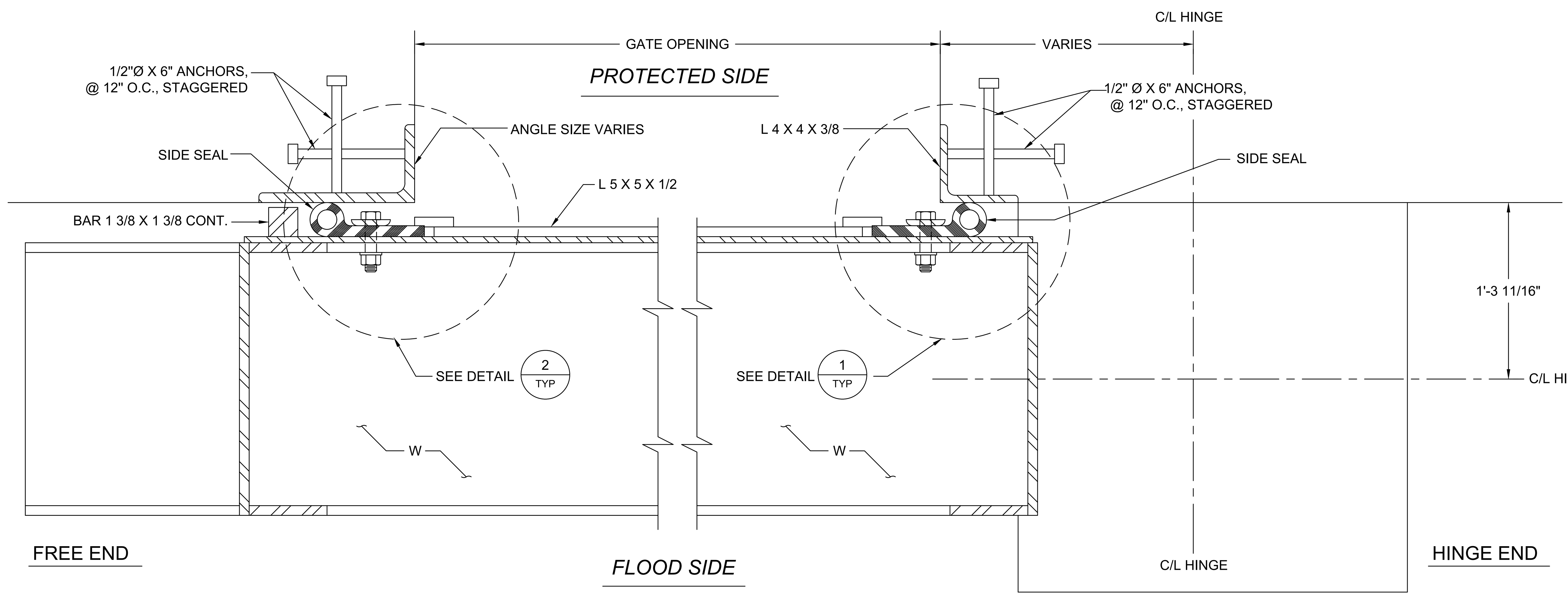
Project Title
WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title
LADDER DETAIL (3 OF 3)

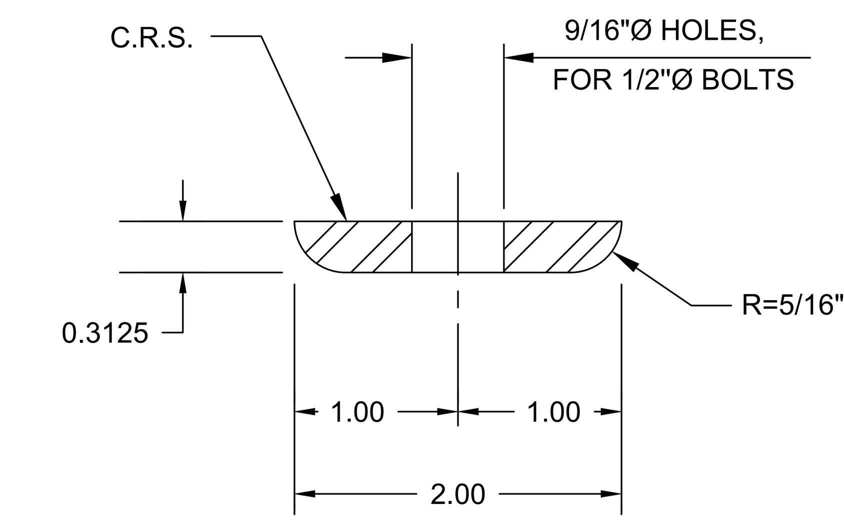
Scale	Designed	Drawn	Checked	Authorized
SEE DWG.	--	--	--	--
Original Size: 22x34	Date: --/--/--	Date: --/--/--	Date: --/--/--	Date: --/--/--

Drawing Number: 100068207-S-517
Revision: 000

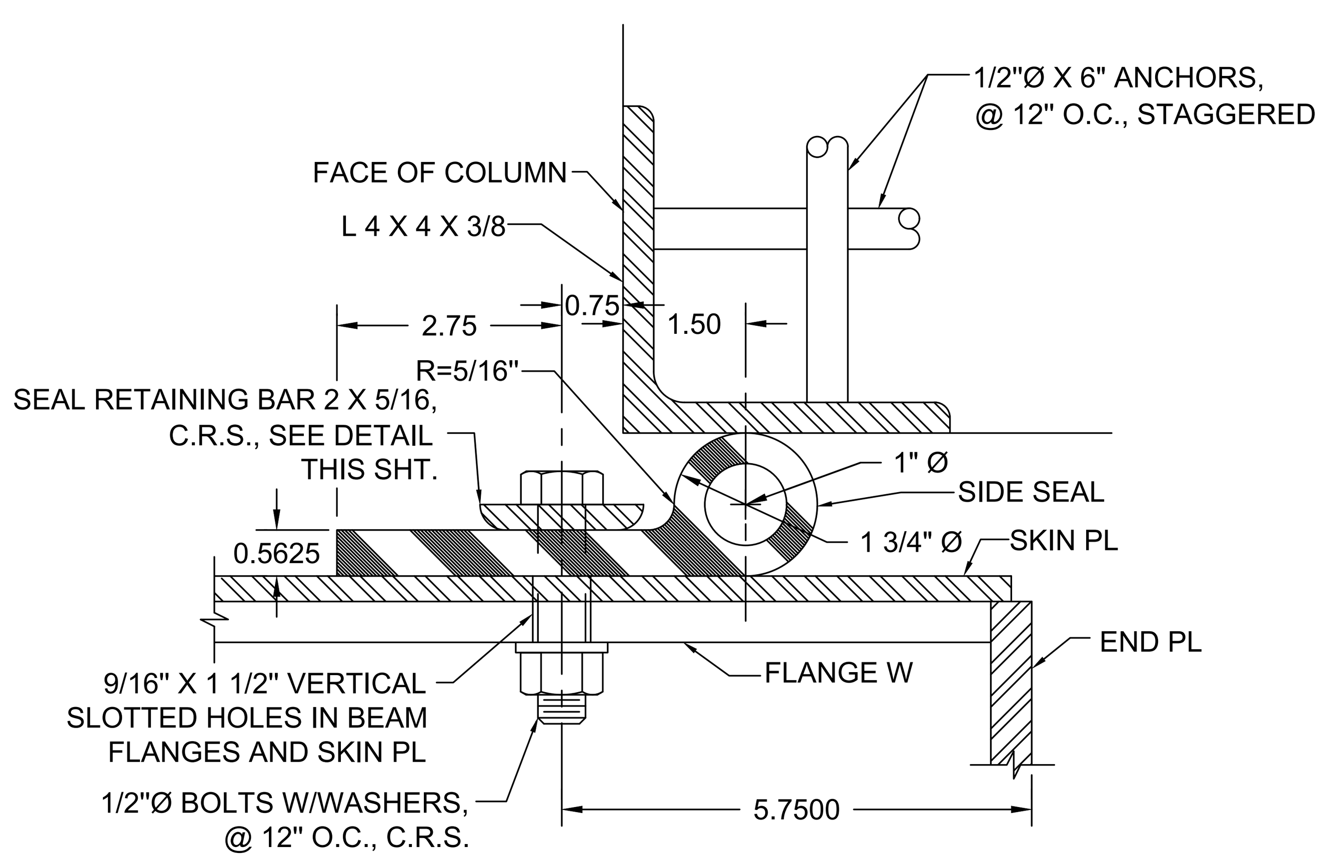
DO NOT SCALE



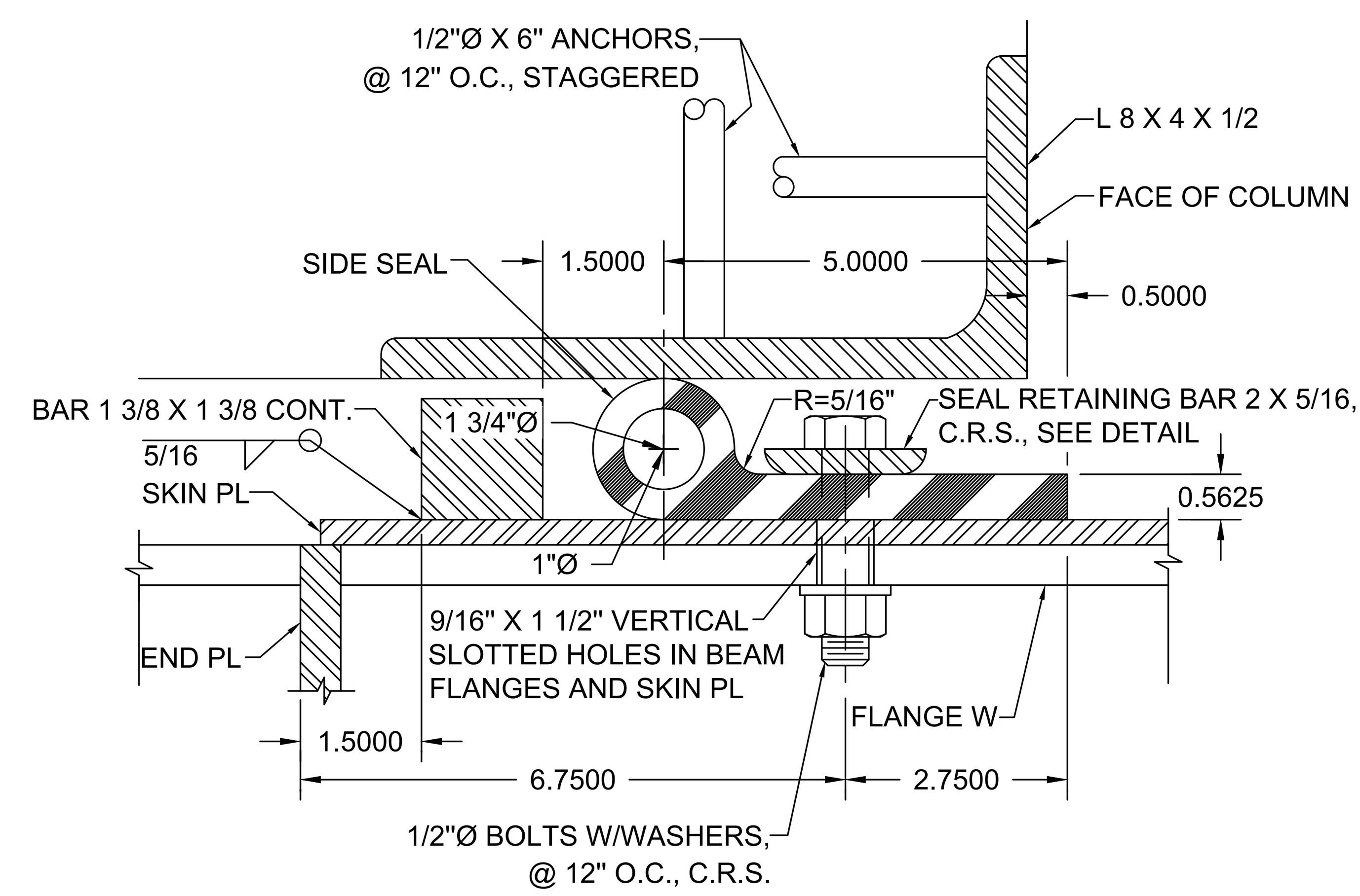
TYPICAL SECTION THRU SWING GATE
SCALE: 3" = 1'-0"



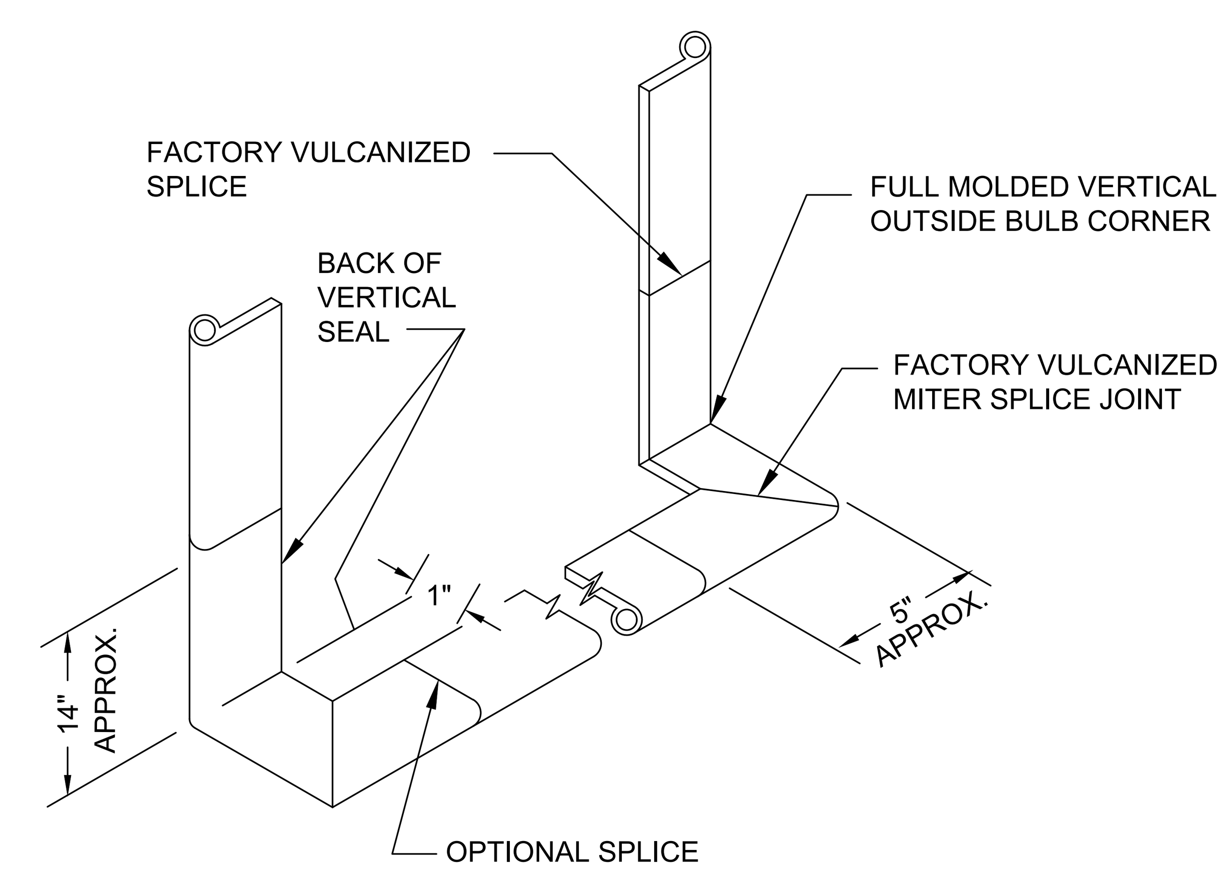
SEAL RETAINING BAR
SCALE: 12" = 1'-0"



1 TYP. TYP. DETAIL
SCALE: 6"= 1'-0"



2 TYP. TYP. DETAIL
SCALE: 6"= 1'-0"



CORNER DETAIL, TYPICAL BOTH SIDES

TYPICAL GATE SEAL
SCALE: N.T.S.

NOTES:

1. FOR GENERAL NOTES, SEE G-001.
2. ALL SPLICES WILL BE FACTORY MADE IN HEAVY STEEL PRESS TYPE MOLDS UNDER PRESSURE AND HEAT.
3. ALL SPLICE JOINTS MUST DEVELOP STRENGTH OF AT LEAST 50% OF THE MINIMUM TENSILE STRENGTH REQUIRED OF THE RUBBER.
4. SEAL CLAMP ANGLES SHALL BE PAINTED ON ALL SIDES PRIOR TO ASSEMBLY.
5. AFTER ASSEMBLY AND SEAL ADJUSTMENTS ARE MADE, ALL GAPS IN SEALS AND SEAL SUPPORTS SHALL BE SEALED WITH A SILICONE RUBBER SEALANT TO PROVIDE WATERTIGHT JOINTS.

0 1/2 1 2
(IN INCHES)
12 inch = 1 ft.

0 3 6 12
(IN INCHES)
3 inch = 1 ft.

0 1 2 4
(IN INCHES)
6 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

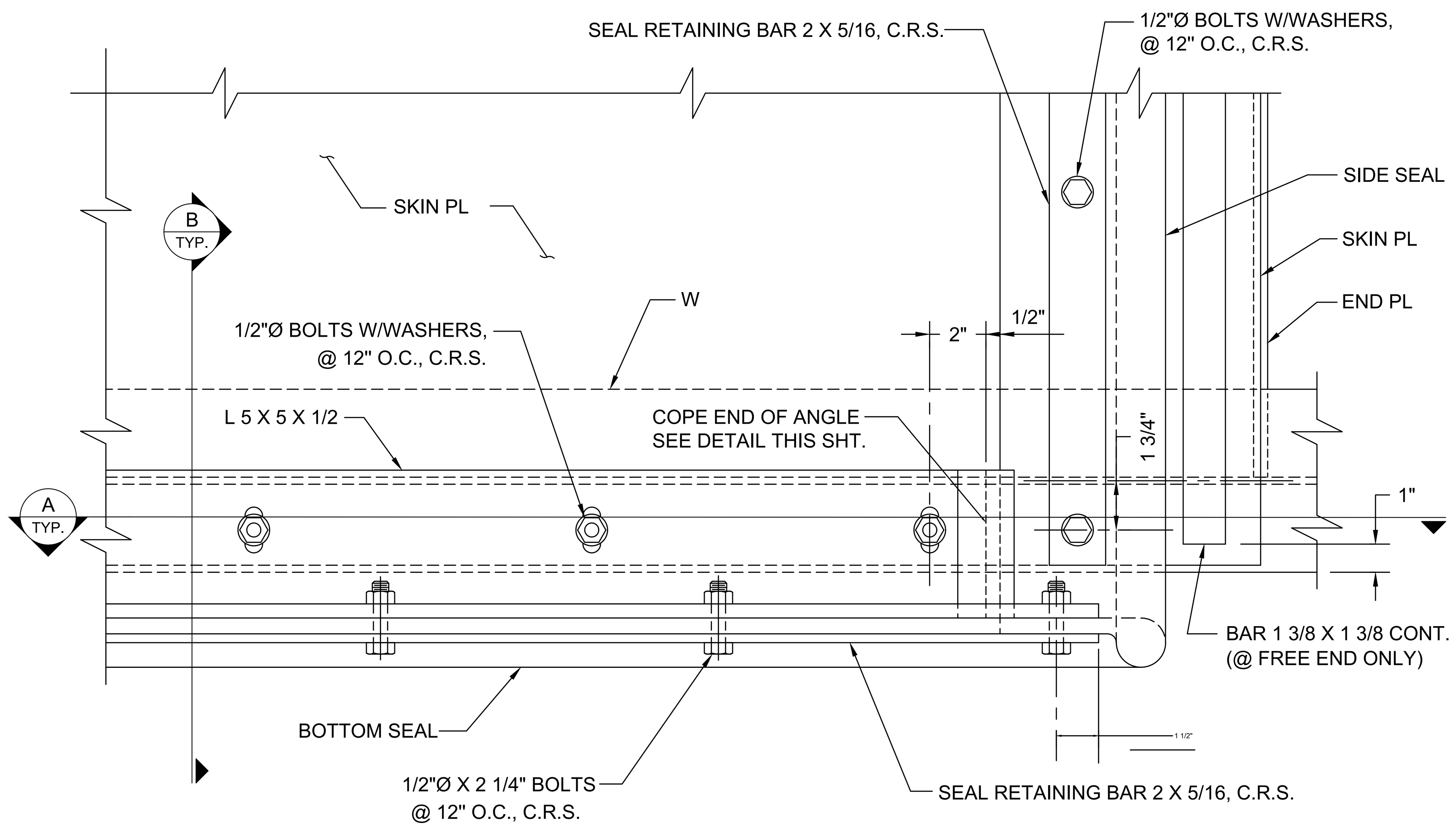
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
SWING GATE
SEAL DETAIL (1 OF 2)

Scale	Designed	Drawn	Checked	Authorized
SEE DWG.	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

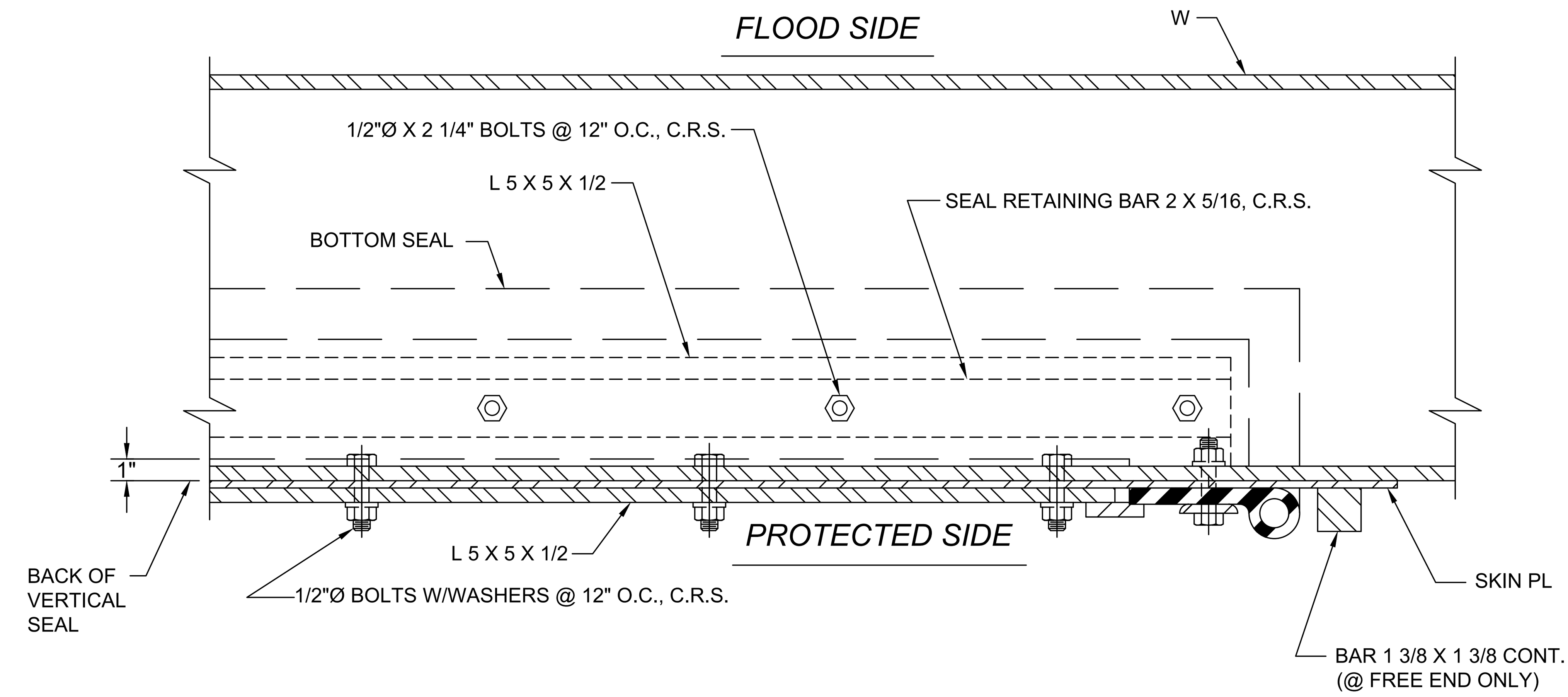
Drawing Number: 100068207-S-520
Revision: 000

DO NOT SCALE



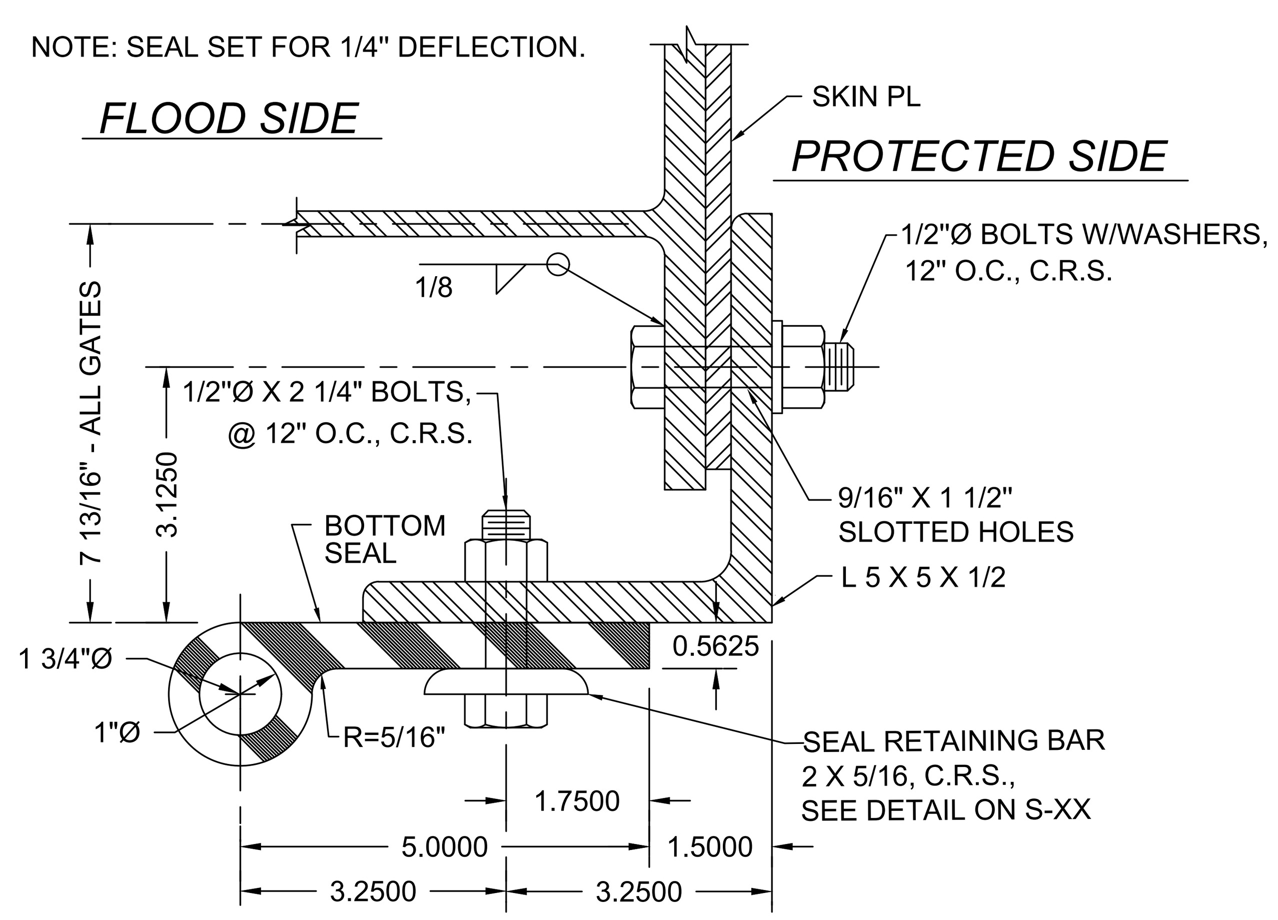
END ELEVATION - PROTECTED SIDE

SCALE: 3" = 1'-0"



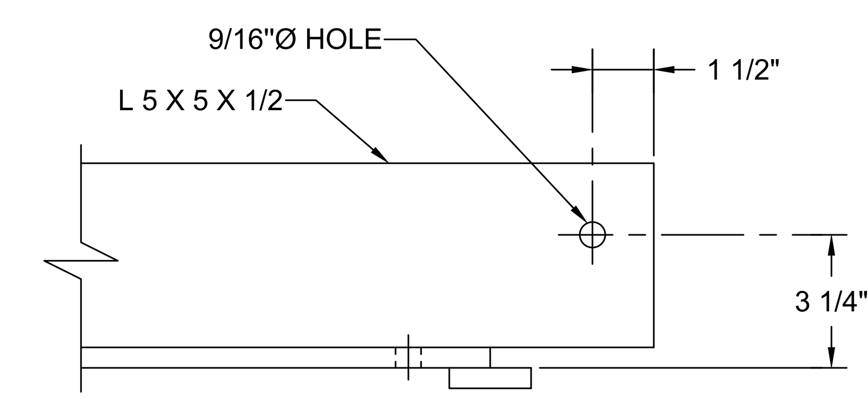
A TYP. TYP. SECTION

SCALE: 3"= 1'-0"

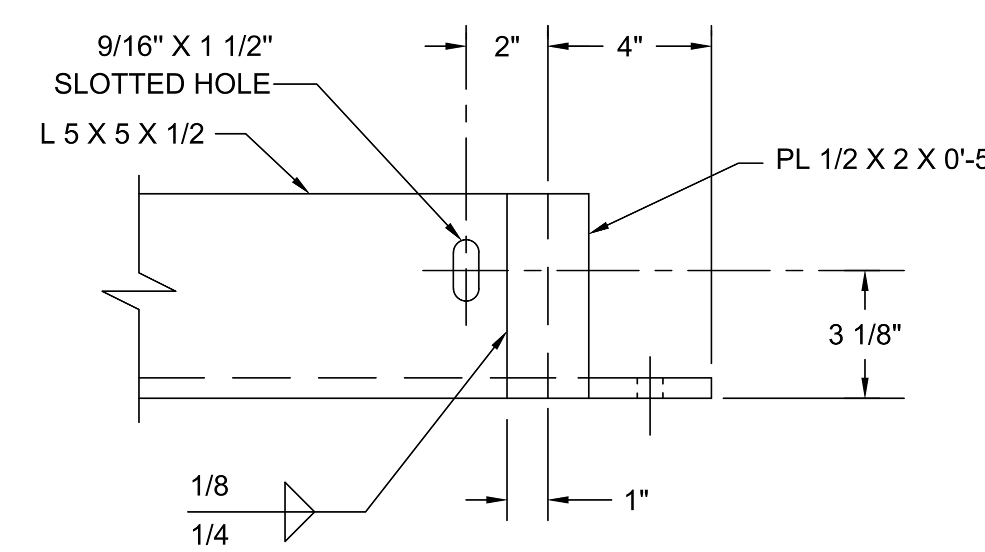


B TYP. TYP. SECTION

SCALE: 6"= 1'-0"



PLAN



ELEVATION (PROTECTED SIDE)

END OF L 5 X 5 X 1/2

SCALE: 3" = 1'-0"

0 3 6 12
(IN INCHES)
3 inch = 1 ft.

0 1 2 4
(IN INCHES)
6 inch = 1 ft.

NOTES:

1. FOR GENERAL NOTES, SEE G-001.
2. ALL SPLICES WILL BE FACTORY MADE IN HEAVY STEEL PRESS TYPE MOLDS UNDER PRESSURE AND HEAT.
3. ALL SPLICE JOINTS MUST DEVELOP STRENGTH OF AT LEAST 50% OF THE MINIMUM TENSILE STRENGTH REQUIRED OF THE RUBBER.
4. SEAL CLAMP ANGLES SHALL BE PAINTED ON ALL SIDES PRIOR TO ASSEMBLY.
5. AFTER ASSEMBLY AND SEAL ADJUSTMENTS ARE MADE, ALL GAPS IN SEALS AND SEAL SUPPORTS SHALL BE SEALED WITH A SILICONE RUBBER SEALANT TO PROVIDE WATERTIGHT JOINTS.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION | Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

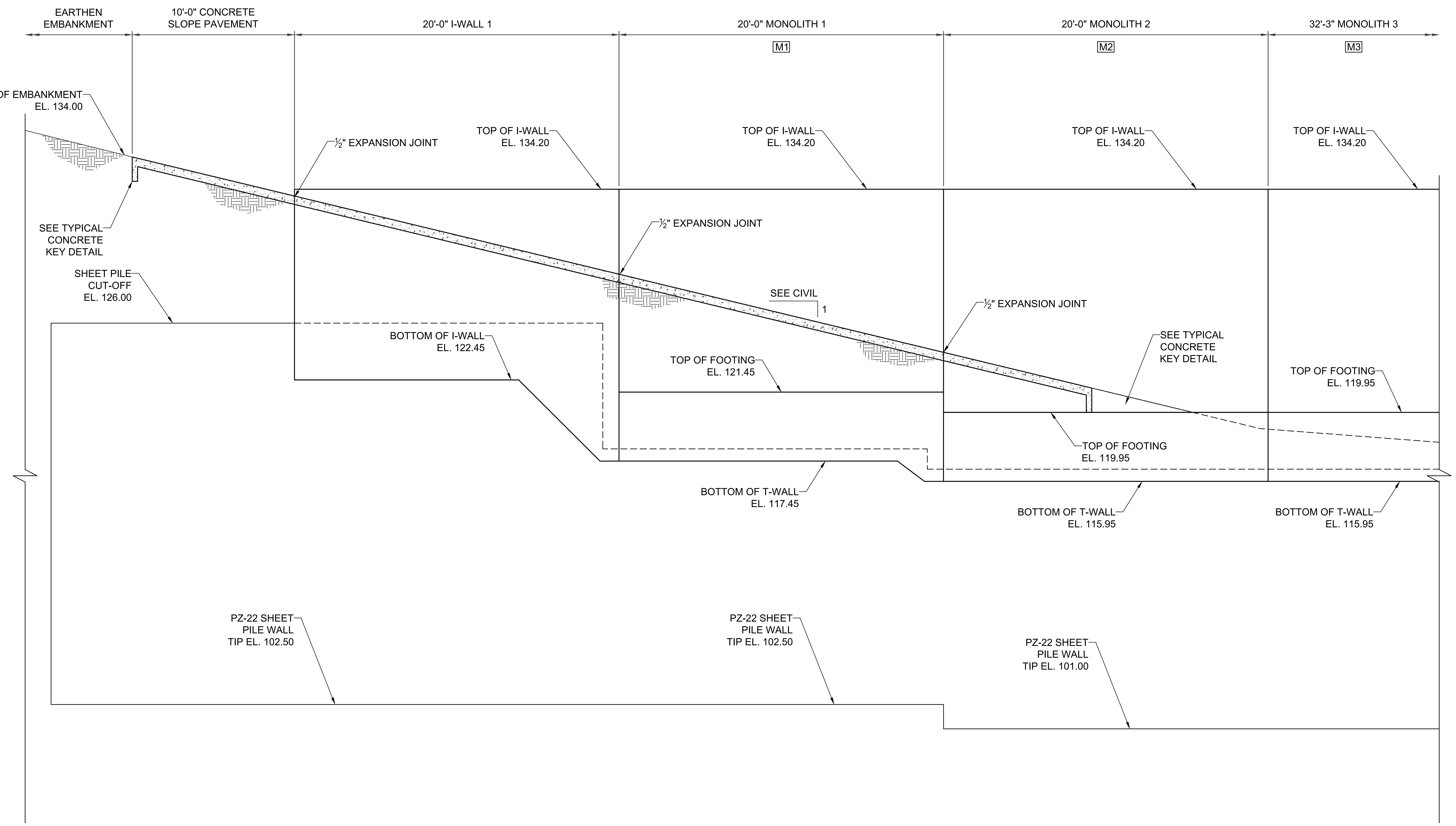
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: SWING GATE SEAL DETAIL (2 OF 2)

Scale	Designed	Drawn	Checked	Authorized
SEE DWG.	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

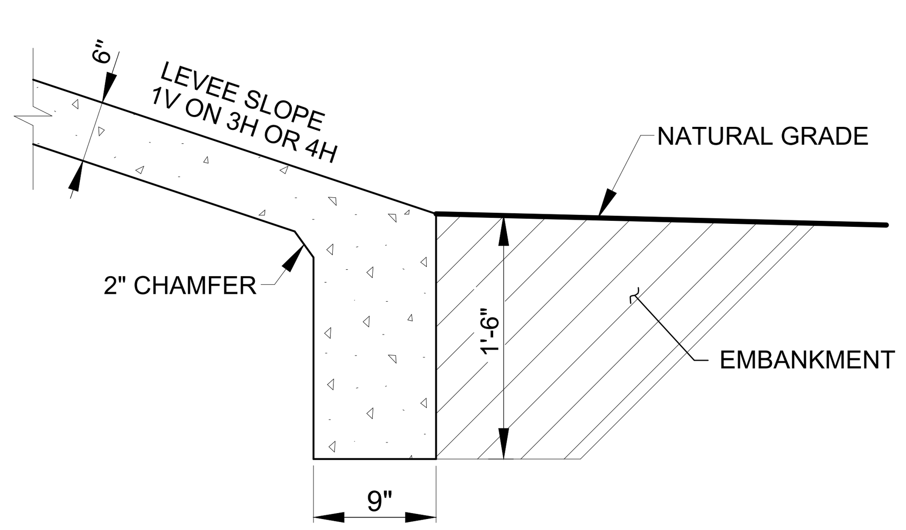
Drawing Number: 100068207-S-521 | Revision: 000

DO NOT SCALE



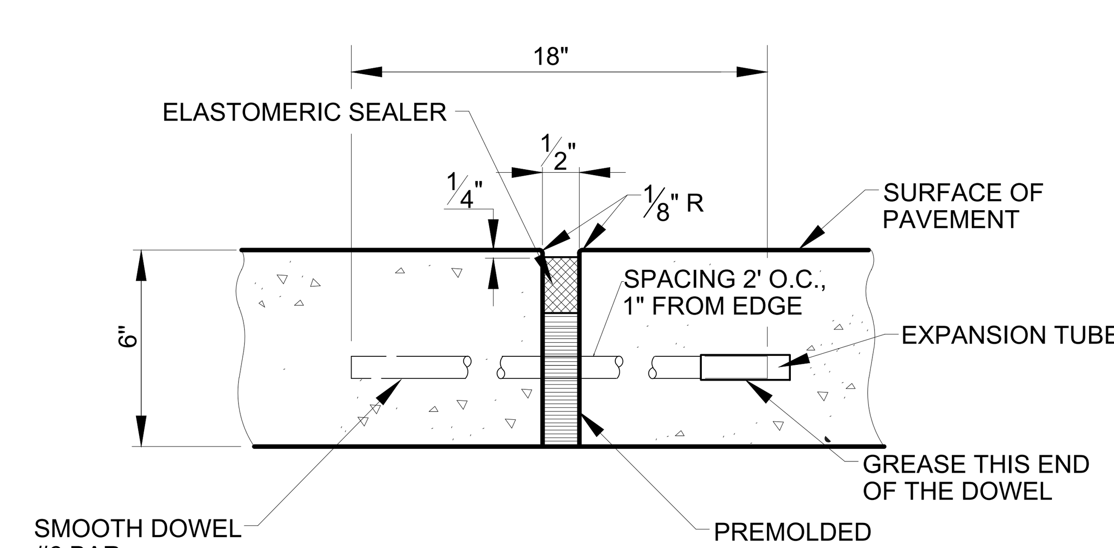
SLOPE PAVEMENT ELEVATION- SOUTH SIDE

SCALE: 1/4" = 1'-0"



TYPICAL CONCRETE KEYS FOR SCOUR PROTECTION DETAIL

SCALE: N.T.S.



EXPANSION JOINT DETAIL

SCALE: N.T.S.

0 2 4 8 12

(IN FEET)
1/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

ENGINEERS ARCHITECTS SURVEYORS
LINFIELD, HUNTER & JUNIUS, INC.
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

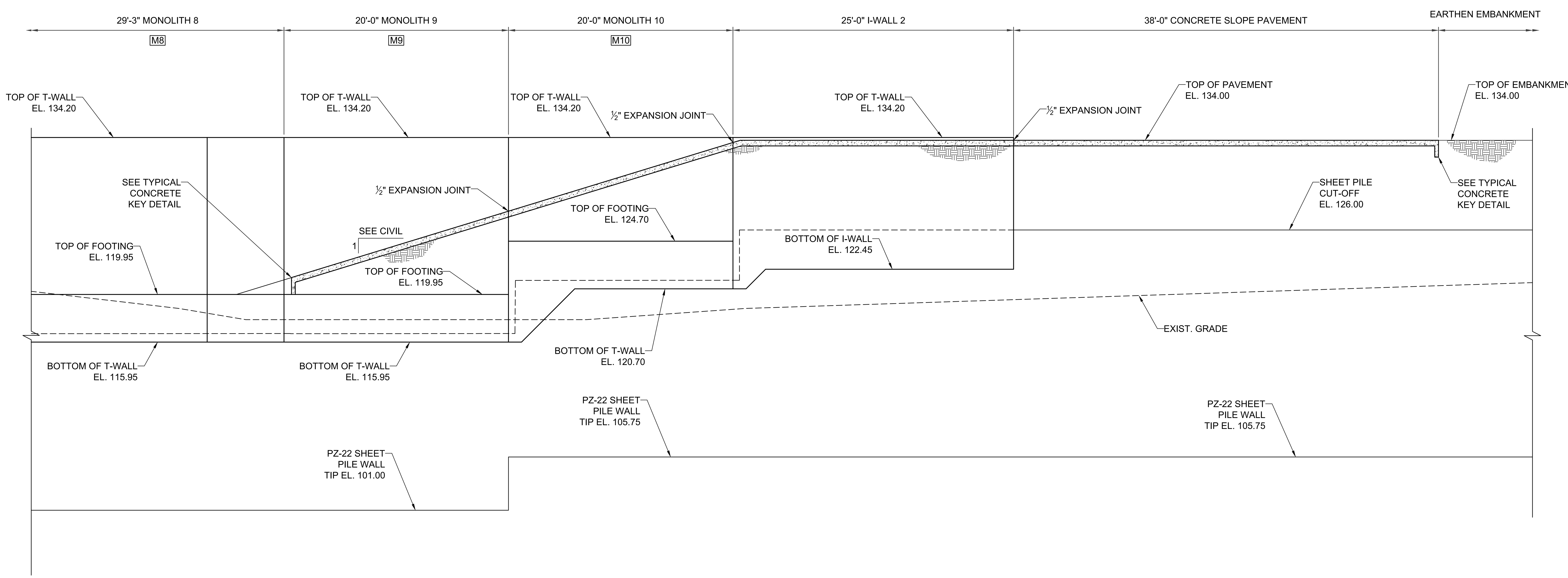
Drawing Title: SCOUR PROTECTION DETAIL (1 OF 2)

Scale	Designed	Drawn	Checked	Authorized
1/4"= 1'	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-522

Revision: 000

DO NOT SCALE



SLOPE PAVEMENT ELEVATION- NORTH SIDE

SCALE: 3/16" = 1'-0"

0 1 2 4 6

(IN FEET)
3/16 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

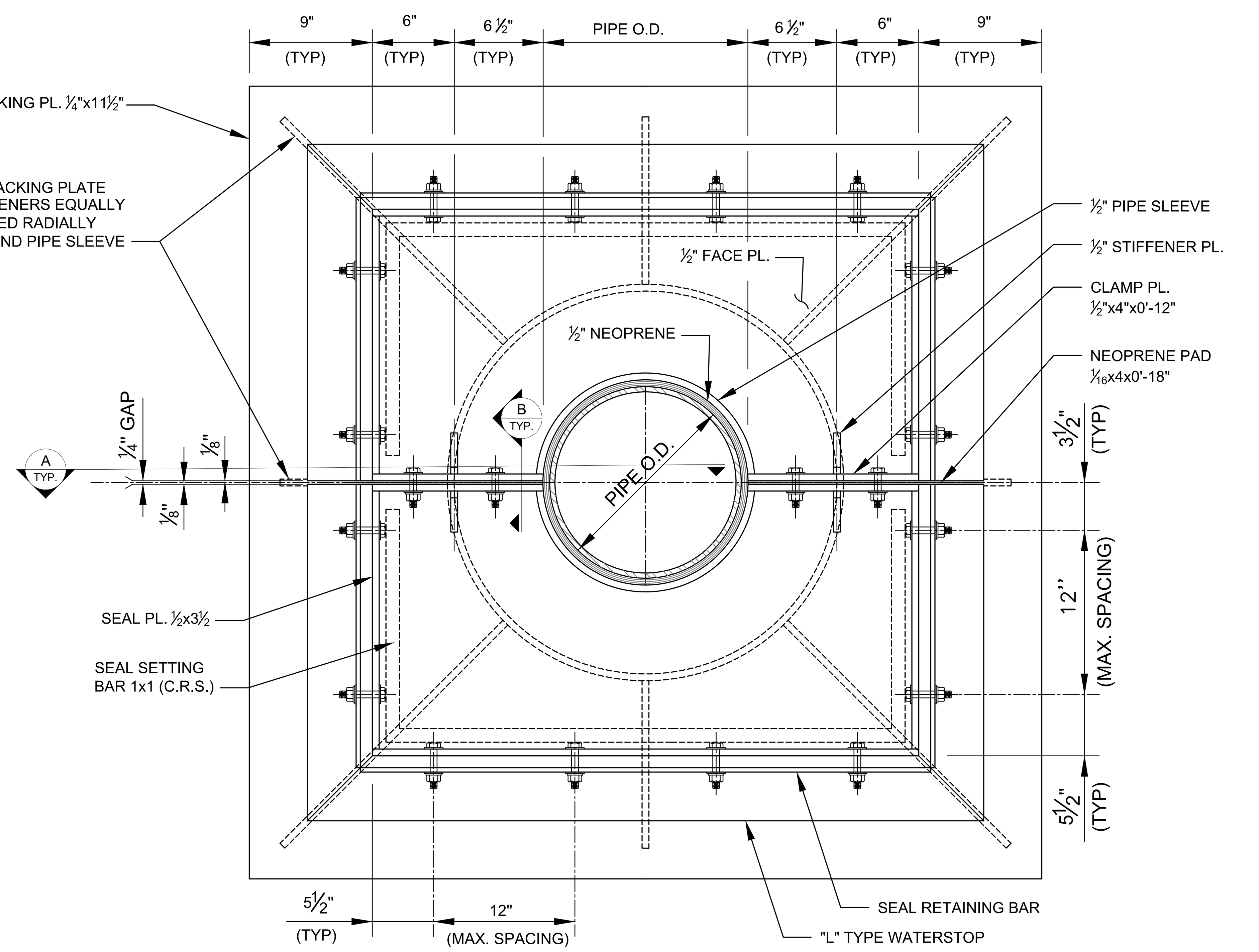
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: SCOUR PROTECTION DETAIL (2 OF 2)

Scale	Designed	Drawn	Checked	Authorized
3/16"= 1'	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

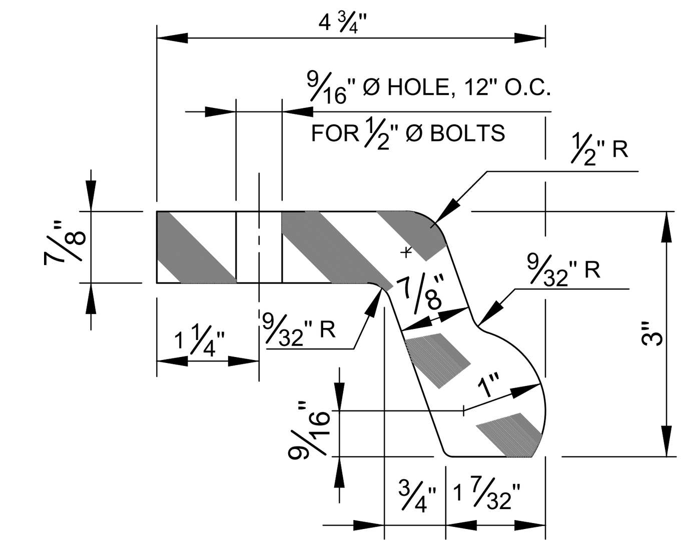
Drawing Number: 100068207-S-523
Revision: 000

DO NOT SCALE



I-WALL PIPE PENETRATION DETAIL

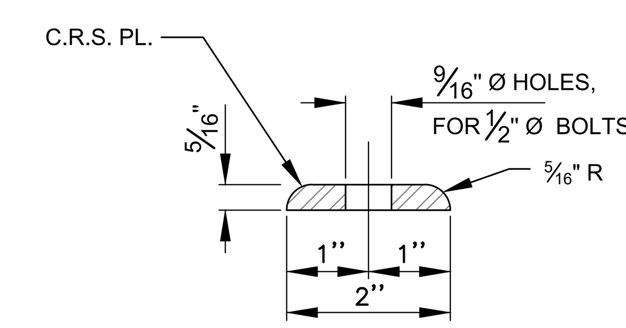
SCALE: N.T.S.



"L" TYPE WATERSTOP

SCALE: 6" = 1'-0"

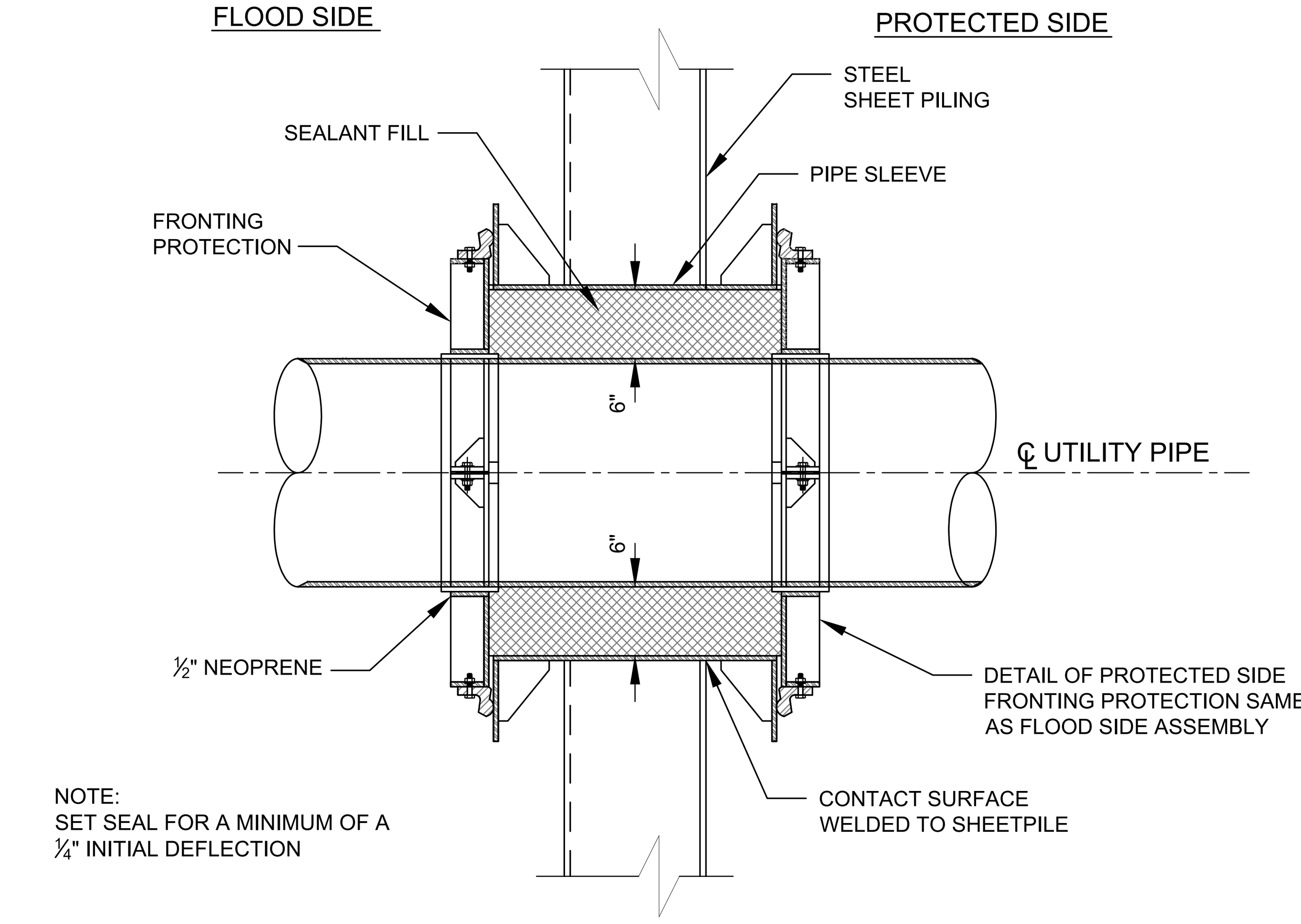
BUCKHORN RUBBER PRODUCTS, INC.
MOLD NO. 6404.
SPECIFICATION: NATURAL-177
OR EQUAL



SEAL RETAINING BAR

SCALE: 6" = 1'-0"

SEE SHEET C-201
FOR LOCATION OF
THESE PENETRATIONS



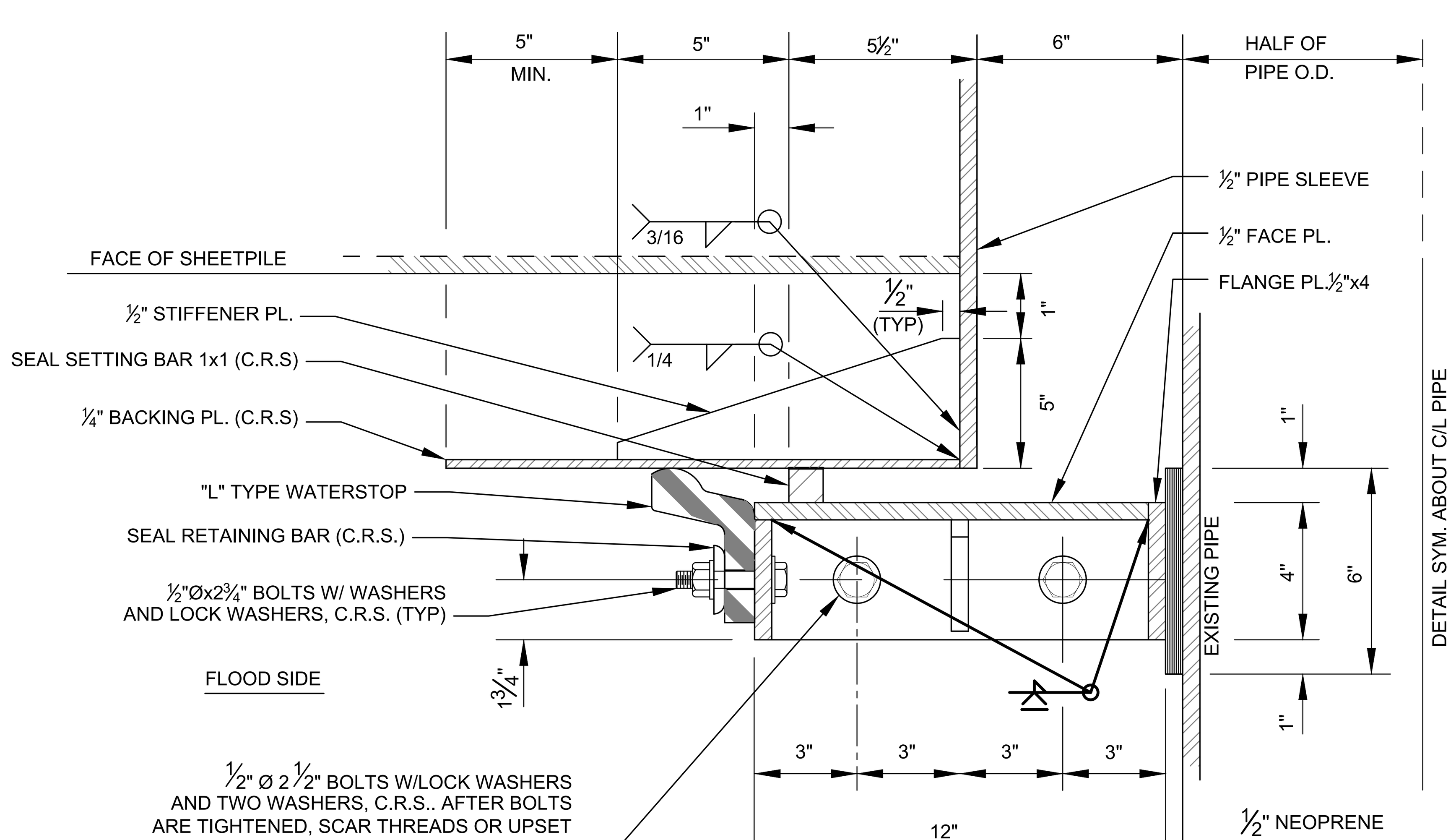
NOTE:
SET SEAL FOR A MINIMUM OF A
¼" INITIAL DEFLECTION

SECTION THRU SHEETPILE WALL

SCALE: N.T.S.

NOTES:

1. THIS DETAIL IS BASED ON THE NEW WALL FACE BEING PERPENDICULAR TO THE PIPE.
2. ALL FLANGE MATERIAL ATTACHED TO THE SHEETPILE SHALL BE STEEL.
3. ALL MATERIAL FOR FRONTING PROTECTION SHALL BE ALUMINUM, UNLESS OTHERWISE NOTED.
4. ALL STRUCTURAL ALUMINUM PLATES SHALL BE ASTM B 209, TYPE 6061-T6.
5. ALL CORROSION-RESISTANT STEEL (C.R.S.) SHALL BE TYPE 316.
6. WELDS SHOWN ARE TYPICAL FOR SIMILAR JOINTS AND ALL WELDS ON WALL SIDE OF FACE PLATE SHALL BE FLUSH WITH BASE METAL.
7. AFTER THE TWO FRAMES ARE LOOSELY CLAMPED ON THE PIPE, THE TOTAL ASSEMBLY SHALL BE PUSHED AGAINST THE WALL, SETTING THE SEALS, THEN TIGHTEN CLAMP PLATES TO CLOSE THE ¼" GAP.
8. UPON COMPLETION OF THE ASSEMBLY, APPLY A ANAEROBIC ADHESIVE (LOCTITE THREADLOCKER 290 OR EQUAL) TO ALL NUT AND BOLT JUNCTURES
9. INCLUDE THE COST OF THE WORK ON THIS SHEET IN THE LUMP SUMP PRICE FOR "DRAINAGE CANAL CROSSINGS AND END TREAMENT"

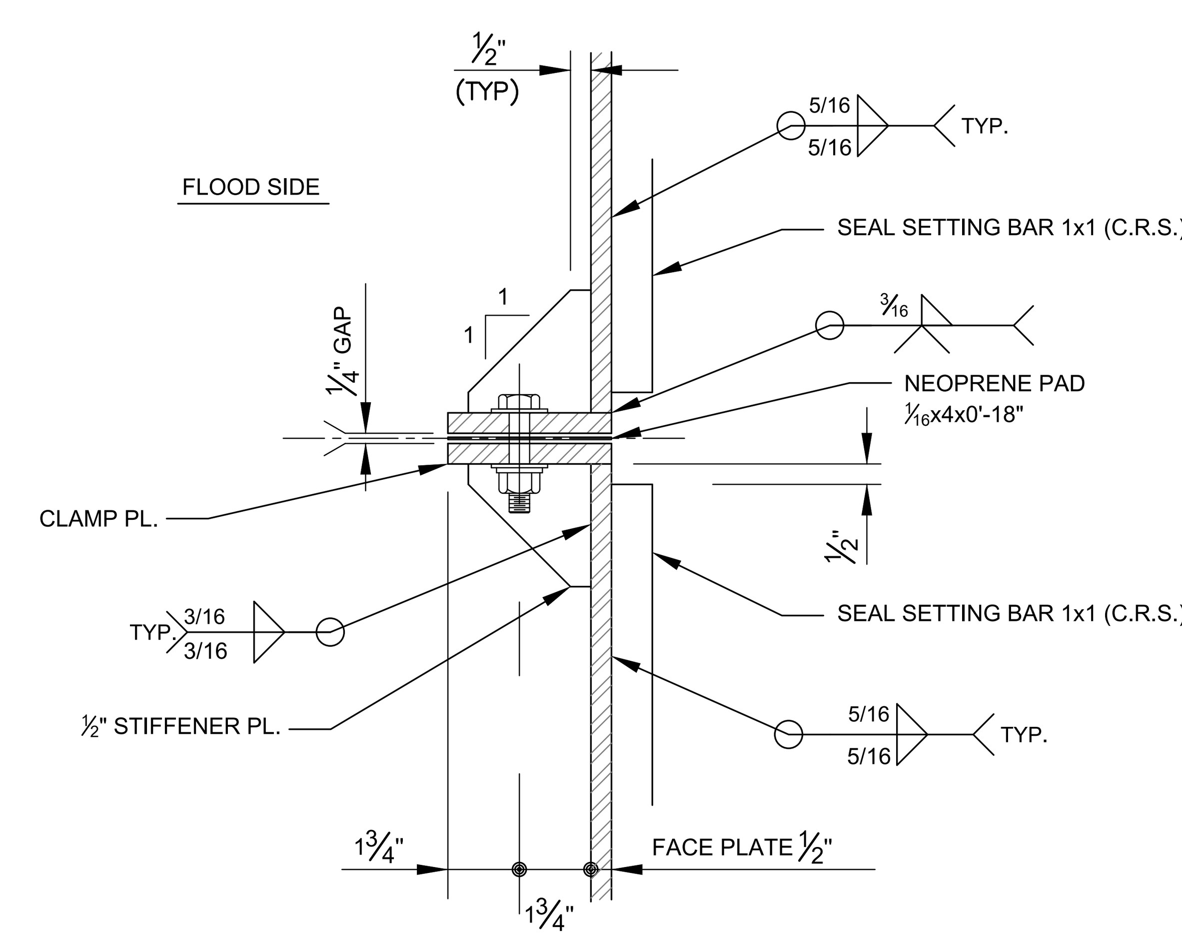


ALL PLATE ½"
UNLESS OTHERWISE NOTED

NOTE:
SET SEAL FOR A MINIMUM OF A
¼" INITIAL DEFLECTION

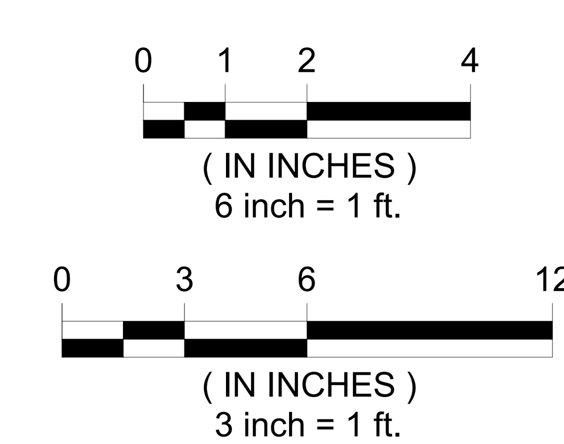
A SECTION

TYP. TYP. SCALE: 3"= 1'-0"



B SECTION

TYP. TYP. SCALE: 3"= 1'-0"



PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION,
CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

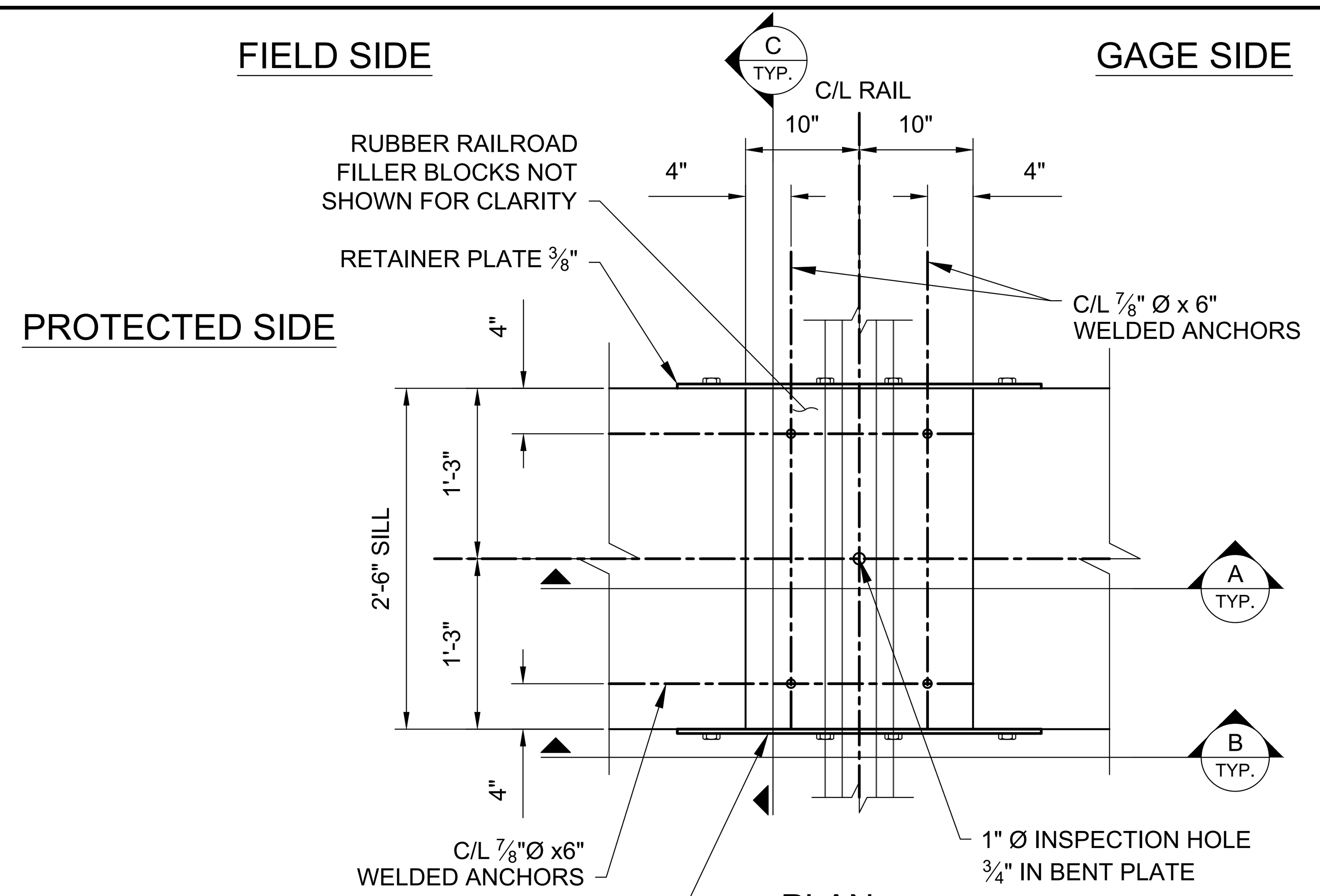
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: DRAINAGE AND UTILITY DETAILS

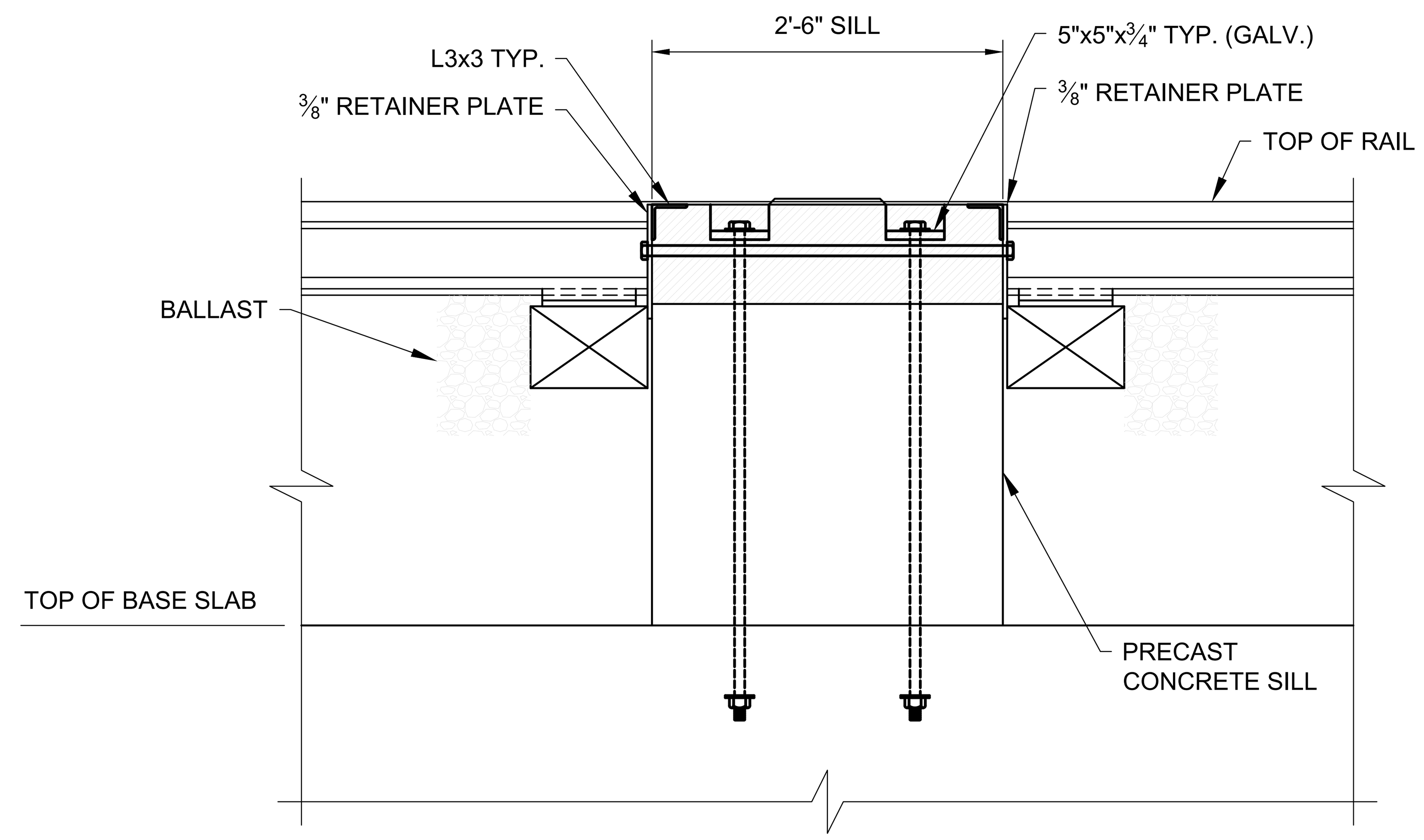
Scale	Designed	Drawn	Checked	Authorized
SEE DWG.	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number: 100068207-S-524
Revision: 000

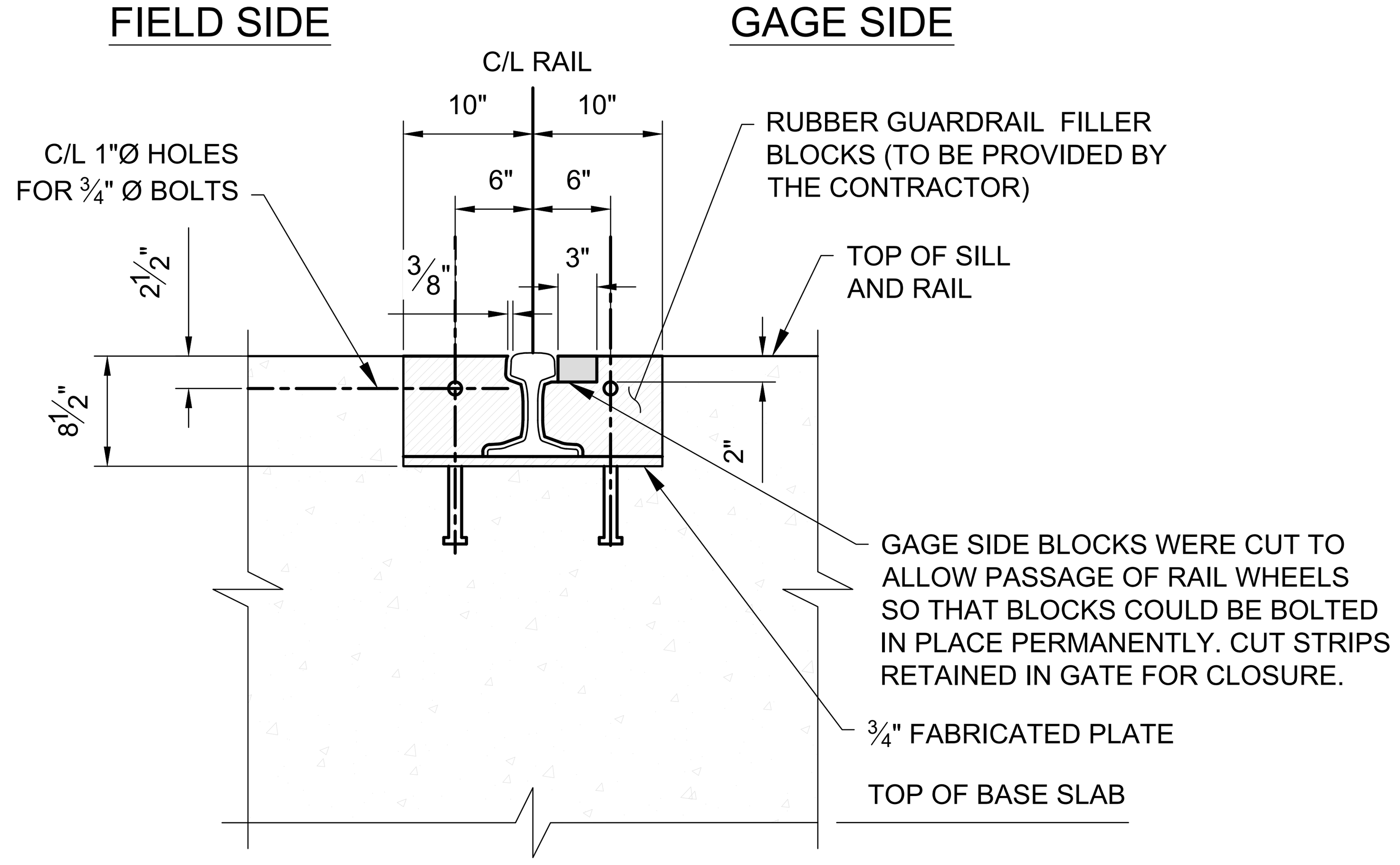
DO NOT SCALE



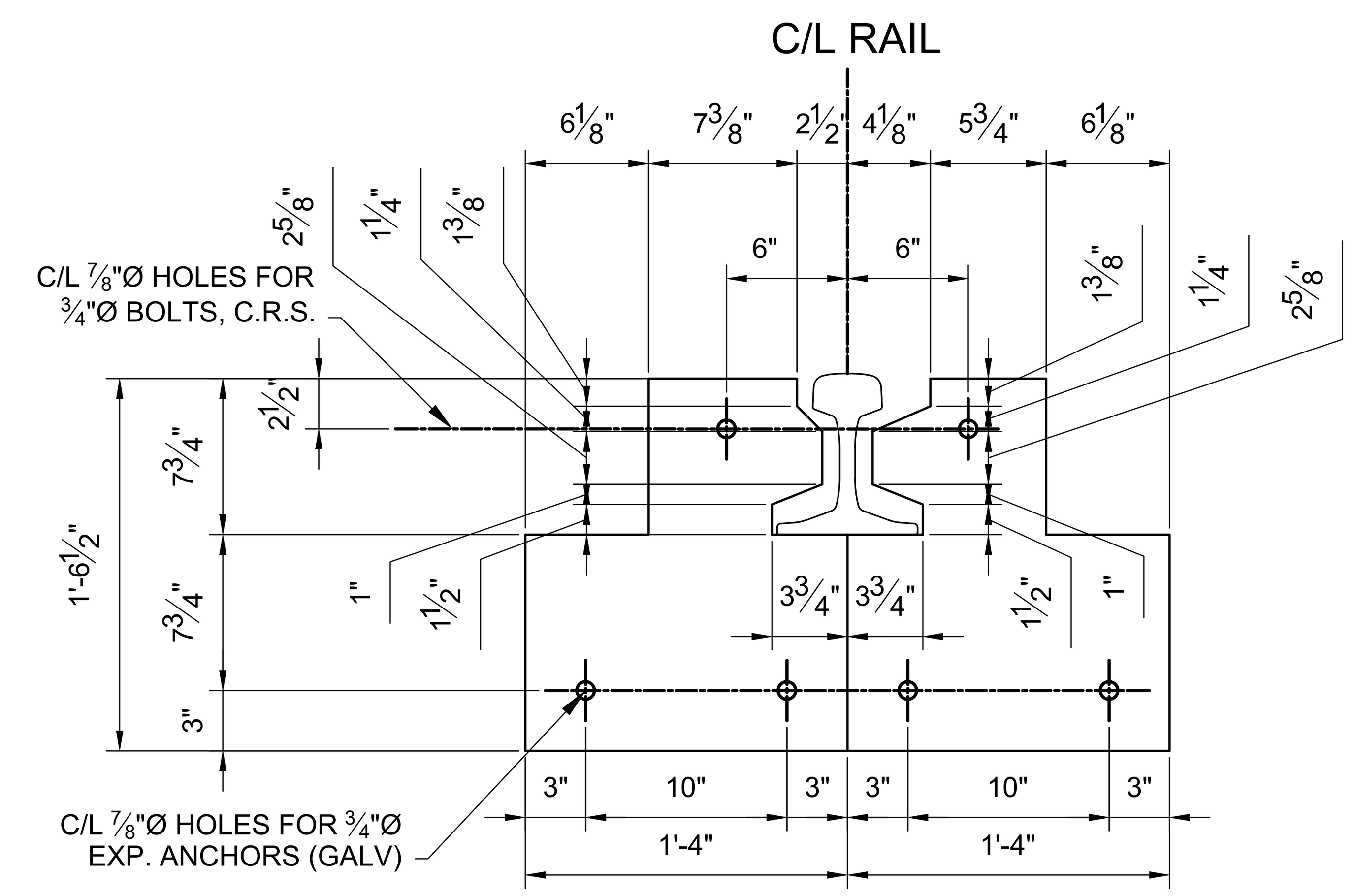
PLAN
SCALE: 1" = 1'-0"



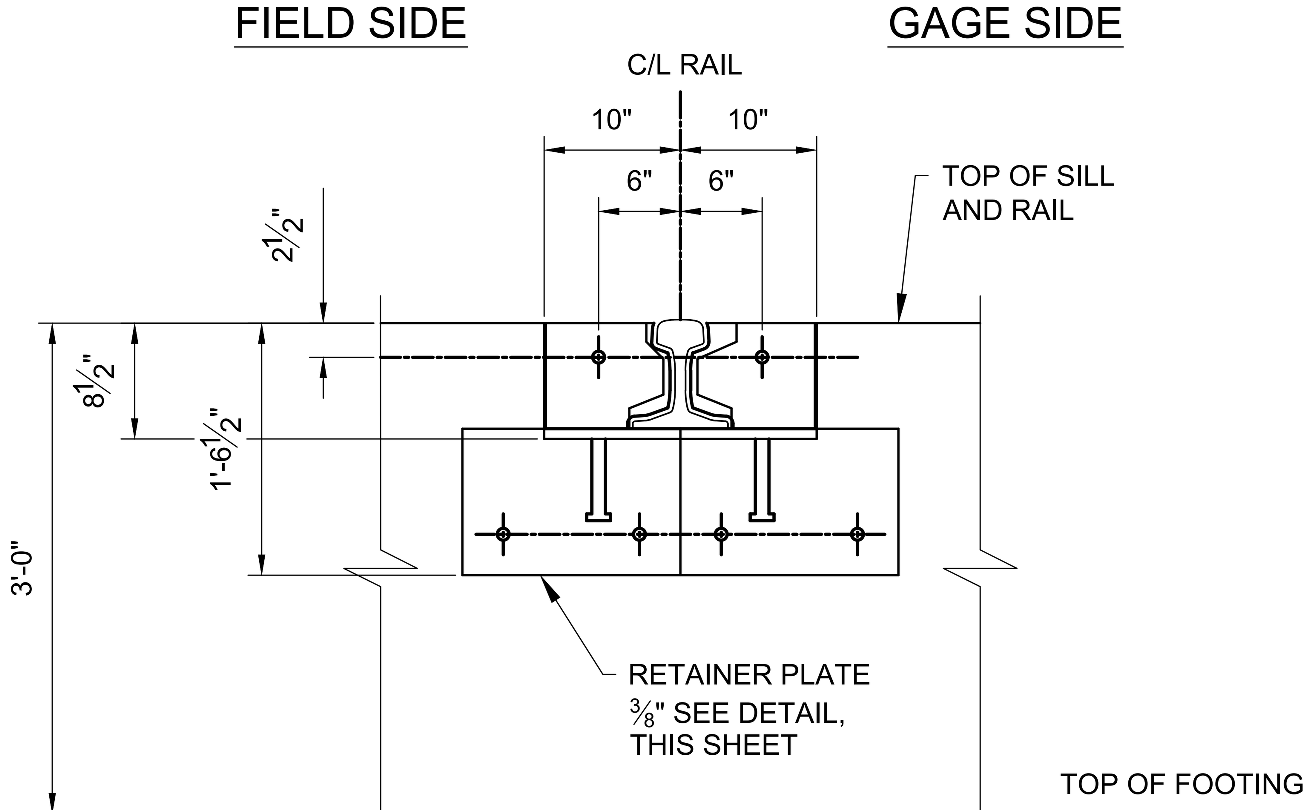
C TYP. | TYP. SECTION- RAIL ASSEMBLY
SCALE: 1"= 1'-0"



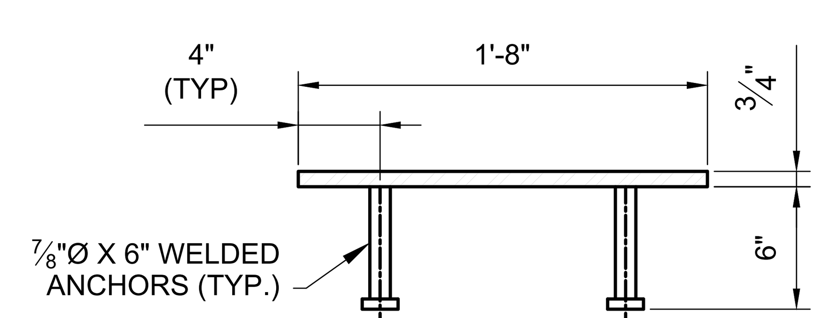
A TYP. | TYP. SECTION
SCALE: 1"= 1'-0"



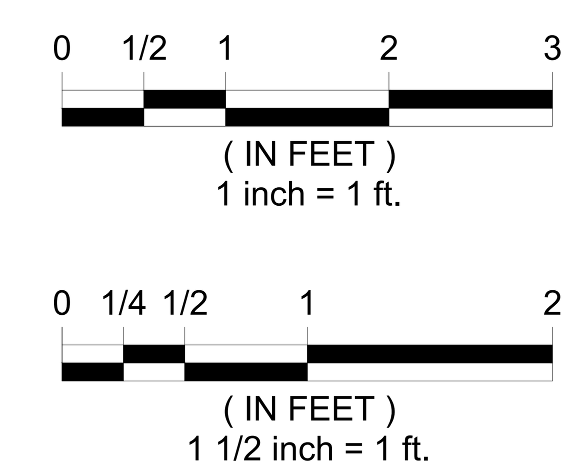
RETAINER PLATE DETAIL
SCALE: 1 1/2" = 1'-0"



B TYP. | TYP. SECTION
SCALE: 1"= 1'-0"



1 TYP. | TYP. DETAIL
SCALE: 1 1/2"= 1'-0"



PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of Lumberton North Carolina

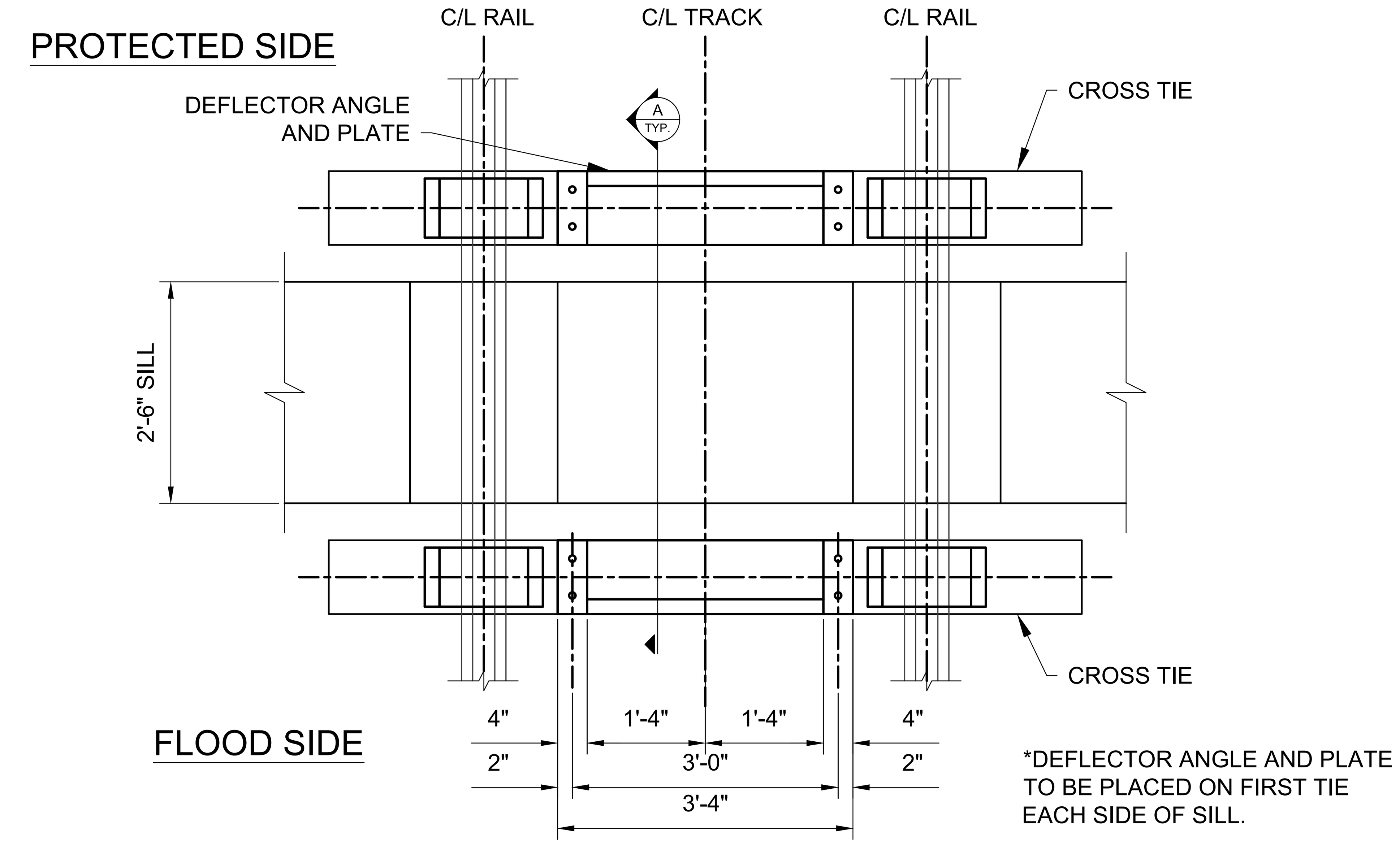
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: RAIL AND COMPONENT PART DETAIL (1 OF 2)

Scale	Designed	Drawn	Checked	Authorized
SEE DWG.	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

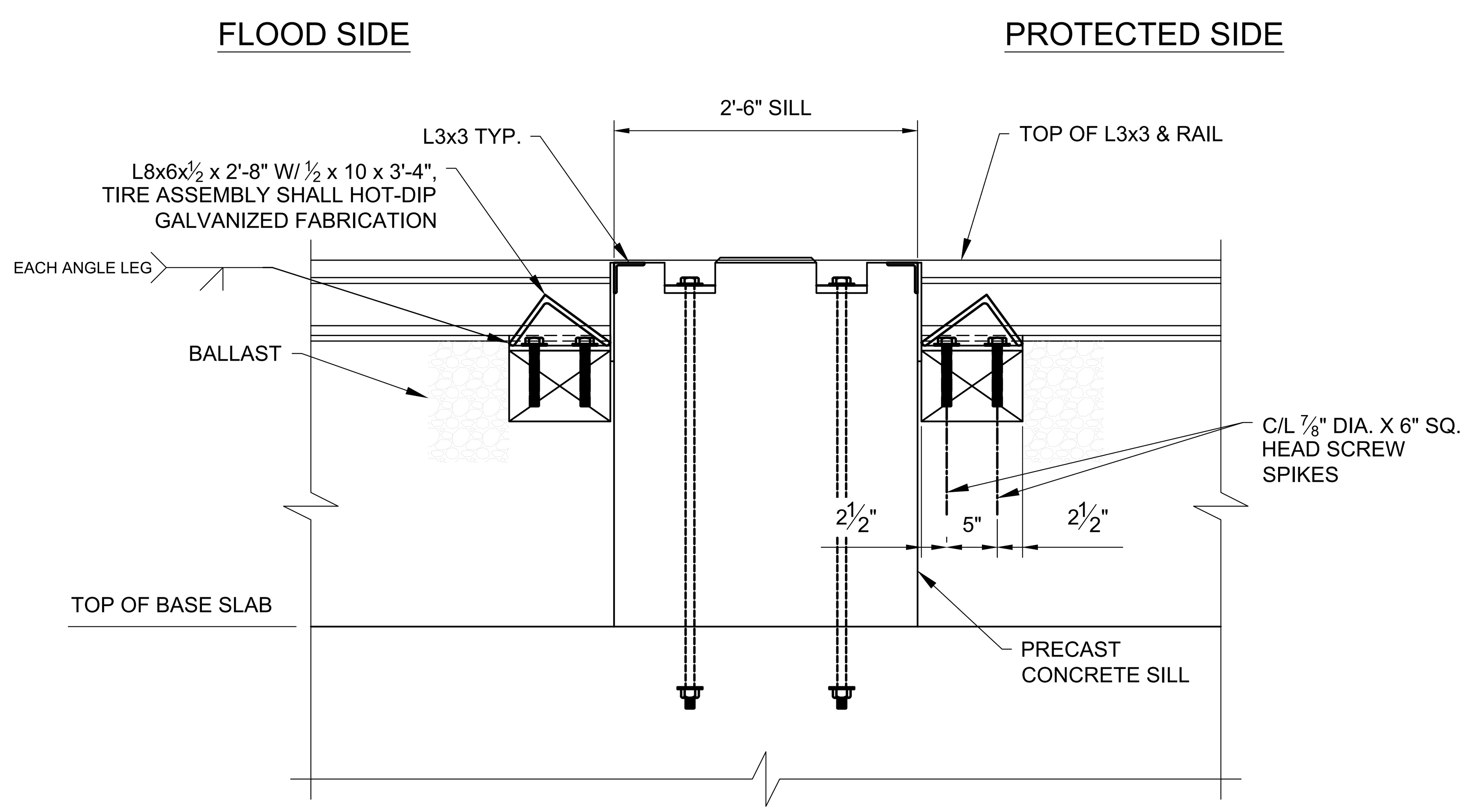
Drawing Number: 100068207-S-526
Revision: 000

DO NOT SCALE



PLAN - DEFLECTOR ANGLE AND PLATE DETAIL

SCALE: 3/4" = 1'-0"



A TYP. | TYP. SECTION

SCALE: 1"= 1'-0"

0 1/2 1 2 3
(IN FEET)
1 inch = 1 ft.

0 1/2 1 2 4
(IN FEET)
3/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

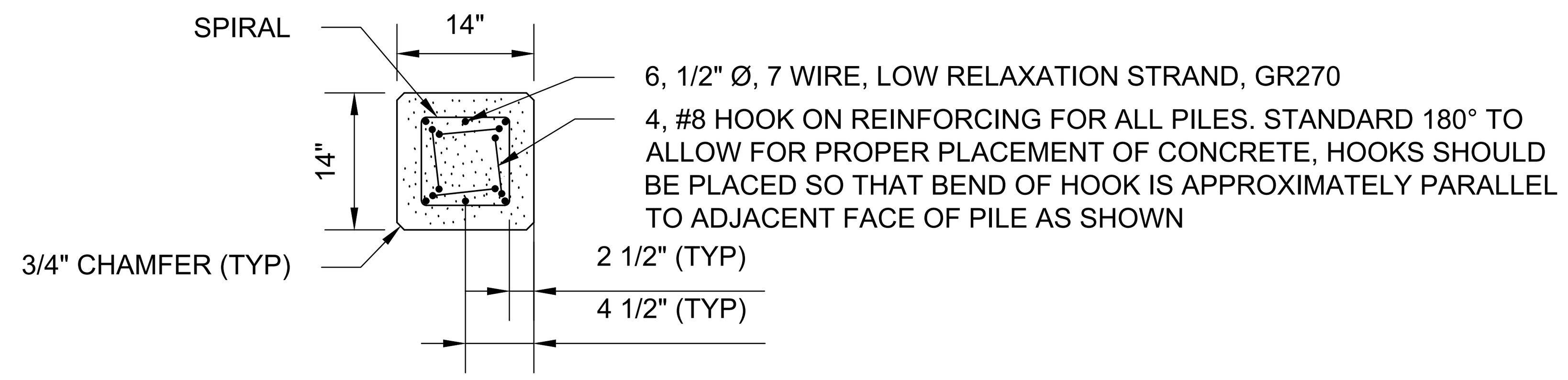
Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

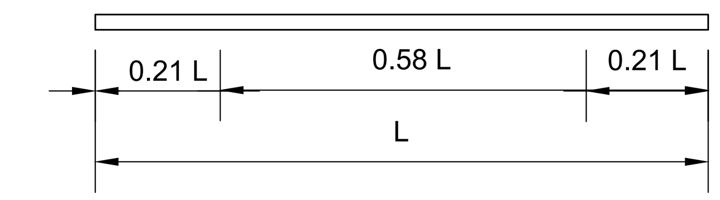
Drawing Title
RAIL AND COMPONENT
PART DETAIL (2 OF 2)

Scale	Designed	Drawn	Checked	Authorized
SEE DWG.	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number: 100068207-S-527
Revision: 000

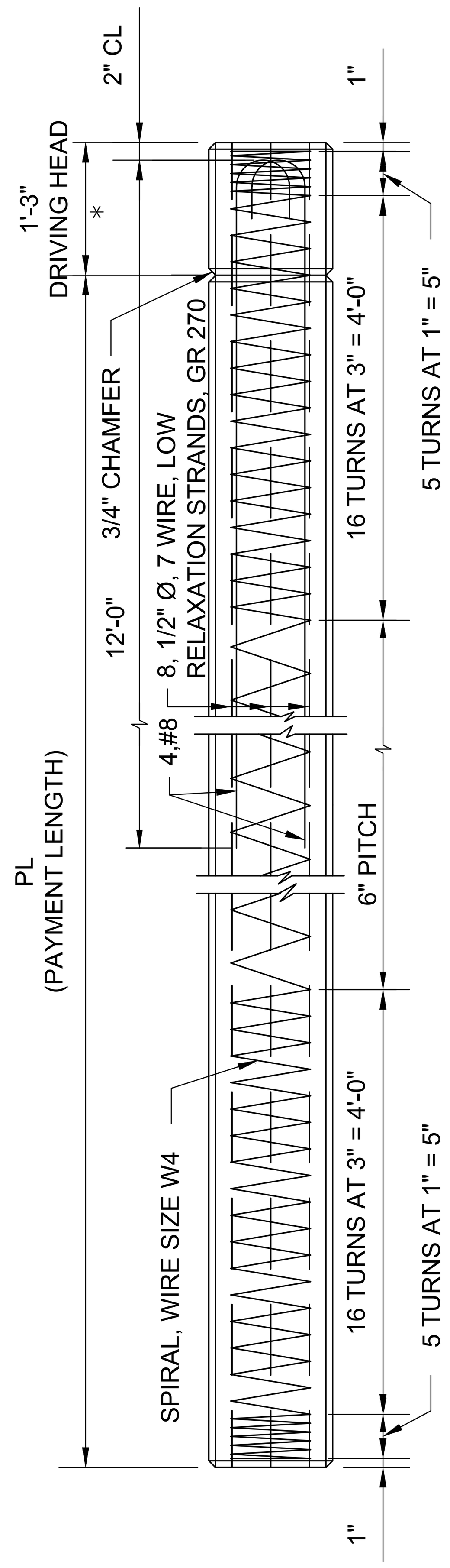
DO NOT SCALE





2 POINT PICKUP (L ≤ 83') 14" X 14" PILE

NOTE: PICKUP POINTS TO BE PLAINLY MARKED ON PILES

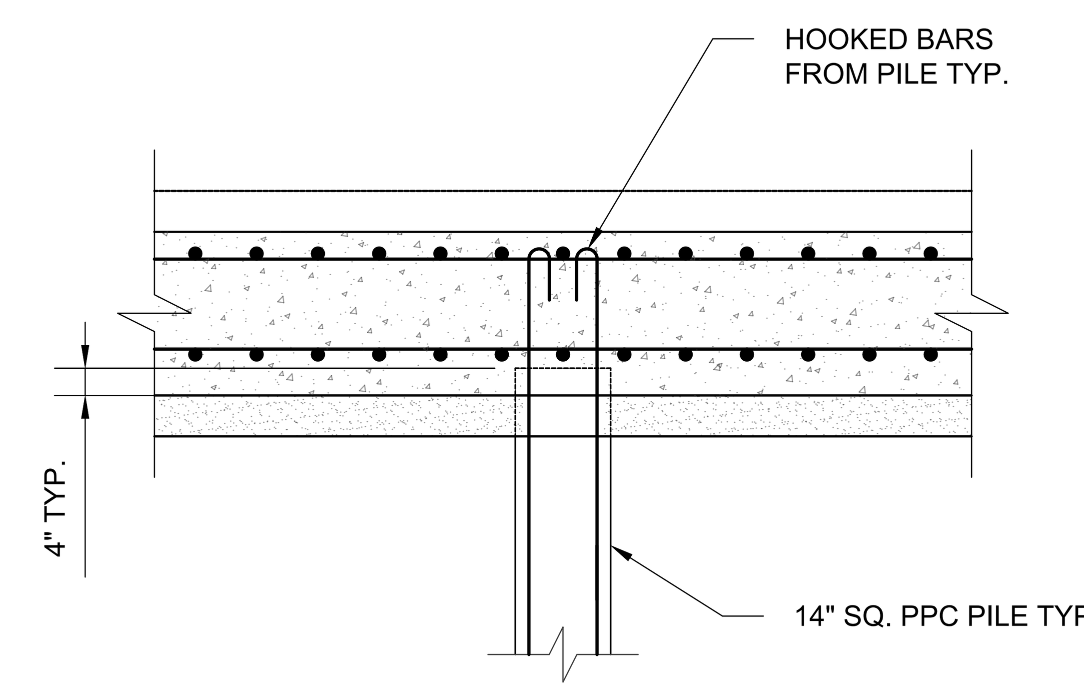


* DRIVING HEAD CONCRETE, STRANDS AND SPIRAL TIES TO BE REMOVED AFTER DRIVING TO EXPOSE HOOKS (NO PAYMENT)

NOTE:
GRIND PRESTRESSED STRANDS FLUSH WITH PILE HEAD AND PILE TIP.

14" X 14" PRESTRESSED PRECAST CONCRETE PILE

NTS



TENSION CONNECTOR DETAIL

NTS

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

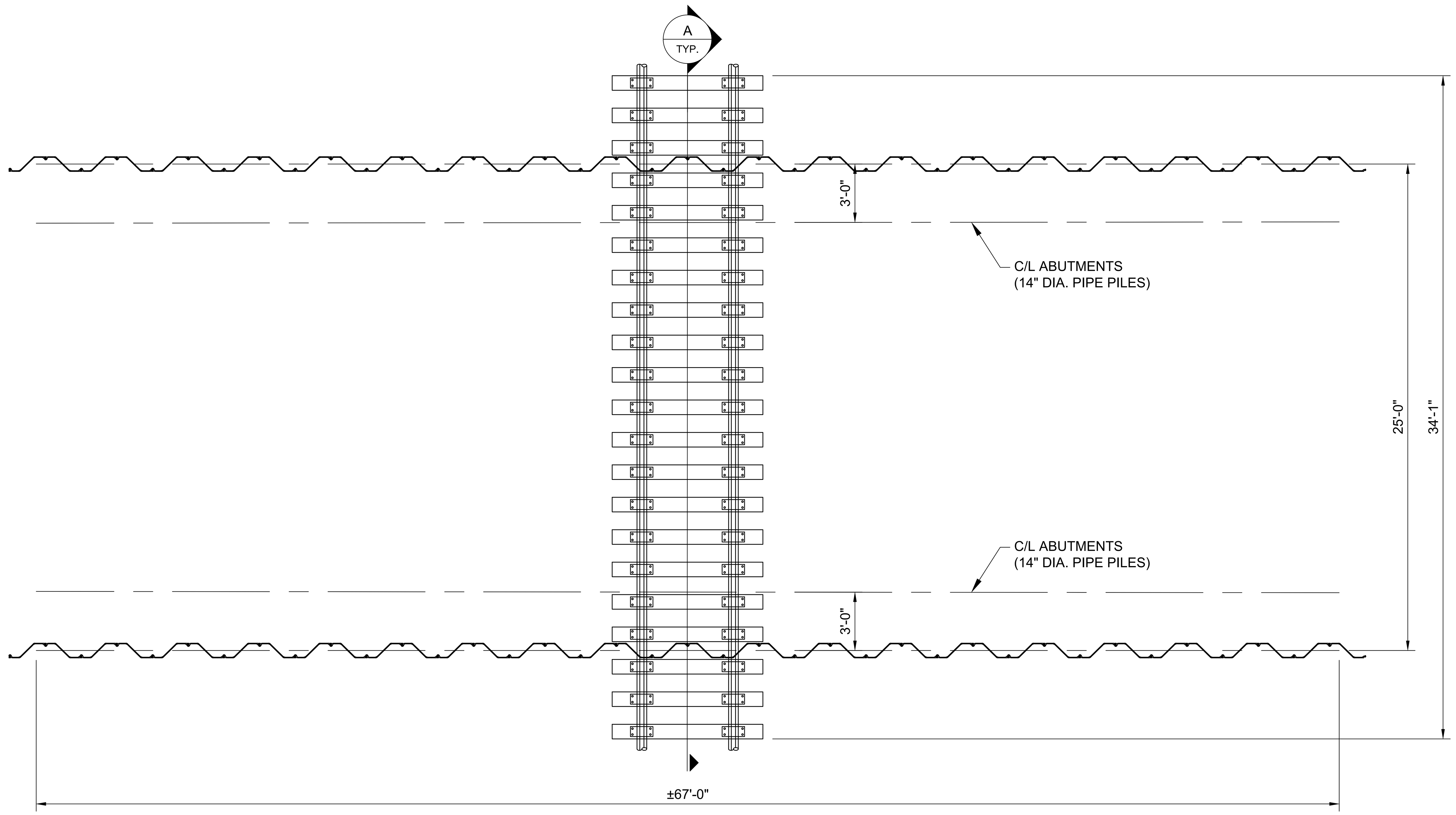
Drawing Title
TYPICAL PILE DETAIL

Scale	Designed	Drawn	Checked	Authorized
NTS	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-S-528

Revision: 000

DO NOT SCALE



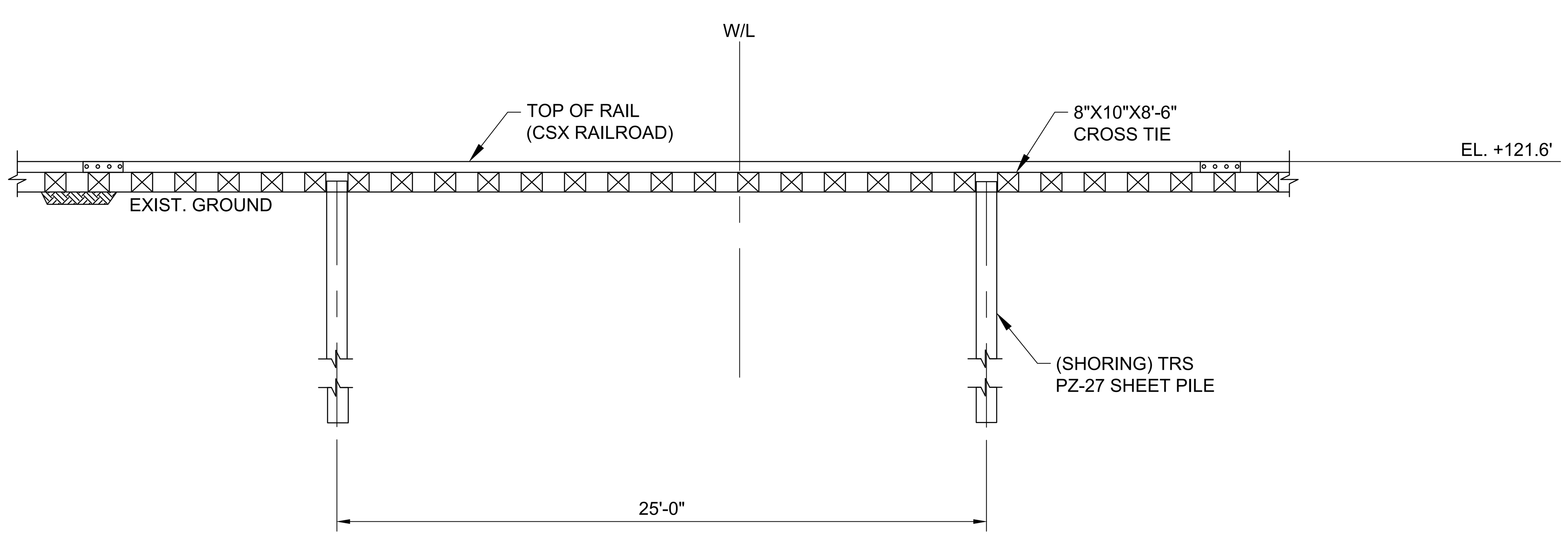
1 TYP. TYP. **PHASE 1 PLAN VIEW**
SCALE: 1/4" = 1'-0"

TRACK WINDOWS WILL BE REQUIRED FOR ALL PHASES OF WORK WHERE TRACK(S) WILL BE BLOCKED OR OUT OF SERVICE, TRACK WINDOWS TO BE COORDINATED WITH CSX.

PHASE 1 CONSTRUCTION SEQUENCING:

1. CONTRACTOR COORDINATES FINAL CONSTRUCTION SEQUENCE WITH THE RAILROAD COMPANY AND EXECUTES A TEMPORARY CONSTRUCTION CROSSING AGREEMENT WITH CSX RAILROAD.

2. THE CONTRACTOR SHALL COORDINATE WITH THE RAILROAD COMPANY TO SCHEDULE TRACK WINDOWS TO INSTALL SECTIONS OF SHORING SHEET PILING. THE RAILROAD COMPANY WILL REMOVE 34-FOOT SECTIONS OF RAIL FROM EACH TRACK. CONTRACTOR TO INSTALL SECTIONS OF SHORING (TRS) SHEET PILING. FINAL ELEVATION OF SHORING SHEET PILING SHALL BE AS SHOWN IN THE PLANS. SHORING SHEET PILING SHALL REMAIN IN-PLACE AT THE COMPLETION OF THE PROJECT AND WILL BE CUT-OFF A MINIMUM OF 2-FT BELOW THE TOP-OF-TIE.



A TYP. TYP. **SECTION**
SCALE: 1/4" = 1'-0"

0 2 4 8 12
(IN FEET)
1/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

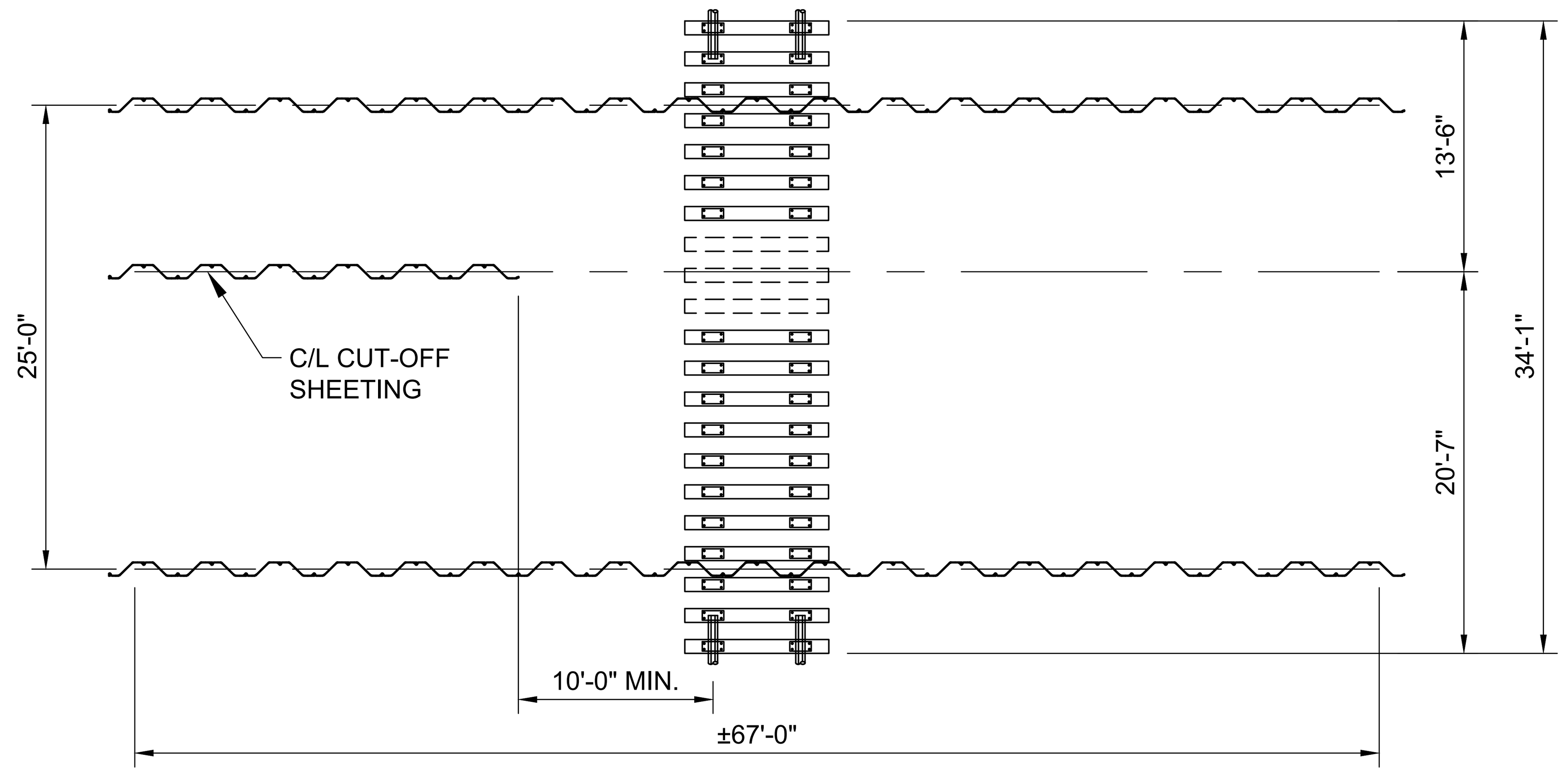
Project Title:
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title:
RAILROAD TRS (1 OF 6)

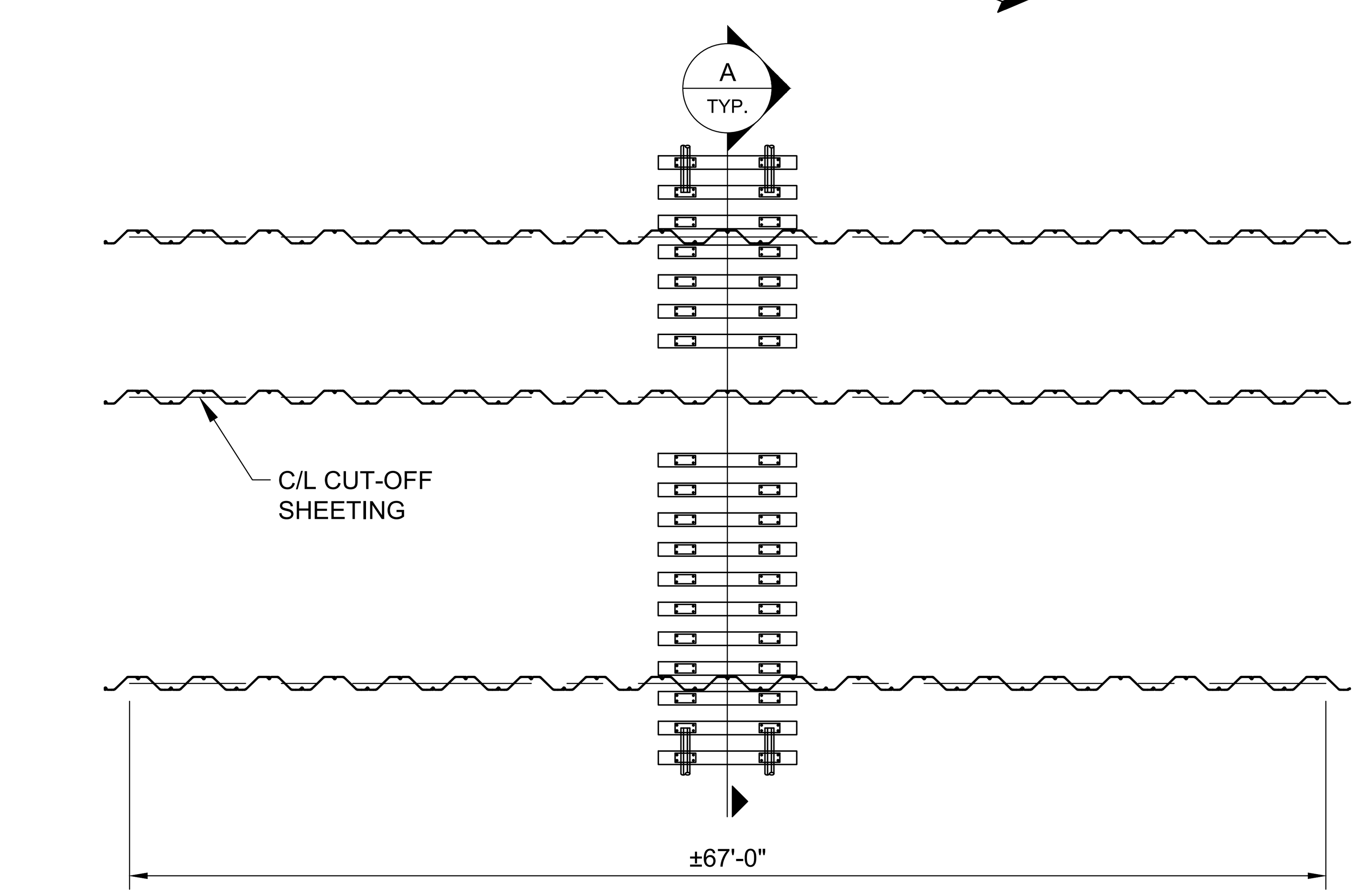
Scale	Designed	Drawn	Checked	Authorized
1/4"=1'-0"	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number: 100068207-CS-100
Revision: 000

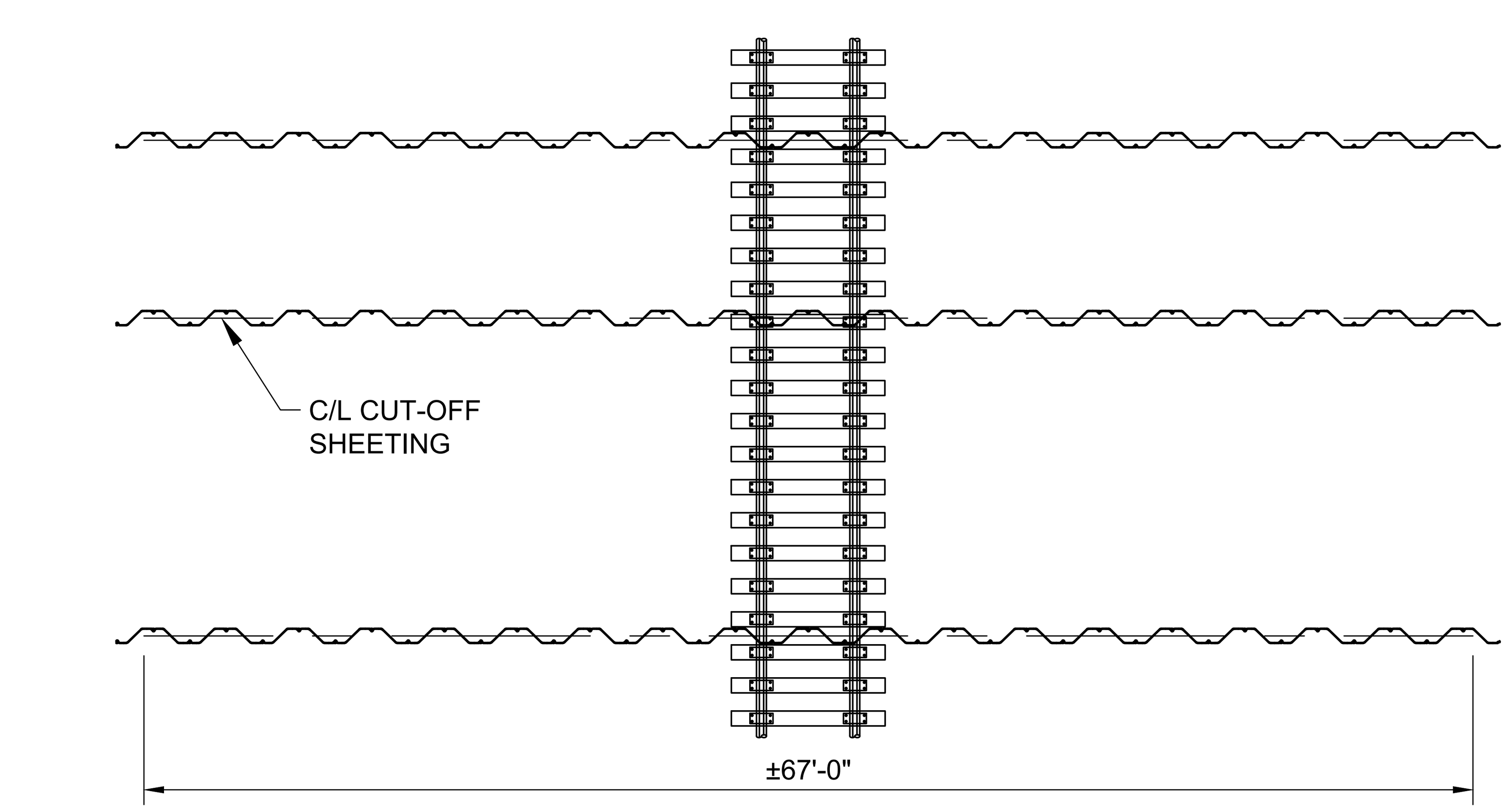
DO NOT SCALE



1 TYP. TYP. PHASE 2 PLAN VIEW
SCALE: 1/8" = 1'-0"



2 TYP. TYP. PHASE 3 PLAN VIEW
SCALE: 1/8" = 1'-0"



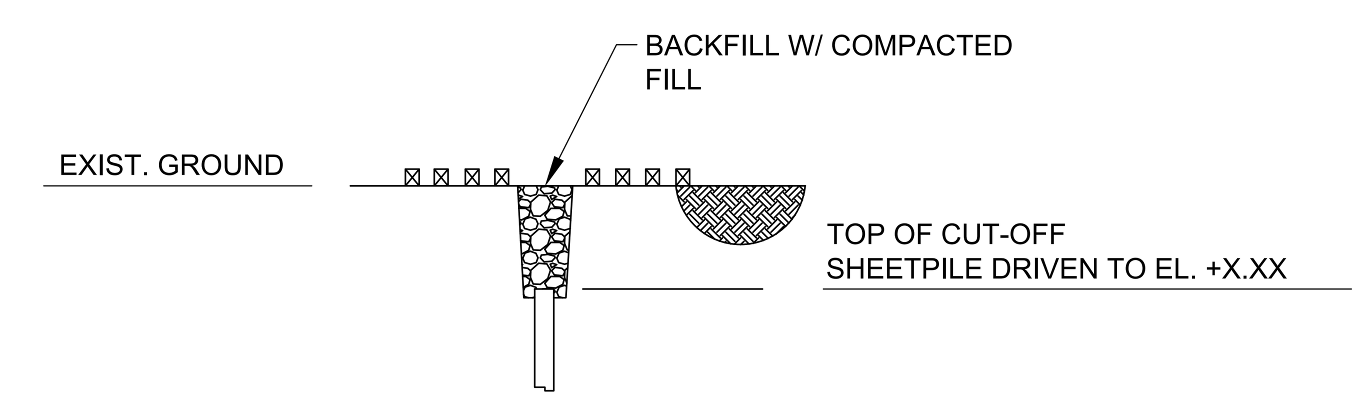
3 TYP. TYP. PHASE 4 PLAN VIEW
SCALE: 1/8" = 1'-0"

PHASE 2 CONSTRUCTION SEQUENCING:

1. CONTRACTOR AND RAILROAD COMPANY WILL COORDINATE AND SCHEDULE STOPPAGE OF TRAIN OPERATIONS (TRACK WINDOW) ON ALL TRACKS TO INSTALL PERMANENT CUT OFF SHEET PILING.
2. RAILROAD COMPANY WILL REMOVE 34-FT TRACK SECTIONS & TWO TIMBER CROSSTIES FROM EACH TRACK. CONTRACTOR TO DRIVE CUT-OFF SHEET PILING AFTER RAILS AND CROSS TIES ARE REMOVED.
3. CONTRACTOR TO INSTALL PERMANENT CUT-OFF SHEET PILING BEGINNING AT OWNER'S NORTH PROPERTY LINE AND PROGRESSING SOUTHWARD TO A POINT TEN FEET NORTH OF TRACK.

PHASE 3 CONSTRUCTION SEQUENCING:

1. CONTRACTOR DRIVES PERMANENT CUT-OFF SHEET PILING FROM A POINT TEN FEET NORTH OF THE TRACK TO INTERSECT WITH THE PZ-27 SHEET PILING, CUT-OFF SHEET PILING SHALL BE "CHASED DOWN" BELOW THE ELEVATION OF THE BOTTOM CHORD OF THE PROPOSED JUMP SPAN BRIDGE.



A TYP. TYP. SECTION
SCALE: 1/8" = 1'-0"

PHASE 4 CONSTRUCTION SEQUENCING:

1. RAILROAD COMPANY WILL REINSTALL TWO TIMBER CROSS TIES AND TWO 34-FOOT SECTIONS OF RAIL ON EACH TRACK, USING STAGGERED JOINTS AND NO WELDS.

0 4 8 16 24
(IN FEET)
1/8 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

811 Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION — Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

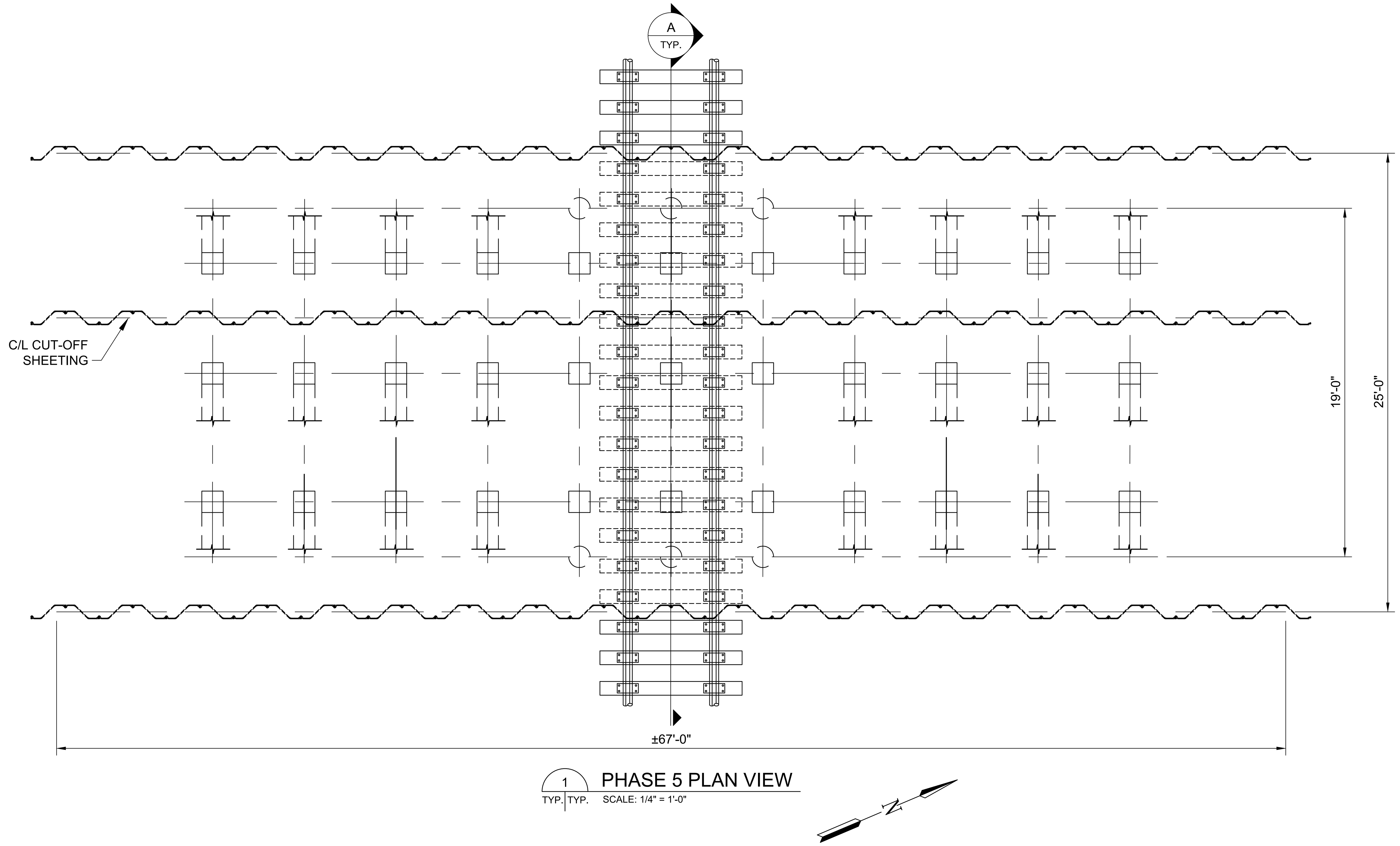
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: RAILROAD TRS (2 OF 6)

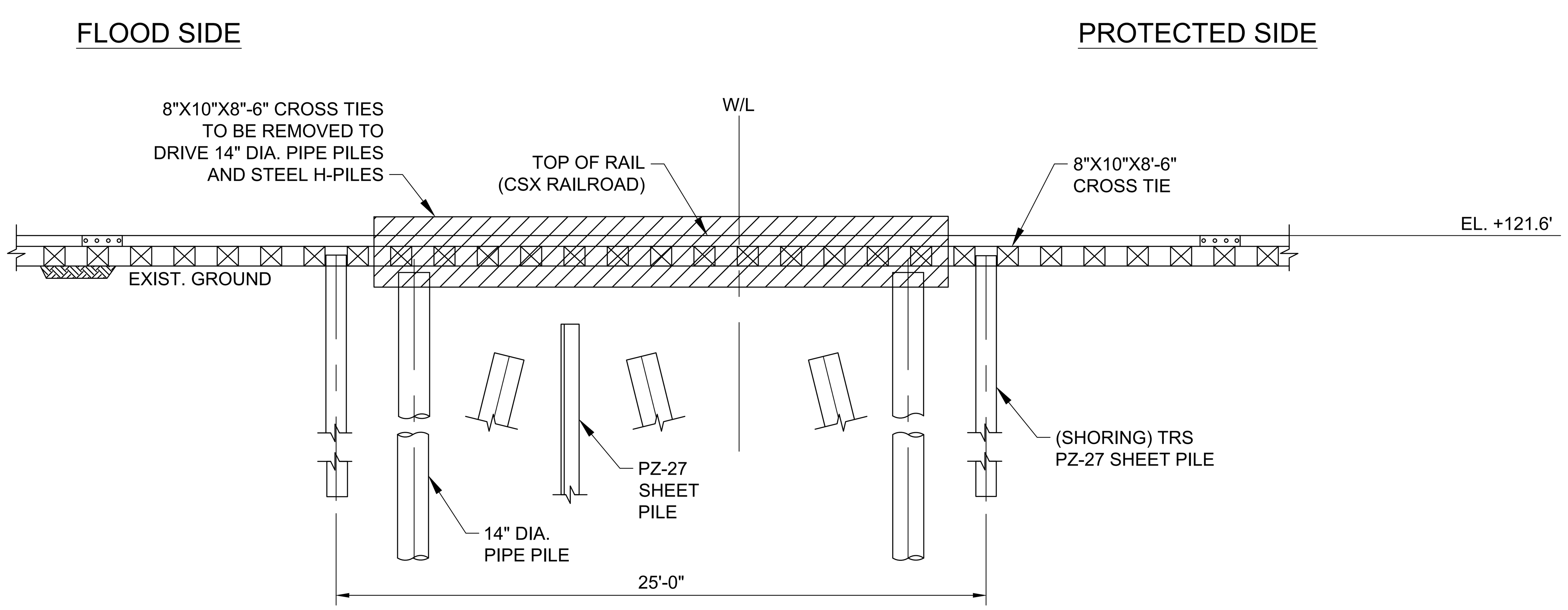
Scale	Designed	Drawn	Checked	Authorized
1/8"=1'-0"	--	--	--	--
Original Size: 22x34	Date: --/--/--	Date: --/--/--	Date: --/--/--	Date: --/--/--

Drawing Number: 100068207-CS-101 — Revision: 000

DO NOT SCALE



1 PHASE 5 PLAN VIEW
TYP. TYP. SCALE: 1/4" = 1'-0"



A SECTION
TYP. TYP. SCALE: 1/4" = 1'-0"

PHASE 5 CONSTRUCTION SEQUENCING:

1. CONTRACTOR AND RAILROAD COMPANY WILL COORDINATE AND SCHEDULE TRACK WINDOWS FOR PILING INSTALLATION (14" DIA. PIPE, AND CONCRETE PILES). THE RAILROAD COMPANY WILL REMOVE TIMBER CROSSTIES AT EACH PILE INSTALLATION LOCATION AS SHOWN IN THE PLANS. PIPE PILES SHALL BE "CHASED-DOWN" (DRIVEN WITH FOLLOWERS) TWELVE INCHES BELOW TOP-OF-TIE (TOP OF RAILROAD TIMBER CROSSTIE). CONCRETE PILES SHALL BE DRIVEN TO FINAL GRADE.

0 2 4 8 12
(IN FEET)
1/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

811 Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION | Suitability: S0

ATKINS Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC. ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

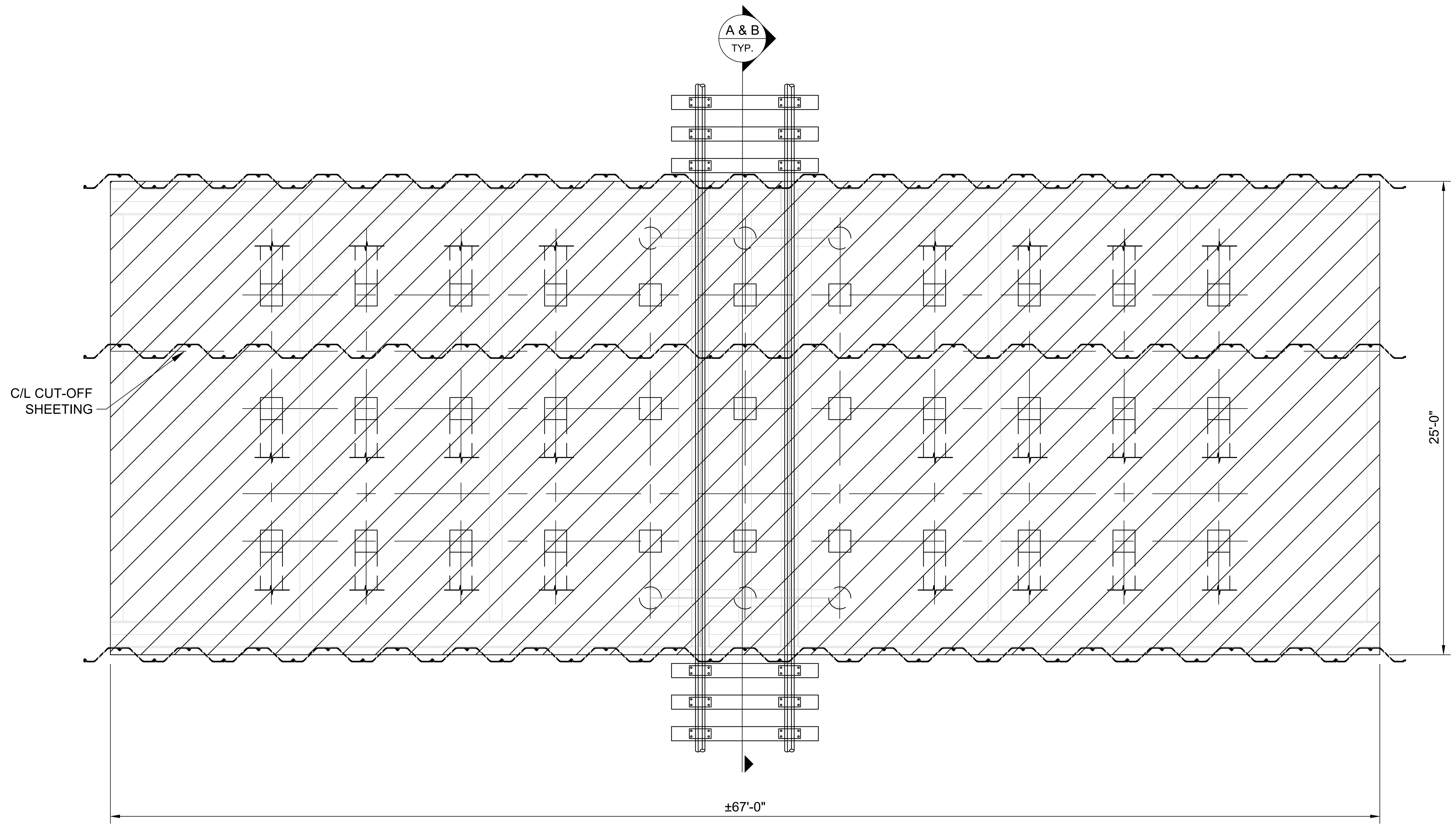
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: RAILROAD TRS (3 OF 6)

Scale	Designed	Drawn	Checked	Authorized
1/4"=1'-0"	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-CS-102 | Revision: 000

DO NOT SCALE



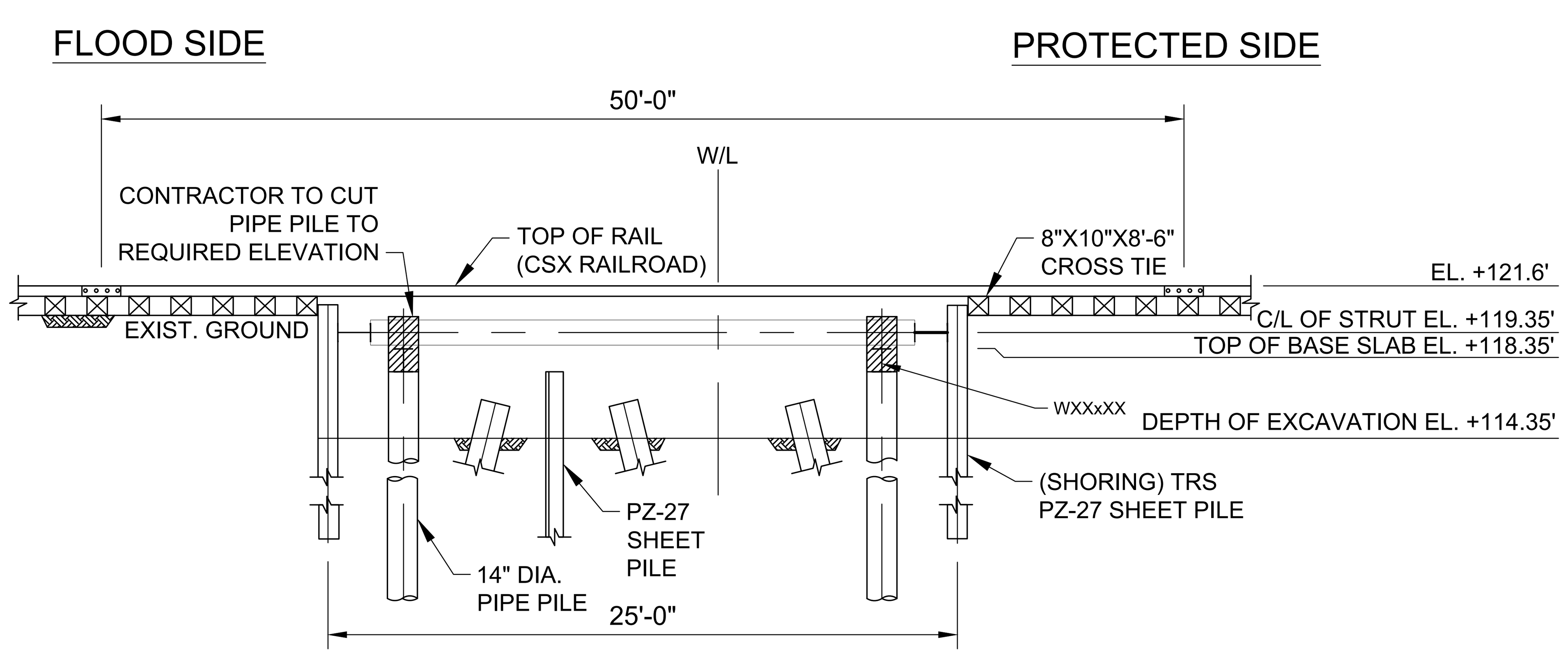
PHASE 6 PLAN VIEW
2 TYP. TYP. SCALE: 1/4" = 1'-0"

PHASE 6 CONSTRUCTION SEQUENCING:

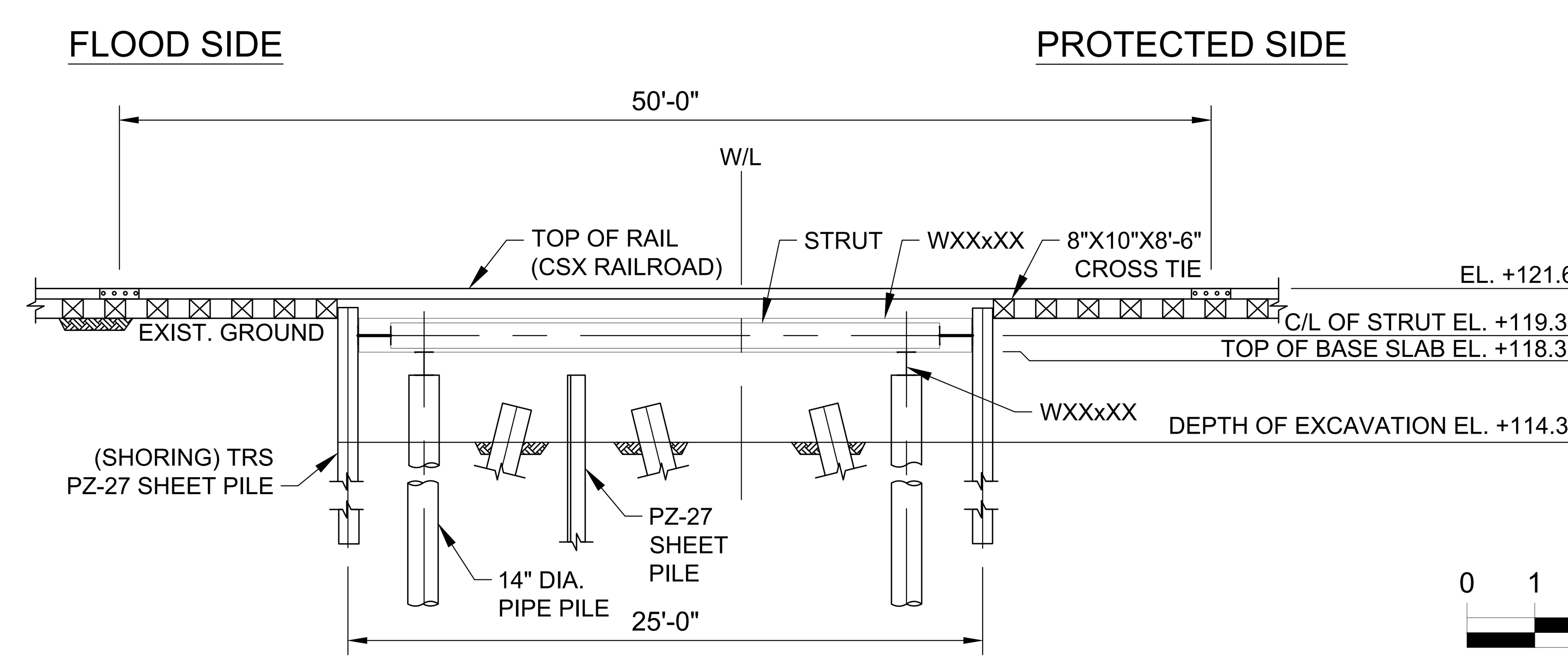
1. CONTRACTOR AND RAILROAD COMPANY WILL COORDINATE AND SCHEDULE ONE 12-HR TRACK WINDOW TO INSTALL THE JUMP SPAN BRIDGE.
2. RAILROAD COMPANY WILL REMOVE ONE 50-FT. SECTION OF TRACK.
3. CONTRACTOR TO EXCAVATE MATERIAL, CUT-OFF PILES, INSTALL WALES & STRUTS, INSTALL PILE CAPS, AND INSTALL THE JUMP SPAN BRIDGE.
4. RAILROAD COMPANY WILL INSTALL ONE 50-FT. PRE-ASSEMBLED TRACK PANEL, AND WELD JOINTS ON EACH TRACK.

NOTES:

1. HATCHED AREA DENOTES APPROXIMATE LIMITS OF EXCAVATION



SECTION
A TYP. TYP. SCALE: 3/16" = 1'-0"



SECTION
B TYP. TYP. SCALE: 3/16" = 1'-0"

0 1 2 4 6
(IN FEET)
3/16 inch = 1 ft.

0 2 4 8 12
(IN FEET)
1/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Know what's below. Call before you dig. Dial 811. North Carolina 811, Inc.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

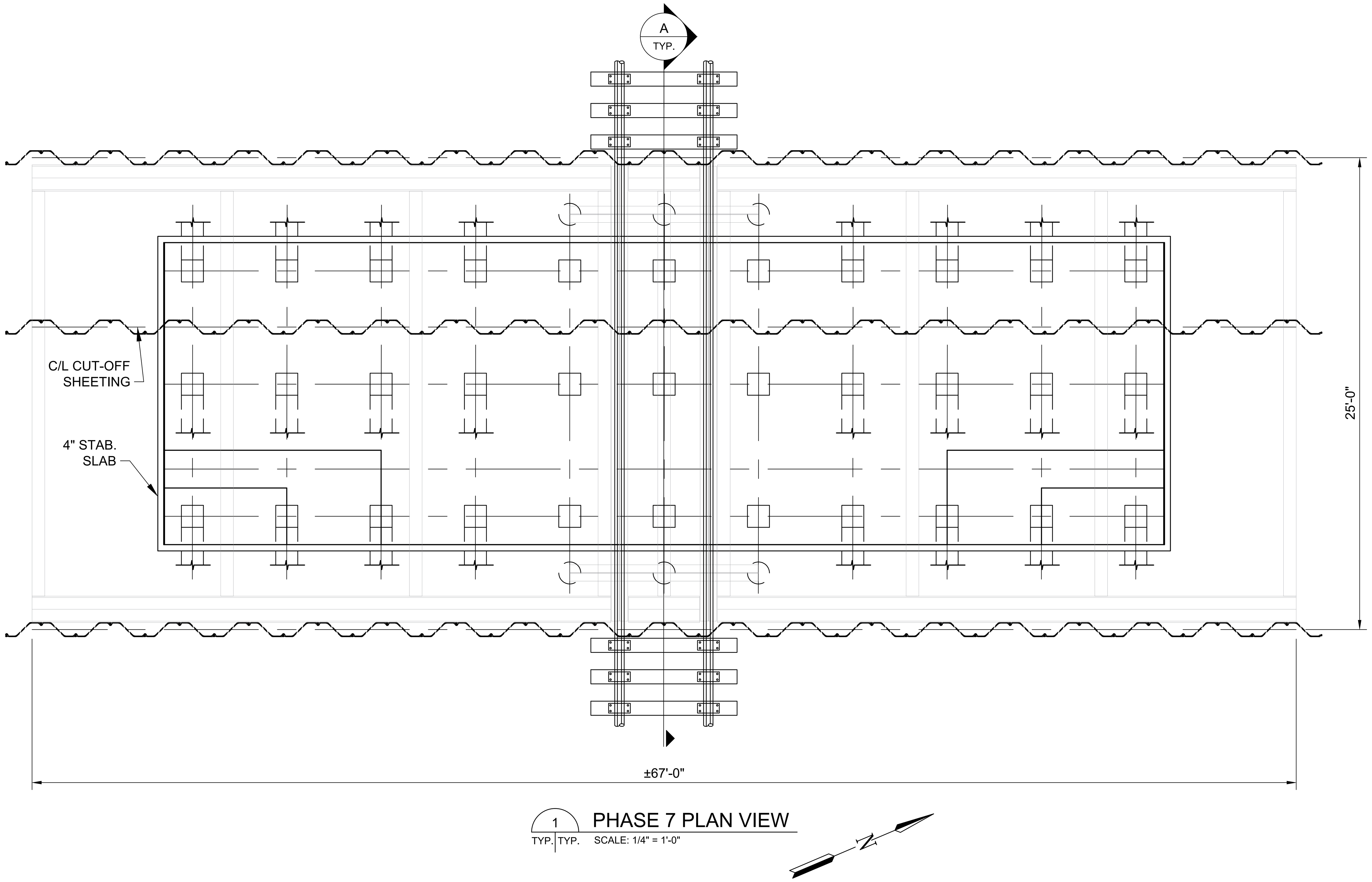
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: RAILROAD TRS (4 OF 6)

Scale	Designed	Drawn	Checked	Authorized
SEE DWG.	--	--	--	--
Original Size	Date	Date	Date	Date
22x34	--/--/--	--/--/--	--/--/--	--/--/--

Drawing Number: 100068207-CS-103
Revision: 000

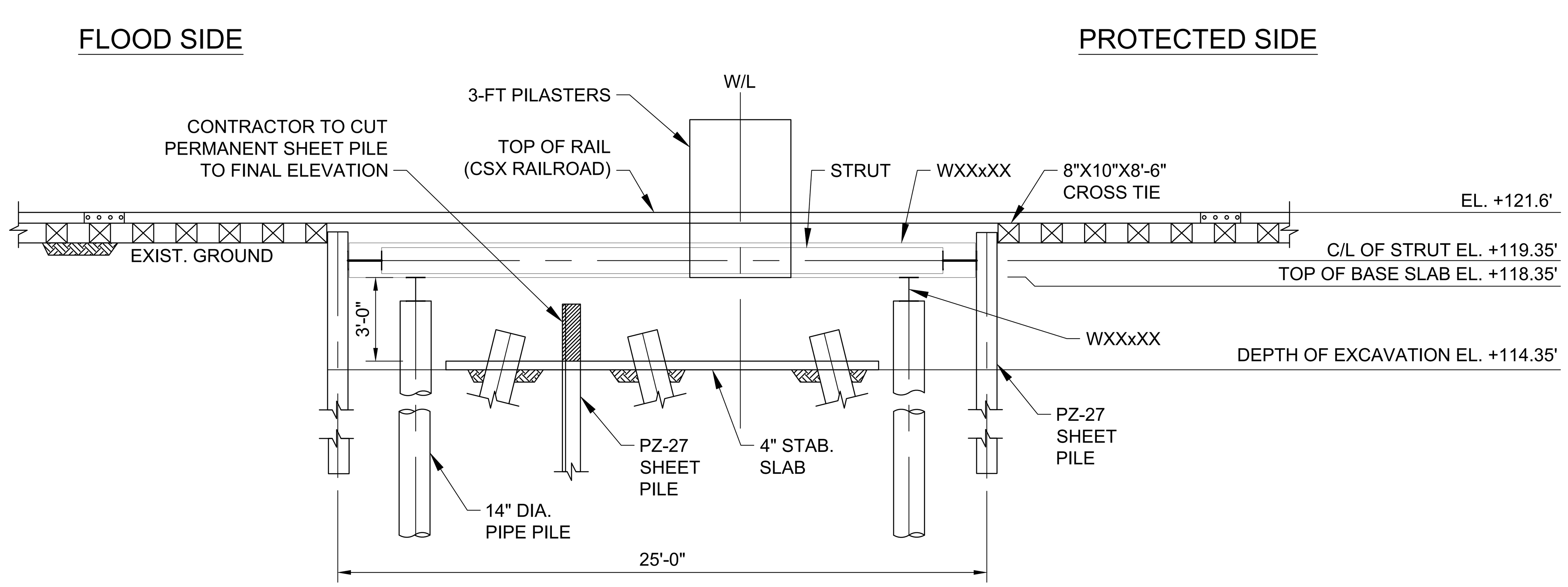
DO NOT SCALE



1 TYP. TYP. PHASE 7 PLAN VIEW
SCALE: 1/4" = 1'-0"

PHASE 7 CONSTRUCTION SEQUENCING:

1. CONTRACTOR WORKS UNDER THE JUMP SPAN BRIDGE TO EXCAVATE, CUT OFF PERMANENT SHEET PILING, AND INSTALL REINFORCED CONCRETE BASE SLAB, WALL STEM, AND PILASTERS.



A TYP. TYP. SECTION
SCALE: 1/4" = 1'-0"

0 2 4 8 12
(IN FEET)
1/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal | Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client: City of LUMBERTON North Carolina

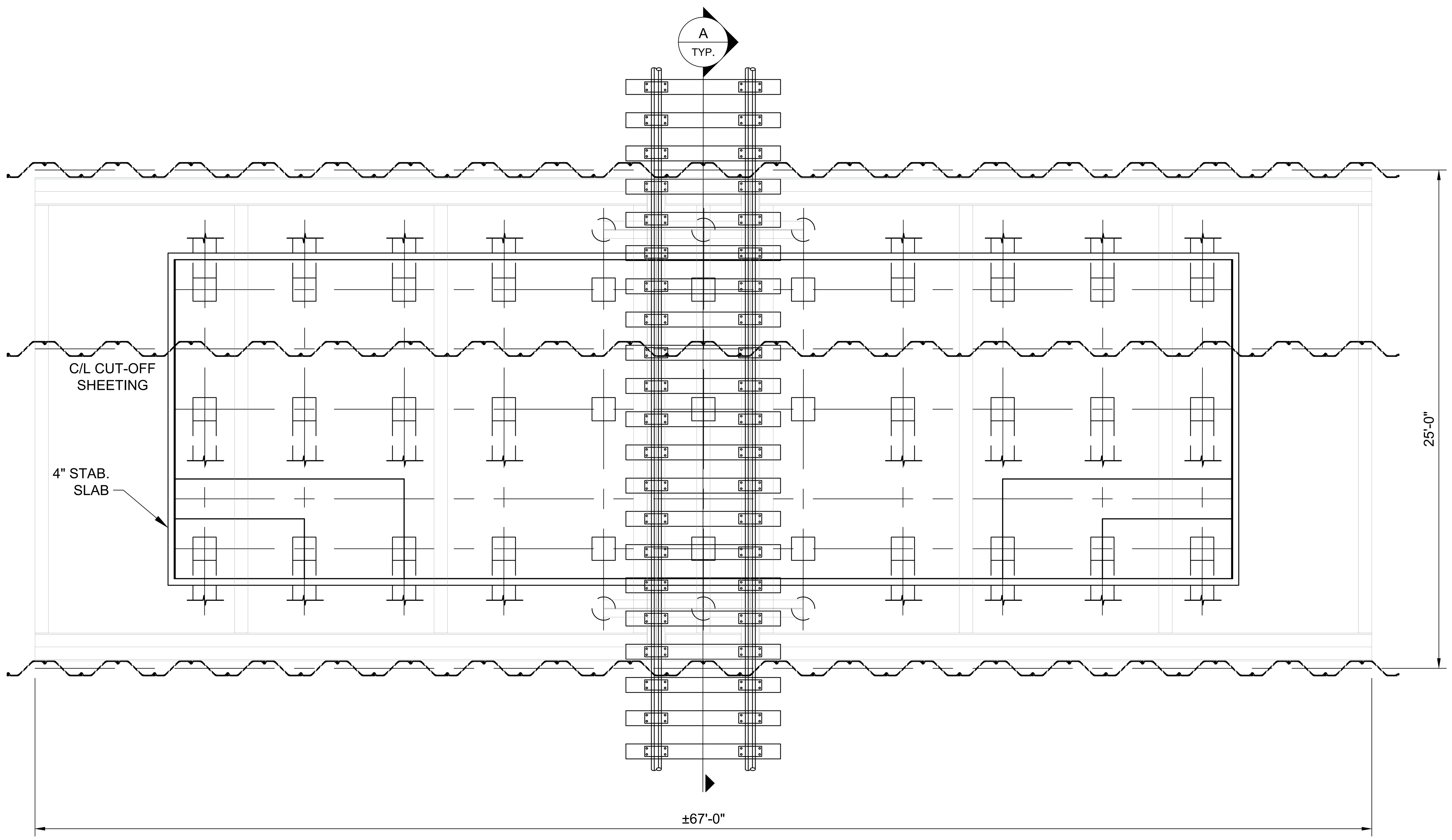
Project Title: WEST LUMBERTON FLOOD G AT VFW ROAD AND RAILROAD UNDERP ENGINEERING SERVICES

Drawing Title: RAILROAD TRS (5 OF 6)

Scale	Designed	Drawn	Checked	Authorized
1/4"=1'-0"	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

Drawing Number: 100068207-CS-104
Revision: 000

DO NOT SCALE



1 TYP. TYP. PHASE 10 PLAN VIEW
SCALE: 1/4" = 1'-0"

PHASE 8 CONSTRUCTION SEQUENCING:

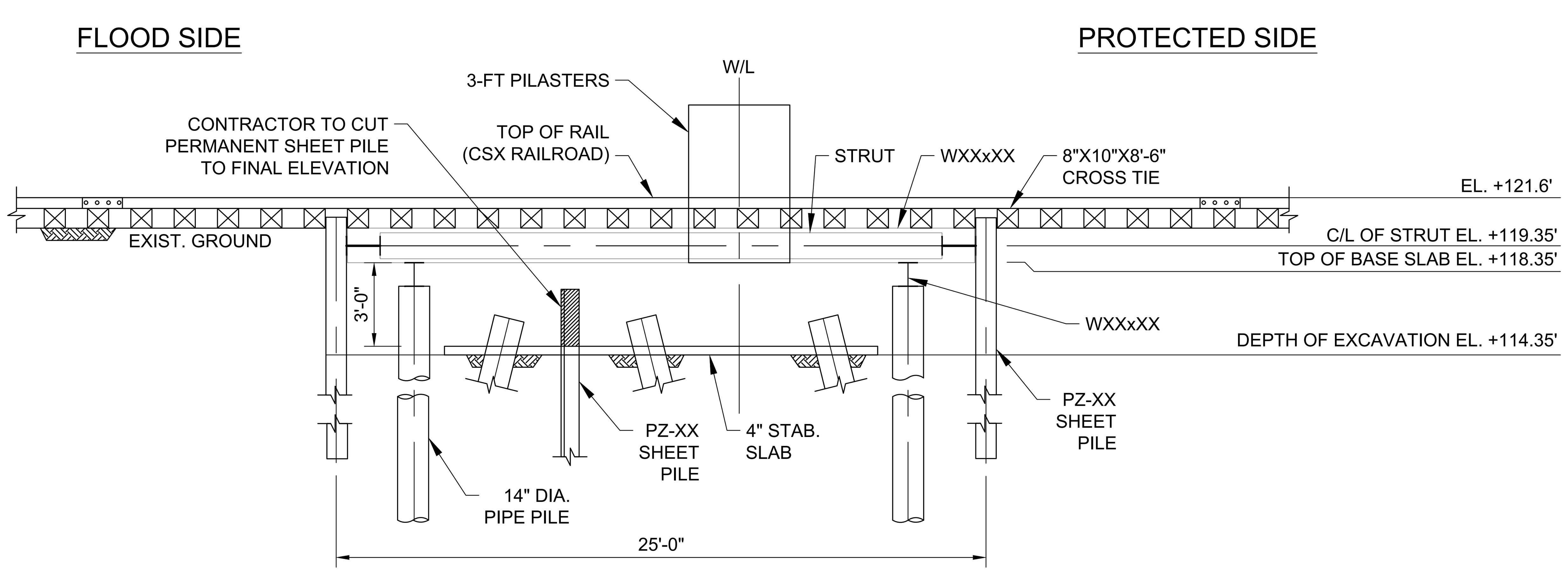
1. CONTRACTOR AND RAILROAD COMPANY WILL COORDINATE AND SCHEDULE TRACK WINDOWS TO REMOVE JUMP SPAN BRIDGE AND COMPLETE THE INSTALLATION OF THE SILL WALL.
2. RAILROAD COMPANY WILL CUT RAILS ON SECTIONS OF TRACK OVER JUMP SPAN BRIDGE.
3. CONTRACTOR REMOVES JUMP SPAN BRIDGE, INCLUDING THE CUT TRACK SECTIONS.
4. CONTRACTOR INSTALLS CAST-IN-PLACE SILL, CUT OFF SHORING AND JUMP SPAN BRIDGE PILES, AND INSTALLS SUBGRADE TO AN ELEVATION 21 INCHES BELOW TOP-OF-TIE.

PHASE 9 CONSTRUCTION SEQUENCING:

1. RAILROAD COMPANY WILL PLACE TWELVE INCHES OF BALLAST ROCK, INSTALL PRE-FABRICATED TRACK PANELS ON ALL TRACKS, AND SURFACE THE TRACKS.
2. RAILROAD COMPANY WILL SCHEDULE TRACK WINDOWS TO WELD JOINTS ON TRACK PANELS ON ALL TRACKS.

PHASE 10 CONSTRUCTION SEQUENCING:

1. THE CONTRACTOR AND RAILROAD COMPANY TO SCHEDULE TRACK WINDOWS TO PLACE STEEL SWING GATE DURING PLACEMENT OF THE GATE, THE CONTRACTOR SHALL MAINTAIN A MINIMUM CLEARANCE OF 15'-0" FROM THE CENTERLINE OF TRACKS. IF CLEARANCE REQUIRED IS LESS THAN 15'-0", A FLAGMAN AND RAILROAD INSPECTOR SHALL BE PRESENT.



A TYP. TYP. SECTION
SCALE: 1/4" = 1'-0"

0 2 4 8 12
(IN FEET)
1/4 inch = 1 ft.

PRELIMINARY
NOT TO BE USED FOR BIDDING, CONSTRUCTION, RECORDATION, CONVEYANCE OR SALES PREPARED UNDER THE SUPERVISION OF
DANIEL A. FLORES GUEVARA
NORTH CAROLINA P.E.LIC. NO. 051021
LINFIELD, HUNTER & JUNIUS, INC.

Drawing Legend

Seal

Seal

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION
Suitability: S0

ATKINS
Member of the SNC-Lavalin Group
1616 East Millbrook Road
Suite 160
Raleigh, NC 27519
Tel: +1 (919) 876-6888
Fax: +1 (919) 876-6848
www.atkinsglobal.com

LINFIELD, HUNTER & JUNIUS, INC.
ENGINEERS ARCHITECTS SURVEYORS
13608 18th Street
Suite 200
Metairie, LA 70002
Tel: +1 (504) 833-5300
Fax: +1 (504) 833-5350
www.lhjunius.com

mcgill
5400 Trinity Road
Suite 107
Raleigh, NC 27607
Tel: +1 (919) 378-9111
NC Firm License # C-0459
mcgillassociates.com

Client
City of LUMBERTON North Carolina

Project Title
WEST LUMBERTON FLOOD G
AT VFW ROAD AND RAILROAD UNDERP
ENGINEERING SERVICES

Drawing Title
RAILROAD TRS (6 OF 6)

Scale	Designed	Drawn	Checked	Authorized
1/4"=1'-0"	--	--	--	--
Original Size 22x34	Date --/--/--	Date --/--/--	Date --/--/--	Date --/--/--

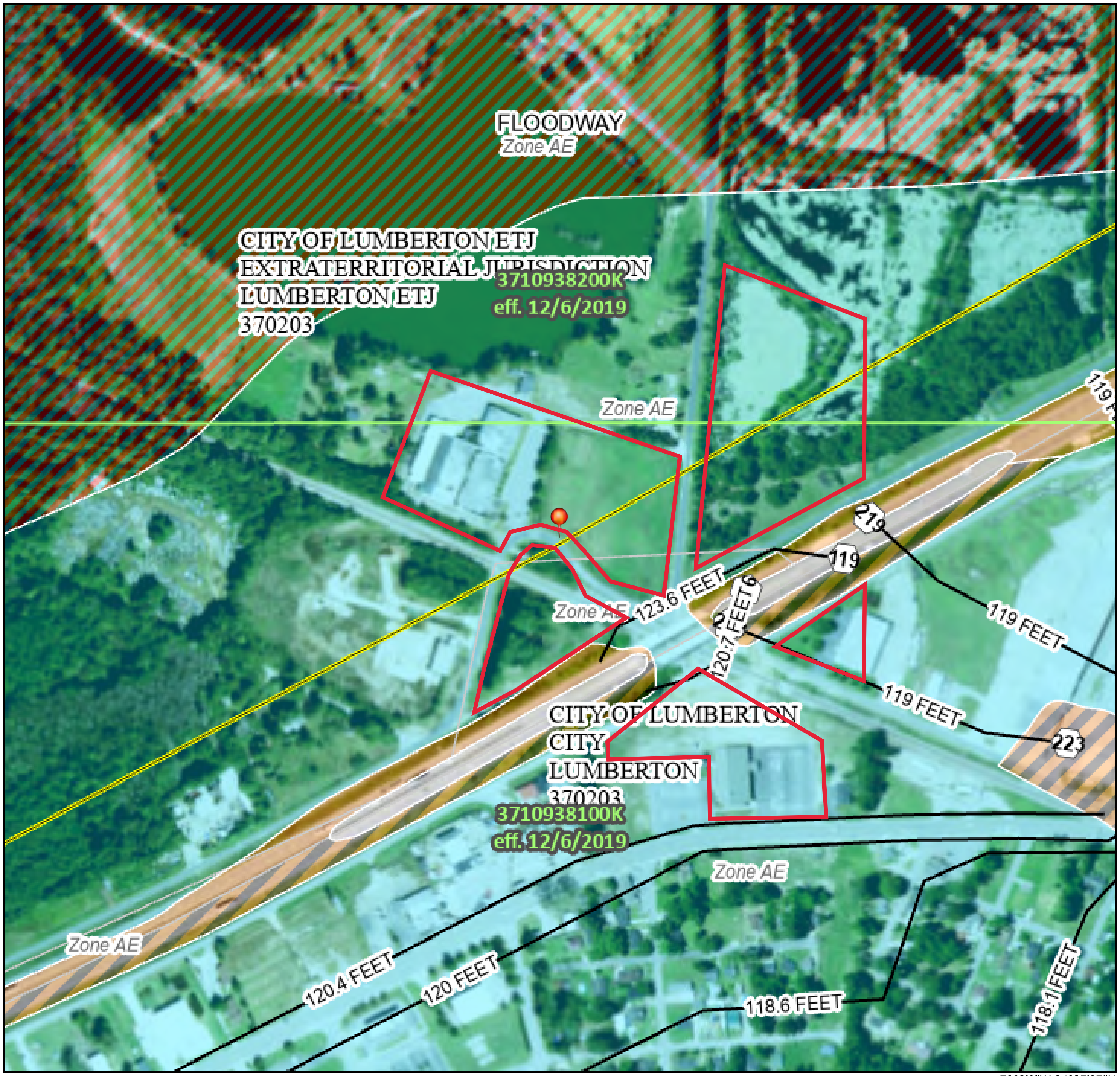
Drawing Number: 100068207-CS-105
Revision: 000

- **FEMA FIRMette**
- **NEPAssist FEMA FIRMs**
- **PFIRMs**
- **NFIP Community Status Book**
- **Hydrologic and Hydraulic Analysis**

National Flood Hazard Layer FIRMette

FEMA

79°2'46"W 34°37'57"N



Feet

0 250 500 1,000 1,500 2,000

1:6,000

79°2'9"W 34°37'27"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- (B) 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

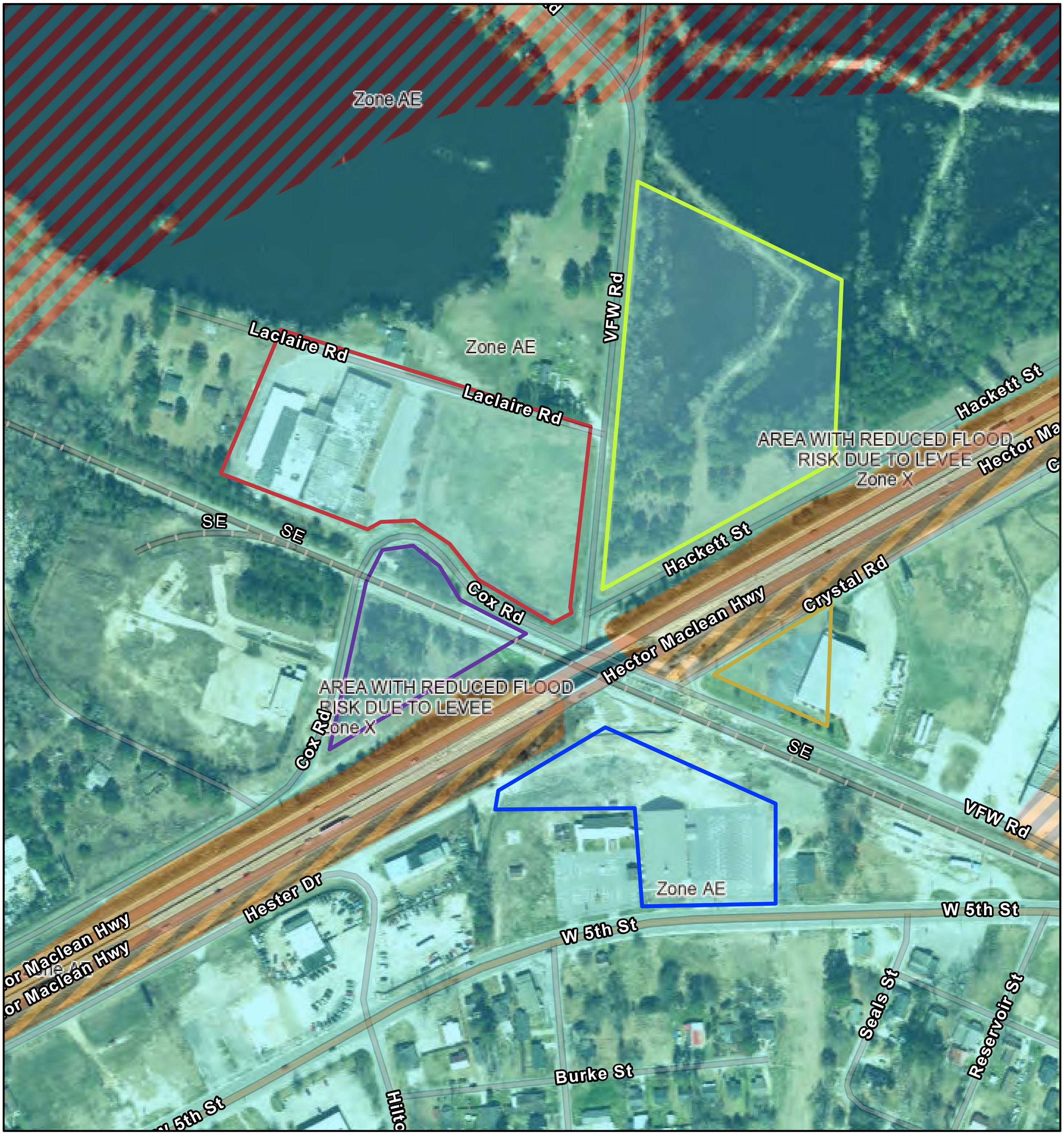
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/28/2023 at 1:00 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

West Lumberton Flood Gate - FEMA FIRM



November 29, 2023

1:4,514

0 0.03 0.06 0.12 mi

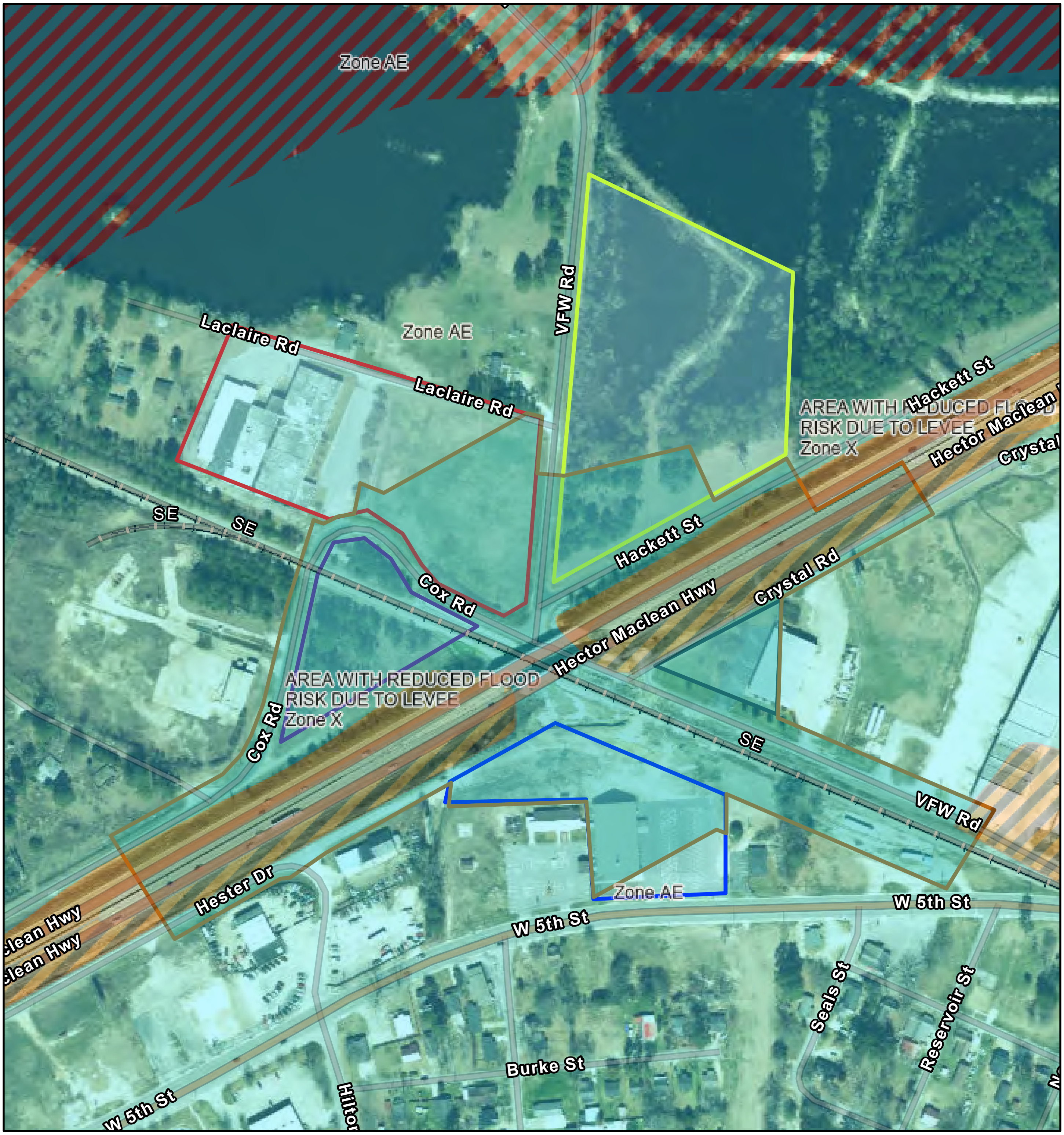
0 0.05 0.1 0.2 km

Flood Hazard Zones

- 1% Annual Chance Flood Hazard
- Regulatory Floodway
- Special Floodway
- Area of Undetermined Flood Hazard
- 0.2% Annual Chance Flood Hazard
- Future Conditions 1% Annual Chance Flood Hazard
- Area with Reduced Risk Due to Levee
- Area with Risk Due to Levee
- 2400 Cox Rd #938179684407
- 2306 W 5th St #938189201500
- 2460 Cox Rd #938179143700
- 550 VFW Rd #938189443052
- VFW & Hackett #938280300700

NC CGIA, Maxar, Esri Community Maps Contributors, State of North Carolina DOT, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA

West Lumberton Flood Gate - FEMA FIRM with Action Area



December 1, 2023

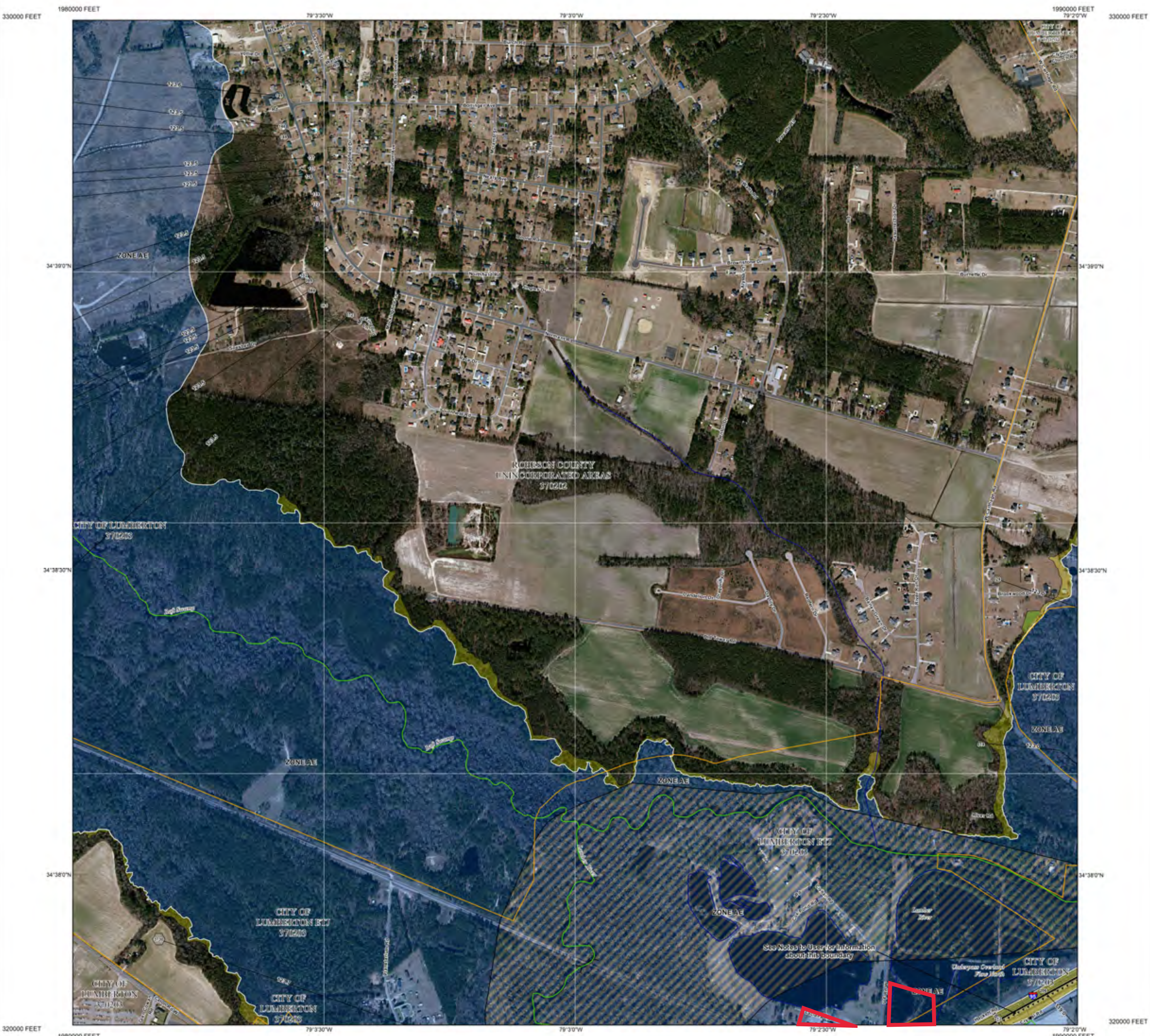
Flood Hazard Zones
- 1% Annual Chance Flood Hazard
- Regulatory Floodway
- Special Floodway
- Area of Undetermined Flood Hazard
- 0.2% Annual Chance Flood Hazard
- Future Conditions 1% Annual Chance Flood Hazard
- Area with Reduced Risk Due to Levee
- Area with Risk Due to Levee
- WLFG Project Action Area
- 550 VFW Rd #938189443052
- 2306 W 5th St #938189201500
- 2400 Cox Rd #938179684407
- 2460 Cox Rd #938179143700
- VFW & Hackett #938280300700
- Railroads

1:4,514

0 0.03 0.06 0.12 mi

0 0.05 0.1 0.2 km

NC CGIA, Maxar, Esri Community Maps Contributors, State of North Carolina DOT, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, EPA OEI



This digital Flood Insurance Rate Map (FIRM) was produced through a unique cooperative partnership between the State of North Carolina and the Federal Emergency Management Agency (FEMA). The State of North Carolina has implemented a long term approach to floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to map flood hazard areas at the local level. As a part of this effort, the State of North Carolina has joined in a Cooperating Technical State agreement with FEMA to produce and maintain this digital FIRM.

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP FOR FIRM PANEL LAYOUT

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://FRIS.NC.GOV/FRIS

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% Annual Chance Flood with Average Depth Less Than One Foot or With Drainage Areas of Less Than One Square Mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes *Zone X*
OTHER AREAS	Areas Determined to be Outside the 0.2% Annual Chance Floodplain *Zone X*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
	Secluded Levee
OTHER FEATURES	16.2 Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
	8 Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at https://msc.fema.gov. An accompanying Flood Insurance Study report, Letter of Map Revision (LOMR) or Letter of Map Amendment (LOMA) revising portions of this panel, and digital versions of this FIRM may be available. Visit the North Carolina Floodplain Mapping Program website at http://www.ncfloodmaps.com, or contact the FEMA Map Service Center.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in the community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Flood Insurance Study (FIS) means an examination, evaluation, and determination of flood hazards, corresponding water surface elevations, flood hazard risk zones, and other flood data in a community issued by the North Carolina Floodplain Mapping Program (NCFMP). The Flood Insurance Study (FIS) is comprised of the following products used together: the Digital Flood Hazard Database, the Water Surface Elevation Rasters, the digitally derived, autogenerated Flood Insurance Rate Map and the Flood Insurance Survey Report. A Flood Insurance Survey is a compilation and presentation of flood risk data for specific watercourses, lakes, and coastal flood hazard areas within a community. This report contains detailed flood elevation data, data tables and FIRM indices. When a flood study is completed for the NFIP, the digital information, reports and maps are assembled into an FIS. Information shown on this FIRM is provided in digital format by the NCFMP. Base map information shown on this FIRM was provided in digital format by the NCFMP. The source of this information can be determined from the metadata available in the digital FLOOD database and in the Technical Support Data Notebook (TSDN).

ACCREDITED LEVEE NOTES TO USERS: If an accredited levee note appears on this panel check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at https://www.fema.gov/national-flood-insurance-program.

PROVISIONALLY ACCREDITED LEVEE NOTES TO USERS: If a Provisionally Accredited Levee (PAL) note appears on this panel, check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection. To maintain accreditation, the levee owner or community is required to submit the data and documentation necessary to comply with Section 65.10 of the NFIP regulations. If the community or owner does not provide the necessary data and documentation or if the data and documentation provided indicates the levee system does not comply with Section 65.10 requirements, FEMA will revise the flood hazard and risk information for this area to reflect de-accreditation of the levee system. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at https://www.fema.gov/national-flood-insurance-program.

Attention: The Levee, dike, or other structure that impacts flood hazards inside this boundary has not been shown to comply with section 65.10 of the NFIP Regulations. As such, this FIRM panel will be revised at a later date to update the flood hazard information associated with this structure.

The flood hazard data inside this boundary, which have been re-published from the previous effective (historic) FIRM for this area, should continue to be used until this FIRM panel is revised to update the flood hazard information in this area.

SCALE

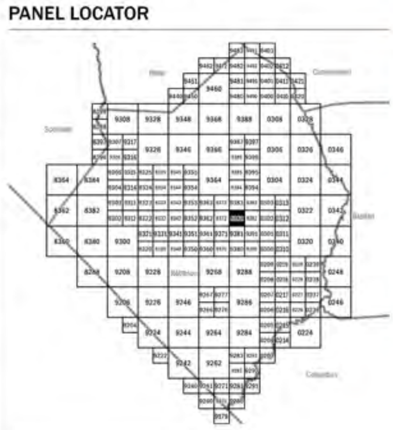
Map Projection:
North Carolina State Plane Projection Feet (Zone 3200)
Datum: NAD 1983 (Horizontal), NAVD 1988 (Vertical)

1 inch = 500 feet — 1:6,000

0 250 500 1,000 Feet

0 75 150 300 Meters

PANEL LOCATOR



National Flood Insurance Program

FEMA

NORTH CAROLINA FLOODPLAIN MAPPING PROGRAM
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

NORTH CAROLINA

PANEL 9382

FEMA

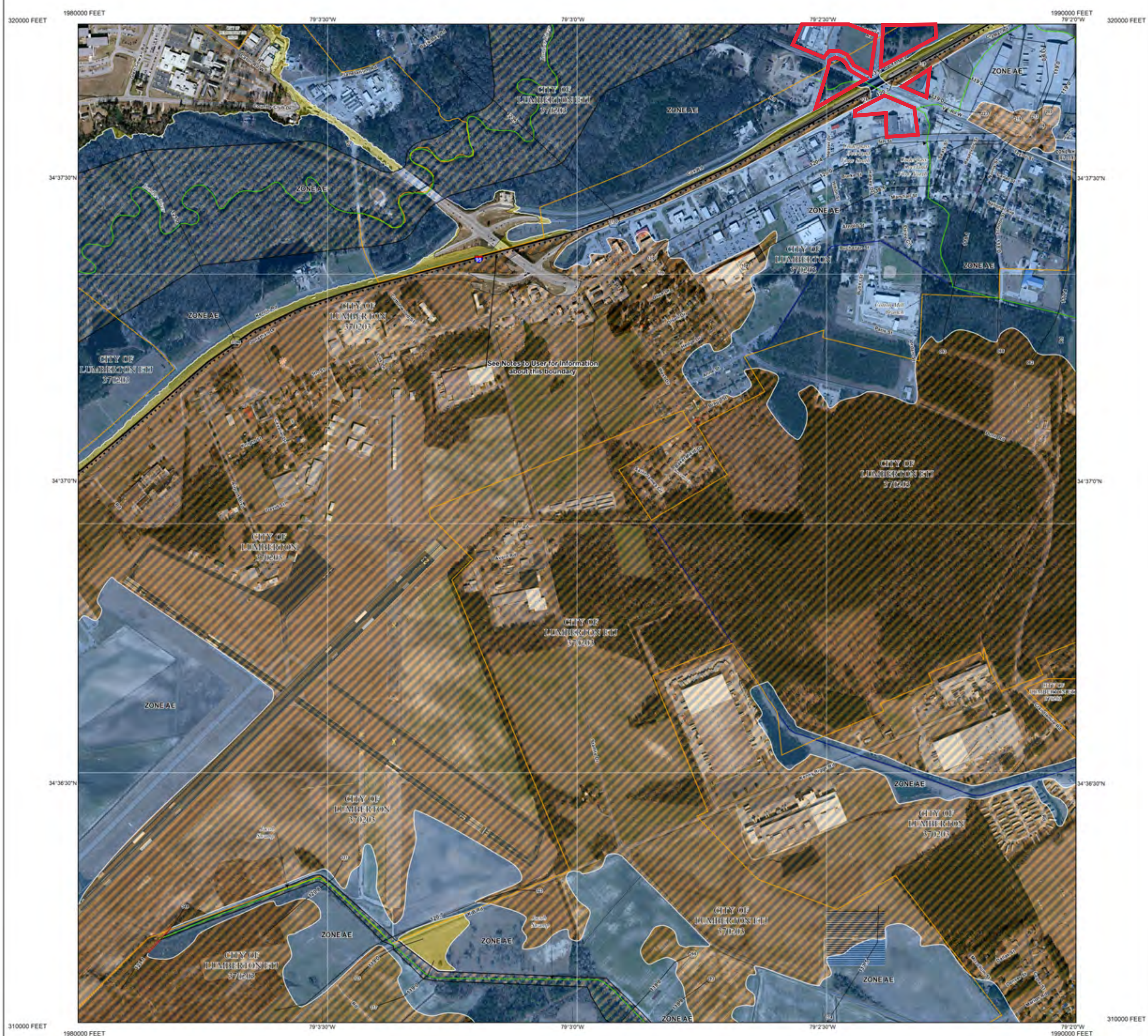
Panel Contains:

COMMUNITY	CID	PANEL	SUFFIX
LUMBERTON, CITY OF	370203	9382	K
ROBESON COUNTY	370202	9382	K

VERSION NUMBER
2.3.3.2

MAP NUMBER
3710938200K

MAP REVISED
December 06, 2019



This digital Flood Insurance Rate Map (FIRM) was produced through a unique cooperative partnership between the State of North Carolina and the Federal Emergency Management Agency (FEMA). The State of North Carolina has implemented a long term approach to floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to map flood hazard areas at the local level. As a part of this effort, the State of North Carolina has joined in a Cooperating Technical State agreement with FEMA to produce and maintain this digital FIRM.

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP FOR FIRM PANEL LAYOUT

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://FRIS.NC.GOV/FRIS

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% Annual Chance Flood with Average Depth Less Than One Foot or With Drainage Areas of Less Than One Square Mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes *Zone X*
OTHER AREAS	Areas Determined to be Outside the 0.2% Annual Chance Floodplain *Zone X*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
	Secluded Levee
	Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
	Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
OTHER FEATURES	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at https://msc.fema.gov. An accompanying Flood Insurance Study report, Letter of Map Revision (LOMR) or Letter of Map Amendment (LOMA) revising portions of this panel, and digital versions of this FIRM may be available. Visit the North Carolina Floodplain Mapping Program website at http://www.ncfloodmaps.com, or contact the FEMA Map Service Center.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in the community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Flood Insurance Study (FIS) means an examination, evaluation, and determination of flood hazards, corresponding water surface elevations, flood hazard risk zones, and other flood data in a community issued by the North Carolina Floodplain Mapping Program (NCFMP). The Flood Insurance Study (FIS) is comprised of the following products used together: the Digital Flood Hazard Database, the Water Surface Elevation Rasters, the digitally derived, autogenerated Flood Insurance Rate Map and the Flood Insurance Survey Report. A Flood Insurance Survey is a compilation and presentation of flood risk data for specific watercourses, lakes, and coastal flood hazard areas within a community. This report contains detailed flood elevation data, data tables and FIRM indices. When a flood study is completed for the NFIP, the digital information, reports and maps are assembled into an FIS. Information shown on this FIRM is provided in digital format by the NCFMP. Base map information shown on this FIRM was provided in digital format by the NCFMP. The source of this information can be determined from the metadata available in the digital FLOOD database and in the Technical Support Data Notebook (TSDN).

ACCREDITED LEVEE NOTES TO USERS: If an accredited levee note appears on this panel check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at https://www.fema.gov/national-flood-insurance-program.

PROVISIONALLY ACCREDITED LEVEE NOTES TO USERS: If a Provisionally Accredited Levee (PAL) note appears on this panel, check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection. To maintain accreditation, the levee owner or community is required to submit the data and documentation necessary to comply with Section 65.10 of the NFIP regulations. If the community or owner does not provide the necessary data and documentation or if the data and documentation provided indicates the levee system does not comply with Section 65.10 requirements, FEMA will revise the flood hazard and risk information for this area to reflect de-accreditation of the levee system. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at https://www.fema.gov/national-flood-insurance-program.

Attention: The Levee, dike, or other structure that impacts flood hazards inside this boundary has not been shown to comply with section 65.10 of the NFIP Regulations. As such, this FIRM panel will be revised at a later date to update the flood hazard information associated with this structure.

The flood hazard data inside this boundary, which have been re-published from the previous effective (historic) FIRM for this area, should continue to be used until this FIRM panel is revised to update the flood hazard information in this area.

SCALE

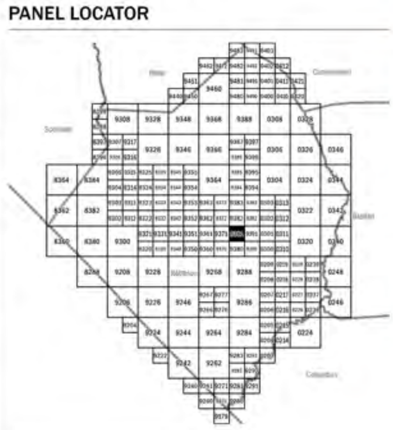
Map Projection:
North Carolina State Plane Projection Feet (Zone 3200)
Datum: NAD 1983 (Horizontal), NAVD 1988 (Vertical)

1 inch = 500 feet 1:6,000

0 250 500 1,000 Feet

0 75 150 300 Meters

PANEL LOCATOR



National Flood Insurance Program

FEMA

NORTH CAROLINA FLOODPLAIN MAPPING PROGRAM
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

NORTH CAROLINA

PANEL 9381

Panel Contains:

COMMUNITY	CID	PANEL	SUFFIX
LUMBERTON, CITY OF	370203	9381	K

VERSION NUMBER
2.3.3.2

MAP NUMBER
3710938100K

MAP REVISED
December 06, 2019

Community Status Book Report

Communities Participating in the National Flood Program

NORTH CAROLINA

CID	Community Name	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal	CRS Entry Date	Curr Eff Date	Curr Class	% Disc SFHA	% Disc Non SFHA
370323#	LOWELL, CITY OF	GASTON COUNTY	08/15/75	03/05/90	11/04/09	03/05/90	No					
370537#	LUCAMA, TOWN OF	WILSON COUNTY		11/03/04	04/16/13	11/03/04	No					
370203K	LUMBERTON, CITY OF	ROBESON COUNTY	06/28/74	11/05/80	12/06/19	11/05/80	No					
370090K	MACCLESFIELD, TOWN OF	EDGECOMBE COUNTY	12/28/73	03/18/80	06/02/15	03/25/80	No					
370150#	MACON COUNTY *	MACON COUNTY	06/30/78	06/01/01	04/19/10	06/01/01	No					
370152#	MADISON COUNTY *	MADISON COUNTY	07/22/77	09/02/82	01/06/10	09/02/82	No					
370207#	MADISON, TOWN OF	ROCKINGHAM COUNTY	11/22/74	11/16/77	01/02/09	11/16/77	No					
370389#	MAGGIE VALLEY, TOWN OF	HAYWOOD COUNTY	07/08/77	04/17/84	04/03/12	04/17/84	No					
370669#	MAGNOLIA, TOWN OF	DUPLIN COUNTY		02/16/06	02/16/07	07/23/10	No					
370056#	MAIDEN, TOWNSHIP OF	LINCOLN COUNTY/CATAWBA COUNTY	09/20/74	09/03/80	07/07/09	09/03/80	No					
375355K	MANTEO, TOWN OF	DARE COUNTY	01/12/73	01/12/73	06/19/20	01/05/73	No	10/01/91	10/01/21	5	25%	10%
370266#	MARION, CITY OF	MCDOWELL COUNTY	09/10/82	07/15/88	01/06/10	05/01/87	No					
370385#	MARS HILL, TOWN OF	MADISON COUNTY	07/02/76	08/19/87	01/06/10	08/19/87	No					
370154#	MARSHALL, TOWN OF	MADISON COUNTY	06/14/74	05/15/78	01/06/10	05/15/78	No					
370474#	MARSHVILLE, TOWN OF	UNION COUNTY		07/05/94	03/02/09	12/15/09	No					
370155K	MARTIN COUNTY *	MARTIN COUNTY	11/29/74	07/16/91	06/19/20	07/16/91	No					
370514#	MARVIN, VILLAGE OF	UNION COUNTY		01/17/97	02/19/14	12/28/98	No					
370310#	MATTHEWS, TOWN OF	MECKLENBURG COUNTY		02/04/04	02/19/14	02/04/04	No					
370587F	MAXTON, TOWN OF	SCOTLAND COUNTY/ROBESON COUNTY		01/19/05	12/06/19	05/26/20	No					
370208#	MAYODAN, TOWN OF	ROCKINGHAM COUNTY		07/18/77	01/02/09	07/18/77	No					
370330#	MAYSVILLE, TOWN OF	JONES COUNTY		07/02/04	02/16/06	08/19/86	No					
370101#	MCADENVILLE,TOWN OF	GASTON COUNTY	06/21/74	06/01/87	11/04/09	06/01/87	No					
370148#	MCDOWELL COUNTY*	MCDOWELL COUNTY	12/20/74	07/15/88	01/06/10	07/15/88	No					
370390J	MEBANE, CITY OF	ORANGE COUNTY/ALAMANCE COUNTY		11/05/80	11/17/17	11/05/80	No					
370158F	MECKLENBURG COUNTY *	MECKLENBURG COUNTY	10/22/76	06/01/81	11/16/18	06/01/81	No	10/01/91	04/01/21	5	25%	10%
370426L	MESIC, TOWN OF	PAMLICO COUNTY		07/02/04	06/19/20	09/04/85	No	05/01/19	04/01/21	8	10%	05%
370500J	MICRO, TOWN OF	JOHNSTON COUNTY		10/20/00	06/20/18	11/08/16	No					
370445#	MIDDLESEX, TOWN OF	NASH COUNTY		01/20/82	07/07/14	03/19/99	No					
370182L	MIDLAND, TOWN OF	CABARRUS COUNTY	12/27/74	05/05/81	11/16/18	06/01/09	No					
370393#	MIDWAY, TOWN OF	DAVIDSON COUNTY		03/16/09	06/16/09	02/05/19	No					
370529#	MINERAL SPRINGS, TOWN OF	UNION COUNTY		07/18/83	03/02/09	05/17/00	No					
370418K	MINNESOTT BEACH, TOWN OF	PAMLICO COUNTY	03/02/79	08/05/85	06/19/20	09/23/85	No	10/01/92	10/01/21	8	10%	05%
370539E	MINT HILL, TOWN OF	MECKLENBURG COUNTY		02/04/04	11/16/18	12/21/07	No					
370026#	MISENHEIMER, VILLAGE OF	STANLY COUNTY		09/03/08	06/16/09	02/17/10	No					
370161#	MITCHELL COUNTY *	MITCHELL COUNTY	06/30/78	09/04/86	06/02/09	09/04/86	No					
370309#	MOCKSVILLE, TOWN OF	DAVIE COUNTY	07/11/75	06/27/00	06/16/09	09/17/08	No					
370657#	MOMEYER, TOWN OF	NASH COUNTY		11/03/04	(NSFHA)	12/29/05	No					
370236#	MONROE, CITY OF	UNION COUNTY	09/20/74	01/19/83	03/02/09	01/19/83	No					
370336#	MONTGOMERY COUNTY*	MONTGOMERY COUNTY	10/13/78	06/01/81	06/16/09	02/20/97	No					
370476#	MONTREAT, TOWN OF	BUNCOMBE COUNTY		05/06/96	01/06/10	09/19/05	No					
370164H	MOORE COUNTY *	MOORE COUNTY	10/13/78	12/15/89	11/17/17	12/15/89	No					
370314#	MOORESVILLE, TOWN OF	IREDELL COUNTY	04/25/75	05/01/80	06/16/09	05/01/80	No					
370048#	MOREHEAD CITY, TOWN OF	CARTERET COUNTY	02/22/74	02/16/77	11/03/05	02/16/77	No	10/01/92	05/01/20	6	20%	10%
370035#	MORGANTON,CITY OF	BURKE COUNTY	03/22/74	02/19/87	07/07/09	02/19/87	No					
370242K	MORRISVILLE, TOWN OF	WAKE COUNTY	10/29/76	11/01/78	07/19/22	11/01/78	No					
370226B	MOUNT AIRY,CITY OF	SURRY COUNTY	06/28/74	12/01/81	11/18/16	12/01/81	No					
370102L	MOUNT HOLLY, CITY OF	GASTON COUNTY	01/09/74	09/28/79	09/02/15	09/28/79	No					
370369K	MOUNT OLIVE, TOWN OF	DUPLIN COUNTY/WAYNE COUNTY	06/17/77	02/17/82	06/20/18	02/17/82	No					
370470J	MOUNT PLEASANT, TOWN OF	CABARRUS COUNTY		11/02/94	11/16/18	02/24/12	No					
370419#	MURFREESBORO,TOWN OF	HERTFORD COUNTY	11/10/78	06/01/87	08/03/09	06/01/87	No					
370061#	MURPHY, TOWN OF	CHEROKEE COUNTY	03/08/74	07/03/86	04/19/10(M)	07/03/86	No					
375356K	NAGS HEAD, TOWN OF	DARE COUNTY		11/10/72	06/19/20	11/10/72	No	10/01/91	04/01/22	5	25%	10%

ATKINS

Member of the SNC-Lavalin Group

West Lumberton Flood Gate Closure Structure

at the VFW Road and CSX Railroad Interstate 95 Underpass

Hydrologic and Hydraulic Analysis

City of Lumberton

9 January 2023

Notice

This document and its contents have been prepared and are intended solely as information for City of Lumberton and use in relation to the design of the flood gate closure structure at the VFW Road and CSX Railroad Interstate 95 Underpass.

SNC-Lavalin assumes no responsibility for the use of the information presented in this report for purposes other than for the design of the flood gate closure structure.

This document has 174 pages including the cover.

Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorized	Date
Rev 0.0	Floodgate Closure Structure Design	KH	EB	DS	AS	3/19/2020
Rev 1.0	Floodgate Closure Structure Design	KH	EB	DS	AS	10/19/2020
Rev 2.0	Floodgate Closure Structure Design	KH	EB	DS	AS	1/09/2023

Client signoff

Client	City of Lumberton
Project	West Lumberton Flood Gate Closure Structure at the VFW Road and CSX Railroad Interstate 95 Underpass
Job number	100068207
Client signature / date	

Contents

Chapter	Page
Acronyms and Abbreviations	**vi**
Executive Summary	**1**
1. Introduction	**2**
1.1. Authorization and Study Purpose	2
1.2. Assumptions and Limitations	3
2. Hydrological Setting	**4**
2.1. Watershed Location and Size(s)	4
2.2. Climate	4
2.3. Historical Floods	5
3. Data Collection	**8**
3.1. Terrain and Watershed Data	8
3.2. Precipitation Data	9
3.3. Streamflow Data	11
3.4. Soils Data	12
3.5. Land Use Data	13
3.6. Field Survey and Data Collection	14
4. Design Flood Selection	**19**
4.1. Review of FEMA Levee Accreditation Guidelines	19
4.2. Flood Frequency Analysis	19
4.3. Recommended Design Flood Frequency	24
5. Hydrologic Model Development	**25**
5.1. General Methodology	25
5.2. HEC-HMS Model Parameters	25
5.3. Sub-basin Delineation	26
5.4. Initial Parameter Estimation	28
5.5. Model Calibration to Historic Events	31
5.6. Model Validation to Historic Events	34
5.7. Design Flood Simulations	35
6. Hydraulic Model Development	**39**
6.1. Model Development	39
6.2. Boundary Conditions	42
6.3. Model Execution	43
6.4. Model Calibration and Verification	43
6.5. Design Flood Simulations and Results	46
7. Freeboard Estimation	**51**
7.1. Estimate average wind speed over an appropriate fetch	51
7.2. Estimate Wave Height and Wave Period	53
7.3. Estimate wind setup and wave runup	54
7.4. Sensitivity Analysis	55
7.5. Results	55
8. Recommendations	**56**
9. References	**57**

Appendices 59

Appendix A. Field Data 60

Appendix B. Hydrologic Analysis 61

Appendix C. Hydraulic Analysis 62

Appendix D. Wind Wave Analysis 63

Appendix E. Electronic Attachments 64

Tables

Table 3-1. Precipitation gage availability and utilization in models. 10

Table 4-1. Calculated discharge per return period at the Lumberton gage (USGS 02134170). 20

Table 4-2. Calculated discharge per return period based on the extended Lumberton gage records (USGS 02134170). 21

Table 4-3. Calculated discharge per return period based on the extended Lumberton gage records (USGS 02134170) and altered Hurricane Matthew. 22

Table 4-4. Regional regression weighted peak flow rate estimates for Methods 2 approaches. 23

Table 5-1. HEC-HMS modeling methods and required parameters. 26

Table 5-2. Sub-basin composite curve numbers. 29

Table 5-3. Calculated sub-basin initial losses. 29

Table 5-4. Muskingum-Cunge routing parameters used for hydrologic modeling. 31

Table 5-5. Peak streamflow reported at USGS gages in Lumberton and Maxton for each study event. 31

Table 5-6. Peak flow comparison between observed and simulated calibrated events. 32

Table 5-7. Time of peak comparison between observed and simulated calibrated events. 33

Table 5-8. Volume comparison between observed (USGS 02134170 at Lumberton) and simulated calibrated events. 33

Table 5-9. Average calibrated HEC-HMS parameters. 33

Table 5-10. Peak flow comparison between observed and simulated for a verification event. 34

Table 5-11. Time of peak flow comparison between observed and simulated for a verification event. 34

Table 5-12. Volume comparison between observed and simulated for a verification event. 34

Table 5-13. Initial and optimized parameters for the HEC-METVue model. 36

Table 5-14. Average PMP depths from optimized HMR 52 storm parameters. 37

Table 5-15. Design Rainfall Depths. 38

Table 5-16. Peak flow comparison between simulated HEC-HMS, FEMA reports, and gage statistics. 38

Table 5-17. Comparison of Peakflows from SCS and Partial Duration Rainfall Distributions. 38

Table 6-1. Manning's n coefficient ranges per land cover type. 39

Table 6-2. Lumber River historical storms used for calibration and verification. 44

Table 7-1. Deep water wave characteristics. 54

Table 7-2. Summary of sensitivity analysis. 55

Table 8-1. Recommended Range of Gate Heights 56

Figures

Figure 1-1. Lumberton site location map. 3

Figure 2-1. Lumber River basin location within southeastern North Carolina. 4

Figure 2-2. Flooding along I-95 and inside the Lumberton Levee from Hurricane Matthew; area to right of road is the levee protected side of Lumberton (Source: City of Lumberton). 6

Figure 2-3. Flooding under I-95 at VFW Road and CSX railroad in Lumberton, NC from Hurricane Florence (Source: City of Lumberton). 7

Figure 3-1. Lumber River basin terrain. 8

Figure 3-2. CRONOS rainfall gages in and near the Lumber River basin. 10

Figure 3-3. Example of Thiessen polygons used to calculate weighted rainfall; shown is the 2004 event Thiessen polygons. 11

Figure 3-4. USGS gage (02134170 Lumber River at Lumberton, NC) within the Lumber River basin. 12

Figure 3-5. Lumber River basin soil type distribution. 13

Figure 3-6. Lumber River basin 2016 land cover type. 14

Figure 3-7. Collected field data for structures, high water marks, and survey points. 15

Figure 3-8. Location of field and USGS high water marks. 17

Figure 3-9. Example of HWM from Lumberton field visit near the VFW Road and railroad intersection by the flood gate location. 18

Figure 4-1. Discharge-Frequency curve for Lumberton gage with reported Hurricane Matthew peak flow rate. 20

Figure 4-2. Discharge-Frequency curve for Lumberton gage with adjusted Hurricane Matthew peak flow rate. 21

Figure 4-3. Discharge-Frequency curve for Lumberton gage with extended record. 22

Figure 4-4. Discharge-Frequency curve for Lumberton gage (USGS 02134170) with extended record and altered Hurricane Matthew. 23

Figure 5-1. Lumber River sub-basin delineation. 27

Figure 5-2. HEC-HMS sub-basins, reaches, and junctions. 28

Figure 5-3. Centroid, channel length (L), and channel length to centroid (L_c) of each sub-basin for Snyder hydrograph development. 30

Figure 5-4. Comparison of observed gage flow (black) and simulated flow (solid blue) for the September 2018 (Hurricane Florence) calibrated event. 32

Figure 5-5. Comparison of observed gage flow (black) and simulated flow (solid blue) for the October 2016 (Hurricane Matthew) verification event. 35

Figure 5-6. HMR 52 storm position with HEC-HMS (optimized) parameters. 37

Figure 6-1. Lumber River 2D external model domain. 40

Figure 6-2. Bridge example. 41

Figure 6-3. I-95 Meadow Branch culvert 2D connection example. 42

Figure 6-4. Boundary condition locations. 43

Figure 6-5. High water marks comparison for Hurricane Florence. 44

Figure 6-6. High water marks comparison for Hurricane Matthew. 46

Figure 6-7. Inundation boundaries without floodgate 49

Figure 6-8. WSE (ft) without flood gate compared to with flood gate and I-95 raised for 100YR storm. 50

Figure 6-9. WSE (ft) without flood gate compared to with flood gate and I-95 raised for 500YR storm. 50

Figure 7-1. Definition sketch for wave runup and wind setup (USACE, 1997). 51

Figure 7-2. Fetch line (red) superimposed on 500-year depth raster and satellite imagery. 52

Acronyms and Abbreviations

1D	one-dimensional
2D	two-dimensional
C	conversion factor
cfs	cubic foot per second
CFR	Code of Federal Regulations
CN	curve number
C_p	peaking coefficient
C_t	basin coefficient
D	average depth of water along fetch line
DEMLR	Division of Energy, Mineral and Land Resources (NCDEQ)
ECONet	North Carolina Environment and Climate Observing Network
FEMA	Federal Emergency Management Agency
Fs	maximum fetch distance
Ft	feet
FWL	ratio of winds over water to winds over land
g	gravity
GIS	Geographic Information System
GPS	Global Positioning System
H	wave height at the toe of the structure
HEC-HMS	Hydrologic Engineering Center's Hydrologic Modeling System
HEC-MetVue	Hydrologic Engineering Center's Meteorological Visualization Utility Engine
HEC-RAS	Hydrologic Engineering Center's River Analysis System
H&H	hydrologic and hydraulic
HMR	Hydrometeorological Reports
hr	hour
HWM	high water mark
I_a	initial loss
in	inch
in/hr	inch per hour
KFAY	Fayetteville Airport CRONOS rainfall gage
KMEB	Laurinburg-Maxton Airport CRONOS rainfall gage
KSOP	Moore County Airport CRONOS rainfall gage
L	length of main channel
L_d	deep water wavelength
L_c	length of main channel to the centroid
LiDAR	Light Detection and Ranging
LILE	NC Electric Cooperative Anson Peaking Plant CRONOS rainfall gage
mi	mile
MOVE	Maintenance of variance estimator
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
mph	miles per hour
NAVD	North American Vertical Datum
NC	North Carolina

NC CRONOS	North Carolina Climate Retrieval and Observations Network of the Southeast Database
NCDOT	North Carolina Department of Transportation
NCDEQ	North Carolina Department of Environmental Quality
NCFMP	North Carolina Floodplain Mapping Program
NCSCO	North Carolina State Climate Office
NLCD	National Land Cover Database
NLUM	Lumberton CRONOS rainfall gage
NOAA	National Oceanic and Atmospheric Administration
NRCK	Rockingham CRONOS rainfall gage
NRCS	Natural Resources Conservation Service
NUWH	Uwharrie-Troy CRONOS rainfall gage
NWS	National Weather Service
R	wave runup
s	seconds
SCS	Soil Conservation Service
S_e	set-up
sq mi	square mile
SSURGO	Soil Survey Geographic Database
t	time
T_d	deep water wave period
T_p	hydrograph lag
U	average wind velocity
U1hr	one hour averaged wind speed
U_{33}	wind speed at height of 33 feet
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
U_t	fastest wind speed at a specified duration
U_w	overwater wind speed
U_z	wind speed at a distance of z above surface
WHIT	Border Belt Tobacco Res Station CRONOS rainfall gage
WSE	water surface elevation
yr	year
z	elevation

Executive Summary

The western part of the City of Lumberton is protected from flooding from the Lumber River by a levee system that consists of three segments: the levee that was designed and constructed by the Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service), a portion of I-95 highway embankment, and a portion of Alamac Road. An opening exists within the I-95 highway embankment portion of the levee system to allow a CSX rail corridor and VFW Road to traverse under the highway. During extreme storms, the Lumber River overflows its banks and floods the western part of the city through this opening. Flow also overtops low segments of the I-95 portion of the levee protection system. Floodwaters from recent extreme weather events, like Hurricane Matthew (2016) and Hurricane Florence (2018) flooded the city through the opening in the I-95 embankment, causing major damages to residences and businesses. The City of Lumberton plans to improve its flood resiliency by installing a flood gate closure structure along the opening within the I-95 highway embankment to prevent future flooding. The North Carolina Department of Transportation (NCDOT) also plans to widen and raise the I-95 portion of the flood protection system to increase capacity and to prevent the I-95 highway embankment from overtopping. This report documents the detailed hydrologic and hydraulic (H&H) study of the Lumber River that was performed to establish the height of the proposed flood gate closure structure.

It is the desire of the City of Lumberton to be protected from flooding events with magnitudes like that of the flood of record (Hurricane Florence) and to pursue FEMA accreditation of the levee protection system. For the levee system to be accredited, its minimum top elevation must be equal to the 100-year elevation plus 4.5 feet of freeboard (128.5 feet, North American Vertical Datum [NAVD]88). The North Carolina Department of Environmental Quality's Division of Energy, Mineral and Land Resources (DEMLR) determined in October 2021 that the proposed floodgate is subject to the jurisdiction of the Dam Safety Law of 1967 and will have a Class C high hazard and large size classification. This classification implies that the proposed floodgate should be designed to withstand the ¾ Probable Maximum Flood (PMF). In determining the design elevation of the gate, a statistical analysis was performed and the recurrence interval of the flood of record was estimated to be about 200-years. Hydraulic simulations were performed without the gate and with the gate and the proposed I-95 configuration in place, to estimate the resulting peak elevations of the 100-year through the Probable Maximum Flood (PMF) return period events, and the flood of record.

Based on the results of the analysis, the recommended range of top of gate elevations and gate heights that meets the objectives of the City of Lumberton and regulatory requirements are shown in tabular form below:

Design Storm	**Recommended Top of Gate Elevation and Gate Height**			
	Max. Stillwater Elevation (feet, NAVD88)	Freeboard (feet)	Top of Gate Elevation (feet, NAVD88)	Gate Height (feet)
100 YR	124.0	5.4	**129.4**	**9.4**
¼ PMF	126.0	6.6	**132.6**	**12.6**
500 YR	127.6	6.6	**134.2**	**14.2**

Reference Elevations: 1. Minimum elevation for levee accreditation = 128.5 feet (ft), NAVD88
2. Flood of record elevation at gate location assuming gate is in place and I-95 raised = 125.6 ft, NAVD88
3. Elevation of ¾ PMF at gate location assuming gate is in place and I-95 raised = 128.8 ft, NAVD88
4. Elevation of PMF at gate location assuming gate is in place and I-95 raised = 129.2 ft, NAVD88
5. Average ground elevation at gate location is 120.0 ft
6. ¼ PMF is the largest storm that does not overtop the levee and proposed I-95
7. Levee is overtopped during the 500-year storm.

The recommended range of top of flood gate elevations of 129.4 to 134.2 feet, NAVD88 ensures that the gate is not overtopped up to the PMF if freeboard is not accounted and meets all the regulatory requirements. The ¼ PMF is the largest event that does not overtop the levees. Minor overtopping of the levee occurs during the 500-year event. Selection of the design gate height from this range should be based on cost, floodplain impacts, and minimum desired level of service.

1. Introduction

1.1. Authorization and Study Purpose

Atkins was authorized to conduct this study through its contract with City of Lumberton dated October 18, 2019. The contract is to provide engineering services for the design of a flood gate closure structure at the VFW Road and CSX Railroad Interstate 95 (I-95) Underpass in the City of Lumberton.

The City of Lumberton is susceptible to flooding from the Lumber River. A levee system provides flood prevention to the City of Lumberton. The levee system consists of three segments: the levee that was designed and constructed by the Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service), a portion of I-95 highway embankment, and a portion of Alamac Road (**Figure 1-1**). The levee begins at the tie in with I-95, approximately 1,100 feet north-east of VFW Road and extends south-east to the tie-in with Alamac Road, running parallel to the Lumber River. An opening exists within the I-95 highway embankment to allow a CSX rail corridor and VFW Road to traverse under the highway. During extreme storms, the Lumber River overflows its banks and through the opening in I-95 flooding portions of the City of Lumberton. Floodwaters from recent extreme weather events, like Hurricane Matthew (2016) and Hurricane Florence (2018) flooded the city through the opening in the I-95 embankment, causing major damages to residences and businesses. During Hurricane Matthew, no attempts were made to close the opening, resulting in significant flows into the protected area. In preparation for Hurricane Florence, sandbags and temporary barriers were placed across the opening. Although these measures provided temporary protection they eventually failed. And, therefore, the City of Lumberton wants to install permanent protection such as flood gates within the opening under I-95. The gate would have to be closed over the CSX railroad corridor and local road to protect the southern part of the city from flooding.. The purpose of this project is to design and install the flood gate at this most vulnerable location to improve the flood resilience of the City of Lumberton.

To establish the height of the flood gate closure structure, a detailed hydrologic and hydraulic (H&H) study of the Lumber River is required. The H&H study includes a hydrologic analysis of the Lumber River from the headwaters located near Eagle Springs, North Carolina (NC) to the confluence of the Lumber River and Jacob Swamp located about 4 miles downstream of Lumberton. A hydraulic model was developed along the Lumber River and of its tributaries near the city of Lumberton to establish flood elevations for use in the flood gate closure design.

It is worth noting that there is a second opening in the levee protection system along Alamac Road. This opening is a bridge that allows Jacob Swamp to connect with the Lumber River. Although flow in the Lumber River backs up through this opening under extreme flooding conditions, it does not result in extensive flooding compared to flow through the I-95 opening. The opening within Alamac road is not a focus of this study.

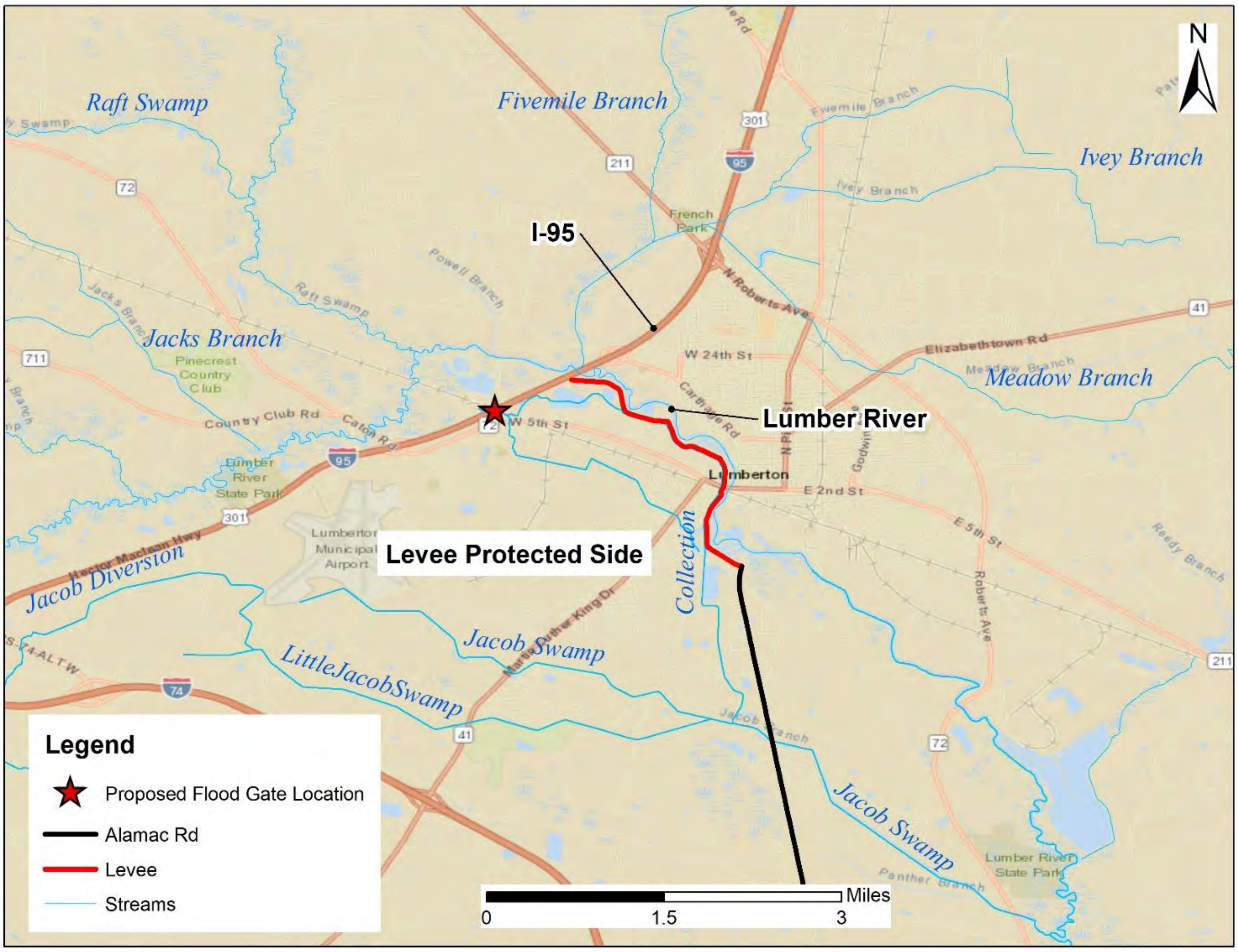


Figure 1-1. Lumberton site location map.

1.2. Assumptions and Limitations

The assumptions and limitations of the analysis and report are as follows:

a. The analysis and results presented in this report are for the sole purpose of designing the flood gate.

b. Top elevations of the Lumberton levee system including the existing I-95 highway are based on terrain data described in **Section 3.1**. The top of levee elevations from the terrain match elevations from a survey performed by others as described in this report. Atkins does not guarantee the accuracy of this data.

c. The geometry of the proposed I-95 embankment and hydraulic structures that traverse the highway embankment are based on 25-percent design plans from NCDOT and is subject to change. Atkins does not guarantee the accuracy of this data.

d. Atkins relied on hydraulic structure data included in the effective Federal Emergency Management Agency (FEMA) models. Atkins spot checked the information gathered on these structures by comparing them to field observations but does not guarantee the accuracy of all the data.

e. Atkins relied on the high-water mark, streamflow, and stage data collected by the United States Geological Survey (USGS) for model calibration. Atkins does not guarantee the accuracy of this data.

2. Hydrological Setting

2.1. Watershed Location and Size(s)

The Lumber River basin is in southeastern North Carolina, approximately 30 miles (mi) south of Fayetteville, NC, and has a total drainage area of 748 mi^2 at the confluence of the Lumber River and Jacob Swamp (**Figure 2-1**). The drainage area to the USGS gage along Lumber River in Lumberton is 708 mi^2. The location of the USGS gage is approximately 1.7 miles downstream from the proposed flood gate closure location. The Lumber River basin at the gage location is entirely within the state of North Carolina and encompasses portions of six different counties: Robeson, Hoke, Scotland, Moore, Richmond, and Montgomery.

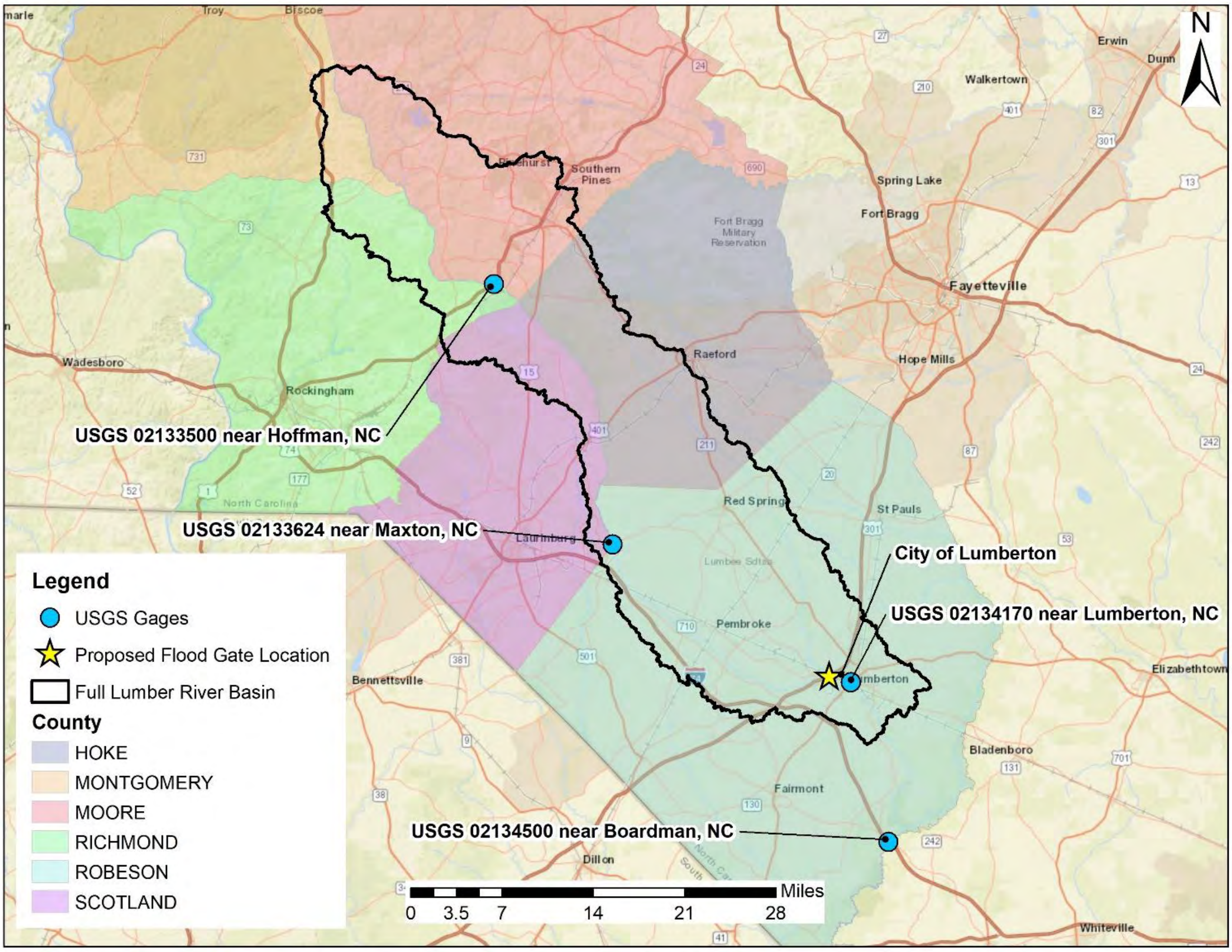


Figure 2-1. Lumber River basin location within southeastern North Carolina.

2.2. Climate

The National Oceanic and Atmospheric Administration (NOAA) provides precipitation and temperature data for the entire United States. The state of North Carolina is divided into eight climate regions (NOAA, 2020). The Lumber River basin is in two of the regions: Southern Piedmont for the northern quarter and Southern Coastal Plains for much of the basin. The mean annual temperature for these regions is 59.7°F and 61.5°F, respectively. This is above the national average of 52.02°F. The mean annual precipitations for the NOAA-defined NC climate regions of Southern Piedmont and Southern Coastal Plain are 46.59-in and 49.23-in, respectively, which are well above the national average of 29.94-in (NOAA, 2020).

Due to its proximity to the Atlantic seaboard, eastern NC is highly susceptible to coastal events including tropical events that mainly occur during the official hurricane season (June 1st to November 30th) as well as extratropical events such as nor'easters and storms that trail along stalled frontal boundaries. Historical data shows that the North Carolina coast is most likely to have a hurricane in September and October based on the prevailing wind patterns (NOAA, 2019a). In 2015, 2016, and 2018, annual precipitation depths were about 14-in, 11-in, and 22-in, respectively, above the annual North Carolina mean (1901-2019) (NOAA, 2020), primarily due to tropical storms and hurricanes.

2.3. Historical Floods

2.3.1. Storms Prior to 2000

Records of major flooding caused by tropical storms dates to the 1600s. However, no flow measurements were available until after the installation of the USGS Gage 02134170 (on Lumber River at Lumberton, NC) circa the year 2000. Notable storms that occurred prior to 2000 include:

- The flood of October 1954 was the result of Hurricane Hazel which made landfall on October 14, 1954, as a category 4 storm near Calabash, NC, approximately 70 miles southeast from Lumberton, NC. Total rainfall was reported to be over 7 inches in parts of NC, including near the upstream portion of the Lumber River basin, with totals between 5 to 6 inches closer to Lumberton, NC (North Carolina State Climate Office (NCSCO), 2015). While tropical events occurred prior to 1954, Hurricane Hazel was noted as one of the most catastrophic in the twentieth century (Barnes, 1998), thus selected as the earliest record of interest.
- The flood of September 1996 was the result of Hurricane Fran which made landfall on September 5, 1996, as a category 3 storm near where the Cape Fear River reaches the Atlantic Ocean (NCSCO, 2015). This is approximately 75 miles southeast of Lumberton, NC. A total of 5 to 10 inches of rainfall across parts of eastern and central NC was reported (USGS, 2016).
- The flood of September 1999 was the result of Hurricane Floyd, which made landfall on September 16, 1999, as a category 2 storm near Cape Fear, NC, approximately 75 miles southeast of Lumberton, NC. Rainfall records across the state ranged from 12 to 20 inches. The rainfall total at the Lumberton Airport was 8.48 inches (NOAA, 2019b) and 7.62 inches in Lumberton (USGS, 2016).

2.3.2. Storm and Flood of September 2004

Significant rainfall fell across the entire state of North Carolina in September 2004 as a result of Hurricane Frances. Hurricane Frances impacted North Carolina from September 7-8 and mainly hit the western part of the state but did result in significant rainfall in the eastern half (National Weather Service [NWS], 2004). Rainfall gages near the Lumber River basin reported total rainfall depths from the storm from 4.31 to 11.87 inches (NCSCO,2020). The USGS gage on Lumber River at Lumberton (USGS 02134170) reported a peak streamflow of 7,420 cubic feet per second (cfs) in the early hours of September 11, 2004 (USGS, 2020).

2.3.3. Storm and Flood of October 2016

The flood of October 2016 was the result of Hurricane Matthew which made landfall on October 8, 2016, as a Category 1 storm southeast of McClellanville, South Carolina, approximately 110 miles southwest of Lumberton, NC. A front moved inland, pushing the storm north and east towards North Carolina. The storm moved back into the Atlantic Ocean on October 9. While the storm was only over land for two days the sharp turn of the path slowed down the forward speed, resulting in heavy precipitation for 2 days over the eastern portions of both North Carolina and South Carolina (NOAA, 2019c). The total recorded precipitation depth in Lumberton, NC from this storm was 12.53 inches, which is the highest recorded until 2018 (previously 7.62 inches in 1999) (Weaver et al., 2016). Recorded peak flows at the USGS gages in Lumberton (02134170) and Boardman, NC (02134500) were 14,600 cfs and 38,200 cfs, respectively (USGS, 2020). The recorded peak of 38,200 cfs at the USGS gage in Boardman, NC is the highest ever recorded flow to date and it resulted in a peak stage of 14.43 ft (USGS, 2016). The Boardman gage is approximately 15 miles downstream of the USGS Lumberton gage.

Based on high water marks (HWM) provided by the USGS, flood depths in and around Lumberton ranged from 0.65 to 6.89 ft. The levee did not overtop or fail during Hurricane Matthew. Flooding in the area was caused by overtopping of I-95, flow through the I-95 opening at VFW Road/CSX Railroad underpass, and inadequate capacity of the internal drainage system (**Figure 2-2**).

Figure 2-2. Flooding along I-95 and inside the Lumberton Levee from Hurricane Matthew; area to right of road is the levee protected side of Lumberton (Source: City of Lumberton).

2.3.4. Storm and Flood of September 2018

The flood of September 2018 was the result of Hurricane Florence. Hurricane Florence made landfall on September 14, 2018, as a Category 1 storm at Wrightsville Beach, NC, approximately 75 miles southeast of Lumberton, NC. After making landfall, the storm turned southwest into South Carolina, where it moved inland and then turned north before becoming a tropical depression. While the winds were lower as a result of being a Category 1 storm, the system moved slowly at about 2 to 3 miles per hour over North and South Carolina, resulting in large rainfall amounts. Rainfall continued over a four-day period across the southeastern portion of North Carolina (NOAA, 2019c). Total rainfall values reported by NOAA at stations 2.3 miles northeast of Lumberton and 2.6 east-southeast of Lumberton are 22.8 inches and 21.4 inches, respectively. Hurricane Florence resulted in the highest ever recorded peak flow at the USGS gage in Lumberton (02134170 Lumber River at Lumberton) of 17,100 cfs with a peak stage of 22.21 ft. Hurricane Florence caused major flooding within the City of Lumberton as floodwaters passed through the opening under I-95 at the VFW Road and CSX railroad intersection into the city (**Figure 2-3)**. USGS estimates about 12-percent of the total recorded peak flow passed through the opening under I-95.

Figure 2-3. Flooding under I-95 at VFW Road and CSX railroad in Lumberton, NC from Hurricane Florence (Source: City of Lumberton).

3. Data Collection

Data used for modeling included field data along with available hydrologic, terrain, and land data. Field data, including high water marks and survey, is provided in **Appendix A**. Hydrologic data, including rainfall, streamflow, and parameter calculations, is provided in **Appendix B**. Hydraulic data, including levee data, is provided in **Appendix C**.

3.1. Terrain and Watershed Data

Terrain tiles were QL2 Light Detection and Ranging (LiDAR) obtained from the North Carolina Floodplain Mapping Program (NCFMP). QL2 data has a standard of 2 points per square meter, allowing for higher resolution than previous LiDAR. The projection of the data source was in NAD_1983_StatePlane_North_Carolina_FIPS_3200 _Feet. The vertical datum is NAVD 88. The terrain was for the entirety of Robeson County and portions of Hoke, Scotland, Moore, Richmond, and Montgomery counties and all are 10 ft resolution. The tiles within the project area were mosaiced using ArcGIS. The elevation within the Lumber River basin ranges from 102 to 734 ft NAVD 88 (**Figure 3-1**).

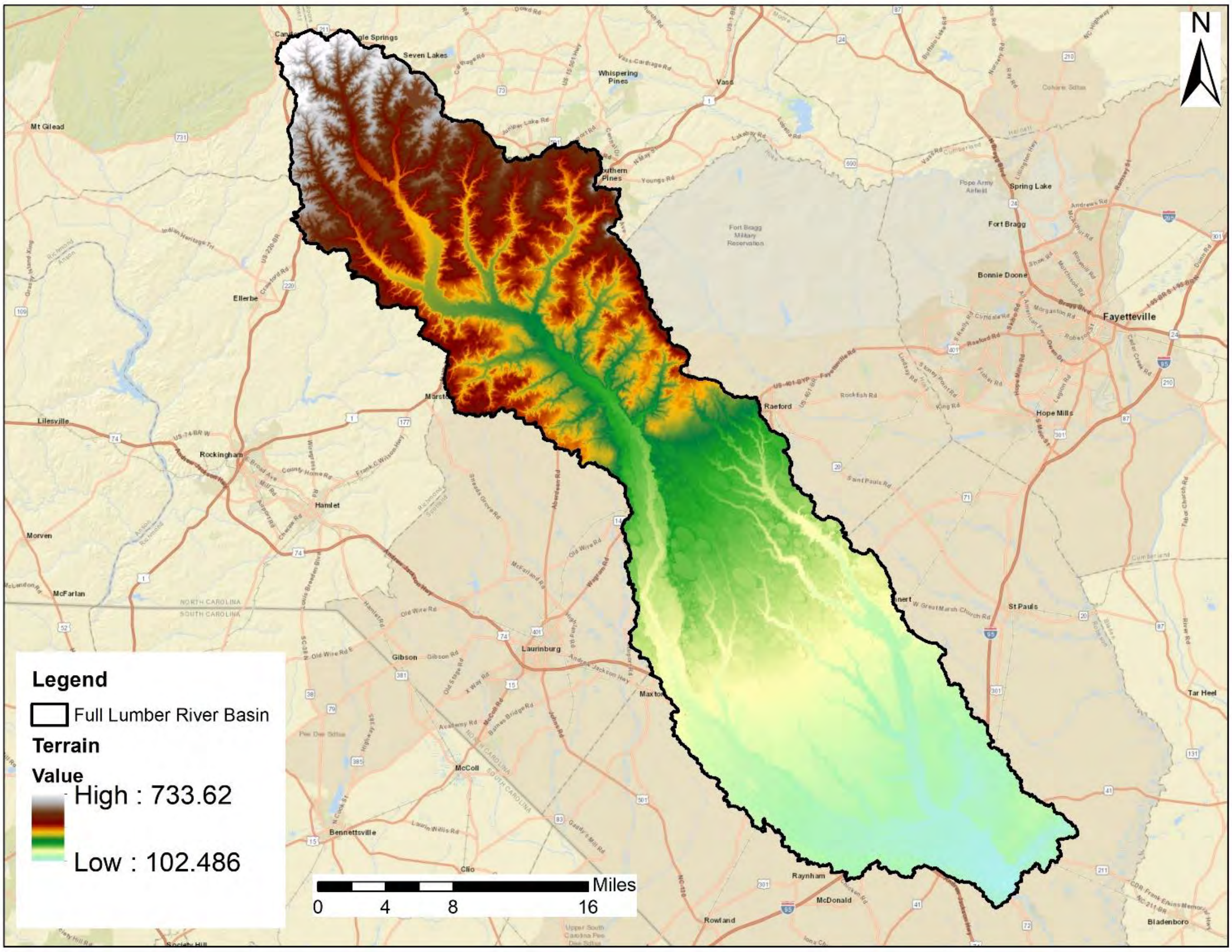


Figure 3-1. Lumber River basin terrain.

The LiDAR terrain source did not account for bathymetry. Bathymetric data for Lumber River were obtained from the Preliminary Lumber River one-dimensional (1D) Hydrologic Engineering Center's River Analysis System (HEC-RAS) model obtained from NCFMP as part of this project. Channel banks were edited to ensure that the channel thalweg and top width were captured. The bank-to-bank elevations at each cross-section were exported as the bathymetry using RASMapper. This same procedure was followed for Jacob Swamp and Little Jacob Swamp.

For Fivemile Branch, Meadow Branch, Gum Branch, Cotton Mill Branch and Collection Canal, cross section data was obtained in the field for at least two points along the channel. This procedure is explained in further detail in **Section 3.6.2**. A slope was interpolated from the two surveyed cross sections, and the slope was used to drop the channel inverts along each reach. This procedure was completed using 1D HEC-RAS models and the bathymetry generated using the approach described for Lumber River and Jacob Swamp.

The separate bathymetric terrains were then mosaiced with the original terrain, giving bathymetry the priority in ArcGIS. At confluences, tributary elevations were altered to match that of the main reach to ensure the terrain merged smoothly.

3.2. Precipitation Data

Hourly precipitation in the area was obtained from the North Carolina Climate Retrieval and Observations Network of the Southeast Database (NC CRONOS)/ North Carolina Environment and Climate Observing Network (ECONet) Database, which was developed by the State Climate Office of North Carolina (2019). There are eleven precipitation gages within or nearby the drainage basin, eight of which had precipitation data for selected calibration and verification storms (**Figure 3-2).** Gages with available data varied across storms (**Table 3-1**).

For each event, Thiessen polygons were created based on the rainfall gages with available data to estimate the rainfall contribution from each gage for each sub-basin **(Figure 3-3**). Thiessen polygons were created for each event based on gages with available data to determine which gages to use for precipitation data for each sub-basin. Depending on the outcome of the Thiessen polygon divisions, some gages with available data were not used, as highlighted for the 2004 event in **Figure 3-3**. Sub-basin delineation is discussed in **Section 5.3**. Additional details on the Thiessen polygon procedure are included in **Appendix B1**. The area proportions determined from the Thiessen polygons were applied as weights to the precipitation data from the contributing gages. The storm hyetograph applied to a sub-basin is the weighted average from all contributing rainfall gages. A summary of gage availability, weighted rainfall data sets, and the applied range of rainfall per event is provided in **Table 3-1**.

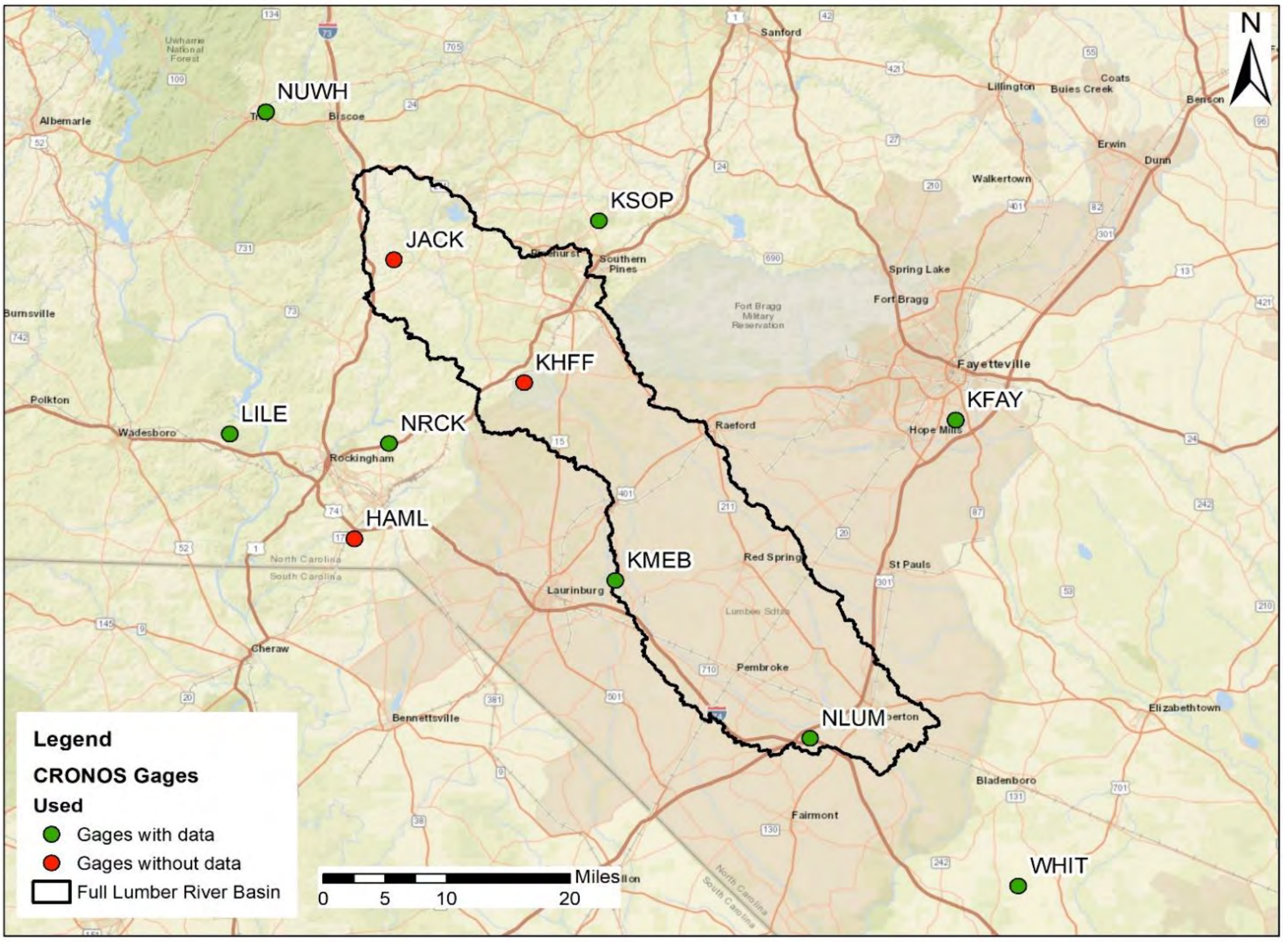


Figure 3-2. CRONOS rainfall gages in and near the Lumber River basin.

Table 3-1. Precipitation gage availability and utilization in models.

Event	Gages Available	Gages Used
Sept 2004	5 (KFAY, HAML, KMEB, NRCK, WHIT)	KFAY, KMEB, NRCK, WHIT
Oct 2015	4 (LILE, NLUM, NUWH, WHIT)	LILE, NLUM, NUWH
Oct 2016	5 (KSOP, LILE, NLUM, NUWH, WHIT)	KSOP, LILE, NLUM, NUWH
Sept 2018	4 (LILE, NLUM, NRCK, WHIT)	NLUM, NRCK

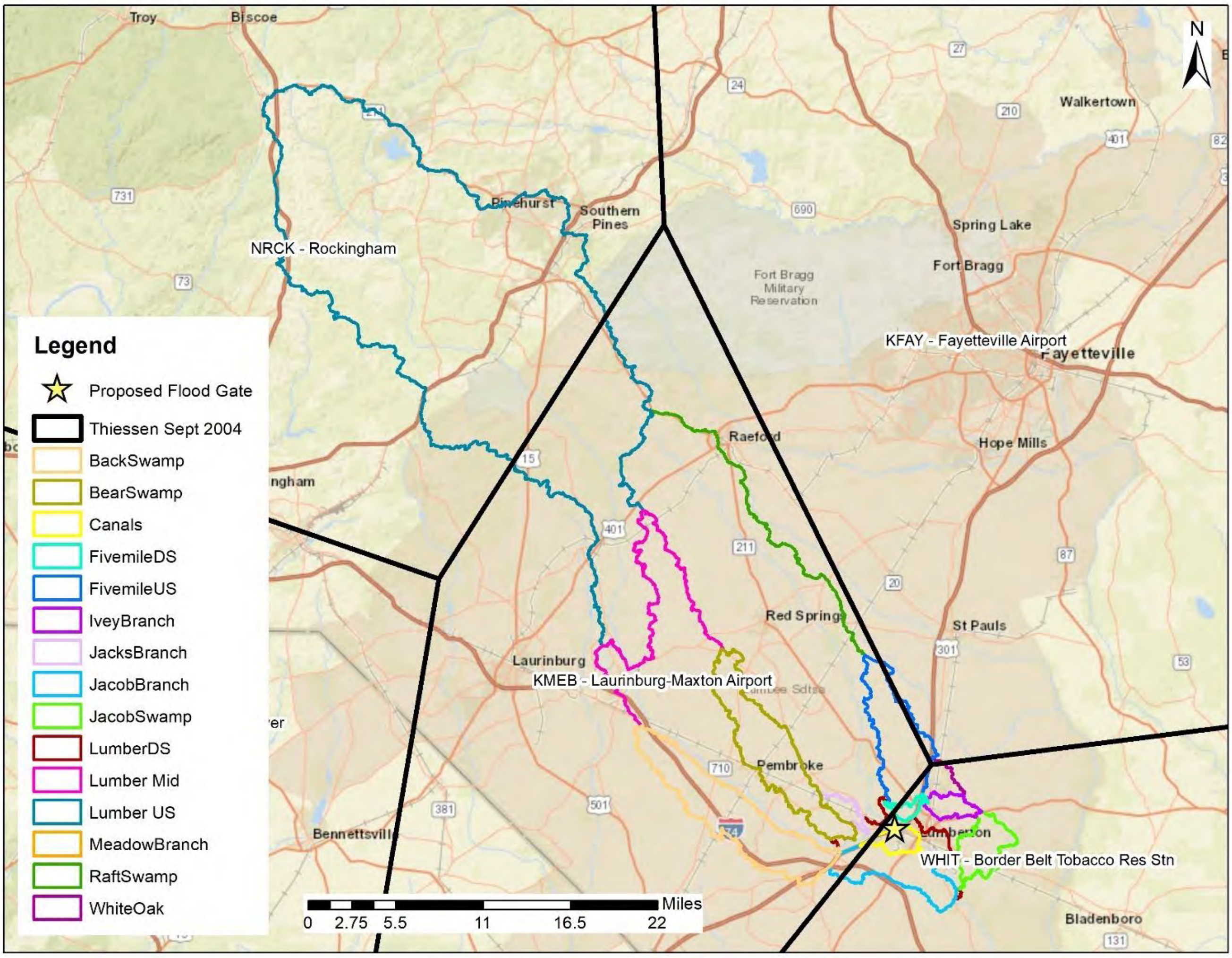


Figure 3-3. Example of Thiessen polygons used to calculate weighted rainfall; shown is the 2004 event Thiessen polygons.

3.3. Streamflow Data

There is a USGS stream gage approximately 1.7 miles downstream of the Lumberton flood gate location, USGS 02134170 Lumber River at Lumberton, NC (**Figure 3-4**). Fifteen (15) minute river discharge (cfs) and gage height (ft) were obtained for the full period of record (July 2, 2000 to present) (USGS, 2020) (**Appendix E2.1**). Additionally, there is a gage upstream on Lumber River in Maxton, NC (USGS 02133624) with a drainage area of 365 sq mi and a gage downstream of our modeled basin on Lumber River in Boardman, NC (USGS 02134500) with a drainage area of 1,228 sq mi (**Figure 3-4**).

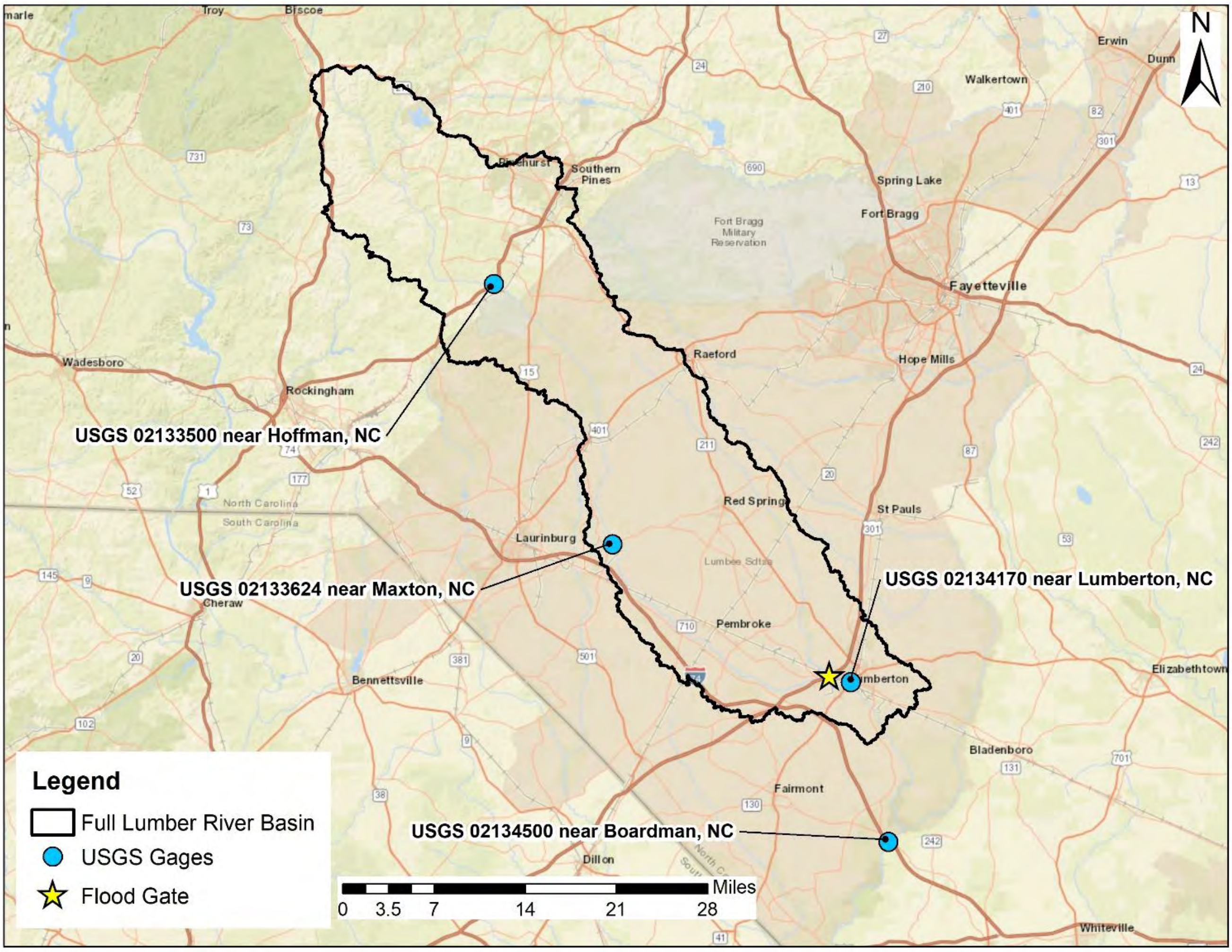


Figure 3-4. USGS gage (02134170 Lumber River at Lumberton, NC) within the Lumber River basin.

3.4. Soils Data

Hydrologic soil group data was obtained from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) GeoSpatial Data Gateway (USDA, 2020). Gridded soil survey from the Soil Survey Geographic (gSSURGO) database was downloaded for all required counties. Most of the basin consists of B and C soils, with some D soils and minimal A soils (**Figure 3-5**).

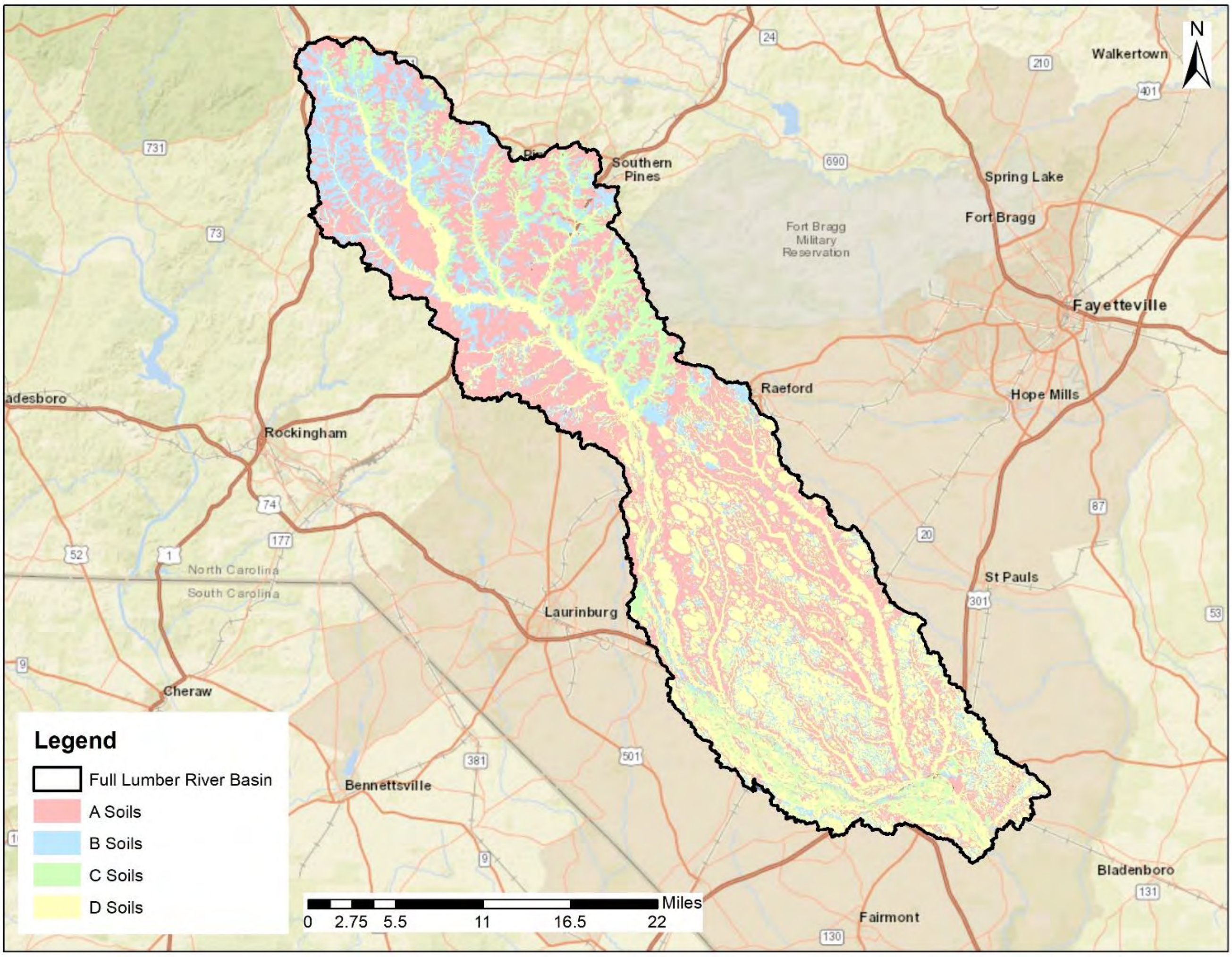


Figure 3-5. Lumber River basin soil type distribution.

3.5. Land Use Data

Land use data was obtained from the 2016 National Land Cover Database (NLCD) (**Figure 3-6**) (USDA, 2020). The northern portion of the watershed is primarily evergreen forest, while the southern half is cultivated crops and the developed area of Lumberton, NC.

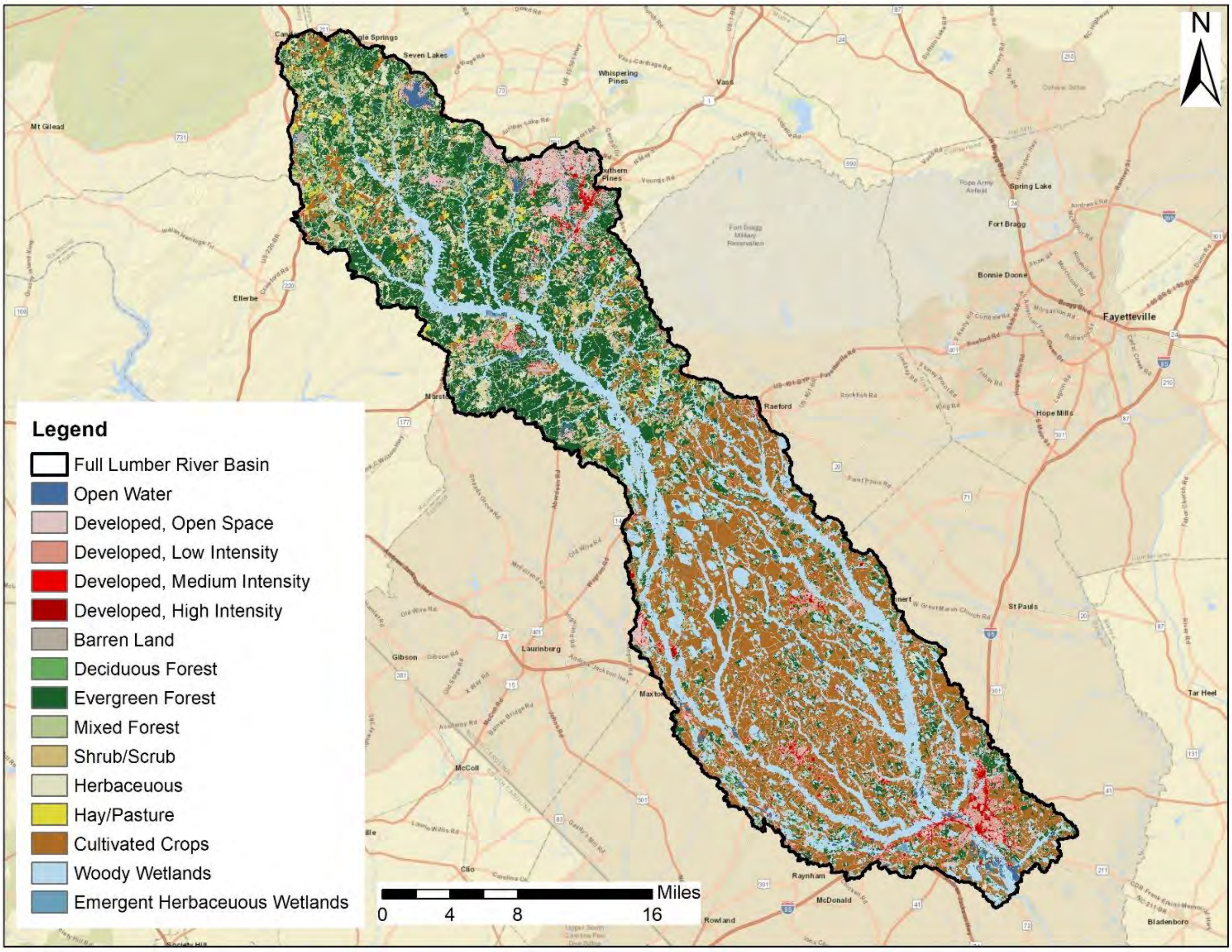


Figure 3-6. Lumber River basin 2016 land cover type.

3.6. Field Survey and Data Collection

A field survey was conducted to validate structure dimensions from effective models/inspection reports and collect dimensions for structures without pre-existing data. A field survey was also conducted to gather cross section information for reaches within the levee protected area that did not have an effective model with bathymetry. **Figure 3-7** below shows the locations of these structures and the cross-section locations. The location map and field measurements are provided in Appendix A1 and photographs for each structure are shown in **Appendix E1**. The team also gathered high water mark information from Hurricanes Florence and Matthew.

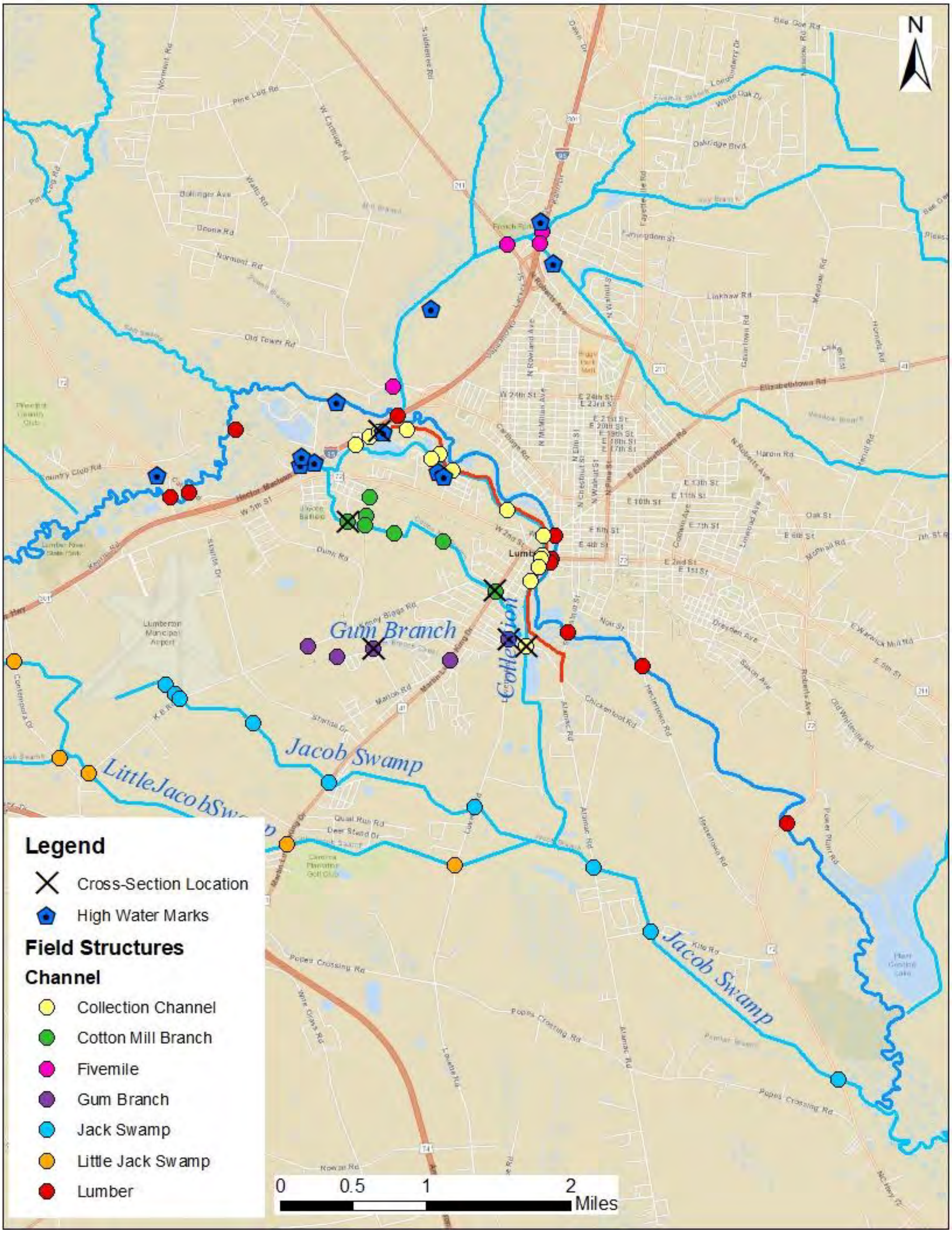


Figure 3-7. Collected field data for structures, high water marks, and survey points.

Additional structure surveys were conducted by McGill Associates for selected structures along the main reaches, Lumber River, and Fivemile Branch. McGill surveyed one structure on Lumber River/I-95 in the vicinity of the proposed flood gate and four structures on Fivemile Branch.

3.6.1. Structure Data

An inventory of hydraulic structures within the project area was derived before the field survey. The initial list of structures came from the effective FEMA models for Lumber River, Jacob Swamp, Little Jacob Swamp, Fivemile Branch, Collection Canal, Cotton Mill Branch, and Raft Swamp. These were all obtained from the North Carolina Flood Risk Information System website (NCFMP, 2019). The second source of known structures was the NCDOT Bridges Map (NCDOT, 2019). Inspection reports were obtained from NCDOT for the structures found on the NCDOT Bridges Map,. Other structures were found using aerial imagery or data. Levee data was obtained from AECOM Project No. 60548447, Lumberton Flood Mitigation Report Levee Plans, provided in **Appendix C2**.

The team collected general structure dimensions, material, skew, bed material and condition, normal depth, channel width, structure condition, scour, sedimentation, obstructions, and guardrail height. More specifically, data for bridges included: number of spans, width of spans, pier dimensions, cap dimensions, girder thickness, seat dimensions, depth from low chord to channel invert, length of bridge, and width of bridge. Data collection for culverts included: culvert type, number of barrels, rise, span/diameter, bed to crown, abutment type, scour, and length of culvert.

The above data was obtained using Global Positioning System (GPS), measuring tapes, measuring wheels and rods. The team also looked for any additional structures not found in aerial imagery or ongoing construction.

3.6.2. Cross Sections

Collection Canal, Gum Branch, and Cotton Mill Branch were surveyed at a minimum of two locations along the reach. This allowed for a slope to be interpolated along the channel bed. The cross sections were taken at the upstream side of a structure.

To collect the cross-section data, the survey team used a laser level, GPS, and rod. A benchmark was determined using GPS coordinates (at top of bank). The elevation of the benchmark was estimated using LiDAR data. The team then took a back sight reading and found the height of instrument. Foresight readings were taken throughout the channel. Points were taken approximately every 5 feet across the channel to capture top of bank, edge of water and channel inverts. calculations were performed to determine the channel elevations from the collected measurements. Cross-section data and plots are provided in **Appendix A3**.

3.6.3. High Water Marks

Eleven high water mark (HWM) locations and depths were obtained from a field visit with City of Lumberton waterworks department personnel (**Figure 3-8**). The City of Lumberton personnel provided the history of each water mark during the field visit. At each mark, the location, height of water from the ground, and event were noted, along with photos for each. An example of a recorded HWM photo is shown in **Figure 3-9**. Measured HWM depths were converted to elevations based on the terrain data described in **Section 3.1**.

Additionally, HWM for Hurricanes Matthew and Florence were obtained from the USGS Flood Event Viewer application ((United States Geological Survey, 2019) (**Figure 3-8**).

The high-water mark located just upstream of the proposed gate location was surveyed by McGill Associates. This HWM can be seen in **Figure 3-8** below. Additional details are included in **Appendix A2**.

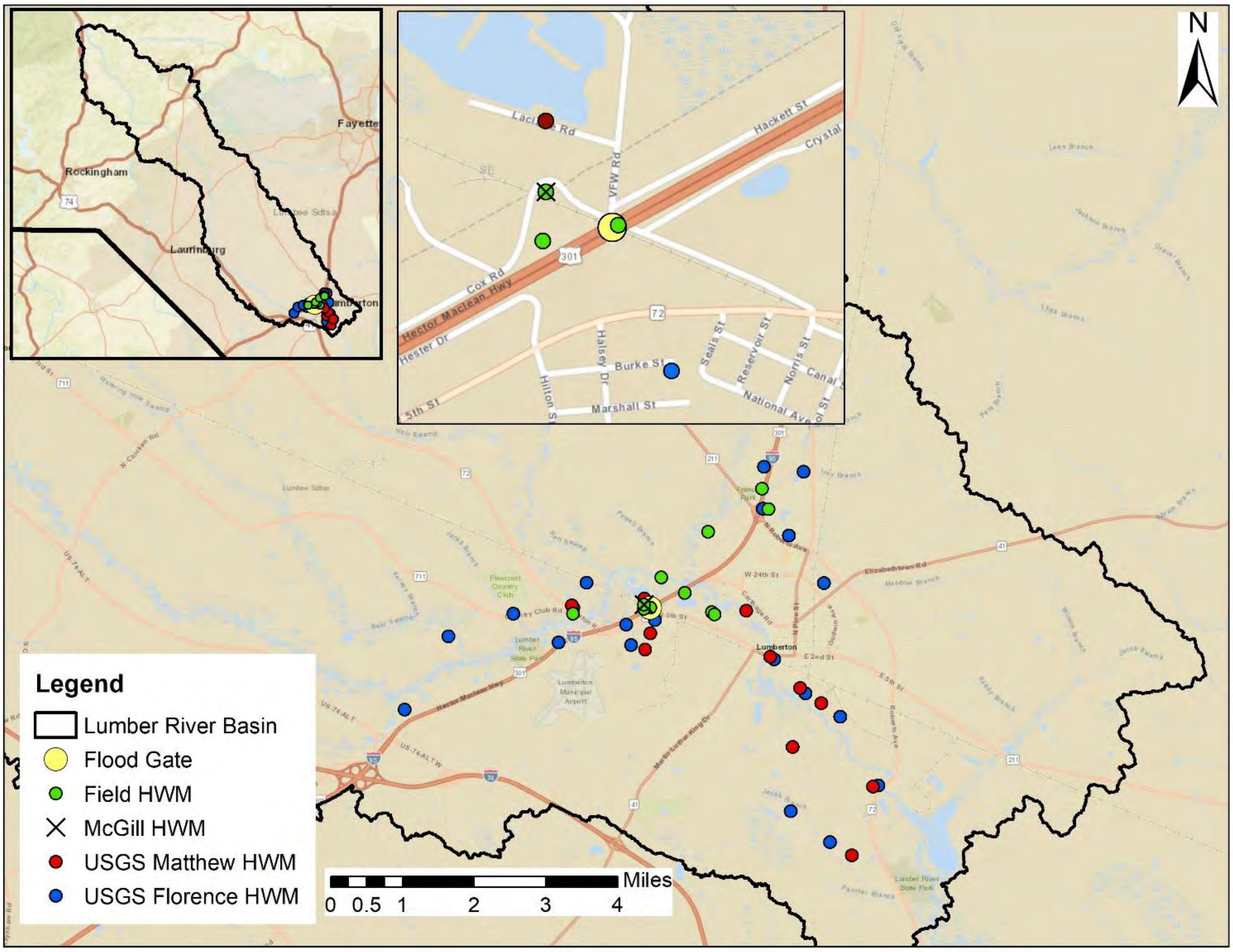


Figure 3-8. Location of field and USGS high water marks.

Figure 3-9. Example of HWM from Lumberton field visit near the VFW Road and railroad intersection by the flood gate location.

4. Design Flood Selection

4.1. Review of FEMA Levee Accreditation Guidelines

FEMA provides guidelines and requirements that must be met for levee systems to be accredited (FEMA, 1986). The FEMA requirements, as specified in 44 Code of Federal Regulations (CFR) 65.10 (FEMA, 2006), related to levee height are as follows:

- Levees mush have a minimum freeboard of 3 feet above the 100-year flood elevation (base flood elevation), with
- an additional 1 foot of freeboard at locations within 100 feet of structures (such as bridges) or wherever the flow is restricted, and
- an additional 0.5 foot of freeboard at the upstream end of a levee.

The minimum elevation of the flood gate will therefore have to be above the 100-year water surface elevation plus 4.5 feet to meet FEMA accreditation requirements. The levee is currently not FEMA accredited.

4.2. Flood Frequency Analysis

It is the desire of the City of Lumberton to have a flood gate that can, at a minimum, prevent flooding from events like that of Hurricanes Matthew and Florence, which are the highest recorded flooding events in Lumberton. Flood frequency analysis was performed to estimate the recurrence intervals of historic floods (Hurricane Matthew and Hurricane Florence) near the site. For reference, the recorded peak flow rate from Hurricane Matthew at the Lumberton and Boardman gages were 14,600 cfs and 38,200 cfs, respectively, and the recorded peak flows for Hurricane Florence at the Lumberton and Boardman gages were 17,100 cfs and 35,400 cfs, respectively.

Flow measurements at the Lumberton gage during Hurricane Matthew did not account for flow that was diverted through the I-95 opening at the VFW Road and the CSX railroad track. The actual peak flow at Lumberton from Hurricane Matthew is therefore larger than the reported peak flow of 14,600 cfs. USGS records indicate that diverted flow through the I-95 opening during Hurricane Florence was about 2,000 cfs, approximately 12% of the total flow (USGS Correspondence, **Appendix B6**). Based on the recorded water surface elevations at the USGS gage in Lumberton (119.7 feet for Hurricane Florence versus 119.4 feet for Hurricane Matthew) for the two events, a similar amount of flow can be assumed to have been diverted through the I-95 opening during Hurricane Matthew. This implies that the actual peak flow at Lumberton from Hurricane Matthew is about 16,600 cfs. This estimate is consistent with the simulated peak flow from the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) model as described in **Section 5.6** and **Table 5-8**. Additional analysis was performed with the adjusted peak flow for Hurricane Matthew to assess the sensitivity of the estimated return periods to the change in the peak flowrate for that event.

PeakFQ (version 7.3) (USGS, 2019a) was utilized for the analysis. This version of the software was released in 2019 and uses Bulletin #17C methodology (USGS, 2019b) for the flood frequency computation. Log Pearson Type III distribution was used for the analysis. Peak streamflow data was downloaded for two USGS gages:

1. USGS 02134170 – Lumber River at Lumberton, NC
    - Near proposed Lumberton flood gate site
2. USGS 02134500 – Lumber River at Boardman, NC
    - Approximately 15 miles downstream of the Lumberton gage

The flood frequency analysis was conducted for the gage at Lumberton (Gage 1). This gage had a record from 2001-2018 and the downstream gage (Gage 2) had a record from 1901-2018.

Two different methods were used in estimating the return periods to assess the impact gage record length and method for gage adjustment based on nearby gage(s) with longer records:

- Method 1 uses Gage 1 observed data only.
- Method 2 extends the record at Gage 1 based on Gage 2 using the MOVE method.

4.2.1. Method 1

The results of the analysis based only on the Gage 1 records with the reported and adjusted peak flow rates of 14,600 cfs, and 16,600 cfs for Hurricane Matthew are shown in **Table 4-1** and **Figures 4-1 and 4-2**. Based on this data, the return periods for Hurricane Matthew and Florence are between 30 to 50 years. The Log Pearson Type III analysis for this is included in **Appendix E4.2**. The upper (95%) and lower (5%) confidence limits of the peak flow estimates are also reported to show the potential range of peak flows that could occur for each return period.

Table 4-1. Calculated discharge per return period at the Lumberton gage (USGS 02134170).

Return Period (years)	With Reported Matthew Peak Flow Rate			With Adjusted Matthew Peak Flow Rate		
	Peak Flow (cfs)	Peak Flow 5% Lower Bound	Peak Flow 95% Upper Bound	Peak Flow (cfs)	Peak Flow 5% Lower Bound	Peak Flow 95% Upper Bound
1.25	1,654	1,122	2,269	1,645	1,109	2,267
2	3,130	2,283	4,375	3,145	2,282	4,427
5	6,139	4,389	9,687	6,254	4,440	9,979
10	8,856	6,103	15,830	9,099	6,218	16,510
25	13,240	8,603	28,460	13,740	8,836	30,140
50	17,270	10,680	43,080	18,050	11,030	46,170
100	22,020	12,920	64,080	23,170	13,410	69,470
200	27,600	15,330	94,040	29,230	15,990	130,100
500	36,460	18,760	153,600	38,940	19,700	171,000

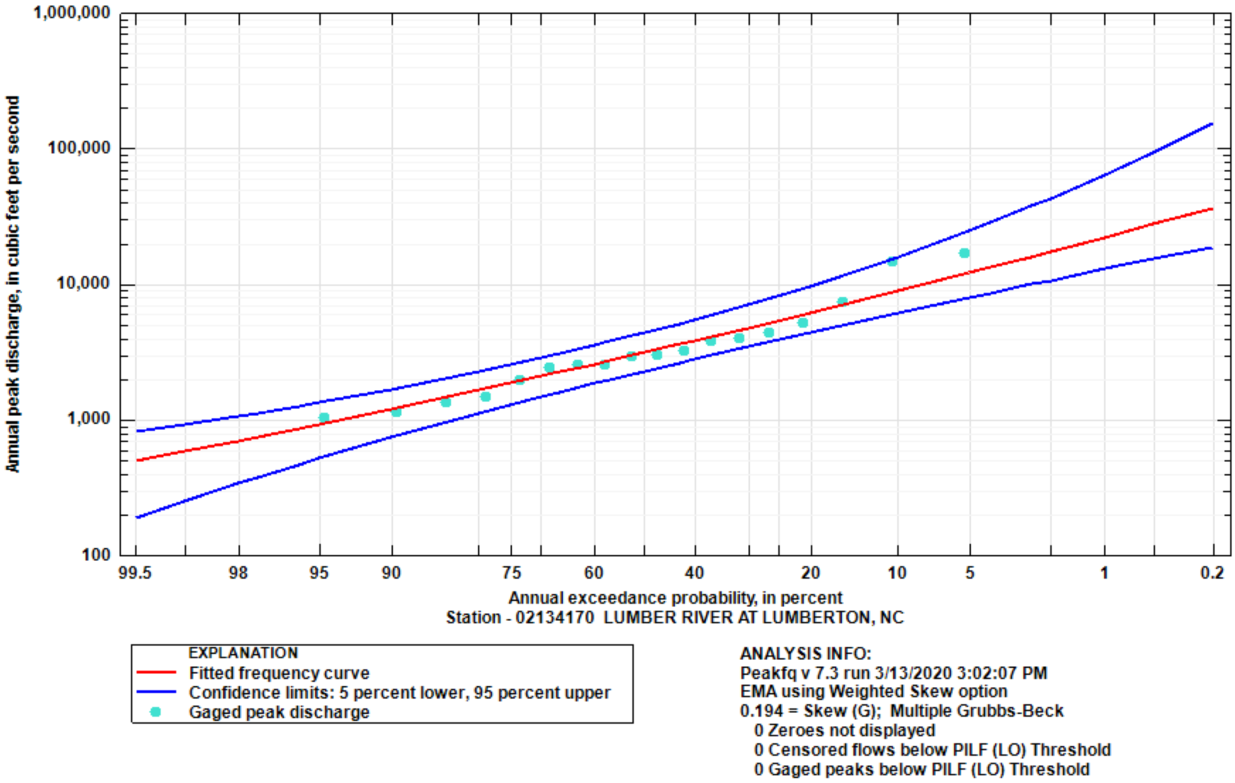


Figure 4-1. Discharge-Frequency curve for Lumberton gage with reported Hurricane Matthew peak flow rate.

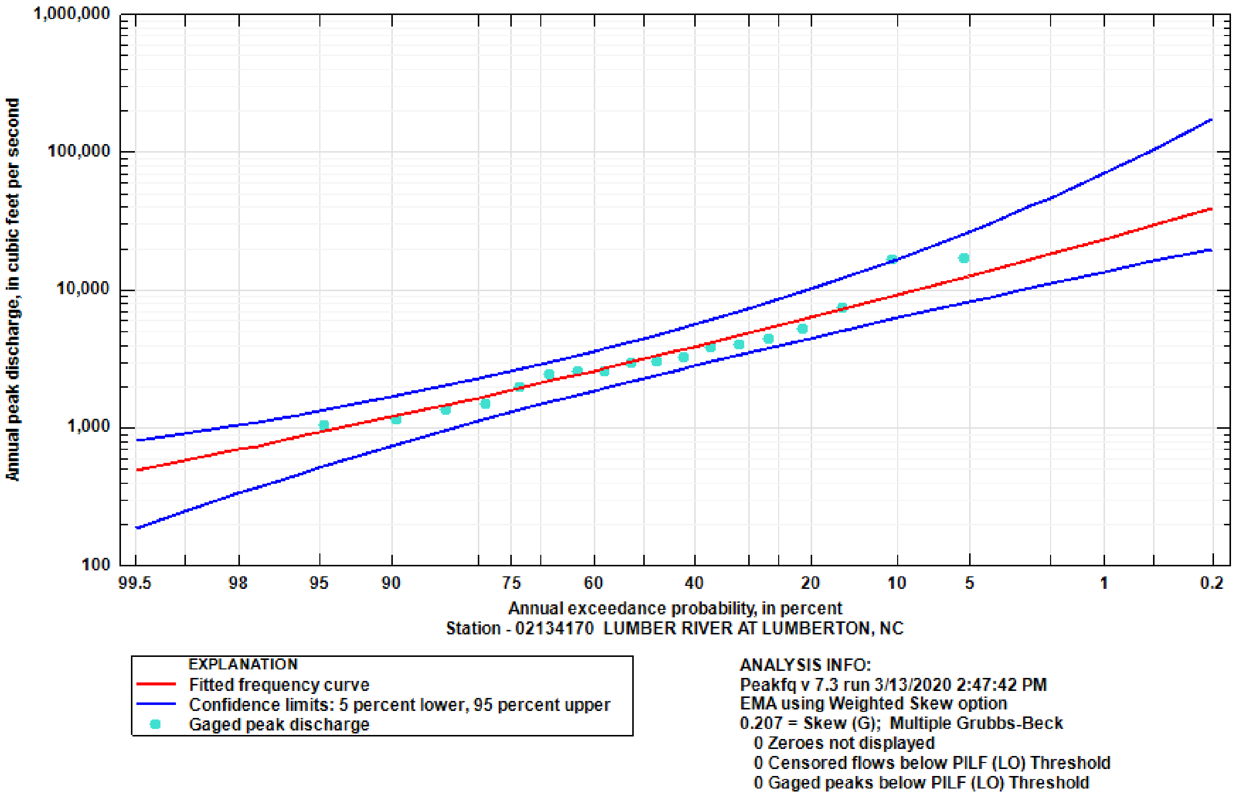


Figure 4-2. Discharge-Frequency curve for Lumberton gage with adjusted Hurricane Matthew peak flow rate.

4.2.2. Method 2

The maintenance of variance estimator (MOVE) method described in Bulletin #17C (USGS, 2019 b) was used to extend Gage 1 records. This method extends a shorter record series using a supplemental series while maintaining the variance of the extended series. The procedure of the MOVE adds observations (ne) to the original records (y). The values of the new observations have the information to transfer the mean and variance of the original records. The statistical analysis following this procedure resulted in a total of 38 records (n1+ne), compared to 18 in the original records (n1). A linear regression model was developed to estimate an additional 20 observations (ne). The 38 records were used as inputs for PeakFQ analysis (**Appendix E4.2**). **Table 4-2** and **Figure 4-3** below show the frequency analysis results.

Table 4-2. Calculated discharge per return period based on the extended Lumberton gage records (USGS 02134170).

Return Period (years)	Peak Flow (cfs)	Peak Flow 5% Lower Bound	Peak Flow 95% Upper Bound
1.25	2,080	1,736	2,442
2	3,305	2,821	3,898
5	5,419	4,547	6,734
10	7,109	5,826	9,393
25	9,588	7,561	14,000
50	11,700	8,923	18,580
100	14,040	10,330	24,370
200	16,640	11,800	31,680
500	20,530	13,820	44,300

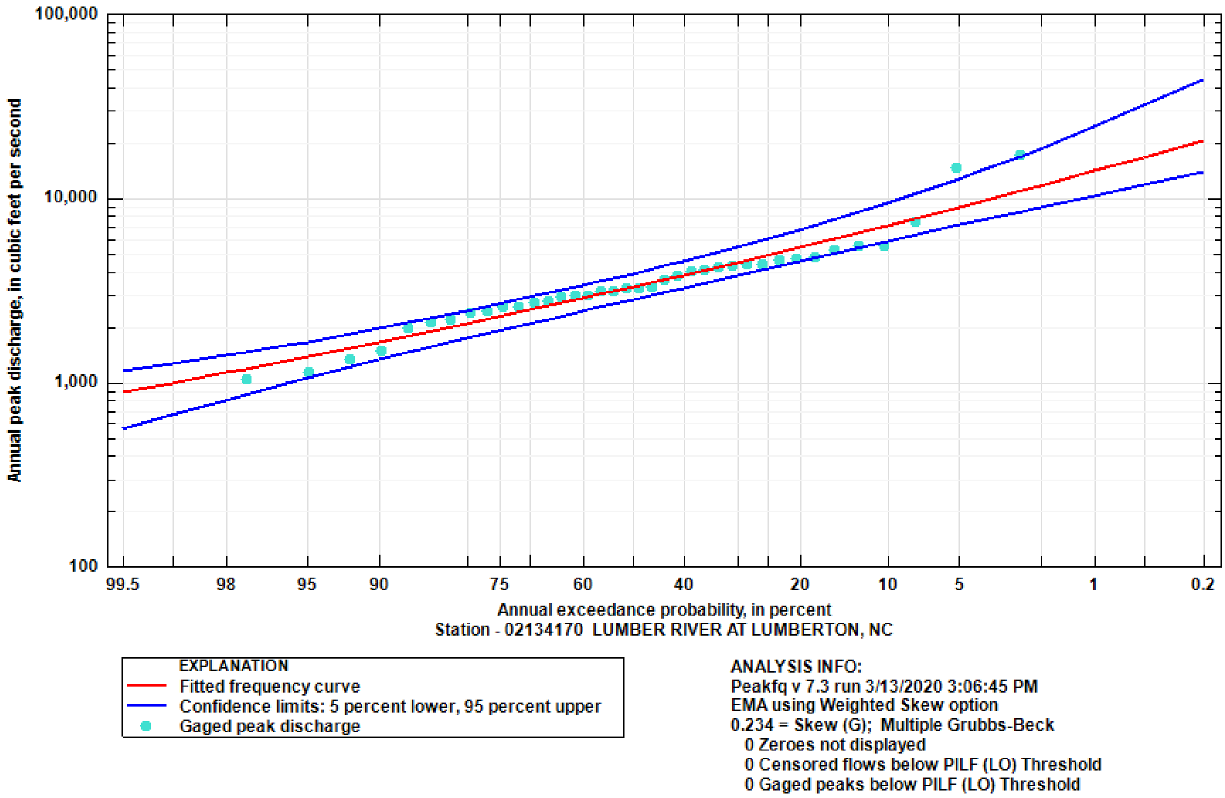


Figure 4-3. Discharge-Frequency curve for Lumberton gage with extended record.

The estimated return periods for Hurricane Matthew and Florence are approximately 120 and 235 years, respectively. The extended record calculations and the Log Pearson Type III analysis for this is included in **Appendix E4.1**.

When using the updated peak flow value of 16,600 cfs for Hurricane Matthew in the analysis, the return period for hurricane Matthew and Florence are approximately 170 and 190 years, respectively. The extended record calculations and the Log Pearson Type III analysis is included in **Appendix E4.1**. **Table 4-3** and **Figure 4-4** below show the results of the analysis using the adjusted flow for Hurricane Matthew.

Table 4-3. Calculated discharge per return period based on the extended Lumberton gage records (USGS 02134170) and altered Hurricane Matthew.

Return Period (years)	Peak Flow (cfs)	Peak Flow 5% Lower Bound	Peak Flow 95% Upper Bound
1.25	2,080	1,742	2,436
2	3,325	2,844	3,916
5	5,500	4,626	6,837
10	7,255	5,964	9,609
25	9,852	7,795	14,460
50	12,080	9,242	19,320
100	14,560	10,750	25,500
200	17,340	12,320	33,340
500	21,520	14,500	46,990

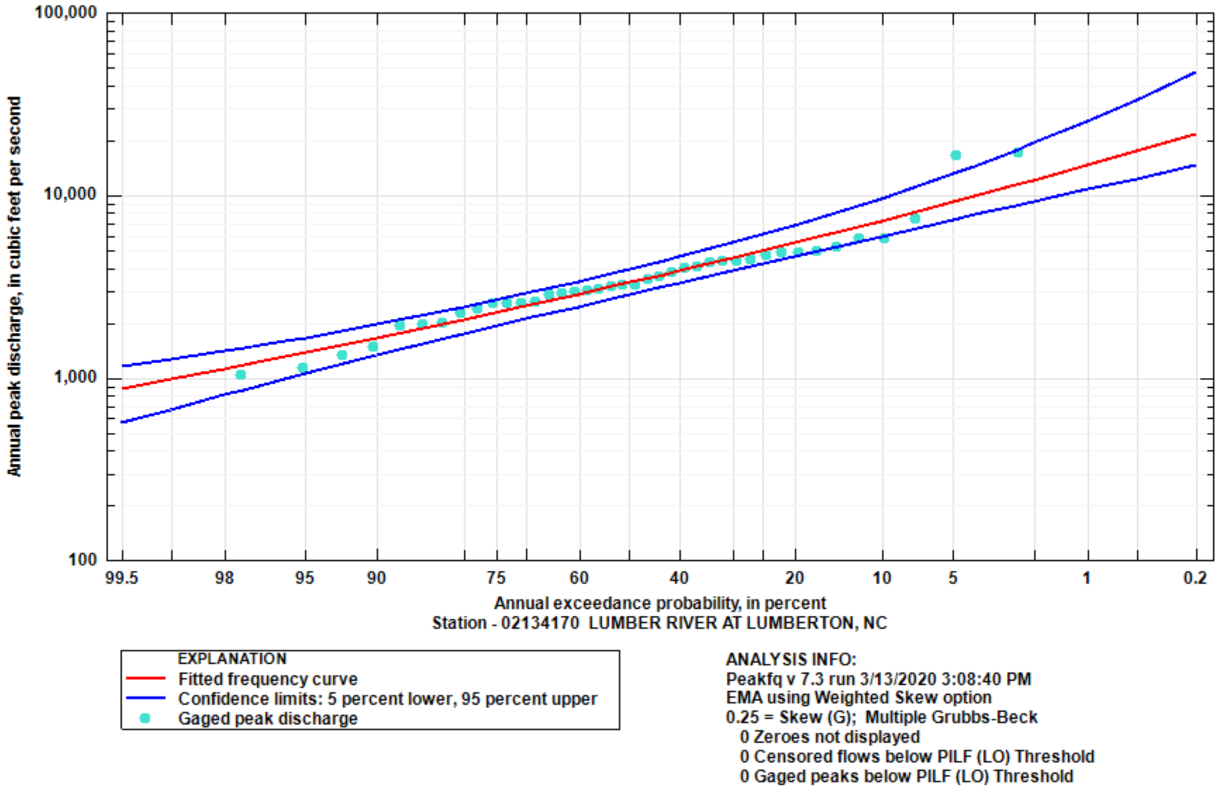


Figure 4-4. Discharge-Frequency curve for Lumberton gage (USGS 02134170) with extended record and altered Hurricane Matthew.

4.2.3. Gage Weighted Regression Estimates

Regional regression flow rate for each return period was calculated using USGS-developed regional regression equations for North Carolina (USGS, 2009). StreamStats was used to determine the basin percentage in each hydrologic region (1-5). A total of 45-percent of Lumber River basin is in Region 3 and 55-percent is in Region 4 (USGS, 2016). Based on the PeakFQ estimated gage peak flow at the Lumberton gage (USGS 02134170), regression estimated peak flow, and variance of prediction for each value, the gage weighted peak flow was estimated for the 2 – 500-year return periods (**Table 4-4**). The resulting return periods for Hurricanes Matthew and Florence remain the same as using only the gage estimates. The gage weighted regression calculation is included in **Appendix E4.3**.

Table 4-4. Regional regression weighted peak flow rate estimates for Methods 2 approaches.

Return Period (yrs)	Regression Peak Flow Rate (cfs)	Weighted Peak Flow Rate (cfs)	
		Method 2 – unaltered Matthew	Method 2 – altered Matthew
2	4,006	3,410	3,429
5	6,740	5,546	5,616
10	8,797	7,320	7,449
25	11,440	9,903	10,125
50	13,620	12,090	12,400
100	15,799	14,463	14,864
200	18,043	17,029	17,539
500	20,993	20,678	21,347

4.3. Recommended Design Flood Frequency

The results of the analysis indicate that there is a high amount of uncertainty regarding the return periods for floods produced by Hurricanes Matthew and Florence at Lumberton, NC. This is due to the limited gage records at that location. Updating the limited gage data at the USGS gage at Lumberton based on the longer record at the USGS gage in Boardman provides more realistic estimates of the return periods. Based on this approach, the return periods for the flood produced by both Hurricanes Matthew and Florence are about 170 and 190 years, respectively.

The minimum top of gate elevation must be the higher of the peak water surface elevation from Hurricane Florence at the gate location or the 100-year elevation at the gate plus 4.5 feet of freeboard. The return period of such a flood will be about 200-years or greater.

5. Hydrologic Model Development

5.1. General Methodology

The Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) version 4.2.1 software was used to model the Lumber River basin and develop outflow hydrographs for each sub-basin. HEC-HMS is a rainfall-runoff model developed by the U.S. Army Corps of Engineers (USACE, 2017) and is widely used for detailed rainfall-runoff modeling across the United States.

HEC-HMS has three main components: watershed physical description (basin model), meteorology description (meteorological model), and hydrologic simulation. For each basin and/or sub-basin a method can be selected for canopy, surface, loss, transform, and baseflow. The meteorological model represents the precipitation input needed by sub-basin elements in the basin model. Hydrologic simulation encompasses control specifications, which detail the simulation times (dates, times, time interval).

The watershed physical description process involved the addition of sub-basins, junctions at the end of each sub-basin, and reaches connecting the junctions. This allowed all sub-basins to be connected and set up how water will move through the model from upstream to downstream.

5.2. HEC-HMS Model Parameters

The modeling methods were selected from methods available in HEC-HMS Version 4.2.1. The hydrologic modeling methods selected were chosen based on the availability of data and ability to define modeling method parameters with this data. Predictive ability of the modeling method based on experience was also a factor. Based on these factors, the Snyder Unit Hydrograph method was selected and used to characterize the rainfall-runoff relationship of the sub-basins within the watershed. The Snyder Unit Hydrograph method allows for parameters to be compared across events and sub-basins so that the method can be transformed to ungagged sub-basins. The method is relatively simple yet detailed enough to provide an adequate unit runoff response for predicting large floods based on calibrated parameters.

For all the sub-basins, the loss method was set to 'Initial and Constant' and a transform method of 'Snyder Unit Hydrograph'. **Table 5-1** summarizes the watershed physical parameters required for the selected modeling methods. A summary of the equations and required parameters for each method are included in the HEC-HMS Technical Reference Manual (USACE, 2000). The initial loss was calculated using the Soil Conservation Service (SCS) runoff curve number method (USDA, 1986). Imperviousness was set to zero (0%) for all sub-basins as this was incorporated into the curve number and thus initial loss value. The remaining loss parameter is constant loss. The two parameters required for the transform method are the standard lag and peaking coefficient. The constant loss, lag time, and peaking coefficient are variables based on basin characteristics and thus were calibrated. Initial losses were also adjusted during calibration based on known antecedent soil conditions for each calibration and verification storm.

The hydrologic simulation control specifications were individually set for each simulation event based on the corresponding dates and times.

Rainfall and streamflow data were added as time series data. A precipitation gage was added for each basin for each simulated event. The number of precipitation gages added per event was based on the number of rainfall gages with available data and the associated weighted rainfall developed. The precipitation gages included values covering the full time period of the control specification with a one-hour interval. Discharge gages were added for each event at the calibration points within the model (USGS Gage 02133624 at Maxton and USGS Gage 02134170 at Lumberton). The discharge gages contained the discharge data for each storm as recorded at those gage locations. Discharge was added at a fifteen-minute interval.

Cross-section data was also added for each reach for use in flow routing.

Initial parameter approximations were estimated using Geographic Information System (GIS) data and applicable parameter ranges. Model parameters were refined through calibration and validated by comparing model results to historic flow measurements.

The calibrated and verified model was then used to simulate design flood hydrographs that were routed in a hydraulic model.

Table 5-1. HEC-HMS modeling methods and required parameters.

Modeling Method	Parameter	Description	Acceptable Values
Initial and Constant-Rate Loss Method	Initial Loss (in)	Initial loss parameter that accounts for the moisture condition in the watershed at the beginning of the simulation – loss from canopy interception, surface storage, and infiltration.	Based on curve number (CN)
	Constant Loss (in/hr)	Infiltration rate during saturated soil conditions.	0+
	Impervious Area (%)	Impervious area directly connected to the channel network (no losses are computed).	0% (for this study)
Snyder Synthetic Unit Hydrograph	Standard Lag (hr)	The time from the center of mass of excess rainfall to the hydrograph peak.	Based on Ct, which ranges from 0.4 to 8, and sub-basin lengths
	Peaking Coefficient (C_p)	Dimensionless parameter affecting hydrograph shape.	0.4 to 0.8

5.3. Sub-basin Delineation

Sub-basins were based on delineation of smaller channels/ tributaries within the Lumber River basin (**Figure 5-1**) using StreamStats, which uses coarser terrain (30 ft x 30 ft) (USGS, 2016). Delineation was done where each channel joins into Lumber River. Additionally, a sub-basin was delineated at the USGS gage in Maxton, NC to allow for hydrograph calibration at the location. The streamstats delineated sub-basins were verified using the QL2 LiDAR, which has a finer tile size of 10 ft x 10 ft and edits were made to the sub-basin boundaries as necessary. Fourteen (14) sub-basins were delineated. There are twelve (12) sub-basins for tributaries to the Lumber River and an additional two (2) sub-basins within the HEC-HMS model to account for the drainage area right along the channel, which was not accounted for in the other basins. The sub-basins are called: Back Swamp, Bear Swamp, Fivemile downstream, Fivemile upstream, Lumberton Canals, Ivey Branch, Jacks Branch, Jacob Branch, Jacob Swamp, Lumber downstream, Lumber upstream, Meadow Branch, Raft Swamp, and White Oak (**Figure 5-1** and **Figure 5-2**). StreamStats for each basin are provided in **Appendix E2.2**.

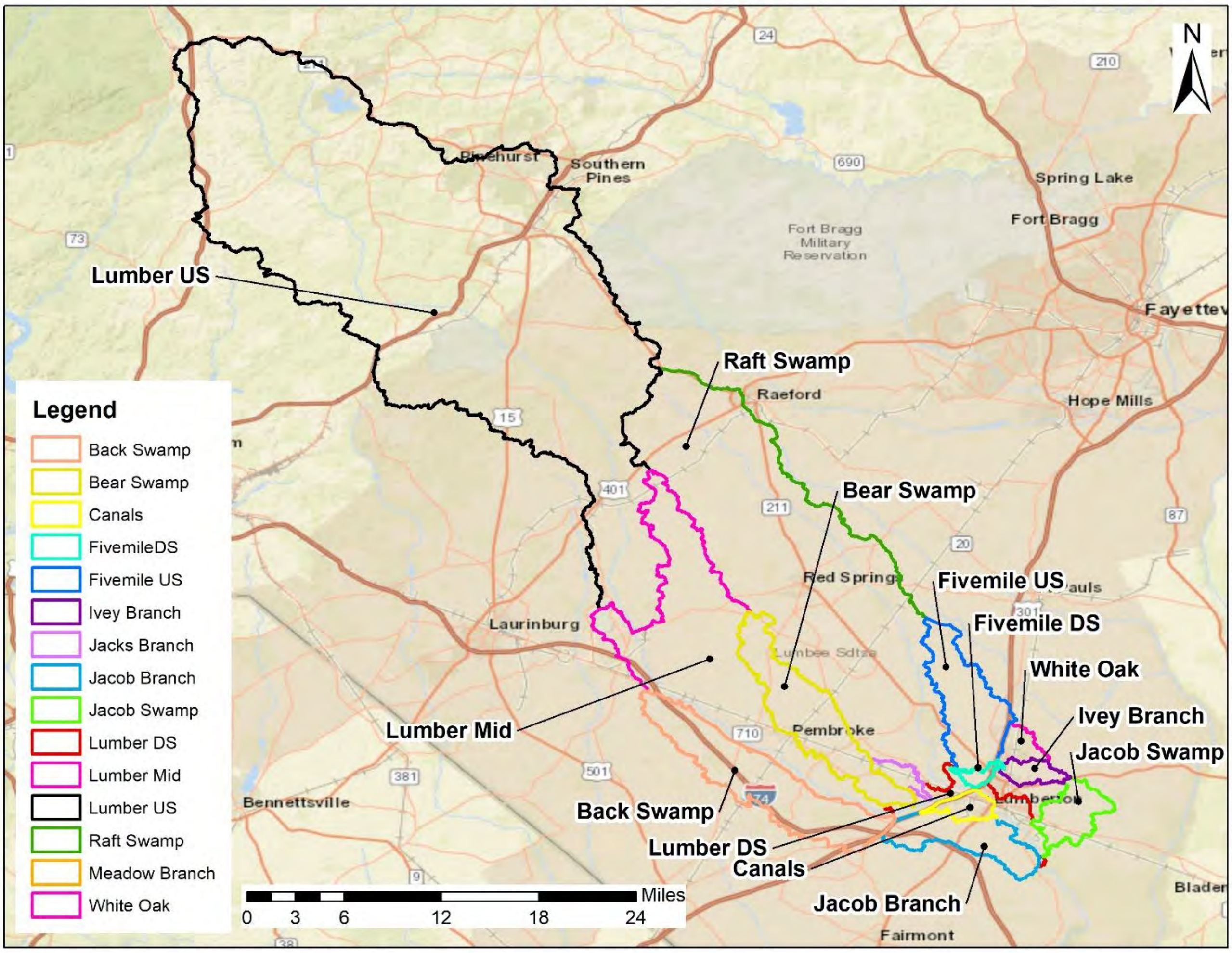


Figure 5-1. Lumber River sub-basin delineation.

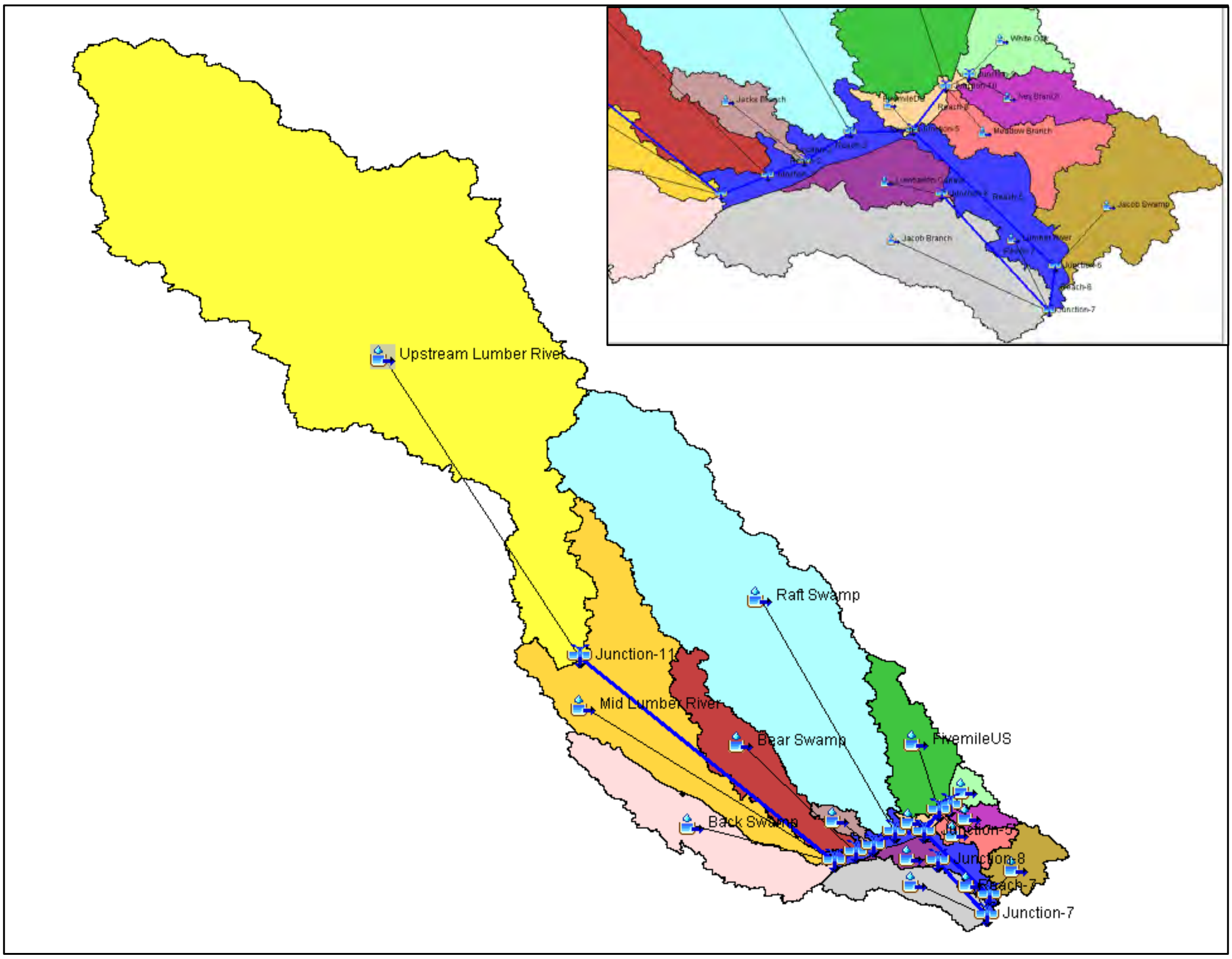


Figure 5-2. HEC-HMS sub-basins, reaches, and junctions.

5.4. Initial Parameter Estimation

Initial parameters were set constant across all sub-basins using: constant loss of 0.4 in/hr, basin coefficient (C_t) of 2.2, and peaking coefficient (C_p) of 0.4. The values were selected as they were the lower end for each parameter range. The starting initial loss estimates for the basins were estimated based on the sub-basin curve number, CN. The standard lag was calculated using the C_t and the previously calculated length of main channel (L, mi) and length of channel to centroid (L_c, mi). The initial loss, constant loss, C_t, and C_p were changed during the calibration process.

5.4.1. Curve Number and Initial Losses

5.4.1.1. Curve Number

The curve number for each sub-basin is a useful basin characteristic and is needed to calculate other parameters, such as the initial loss rate. To calculate a sub-basin curve number, the soil type and land cover is required.

A composite curve number was calculated for each sub-basin because each sub-basin had multiple soil types and land use classifications. Good condition curve numbers (USDA, 1986) were paired with the associated 2016 NLCD land cover classifications. ArcGIS was used to calculate the area of each land use classification associated with each soil type. The area of each land use per soil type was used to create a curve number for each soil type, and then those were used to calculate a composite curve number for each sub-basin (**Table 5-2**). Curve number calculation are provided in **Appendix B4**.

Table 5-2. Sub-basin composite curve numbers.

Sub-basin	Curve Number
Back Swamp	85.7
Bear Swamp	83.1
Fivemile DS	82.8
Fivemile US	81.7
Lumberton Canals	83.2
Ivey Branch	79.4
Jacks Branch	82.2
Jacob Branch	85.2
Jacob Swamp	79.9
Lumber DS	84.3
Lumber Mid	82.9
Lumber US	62.1
Meadow Branch	78.0
Raft Swamp	78.9
White Oak	79.6

5.4.1.2. Initial Losses

Based on the curve number, the initial loss was calculated using the SCS runoff method (USACE, 1986). The good condition curve number was used to calculate S (**Equation 5-1**), a value related to soil and cover conditions, which was then used to calculate the initial loss (I_a) (**Equation 5-2**) (**Table 5-3**). The initial loss for each sub-basin was input into the HEC-HMS model and was not altered during calibration.

$$S = \frac{1000}{CN} - 10 \qquad (5\text{-}1)$$

$$I_a = 0.2S \qquad (5\text{-}2)$$

Table 5-3. Calculated sub-basin initial losses.

Sub-basin	S	Ia (in)
Back Swamp	1.67	0.33
Bear Swamp	2.03	0.41
Fivemile DS	2.08	0.42
Fivemile US	2.24	0.45
Lumberton Canals	2.02	0.40
Ivey Branch	2.59	0.52
Jacks Branch	2.17	0.43
Jacob Branch	1.74	0.35
Jacob Swamp	2.52	0.50
Lumber DS	1.86	0.37
Lumber Mid	2.06	0.41
Lumber US	6.10	1.22
Meadow Branch	2.82	0.56
Raft Swamp	2.67	0.53
White Oak	2.56	0.51

5.4.2. Snyder Unit Hydrograph Parameters

As previously stated, Snyder unit hydrograph was selected for the transform method. The equation for lag is (**Equation 5-3**):

$$t_p = CC_t(LL_c)^{0.3} \quad (5\text{-}3)$$

Where t_p is the hydrograph lag (hr), C is a conversion factor (1 for foot-pound system), C_t is a basin coefficient, L is the length of the main channel (mi), and L_c is the length of the channel from the outlet to the nearest watershed centroid (mi).

GIS was used to calculate L and L_c. The flow path was drawn from the outlet of the sub-basin along the channel to the most remote point in the watershed. A centroid for each sub-basin was calculated in GIS (**Figure 5-3**). Based on the centroid, the length of channel to this point was measured. Values for L and L_c are available in **Appendix B3**.

The basin coefficient, C_t, is a dimensionless parameter that can range from 0.4 in the mountains to 8.0 along the coast. Since this is not a physically-based parameter it was determined via calibration.

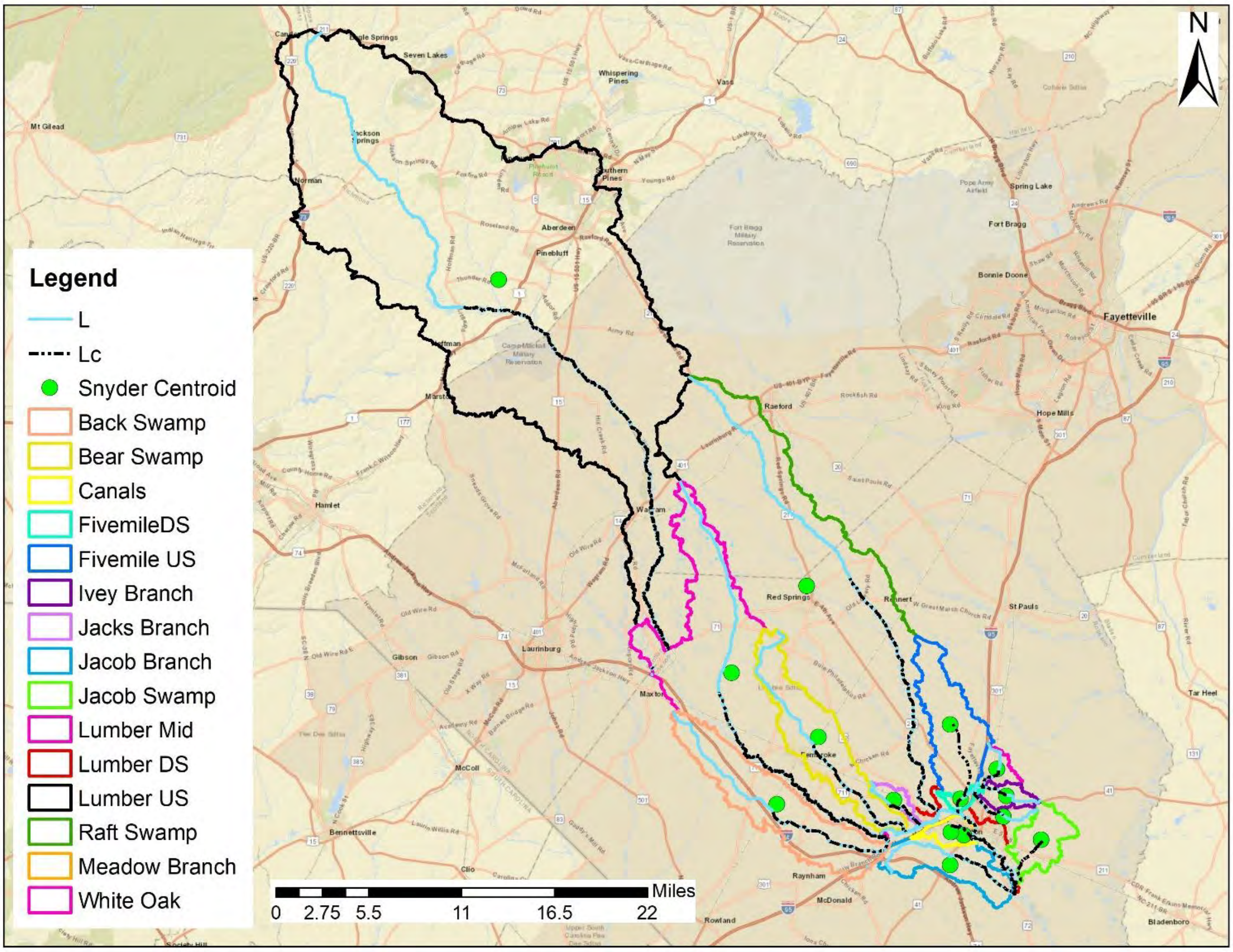


Figure 5-3. Centroid, channel length (L), and channel length to centroid (L_c) of each sub-basin for Snyder hydrograph development.

5.4.3. Reach Routing Parameters

Routing of sub-basin hydrographs within a watershed is necessary to capture the attenuation of flow while moving downstream through the channel and floodplain. In the hydrologic model this is performed using routing reaches. The Muskingum-Cunge hydrologic routing method was used for the main river reaches throughout the Lumber River watershed. This method was chosen based on the need for a routing method capable of properly calculating discharge through a routing reach for a wide range of flow conditions.

A representative 8-point cross-section was derived for each reach from representative 1-D HEC-RAS cross-sections from the FEMA effective model or LiDAR data and used to characterize the reach channel and floodplain. A location was selected that was reasonably characteristic of the reach of interest. This primarily relates to the typical channel and floodplain width under high flow conditions. The 8-point cross-sections are included in **Appendix B5**. The adopted routing parameters used for this study are listed in **Table 5-4**.

Table 5-4. Muskingum-Cunge routing parameters used for hydrologic modeling.

Reach	HMS Junctions	Length (ft)	Slope (ft/ft)	Channel N-Value	Left N-Value	Right N-Value	Cross-section
1	0 to 1	11284	0.0002	0.045	0.1	0.1	8-point
2	1 to 2	10922	0.0006	0.045	0.13	0.1	8-point
3	2 to 3	14490	0.0002	0.045	0.15	0.09	8-point
4	3 to 4	7220	0.0003	0.045	0.13	0.11	8-point
5	4 to 5	39679	0.0002	0.045	0.125	0.125	8-point
6	5 to 6	7849	0.0003	0.045	0.125	0.125	8-point
7	7 to 6	24525	0.0008	0.065	0.035	0.16	8-point
8	8 to 4	6644	0.0002	0.045	0.12	0.12	8-point
9	11 to 1	183005	0.0003	0.08	0.16	0.16	8-point

5.5. Model Calibration to Historic Events

Four events were selected based on peak discharge: September 2004, October 2015, October 2016 (Hurricane Matthew), and September 2018 (Hurricane Florence) (**Table 5-5**). A complete hydrograph (rising limb, peak, and falling limb) was needed for analysis to allow for calibration to the storm peak and full storm volume. Of these, three calibration events were selected: September 2004, October 2015, and September 2018. The 2004 and 2015 events were peak water-year gage events, with peaks of 7,420 and 2,390 respectively. The 2018 event corresponds to Hurricane Florence, which is one of the largest rainfall events to hit the state of North Carolina. The peak flow at the USGS Lumberton gage set a peak record at 17,100 cfs. Hydrographs of the selected events for both gages are provided in **Appendix B2**.

Table 5-5. Peak streamflow reported at USGS gages in Lumberton and Maxton for each study event.

Event	USGS Gage 02134170 at Lumberton, NC		USGS Gage 02133624 at Maxton, NC	
	Peak Streamflow (cfs)	Time of Peak	Peak Streamflow (cfs)	Time of Peak
Sept 2004	7,420	9/11/2004 2:00	2,280	9/11/2004 8:00
Oct 2015	2,390	10/9/2015 15:45	2,460	10/6/2015 12:15
Oct 2016	14,600	10/10/2016 7:00	6,790	10/11/2016 6:45
Sept 2018	17,100	9/17/2018 11:00	12,300	9/19/2018 4:00

The points of comparing simulated and observed peak flow rate, volume, and time of peak are at a junction along Lumber River where the USGS gage in Lumberton is located and at the location of the USGS gage in Maxton. During calibration trials the peak simulated flow rate, hydrograph shape, and time of peak flowrate were compared to what was observed at the USGS gages from the respective storm event.

Calibration of the model to the observed values at the USGS gage in Lumberton was prioritized over the observed values at the USGS gage in Maxton due to the proximities of the two gage locations to the location of the proposed gate.

Hurricane Florence was the first event to be calibrated due to its magnitude. The calibration parameters were changed for each of the sub-basins, relative to basin characteristics, until the peak flow rate, volume, and time to peak were as close to that of the observed as the model could achieve (**Figure 5-4**). The first set of calibrated constant loss, C_t, and C_p values were applied to the other two calibration events for an initial baseline and adjusted iteratively until the simulated hydrographs matched reasonably well with the observed hydrographs for those storms. Results for each calibration are shown in **Tables 5-6, 5-7, and 5-8**. The calibrated parameters were able to accurately model the peak flow rate and time of peak for all the storms. Except for the October 2015 storm, the calibrated parameters were also able to accurately model the hydrograph shapes and volumes for the storms. The October 2015 storm is the smallest of the three storms, with a return period of less than 2 years. Since the design storms are more like the other two storms in terms of magnitude, additional iterations of the calibration parameters to get a better match for the volume for that storm was not necessary.

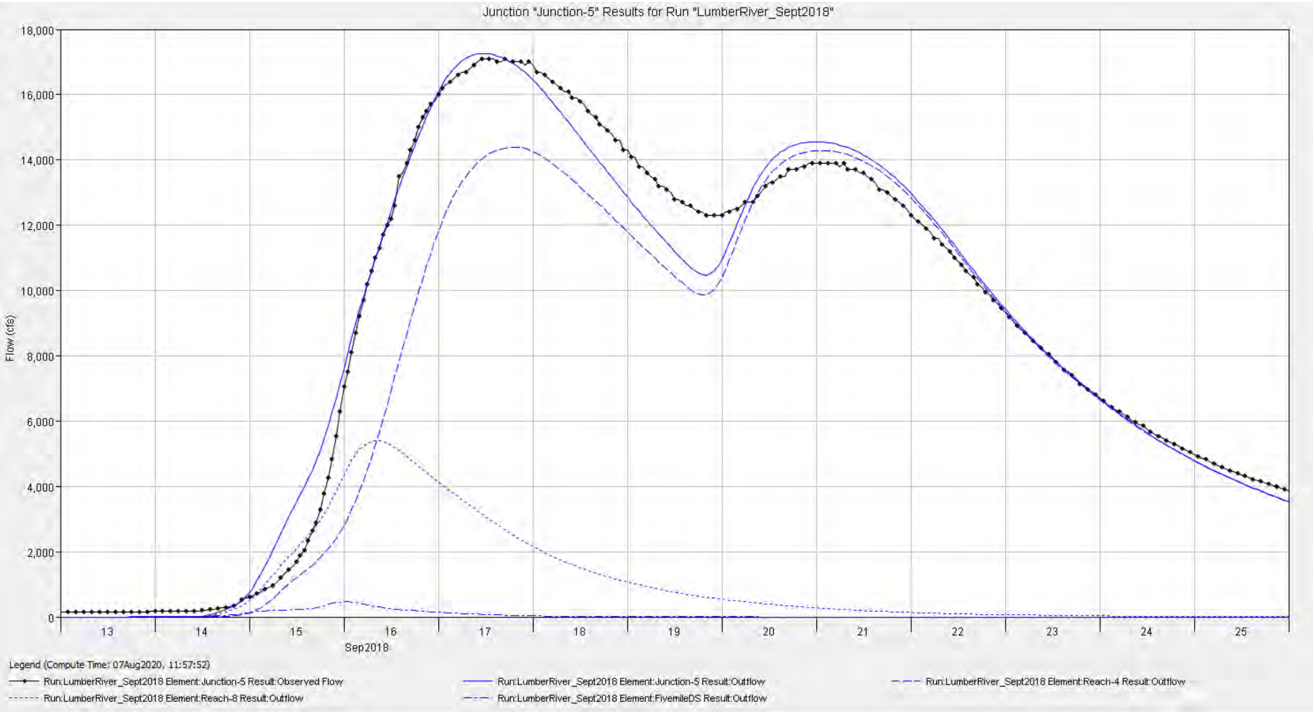


Figure 5-4. Comparison of observed gage flow (black) and simulated flow (solid blue) for the September 2018 (Hurricane Florence) calibrated event.

Table 5-6. Peak flow comparison between observed and simulated calibrated events.

Storm	Peak Flow rate (cfs)		
	Observed	Simulated	% Difference
At Lumberton Gage (USGS 02134170)			
Sept 2004	7,420	7,097	-4%
Oct 2015	2,390	2,421	1%
Sept 2018	17,100	17,257	1%
At Maxton Gage (USGS 02133624)			
Sept 2004	2,280	3,439	51%
Oct 2015	2,460	2,330	-5%
Sept 2018	12,300	8,281	-33%

Table 5-7. Time of peak comparison between observed and simulated calibrated events.

Storm	Time Date and Time		
	Observed	Simulated	Difference (hrs)
At Lumberton Gage (USGS 02134170)			
Sept 2004	9/11/2004 0:30	9/11/2004 12:00	10
Oct 2015	10/9/2015 15:45	10/9/2015 12:00	-3.75
Sept 2018	9/17/2018 11:00	9/17/2018 11:00	0
At Maxton Gage (USGS 02133624)			
Sept 2004	9/11/2004 8:00	9/11/2004 6:00	-2
Oct 2015	10/6/2015 14:00	10/6/2015 11:00	-3
Sept 2018	9/19/2018 4:00	9/19/2018 11:00	7

Table 5-8. Volume comparison between observed (USGS 02134170 at Lumberton) and simulated calibrated events.

Storm	Volume (ac-ft)		
	Observed	Simulated	% Difference
At Lumberton Gage (USGS 02134170)			
Sept 2004	152,897	149,569	-2%
Oct 2015	38,912	27,568	-29%
Sept 2018	230,179	229,185	-0.4%
At Maxton Gage (USGS 02133624)			
Sept 2004	59,436	39,728	-33%
Oct 2015	29,054	21,498	-26%
Sept 2018	79,108	59,424	-25%

The calibrated parameters for each of the three calibration storms were averaged to obtain the calibrated parameters for the sub-basins. The calibrated parameters are shown in **Table 5-9**.

Table 5-9. Average calibrated HEC-HMS parameters.

Sub-basin	Constant Loss (in/hr)	Initial Loss (in)	C_t	Lag Time based on Ct (hr)	C_p
Back Swamp	0.14	0.36	7	31.3	0.40
Bear Swamp	0.14	0.41	7	31.8	0.40
Fivemile DS	0.05	0.44	7	9.1	0.40
Fivemile US	0.05	0.42	7	23.7	0.40
Lumberton Canals	0.05	0.43	7	13.9	0.40
Ivey Branch	0.05	0.58	7	12.6	0.40
Jacks Branch	0.05	0.39	7	21.1	0.40
Jacob Branch	0.05	0.34	7	22.4	0.40
Jacob Swamp	0.05	0.52	7	18.2	0.40
Lumber DS	0.05	0.37	7	33.0	0.40
Lumber Mid	0.14	0.43	8	62.7	0.40
Lumber US	0.14	5	7	76.0	0.73
Meadow Branch	0.05	0.68	7	15.2	0.40
Raft Swamp	0.19	0.46	8	56.2	0.40
White Oak	0.05	0.5	7	12.3	0.40

It is noted that the calibrated initial loss for the Lumber US sub-basin is higher than normal. This will likely lead to underestimation of more frequent storm events. The calibrated parameters noted in Table 5-9 are appropriate for storms with recurrence intervals similar to that of the design storm for the flood gate project (100yr or greater). A spreadsheet with the simulated results and calibrated parameters is provided in **Appendix E2.3**.

5.6. Model Validation to Historic Events

Following calibration, the average parameters were applied to a verification event. Hurricane Matthew, October 2016, was selected as the verification event. As previously discussed, Matthew was another large hurricane to hit North Carolina, setting many rainfall and streamflow records prior to Florence. Verification using the average parameters overpredicted the peak flow rate but matched the time of peak (**Tables 5-10, 5-11, and 5-12)**. Graphical inspection of the observed and simulated hydrographs also indicates a good match of the rising and falling limbs (**Figure 5-5**). As discussed in **Section 4.2**, the recorded peak flow at the USGS gage of 14,600 cfs during Hurricane Matthew did not account for the diverted flow through the I-95 opening. Thus, this verification, while higher, is an accurate representation of the peak flows in the area.

Table 5-10. Peak flow comparison between observed and simulated for a verification event.

Storm	Peak Flow rate (cfs)		
	Observed	Simulated	% Difference
At Lumberton Gage (USGS 02134170)			
Oct 2016	14,600	16,550	13%
At Maxton Gage (USGS 02133624)			
Oct 2016	6,750	3,277	-51%

Table 5-11. Time of peak flow comparison between observed and simulated for a verification event.

Storm	Time Date and Time		
	Observed	Simulated	Difference (hrs)
At Lumberton Gage (USGS 02134170)			
Oct 2016	10/10/2016 7:00	10/10/2016 10:00	3
At Maxton Gage (USGS 02133624)			
Oct 2016	10/11/2016 8:00	10/11/2016 14:00	6

Table 5-12. Volume comparison between observed and simulated for a verification event.

Storm	Volume (acre-ft)		
	Observed	Simulated	% Difference
At Lumberton Gage (USGS 02134170)			
Oct 2016	223,956	197,598	-12%
At Maxton Gage (USGS 02133624)			
Oct 2016	82,111	27,026	-67%

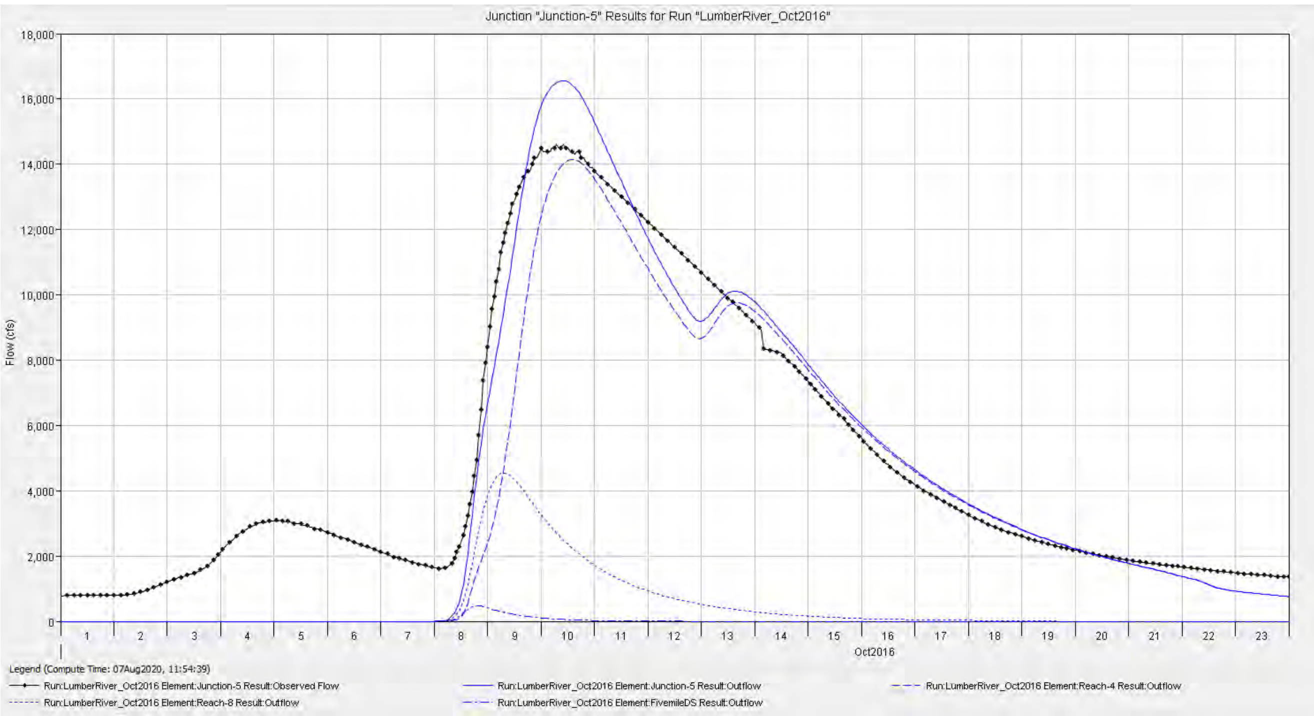


Figure 5-5. Comparison of observed gage flow (black) and simulated flow (solid blue) for the October 2016 (Hurricane Matthew) verification event.

5.7. Design Flood Simulations

Using the calibrated and verified parameters, floods from a 100-year through the Probable Maximum Flood (PMF) were simulated in HEC-HMS. The 100-year through 1,000-year flows were generated using the procedure described in Section 5.7.1. The Probable Maximum Precipitation (PMP) and resulting PMF values were estimated using the procedure described in Section 5.7.2

5.7.1. 100-Year through 1,000-Year Flows

Analysis of the durations of previous rainfall events within the Lumber Basin ranged from 24 to 72 hours, with most of the major events having a duration of 48-hours. Thus, a 48-hour rainfall event was selected as the design flood duration for the 100-year to 1000-year return period events. Based on the location, an SCS Type II rainfall distribution (NRCS, 2019) was used. A spreadsheet with the distribution was downloaded from the NRCS website (NRCS, 2019). The spreadsheet provides the distribution for the peak 24-hour period which is assumed to occur during the first 24-hour period for any duration storm. Based on our sensitivity analysis, this assumption provided more conservative peak flow estimates compared to other placements of the peak 24-hour period. For the 48-hour duration storm, the difference between the total 24-hour and 48-hour total rainfall depths is distributed evenly on the second day. For the 72-hour storm, the difference between the total 24-hour and 72-hour total rainfall depths is distributed evenly on the second and third days. Electronic files of the sensitivity analysis are included in **Appendix E2.7**. NOAA Atlas 14 was used to find the rainfall totals associated with 100-year to 1000-year return periods, assuming a 48-hour event.

5.7.2. PMP and PMF Estimation

The PMP values for the Lumberton flood gate dam were estimated using the Hydrologic Engineering Center's HEC-MetVue (version 3.0) and HEC-HMS (version 4.8) software packages (**Appendix E5**). The HEC-MetVue software has HMR52 plugin extension that allows the modeler to use NOAA's Hydrometeorological Reports HMR 51 and 52 (HMR 51/52) to estimate the storm characteristics and generate PMP hyetographs. The initial storm parameters obtained from the HEC-MetVue model were optimized to maximize peak flow at the watershed outlet. The parameters were optimized using the HMR 52 precipitation method in the HEC-HMS meteorologic model. The calibrated HEC-HMS model described in the above sections was used for the optimization run. This calibrated model required an upgrade from version 4.2.1 to version 4.8 to perform the optimization run. The initial and optimized storm parameters are summarized below in **Table 5-13** and the positions of the storms based on the initial and optimized parameters are shown in **Figure 5-6** and **Figure 5-7**, respectively.

The optimized storm parameters were used in the HEC-MetVue model (**Appendix E5**) to generate the average PMP depths and hyetographs. The resulting 72-hour PMP depths and volumes for the sub-basins are summarized below in **Table 5-14**. The hyetographs from HEC-MetVue were then saved to a DSS file and linked to the calibrated HEC-HMS (version 4.2.1) model to estimate the Probable Maximum Flood (PMF).

Discharge ratio factors of 0.25, 0.5, 0.67, and 0.75 were applied to the subbasins in the HEC-HMS simulation run to generate the ¼ PMF. 1/3 PMF, ½ PMF, 2/3 PMF, and ¾ PMF, respectively (**Appendix E5**).

Table 5-13. Initial and optimized parameters for the HEC-METVue model.

HMR 52 Storm Characteristics	HEC-MetVue (Initial Parameters)	HEC-HMS (Optimized Parameters)
X Coordinate	-79.33	-79.413
Y Coordinate	34.93	34.995
Orientation (deg.)	145.63	141.51
Peak Intensity	Hours 36 to 42	Hours 36 to 42
Area (sq. mi.)	984.04	982.84

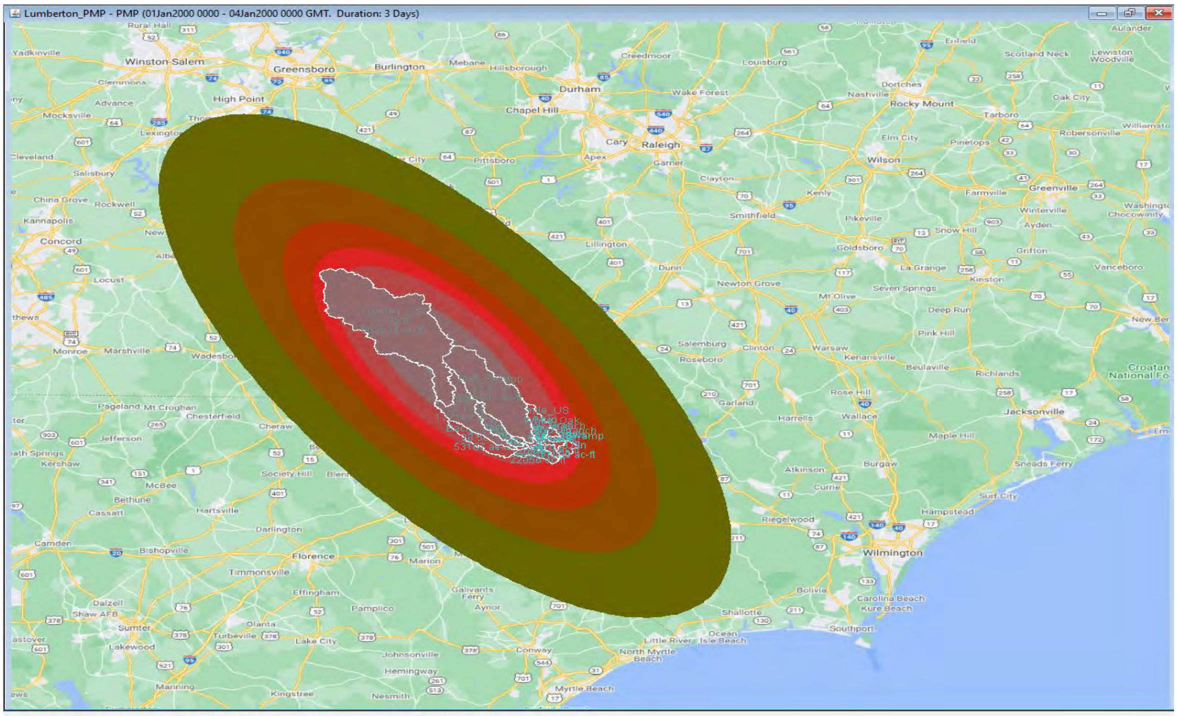


Figure 5-6. HMR 52 storm position with HEC-MetVue (initial) parameters

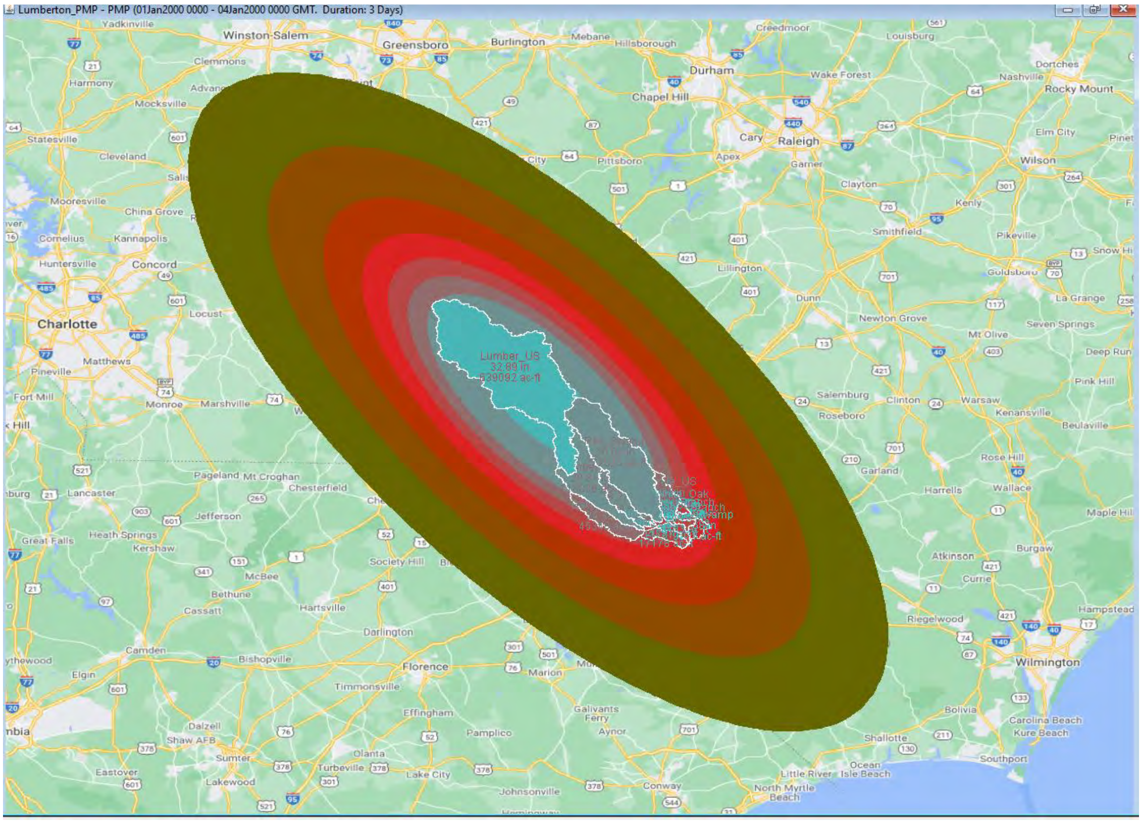


Figure 5-7. HMR 52 storm position with HEC-HMS (optimized) parameters.

Table 5-14. Average PMP depths from optimized HMR 52 storm parameters.

Name	Average Depth (in)	Volume (ac-ft)
Back Swamp	24.38	45340
Bear Swamp	28.27	42664
Fivemile DS	23.17	2092
Fivemile US	25.33	29744
Ivey Branch	20.97	4214
Jacks Branch	25.55	4100
Jacob Branch	20.91	17178
Jacob Swamp	18.68	9531
Lumber DS	21.79	11787
Lumber Mid	29.81	118036
Lumber US	32.89	639092
Lumberton Canals	22.3	4616
Meadow Branch	20.73	5483
Raft Swamp	30.63	272525
White Oak	21.8	4322
Watershed	**30.4**	**1210726**

5.7.3. Results

The total rainfall depths ranged from 10.2 inches (100-yr) to 14.9 inches (1,000-yr) (**Table 5-15**). The total rainfall for watershed for the full PMP storm event is 30.4 inches. The design flood hydrographs are provided in **Appendix E2.2**. Rainfall distributions are provided in **Appendix E2.4**.

Table 5-15. Design Rainfall Depths.

Recurrence Interval (Yrs)	Rainfall Duration		
	24 Hours	48 Hours	72 Hours
100	8.99	10.20	10.60
500	11.90	13.30	13.70
1,000	13.30	14.90	15.20
Full PMP (Watershed Average)			30.4

The developed rainfall distribution was added to the HEC-HMS model as a cumulative precipitation gage for each event (**Appendix E2.4**). The simulated peak flow rates, FEMA peak flow rates (FEMA, 2014) and gage statistics (**Section 4.2**), at the location of the USGS gage in Lumberton are shown in **Table 5-16**. Simulated peak flow rates were lower than both those from FEMA and the gage statistics. The FEMA peak flow estimates are based on regression equations which are regionally based and not specific to the Lumber River Basin. The simulated results are from a calibrated and verified model for the basin and hence provide a more reliable estimate of both the peak flow and streamflow hydrograph for the basin.

Table 5-16. Peak flow comparison between simulated HEC-HMS, FEMA reports, and gage statistics.

Recurrence Interval (Yrs)	Simulated Peak Flow (cfs)	FEMA Peak Flow (cfs)	Gage Statistics Flow (cfs)	% Difference FEMA	% Difference Gage
100	13,140	14,900	14,000	-13%	-11%
500	22,110	20,200	20,530	9%	3%
1,000	26,990	-	-	-	-
1/4 PMF	17,370	-	-	-	-
1/3 PMF	23,590	-	-	-	-
1/2 PMF	36,210	-	-	-	-
2/3 PMF	48,990	-	-	-	-
3/4 PMF	55,450	-	-	-	-
Full PMF	74,960	-	-	-	-

Additionally, partial duration rainfall distributions were created based on the NOAA Atlas 14 precipitation-frequency data for each return period and simulated in HEC-HMS. The partial duration rainfall distribution is an updated distribution compared to the SCS distribution (NRCS, 2019). The spreadsheet to develop the rainfall temporal distribution was also downloaded from the NRCS website (NRCS, 2019). However, this distribution produced lower stream flows than that of the SCS method and thus were not utilized for the hydraulic analysis. A comparison of the 48-hour duration peak flows from the SCS and partial duration distribution methods are shown in **Table 5-17**. Partial distributions are provided in **Appendix E2.4**. The HEC-HMS model is included the electronic **Appendix E2.1.**

Table 5-17. Comparison of Peakflows from SCS and Partial Duration Rainfall Distributions.

Recurrence Interval (Yrs)	SCS Type II Peak Flow (cfs)	Partial Duration Peak Flow (cfs)
100	13,140	10,670
500	22,110	19,330
1,000	26,990	23,980

6. Hydraulic Model Development

A detailed two-dimensional model of the City of Lumberton, Lumber River, and its tributaries in the vicinity of the city was developed to help determine design flood elevations for the proposed gate. The model was developed using version 6.0 of the USACE HEC-RAS model (USACE, 2021). This section summarizes data used, assumptions and results of the hydraulic modeling effort.

6.1. Model Development

The two-dimensional (2D) domain was selected to include all areas of flood concern within the extents of Lumber River. The domain extends along each river that confluences with Lumber River: Raft Swamp, Back Swamp, Bear Swamp, White Oak Branch, Meadow Branch, Jacob Swamp, Ivey Branch, Jack's Branch and Fivemile Branch. It also extends in the Northeast region to include North Lumberton so that project impacts related to flooding levels can be assessed at those locations. Except for inflow and outflow boundary locations, the model boundary was placed at relatively high ground so that flooding is fully contained within the computational mesh. The locations of the boundary conditions were placed far enough from the location of the proposed gate so that boundary condition impacts would be negligible. The location and geometry of the flood gate within the model is based on the proposed layout of the flood gate. The model domain is shown in **Figure 6-1** (see **Section 6.1.2**).

6.1.1. Manning's N Coefficients

Base model Manning's n coefficients were based on land use classes selected from **Table 6-1**. Values were based on the "normal" column. A GIS shapefile of Lumber River and Fivemile Branch was used to override the land use of Lumber River and Fivemile Branch. The channel segment was assigned a base Manning's n coefficient of 0.045. The initial roughness coefficients were modified during the model calibration phase. The calibrated roughness values and the procedure followed are documented in **Section 6.2.5**.

Table 6-1. Manning's n coefficient ranges per land cover type.

	NLCD Classification	Manning's Roughness			Source
		Minimum	Normal	Maximum	
11	Open Water	0.025	0.03	0.033	Chow, 1959
21	Developed, Open Space	0.01	0.013	0.016	Calenda et al., 2005
22	Developed, Low Intensity	0.038	0.05	0.063	Calenda et al., 2005
23	Developed, Medium Intensity	0.056	0.075	0.094	Calenda et al., 2005
24	Developed, High Intensity	0.075	0.1	0.125	Calenda et al., 2005
31	Barren Land	0.025	0.03	0.035	Chow, 1959
41	Deciduous Forest	0.1	0.12	0.16	Chow, 1959
42	Evergreen Forest	0.1	0.12	0.16	Chow, 1959
43	Mixed Forest	0.1	0.12	0.16	Chow, 1959
52	Scrub/Shrub	0.035	0.05	0.07	Chow, 1959
71	Grassland Herbaceous	0.025	0.03	0.035	Chow, 1959
81	Pasture/Hay	0.03	0.04	0.05	Chow, 1959
82	Cultivated Crops	0.025	0.035	0.045	Chow, 1959
90	Woody Wetlands	0.08	0.1	0.15	Chow, 1959
95	Emergent Herbaceous Wetland	0.075	0.1	0.15	Chow, 1959
	Channel	0.035	0.045	0.05	Chow, 1959

6.1.2. Mesh Development

The 2D model domain for the hydraulic analysis is shown in **Figure 6-1.** The mesh utilized refinement regions, 2D connections, and breaklines to accurately capture focal points and variations within the terrain. **Figure 6-1-A(1)** shows the extent of the 2D domain with breaklines and 2D Connections. **Figure 6-1-A(2)** is an example of one of the refinement regions utilized in the mesh. This one is located at the gate. **Figure 6-1-A(3)** is a zoomed in example of how breaklines were applied and enforced. This breakline is representing the centerline of Lumber River.

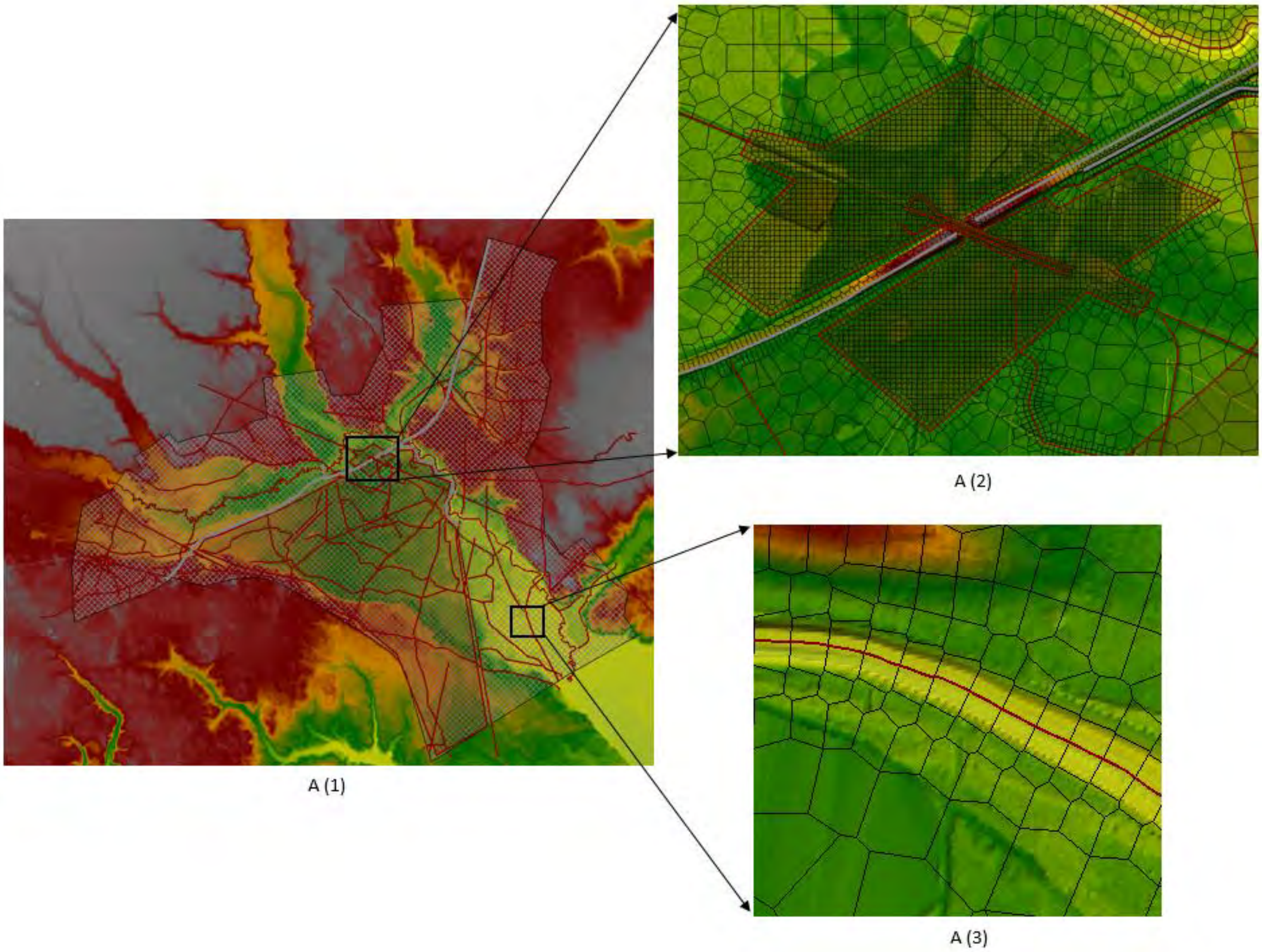


Figure 6-1. Lumber River 2D external model domain.

A mesh resolution of 250-feet was applied to the 2D flow area. Refinement regions were used to represent areas of higher urbanization, Lumber River, and the flood gate location. A resolution of 100-ft was applied for urban areas and Lumber River, while a resolution of 50-feet was used for the flood gate location.

A breakline was enforced with 100-foot spacing along the Lumber River stream centerline to capture the lowest points in the terrain and account for total storage capacity. Breaklines were drawn and enforced with 50-foot spacing along all additional channels within the domain. Breaklines were then drawn along points of higher elevation representing roads, railroads, or berms. These were enforced with a spacing that varied between 50 and 100-feet. Within the flood gate opening, breaklines were also drawn with a spacing of 25-feet to properly align the grid representing the railroad.

6.1.3. Lumberton Levee System

The Lumberton levee was included as a 2D connection with top of levee elevations taken from AECOM Project No. 60548447, Lumberton Flood Mitigation Report. Provided surveyed top of levee elevations were within a few inches of the top of levee elevations in the terrain. See **Appendix C2** for detailed comparison. For levee segments that were not surveyed, LiDAR elevations were utilized. Levee grid size was enforced as 20x20-feet to define the top width.

Gravity drains were not modeled. Gravity drains are pipes within the levee embankments that drain rainfall trapped on the landward side of the levee system through the levee embankment. The gravity drains have gates on the pipe outlet to restrict river backwater from backing up in the pipe during periods of high river flows. The gravity drains therefore do not serve any hydraulic purpose when modelling flows in the Lumber River.

6.1.4. Hydraulic Structures

HEC-RAS v6.0 provides the capability to model bridges within a 2D model. This version was utilized to model all the hydraulic structures within the modeled domain as either culverts or bridges. The normal 2D equation was selected as the overflow computation method as it is computationally more stable compared to the weir equation option. A full list of structures within the hydraulic model and their areas are included in **Appendices C1 and E3.3**.

Bridges along Lumber River were modeled using bridge geometry data from the effective model. **Figure 6-2** below shows an example of a bridge that was modeled.

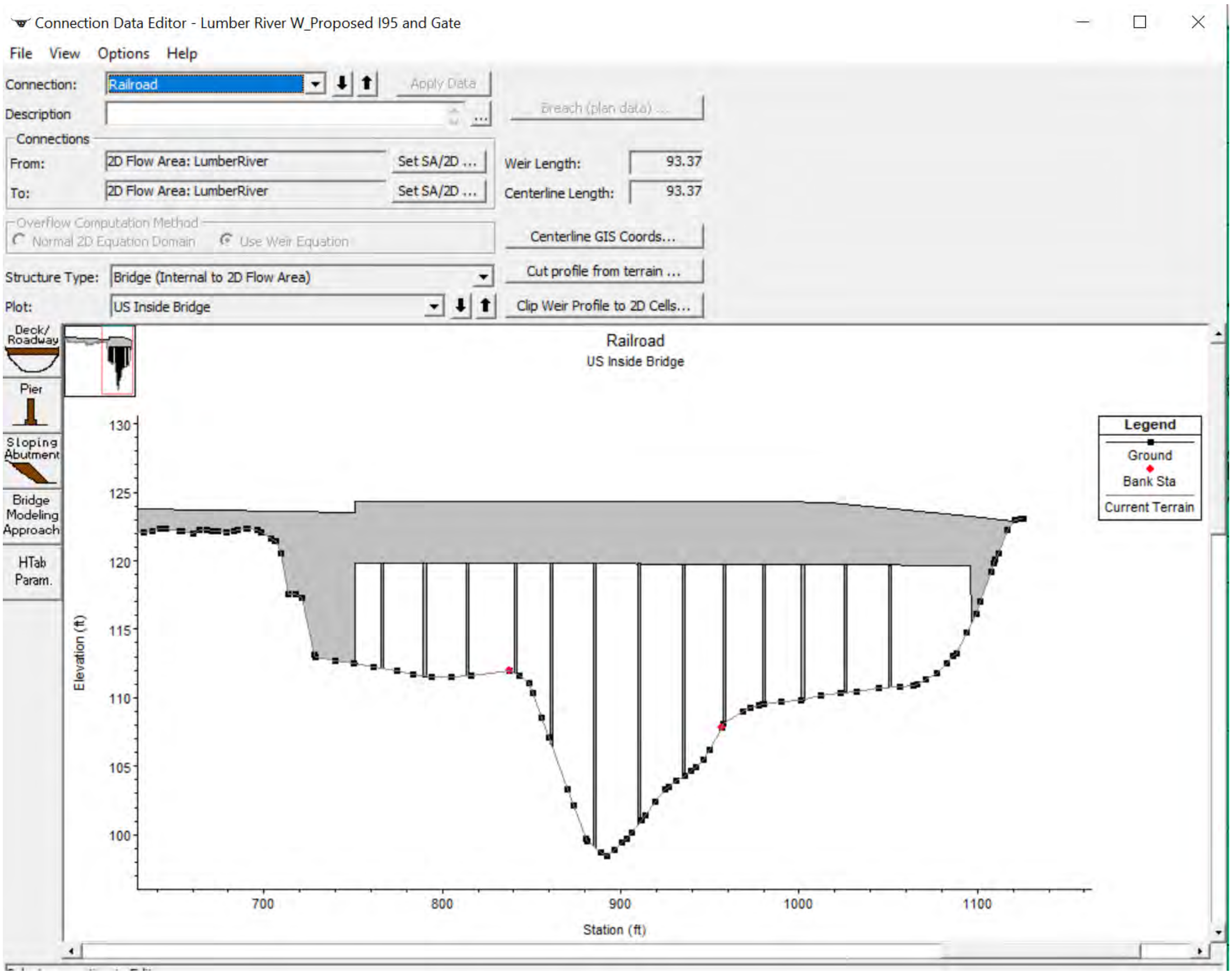


Figure 6-2. Bridge example.

Large culverts on Fivemile Branch were modeled as 2D connections with a rectangular notch when possible. However, for the culverts on I-95, the structure length was too long to be considered for a notch, so they were modeled as culverts. For these structures, roadway and deck elevations were taken from LiDAR. See **Figure 6-3** for an example of a long culvert on I-95.

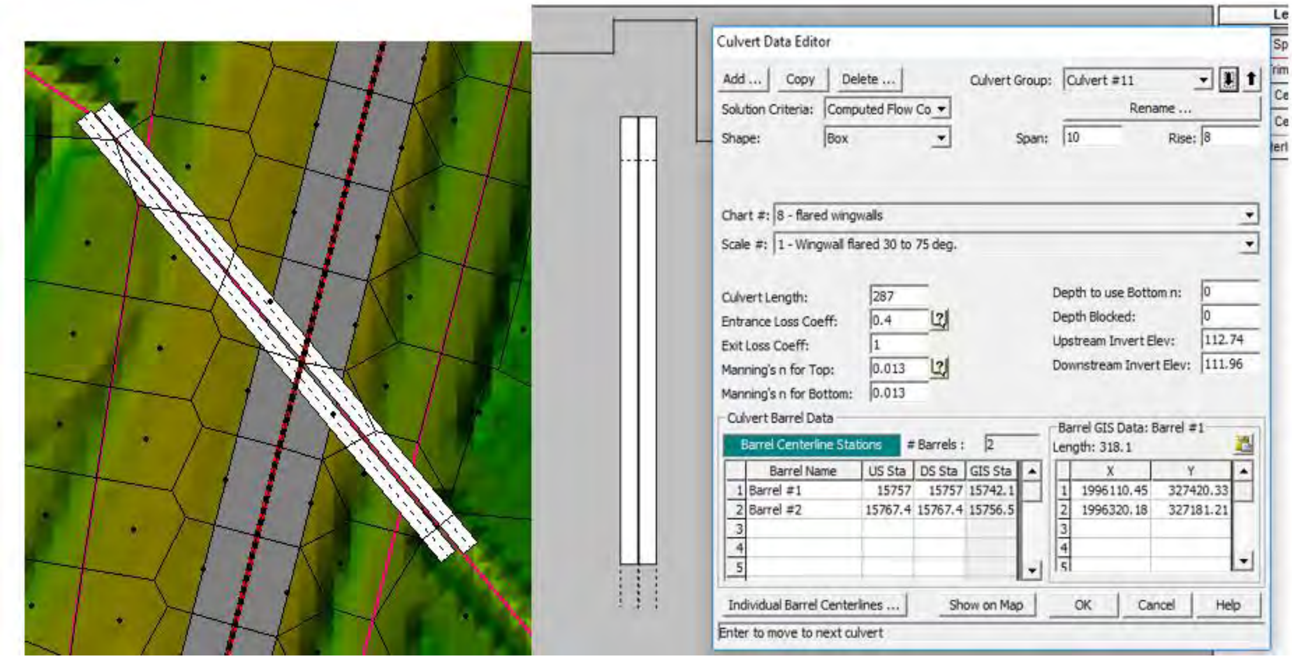


Figure 6-3. I-95 Meadow Branch culvert 2D connection example.

6.2. Boundary Conditions

There are nine inflow locations representing flow from Lumber River, Raft Swamp, Jacob Swamp, Jacks Branch, Fivemile Branch, Meadow Branch, Ivey Branch, and White Oak Branch. Flows from Back Swamp were included in the flows for Lumber River. There are no significant inflows within the project area that would cause direct impact. A normal depth boundary condition was applied at the downstream end of the model and upstream along Back Swamp to prevent flows reaching that boundary from piling up. The normal depth was set to a friction slope of 0.001 after averaging the slope of several locations along the boundary. The boundary condition locations are shown in **Figure 6-4**.

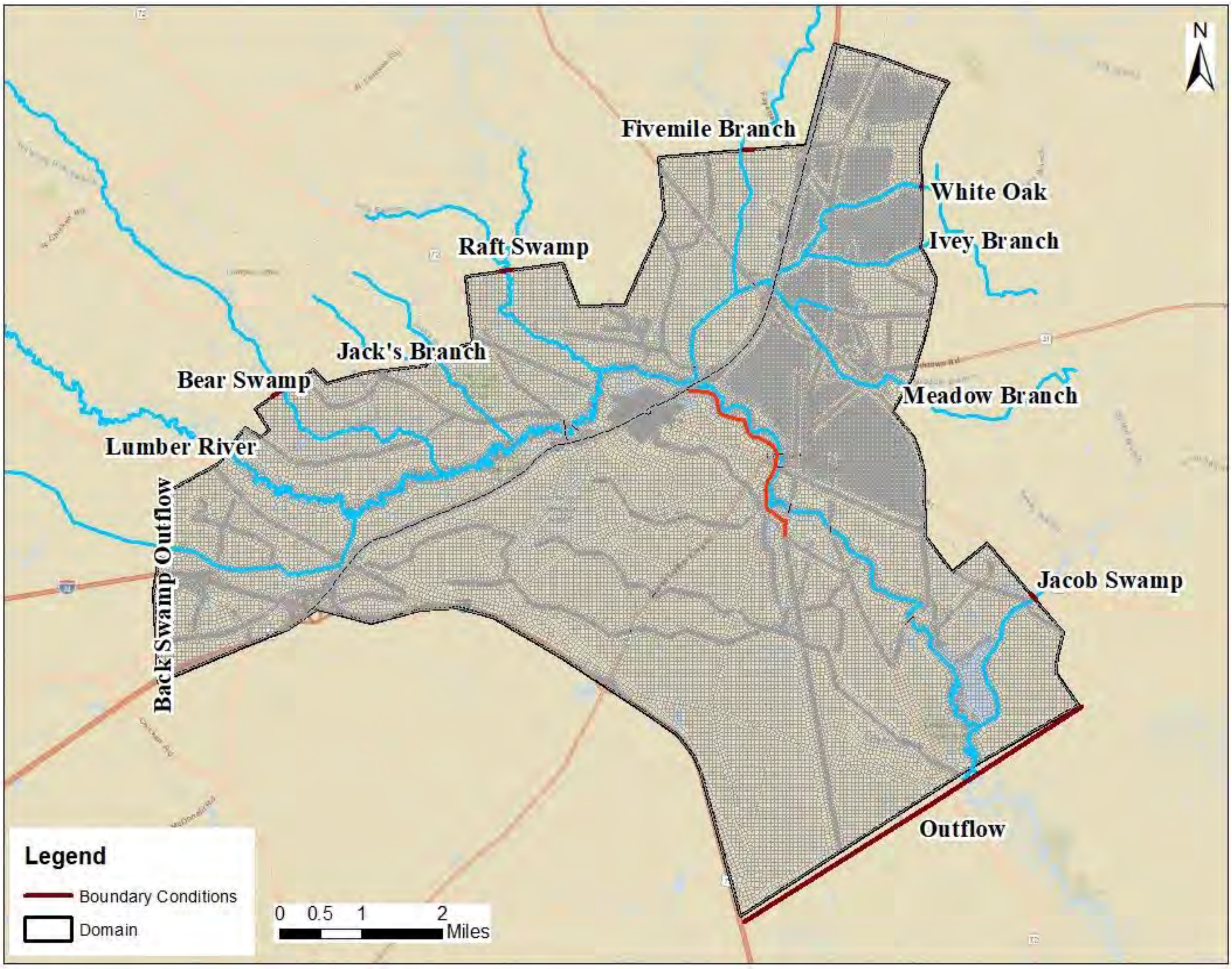


Figure 6-4. Boundary condition locations.

6.3. Model Execution

The completed models were executed using a fixed timestep of 5 seconds. The selected timestep provided stable results without unduly prolonging the simulation time. The Shallow Water Equations with a Eulerian-Lagrangian approach to solving for advection (SWE-ELM equation set) was used for all simulations.

Stage and flow hydrograph data at hydraulic structure locations were reviewed and verified to be appropriate. In certain cases, minor instabilities were noted in the flow data going through the structures, however, this did not impact the stages and hence do not impact the accuracy of the results.

6.4. Model Calibration and Verification

The 2D HEC-RAS model was calibrated and verified by comparing the simulated peak stages and flows to observed peak stages and flows, and high-water marks.

Observed data used for calibration and verification included USGS streamflow gage data at the USGS gage in Lumberton (USGS Gage 02134170), high water marks obtained during field data collection, a surveyed high-water mark, and high-water marks from the USGS National Water Information System Database (USGS, 2019).

Available peak flows and stages at the USGS gage in Lumberton were reviewed to identify significant flooding events for use in calibration and verification. Two flooding events were identified and selected for use in calibration and verification (**Table 6-2**). Hurricane Florence in September 2018 was used for calibration and Hurricane Matthew from October 2016, was used for verification.

Table 6-2. Lumber River historical storms used for calibration and verification.

Storm	Peak Flow (cfs)	Peak Stage (ft, NAVD88)	Purpose
Sept 2018 (Hurricane Florence)	17,100	119.69	Calibration
Oct 2016 (Hurricane Matthew)	16,600[1]	119.36	Verification

1 Flow adjusted to account for bypass flow through I-95 opening. Recorded flow at gate without bypass flow was 14,600 cfs.

The inflows for these storms were derived from the HEC-HMS model generated in the hydrology phase of this project. Manning's n-coefficients were adjusted iteratively until the simulated values matched the observed values at both the USGS gage location and at the high-water mark locations. The comparison between the calibrated model results and observed data for the two storms are provided in **Table 6-3**. **Figure 6-5** shows the differences between the simulated water surface elevations and the observed high-water marks for Hurricane Florence (September 2018).

Matching HWMs in the vicinity of the proposed gate was prioritized over matching water surface elevations at the USGS gage location during the calibration process.

Table 6-3. Observed versus simulated results at the USGS Gage in Lumberton.

Gage vs. Simulated Results						
Storm	Peak Flowrate (cfs)			Peak Stage (ft, NAVD88)		
	Observed	Simulated	% Difference	Observed	Simulated	Difference (ft)
Calibration						
Sept 2018 (Hurricane Florence)	17,100	15,877	-7.2	119.69	120.63	0.94

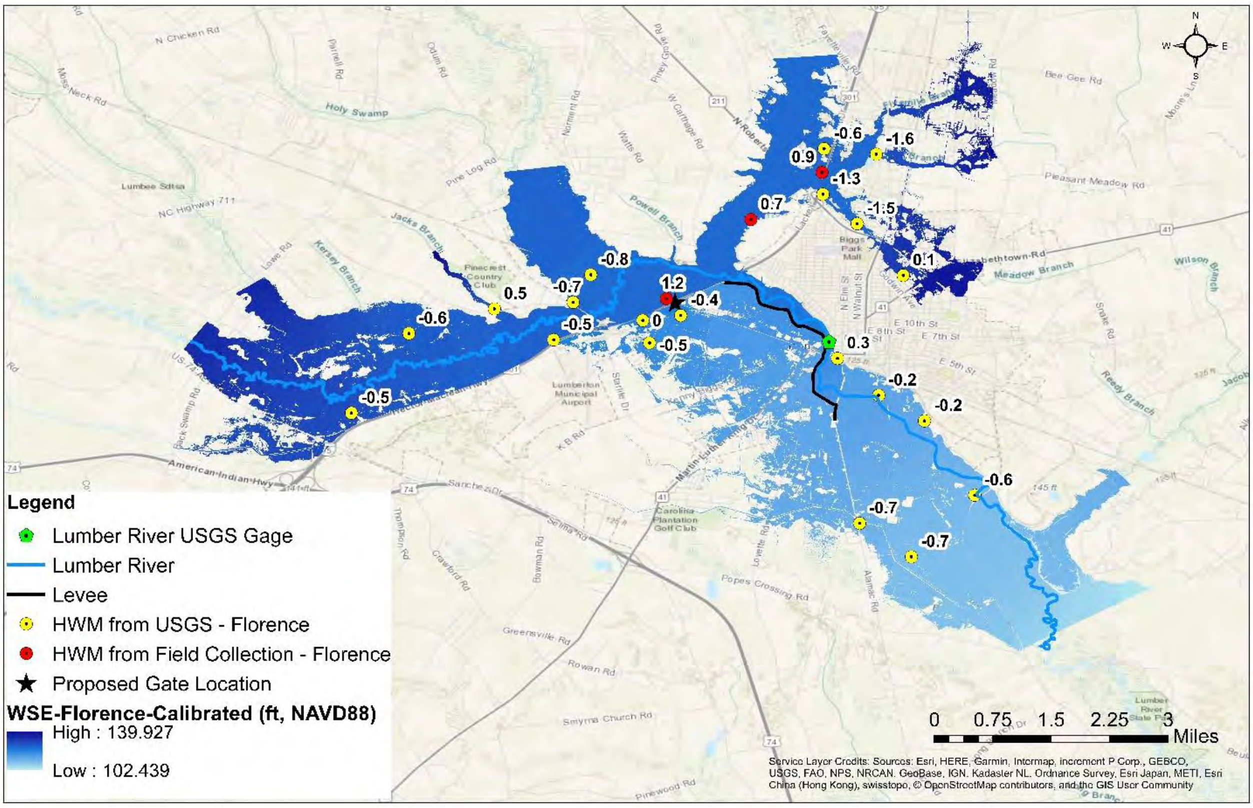


Figure 6-5. High water marks comparison for Hurricane Florence.

The difference between the simulated peak water surface elevation and the USGS high-water marks ranges from -1.6 feet to 1.2 feet. Near the gate, the model results are within 0.5 feet of the USGS HWM elevations. The simulated peak water surface elevation is about 1.2 feet higher than the observed elevation at the location of the surveyed high-water mark near the proposed gate location. Along Lumber River, the results indicate that the simulated results are within 1 foot of the HWM elevations, although mostly lower than the HWM elevations. The model results at the USGS gage location were 0.9 feet higher than the recorded gage elevation. The analysis shows that for USGS high-water marks around the gate location, the model tends to underpredict values. Whereas for field collected high-water marks around the gate location, the model overpredicts values. This trend may reflect inherent errors associated with the collection of the high-water mark data. Achieving calibration results that fall in-between the two data sets was the desired goal.

Note that the resulting flows in HEC-RAS at the USGS gage location are slightly different from those applied as boundary conditions due to attenuation of the peak flows within the HEC-RAS model and 2-dimensional distribution of the flows.

The final calibrated roughness coefficients that were assigned to the various land use classifications are provided in **Table 6-4**. Results of the various calibration iterations are included in **Appendix C3**.

During the calibration process, the Manning's n values were generally increased to achieve a better match between simulated and observed water levels. Changes to the Manning's n values for all land use classes are within the published Manning's n value ranges (**Table 6-1**). Additionally, Manning's n refinement regions were created for portions of the Lumber River and the area in the immediate vicinity of the proposed gate location. This was done to better capture the variations in land uses in those areas and were necessary in achieving good calibration results. The land use classes and assigned Manning's n values for the refinement regions are included in **Table 6-4**.

The calibrated Manning's n coefficient was used to simulate Hurricane Matthew for verification. The results are shown in **Table 6-5**.

Table 6-4. Calibrated Manning's n coefficients.

NLCD Code	NLCD Classification	Base N	Final Calibrated N
11	Open Water	0.03	0.033
21	Developed, Open Space	0.013	0.016
22	Developed, Low Intensity	0.05	0.063
23	Developed, Medium Intensity	0.075	0.094
24	Developed, High Intensity	0.1	0.125
31	Barren Land	0.03	0.03
41	Deciduous Forest	0.12	0.12
42	Evergreen Forest	0.12	0.12
43	Mixed Forest	0.12	0.12
52	Scrub/Shrub	0.05	0.05
71	Grassland Herbaceous	0.03	0.03
81	Pasture/Hay	0.04	0.04
82	Cultivated Crops	0.035	0.045
90	Woody Wetlands	0.1	0.15
95	Emergent Herbaceous Wetland	0.1	0.1
	Channel	0.045	0.065
	Area Upstream of Gate	0.05	0.05
	Black's Tire and Auto Service	0.1	0.1
	I-95	0.013	0.013
	Ponds	0.03	0.033
	Railroad Area	0.02	0.02
	Wetland Upstream of I-95	0.1	0.1
	Wooded Area	0.12	0.12

Table 6-5. Lumber River verification historical storms data versus simulated results.

Gage vs. Simulated Results						
Storm	Peak Flowrate (cfs)			Peak Stage (ft, NAVD88)		
	Observed	Simulated	% Difference	Observed	Simulated	Difference (ft)
Verification						
Oct 2016 (Hurricane Matthew)	16,600	14,924	-10.1	119.36	120.42	1.06

Like Hurricane Florence, final water surface elevations produced from the Hurricane Matthew simulation were compared to the USGS high-water mark elevations. The results of this comparison can be seen in **Figure 6-6**. The trend noted in calibration was consistent throughout the verification process.

The results of calibration trial runs are included in **Appendix C3.** The calibration of HEC-RAS model is included in the electronic **Appendix E3.1.** The calibration model consists of 2 geometries, 2 unsteady flow files and 3 plans. Each unsteady flow file is a different storm event, and each geometry is a different trial, utilizing different roughness coefficients. Ultimately, there was a base Manning's n coefficient plan, and three trials were run for the calibration storm. The verification storm (Hurricane Matthew) was only run once with the final geometry.

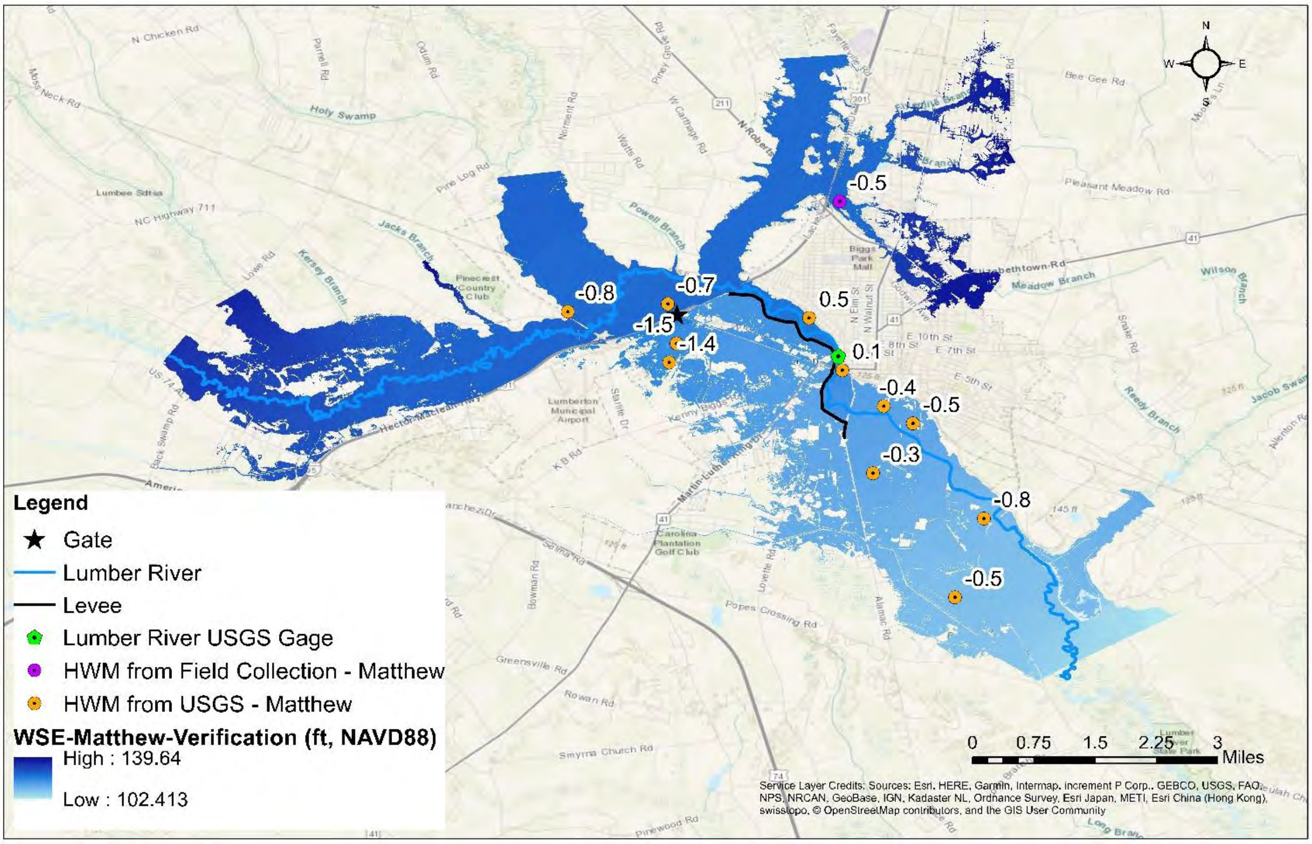


Figure 6-6. High water marks comparison for Hurricane Matthew.

6.5. Design Flood Simulations and Results

6.5.1. Design Flood Simulations

The 100-year, 500-year, 1,000-year, ¼ PMF, 1/3 PMF, ½ PMF, 2/3 PMF, ¾ PMF and PMF peak stages at the proposed gate location were simulated using the calibrated HEC-RAS model. The hydrographs developed in

Section 5.7 were used as the inflow boundary conditions for the simulations. As stated in **Section 5.7**, the duration of all the design storms was 48 hours.

Geometry files were created for the existing conditions (without the proposed gate), and for the proposed conditions (with the proposed floodgate in place and I-95 embankment raised). Both geometry files use the calibrated and verified Manning's n-coefficients.

Nineteen different runs were performed using two different geometry files. The ten plans are:

1. **100yr Without Gate** – Unsteady flow: 100YR, Geometry: Lumber River without Gate
2. **100yr with Gate and Proposed I-95** – Unsteady flow: 100YR, Geometry: Lumber River with Proposed I-95 and Gate
3. **500yr Without Gate** – Unsteady flow: 500YR, Geometry: Lumber River without Gate
4. **500yr With Gate and Proposed I-95** – Unsteady flow: 500YR, Geometry: Lumber River with Proposed I-95 and Gate
5. **1,000yr Without Gate** – Unsteady flow: 1,000YR, Geometry: Lumber River without Gate
6. **1,000yr With Gate and Proposed I-95** – Unsteady flow: 1,000YR, Geometry: Lumber River with Proposed I-95 and Gate
7. **Florence Design** – Unsteady flow: Hurricane Florence, Geometry: Lumber River with Proposed I-95 and Gate
8. **0.25PMF Without Gate** – Unsteady flow: 0.25PMP, Geometry: Lumber River without Gate
9. **0.25 PMF With Gate and Proposed I-95** – Unsteady flow: 0.25PMP, Geometry: Lumber River with Proposed I-95 and Gate
10. **0.33 PMF Without Gate** – Unsteady flow: 0.33PMP, Geometry: Lumber River without Gate
11. **0.33 PMF With Gate and Proposed I-95** – Unsteady flow: 0.33PMP, Geometry: Lumber River with Proposed I-95 and Gate
12. **0.5 PMF Without Gate** – Unsteady flow: 0.5PMP, Geometry: Lumber River without Gate
13. **0.5 PMF With Gate and Proposed I-95** – Unsteady flow: 0.5PMP, Geometry: Lumber River with Proposed I-95 and Gate
14. **0.67 PMF Without Gate** – Unsteady flow: 0.67PMP, Geometry: Lumber River without Gate
15. **0.67 PMF With Gate and Proposed I-95** – Unsteady flow: 0.67PMP, Geometry: Lumber River with Proposed I-95 and Gate
16. **0.75 PMF Without Gate** – Unsteady flow: 0.75PMP, Geometry: Lumber River without Gate
17. **0.75 PMF With Gate and Proposed I-95** – Unsteady flow: 0.67PMP, Geometry: Lumber River with Proposed I-95 and Gate
18. **FullPMP Without Gate** – Unsteady flow: FullPMP, Geometry: Lumber River without Gate
19. **PMF With Gate and Proposed I-95** – Unsteady flow: FullPMP, Geometry: Lumber River with Proposed I-95 and Gate

Plans using the geometry "Lumber River without Gate" represent existing conditions; without the gate in place and without a raised I-95. Plans with the geometry "Lumber River with Proposed I-95 and Gate" represent proposed conditions with the flood gate and proposed I-95 raised embankment configuration in place.

Simulations with and without the gate provide insights into possible impacts from the installation of the flood gate and raising of I-95.

Hurricane Florence was also simulated with the proposed conditions geometry to determine the resulting peak water surface elevation at the proposed gate location for the flood of record.

The models are included in the electronic **Appendix E3.2**.

6.5.2. Hydraulic Results

6.5.2.1. Water Surface Elevations

The maximum water surface elevations from the ten simulations are summarized in **Table 6-6**. The maximum water surface elevations were extracted from a profile line along the upstream end of the proposed gate location in RasMapper.

Table 6-6. Maximum Water Surface Elevation (WSE) from simulations at the flood gate location .

Storm Event	Maximum WSE (feet, NAVD88)	
	Existing Conditions	Proposed Conditions
100 YR	123.7	124.0
Hurricane Florence	124.8	125.6
¼ PMF	124.8	126.0
500 YR	125.5	127.6
1/3 PMF	125.6	127.7
1,000 YR	125.8	128.1
½ PMF	126.1	128.4
2/3 PMF	126.4	128.7
¾ PMF	126.5	128.8
PMF	126.8	129.2

Under the 100-year flood conditions, Lumber River overtops its banks and flows through the I-95 opening at the VFW Road (proposed gate location). The peak water surface elevation upstream of the gate is 123.7 feet, NAVD88. No segments of the levee system are overtopped. Installing the floodgate and raising I-95 results in an increase in the peak water surface elevation of 0.3 feet (**Table 6-6**) upstream of the gate. Inundation maps for these simulations are included in **Appendix C4**.

Under the ¼ PMF flood conditions, Lumber River overtops its banks and flows through the I-95 opening at the VFW Road (proposed gate location). The peak water surface elevation upstream of the gate is 124.8 feet, NAVD88. No segments of the levee system are overtopped. Installing the floodgate and raising I-95 results in an increase in the peak water surface elevation by 1.2 feet (**Table 6-6**) upstream of the gate. Inundation maps for these simulations are included in **Appendix C4**.

Under the 500-year flood conditions, Lumber River overtops its banks and flows through the I-95 opening at the VFW Road (proposed gate location). About 2,500 cfs of flow goes through the I-95 opening. In addition to flow through the I-95 opening, flow overtops the low segments of I-95 east and west of the proposed gate location. The overtopping flowrate at the low segments of I-95 is about 2,800 cfs on the west side and about 2,500 cfs on the east side. No overtopping occurs with the gate in place and I-95 raised. However, minor overtopping of the levee occurs at the intersection of the levee and NC72 where the levee is relatively low. Peak water surface elevation upstream of the gate under this scenario is 127.6 feet, NAVD88. Installing the floodgate and raising I-95 results in an increase in the peak water surface elevation 2.1 feet (**Table 6-6**) upstream of the gate. Inundation maps for these simulations are included in **Appendix C4**.

Under the 1/3 PMF flood conditions, Lumber River overtops its banks and flows through the I-95 opening at the VFW Road (proposed gate location). In addition to flow through the I-95 opening, flow overtops at multiple locations along I-95 and causes widespread inundation in the city. Overtopping occurs on the west side of I-95 farther away from the gate location when the gate is in place and I-95 raised. The levee is also overtopped at multiple locations. Peak water surface elevation upstream of the gate under this scenario is 127.7 feet, NAVD88. Installing the floodgate and raising I-95 results in an increase in the peak water surface elevation 2.1 feet (**Table 6-6**) upstream of the gate. Inundation maps for these simulations are included in **Appendix C4**.

Under the 1,000-year flood conditions, Lumber River overtops its banks and flows through the I-95 opening at the VFW Road (proposed gate location). In addition to flow through the I-95 opening, flow overtops at multiple locations along I-95 and the levee and causes widespread inundation in the city. Overtopping occurs on the west side of I-95 farther away from the gate location when the gate is in place and I-95 raised. Peak water surface elevation upstream of the gate under this scenario is 128.1 feet, NAVD88. Installing the floodgate and raising I-95 will result in an increase in the peak water surface elevation of 2.3 feet (**Table 6-6**) upstream of the gate. Inundation maps for these simulations are included in **Appendix C4**.

Under the ½ PMF, 2/3 PMF, ¾ PMF and full PMF flood conditions, Lumber River overtops its banks and flows through the I-95 opening at the VFW Road (proposed gate location). Flow also overtops at multiple locations along I-95 and the levee and causes widespread inundation in the city. The peak water surface elevations upstream of the gate without the gate and with the gate installed and I-95 raised for the different PMF runs are listed in **Table 6-6.** For the ¾ PMF flood condition, the peak water surface elevation upstream of the gate is 128.8 feet when the gate is in place and I-94 raised. Installing the floodgate and raising I-95 results in an increase in the peak water surface elevation by 2.3 feet (**Table 6-6**) upstream of the gate for the ¾ PMF flood condition.

Peak water surface elevations upstream of the gate for the flood of record (Hurricane Florence) under existing conditions is 124.8 feet, NAVD88. Installing the gate and raising I-95 to prevent overtopping increases the peak water surface elevation to 125.6 feet, NAVD88.

When comparing the simulated 100-year existing conditions (without gate) inundation boundary to the effective floodplain, the internal flooding estimated by the model is less extensive (**Figure 6-7**). This difference is due to the fact that the effective floodplain includes mapping for Jacob Swamp and Little Jacob Swamp, whereas the model does not include either stream as an inflow. However, in the northeast and northwest corners of the domain, the simulated boundary is predicted to spread further. Jack's Branch, to the west of Raft Swamp, is not included in the effective floodplain, but shows substantial flow within the model. The same scenario occurs with Ivey Branch, north of Meadow Branch.

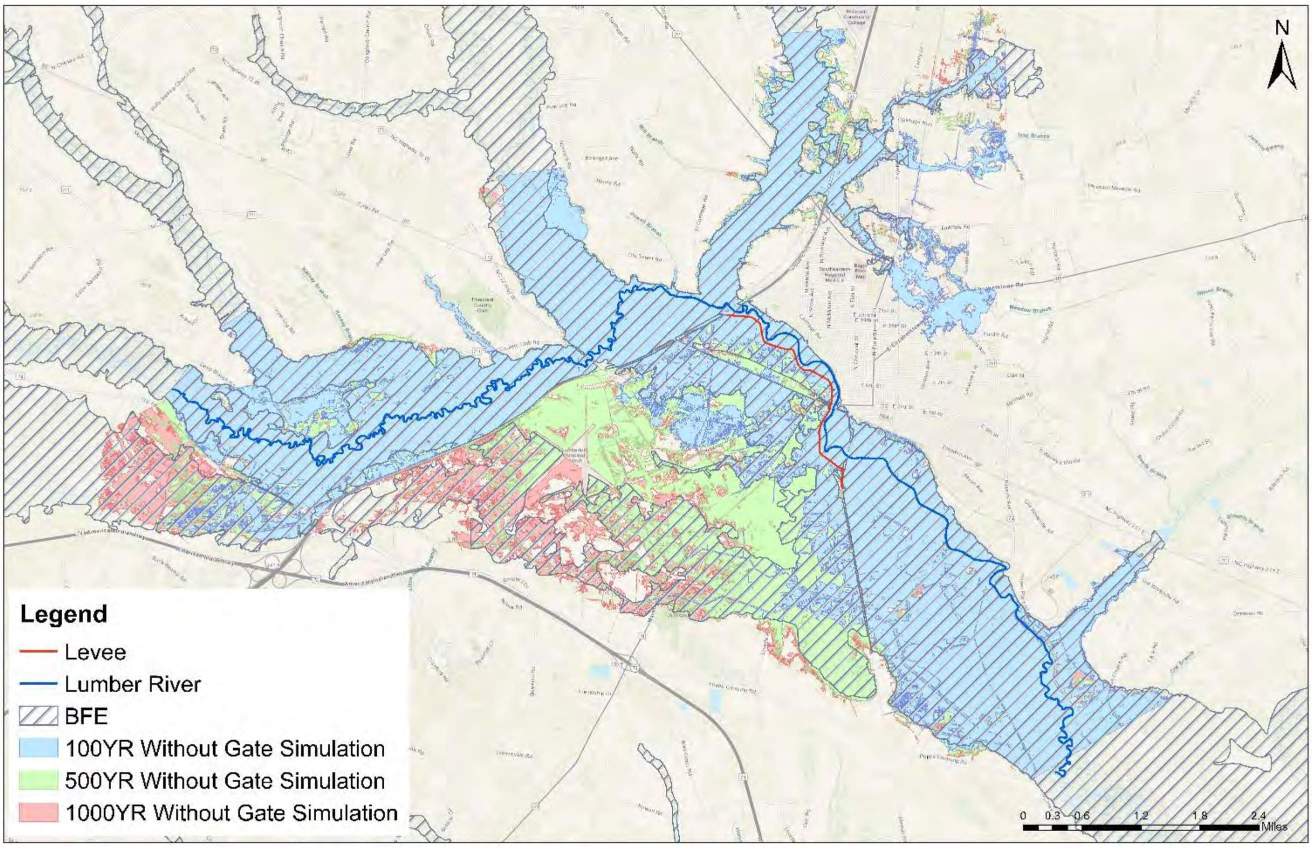


Figure 6-7. Inundation boundaries without floodgate

6.5.2.2. Impacts of Flood Gate Installation

The impacts of the flood gate installation in terms of increases in water surface elevations were assessed by comparing flood depths and inundation areas from model simulations with and without the flood gate for the 100-year, and 500-year floods.

Figures 6-8 and 6-9 show the difference in water surface elevations and extents of impact of the proposed projects (floodgate and raising of I-95) for the 100-year and 500-year storms. The results show that proposed projects will result in peak water surface elevation increases of up to about 0.4 feet are expected during the 100-year flood (**Figure 6-8**) and up to about 3 feet during the 500-year flood (**Figure 6-9**).

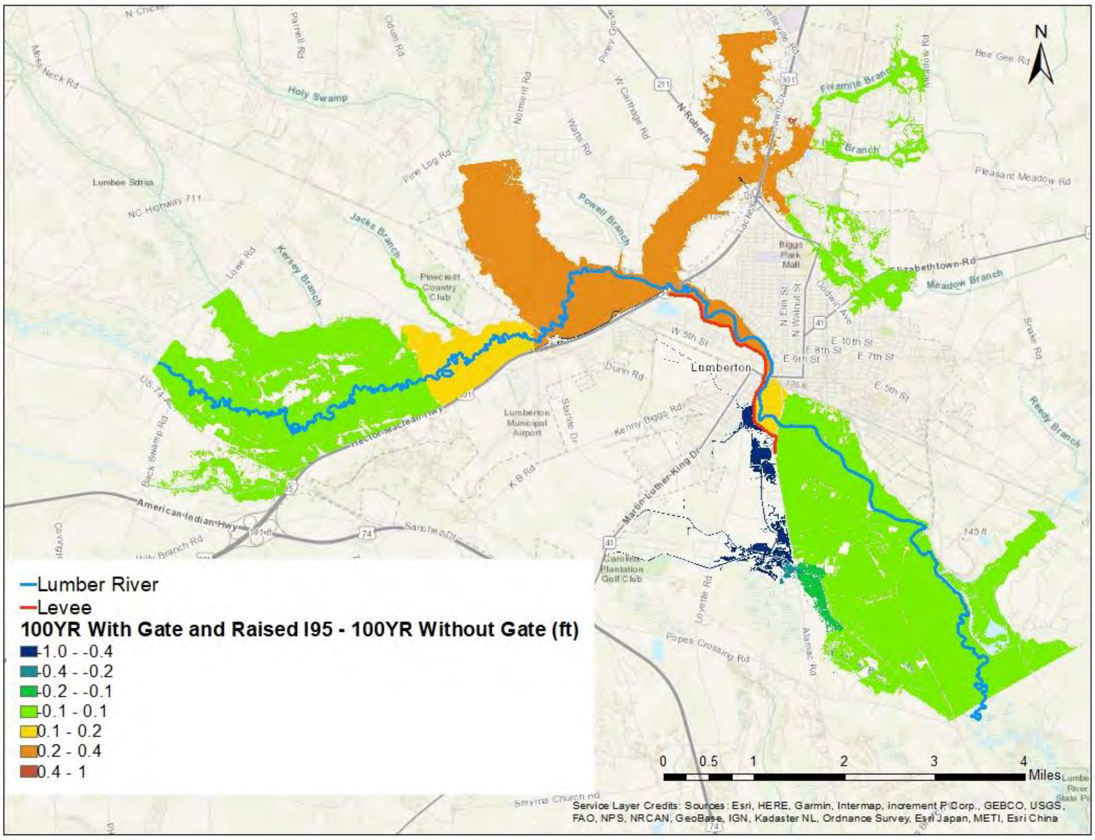


Figure 6-8. WSE (ft) without flood gate compared to with flood gate and I-95 raised for 100YR storm.

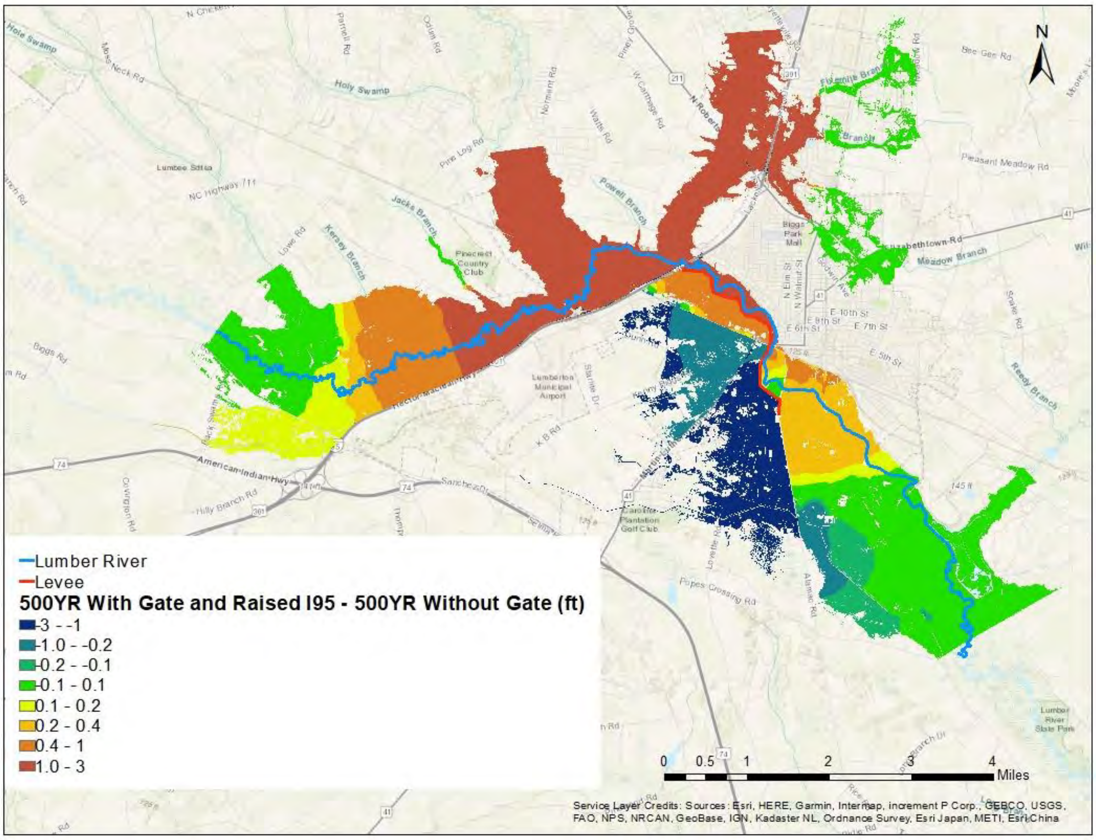


Figure 6-9. WSE (ft) without flood gate compared to with flood gate and I-95 raised for 500YR storm.

7. Freeboard Estimation

The proposed flood gate will impound water leading to temporary pond-like situation at the northern side of the gate. This situation is expected to last for about 5 days during the design flood. During this temporary pond-like situation, wind setup caused by the horizontal stress exerted on the water surface by the winds and runup associated with wind generated waves (**Figure 7-1**) may develop. The height of the flood gate should include freeboard allowance that considers these wind effects on the surface of water.

This section outlines the procedure used to calculate the wind setup and wave run-up based on simplified wave models.

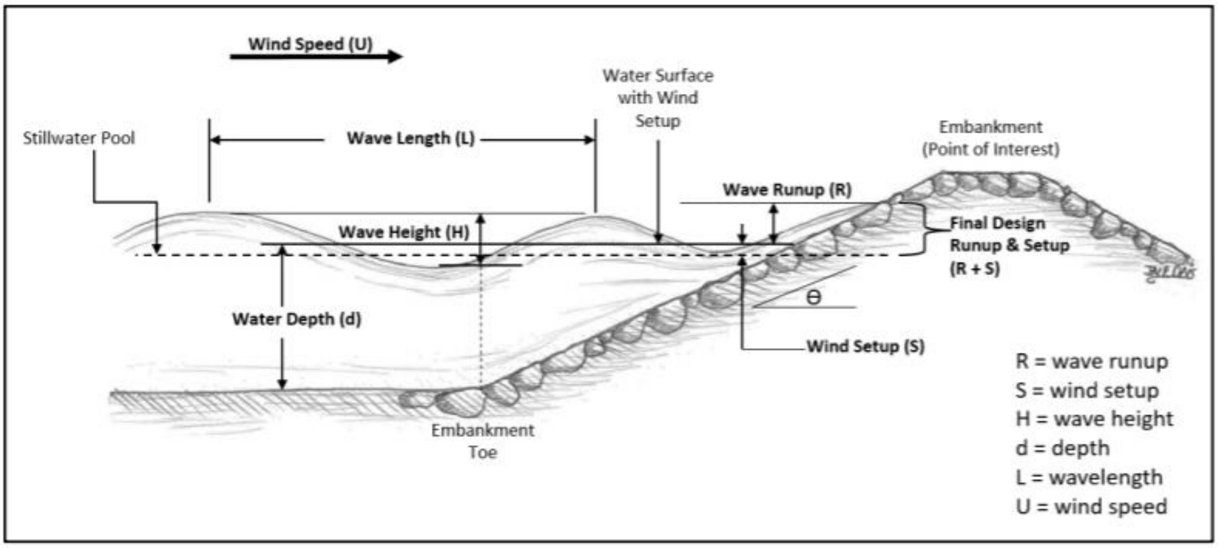


Figure 7-1. Definition sketch for wave runup and wind setup (USACE, 1997).

In general, the different steps involved in calculating wave run-up are as follows:

- Estimate average wind speed over an appropriate fetch
- Estimate wave height and wave period
- Estimate wind setup and wave-runup

Above steps are described in more detail in the following sections.

7.1. Estimate average wind speed over an appropriate fetch

7.1.1. Fetch

Fetch is defined as the unobstructed distance along which wind blows over the surface of water to create wind generated waves. The inundation extents computed from H&H modeling for the 500-year storm with gate and I-95 raised was superimposed on satellite imagery to determine the longest unobstructed distance (measured along a straight line) that is exposed to wind effects when water pools behind the Lumberton Flood Gate during the flood. The longest fetch was estimated to be around 2 miles to the northwest of the flood gate (red line in **Figure 7-2**).

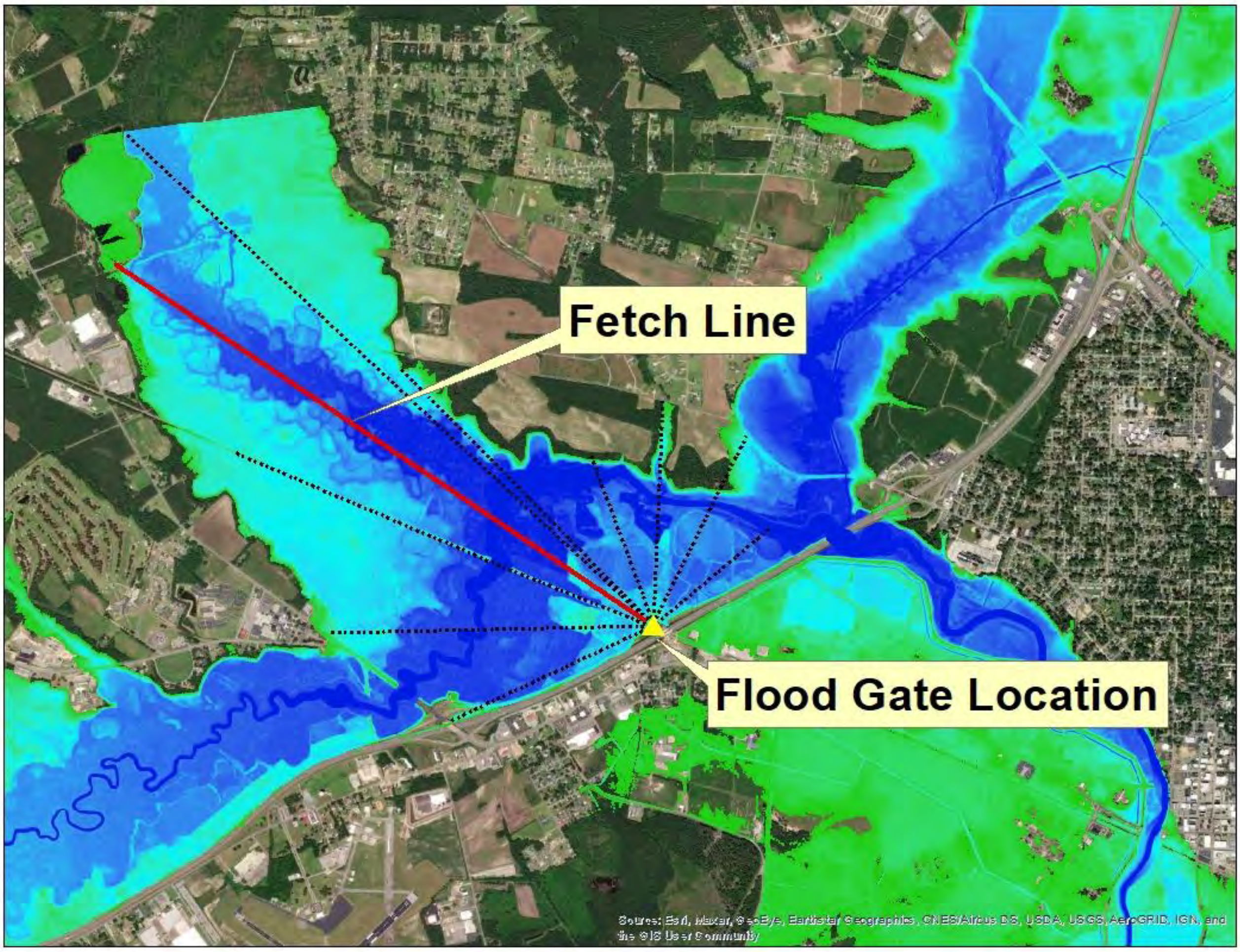


Figure 7-2. Fetch line (red) superimposed on 500-year depth raster and satellite imagery.

7.1.2. Wind Speed

Annual extreme fastest mile wind speed measured at 30 feet for 138 stations around United States was used to draw maps for the 2-year, 50-year and 100-year mean recurrence intervals (Thorn, 1968, shown in **Appendix D**). The 2-yr return period wind speed from that dataset was used as the input to compute the design wind speed. The estimated 2-year fastest mile wind speed over the state of North Carolina is 50 miles per hour.

The following assumptions (USACE, 1989) are made about the wind speed used as input for wave growth models:

- Wind fields are well organized and can be adequately described using an average wind speed and direction over the entire fetch
- Wind speed should be corrected to the 33-foot (10 meter) level.
- Wind speed should be representative of the average wind speed measured over the fetch
- When the fetch length is 10 miles (16 kilometers) or less, the wind has not fully adjusted to the frictional characteristics of the waves.
- When the fetch length is greater than 10 miles (16 kilometers), thermal stability effects must be included in the wind speed transformation.

To satisfy these assumptions, the following adjustments are made to the wind speed.

7.1.2.1. Height Adjustment

Since the wind speed was measured at 30 feet, an adjustment was applied to get the equivalent wind speed at a height of 33 feet using the 1/7 power law (USACE, 1989) (**Equation 7-1**):

$$U_{33} = \left(\frac{33}{z}\right)^{\frac{1}{7}} * U_z \qquad (7\text{-}1)$$

Where U_{33} is the wind speed at the 33-foot level (miles per hour [mph]), z is the elevation above the surface (ft), and U_z is the wind speed at a distance of z above the surface (mph). When z is 30 feet and U_{30} is 50 mph, U_{33} is equal to 50.68 mph.

7.1.2.2. Overland Wind Adjustment

The fastest mile data is based on measurements at land-based stations. Under comparable meteorological conditions, wind velocities over water are higher than over land surfaces because of smoother and more uniform surface conditions. Factors to adjust land-based wind speed measurements to account for these effects are presented on page 15-2 of USACE, 1997 (see **Appendix D**). For a wind fetch of 2 miles (see **section 7.1.1**), the ratio of winds over water to the winds over land (FWL) was estimated to be 1.21. The overwater wind speed, U_w was calculated using **Equation 7-2**.

$$U_w = FWL * U_{33} \qquad (7\text{-}2)$$

$$U_w = 1.21 * 50.68 = 61.32\ mph$$

Where FLW is the ratio of winds over water to winds over land, and U_{33} is the previously calculated wind speed at the 33-foot level (mph). With an FWL of 1.21 and the U_{33} of 50.68 mph, the U_w is 61.32 mph.

7.1.2.3. Computing Adjusted Wind Speeds based on Averaging Time

There are two approaches (fetch-limited and duration-limited) for determining the characteristics of wind generated waves. Fetch-limited conditions assume that the wind blows with a constant speed and direction over a certain fetch for sufficient time for the waves to travel the entire fetch length (Ozeren et al., 2009). Within this time steady state conditions are achieved within the fetch. If the wind duration is less than the required time for the waves to travel the fetch, then the wave conditions will be time dependent, and such wave conditions are described as duration-limited.

In the present work, since the wind generated waves are limited by the extent of the ponded areas adjacent to the flood gate, the assumption of fetch-limited conditions is appropriate. Therefore, a minimum duration (t) must be selected to meet the assumptions of the fetch-limited conditions discussed above. An averaging interval (larger than the minimum duration, t) over which wind speeds are relatively constant should also be selected and the corresponding averaged wind speed must be computed.

The equations for computing wind speeds over different averaging intervals are based on Figure 5-26 in USACE, 1989 (also shown in **Appendix D**).

First, the duration corresponding to a fastest mile wind speed of 50 mph was determined from the relationship t=3600/U (from Figure 5-35 in USACE, 1989), where U_t is the fastest mile wind speed. Thus, t = 72 s.

The 72s fastest mile winds to which overland adjustment has been applied is converted to 1 hour averaged wind speed using equation below (**Equation 7-3**):

$$\frac{U_t}{U_{1hr}} = 1.277 + 0.296 \tanh\left(0.9 \log\left(\frac{49}{t}\right)\right) \qquad (7\text{-}3)$$

$$\frac{U_{72}}{U_{1hr}} = 1.277 + 0.296 \tanh\left(0.9 \log\left(\frac{49}{72}\right)\right)$$

$$U_{1hr} = 50.13\ \text{mph}$$

7.2. Estimate Wave Height and Wave Period

Deepwater wave characteristics based on the fetch and adjusted wind speeds computed in **Section 7.1** are determined using hindcasting charts for deep water waves (Figure 5-34, USACE, 1989, shown in **Appendix D**). The computed wave heights, periods and minimum duration are shown in **Table 7-1**

Table 7-1. Deep water wave characteristics.

Adjusted Wind Speed (mph)	Fetch (miles)	Duration (min)	Deep water Wave Height (ft)	Deep water Wave Period (s)
50.13	2	45	**3**	**3**

The minimum duration computed from the chart is around 45 minutes, therefore the assumption of fetch-limited conditions is valid if we assume a duration of 1 hour. Therefore, the design deep water wave height and period is selected to be equal to 3 ft and 3 seconds (s) respectively.

Next, we compute the deep-water wavelength (**Equation 7-4**) using the dispersion relationship to verify the assumption of deep-water conditions.

$$L_d = \frac{gT_d^{\ 2}}{2\pi} \tag{7-4}$$

Where L_d is the deep-water wavelength (ft), g is gravity (ft/s^2), and T_d is the deep-water wave period (s). When T_d is 3 s, the deep-water wavelength (L_d) is 46.12 ft.

$$L_d = \frac{32.2 * 3^2}{2\pi} = 46.12 \text{ feet}$$

For deep water wave growth to be unimpeded by the bottom, the ratio of water depth to wavelength must be equal to or greater than 0.5 (USACE, 1989). Design flood depth at the gate is about 8 feet so the ratio of the water depth to wavelength is 0.17 which is significantly less than half the wavelength. Therefore, the assumption of deep-water wave growth is not applicable. The wave height and period should therefore be based on shallow water curves. The hindcasting charts for computing shallow water wave characteristics at a depth of ten feet is shown in **Appendix D**, Figure D-5 (or Figure 5-36 USACE, 1989). For a wind speed of 50.13 mph and fetch of 2 miles, the shallow water wave height and wave period are **2.5 feet** and **2.75 s** respectively.

7.3. Estimate wind setup and wave runup

7.3.1 Wind Setup

Set-up (S_e) is the piling up of water at the leeward end, and a lowering of water level at the windward end in a reservoir caused by wind (**Figure 7-1**). Wind set-up can be estimated for the reservoir, based on the following equation (USACE, 1989) (**Equation 7-5**):

$$S_e = \frac{U^2 * F_S}{1400D} \tag{7-5}$$

Where S_e is set-up in feet above the still water level (ft), U is the average wind velocity (mph) over the maximum fetch distance (Fs) (mi) that influences the wind, and D is the average depth of water along the fetch line (ft). When D is 13 ft and F_s is 2 ft the S_e is 0.3 ft.

$$S_e = \frac{50.13^2 * 2}{1400 * 13} = 0.3 \text{ ft}$$

7.3.2 Wave Runup

Wave runup is defined as the height above still water level to which a wave will rise on a structure or beach (**Figure 7-1**).

The upper limit for relative runup on smooth vertical walls (derived from laboratory experiments), is presented in the U.S Army Corps of Engineers miscellaneous paper CERC-90-4 (USACE, 1990) and is equal to (**Equation 7-6**):

$$\frac{R}{H} = 2.5 \tag{7-6}$$

Where R is the wave runup (ft) and H is the wave height at the toe of the structure (ft). For a wave height of 2.5 ft, the runup is 6.25 ft.

$$R = 2.5 * 2.5 = 6.25\ ft$$

7.4. Sensitivity Analysis

A sensitivity analysis was performed to understand the variability of the computed wave runup and was setup with changes in the fetch and wind speed for the 100-year, 500-year and the ¼ PMF return period events. As stated in Section 3, the top elevation of the flood gate should be at a minimum higher than the elevation from the flood of record, which has a return period of about of 200 years. The sensitivity analysis provides a range of values for freeboard for the 100-year and 500-year floods to provide lower and upper freeboard threshold estimates.

The direction of the prevailing winds determines the fetch length. The black dashed lines in **Figure 7-2** indicate the different fetch lines that may be applicable depending on the wind direction over the study area. Thus, the fetch length can vary between a maximum of 2 feet to a minimum of 0.6 feet. Also plotted were the modeled depths along the fetch to confirm that the average depth along the fetch length (around 12 feet) is large enough to overtop the vegetation in that area and thereby provide an unobstructed path for the winds. The wind setup and wave runup computed for the different fetch-wind speed combinations are summarized in **Table 7-2**. These quantities were found to be sensitive to changes in the fetch.

Table 7-2. Summary of sensitivity analysis.

Design Storm	Fetch (mi)	Wind Speed (mph)	Wave Runup (ft)	Wind Setup (ft)	Total Wind and Wave Component (ft)
100-Year	2	50	5	0.4	**5.4**
	0.6	50	3.8	0.1	3.9
500-Year	2	50	6.3	0.3	**6.6**
	0.6	50	3.8	0.1	3.9
¼ PMF	2	50	6.3	0.3	**6.6**
	0.6	50	3.8	0.1	3.9

7.5. Results

The estimated range of freeboard to account for wind-wave action is 3.9 feet to 5.4 feet for the 100-year flood and 3.9 feet to 6.6 feet for the 500-year and ¼ PMF return period events. The lower bound estimate of 3.9 feet results from the use of a fetch of 0.6 miles during either the 100-year or 500-year or ¼ PMF event. The upper bound estimates of 5.4 and 6.6 feet corresponds to a fetch of 2 miles during the 100-year and 500-year or ¼ PMF events, respectively.

8. Recommendations

The recommended range of top of gate elevations and gate heights are shown in **Table 8.1**.

Table 8-1. Recommended Range of Gate Heights

Design Storm	Recommended Top of Gate Elevation and Gate Height			
	Max. Stillwater Elevation (feet, NAVD88)	Freeboard (feet)	Top of Gate Elevation (feet, NAVD88)	Gate Height (feet)
100 YR	124.0	5.4	**129.4**	**9.4**
¼ PMF	126.0	6.6	**132.6**	**12.6**
500 YR	127.6	6.6	**134.2**	**14.2**
Reference Elevations: 1. Minimum elevation for levee accreditation = 128.5 feet (ft), NAVD88 2. Flood of record elevation at gate location assuming gate is in place and I-95 raised = 125.6 ft, NAVD88 3. Elevation of ¾ PMF at gate location assuming gate is in place and I-95 raised = 128.8 ft, NAVD88 4. Elevation of PMF at gate location assuming gate is in place and I-95 raised = 129.2 ft, NAVD88 5. Average ground elevation at gate location is 120.0 ft 6. ¼ PMF is the largest storm that does not overtop the levee and proposed I-95 7. Levee is overtopped during the 500-year storm.				

The resulting peak elevation upstream of the gate for the flood of record, the minimum elevation required for levee accreditation, and the ¾ PMF and PMF peak water surface elevations are also shown in the table for reference. The range of recommended top of flood gate elevation of 129.4 feet, NAVD88 to 134.2 feet, NAVD88 all meet the minimum requirements for levee certification. The recommended top of gate elevation also ensures that the gate is not overtopped even during the PMF, if freeboard is not considered. Selection of the gate height from the range provided should consider the following factors:

- Cost;
- Floodplain Impacts; and
- Minimum desired level of service

9. References

1. Barnes, J., 1998. *North Carolina's Hurricane History, Revised and updated version*. University of North Carolina Press.

2. Calenda et al., 2005. Distribution of the extreme peak floods of the Tiber River from the XV century. Advances in water resources, 28(6), 615-625.

3. Chow, 1959. Open Channel Hydraulics. McGraw-Hill, New York.

4. Federal Emergency Management Agency, 2008. *Meeting the Criteria for Accrediting Levee Systems on NFIP Flood Maps*. Federal Emergency Management Agency (FEMA), 2008, *Meeting the Criteria for Accrediting Levee Systems on NFIP Flood Maps*, www.fema.gov/media-library-data/20130726-1600-20490-4180/lv_accredit_checklist_nov08.pdf.

5. Federal Emergency Management Agency, 2006. Mapping of areas protected by levee systems. Code of Federal Regulations Title 44 Section 65.10. Federal Emergency Management Agency, Aug. 25, 1986

6. Federal Emergency Management Agency, 2014. A Report of Flood Hazards in Robeson County, North Carolina and Incorporated Areas, Flood Insurance Study Number 37155CV000, Federal Emergency Management, Atlanta, GA.

7. National Institute of Standards and Technology, 2015. Maps of Non-hurricane Non-tornadic Wind Speeds with Specified Mean Recurrence Intervals for the Contiguous United States Using a Two-dimensional Poisson Process Extreme Value Model and Local Regression, National Institute of Standards and Technology Special Publication 500-301, 102 pages

8. National Oceanic and Atmospheric Administration, 2019a. Tropical Cyclone Climatology. National Oceanic and Atmospheric Administration National Hurricane Center and Central Pacific Hurricane Center. Available at: nhc.noaa.gov/climo

9. National Weather Service, 2019a. Hurricane Floyd: September 16, 1999. National Oceanic and Atmospheric Administration National Weather Service. Available at: http://weather.gov/ilm/Floyd

10. National Weather Service, 2019b. Hurricane Florence: September 14, 2018. National Oceanic and Atmospheric Administration National Weather Service. Available at: http://weather.gov/ilm/HurricaneFlorence

11. National Oceanic and Atmospheric Administration, 2020. Climate at a Glance-Statewide Time Series. National Oceanic and Atmospheric Administration National Centers for Environmental Information. Available at: ncdc.noaa.gov/cag/statewide/time-series

12. National Weather Service, 2017. Hurricane Matthew in the Carolinas: October 8, 2016. National Oceanic and Atmospheric Administration National Weather Service. Available at: http://weather.gov/ilm/Matthew

13. North Carolina Department of Transportation, 2019. North Carolina Department of Transportation Bridges Map, ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=db3b56c3228743b3811e36761393d661. Date accessed: 9 Dec. 2019

14. North Carolina Flood Risk Information System, North Carolina Floodplain Mapping Program, fris.nc.gov/fris/Index.aspx?user=General Public&ST=NC&FIPS=161.

15. Natural Resources Conservation Service, 2019. National Engineering Handbook, Part 630 Hydrology., United States Department of Agriculture, Natural Resources Conservation Service, August 2019. Rainfall Distribution spreadsheet available at https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/?&cid=stelprdb1044959

16. Ozeren, Yavuz & Wren, D., 2009. Technical Note: Predicting Wind-Driven Waves in Small Reservoirs. Transactions of the American Society of Agricultural and Biological Engineers, Vol. 52(4), pages 1213 – 1221.

17. Rucker, Gregory C. *Hurricane Matthew: Sources of Flooding and Mitigation Strategies in Lumberton, NC*. AECOM, 2017, pp. Appendix C, *Hurricane Matthew: Sources of Flooding and Mitigation Strategies in Lumberton, NC*.

18. State Climate Office of North Carolina, 2015. NC Extremes: Damaging hurricanes from slopes to shores. NC State University. Available at: http://climate.ncsu.edu/climateblog?id=157

19. State Climate Office of North Carolina, NC State University. CRONOS [internet database] available at http://climate.ncsu.edu/cronos/. Accessed December 20, 2019.

20. Thorn, H.C.S, 1968. New Distributions of Extreme Winds in the United States. Journal of the Structural Division, 1968, Vol. 94, Issue 7, Pg. 1787-1802

21. United States Army Corps of Engineers, 1984. Shore protection manual. Vicksburg, Miss: Dept. of the Army, Waterways Experiment Station, Corps of Engineers, Coastal Engineering Research Center.

22. United States Army Corps of Engineers, 1989. "Water Levels and Wave Heights for Coastal Engineering Design," US Army Corps of Engineers EM 1110-2-1414, July 5, 1989.

23. United States Army Corps of Engineers, 1990. “Maximum Periodic Wave Runup on smooth slopes”, US Army Corps of Engineers Miscellaneous Paper CERC-90-4.

24. United States Army Corps of Engineers, 1997. "Hydrologic Engineering Requirements 1. for Reservoirs," US Army Corps of Engineers EM 1110-2-1420.

25. United States Army Corps of Engineers, 2000. Hydrologic Modeling System HEC-HMS Technical Reference Manual. Report CPD-74B. United States Army Corps of Engineers, Davis, CA.

26. United States Army Corps of Engineers, 2017. Hydrologic Modeling System Version 4.2.1, United States Army Corps of Engineers, March 2017, Davis, CA.

27. United States Army Corp of Engineers (USACE). 2021. Hydrologic Engineering Center's River Analysis System (HEC-RAS), *Version 6.0*. February 2021.

28. United States Department of Agriculture Natural Resources Conservation Service. Geospatial Data Gateway [internet database] available at: http://datagateway.nrcs.usda.gov. Accessed October 30, 2019.

29. United States Geological Survey, 2009. Magnitude and Frequency of Rural floods in the Southeastern United States, through 2006: Volume 2, North Carolina. U.S department of Interior, U.S Geological Survey.

30. United States Geological Survey, 2016. The StreamStats program. Available at: http://streamstats.usgs.gov. Accessed on: November 1, 2019.

31. United States Geological Survey, 2019 a. PeakFQ Version 7.3. November 21, 2019.

32. United States Geological Survey, 2019 b. U.S. Guidelines for Determining Flood Frequency. Bulletin 17C.Techniques and Methods 4-B5 version 1.1., Department of Interior, U.S. Geological Survey, May 2019.

33. United States Geological Survey, 2020. USGS Current Conditions for North Carolina. Available at: https://waterdata.usgs.gov/nc/nwis/uv?. Accessed on January 4,2020.

34. *USGS Flood Event Viewer*, 2019. United States Geological Survey National Water Information System Database, stn.wim.usgs.gov/fev/.

35. Weaver, J.C., Feaster, T.D., and Robbins, J.C., 2016. Preliminary peak stage and streamflow data at selected streamgaging stations in North Carolina and South Carolina for flooding following Hurricane Matthew, October 2016: US Geological Survey Open-File Report 2016-1205, 38: https://doilorg/10.3133/ofr20161205

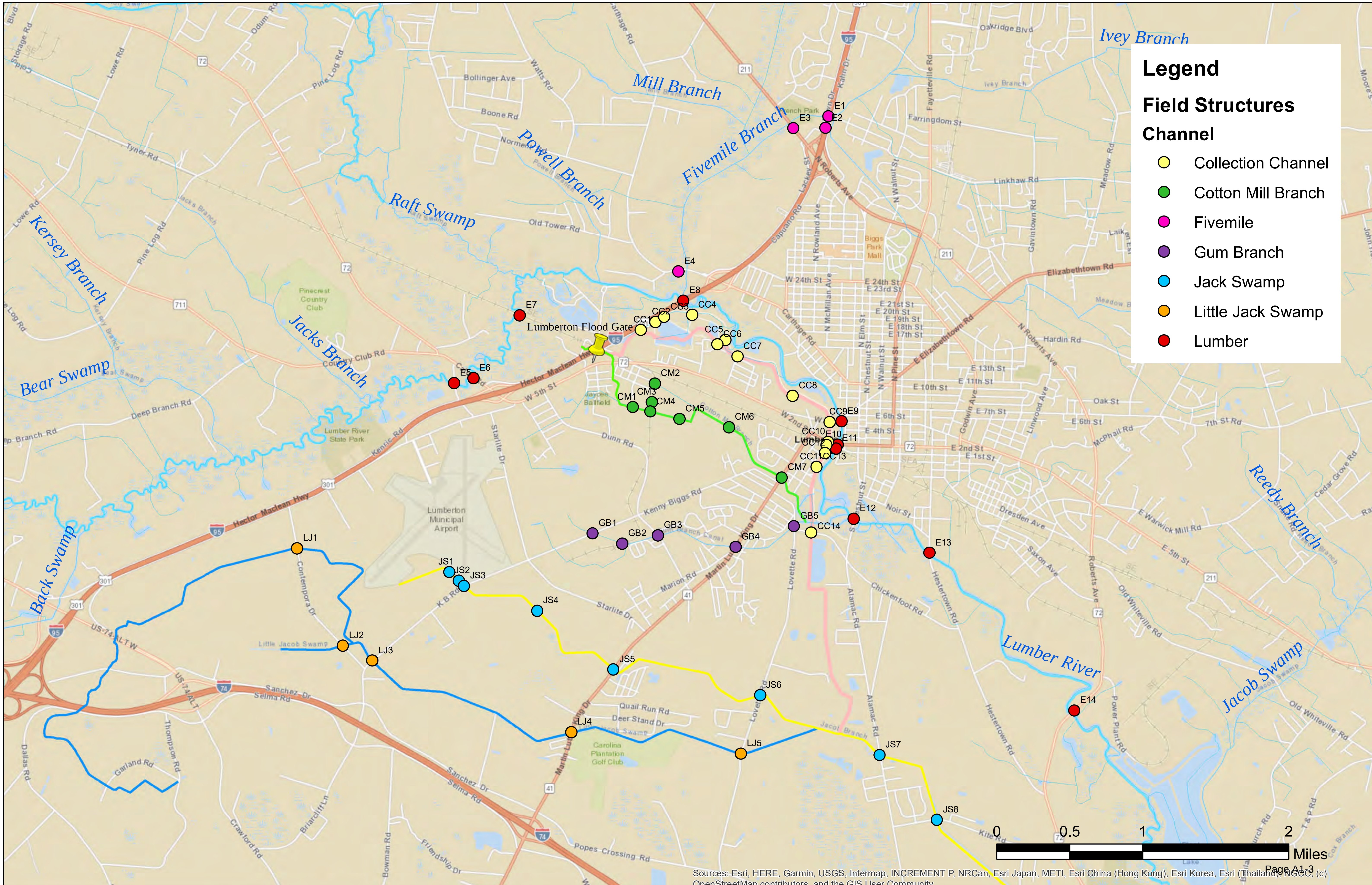
Appendices

Appendix A. Field Data

HYDRAULIC STRUCTURE DATA

Complete Structure List from Field Data Collection

Label Name	Channel	Street Name	Field Accesible?	Status	Latitude	Longitude	Structure Type	Material	Inlet	Rise	Span	Diameter	# Piers	Culvert Length	Obstruction/ Buried
E1	Fivemile Branch	Dawn Dr (next to I-95)		Will be surveyed	34.650605	-79.012221	2RCBC	Concrete		8	10				
E2	Meadow Branch	Dawn Dr (next to I-95)		Will be surveyed	34.649444	-79.012578	2RCBC	Concrete		8	10				
E3	Fivemile Branch	N Roberts Ave (SR 211)		Will be surveyed	34.649424	-79.016424	3RCBC	Concrete		9	14				
E4	Fivemile Branch	W Carthage Rd (SR 1536)		Will be surveyed	34.635177	-79.030266	3RCBC	Concrete		11	14				
E5	Lumber River	Kenric Rd (SR 1539)		Effective	34.624071	-79.057228	Bridge				194.9		2		
E6	Lumber River	S Caton Rd		Effective	34.624567	-79.054882	Bridge				354.9		4		
E7	Lumber River	CSX Railroad	Not accessible	Effective	34.630821	-79.04933	Bridge				350		14		
E8	Lumber River	I-95		Effective	34.632279	-79.029675	2 Bridges						7		
E9	Lumber River	5th Street		Effective	34.620186	-79.010729	Bridge				236.6		5		
E10	Lumber River	W 2nd St		Effective	34.617969	-79.011103	Bridge				282.9		5		
E11	Lumber River	CSX Railroad		Effective	34.617576	-79.011324	Bridge						14		
E12	Lumber River	Alamac Rd (SR 2289)		Effective	34.610595	-79.009171	Bridge				330.5		6		
E13	Lumber River	S Chippewa St/ Hestertown Rd		Will be surveyed	34.607211	-79.000088	Bridge				198		4		
E14	Lumber River	NC HWY 72		Effective	34.591539	-78.982678	Bridge				360.9		7		
E15	Small Trib	NC Hwy 72		Missing	34.584553	-79.986302	Arch Culvert	Aluminum		6.4	26				
LJ1	Little Jacob Swamp Diversion	Contempora Dr (SR 2513)		Effective	34.607631	-79.076069	Circular Culverts (2)	CMP	Headwall			4.5		60	Look at field sketch; Left = 3.1', Right = 1.8'
LJ2	Little Jacob Swamp	Contempora Dr (SR 2513)		Effective	34.597965	-79.070544	Circular Culvert	Concrete	Square edge entrance with headwall			5		40	
LJ3	Little Jacob Swamp	KB Rd (SR 2413)		Effective	34.596479	-79.067027	Circular Culverts (2)	CMP	L @ Mitered to conform to slope; R @ Headwall					60	
LJ4	Little Jacob Swamp	MLK Dr (NC 41)		Effective	34.589393	-79.043117	Arch (2)	Corrugated Metal	90 degree headwall	7.1	15			60	
LJ5	Little Jacob Swamp	Lovette Rd (SR 2204)		Effective	34.587254	-79.022739	Arch	Corrugated Metal	90 degree headwall	8	20			40	
JS1	Jacob Swamp	Culvert in Field		Missing	34.605287	-79.057754									
JS2	Jacob Swamp	Culvert in Field		Missing	34.604426	-79.056623									
JS3	Jacob Swamp	KB Rd (SR 2413)		Effective	34.603918	-79.055988	CMP	Corrugated Metal	Thin wall projecting			6		50	
JS4	Jacob Swamp	Culvert in Field	Not accessible	Missing	34.601447	-79.047198	Culvert								
JS5	Jacob Swamp	MLK Dr (NC 41)		Effective	34.595612	-79.038041	Box Culverts (2)	Concrete	Wingwall flared 30 to 75 deg	4.5	6			40	
JS6	Jacob Swamp	Lovette Rd (SR 2204)		Effective	34.59306	-79.020421	Bridge			7.4 to LC	24		0	40	
JS7	Jacob Swamp	Alamac Rd (SR 2289)	Not accessible	Effective	34.587111	-79.006068	Bridge								
JS8	Jacob Swamp	SR 2305		Effective	34.580668	-78.99918	Bridge			11 to LC	90		1		
JS9	Jacob Swamp	Wilmington Hwy (NC 72)		Effective	34.565913	-78.976465	Bridge			14 to LC	90		2		
GB1	Gum Branch	Kenny Biggs Rd (SR 2413)		Missing	34.609149	-79.040569	Elliptical CMP (2)	CMP	90-deg HW	5	8				
GB2	Gum Branch	Railroad	Not accessible	Missing	34.608131	-79.036988	Culvert								
GB3	Gum Branch	Crandlemire Rd		Missing	34.608943	-79.032704	2 CMP	CMP	Stone HW			6			
GB4	Gum Branch	MLK Dr (NC 41)		Missing	34.60779	-79.023378	Arched Bridge			7.3	23.5				
GB4.5	Gum Branch						CMP	CMP				5.5		39	
GB5	Gum Branch	Lovette Rd (SR 2204)		Missing	34.609855	-79.016345	2 Arched CMP	CMP		6	12				
CM1	Cotton Mill Branch	School St		Missing	34.621688	-79.035749	Culvert	Plastic				4			
CM2	Cotton Mill Branch	Railroad	Not accessible	Missing	34.624044	-79.033085	Culvert								
CM3	Cotton Mill Branch	Railroad	Not accessible	Missing	34.622187	-79.033458	Culvert								
CM4	Cotton Mill Branch	Railroad	Not accessible	Missing	34.621246	-79.033609	Culvert								
CM5	Cotton Mill Branch	Culvert in Field	Not accessible	Missing	34.620526	-79.030114	Culvert								
CM6	Cotton Mill Branch	Culvert in Field	Not accessible	Missing	34.619697	-79.024166	Culvert								
CM7	Cotton Mill Branch	MLK Dr (NC 41)		Effective	34.614704	-79.01783	2RCBC	Concrete	Flared WW, Beveled	8	9				
CC1	Collection Canal	Crystal Rd		Missing	34.629362	-79.03478	Pipe Culvert	Concrete	Proj.			2		52	
CC2	Collection Canal	Crystal Rd		Missing	34.630156	-79.033034	Pipe Culvert	Concrete, Open Bottom	3:1 Tapered Inlet, Proj.	3	1			54	
CC3	Collection Canal	Crystal Rd	Obstructed	Missing	34.630653	-79.03194	Culvert								Completely obstructed
CC4	Collection Canal	The Riverwalk (Levee)		Missing	34.630864	-79.028611	Bridge	Aluminum			37.4		0	3	
CC5	Collection Canal	The Riverwalk (Levee)		Missing	34.628388	-79.024622	Arched Bridge	Aluminum		9' to LC	59		0	8.9	
CC6	Collection Canal	Lowery St	Not accessible	Missing	34.62794	-79.025577	Culvert								Outlet Submersed, no inlet found
CC6.5	Collection Canal						Pipe Culvert	Concrete				1.5			Couldn't located inlet
CC7	Collection Canal	The Riverwalk (Levee)		Missing	34.62674	-79.023144	Bridge	Wood			51		2	5.7	
CC8	Collection Canal	The Riverwalk (Levee)		Missing	34.622822	-79.016516	2 Pipes	CMP				4			
CC9.5	Collection Canal						Bridge				41		2	7	
CC9	Collection Canal	W 5th Street		Missing	34.62021	-79.01208	RCP	Concrete	90 degree headwall			6			
CC10	Collection Canal	MLK Dr (NC 41)		Missing	34.618242	-79.012282	Pipe Culvert	CMP	90 degree headwall			7			
CC11	Collection Canal	Railroad	Not accessible	Missing	34.61793	-79.012451	Pipe Culvert	CMP				7			Completely blocked with Sediment
CC12	Collection Canal	Bullard St/ The Riverwalk		Missing	34.617154	-79.012644	2 CMP	CMP	Proj.			4		29.5	
CC12.5	Collection Canal			Missing			RCP	Concrete				3		76	
CC13	Collection Canal	Fig St/ The Riverwalk		Missing	34.615763	-79.013626	Culvert (long)	RCP	Proj.			5/7			
CC14	Collection Canal	Chicken Foot Rd		Missing	34.609231	-79.014287	Arch Culvert	CMP	HW	9	22				



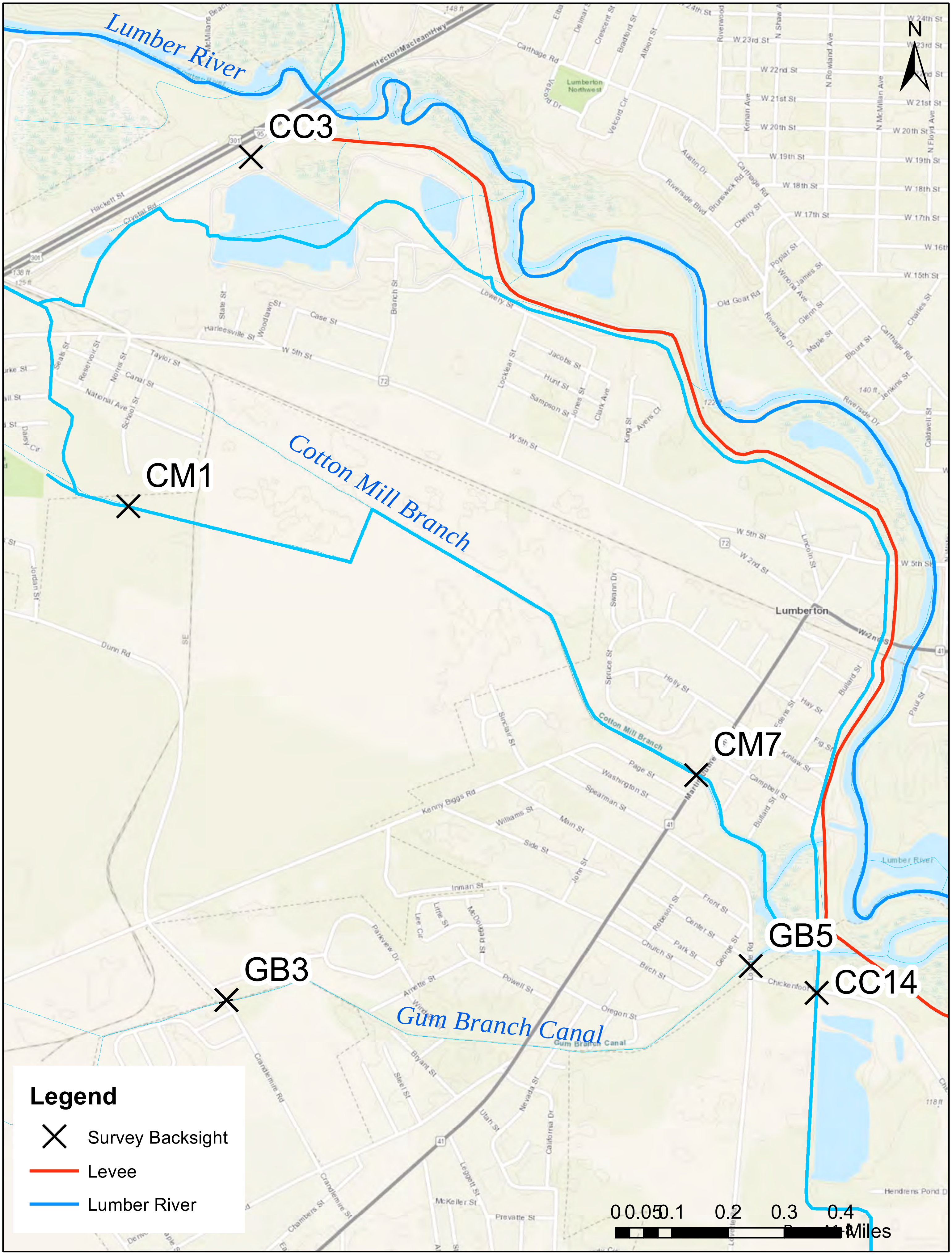
Legend
Field Structures
Channel
Collection Channel
Cotton Mill Branch
Fivemile
Gum Branch
Jack Swamp
Little Jack Swamp
Lumber
Lumberton Flood Gate
Ivey Branch
Mill Branch
Powell Branch
Fivemile Branch
Raft Swamp
Kersey Branch
Jacks Branch
Bear Swamp
Back Swamp
Lumber River
Reedy Branch
Jacob Swamp
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
E11
E12
E13
E14
CC1
CC2
CC3
CC4
CC5
CC6
CC7
CC8
CC9
CC10
CC13
CC14
CM1
CM2
CM3
CM4
CM5
CM6
CM7
GB1
GB2
GB3
GB4
GB5
JS1
JS2
JS3
JS4
JS5
JS6
JS7
JS8
LJ1
LJ2
LJ3
LJ4
LJ5
Lumberton Municipal Airport
Pinecrest Country Club
Lumber River State Park
Carolina Plantation Golf Club
0
0.5
1
2
Miles
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

HIGH-WATER MARKS DATA


Legend
HWM_All_Field_Collected
Lumber River
Levee
Lift Station #27
Lift Station #31 (Ramada Inn)
Lift Station #25
Raw Water Intake
Well Site #2 (Park)
Steel building by CSX RR (by gate)
Lift Station #23
VFW Crest by future Flood Gate
Lift Station #21
Lumberton Water Plant
Lumberton Water Plant Maintenance Building
0 0.2 0.4 0.8 1.2 1.6
Miles
N

Number	Street Name	Business/Address	Height	Latitude	Longitude	Storm	Notes
1	1451 Lowery St	Lumberton Water Plant	39" from floor	34.626688	-79.024735	Matthew	
2	1451 Lowery St	Lumberton Water Plant Maintenance Building	41" from floor	34.626243	-79.024175	Matthew	
3		Well Site #2 (Park)	42-43" from ground	34.630742	-79.031307	Matthew	
4		VFW Crest by future Flood Gate	36" from crest	34.627654	-79.039719	Florence	
5	2460 Cox Rd	Lift Station #23	85"	34.627352	-79.04139	Florence	Top of barbed wire
6		Steel building by CSX Railroad (by gate location)	36"	34.628221	-79.041324	Florence	
7		Raw Water Intake	120"	34.633669	-79.037256	Matthew; Florence	
8	415 County Club Dr	Lift Station #21		34.626366	-79.058788	Florence	68" from mound to bottom of generator; 40" from ground to mound base
9	2385 Lackey St	Lift Station #25	77"	34.64292	-79.025638	Florence	
10	3621 Dawn Drive	Lift Station #27	66"	34.65168	-79.012432	Florence	
11		Ramada Inn - Lift Station #31	45" from floor	34.647553	-79.010911	Matthew?	

CHANNEL CROSS-SECTION DATA


Lumber River
Cotton Mill Branch
Gum Branch Canal
CC3
CM1
CM7
GB3
GB5
CC14
N
Legend
Survey Backsight
Levee
Lumber River
Lumberton
0 0.05 0.1 0.2 0.3 0.4
Miles

Cross Section Data Analysis

Table 1. CC3 Survey Data

Station	BS	HI	FS	Elev
BM	4.36	119.2087		114.8487
0			4.36	114.8487
5			5.99	113.2187
15.5			9.15	110.0587
19			11.8	107.4087
22.5			11.3	107.9087
25.7			8	111.2087
30			5.82	113.3887
33			5.44	113.7687

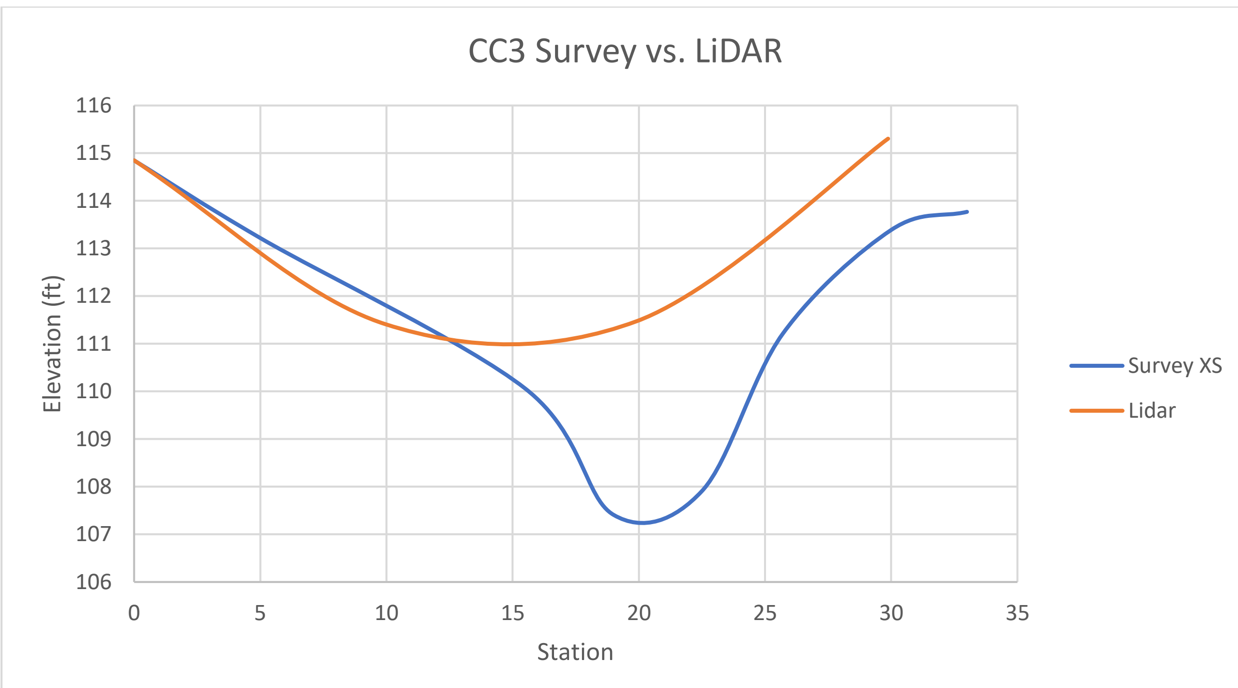


Figure 1. CC3 cross section

Table 2. CC14 Survey Data

Station	BS	HI	FS	Elev
BM	3.39	115.75		112.36
0			3.39	112.36
5			3.79	111.96
13			6.92	108.83
21			13.14	102.61
34			14.35	101.4
48			14.37	101.38
56			10.16	105.59
64			5.71	110.04
75			3.93	111.82

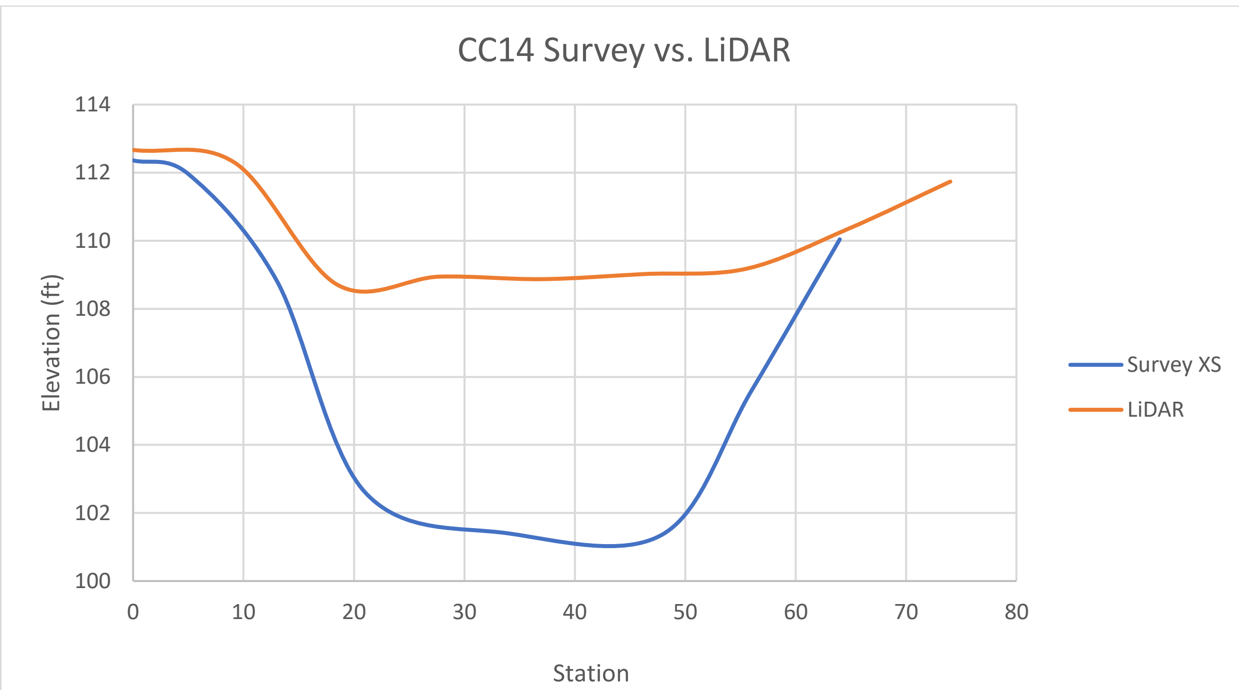


Figure 2. CC14 cross section

Table 3. CM7 Survey Data

Station	BS	HI	FS	Elev
BM	3.35	119.37		116.02
0			4.97	114.4
8			6.03	113.34
13			11.78	107.59
16			12.84	106.53
20			13.4	105.97
22			12.46	106.7
26			12.67	106.9
27.5			12.47	111.07
33			8.3	113.85
37			5.52	114.31
43			5.06	119.37

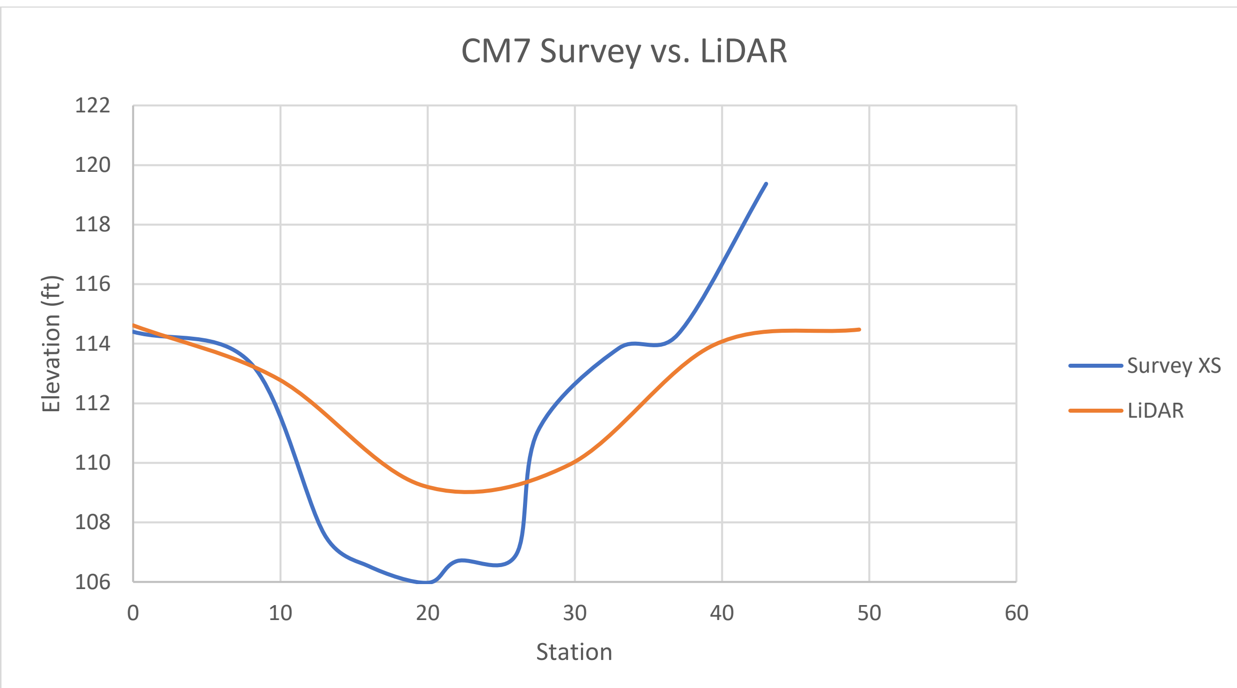


Figure 3. CM7 cross section

Table 4. GB3 Survey Data

Station	BS	HI	FS	Elev
BM	4.52	121.16		116.64
0			5.88	115.28
17			5.64	115.52
25			8.04	113.12
30			11.43	109.73
34.5			12.45	108.71
44			11.69	110.53
48.5			10.63	114.26
53			6.9	114.94
60			6.22	121.16

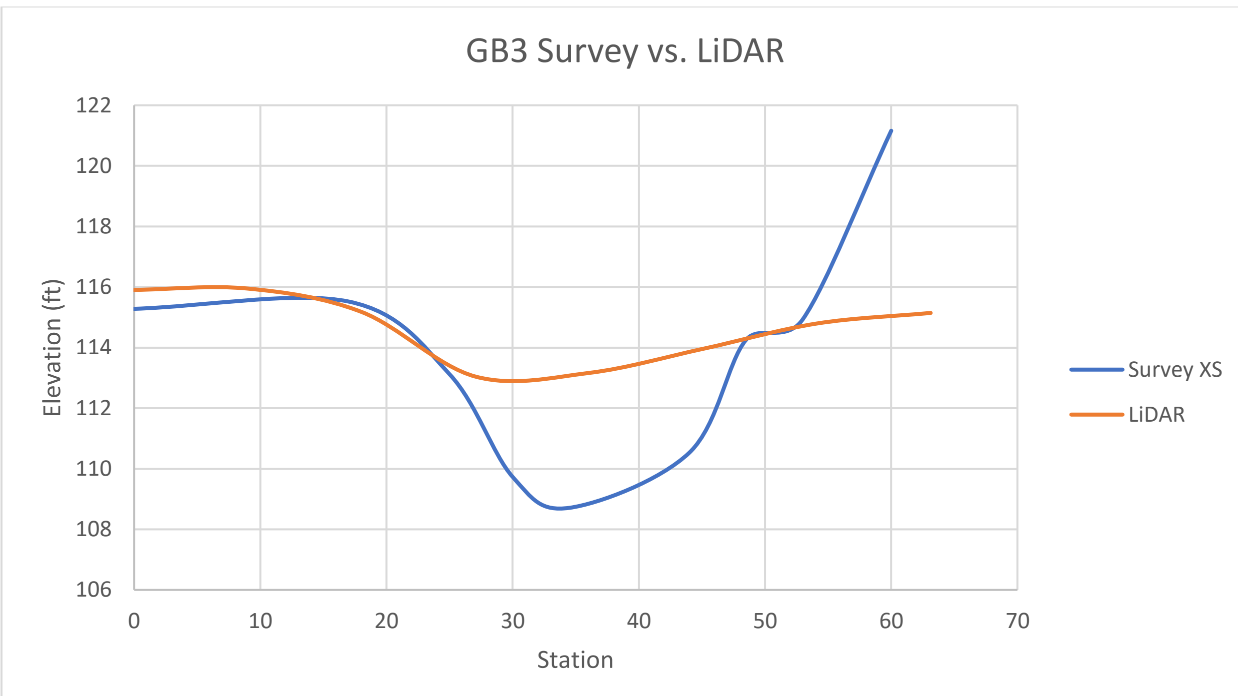


Figure 4. GB3 cross section

Table 5. GB5 Survey Data

Station	BS	HI	FS	Elev	
BM	4.48	117.3		112.82	
0			6.39	110.91	
6			6.76	110.54	
11			10.23	107.07	
21			12.46	104.84	
35			10.4	106.9	
42.5			4.32	117.3	not reliable

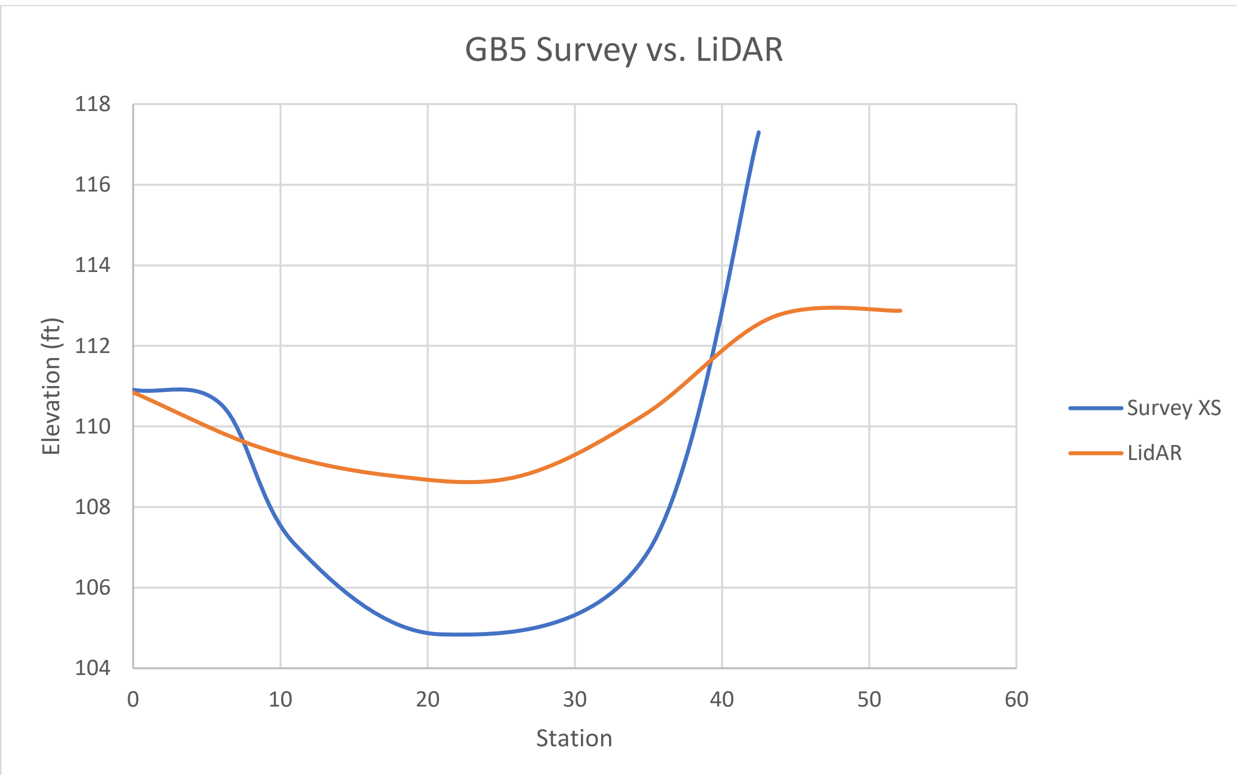


Figure 5. GB5 cross section

Table 6. CM1 Survey Data

Station	BS	HI	FS	Elev
BM	5.42	122.15		116.73
0			6.21	115.94
9			5.89	116.26
13			8.78	113.37
17			10.59	111.56
21			11.67	110.48
27			10.6	111.55
30.5			8.72	113.43
36			5.22	116.93

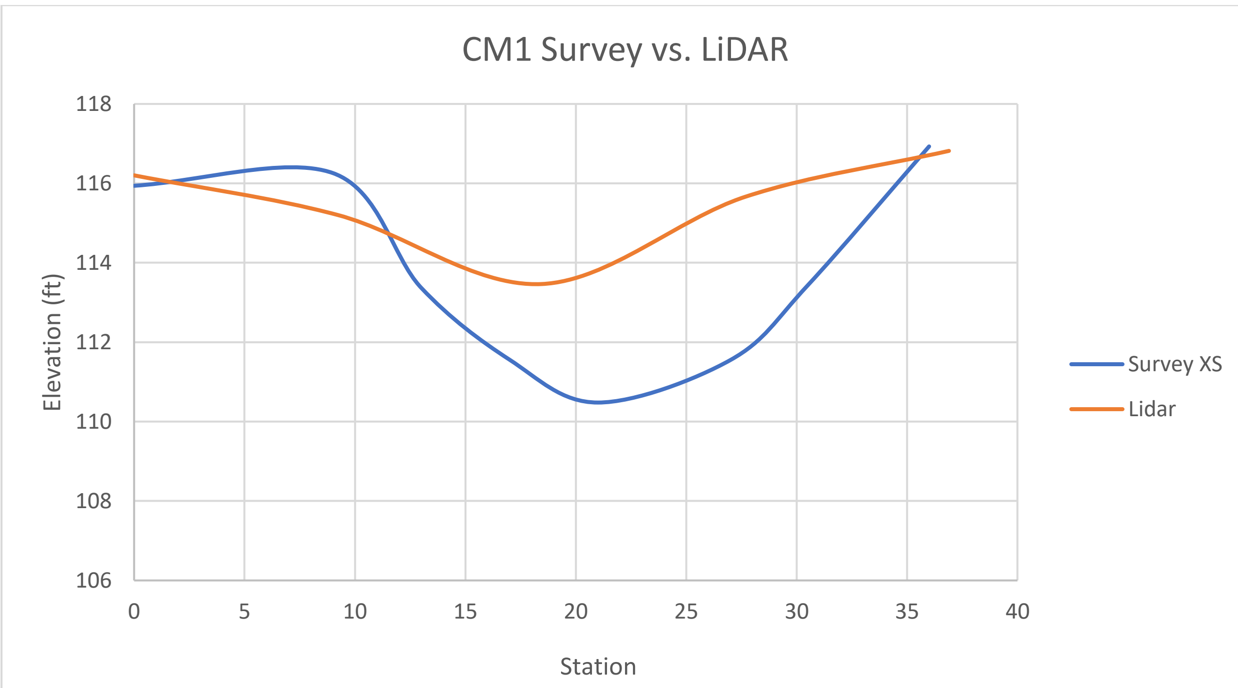


Figure 6. CM1 cross section

Appendix B. Hydrologic Analysis

B1 Rainfall Data and Analysis

Thiessen Polygon Procedure

1. Determine precipitation gage data availability for specific event (see table below)
2. Use a point shapefile with only the available gages to create a set of Thiessen polygons in GIS
3. Determine which polygons overlay the sub-basins
4. If a basin is within two or more polygons, calculate the area in each polygon and its proportion in relation to the sub-basin's total area. This proportion will become the weight
5. For sub-basins that have area-based weights collect the raw data from all rainfall gages being used (polygons falling within). The incremental rainfall for each gage will be multiplied by the appropriate area-based weight. The weighted rainfall from each of the gages utilized will be added across each time interval to get the new weighted rainfall.
6. Any sub-basin that completely falls within one thiessen polygon will use the rainfall gage data from that one gage with no weighting applied

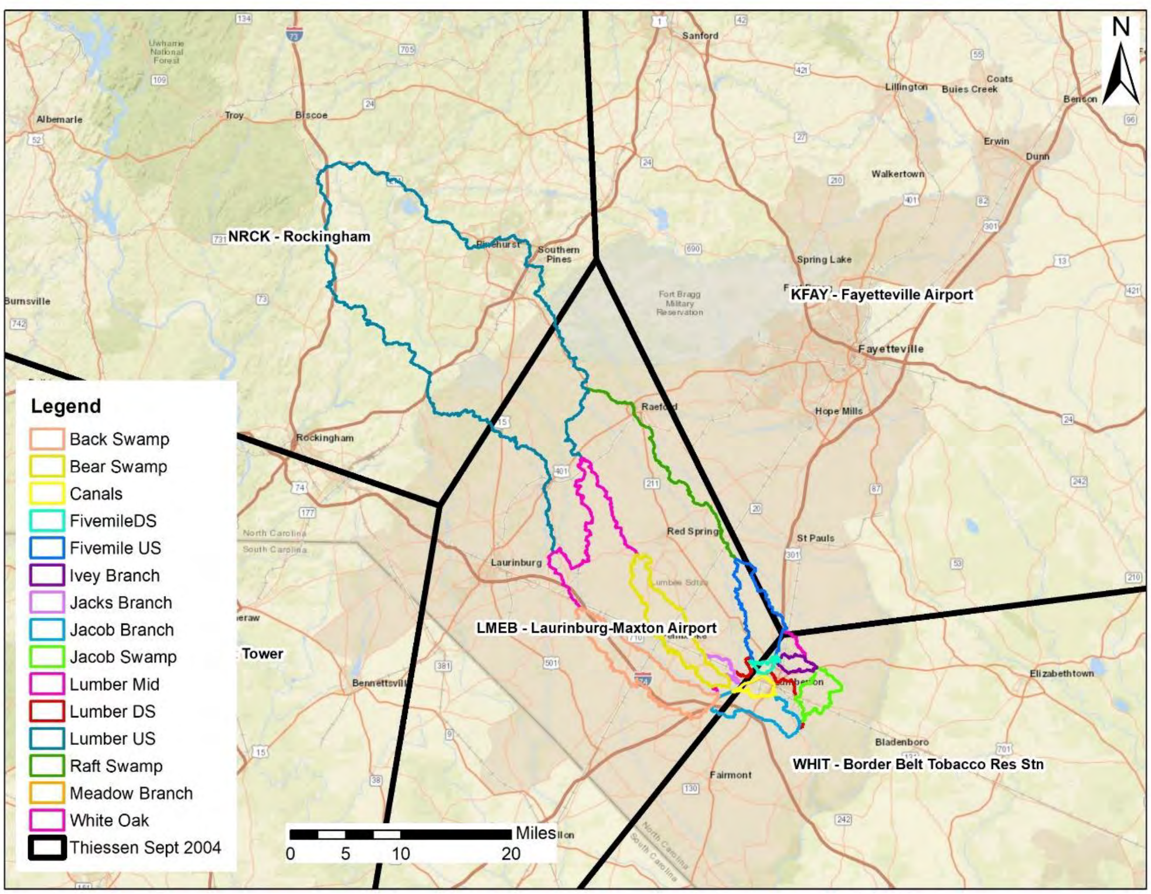
Gage	Sep-04	Oct-15	Oct-16	Sep-18
Fayetteville Airport				
Hamlet				
Jackson Springs				
Laurinburg				
Lilesvile				
Lumberton				
Mackall Airfield				
Moore Airport				
Rockingham				
Troy				
Whiteville				

Event	Gage Rainfall Range (in)
Sept 2004	4.31 – 11.87
Oct 2015	5.74 – 7.40
Oct 2016	8.12 – 12.59
Sept 2018	12.95 – 17.53

Thiessen Weights

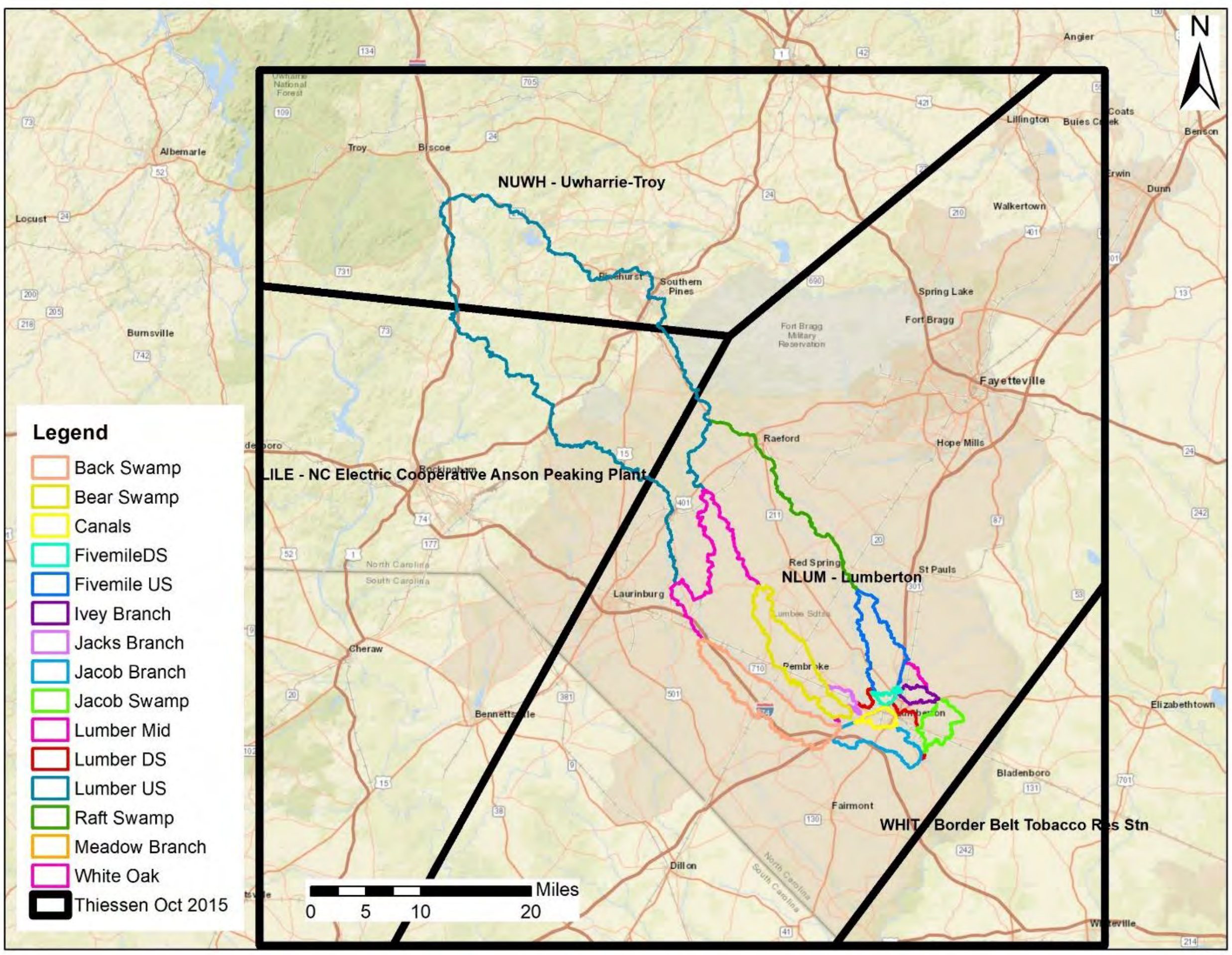
September 2004

Sub-basin	KFAY	KMEB	NRCK	WHIT
Back Swamp	0	1	0	0
Bear Swamp	0	1	0	0
Fivemile DS	0	0.13	0	0.87
Fivemile US	0.08	0.86	0	0.06
Internal Canals	0	0.03	0	0.97
Ivey Branch	0	0	0	1
Jacks Branch	0	1	0	0
Jacob Branch	0	0.14	0	0.86
Jacob Swamp	0	0	0	1
Lumber DS	0	0.32	0	0.68
Lumber Mid	0	1	0	0
Lumber US	0	0.24	0.76	0
Meadow Branch	0	0	0	1
Raft Swamp	0	1	0	0
White Oak	0.05	0	0	0.95



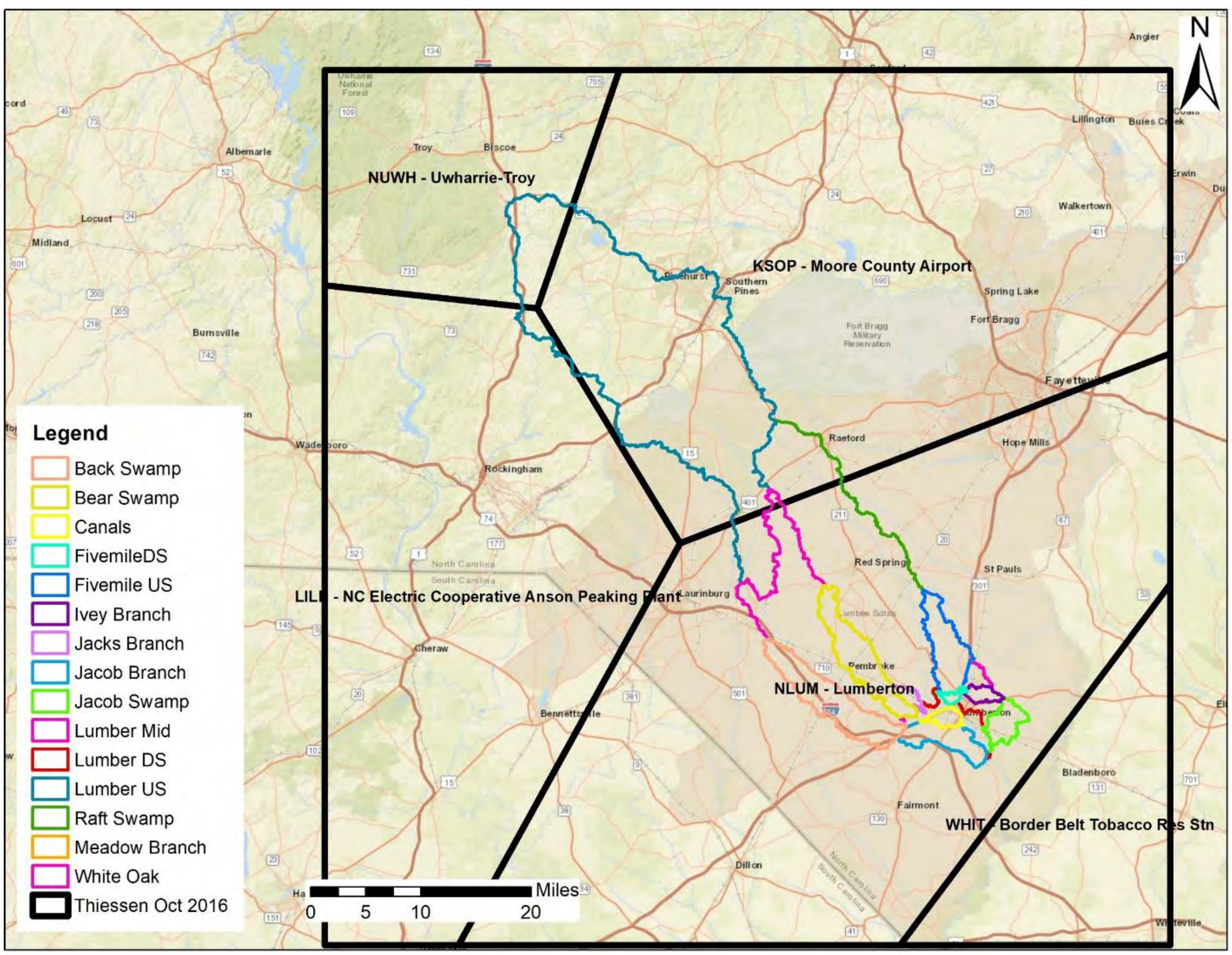
October 2015

Sub-basin	LILE	NLUM	NUWH
Back Swamp	0	1	0
Bear Swamp	0	1	0
Fivemile DS	0	1	0
Fivemile US	0	1	0
Internal Canals	0	1	0
Ivey Branch	0	1	0
Jacks Branch	0	1	0
Jacob Branch	0	1	0
Jacob Swamp	0	1	0
Lumber DS	0	1	0
Lumber Mid	0	1	0
Lumber US	0.5	0.14	0.36
Meadow Branch	0	1	0
Raft Swamp	0	1	0
White Oak	0	1	0



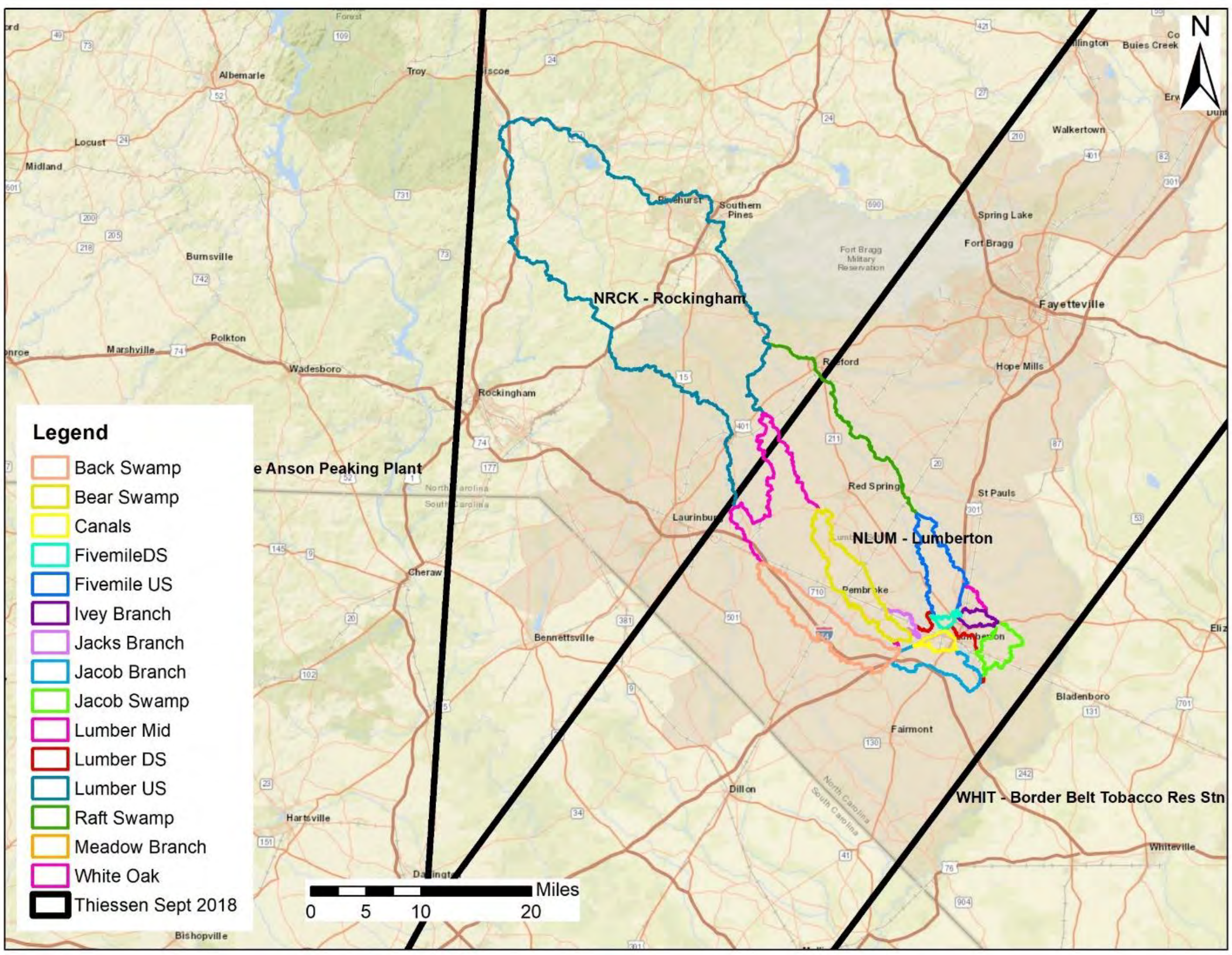
October 2016

Sub-basin	KSOP	LILE	NLUM	NUWH
Back Swamp	0	0	0	0
Bear Swamp	0	0	0	0
Fivemile DS	0	0	0	0
Fivemile US	0	0	0	0
Internal Canals	0	0	0	0
Ivey Branch	0	0	0	0
Jacks Branch	0	0	0	0
Jacob Branch	0	0	0	0
Jacob Swamp	0	0	0	0
Lumber DS	0	0	0	0
Lumber Mid	0.02	0	0.98	0
Lumber US	0.82	0.02	0.06	0.1
Meadow Branch	0	0	0	0
Raft Swamp	0.22	0	0.78	0
White Oak	0	0	0	0



September 2018

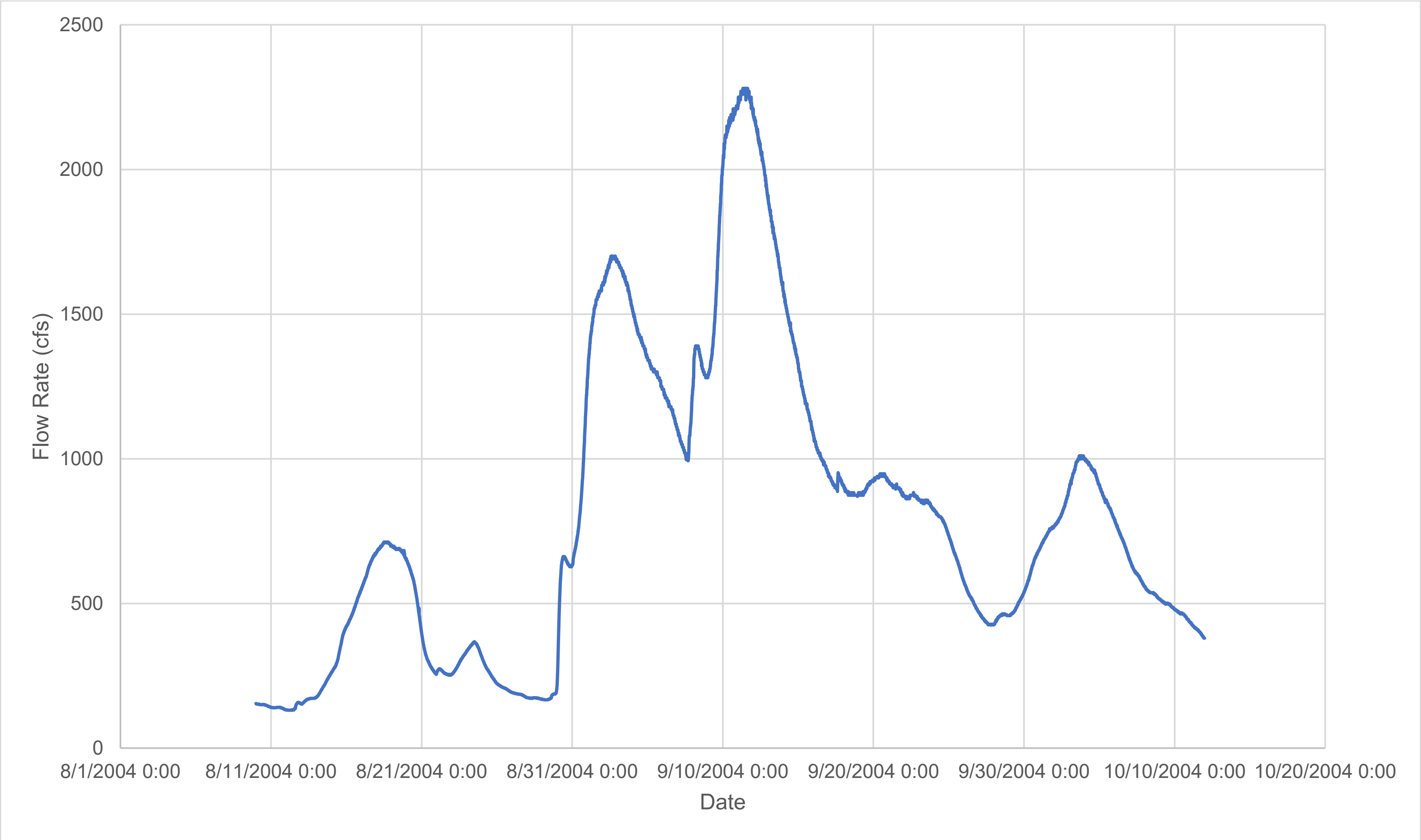
Sub-basin	NLUM	NRCK
Back Swamp	1	0
Bear Swamp	1	0
Fivemile DS	1	0
Fivemile US	1	0
Internal Canals	1	0
Ivey Branch	1	0
Jacks Branch	1	0
Jacob Branch	1	0
Jacob Swamp	1	0
Lumber DS	1	0
Lumber Mid	0.95	0.05
Lumber US	0.03	0.97
Meadow Branch	1	0
Raft Swamp	0.81	0.19
White Oak	1	0



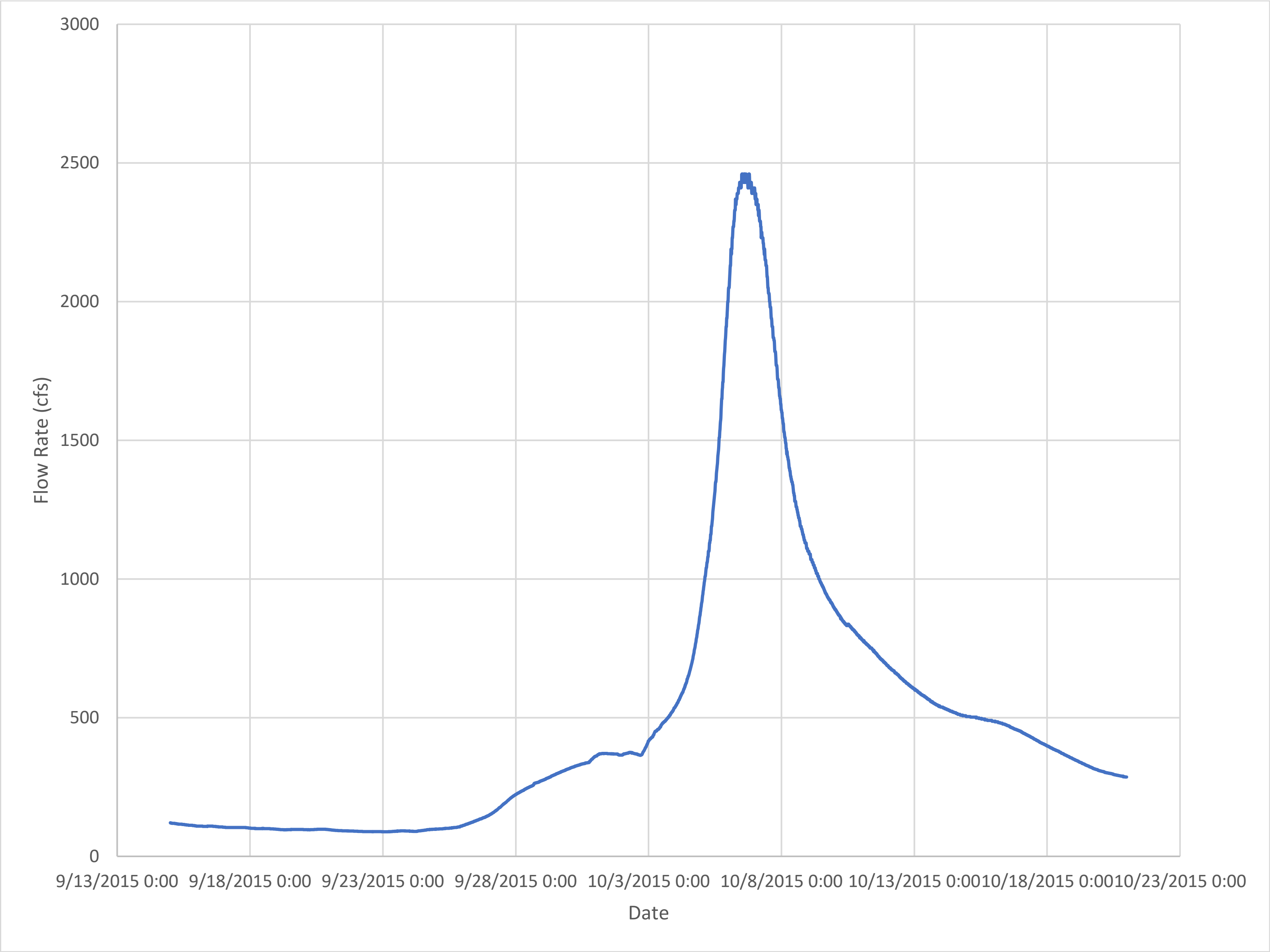
B2 Streamflow Data

USGS 02133624 Lumber River at Maxton, NC

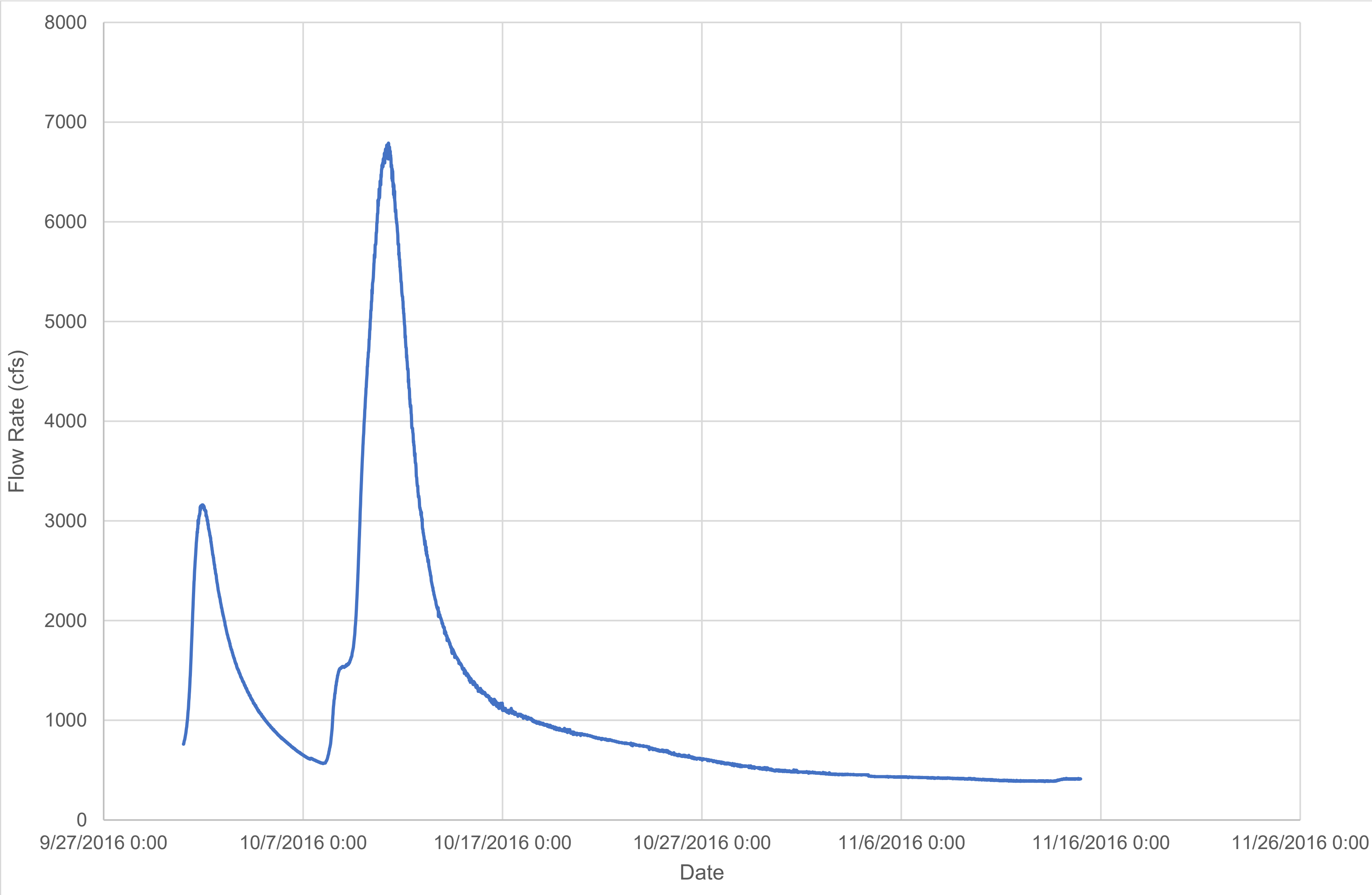
September 2004



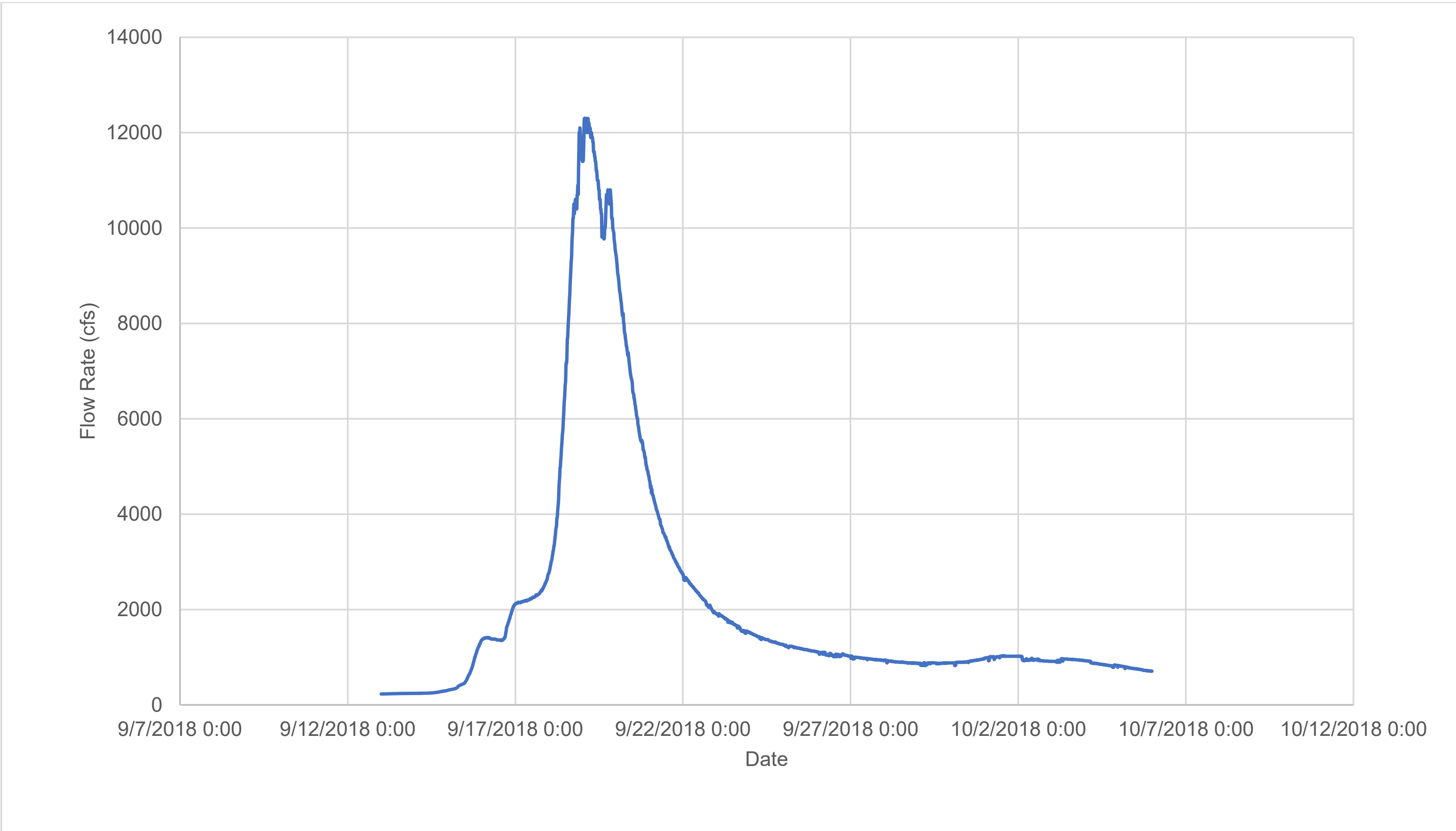
October 2015



October 2016

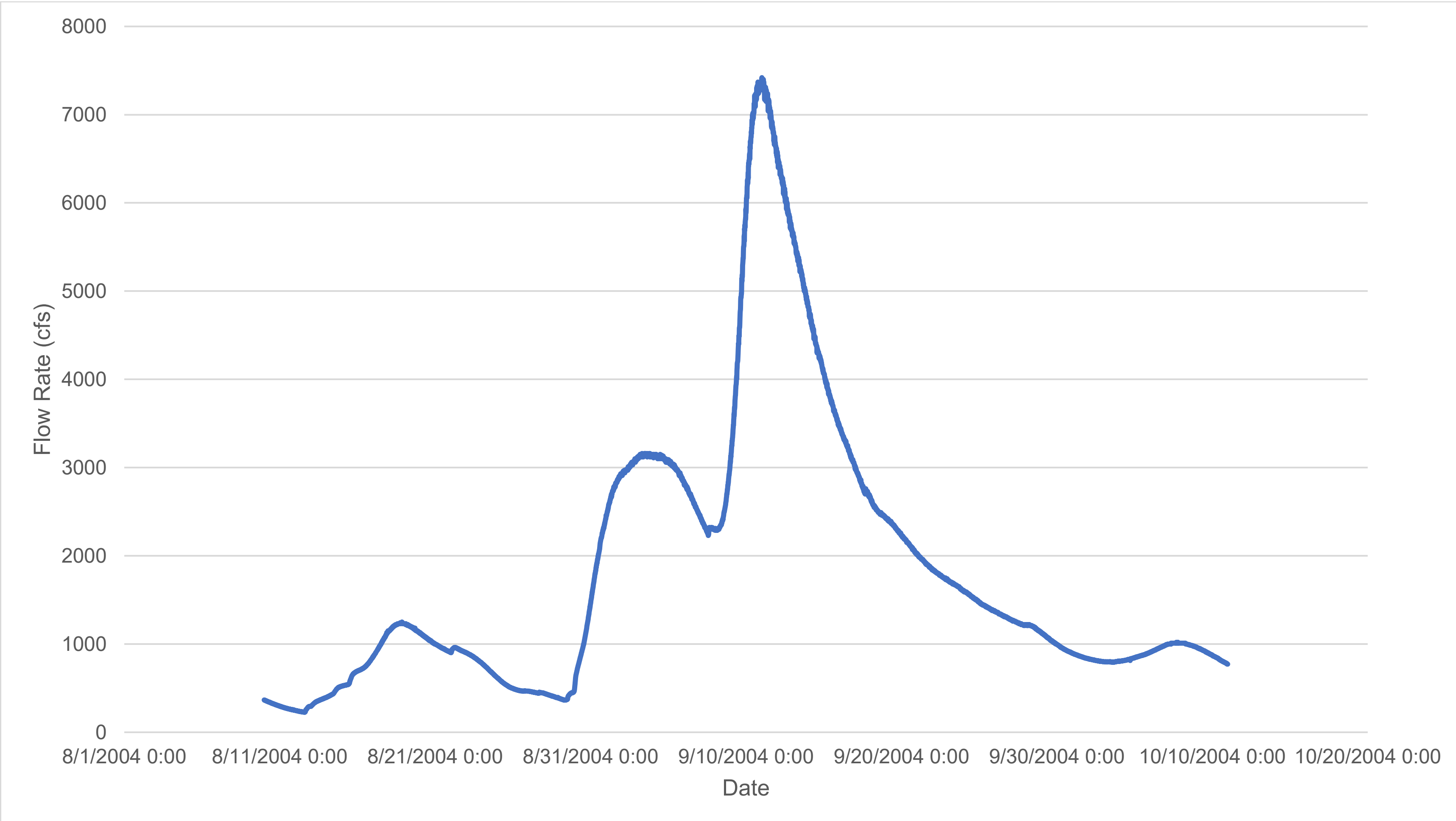


September 2018

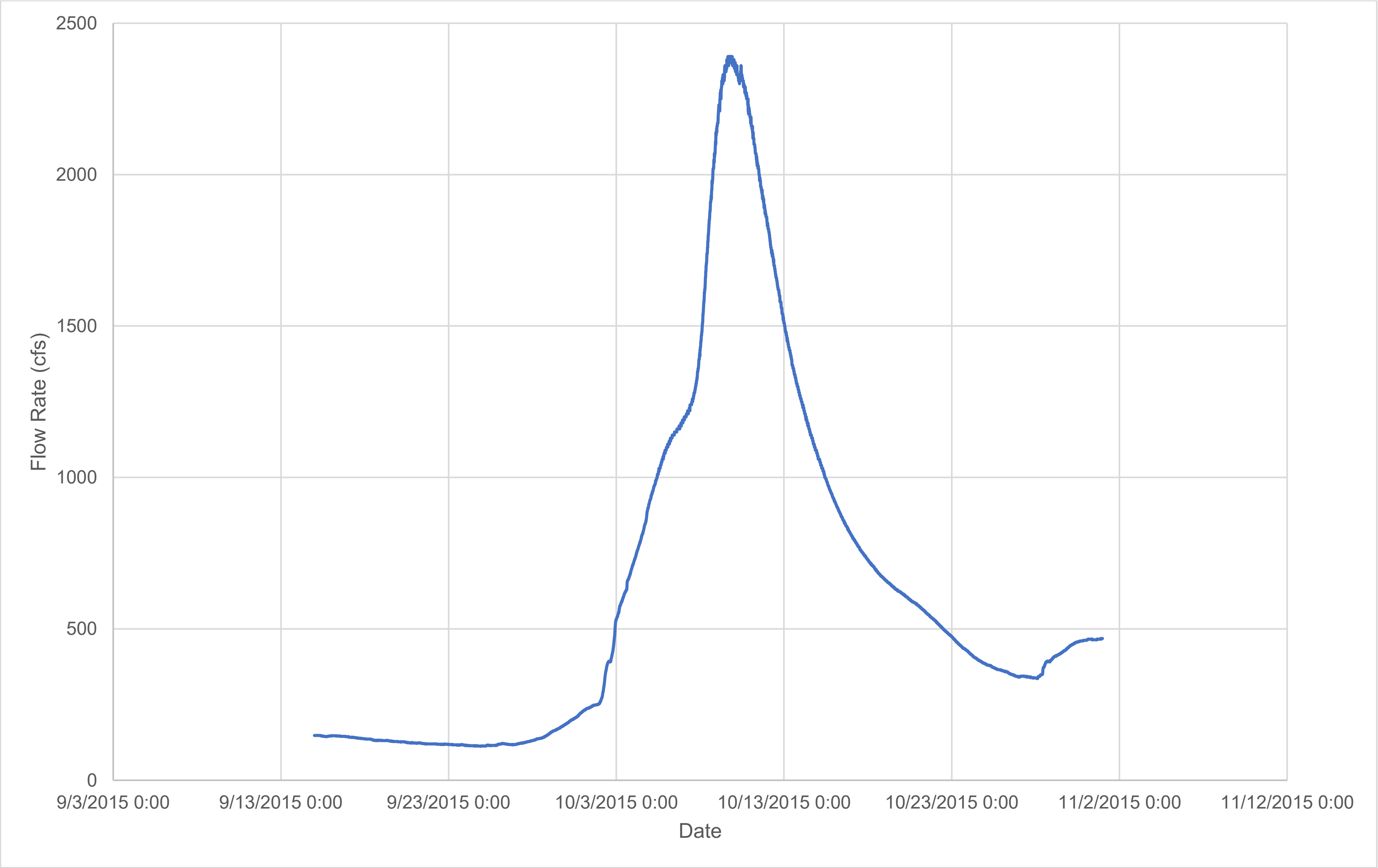


USGS 02134170 Lumber River at Lumberton, NC

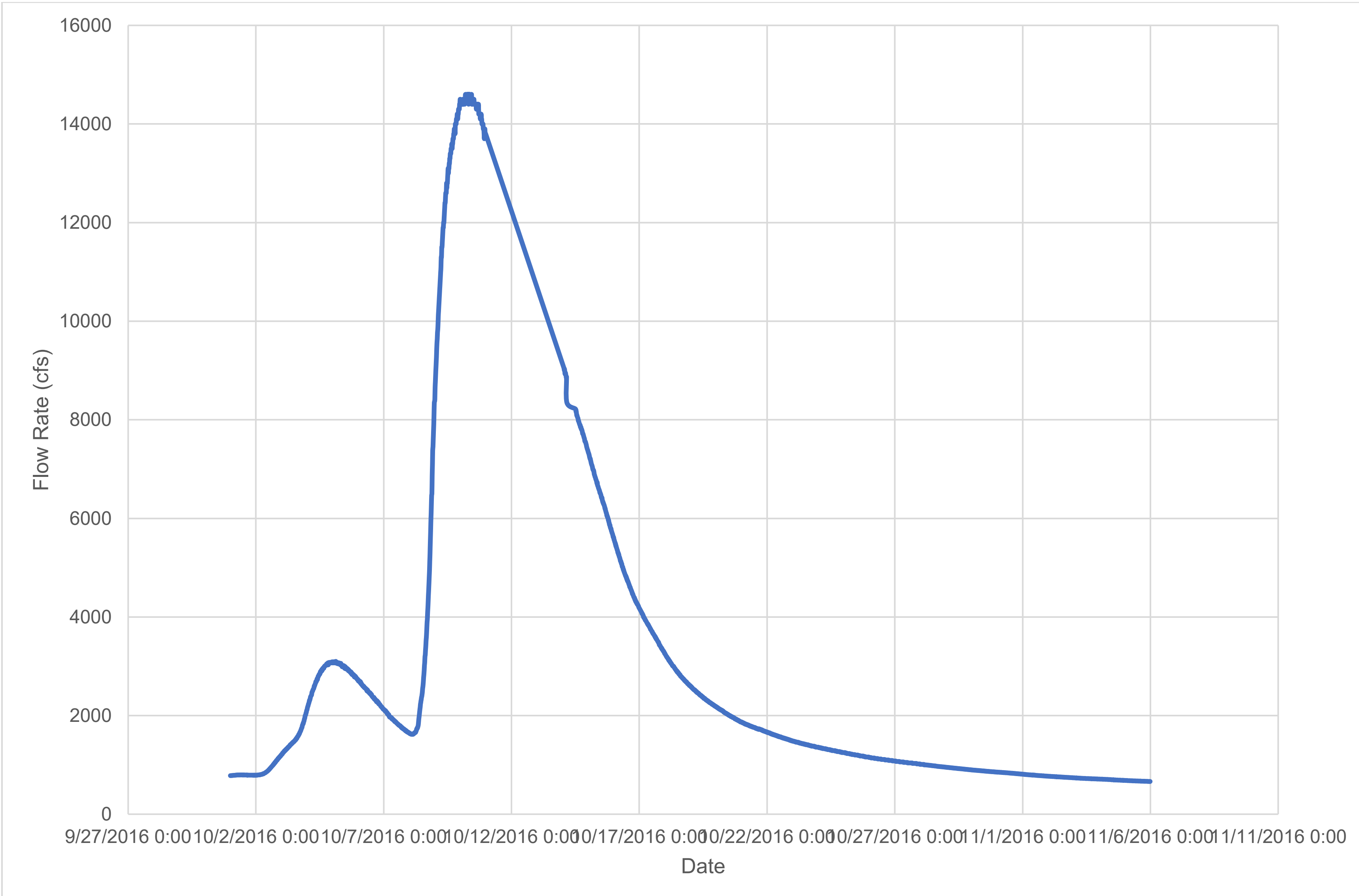
September 2004



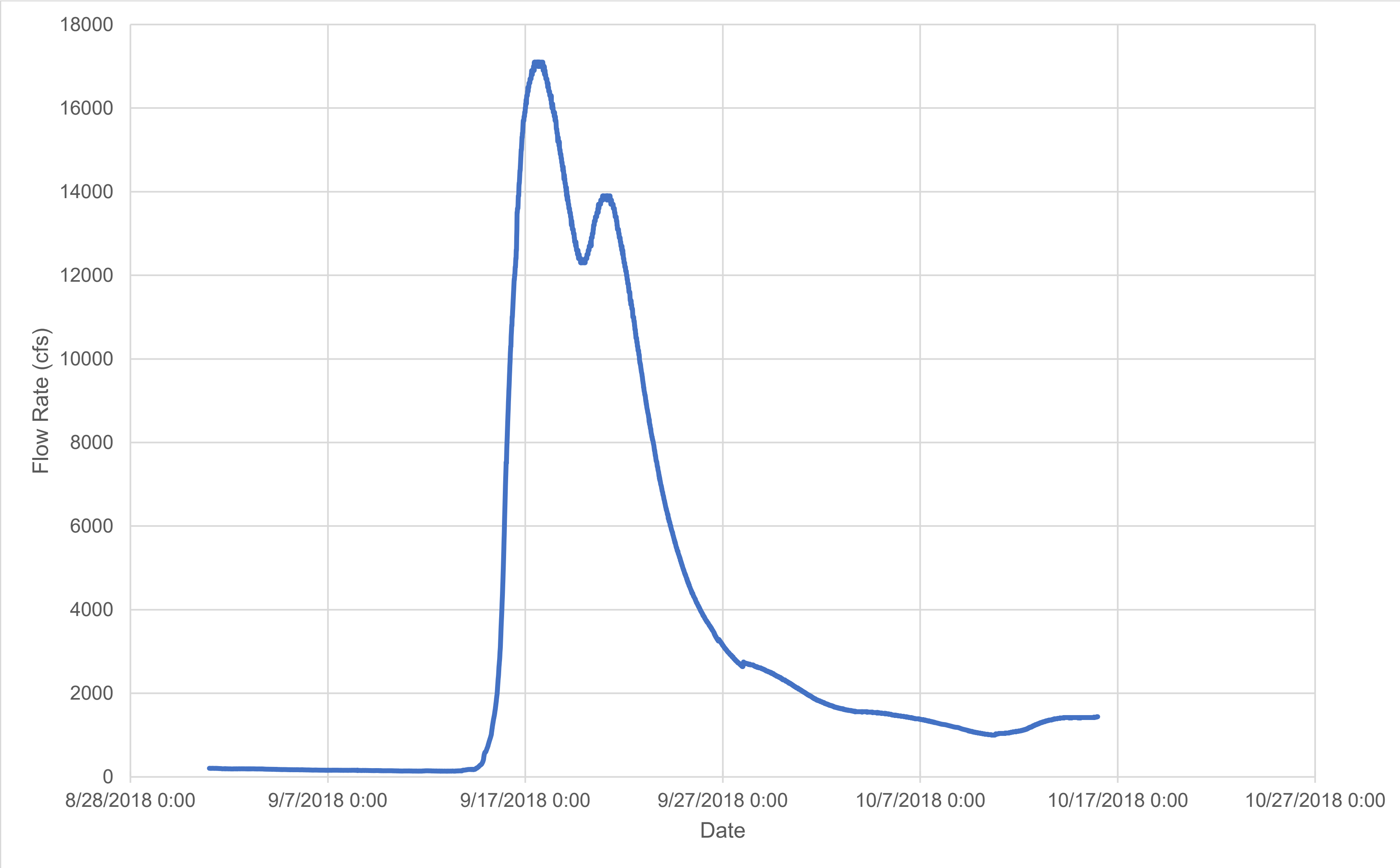
October 2015



October 2016



September 2018



B3 HEC-HMS Model Calibration and Verification Results

HEC-HMS Calibration

Junction 5

Storm	Approx. Return Period (Yrs)	Peak Flowrate (cfs)			Time Date and Time			Notes	Observed volume	Computed Volume	Volume Differential
		Observed	Simulated	% Difference	Observed	Simulated	Difference (hrs)				
Sep 2004		7420	7097.2	-4%	9/11/2004 2:00	9/11/2004 12:00	10		152897	149569	-2%
Oct 2015		2390	2421.1	1%	10/9/2015 15:45	10/9/2015 12:00	-3.75	10/9/2015 18:00	38912	27568	-29%
Sept 2018		17100	17257	1%	9/17/2018 11:00	9/17/2018 11:00	0	Hurricane Florence	230179	229185	-0.4%

Junction 11

Storm	Approx. Return Period (Yrs)	Peak Flowrate (cfs)			Time Date and Time			Notes
		Observed	Simulated	% Difference	Observed	Simulated	Difference (hrs)	
Sep 2004		2280	3438.8	51%	9/11/2004 8:00	9/11/2004 6:00	-2	
Oct 2015		2460	2329.6	-5%	10/6/2015 14:00	10/6/2015 11:00	-3	10/9/2015 18:00
Sept 2018		12300	8281	-33%	9/19/2018 4:00	9/19/2018 11:00	7	Hurricane Florence

	Reach 9 Routing	0.0003	0.08		Reach 9 Routing	0.0003	0.08		Reach 9 Routing	0.001	0.03				
	Sep-18				Oct-15				Sep-04				AVERAGE		
	Initial Loss	Constant Loss	Ct	Cp	Initial Loss	Constant Loss	Ct	Cp	Initial Loss	Constant Loss	Ct	Cp	Constant Loss	Ct	Cp
Back Swamp		0.15	7	0.4		0.15	7	0.4		0.12	7	0.4	0.14	7	0.40
Bear Swamp		0.15	7	0.4		0.15	7	0.4		0.12	7	0.4	0.14	7	0.40
Fivemile DS		0.05	6	0.4		0.05	7	0.4		0.05	7	0.4	0.05	7	0.40
Fivemile US		0.05	6	0.4		0.05	7	0.4		0.05	7	0.4	0.05	7	0.40
Internal Canals		0.05	6	0.4		0.05	7	0.4		0.05	7	0.4	0.05	7	0.40
Ivey Branch		0.05	6	0.4		0.05	7	0.4		0.05	7	0.4	0.05	7	0.40
Jacks Branch		0.05	6	0.4		0.05	7	0.4		0.05	7	0.4	0.05	7	0.40
Jacob Branch		0.05	6	0.4		0.05	7	0.4		0.05	7	0.4	0.05	7	0.40
Jacob Swamp		0.05	6	0.4		0.05	7	0.4		0.05	7	0.4	0.05	7	0.40
Lumber DS		0.05	6	0.4		0.05	7	0.4		0.05	7	0.4	0.05	7	0.40
Lumber Upper	5	0.14	6	0.8	3.3	0.14	8	0.8	4	0.14	8	0.6	0.14	7	0.73
Lumber Mid		0.15	8	0.4		0.15	8	0.4		0.12	8	0.4	0.14	8	0.40
Meadow Branch		0.05	6	0.4		0.05	7	0.4		0.05	7	0.4	0.05	7	0.40
Raft Swamp		0.18	8	0.4		0.18	8	0.4		0.2	8	0.4	0.19	8	0.40
White Oak		0.05	6	0.4		0.05	7	0.4		0.05	7	0.4	0.05	7	0.40

HEC-HMS Design Storm Comparison

	SCS-24HR	SCS-48HR	SCS-72HR			SCS 24HR		SCS-48HR		SCS-72HR	
Recurrence Interval (Yrs)	Simulated Peak Flow (cfs)			FEMA Peakflows(cfs)	Gage Statistics (cfs)	% Diff_FEMA	% Diff_Gage	% Diff_FEMA	% Diff_Gage	% Diff_FEMA	% Diff_Gage
10	**5,334**	**5,506**	**5,520**	8,150	7,255	-53%	-36%	-48%	-32%	-48%	-31%
25	**6,991**	**7,191**	**7,204**	10,700	9,852	-53%	-41%	-49%	-37%	-49%	-37%
50	**8,451**	**9,683**	**10,569**	12,800	12,080	-51%	-43%	-32%	-25%	-21%	-14%
100	**10,103**	**13,141**	**13,993**	14,900	14,560	-47%	-44%	-13%	-11%	-6%	-4%
500	**18,720**	**22,105**	**23,025**	20,200	21,520	-8%	-15%	9%	3%	12%	7%
1000	**22,920**	**26,991**	**27,634**								

NOAA Partial - 48HR

Recurrence Interval (Yrs)	Simulated Peak Flow (cfs)	FEMA Peakflows(cfs)	Gage Statistics (cfs)	% Diff_FEMA	% Diff_Gage
10	5,661	8,150	7,255	-44%	-28%
25	7,030	10,700	9,852	-52%	-40%
50	8,487	12,800	12,080	-51%	-42%
100	10,665	14,900	14,560	-40%	-37%
500	19,333	20,200	21,520	-4%	-11%
1000	23,977				

HEC-HMS Verification

Storm	Approx. Return Period (Yrs)	Peak Flowrate (cfs)			Time Date and Time			Notes	Observed volume	Computed Volume	Volume Differential
		Observed	Simulated	% Difference	Observed	Simulated	Difference (hrs)				
Oct 2016		14600	16551.3	13%	10/10/16 7:00	10/10/16 10:00	3	Hurricane Matthew	223956	197598	-12%

Sub-basin Snyder Characteristics

Subbasin	L (mi)	Lc (mi)
Back Swamp	17.61	8.39
Bear Swamp	17.94	8.66
Fivemile DS	2.48	0.98
Fivemile US	12.49	4.67
Internal Canals	5.31	1.85
Ivey Branch	4.17	1.69
Jacks Branch	8.21	4.85
Jacob Branch	10.5	4.59
Jacob Swamp	7.32	3.33
Lumber DS	18.84	9.34
Lumber US	101.36	68.64
Meadow Branch	5.21	2.57
Raft Swamp	35.77	18.55
White Oak	3.87	1.69

B4 Curve Number Calculations

Sub-basin Curve Number

Sub-basin	Basin Area (sq. mi)	Good Conditions Composite CN
Back Swamp	35.09	85.7
Bear Swamp	28.39	83.1
Fivemile DS	1.71	82.8
Fivemile US	22.14	81.7
Lumberton Canals	3.88	83.2
Ivey Branch	3.76	79.4
Jacks Branch	3	82.2
Jacob Branch	15.28	85.2
Jacob Swamp	9.61	79.9
Lumber DS	10.15	84.3
Lumber Mid	73.54	82.9
Lumber US	365.27	62.1
Meadow Branch	4.94	78
Raft Swamp	167.02	78.9
White Oak	3.73	79.6

Back Swamp

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	58.5	2.5	100	16.3	0.9	100	89.0	1.7	100	284.7	2.2	100
21	Developed, Open Space	269.1	11.4	49	167.6	9.4	69	441.5	8.2	79	742.4	5.7	84
22	Developed, Low Intensity	133.1	5.6	54	103.0	5.8	70	242.6	4.5	80	376.9	2.9	85
23	Developed, Medium Intensity	38.9	1.6	61	31.2	1.7	75	71.1	1.3	83	90.5	0.7	87
24	Developed, High Intensity	3.4	0.1	77	0.2	0.0	85	7.2	0.1	90	12.0	0.1	92
31	Barren Land	1.7	0.1	77	1.0	0.1	86	1.1	0.0	91	1.3	0.0	94
41	Deciduous Forest	60.3	2.5	36	11.5	0.6	60	205.3	3.8	73	334.7	2.6	79
42	Evergreen Forest	150.5	6.4	36	99.7	5.6	60	766.1	14.3	73	1589.9	12.3	79
43	Mixed Forest	13.4	0.6	36	3.9	0.2	60	39.3	0.7	73	98.7	0.8	79
52	Shrub/Scrub	54.9	2.3	35	19.4	1.1	56	194.5	3.6	70	331.9	2.6	77
71	Grassland/Herbaceous	5.5	0.2	30	7.0	0.4	58	19.3	0.4	71	40.4	0.3	78
81	Pasture/Hay	4.2	0.2	39	0.0	0.0	61	4.7	0.1	74	3.1	0.0	80
82	Cultivated Crops	1230.2	52.0	67	1193.8	66.7	78	2323.4	43.3	85	4176.3	32.3	89
90	Woody Wetlands	341.3	14.4	100	132.4	7.4	100	946.4	17.6	100	4789.2	37.0	100
95	Emergent Herbaceous Wetlands	1.1	0.0	100	2.6	0.1	100	16.0	0.3	100	63.9	0.5	100
Total		2365.9	100.0	65.9	1789.6	100.0	77.0	5367.6	100.0	84.3	12936.0	100.0	91.0

Weighted Average CN = 85.7

Bear Swamp

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	7.9	0.2	100	0.0	0.0	100	0.0	0.0	100	55.1	0.5	100
21	Developed, Open Space	364.5	8.4	49	288.3	10.4	69	7.5	9.1	79	822.1	7.5	84
22	Developed, Low Intensity	130.1	3.0	54	135.8	4.9	70	2.6	3.2	80	348.8	3.2	85
23	Developed, Medium Intensity	34.1	0.8	61	31.5	1.1	75	0.2	0.3	83	145.5	1.3	87
24	Developed, High Intensity	8.0	0.2	77	18.9	0.7	85	0.0	0.0	90	33.8	0.3	92
31	Barren Land	0.0	0.0	77	0.0	0.0	86	0.0	0.0	91	0.0	0.0	94
41	Deciduous Forest	29.0	0.7	36	8.5	0.3	60	1.4	1.7	73	62.0	0.6	79
42	Evergreen Forest	151.9	3.5	36	183.8	6.6	60	5.1	6.2	73	881.4	8.1	79
43	Mixed Forest	6.1	0.1	36	8.3	0.3	60	1.0	1.2	73	28.9	0.3	79
52	Shrub/Scrub	36.1	0.8	35	45.4	1.6	56	2.4	2.9	70	146.3	1.3	77
71	Grassland/Herbaceous	5.2	0.1	30	6.8	0.2	58	0.0	0.0	71	23.8	0.2	78
81	Pasture/Hay	0.0	0.0	39	0.0	0.0	61	0.0	0.0	74	0.2	0.0	80
82	Cultivated Crops	3052.5	70.1	67	1846.5	66.5	78	53.7	65.5	85	4830.1	44.2	89
90	Woody Wetlands	525.6	12.1	100	200.7	7.2	100	7.2	8.7	100	3528.8	32.3	100
95	Emergent Herbaceous Wetlands	3.4	0.1	100	0.2	0.0	100	0.9	1.1	100	29.4	0.3	100
Total		4354.4	100.0	67.5	2774.8	100.0	76.6	82.0	100.0	84.2	10936.2	100.0	91.0

Weighted Average CN = 83.1

Lumberton Canals

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	2.1	1.2	100	1.0	1.3	100	15.1	1.4	100	85.0	7.3	100
21	Developed, Open Space	27.1	16.1	49	13.3	17.0	69	220.3	20.6	79	233.6	20.0	84
22	Developed, Low Intensity	32.4	19.2	54	12.6	16.2	70	258.0	24.2	80	151.2	13.0	85
23	Developed, Medium Intensity	19.1	11.4	61	14.7	18.8	75	174.4	16.3	83	57.3	4.9	87
24	Developed, High Intensity	7.3	4.4	77	8.0	10.3	85	81.7	7.7	90	13.5	1.2	92
31	Barren Land	0.0	0.0	77	0.0	0.0	86	0.0	0.0	91	0.0	0.0	94
41	Deciduous Forest	1.1	0.7	36	0.0	0.0	60	1.7	0.2	73	8.4	0.7	79
42	Evergreen Forest	30.7	18.2	36	0.1	0.1	60	86.6	8.1	73	123.9	10.6	79
43	Mixed Forest	0.0	0.0	36	0.0	0.0	60	0.0	0.0	73	0.7	0.1	79
52	Shrub/Scrub	15.2	9.0	35	0.0	0.0	56	8.5	0.8	70	24.5	2.1	77
71	Grassland/Herbaceous	0.0	0.0	30	0.0	0.0	58	0.5	0.0	71	7.6	0.6	78
81	Pasture/Hay	4.4	2.6	39	0.0	0.0	61	0.0	0.0	74	0.5	0.0	80
82	Cultivated Crops	19.1	11.4	67	28.2	36.0	78	197.3	18.5	85	234.9	20.1	89
90	Woody Wetlands	9.9	5.9	100	0.3	0.3	100	23.4	2.2	100	224.8	19.3	100
95	Emergent Herbaceous Wetlands	0.0	0.0	100	0.0	0.0	100	0.1	0.0	100	1.0	0.1	100
Total		168.5	100.0	54.2	78.2	100.0	75.7	1067.6	100.0	82.0	1166.9	100.0	88.9

Weighted Average CN = **83.2**

Fivemile DS

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	0.7	0.2	100	0.0	0.0	100	0.0	0.0	100	18.1	3.0	100
21	Developed, Open Space	36.1	9.8	49	11.1	16.9	69	6.2	10.2	79	47.0	7.9	84
22	Developed, Low Intensity	23.0	6.2	54	5.0	7.6	70	4.9	8.0	80	23.7	4.0	85
23	Developed, Medium Intensity	11.6	3.1	61	9.7	14.8	75	24.6	40.3	83	23.2	3.9	87
24	Developed, High Intensity	3.5	0.9	77	3.4	5.1	85	8.0	13.1	90	6.7	1.1	92
31	Barren Land	0.0	0.0	77	0.0	0.0	86	0.0	0.0	91	0.0	0.0	94
41	Deciduous Forest	0.0	0.0	36	1.1	1.7	60	0.0	0.0	73	3.9	0.7	79
42	Evergreen Forest	19.9	5.4	36	9.7	14.8	60	6.8	11.2	73	33.2	5.6	79
43	Mixed Forest	0.1	0.0	36	0.0	0.0	60	0.3	0.5	73	5.9	1.0	79
52	Shrub/Scrub	3.8	1.0	35	0.1	0.1	56	0.7	1.1	70	9.8	1.6	77
71	Grassland/Herbaceous	0.0	0.0	30	0.0	0.0	58	0.0	0.0	71	0.0	0.0	78
81	Pasture/Hay	0.0	0.0	39	0.0	0.0	61	0.0	0.0	74	0.0	0.0	80
82	Cultivated Crops	227.8	61.8	67	12.7	19.3	78	5.6	9.2	85	109.0	18.2	89
90	Woody Wetlands	41.1	11.1	100	12.9	19.7	100	3.9	6.4	100	311.7	52.1	100
95	Emergent Herbaceous Wetlands	1.3	0.4	100	0.0	0.0	100	0.0	0.0	100	5.6	0.9	100
Total		368.9	100.0	66.2	65.7	100.0	77.1	61.0	100.0	83.2	597.8	100.0	93.7

Weighted Average CN = 82.8

Fivemile US

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	8.4	0.2	100	0.0	0.0	100	0.0	0.0	100	32.4	0.4	100
21	Developed, Open Space	446.2	11.3	49	116.7	6.1	69	30.3	16.5	79	362.0	4.5	84
22	Developed, Low Intensity	215.3	5.4	54	46.0	2.4	70	20.0	10.9	80	147.3	1.8	85
23	Developed, Medium Intensity	64.0	1.6	61	16.6	0.9	75	18.7	10.2	83	52.4	0.6	87
24	Developed, High Intensity	21.7	0.5	77	6.2	0.3	85	1.0	0.5	90	6.2	0.1	92
31	Barren Land	0.4	0.0	77	0.0	0.0	86	0.0	0.0	91	0.0	0.0	94
41	Deciduous Forest	26.7	0.7	36	17.2	0.9	60	1.3	0.7	73	92.8	1.1	79
42	Evergreen Forest	279.7	7.1	36	300.8	15.8	60	12.3	6.7	73	1223.9	15.1	79
43	Mixed Forest	4.2	0.1	36	4.3	0.2	60	0.0	0.0	73	24.9	0.3	79
52	Shrub/Scrub	68.9	1.7	35	27.2	1.4	56	4.0	2.2	70	162.9	2.0	77
71	Grassland/Herbaceous	11.8	0.3	30	39.7	2.1	58	2.6	1.4	71	30.0	0.4	78
81	Pasture/Hay	8.4	0.2	39	0.0	0.0	61	0.0	0.0	74	6.7	0.1	80
82	Cultivated Crops	2393.1	60.5	67	1091.3	57.4	78	57.6	31.4	85	2662.2	32.9	89
90	Woody Wetlands	403.8	10.2	100	227.6	12.0	100	35.0	19.0	100	3230.7	39.9	100
95	Emergent Herbaceous Wetlands	3.7	0.1	100	7.2	0.4	100	1.0	0.6	100	64.5	0.8	100
Total		3956.3	100.0	64.5	1900.8	100.0	76.2	183.9	100.0	84.8	8098.9	100.0	91.3

Weighted Average CN = **81.7**

Ivey Branch

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	0.0	0.0	100	0.0	0.0	100	0.0	0.0	100	5.7	0.4	100
21	Developed, Open Space	52.2	11.8	49	56.4	11.8	69	27.7	26.5	79	176.6	12.7	84
22	Developed, Low Intensity	76.3	17.3	54	36.9	7.8	70	32.4	31.0	80	131.8	9.5	85
23	Developed, Medium Intensity	56.5	12.8	61	14.3	3.0	75	13.5	12.9	83	75.9	5.5	87
24	Developed, High Intensity	16.8	3.8	77	5.8	1.2	85	2.9	2.8	90	20.7	1.5	92
31	Barren Land	0.0	0.0	77	0.0	0.0	86	0.0	0.0	91	0.0	0.0	94
41	Deciduous Forest	2.6	0.6	36	2.8	0.6	60	0.0	0.0	73	22.7	1.6	79
42	Evergreen Forest	29.2	6.6	36	46.9	9.9	60	1.4	1.4	73	235.1	17.0	79
43	Mixed Forest	0.0	0.0	36	0.7	0.1	60	0.0	0.0	73	1.9	0.1	79
52	Shrub/Scrub	1.1	0.2	35	8.3	1.7	56	0.9	0.9	70	18.4	1.3	77
71	Grassland/Herbaceous	0.0	0.0	30	0.1	0.0	58	0.0	0.0	71	0.1	0.0	78
81	Pasture/Hay	0.0	0.0	39	0.0	0.0	61	0.0	0.0	74	0.0	0.0	80
82	Cultivated Crops	199.3	45.2	67	289.6	60.8	78	25.4	24.3	85	582.7	42.0	89
90	Woody Wetlands	7.4	1.7	100	14.0	2.9	100	0.3	0.3	100	114.6	8.3	100
95	Emergent Herbaceous Wetlands	0.0	0.0	100	0.0	0.0	100	0.0	0.0	100	0.0	0.0	100
Total		441.2	100.0	60.5	476.0	100.0	74.7	104.6	100.0	81.5	1386.2	100.0	86.8

Weighted Average CN = 79.4

Jacks Branch

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	0.0	0.0	100	0.0	0.0	100	0.0	0.0	100	3.4	0.3	100
21	Developed, Open Space	52.7	18.5	49	40.0	6.8	69	1.2	3.5	79	46.3	4.6	84
22	Developed, Low Intensity	13.6	4.8	54	13.3	2.2	70	1.4	4.2	80	11.7	1.2	85
23	Developed, Medium Intensity	6.1	2.1	61	3.2	0.5	75	0.7	2.0	83	1.4	0.1	87
24	Developed, High Intensity	1.3	0.5	77	4.2	0.7	85	0.1	0.3	90	0.0	0.0	92
31	Barren Land	0.0	0.0	77	0.0	0.0	86	0.0	0.0	91	0.0	0.0	94
41	Deciduous Forest	0.0	0.0	36	0.3	0.0	60	0.0	0.0	73	4.9	0.5	79
42	Evergreen Forest	19.2	6.7	36	111.2	18.8	60	10.6	31.2	73	227.1	22.5	79
43	Mixed Forest	0.1	0.0	36	0.4	0.1	60	0.0	0.0	73	6.7	0.7	79
52	Shrub/Scrub	0.2	0.1	35	17.9	3.0	56	0.0	0.0	70	29.6	2.9	77
71	Grassland/Herbaceous	0.6	0.2	30	8.3	1.4	58	0.0	0.0	71	2.8	0.3	78
81	Pasture/Hay	0.0	0.0	39	0.0	0.0	61	0.0	0.0	74	0.0	0.0	80
82	Cultivated Crops	154.9	54.3	67	279.0	47.2	78	15.5	45.6	85	307.2	30.4	89
90	Woody Wetlands	35.0	12.3	100	111.2	18.8	100	4.4	12.8	100	369.0	36.5	100
95	Emergent Herbaceous Wetlands	1.3	0.5	100	2.1	0.3	100	0.1	0.4	100	0.9	0.1	100
Total		285.0	100.0	65.0	590.9	100.0	77.1	34.1	100.0	82.8	1011.1	100.0	90.0

Weighted Average CN = 82.2

Jacob Branch

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	41.0	2.3	100	18.1	2.8	100	101.1	5.1	100	273.4	5.1	100
21	Developed, Open Space	167.3	9.3	49	45.0	7.0	69	188.9	9.5	79	381.1	7.1	84
22	Developed, Low Intensity	111.5	6.2	54	29.8	4.7	70	150.7	7.6	80	160.9	3.0	85
23	Developed, Medium Intensity	54.1	3.0	61	21.6	3.4	75	81.2	4.1	83	60.5	1.1	87
24	Developed, High Intensity	11.1	0.6	77	2.3	0.4	85	20.3	1.0	90	16.4	0.3	92
31	Barren Land	0.5	0.0	77	0.0	0.0	86	0.0	0.0	91	1.0	0.0	94
41	Deciduous Forest	3.2	0.2	36	6.2	1.0	60	41.5	2.1	73	46.3	0.9	79
42	Evergreen Forest	97.9	5.4	36	71.5	11.2	60	271.3	13.6	73	526.0	9.9	79
43	Mixed Forest	3.8	0.2	36	1.7	0.3	60	6.7	0.3	73	9.1	0.2	79
52	Shrub/Scrub	33.0	1.8	35	6.6	1.0	56	42.3	2.1	70	108.3	2.0	77
71	Grassland/Herbaceous	43.3	2.4	30	9.5	1.5	58	21.4	1.1	71	47.1	0.9	78
81	Pasture/Hay	0.4	0.0	39	0.1	0.0	61	2.9	0.1	74	3.1	0.1	80
82	Cultivated Crops	984.2	54.5	67	315.3	49.3	78	795.7	39.9	85	1308.4	24.5	89
90	Woody Wetlands	195.9	10.8	100	111.2	17.4	100	211.8	10.6	100	2177.3	40.8	100
95	Emergent Herbaceous Wetlands	58.1	3.2	100	0.4	0.1	100	60.6	3.0	100	220.3	4.1	100
Total		1805.2	100.0	66.5	639.4	100.0	78.6	1996.4	100.0	84.4	5339.2	100.0	92.6

Weighted Average CN = 85.2

Jacob Swamp

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	0.8	0.0	100	3.5	0.4	100	0.0	0.1	100	65.0	2.1	100
21	Developed, Open Space	219.1	10.5	49	58.0	7.2	69	0.3	0.5	79	159.2	5.0	84
22	Developed, Low Intensity	99.3	4.7	54	35.9	4.5	70	0.2	0.3	80	61.2	1.9	85
23	Developed, Medium Intensity	11.1	0.5	61	6.1	0.8	75	0.0	0.0	83	12.5	0.4	87
24	Developed, High Intensity	2.5	0.1	77	0.7	0.1	85	0.0	0.0	90	4.1	0.1	92
31	Barren Land	0.0	0.0	77	0.0	0.0	86	0.0	0.0	91	0.2	0.01	94
41	Deciduous Forest	13.8	0.7	36	4.9	0.6	60	0.4	0.8	73	31.3	1.0	79
42	Evergreen Forest	158.7	7.6	36	113.5	14.1	60	22.6	44.6	73	506.9	16.0	79
43	Mixed Forest	5.0	0.2	36	1.2	0.1	60	0.6	1.2	73	14.3	0.5	79
52	Shrub/Scrub	33.0	1.6	35	15.2	1.9	56	0.3	0.6	70	58.0	1.8	77
71	Grassland/Herbaceous	1.8	0.1	30	0.4	0.0	58	0.03	0.1	71	2.4	0.1	78
81	Pasture/Hay	0.0	0.0	39	0.0	0.0	61	0.0	0.0	74	0.0	0.0	80
82	Cultivated Crops	1380.1	65.9	67	464.5	57.6	78	20.6	40.7	85	1014.0	32.0	89
90	Woody Wetlands	168.8	8.1	100	102.1	12.7	100	5.7	11.3	100	1224.9	38.7	100
95	Emergent Herbaceous Wetlands	0.8	0.0	100	0.2	0.03	100	0.0	0.0	100	13.7	0.4	100
Total		2094.6	100.0	64.0	806.1	100.0	76.8	50.7	100.0	81.0	3167.7	100.0	91.2

Weighted Average CN = 79.9

Lumber DS

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	24.5	1.4	100	5.4	1.1	100	66.8	10.8	100	703.0	19.2	100
21	Developed, Open Space	329.7	18.5	49	118.4	24.3	69	73.3	11.8	79	309.5	8.5	84
22	Developed, Low Intensity	374.3	21.0	54	156.1	32.0	70	57.7	9.3	80	249.6	6.8	85
23	Developed, Medium Intensity	178.2	10.0	61	56.5	11.6	75	76.5	12.4	83	98.8	2.7	87
24	Developed, High Intensity	83.7	4.7	77	12.0	2.5	85	21.5	3.5	90	28.4	0.8	92
31	Barren Land	3.1	0.2	77	0.0	0.0	86	1.4	0.2	91	3.8	0.1	94
41	Deciduous Forest	9.4	0.5	36	0.7	0.1	60	11.7	1.9	73	16.1	0.4	79
42	Evergreen Forest	113.9	6.4	36	20.1	4.1	60	50.3	8.1	73	166.6	4.5	79
43	Mixed Forest	2.7	0.2	36	0.4	0.1	60	1.3	0.2	73	5.1	0.1	79
52	Shrub/Scrub	27.4	1.5	35	7.2	1.5	56	8.0	1.3	70	31.4	0.9	77
71	Grassland/Herbaceous	2.6	0.1	30	0.3	0.1	58	1.7	0.3	71	11.3	0.3	78
81	Pasture/Hay	0.2	0.0	39	0.0	0.0	61	0.0	0.0	74	0.2	0.01	80
82	Cultivated Crops	369.6	20.8	67	76.5	15.7	78	98.6	15.9	85	191.5	5.2	89
90	Woody Wetlands	249.1	14.0	100	33.2	6.8	100	121.4	19.6	100	1774.6	48.5	100
95	Emergent Herbaceous Wetlands	10.1	0.6	100	0.8	0.2	100	28.5	4.6	100	71.3	1.9	100
Total		1778.5	100.0	63.3	487.7	100.0	73.7	618.6	100.0	87.6	3661.3	100.0	95.3

Weighted Average CN = 84.3

Lumber Mid

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	54.9	0.4	100	64.5	1.5	100	12.8	0.5	100	679.5	2.7	100
21	Developed, Open Space	1041.5	7.2	49	391.0	9.3	69	681.4	24.1	79	1195.1	4.7	84
22	Developed, Low Intensity	382.7	2.6	54	175.0	4.2	70	215.9	7.6	80	518.6	2.0	85
23	Developed, Medium Intensity	63.9	0.4	61	65.0	1.5	75	118.4	4.2	83	163.6	0.6	87
24	Developed, High Intensity	23.7	0.2	77	20.1	0.5	85	34.7	1.2	90	48.6	0.2	92
31	Barren Land	0.2	0.002	77	0.4	0.01	86	0.0	0.0	91	0.1	0.0003	94
41	Deciduous Forest	176.4	1.2	36	41.4	1.0	60	15.4	0.5	73	222.6	0.9	79
42	Evergreen Forest	867.0	6.0	36	225.6	5.4	60	136.9	4.8	73	1486.8	5.8	79
43	Mixed Forest	39.1	0.3	36	13.4	0.3	60	10.1	0.4	73	82.6	0.3	79
52	Shrub/Scrub	314.5	2.2	35	70.4	1.7	56	47.2	1.7	70	274.5	1.1	77
71	Grassland/Herbaceous	123.5	0.9	30	26.2	0.6	58	12.5	0.4	71	77.0	0.3	78
81	Pasture/Hay	23.8	0.2	39	7.6	0.2	61	5.0	0.2	74	11.4	0.04	80
82	Cultivated Crops	9680.8	66.6	67	2698.8	64.3	78	1306.5	46.2	85	8541.3	33.5	89
90	Woody Wetlands	1705.8	11.7	100	395.2	9.4	100	224.0	7.9	100	11896.2	46.6	100
95	Emergent Herbaceous Wetlands	27.3	0.2	100	5.5	0.1	100	6.3	0.2	100	314.3	1.2	100
Total		14525.1	100.0	66.1	4200.0	100.0	77.5	2826.9	100.0	83.4	25512.2	100.0	93.4

Weighted Average CN = 82.9

Lumber US

Existing Landuse Conditions

LUCODE	Land Use Descriptions		CN for Soil Type A				CN for Soil Type B				CN for Soil Type C				CN for Soil Type D		
			Area (ac)	Area (%)	CN		Area (ac)	Area (%)	CN		Area (ac)	Area (%)	CN		Area (ac)	Area (%)	CN
11	Open Water		96.2	0.1	100		3603.7	7.3	100		275.7	0.7	100		304.3	0.8	100
21	Developed, Open Space		12212.7	11.2	49		3287.0	6.7	69		3659.3	9.5	79		863.2	2.3	84
22	Developed, Low Intensity		3886.1	3.6	54		823.6	1.7	70		809.9	2.1	80		130.6	0.4	85
23	Developed, Medium Intensity		1077.9	1.0	61		285.2	0.6	75		256.0	0.7	83		31.7	0.1	87
24	Developed, High Intensity		243.3	0.2	77		36.3	0.1	85		49.8	0.1	90		3.5	0.01	92
31	Barren Land		692.7	0.6	77		379.2	0.8	86		76.4	0.2	91		13.3	0.04	94
41	Deciduous Forest		3299.2	3.0	36		2152.4	4.4	60		1789.9	4.7	73		374.7	1.0	79
42	Evergreen Forest		44799.7	41.2	36		20704.5	42.0	60		17445.5	45.3	73		4677.0	12.5	79
43	Mixed Forest		2070.3	1.9	36		5405.0	11.0	60		2229.7	5.8	73		894.8	2.4	79
52	Shrub/Scrub		6893.8	6.3	35		2137.8	4.3	56		1887.5	4.9	70		338.2	0.9	77
71	Grassland/Herbaceous		14772.7	13.6	30		4267.2	8.7	58		2355.9	6.1	71		457.6	1.2	78
81	Pasture/Hay		3576.2	3.3	39		1142.3	2.3	61		631.1	1.6	74		60.3	0.2	80
82	Cultivated Crops		12211.6	11.2	67		2687.9	5.5	78		1673.7	4.3	85		2381.4	6.4	89
90	Woody Wetlands		2763.4	2.5	100		2311.1	4.7	100		5214.6	13.5	100		26340.0	70.6	100
95	Emergent Herbaceous Wetlands		99.5	0.1	100		57.2	0.1	100		130.5	0.3	100		419.6	1.1	100
Total			108695.4	100.0	43.2		49280.3	100.0	66.6		38485.6	100.0	78.1		37290.2	100.0	95.0

Weighted Average CN = 62.1

Meadow Branch

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	0.5	0.1	100	0.2	0.0	100	0.0	0.0	100	0.7	0.0	100
21	Developed, Open Space	115.2	15.1	49	108.0	18.3	69	20.1	15.0	79	275.7	16.6	84
22	Developed, Low Intensity	161.0	21.1	54	152.2	25.8	70	27.1	20.2	80	265.1	16.0	85
23	Developed, Medium Intensity	73.4	9.6	61	61.7	10.5	75	35.8	26.7	83	162.9	9.8	87
24	Developed, High Intensity	36.9	4.8	77	17.2	2.9	85	49.5	37.0	90	50.3	3.0	92
31	Barren Land	0.0	0.0	77	0.0	0.0	86	0.0	0.0	91	0.0	0.0	94
41	Deciduous Forest	3.0	0.4	36	3.0	0.5	60	0.0	0.0	73	10.7	0.6	79
42	Evergreen Forest	40.9	5.3	36	34.1	5.8	60	1.4	1.1	73	180.0	10.8	79
43	Mixed Forest	0.5	0.1	36	0.0	0.0	60	0.0	0.0	73	3.3	0.2	79
52	Shrub/Scrub	5.7	0.7	35	6.9	1.2	56	0.0	0.0	70	21.5	1.3	77
71	Grassland/Herbaceous	0.4	0.1	30	0.4	0.1	58	0.0	0.0	71	1.2	0.1	78
81	Pasture/Hay	0.0	0.0	39	0.0	0.0	61	0.0	0.0	74	0.0	0.0	80
82	Cultivated Crops	307.3	40.2	67	185.9	31.5	78	0.0	0.0	85	505.0	30.4	89
90	Woody Wetlands	19.9	2.6	100	20.1	3.4	100	0.0	0.0	100	184.0	11.1	100
95	Emergent Herbaceous Wetlands	0.0	0.0	100	0.0	0.0	100	0.0	0.0	100	0.0	0.0	100
Total		764.6	100.0	60.3	589.8	100.0	73.5	134.0	100.0	84.3	1660.3	100.0	87.3

Weighted Average CN = 78.0

Raft Swamp

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	110.5	0.2	100	6.3	0.1	100	44.5	1.5	100	896.3	1.9	100
21	Developed, Open Space	3527.5	7.5	49	672.0	7.3	69	135.8	4.7	79	1501.3	3.1	84
22	Developed, Low Intensity	1386.9	2.9	54	351.2	3.8	70	57.4	2.0	80	723.6	1.5	85
23	Developed, Medium Intensity	213.0	0.5	61	112.8	1.2	75	19.9	0.7	83	131.8	0.3	87
24	Developed, High Intensity	68.3	0.1	77	45.3	0.5	85	12.8	0.4	90	41.9	0.1	92
31	Barren Land	10.4	0.02	77	0.2	0.002	86	0.6	0.02	91	0.6	0.001	94
41	Deciduous Forest	746.3	1.6	36	151.4	1.6	60	60.7	2.1	73	426.1	0.9	79
42	Evergreen Forest	4666.1	9.9	36	1335.4	14.5	60	482.7	16.8	73	4057.3	8.5	79
43	Mixed Forest	274.7	0.6	36	94.8	1.0	60	27.9	1.0	73	235.7	0.5	79
52	Shrub/Scrub	1594.4	3.4	35	357.5	3.9	56	89.2	3.1	70	723.4	1.5	77
71	Grassland/Herbaceous	788.1	1.7	30	114.9	1.2	58	60.1	2.1	71	225.9	0.5	78
81	Pasture/Hay	103.6	0.2	39	12.7	0.1	61	1.6	0.1	74	11.3	0.02	80
82	Cultivated Crops	27567.2	58.6	67	5091.3	55.3	78	954.5	33.2	85	12306.4	25.8	89
90	Woody Wetlands	5916.2	12.6	100	834.4	9.1	100	916.1	31.8	100	26044.2	54.5	100
95	Emergent Herbaceous Wetlands	66.6	0.1	100	20.8	0.2	100	15.5	0.5	100	448.5	0.9	100
Total		47039.8	100.0	64.0	9200.9	100.0	74.9	2879.4	100.0	86.6	47774.3	100.0	93.9

Weighted Average CN = **78.9**

White Oak

Existing Landuse Conditions

LUCODE	Land Use Descriptions	CN for Soil Type A			CN for Soil Type B			CN for Soil Type C			CN for Soil Type D		
		Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN	Area (ac)	Area (%)	CN
11	Open Water	1.2	0.7	100	0.3	0.05	100	0.0	0.0	100	11.3	0.7	100
21	Developed, Open Space	32.5	18.6	49	81.9	14.7	69	3.3	20.3	79	253.8	15.5	84
22	Developed, Low Intensity	39.5	22.7	54	59.0	10.6	70	5.3	32.3	80	145.9	8.9	85
23	Developed, Medium Intensity	37.1	21.3	61	25.8	4.6	75	4.0	24.4	83	64.9	4.0	87
24	Developed, High Intensity	21.3	12.2	77	11.3	2.0	85	0.5	2.7	90	24.9	1.5	92
31	Barren Land	0.0	0.0	77	0.0	0.0	86	0.0	0.0	91	0.0	0.0	94
41	Deciduous Forest	2.3	1.3	36	4.6	0.8	60	0.0	0.0	73	13.8	0.8	79
42	Evergreen Forest	16.0	9.2	36	232.2	41.8	60	1.8	10.8	73	619.7	37.7	79
43	Mixed Forest	0.0	0.0	36	5.5	1.0	60	0.0	0.0	73	5.4	0.3	79
52	Shrub/Scrub	1.5	0.9	35	16.3	2.9	56	0.0	0.0	70	68.8	4.2	77
71	Grassland/Herbaceous	0.0	0.0	30	0.1	0.03	58	0.0	0.0	71	3.6	0.2	78
81	Pasture/Hay	0.0	0.0	39	0.0	0.0	61	0.0	0.0	74	0.0	0.0	80
82	Cultivated Crops	12.7	7.3	67	88.0	15.8	78	0.0	0.0	85	128.8	7.8	89
90	Woody Wetlands	10.2	5.8	100	31.0	5.6	100	1.6	9.5	100	297.8	18.1	100
95	Emergent Herbaceous Wetlands	0.0	0.0	100	0.1	0.02	100	0.0	0.0	100	3.7	0.2	100
Total		174.3	100.0	59.3	556.1	100.0	68.6	16.4	100.0	81.9	1642.4	100.0	85.5

Weighted Average CN = 79.6

B5 Reach Routing Parameters

Muskingum-Cunge Routing Parameters

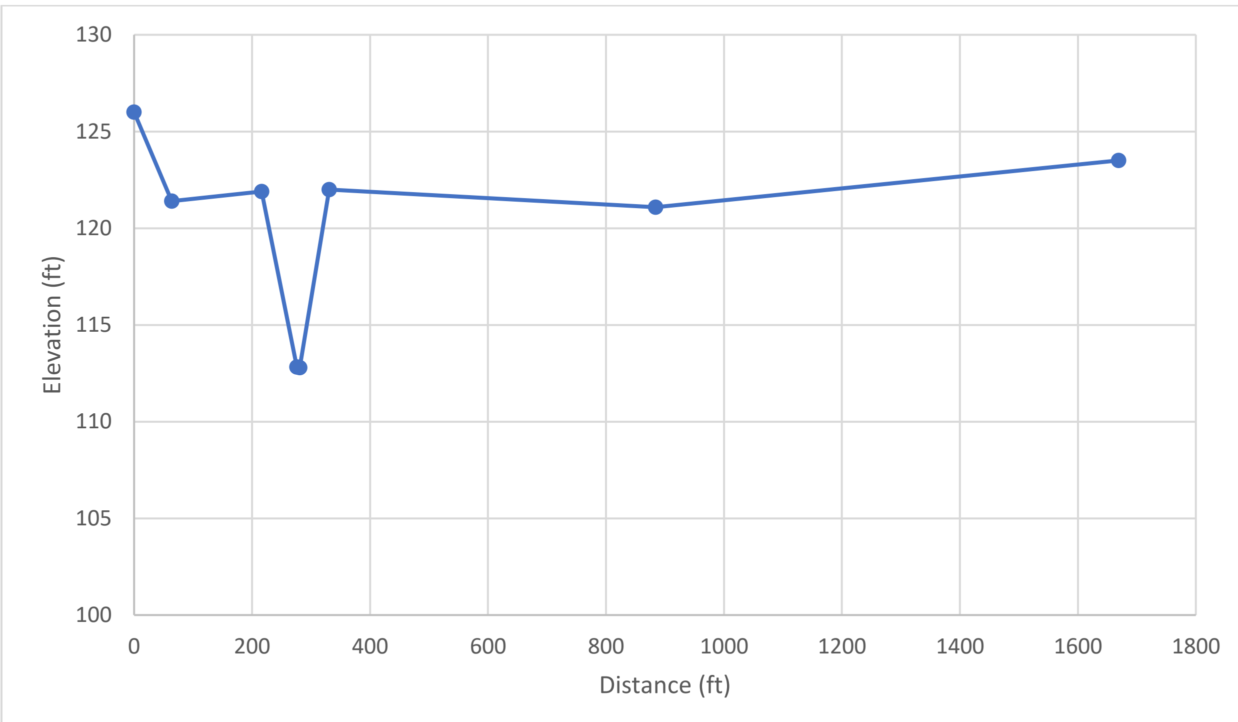
Notes:

- Cross-section data from terrain with bathymetry for all reaches

Reach	HMS Junctions	Length (ft)	Slope (ft/ft)	Channel N-Value	Left N-Value	Right N-Value	8pt XS #
1	0 to 1	11284	0.0002	0.045	0.1	0.1	XS1
2	1 to 2	10922	0.0006	0.045	0.13	0.1	XS2
3	2 to 3	14490	0.0002	0.045	0.15	0.09	XS3
4	3 to 4	7220	0.0003	0.045	0.13	0.11	XS4
5	4 to 5	39679	0.0002	0.045	0.125	0.125	XS5
6	5 to 6	7849	0.0003	0.045	0.125	0.125	XS6
7	7 to 6	24525	0.0008	0.065	0.035	0.16	XS7
8	8 to 4	6644	0.0002	0.045	0.12	0.12	XS8
9	11 to 1	183005	0.0003	0.08	0.16	0.16	XS9

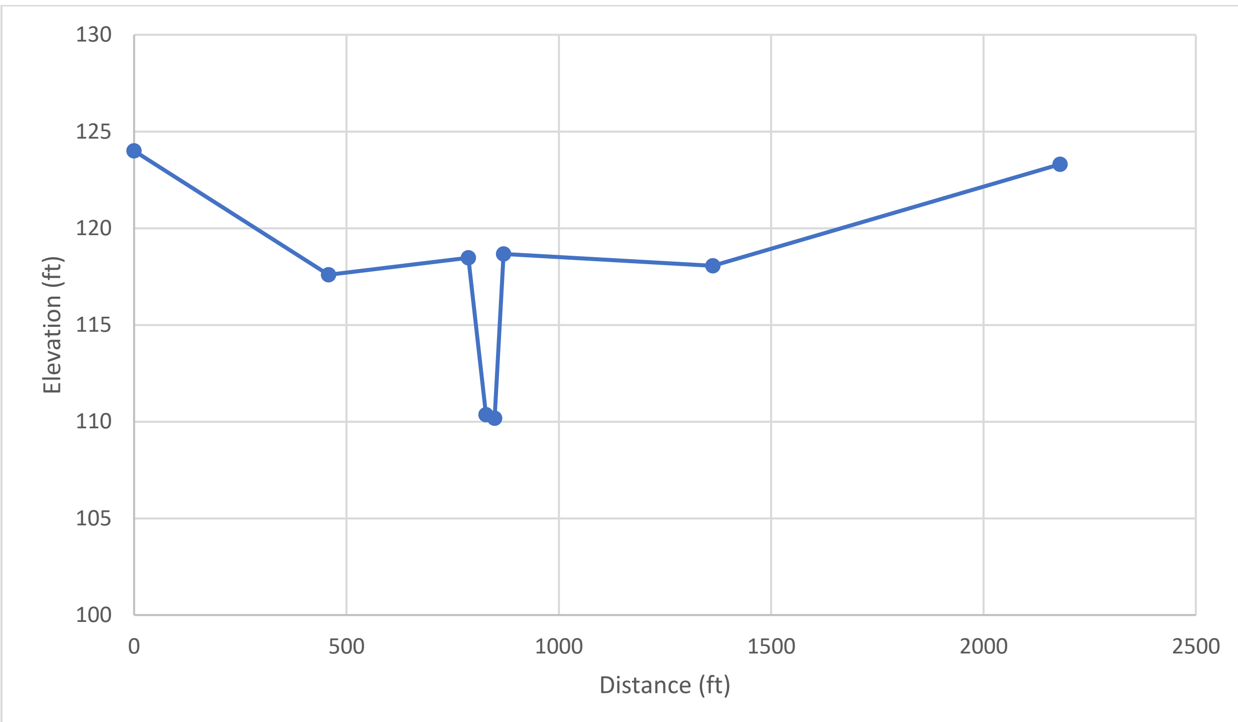
Cross-Section 1

Station (ft)	Elevation (ft)
0	126
64	121.4
216	121.9
275.78	112.82
281	112.79
330.5	122
884	121.09
1669	123.5



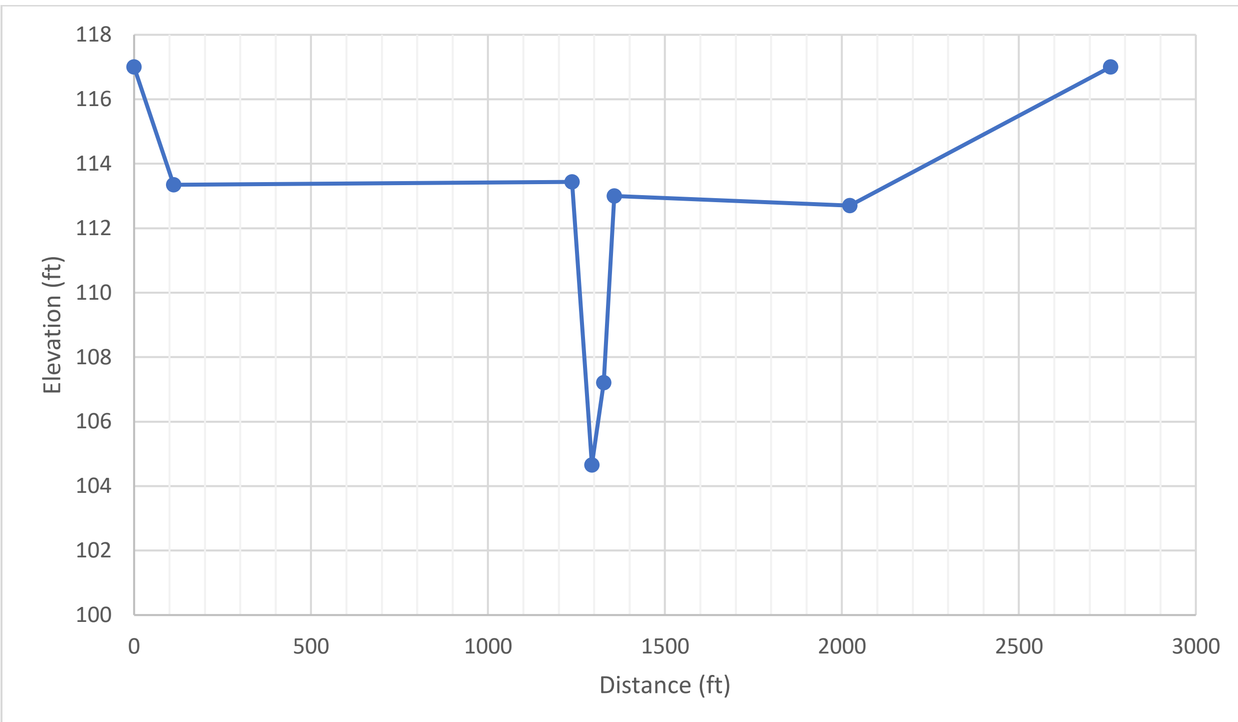
Cross-Section 2

Station (ft)	Elevation (ft)
0	124
458	117.6
787	118.47
828.42	110.36
849.05	110.17
870.1	118.67
1362.6	118.05
2180	123.3



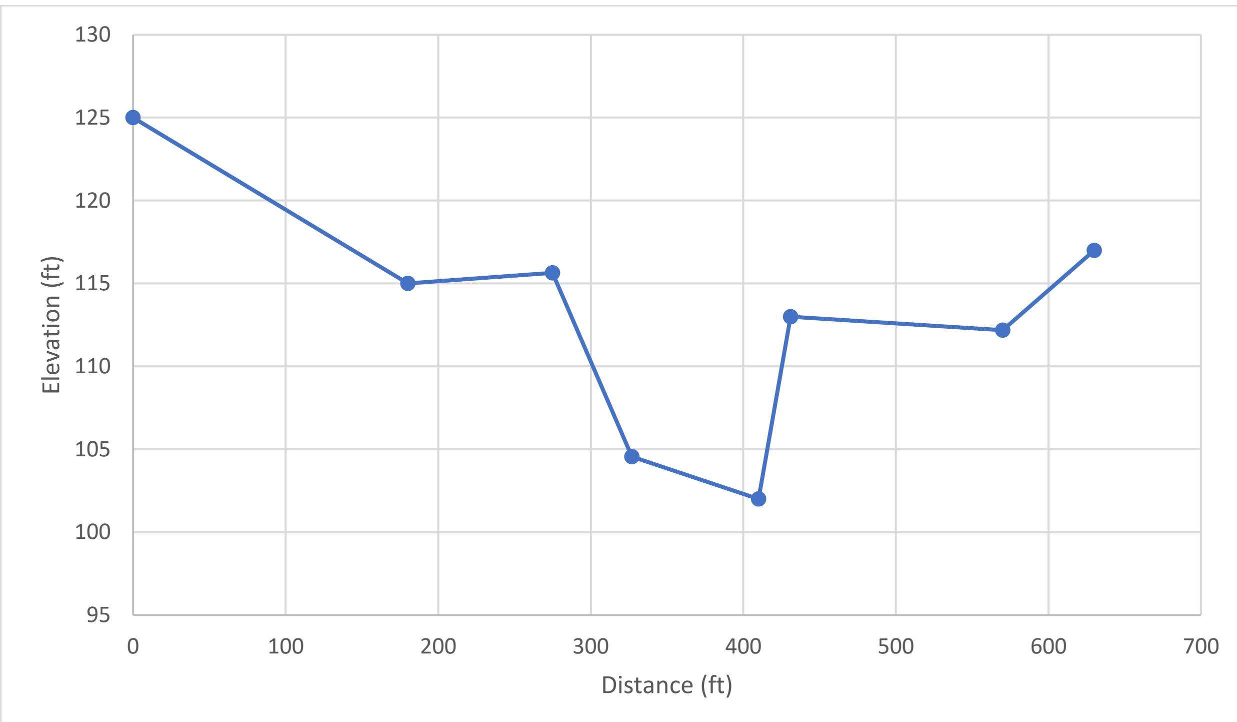
Cross-Section 3

Station (ft)	Elevation (ft)
0	117
112	113.35
1237	113.44
1293.34	104.66
1327	107.21
1356.5	113
2022.5	112.7
2759	117



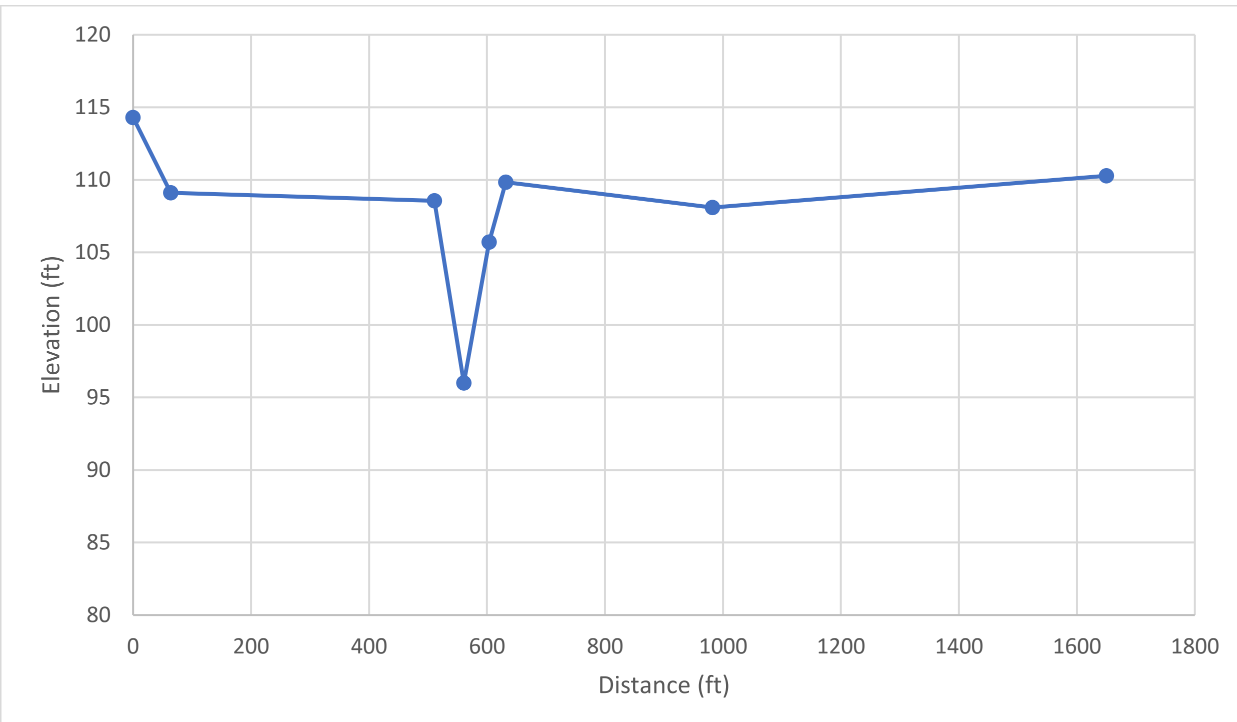
Cross-Section 4

Station (ft)	Elevation (ft)
0	125
180	115
275	115.65
327	104.56
410	102
431	113
570	112.19
630	117



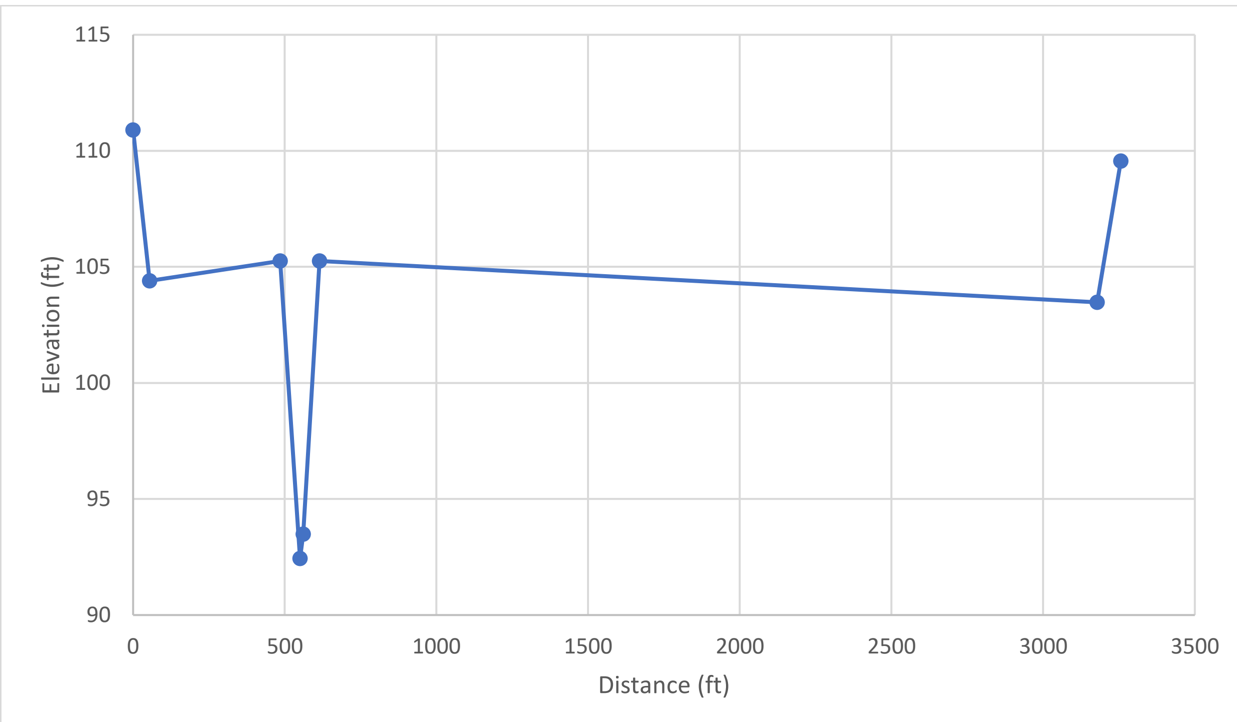
Cross-Section 5

Station (ft)	Elevation (ft)
0	114.3
64	109.1
510.9	108.55
560.6	96
603.4	105.71
632	109.83
982.5	108.1
1650	110.27



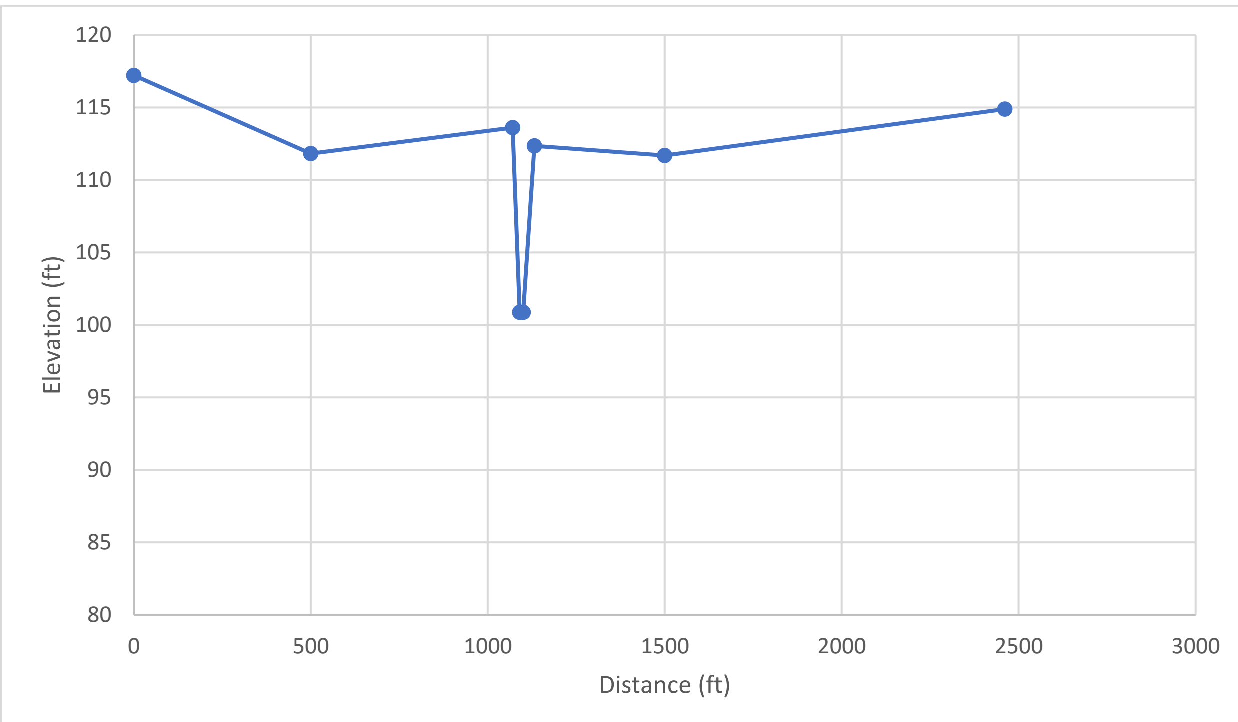
Cross-Section 6

Station (ft)	Elevation (ft)
0	110.9
54	104.4
485.1	105.25
550	92.43
560.5	93.48
614.4	105.26
3178.25	103.48
3256	109.56



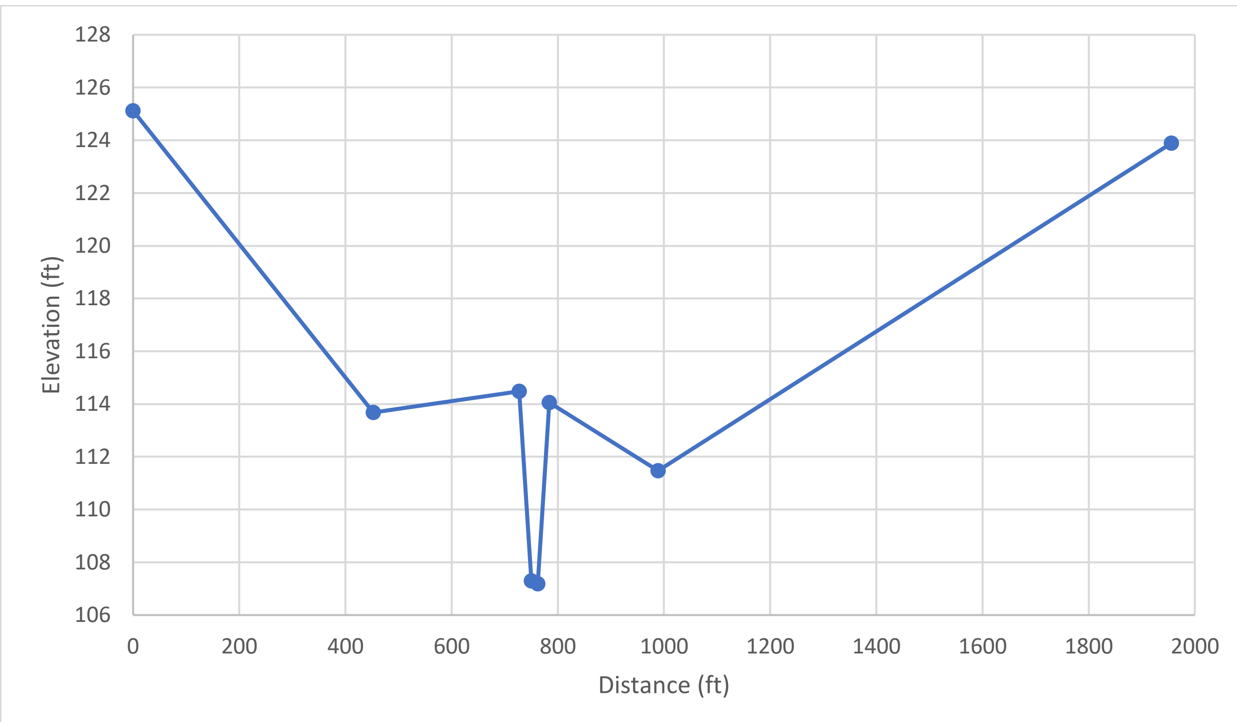
Cross-Section 7

Station (ft)	Elevation (ft)
0	117.22
500	111.83
1070	113.62
1090	100.88
1100	100.88
1131.25	112.36
1500	111.69
2461	114.9



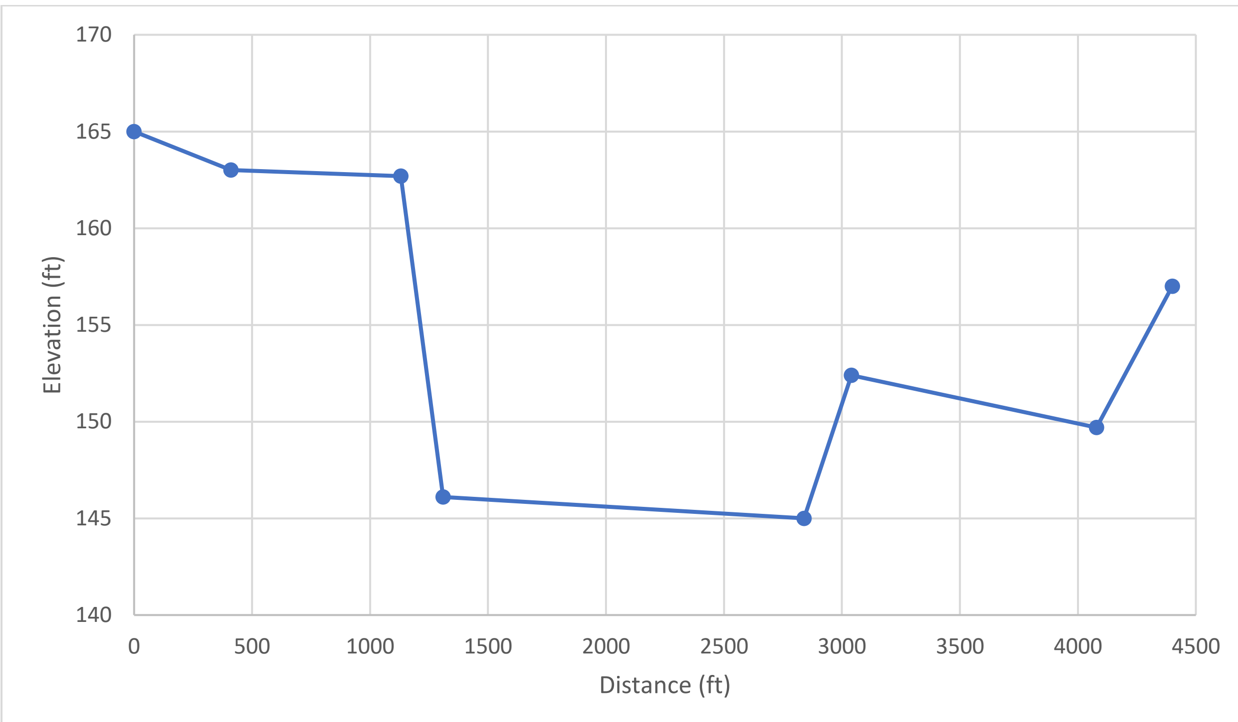
Cross-Section 8

Station (ft)	Elevation (ft)
0	125.12
452.65	113.68
727.02	114.48
750.33	107.29
762.12	107.19
784	114.06
989	111.47
1956	123.89



Cross-Section 9

Station (ft)	Elevation (ft)
0	165
410	163
1130	162.7
1310	146.1
2840	145
3039.7	152.4
4079.7	149.7
4400	157



B6 USGS Correspondence

From: McClenney, Bryce J <bjmcclen@usgs.gov>

Sent: Monday, February 3, 2020 12:38 PM

To: Sachan, Amit

Cc: Walters, Douglas A; Weaver, John C; Hunu, Kenneth; Beadenkopf, Edward G

Subject: Re: Lumber River flows discussion

Per your request after our conversation today, I looked into the Hurricane Matthew peak discharges. We did make a slight change to the rating based on the measurement made during Florence. The peak recorded gage height for the Matthew event was 21.87 ft. Rating 4.0 was in use at the time a gives a value of 14,600 cfs for this peak. Rating 5.0 was developed following the Florence measurement in 2018 and activated in September 2018. It computes a discharge of 15,700 cfs for the 21.87 peak gage height for Matthew. This is around 7% different. We would not have issues a revision based on this as the uncertainty of the measurements are higher than the percent difference of the computed discharges.

There were three measurements made during Matthew as follows:

142- GH=19.85 Q=9900

143- GH=19.05 Q=8000

144-GH=19.02 Q=7380

It was noted during all three measurements that large pumps were setup behind the levee that were pumping water back into the channel downstream of the gage from behind the levee. This flow was not able to be measured. There was no note of any secondary channel being measured such as with Florence, however, the gage height was roughly 2.5 ft lower than the Florence measurement at 22.20 ft so there likely would not have been as much flow through the breach at that time.

Hope this helps.

Bryce McClenney

Hydrologic Technician

USGS South Atlantic Water Science Center

Raleigh, NC (919)417-7021

From: Sachan, Amit <Amit.Sachan@atkinsglobal.com>
Sent: Friday, January 31, 2020 9:28 AM
To: McClenney, Bryce J <bjmcclen@usgs.gov>
Cc: Walters, Douglas A <dwalters@usgs.gov>; Weaver, John C <jcweaver@usgs.gov>; Hunu, Kenneth <Kenneth.Hunu@atkinsglobal.com>; Beadenkopf, Edward G <Edward.Beadenkopf@atkinsglobal.com>
Subject: [EXTERNAL] RE: Lumber River flows discussion

Thanks Bryce. We will call you on Monday (2/3) at 11 AM.

Amit Sachan, *PE, CFM*
Project Director, Public & Private Business Unit
Tel: +1 919 431 5253 Cell: +1 919 985 1095

Atkins, member of the SNC-Lavalin Group
1616 East Millbrook Road, Suite 160, Raleigh, NC 27519

From: McClenney, Bryce J <bjmcclen@usgs.gov>
Sent: Friday, January 31, 2020 7:44 AM
To: Sachan, Amit <Amit.Sachan@atkinsglobal.com>
Cc: Walters, Douglas A <dwalters@usgs.gov>; Weaver, John C <jcweaver@usgs.gov>; Hunu, Kenneth <Kenneth.Hunu@atkinsglobal.com>; Beadenkopf, Edward G <Edward.Beadenkopf@atkinsglobal.com>
Subject: Re: Lumber River flows discussion

That should work for me. I could do Monday or Tuesday mornings.

Bryce McClenney
Hydrologic Technician
USGS South Atlantic Water Science Center
Raleigh, NC (919)417-7021

From: Sachan, Amit <Amit.Sachan@atkinsglobal.com>
Sent: Thursday, January 30, 2020 1:57 PM
To: McClenney, Bryce J <bjmcclen@usgs.gov>
Cc: Walters, Douglas A <dwalters@usgs.gov>; Weaver, John C <jcweaver@usgs.gov>; Hunu, Kenneth

<Kenneth.Hunu@atkinsglobal.com>; Beadenkopf, Edward G <Edward.Beadenkopf@atkinsglobal.com>
Subject: [EXTERNAL] RE: Lumber River flows discussion

Hi Bryce, Hope that you are doing well. We would like to learn about your experience during hurricanes Florence and Matthew. Would you be available for a brief call sometime in next few days? Let me know and we will plan accordingly. Thanks

Amit Sachan, *PE, CFM*
Project Director, Public & Private Business Unit
Tel: +1 919 431 5253 Cell: +1 919 985 1095

Atkins, member of the SNC-Lavalin Group
1616 East Millbrook Road, Suite 160, Raleigh, NC 27519

From: Walters, Douglas A <dwalters@usgs.gov>
Sent: Friday, January 24, 2020 7:36 AM
To: Hunu, Kenneth <Kenneth.Hunu@atkinsglobal.com>; Sachan, Amit <Amit.Sachan@atkinsglobal.com>; Beadenkopf, Edward G <Edward.Beadenkopf@atkinsglobal.com>
Cc: Weaver, John C <jcweaver@usgs.gov>; McClenney, Bryce J <bjmcclen@usgs.gov>
Subject: Re: Lumber River flows discussion

Amit, Ken and Ed,
I spoke with the technician, Bryce McClenney, who measured Lumberton flows during Florence. As you can see below, they did measure the main channel at the gage (15,100 cfs) as well as the the overflow (1,977 cfs) under I-95 (railroad opening). The overflow was significant, comprising almost 12% of the total flow. The overflow was measured by wading the flows (split into 2 sections) overtopping 5th street, downstream of the I-95 opening. I hope this information is helpful. If you have further questions about the measurement or the conditions at the time, you can contact Bryce directly (cc'd in this email or at 919-417-7021). Bryce also has pictures and video of the conditions which he can share with you, if you like.

Discharge Values	Discharge (ft^3/s)
overflow 2	457
main	15100
overflow 1	1520
Subtotal	17100
Adjustment	0.00
Adjusted Total Discharge	**17100**

U.S. DEPARTMENT OF THE INTERIOR
U.S. Geological Survey

SITE VISIT NOTES

Meas #: 157
Processed by ____________
Checked by ____________

Site Visit Summary

02134170 - LUMBER RIVER AT LUMBERTON, NC

Date: 2018-09-17 | Start Time: 14:35:00-05:00 EST | End Time: 17:00:01-05:00
Party: BJM/JES

Site Visit Tasks

Discharge Measurement: ✓ | Water Temp with Acoustic Meas: ⛔
Control Inspection: ⛔

Discharge Measurement Summary

Meas No: 157

Gage Ht: 22.20 ft.
Meas Start Time: 14:50:05-05:00
Meas Rated: Poor (8%+)

Total Meas Flow: 17050.46 cfs (Measured)
Meas End Time: 17:00:24-05:00
Base Flow? Non-base flow

Rating Information:

Meas. plots: ________% Different from rating no. ________ Indicated shift: ________

Comment:

likely holding steady due to levy breach

Channel 1 (main) Summary - QMIDSECTION Measurement

Bridge downstream side Measurement

Meas Flow: 15073.46 cfs | Vel Method: ADCP
Horiz Flow: Uneven | Vel Desc:
Vert Vel Desc: Unspecified | Channel Conditions: Unspecified , Unspecified , Unspecified
Sect Loc.: At the gage - 0 ft. to gage

ADCP Midsection Measurement Details

Stations: 31 | Total Width: 236.00 ft
Total Area: 2893.57 ft^2 | Mean Vel: 5.21 ft/s
Start Point: Right edge of water | Mtr Type: ADCP
Serial No: RFO_M9_1425 | Mtr Susp: Tethered boat
Mtr Insp B4: true | Mtr Insp Aft: true

Channel 2 (overflow 1) Summary - QMIDSECTION Measurement

Wading Measurement

Meas Flow: 1520 cfs | Vel Method: ADV
Horiz Flow: Uneven | Vel Desc:
Vert Vel Desc: Unspecified | Channel Conditions: Unspecified , Unspecified , Unspecified
Sect Loc.: At the gage - 0 ft. to gage

ADV Measurement Details

Stations: 18 | Total Width: 1810
Total Area: 1765 | Mean Vel: .86
Start Point: Left edge of water | Mtr Type:
Serial No: RFO_FT_P1245 | Mtr Susp: Top-setting wading rod
Mtr Insp B4: true | Mtr Insp Aft: true

Channel 3 (overflow 2) Summary - QMIDSECTION Measurement

Wading Measurement

Meas Flow: 457 cfs | Vel Method: ADV
Horiz Flow: Unspecified | Vel Desc:
Vert Vel Desc: Unspecified | Channel Conditions: Unspecified , Unspecified , Unspecified
Sect Loc.: Unspecified - ft. to gage

ADV Measurement Details

Stations: 14 | Total Width: 1540
Total Area: 1420 | Mean Vel: .32
Start Point: Left edge of water | Mtr Type:
Serial No: RFO_FT_P1245 | Mtr Susp: Top-setting wading rod
Mtr Insp B4: true | Mtr Insp Aft: true

Gage Readings

Time	Non-Subm Pres Tran HGNTRAN (Unspecified) Name:	Wire Weight Gage HGWWG (Unspecified) Name:
14:36:00	22.19 [Routine]	22.35 (+/-.1) [Reference - Primary]
15:24:00	22.20 [Routine]	22.32 (+/-.10) [Routine]

Key: Blue=Primary Reference Green=Routine (Rec) Reading Black=Unsp/Reference

Sensor Inspection

Non-Subm Pres Tran

Name: | Serial Number:Unspecified
Gas Type: | Orif Serviced: | Service Time:

Sensor Inspection

Wire Weight Gage

Name: | Serial Number:Unspecified
Chkbar Found: | Chkbar Chng Time:
Chkbar Chng: | Chkbar Elev:

Streamflow Control Inspection

Type	Dist to Gage (ft)	Cleaned?	Time Cleaned	Condition
Channel		Unspecified		Unspecified

Comment:

Levy under I95 has breached and overflows were over 5th street

Doug,

Can you swing by for a few minutes before you leave for the day?

JCWeaver

J. Curtis Weaver, Hydrologist, PE
USGS South Atlantic Water Science Center
North Carolina - South Carolina - Georgia
3916 Sunset Ridge Road
Raleigh, NC 27607
Phone: (919) 571-4043 // Fax: (919) 571-4041
Email: jcweaver@usgs.gov
Online: https://www.usgs.gov/centers/sa-water

From: Sachan, Amit <Amit.Sachan@atkinsglobal.com>
Sent: Wednesday, January 22, 2020 2:33 PM
To: Weaver, John C <jcweaver@usgs.gov>
Cc: Hunu, Kenneth <Kenneth.Hunu@atkinsglobal.com>; Beadenkopf, Edward G <Edward.Beadenkopf@atkinsglobal.com>
Subject: [EXTERNAL] RE: Lumber River flows discussion

Hi Curtis, Here are few questions for our discussion. I'll send out a meeting invite for everyone's calendars. Thanks

- Does the USGS have any official estimate of the frequency of Matthew and Florence at Lumberton?
- Can the USGS comment to how Atkins has done the frequency analyses and offer any suggestions for what we have not done?
- Can we discuss the rating curve at Lumberton? Is the backup available? Is the USGS comfortable with the observed hydrographs and peaks for the two major Hurricanes?
- Significant flow left the Lumber River at I-95 during these events and we were told for Florence that was overtopped and/or out of service for a time. How was the rating curve developed and how reliable are the flow estimated and hydrographs for Florence and Matthew?

From: Sachan, Amit
Sent: Tuesday, January 21, 2020 11:43 AM
To: Weaver, John C <jcweaver@usgs.gov>
Cc: Hunu, Kenneth <Kenneth.Hunu@atkinsglobal.com>; Beadenkopf, Edward G <Edward.Beadenkopf@atkinsglobal.com>
Subject: RE: Lumber River flows discussion

Curtis, Thanks for your prompt response. Our discussion will be focused on a flood gate design project for the City of Lumberton on opening under I-95. Our questions will be based on flood frequency analysis and rating curves on Lumber River stream gages. We will send few specific questions this afternoon. Let me know if we can meet on Thursday (1/23) afternoon (say 3 PM). Thanks

Amit Sachan, *PE, CFM*
Project Director, Public & Private Business Unit
Tel: +1 919 431 5253 Cell: +1 919 985 1095

Atkins, member of the SNC-Lavalin Group
1616 East Millbrook Road, Suite 160, Raleigh, NC 27519

From: Weaver, John C <jcweaver@usgs.gov>
Sent: Tuesday, January 21, 2020 11:14 AM
To: Sachan, Amit <Amit.Sachan@atkinsglobal.com>
Cc: Weaver, John C <jcweaver@usgs.gov>
Subject: Re: Lumber River flows discussion

Amit,

Aside from an appointment on Thursday morning, I am generally available the coming several days.

In the interest of transparency, I just completed a review for NCDOT a few weeks ago of several FF analyses for the streamgage on the Lumber River at Lumberton that were completed as part of their planning for future I-95 work near Lumberton. Please let me know if you're interest in the Lumber River issues is related to this NCDOT planning.

Also, it would be helpful to get a heads up on the specific questions you have on the Lumber River so I could plan accordingly in advance of a conversation.

Thank you.

JCWeaver

J. Curtis Weaver, Hydrologist, PE ***Email: jcweaver@usgs.gov***
USGS South Atlantic Water Science Center ***Online: https://www.usgs.gov/centers/sa-water***
North Carolina - South Carolina - Georgia
3916 Sunset Ridge Road
Raleigh, NC 27607
Phone: (919) 571-4043 // Fax: (919) 571-4041

From: Sachan, Amit <Amit.Sachan@atkinsglobal.com>
Sent: Monday, January 20, 2020 3:30 PM

To: Weaver, John C <jcweaver@usgs.gov>
Subject: [EXTERNAL] Lumber River flows discussion

Hi Curtis, Hope that you are doing well. We have talked briefly at the NCAFPM conferences. I would like to request a quick meeting to discuss a project that we are working on. It is flood control project for the City of Lumberton and we want to get your input on Lumber River gages and flows. Let me know a convenient time in next few days and we'll plan accordingly. Regards

Amit Sachan *PE, CFM*
Project Director, Mid-Atlantic
Private & Public Business Unit

View my profile

+1(919) 431 5253 +1(919) 985 1095

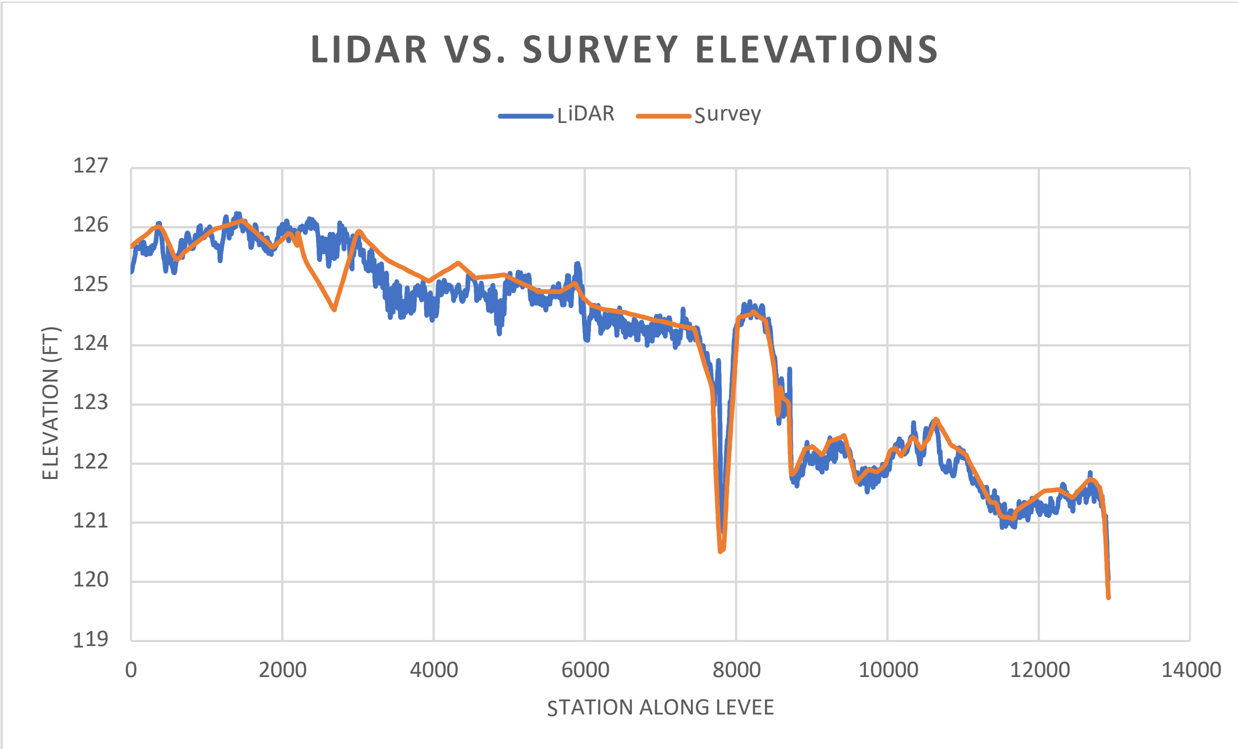
Atkins, member of the SNC-Lavalin Group
1616 E. Millbrook Road, Suite 160, Raleigh, NC 27609

Appendix C. Hydraulic Analysis

C1 Hydraulic Structures Data

Summary of Final Structures in External Hydraulic Model								
Label Name	Channel	Street Name	Effective Model XS	Data Origin	Structure Type	Rise	Span or Diameter	# Piers
E1	Fivemile Branch	Dawn Dr (next to I-95)	NA	McGill Survey	2RCBC	7.67	10	
E2	Meadow Branch	Dawn Dr (next to I-95)	NA	McGill Survey	2RCBC	8	10	
E3	Fivemile Branch	N Roberts Ave (SR 211)	NA	McGill Survey	3RCBC	10	14	
E4	Fivemile Branch	W Carthage Rd (SR 1536)	NA	McGill Survey	3RCBC	11	13	
E5	Lumber River	Kenric Rd (SR 1539)	376455	Effective Model	Bridge		194.9	2
E6	Lumber River	S Caton Rd	375387	Effective Model	Bridge		354.9	4
E8	Lumber River	I-95	360856	Effective Model	Bridge		214.7	7
E9	Lumber River	5th Street	350697	Effective Model	Bridge		236.6	5
E10	Lumber River	W 2nd St	349864	Effective Model	Bridge		282.9	5
E12	Lumber River	S Chestnut St [Alamac Rd (SR 2289) in model]	345664	Effective Model	Bridge		330.5	6
E13	Lumber River	S Chippewa St/ Hestertown Rd	NA	McGill Survey	Bridge		197.7	2
E14	Lumber River	Structure 44 on NC HWY 72	323321.5	Effective Model	Bridge		360.9	7
E15	Lumber River	I-95 Proposed Bridge	360856	Preliminary Model	Bridge		428.8	4
E16	Lumber River	CSX Railroad	370045	Effective Model	Bridge		350	14
E17	Lumber River	Railroad	349691	Effective Model	Bridge		345	13
LJ4	Little Jacob Swamp	MLK Dr (NC 41)	NA	Field Data	Arch (2)	7.1	15	
JS5	Jacob Swamp	MLK Dr (NC 41)	25316.41	Effective Model	Box Culverts (2)	4.5	6	
CC9	Collection Canal	W 5th Street	NA	Field Data	RCP		6	
CC10	Collection Canal	MLK Dr (NC 41)	NA	Field Data	Pipe Culvert		7	

C2 Lumber Levee and I-95 Data



LIDAR VS. SURVEY ELEVATIONS
LiDAR
Survey
127
126
125
124
123
122
121
120
119
ELEVATION (FT)
0
2000
4000
6000
8000
10000
12000
14000
STATION ALONG LEVEE

CITY OF LUMBERTON

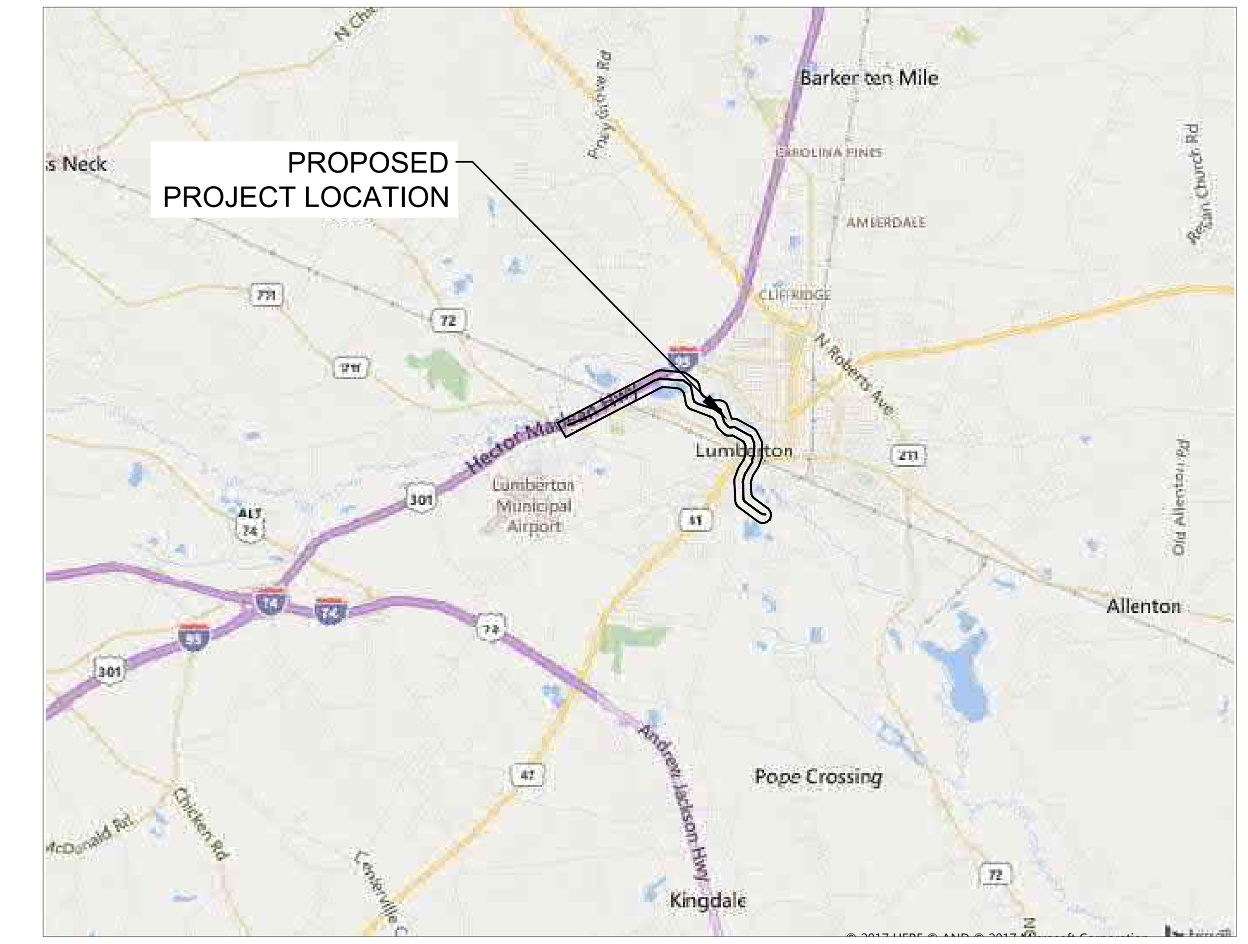
AECOM PROJECT NO. 60548447
STATE PROJECT NO. XXXX

LUMBERTON FLOOD MITIGATION

FUNDED IN PART BY XXXX

ROBESON COUNTY

XX % SUBMITTAL
XXXX, 2017



VICINITY MAP

SCALE: 1" = 10,000'

DRAWING INDEX

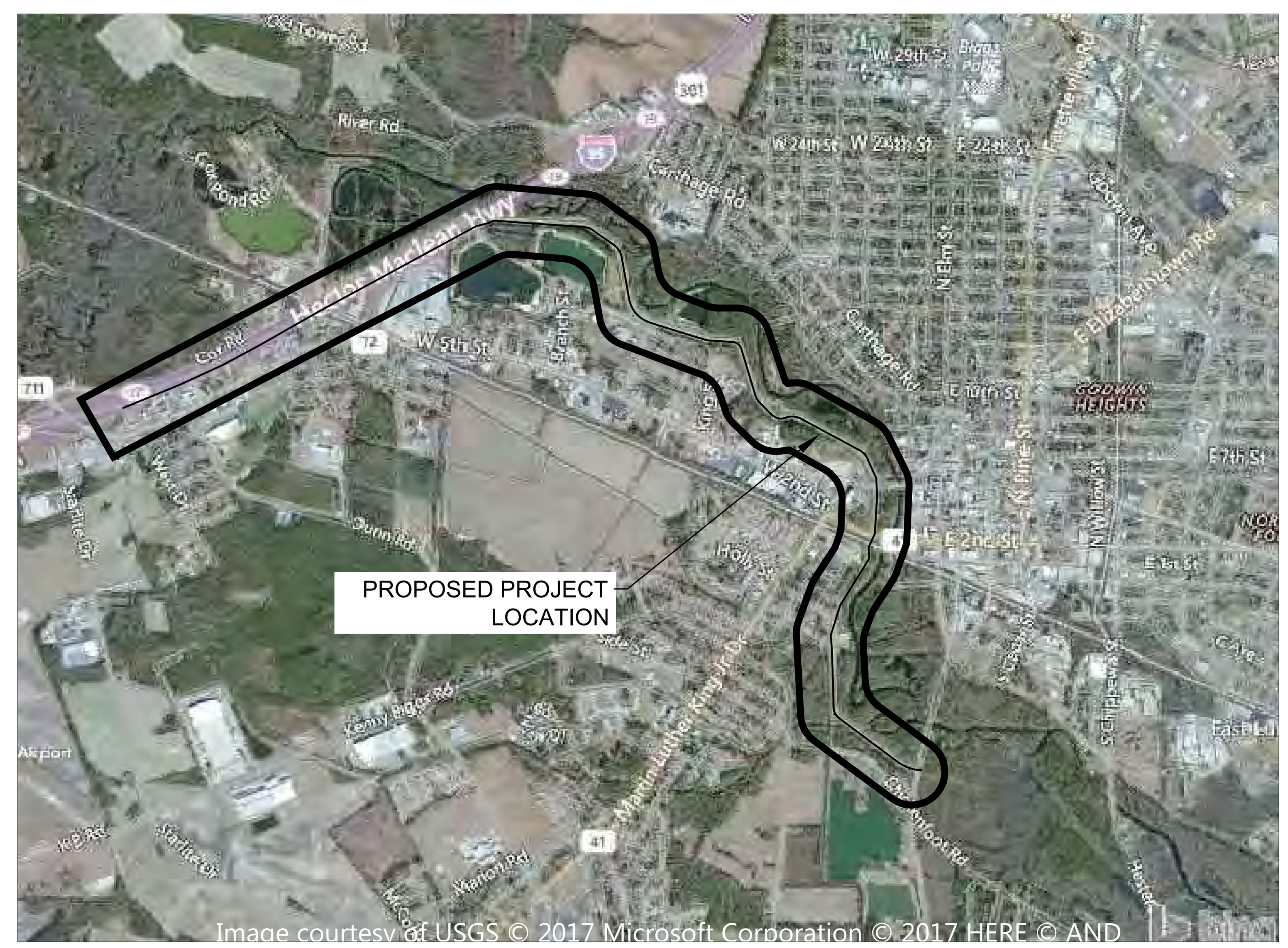
DWG. No.

GENERAL DRAWINGS

G-101	COVER SHEET
G-102	GENERAL NOTES

CIVIL DRAWINGS

C-100	GENERAL SITE PLAN



PROJECT LOCATION MAP

SCALE: 1" = 2000'

ADMINSTRATION
APPROVED BY:

EXECUTIVE DIRECTOR

DATE

PLANS PREPARED
AND APPROVED BY:

AECOM

DATE

MARK	DESCRIPTION	DATE	APPR

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

DATE: AUGUST 2017
SOLICITATION NO.: NA
CONTRACT NO.: NA
FILE NUMBER: NA
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE: NOTED
PLOT DATE:
SIZE: ANSI D
FILE NAME:

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM PROJECT No. xxxxxx

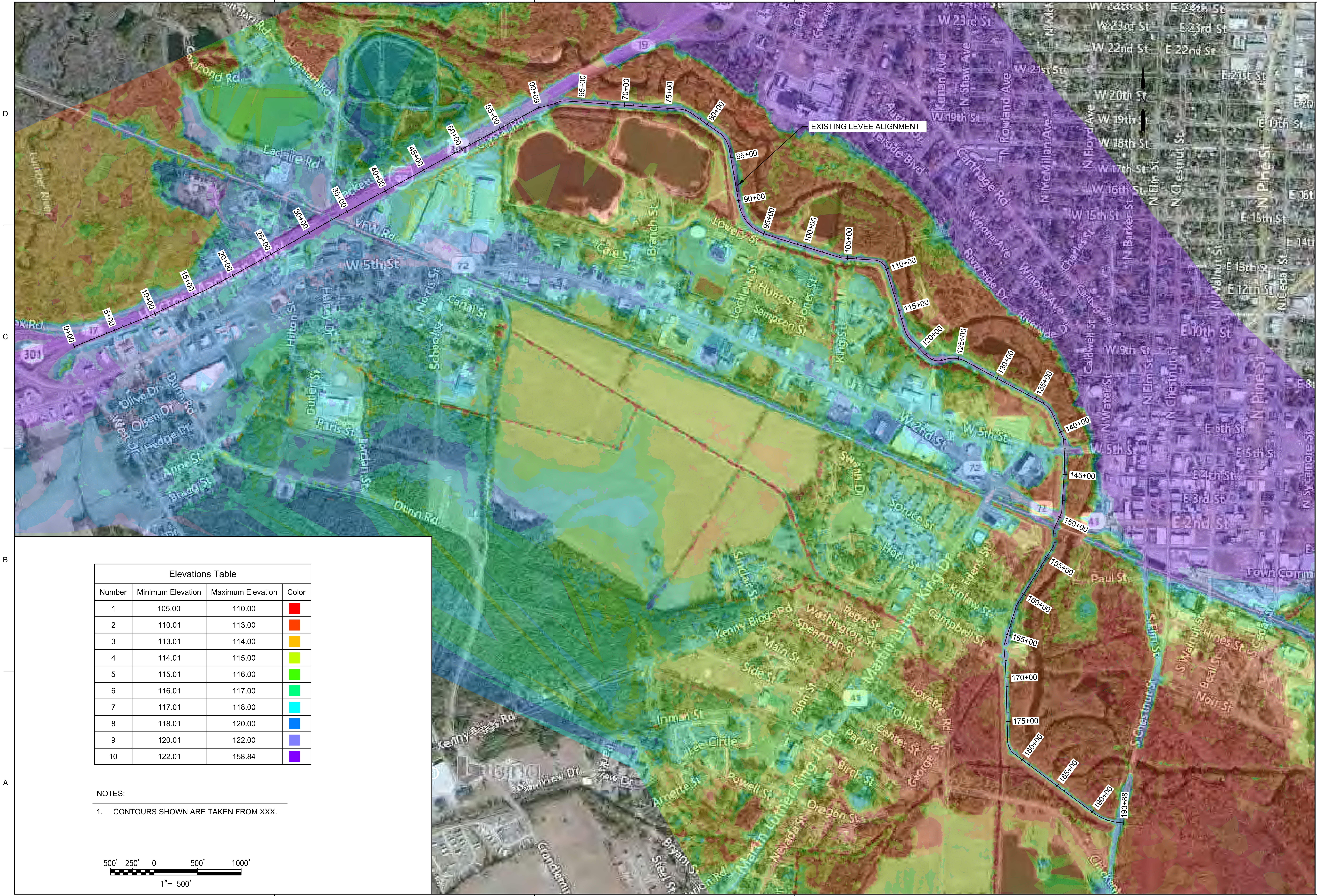
AECOM
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

LUMBERTON FLOOD MITIGATION

COVER SHEET

SHEET IDENTIFICATION
G-101

N:\Projects\Lumberton\CAD\Cover.dwg, Jul 20, 2017 - 10:35:59AM, phillip.olivier



Elevations Table

Number	Minimum Elevation	Maximum Elevation	Color
1	105.00	110.00	
2	110.01	113.00	
3	113.01	114.00	
4	114.01	115.00	
5	115.01	116.00	
6	116.01	117.00	
7	117.01	118.00	
8	118.01	120.00	
9	120.01	122.00	
10	122.01	158.84	

NOTES:

1. CONTOURS SHOWN ARE TAKEN FROM XXX.

500' 250' 0 500' 1000'

1"= 500'

N:\Projects\Lumberton\CAD\Project Overview.dwg, Jul 20, 2017 – 10:38:05AM, phillip.olivier

MARK	DESCRIPTION	DATE	APPR

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

DESIGNED BY: | DWN BY: | CKD BY: | SUBMITTED BY: | PLOT SCALE: NOTED | PLOT DATE: | SIZE: ANSI D | FILE NAME:

DATE: AUGUST 2017
SOLICITATION NO.: NA
CONTRACT NO.: NA
FILE NUMBER: NA

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM
AECOM PROJECT No. xxxxxx
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

LUMBERTON FLOOD MITIGATION

PROJECT OVERVIEW

SHEET IDENTIFICATION
G-101

PLAN

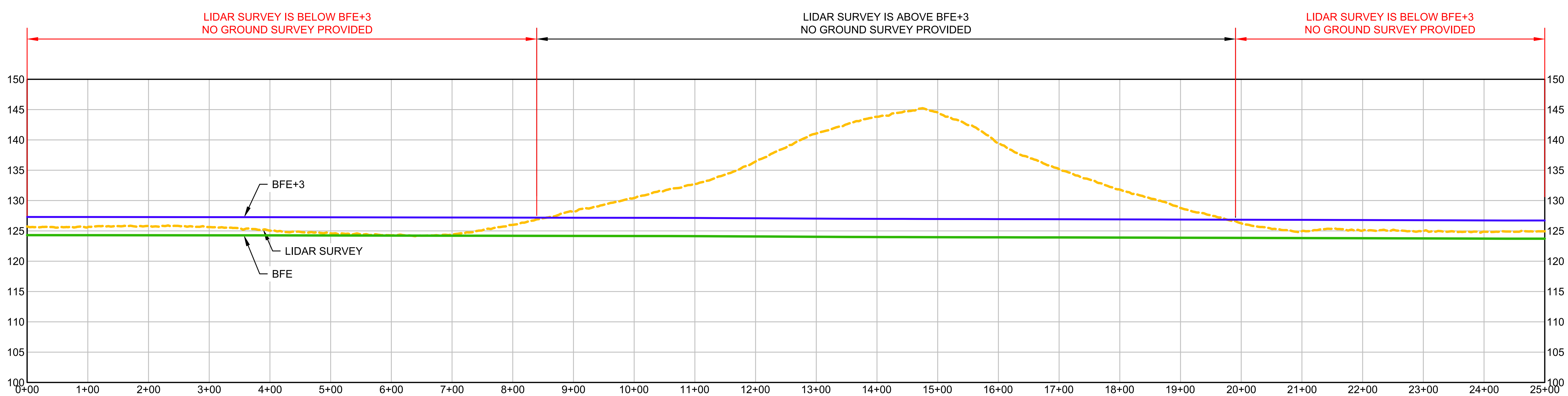
SCALE: 1" = 100'

LEGEND:

- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY

NOTES:

1. GROUND SURVEY SHOTS WERE COLLECTED IN NOVEMBER 2009.
2. BASE FLOOD ELEVATION (BFE) TAKEN FROM THE NORTH CAROLINA FLOOD RISK INFORMATION SYSTEM (NC FRIS) WEBSITE.



	0+00	1+00	2+00	3+00	4+00	5+00	6+00	7+00	8+00	9+00	10+00	11+00	12+00
BFE	124.29	124.29	124.28	124.27	124.26	124.24	124.22	124.21	124.19	124.17	124.15	124.13	124.08
BFE+3	127.29	127.29	127.28	127.27	127.26	127.24	127.22	127.21	127.19	127.17	127.15	127.13	127.08
LIDAR Δ	-1.57	-1.66	-1.46	-1.64	-2.21	-2.64	-2.95	-2.80	-1.19	0.94	3.27	5.59	9.36
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

	13+00	14+00	15+00	16+00	17+00	18+00	19+00	20+00	21+00	22+00	23+00	24+00	25+00
BFE	124.03	123.99	123.96	123.94	123.92	123.89	123.87	123.84	123.82	123.79	123.76	123.72	123.71
BFE+3	127.03	126.99	126.96	126.94	126.92	126.89	126.87	126.84	126.82	126.79	126.76	126.72	126.71
LIDAR Δ	14.04	16.83	17.56	12.52	8.28	4.92	1.91	-0.60	-1.86	-1.73	-1.79	-1.85	-1.78
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

100' 50' 0 100' 200'

1"= 100'

PROFILE

SCALE: 1" = 100'

N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 – 2:17:42PM, phillip.olivier

MARK | DESCRIPTION | DATE | APPR

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

DATE: AUGUST 2017
SOLICITATION NO.: NA
CONTRACT NO.: 60548447
FILE NUMBER: NA
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE: NOTED
PLOT DATE:
SIZE: ANSI D
FILE NAME:

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM
AECOM PROJECT No. 60548447
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

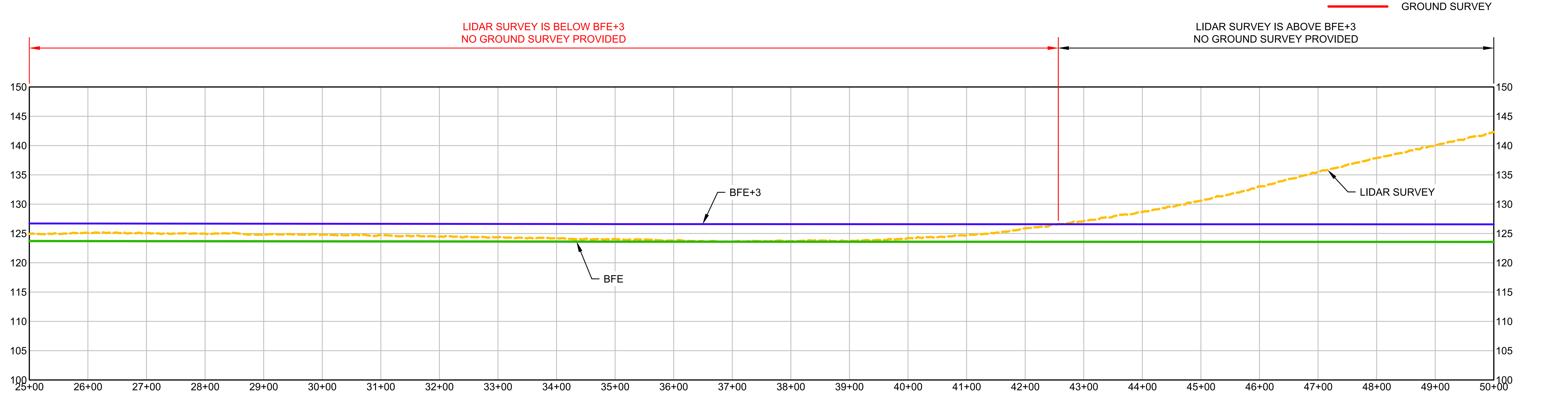
LUMBERTON FLOOD MITIGATION

PLAN AND PROFILE

SHEET IDENTIFICATION
C-100

PLAN

SCALE: 1" = 100'



	25+00	26+00	27+00	28+00	29+00	30+00	31+00	32+00	33+00	34+00	35+00	36+00	37+00
BFE	123.71	123.70	123.69	123.68	123.67	123.66	123.65	123.63	123.62	123.61	123.60	123.60	123.60
BFE+3	126.71	126.70	126.69	126.68	126.67	126.66	126.65	126.63	126.62	126.61	126.60	126.60	126.60
LIDAR Δ	-1.78	-1.59	-1.65	-1.72	-1.88	-1.86	-1.95	-2.19	-2.25	-2.42	-2.55	-2.82	-2.98
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

	38+00	39+00	40+00	41+00	42+00	43+00	44+00	45+00	46+00	47+00	48+00	49+00	50+00
BFE	123.60	123.59	123.59	123.59	123.58	123.58	123.58	123.57	123.57	123.57	123.56	123.56	123.56
BFE+3	126.60	126.59	126.59	126.59	126.58	126.58	126.58	126.57	126.57	126.57	126.56	126.56	126.56
LIDAR Δ	-2.91	-2.91	-2.36	-1.91	-0.71	0.54	2.07	4.03	6.49	8.93	11.30	13.43	15.75
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

PROFILE

SCALE: 1" = 100'

100' 50' 0 100' 200'
1"= 100'

N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 – 2:19:03PM, phillip.olivier

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

MARK | DESCRIPTION | DATE | APPR

DATE: AUGUST 2017
SOLICITATION NO.: NA
CONTRACT NO.: 60548447
FILE NUMBER: NA
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE: NOTED
PLOT DATE:
SIZE: ANSI D
FILE NAME:

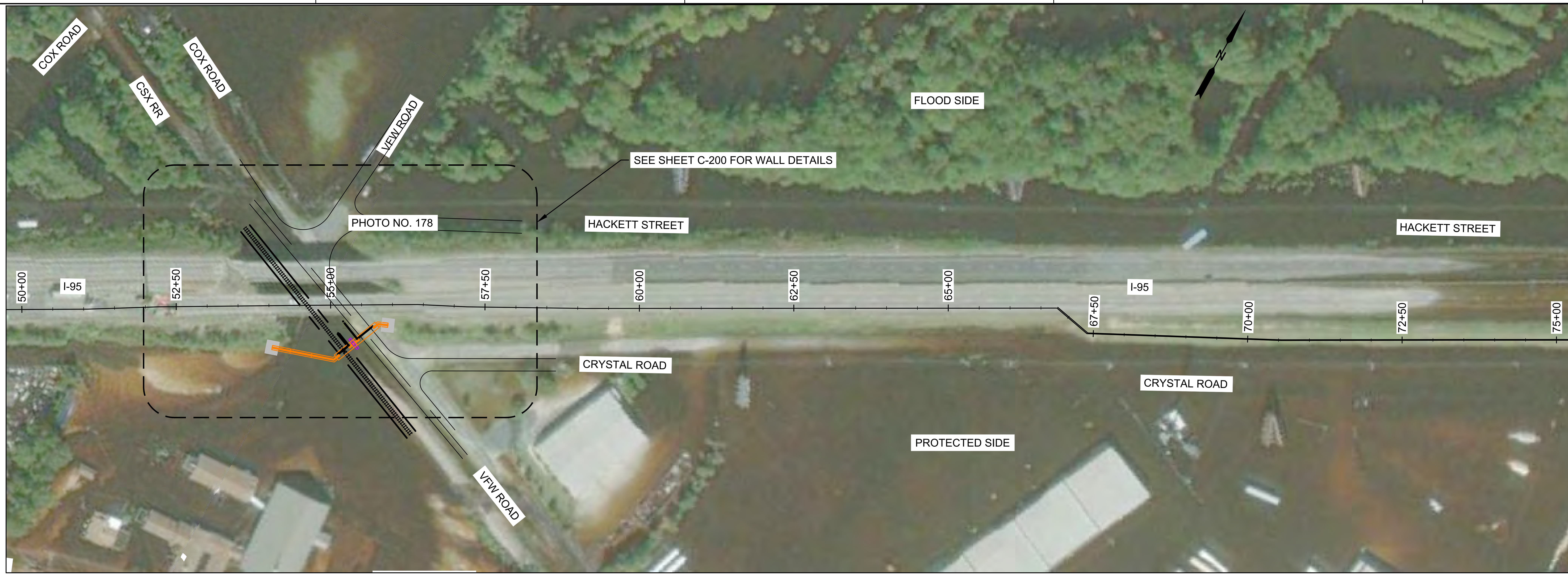
CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM
AECOM PROJECT No. 60548447
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

LUMBERTON FLOOD MITIGATION

PLAN AND PROFILE

SHEET IDENTIFICATION
C-101

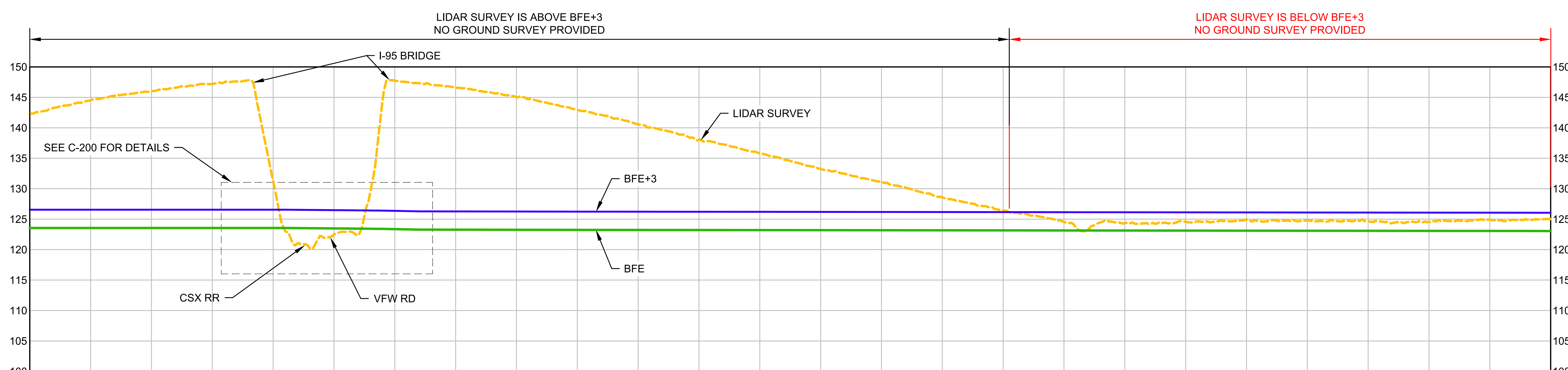


PLAN

SCALE: 1" = 100'

LEGEND:

- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY



	50+00	51+00	52+00	53+00	54+00	55+00	56+00	57+00	58+00	59+00	60+00	61+00	62+00
BFE	123.56	123.55	123.55	123.55	123.55	123.48	123.36	123.27	123.25	123.24	123.23	123.21	123.20
BFE+3	126.56	126.55	126.55	126.55	126.55	126.48	126.36	126.27	126.25	126.24	126.23	126.21	126.20
LIDAR Δ	15.75	17.97	19.45	20.63	4.72	-4.02	21.38	20.31	18.76	16.72	14.34	11.83	9.59
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

	63+00	64+00	65+00	66+00	67+00	68+00	69+00	70+00	71+00	72+00	73+00	74+00	75+00
BFE	123.19	123.18	123.17	123.16	123.14	123.13	123.12	123.11	123.10	123.09	123.08	123.07	123.05
BFE+3	126.19	126.18	126.17	126.16	126.14	126.13	126.12	126.11	126.10	126.09	126.08	126.07	126.05
LIDAR Δ	7.06	4.90	2.41	0.25	-1.57	-1.76	-1.54	-1.19	-1.31	-1.47	-1.55	-1.18	-1.02
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

100' 50' 0 100' 200'
1"= 100'

PROFILE

SCALE: 1" = 100'

N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 - 2:20:22PM, phillip.olivier

MARK | DESCRIPTION | DATE | APPR

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

DATE: AUGUST 2017
SOLICITATION NO.: NA
CONTRACT NO.: 60548477
FILE NUMBER: NA
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE: NOTED
PLOT DATE:
SIZE: ANSI D
FILE NAME:

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM PROJECT No. 60548447
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

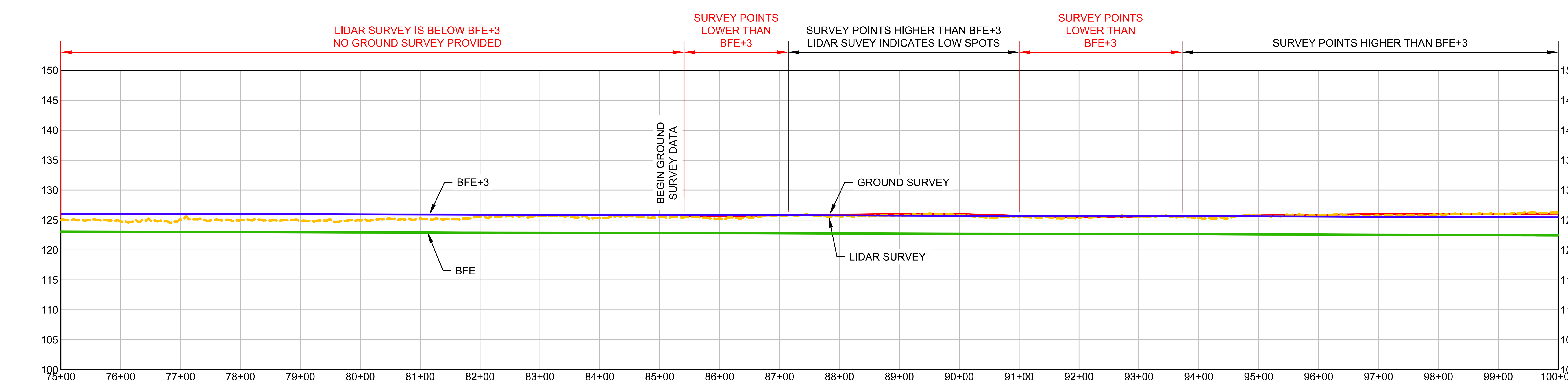
LUMBERTON FLOOD MITIGATION
PLAN AND PROFILE

SHEET IDENTIFICATION
C-102

LEGEND:
- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY

PLAN

SCALE: 1" = 100'



	75+00	76+00	77+00	78+00	79+00	80+00	81+00	82+00	83+00	84+00	85+00	86+00	87+00	88+00	89+00	90+00	91+00	92+00	93+00	94+00	95+00	96+00	97+00	98+00	99+00	100+00
BFE	123.05	123.02	122.99	122.97	122.95	122.93	122.91	122.89	122.87	122.86	122.84	122.81	122.80	122.77	122.75	122.73	122.71	122.68	122.66	122.63	122.60	122.57	122.54	122.51	122.48	122.45
BFE+3	126.05	126.02	125.99	125.97	125.95	125.93	125.91	125.89	125.87	125.86	125.84	125.81	125.80	125.77	125.75	125.73	125.71	125.68	125.66	125.63	125.60	125.57	125.54	125.51	125.48	125.45
LIDAR Δ	-1.02	-1.26	-0.92	-0.98	-1.05	-1.05	-0.64	-0.31	-0.21	-0.49	-0.32	-0.57	-0.04	-0.17	0.01	0.09	-0.19	-0.37	-0.16	-0.26	0.15	0.22	0.20	0.38	0.59	0.80
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.14	-0.02	0.10	0.23	0.25	0.01	-0.22	-0.09	0.04	0.17	0.30	0.42	0.49	0.56	0.63

100' 50' 0 100' 200'
1"= 100'

PROFILE

SCALE: 1" = 100'

MARK | DESCRIPTION | DATE | APPR

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

DATE: AUGUST 2017
SOLICITATION NO.: NA
CONTRACT NO.: 60548447
FILE NUMBER: NA
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE: NOTED
PLOT DATE:
SIZE: ANSI D
FILE NAME:

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM
AECOM PROJECT No. 60548447
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

LUMBERTON FLOOD MITIGATION

PLAN AND PROFILE

SHEET IDENTIFICATION
C-103

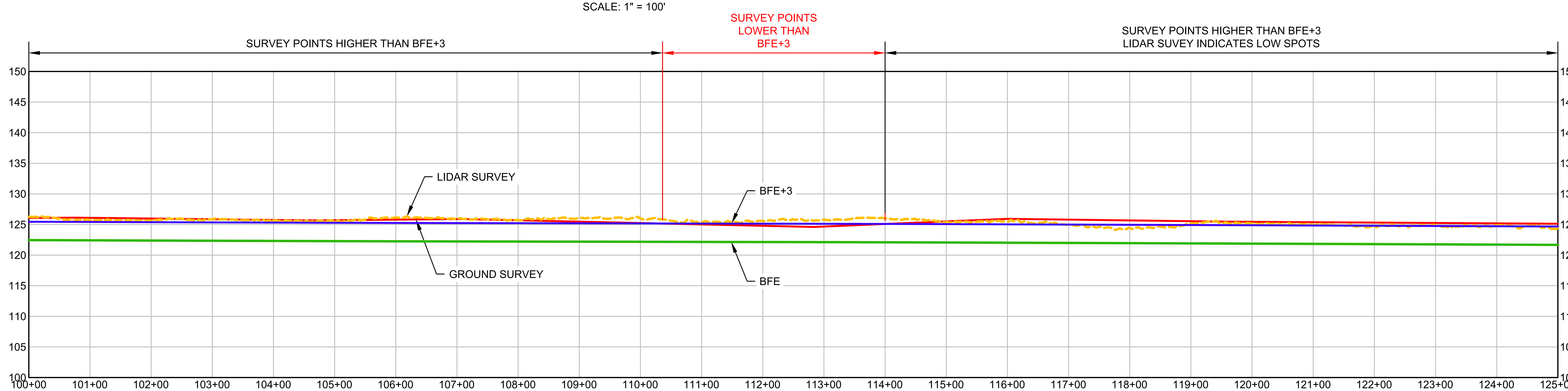
N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 – 2:21:41PM, phillip.olivier

LEGEND:

- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY

PLAN

SCALE: 1" = 100'



	100+00	101+00	102+00	103+00	104+00	105+00	106+00	107+00	108+00	109+00	110+00	111+00	112+00
BFE	122.45	122.41	122.38	122.34	122.31	122.28	122.25	122.23	122.21	122.19	122.17	122.16	122.14
BFE+3	125.45	125.41	125.38	125.34	125.31	125.28	125.25	125.23	125.21	125.19	125.17	125.16	125.14
LIDAR Δ	0.80	0.28	0.20	0.50	0.37	0.30	0.88	0.73	0.51	0.87	0.81	0.23	0.43
SURVEY Δ	0.63	0.67	0.59	0.51	0.43	0.41	0.54	0.66	0.48	0.27	0.06	-0.14	-0.35

	113+00	114+00	115+00	116+00	117+00	118+00	119+00	120+00	121+00	122+00	123+00	124+00	125+00
BFE	122.11	122.09	122.06	122.02	121.98	121.95	121.91	121.87	121.83	121.79	121.75	121.71	121.67
BFE+3	125.11	125.09	125.06	125.02	124.98	124.95	124.91	124.87	124.83	124.79	124.75	124.71	124.67
LIDAR Δ	0.68	0.92	0.35	0.47	-0.02	-0.49	0.26	0.31	0.12	-0.11	0.10	0.16	-0.30
SURVEY Δ	-0.45	0.00	0.45	0.90	0.81	0.72	0.63	0.57	0.54	0.52	0.49	0.47	0.44

100' 50' 0 100' 200'
1"= 100'

PROFILE

SCALE: 1" = 100'

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

MARK | DESCRIPTION | DATE | APPR

DESIGNED BY: | DWN BY: | CKD BY: | SUBMITTED BY: | PLOT SCALE: NOTED | PLOT DATE: | SIZE: ANSI D | FILE NAME:

DATE: AUGUST 2017 | SOLICITATION NO.: NA | CONTRACT NO.: 60548447 | FILE NUMBER: NA

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM PROJECT No. 60548447

AECOM
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

LUMBERTON FLOOD MITIGATION

PLAN AND PROFILE

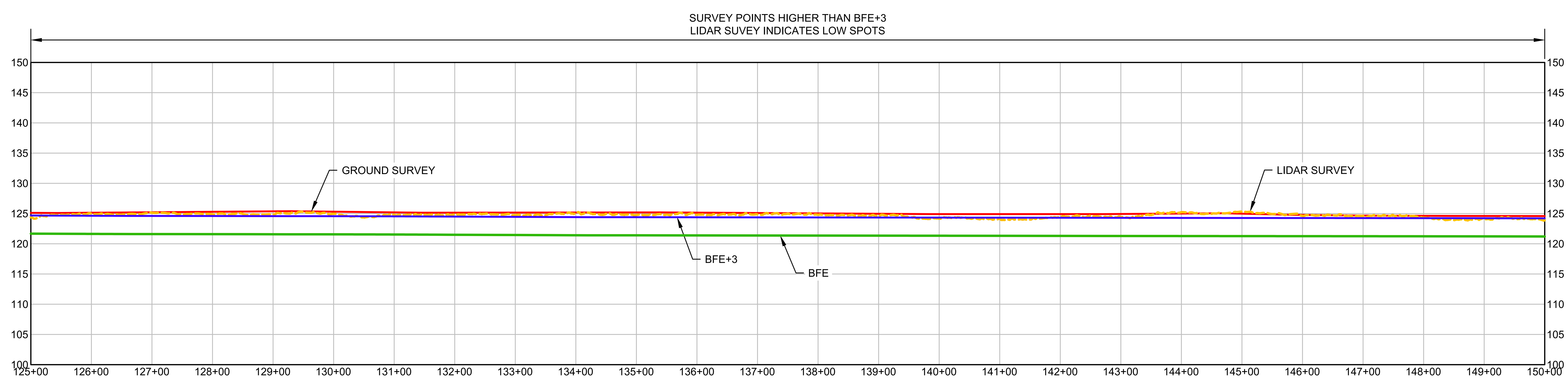
SHEET IDENTIFICATION
C-104

N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 - 2:23:00PM, phillip.olivier

LEGEND:
- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY

PLAN

SCALE: 1" = 100'



	125+00	126+00	127+00	128+00	129+00	130+00	131+00	132+00	133+00	134+00	135+00	136+00	137+00
BFE	121.67	121.64	121.61	121.59	121.58	121.56	121.54	121.50	121.45	121.41	121.40	121.38	121.37
BFE+3	124.67	124.64	124.61	124.59	124.58	124.56	124.54	124.50	124.45	124.41	124.40	124.38	124.37
LIDAR Δ	-0.30	0.36	0.53	0.28	0.28	0.40	0.26	0.40	0.28	0.60	0.35	0.40	0.49
SURVEY Δ	0.44	0.50	0.61	0.70	0.79	0.75	0.66	0.65	0.71	0.76	0.79	0.77	0.72

	138+00	139+00	140+00	141+00	142+00	143+00	144+00	145+00	146+00	147+00	148+00	149+00	150+00
BFE	121.36	121.35	121.33	121.32	121.31	121.29	121.28	121.27	121.26	121.25	121.24	121.22	121.20
BFE+3	124.36	124.35	124.33	124.32	124.31	124.29	124.28	124.27	124.26	124.25	124.24	124.22	124.20
LIDAR Δ	0.44	0.20	-0.16	-0.20	0.18	0.11	0.94	1.05	0.36	0.36	0.09	-0.12	-0.31
SURVEY Δ	0.67	0.62	0.58	0.59	0.60	0.64	0.72	0.71	0.52	0.42	0.39	0.38	0.38

100' 50' 0 100' 200'
1"= 100'

PROFILE

SCALE: 1" = 100'

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

DATE: AUGUST 2017
AECOM PROJECT No. 60548447

LUMBERTON FLOOD MITIGATION
PLAN AND PROFILE

SHEET IDENTIFICATION
C-105

N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 - 2:24:20PM, phillip.olivier

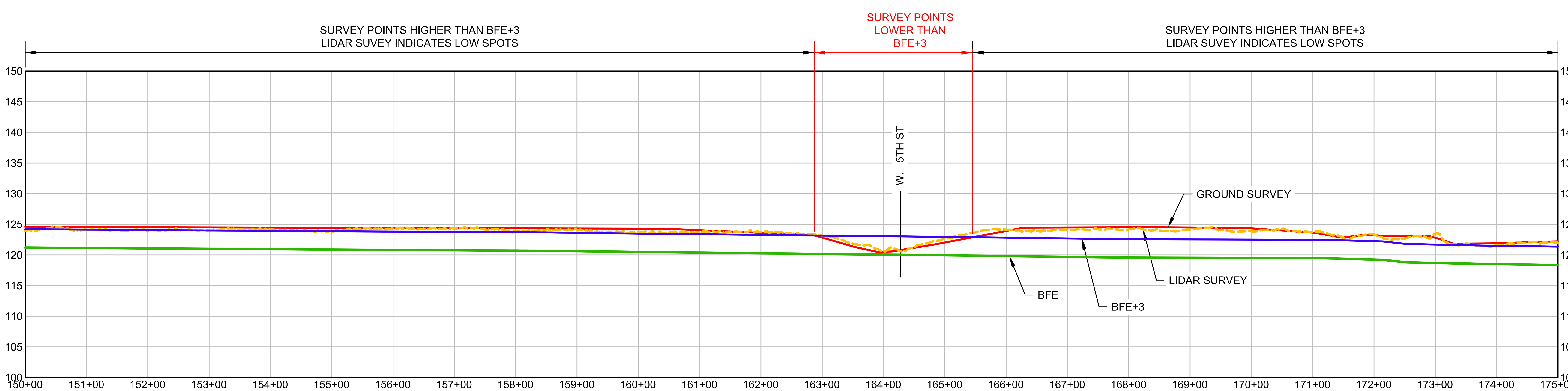
MATCHLINE STA 150+00
SHEET C-105

MATCHLINE STA 175+00
SHEET C-107

LEGEND:
- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY

PLAN

SCALE: 1" = 100'



	150+00	151+00	152+00	153+00	154+00	155+00	156+00	157+00	158+00	159+00	160+00	161+00	162+00
BFE	121.20	121.13	121.06	121.00	120.94	120.87	120.82	120.76	120.70	120.61	120.49	120.38	120.27
BFE+3	124.20	124.13	124.06	124.00	123.94	123.87	123.82	123.76	123.70	123.61	123.49	123.38	123.27
LIDAR Δ	-0.31	-0.01	-0.07	0.01	0.18	-0.07	0.52	0.55	0.19	0.49	0.23	0.41	0.48
SURVEY Δ	0.38	0.43	0.47	0.50	0.53	0.56	0.59	0.62	0.64	0.71	0.80	0.66	0.34

	163+00	164+00	165+00	166+00	167+00	168+00	169+00	170+00	171+00	172+00	173+00	174+00	175+00
BFE	120.16	120.05	119.94	119.81	119.69	119.56	119.53	119.50	119.47	119.24	118.69	118.49	118.35
BFE+3	123.16	123.05	122.94	122.81	122.69	122.56	122.53	122.50	122.47	122.24	121.69	121.49	121.35
LIDAR Δ	-0.04	-2.55	-0.29	1.31	1.45	1.61	1.55	1.36	1.26	1.09	1.78	0.12	0.64
SURVEY Δ	-0.33	-2.52	-0.92	1.10	1.80	1.97	1.96	1.84	1.17	0.97	1.10	0.43	0.87

100' 50' 0 100' 200'
1"= 100'

PROFILE

SCALE: 1" = 100'

N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 – 2:25:40PM, phillip.olivier

MARK | DESCRIPTION | DATE | APPR

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

DESIGNED BY: | DWN BY: | CKD BY: | SUBMITTED BY: | PLOT SCALE: NOTED | PLOT DATE: | SIZE: ANSI D | FILE NAME:
DATE: AUGUST 2017 | SOLICITATION NO.: NA | CONTRACT NO.: 60548447 | FILE NUMBER: NA

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

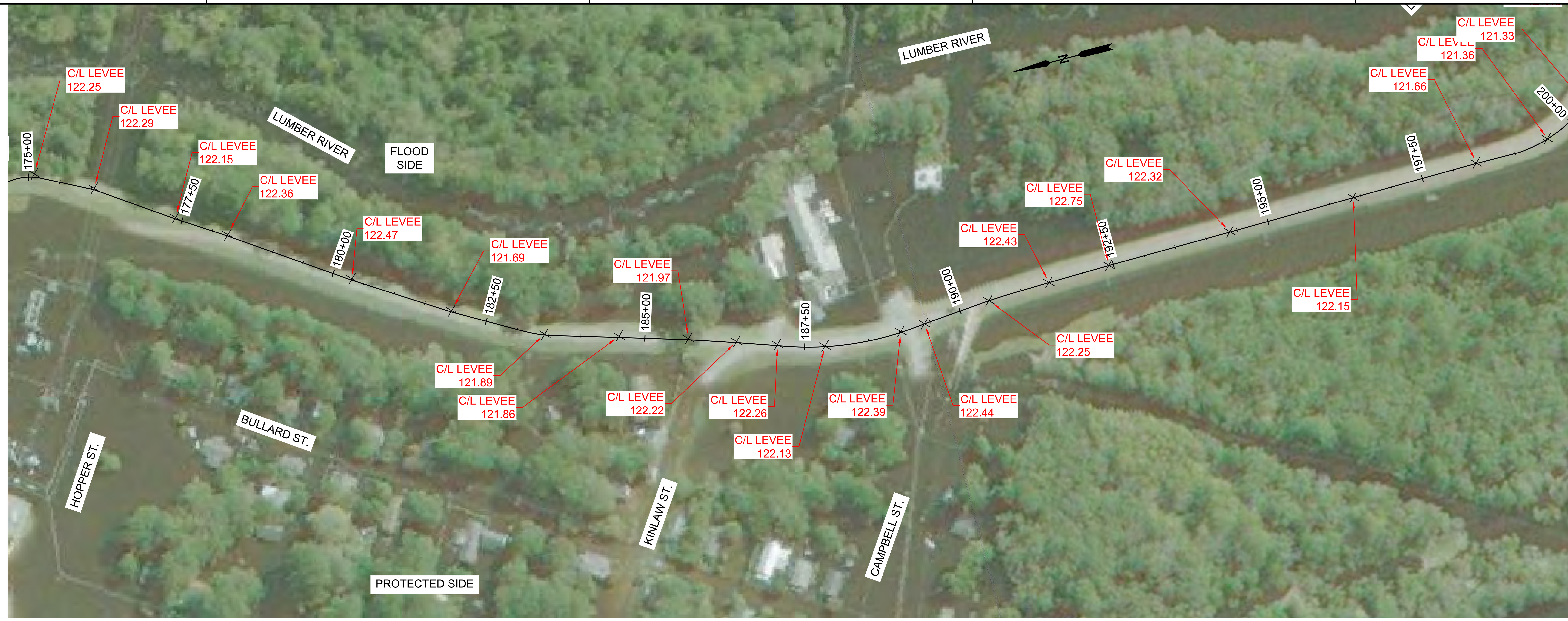
AECOM
AECOM PROJECT No. 60548447
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

LUMBERTON FLOOD MITIGATION
PLAN AND PROFILE

SHEET IDENTIFICATION
C-106

1 2 3 4 5

D C B A

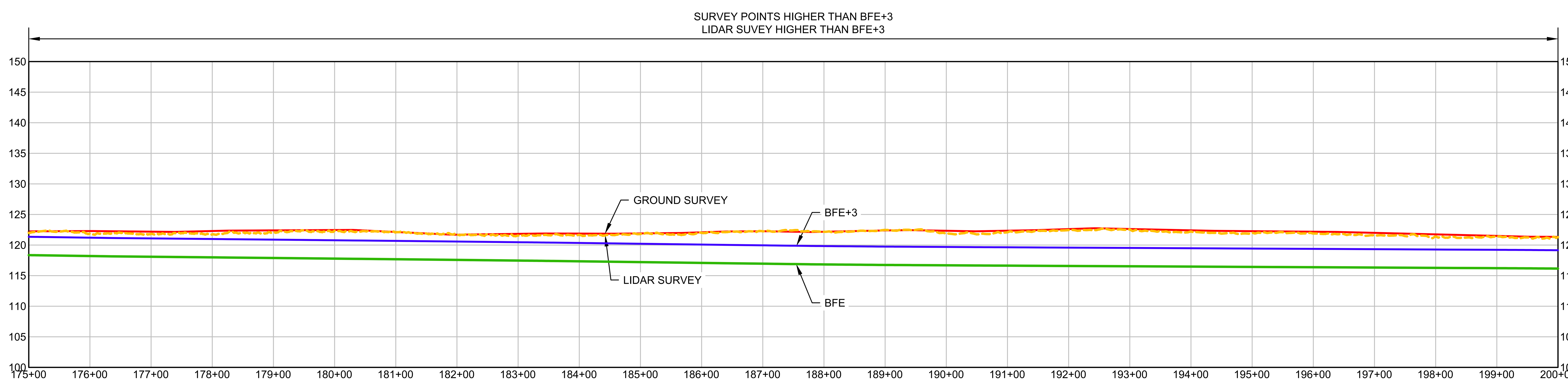


PLAN

SCALE: 1" = 100'

LEGEND:

- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY



	175+00	176+00	177+00	178+00	179+00	180+00	181+00	182+00	183+00	184+00	185+00	186+00	187+00
BFE	118.35	118.20	118.09	117.98	117.88	117.78	117.68	117.57	117.46	117.34	117.21	117.08	116.95
BFE+3	121.35	121.20	121.09	120.98	120.88	120.78	120.68	120.57	120.46	120.34	120.21	120.08	119.95
LIDAR Δ	0.64	0.67	0.76	0.74	1.21	1.56	1.40	1.15	1.08	1.32	1.60	1.91	2.29
SURVEY Δ	0.87	1.08	1.10	1.31	1.52	1.67	1.46	1.13	1.37	1.54	1.69	2.00	2.30

	188+00	189+00	190+00	191+00	192+00	193+00	194+00	195+00	196+00	197+00	198+00	199+00	200+00
BFE	116.83	116.74	116.69	116.63	116.58	116.53	116.48	116.43	116.37	116.32	116.27	116.22	116.15
BFE+3	119.83	119.74	119.69	119.63	119.58	119.53	119.48	119.43	119.37	119.32	119.27	119.22	119.15
LIDAR Δ	2.34	2.73	2.22	2.46	2.87	3.02	2.73	2.57	2.51	2.26	2.14	2.19	2.13
SURVEY Δ	2.34	2.64	2.65	2.72	3.03	3.10	2.93	2.84	2.81	2.67	2.48	2.28	2.19

100' 50' 0 100' 200'

1"= 100'

PROFILE

SCALE: 1" = 100'

N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 - 2:27:05PM, phillip.olivier

MARK | DESCRIPTION | DATE | APPR

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

DESIGNED BY: | DWN BY: | CKD BY: | SUBMITTED BY:

DATE: AUGUST 2017 | SOLICITATION NO.: NA | CONTRACT NO.: 60548447 | FILE NUMBER: NA

PLOT SCALE: NOTED | PLOT DATE: | SIZE: ANSI D | FILE NAME:

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM PROJECT No. 60548447

AECOM
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

LUMBERTON FLOOD MITIGATION

PLAN AND PROFILE

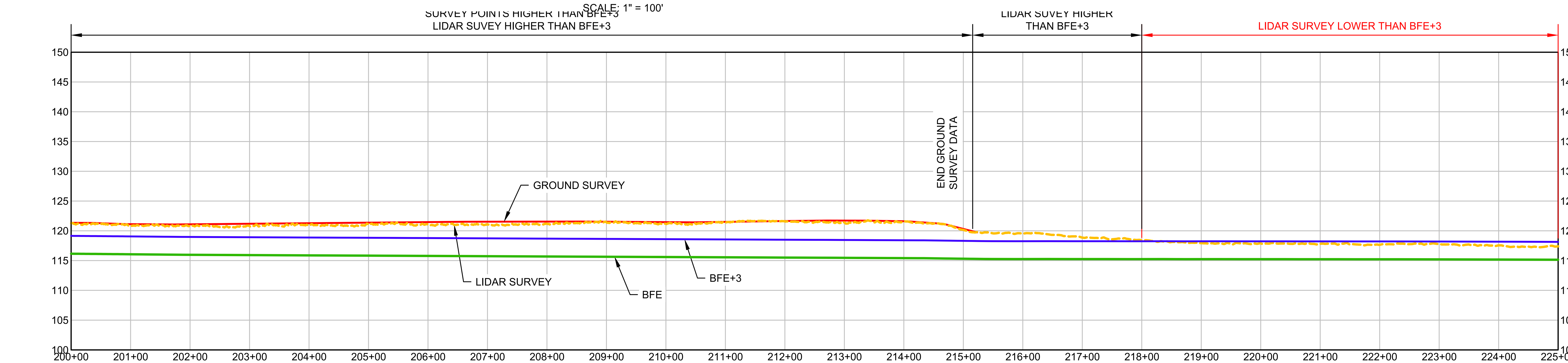
SHEET IDENTIFICATION
C-107

LEGEND:

- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY

PLAN

SCALE: 1" = 100'



	200+00	201+00	202+00	203+00	204+00	205+00	206+00	207+00	208+00	209+00	210+00	211+00	212+00
BFE	116.15	116.06	115.97	115.93	115.88	115.83	115.78	115.74	115.69	115.64	115.60	115.55	115.51
BFE+3	119.15	119.06	118.97	118.93	118.88	118.83	118.78	118.74	118.69	118.64	118.60	118.55	118.51
LIDAR Δ	2.13	1.74	1.78	1.86	2.04	2.23	2.25	2.34	2.49	2.79	2.56	2.89	3.07
SURVEY Δ	2.19	2.06	2.12	2.26	2.41	2.54	2.69	2.80	2.86	2.89	2.86	2.95	3.13

	213+00	214+00	215+00	216+00	217+00	218+00	219+00	220+00	221+00	222+00	223+00	224+00	225+00
BFE	115.46	115.41	115.31	115.25	115.25	115.25	115.24	115.23	115.23	115.22	115.20	115.18	115.15
BFE+3	118.46	118.41	118.31	118.25	118.25	118.25	118.24	118.23	118.23	118.22	118.20	118.18	118.15
LIDAR Δ	2.94	3.10	1.85	1.31	0.61	0.13	-0.31	-0.35	-0.40	-0.57	-0.44	-0.62	-0.76
SURVEY Δ	3.26	3.19	2.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

100' 50' 0 100' 200'
1"= 100'

PROFILE

SCALE: 1" = 100'

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

MARK | DESCRIPTION | DATE | APPR

DATE: AUGUST 2017
SOLICITATION NO.: NA
CONTRACT NO.: 60548447
FILE NUMBER: NA
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE: NOTED
PLOT DATE:
SIZE: ANSI D
FILE NAME:

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112
AECOM PROJECT No. 60548447

LUMBERTON FLOOD MITIGATION

PLAN AND PROFILE

SHEET IDENTIFICATION
C-108

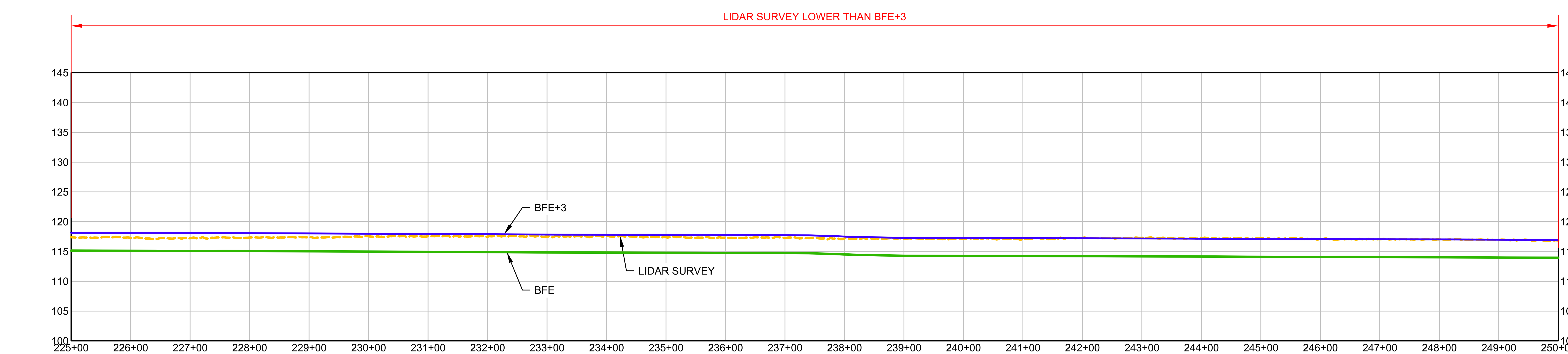
N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 – 2:28:29PM, phillip.olivier

PLAN

SCALE: 1" = 100'

LEGEND:

- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY



	225+00	226+00	227+00	228+00	229+00	230+00	231+00	232+00	233+00	234+00	235+00	236+00	237+00
BFE	115.15	115.12	115.09	115.06	115.03	114.98	114.93	114.89	114.84	114.82	114.79	114.76	114.73
BFE+3	118.15	118.12	118.09	118.06	118.03	117.98	117.93	117.89	117.84	117.82	117.79	117.76	117.73
LIDAR Δ	-0.76	-0.84	-0.88	-0.73	-0.64	-0.43	-0.37	-0.39	-0.32	-0.24	-0.40	-0.45	-0.45
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

	238+00	239+00	240+00	241+00	242+00	243+00	244+00	245+00	246+00	247+00	248+00	249+00	250+00
BFE	114.50	114.27	114.25	114.23	114.21	114.18	114.15	114.11	114.07	114.05	114.02	113.98	113.95
BFE+3	117.50	117.27	117.25	117.23	117.21	117.18	117.15	117.11	117.07	117.05	117.02	116.98	116.95
LIDAR Δ	-0.32	-0.18	-0.16	-0.14	0.06	0.12	0.08	0.08	0.00	0.01	0.02	-0.04	-0.09
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

PROFILE

SCALE: 1" = 100'

100' 50' 0 100' 200'

1"= 100'

N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 – 2:29:48PM, phillip.olivier

MARK | DESCRIPTION | DATE | APPR

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

DATE: AUGUST 2017
SOLICITATION NO.: NA
CONTRACT NO.: 60548447
FILE NUMBER: NA
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE: NOTED
PLOT DATE:
SIZE: ANSI D
FILE NAME:

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM PROJECT No. 60548447

AECOM
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

LUMBERTON FLOOD MITIGATION

PLAN AND PROFILE

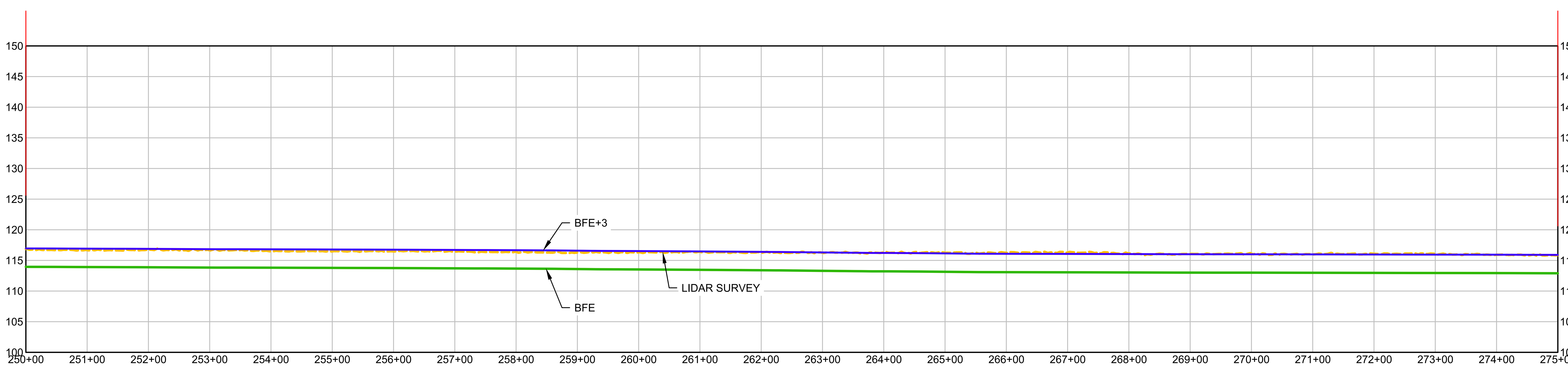
SHEET IDENTIFICATION
C-109

PLAN

SCALE: 1" = 100'

LEGEND:

- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY



	250+00	251+00	252+00	253+00	254+00	255+00	256+00	257+00	258+00	259+00	260+00	261+00	262+00
BFE	113.95	113.92	113.89	113.84	113.81	113.78	113.76	113.71	113.66	113.59	113.53	113.47	113.40
BFE+3	116.95	116.92	116.89	116.84	116.81	116.78	116.76	116.71	116.66	116.59	116.53	116.47	116.40
LIDAR Δ	-0.09	-0.24	-0.13	-0.19	-0.33	-0.31	-0.29	-0.29	-0.27	-0.29	-0.22	-0.09	-0.20
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

	263+00	264+00	265+00	266+00	267+00	268+00	269+00	270+00	271+00	272+00	273+00	274+00	275+00
BFE	113.30	113.22	113.14	113.08	113.06	113.04	113.01	113.00	112.98	112.97	112.95	112.93	112.90
BFE+3	116.30	116.22	116.14	116.08	116.06	116.04	116.01	116.00	115.98	115.97	115.95	115.93	115.90
LIDAR Δ	-0.06	0.11	0.13	0.16	0.23	0.13	0.06	0.11	-0.01	0.13	0.07	-0.01	-0.05
SURVEY Δ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

PROFILE

SCALE: 1" = 100'

100' 50' 0 100' 200'

1"= 100'

N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 – 2:31:05PM, phillip.olivier

MARK | DESCRIPTION | DATE | APPR

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

DATE: AUGUST 2017
SOLICITATION NO.: NA
CONTRACT NO.: 60548447
FILE NUMBER: NA
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE: NOTED
PLOT DATE:
SIZE: ANSI D
FILE NAME:

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112
AECOM PROJECT No. 60548447

LUMBERTON FLOOD MITIGATION

PLAN AND PROFILE

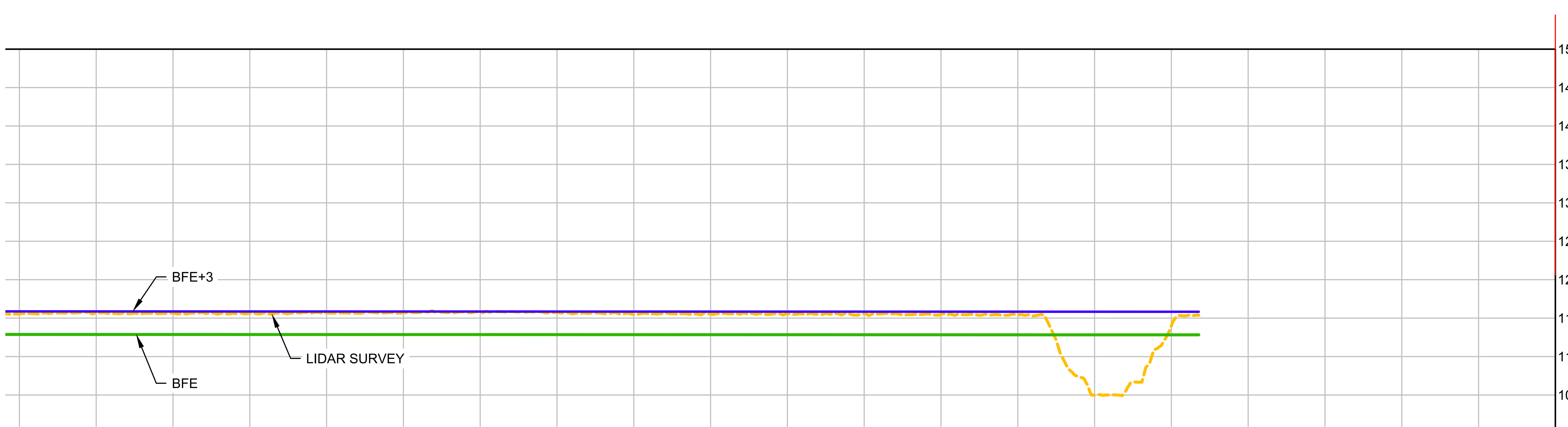
SHEET IDENTIFICATION

C-110

LEGEND:
- BASE FLOOD ELEVATION (BFE)
- BASE FLOOD ELEVATION +3' (BFE+3)
- LIDAR SURVEY
- GROUND SURVEY

PLAN

SCALE: 1" = 100'



280+00	281+00	282+00	283+00	284+00	285+00	286+00	287+00	288+00	289+00	290+00
112.88	112.88	112.87	112.87	112.87	112.86	112.86	112.86	112.85	112.85	112.85
115.88	115.88	115.87	115.87	115.87	115.86	115.86	115.86	115.85	115.85	115.85
-0.33	-0.18	-0.22	-0.24	-0.15	-0.17	-0.06	-0.14	-0.39	-0.32	-0.26
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

291+00	292+00	293+00	294+00	295+00	296+00	297+00	298+00	299+00	300+00
112.84	112.84	112.83	112.83	112.83					
115.84	115.84	115.83	115.83	115.83					
-0.28	-0.34	-0.43	-10.84	-1.83					
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

PROFILE

SCALE: 1" = 100'

100' 50' 0 100' 200'

1"= 100'

N:\Projects\Lumberton\CAD\Current Drawings\Plan and Profile.dwg, Aug 18, 2017 – 2:32:26PM, phillip.olivier

MARK | DESCRIPTION | DATE | APPR

NOT FOR CONSTRUCTION
PRELIMINARY SUBMITTAL

DATE: AUGUST 2017
SOLICITATION NO.: NA
CONTRACT NO.:
FILE NUMBER: NA
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE: NOTED
PLOT DATE:
SIZE: ANSI D
FILE NAME:

CITY OF LUMBERTON
NORTH CAROLINA
215 S CEDAR STREET
LUMBERTON, NC 28358

AECOM
AECOM PROJECT No. 60548447
1515 POYDRAS ST STE 2700
NEW ORLEANS, LA 70112

LUMBERTON FLOOD MITIGATION

PLAN AND PROFILE

SHEET IDENTIFICATION
C-111

C3 Calibration Results

Table 1. Roughness coefficients used for calibration trial runs

	NLCD Classification	Base N	Min. Value	Max. Value	Final Calibrated N
11	Open Water	0.03	0.025	0.033	**0.033**
21	Developed, Open Space	0.013	0.01	0.016	**0.016**
22	Developed, Low Intensity	0.05	0.038	0.063	**0.063**
23	Developed, Medium Intensity	0.075	0.056	0.094	**0.094**
24	Developed, High Intensity	0.1	0.075	0.125	**0.125**
31	Barren Land	0.03	0.025	0.035	
41	Deciduous Forest	0.12	0.1	0.16	
42	Evergreen Forest	0.12	0.1	0.16	
43	Mixed Forest	0.12	0.1	0.16	
52	Scrub/Shrub	0.05	0.035	0.07	
71	Grassland Herbaceous	0.03	0.025	0.035	
81	Pasture/Hay	0.04	0.03	0.05	
82	Cultivated Crops	0.035	0.025	0.045	**0.045**
90	Woody Wetlands	0.1	0.08	0.15	**0.15**
95	Emergent Herbaceous Wetland	0.1	0.075	0.15	
	Channel	0.045	0.035	0.05	**Override Region 0.065**
	Area Upstream of Gate	0.05			
	Black's Tire and Auto Service	0.1			
	I-95	0.013			
	Ponds	0.03			**0.033**
	Railroad Area	0.02			
	Wetland Upstream of I-95	0.1			
	Wooded Area	0.12			

Hurricane Florence Calibration Results at USGS Gage Location

Table 2. Hurricane Florence water surface elevations for calibration trial runs.

Water Surface Elevation (ft)		
Gage Peak	Base n	Final
119.69	120.02	120.63

Table 3. Hurricane Florence peak discharges for calibration trial runs.

Peak Flow Rate (cfs)		
Gage Peak	Base n	Final
17,100	16,092	15,877

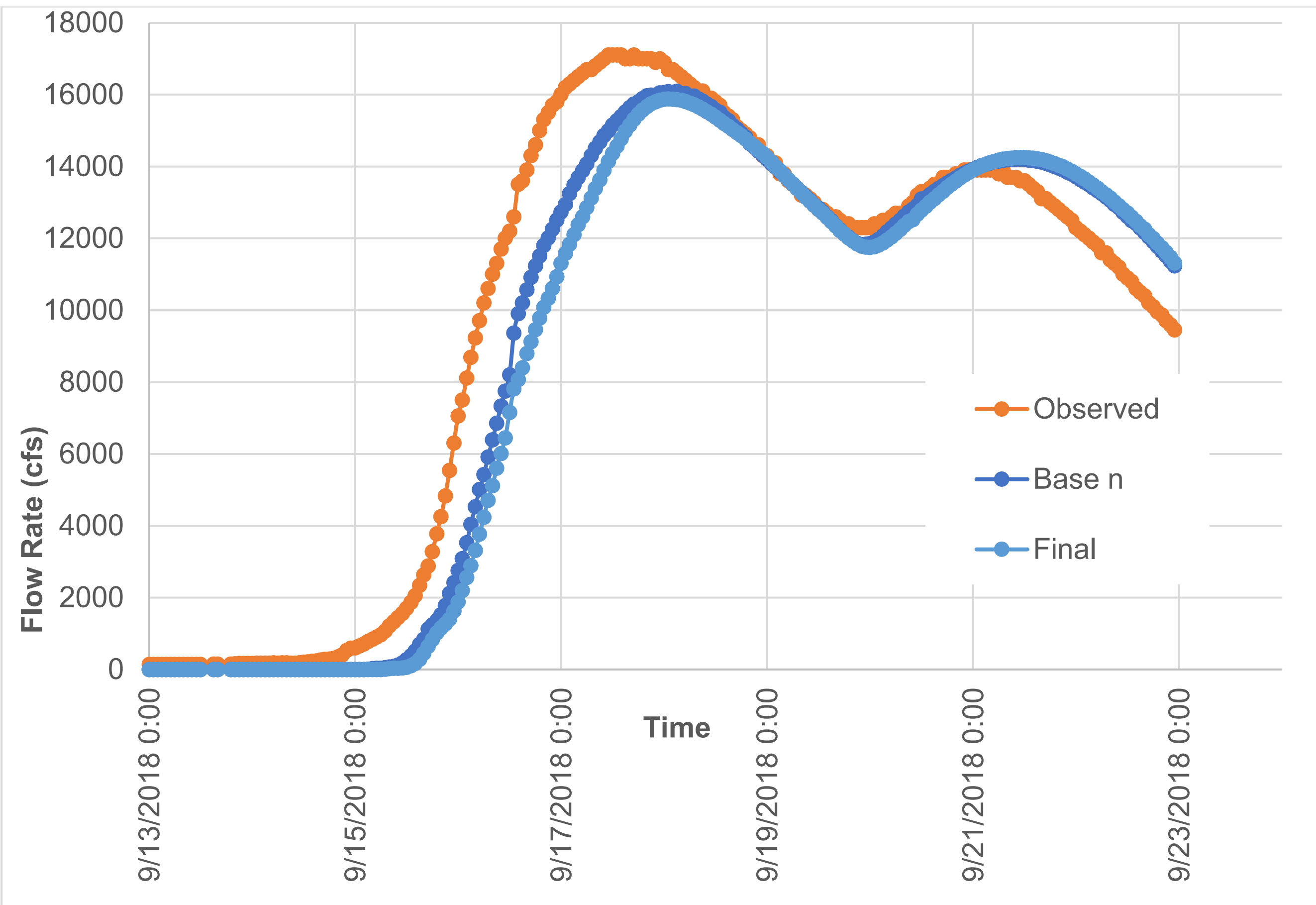


Figure 1- Hurricane Florence hydrographs for calibration trial runs.

Hurricane Matthew Verification Results at USGS Gage Location

Table 4. Hurricane Matthew water surface elevations for verification.

Water Surface Elevation (ft)	
Gage Peak	Verification
119.36	120.42

Table 5. Hurricane Matthew peak discharges for verification

Peak Flow Rate (cfs)	
Gage Peak	Verification
14,600	14,924

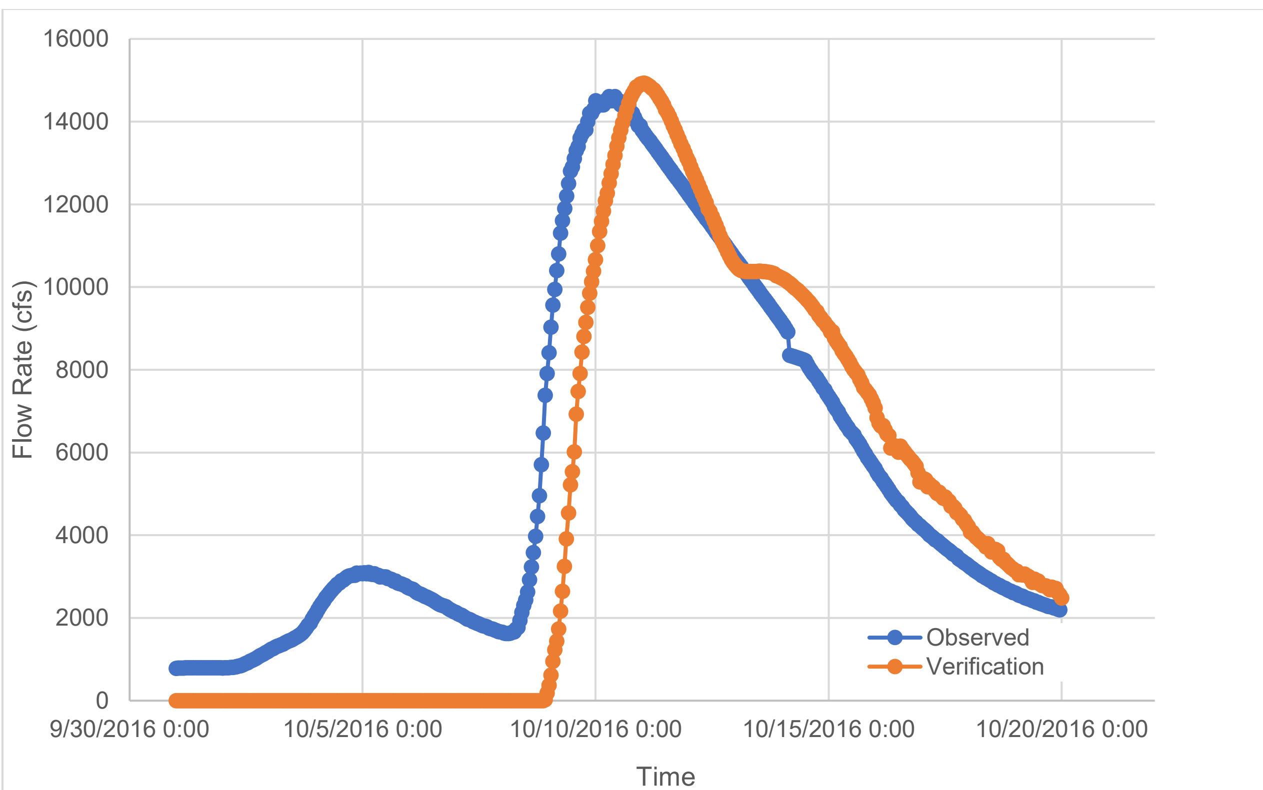


Figure 2. Hurricane Matthew hydrographs for verification run.

C4. Inundation Maps

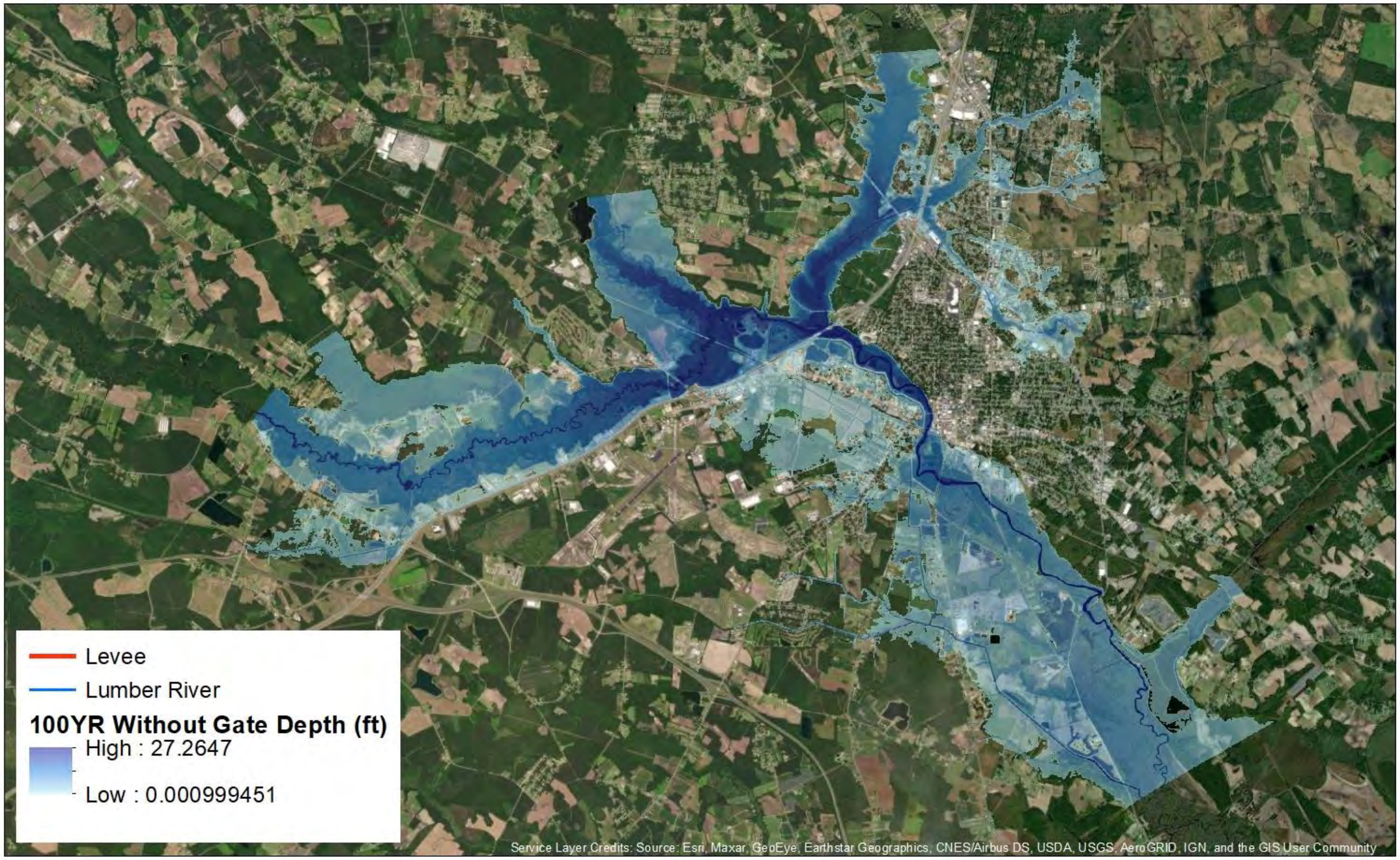


Figure C4-1 – Water depths (ft) for the 100YR flood event during the Scenario - Without Gate.

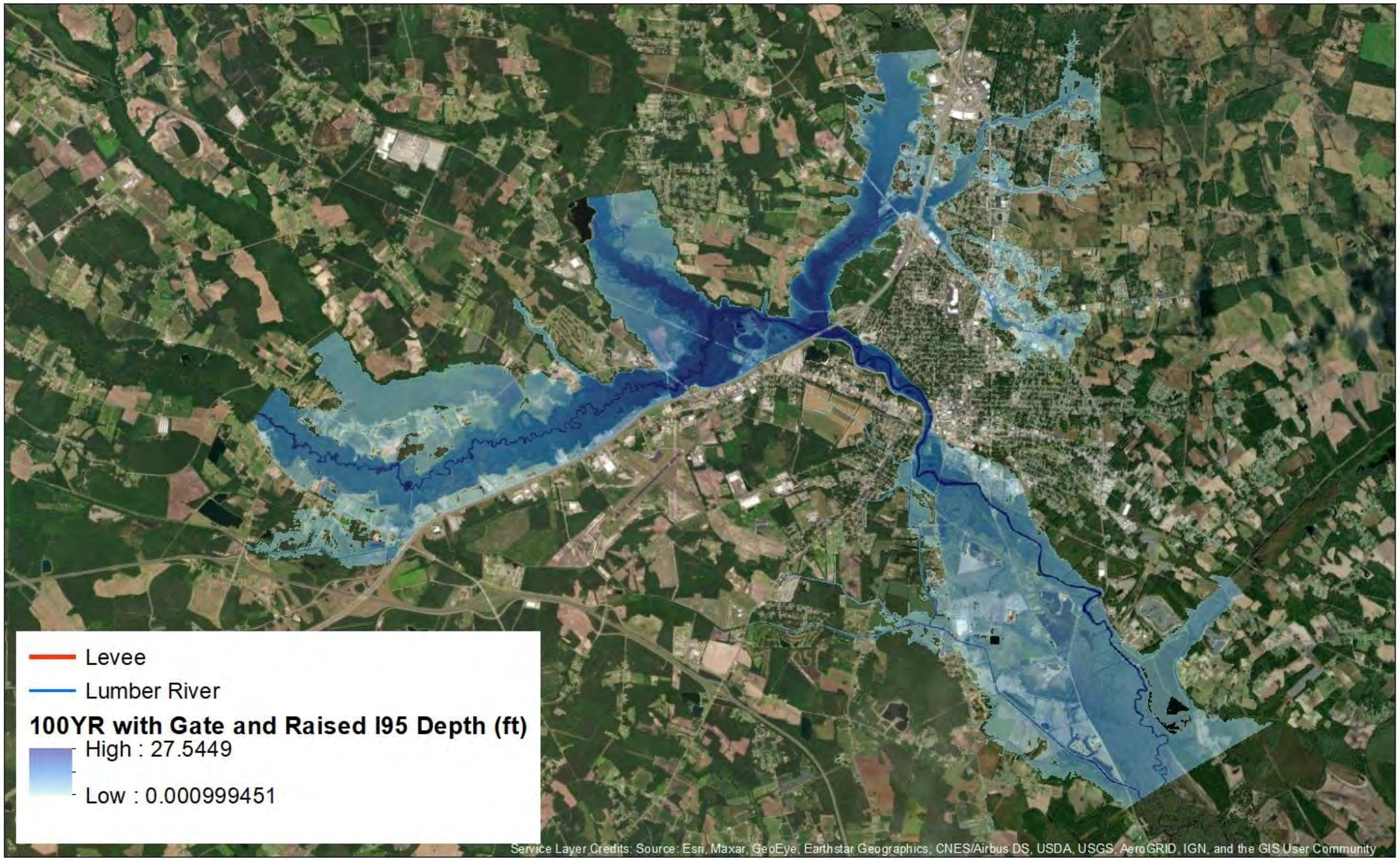


Figure C4-2 – Water depths (ft) for the 100YR flood event during the Scenario – With Gate and I-95 raised

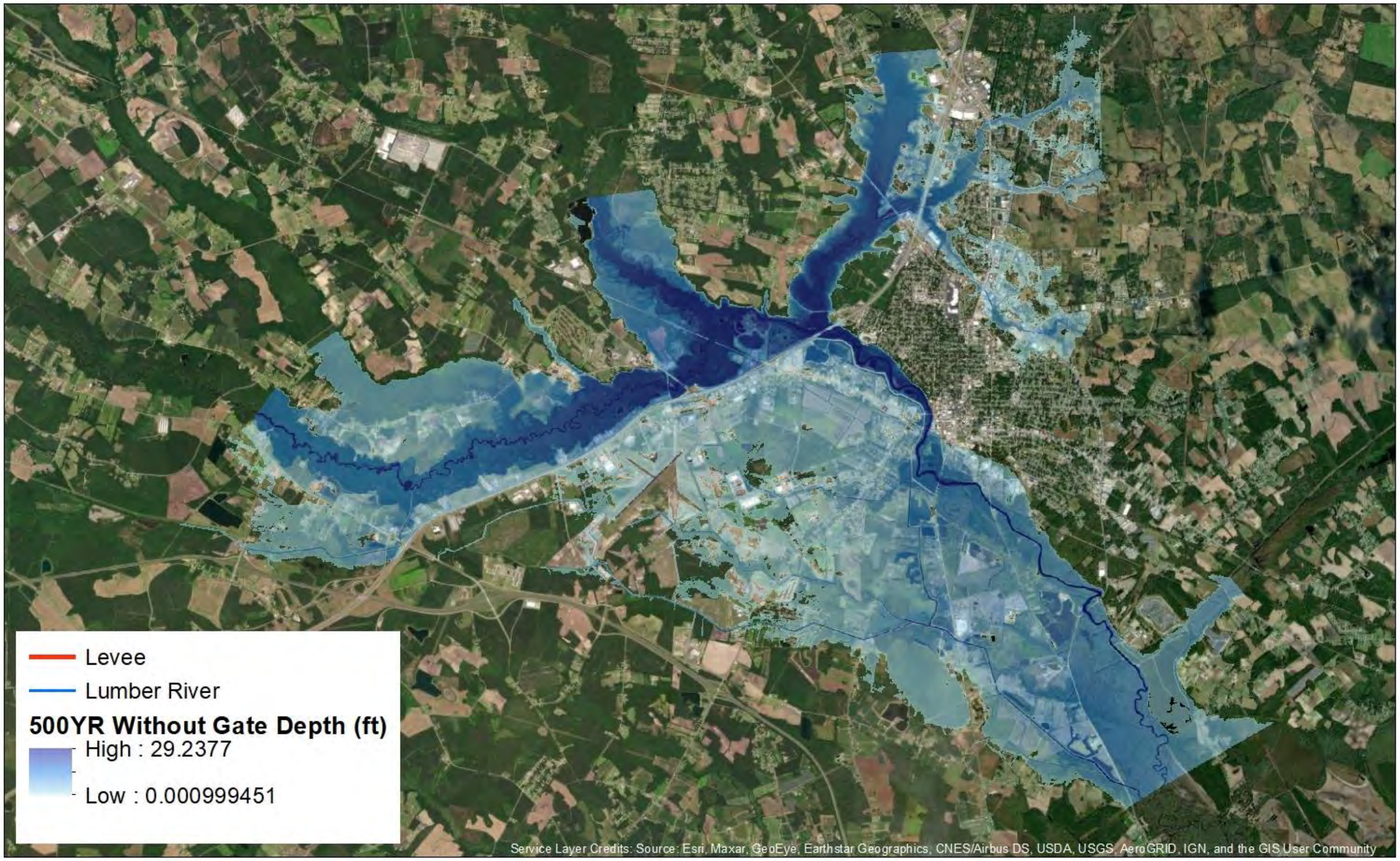


Figure C4-3 – Water depths (ft) for the 500YR flood event during the Scenario - Without Gate.

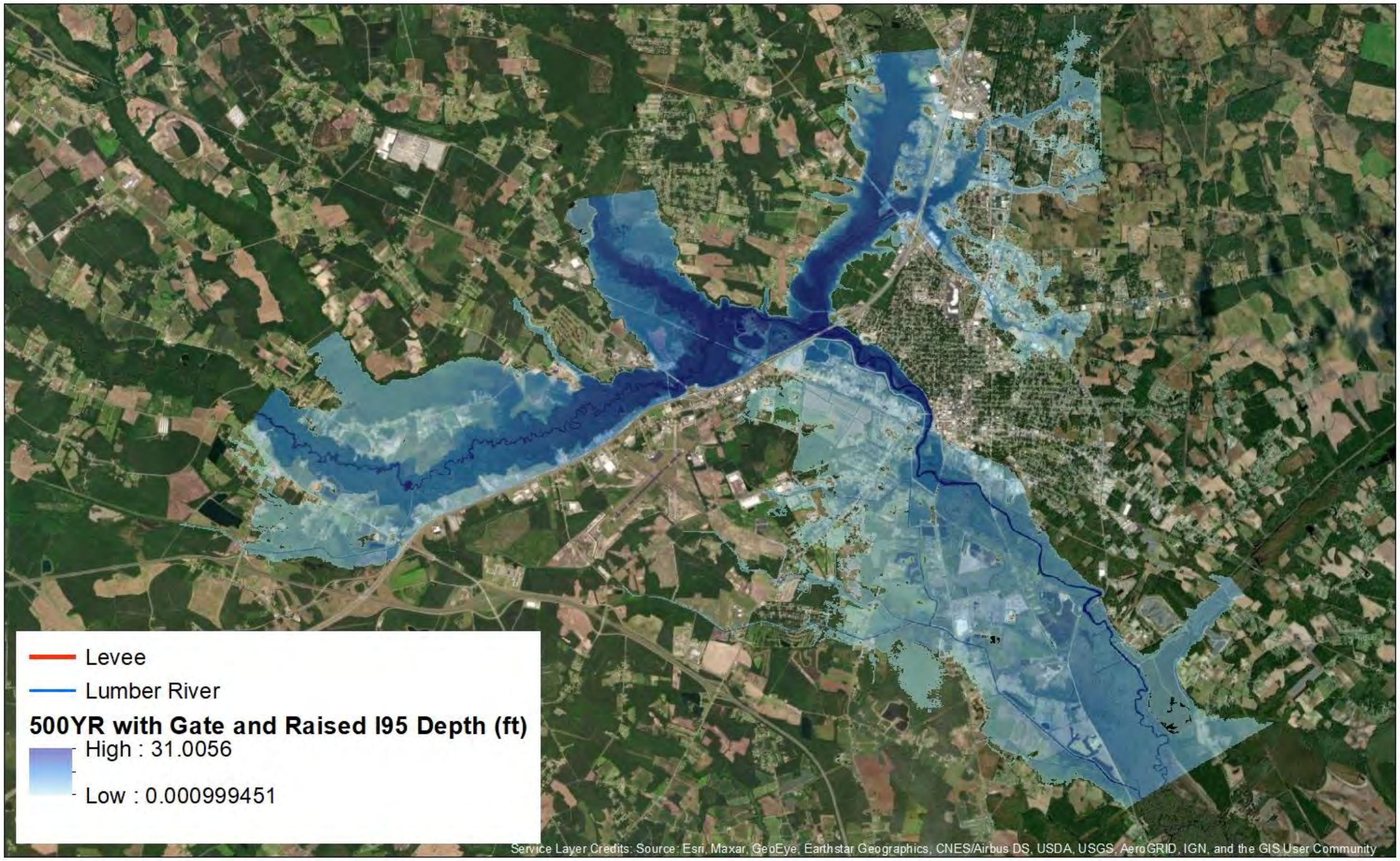


Figure C4-4 – Water depths (ft) for the 500YR flood event during the Scenario – With Gate and I-95 raised.

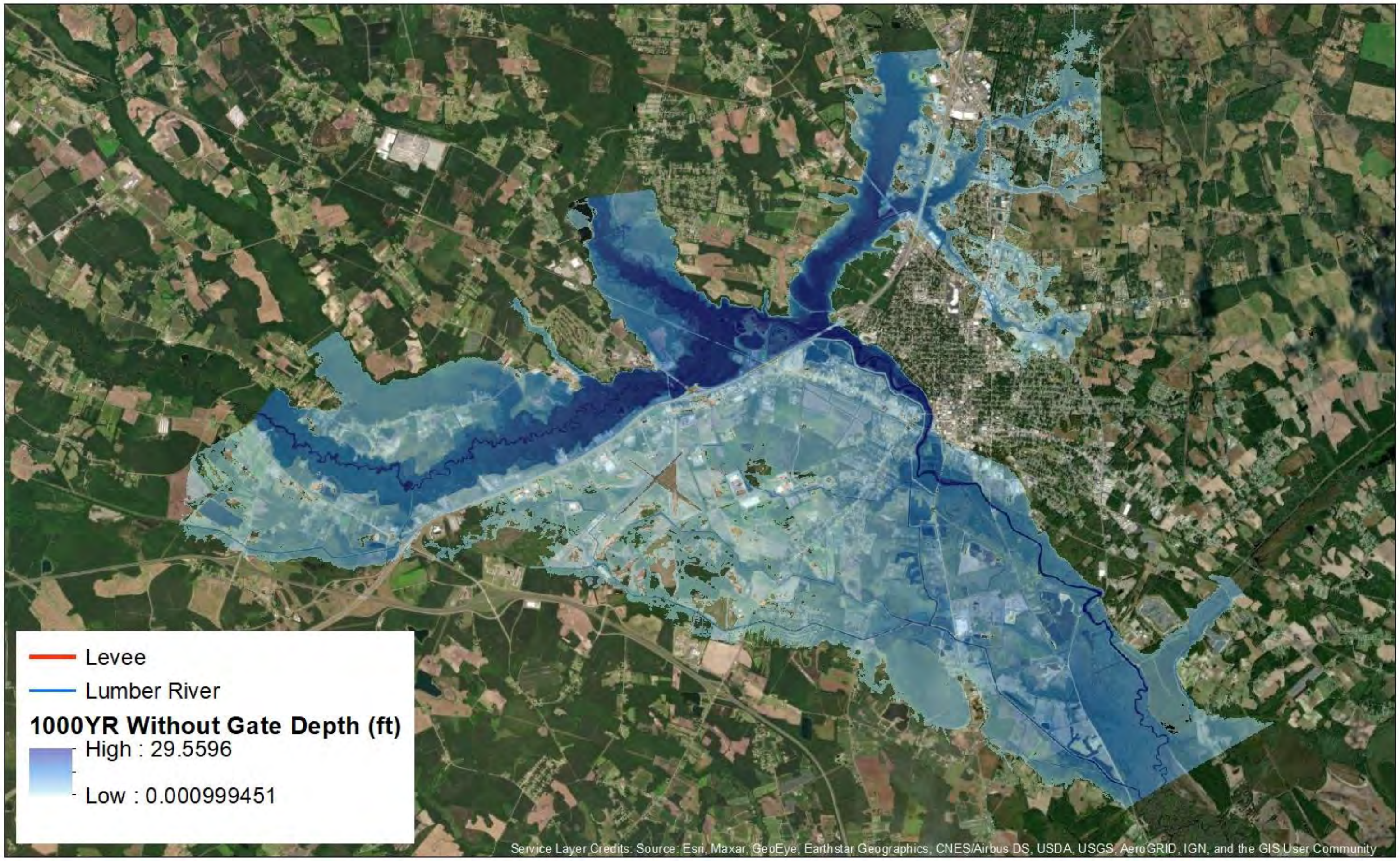


Figure C4-5 – Water depths (ft) for the 1000YR flood event during the Scenario - Without Gate.

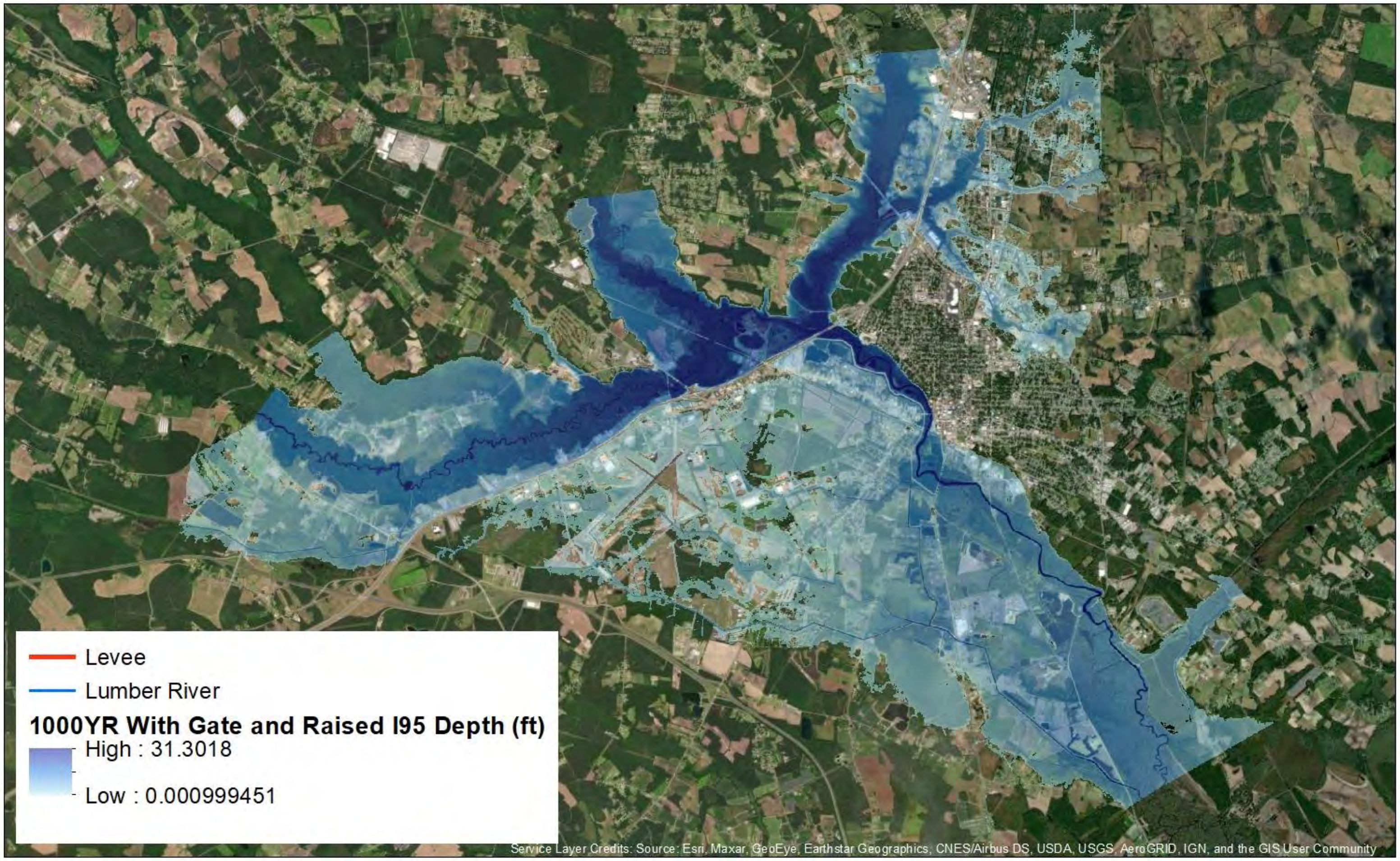


Figure C4-6 – Water depths (ft) for the 1000YR flood event during the Scenario – With Gate and I-95 raised.

Appendix D. Wind Wave Analysis

FIGURES FOR WIND SET-UP AND WAVE RUNUP CALCULATIONS

FIG. 1.—ISOTACH 0.50 QUANTILES, IN MILES PER HOUR: ANNUAL EXTREME-MILE 30 FT ABOVE GROUND, 2-YR MEAN RECURRENCE INTERVAL

Figure D-1. Isotachs showing wind speeds with a recurrence interval of 2 years over the United States (Thorn, 1968)

Fetch (F_e) in Miles	Wind ratio Over Water / Over Land
0.5	1.08
1	1.13
2	1.21
3	1.26
4	1.28
5 (or over)	1.30

Figure D-2 Table for overland to over water conversion of wind speeds from USACE, 1997

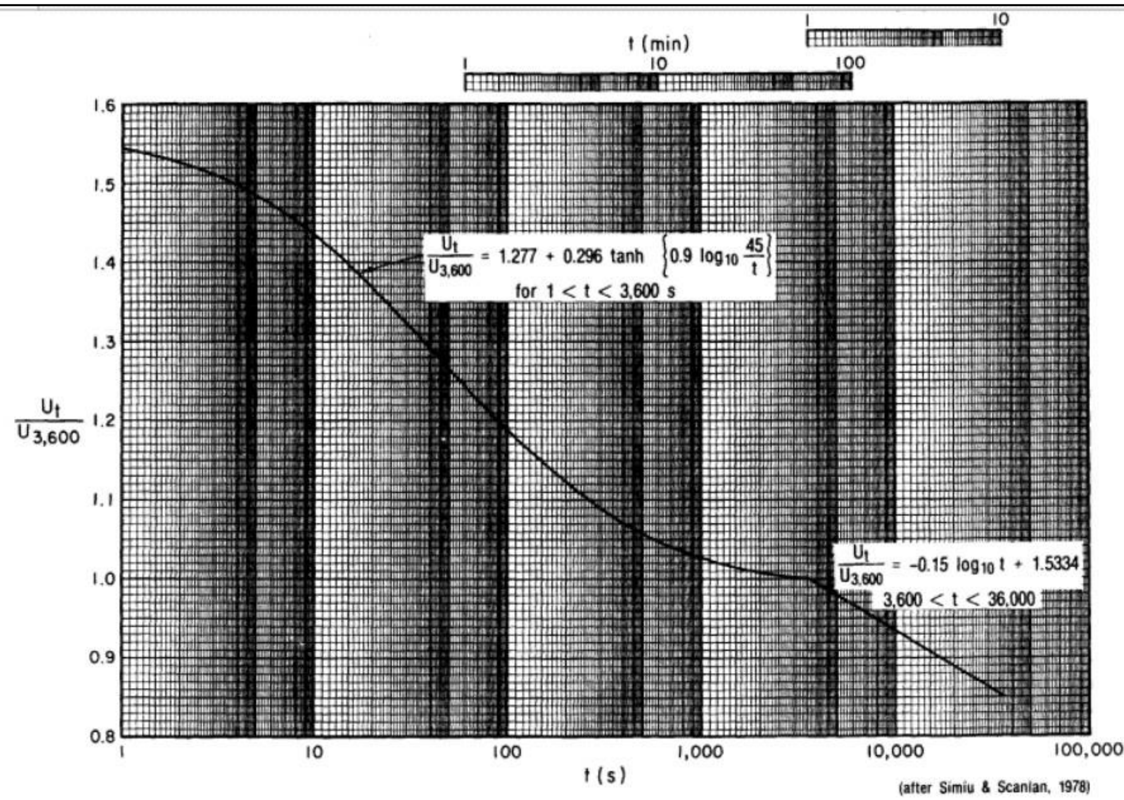


Figure 5-26. Ratio of wind speed of any duration U_t to the 1-hour wind speed U_{3600} (after item 120)

7 Jul 89

Figure D-3 Chart for converting wind speeds between various averaging intervals from USACE, 1989

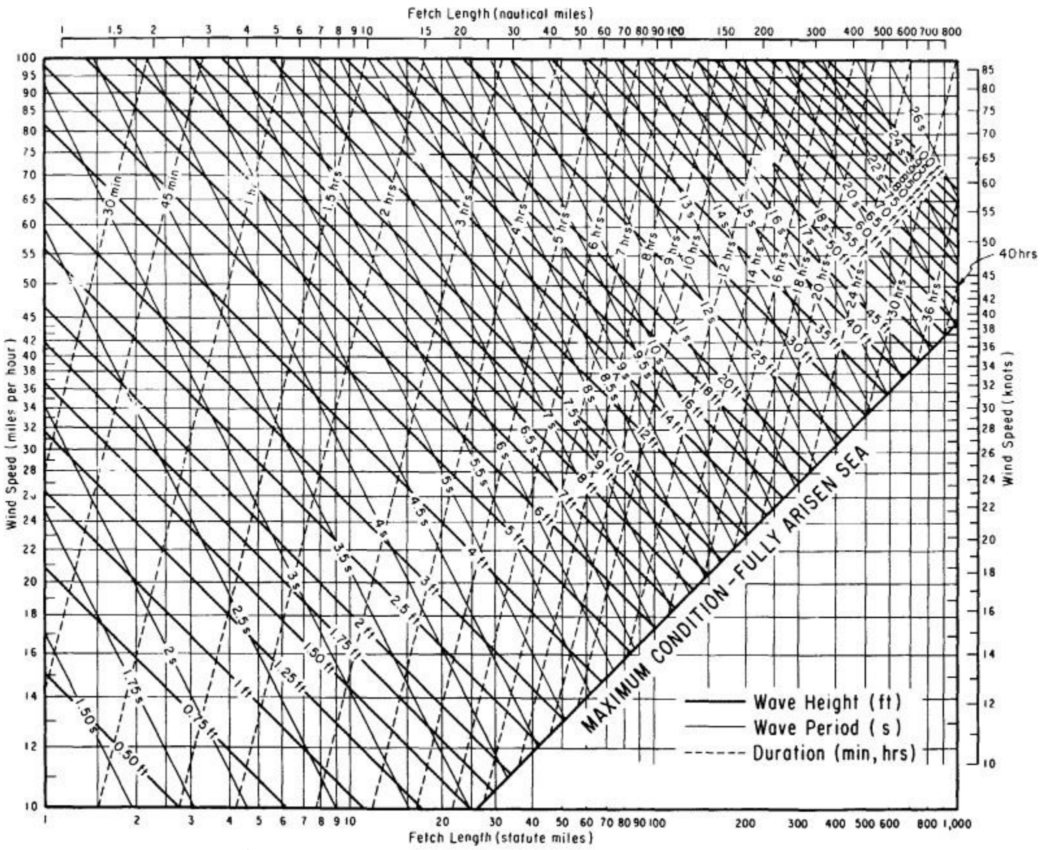


Figure 5-34. Nomograms of deepwater significant wave prediction curves as functions of wind speed, fetch length, and wind duration

Figure D-4 Hindcasting Charts for Deep water Wave Characteristics from USACE, 1989

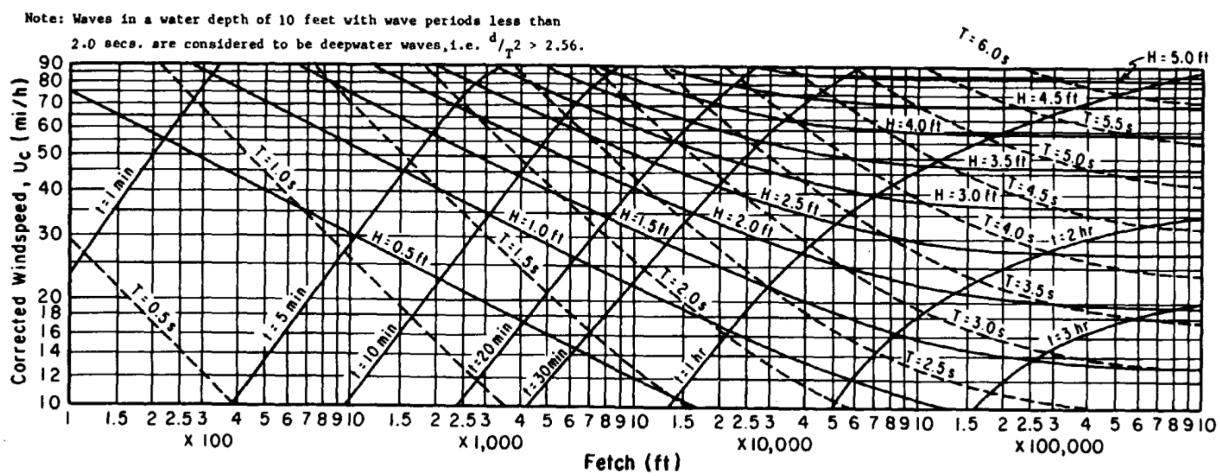


Figure 5-36. Forecasting curves for shallow-water waves (constant depth = 10 ft)

Figure D-5 Hindcasting Charts for Shallow water Wave Characteristics from USACE, 1989

Appendix E. Electronic Attachments

Items submitted electronically are:

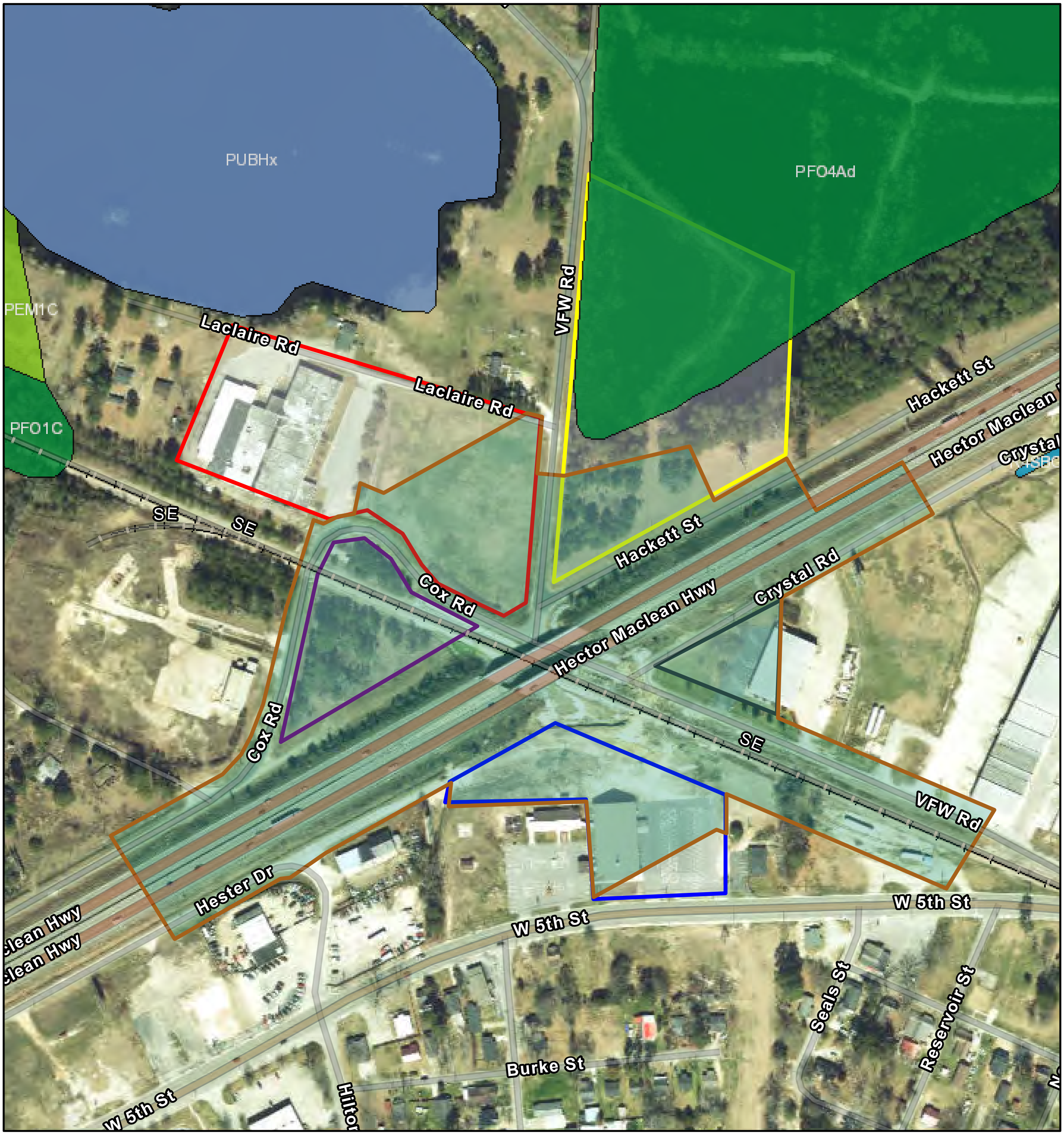
1. E1 – Field Data
    a. F1 – Photo Log
2. E2 – Hydrologic Analysis
    a. E2.1 – HEC-HMS Model
    b. E2.2 – Design Flood Hydrographs
    c. E2.3 – Calibration and Verification Spreadsheets
    d. E2.4 – Rainfall Hyetographs and Thiessen Polygon Weights
    e. E2.5 – StreamStats Reports
    f. E2.6 – USGS Gage Data
    g. E2.7 – Hydrograph Sensitivity
3. E3 – Hydraulic Analysis
    a. E3.1 – Final HEC-RAS Model
    b. E3.2 – Calibration Runs
    c. E3.3 – Hydraulic Structure Data
4. E4 – Flood Frequency Analysis
    a. E4.1 – Gage Data Record Extension
    b. E4.2 – PeakFQ Analysis
    c. E4.3 – Regional Regression Weighted Peak Flowrates

Atkins North America
1616 East Millbrook RoadRaleigh, NC
27609

Ken Hunu, PE, DWRE, PMP, CFM
Kenneth.hunu@atkinsglobal.com

- **USFWS NWI Map**
- **Total Wetlands Area Map**
- **USACE Correspondence**

West Lumberton Flood Gate - NWI Map



December 1, 2023

1:4,514

0 0.03 0.06 0.12 mi

0 0.05 0.1 0.2 km

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine
- WLFG Project Action Area
- 550 VFW Rd #938189443052
- 2306 W 5th St #938189201500
- 2400 Cox Rd #938179684407
- 2460 Cox Rd #938179143700
- VFW & Hackett #938280300700
- Railroads

U.S. Fish and Wildlife Service, National Standards and Support Team, wetlands_team@fws.gov, NC CGIA, Maxar, Esri Community Maps Contributors, State of North Carolina DOT, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, EPA OEI

West Lumberton Flood Gate – Total Wetlands Area Map

Gievers, Andrea

From: Gievers, Andrea
Sent: Monday, December 20, 2021 12:06 PM
To: Beecher, Gary H CIV USARMY CESAW (USA)
Cc: Hair, Sarah E CIV USARMY CESAW (USA); matt.cusack@atkinsglobal.com; Sachan, Amit
Subject: FW: West Lumberton Flood Gate Project (Previous Correspondence)
Attachments: I-95 Flood Gate Lidar.pdf; WLFG CONCEPTUAL Plan 11.3.21.pdf

Hello:

Please see the email below from August 18, 2020 regarding the West Lumberton Flood Gate project. Matt Cusack is the contact along with Amit Sachan at Atkins, cc'd on this email. The original design was located on the eastern side and the current proposal is for the *western* side of I-95. I am attaching the conceptual plan as well. As you can see in the emails below, the proposed project is being conducted in concert with the I-95 widening team. Please let me know if you have any questions. Thank you.

Sincerely,

Andrea

Andrea Gievers, JD, MSEL, ERM
Environmental SME
Community Development
NC Office of Recovery and Resiliency
Andrea.L.Gievers@Rebuild.NC.Gov
(845) 682-1700

From: Beecher, Gary H CIV USARMY CESAW (USA) <Gary.H.Beecher@usace.army.mil>
Sent: Tuesday, August 18, 2020 8:26 AM
To: Cusack, Matthew T <matt.cusack@atkinsglobal.com>
Cc: Hair, Sarah E CIV CESAW CESAD (US) <Sarah.E.Hair@usace.army.mil>; Mickey Sugg <Mickey.t.sugg@usace.army.mil>
Subject: RE: City of Lumberton floodgate project overlapped by I-6064 DRAFT waters of the US Delineations

Mr. Cusack,

Based on the Lidar Image and Soils Map for the site it does appear that the proposed project area will not be in wetlands or Waters of the US.

I can write a No Permit Required, however I must issue an Approved JD with it. I've attached a Jurisdictional Determination Request Form for you to fill out. If you already have one filled out, please send it to me.

Respectfully,

Gary

From: Hair, Sarah E CIV CESAW CESAD (US) <Sarah.E.Hair@usace.army.mil>
Sent: Monday, August 17, 2020 2:33 PM
To: Beecher, Gary H CIV USARMY CESAW (USA) <Gary.H.Beecher@usace.army.mil>; Sugg, Mickey T CIV USARMY CESAW

(USA) <Mickey.T.Sugg@usace.army.mil>
Subject: RE: City of Lumberton floodgate project overlapped by I-6064 DRAFT waters of the US Delineations

Gary/Mickey,

I issued a PJD for the NC DOT I-6064 project (I-95 widening). If the City of Lumberton is asking for a No permit required, then I believe you would need to do an AJD for the project area. I believe the site is all uplands based on the PJD and information provided by Matt Cusack.

Please let me know if you have any questions.

Liz

From: Cusack, Matthew T <matt.cusack@atkinsglobal.com>
Sent: Monday, August 17, 2020 2:22 PM
To: Beecher, Gary H CIV USARMY CESAW (USA) <Gary.H.Beecher@usace.army.mil>; Hair, Sarah E CIV CESAW CESAD (US) <Sarah.E.Hair@usace.army.mil>
Cc: Boot, Robert A <Robert.Boot@atkinsglobal.com>; Price, Gregory W <gwprice2@ncdot.gov>; Huff, Christy <chuff@ncdot.gov>; Sachan, Amit <Amit.Sachan@atkinsglobal.com>; rarmstrong@ci.lumberton.nc.us
Subject: [Non-DoD Source] RE: City of Lumberton floodgate project overlapped by I-6064 DRAFT waters of the US Delineations

Greetings Mr. Beecher,

I am following up with regards to this email below. I also tried to reach your office voicemail, which instructed me to correspond with you via email.

There are more project details below, but the essential question is whether you will agree to use the NCDOT data from I-6064 to issue a "No Permit Required" form for the City of Lumberton's floodgate project, or whether independent project review is required. The NCDOT data is current, and has recently been reviewed by Ms. Hair.

Please let me know if you would like to setup a Webex to screenshare and discuss this request and the associated information we have that is pertinent.

Thanks!

Best,
Matt

Matt Cusack *PWS*
Senior Project Manager/Scientist, Technical Professional Organization
North America
Engineering, Design, and Project Management

919-431-5255 919-800-1234

1616 E. Millbrook Road, Suite 160, Raleigh, NC 27609

Company

From: Cusack, Matthew T
Sent: Friday, June 12, 2020 8:52 AM
To: gary.h.beecher@usace.army.mil; sarah.e.hair@usace.army.mil
Cc: Boot, Robert A <Robert.Boot@atkinsglobal.com>; Price, Gregory W <gwprice2@ncdot.gov>; Huff, Christy <chuff@ncdot.gov>; Sachan, Amit <Amit.Sachan@atkinsglobal.com>; rarmstrong@ci.lumberton.nc.us
Subject: City of Lumberton floodgate project overlapped by I-6064 DRAFT waters of the US Delineations

Greetings,

For the benefit of this email, please see a screen capture below for an overlap area between a proposed natural resources Study Area related to the City of Lumberton's flood gate project and the I-6064 corridor that Liz Hair is currently reviewing for NCDOT. The flood gate project is possibly new to USACE regulatory, but Civil Works has been involved. The proposed floodgate is located where the CSX rail line and Cox Rd/VFW Road passes under I-95 centered at 34.6227789,-79.0329097.

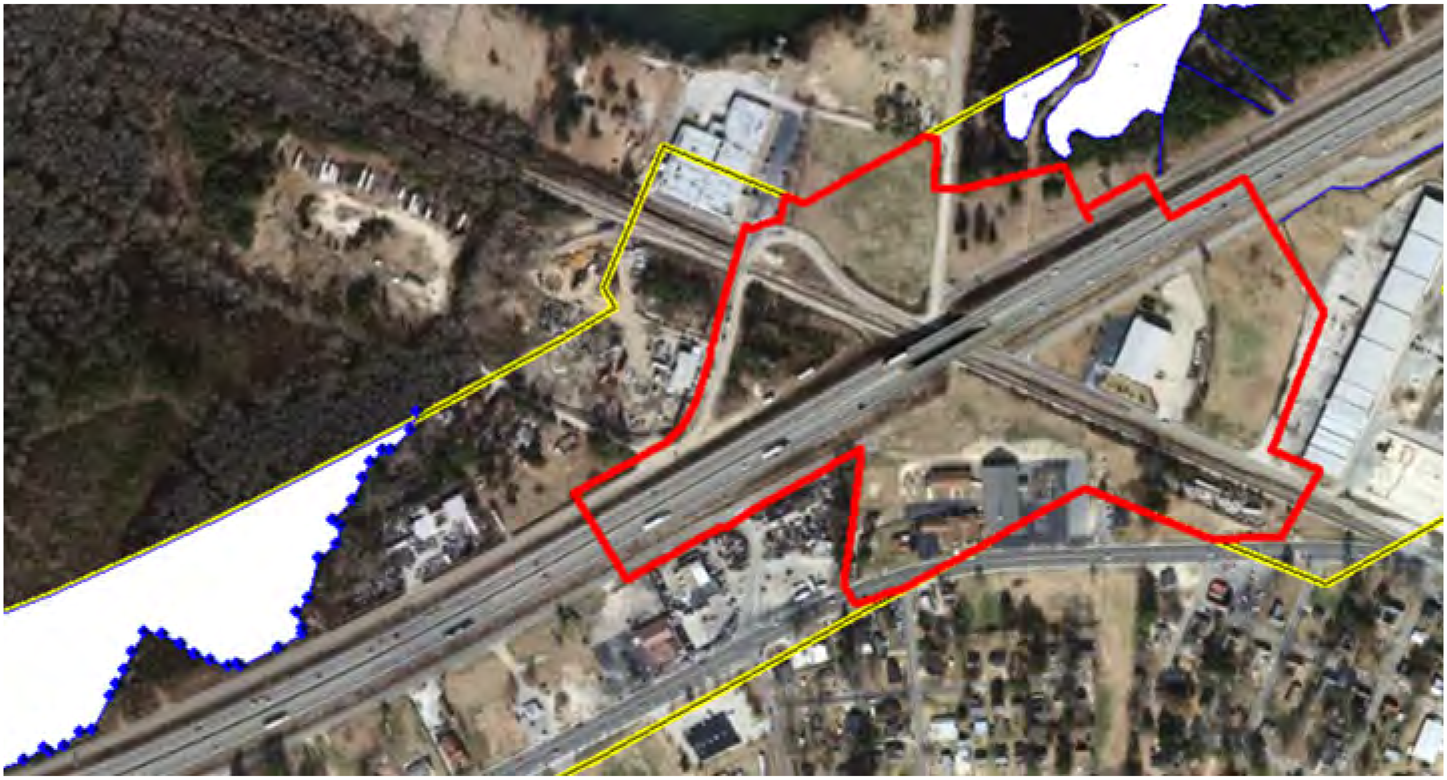
We understand that Liz has been working with NCDOT to evaluate delineations performed by their consultants for I-6064. Through coordination with NCDOT, Atkins and the City of Lumberton have determined that the entire natural resources Study Area for flood gate project has already been evaluated for I-6064. Further, the entirety of the City's Study Area did not have any waters of the U.S. features. Please see the Study Area for the flood gate project (red outline below) appears to contain no waters of the US. Correspondence with NCDOT is also provided below.

To support everyone's goal of avoiding overlapping work between these projects, the City of Lumberton would like to rely upon NCDOT's findings for the flood gate project once Liz has completed her review. This would include the PJD and NRTR prepared by NCDOT (when available) as basis for the environmental documentation related to waters of the U.S. for the proposed floodgate. **All we need right now is agreement from Gary that he will consider those resources when they are available, and will be willing to issue a "No Permit Required" determination for the City's Study Area if the documents approved by Liz for NCDOT end up demonstrating what is explained in this email.**

Please let me know if that is an agreeable plan. If you have any questions, please let Amit Sachan and/or me know and we can set up a teleconference to better describe this situation. I am available to coordinate as necessary.

Best,
Matt

Yellow is I-6064 Study Limits with blue/white depicting waters of the US as identified by NV5. Red is the natural resources study area for the City of Lumberton floodgate project



Matt Cusack *PWS*
Senior Project Manager/Scientist, Technical Professional Organization
North America
Engineering, Design, and Project Management

919-431-5255 919-800-1234

1616 E. Millbrook Road, Suite 160, Raleigh, NC 27609

Company

From: Rerko, James J <jjrerko@ncdot.gov>
Sent: Tuesday, May 19, 2020 9:37 AM
To: Cusack, Matthew T <matt.cusack@atkinsglobal.com>; Huff, Christy <chuff@ncdot.gov>; Price, Gregory W <gwprice2@ncdot.gov>
Cc: Boot, Robert A <Robert.Boot@atkinsglobal.com>; Heather Wallace <Heather.Wallace@nv5.com>; Nick Mountcastle <Nick.Mountcastle@nv5.com>; Sachan, Amit <Amit.Sachan@atkinsglobal.com>; rarmstrong@ci.lumberton.nc.us
Subject: RE: [External] City of Lumberton floodgate project overlapped by I-6064 DRAFT Wetland Delineations

Matt

I am fine with the plan. We are getting together with the Corps and DWR virtually to start the review today.

James J. Rerko, PWS
Project Development and Environmental Analysis Engineer
North Carolina Department of Transportation

910 364-0834 office
910 486 1959 fax
jjrerko@ncdot.gov Email

1000 Transportation Drive
Fayetteville, NC 28302

From: Cusack, Matthew T <matt.cusack@atkinsglobal.com>
Sent: Monday, May 18, 2020 7:43 PM
To: Huff, Christy <chuff@ncdot.gov>; Rerko, James J <jjrerko@ncdot.gov>; Price, Gregory W <gwprice2@ncdot.gov>
Cc: Boot, Robert A <robert.boot@atkinsglobal.com>; Heather Wallace <Heather.Wallace@nv5.com>; Nick Mountcastle <Nick.Mountcastle@nv5.com>; Sachan, Amit <amit.sachan@atkinsglobal.com>; rarmstrong@ci.lumberton.nc.us
Subject: [External] City of Lumberton floodgate project overlapped by I-6064 DRAFT Wetland Delineations

Greetings,

For the benefit of this email, please see a screen capture of the overlap area between the I-6064 corridor and the natural resources Study Area for the City of Lumberton's flood gate project.

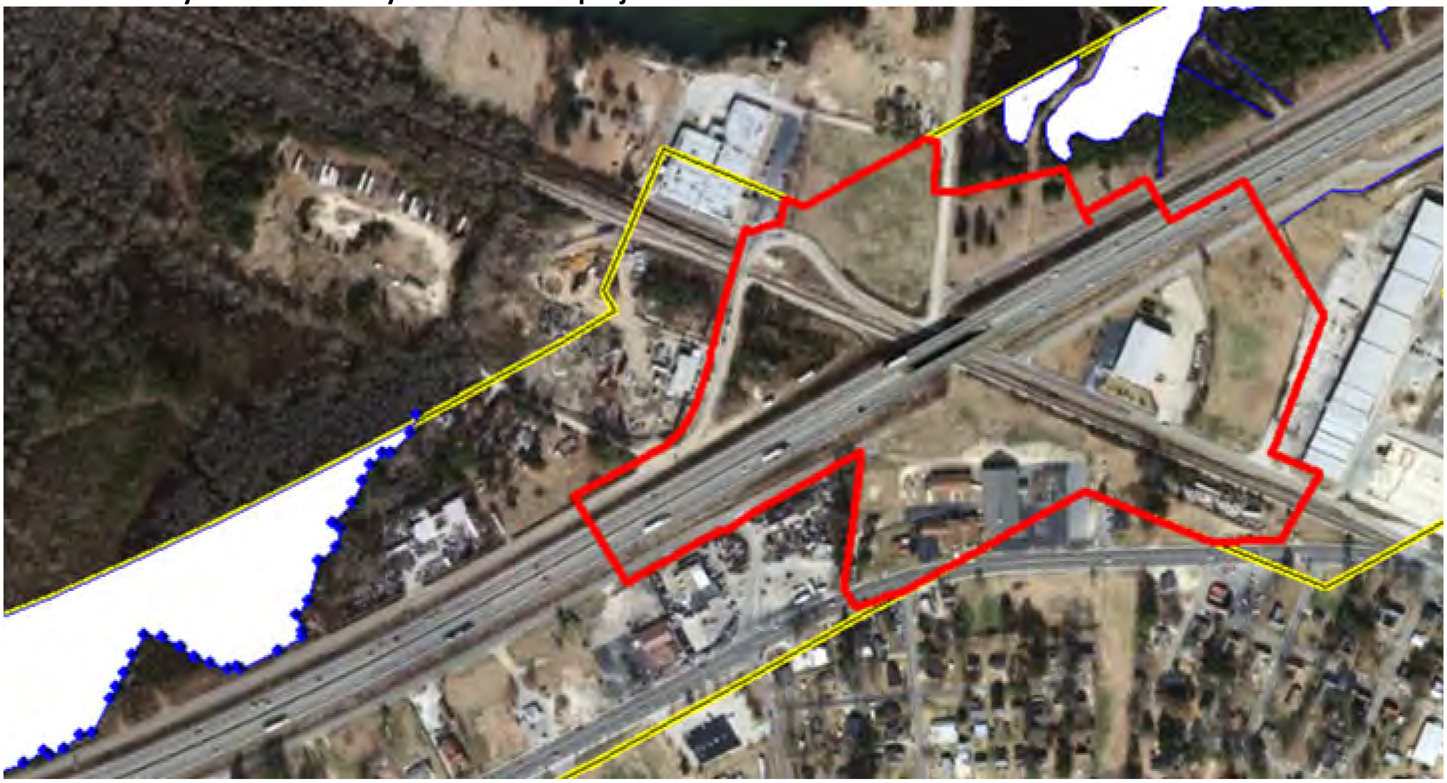
I understand that NCDOT and it's consultants are waiting on a field concurrence meeting with the USACE to approve the delineation for I-6064. I am also curious if the other environmental work, specifically the protected species surveys, identified anything that isn't resolved at this location in Lumberton where the rail line and Cox Rd/VFW Road passes under I-95 centered at 34.6227789,-79.0329097.

To support everyone's goal of avoiding overlapping work between these projects, we would like to rely upon NCDOT's findings for our project. This would include the PJD and NRTR prepared for NCDOT (when available) as our basis for our environmental documentation. Since my understanding is that the City's Study Area (red outline below) appears to contain no waters of the US or protected species (assumption), this seems to be the logical choice. Obviously, we don't need NCDOT's documents at this time, but I wanted to confirm there isn't an issue of the City proceeding in this manner. If NCDOT is amenable to this approach, Atkins will reach out to the NCDOT and private Corps reps and confirm that our project will be relying upon NCDOT's findings and environmental documentation and that our project has no impacts.

Please let me know if that is an agreeable plan. If you have any questions, please let Amit Sachan and/or me know and we can coordinate as necessary.

Best,
Matt

Yellow is I-6064 Study Limits with blue/white depicting waters of the US as identified by NV5. Red is the natural resources study area for the City of Lumberton project



Matt Cusack *PWS*
Senior Project Manager/Scientist, Technical Professional Organization
North America
Engineering, Design, and Project Management

919-431-5255 919-800-1234

1616 E. Millbrook Road, Suite 160, Raleigh, NC 27609

Company

From: Brian Yamamoto <Brian.Yamamoto@nv5.com>
Sent: Monday, April 20, 2020 4:46 PM
To: Sachan, Amit <Amit.Sachan@atkinsglobal.com>
Cc: Huff, Christy <chuff@ncdot.gov>; Nick Mountcastle <Nick.Mountcastle@nv5.com>; Rerko, James J <jjrerko@ncdot.gov>; Price, Gregory W <gwprice2@ncdot.gov>; Heather Wallace <Heather.Wallace@nv5.com>; Boot, Robert A <Robert.Boot@atkinsglobal.com>; Cusack, Matthew T <matt.cusack@atkinsglobal.com>
Subject: RE: I-6064 DRAFT Wetland Delineations

OK Amit.

Sounds like there is no way right now to put a schedule on that, but we will stay tuned to what is happening with COVID-19 situation.

Brian Yamamoto, PE | Senior Project Development Engineer | **NV5**
6750 Tryon Road | Cary, NC 27518 | P: 919.858.1865 | C: 919.606.9716

From: Sachan, Amit <Amit.Sachan@atkinsglobal.com>
Sent: Monday, April 20, 2020 4:35 PM
To: Brian Yamamoto <Brian.Yamamoto@nv5.com>
Cc: Huff, Christy <chuff@ncdot.gov>; Nick Mountcastle <Nick.Mountcastle@nv5.com>; Rerko, James J <jjrerko@ncdot.gov>; Price, Gregory W <gwprice2@ncdot.gov>; Heather Wallace <Heather.Wallace@nv5.com>; Boot, Robert A <Robert.Boot@atkinsglobal.com>; Cusack, Matthew T <matt.cusack@atkinsglobal.com>
Subject: RE: I-6064 DRAFT Wetland Delineations

Thanks for sending these over, Brian. Please let us know when these have been verified by the USACE. Regards

Amit Sachan, *PE, CFM*
Project Director, Public & Private Business Unit
Tel: +1 919 431 5253 Cell: +1 919 985 1095

Atkins, member of the SNC-Lavalin Group
1616 East Millbrook Road, Suite 160, Raleigh, NC 27519

From: Brian Yamamoto <Brian.Yamamoto@nv5.com>
Sent: Monday, April 20, 2020 2:11 PM

To: Sachan, Amit <Amit.Sachan@atkinsglobal.com>; Boot, Robert A <Robert.Boot@atkinsglobal.com>
Cc: Huff, Christy <chuff@ncdot.gov>; Nick Mountcastle <Nick.Mountcastle@nv5.com>; Rerko, James J <jjrerko@ncdot.gov>; Price, Gregory W <gwprice2@ncdot.gov>; Heather Wallace <Heather.Wallace@nv5.com>
Subject: I-6064 DRAFT Wetland Delineations

Hey guys,

See attached DRAFT delineations for the I-6064 (I-95 widening from Exit 13 to Exit 22 in Robeson County near Lumberton). These probably cover your study area for the Lumberton Floodgate Project that you are currently working on. Because of the COVID-19 situation, the USACE is restricted from doing field work. As such, these delineations are unverified at this stage. I don't know if you all were planning to conduct delineations as part of your project, but this will help USACE to avoid dual delineations in overlapping areas. We plan to have these delineations (conducted by NV5 biologists) verified as soon as restrictions are lifted on the USACE.

Let me know if you have any questions.

Brian Yamamoto, PE | Senior Project Development Engineer | **NV5**
6750 Tryon Road | Cary, NC 27518 | P: 919.858.1865 | C: 919.606.9716