

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
TECHNICAL REPORT COVERSHEET

650-050-38
ENVIRONMENTAL
MANAGEMENT
08/22

FINAL LOCATION HYDRAULICS MEMO

Florida Department of Transportation

District Four

Cove Road Project Development and Environment (PD&E) Study

Limits of Project: FROM SR 76/Kanner Highway to SR 5/US 1/Federal Highway

Martin County, Florida

Financial Management Number: 441700-1-22-02

ETDM Number: 14479

Date: December 2024

The environmental review, consultation, and other actions required by applicable federal environmental laws for this project are being, or have been, carried out by the Florida Department of Transportation (FDOT) pursuant to 23 U.S.C. § 327 and a Memorandum of Understanding dated May 26, 2022 and executed by the Federal Highway Administration and FDOT.

FINAL
LOCATION HYDRAULICS MEMO

COVE ROAD PD&E STUDY
From SR 76/Kanner Highway to SR 5/US 1/Federal Highway
Martin County, Florida

Financial Project ID No.: 441700-1-22-02



Prepared for:
FLORIDA DEPARTMENT OF TRANSPORTATION

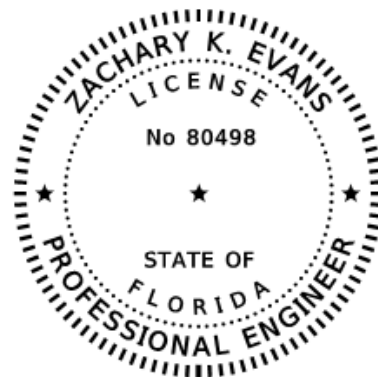
Prepared by:
Ardurra Group, Inc.
3000 Dovera Drive
Oviedo, FL 32765

December 2024

Professional Engineer Certificate

I hereby certify that I am a registered professional engineer in the State of Florida practicing with Ardurra Group, Inc., a corporation authorized to operate as an engineering business, FEID No. 59-1782900, by the State of Florida, Department of Professional Regulation, and Board of Professional Engineers. I have reviewed or approved the evaluation, findings, opinions and conclusions as reported in this Location Hydraulics Memo.

The Location Hydraulics Memo includes a summary of data collection efforts and design analysis for Cove Road PD&E Study from SR 76/Kanner Highway to SR 5/US 1/Federal Highway. I acknowledge that the procedures and references used to develop the results contained in this report are standard to the professional practice of civil engineering as applied through design standards and criteria set forth by the federal, state, and local regulatory agencies as well as professional judgment and experience.



Ardurra Group, Inc.
3000 Dovera Drive, Suite 200
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Phone: (407) 971-8850
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Signature: _____

Name: **Zachary Evans, P. E.**

P.E. Number: **80498**

Date: **December 5th, 2024**

TABLE OF CONTENTS

	<u>PAGE</u>
EXECUTIVE SUMMARY	1
SECTION 1 INTRODUCTION	2
SECTION 2 PROJECT DESCRIPTION	2
SECTION 3 DATA COLLECTION	3
SECTION 4 EXISTING SITE CONDITIONS	3
4.1 TOPOGRAPHY & HYDROLOGIC FEATURES	3
4.1.1 FLOODPLAINS	4
SECTION 5 PROPOSED DRAINAGE CONDITIONS	4
5.1 CROSS DRAIN ANALYSIS	4

TABLES

Table 1 – Summary of Existing Cross Drains	4
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APPENDICES

- Appendix 1 – Exhibits
- Appendix 2 – Basin Maps
- Appendix 3 – Cross Drain Analysis
- Appendix 4 – Correspondence

EXECUTIVE SUMMARY

This project involves the proposed widening of Cove Road, from State Road (SR) 76/Kanner Highway to SR 5/US 1/Federal Highway in Martin County, Florida. This 3.2-mile segment of Cove Road is a two-lane, undivided, rural roadway with 12-foot-wide travel lanes. A six-foot sidewalk is located on the north side of the roadway for the entire project limits and a six-foot sidewalk is located on the south side of the roadway from Kanner Highway to Atlantic Ridge Drive and from west of Montego Cove to Federal Highway. There are no existing bike lanes or shared-use paths within the project limits. Signalized intersections within the project limits are located at Kanner Highway, Atlantic Ridge, Legacy Cove Circle/Classical Way, Willoughby Boulevard, and Federal Highway. Martin County also classifies Cove Road as a major arterial roadway.

The proposed improvements include widening Cove Road from Kanner Highway to Federal Highway from a two-lane undivided to a four-lane divided roadway with accommodations for bicyclists and pedestrians through the entire project limits. Stormwater management needs will be determined, and the addition of roadway lighting will be considered. Intersection improvements within the project limits will also be evaluated to accommodate anticipated future traffic needs.

The purpose of this Location Hydraulics Report is to address base floodplain encroachments resulting from the roadway improvements evaluated in the Cove Road PD&E Study for FDOT District 4. In accordance with Executive Order 11988 "Floodplain Management", US DOT Order 5650.2 "Floodplain Management Protection", and Federal-Aid Policy Guide 23 CFR 650A, Floodplains must be protected. The intent of these regulations is to avoid or minimize highway encroachments within the 100-year (base) floodplains and to avoid supporting land use development incompatible with floodplain values.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs), floodplains are present south of Cove Road near the Kanner Highway at the begin project limits, however, the study limits lie outside of the 100-year floodplain limits and within Zone X. Therefore, the floodplain involvement has been classified as "No Encroachment". No encroachment means that there are floodplains in the vicinity of the project alternatives, but there is no floodplain encroachment. Please refer to Section 4 for more information.

In conclusion, the following floodplain statement applies for this study:

PROJECTS WHICH WILL NOT INVOLVE ANY WORK BELOW THE 100 YEAR FLOOD ELEVATION

"Although this project is located adjacent to the limits of the 100-year floodplain, no work is being proposed below the 100-year flood elevation and, thus, this project does not encroach upon the base floodplain."

SECTION 1 INTRODUCTION

The Florida Department of Transportation (FDOT), District Four, is proposing to widen Cove Road from SR 76/Kanner Highway to SR 5/US 1/Federal Highway in Martin County, Florida. The improvements consist of widening Cove Road from two to four lanes and include accommodations for bicyclists and pedestrians. The project is split into two roadway segments. Segment 1 extends from the beginning of the study to the Hibiscus Park Ditch. Segment 2 is from the Hibiscus Park Ditch to the end of the study. There are two alternatives being investigated within Segment 1. Four alternatives are being investigated for Segment 2.

The study area is located within the South St. Lucie and Indian River Lagoon South Coastal watersheds and traverses three WBID's; WBID 3210C (South Fork St. Lucie River (Tidal Segment), WBID 3220 (Basin 2), and WBID 3208C (Manatee Pocket). Manatee Pocket ultimately discharges to the Jensen Beach to Jupiter Inlet Aquatic Preserve, an Outstanding Florida Water (OFW). The St. Lucie River and Estuary Basin has adopted a Basin Management Action Plan (BMAP) for nutrients and dissolved oxygen.

The existing roadway was permitted under SFWMD Permit No. 43-00642-S for an ultimate 4-lane condition. The ultimate condition was not built out and Cove Road exists in an interim condition as a 2-lane roadway. The existing permit has 5 basins along the corridor and provides treatment within swales along the roadway.

The purpose of this Location Hydraulics Report is to address base floodplain encroachments resulting from the roadway improvements evaluated in the Cove Road PD&E Study for FDOT District 4. In accordance with Executive Order 11988 "Floodplain Management", US DOT Order 5650.2 "Floodplain Management Protection", and Federal-Aid Policy Guide 23 CFR 650A, Floodplains must be protected. The intent of these regulations is to avoid or minimize highway encroachments within the 100-year (base) floodplains and to avoid supporting land use development incompatible with floodplain values.

SECTION 2 PROJECT DESCRIPTION

This project involves the proposed widening of Cove Road, from State Road (SR) 76/Kanner Highway to SR 5/US 1/Federal Highway in Martin County, Florida. This 3.2-mile segment of Cove Road is a two-lane, undivided, rural roadway with 12-foot-wide travel lanes. A six-foot sidewalk is located on the north side of the roadway for the entire project limits and a six-foot sidewalk is located on the south side of the roadway from Kanner Highway to Atlantic Ridge Drive and from west of Montego Cove to Federal Highway. There are no existing bike lanes or shared-use paths within the project limits. Signalized intersections within the project limits are located at Kanner Highway, Atlantic Ridge, Legacy Cove Circle/Classical Way, Willoughby Boulevard, and Federal Highway. Martin County also classifies Cove Road as a major arterial roadway. Please see [Exhibit 1](#) for the [Project Location Map](#) in [Appendix 1](#).

Stormwater management needs will be determined, and the addition of roadway lighting will be considered. Intersection improvements within the project limits will also be evaluated to accommodate anticipated future traffic needs.

SECTION 3 DATA COLLECTION

The design team collected and reviewed data from the following sources:

- FDOT Drainage Manual, January 2024
- FDOT Drainage Design Guide, January 2024
- SFWMD Permit No. 43-00642-S, Cove Road Widening
- SFWMD Environmental Resource Permit Applicant's Handbook Volume II – May 2016
- SWERP Environmental Resource Permit Information Manual, 2020
- National Flood Insurance Program (NFIP) Flood Insurance Rate Map (FIRM), Panels Nos. 12085C0282H, 12085C0301H, 12085C0163H, and 12085C0164H, Martin County, Florida dated February 19, 2020.
- U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey of Martin County, Florida
- USDA NRCS Soil Survey Geographic (SSURGO) Database
- United States Geological Survey (USGS) Quadrangle Maps
- Martin County Stormwater and Flood Protection Standards
- Article 4, Site Design Standards, Division 8, Excavating, Filling, and Mining, Division 9, Stormwater Management, Division 10, Flood protection, Division 19, Roadway Design, Martin County Land Development Regulations
- Field Reconnaissance (June 2024)

SECTION 4 EXISTING SITE CONDITIONS

4.1 TOPOGRAPHY & HYDROLOGIC FEATURES

The topography of the project area general slopes to the west towards Kanner Highway/SR 76 from Ault Avenue with elevations ranging from elevation 18 feet at Ault Avenue to elevation 9.0 feet at the roadway low point near SW Gaines Avenue. From Ault Avenue east to SR 5/US 1 relatively flat with elevations ranging from a high of approximately 18 feet to a low of 17 feet NAVD 88. Please refer to the [USGS Quadrangle Map, Exhibit 3](#) in [Appendix 1](#). The study area is located within the South St. Lucie and Indian River Lagoon South Coastal watersheds and traverses three WBID's; WBID 3210C (South Fork St. Lucie River (Tidal Segment)), WBID 3220 (Basin 2), and WBID 3208C (Manatee Pocket). Manatee Pocket ultimately discharges to the Jensen Beach to Jupiter Inlet Aquatic Preserve, an Outstanding Florida Water (OFW). The St. Lucie River and Estuary Basin has adopted a Basin Management Action Plan (BMAP) for nutrients and dissolved oxygen.

There are four existing cross drains within the project limits. The cross drains allow for conveyance of offsite flow and interconnectivity of offsite wetland systems along the corridor.

Please refer to the **Basin Maps** in **Appendix 2** and to **Table 1** for a **Summary of Existing Cross Drains**.

Table 1 – Summary of Existing Cross Drains

Structure Number	Station	Description
CD-1	203+20	15" RCP
CD-2	255+35	27"x42" ERCP
CD-3	316+80	Double 18" RCP
CD-4	340+60	18" RCP

4.1.1 FLOODPLAINS

The Federal Emergency Management Agency (FEMA) has developed a Flood Insurance Rate Map (FIRM) for the study area. The relevant FIRM panel numbers are 12085C0282H, 12085C0301H, 12085C0163H and 12085C0164H, for Martin County, Florida dated February 19, 2020. The project is designated Zone X and will not have any floodplain impacts. Please see the **FEMA Map in Appendix 1, Exhibit 6**.

SECTION 5 PROPOSED DRAINAGE CONDITIONS

The stormwater runoff from the project limits will be collected and conveyed in closed drainage systems consisting of curb and gutter, inlets, and pipes to the proposed stormwater management site. The treatment facilities will discharge to the existing outfall locations along the corridor. The proposed roadway will impact the existing stormwater treatment swales along the corridor. Water quality treatment and water quantity attenuation will be provided in the proposed treatment site to replace the impacted volume in the existing swales and for the proposed roadway improvements. Additional information regarding the stormwater treatment approach for the study is included in the Pond Siting Report, under a separate cover.

5.1 CROSS DRAIN ANALYSIS

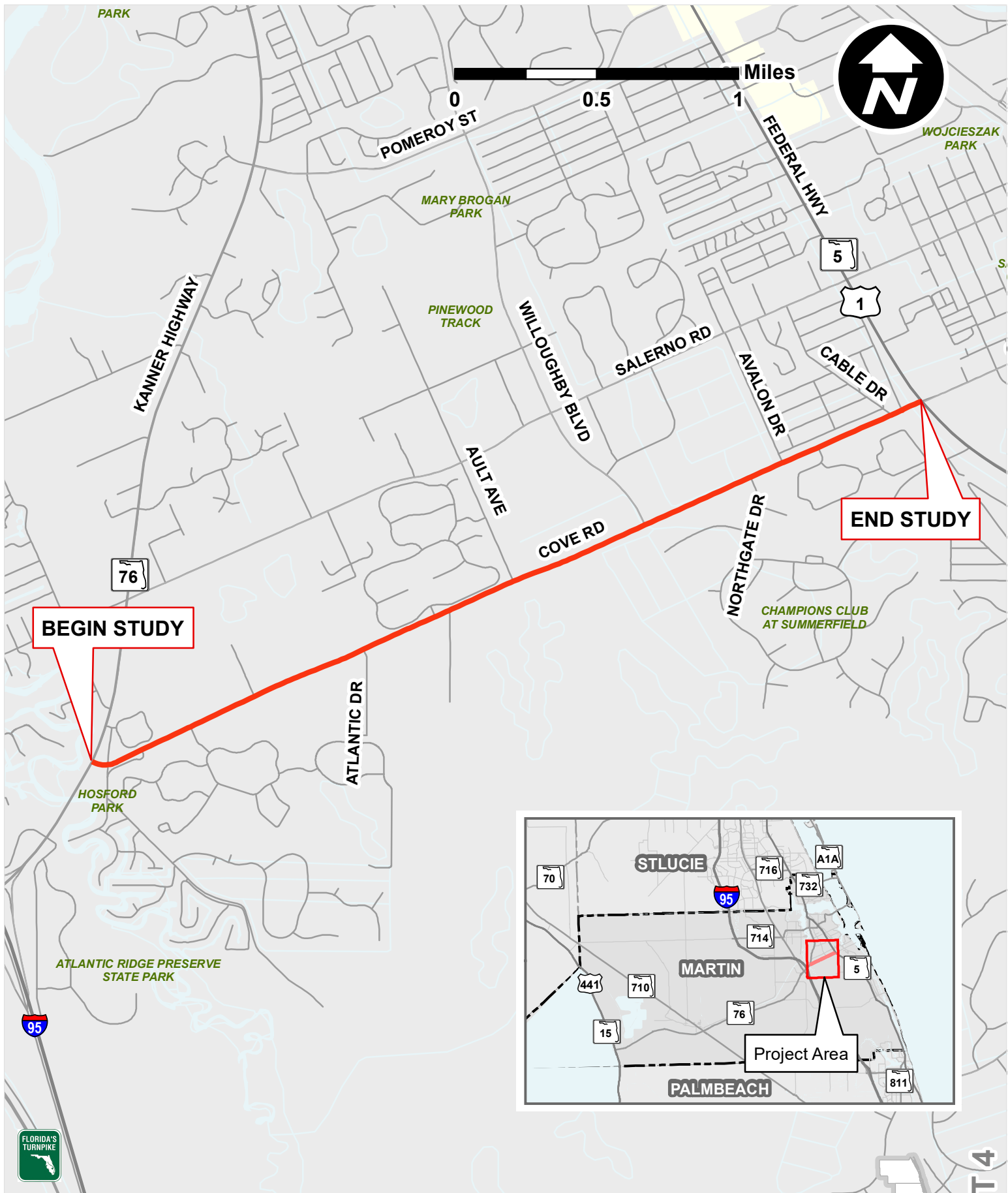
There are four existing cross drains, of which only three will need to be extended or replaced to accommodate the proposed improvements to Cove Road. CD-1 and CD-4 convey offsite runoff flowing from north to south of Cove Road. Available LiDAR data was used to identify the contributing area and the Rational Equation was utilized to calculate the flow being conveyed. CD-2 and CD-3 provide interconnectivity between wetland systems. CD-3 extends outside of the study limits and will not be impacted by the proposed work. Flow data was not available for CD-2. Due to the cross drain providing interconnectivity across Cove Road, for the analysis the velocity method was utilized to identify the flow within the cross drain. Preliminary cross drain analyses have been performed in HY-8 using the survey information available. The existing 26" x 47" cross drain is not a standard FDOT pipe size. The proposed crossing was analyzed to be replaced with a standard pipe size that would not cause any adverse impacts to the upstream elevations. Two of the existing cross drains were found to be undersized in the existing condition and are recommended for upsizing. Please see **Appendix 3 – Cross Drain Analysis**

for the cross drain analysis. During design, existing cross drains will be required to be video inspected to determine their condition and if they are eligible for extension or will need to be replaced.

Exhibit 1 – Project Location Map
Exhibit 2 – Proposed Typical Sections
Exhibit 3 – USGS Quadrangle Map
Exhibit 4 – NRCS Soils Map
Exhibit 5 – Future Land Use Map
Exhibit 6 – FEMA Map
Exhibit 7 – WBID Map

APPENDIX 1

Exhibits



Cove Road PD&E Study

from SR 76/Kanner Hwy. to SR 5/US 1

Martin County, Florida

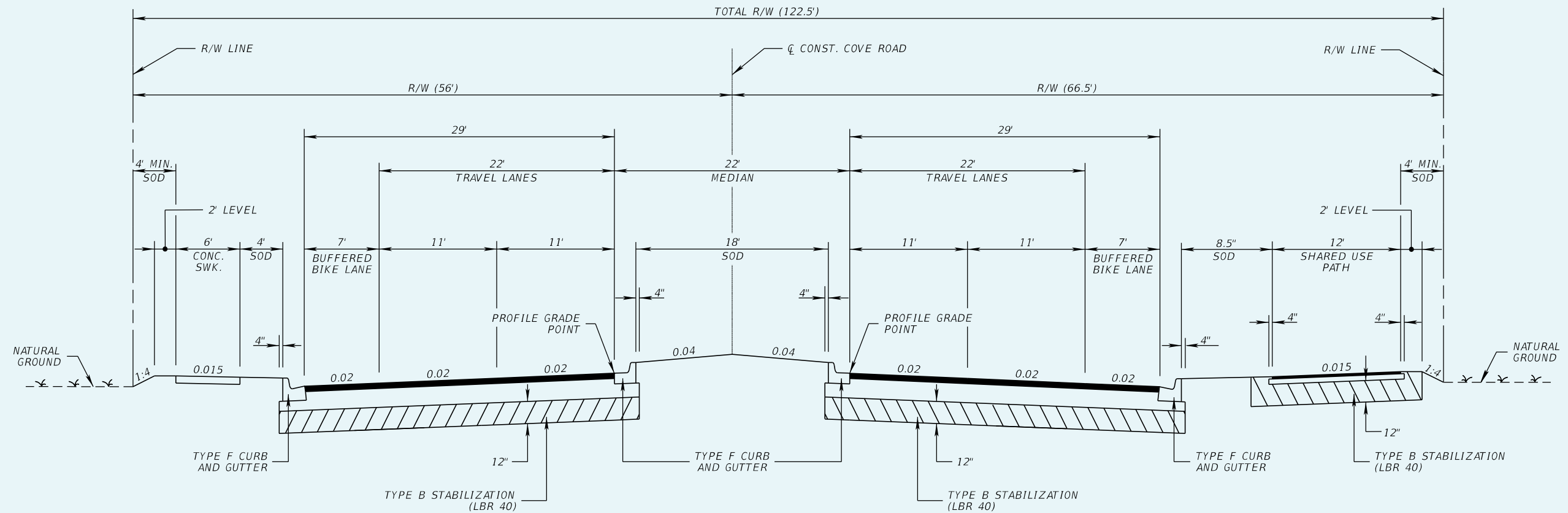
FPID: 441700-1

Federal ID: D421-137-B

Project Location Map EXHIBIT 1



DISTRICT 4



SEGMENT 1
 KANNER HIGHWAY (SR 76) TO AVALON DRIVE
 TYPICAL SECTION ALTERNATIVE 1A
 DESIGN SPEED = 40 MPH

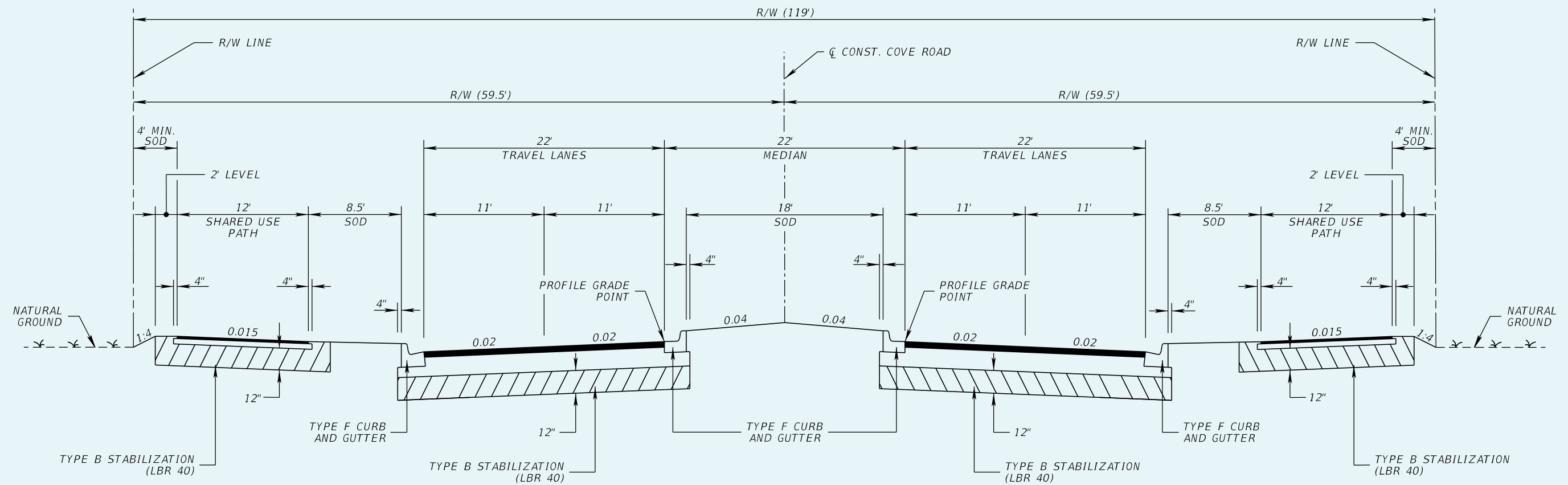


Cove Road PD&E Study
 from SR 76/Kanner Hwy. to SR 5/US 1
 Martin County, Florida
 FPID: 441700-1
 Federal ID: D421-137-B

**Typical Section
 EXHIBIT 2A**



DISTRICT 4



SEGMENT 1
 KANNER HIGHWAY (SR 76) TO AVALON DRIVE
 TYPICAL SECTION ALTERNATIVE 1B
 DESIGN SPEED = 40 MPH

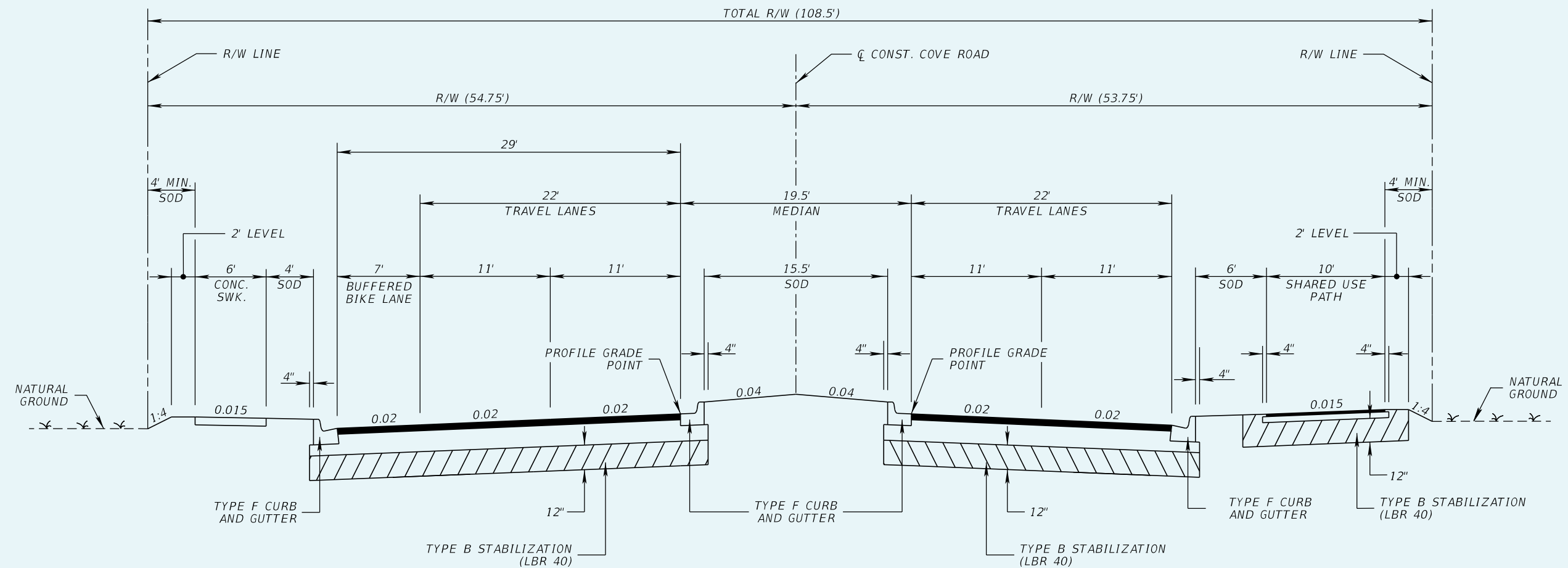


Cove Road PD&E Study
 from SR 76/Kanner Hwy. to SR 5/US 1
 Martin County, Florida
 FPID: 441700-1
 Federal ID: D421-137-B

**Typical Section
 EXHIBIT 2B**



DISTRICT 4



SEGMENT 2
 AVALON DRIVE TO US-1 (SR 5)
 TYPICAL SECTION ALTERNATIVE 2A
 DESIGN SPEED = 35 MPH

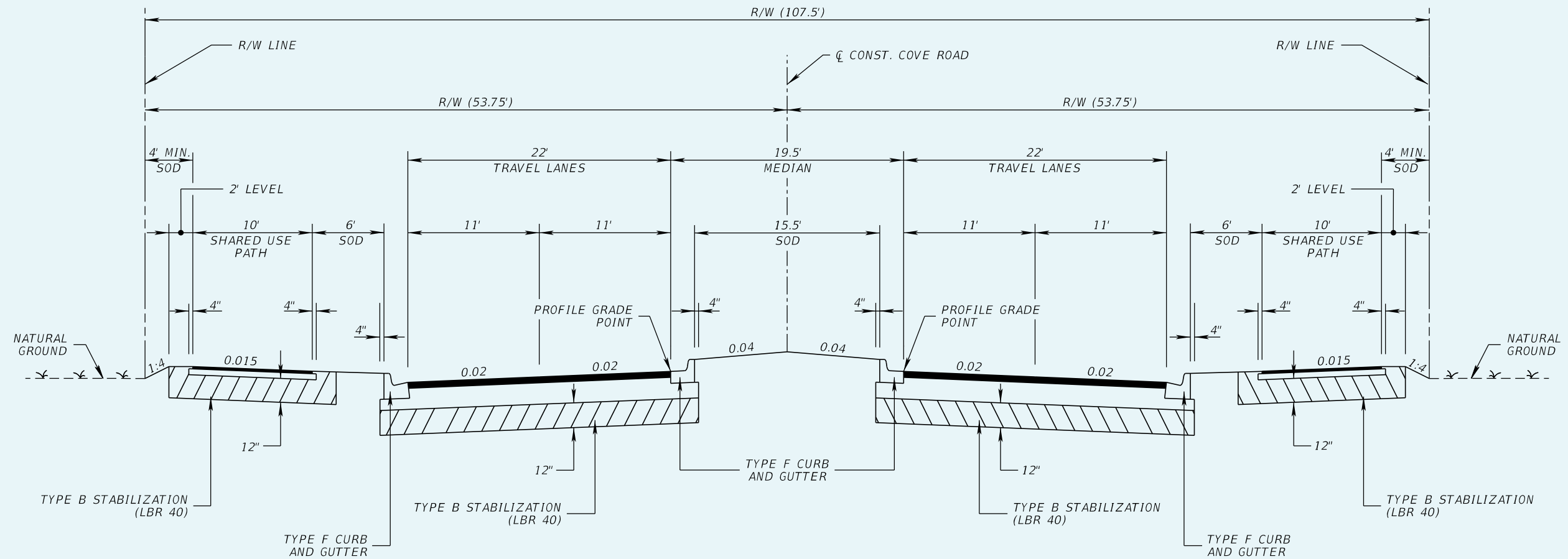


Cove Road PD&E Study
 from SR 76/Kanner Hwy. to SR 5/US 1
 Martin County, Florida
 FPID: 441700-1
 Federal ID: D421-137-B

**Typical Section
 EXHIBIT 2C**



DISTRICT 4



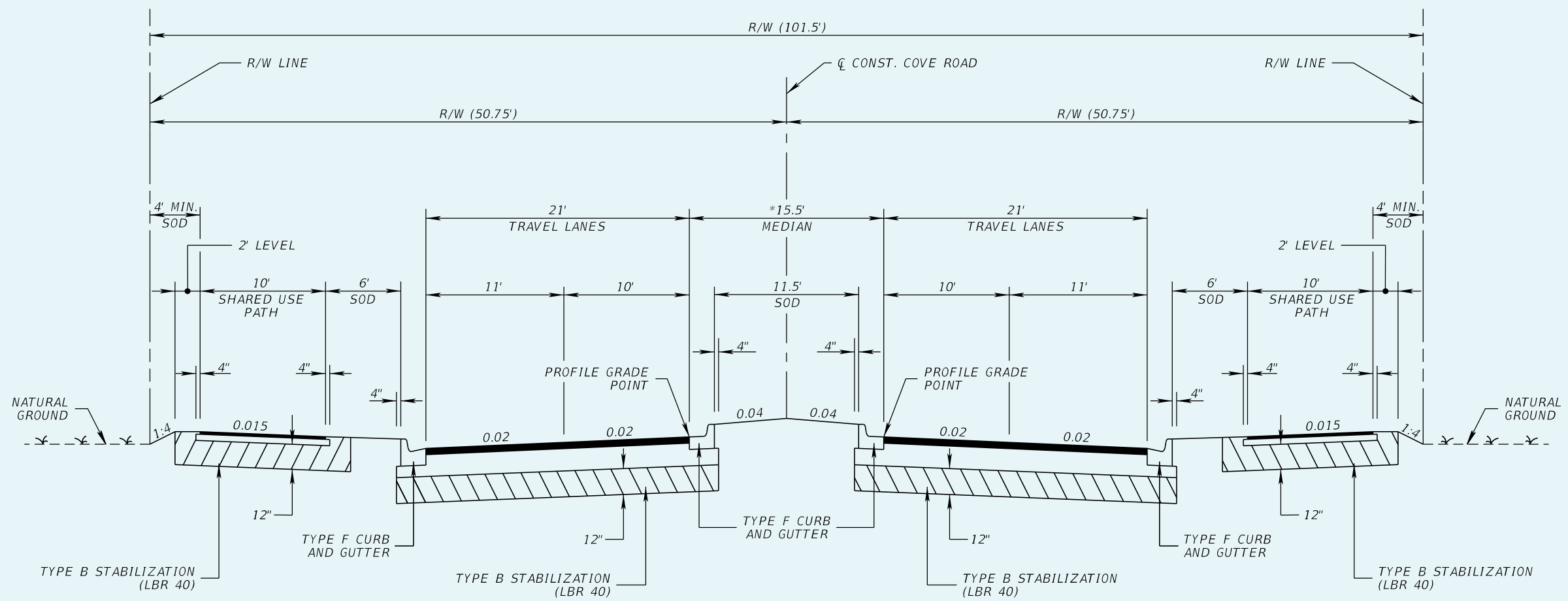
SEGMENT 2
 AVALON DRIVE TO US-1 (SR 5)
 TYPICAL SECTION ALTERNATIVE 2B
 DESIGN SPEED = 35 MPH



Cove Road PD&E Study
 from SR 76/Kanner Hwy. to SR 5/US 1
 Martin County, Florida
 FPID: 441700-1
 Federal ID: D421-137-B

**Typical Section
 EXHIBIT 2D**





SEGMENT 2
 AVALON DRIVE TO US-1 (SR 5)
 TYPICAL SECTION ALTERNATIVE 2C

DESIGN SPEED = 35 MPH

DESIGN VARIATION:

* MEDIAN WIDTH

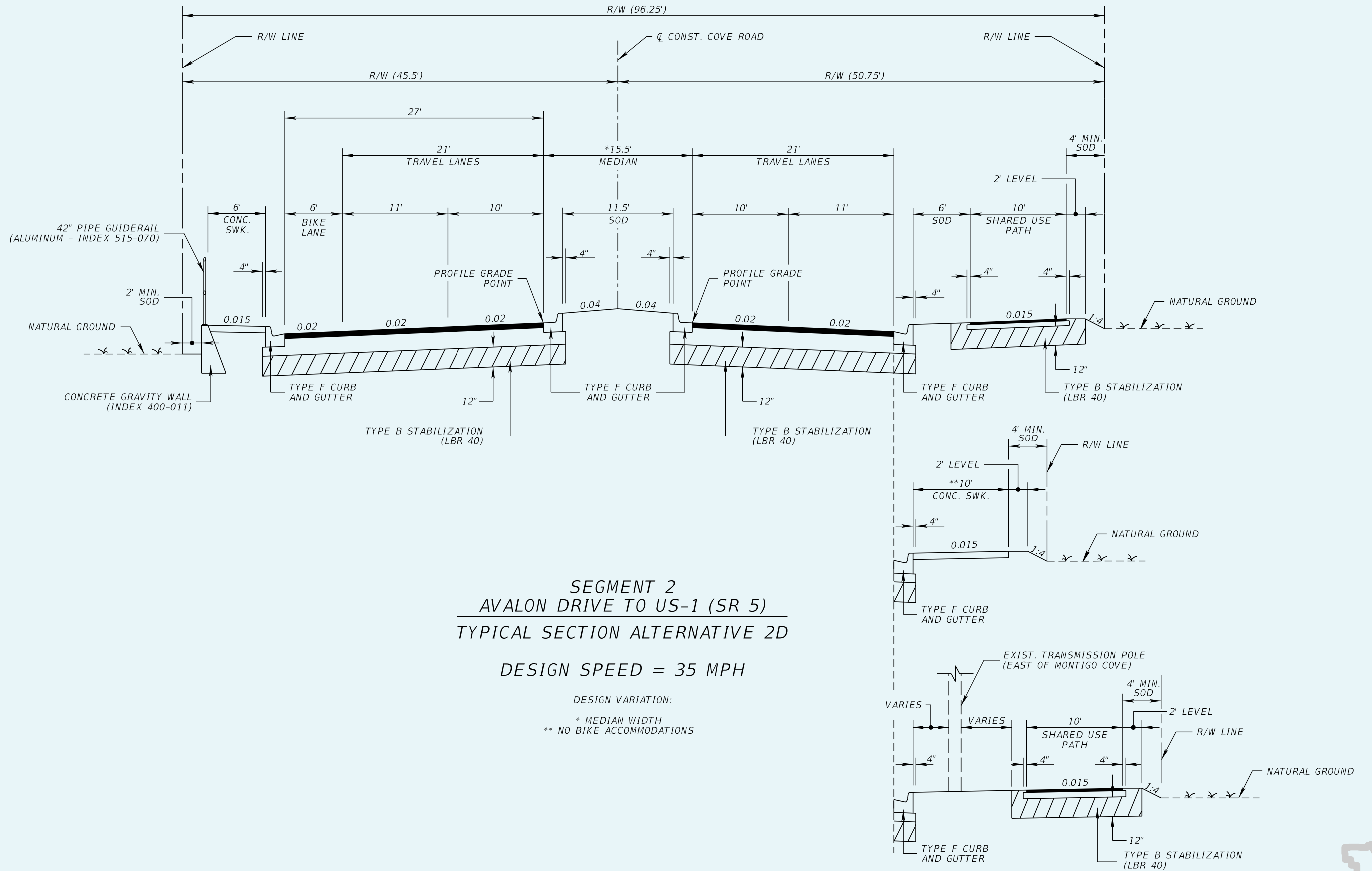


Cove Road PD&E Study
 from SR 76/Kanner Hwy. to SR 5/US 1
 Martin County, Florida
 FPID: 441700-1
 Federal ID: D421-137-B

**Typical Section
 EXHIBIT 2E**



DISTRICT 4

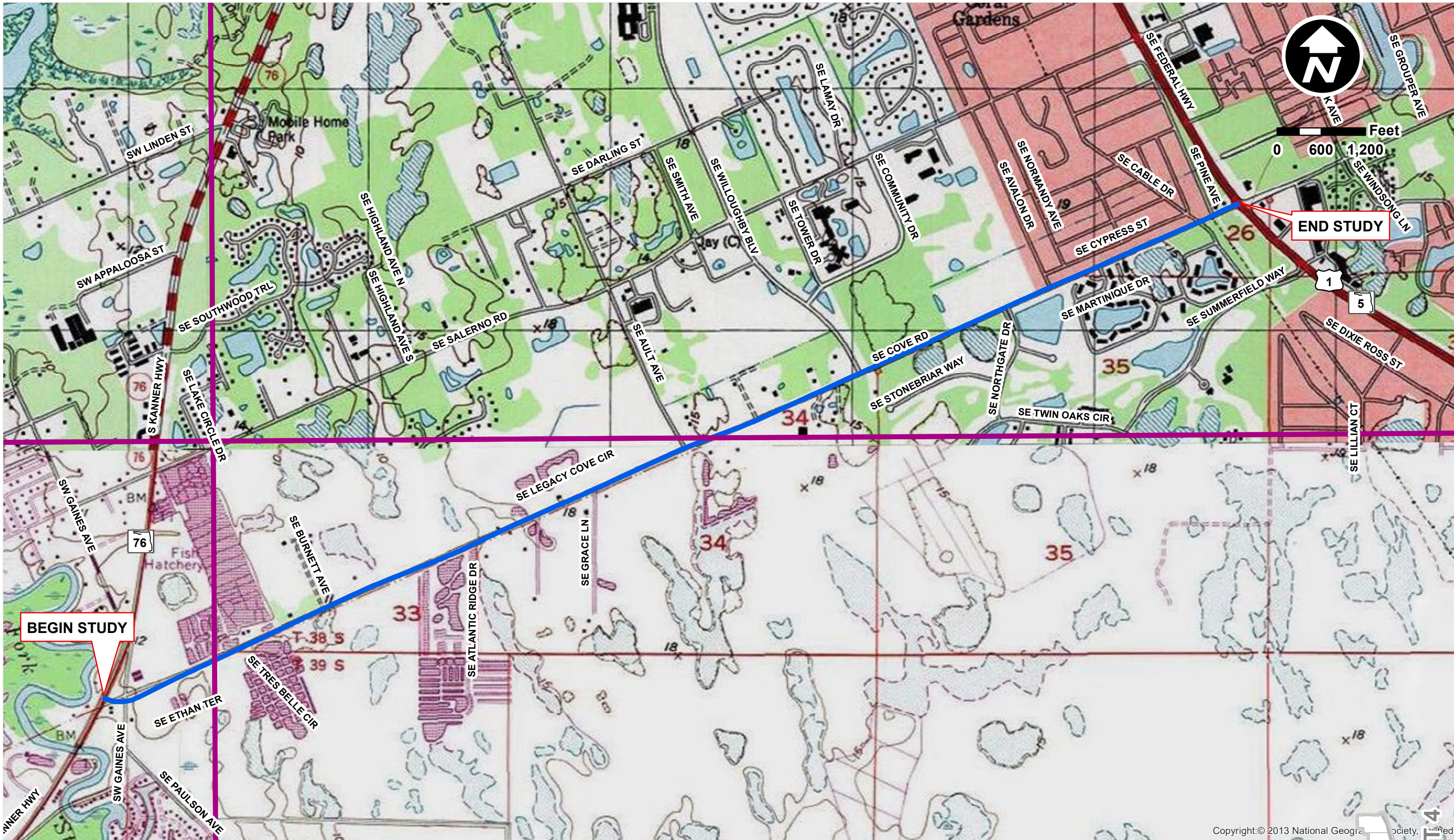


Cove Road PD&E Study
from SR 76/Kanner Hwy. to SR 5/US 1
Martin County, Florida
FPID: 441700-1
Federal ID: D421-137-B

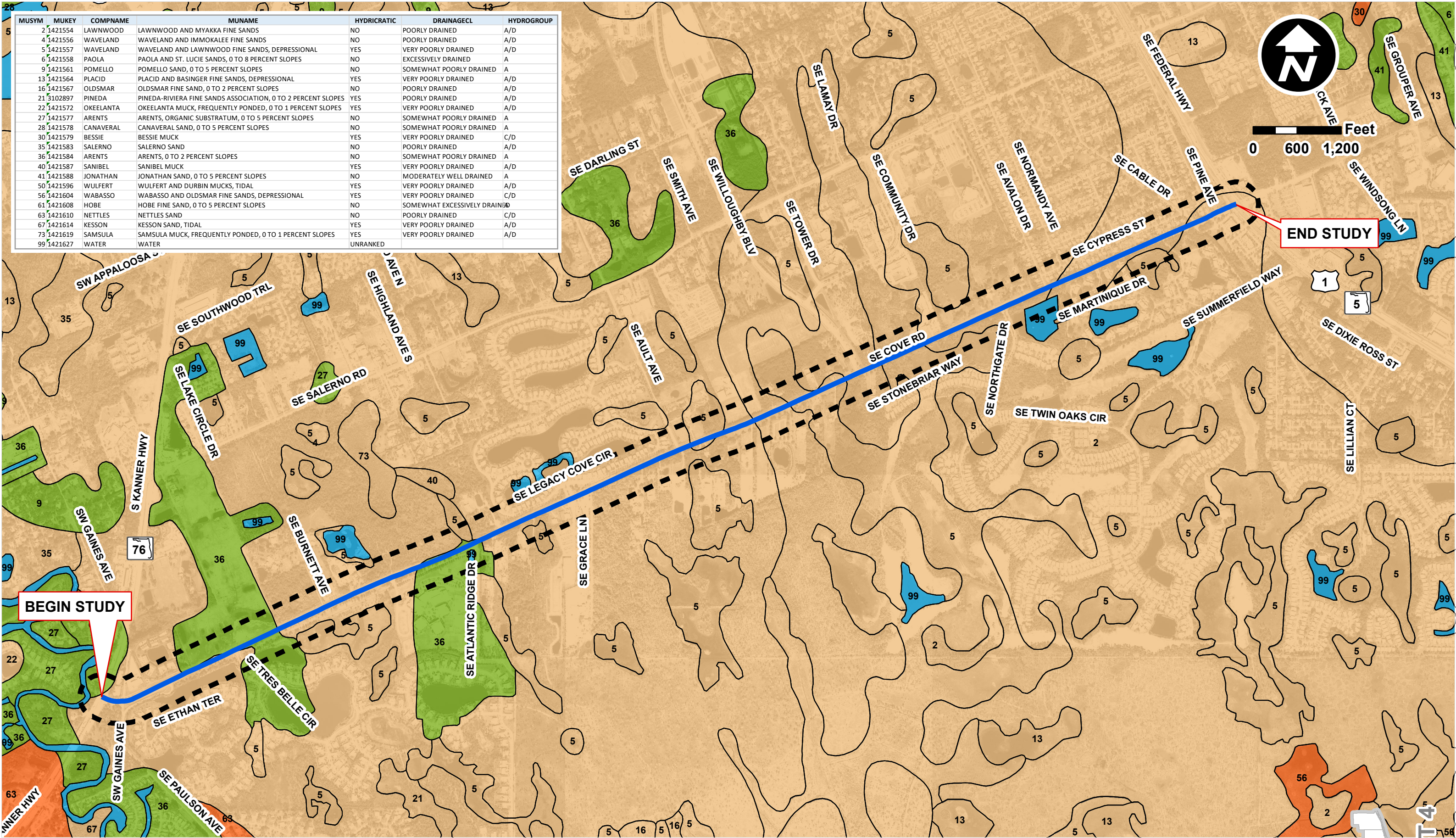
**Typical Section
EXHIBIT 2F**



DISTRICT 4



MUSYM	MUKEY	COMPNAME	MUNAME	HYDRICRATIC	DRAINAGECL	HYDROGROUP
2	1421554	LAWNWOOD	LAWNWOOD AND MYAKKA FINE SANDS	NO	POORLY DRAINED	A/D
4	1421556	WAVELAND	WAVELAND AND IMMOKALEE FINE SANDS	NO	POORLY DRAINED	A/D
5	1421557	WAVELAND	WAVELAND AND LAWNWOOD FINE SANDS, DEPRESSIONAL	YES	VERY POORLY DRAINED	A/D
6	1421558	PAOLA	PAOLA AND ST. LUCIE SANDS, 0 TO 8 PERCENT SLOPES	NO	EXCESSIVELY DRAINED	A
9	1421561	POMELLO	POMELLO SAND, 0 TO 5 PERCENT SLOPES	NO	SOMEWHAT POORLY DRAINED	A
13	1421564	PLACID	PLACID AND BASINGER FINE SANDS, DEPRESSIONAL	YES	VERY POORLY DRAINED	A/D
16	1421567	OLDSMAR	OLDSMAR FINE SAND, 0 TO 2 PERCENT SLOPES	NO	POORLY DRAINED	A/D
21	3102897	PINEDA	PINEDA-RIVIERA FINE SANDS ASSOCIATION, 0 TO 2 PERCENT SLOPES	YES	POORLY DRAINED	A/D
22	1421572	OKEELANTA	OKEELANTA MUCK, FREQUENTLY PONDED, 0 TO 1 PERCENT SLOPES	YES	VERY POORLY DRAINED	A/D
27	1421577	ARENTS	ARENTS, ORGANIC SUBSTRATUM, 0 TO 5 PERCENT SLOPES	NO	SOMEWHAT POORLY DRAINED	A
28	1421578	CANAVERAL	CANAVERAL SAND, 0 TO 5 PERCENT SLOPES	NO	SOMEWHAT POORLY DRAINED	A
30	1421579	BESSIE MUCK	BESSIE MUCK	YES	VERY POORLY DRAINED	C/D
35	1421583	SALERNO	SALERNO SAND	NO	POORLY DRAINED	A/D
36	1421584	ARENTS	ARENTS, 0 TO 2 PERCENT SLOPES	NO	SOMEWHAT POORLY DRAINED	A
40	1421587	SANIBEL	SANIBEL MUCK	YES	VERY POORLY DRAINED	A/D
41	1421588	JONATHAN	JONATHAN SAND, 0 TO 5 PERCENT SLOPES	NO	MODERATELY WELL DRAINED	A
50	1421596	WULFERT	WULFERT AND DURBIN MUCKS, TIDAL	YES	VERY POORLY DRAINED	A/D
56	1421604	WABASSO	WABASSO AND OLDSMAR FINE SANDS, DEPRESSIONAL	YES	VERY POORLY DRAINED	C/D
61	1421608	HOBE	HOBE FINE SAND, 0 TO 5 PERCENT SLOPES	NO	SOMEWHAT EXCESSIVELY DRAINED	C/D
63	1421610	NETTLES	NETTLES SAND	NO	POORLY DRAINED	C/D
67	1421614	KESSON	KESSON SAND, TIDAL	YES	VERY POORLY DRAINED	A/D
73	1421619	SAMSULA	SAMSULA MUCK, FREQUENTLY PONDED, 0 TO 1 PERCENT SLOPES	YES	VERY POORLY DRAINED	A/D
99	1421627	WATER	WATER	UNRANKED		



Cove Road PD&E Study
from SR 76/Kanner Hwy. to SR 5/US 1
Martin County, Florida
FPID: 441700-1
Federal ID: D421-137-B

Legend

- 300 ft. Buffer
- Project Limits

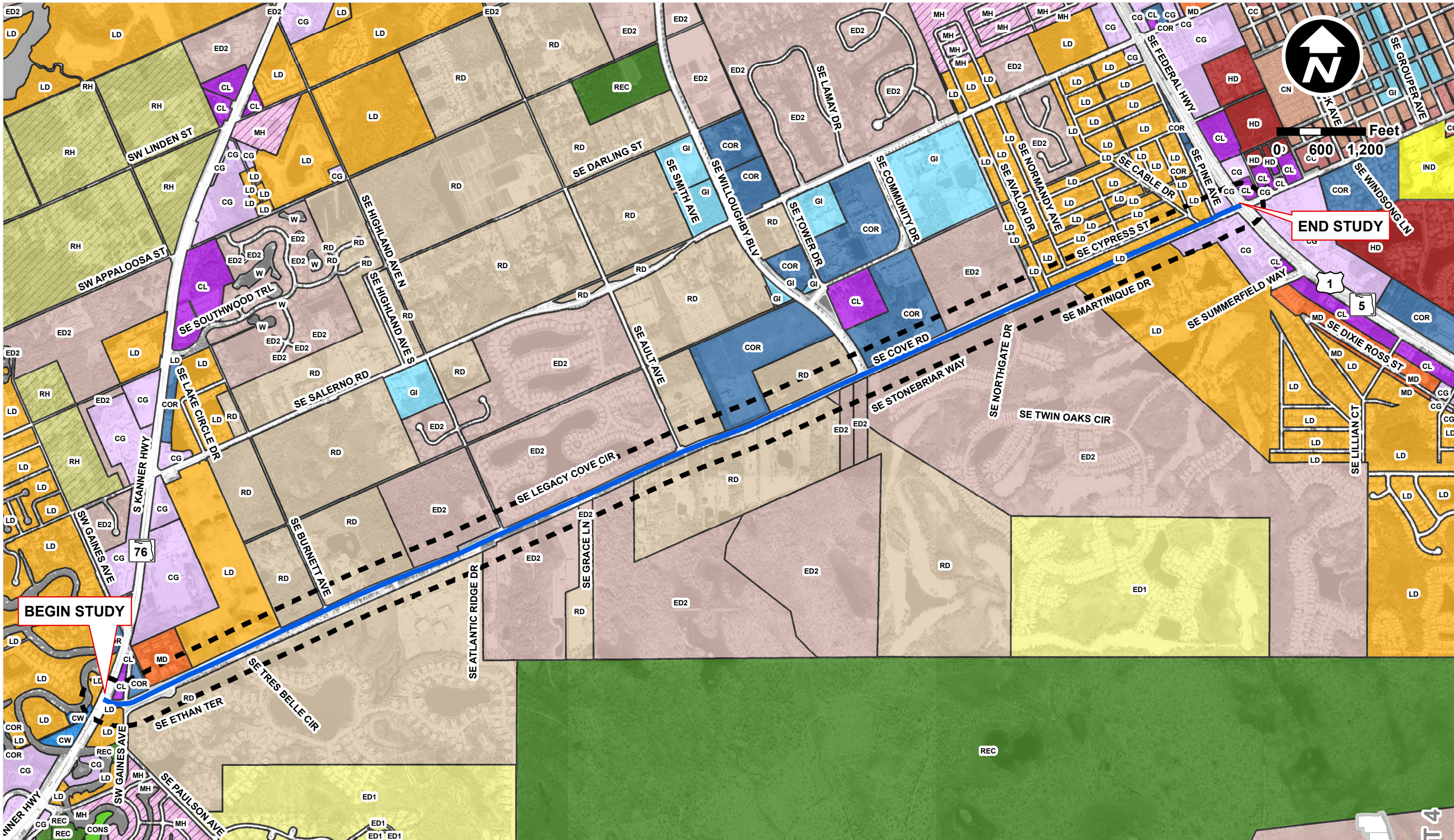
Hydro Group

- A
- C/D
- A/D
- Water

NRCS Soils (SSURGO) Map
EXHIBIT 4



DISTRICT 4



Cove Road PD&E Study
from SR 76/Kanner Hwy. to SR 5/US 1
Martin County, Florida
FPID: 441700-1
Federal ID: D421-137-B

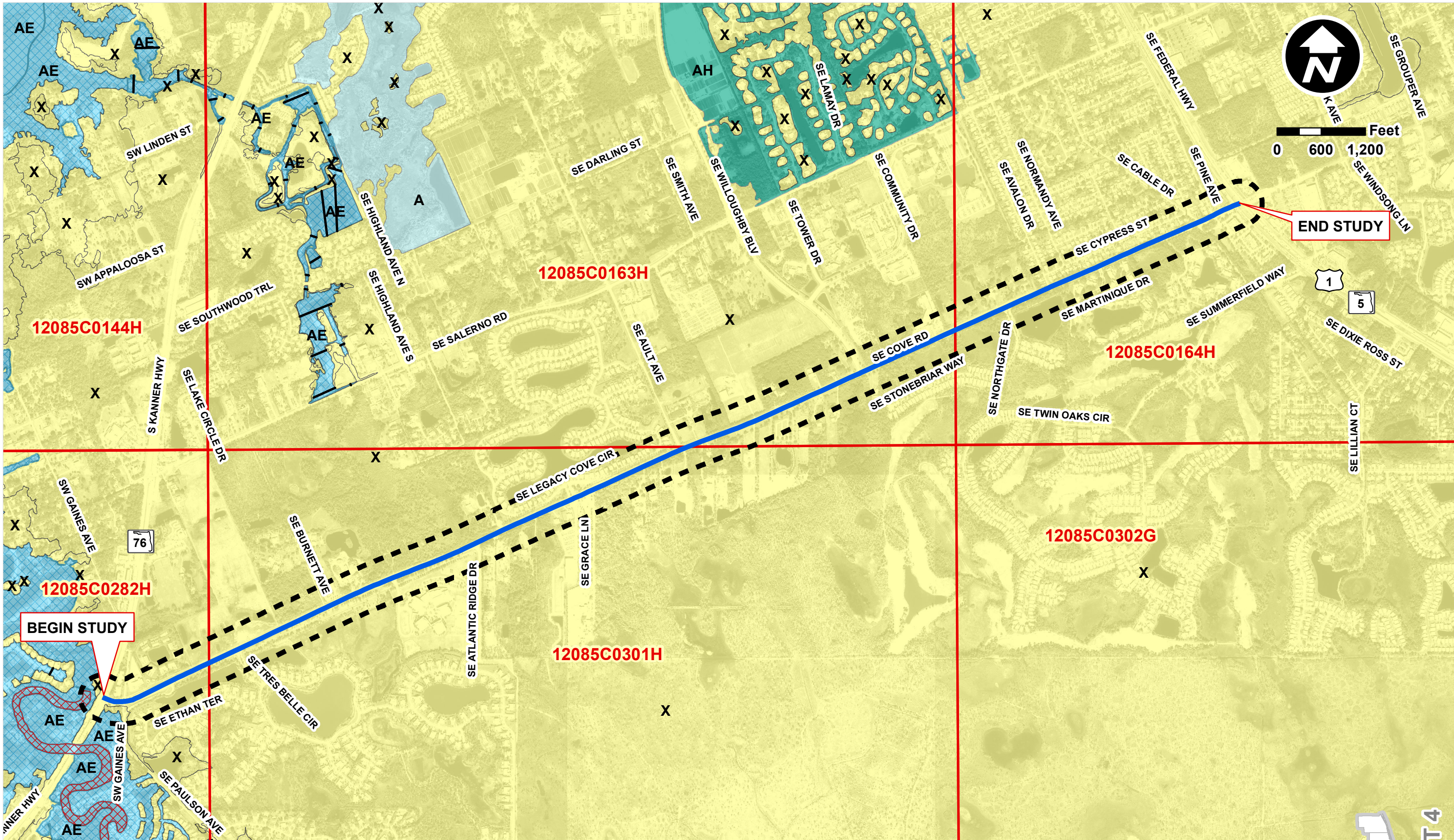
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|--------------------------|-------------------------------------|-------------------|-------------------|
| CRA Center-CC | Commercial/ Office/ Residential-COR | Industrial-IND | Recreational-REC |
| CRA Neighborhood-CN | Public Conservation-CONS | High Density-HD | Rural Density-RD |
| Commercial General-CG | Estate Density up to 1 UPA-ED1 | Low Density-LD | Rural Heritage-RH |
| Commercial Limited-CL | Estate Density up to 2 UPA-ED2 | Medium Density-MD | 300 ft. Buffer |
| Commercial Waterfront-CW | General Institutional-GI | Mobile Home-MH | Project Limits |

Future Land Use Map
EXHIBIT 5



DISTRICT 4



Cove Road PD&E Study
 from SR 76/Kanner Hwy. to SR 5/US 1
 Martin County, Florida
 FPID: 441700-1
 Federal ID: D421-137-B

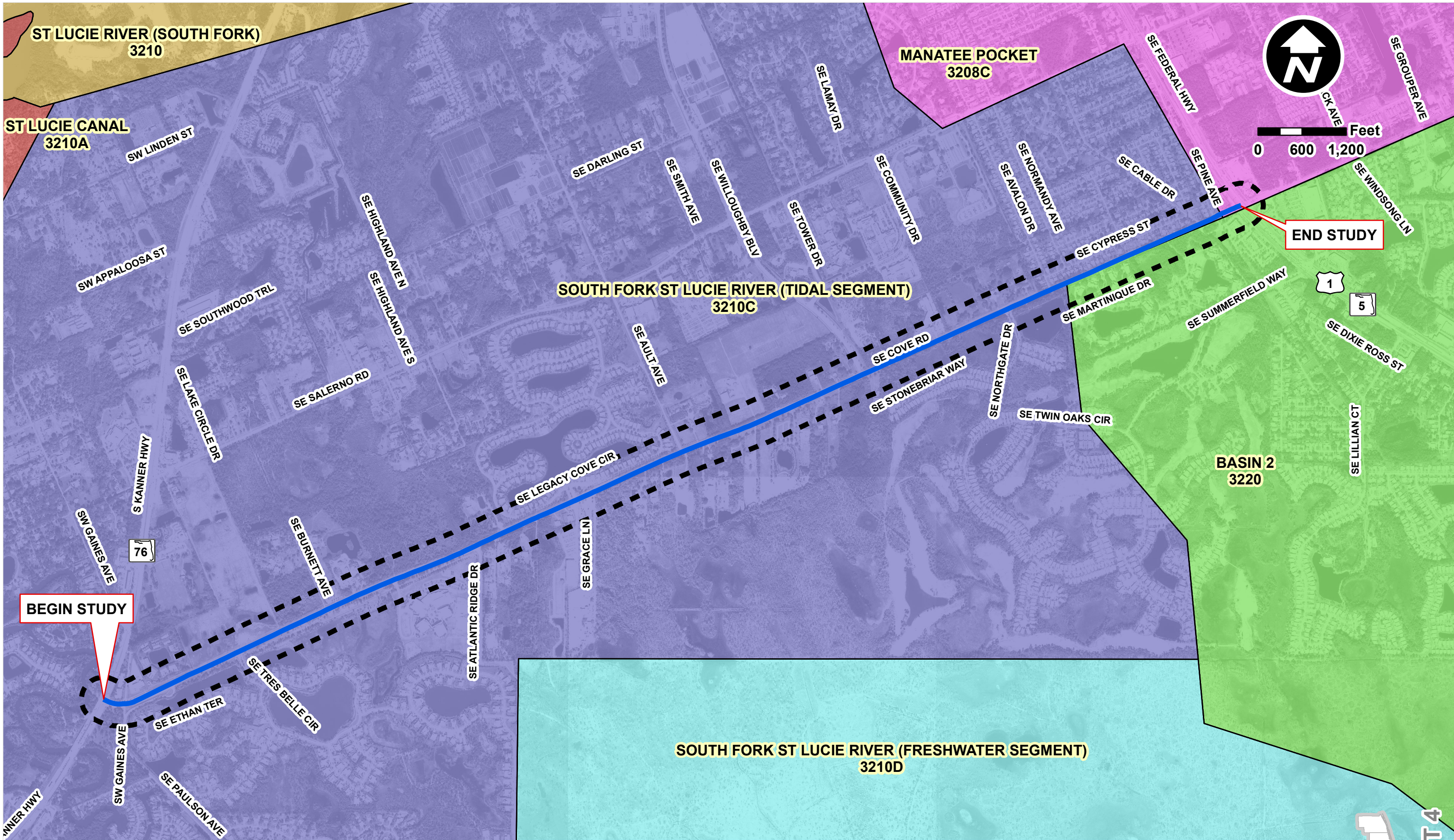
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|----|----|----------------------|----------------|
| A | AH | Floodway | Project Limits |
| AE | X | DFIRM Panel Boundary | 300 ft. Buffer |

**FEMA Floodplain Map
 EXHIBIT 6**



DISTRICT 4



Cove Road PD&E Study
from SR 76/Kanner Hwy. to SR 5/US 1
Martin County, Florida
FPID: 441700-1
Federal ID: D421-137-B

Legend

300 ft. Buffer
Project Limits

3208C-MANATEE POCKET
3210-ST LUCIE RIVER (SOUTH FORK)
3210A-ST LUCIE CANAL

3210C-SOUTH FORK ST LUCIE RIVER (TIDAL SEGMENT)
3210D-SOUTH FORK ST LUCIE RIVER (FRESHWATER SEGMENT)
3220-BASIN 2

**Water Body
Identification Map (WBID)
EXHIBIT 7**



DISTRICT 4

APPENDIX 2

Basin Maps

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REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

PROFESSIONAL TYPE
ZACHARY EVANS, P. E. LICENSE NUMBER: 80498 ARDIRRA GROUP, INC. 3000 DOVERA DRIVE OVIEDO, FL 32765

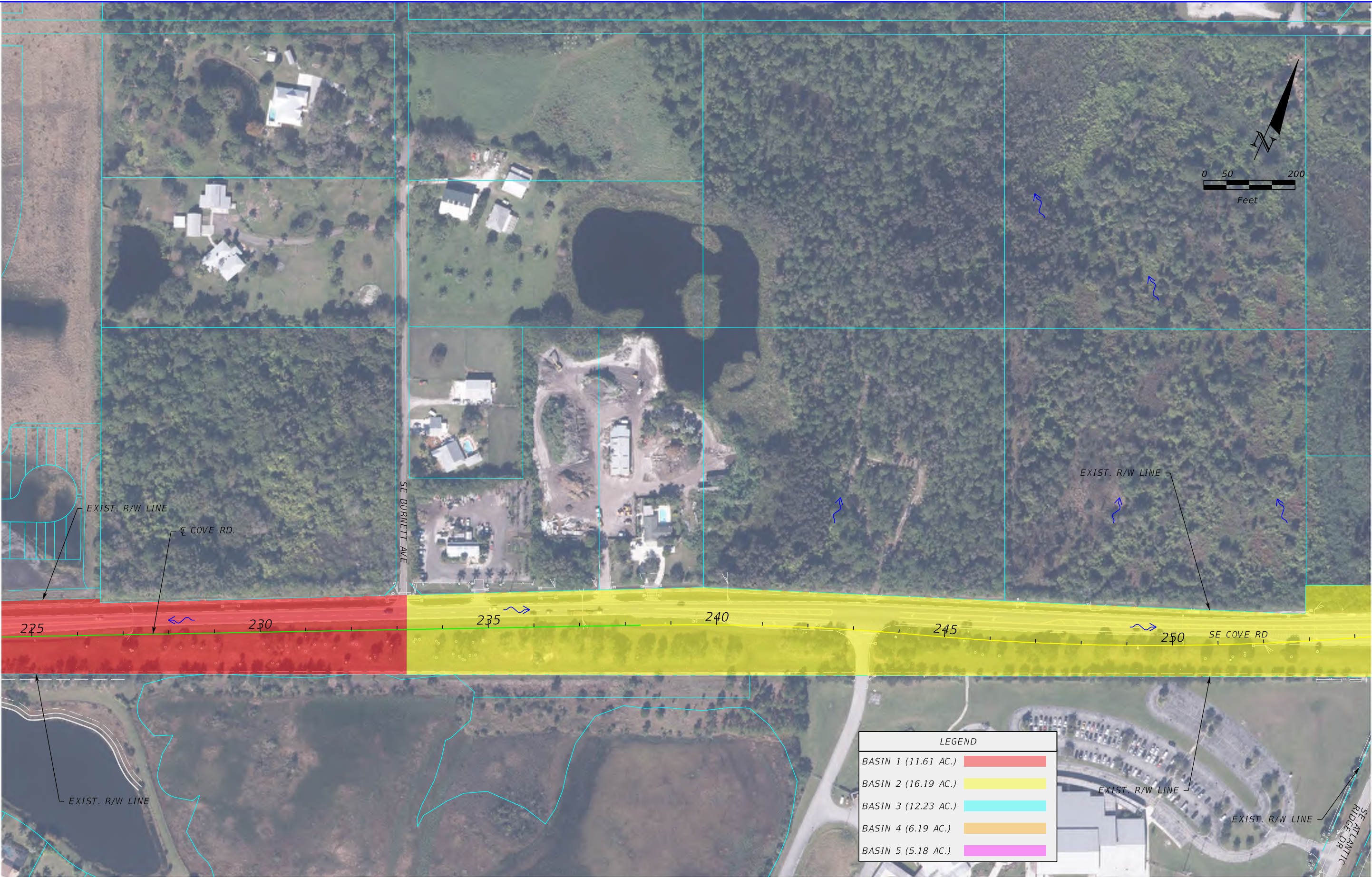
STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION		
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
COVE	MARTIN	441700-1-22-02

EXISTING BASIN MAP	

SHEET NO.

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REVISIONS				PROFESSIONAL TYPE	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION			EXISTING BASIN MAP
DATE	DESCRIPTION	DATE	DESCRIPTION	ZACHARY EVANS, P. E. LICENSE NUMBER: 80498 ARDIRRA GROUP, INC. 3000 DOVERA DRIVE OVIEDO, FL 32765	ROAD NO.	COUNTY	FINANCIAL PROJECT ID	
					COVE	MARTIN	441700-1-22-02	

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DATE	DESCRIPTION	DATE	DESCRIPTION		ROAD NO.	COUNTY	FINANCIAL PROJECT ID	
					COVE	MARTIN	441700-1-22-02	

EXISTING BASIN MAP

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REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

PROFESSIONAL TYPE
ZACHARY EVANS, P. E. LICENSE NUMBER: 80498 ARDIRRA GROUP, INC. 3000 DOVERA DRIVE OVIEDO, FL 32765

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION		
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
COVE	MARTIN	441700-1-22-02

EXISTING BASIN MAP	

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REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

PROFESSIONAL TYPE
ZACHARY EVANS, P. E. LICENSE NUMBER: 80498 ARDIRRA GROUP, INC. 3000 DOVERA DRIVE OVIEDO, FL 32765

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION		
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
COVE	MARTIN	441700-1-22-02

EXISTING BASIN MAP	

SHEET NO.

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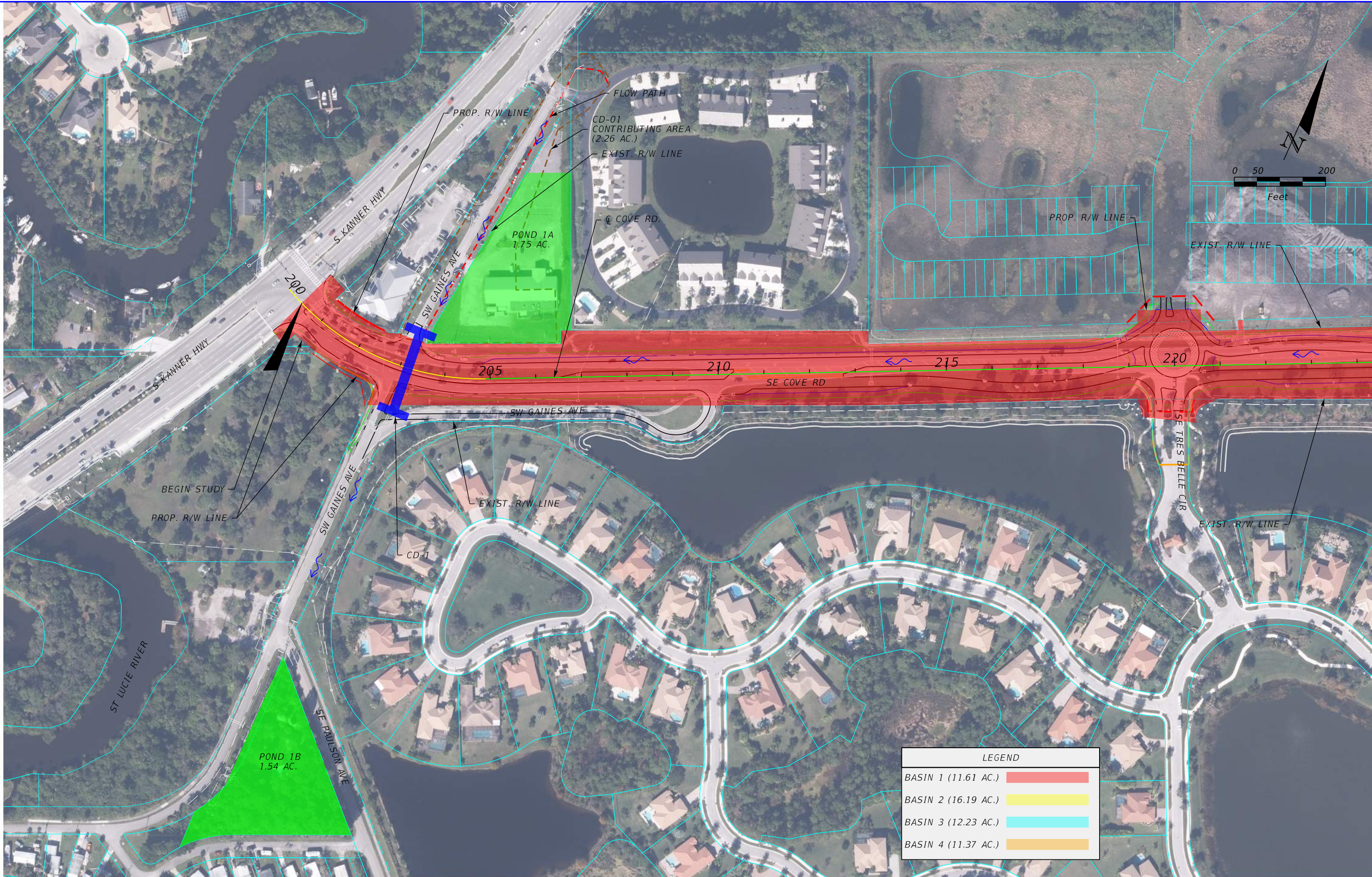
LEGEND	
BASIN 1 (11.61 AC.)	
BASIN 2 (16.19 AC.)	
BASIN 3 (12.23 AC.)	
BASIN 4 (6.19 AC.)	
BASIN 5 (5.18 AC.)	

REVISIONS				PROFESSIONAL TYPE	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION			SHEET NO.
DATE	DESCRIPTION	DATE	DESCRIPTION		ROAD NO.	COUNTY	FINANCIAL PROJECT ID	
					COVE	MARTIN	441700-1-22-02	

EXISTING BASIN MAP

FAC NOTE

12/4/2024 4:56:35 PM lthoang
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REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

PROFESSIONAL TYPE
ZACHARY EVANS, P. E. LICENSE NUMBER: 80498 ARDIRRA GROUP, INC. 3000 DOVERA DRIVE OVIEDO, FL 32765

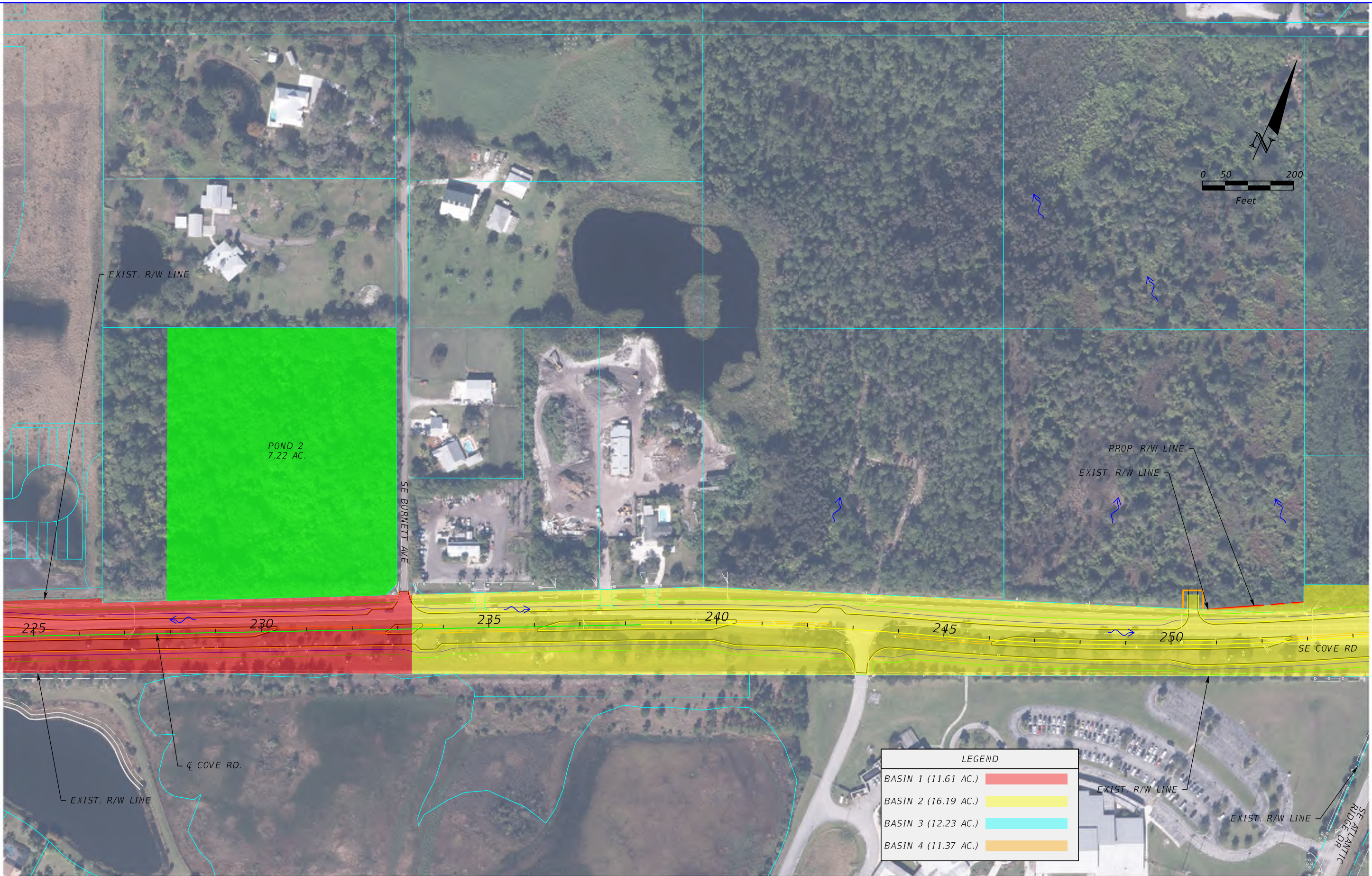
STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION		
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
COVE	MARTIN	441700-1-22-02

PROPOSED BASIN MAP	

SHEET NO.

FAC NOTE

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REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

PROFESSIONAL TYPE
ZACHARY EVANS, P. E. LICENSE NUMBER: 80498 ARDIRRA GROUP, INC. 3000 DOVERA DRIVE OVIEDO, FL 32765

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION		
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
COVE	MARTIN	441700-1-22-02

PROPOSED BASIN MAP	

SHEET NO.

FAC NOTE

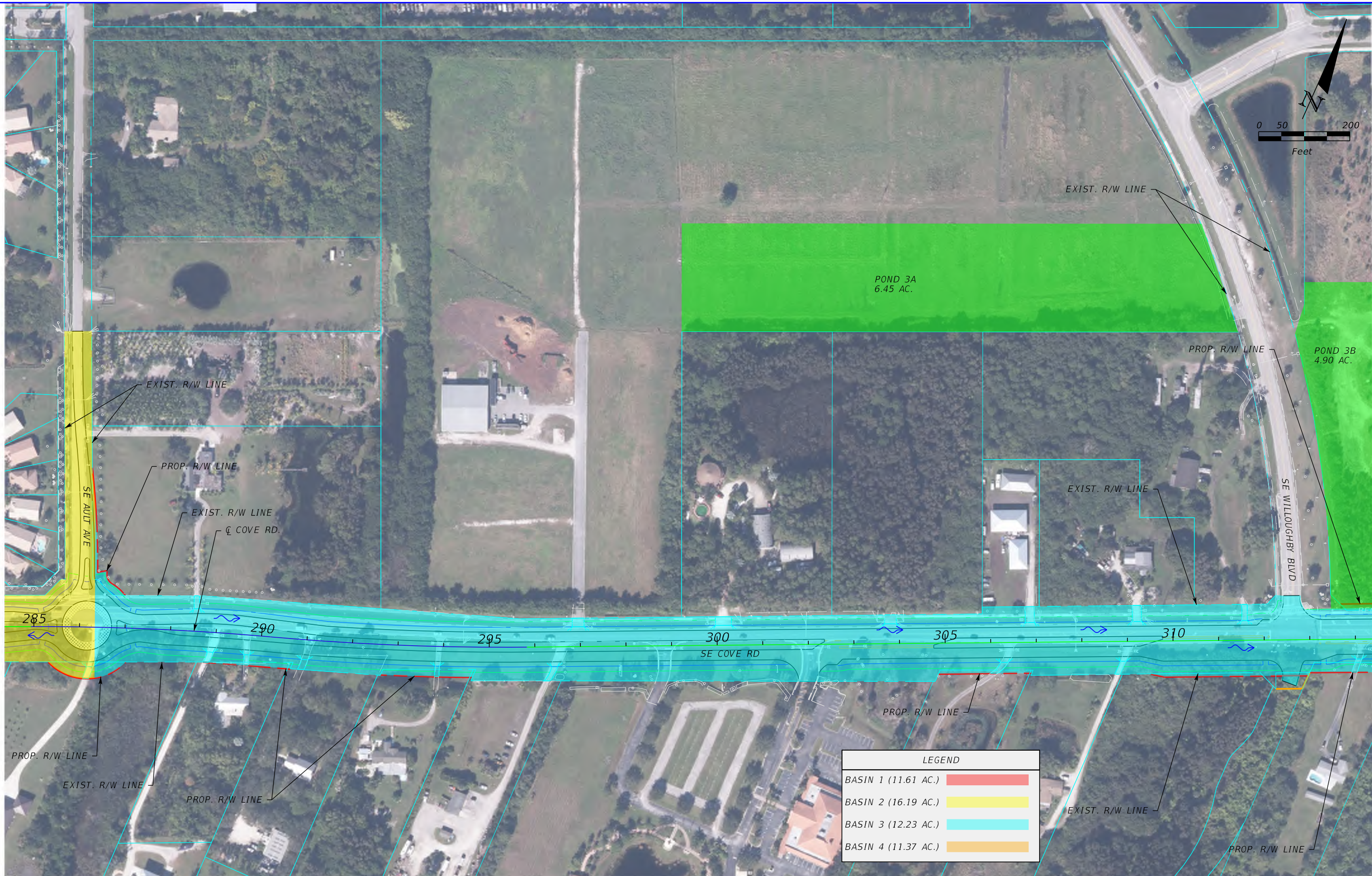
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REVISIONS				PROFESSIONAL TYPE		STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION			PROPOSED BASIN MAP	SHEET NO.
DATE	DESCRIPTION	DATE	DESCRIPTION	ZACHARY EVANS, P. E. LICENSE NUMBER: 80498 ARDIRRA GROUP, INC. 3000 DOVERA DRIVE OVIEDO, FL 32765		ROAD NO.	COUNTY	FINANCIAL PROJECT ID		
						COVE	MARTIN	441700-1-22-02		

FAC NOTE

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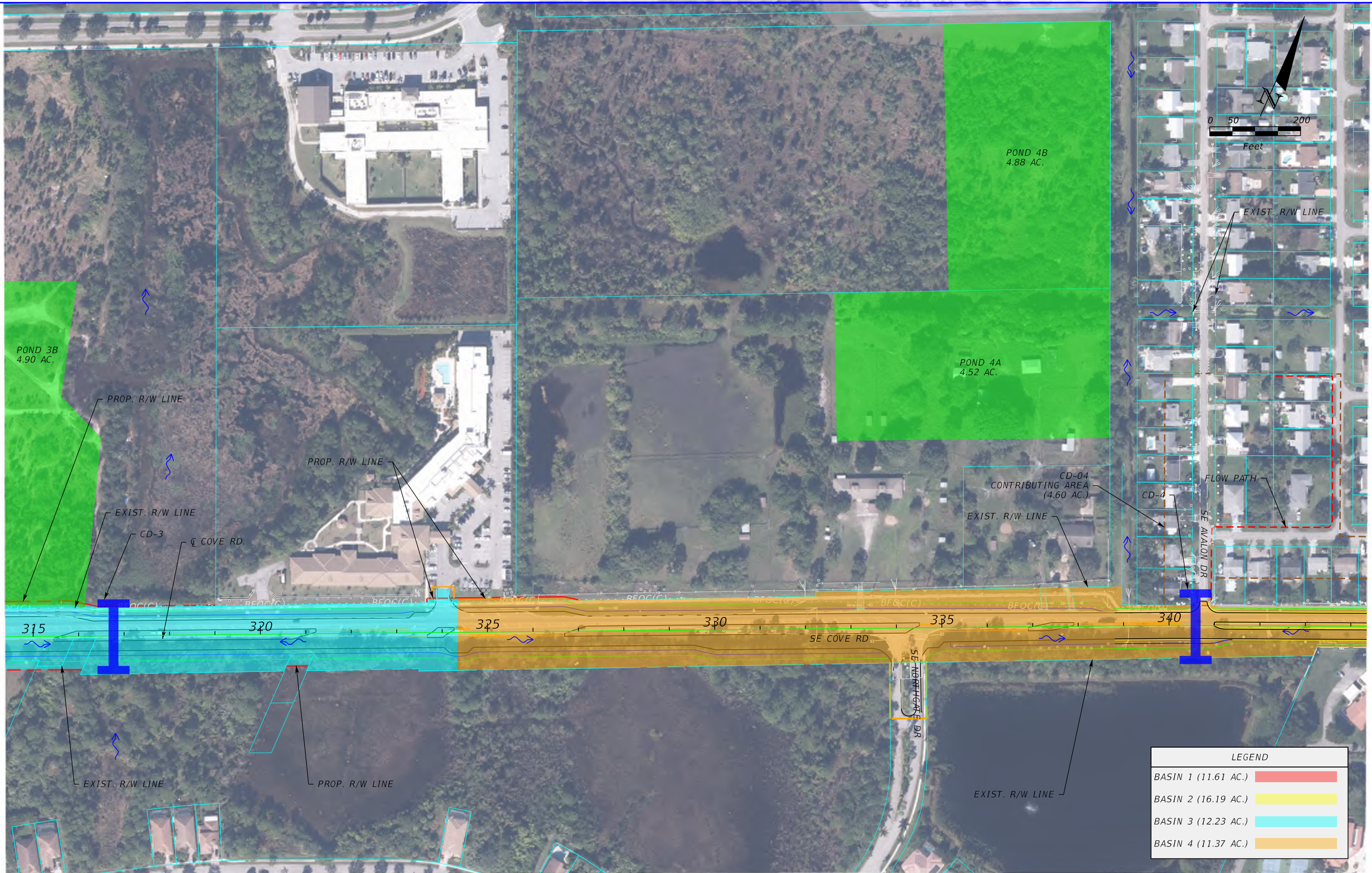


REVISIONS				PROFESSIONAL TYPE	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION			SHEET NO.
DATE	DESCRIPTION	DATE	DESCRIPTION		ROAD NO.	COUNTY	FINANCIAL PROJECT ID	
					COVE	MARTIN	441700-1-22-02	

PROPOSED BASIN MAP

FAC NOTE

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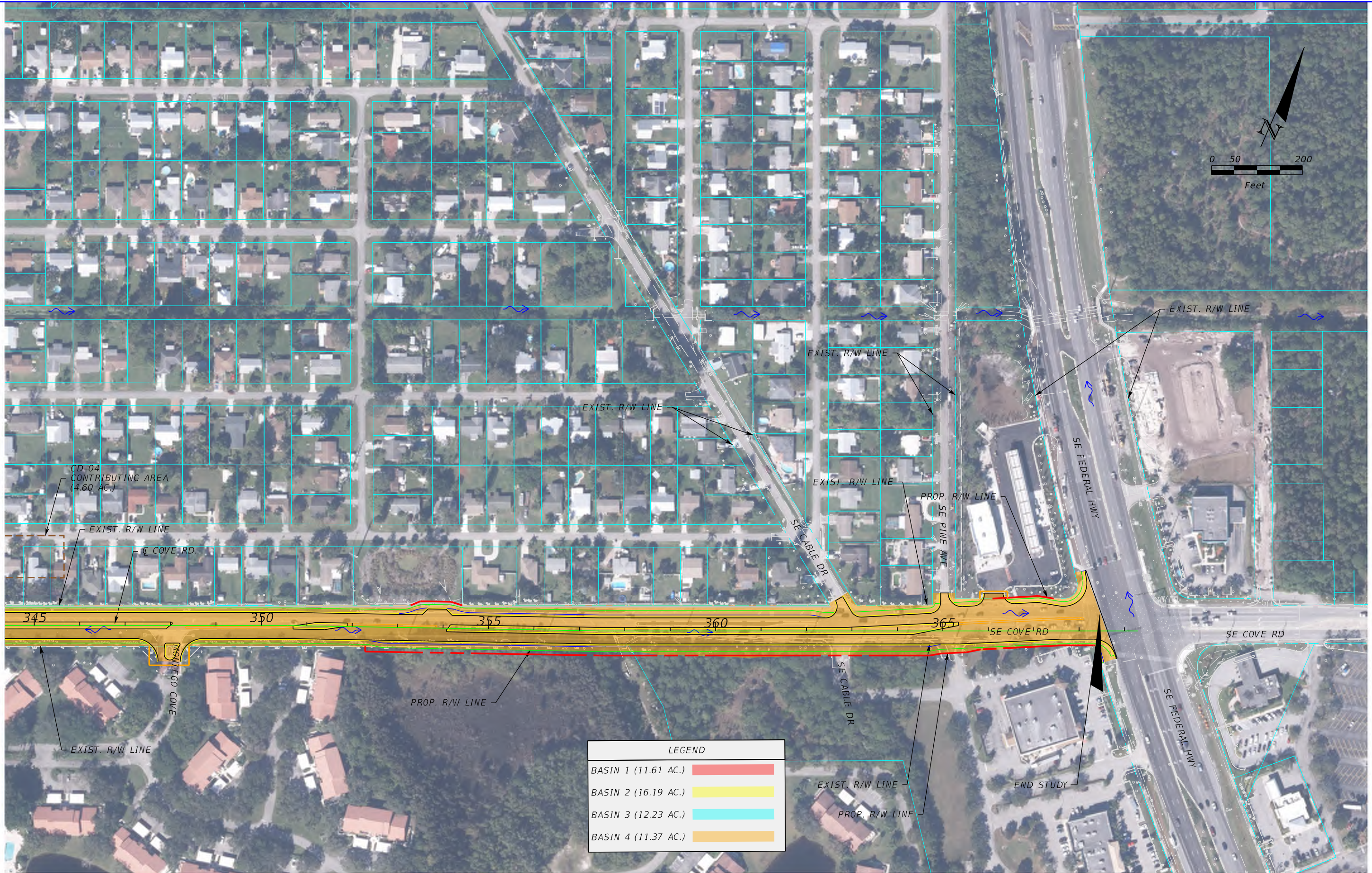


REVISIONS				PROFESSIONAL TYPE	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION			SHEET NO.
DATE	DESCRIPTION	DATE	DESCRIPTION					
					ROAD NO.	COUNTY	FINANCIAL PROJECT ID	
				ZACHARY EVANS, P. E. LICENSE NUMBER: 80498 ARDIRRA GROUP, INC. 3000 DOVERA DRIVE OVIEDO, FL 32765	COVE	MARTIN	441700-1-22-02	

PROPOSED BASIN MAP

FAC NOTE

11/22/2024 10:29:34 AM lthoang
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REVISIONS				PROFESSIONAL TYPE	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION			PROPOSED BASIN MAP	SHEET NO.
DATE	DESCRIPTION	DATE	DESCRIPTION		ROAD NO.	COUNTY	FINANCIAL PROJECT ID		
					COVE	MARTIN	441700-1-22-02		

FAC NOTE

APPENDIX 3
Cross Drain Analysis



NOAA Atlas 14, Volume 9, Version 2
Location name: Stuart, Florida, USA*
Latitude: 27.1278°, Longitude: -80.2229°
Elevation: 18 ft**

* source: ESRI Maps

** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerals](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	6.64 (5.35-8.26)	7.55 (6.08-9.41)	9.06 (7.28-11.3)	10.3 (8.28-13.0)	12.2 (9.42-15.8)	13.6 (10.3-17.9)	15.0 (11.0-20.3)	16.5 (11.6-23.0)	18.5 (12.6-26.6)	20.1 (13.3-29.3)
10-min	4.85 (3.19-6.05)	5.53 (4.46-6.89)	6.64 (5.33-8.30)	7.58 (6.06-9.52)	8.90 (6.90-11.6)	9.94 (7.54-13.1)	11.0 (8.07-14.9)	12.1 (8.52-16.8)	13.6 (9.21-19.5)	14.7 (9.73-21.4)
15-min	3.95 (3.19-4.92)	4.49 (3.62-5.60)	5.40 (4.34-6.74)	6.16 (4.93-7.74)	7.24 (5.61-9.40)	8.08 (6.12-10.7)	8.94 (6.56-12.1)	9.84 (6.93-13.7)	11.0 (7.49-15.8)	12.0 (7.91-17.4)
30-min	3.04 (2.45-3.79)	3.46 (2.79-4.31)	4.16 (3.34-5.20)	4.75 (3.80-5.96)	5.58 (4.33-7.25)	6.24 (4.73-8.22)	6.90 (5.06-9.34)	7.59 (5.35-10.6)	8.52 (5.78-12.2)	9.24 (6.11-13.5)
60-min	2.06 (1.67-2.57)	2.33 (1.88-2.91)	2.78 (2.24-3.48)	3.16 (2.53-3.97)	3.70 (2.86-4.80)	4.12 (3.12-5.43)	4.55 (3.34-6.15)	4.99 (3.52-6.95)	5.60 (3.80-8.02)	6.06 (4.01-8.83)
2-hr	1.30 (1.06-1.61)	1.47 (1.19-1.82)	1.74 (1.41-2.16)	1.97 (1.59-2.46)	2.30 (1.79-2.97)	2.56 (1.95-3.35)	2.82 (2.08-3.79)	3.10 (2.19-4.28)	3.46 (2.37-4.94)	3.75 (2.50-5.43)
3-hr	0.969 (0.790-1.20)	1.09 (0.889-1.35)	1.30 (1.05-1.61)	1.48 (1.19-1.84)	1.73 (1.35-2.22)	1.93 (1.47-2.52)	2.13 (1.58-2.85)	2.34 (1.67-3.23)	2.63 (1.80-3.74)	2.86 (1.91-4.12)
6-hr	0.561 (0.460-0.688)	0.646 (0.529-0.792)	0.790 (0.645-0.971)	0.914 (0.742-1.13)	1.09 (0.862-1.40)	1.24 (0.953-1.61)	1.39 (1.03-1.85)	1.54 (1.10-2.12)	1.76 (1.21-2.48)	1.93 (1.30-2.76)
12-hr	0.310 (0.256-0.378)	0.370 (0.305-0.451)	0.474 (0.389-0.579)	0.564 (0.461-0.692)	0.697 (0.554-0.892)	0.804 (0.624-1.04)	0.917 (0.689-1.22)	1.04 (0.748-1.42)	1.20 (0.837-1.69)	1.34 (0.903-1.90)
24-hr	0.178 (0.148-0.216)	0.214 (0.177-0.259)	0.277 (0.228-0.336)	0.333 (0.274-0.406)	0.418 (0.335-0.534)	0.488 (0.382-0.631)	0.563 (0.426-0.747)	0.644 (0.468-0.878)	0.758 (0.531-1.06)	0.849 (0.578-1.20)
2-day	0.107 (0.089-0.129)	0.124 (0.103-0.149)	0.155 (0.129-0.187)	0.184 (0.152-0.223)	0.229 (0.185-0.292)	0.267 (0.211-0.344)	0.308 (0.235-0.408)	0.354 (0.260-0.481)	0.419 (0.296-0.585)	0.472 (0.324-0.664)
3-day	0.079 (0.066-0.095)	0.091 (0.076-0.109)	0.112 (0.093-0.134)	0.132 (0.109-0.159)	0.162 (0.131-0.205)	0.187 (0.148-0.240)	0.215 (0.165-0.283)	0.246 (0.181-0.332)	0.289 (0.205-0.402)	0.325 (0.223-0.455)
4-day	0.064 (0.054-0.077)	0.073 (0.061-0.087)	0.089 (0.075-0.107)	0.104 (0.087-0.125)	0.127 (0.103-0.160)	0.146 (0.116-0.187)	0.167 (0.128-0.218)	0.189 (0.140-0.255)	0.221 (0.157-0.306)	0.247 (0.170-0.345)
7-day	0.043 (0.037-0.052)	0.049 (0.041-0.058)	0.058 (0.049-0.070)	0.067 (0.056-0.080)	0.080 (0.065-0.100)	0.091 (0.072-0.115)	0.102 (0.079-0.133)	0.114 (0.085-0.153)	0.132 (0.094-0.181)	0.146 (0.101-0.203)
10-day	0.034 (0.029-0.041)	0.038 (0.032-0.046)	0.045 (0.038-0.054)	0.052 (0.043-0.062)	0.061 (0.050-0.076)	0.069 (0.055-0.086)	0.077 (0.059-0.099)	0.085 (0.063-0.114)	0.097 (0.070-0.133)	0.107 (0.075-0.148)
20-day	0.023 (0.019-0.027)	0.025 (0.021-0.030)	0.030 (0.025-0.035)	0.034 (0.028-0.040)	0.039 (0.032-0.048)	0.044 (0.035-0.054)	0.048 (0.037-0.062)	0.053 (0.039-0.070)	0.059 (0.043-0.081)	0.065 (0.045-0.089)
30-day	0.018 (0.015-0.021)	0.020 (0.017-0.024)	0.024 (0.020-0.028)	0.027 (0.023-0.032)	0.031 (0.026-0.038)	0.035 (0.028-0.043)	0.038 (0.029-0.048)	0.041 (0.031-0.054)	0.046 (0.033-0.062)	0.050 (0.035-0.068)
45-day	0.015 (0.012-0.017)	0.016 (0.014-0.019)	0.019 (0.017-0.023)	0.022 (0.019-0.026)	0.025 (0.021-0.031)	0.028 (0.022-0.034)	0.030 (0.024-0.038)	0.033 (0.024-0.043)	0.036 (0.026-0.048)	0.039 (0.027-0.053)
60-day	0.013 (0.011-0.015)	0.014 (0.012-0.017)	0.017 (0.014-0.020)	0.019 (0.016-0.022)	0.022 (0.018-0.026)	0.024 (0.019-0.029)	0.026 (0.020-0.033)	0.028 (0.021-0.036)	0.030 (0.022-0.041)	0.032 (0.023-0.044)

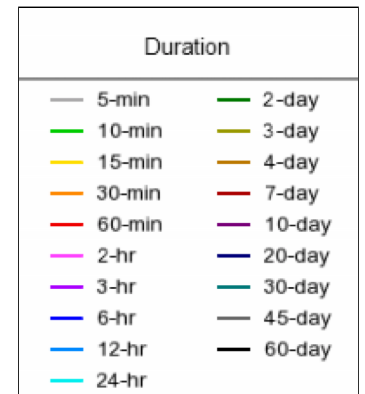
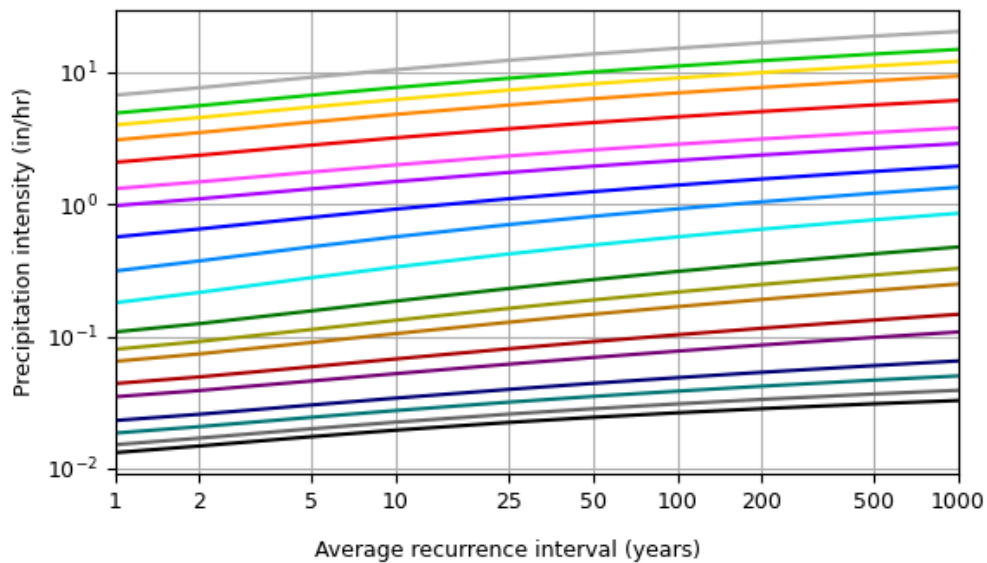
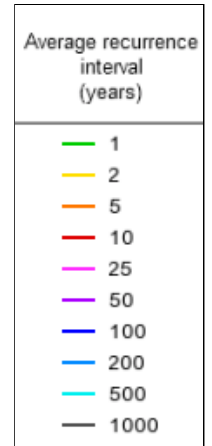
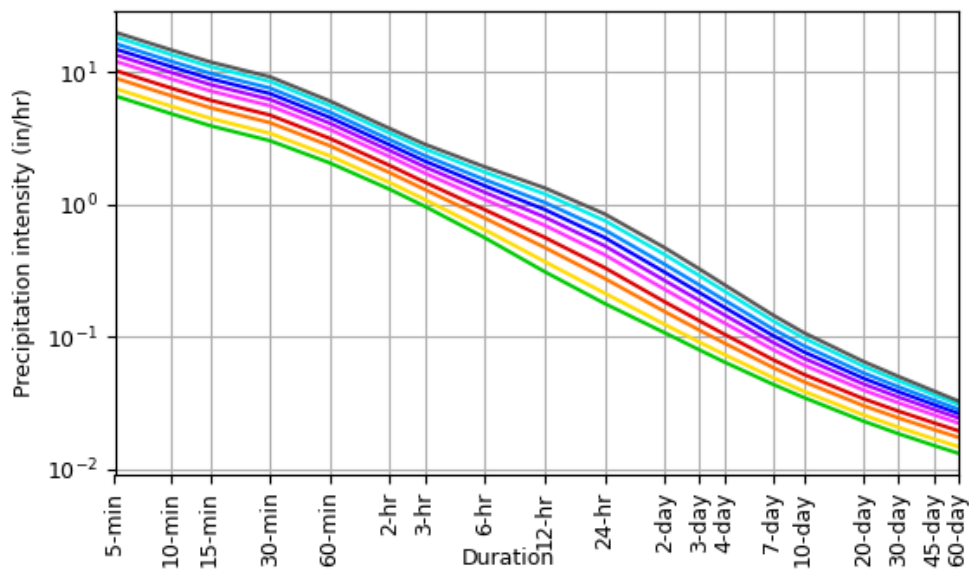
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical

PDS-based intensity-duration-frequency (IDF) curves

Latitude: 27.1278°, Longitude: -80.2229°



NOAA Atlas 14, Volume 9, Version 2

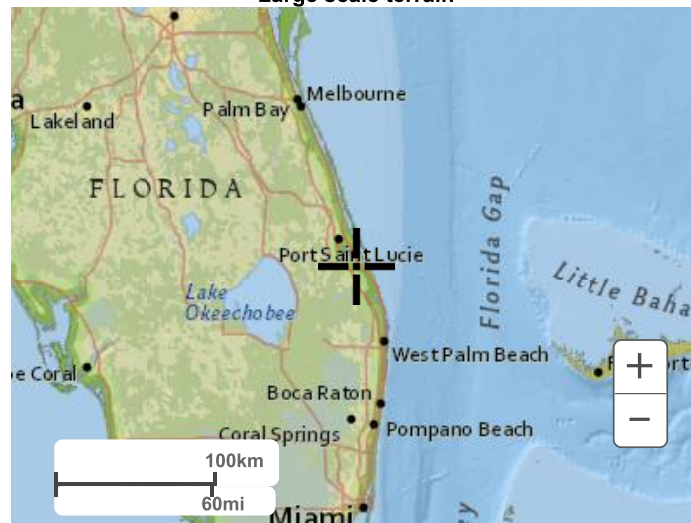
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[Back to Top](#)**Maps & aerals**

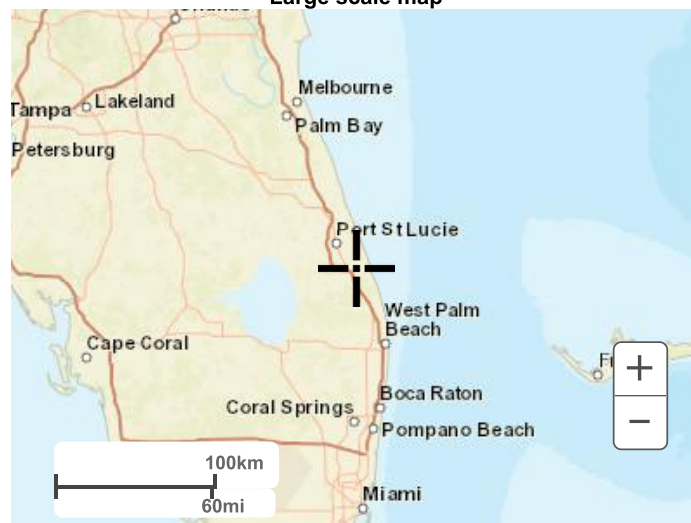
Small scale terrain



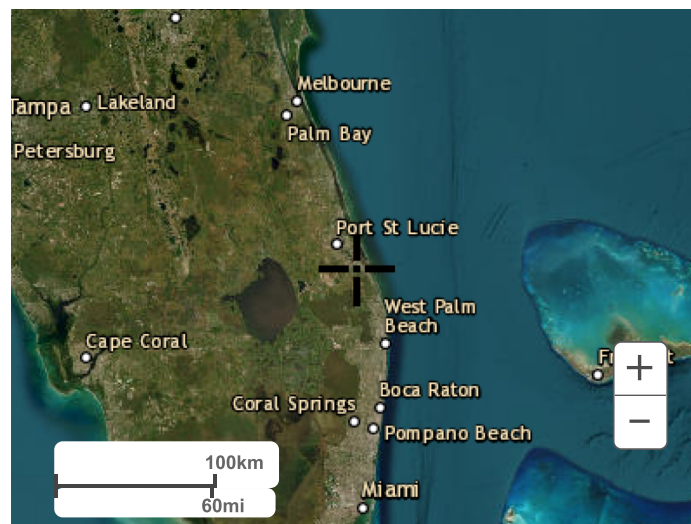
Large scale terrain



Large scale map



Large scale aerial



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1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov
[Disclaimer](#)

Ardurra
3000 Dovera Drive, Ste 200
Oviedo, FL 32708

Project Name: **Cove Road PD&E**
Project Number: **DT4-010-01**
CD Name: **CD-01**
Description: **Existing Condition**

Design By: **ZKE** Date: **8/8/2024**
Check By: **REC** Date: **8/8/2024**



EXISTING CULVERT DATA

Methodology Used: **RATIONAL METHOD**
Existing Culvert Information:
Culvert Shape: **Circular**
Culvert Diameter: **15 in**
No. of barrels: **1**
Area of Culvert: **1.23 sqft**
Existing Length: **178.00 ft**
Avg. Flowline Elevation Upstream: **3.43 ft NAVD**
Avg. Flowline Elevation Downstream: **2.57 ft NAVD**
Slope: **0.005 ft/ft**
Tailwater: **4.03**

or **0.48%**

Culvert Location: **203+20.00**
Material: **Concrete, Reinforced**
Manning's n: **0.012**
Inlet Configuration: **Mitered to Conform to Slope**
Inlet Depression: **No**
Roadway Crest: **9.75 ft NAVD**
Surface: **Paved**
Top Width: **105**

Maintenance & Site Condition Notes:

TW Elevation determined from observed stain lines on downstream structure.

TIME OF CONCENTRATION

OVERLAND FLOW(SHEET FLOW):

$$T_o = 0.93 * (L^{0.6}) * (n^{0.6}) = T_o(\text{hr.'s})$$
$$(t^{0.4}) * (S^{0.3})$$

SURFACE	MANNING'S 'n'	LENGTH (ft)	BEGIN ELEV (ft)	END ELEV (ft)	SLOPE (%)	RAINFALL INTENSITY (in/hr)	CALCULATED INTENSITY (in/hr)	TIME (min)
Asphalt	0.012	10 ft.	10.70	10.50	2.00%	13.60 in./hr.	13.60 in./hr.	0.30
Grass (bluegrass sod)	0.450	80 ft.	10.50	8.00	3.13%	10.90 in./hr.	10.90 in./hr.	8.69
Total Overland Flow Time of Concentration:								8.98

SHALLOW CONCENTRATED FLOW:

$$T_{sh} = \frac{L_{sh}}{60 \times V} = T_{sh}(\text{minutes}) \text{ where:}$$

VELOCITY = V_{unpaved}, V_{paved}, V_{pipe} and/or V_{ditch}

V_{unpaved} = 16.1345 x S^{0.5}, where S = Slope in ft/ft.

V_{paved} = 20.3282 x S^{0.5}, where S = Slope in ft/ft.

V_{pipe} = 2.5 fps (Established)

V_{ditch} = 0.5 fps (Established)

SURFACE	LENGTH (ft)	BEGIN ELEV (ft)	END ELEV (ft)	SLOPE (%)	VELOCITY (fps)	TIME (min)
Unpaved	10 ft.	8.00	6.80	12.00%	5.59 fps	0.03
Total Shallow Concentrated Flow Time of Concentration:						0.03

CHANNEL FLOW GEOMETRY:

Depth of Flow (ft)	Front Slope (1:) (ft)	Bottom Width (ft)	Back Slope (1:) (ft)	Top Span (ft)	Area (ft ²)	Wetted Perimeter (ft)	HYDRAULIC RADIUS (ft)
2	2	0.5	2	8.50	9.00	9.44	0.95
2	2	0.5	2	8.50	9.00	9.44	0.953

CHANNEL FLOW:

$$T_{sh} = \frac{L_{sh}}{60 \times V} = T_{sh}(\text{minutes}) \text{ where:}$$

$$\text{VELOCITY} = V = \frac{1.49 R^{2/3} S^{1/2}}{n}$$

SURFACE	MANNING'S 'n'	LENGTH (ft)	BEGIN ELEV (ft)	END ELEV (ft)	SLOPE (%)	VELOCITY (fps)	TIME (min)
Well Maintained	0.060	400 ft.	6.80	6.30	0.13%	0.850	7.85
Well Maintained	0.060	170 ft.	6.30	3.43	1.69%	3.123	0.91
Total Channel Flow Time of Concentration:							8.75

TOTAL TIME of CONCENTRATION = **17.77 min**

Ardurra
3000 Dovera Drive, Ste 200
Oviedo, FL 32708

Project Name: **Cove Road PD&E**
Project Number: **DT4-010-01**
CD Name: **CD-01**
Description: **Existing Condition**

Design By : **ZKE** Date: **8/8/2024**
Check By : **REC** Date: **8/8/2024**



CROSS DRAIN DESIGN

HYDROLOGIC ANALYSIS

Rational Method:

$$Q = CiA$$

Q = Peak Runoff for Return Period T (cfs)

C = Composite Runoff Coefficient $((C_1 \cdot A_1 + C_2 \cdot A_2 + C_3 \cdot A_3 + \dots + C_n \cdot A_n) / A_T)$

i = Rainfall Intensity for Return Period T (in/hr)

A = Contributing Basin Area $(A_1 + A_2 + A_3 + \dots + A_n)$ (Ac)

Terrain Slope: **0-2%**

Soil Type: **Sandy Soils**

$i_{25 \text{ yr}}$	6.93 in/hr
$i_{50 \text{ yr}}$	7.74 in/hr
$i_{100 \text{ yr}}$	8.56 in/hr
$i_{500 \text{ yr}}$	10.54 in/hr

Composite $C_T =$ Total $C \cdot A / A_T =$ **0.691**

$Q_{25 \text{ yr}}$	$C_T i_{25} A_T =$	10.83 cfs
$Q_{50 \text{ yr}}$	$C_T i_{50} A_T =$	12.09 cfs
$Q_{100 \text{ yr}}$	$C_T i_{100} A_T =$	13.38 cfs
$Q_{500 \text{ yr}}$	$C_T i_{500} A_T =$	16.47 cfs

Landuse	Runoff Coeff.	Area (ac)	C*A
Rooflops & Pavement	0.95	1.48	1.41
Pasture, grass, farmland	0.20	0.78	0.16
Total:		2.26	1.56

OVERTOPPING FREQUENCY ANALYSIS

Name	$Q_{(25)}$	$Q_{(50)}$	$Q_{(100)}$	$Q_{(OT)}$	$Q_{(500)}$
CD-01	10.83	12.09	13.38	10.32	16.47

*OT = Overtopping

Sample Calculations:

x = **7.55%** (From extrapolation)

Storm Event = $1/\text{Storm Freq}$
13-yr

Storm Event			
50-yr	100-yr	13-yr	500-yr
Strom Frequency (%)			
2	1	7.55	0.2

Ardurra
3000 Dovera Drive, Ste 200
Oviedo, FL 32708

Project Name: **Cove Road PD&E**
Project Number: **DT4-010-01**
CD Name: **CD-02**
Description: **Existing Condition**

Design By : **ZKE**
Check By : **REC**

Date: **8/8/2024**
Date: **8/8/2024**



EXISTING CULVERT DATA

Methodology Used: **VELOCITY METHOD**
Existing Culvert Information:

Culvert Shape: **Elliptical**
Culvert Span: **27 in**
No. of barrels: **1**
Area of Culvert: **6.19 sqft**
Existing Length: **133.00 ft**
Avg. Flowline Elevation Upstream: **10.66 ft NAVD**
Avg. Flowline Elevation Downstream: **10.37 ft NAVD**
Slope: **0.002 ft/ft**
Tailwater: **12.54**

or **0.22%**

Culvert Location: **255+35.00**
Culvert Rise: **42 in**
Material: **Concrete, Reinforced**
Manning's n: **0.012**
Inlet Configuration: **Mitered to Conform to Slope**
Inlet Depression: **No**
Roadway Crest: **15.95 ft NAVD**
Surface: **Paved**
Top Width: **77**

Maintenance & Site Condition Notes:

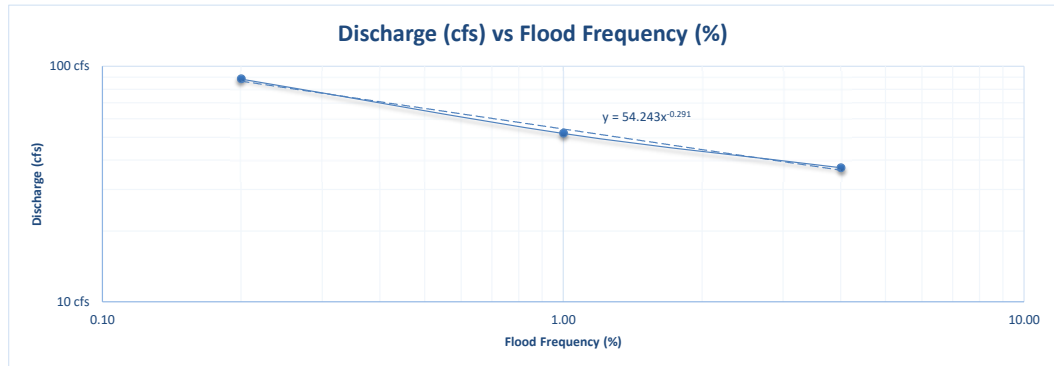
No observed stain lines on structure. TOP elevation used for TW elevation for analysis.

HYDROLOGIC ANALYSIS

Velocity Method:

$Q = AVn$
 Q = Peak Runoff for Return Period T (cfs)
 A = Existing Culvert Cross Section Area
 V = 6 feet per second (maximum)
 n = Number of barrels

A_1 = **6.19 sq.ft.**
 n = **1 Barrels**
 $Q_{25yr} = A_1 V =$ **37.11 cfs**
 $Q_{50yr} = 52.234(.2)^{-0.291} =$ **44.33 cfs**
 $Q_{100yr} = 1.4Q_{25yr} =$ **51.95 cfs**
 $Q_{500yr} = 1.7Q_{100yr} =$ **88.32 cfs**



OVERTOPPING FREQUENCY ANALYSIS

Name	$Q_{(25)}$	$Q_{(50)}$	$Q_{(100)}$	$Q_{(OT)}$	$Q_{(500)}$
CD-02	37.11	44.33	51.95	61.07	88.32

*OT = Overtopping

Sample Calculations:

$Q_{(OT)} =$ **52.234x^{-0.291}** (from curve fitting equation)
 $x =$ **0.58%**

Storm Event = 1/Storm Freq

171-yr

Storm Event			
50-yr	100-yr	171-yr	500-yr
Storm Frequency (%)			
2	1	0.58	0.2

Ardurra
3000 Dovera Drive, Ste 200
Oviedo, FL 32708

Project Name: **Cove Road PD&E**
Project Number: **DT4-010-01**
CD Name: **CD-04**
Description: **Existing Condition**

Design By: **ZKE** Date: **8/8/2024**
Check By: **REC** Date: **8/8/2024**



CROSS DRAIN DESIGN

EXISTING CULVERT DATA

Methodology Used: **RATIONAL METHOD**
Existing Culvert Information:
Culvert Shape: **Circular**
Culvert Diameter: **18 in**
No. of barrels: **1**
Area of Culvert: **1.77 sqft**
Existing Length: **99.00 ft**
Avg. Flowline Elevation Upstream: **14.71 ft NAVD**
Avg. Flowline Elevation Downstream: **13.93 ft NAVD**
Slope: **0.008 ft/ft**
Tailwater: **16.21**

or **0.79%**

Culvert Location: **340+60.00**
Material: **Concrete, Reinforced**
Manning's n: **0.012**
Inlet Configuration: **Mitered to Conform to Slope**
Inlet Depression: **No**
Roadway Crest: **17.50 ft NAVD**
Surface: **Paved**
Top Width: **40**

Maintenance & Site Condition Notes:

No observed stain lines on structure. TOP elevation used for TW elevation for analysis.

TIME OF CONCENTRATION

OVERLAND FLOW(SHEET FLOW):

$$T_o = \frac{0.93 * (L^{0.6}) * (n^{0.6})}{(i^{0.4}) * (S^{0.3})} = T_o(\text{hr.'s})$$

SURFACE	MANNING'S 'n'	LENGTH (ft)	BEGIN ELEV (ft)	END ELEV (ft)	SLOPE (%)	RAINFALL INTENSITY (in/hr)	CALCULATED INTENSITY (in/hr)	TIME (min)
Grass (bluegrass sod)	0.450	100 ft.	17.25	17.00	0.25%	6.78 in./hr.	6.78 in./hr.	25.62
Total Overland Flow Time of Concentration:								25.62

SHALLOW CONCENTRATED FLOW:

$$T_{sh} = \frac{L_{sh}}{60 * V} = T_{sh}(\text{minutes}) \text{ where:}$$

VELOCITY = V_{unpaved}, V_{paved}, V_{pipe} and/or V_{ditch}

V_{unpaved} = 16.1345 x S^{0.5}, where S = Slope in ft/ft.

V_{paved} = 20.3282 x S^{0.5}, where S = Slope in ft/ft.

V_{pipe} = 2.5 fps (Established)

V_{ditch} = 0.5 fps (Established)

SURFACE	LENGTH (ft)	BEGIN ELEV (ft)	END ELEV (ft)	SLOPE (%)	VELOCITY (fps)	TIME (min)
Unpaved	25 ft.	17.00	15.80	4.80%	3.53 fps	0.12
Total Shallow Concentrated Flow Time of Concentration:						0.12

CHANNEL FLOW GEOMETRY:

Depth of Flow (ft)	Front Slope (1:_) (ft)	Bottom Width (ft)	Back Slope (1:_) (ft)	Top Span (ft)	Area (ft ²)	Wetted Perimeter (ft)	HYDRAULIC RADIUS (ft)
1	6	0	6	12.00	6.00	12.17	0.49

CHANNEL FLOW:

$$T_{sh} = \frac{L_{sh}}{60 * V} = T_{sh}(\text{minutes}) \text{ where:}$$

$$\text{VELOCITY} = V = \frac{1.49 R^{2/3} S^{1/2}}{n}$$

SURFACE	MANNING'S 'n'	LENGTH (ft)	BEGIN ELEV (ft)	END ELEV (ft)	SLOPE (%)	VELOCITY (fps)	TIME (min)
Channel, Clear bottom	0.080	695 ft.	15.80	14.80	0.14%	0.441	26.28
Total Channel Flow Time of Concentration:							26.28

TOTAL TIME of CONCENTRATION = **52.02 min**

Storm Event			
50-yr	100-yr	26-yr	500-yr
Strom Frequency (%)			
2	1	3.85	0.2

CROSS DRAIN DESIGN

Ardurra
3000 Dovera Drive, Ste 200
Oviedo, FL 32708

Project Name: **Cove Road PD&E**
Project Number: **DT4-Q10-01**



Design By: **ZKE** Date: **8/8/2024**
Check By: **REC** Date: **8/8/2024**

CROSS DRAIN FLOOD DATA SHEET - EXISTING VS. PROPOSED

[illegible]

Existing

HY-8 Culvert Analysis Report

CD-01 Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 12.09 cfs

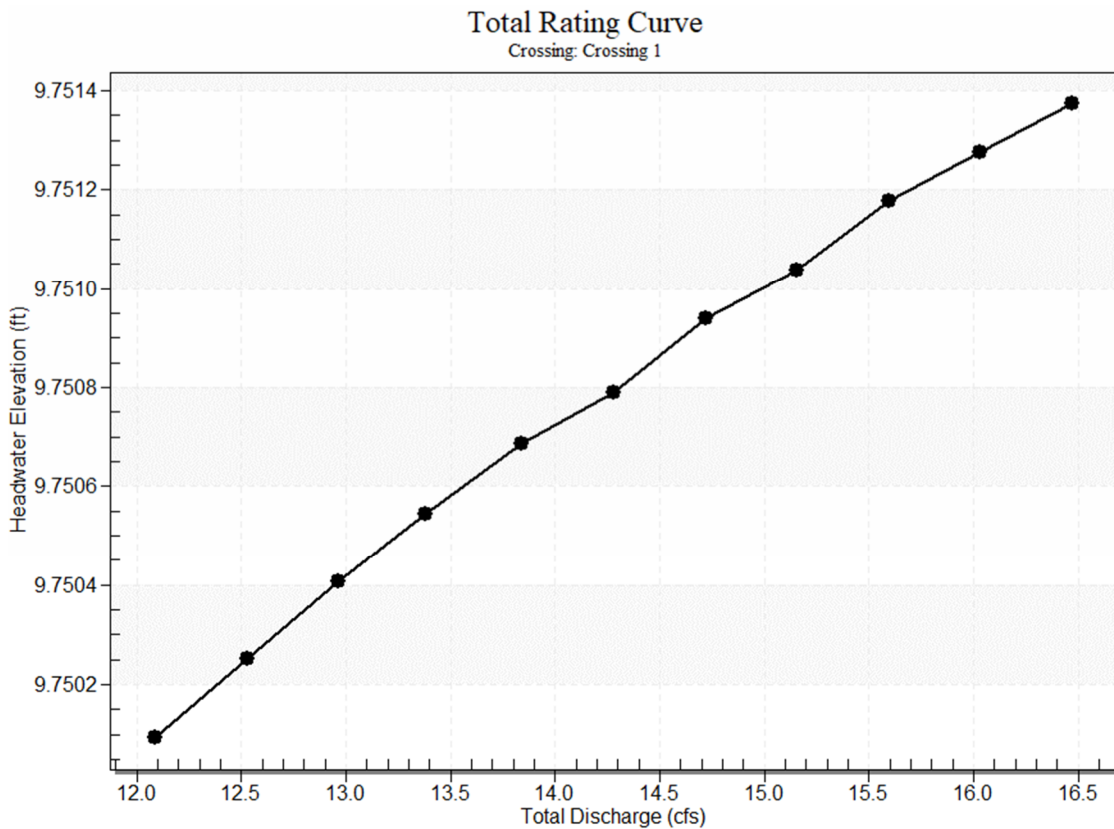
Design Flow: 13.38 cfs

Maximum Flow: 16.47 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing 1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
9.75	12.09	10.32	1.71	43
9.75	12.53	10.32	2.14	3
9.75	12.97	10.32	2.59	3
9.75	13.38	10.32	3.02	3
9.75	13.84	10.32	3.49	3
9.75	14.28	10.32	3.83	2
9.75	14.72	10.32	4.36	3
9.75	15.16	10.32	4.72	2
9.75	15.59	10.32	5.24	3
9.75	16.03	10.32	5.62	2
9.75	16.47	10.32	6.01	2
9.75	10.32	10.32	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 1



Culvert Data: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
12.09 cfs	10.32 cfs	9.75	4.29	6.320	4-FFf	1.25	1.19	1.25	1.33	8.41	0.00
12.53 cfs	10.32 cfs	9.75	4.29	6.320	4-FFf	1.25	1.19	1.25	1.33	8.41	0.00
12.97 cfs	10.32 cfs	9.75	4.29	6.320	4-FFf	1.25	1.19	1.25	1.33	8.41	0.00
13.38 cfs	10.32 cfs	9.75	4.29	6.321	4-FFf	1.25	1.19	1.25	1.33	8.41	0.00
13.84 cfs	10.32 cfs	9.75	4.29	6.321	4-FFf	1.25	1.19	1.25	1.33	8.41	0.00
14.28 cfs	10.32 cfs	9.75	4.29	6.321	4-FFf	1.25	1.19	1.25	1.33	8.41	0.00

14.72 cfs	10.32 cfs	9.75	4.29	6.32 1	4- FFf	1.25	1.19	1.2 5	1.33	8.41	0.00
15.16 cfs	10.32 cfs	9.75	4.29	6.32 1	4- FFf	1.25	1.19	1.2 5	1.33	8.41	0.00
15.59 cfs	10.32 cfs	9.75	4.29	6.32 1	4- FFf	1.25	1.19	1.2 5	1.33	8.41	0.00
16.03 cfs	10.32 cfs	9.75	4.29	6.32 1	4- FFf	1.25	1.19	1.2 5	1.33	8.41	0.00
16.47 cfs	10.32 cfs	9.75	4.29	6.32 1	4- FFf	1.25	1.19	1.2 5	1.33	8.41	0.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

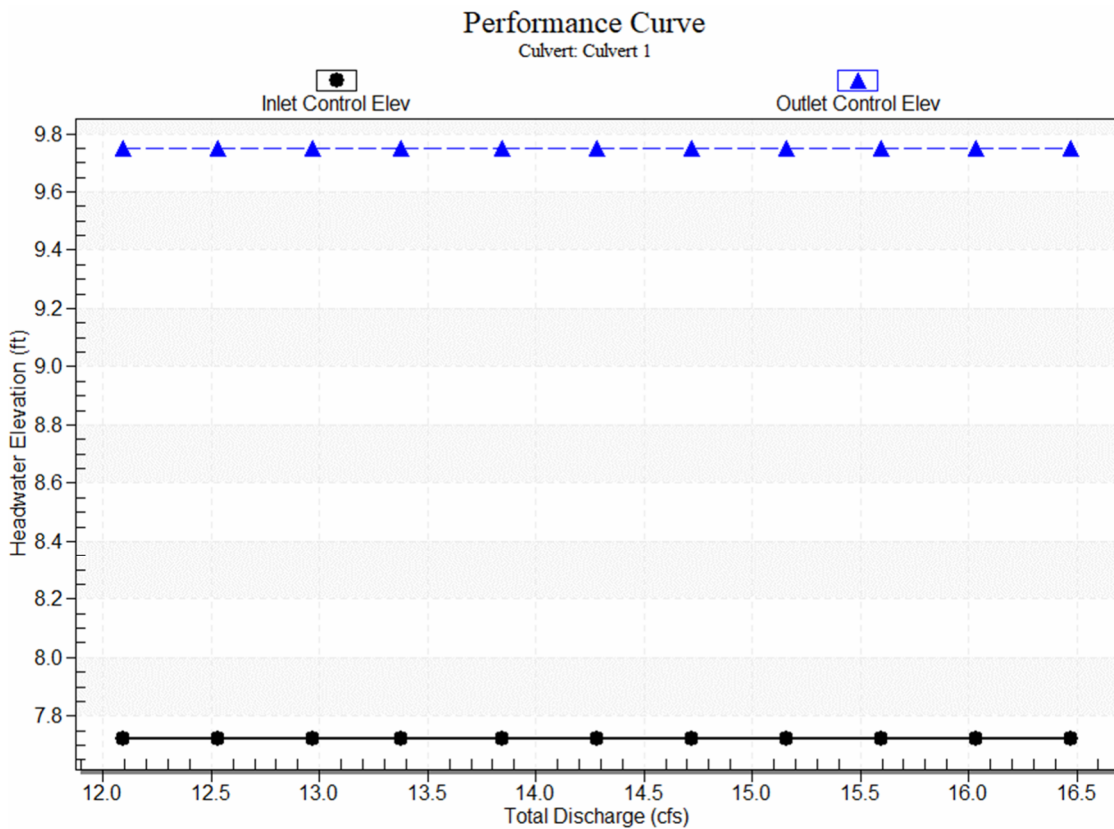
Inlet Elevation (invert): 3.43 ft,

Outlet Elevation (invert): 2.57 ft

Culvert Length: 178.00 ft,

Culvert Slope: 0.0048

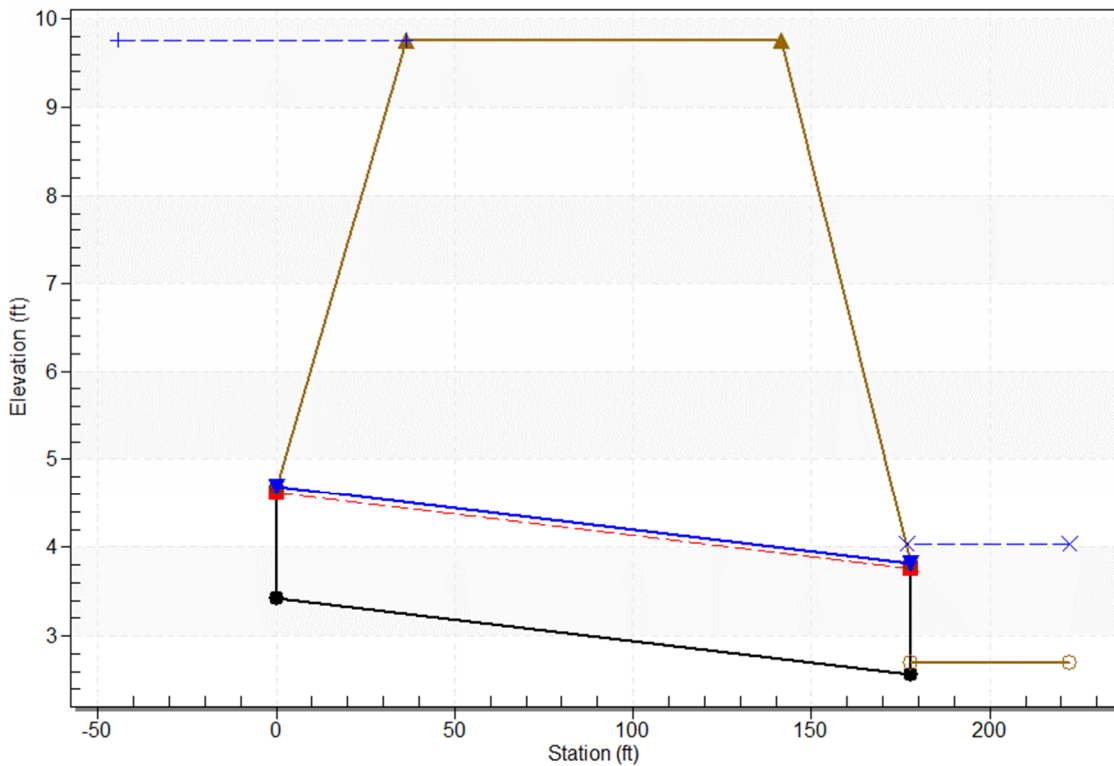
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Crossing 1, Design Discharge - 13.4 cfs

Culvert - Culvert 1, Culvert Discharge - 10.3 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 3.43 ft

Outlet Station: 178.00 ft

Outlet Elevation: 2.57 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope ($K_e=0.7$)

Inlet Depression: None

Tailwater Data for Crossing: Crossing 1

Table 3 - Downstream Channel Rating Curve (Crossing: Crossing 1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
12.09	4.03	1.33
12.53	4.03	1.33
12.97	4.03	1.33
13.38	4.03	1.33
13.84	4.03	1.33
14.28	4.03	1.33
14.72	4.03	1.33
15.16	4.03	1.33
15.59	4.03	1.33
16.03	4.03	1.33
16.47	4.03	1.33

Tailwater Channel Data - Crossing 1

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 4.03 ft

Roadway Data for Crossing: Crossing 1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 600.00 ft

Crest Elevation: 9.75 ft

Roadway Surface: Paved

Roadway Top Width: 105.00 ft

CD-02

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 44.33 cfs

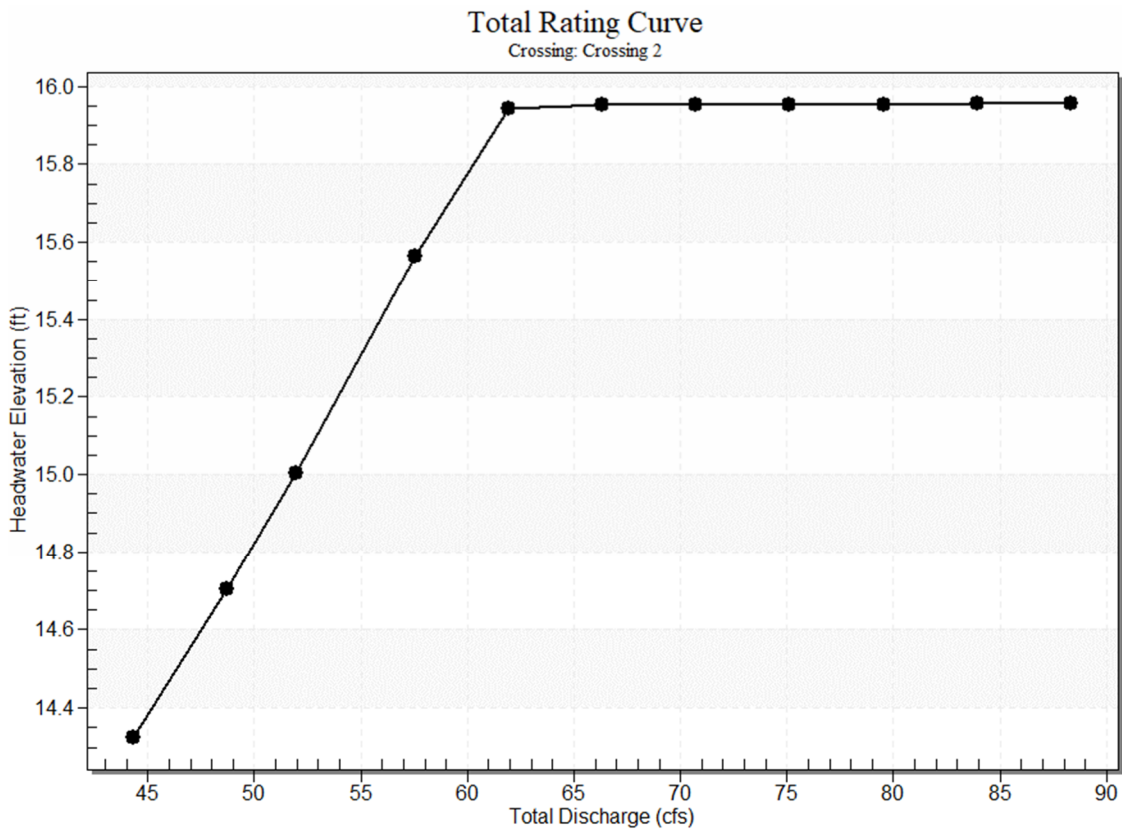
Design Flow: 51.95 cfs

Maximum Flow: 88.32 cfs

Table 4 - Summary of Culvert Flows at Crossing: Crossing 2

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
14.33	44.33	44.33	0.00	1
14.70	48.73	48.73	0.00	1
15.00	51.95	51.95	0.00	1
15.56	57.53	57.53	0.00	1
15.94	61.93	61.02	0.00	175
15.95	66.32	61.09	4.69	12
15.95	70.72	61.10	9.25	4
15.95	75.12	61.10	13.41	3
15.95	79.52	61.11	17.91	3
15.95	83.92	61.11	22.44	3
15.96	88.32	61.12	26.95	3
15.95	61.07	61.07	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 2



Culvert Data: Culvert 1

Table 5 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
44.33 cfs	44.33 cfs	14.33	3.41	3.666	7-M2t	2.25	1.84	2.17	2.17	6.98	0.00
48.73 cfs	48.73 cfs	14.70	3.80	4.044	7-M2t	2.25	1.92	2.17	2.17	7.68	0.00
51.95 cfs	51.95 cfs	15.00	4.11	4.342	7-M2t	2.25	1.97	2.17	2.17	8.19	0.00
57.53 cfs	57.53 cfs	15.56	4.69	4.904	7-M2t	2.25	2.04	2.17	2.17	9.06	0.00

61.93 cfs	61.02 cfs	15.94	5.09	5.28 4	7- M2 t	2.25	2.07	2.1 7	2.17	9.61	0.00
66.32 cfs	61.09 cfs	15.95	5.10	5.29 2	7- M2 t	2.25	2.07	2.1 7	2.17	9.62	0.00
70.72 cfs	61.10 cfs	15.95	5.10	5.29 3	7- M2 t	2.25	2.07	2.1 7	2.17	9.63	0.00
75.12 cfs	61.10 cfs	15.95	5.10	5.29 3	7- M2 t	2.25	2.07	2.1 7	2.17	9.63	0.00
79.52 cfs	61.11 cfs	15.95	5.11	5.29 4	7- M2 t	2.25	2.07	2.1 7	2.17	9.63	0.00
83.92 cfs	61.11 cfs	15.95	5.11	5.29 5	7- M2 t	2.25	2.07	2.1 7	2.17	9.63	0.00
88.32 cfs	61.12 cfs	15.96	5.11	5.29 5	7- M2 t	2.25	2.07	2.1 7	2.17	9.63	0.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

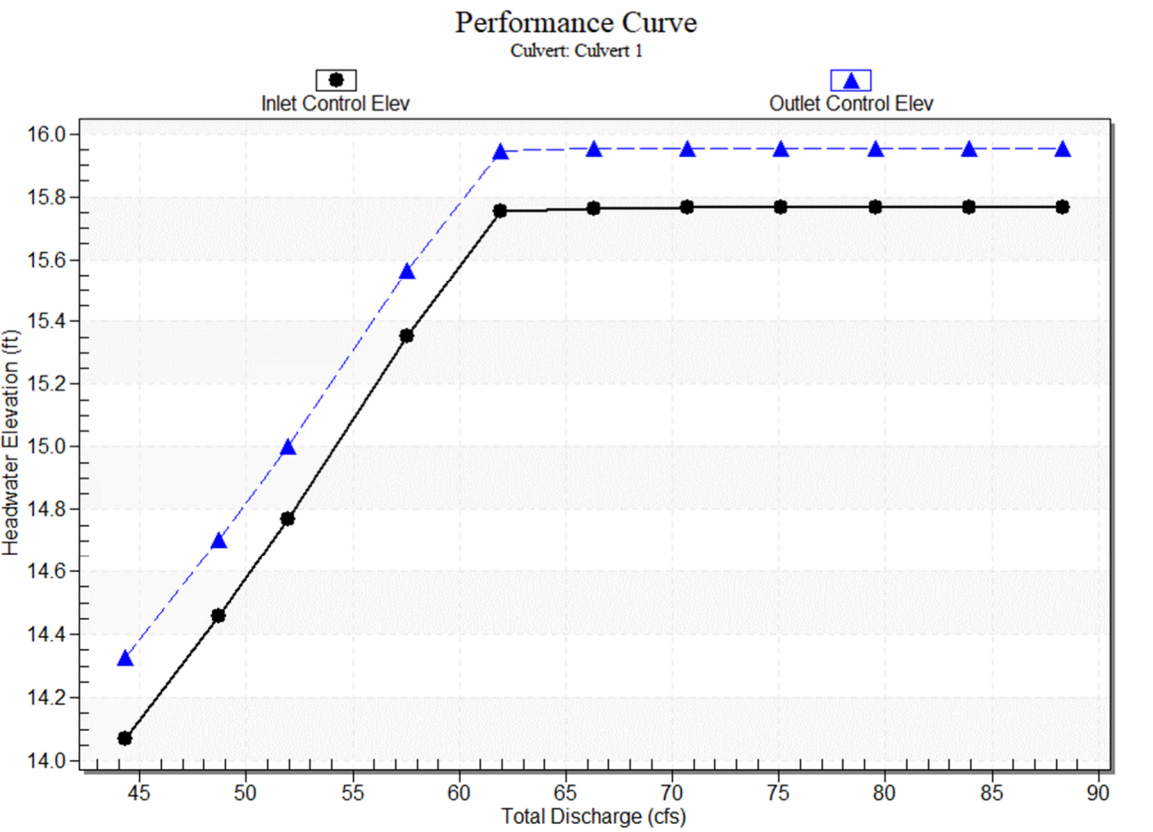
Inlet Elevation (invert): 10.66 ft,

Outlet Elevation (invert): 10.37 ft

Culvert Length: 133.00 ft,

Culvert Slope: 0.0022

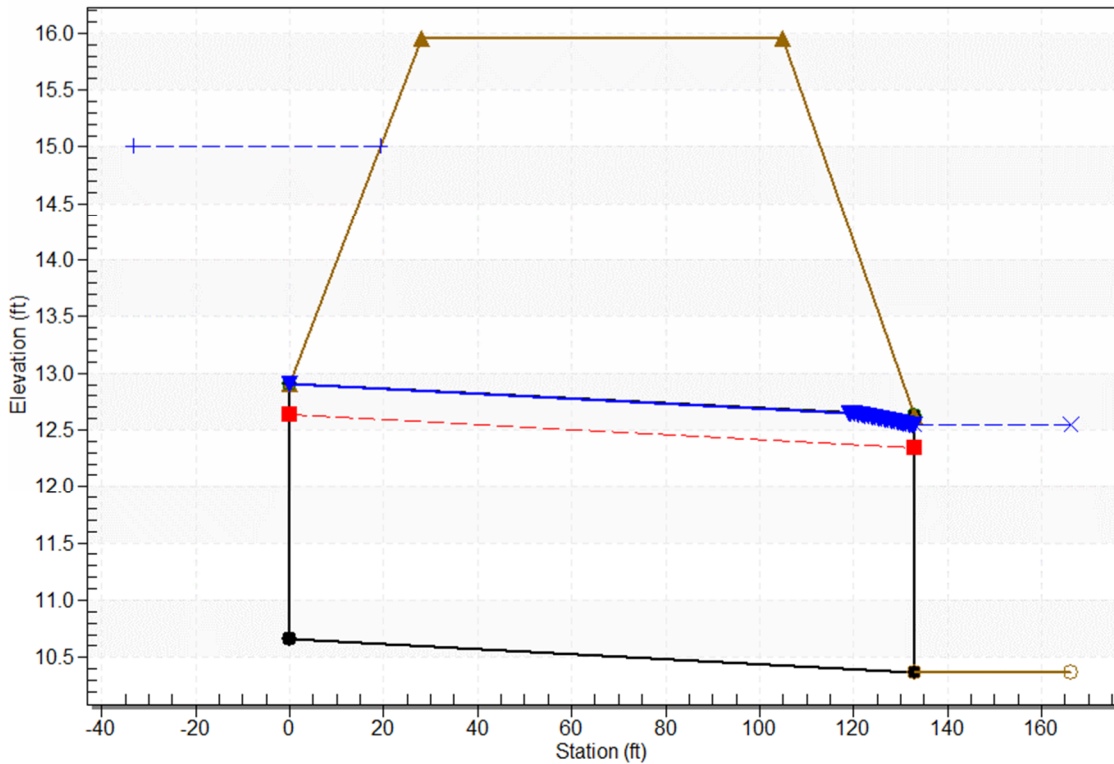
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Crossing 2, Design Discharge - 52.0 cfs

Culvert - Culvert 1, Culvert Discharge - 52.0 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 10.66 ft

Outlet Station: 133.00 ft

Outlet Elevation: 10.37 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Elliptical

Barrel Span: 42.00 in

Barrel Rise: 27.00 in

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Crossing 2

Table 6 - Downstream Channel Rating Curve (Crossing: Crossing 2)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
44.33	12.54	2.17
48.73	12.54	2.17
51.95	12.54	2.17
57.53	12.54	2.17
61.93	12.54	2.17
66.32	12.54	2.17
70.72	12.54	2.17
75.12	12.54	2.17
79.52	12.54	2.17
83.92	12.54	2.17
88.32	12.54	2.17

Tailwater Channel Data - Crossing 2

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 12.54 ft

Roadway Data for Crossing: Crossing 2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 15.95 ft

Roadway Surface: Paved

Roadway Top Width: 77.00 ft

CD-04

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 11.85 cfs

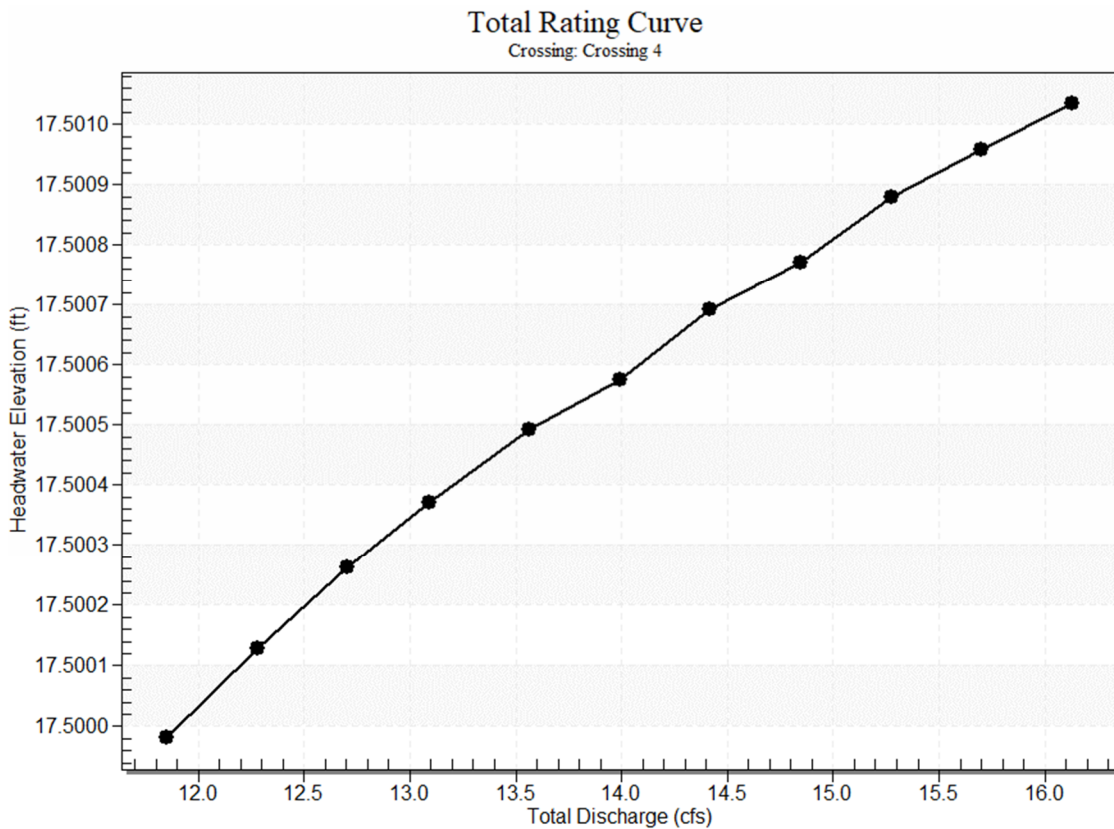
Design Flow: 13.09 cfs

Maximum Flow: 16.13 cfs

Table 7 - Summary of Culvert Flows at Crossing: Crossing 4

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
17.50	11.85	10.72	1.00	34
17.50	12.28	10.72	1.46	3
17.50	12.71	10.72	1.92	3
17.50	13.09	10.72	2.32	3
17.50	13.56	10.72	2.80	3
17.50	13.99	10.72	3.14	2
17.50	14.42	10.72	3.66	3
17.50	14.85	10.72	4.02	2
17.50	15.27	10.72	4.53	3
17.50	15.70	10.73	4.90	2
17.50	16.13	10.73	5.28	2
17.50	10.72	10.72	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 4



Culvert Data: Culvert 1

Table 8 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
11.85 cfs	10.72 cfs	17.50	2.79	2.566	4-FFf	1.33	1.26	1.50	1.50	6.07	0.00
12.28 cfs	10.72 cfs	17.50	2.79	2.566	4-FFf	1.33	1.26	1.50	1.50	6.07	0.00
12.71 cfs	10.72 cfs	17.50	2.79	2.566	4-FFf	1.33	1.26	1.50	1.50	6.07	0.00
13.09 cfs	10.72 cfs	17.50	2.79	2.566	4-FFf	1.33	1.26	1.50	1.50	6.07	0.00
13.56 cfs	10.72 cfs	17.50	2.79	2.566	4-FFf	1.33	1.26	1.50	1.50	6.07	0.00
13.99 cfs	10.72 cfs	17.50	2.79	2.566	4-FFf	1.33	1.26	1.50	1.50	6.07	0.00

14.42 cfs	10.72 cfs	17.50	2.79	2.56 7	4- FFf	1.33	1.26	1.5 0	1.50	6.07	0.00
14.85 cfs	10.72 cfs	17.50	2.79	2.56 7	4- FFf	1.33	1.26	1.5 0	1.50	6.07	0.00
15.27 cfs	10.72 cfs	17.50	2.79	2.56 7	4- FFf	1.33	1.26	1.5 0	1.50	6.07	0.00
15.70 cfs	10.73 cfs	17.50	2.79	2.56 7	4- FFf	1.33	1.26	1.5 0	1.50	6.07	0.00
16.13 cfs	10.73 cfs	17.50	2.79	2.56 7	4- FFf	1.33	1.26	1.5 0	1.50	6.07	0.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

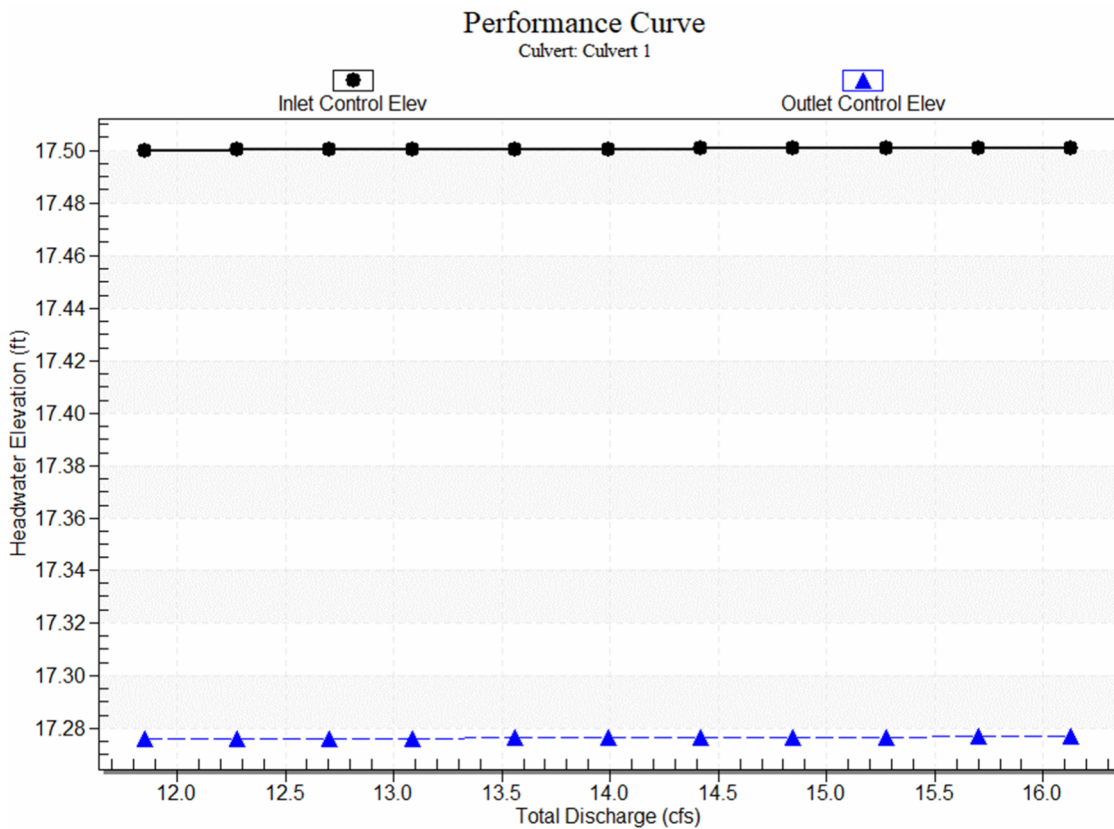
Inlet Elevation (invert): 14.71 ft,

Outlet Elevation (invert): 13.93 ft

Culvert Length: 99.00 ft,

Culvert Slope: 0.0079

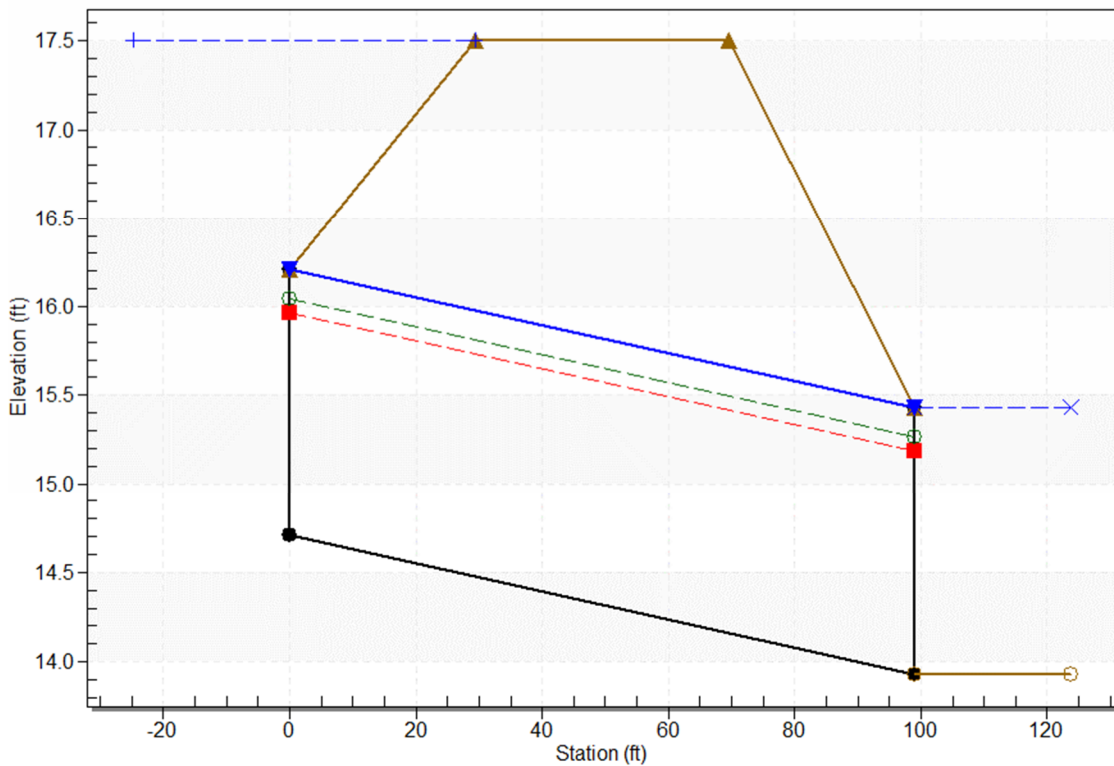
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Crossing 4, Design Discharge - 13.1 cfs

Culvert - Culvert 1, Culvert Discharge - 10.7 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 14.71 ft

Outlet Station: 99.00 ft

Outlet Elevation: 13.93 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope ($K_e=0.7$)

Inlet Depression: None

Tailwater Data for Crossing: Crossing 4

Table 9 - Downstream Channel Rating Curve (Crossing: Crossing 4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
11.85	15.43	1.50
12.28	15.43	1.50
12.71	15.43	1.50
13.09	15.43	1.50
13.56	15.43	1.50
13.99	15.43	1.50
14.42	15.43	1.50
14.85	15.43	1.50
15.27	15.43	1.50
15.70	15.43	1.50
16.13	15.43	1.50

Tailwater Channel Data - Crossing 4

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 15.43 ft

Roadway Data for Crossing: Crossing 4

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 17.50 ft

Roadway Surface: Paved

Roadway Top Width: 40.00 ft

Proposed

HY-8 Culvert Analysis Report

CD-01

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 12.09 cfs

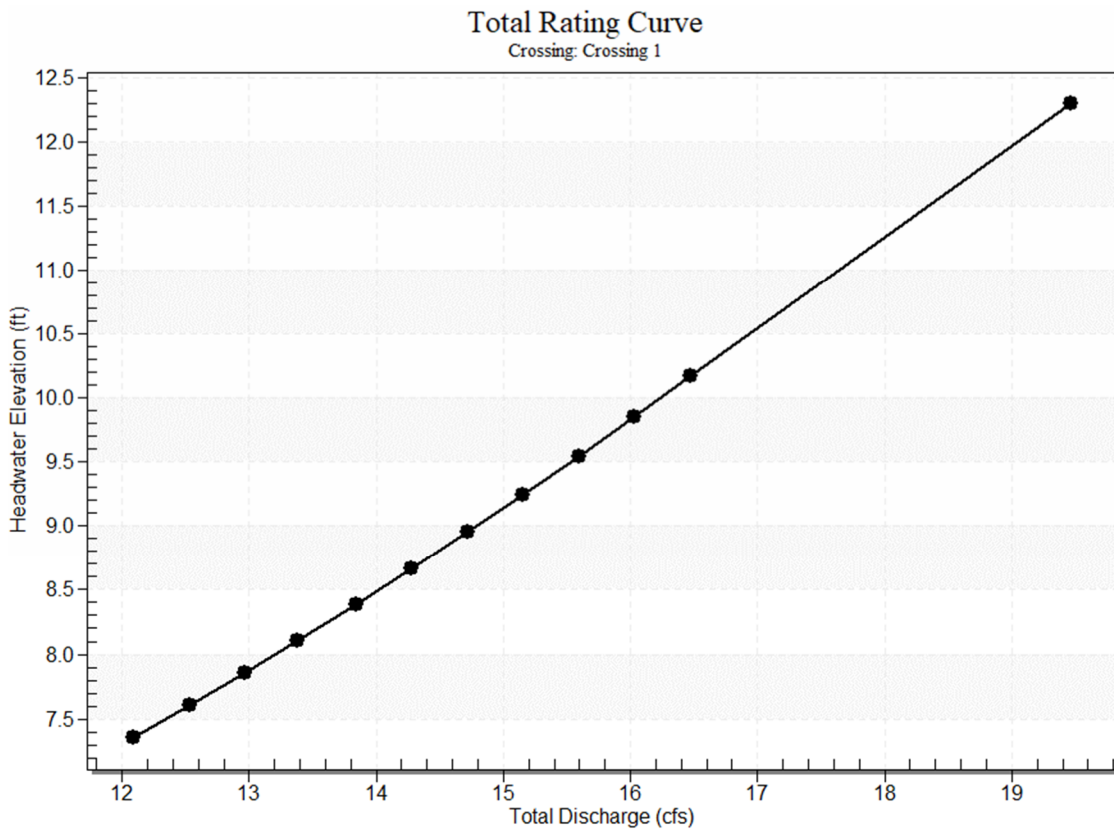
Design Flow: 13.38 cfs

Maximum Flow: 16.47 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing 1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7.36	12.09	12.09	0.00	1
7.60	12.53	12.53	0.00	1
7.86	12.97	12.97	0.00	1
8.10	13.38	13.38	0.00	1
8.39	13.84	13.84	0.00	1
8.67	14.28	14.28	0.00	1
8.95	14.72	14.72	0.00	1
9.25	15.16	15.16	0.00	1
9.55	15.59	15.59	0.00	1
9.86	16.03	16.03	0.00	1
10.18	16.47	16.47	0.00	1
12.30	19.14	19.14	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 1



Culvert Data: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
12.09 cfs	12.09 cfs	7.36	3.29	4.358	7-M2t	1.50	1.32	1.33	1.33	7.30	0.00
12.53 cfs	12.53 cfs	7.60	3.46	4.605	7-M2c	1.50	1.33	1.33	1.33	7.54	0.00
12.97 cfs	12.97 cfs	7.86	3.63	4.860	7-M2c	1.50	1.35	1.35	1.33	7.74	0.00
13.38 cfs	13.38 cfs	8.10	3.80	5.104	7-M2c	1.50	1.36	1.36	1.33	7.93	0.00

13.84 cfs	13.84 cfs	8.39	3.99	5.38 9	7- M2 c	1.50	1.38	1.3 8	1.33	8.15	0.00
14.28 cfs	14.28 cfs	8.67	4.17	5.66 7	7- M2 c	1.50	1.39	1.3 9	1.33	8.36	0.00
14.72 cfs	14.72 cfs	8.95	4.36	5.95 2	7- M2 c	1.50	1.40	1.4 0	1.33	8.58	0.00
15.16 cfs	15.16 cfs	9.25	4.56	6.24 6	7- M2 c	1.50	1.41	1.4 1	1.33	8.80	0.00
15.59 cfs	15.59 cfs	9.55	4.78	6.54 8	7- M2 c	1.50	1.42	1.4 2	1.33	9.02	0.00
16.03 cfs	16.03 cfs	9.86	5.01	6.85 7	7- M2 c	1.50	1.43	1.4 3	1.33	9.24	0.00
16.47 cfs	16.47 cfs	10.18	5.24	7.17 7	7- M2 c	1.50	1.43	1.4 3	1.33	9.47	0.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

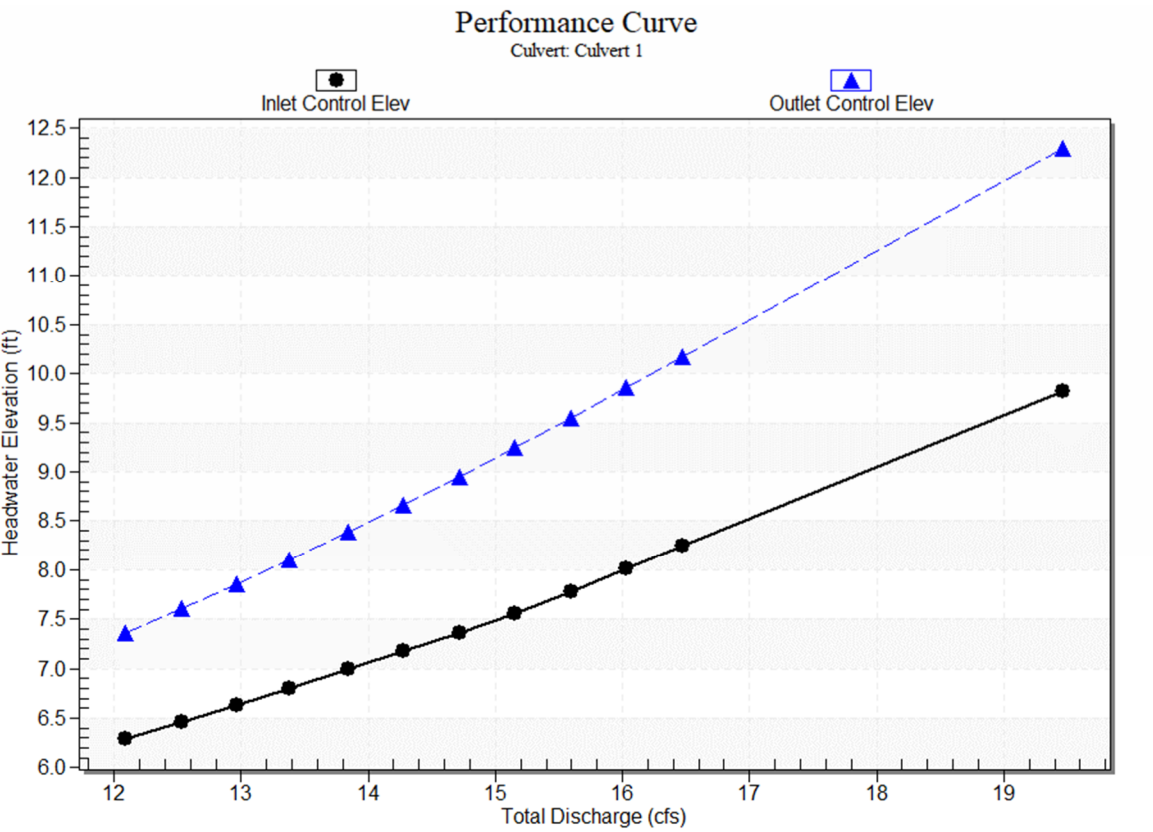
Inlet Elevation (invert): 3.00 ft,

Outlet Elevation (invert): 2.70 ft

Culvert Length: 178.00 ft,

Culvert Slope: 0.0017

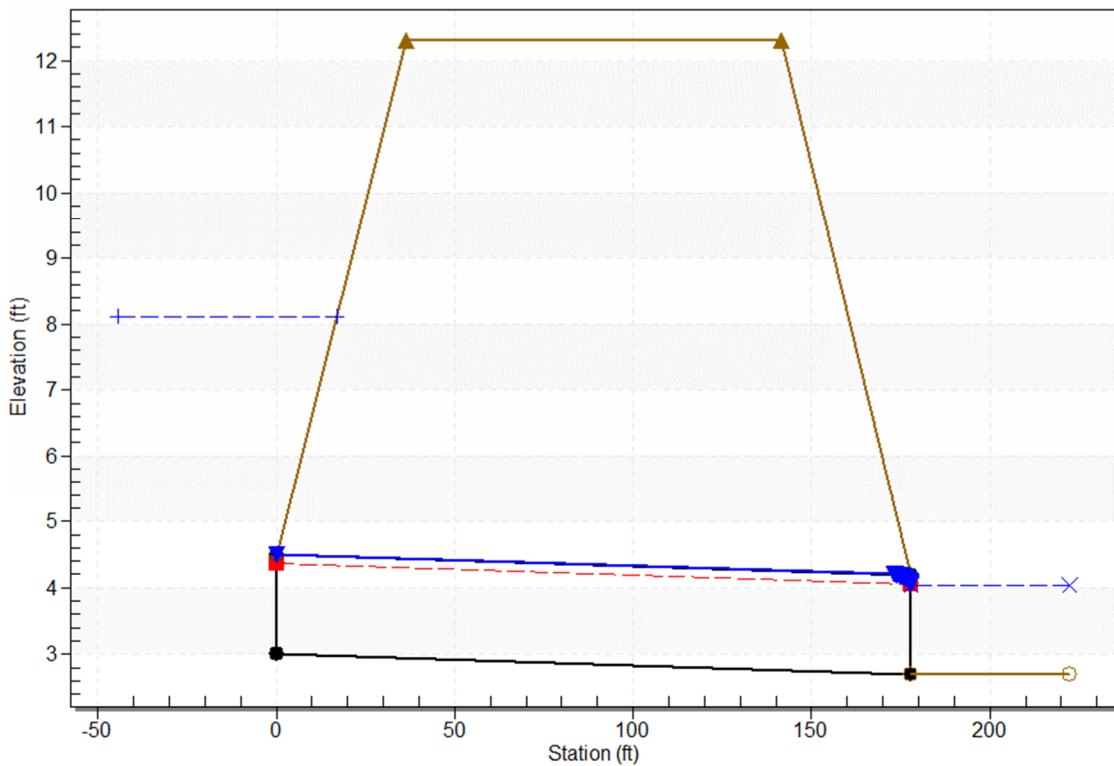
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Crossing 1, Design Discharge - 13.4 cfs

Culvert - Culvert 1, Culvert Discharge - 13.4 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 3.00 ft

Outlet Station: 178.00 ft

Outlet Elevation: 2.70 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope ($K_e=0.7$)

Inlet Depression: None

Tailwater Data for Crossing: Crossing 1

Table 3 - Downstream Channel Rating Curve (Crossing: Crossing 1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
12.09	4.03	1.33
12.53	4.03	1.33
12.97	4.03	1.33
13.38	4.03	1.33
13.84	4.03	1.33
14.28	4.03	1.33
14.72	4.03	1.33
15.16	4.03	1.33
15.59	4.03	1.33
16.03	4.03	1.33
16.47	4.03	1.33

Tailwater Channel Data - Crossing 1

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 4.03 ft

Roadway Data for Crossing: Crossing 1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 600.00 ft

Crest Elevation: 12.30 ft

Roadway Surface: Paved

Roadway Top Width: 105.00 ft

CD-02

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 44.33 cfs

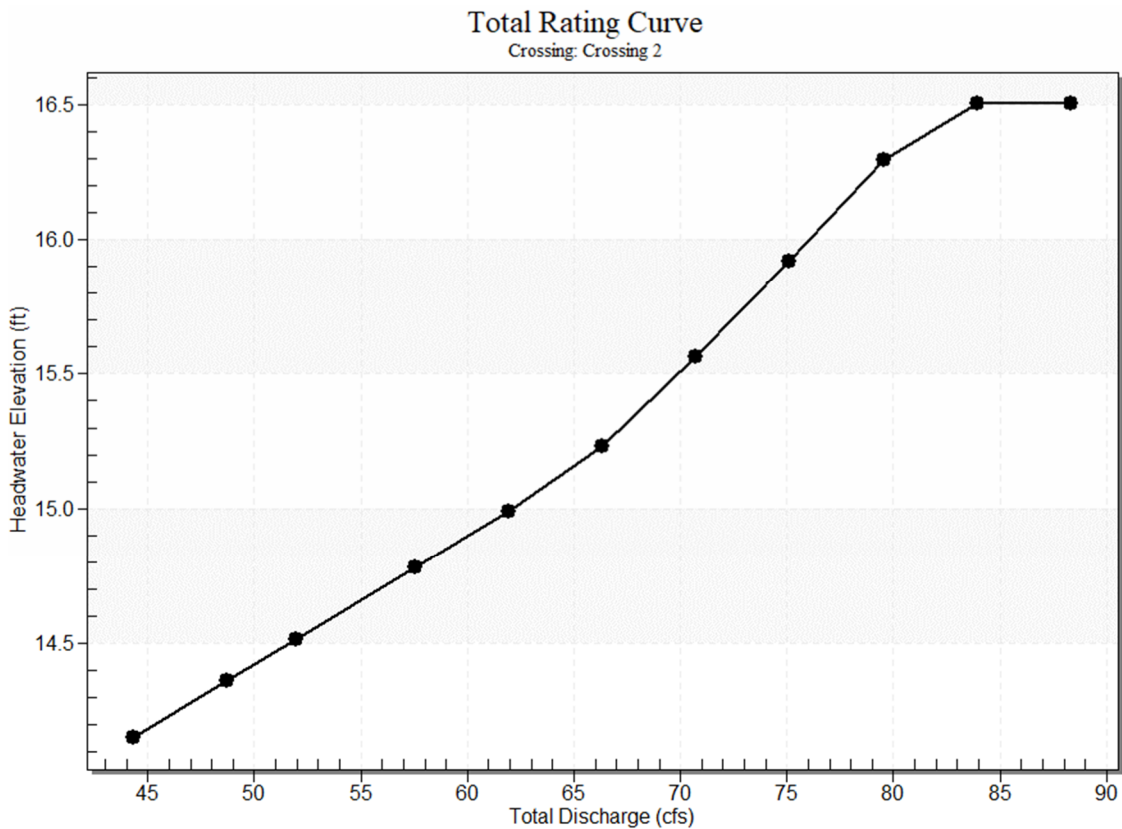
Design Flow: 51.95 cfs

Maximum Flow: 88.32 cfs

Table 4 - Summary of Culvert Flows at Crossing: Crossing 2

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
14.16	44.33	44.33	0.00	1
14.36	48.73	48.73	0.00	1
14.51	51.95	51.95	0.00	1
14.78	57.53	57.53	0.00	1
14.99	61.93	61.93	0.00	1
15.23	66.32	66.32	0.00	1
15.56	70.72	70.72	0.00	1
15.92	75.12	75.12	0.00	1
16.30	79.52	79.52	0.00	1
16.50	83.92	81.81	1.42	97
16.50	88.32	81.82	5.77	4
16.50	81.80	81.80	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 2



Culvert Data: Culvert 1

Table 5 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
44.33 cfs	44.33 cfs	14.16	3.19	3.455	3-M2t	2.31	2.08	2.24	2.17	6.82	0.00
48.73 cfs	48.73 cfs	14.36	3.42	3.663	3-M2t	2.48	2.18	2.24	2.17	7.49	0.00
51.95 cfs	51.95 cfs	14.51	3.60	3.815	7-M2c	2.61	2.25	2.25	2.17	7.93	0.00
57.53 cfs	57.53 cfs	14.78	3.93	4.079	7-M2c	2.88	2.38	2.38	2.17	8.28	0.00

61.93 cfs	61.93 cfs	14.99	4.22	4.29 2	7- M2 c	3.50	2.47	2.4 7	2.17	8.55	0.00
66.32 cfs	66.32 cfs	15.23	4.53	4.51 2	7- M2 c	3.50	2.55	2.5 5	2.17	8.82	0.00
70.72 cfs	70.72 cfs	15.56	4.86	4.74 4	7- M2 c	3.50	2.63	2.6 3	2.17	9.10	0.00
75.12 cfs	75.12 cfs	15.92	5.22	4.99 4	7- M2 c	3.50	2.71	2.7 1	2.17	9.39	0.00
79.52 cfs	79.52 cfs	16.30	5.60	5.27 6	7- M2 c	3.50	2.79	2.7 9	2.17	9.68	0.00
83.92 cfs	81.81 cfs	16.50	5.80	5.45 1	7- M2 c	3.50	2.82	2.8 2	2.17	9.84	0.00
88.32 cfs	81.82 cfs	16.50	5.80	5.45 2	7- M2 c	3.50	2.82	2.8 2	2.17	9.84	0.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

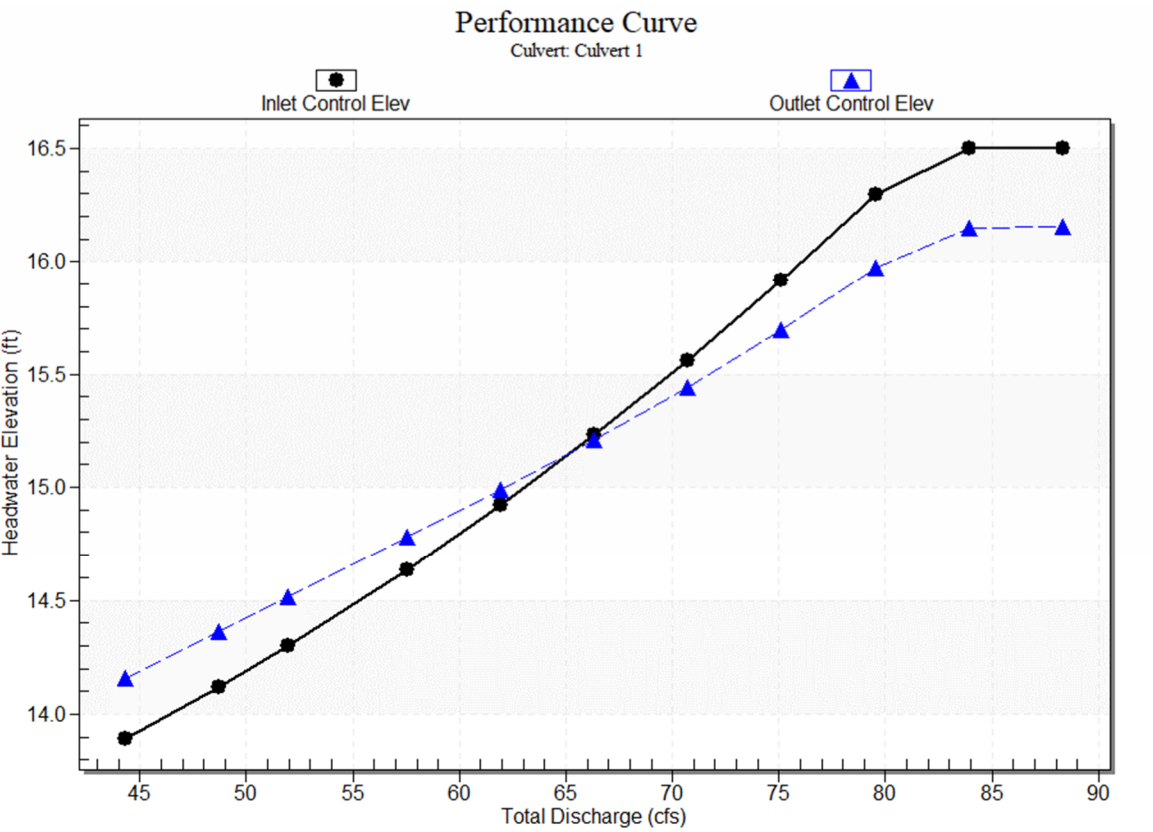
Inlet Elevation (invert): 10.70 ft,

Outlet Elevation (invert): 10.30 ft

Culvert Length: 145.00 ft,

Culvert Slope: 0.0028

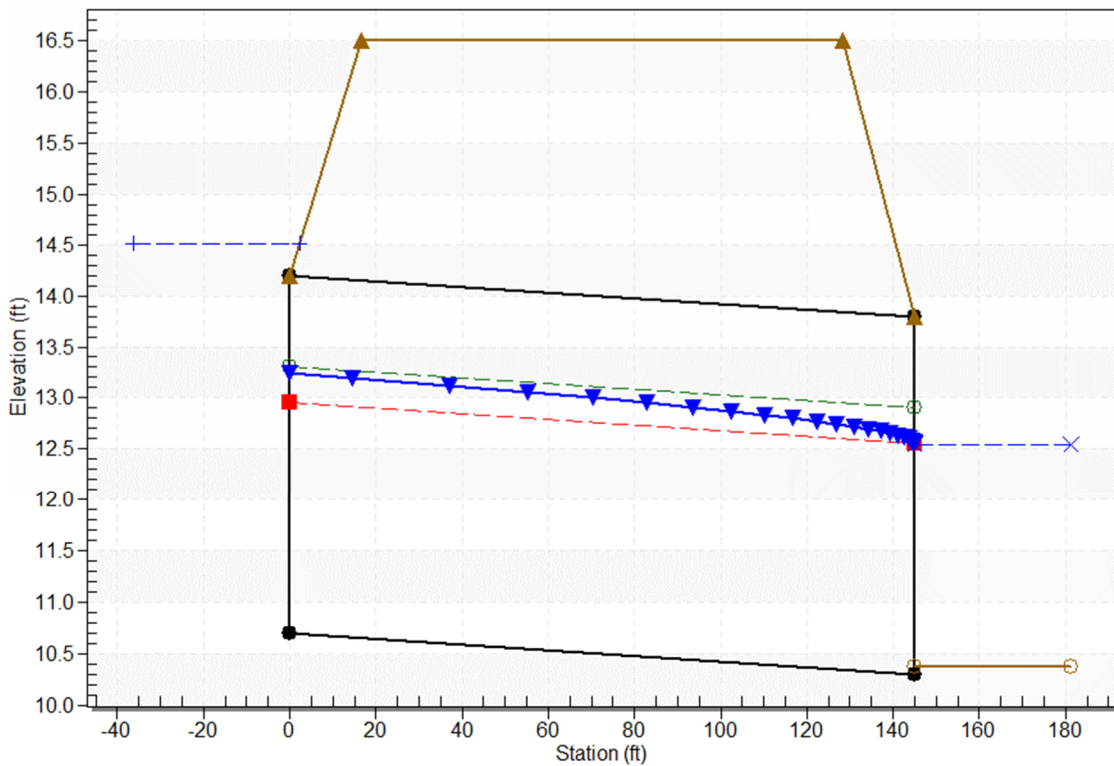
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Crossing 2, Design Discharge - 52.0 cfs

Culvert - Culvert 1, Culvert Discharge - 52.0 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 10.70 ft

Outlet Station: 145.00 ft

Outlet Elevation: 10.30 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope ($K_e=0.7$)

Inlet Depression: None

Tailwater Data for Crossing: Crossing 2

Table 6 - Downstream Channel Rating Curve (Crossing: Crossing 2)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
44.33	12.54	2.17
48.73	12.54	2.17
51.95	12.54	2.17
57.53	12.54	2.17
61.93	12.54	2.17
66.32	12.54	2.17
70.72	12.54	2.17
75.12	12.54	2.17
79.52	12.54	2.17
83.92	12.54	2.17
88.32	12.54	2.17

Tailwater Channel Data - Crossing 2

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 12.54 ft

Roadway Data for Crossing: Crossing 2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 16.50 ft

Roadway Surface: Paved

Roadway Top Width: 112.00 ft

CD-04

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 11.85 cfs

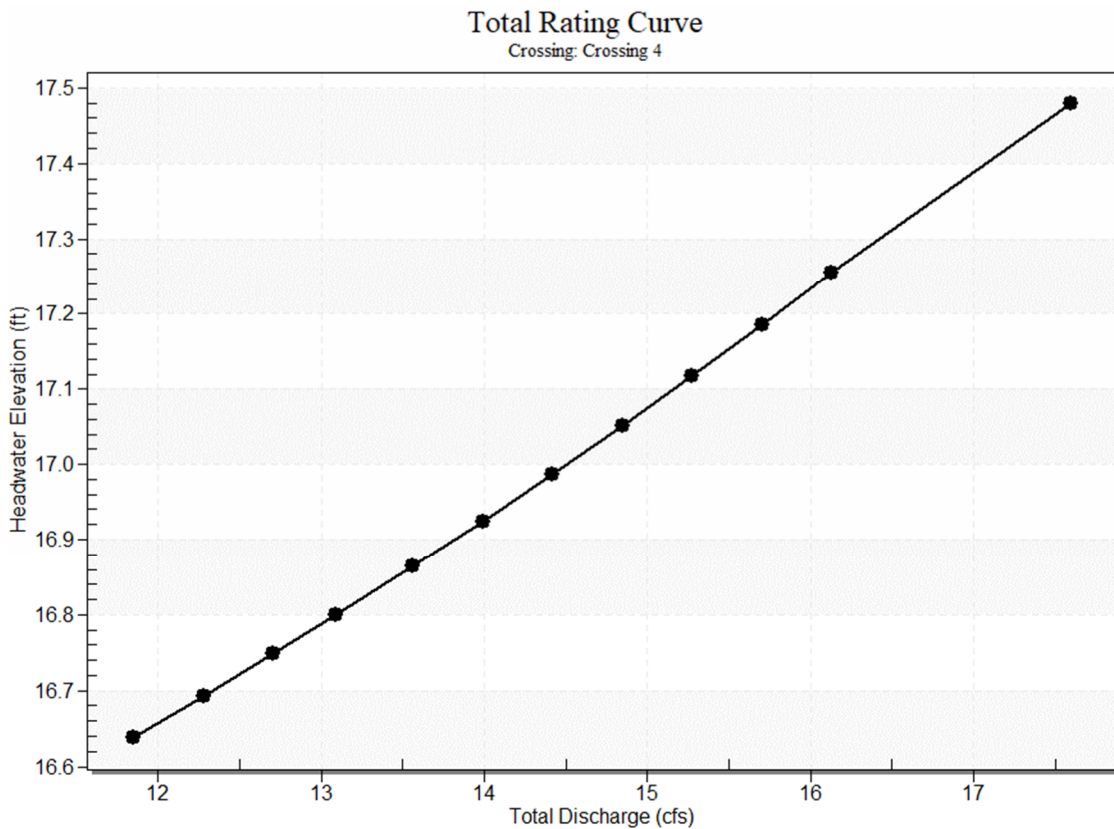
Design Flow: 13.09 cfs

Maximum Flow: 16.13 cfs

Table 7 - Summary of Culvert Flows at Crossing: Crossing 4

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
16.64	11.85	11.85	0.00	1
16.69	12.28	12.28	0.00	1
16.75	12.71	12.71	0.00	1
16.80	13.09	13.09	0.00	1
16.86	13.56	13.56	0.00	1
16.92	13.99	13.99	0.00	1
16.99	14.42	14.42	0.00	1
17.05	14.85	14.85	0.00	1
17.12	15.27	15.27	0.00	1
17.18	15.70	15.70	0.00	1
17.26	16.13	16.13	0.00	1
17.50	17.54	17.54	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 4



Culvert Data: Culvert 1

Table 8 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
11.85 cfs	11.85 cfs	16.64	1.94	1.351	1-JS1t	1.08	1.24	1.52	1.49	4.63	0.00
12.28 cfs	12.28 cfs	16.69	1.99	1.398	1-JS1t	1.10	1.26	1.52	1.49	4.79	0.00
12.71 cfs	12.71 cfs	16.75	2.05	1.446	5-S2n	1.12	1.28	1.12	1.49	6.99	0.00
13.09 cfs	13.09 cfs	16.80	2.10	1.490	5-S2n	1.15	1.30	1.15	1.49	7.03	0.00

13.56 cfs	13.56 cfs	16.86	2.16	1.54 7	5- S2 n	1.17	1.33	1.1 7	1.49	7.09	0.00
13.99 cfs	13.99 cfs	16.92	2.22	1.60 0	5- S2 n	1.20	1.35	1.2 0	1.49	7.14	0.00
14.42 cfs	14.42 cfs	16.99	2.29	1.65 5	5- S2 n	1.22	1.37	1.2 2	1.49	7.19	0.00
14.85 cfs	14.85 cfs	17.05	2.35	1.71 1	5- S2 n	1.24	1.39	1.2 4	1.49	7.23	0.00
15.27 cfs	15.27 cfs	17.12	2.42	1.76 9	5- S2 n	1.27	1.41	1.2 7	1.49	7.24	0.00
15.70 cfs	15.70 cfs	17.18	2.48	1.82 8	5- S2 n	1.29	1.43	1.2 9	1.49	7.32	0.00
16.13 cfs	16.13 cfs	17.26	2.56	1.89 0	5- S2 n	1.32	1.45	1.3 2	1.49	7.34	0.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

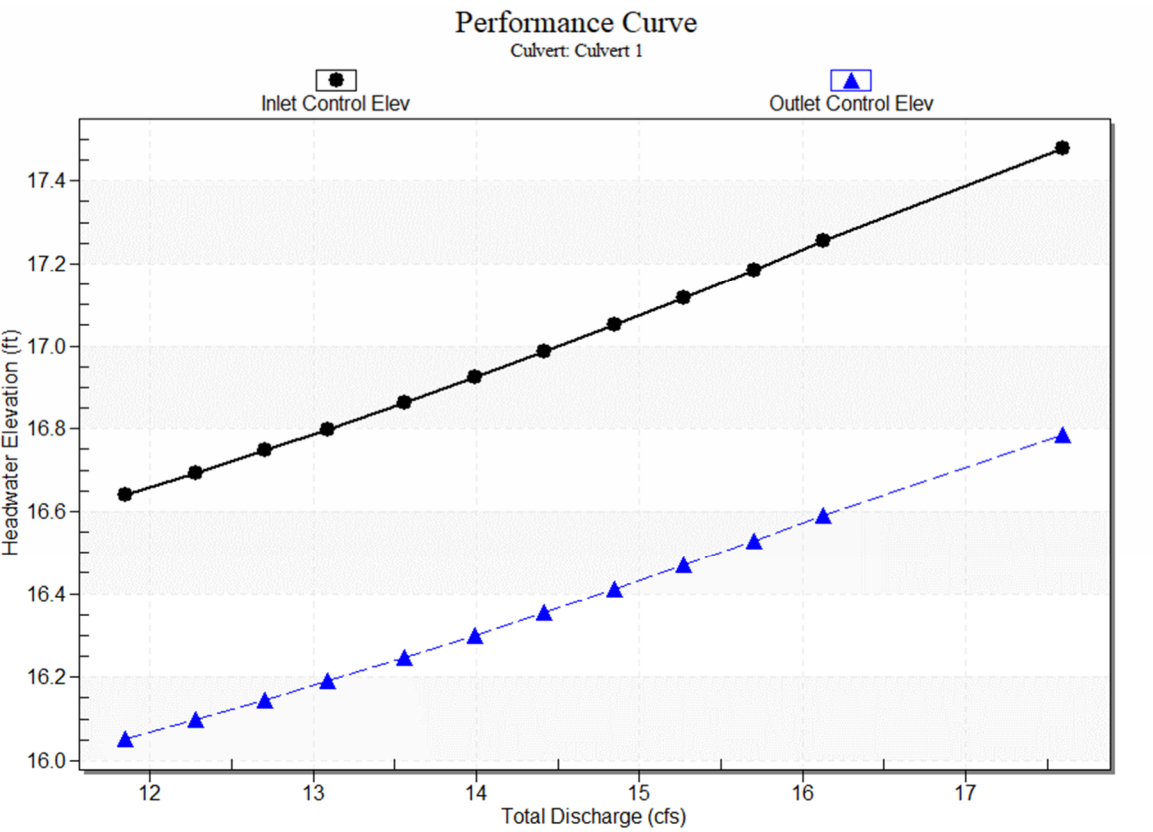
Inlet Elevation (invert): 14.70 ft,

Outlet Elevation (invert): 13.90 ft

Culvert Length: 110.00 ft,

Culvert Slope: 0.0073

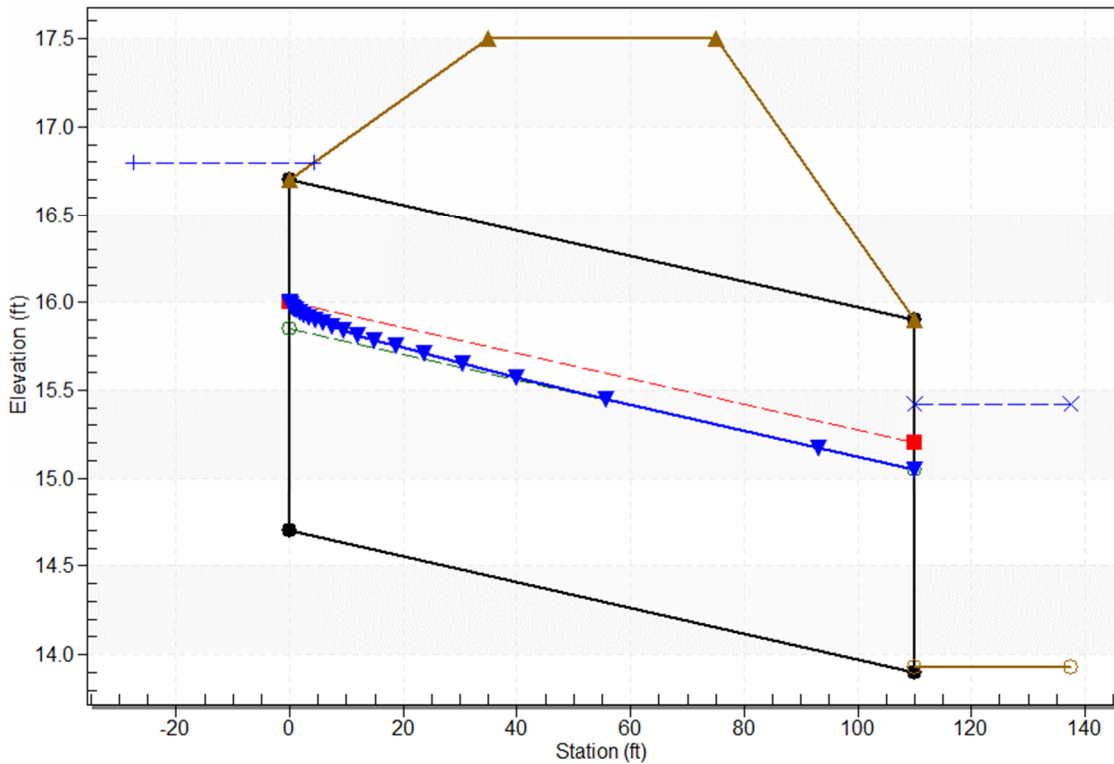
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Crossing 4, Design Discharge - 13.1 cfs

Culvert - Culvert 1, Culvert Discharge - 13.1 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 14.70 ft

Outlet Station: 110.00 ft

Outlet Elevation: 13.90 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope ($K_e=0.7$)

Inlet Depression: None

Tailwater Data for Crossing: Crossing 4

Table 9 - Downstream Channel Rating Curve (Crossing: Crossing 4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
11.85	15.42	1.49
12.28	15.42	1.49
12.71	15.42	1.49
13.09	15.42	1.49
13.56	15.42	1.49
13.99	15.42	1.49
14.42	15.42	1.49
14.85	15.42	1.49
15.27	15.42	1.49
15.70	15.42	1.49
16.13	15.42	1.49

Tailwater Channel Data - Crossing 4

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 15.42 ft

Roadway Data for Crossing: Crossing 4

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 17.50 ft

Roadway Surface: Paved

Roadway Top Width: 40.00 ft

APPENDIX 4
Correspondence

Cove Road PD&E – Meeting Minutes

INWOOD Consulting Engineers, Inc | 3000 Dovera Drive, Suite 200, Oviedo, FL 32765 | P: 407-971-8850

DATE: August 29, 2023

TO: All Attendees (via email)

FROM: Zachary K. Evans, PE

RE: Cove Road from SR76 (Kanner Hwy) to SR 5/US 1 PD&E Study (FPID: 441700-1)

CC: File

The Drainage Methodology / Kick-Off Meeting for the Cove Road Project Development and Environment (PD&E) Study was held at 1:15pm on August 29, 2023, via Microsoft Teams. The purpose of this meeting was to review the requirements of the project and provide an opportunity for drainage-specific scope discussion on choices made on pond siting.

The meeting began with introductions and an overview of the project. The bulleted items below summarize the key points of discussion. The meeting agenda and sign-in sheet provided at the meeting are attached to this document for reference.

Discussion Items

- Inwood gave a Project Overview/Scope Discussion
- Inwood then reviewed the existing drainage conditions of the corridor
 - The project is located within the South St. Lucie and Indian River Lagoon South Coastal watersheds and traverses three WBIDs; WBID 3210C – South Fork St. Lucie River (Tidal Segment), WBID 3220 – Basin 2, and WBID 3208C – Manatee Pocket. Manatee Pocket is an Outstanding Florida Water (OFW).
 - The St. Lucie River and Estuary Basin has adopted a Basin Management Action Plan (BMAP), which will require a nutrient loading analysis.
 - The existing roadway was permitted under SFWMD Permit No. 43-00642-S for a 4-lane condition. The existing permit has 5 basins along the corridor and provides treatment within swales along the roadway. The ultimate condition was not built out and Cove Road currently exists as a 2-lane roadway.
 - There are cross drains along the corridor which provide equalization and conveyance for the wetlands that are along the corridor.
- Inwood then reviewed the drainage approach and methodology for the study. Open discussion was had for the Pond alternatives for each basin.
 - A Pond Siting Report (PSR) will be provided. The Five (5) existing basins are anticipated to remain and an offsite pond and exfiltration alternative will be investigated for each basin.
 - Basin 1 begins at Kanner Highway and extends east.
 - There are limited pond sites available within the basin limits due to the majority of the area being built out or planned for development. Potential locations would create significant relocations or impact 4f parcels (Hosford Park)
 - The roadway low point is near Gaines Avenue, creating difficulty in conveying stormwater to the east end of the basin, which is at a higher elevation.
 - Inwood asked about the potential to work with I-95 / Kanner Hwy PD&E and have portions of Basin 1 included in their study.
 - Currently the approach is to shift the eastern basin limit to the west and provide treatment for the basin in Pond 2.
 - Martin County stated the outfall structure at Gaines Avenue flows south within a culverted system that crosses Paulson Avenue before crossing underneath Gaines Avenue and ultimately outfalling into the river.

Cove Road PD&E – Meeting Minutes

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- Martin County stated they would confirm what the plans were for Hosford Park as there may be potential to utilize that parcel if there are no planned improvements.
 - Martin County later followed up stating that Hosford Park has been permitted and planned for a dog park.
 - It was determined that the park would not be considered for a potential Pond Site during the PD&E, but the County is looking to potentially change the land use of the park and it may be reconsidered during design.
- Basin 2
 - Basin 2 has a roadway highpoint at the western limit of the basin and flows east.
 - The pond site being investigated for this basin is currently west of the existing basin divide and will utilize the entirety of the impacted parcel. This will allow for additional volume within the pond to account for portion of Basin 1.
 - Martin County stated the existing basin currently ultimately outfalls both north along Fern Creek and south through the wetland systems.
 - Martin County stated there were several properties within the basin that were not planned for development.
 - Inwood stated the site being investigated was chosen due to its proximity to the basin low point.
 - The basin limit will be controlled hydraulically by the elevation of the roadway that allows stormwater runoff to be conveyed back to the pond.
 - Martin County stated that Legacy Cove outfalls to Fern Creek along the roadway R/W at the southwest corner of the development.
- Basin 3
 - Inwood reviewed multiple sites for a pond within Basin 3 asking for the County's input on preference. Inwood asked if a pond at the corner of Willoughby Blvd and Cove Road as an expansion of the existing County Ponds would be ideal.
 - Martin County stated that the ponds along Willoughby had excess volume to accommodate the future 4 laning of Willoughby, but an additional site would likely be necessary.
 - Martin County also stated pre-application request was submitted for potential future development on the site being investigated at the intersection of Willoughby and Cove Road.
 - In order to avoid future conflict with this development the site west of Willoughby would be preferred.
 - Martin County stated the existing ponds on Willoughby discharge north along a bypass ditch before outfalling into the Tower Road ditch.
 - Martin County stated there is a drainage easement for the inlets along the west side of Willoughby Blvd.
 - Martin County asked if parcel 55-38-41-000-066-00071-0 had been considered. Stating that the parcel has a Preserve Area Management Plan (PAMP) for a portion of the site, but it does not encompass the entire site.
 - Inwood stated the site was avoided due to likely wetland impacts, but would coordinate with the ecological team and review the site.
 - Review of the National Wetlands Inventory (NWI) indicated that the majority of the parcel has wetland FLUCFCS.
- Basin 4
 - Inwood reviewed Basin 4 and the limited pond site availability citing the existing development to the south and conservation easements over the wetlands.
 - A potential pond site was identified near the Hibiscus Park outfall ditch at back of parcel.

Cove Road PD&E – Meeting Minutes

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- Martin County stated the Hibiscus Park ditch was County R/W and could be utilized as an access easement to the pond.
- Inwood agreed and will remove the easement shown along the property line.
- Inwood stated the property to the north is owned by Indian River State College District Board of Trustees and asked if the County knew of any planned developments or if the State College would be interested in a joint use opportunity.
 - The County stated they would provide contact information to Inwood so that a coordination meeting can be scheduled regarding future plans for the school's vacant parcel.
- Basin 5
 - Inwood reviewed Basin 5, stating there were limited options for offsite ponds. The north side of the roadway are single family homes, in which the potential R/W impacts from the roadway would not be significant enough to be total takes. Siting a pond to the north would cause a multitude of relocations.
 - There are developments along the southside of the roadway and conservation easements over existing wetlands.
 - Inwood identified a site south within Montego Cove, in which the parcels were not fully built out. The potential pond site would utilize the vacant lots and an access easement to convey stormwater.
- Inwood reviewed the design criteria that would be utilized for this project.
 - The proposed study would analyze treatment of total impervious for the proposed roadway due to the existing treatment swales being impacted.
 - 50% additional water quality would be provided for basins outfalling to OFW
 - Nutrient loading analysis would be provided due to the adopted BMAP
 - Inwood asked to clarify Martin County criteria
 - Attenuation
 - 25-year/72-hour storm
 - 3-year/24-hour storm
 - Treatment
 - Pre- vs post-development mass pollutant loading
 - Martin County Municode design analysis volumes were clarified:
 - 3 inches over impervious for dry retention ponds
 - 3 inches over impervious + 25% for dry detention ponds
 - 3 inches over impervious + 50% for wet detention ponds
- Inwood stated there were not any anticipated floodplain impacts associated with this study. A hydraulics memo would be provided documenting this and would provide preliminary analysis of the cross drains along the corridor.
- Inwood requested that this projected be added to FDOT's September agenda for pre-app with SFWMD

Action Items

- FDOT
 - Include Cove Road on agenda for September Interagency meeting with SFWMD
- Martin County
 - Provide contact information for Indian River State College District Board of Trustees
 - Contact information has been provided and as a follow-up. Inwood will contact and schedule a meeting with the Indian River State College District Board of Trustees.

Note: The above reflects the writer's understanding of the contents of the meeting. If any misinterpretations or inaccuracies are included, please contact Zach Evans (407-971-8850) as soon as possible for resolution and revisions if necessary.

Cove Road PD&E – Meeting Minutes

INWOOD Consulting Engineers, Inc | 3000 Dovera Drive, Suite 200, Oviedo, FL 32765 | P: 407-971-8850

Attendees

Name	Firm/Dept	E-mail	Phone
<i>Zach Evans, PE</i>	<i>Inwood Drainage</i>	<i>zevans@inwoodinc.com</i>	
<i>David Dangel, PE</i>	<i>Inwood PD&E</i>	<i>ddangel@inwoodinc.com</i>	
<i>Kevin Iannarone, PE</i>	<i>Inwood Roadway</i>	<i>Kiannarone@inwoodinc.com</i>	
<i>Forrest McClellan, EI</i>	<i>Inwood Drainage</i>	<i>fmcclellan@inwoodinc.com</i>	
<i>Alex Paradiz</i>	<i>FDOT</i>	<i>Alex.paradiz@dot.state.fl.us</i>	
<i>Robert Vater</i>	<i>FDOT</i>	<i>Robert.vater@dot.state.fl.us</i>	
<i>Lisa Wichser</i>	<i>Martin Co</i>	<i>lwichser@martin.fl.us</i>	
<i>Nick Muzia</i>	<i>Martin Co</i>	<i>nmuzia@martin.fl.us</i>	