

ATTACHMENT O

WEST TERMINUS CROSS-FLORIDA GREENWAY ASSESSMENT WORK ORDERS 1 & 2

SUBMITTED BY DAN HILLIARD



West Terminus - Cross-Florida Greenway Assessment

Work Order 1 Final Report

Lower Withlacoochee River Restoration Alternatives Feasibility Study

Prepared for:
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
7329 Broad Street
Brooksville, Florida 34604



Prepared by:

URS

URS Corporation Southern
7650 West Courtney Campbell Causeway
Tampa, Florida 33607-1462

December 31, 2003

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1 GENERAL PROJECT INFORMATION

1.1 Background

The West Terminus Cross-Florida Greenway is comprised of a number of facilities, which are part of the Cross Florida Barge Canal system. The Cross Florida Barge Canal system and its components are illustrated on **Figure 1**. The system was partially constructed in the 1960's and later abandoned in the early 1970's. Authorized by the U.S. Congress during the 1940's, the project was intended to facilitate the movement of ocean going vessels traveling between the Atlantic Ocean and the Gulf of Mexico, the Caribbean Sea, and the Panama Canal. The Barge Canal facilities were designed by the U.S. Army Corps of Engineers. Significant elements of the overall project completed by the Corps within the west terminus area include: 1) the portion of the canal from the Gulf of Mexico to the Inglis Lock; 2) the Inglis Lock; the Inglis (Lake Rousseau) Dam; 3) the Bypass Channel and Spillway; and the 4) Rock Dam.

Construction of the Barge Canal system was halted during the Nixon administration in 1971 because of concerns related to cost and the project's effect on the environment. Although construction activities ended three decades ago, it was not until 1990 that the official construction de-authorization was approved by Congress and signed by President Bush (after an extensive study by the Corps of Engineers). Subsequent to its de-authorization, the Inglis Lock and associated facilities became part of the Cross Florida Greenbelt State Recreation and Conservation Area that was established by the Florida State Legislature through the enactment of a law (F.S. 90-328). Currently, the Cross Florida Barge Canal facilities constructed near Inglis are owned by the Florida Department of Environmental Protection (FDEP). With the exception of the Main Dam and Bypass Channel Spillway, these facilities are operated by FDEP's Office of Greenways and Trails. The dam and spillway are operated by the Southwest Florida Water Management District.

1.2 Purpose

The portion of the Withlacoochee River downstream of Inglis Dam has undergone significant alteration since the turn of the twentieth century. The construction of the Cross-Florida Barge Canal in the 1960's created additional impacts to the segment of the river downstream of the canal. Construction of the barge canal included a dam on the Withlacoochee River known locally as the "Rock Dam". This dam effectively severs all flows released from the Inglis Dam main gates including large flood flows. The lower segment of the river downstream of the Rock Dam receives flows only from the bypass channel system via a spillway at its western terminus. The maximum flow rate from this bypass system is estimated to be 1,540 cfs, which is considerably less than flood flow rates expected for the river system. The changes described above have altered the historic flow regime of the Withlacoochee River downstream of Inglis Dam, which have created environmental impacts. It should be noted, pursuant to the results of a recent dam safety planning study, the Rock Dam is presently being reconstructed as a flood protection levee. The flood protection levee is designed to offer full protection to downstream structures on the Withlacoochee River in case of an Inglis Dam failure.

A Basin Initiative was requested by the Withlacoochee River Basin Board in fiscal year 2003 to evaluate restoration alternatives for the portion of the Withlacoochee River downstream of Inglis Dam. The purpose of this study is to carry out this Basin Initiative and evaluate a number of restoration alternatives, which are intended to mitigate some of the environmental impacts created by the construction of the Cross-Florida Barge Canal. The list below is a summary of alternatives that are to be evaluated as part of this study. Each of the alternatives will be evaluated with respect to their impact on flooding, natural systems, water quality, and navigation. In addition, a cost to construct and maintain the facilities necessary for each of the alternatives will be estimated. This information and the results of the evaluation will be used to create a decision matrix, which will be useful in determining the feasibility of each alternative.

1. Remove the Rock Dam, which presently severs the connection of the lower and upper river segments, and construct a variable-elevation control structure in the Barge Canal.
2. Replace the Rock Dam with a variable-elevation control structure (at the same location), construct a variable-elevation control structure in the Barge Canal, and construct a lock for navigation.
3. Reconstruct the Bypass Channel spillway with increased discharge capacity to facilitate increased flows in the lower segment of the river.
4. No improvement/baseline condition alternative.

The restoration alternatives study has been broken down into two work orders. The report contained herein is intended to document the tasks conducted as part of Work Order 1. The tasks are listed below, and were taken from the District Scope of Work. The following sections of this report address each of the tasks listed below in the order shown.

- 1.1.2.1 Review Existing Watershed Parameters
- 1.1.2.2 Field Reconnaissance
- 1.1.2.3 Hydraulic Features Inventory
- 1.1.2.4 Identification of Surveys to be Performed
- 1.1.2.5 Update Watershed Parameters
- 1.1.2.6 Phase I Report of Findings



2 DATA COLLECTION AND ASSESSMENT

The data collection and assessment task was conducted as part of Task 1.1.2.1 Review Existing Watershed Parameters, defined in the scope-of-work. This task included acquiring and reviewing available data from studies previously conducted by URS, FDOT, FDEP and others for the subject area, as well as available data on navigation, natural systems and cost. The results of this data collection and assessment task were used to determine required field reconnaissance (Task 1.1.2.2) and to identify additional information and land survey requirements (Task 1.1.2.4). An inventory of the data collected as part of this study is contained in Table 1.

**Table 2-1
 INVENTORY OF DATA COLLECTED**

TITLE	SOURCE	DATE
Reports and Other Documents		
Lake Rousseau Dam Failure Assessment, Final Report	URS Tampa	February, 2001
Lake Rousseau Dam Failure Assessment, Supplemental Numerical Modeling Report	URS Tampa	March, 2003
Emergency Action Plan - Inglis Main Dam and Bypass Channel Dam	URS Tampa	February, 2003
Boat User Survey - US 19/US 98 Cross Florida Barge Canal Bridge from West Cornflower Drive to West Foss Grove Path	Florida Department of Transportation	November, 2002
Inglis Lock Rehabilitation and New Smaller Lock Study - Volume 1 Rehabilitation Alternative	Bergmann Associates &	January, 2002
Dept. of Env. Protection Office of Greenways and Trails - Marjorie Harris Carr Cross Florida Greenway - Levy Construction Plans	URS	October, 2002
Report Geotechnical Engineering Services - Flood Protection Levee at Lower Withlacoochee and Cross Florida Barge Canal - Levy County, FL	URS Corporation	April, 2001
Addendum Report Geotechnical Engineering Services - Flood Protection Levee Alternatives - Lower Withlacoochee and Cross Florida Barge Canal - Levy County, FL	URS Corporation	April, 2002
Structure Profile - Channel G Salinity Barrier with Construction Costs	SWFWMD	June, 2002
Structure Profile - S-159 Lower with Construction Costs	SWFWMD	February, 2001
Structure Profile - S-551 Salinity Barrier with Construction Costs	SWFWMD	April, 2001
Structure Profile - S-155	SWFWMD	February, 2001
Yankeetown Watershed Mgmt. Plan Update	Jones, Edmunds and Associates	October, 2003
US 19 Bridge Over Florida Barge Canal PD&E Study - Plan and Profile	Florida Department of Transportation	February, 2003
SR 55 (US 19) Over Withlacoochee River - Construction Plan Set	State of Florida Department of Transportation Structures	1970
SWFWMD Aerial Topography, 22 Sections Within the Study Area in T17S, R16E and T17s, R17E		Various
Regulation Manual for Lower Hillsborough Flood Detention Area and Tampa Bypass Canal	USACOE, Jacksonville District	N/A
Digital Aerials with Contours - For the following Sections: 1, 3, 4, 5, 6, 7, 17, 16, 19, 30, 31, 16, 17, 24, 25, 26, 27, 32, 33, 34, 35, 36/16/16	SWFWMD	August, 2003
Lake Rousseau Dam Failure Assessment, Hydrologic and Hydraulic Models used for Study	URS Tampa	February, 2001
Lake Rousseau Dam Failure Assessment Study, Supplemental Numerical Modeling Hydraulic Models used for Study	URS Tampa	March, 2003

Table 2-1 (Continued)
INVENTORY OF DATA COLLECTED

TITLE	SOURCE	DATE
Emergency Action Plan - Inglis Main Dam and Bypass Channel Dam, Affected Structure Data Base with Finished Floor Elevations	URS Tampa	February, 2003
Emergency Action Plan - Inglis Main Dam and Bypass Channel Dam, Hydraulic Models for Allowable Flood Flows Assessment	URS Tampa	February, 2003
1970 Cross-Florida Barge Canal-Plans for Construction of Inglis Spillway and Dam	United States Army Corp of Engineers	March, 1970
Detailed Design Memorandum No. 10, Cross Florida Barge Canal, Inglis Spillway and Dam	Department of the Army, Jacksonville District Corps of Engineers	September, 1966
Cross-Florida Barge Canal Project, Inglis Bypass Spillway, Pre-Inspection Brochure	Department of the Army, Jacksonville District Corps of Engineers	N/A
Water Control Plan for Inglis Project Works	State of Florida, DEP, Office of Greenways and Trails	June, 2001
Assessment of Navigation Alternatives	Greiner, Inc.	November, 1993
Evaluation of "Special Assessment and Review of the Inglis Works and Navigation Options"	Greenway Trails FDEP	July, 1994
Conceptual Design for Implementation of the Lake Rousseau Operations and Management Plan	Greiner, Inc.	June, 1992
Inglis Lock Usage	FDEP	May, 1999
Dam Breach Analysis	Greiner, Inc.	May, 1992
Draft - Lake Rousseau Operations and Mgmt Study	South West Florida Water Management Disttict	August, 1988
Lake Rousseau Operations and Management Study	South West Florida Water Management Disttict	February, 1989
An Analysis of Vegetation-Salinity Relationships in Seven Tidal Rivers on the Coast of West-Central Florida (Draft)	South West Florida Water Management Disttict	December, 2002
Functions of the Inglis Project Works on the Former Cross Florida Barge Canal	Greiner, Inc.	December, 1993
Cross Florida Barge Canal Inglis Lock Bypass Channel Channel Sections	Department of the Army, Jacksonville District Corps of Engineers	February, 1968
Cross-Florida Barge Canal Inglis Lock Cooling Water Bypass Channel Layout Plan & Sections	Department of the Army, Jacksonville District Corps of Engineers	January, 1966
Cross-Florida Barge Canal Inglis Lock-Bypass Channel Layout Plan	Department of the Army, Jacksonville District Corps of Engineers	February, 1968
Hydrologic Data		
Withlacoochee River near Holder - Daily Streamflow / 1928 to 2002	USGS 02313000	September, 2003
Withlacoochee River near Holder - Peak Streamflow / 1932 to 2002	USGS 02313000	September, 2003
Rainbow Springs near Dunnellon - Daily Streamflow / 1965 to 2002	USGS 02313000	September, 2003
Rainbow Springs near Dunnellon - Peak Streamflow / 1965 to 2002	USGS 02313000	September, 2003
Withlacoochee River at Inglis Dam near Dunnellon - Daily Streamflow / 1969 to 2001	USGS 02313230	September, 2003
Withlacoochee River at Inglis Dam near Dunnellon - Peak Streamflow / 1970 to 2001	USGS 02313230	September, 2003
Withlacoochee River at Bypass Channel near Inglis - Daily Streamflow / 1970 to 2001	USGS 02313250	September, 2003
Withlacoochee River at Bypass Channel near Inglis - Peak Streamflow / 1971 to 2001	USGS 02313250	September, 2003
Cedar Key Tide Gage (Adjusted for Withlacoochee River, Various P.O.R.)	NOAA Station No. 8727520	N/A
Environmental Data Inventory:		
US Department of Agricultural, Natural Resources Conservation Service	Citrus County Soil Survey	October, 1988
US Department of Agricultural, Natural Resources Conservation Service	Levy County Soil Survey	September, 1996
National Wetlands Inventory Maps	US Fish and Wildlife Service	Various
Florida Department of Transportation, Florida Land Use, Cover and Forms Classification System, 3rd Edition		1999

Table 2-1 (Continued)
INVENTORY OF DATA COLLECTED

TITLE	SOURCE	DATE
US Fish and Wildlife Service, Classification of Wetlands and Deepwater Habitats of the United States	Cowardin, et.al	1979
Inglis Lock Rehabilitation and New Smaller Lock Study, Environmental Assessment	Bergmann Associates & URS Corporation	January, 2002
7.5 Minute Series Topographic Quadrangles: Yankeetown SE, Fla. Yankeetown, Fla. Red Level, Fla. Crystal River, Fla. Dunnellon, Fla.	US Geological Survey	19911993198819541954
GFC Biodiversity Hot Spots - grid	Florida Game and Fresh Water Fish Commission	N/A
GFC Habitat and Landcover - grid	Florida Game and Fresh Water Fish Commission	N/A
GFC Priority Wetland Habitats - grid	Florida Game and Fresh Water Fish Commission	N/A
GFC Strategic Habitat Conservation Areas - grid	Florida Game and Fresh Water Fish Commission	N/A
Property Appraiser Office		
Property Value & Structure Information - Parcel 06-17-17-03970-001-00	Levy County Soil Survey	October, 2003
Property Value & Structure Information - Parcel 05-17-17-03961-000-00	Levy County Soil Survey	October, 2003
Property Value & Structure Information - Parcel 06-17-17-03967-000-00	Levy County Soil Survey	October, 2003
Property Value & Structure Information - Parcel 05-17-17-03965-000-00	Levy County Soil Survey	October, 2003

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3 FIELD RECONNAISSANCE

The field reconnaissance task was conducted as part of Task 1.1.2.2 Field Reconnaissance, defined in the scope-of-work. Following a review of the data collected for this study, a field reconnaissance visit was scheduled. The reconnaissance work was intended to familiarize personnel working on the project with the project site including layout of the system, known flooding areas and environmentally sensitive areas. This fieldwork was also used to acquire any available background information from local sources.

Representatives from the Southwest Florida Water Management District, URS and the Florida Department of Environmental Protection, Office of Greenways and Trails participated in the field reconnaissance. The field work consisted of: 1) meeting with government officials and representatives from the Towns of Inglis and Yankeetown to document flood prone areas and gather information on flood events and tides, 2) visiting flood prone and environmentally sensitive areas, 3) and touring the Cross-Florida Barge Canal facilities. The photograph shown below was taken near the south end of Magnolia Avenue located on the west end of Yankeetown. The photograph illustrates a wetland area on the north side of the river. Appendix A of this report contains full documentation of the field reconnaissance work conducted on September 12, 2003 including photographs of the areas and facilities visited.



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4 CROSS-FLORIDA BARGE CANAL SYSTEM COMPONENTS INVENTORY

The system component inventory task was conducted as part of Task 1.1.2.3 Hydraulic Features Inventory, defined in the scope-of-work.

4.1 Introduction

The west terminus portion of the Cross-Florida Barge Canal System consists of a number of components, which are illustrated on **Figure 1**. The system components include hydraulic structures and associated facilities, which are summarized as follows:

- Lake Rousseau,
- Inglis Dam and Main Spillway,
- Withlacoochee River – Upper Segment,
- Cross-Florida Barge Canal,
- Rock Dam,
- Inglis Lock,
- Bypass Channel and Bypass Channel Spillway,
- Withlacoochee River – Lower Segment,
- US-19 Bridge at Withlacoochee River,
- US-19 Bridge at Barge Canal, and
- Lock Access Road Bridge at Bypass Channel.

Section 4.2 of this inventory provides a brief description and a photograph of each of the Cross-Florida Barge Canal System components. Section 4.3 provides a design summary in tabular form for each of the components.

4.2 Description Of Features

Lake Rousseau

Lake Rousseau is a man-made impoundment of the Withlacoochee River formed primarily by Inglis Dam. The lake is located in Citrus and Levy Counties and presently serves to supply water for the Inglis Lock and barge canal system. The lake is characterized by large shallow areas that vary in depth from zero feet on the east end to ten feet on the west end. Given the shallow nature of the lake and only minimum freeboard, this lake provides only minor flood protection and little long term water storage. There are three outlets for water from the lake including: (1) the Main

Spillway, (2) the Bypass Spillway, and (3) Inglis Lock. A view of the west end of the lake is shown in **Photo 4-1**.

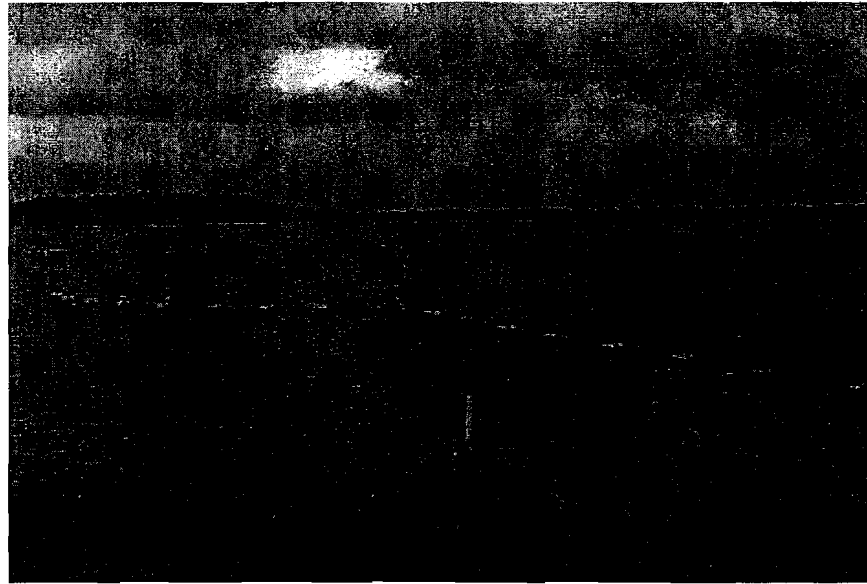


Photo 4-1: Lake Rousseau looking northwest from Inglis Dam

Inglis Dam and Main Spillway

A dam in one form or another has been in place at the Inglis Dam site since 1908. The dam is located 8 ½ miles upstream of the mouth of the Withlacoochee River and about two miles east of US-19. Inglis Dam is an earthen embankment approximately 34 feet high and 1,100 feet long. It is built across the Withlacoochee River valley and creates the Lake Rousseau reservoir. The dam's appurtenant facilities include a two-gate spillway system with ogee weirs, which are used to control flood stages in the reservoir. **Photo 4-2** illustrates the dam and spillway system. Discharge from the main spillway system enters the short segment of the Withlacoochee River upstream of the Barge Canal. **Photo 4-3** illustrates the outlet pool below the spillway. **Figure 2** is plan of Inglis Dam and the main spillway.



Photo 4-2: Inglis Dam and Main Spillway

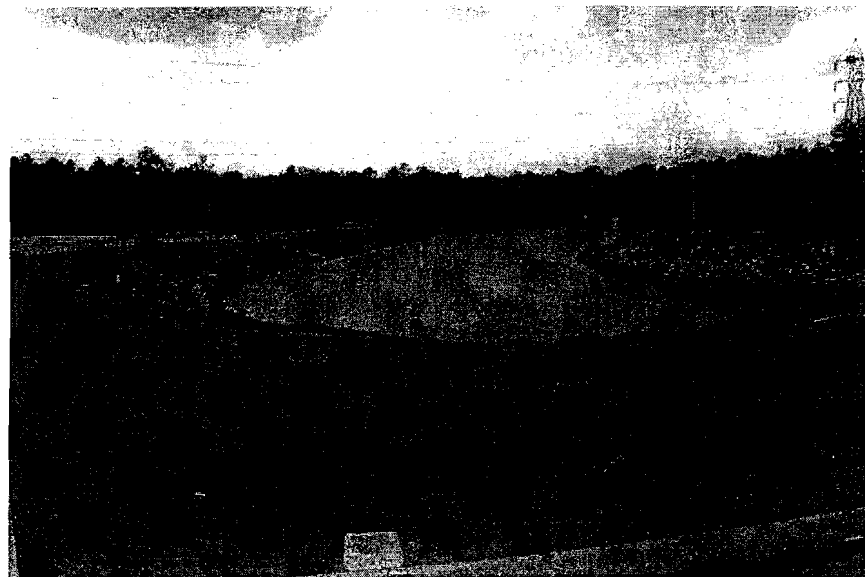


Photo 4-3: Main Spillway outlet pool, also head area for the Withlacoochee River - Upper Segment

Withlacoochee River – Upper Segment

The segment of the Withlacoochee River located between the Barge Canal and Inglis Dam is commonly referred to as the Upper Segment. This river segment, which is approximately 1.44 miles long and has an average bottom slope of 0.1 percent, carries flood flows discharged

through the Inglis Dam Main Spillway. This natural conveyance system is characterized by forested channel banks and flood plain areas. Urbanization is occurring on the south bank of the system over the entire reach length. As of December 2002 there were 15 known residences in this reach, several of whom have docks on the river. **Photo 4-4** illustrates a typical segment of this reach.

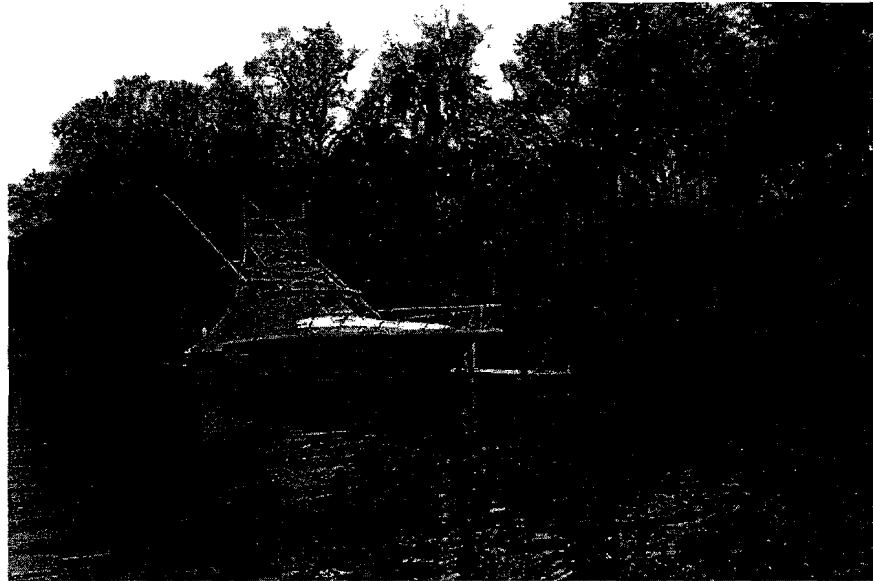


Photo 4-4: Withlacoochee River - Upper Segment

Cross-Florida Barge Canal

The Cross-Florida Barge Canal within the west terminus area is approximately 7.4 miles long. The canal begins on its west end at the Gulf of Mexico and terminates on the east end at Inglis Lock. The canal, a prismatic channel, was designed to provide a minimum draft of 12 feet and ranges in width from 350 feet to 500 feet. The Barge Canal has a 1,500 feet long waiting basin at the west end of the lock. **Figure 3** illustrates a typical section of the Barge Canal.

The Cross-Florida Barge Canal in this reach is characterized as having steep side slopes, which are heavily vegetated with trees and shrubs, and spoil rows are located on both sides adjacent to the top of bank. The spoil rows were placed as part of canal construction and exist throughout most of the reach. The Barge Canal receives flood flows from the upper segment of the Withlacoochee River and conveys these flows to the Gulf of Mexico. **Photos 4-5 and 4-6** illustrate the Barge Canal in this reach.

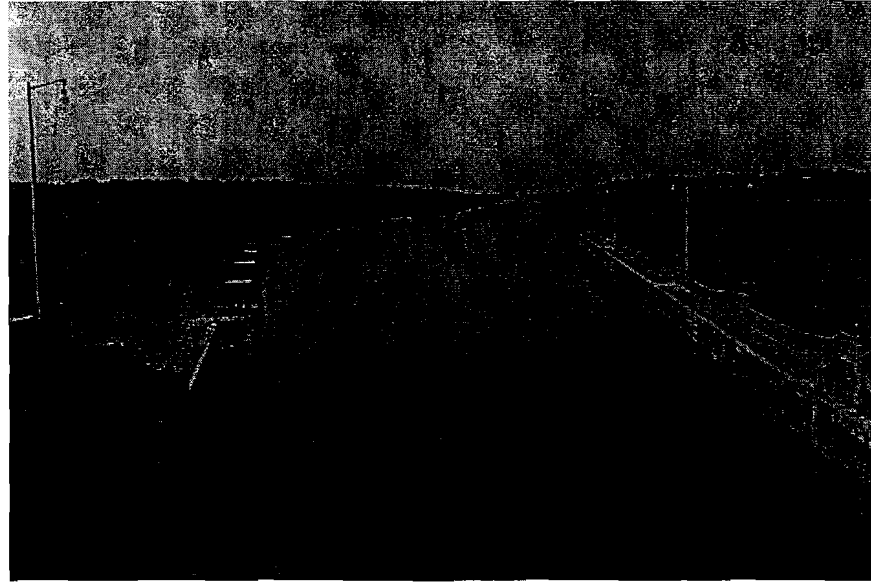


Photo 4-5: Cross-Florida Barge Canal looking west from Inglis Lock

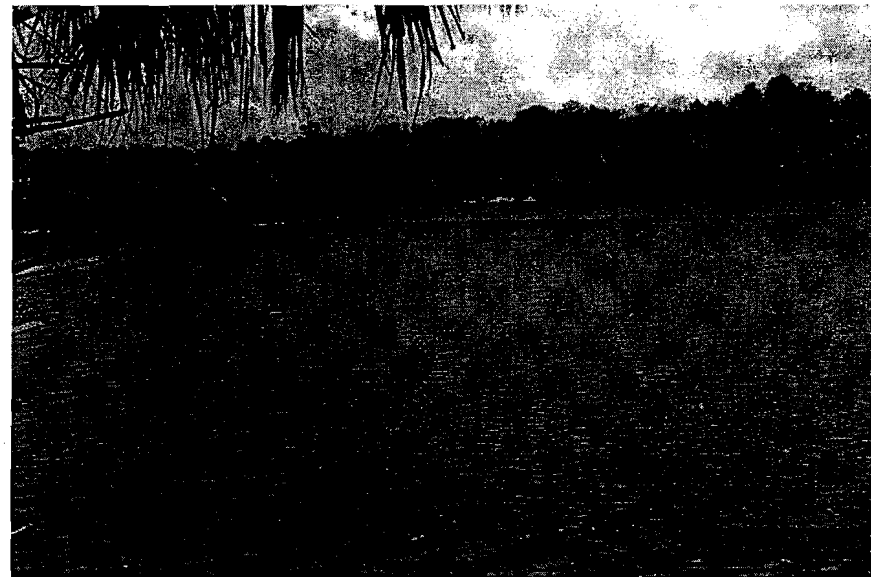


Photo 4-6: Cross-Florida Barge Canal at confluence with Withlacoochee River - Upper Segment

Rock Dam

The Rock Dam is located on the Withlacoochee River about 6 ½ miles upstream of the mouth. This facility forms the right bank of the Barge Canal and is technically a levee as there are no discharge facilities to pass flow to downstream areas, and it was not designed to overflow. The construction of this facility effectively severed the upper and lower segments of the

Withlacoochee River and allowed flood flows from the upper segment to be shunted down the Barge Canal. The facility as originally constructed consisted of an earthen embankment with top of bank elevation higher than the 100-year flood stage within the Barge Canal. The facility is currently being reconstructed with a higher top elevation as a dam safety measure. The new facility incorporates an MSE wall into the existing embankment. **Figures 4 and 5** are sections of the existing Rock Dam and proposed flood protection levee. **Photos 4-7 and 4-8** illustrate the existing Rock Dam and proposed flood protection levee.

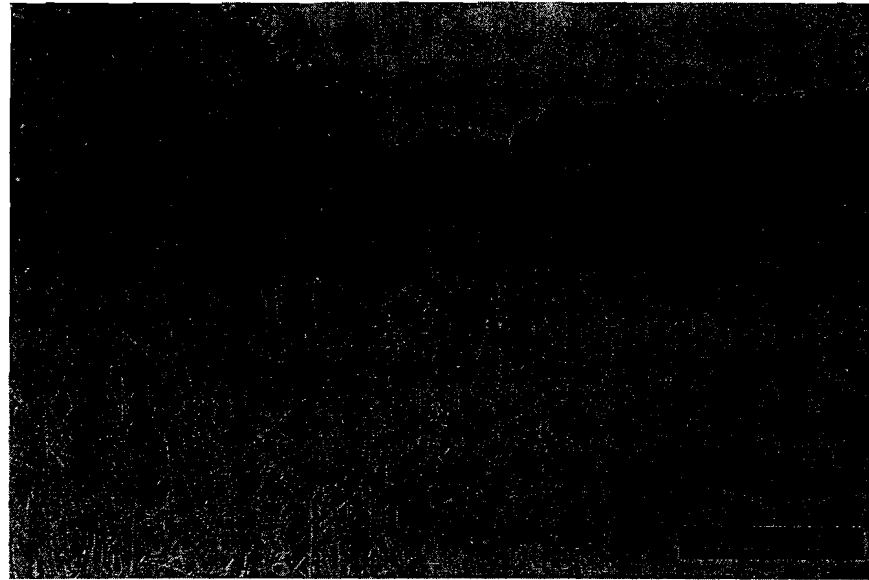


Photo 4-7: Rock Dam



Photo 4-8: Flood protection levee under construction

Inglis Lock

Inglis Lock is located at the eastern terminus of the Barge Canal. The lock was designed to raise and lower ocean-going vessels between the Gulf of Mexico and Lake Rousseau, and works with water levels in the range of -2 to 28 ft-NGVD. One lockage cycle requires about 11 million gallons of water supplied from Lake Rousseau (Inglis Pool). **Photos 4-9, 4-10 and 4-11** illustrate the Inglis Lock and its associated gates. At present, Inglis Lock is not operational. The State of Florida is in the process of developing design plans for future renovations.



Photo 4-9: Inglis Lock



Photo 4-10: Inglis Lock – Head Gate

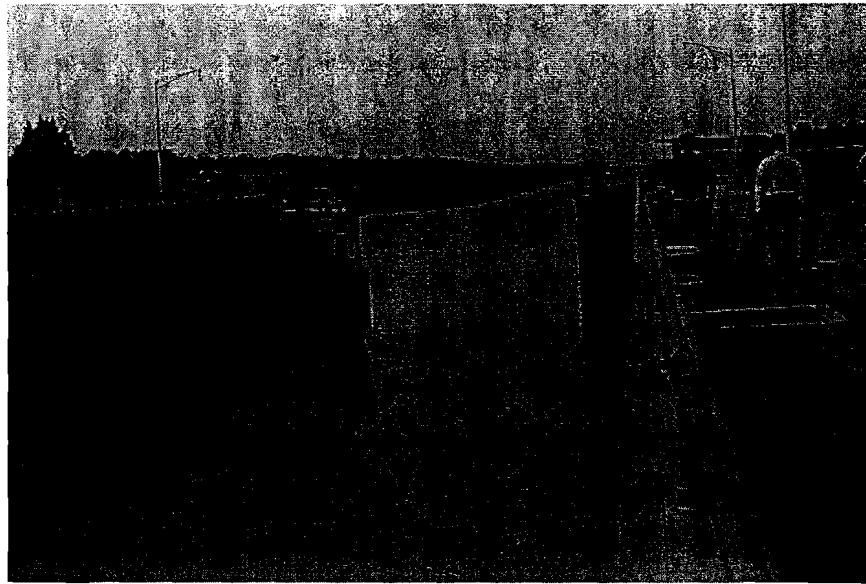


Photo 4-11: Inglis Lock – Tail Gate

Bypass Channel and Bypass Channel Spillway

The Bypass Channel and Spillway system is located north and west of Inglis Lock. These facilities allow for the controlled discharge of water from Lake Rousseau to the lower segment of the Withlacoochee River, which was necessitated due to the severance of the upper and lower segments of the river by the Rock Dam. **Figure 6** illustrates the Bypass Channel cross-sections. **Figure 7** is the Bypass Channel Spillway plan. **Figure 10** illustrates the Bypass Channel System layout. **Photos 4-12, through 4-15** illustrate the Bypass Channel and Spillway.

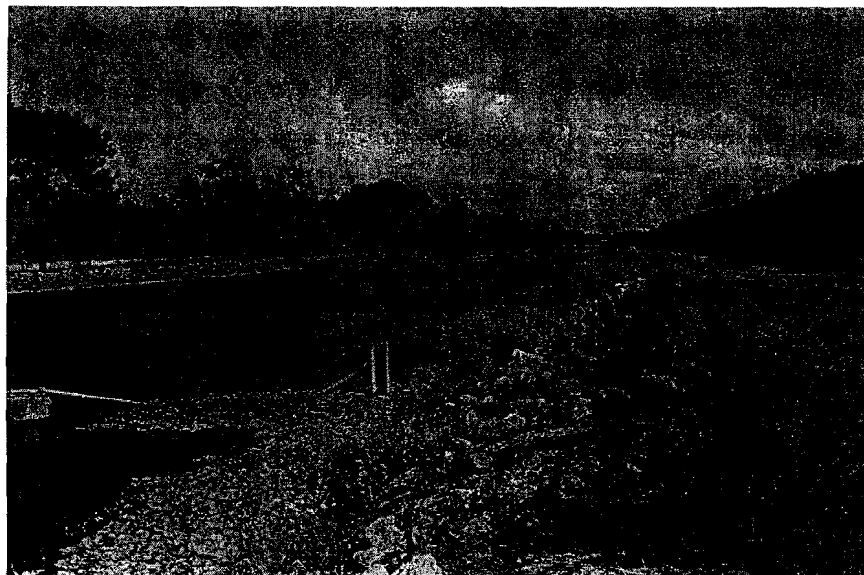


Photo 4-12: Bypass Channel looking upstream from the spillway



Photo 4-13: Bypass Channel Spillway

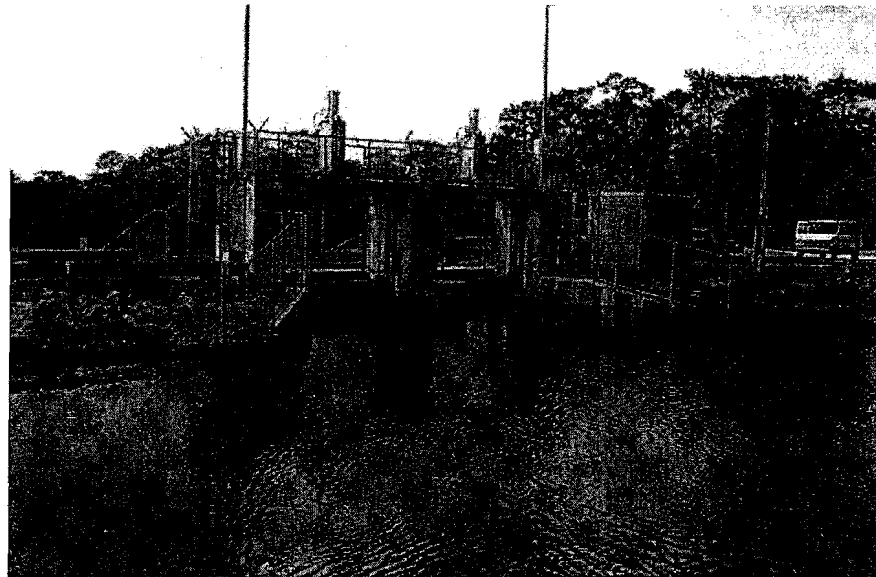


Photo 4-14: Bypass Channel Spillway – upstream side

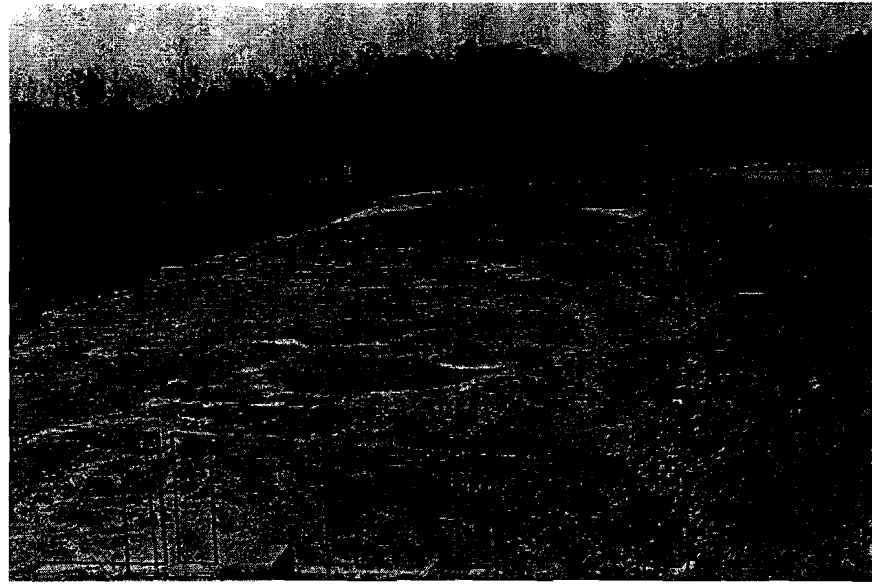


Photo 4-15: Bypass Channel Spillway outlet pool, also head area for the Withlacoochee River - Lower Segment

Withlacoochee River – Lower Segment

The segment of the Withlacoochee River starting at the mouth and going upstream to the Bypass Channel Spillway is commonly referred to as the Lower Segment. The lower segment is approximately 6.5 miles long and has an average bottom slope of 0.006 percent. The primary source of fresh water for this segment of the river is from Lake Rousseau via the Bypass Channel Spillway. This natural conveyance system is characterized by forested channel banks and flood plain areas. Urbanization is occurring primarily on the north bank of the system over the entire reach length and to a lesser degree on the south bank areas. As of December 2002 there were 448 known residences in this reach and a large number docks on the river. This reach contains a single pair of bridges that serve US-19. **Photos 4-16 and 4-17** illustrate some typical areas within this segment.

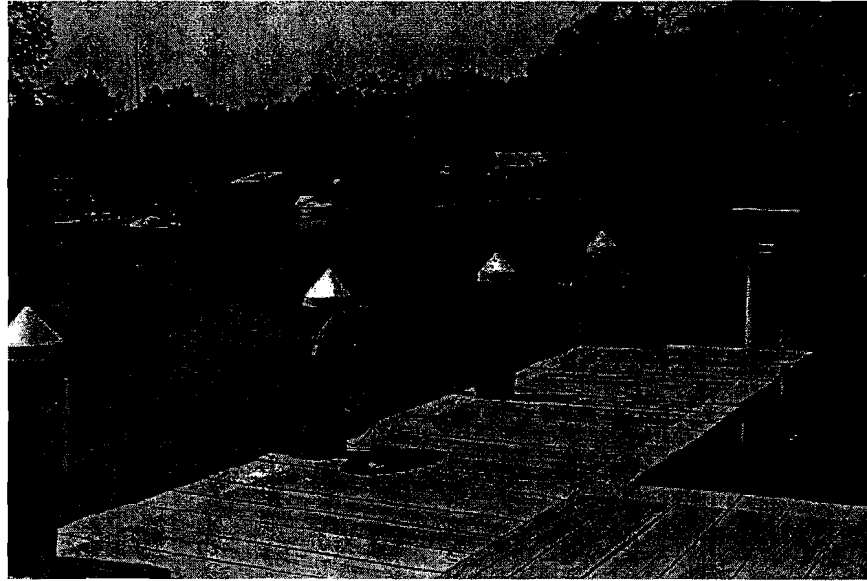


Photo 4-16: Withlacoochee River - Lower Segment at Coast Guard Station

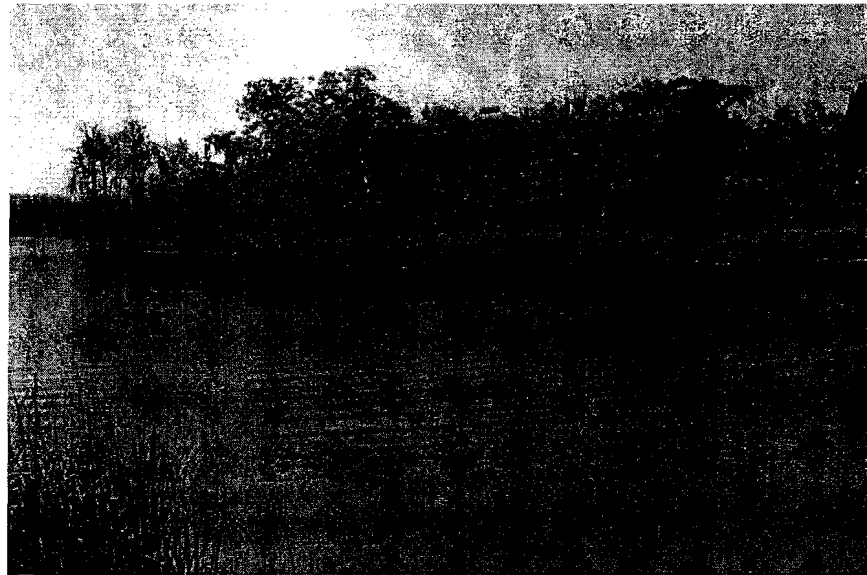


Photo 4-17: Withlacoochee River - Lower Segment at West Yankeetown

US-19 Bridge at Withlacoochee River

The US-19 Bridge at the Withlacoochee River was constructed circa 1970. This bridge consists of two spans each with two lanes. The bridge low member is at elevation 13.6 ft-NGVD and is

suitable in height to accommodate only relatively small vessels. **Photo 4-18** illustrates the existing bridge. **Figure 8** is a plan and elevation of the bridge.



Photo 4-18: US-19 Bridge over Withlacoochee River

US-19 Bridge at Barge Canal

The existing US-19 Bridge at the barge canal was constructed as part of the Cross-Florida Barge Canal System. The bridge is a single span two-lane bridge with sufficient height to accommodate ocean-going vessels. **Photos 4-19 and 4-20** illustrate the existing bridge. **Figure 9, Alternative 1** is a profile of a proposed bridge that is equivalent to the existing span. A second bridge is being planned at this location as part of the Florida Suncoast Parkway expansion. **Figure 9, Alternative 2** is a profile of a proposed bridge.



Photo 4-19: US-19 Bridge over Barge Canal



Photo 4-20: US-19 Bridge over Barge Canal with canal in background

Lock Access Road Bridge at Bypass Channel

The Lock Access Road Bridge at the Bypass Channel was constructed as part of the Cross-Florida Barge Canal System. The bridge consists of three concrete box culverts wide enough to accommodate two traffic lanes. This bridge forms the flow control for the Bypass Channel System. **Photo 4-21** illustrates the existing bridge. **Figure 10** illustrates the location and alignment of the lock access road at the Bypass Channel.

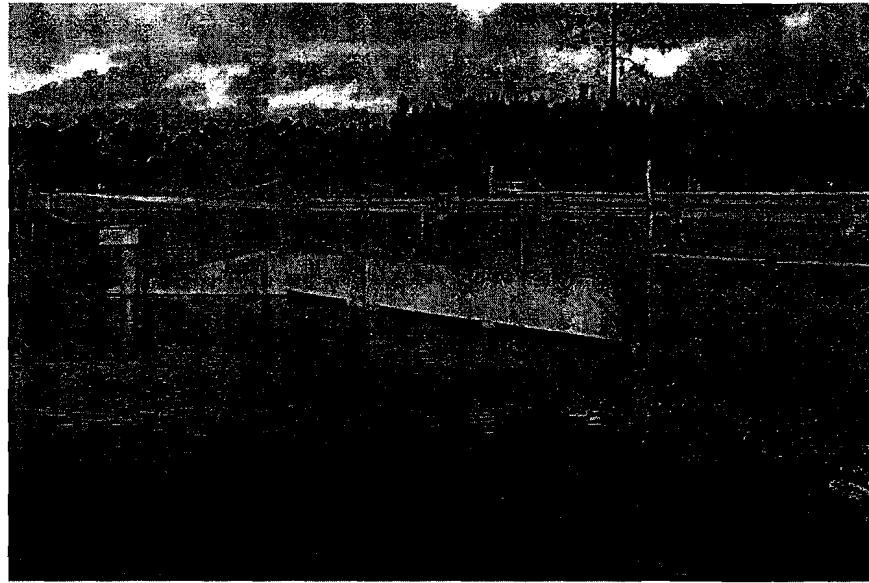


Photo 4-21: Lock Access Road Bridge over Bypass Channel

4.3 Summary of Features

The table below presents a summary of design parameters for each of the Barge Canal System components.

**Table 4-1
 SYSTEM COMPONENT DESIGN SUMMARY**

System Component	Design Data	Plans and Details
Lake Rousseau	<ul style="list-style-type: none"> • Length 11 mi • Surface Area 6.5 mi² • Normal Pool 27.5 ft-NGVD • Drainage Area 2,020 mi² 	
Inglis Dam and Main Spillway	<ul style="list-style-type: none"> • Earthen Embankment: <ul style="list-style-type: none"> - Length 1,100 ft - Top Elevation 34 ft-NGVD - Crown Width 32 ft - Side Slopes: <ul style="list-style-type: none"> Pool Side 6:1 Land Side 3:1 • Horizontal Apron Elev. (-)7.0 ft-NGVD • Spillway: <ul style="list-style-type: none"> - Hydraulic Design Condition: <ul style="list-style-type: none"> Discharge 18,000 cfs Headwater Elev. 27 ft-NGVD Tailwater Elev. 17.2 ft-NGVD - Crest: <ul style="list-style-type: none"> Shape Ogee Elevation 11.3 ft-NGVD Net Length 80 ft. - Control Gates: <ul style="list-style-type: none"> Number 2 Width x Height 40 ft x 16.7 ft. 	Figure 2
Withlacoochee River - Upper Segment	<ul style="list-style-type: none"> • Length 1.44 mi • Channel Slope 0.1% • Bottom Elev. (-)6.5 → (-)14.0 ft-NGVD 	
Cross-Florida Barge Canal	<ul style="list-style-type: none"> • Canal Segment Length 7.4 mi • Channel Geometry: <ul style="list-style-type: none"> - Shape Trapezoidal - TOB Elev. 10-15 ft-NGVD - Top Width 350-500 ft - Bottom Elev. (typ) (-)14 ft-NGVD 	Figure 3
Rock Dam (Existing)	<ul style="list-style-type: none"> • Earthen Embankment: <ul style="list-style-type: none"> - Length 350 ft - Top Elevation 15 ft-NGVD - Crown Width ≥20 ft - Side Slopes: <ul style="list-style-type: none"> Upstream Side 3:1 Downstream Side 2:1 	Figure 4
Rock Dam (Proposed Flood Protection Level)	<ul style="list-style-type: none"> • Earthen Embankment: <ul style="list-style-type: none"> - Length 682 ft - Top Elev. 33.8 ft-NGVD - Side Slopes: 	Figure 5

Table 4-1 (Continued)
SYSTEM COMPONENT DESIGN SUMMARY

System Component	Design Data	Plans and Details
	Upstream Side 3:1 Downstream Side 2:1 - Access Bench: Elevation 20 ft-NGVD Width (typ) 20 ft • MSE Wall: - Length 660 ft - Top Elev. 34 ft-NGVD - Base Elev. 20.5 ft-NGVD - Top Berm Width (typ) 10 ft - Facing Segmental Concrete Block	
Inglis Lock	• Lock Chamber: - Length (nominal) 600 ft - Width (nominal) 84 ft - Bottom Elev. (-)14 ft-NGVD - Draft (min) 12 ft • Upstream Pool 24 → 28 ft-NGVD • Downstream Pool (-)3 → 9.6 ft-NGVD • Miter Gates: - Top Elev. 31.5 ft-NGVD - Tail Gate Height 47.5 ft - Head Gate Height 21.5 ft	
Bypass Channel	• Length 8,500 ft • Bottom Width 5 ft • Side Slopes 3:1 • Bottom Elev. 12 ft-NGVD • Top of Bank Elev. (typ) ≥30 ft-NGVD	Figure 6
Bypass Channel Spillway	• Hydraulic Design Condition: - Design Discharge 1,100 cfs - Maximum Discharge 1,540 cfs - Headwater Elev. 25.9 ft-NGVD - Tailwater Elev. (tidal) 0.8 ft-NGVD • Control Gates: - Number 2 - Width x Height 14 ft x 7 ft • Crest: - Shape Ogee - Elevation 21.0 ft-NGVD - Net Length 28 ft • Horizontal Apron Elev. (-)9.5 ft-NGVD	Figure 7
Withlacoochee River - Lower Segment	• Channel Length 6.5 mi • Bottom Elev. (-)6 → (-)8 ft-NGVD • Channel Slope 0.006%	
US-19 Bridge at Withlacoochee River	• Number Spans 2 • Lanes Each Span 2 • Clear Span Length 215 ft • Low Chord Elev. 13.6 ft-NGVD	Figure 8
US-19 Bridge at Barge Canal (existing)	• Number Spans 1 • Lanes Each Span 2 • Clear Span Length 1,694 ft • Bridge w/Abutments 4,100 ft • Vertical Clearance 65 ft	Figure 9
US-19 Bridge at Barge Canal	• Number Spans 1	Figure 9

Table 4-1 (Continued)
SYSTEM COMPONENT DESIGN SUMMARY

System Component	Design Data	Plans and Details
(proposed)	<ul style="list-style-type: none"> • Lanes Each Span 2 • Clear Span Length 753 ft • Vertical Clearance 40 ft 	
Lock Access Road Bridge at Bypass Channel	<ul style="list-style-type: none"> • Lanes 2 • Hydraulic Design Condition: <ul style="list-style-type: none"> - Design Discharge 1,540 cfs - Headwater Elev. 26.9 ft-NGVD - Tailwater Elev. (tidal) 26.5 ft-NGVD • Box Culvert: <ul style="list-style-type: none"> - Number of Openings 3 - Width x Height 12 ft x 12 ft - Invert Elev. 16 ft-NGVD 	Figure 10



5 ADDITIONAL INFORMATION AND LAND SURVEY REQUIREMENTS

The **Additional Information and Land Survey Requirements** task was conducted as part of Task 1.1.2.4 Identification of Surveys to be Performed, defined in the scope-of-work.

5.1 Introduction

Available data were collected and assessed as part of Task 1.1.2.1. Critical additional data survey needs for studies to be conducted under Work Order 1 and Work Order 2 of this project have been identified as part of Task 1.1.2.4. These additional data and survey needs are summarized briefly below:

- Long-term tide data for the mouth of the Withlacoochee River and Barge Canal,
- Land survey data of river and barge canal cross-sections to refine existing data,
- Land survey data of Bypass Channel cross-sections,
- Land survey to support structure siting studies, and
- Property data to support the land acquisition and cost assessment.

Section 5.2 below provides a detailed purpose and description of the additional data required. Section 5.3 provides a summary table of the required data as well as estimated cost for data and survey acquisition. Please note that design data for existing structures and bridges associated with the Cross-Florida Barge Canal system will be taken from available design documents.

5.2 Description of Data Required

Tide Data

Long-term tide data will be acquired for the mouth of the Withlacoochee River and Barge Canal. Data will be obtained from NOAA for the Cedar Key Station (ID 8727520), and will be adjusted to represent tidal conditions in the Barge Canal and the Withlacoochee River at or near the mouth of each system.

This tide data will be used, as the downstream boundary condition for the hydraulic models that will be developed to assess impacts to natural systems and water quality in the river and canal. Additionally, portions of the time series will be used as the downstream boundary conditions for the flood impact assessment and navigation assessment. Hourly data for years 1960, 1982, 1993, 1996, and 1999 will be requested from NOAA. The estimated cost of this data acquisition is \$75, based on correspondence with NOAA personnel.

Land Survey Data

Land survey data will be required at a number of locations in support of the hydraulic and siting studies that will be conducted as part of Work Order 2 of this project. Previously developed

hydraulic models of the Withlacoochee River and Barge Canal system in the West Terminus area were used to assess flooding that would occur due to a failure of Inglis Dam. The cross-sectional configuration of the main channel was of relative less importance than that of the overbank areas, as most of the flow was conveyed in the overbank areas for these high flow studies. **Figure 11** illustrates the location of cross-sections used in the previous studies.

The existing models will be refined to include more accurate main channel data as part of the West Terminus study. This will be done to improve the accuracy of long-term low flow simulations that will be conducted as part of the natural systems and water quality assessments. To accomplish this, bank-to-bank surveys at selected cross-sections (20) in the Withlacoochee River, Barge Canal and Bypass Channel will be conducted, and the new information incorporated into the models. **Figure 11** illustrates the location of the cross-sections that will be surveyed as part of this study.

It should be noted that Cross-Sections 21 and 29 would be extended beyond the Barge Canal top of channel bank to include the adjacent spoil berms on each side. This will be done to aid in the siting of control and lock structures, which will be evaluated as part of this study. Additionally, Cross-Sections 33 through 35 will be entirely new sections developed as part of this study. At present cross-sections are not available for the Bypass Channel. Cross-Sections 33 through 35 will also be extended a sufficient length beyond the existing top of bank to facilitate potential design improvements to the Bypass Channel. The remaining 15 cross-sections will extend from bank to bank.

A preliminary estimate by a surveyor familiar with the West Terminus area indicates that the survey work described above will cost approximately \$13,000.

Property Data

The Barge Canal and adjacent spoil areas are owned by the State of Florida. Any proposed structures that are to be sited in the Barge Canal are assumed to have no property acquisition issues. This study also includes assessing potential structural revisions to the Bypass Channel Control Structure and Bypass Channel. Areas north of this system are under private ownership. In order to assess property acquisition and development costs of any potential alternatives, information concerning property boundary and ownership must be acquired for the affected areas.

Property data will be collected from the appropriate municipality or county Tax Assessor once the affected areas are determined. Data on property ownership and parcel boundary will be taken from available records. Property boundary surveys will not be conducted as part of this data collection effort. In previous work conducted by URS in this locality, a survey subcontractor was used to conduct a similar data collection exercise. A preliminary estimate by a surveyor familiar with the West Terminus area indicates that the property data collection described above will cost approximately \$2,000.

5.3 Summary Data Table and Estimated Costs

The following table is a summary of the additional data that is anticipated to be required to complete the proposed studies in Work Orders 1 and 2 of this project. These information

requirements are based on the work completed to date and may change as additional work is completed.

Table 5-1
ADDITIONAL INFORMATION REQUIREMENT SUMMARY

Required Data	Estimated Cost
Tide Data: <ul style="list-style-type: none">• Cedar Key Tide Gage (NOAA Station 8727520), hourly data for years 1960, 1982, 1993, 1996, and 1999.	\$75
Land Survey Data <ul style="list-style-type: none">• Selected bank-to-bank cross-sections including four (4) on the Upper Withlacoochee River segment, ten (10) on the Lower Withlacoochee River segment and three (3) on the Barge Canal,• Cross-sections (3) on the Bypass Channel and adjacent areas,• Survey of selected overbank areas to support structure siting.	\$13,000
Property Data <ul style="list-style-type: none">• Property data collection for areas adjacent to Bypass Channel System to support the land acquisition and cost assessment.	\$2,000
Total	\$15,075

A detailed survey and data collection scope of work will be prepared during Work Order 2 of this project. This scope of work will be provided to the survey subcontractor and will be used as a basis for a cost proposal.



6 HYDROLOGIC STUDIES

The Hydrologic Studies task was conducted as part of Task 1.1.2.5 Update Watershed Parameters defined in the scope-of-work.

6.1 Background

The hydrologic studies conducted as part of this task will be used in support of the restoration alternatives analysis, which will be conducted under Work Order 2 of this project. This task builds upon the hydrologic studies conducted as part of previous studies of the Cross Florida Barge Canal system and includes the following subtasks:

- Long-term flow assessment,
- Flood flow assessment for a selected flood frequency, and
- Tidal assessment.

Hydrologic analyses were conducted to determine long-term flow and flood flow hydrographs for the segment of the Withlacoochee River downstream of Inglis Dam. These hydrographs will be used as input to the hydraulic routing models, which will be developed under Work Order 2. Hydrographs were developed for the baseline condition (Alternative 4), which simulates the system as it exists today. Hydrographs were also developed to assess the proposed restoration alternatives condition (Alternatives 1, 2 and 3), which are described in Section 1.2 of this report. The development of long-term flow and flood flow hydrographs is described in detail in the following sections.

It is important to note that baseline conditions (Alternative 4) were determined from Lake Rousseau discharge data for the long-term flow analysis and from adjusted reservoir inflow data for the flood flow analysis. The Lake Rousseau discharge data most accurately represents baseline conditions. However, discharge data were not available for the selected flood frequency, thus inflow data were used to estimate reservoir discharge for the flood flow analysis. For the remaining alternatives (Alternatives 1, 2, and 3) reservoir discharge hydrographs were developed from adjusted reservoir inflow data. This reservoir inflow data most accurately represents the system under alternative conditions, as it is free from the operational influences due to discharge from Inglis Dam main gates and the bypass channel.

Hydrologic analyses were also conducted to determine tidal conditions in the Withlacoochee River. This tidal information was used to develop tide stage hydrographs for long-term flow and flood flow model simulations. These tide stage hydrographs were used as downstream boundary conditions in the simulation models. The development of the tide stage hydrographs for long-term flow and flood flow simulations is described in detail in the following sections.

6.2 Data

The long-term flow and flood flow hydrographs used in this study were developed from existing streamflow records from the U.S.G.S. gaging stations listed below. **Figure 12** illustrates the location of the selected gage stations. The first two gages listed below measure the majority of

the water that flows into the Lake Rousseau reservoir. The latter two gages measure discharges from the reservoir to the Withlacoochee River downstream reaches from the Inglis Dam and the Bypass Spillway respectively.

1. Withlacoochee River near Holder, USGS Station No. 02313000
2. Rainbow Springs near Dunnellon, USGS Station No. 02313100
3. Withlacoochee River at Inglis Dam Near Dunnellon, USGS Station No. 02313230 (Main Gates)
4. Withlacoochee River Bypass Channel near Inglis, USGS 02313250

Tidal stage hydrographs for the proposed tidal boundary at the Gulf of Mexico were developed from data obtained for the NOAA Cedar Key tide station (NOAA Station No. 8727520). Hourly tide data were estimated for several years (1960, 1996) by NOAA. NOAA also made estimates of tidal variations at the mouth of the Withlacoochee River from data for the Cedar Key station.

6.3 Long-Term Flow Hydrographs Assessment

Long-term (one-year duration) daily flow hydrographs representative of the “Average Year” condition were selected for use in the natural systems and water quality modeling assessments. Mean annual streamflow, which is a volumetric indicator was used as basis for its selection. Separate hydrographs were developed for the baseline condition and the alternatives condition as described below in Sections 6.3.1 and 6.3.2.

The statistically “Average Year” was determined by analyzing 75 years of record from the USGS gaging station near Holder, Florida (No. 02313000). This gage has the longest record of all of the gages selected for use in this study, and accounts for flows from 89 percent of the Lake Rousseau watershed. The time series of mean annual streamflows was analyzed by using the Weibull formula:

$$p = m / (n+1)$$

where p is the probability, m is the ranking position, and n is the number of data points.

The Weibull formula was used to identify years with flows corresponding to 50 percent probability or median year. For the purpose of this study, it is assumed that the median year represents the “Average Year” condition. The flow hydrograph for year 1987 with a mean annual flow of 908 cfs has a 49 percent occurrence probability, and was the closest to 50 percent probability. However, the annual flow distribution was atypical due to an event that produced a flow of over 3,000 cfs in April with the remainder of the year having relatively low flows. The flow hydrograph for year 1996 with a mean annual flow of 877 cfs has a 47 percent occurrence probability and a reasonable annual flow distribution. For this reason, the 1996 flow hydrograph was selected for use in this study as the “Average Year” condition. **Figure 13** shows a comparison of the 1987 and 1996 flow hydrographs for the USGS gaging station near Holder, Florida. It should be noted that 910 cfs is the computed mean annual flow for the median year. The year 1996 selected flow hydrograph with a mean annual flow of 877 cfs has about 3.6 percent less volume of flow than the statistically median year.

6.3.1 Alternative 4, Baseline Condition Hydrograph

As described above, the “Average Year” flow condition was determined to be 1996. The long-term flow hydrograph for the baseline condition (Alternative 4) was determined from Lake Rousseau discharge data. Presently, discharge occurs from Lake Rousseau from two locations, the main gates and the Bypass Channel spillway system. These discharge locations have the associated USGS gage stations listed below:

- USGS Station No. 02313230 (Main Gates)
- USGS Station No. 02313250 (Bypass Channel)

The flow records for year 1996 were extracted from the period of record for each of the gage stations listed above. **Figure 14** illustrates the “Average Year” flow hydrograph selected for use in the long-term simulations. These hydrographs represent discharges from Lake Rousseau, which will be used as the upstream boundary condition in the simulation models.

6.3.2 Alternatives 1, 2, and 3 Hydrographs

The alternatives proposed as part of this study require a change in the manner in which water is discharged from Lake Rousseau relative to the baseline condition. Proposed modifications to the system that will be assessed include making the Inglis Dam main gates the primary discharge point for the system and re-sizing the Bypass Channel system. This reservoir outflow will be manipulated in the hydraulic study to determine its destination (i.e. all directly to the Withlacoochee, or a portion to the Bypass Channel etc.). For the alternatives modeling, the total potential outflow from the reservoir is required. The potential outflow may therefore, be different from the baseline condition due to different gate manipulations to meet downstream demand criteria. The potential discharge for use in the alternatives assessment should then be an estimate of outflow without current reservoir spillway system manipulations. The long-term flow hydrograph for the Lake Rousseau outflow was determined as described below.

Again, the “Average Year” flow condition was determined to be 1996. Total potential discharge (outflow) from the reservoir was determined by combining the 1996 daily flows at the Withlacoochee River near Holder (USGS Station No. 02313000) with the daily flows at Rainbow Springs near Dunnellon (USGS Station No. 02313100). This composite hydrograph represents the total potential **measured** inflow into the reservoir. The total potential discharge from the reservoir was computed by adjusting this composite hydrograph by a factor of 1.05. This factor was determined by comparing discharge volumes for the existing condition reservoir outflow (combined main gate and bypass channel discharge) with the total potential **measured** inflow. This comparison indicated that for the year 1996 about five percent more runoff volume discharges from the reservoir than could be accounted for by the measured inflow. This difference can be attributed primarily to the additional catchment area downstream of the Holder station, which drains to the reservoir. This catchment area accounts for about 11 percent of the total watershed area. This factor also accounts for evaporation or other losses.

6.4 Flood Flow Hydrographs Assessment

Flood flow hydrographs representative of the 100-year flood frequency were selected for use in the flood assessment. Separate hydrographs were developed for the baseline condition and the alternatives conditions as described below.

6.4.1 Selection of Flood Event

The statistically derived "100-year" flood flow was determined by analyzing 75 years of record from the USGS gaging station near Holder, Florida (No. 02313000). This gage has the longest record of all of the gages selected for use in this study, and accounts for flows from 89 percent of the Lake Rousseau watershed. The 100-year flood discharge was determined using a time series of annual peak instantaneous discharges that were fitted to the Log Pearson Type III Frequency Distribution. The results of this analysis are presented in Table 6-1, which provides a summary of estimated flood frequency versus flow rate for a series of flood frequencies from the two (2) to 200 year return period.

Table 6-1
FLOOD FREQUENCY ANALYSIS FOR WITHLACOOCHEE NEAR HOLDER

Return Period (yrs)	Flow (cfs)
2	2,132
5	3,638
10	4,758
20	5,906
50	7,488
100	8,741
200	10,046

As indicated in Table 6-1, the 100-year flood flow rate is estimated to be 8,741 cfs. The time series of annual peak instantaneous discharges for the 75-year period of record were examined to determine if there was a corresponding flood flow rate in the data. The closest flow rate in the data, is a peak flow of 8,660 cfs, which occurred on April 5, 1960. This measured flow is approximately 99 percent of the estimated 100-year flow calculated from the frequency analysis. Next, the hydrograph of the event associated with the April 5, 1960 peak flow was examined for reasonableness. The hydrograph of this event has a time base of approximately 75 days and appears to be reasonable in terms of its shape. No other precipitation events of any significance occurred during this period. It should be noted that the Withalcoochee River system, by virtue of a large amount of floodplain storage, has relatively long peak lag times associated with it. The flood event that culminated with a peak flow of 8,660 cfs on April 5, 1960 was selected for use in this study as the 100-year flood frequency.

Hourly flow data is typically desirable for detailed hydraulic modeling such as that proposed for use in this study. However, hourly flow records were not available for the selected USGS gage. Therefore, an assessment was conducted to determine the suitability of using average daily flows in this study. A comparison of maximum instantaneous peak flows with daily average flows for a

number of data points was conducted for this assessment. The results of this comparison showed that the instantaneous peak flows compared well with the daily average flows in most instances. This is due primarily to the size and characteristic of the Withlacoochee River watershed, which produces long flood duration's with peak flow rates well in excess of one (1) day. The daily flow data available for the selected USGS gage (Station No. 02313000) were therefore found acceptable for use in the analysis.

6.4.2 Reservoir Inflow and Discharge Hydrographs

The lake Rousseau reservoir receives flow contributions from three major sources. Two of the sources are gaged including the USGS station near Holder, Florida (No. 02313000) and the USGS Rainbow Springs station near Dunnellon, Florida (No. 02313100). The third inflow consists of runoff from the area surrounding the lake, which is downstream of the Holder gage. The flow contribution measured at the Holder gage is the dominant inflow, with approximately 89 percent of the total contributing watershed to the reservoir being upstream of the gage. The directly contributing ungaged areas surrounding the lake accounts for approximately 11 percent of the total watershed. Rainbow Springs, which has no contributing drainage area, contributes lesser flows than the river at Holder. Flows from each of these sources must be considered in the development of an inflow hydrograph for the lake.

As described above, data from the USGS station near Holder, Florida (No. 02313000) was used to conduct the frequency analysis and to select a 100-year flood event (April 5, 1960). It should be noted that gage data were not available for any of the other three gages used in this study for 1960. As such, flow contribution from Rainbow Springs as well as the areas surrounding the lake for the 100-year flood had to be estimated.

Flood flows for Rainbow Springs were estimated from available gage data for the period of record 1970 to 2002. The highest flow on record (1,060 cfs), which occurred on September 19, 1998, was selected for use in the study. It was assumed that the 1998 daily hydrograph for Rainbow Springs was similar to the 1960 Rainbow Springs daily hydrograph. The assumption that the 1960 flow from Rainbow Springs could be estimated from the 1998 records was based on the fact, that flood flow from the springs is relatively constant in comparison to the river flow. In support of this assumption, it was found that the second highest peak flow at the Holder station occurred on March 21, 1998 and had a magnitude of 5,310 cfs, while the measured flow at Rainbow Springs on this date was 1,030 cfs, which is only 30 cfs different from the measured 1,060 cfs maximum on September 19, 1998.

The daily flow hydrograph for the 100-year event as documented in Section 6.4.1, was added to the daily flow hydrograph for Rainbow Springs (1998) for a similar time base. This was accomplished by superimposing one hydrograph on the other and by assuming peak flows were coincident. This composite hydrograph represents the estimated total **measured** inflow into the reservoir.

This hydrograph was further adjusted to determine the **estimated** total potential outflow from the reservoir. The estimated total potential outflow was computed by adjusting this measured inflow hydrograph by a factor of 1.04. This factor was determined by comparing annual volumes of measured inflow with reservoir outflow volumes from the combined Inglis Dam main gates and

Bypass Channel spillway. These reservoir discharge volumes were determined from the USGS gage stations at each of these locations. The comparison indicated that the measured inflow hydrograph should be incremented by about four (4) percent to account for the ungaged contributing areas and to account for evaporation and other losses from the lake. The estimated 100-year event, total potential discharge hydrograph for the Lake Rousseau system is illustrated on **Figure 15**.

6.4.3 Alternative 4, Baseline Condition Hydrograph

The estimated 100-year event, total potential discharge hydrograph for the Lake Rousseau system was used to estimate discharge from the system under baseline conditions. For baseline conditions discharge would occur from the Inglis Dam main gates and from the Bypass Channel system via the spillway. For this analysis, it was assumed that the bypass channel would be operated at its maximum discharge capacity of 1,540 cfs. Thus, the remaining flow ($8,660 - 1,540 = 7,210$ cfs) would be discharged from the main gates, which have a design capacity of approximately 18,000 cfs. The Inglis Dam main gate discharge hydrograph was constructed by subtracting the constant 1,540 cfs flow (Bypass System) from the total potential discharge hydrograph for the Lake Rousseau system. **Figure 15** illustrates the resultant Inglis Dam main gate hydrograph and the Bypass Channel discharge hydrograph.

6.4.4 Alternative 1, 2, and 3, Proposed Conditions

As indicated in Section 6.3.2, the alternatives proposed as part of this study require a change in the manner in which water is discharged from Lake Rousseau relative to the baseline condition. Proposed modifications to the system that will be assessed include making the Inglis Dam main gates the primary discharge point for the system and re-sizing the Bypass Channel system. This reservoir outflow will be manipulated in the hydraulic study to determine its destination (i.e. all directly to the Withlacoochee, or a portion to a Bypass Channel etc.). For the alternatives modeling, the total potential outflow from the reservoir is required. The total potential discharge hydrograph for the Lake Rousseau system is the hydrograph that will be used to assess Alternatives 1 and 2. **Figure 16** illustrates the discharge hydrograph that will be used for these alternatives. Alternative 3 requires increasing the discharge capacity of the Bypass Channel system. The maximum allowable flow rate of the proposed Bypass Channel system will be determined as part of this study. The allowable discharge hydrograph for the bypass system will be abstracted from the total potential discharge hydrograph for the Lake Rousseau system (Figure 16) to develop the Inglis Dam main gate discharge hydrograph.

The potential outflow for the alternatives may therefore, be different from the baseline condition due to different gate manipulations to meet downstream demand criteria. The potential outflow for use in the alternatives assessment should then be an estimate of outflow without current reservoir manipulations. The long-term flow hydrograph for the Lake Rousseau outflow was determined as described below.

6.5 Tide Stage Hydrographs

An analysis was conducted to determine tidal conditions in the Withlacoochee River. This tidal information was used to develop tide stage hydrographs for long-term flow and flood flow model

simulations. The tide stage hydrographs were used as downstream boundary conditions in the simulation models.

Tidal stage hydrographs for the boundary at the Gulf of Mexico were developed from the NOAA Cedar Key tide station (NOAA Station No. 8727520). Hourly tide data were estimated for several years by NOAA. NOAA made estimates of tidal variations at the mouth of the Withlacoochee River from data for the Cedar Key station. NOAA's estimates were provided in Mean Lower Low Water datum (MLLW) and were converted to NGVD by using the relationship between NGVD and MLLW for Cedar Key.

6.5.1 Long-term Flow Assessment

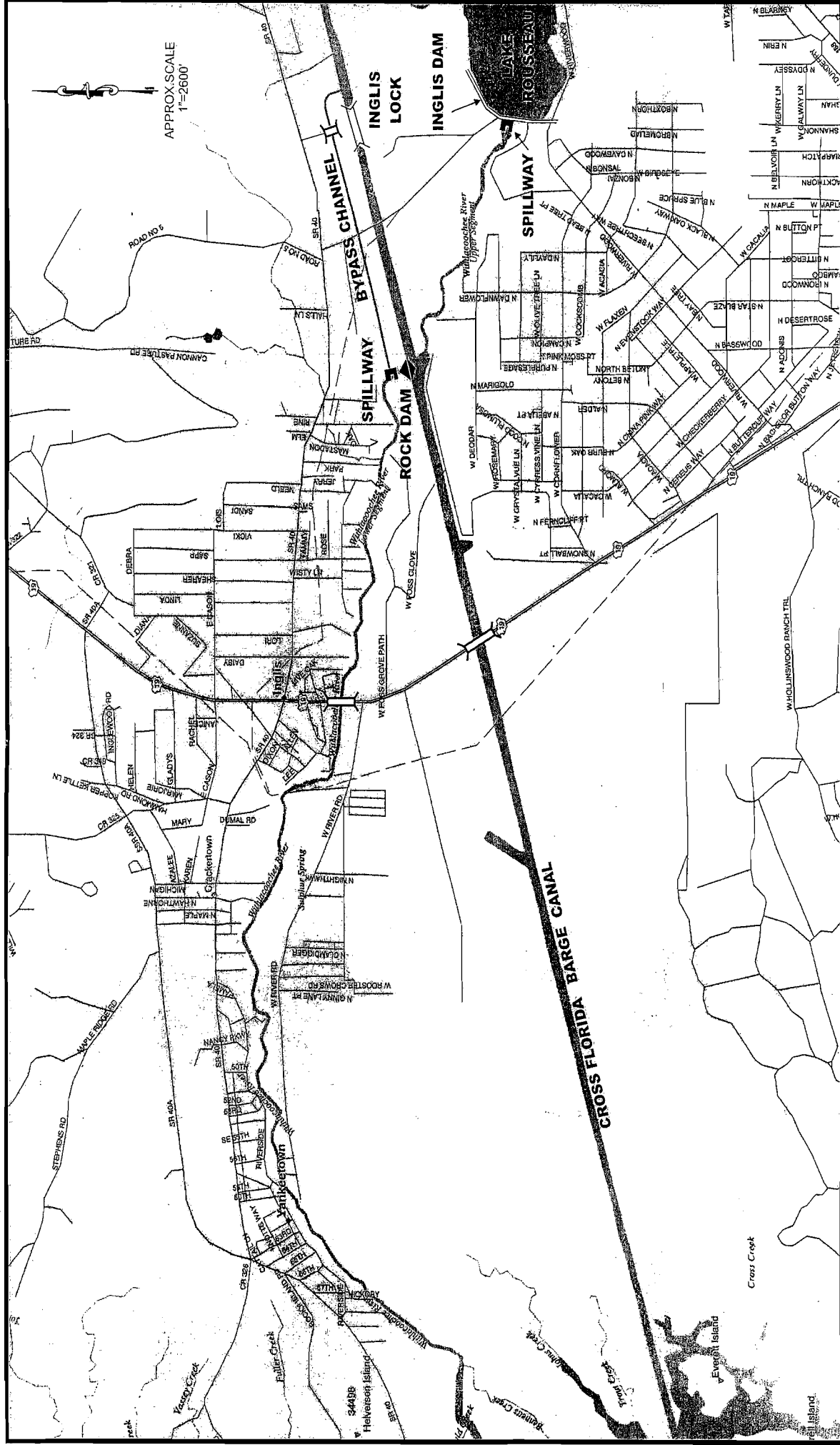
Hourly tide data for the year 1996 was selected for use in the long-term flow assessment. This year was selected to correlate with the "Average Year" condition for the Withlacoochee River system as detailed in Section 6.3. **Figure 17** illustrates the first 50 days of record for the 1996 tidal variation of the Withlacoochee River near the mouth. The maximum tide stage during the year was 5.88 ft-NGVD and occurred on June 30, and the minimum was tide stage was 0.48 ft-NGVD and occurred on January 18. This information will be used as the downstream boundary condition for all of the proposed alternatives assessments of natural systems and water quality.

6.5.2 Flood Flow Assessment

Hourly tide data for the year 1960 was selected for use in the flood flow assessment. This year was selected to correlate with the 100-year flood event on the Withlacoochee River system as detailed in Section 6.4. This information will be used as the downstream boundary condition for all of the proposed alternatives assessment of flooding.

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FIGURES

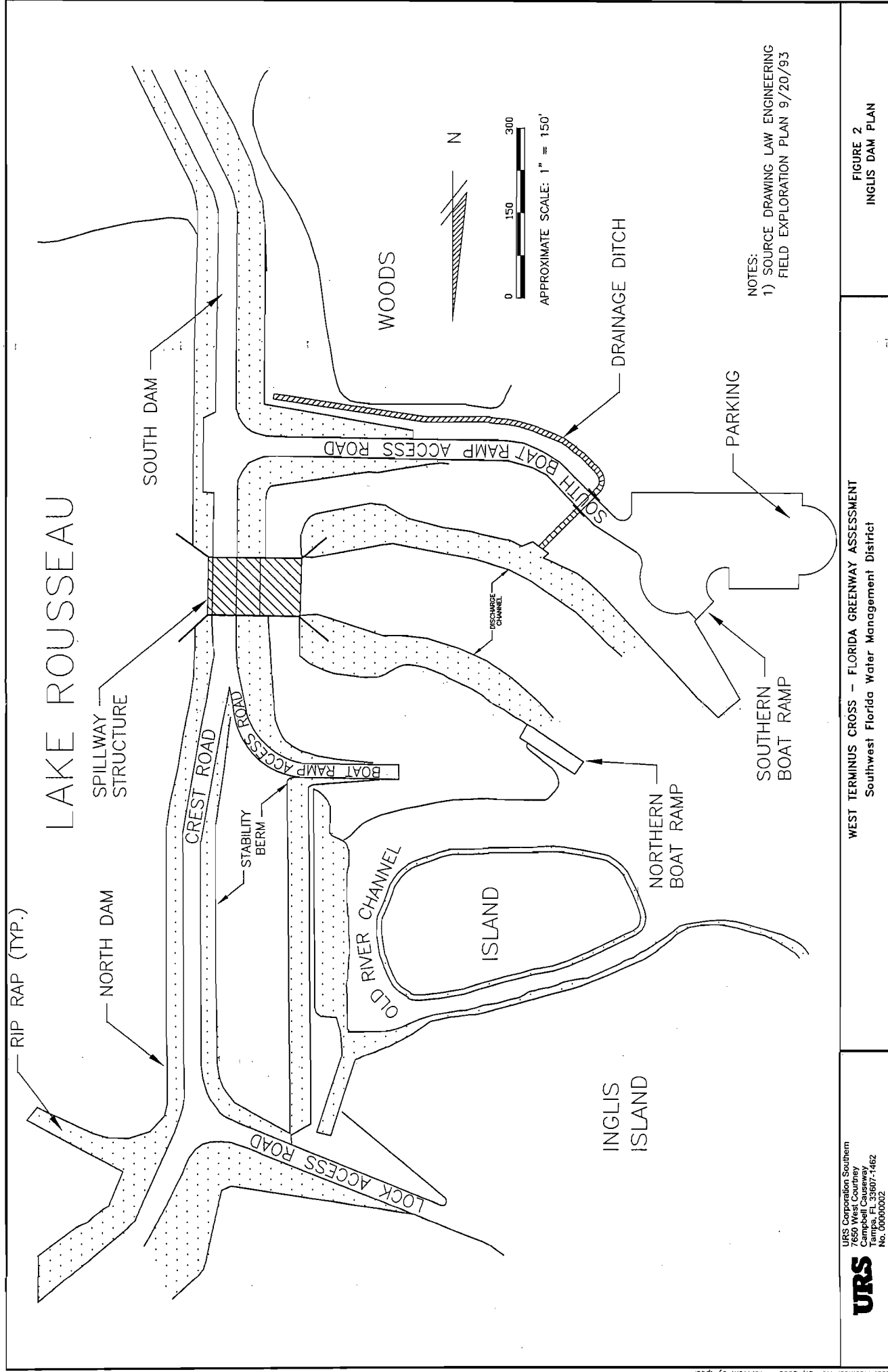


APPROX SCALE
1"=2600'

FIGURE 1
CROSS-FLORIDA BARGE CANAL
SYSTEM COMPONENTS

WEST TERMINUS CROSS - FLORIDA GREENWAY ASSESSMENT
Southwest Florida Water Management District





URS Corporation Southern
7650 West Courtney
Campbell Causeway
Tampa, FL 33607-1462
No. 00060002

URS

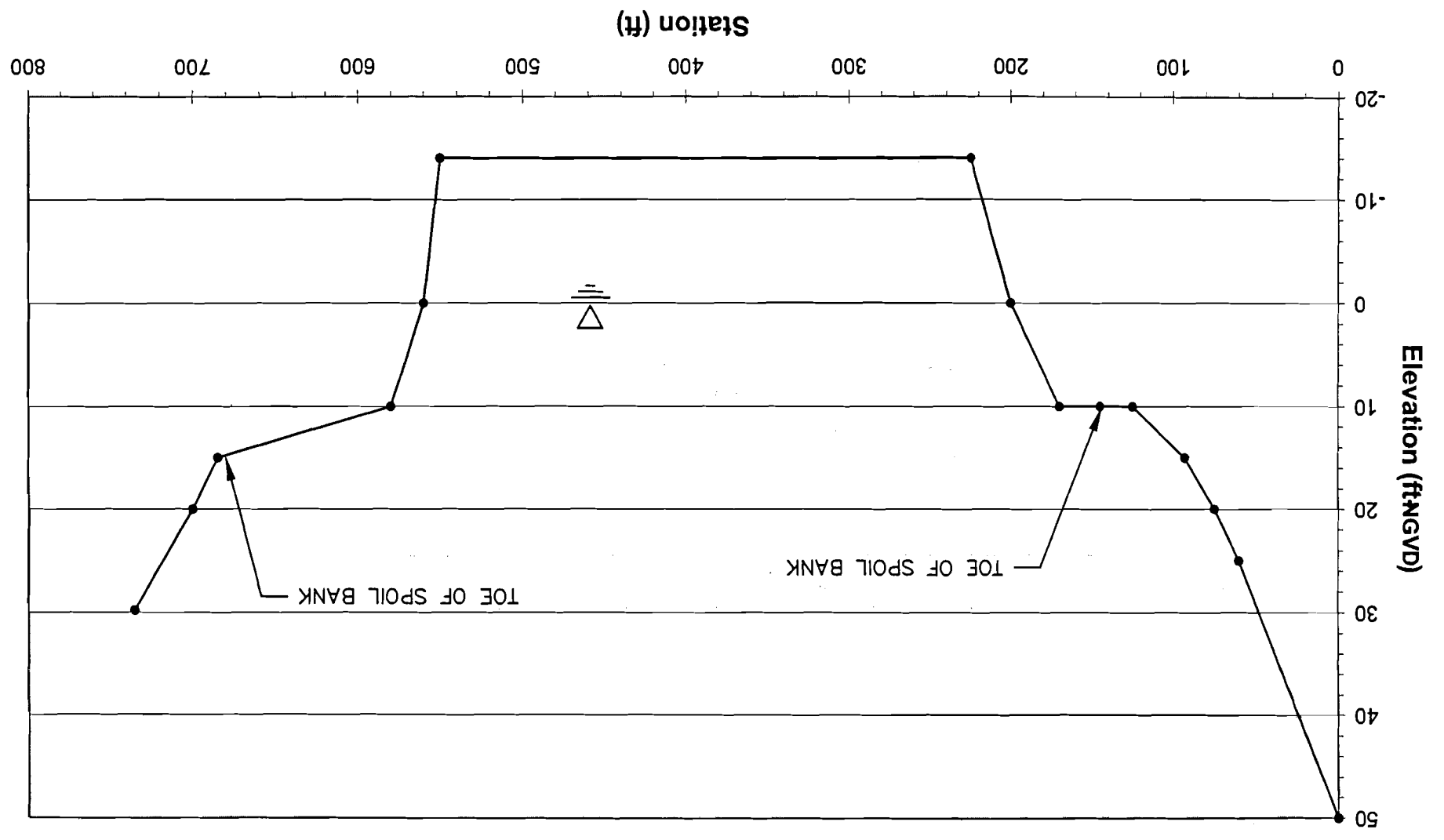
WEST TERMINUS CROSS - FLORIDA GREENWAY ASSESSMENT
Southwest Florida Water Management District

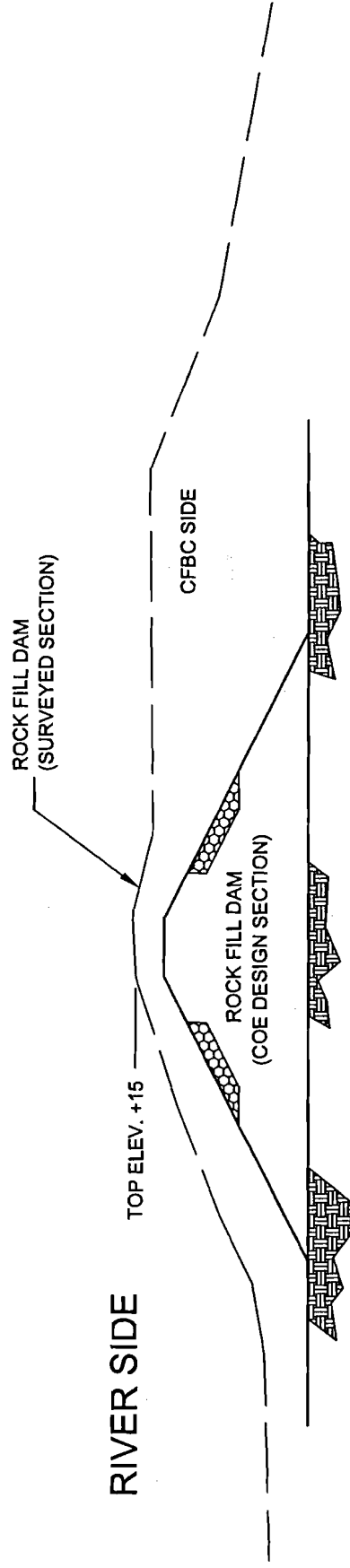
FIGURE 2
INGLIS DAM PLAN

URS
URS Corporation Southern
7850 West Courtney
Campbell Causeway
Tampa, FL 33607-1482
NO. 00000002

WEST TERMINUS CROSS - FLORIDA GREENWAY ASSESSMENT
Southwest Florida Water Management District

FIGURE 3
BARGE CANAL CROSS-SECTION
(Typical)





Survey Performed February 2001



SCALE: 1" = 30'

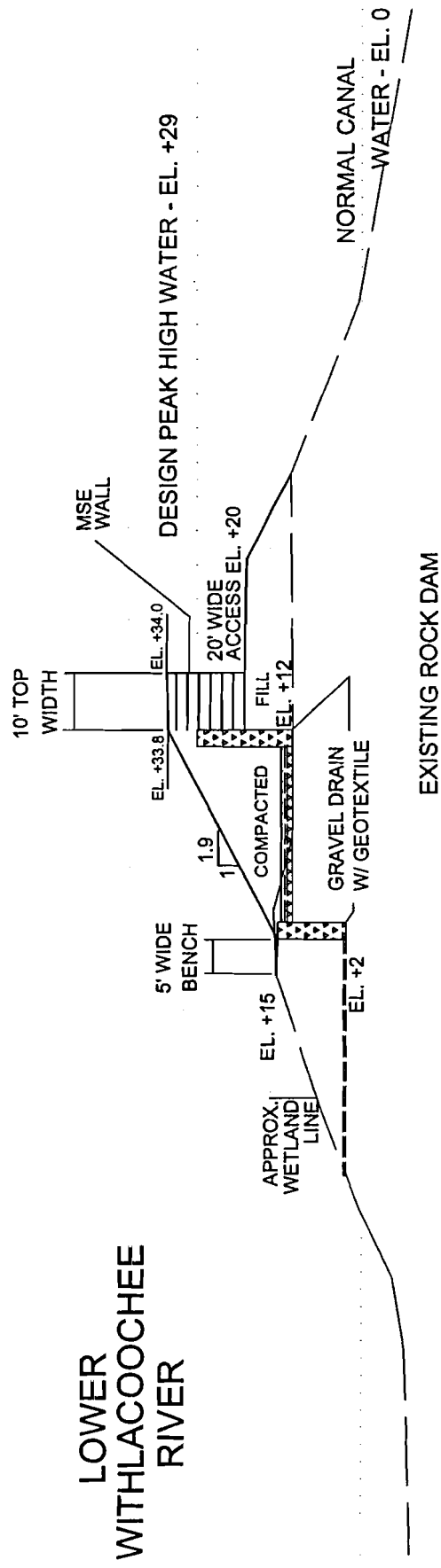
URS Corporation Southern
7880 West Courtney
Campbell Causeway
Tampa, FL 33607-1462
No. 00000002

URS

WEST TERMINUS CROSS - FLORIDA GREENWAY ASSESSMENT
Southwest Florida Water Management District

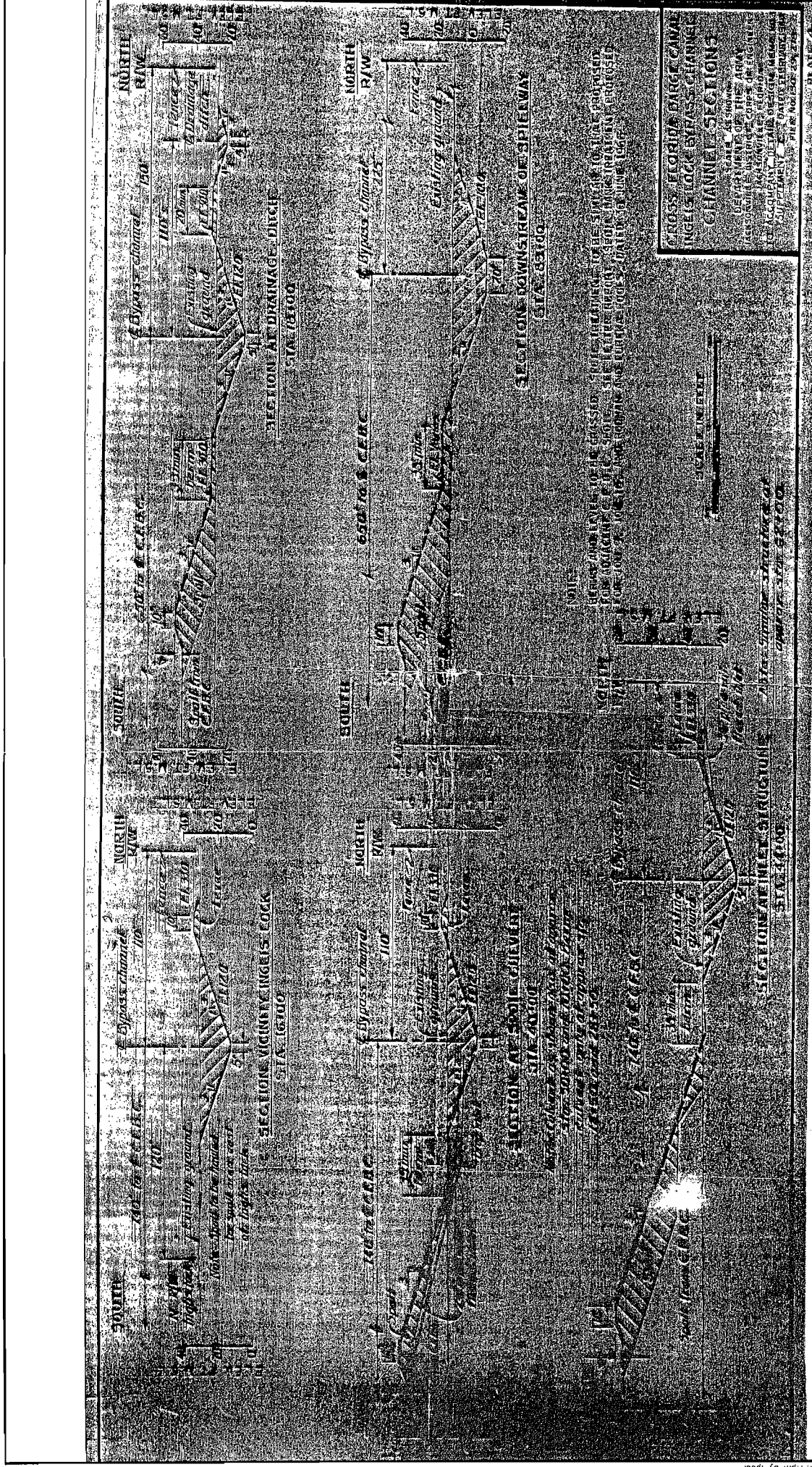
FIGURE 4
ROCK DAM - EXISTING SECTION

CROSS FLORIDA BARGE CANAL



Note: All elevations are stated in feet NGVD.



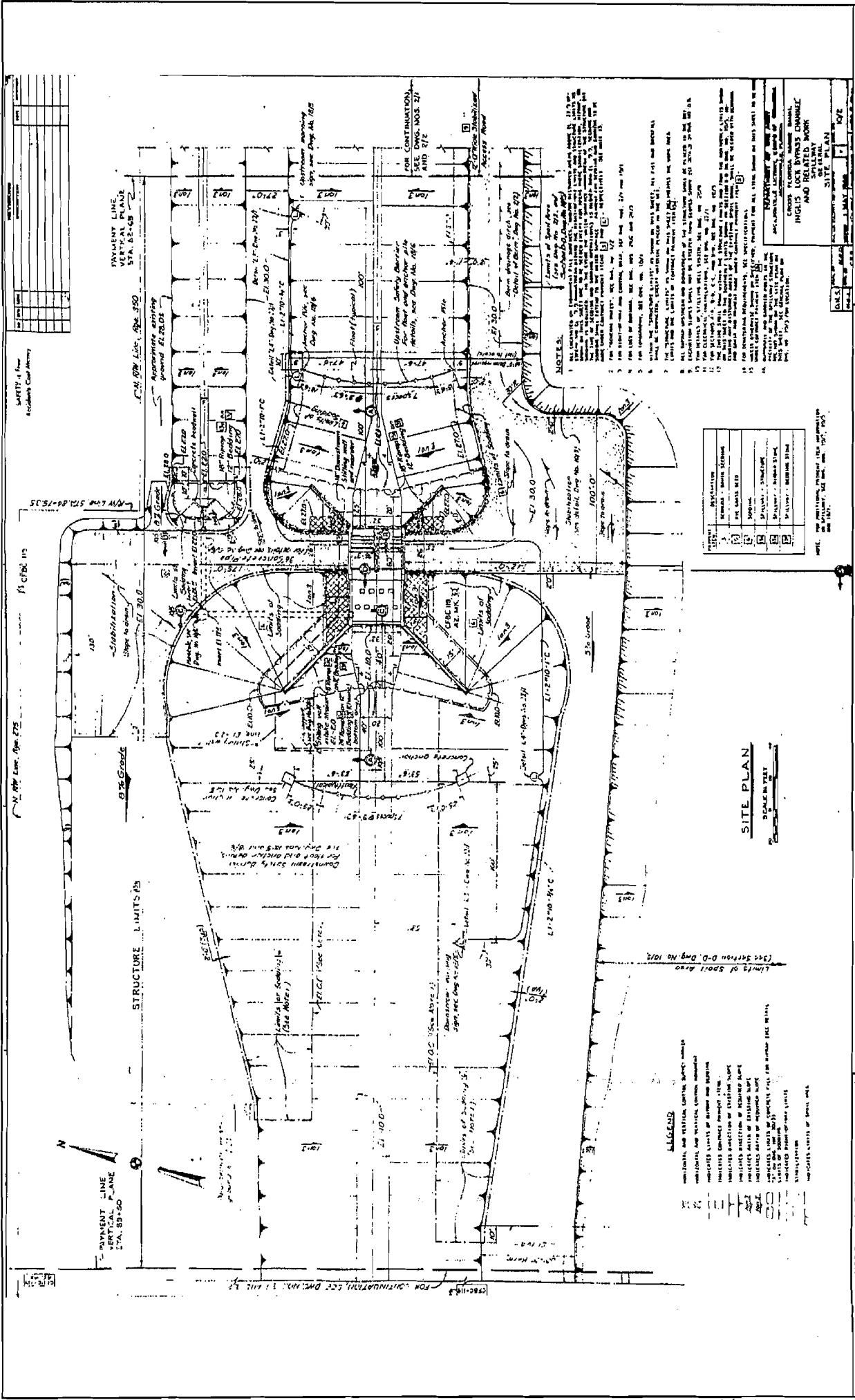


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Campbell Causeway
Houston, TX 77063-1662
No. 00000002

URS

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Southwest Florida Water Management District

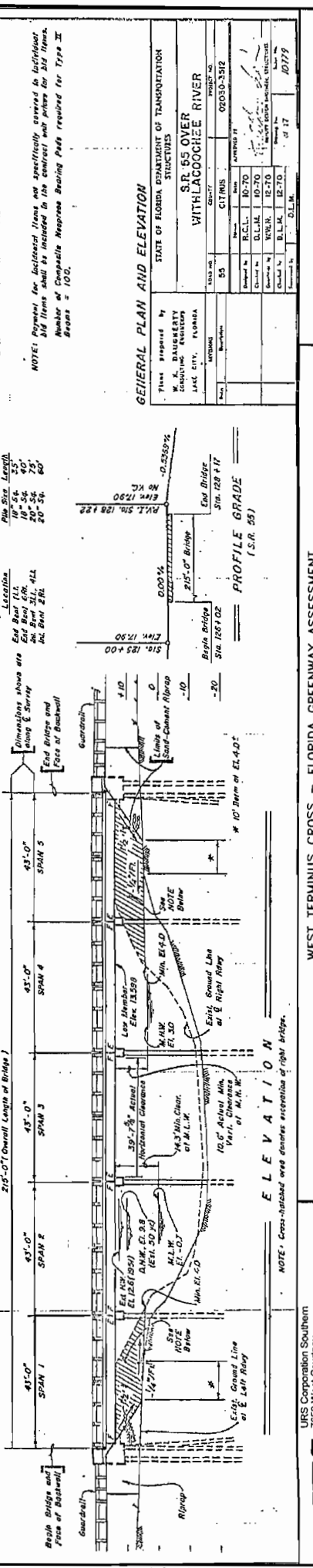
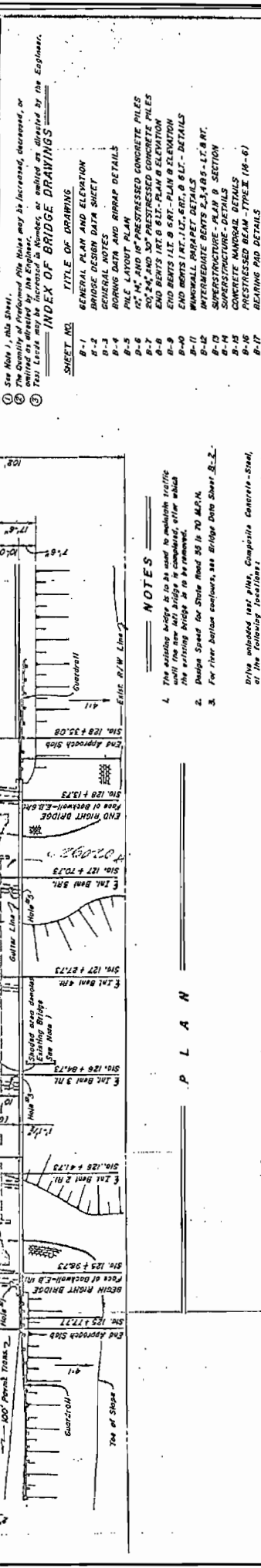
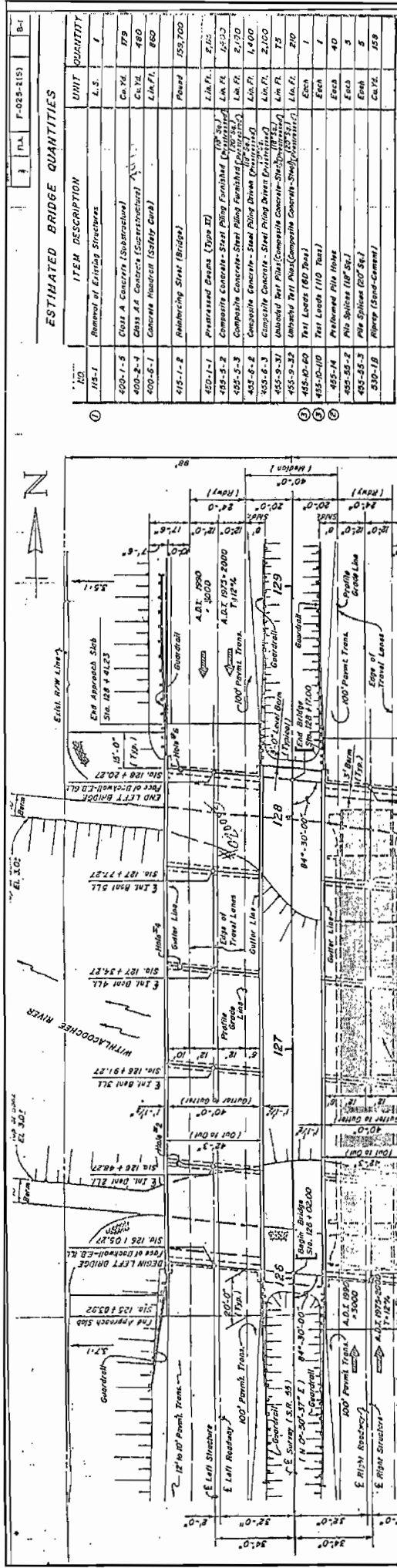
FIGURE 6
BYPASS CHANNEL CROSS-SECTIONS



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FIGURE 7
 BYPASS CHANNEL SPILLWAY



ESTIMATED BRIDGE QUANTITIES		
ITEM NO.	ITEM DESCRIPTION	UNIT QUANTITY
420-1-1	Removal of Existing Structures	L.S.
420-1-2	Class A Concrete (Substructure)	Cu Yd
420-1-3	Class A Concrete (Superstructure)	Cu Yd
420-1-4	Class A Concrete (Structural)	Cu Yd
420-1-5	Class A Concrete (Structural)	Cu Yd
420-1-6	Class A Concrete (Structural)	Cu Yd
420-1-7	Class A Concrete (Structural)	Cu Yd
420-1-8	Class A Concrete (Structural)	Cu Yd
420-1-9	Class A Concrete (Structural)	Cu Yd
420-1-10	Class A Concrete (Structural)	Cu Yd
420-1-11	Class A Concrete (Structural)	Cu Yd
420-1-12	Class A Concrete (Structural)	Cu Yd
420-1-13	Class A Concrete (Structural)	Cu Yd
420-1-14	Class A Concrete (Structural)	Cu Yd
420-1-15	Class A Concrete (Structural)	Cu Yd
420-1-16	Class A Concrete (Structural)	Cu Yd
420-1-17	Class A Concrete (Structural)	Cu Yd
420-1-18	Class A Concrete (Structural)	Cu Yd
420-1-19	Class A Concrete (Structural)	Cu Yd
420-1-20	Class A Concrete (Structural)	Cu Yd
420-1-21	Class A Concrete (Structural)	Cu Yd
420-1-22	Class A Concrete (Structural)	Cu Yd
420-1-23	Class A Concrete (Structural)	Cu Yd
420-1-24	Class A Concrete (Structural)	Cu Yd
420-1-25	Class A Concrete (Structural)	Cu Yd
420-1-26	Class A Concrete (Structural)	Cu Yd
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420-1-97	Class A Concrete (Structural)	Cu Yd
420-1-98	Class A Concrete (Structural)	Cu Yd
420-1-99	Class A Concrete (Structural)	Cu Yd
420-1-100	Class A Concrete (Structural)	Cu Yd

INDEX OF BRIDGE DRAWINGS

SHEET NO. _____

TITLE OF DRAWING

8-1 GENERAL PLAN AND ELEVATION
8-2 BRIDGE DESIGN DATA SHEET
8-3 GENERAL NOTES
8-4 WORKING DATA AND RAMP DETAILS
8-5 PILE AND PILE CAP DETAILS
8-6 20" DIA. AND 30" DIA. PRESTRESSED CONCRETE PILES
8-7 END BENTS 1 & 2 - PLAN & ELEVATION
8-8 END BENTS 1 & 2 - PLAN & ELEVATION
8-9 END BENTS 1 & 2 - PLAN & ELEVATION
8-10 END BENTS 1 & 2 - PLAN & ELEVATION
8-11 END BENTS 1 & 2 - PLAN & ELEVATION
8-12 END BENTS 1 & 2 - PLAN & ELEVATION
8-13 END BENTS 1 & 2 - PLAN & ELEVATION
8-14 END BENTS 1 & 2 - PLAN & ELEVATION
8-15 END BENTS 1 & 2 - PLAN & ELEVATION
8-16 END BENTS 1 & 2 - PLAN & ELEVATION
8-17 END BENTS 1 & 2 - PLAN & ELEVATION

GENERAL PLAN AND ELEVATION

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
STRUCTURES

Drawn by: _____
Checked by: _____
Reviewed by: _____

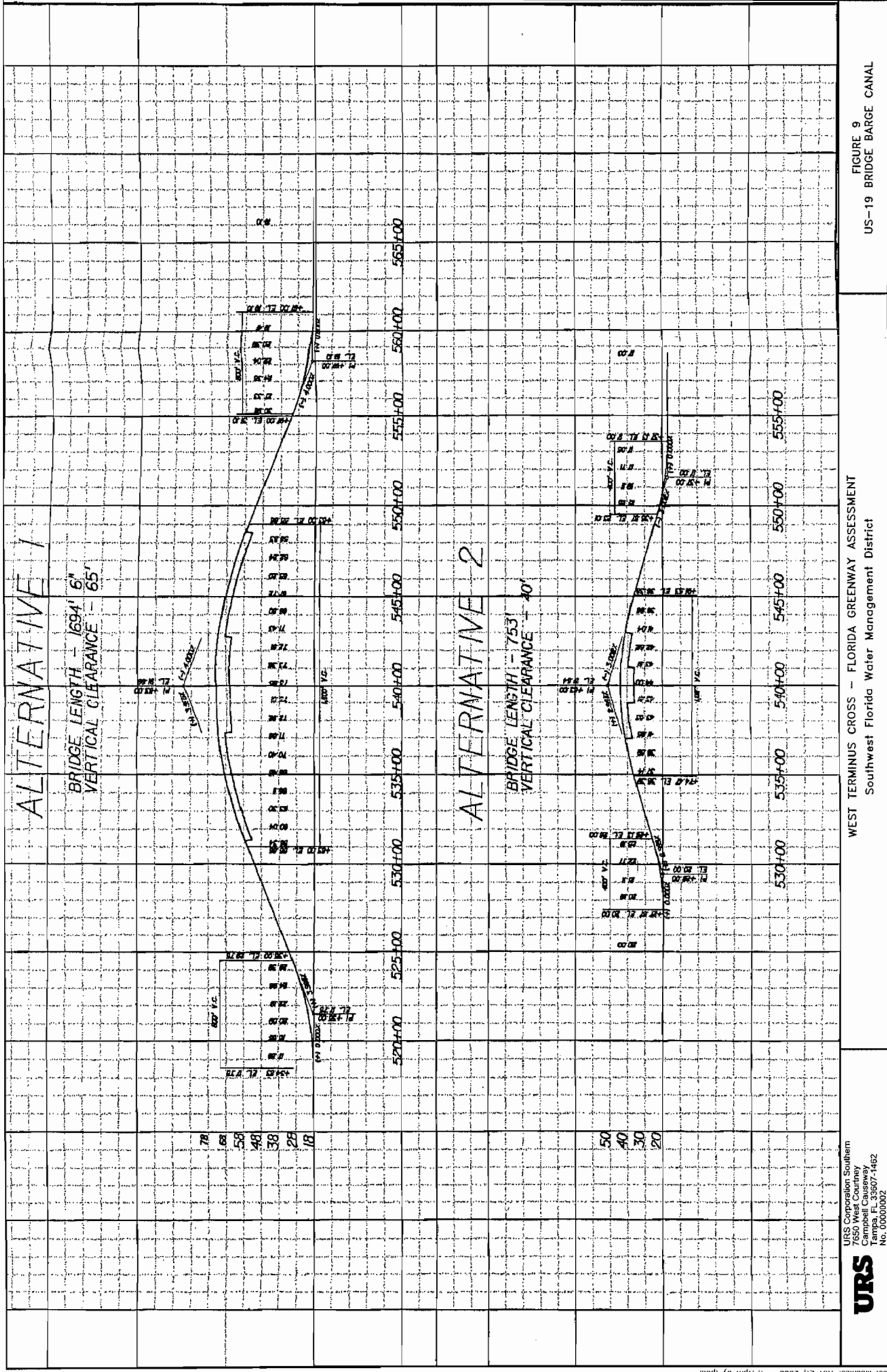
Project No.: 02030-3512
Sheet No.: 8-1

DATE: _____

FIGURE 8
US-19 BRIDGE WITHLACOCHEE RIVER

WEST TERMINUS CROSS - FLORIDA GREENWAY ASSESSMENT
Southwest Florida Water Management District

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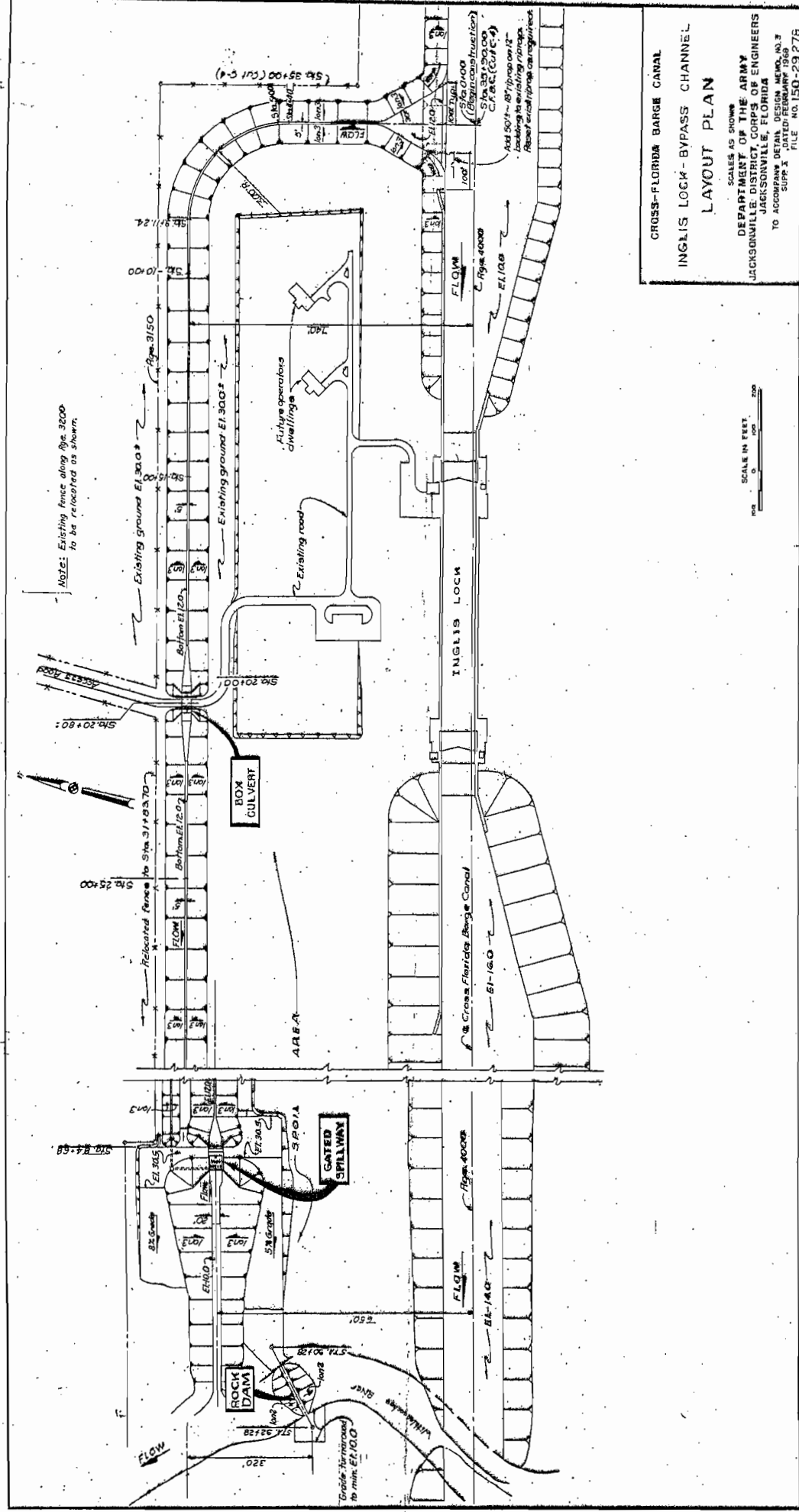


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FIGURE 9
 US-19 BRIDGE BARGE CANAL



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FIGURE 10
BYPASS CHANNEL SYSTEM LAYOUT PLAN

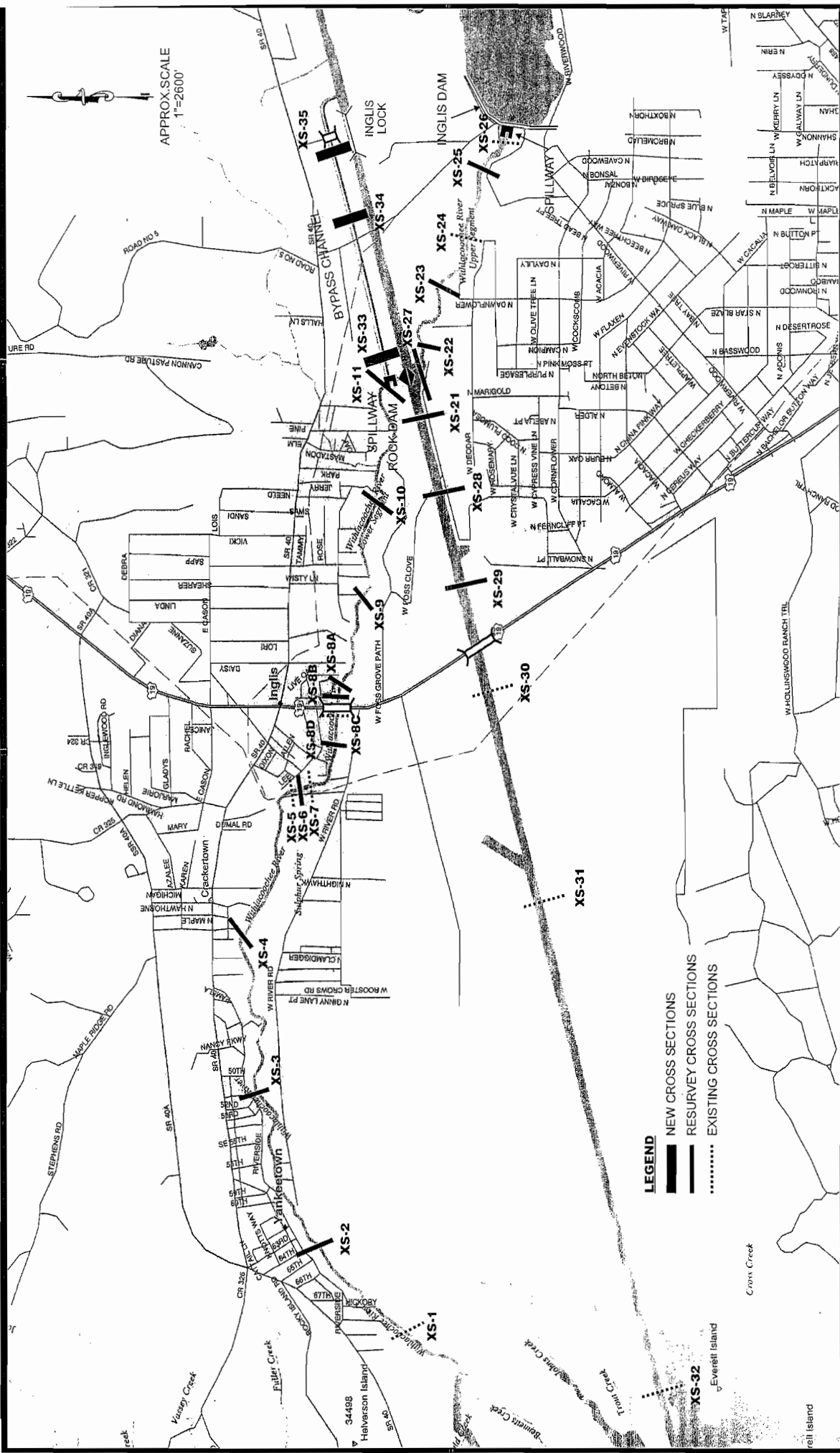
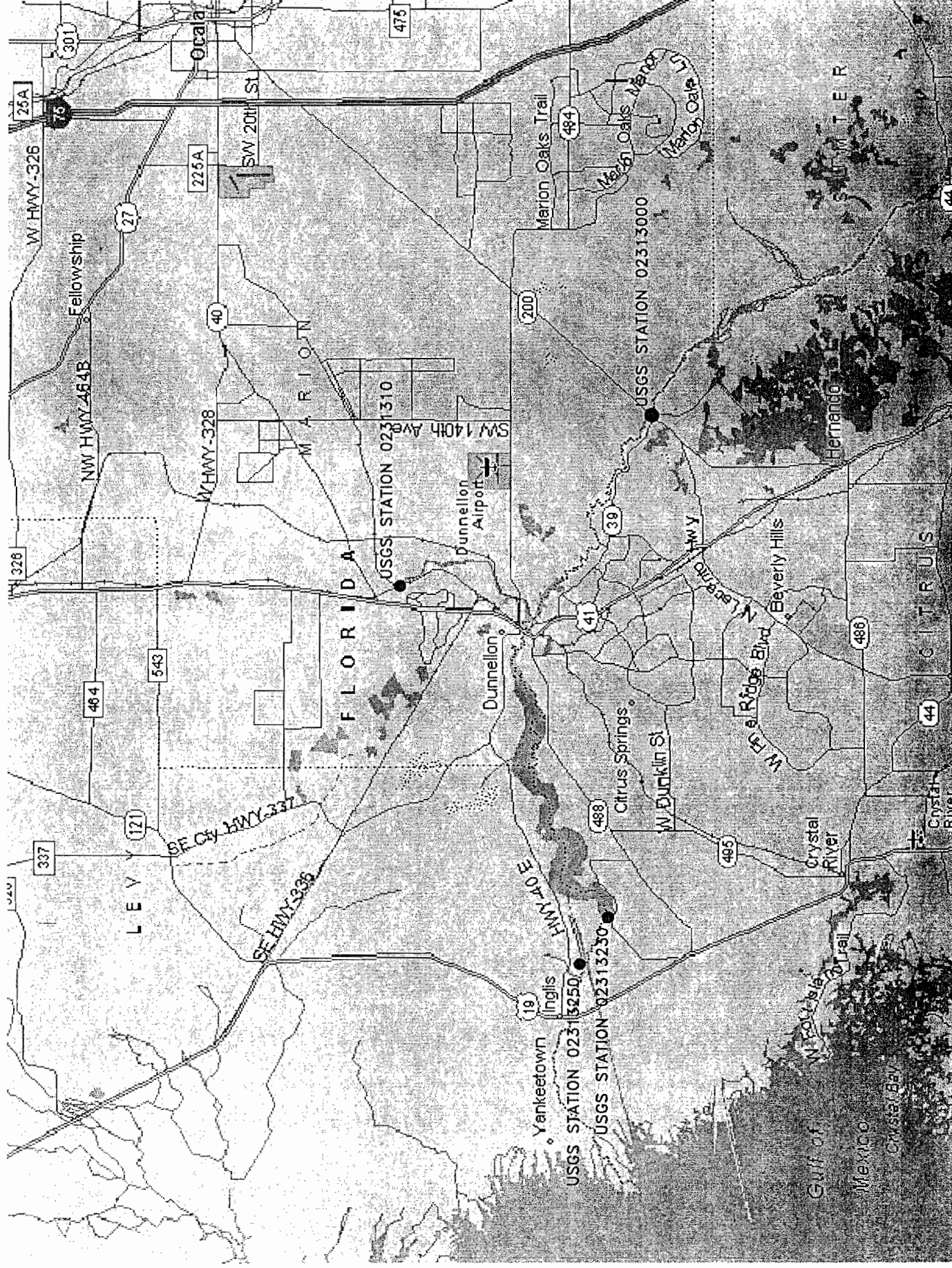


FIGURE II
ADDITIONAL LAND SURVEY LOCATIONS

WEST TERMINUS - CROSS FLORIDA GREENWAY ASSESSMENT
Southwest Florida Water Management District

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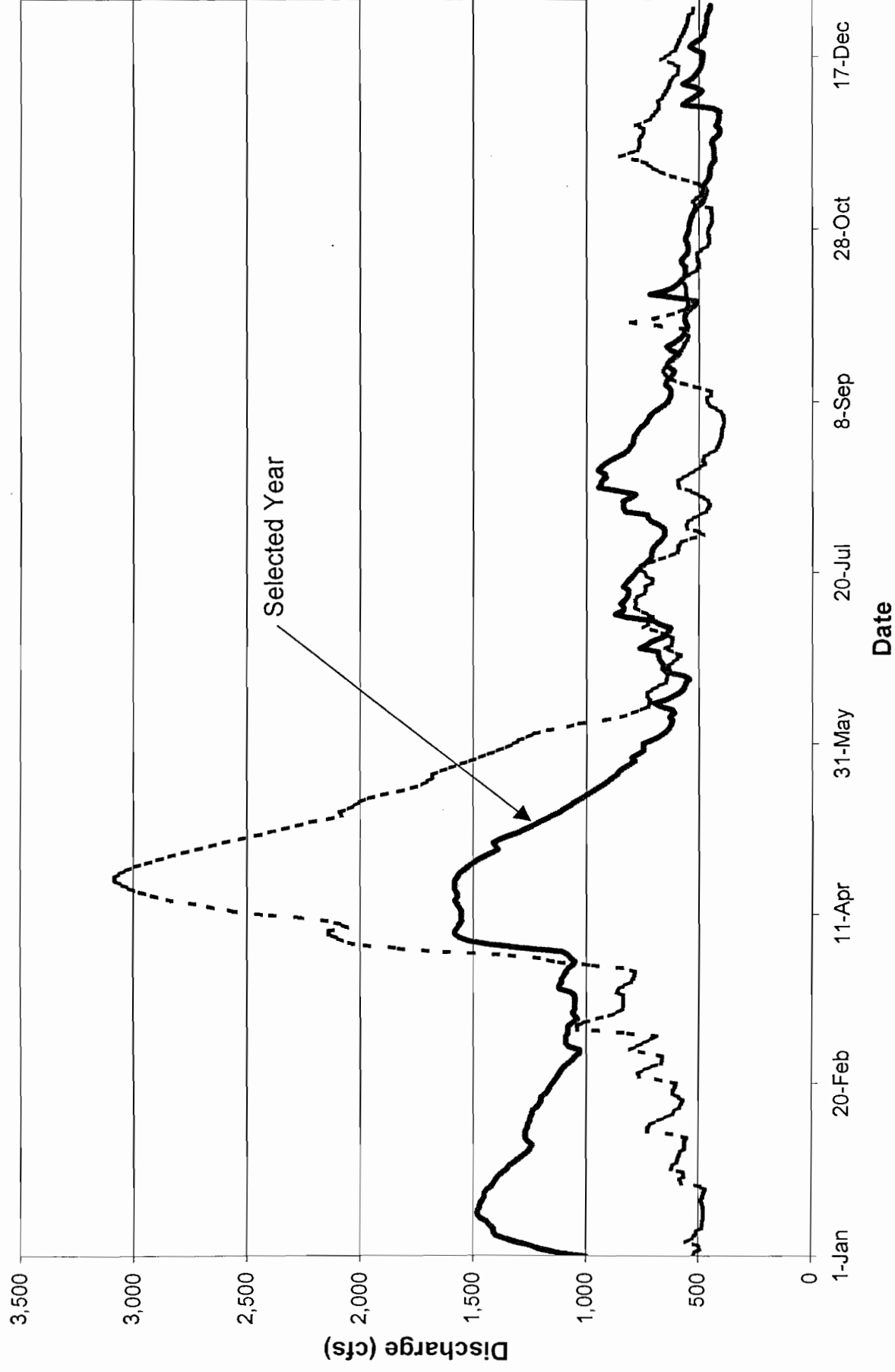
URS Corporation Southern
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 Tampa, FL 33607-1462
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 Southwest Florida Water Management District

FIGURE 12
 USGS GAGE LOCATIONS

Comparison of Daily Streamflow for Median Years (Withlacochee River near Holder, Florida)



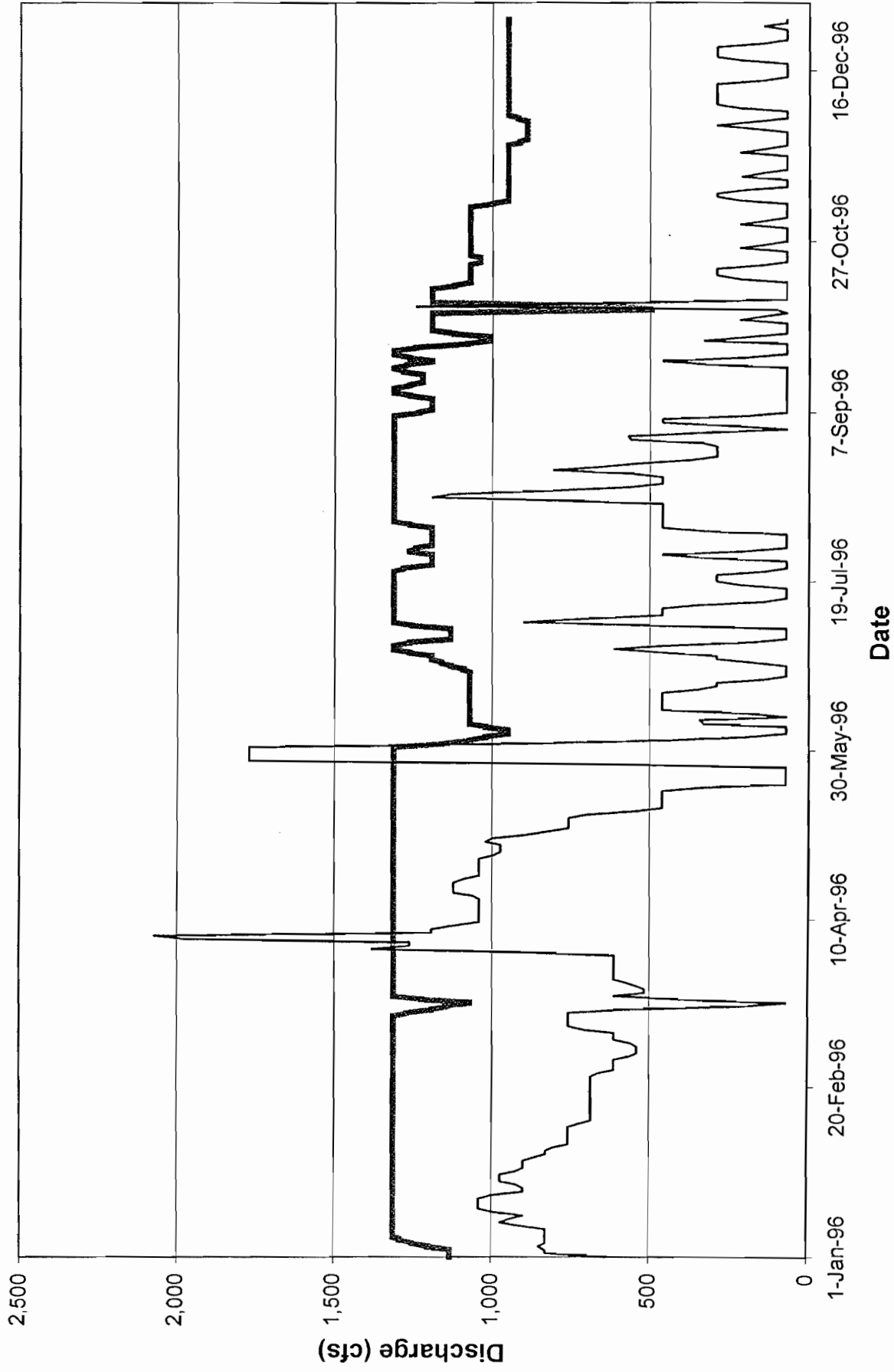
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No. 00000002

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FIGURE 13
COMPARISON OF DAILY STREAMFLOW
FOR MEDIAN YEARS

Lake Rousseau Median Year Discharge Alternative 4 (Baseline Condition)



Bypass Channel
 Inglis Dam Main Gates

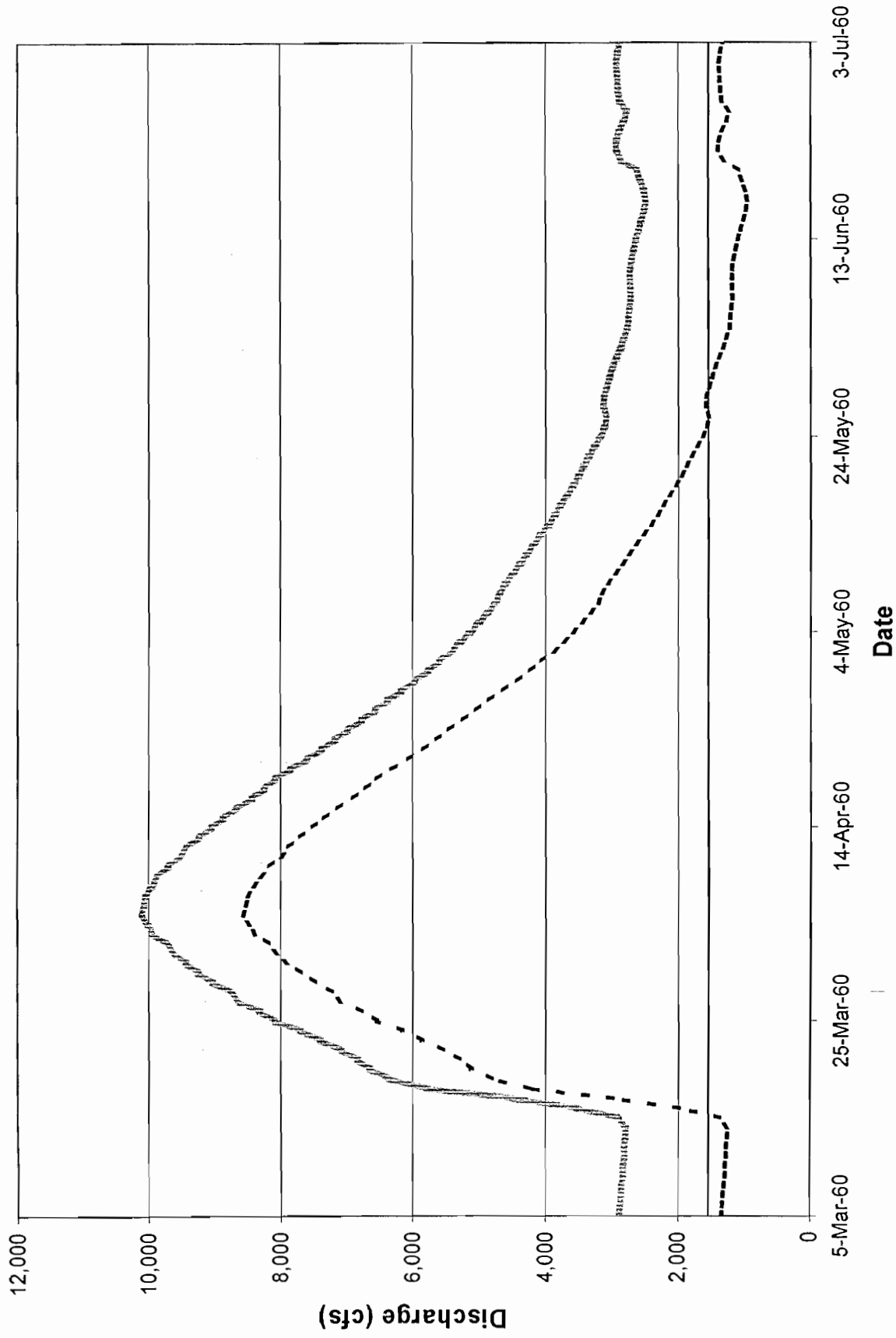
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 Southwest Florida Water Management District

FIGURE 14
 LAKE ROUSSEAU MEDIAN YEAR DISCHARGE
 ALTERNATIVE 4 (Baseline Condition)

Lake Rousseau 100-year Discharge Alternative 4 (Baseline Condition)



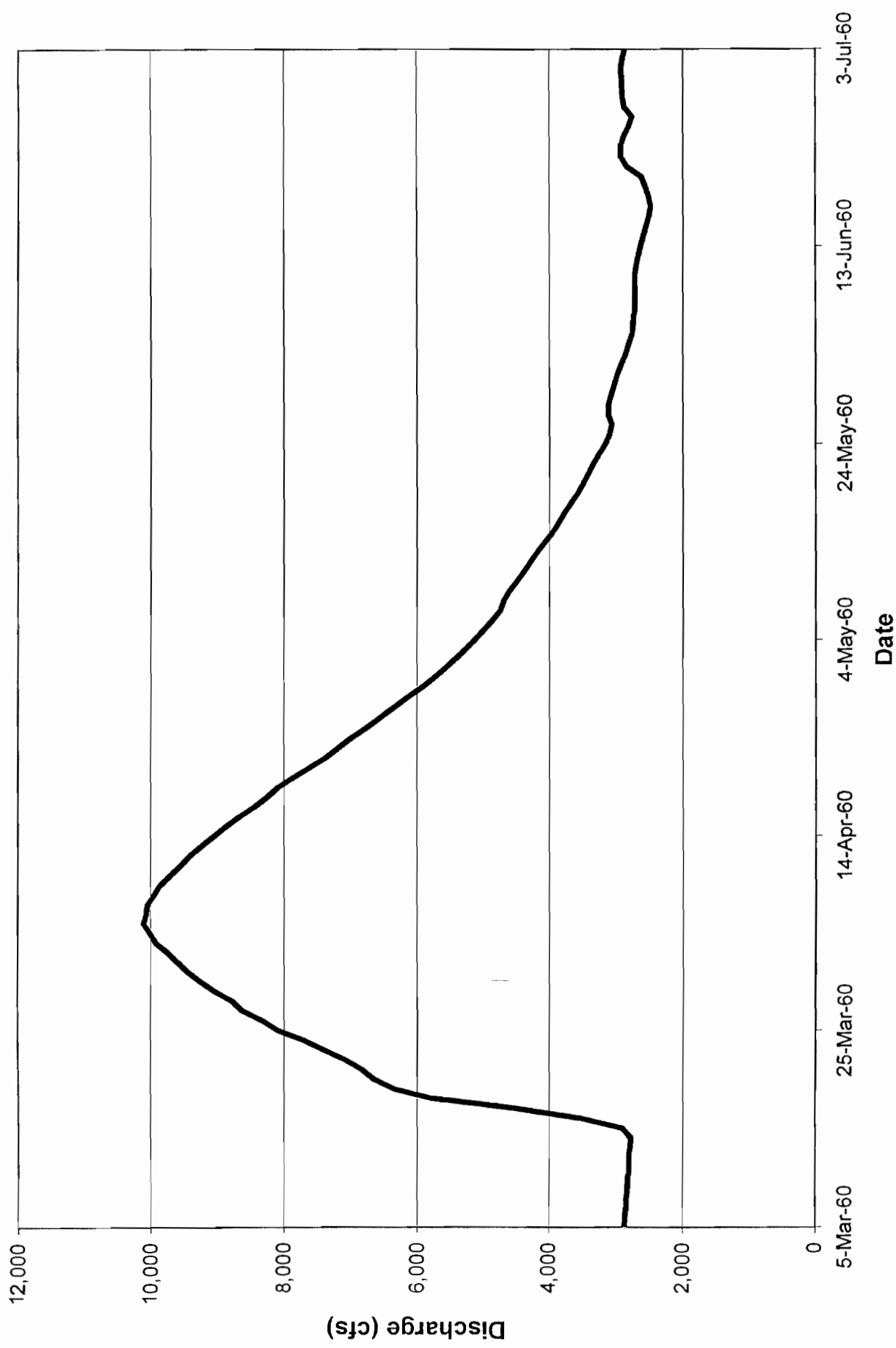
100-yr Total Potential Discharge
 Inglis Main Gate Discharge

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 Tampa, FL 33607-1462
 No. 00000002

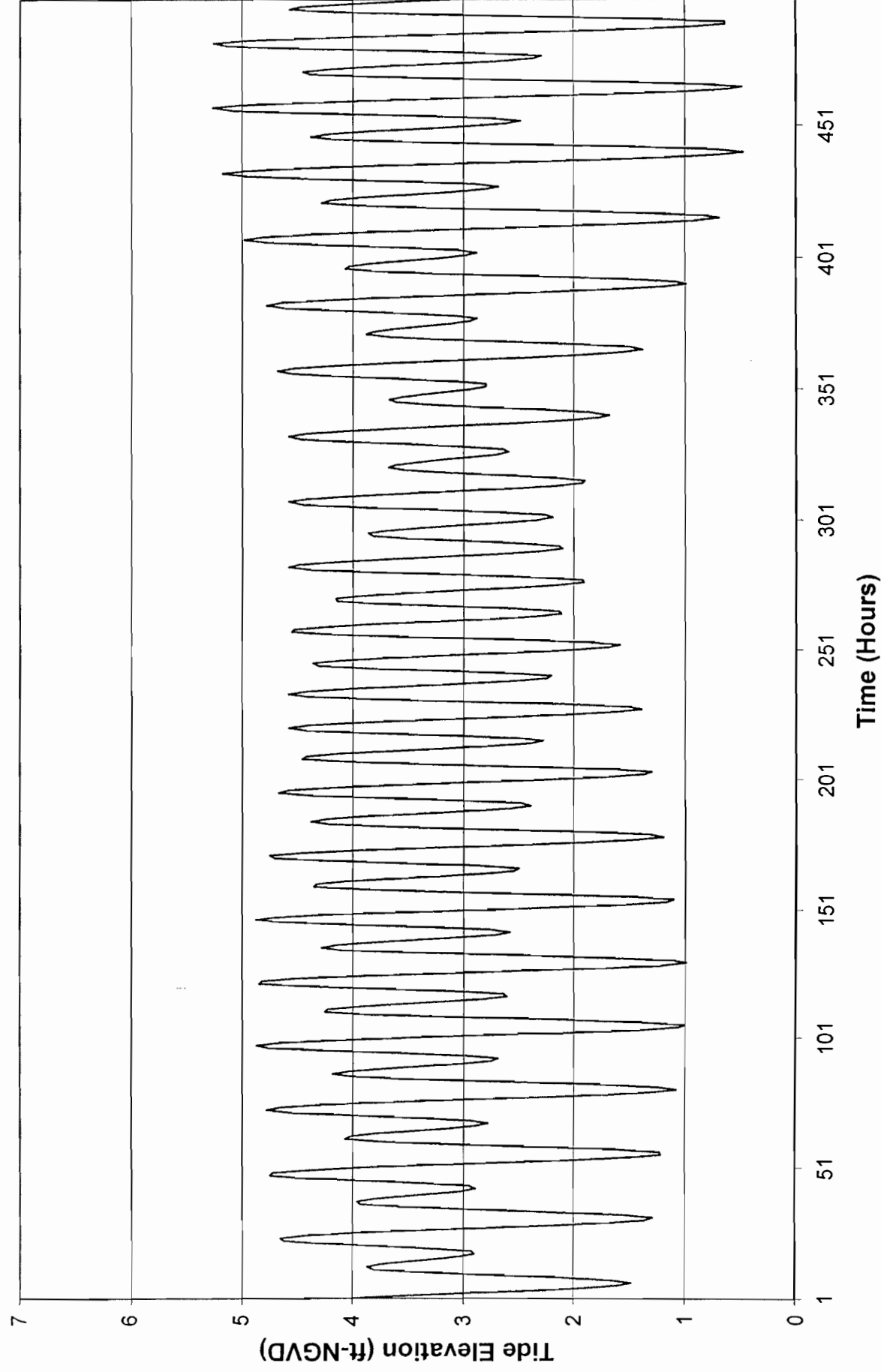
WEST TERMINUS CROSS - FLORIDA GREENWAY ASSESSMENT
 Southwest Florida Water Management District

FIGURE 15
 LAKE ROUSSEAU 100-YEAR DISCHARGE
 ALTERNATIVE 4 (Baseline Condition)

Lake Rousseau 100-year Discharge Alternatives 1, 2 and 3



**Withlacochee River Tidal Variation - Median Year
Baseline Condition (First 500 hours of 1-Year Dataset)**



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Southwest Florida Water Management District

FIGURE 17
WITHLACOOCHEE RIVER TIDAL VARIATION-MEDIAN YEAR
BASELINE CONDITION

APPENDIX A

FIELD RECONNAISSANCE SUMMARY – SEPTEMBER 12, 2003

WEST TERMINUS – CROSS FLORIDA GREENWAY ASSESSMENT
Field Reconnaissance Summary – September 12, 2003

- Attendees:
 - Lisann Morris/SWFWMD
 - Dale Ravencraft/SWFWMD
 - Joe Ruperto/URS
 - Mike Walters/URS
 - Kevin Conner/URS
 - Jim Wolfe/FDEP-OGT

- Met at 10:15 a.m.

- Spoke to Mayor of Inglis:
 - Only minor flooding problems in Inglis due to Withlacoochee River.
 - Mayor specifically identified Palm Circle Dr., south of SR-40 and east of US 19.

- Visited Palm Circle Drive in the afternoon:
 - Review of mapping indicates that ground elevation in the vicinity of residential buildings is 9 ft. Riverbank elevation is 5 ft, and yard elevations range from 5 ft to 8ft.

- Visited Yankeetown Town Hall:
 - Met with Fire Department Lt. Rob Kubustek to discuss local tide induced flooding.
 - Rob indicated that the tides in Yankeetown are not well represented by the nearest NOAA tide gauge. He believes there are timing and height differences.
 - Rob offered to provide his tide information.
 - Contact numbers:
 - (352) 447-0118 (home)
 - (352) 447-4643 (office)
 - (352) 506-0008 (pgr)
 - Received a copy of the Yankeetown Watershed Management Plan by JEA. There are two areas indicated to flood by tidal influence including:
 - 1 West end of town in the vicinity of Magnolia, and
 - 2 Town center between 62nd and 66th Streets.

- Visited the sites indicated above in the morning:
 - In general Hickory Ave., Magnolia Ave and Palm Dr. are very low. River bank elevations as well as yard elevations are below elevation 5 ft. See Photos 1 through 6.
 - 22 Palm Dr. (McCrimmon) has a Finished Floor E1= 7.01 ft. The owner provided the following information:
 - Had 1ft water in house 1993, and
 - Had 1"-2" water in house 1996
 - Marina at Hickory, see Photo 7.

- The area on Riverside Drive between 63rd and 64th Streets (north side) is all below elevation 4 ft with the riverbank at or below elevation 5 ft. See Photo 8.
- Visited Coast Guard Station.
 - See Photo 9.
- Visited the Rock Dam Construction Site and the Bypass Channel Spillway.
 - See Photos 10 through 12.
 - Note that spillway was releasing 1,540 cfs allowable maximum.
- Visited Inglis Lock.
- Visited Inglis Dam.
 - See Photo 13.
- Visited the upper segment of the river just below the dam via Dawnflower Ave. and Deoder.



Photo 1: House on Magnolia Avenue with stain line.



Photo 2: Canal on east side of Magnolia Avenue, Rob Kubistek residence.



Photo 3: Canal at Magnolia Avenue terminus looking south towards river.



Photo 4: Looking west across canal at above location.



Photo 5: Canal at Palm Drive terminus looking southwest towards river.



Photo 6: Looking west across canal at above location.



Photo 7: Hickory Avenue Marina looking north towards wetland on right bank.

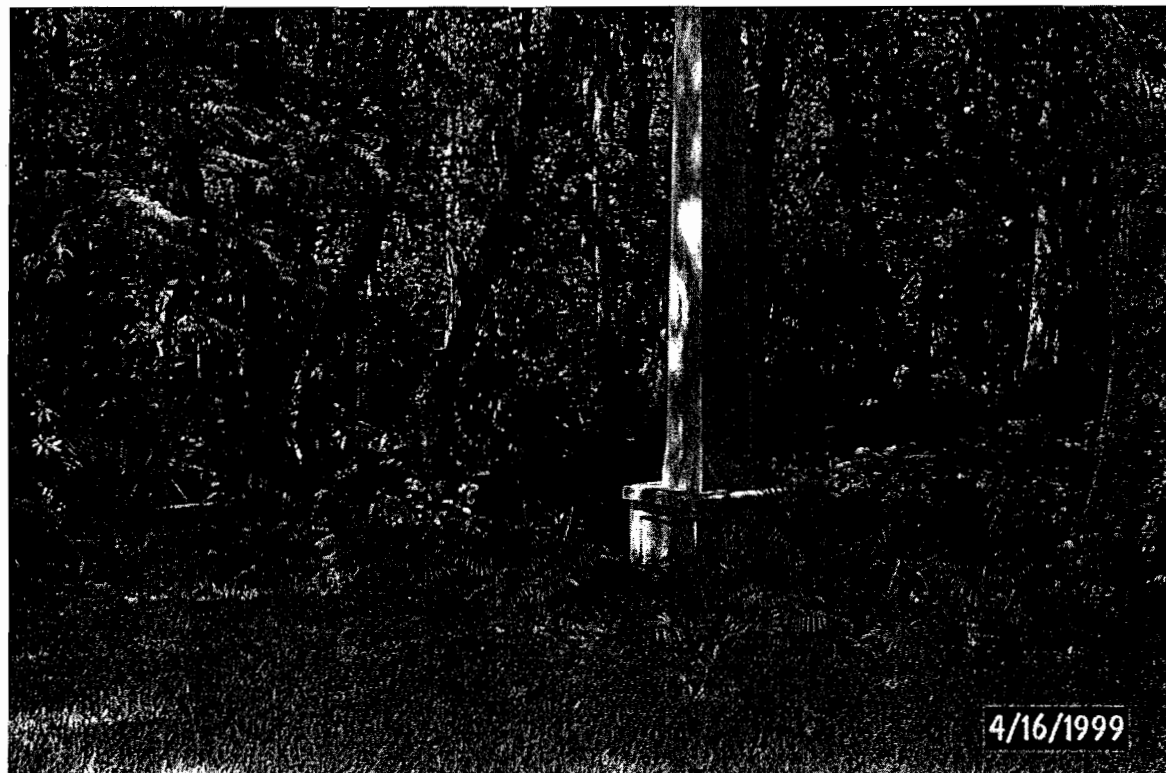


Photo 8: Depressional area at Riverside Drive and 64th Street.



Photo 9: Coast Guard Station w/SWFWMD gage.



Photo 10: Confluence of Barge canal at Upper Segment Withlacoochee River.



Photo 11: Rock Dam construction site looking at west spoil bank tie in.



Photo 12: Rock Dam construction site looking at east spoil bank tie in.

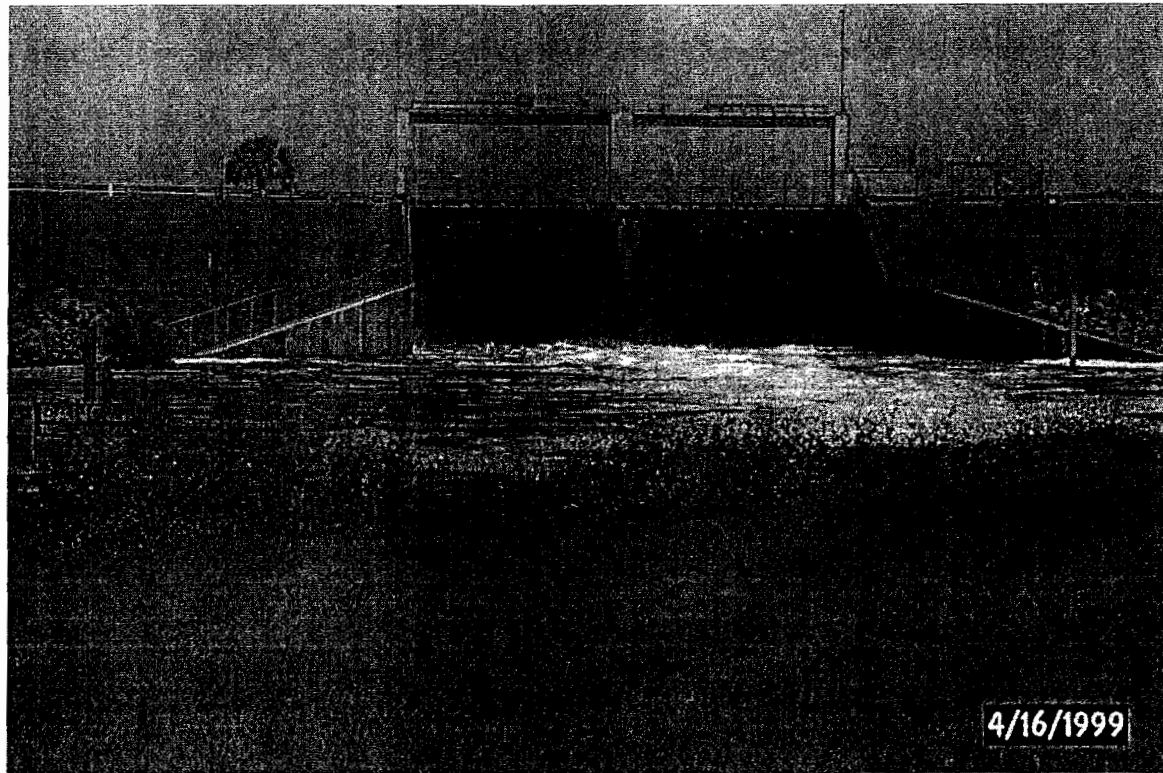


Photo 13: Inglis Dam main gates.

APPENDIX B
HYDROLOGIC ANALYSIS DOCUMENTATION

NOAA's NATIONAL OCEAN SERVICE
CENTER FOR OPERATIONAL OCEANOGRAPHIC PRODUCTS AND SERVICES



Products and Services Division

1305 East-West Highway
SSMC Bldg. # 4 - N/OPS3
Silver Spring, MD 20910-3281
301-713-2815
301-713-4500 (fax)
<http://www.tidesandcurrents.noaa.gov>

TO:	DATE:	October 1, 2003
Michael Walters	ACCOUNT#:	04-0001
URS	LOG#:	10331
7650 West Courtney Campbell Causeway		
Waterford Plaza, Suite 700	Todd Ehret	
Tampa, FL 33607-1462	Physical Oceanographer for	
	Tide & Tidal Current Predictions	
	E-mail: Todd.Ehret@noaa.gov	

**** IMPORTANT NOTICE ****

The enclosed data are based upon the latest information available as of the date of your request. The official Tide and Tidal Current prediction tables are published annually on October 1, for the following calendar year. Tide and Tidal Current predictions requested prior to the publishing date of the official tables are subject to change. Please check the information provided to insure completeness and readability of hard-copy and electronic media. This is not an invoice. Please retain a copy of this page for reference on future requests.

Enclosed:

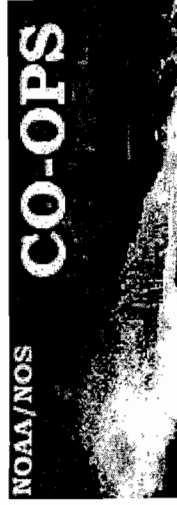
Tide predictions at "Withlacoochee River Entrance, Florida" for

- 1960
- 1982
- 1993
- 1996
- 1999

Provided on diskette in International Format, 24-Hour Clock, Daylight Saving Time.

Please Note: These predictions are based on the latest information we have available for the station at "Withlacoochee River Entrance, Florida". These predictions may not match the published predictions for these dates.

An invoice for \$65.00 has been mailed separately.



Center for Operational Oceanographic Products and Services (CO-OPS)

Station Information for Cedar Key, FL

Water Level Station Information:

Station Name: **Cedar Key, FL**

Station Identification Number: **8727520**

Latitude: **29° 8.1' N**

Longitude: **83° 1.9' W**

Date Established: **Mar 12 1914**

Maximum Water Level: **5.15 ft. above MHHW**
(10/07/1996)

Minimum Water Level: **-4.21 ft. below MLLW**
(09/18/1947)

Mean Range: **2.83 ft.**

Diurnal Range: **3.80 ft.**

Tidal and Geodetic Datums: **Click HERE**

Bench Mark Data Sheet: **Click HERE**

EPOCH Update Information: NEW

EPOCH Datum Comparison: [Click HERE](#) -

check datum differences between the old epoch (1960-1978) and the new epoch (1983-2001)

Superseded Bench Mark Data Sheet: [Click HERE](#) -

bench mark sheet on the old Tidal Datum Epoch (1960-1978)

Superseded Datums: [Click HERE](#) -

datums on the old Tidal Datum Epoch (1960-1978)

Mean Sea Level Differences List: [Click HERE](#) -

mean sea level differences between the two epochs for all stations.

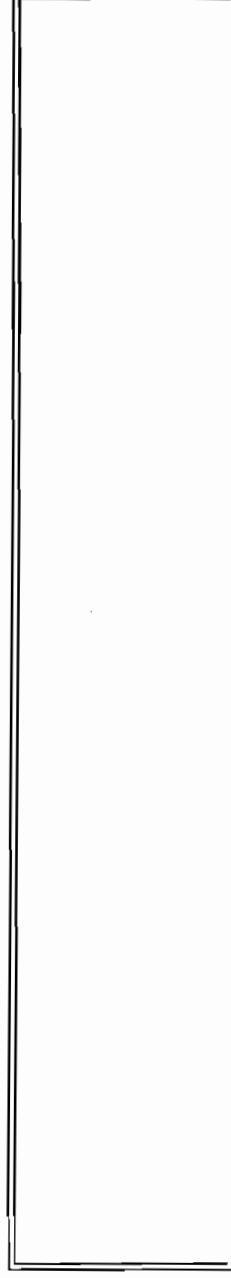
Mean Sea Level Difference: **1983-2001** for 8727520 Cedar Key, FL

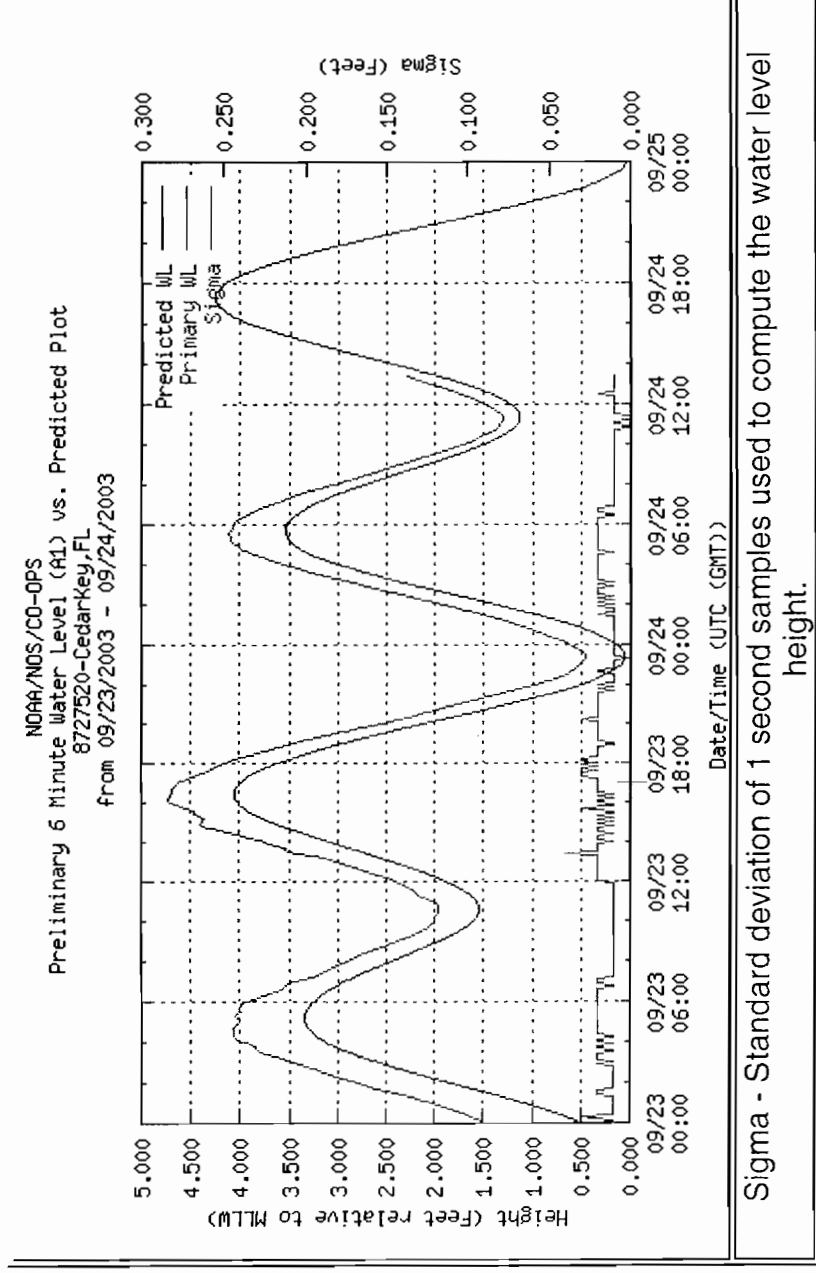
1960-1978 Difference: 3.84 ft. 3.70 ft. 0.14 ft.

Data Types Available:

Primary Water Level
Backup Water Level
Wind
Air Temperature
Water Temperature
Barometric Pressure

Current Water Level Data Plot





Retrieve Data Listing

[Data Inventory](#)

[Station Data Plots](#)

[Water Level Data Listing \(preliminary\)](#)

[Water Level Data Listing \(historical\)](#)

[Meteorological/Oceanographic Data Listing](#)

Location:

http://tidesandcurrents.noaa.gov/cgi-bin/station_info.cgi?stn=8727520+Cedar+Key,+FL

9/24/03

To reach the tidal bench marks from the Post Office at Second Avenue and C Street in Cedar Key, proceed SE on C Street for 0.03 km (0.2 mi) to Levy County Pier. The bench marks are in the area between the Fish House and G Street going east/west and between Whiddon Street and the county pier going north/south. The tide gauge and staff are at the NW end of the restroom building near the foot of the pier.

Station Location Map

Click [HERE](#) for Map

(Not for navigational use)

For other questions contact us at:

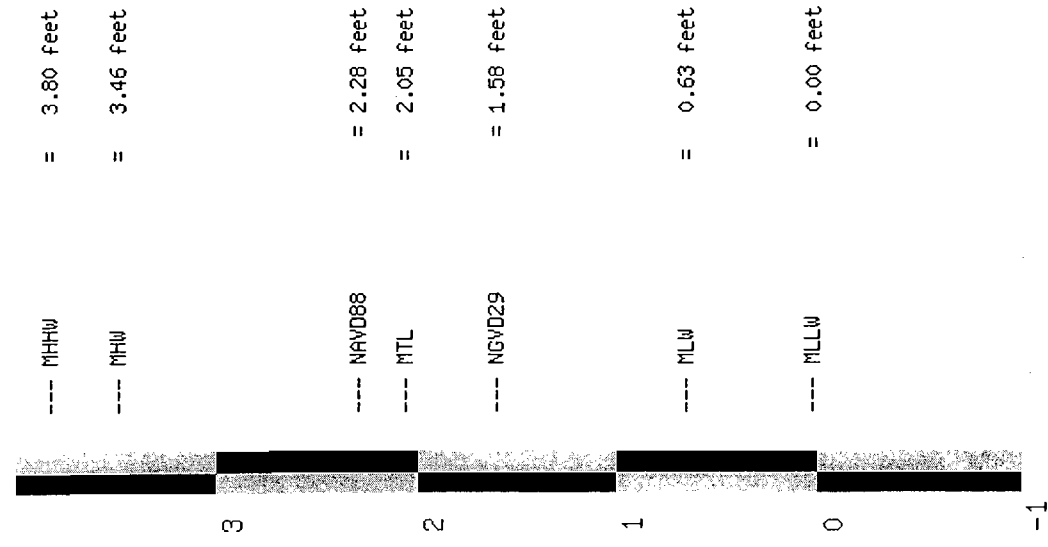
NOAA, National Ocean Service
Center for Operational Oceanographic
Products and Services (CO-OPS)
1305 East-West Highway
Silver Spring, Maryland 20910 U.S.A.

Telephone: 1-301-713-2877 or 2890
Fax: 1-301-713-4437
Website: <http://co-ops.nos.noaa.gov>
E-mail: Stephen.Lyles@noaa.gov

[* Home](#)[* PORTS](#)[* Predictions](#)[* Observations](#)[* Bench Marks](#)[* FAQ](#)[* Station Locator](#)[* Publications](#)[* About CO-OPS](#)[* Product Info.](#)

Date created
Wed Sep 24 09:56:21 EDT 2003

Elevation Information for PID = AR1204, VM = 751
Station_ID --- 8727520



Water Resources

Data Category:

Site Map for Florida

[Click Here](#) for information on data reliability

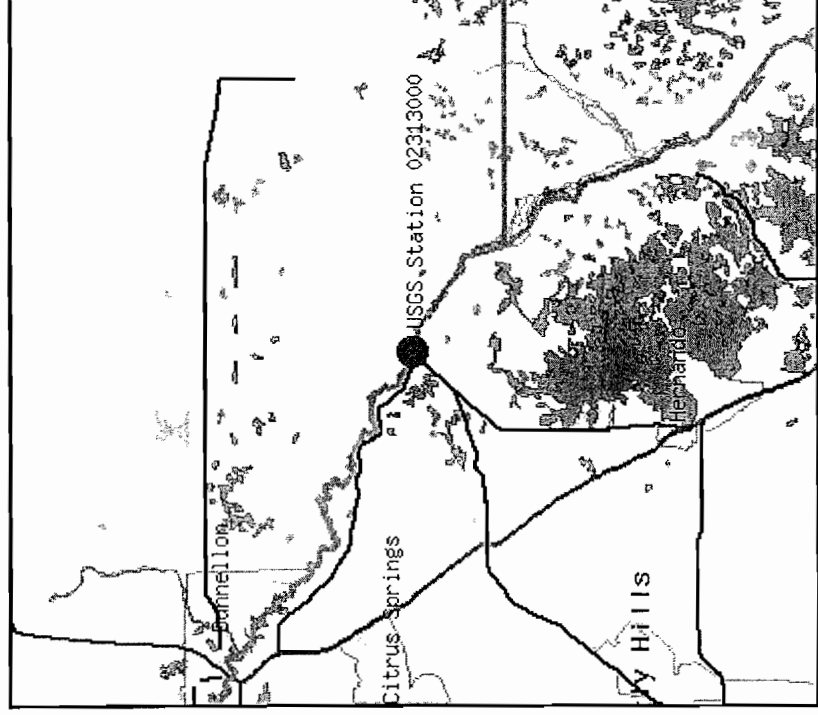
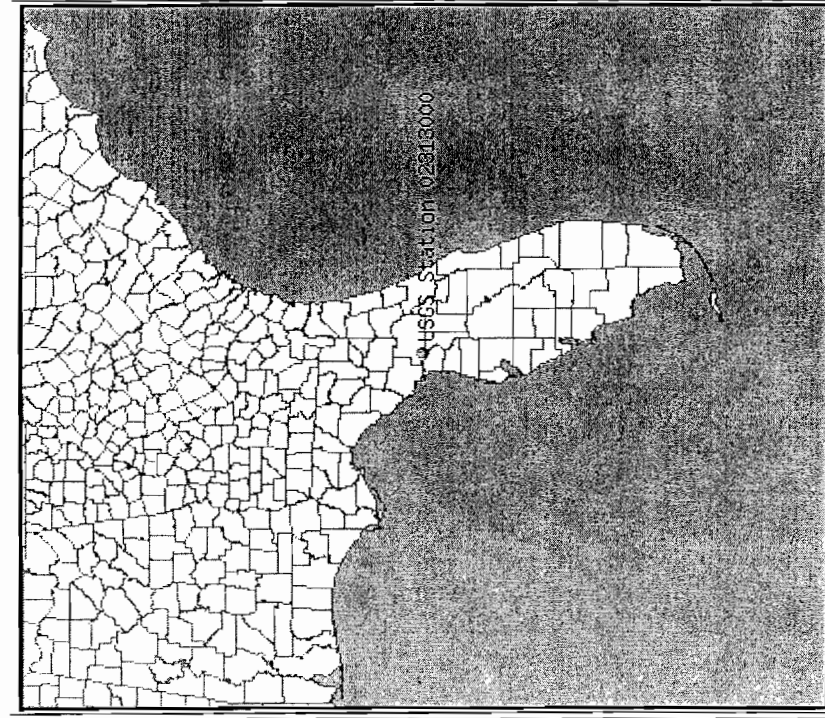
USGS 02313000 WITHLACOOCHEE RIVER NR HOLDER, FLA.

Available data for this site

Marion County, Florida
 Hydrologic Unit Code 03100208
 Latitude 28°59'19", Longitude 82°20'59" NAD27
 Drainage area 1,820.00 square miles
 Gage datum 27.52 feet above sea level NGVD29

Location of the site in Florida.

Site map.



ZOOM IN 2X, 4X, 6X, 8X, or ZOOM OUT 2X, 4X, 6X, 8X.

Maps are generated by **US Census Bureau TIGER Mapping Service.**

Questions about data [gs-w-fl_NWISWeb Data_Inquiries@usgs.gov](mailto:gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov)
Feedback on this website gs-w-fl_NWISWeb_Maintainer@usgs.gov
NWIS Site Inventory for Florida: Site Map
<http://waterdata.usgs.gov/fl/nwis/nwismap/>

Retrieved on 2003-09-17 08:36:35 EDT
Department of the Interior, U.S. Geological Survey
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Water Resources

Data Category:

[Click Here for information on data reliability](#)

USGS 02313000 WITHLACOCHEE RIVER NR HOLDER, FLA.

Available data for this site

Station Description

LOCATION

Latitude 28°59'19", Longitude 82°20'59" NAD27,
Marion County, Florida , Hydrologic Unit 03100208

DRAINAGE AREA

1,820.00 square miles

GAGE

Datum of gage is 27.52 feet above sea level NGVD29.

STATION TYPE:

Surface Water

STATION DATA:

Data Type	Begin Date	End Date	Count
Real-time	This is a real-time site		
Peak streamflow	1932-09-09	2002-09-28	71
Daily streamflow	1928-09-01	2002-09-30	26116
Water Quality Samples	1950-01-01	1999-09-01	561

SITE OPERATION:

Site is located in Florida; record is maintained by Florida - Altamonte Springs Office
CONTACT INFORMATION

Email questions about this station to gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov

Questions about data gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov

Feedback on this website gs-w-fl_NWISWeb_Maintainer@usgs.gov

**** USGS 02313000 WITHLACOCHEE RIVER NR HOLDER, FLA.**

<http://waterdata.usgs.gov/fl/nwis/nwisman?>

Retrieved on 2003-09-17 08:37:11 EDT

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0.65 0.66

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4/17/03

Data Category: Site Information Geographic Area:

Water Resources

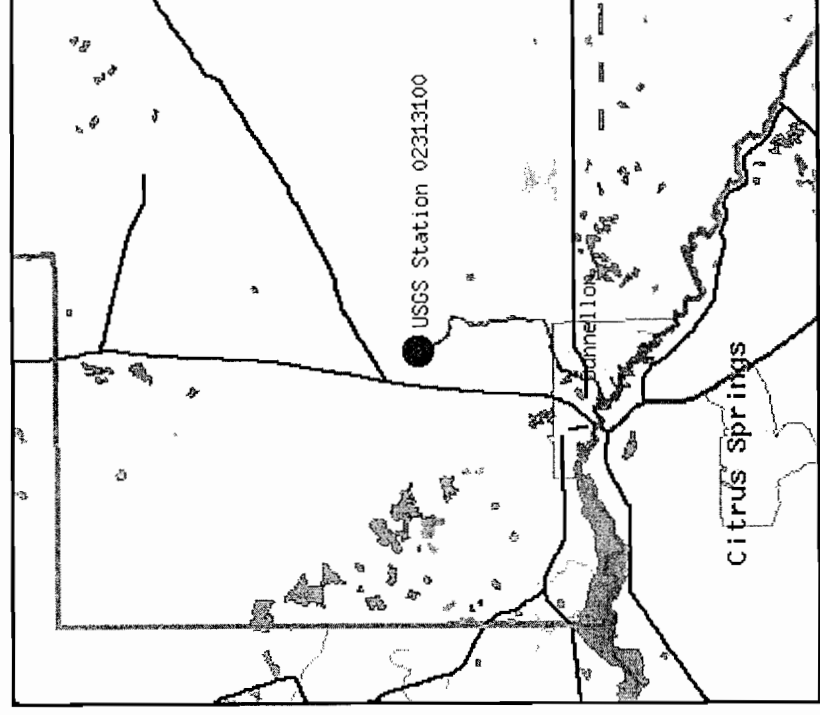
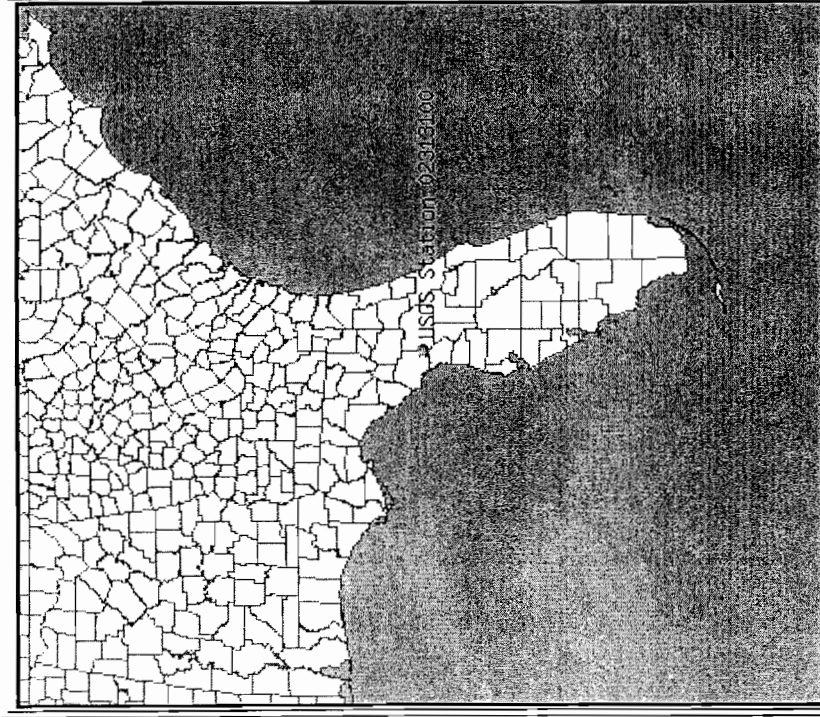
Site Map for Florida

[Click Here](#) for information on data reliability

USGS 02313100 RAINBOW SPRINGS NEAR DUNNELON, FLA.

Available data for this site

Marion County, Florida Hydrologic Unit Code 03100208 Latitude 29°06'08", Longitude 82°26'16" NAD27 Gage datum 28.34 feet above sea level NGVD29	
Location of the site in Florida.	Site map.



ZOOM IN 2X, 4X, 6X, 8X, or ZOOM OUT 2X, 4X, 6X, 8X.

Maps are generated by [US Census Bureau TIGER Mapping Service](#).

Questions about data gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov
Feedback on this website gs-w-fl_NWISWeb_Maintainer@usgs.gov
NWIS Site Inventory for Florida: Site Map
<http://waterdata.usgs.gov/fl/nwis/nwismap/>

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http://waterdata.usgs.gov/fl/nwis/nwismap/?site_no=02313100&agency_cd=USGS

9/17/03

Water Resources

Data Category: Site Information

Florida

Geographic Area:

GO

[Click Here](#) for information on data reliability

USGS 02313100 RAINBOW SPRINGS NEAR DUNNELLON, FLA.

Available data for this site

[Station home page](#)

GO

Station Description

LOCATION

Latitude 29°06'08", Longitude 82°26'16" NAD27,
Marion County, Florida, Hydrologic Unit 03100208

GAGE

Datum of gage is 28.34 feet above sea level NGVD29.

STATION TYPE:

Spring

STATION DATA:

Data Type	Begin Date	End Date	Count
Peak streamflow	1965-10-01	2001-10-23	34
Daily streamflow	1965-01-01	2002-09-30	13787
Water Quality Samples	1898-12-22	1999-09-02	624

SITE OPERATION:

Site is located in Florida; record is maintained by Florida - Altamonte Springs Office

CONTACT INFORMATION

Email questions about this station to gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov

Questions about data gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov
Feedback on this website gs-w-fl_NWISWeb_Maintainer@usgs.gov
** **USGS 02313100 RAINBOW SPRINGS NEAR DUNNELON, FLA.**
<http://waterdata.usgs.gov/fl/nwis/nwisman?>

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0.64 0.63



Water Resources

Data Category: Geographic Area:

Daily Streamflow for Florida

[Click Here](#) for information on data reliability

USGS 02313230 WITHLACOOCHEE R AT INGLIS DAM NR DUNNELLO, FLA.

Available data for this site

Levy County, Florida
 Hydrologic Unit Code 03100208
 Latitude 29°00'35", Longitude 82°37'01" NAD27
 Drainage area 2,020.00 square miles

Period of record

From	To	Count
1969-10-01	2002-09-30	12053

Choose Output Format

Retrieve Daily streamflow data for Selected Sites

Choose one of the following options for displaying data for the sites meeting the criteria above:

- Retrieve data from: to: (YYYY-MM-DD -- Blank = all data)
- Graphs of data
- Tab-separated data



Questions about data gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov
Feedback on this website gs-w-fl_NWISWeb_Maintainer@usgs.gov
Daily Streamflow -- 1 sites found
<http://waterdata.usgs.gov/fl/nwis/discharge?>

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Water Resources

Data Category:

Site Map for Florida

[Click Here](#) for information on data reliability

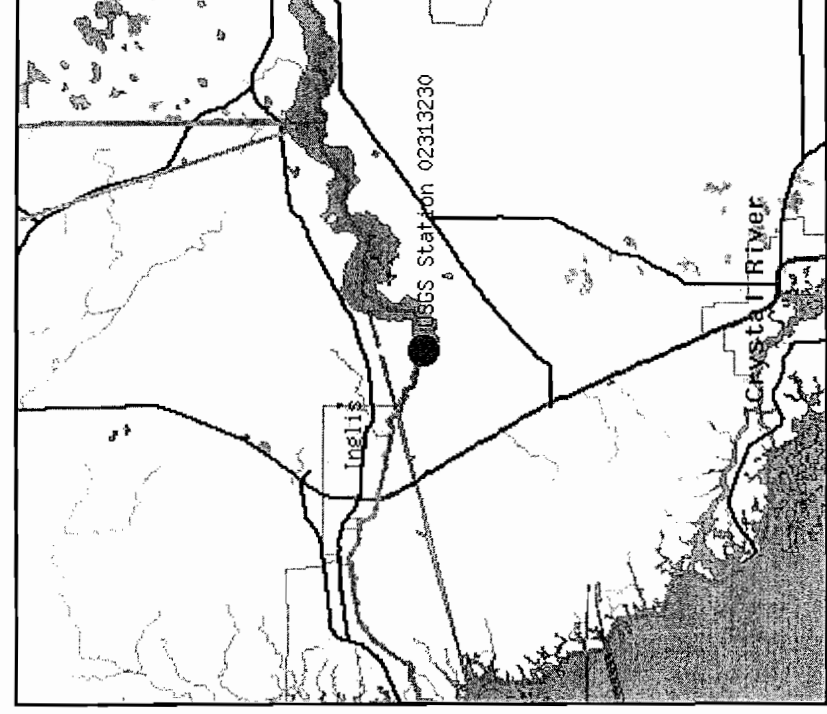
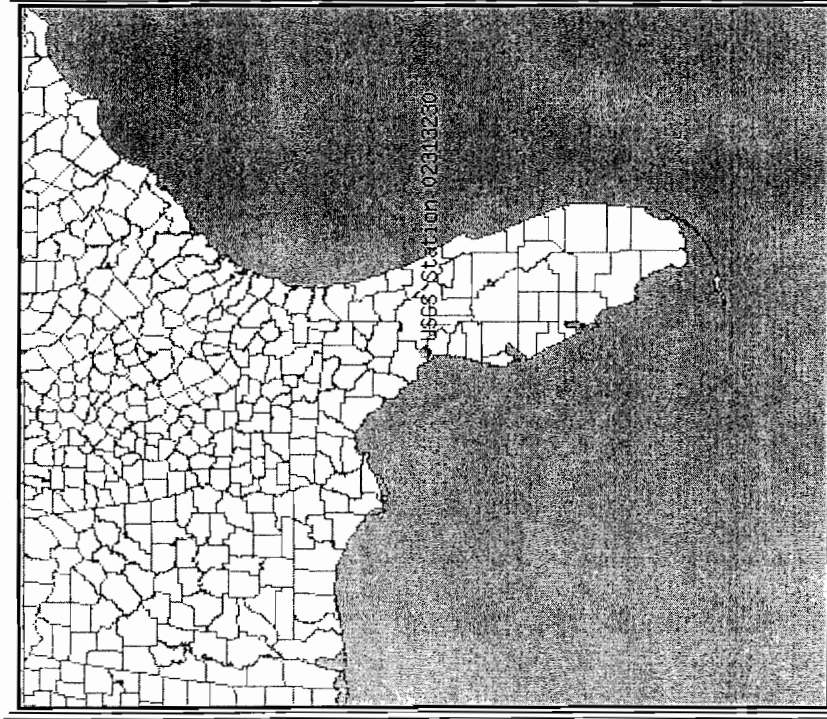
USGS 02313230 WITHLACOCHEE R AT INGLIS DAM NR DUNNELLO, FLA.

Available data for this site

Levy County, Florida
 Hydrologic Unit Code 03100208
 Latitude 29°00'35", Longitude 82°37'01" NAD27
 Drainage area 2,020.00 square miles

Location of the site in Florida.

Site map.



ZOOM IN 2X, 4X, 6X, 8X, or ZOOM OUT 2X, 4X, 6X, 8X.

Maps are generated by [US Census Bureau TIGER Mapping Service](#).

Questions about data gs-w-fl_nwisweb_data_inquiries@usgs.gov
Feedback on this website gs-w-fl_nwisweb_maintainer@usgs.gov
NWIS Site Inventory for Florida: Site Map
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Water Resources

Data Category:

[Click Here for information on data reliability](#)

USGS 02313230 WITHLACOOCHEE R AT INGLIS DAM NR DUNNELLO, FLA.

Available data for this site

Station Description

LOCATION

Latitude 29°00'35", Longitude 82°37'01" NAD27,
Levy County, Florida, Hydrologic Unit 03100208

DRAINAGE AREA

2,020.00 square miles

STATION TYPE:

Surface Water

STATION DATA:

Data Type	Begin Date	End Date	Count
Peak streamflow	1970-01-21	2002-09-26	33
Daily streamflow	1969-10-01	2002-09-30	12053
Water Quality Samples	1963-03-21	1999-06-30	191

SITE OPERATION:

Site is located in Florida; record is maintained by Florida - Altamonte Springs Office

CONTACT INFORMATION

Email questions about this station to gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov

Questions about data gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov

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Feedback on this website gs-w-fl_NWISWeb_Maintainer@usgs.gov

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** USGS 02313230 WITHLACOCHEE R AT ENGLIS DAM NR DUNNELLO, FLA.
<http://waterdata.usgs.gov/fl/nwis/nwisman?>

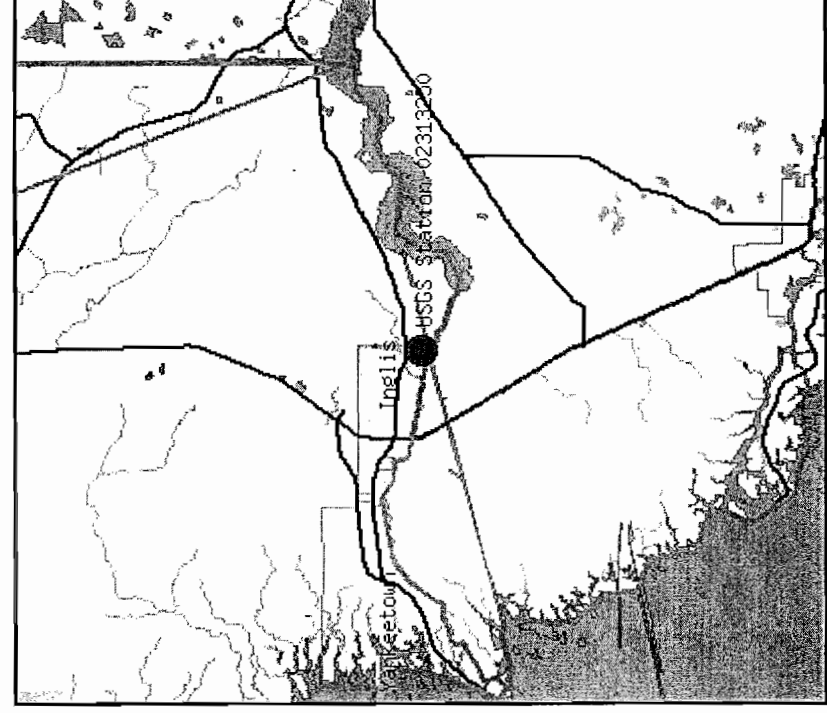
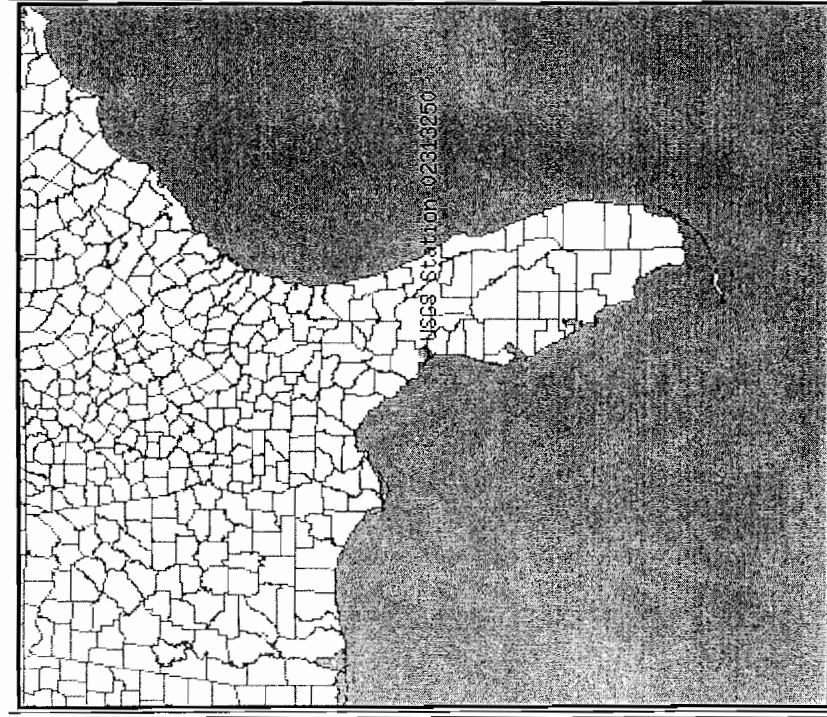
Retrieved on 2003-09-17 08:39:07 EDT

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ZOOM IN 2X, 4X, 6X, 8X, or ZOOM OUT 2X, 4X, 6X, 8X.

Maps are generated by [US Census Bureau TIGER Mapping Service](#).

Questions about data gs-w-fl_nwisweb_data_inquiries@usgs.gov
Feedback on this website gs-w-fl_nwisweb_maintainer@usgs.gov
NWIS Site Inventory for Florida: Site Map
<http://waterdata.usgs.gov/fl/nwis/nwismap/>

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Data Category:
Geographic Area:

Water Resources

Site Map for Florida

[Click Here](#) for information on data reliability

USGS 02313250 WITHLACOOCHEE R BYPASS CHANNEL NR INGLIS FLA

Available data for this site

Levy County, Florida Hydrologic Unit Code 03100208 Latitude 29°01'15", Longitude 82°38'17" NAD27	
Location of the site in Florida.	Site map.

Water Resources

Water Resources

Data Category: Geographic Area:

[Click Here](#) for information on data reliability

USGS 02313250 WITHLACOCHEE R BYPASS CHANNEL NR INGLIS FLA

Available data for this site

Station Description

LOCATION

Latitude 29°01'15", Longitude 82°38'17" NAD27,
Levy County, Florida , Hydrologic Unit 03100208

STATION TYPE:

Surface Water

STATION DATA:

Data Type	Begin Date	End Date	Count
Peak streamflow	1971-09-09	2001-10-08	28
Daily streamflow	1970-01-01	2002-09-30	11961
Water Quality Samples	1971-05-04	1984-10-16	44

SITE OPERATION:

Site is located in Florida; record is maintained by Florida - Altamonte Springs Office

CONTACT INFORMATION

Email questions about this station to gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov

Questions about data gs-w-fl_NWISWeb_Data_Inquiries@usgs.gov
Feedback on this website gs-w-fl_NWISWeb_Maintainer@usgs.gov
** USGS 02313250 WITHLACOCHEER BYPASS CHANNEL NR INGLIS FLA
<http://waterdata.usgs.gov/fl/nwis/nwisman?>

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File: G:\WATER\Projects\SWFWMD Projects\SWFWMD West Terminus CFBC\Work\Task 1.2.5 Update Water:
shed Parameters\Flood Analysis\Holder calendar_year.txt 9/19/2003, 3:20:30]

```
#
#
# US Geological Survey, Water Resources Data
# retrieved: 2003-09-19 16:19:19 EDT
#
# This file contains Calendar Year Streamflow Statistics
#
# This file includes the following columns:
#
#
# agency_cd  agency code
# site_no   USGS site number
# year_nu   Calendar year for value
# mean_va   annual-mean value in cubic-feet per-second.
#           if there is not complete record
#           for a year this field is blank
#
#
# Sites in this file include:
# USGS 02313000 WITHLACOCHEE RIVER NR HOLDER, FLA.
#
#
```

agency_cd	site_no	year_nu	mean_va
5s	15s	4s	12n
USGS	02313000	1932	320
USGS	02313000	1933	1201
USGS	02313000	1934	1755
USGS	02313000	1935	954
USGS	02313000	1936	1263
USGS	02313000	1937	1148
USGS	02313000	1938	937
USGS	02313000	1939	1010
USGS	02313000	1940	709
USGS	02313000	1941	989
USGS	02313000	1942	1067
USGS	02313000	1943	912
USGS	02313000	1944	698
USGS	02313000	1945	1675
USGS	02313000	1946	1271
USGS	02313000	1947	1477
USGS	02313000	1948	1591
USGS	02313000	1949	1474
USGS	02313000	1950	1251
USGS	02313000	1951	847
USGS	02313000	1952	894
USGS	02313000	1953	1689
USGS	02313000	1954	936
USGS	02313000	1955	484
USGS	02313000	1956	327
USGS	02313000	1957	771
USGS	02313000	1958	1265
USGS	02313000	1959	2829
USGS	02313000	1960	3561
USGS	02313000	1961	837
USGS	02313000	1962	480
USGS	02313000	1963	608
USGS	02313000	1964	1474
USGS	02313000	1965	1274
USGS	02313000	1966	1704
USGS	02313000	1967	830
USGS	02313000	1968	979
USGS	02313000	1969	1268
USGS	02313000	1970	1456
USGS	02313000	1971	799
USGS	02313000	1972	612
USGS	02313000	1973	762
USGS	02313000	1974	979
USGS	02313000	1975	476
USGS	02313000	1976	737
USGS	02313000	1977	438
USGS	02313000	1978	822
USGS	02313000	1979	1125

File: G:\WATER\Projects\SWFWMD Projects\SWFWMD West Terminus CFBC\Work\Task 1.2.5 Update Water.
shed Parameters\Flood Analysis\Holder calendar_year.txt 9/19/2003, 3:20:30}

USGS	02313000	1980	662
USGS	02313000	1981	276
USGS	02313000	1982	1542
USGS	02313000	1983	1538
USGS	02313000	1984	1201
USGS	02313000	1985	710
USGS	02313000	1986	705
USGS	02313000	1987	908
USGS	02313000	1988	1108
USGS	02313000	1989	564
USGS	02313000	1990	314
USGS	02313000	1991	531
USGS	02313000	1992	230
USGS	02313000	1993	363
USGS	02313000	1994	746
USGS	02313000	1995	1117
USGS	02313000	1996	877
USGS	02313000	1997	408
USGS	02313000	1998	1927
USGS	02313000	1999	362
USGS	02313000	2000	110
USGS	02313000	2001	274

U.S. Geological Survey
 # National Water Information System
 # Retrieved: 2003-09-15 09:48:31 EDT
 #
 # -----WARNING-----
 # The data you have obtained from this automated
 # U.S. Geological Survey database have not received
 # Director's approval and as such are provisional
 # and subject to revision. The data are released
 # on the condition that neither the USGS nor the
 # United States Government may be held liable for
 # any damages resulting from its use.

This file contains the annual peak streamflow data.

This information includes the following fields:

agency_cd Agency Code
 # site_no USGS station number
 # peak_dt Format YYYY-MM-DD
 # peak_va Annual peak streamflow value in cfs
 # gage_cd Gage height for the associated peak streamflow in feet
 # gage_ht Gage height qualification codes (see explanation below)
 # year_last_pk Gage height qualification codes
 # ag_dt Date of maximum gage-height for water year (if not concurrent with peak)
 # ag_tm Time of maximum gage-height for water year (if not concurrent with peak)
 # ag_gage_ht maximum Gage height for water year in feet (if not concurrent with peak)
 # ag_gage_ht_cd maximum Gage height code

Sites in this file include:

USGS 02313000 WITHLACOCHEE RIVER NR HOLDER, FLA.

Peak Streamflow-Qualification Codes(peak_cd):

- 1 ... Discharge is a Maximum Daily Average
- 2 ... Discharge is an Estimate
- 3 ... Discharge affected by Dam Failure
- 4 ... Discharge less than indicated value,
 which is Minimum Recordable Discharge at this site
- 5 ... Discharge affected to unknown degree by
 Regulation or Diversion
- 6 ... Discharge affected by Regulation or Diversion
- 7 ... Discharge is an Historic Peak
- 8 ... Discharge actually greater than indicated value
- 9 ... Discharge due to Snowmelt, Hurricane,
 Ice-Jam or Debris Dam breakup
- A ... Year of occurrence is unknown or not exact
- B ... Month or Day of occurrence is unknown or not exact
- C ... All or part of the record affected by Urbanization,
 Mining, Agricultural changes, Channelization, or other
- D ... Base Discharge changed during this year
- E ... Only Annual Maximum Peak available for this year

Gage height qualification codes(gage_ht_cd,ag_gage_ht_cd):

- 1 ... Gage height affected by backwater
- 2 ... Gage height not the maximum for the year
- 3 ... Gage height at different site and(or) datum
- 4 ... Gage height below minimum recordable elevation
- 5 ... Gage height is an estimate
- 6 ... Gage datum changed during this year

agency_cd	site_no	peak_dt	peak_tm	peak_va	peak_cd	gage_ht	gage_ht_cd	year_last_pk	ag_dt	ag_tm	ag_gage_ht	ag_gage_ht_cd	modify_dt
5s	15s	6s	8s	27s	8s	11s	10d	6s	8s	11s	19d		
USGS	02313000	1932-09-09		555		11.17			1933-10-01		3.85		2003-09-14 03:58:33
USGS	02313000	1933-09-26		5860		11.63							2003-09-14 03:58:33
USGS	02313000	1934-07-08		6740		8.86							2003-09-14 03:58:33
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USGS	02313000	1936-01-11		2800		8.46		1937-10-01			8.85		2003-09-14 03:58:33
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USGS	02113000	1940-08-08	4.77	1941-10-01	7.51	2003-09-14	03:58:33
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USGS	02113000	1955-09-28	2.25			2003-09-14	03:58:33
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USGS	02113000	1959-04-07	9.95			2003-09-14	03:58:33
USGS	02113000	1960-04-05	13.28			2003-09-14	03:58:33
USGS	02113000	1960-10-10	12.05			2003-09-14	03:58:33
USGS	02113000	1962-09-28	3.20			2003-09-14	03:58:33
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USGS	02113000	1964-02-11	2170			2003-09-14	03:58:33
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USGS	02113000	1985-09-25	3100			2003-09-14	03:58:33
USGS	02113000	1986-03-19	1860			2003-09-14	03:58:33
USGS	02113000	1987-04-21	3100			2003-09-14	03:58:33
USGS	02113000	1988-03-14	1500			2003-09-14	03:58:33
USGS	02113000	1988-10-01	2950			2003-09-14	03:58:33
USGS	02113000	1990-01-08	800			2003-09-14	03:58:33
USGS	02113000	1991-08-14	1770			2003-09-14	03:58:33
USGS	02113000	1991-10-05	531			2003-09-14	03:58:33
USGS	02113000	1992-10-03	1510			2003-09-14	03:58:33
USGS	02113000	1994-01-31	814			2003-09-14	03:58:33
USGS	02113000	1995-09-27	2480			2003-09-14	03:58:33
USGS	02113000	1995-10-23	3450			2003-09-14	03:58:33
USGS	02113000	1996-10-08	740			2003-09-14	03:58:33
USGS	02113000	1998-03-21	5360			2003-09-14	03:58:33
USGS	02113000	1998-10-02	1700			2003-09-14	03:58:33
USGS	02113000	1999-11-02	530			2003-09-14	03:58:33
USGS	02113000	2001-09-15	661			2003-09-14	03:58:33
USGS	02113000	2002-09-18	1630			2003-09-14	03:58:33
USGS	02113000	1987-04-22	8.55	1987-04-22	8.55	2003-09-14	03:58:33
USGS	02113000	1988-09-30	8.15	1988-09-30	8.15	2003-09-14	03:58:33
USGS	02113000		8.16			2003-09-14	03:58:33
USGS	02113000		2.35			2003-09-14	03:58:33
USGS	02113000		5.67			2003-09-14	03:58:33
USGS	02113000		1.88			2003-09-14	03:58:33
USGS	02113000		4.94			2003-09-14	03:58:33
USGS	02113000		3.01			2003-09-14	03:58:33
USGS	02113000		7.05			2003-09-14	03:58:33
USGS	02113000		8.46			2003-09-14	03:58:33
USGS	02113000		2.45			2003-09-14	03:58:33
USGS	02113000		10.69			2003-09-14	03:58:33
USGS	02113000		4.88			2003-09-14	03:58:33
USGS	02113000		1.50			2003-09-14	03:58:33
USGS	02113000		2.38			2003-09-14	03:58:33
USGS	02113000		5.33			2003-09-14	03:58:33
USGS	02113000		3.21	2001-09-30	3.21	2003-09-14	03:58:33

R R

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# U.S. Geological Survey
# National Water Information System
# Retrieved: 2003-09-15 09:57:53 EDT
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# United States Government may be held liable for
# any damages resulting from its use.
#
# This file contains the annual peak streamflow data.
#
# This information includes the following fields:
#
# agency_cd      Agency Code
# site_no       USGS station number
# peak_dt      Format YYYY-MM-DD
# peak_va      Annual peak streamflow value in cfs
# peak_cd      Peak Discharge-Qualification codes (see explanation below)
# gage_ht      Gage height for the associated peak streamflow in feet
# gage_ht_cd   Gage height qualification codes
# year_last_pk Year streamflow reported is the highest since this year
# ag_dt       Date of maximum gage-height for water year (if not concurrent with peak)
# ag_tm       Time of maximum gage-height for water year (if not concurrent with peak)
# ag_gage_ht  maximum gage height for water year in feet (if not concurrent with peak)
# ag_gage_ht_cd maximum gage height code

```

```

# sites in this file include:
# USGS 02131100 RAINBOW SPRINGS NEAR DUNNELLON, FLA.

```

```

# Peak Streamflow-Qualification Codes(peak_cd) :

```

- 1 ... Discharge is a Maximum Daily Average
- 2 ... Discharge is an Estimate
- 3 ... Discharge affected by Dam Failure
- 4 ... Discharge less than indicated value,
 - Which is Minimum Recordable Discharge at this site
- 5 ... Discharge affected to unknown degree by
 - Regulation or Diversion
- 6 ... Discharge affected by Regulation or Diversion
- 7 ... Discharge is an Historic Peak
- 8 ... Discharge actually greater than indicated value
- 9 ... Discharge due to Snowmelt, Hurricane,
 - Ice-Jam or Debris Dam Breakup
- A ... Year of occurrence is unknown or not exact
- B ... Month or Day of occurrence is unknown or not exact
- C ... All or part of the record affected by Urbanization
 - Mining, Agricultural changes, Channelization, or other
- D ... Base discharge changed during this year
- E ... Only Annual Maximum Peak available for this year

```

# Gage height qualification codes(gage_ht_cd,ag_gage_ht_cd):

```

- 1 ... Gage height affected by backwater
- 2 ... Gage height not the maximum for the year
- 3 ... Gage height at different site and/or datum
- 4 ... Gage height below minimum recordable elevation
- 5 ... Gage height is an estimate
- 6 ... Gage datum changed during this year

agency_cd	site_no	peak_dt	peak_tm	peak_va	peak_cd	gage_ht	gage_ht_cd	gage_ht_10d	year_last_pk	ag_dt	ag_tm	ag_gage_ht	ag_gage_ht_cd	modify_dt
5s	15s	10d	6s	27s	8s	13s	4s	10d	6s	11s	19d			
USGS	02131100	1965-10-05			4040	1						2003-09-14	03:58:33	
USGS	02131100	1966-10-11			345	1						2003-09-14	03:58:33	
USGS	02131100	1968-08-17			856	1						2003-09-14	03:58:33	
USGS	02131100	1970-08-29			867	1						2003-09-14	03:58:33	
USGS	02131100	1970-08-21			993	1			1970-10-20		3.44			2003-09-14 03:58:33
USGS	02131100	1971-10-11			778				1971-11-05		2.79			2003-09-14 03:58:33
USGS	02131100	1971-10-19			785				1971-08-21		2.61			2003-09-14 03:58:33
USGS	02131100	1972-10-08			744	1								

USGS	02313100	1974-09-25	755	1	1975-10-11	2.69	2003-09-14	03:58:33
USGS	02313100	1974-10-01	750		1974-10-22	2.44	2003-09-14	03:58:33
USGS	02313100	1976-08-18	692	1	1976-09-13	2.57	2003-09-14	03:58:33
USGS	02313100	1977-02-05	684	1	1978-11-03	2.48	2003-09-14	03:58:33
USGS	02313100	1978-03-26	852	1	1978-03-16	3.08	2003-09-14	03:58:33
USGS	02313100	1982-09-30	987	1	1982-08-30	3.31	2003-09-14	03:58:33
USGS	02313100	1982-10-07	1000	1	1982-11-03	3.61	2003-09-14	03:58:33
USGS	02313100	1983-10-17	891	1	1983-10-05	3.10	2003-09-14	03:58:33
USGS	02313100	1985-09-20	915	1	1985-09-27	3.32	2003-09-14	03:58:33
USGS	02313100	1985-10-01	904	1	1985-11-14	2.94	2003-09-14	03:58:33
USGS	02313100	1987-04-25	879		1987-04-07	2.75	2003-09-14	03:58:33
USGS	02313100	1988-09-19	1060		1988-06-29	3.32	2003-09-14	03:58:33
USGS	02313100	1988-10-01	1010	1	1987-05-31	3.18	2003-09-14	03:58:33
USGS	02313100	1989-10-21	643		1988-08-29	2.34	2003-09-14	03:58:33
USGS	02313100	1991-08-30	693		1991-09-19	2.50	2003-09-14	03:58:33
USGS	02313100	1991-10-02	667	1	1991-11-26	2.33	2003-09-14	03:58:33
USGS	02313100	1992-10-25	756	1	1992-12-03	2.60	2003-09-14	03:58:33
USGS	02313100	1994-03-04	707	1	1994-09-27	2.63	2003-09-14	03:58:33
USGS	02313100	1994-11-21	707	1	1994-10-14	3.44	2003-09-14	03:58:33
USGS	02313100	1996-08-30	783	1	1996-08-30	3.99	2003-09-14	03:58:33
USGS	02313100	1996-10-07	774	1	1996-10-07	3.90	2003-09-14	03:58:33
USGS	02313100	1998-03-21	1030	1	1998-04-06	3.43	2003-09-14	03:58:33
USGS	02313100	1998-11-05	892	1	1998-10-14	2.91	2003-09-14	03:58:33
USGS	02313100	1999-10-22	608	1	1999-10-26	1.97	2003-09-14	03:58:33
USGS	02313100	2001-09-27	626	1	2001-08-30	2.13	2003-09-14	03:58:33
USGS	02313100	2001-10-23	650	1	2001-11-05	2.48	2003-09-14	03:58:33

U.S. Geological Survey
 # National Water Information System
 # Retrieved: 2003-09-15 10:10:30 EDT
 #
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 # United States Government may be held liable for
 # any damages resulting from its use.

This file contains the annual peak streamflow data.
 # This information includes the following fields:

agency_cd Agency Code
 # site_no USGS station number
 # peak_dt format VVYY-MM-DD
 # peak_va Annual peak streamflow value in cfs
 # peak_cd Peak Discharge-Qualification codes (see explanation below)
 # gage_ht Gage height for the associated peak streamflow in feet
 # year_last_pk Gage height qualification codes
 # ag_dt Date of maximum flow reported is the highest since this year
 # ag_tm Date of maximum gage-height for water year (if not concurrent with peak)
 # ag_ht Time of maximum gage-height for water year (if not concurrent with peak)
 # ag_gage_ht maximum Gage height for water year in feet (if not concurrent with peak)
 # ag_gage_ht_cd maximum Gage height code

Sites in this file include:

USGS 02113230 WITHLACOCHEE R AT INGLIS DAM NR DUNNELLON, FLA.

Peak Streamflow-Qualification Codes(peak_cd):

- 1 ... Discharge is a Maximum Daily Average
- 2 ... Discharge is an Estimate
- 3 ... Discharge affected by Dam Failure
- 4 ... Discharge less than indicated value
 which is Minimum Recordable Discharge at this site
- 5 ... Discharge affected unknown degree by
 regulation or diversion
- 6 ... Discharge affected by regulation or diversion
- 7 ... Discharge is a Historical Peak
- 8 ... Discharge actually greater than indicated value
- 9 ... Discharge due to Snowmelt, Hurricane,
 Ice-dam or debris Dam breakup
- A ... Year of occurrence is unknown or not exact
- B ... Month or Day of occurrence is unknown or not exact
- C ... All or part of the record affected by Urbanization,
 Mining, Agricultural changes, Channelization, or other
- D ... Base Discharge changed during this year
- E ... Only Annual Maximum Peak available for this year

Gage height qualification codes(gage_ht_cd,ag_gage_ht_cd):

- 1 ... Gage height affected by backwater
- 2 ... Gage height not the maximum for the year
- 3 ... Gage height at different site and/or datum
- 4 ... Gage height below minimum recordable elevation
- 5 ... Gage height is an estimate
- 6 ... Gage datum changed during this year

agency_cd	site_no	peak_dt	peak_va	peak_cd	gage_ht	gage_ht_cd	year_last_pk	ag_dt	ag_tm	ag_gage_ht	ag_gage_ht_cd	modify_dt
5s	10d	6s	8s	27s	13s	4s	6s	11s	19d			
USGS	02113230	1970-01-21	3600	1.6		10d	8s	1970-08-11		27.98		2003-09-14 03:58:33
USGS	02113230	1971-09-17	1450	1.6		10d	8s	1971-06-26		28.07		2003-09-14 03:58:33
USGS	02113230	1972-09-08	2540	1.6		10d	8s	1972-04-03		28.05		2003-09-14 03:58:33
USGS	02113230	1972-10-08	2440	1.6		10d	8s	1971-09-01		27.99		2003-09-14 03:58:33
USGS	02113230	1974-08-07	2560	1.6		10d	8s	1975-10-17		27.81		2003-09-14 03:58:33
USGS	02113230	1974-10-01	685	1.6		10d	8s	1973-06-21		27.71		2003-09-14 03:58:33
USGS	02113230	1976-05-24	890	1.6		10d	8s	1976-04-08		27.86		2003-09-14 03:58:33
USGS	02113230	1976-10-01	370	1.6		10d	8s	1975-07-15		27.83		2003-09-14 03:58:33

File: G:\WATER\Projects\SWFRWD Projects\SWFRWD West Terminus CFBC\Work\Task 1.2.5 Update Watershed Parameters\Flood Analysis\With at Englis Dam peak.txt 9/15/2003, 9:11:11AM

USGS	02113230	1978-03-09	2220	1978-03-03	27.94	2003-09-14	03:58:33
USGS	02113230	1979-09-30	1940	1979-05-14	27.78	2003-09-14	03:58:33
USGS	02113230	1979-10-12	4500	1978-06-26	27.90	2003-09-14	03:58:33
USGS	02113230	1980-11-25	170	1980-11-24	27.74	2003-09-14	03:58:33
USGS	02113230	1982-09-23	4280	1982-06-19	28.28	2003-09-14	03:58:33
USGS	02113230	1982-10-08	3820	1981-06-13	27.95	2003-09-14	03:58:33
USGS	02113230	1984-03-29	2180	1984-05-05	28.01	2003-09-14	03:58:33
USGS	02113230	1985-09-01	3560	1985-06-14	27.92	2003-09-14	03:58:33
USGS	02113230	1985-11-01	2540	1984-01-23	28.05	2003-09-14	03:58:33
USGS	02113230	1987-04-21	3680	1987-09-30	27.92	2003-09-14	03:58:33
USGS	02113230	1988-09-06	4370	1989-11-17	27.94	2003-09-14	03:58:33
USGS	02113230	1988-10-01	2790	1987-03-02	27.96	2003-09-14	03:58:33
USGS	02113230	1990-01-10	900	1990-07-14	27.95	2003-09-14	03:58:33
USGS	02113230	1991-07-28	1620	1992-10-11	28.02	2003-09-14	03:58:33
USGS	02113230	1992-09-05	1010	1992-09-04	27.90	2003-09-14	03:58:33
USGS	02113230	1992-10-03	3020	1992-10-03	28.05	2003-09-14	03:58:33
USGS	02113230	1994-09-21	1480	1994-07-12	28.25	2003-09-14	03:58:33
USGS	02113230	1994-10-12	1910	1994-08-19	28.02	2003-09-14	03:58:33
USGS	02113230	1995-10-05	2790	1994-04-04	27.92	2003-09-14	03:58:33
USGS	02113230	1996-10-08	1240	1996-12-04	27.83	2003-09-14	03:58:33
USGS	02113230	1998-03-20	6000	1999-12-25	28.06	2003-09-14	03:58:33
USGS	02113230	1998-10-01	2319	1997-06-04	28.05	2003-09-14	03:58:33
USGS	02113230	2000-09-18	948	2001-10-21	27.81	2003-09-14	03:58:33
USGS	02113230	2001-09-16	1300	2001-09-25	27.92	2003-09-14	03:58:33
USGS	02113230	2002-09-26	1690	2002-06-23	28.01	2003-09-14	03:58:33

```

# U.S. Geological Survey
# National Water Information System
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# United States Government may be held liable for
# any damages resulting from its use.
#
# This file contains the annual peak streamflow data.
# This information includes the following fields:
#
# agency_cd      Agency Code
# site_no       USGS station number
# peak_dt       format YYYY-MM-DD
# peak_va       Annual peak streamflow value in cfs
# peak_cd       Peak Discharge-Qualification codes (see explanation below)
# gage_ht       Gage height for the associated peak streamflow in feet
# gage_ht_cd    Gage height qualification codes
# year_last_pk  Peak streamflow reported is the highest since this year
# ag_dt         Date of maximum gage-height for water year (if not concurrent with peak)
# ag_tm         Time of maximum gage-height for water year (if not concurrent with peak)
# ag_gage_ht    maximum Gage height for water year in feet (if not concurrent with peak)
# ag_gage_ht_cd maximum Gage height code
#
# Sites in this file include:
# USGS 02313250 WITHLACOCHEE R. BYPASS CHANNEL NR INCLIS FLA
#
# Peak Streamflow-Qualification Codes(peak_cd):
# 1 ... Discharge is a Maximum Daily Average
# 2 ... Discharge is an Estimate
# 3 ... Discharge affected by Dam Failure
# 4 ... Discharge less than indicated value,
#    ... which is Minimum Recordable Discharge at this site
# 5 ... Discharge affected to unknown degree by
#    ... Regulation or Diversion
# 6 ... Discharge affected by Regulation or Diversion
# 7 ... Discharge is an Historic Peak
# 8 ... Discharge actually greater than indicated value
# 9 ... Discharge due to Snowmelt, Hurricane,
#    ... Ice-Jam or Debris Dam breakup
# A ... Year of occurrence is unknown or not exact
# B ... Month or Day of occurrence is unknown or not exact
# C ... All or part of the record affected by Urbanization,
#    ... Mining, Agricultural changes, Channelization, or other
# D ... Base Discharge changed during this year
# E ... Only Annual Maximum peak available for this year
#
# Gage height qualification codes(gage_ht_cd, ag_gage_ht_cd):
# 1 ... Gage height affected by backwater
# 2 ... Gage height not the maximum for the year
# 3 ... Gage height at different site and(or) datum
# 4 ... Gage height below minimum recordable elevation
# 5 ... Gage height is an estimate
# 6 ... Gage datum changed during this year
#
# agency_cd    site_no peak_dt peak_tm peak_va peak_cd gage_ht gage_ht_cd 10d 4s 4s 10d 6s year_last_pk 8s_pk 8s_pk 11s 11s ag_dt 19d ag_tm 19d ag_gage_ht 27.52 2003-09-14 03:58:33
# USGS 02313250 10d 6s 8s 1971-09-09 1550 1.6 1972-06-22 1971-06-22 11s 11s 1972-06-16 27.79 2003-09-14 03:58:33
# USGS 02313250 1972-04-09 1690 1.6 1973-09-01 1973-09-01 1973-09-01 27.66 2003-09-14 03:58:33
# USGS 02313250 1973-09-02 1740 1.6 1972-04-21 1972-04-21 1972-04-21 27.43 2003-09-14 03:58:33
# USGS 02313250 1974-10-01 1660 1.6 1973-09-22 1973-09-22 1973-09-22 27.44 2003-09-14 03:58:33
# USGS 02313250 1976-06-30 1550 1.6 1976-06-23 1976-06-23 1976-06-23 28.16 2003-09-14 03:58:33
# USGS 02313250 1977-01-04 1630 1.6 1977-08-13 1977-08-13 1977-08-13 28.31 2003-09-14 03:58:33
# USGS 02313250 1978-08-02 1600 1.6 1978-08-15 1978-08-15 1978-08-15 28.20 2003-09-14 03:58:33

```

File: G:\WATER\Projects\SWFMD Projects\SWFMD West Terminus CFBC\Work\Task 1.2.5 Update Watershed Parameters\Flood Analysis\With Bypass Peak.txt 9/15/2003, 9:12:39AM

USGS	02313250	1982-06-19	1800	1.6	C	1982-06-18	27.80	1	2003-09-14	03:58:33
USGS	02313250	1983-02-19	1610	1.6	C	1983-01-20	27.76	1	2003-09-14	03:58:33
USGS	02313250	1984-02-22	1760	1.6	C	1984-05-05	27.93		2003-09-14	03:58:33
USGS	02313250	1985-08-16	1540	1.6	C	1985-06-14	27.73		2003-09-14	03:58:33
USGS	02313250	1986-01-22	1670	1.6		1987-10-31	27.90		2003-09-14	03:58:33
USGS	02313250	1987-03-09	1880	1.6		1987-06-03	28.20		2003-09-14	03:58:33
USGS	02313250	1987-10-01	1840	1.6		1986-06-06	28.12		2003-09-14	03:58:33
USGS	02313250	1988-02-01	1640	1.6		1989-06-08	27.76		2003-09-14	03:58:33
USGS	02313250	1990-07-15	1540	1.6		1990-07-14	27.78		2003-09-14	03:58:33
USGS	02313250	1991-09-10	1630	1.6		1991-01-30	27.98		2003-09-14	03:58:33
USGS	02313250	1991-10-06	1160	1.6		1990-01-17	27.83		2003-09-14	03:58:33
USGS	02313250	1994-01-31	1310	1.6		1994-01-02	28.20		2003-09-14	03:58:33
USGS	02313250	1994-10-27	1400	1.6		1994-10-15	27.98		2003-09-14	03:58:33
USGS	02313250	1995-10-07	1310	1.6		1994-04-18	28.14		2003-09-14	03:58:33
USGS	02313250	1997-09-30	1820	1.6		1997-09-29	28.00		2003-09-14	03:58:33
USGS	02313250	1997-12-25	1820	1.6		1996-09-06	27.72		2003-09-14	03:58:33
USGS	02313250	1998-10-03	1820	1.6		1997-08-11	27.96		2003-09-14	03:58:33
USGS	02313250	1999-10-22	1860	1.6		1998-03-31	27.89		2003-09-14	03:58:33
USGS	02313250	2001-09-29	1500	1.6		2001-07-23	27.84		2003-09-14	03:58:33
USGS	02313250	2001-10-08	1540	1.6		2000-06-23	27.89		2003-09-14	03:58:33

1

Flood Frequency Analysis
 Time Series (Water Year) of Maximum Instantaneous Discharge
 URS
 Withlachochee River nr Holder, cfs

RANK	QUANTITY	CALIFORNIA	GINGORTEN	BLOM
1	530.0	1.39	.79	.88
2	531.0	2.78	2.19	2.28
3	555.0	4.17	3.60	3.68
4	601.0	5.56	5.01	5.09
5	661.0	6.94	6.41	6.49
6	740.0	8.33	7.82	7.89
7	800.0	9.72	9.22	9.30
8	814.0	11.11	10.63	10.70
9	930.0	12.50	12.04	12.11
10	959.0	13.89	13.44	13.51
11	1020.0	15.28	14.85	14.91
12	1050.0	16.67	16.25	16.32
13	1160.0	18.06	17.66	17.72
14	1220.0	19.44	19.07	19.12
15	1350.0	20.83	20.47	20.53
16	1400.0	22.22	21.88	21.93
17	1400.0	23.61	23.28	23.33
18	1420.0	25.00	24.69	24.74
19	1460.0	26.39	26.10	26.14
20	1490.0	27.78	27.50	27.54
21	1500.0	29.17	28.91	28.95
22	1510.0	30.56	30.31	30.35
23	1520.0	31.94	31.72	31.75
24	1550.0	33.33	33.13	33.16
25	1590.0	34.72	34.53	34.56
26	1630.0	36.11	35.94	35.96
27	1700.0	37.50	37.35	37.37
28	1710.0	38.89	38.75	38.77
29	1770.0	40.28	40.16	40.18
30	1860.0	41.67	41.56	41.58
31	1890.0	43.06	42.97	42.98
32	1900.0	44.44	44.38	44.39
33	1990.0	45.83	45.78	45.79
34	2060.0	47.22	47.19	47.19
35	2070.0	48.61	48.59	48.60
36	2120.0	50.00	50.00	50.00
37	2150.0	51.39	51.41	51.40
38	2170.0	52.78	52.81	52.81
39	2240.0	54.17	54.22	54.21
40	2260.0	55.56	55.62	55.61
41	2480.0	56.94	57.03	57.02
42	2700.0	58.33	58.44	58.42
43	2720.0	59.72	59.84	59.82
44	2730.0	61.11	61.25	61.23
45	2780.0	62.50	62.65	62.63
46	2800.0	63.89	64.06	64.04
47	2950.0	65.28	65.47	65.44
48	3000.0	66.67	66.87	66.84
49	3020.0	68.06	68.28	68.25
50	3090.0	69.44	69.69	69.65

1

Flood Frequency Analysis
 Time Series (Water Year) of Maximum Instantaneous Discharge
 URS
 Withlachochee River nr Holder, cfs

RANK	QUANTITY	CALIFORNIA	GINGORTEN	BLOM
51	3100.0	70.83	71.09	71.05
52	3100.0	72.22	72.50	72.46
53	3210.0	73.61	73.90	73.86
54	3240.0	75.00	75.31	75.26
55	3290.0	76.39	76.72	76.67
56	3390.0	77.78	78.12	78.07
57	3430.0	79.17	79.53	79.47
58	3450.0	80.56	80.93	80.88

59	3680.0	81.94	82.34	82.28
60	3970.0	83.33	83.75	83.68
61	3980.0	84.72	85.15	85.09
62	4160.0	86.11	86.56	86.49
63	4600.0	87.50	87.96	87.89
64	4980.0	88.89	89.37	89.30
65	5050.0	90.28	90.78	90.70
66	5330.0	91.67	92.18	92.11
67	5360.0	93.06	93.59	93.51
68	5860.0	94.44	94.99	94.91
69	6740.0	95.83	96.40	96.32
70	7060.0	97.22	97.81	97.72
71	8660.0	98.61	99.21	99.12

DISTRIBUTION

CHI TEST

NORMAL	296.20	416.96	365.85
LOG-NORMAL	6.65	10.01	8.87
LOG-PEARSON T3	6.57	5.86	5.55
EXPONENTIAL	23.89	21.11	21.23
EXTREME VALUE T1	100.66	92.59	86.25

	LIN	LOG
MEAN=	2551.986	3.320
STDV=	1657.641	.283
SKEW=	1.396	-.182

DISTRIBUTION		PROBABILITY OF NONE EXCEEDENCY					
		50.0%	80.0%	90.0%	95.0%	98.0%	
99.0%	99.5%						
6408.2	6821.8	NORMAL	2552.0	3947.1	4676.3	5278.6	5956.4
9541.5	11228.8	LOG-NORMAL	2090.3	3620.5	4824.7	6115.7	7986.3
8740.6	10046.0	LOG-PEARSON T3	2132.1	3638.2	4758.3	5906.1	7487.6
8528.1	9677.1	EXPONENTIAL	2043.3	3562.2	4711.2	5860.2	7379.1
7753.9	8653.3	EXTREME VALUE T1	2279.9	3745.4	4715.7	5646.4	6851.1
•	2552.0	3947.1	4676.3	5278.6	5956.4	6408.2	6821.8
9541.5	11228.8	LOG-NORMAL	2090.3	3620.5	4824.7	6115.7	7986.3

1

STREAMFLOW FREQUENCY ANALYSIS
TIME SERIES OF ANNUAL MAXIMA FOR WITHLACHOOCEE AT INGLIS AND BYPASS
URS FOR THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
ONE-DAY MAXIMUMS WITHLACHOOCEE

RANK	QUANTITY	CALIFORNIA	GINGORTEN	BLOM
1	1320.0	2.94	1.69	1.88
2	1393.0	5.88	4.71	4.89
3	1660.0	8.82	7.73	7.89
4	1700.0	11.76	10.75	10.90
5	1847.0	14.71	13.77	13.91
6	2047.0	17.65	16.79	16.92
7	2133.0	20.59	19.81	19.92
8	2164.0	23.53	22.83	22.93
9	2210.0	26.47	25.85	25.94
10	2469.0	29.41	28.86	28.95
11	2500.0	32.35	31.88	31.95
12	2700.0	35.29	34.90	34.96
13	2800.0	38.24	37.92	37.97
14	2910.0	41.18	40.94	40.98
15	2970.0	44.12	43.96	43.98
16	2980.0	47.06	46.98	46.99
17	2990.0	50.00	50.00	50.00
18	3050.0	52.94	53.02	53.01
19	3217.0	55.88	56.04	56.02
20	3280.0	58.82	59.06	59.02
21	3360.0	61.76	62.08	62.03
22	3380.0	64.71	65.10	65.04
23	3630.0	67.65	68.12	68.05
24	3880.0	70.59	71.14	71.05
25	3960.0	73.53	74.15	74.06
26	4230.0	76.47	77.17	77.07
27	4520.0	79.41	80.19	80.08
28	4710.0	82.35	83.21	83.08
29	4815.0	85.29	86.23	86.09
30	5050.0	88.24	89.25	89.10
31	5139.0	91.18	92.27	92.11
32	5232.0	94.12	95.29	95.11
33	6979.0	97.06	98.31	98.12

DISTRIBUTION

CHI TEST

NORMAL	28.40	58.47	49.30
LOG-NORMAL	7.96	6.56	6.36
LOG-PEARSON T3	8.09	5.53	5.59
EXPONENTIAL	35.30	32.99	32.89
EXTREME VALUE T1	10.55	6.54	6.81

	LIN	LOG
MEAN=	3249.242	3.478
STDV=	1298.470	.176
SKEW=	.791	-.156

1

STREAMFLOW FREQUENCY ANALYSIS
TIME SERIES OF ANNUAL MAXIMA FOR WITHLACHOOCEE AT INGLIS AND BYPASS
URS FOR THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

DISTRIBUTION		PROBABILITY OF NONE EXCEEDENCY					
		50.0%	80.0%	90.0%	95.0%	98.0%	
99.0%	99.5%						
6269.9	6593.9	NORMAL	3249.2	4342.1	4913.3	5385.0	5916.0
7708.0	8526.7	LOG-NORMAL	3007.3	4227.3	5050.8	5850.5	6903.1
7358.8	8038.8	LOG-PEARSON T3	3039.0	4238.5	5014.4	5744.1	6671.9
7930.4	8830.5	EXPONENTIAL	2850.8	4040.6	4940.6	5840.6	7030.4
7324.0	8028.6	EXTREME VALUE T1	3036.1	4184.1	4944.1	5673.2	6616.8

File: G:\WATER\Projects\SWFWMD Projects\SWFWMD West Terminus CFBC\Work\Task 1.2.5 Update Watershed Parameters\Flood Analysis\INGLIS.OUT 12/15/2003, 9:08:36?

• 3249.2 4342.1 4913.3 5385.0 5916.0 6269.9 6593.9
7708.0 8526.7 LOG-NORMAL 3007.3 4227.3 5050.8 5850.5 6903.1
LOG-PEARSON T3 3039.0 4238.



West Terminus - Cross-Florida Greenway Assessment

Work Order 2 Final Report

Lower Withlacoochee River Restoration Alternatives Feasibility Study

Prepared for:
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
2379 Broad Street
Brooksville, Florida 34604



Prepared by:

URS

URS Corporation Southern
7650 West Courtney Campbell Causeway
Tampa, Florida 33607-1462

August 12, 2004

**WEST TERMINUS - CROSS-FLORIDA GREENWAY
ASSESSMENT
WORK ORDER 2 FINAL REPORT**

**LOWER WITHLACOOCHEE RIVER RESTORATION
ALTERNATIVES FEASIBILITY STUDY**

Prepared for:

**SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
7329 Broad Street
Brooksville, Florida 34604**

By:

URS

**URS Corporation Southern
7650 West Courtney Campbell Causeway
Tampa, Florida 33607-1462**

August 12, 2004

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EXECUTIVE SUMMARY

ES-1 GENERAL PROJECT INFORMATION

A Basin Initiative was requested by the Withlacoochee River Basin Board in fiscal year 2003 to evaluate restoration alternatives for the portion of the Withlacoochee River downstream of Inglis Dam. The purpose of this study is to carry out this Basin Initiative and evaluate a number of restoration alternatives, which are intended to mitigate some of the environmental impacts created by the construction of the Cross-Florida Barge Canal system.

The West Terminus Cross-Florida Greenway comprises a number of facilities, within the Cross Florida Barge Canal system, (illustrated on **Figure 1**). Currently, the Cross-Florida Barge Canal facilities are owned by the Florida Department of Environmental Protection (FDEP). With the exception of the Main Dam and Bypass Channel Spillway, these facilities are operated by FDEP's Office of Greenways and Trails. The dam and spillway are operated by the Southwest Florida Water Management District (District).

The portion of the Withlacoochee River downstream of Inglis Dam has undergone significant alteration since the turn of the twentieth century. The lower segment of the river receives flows only from the Bypass Channel System via a spillway at its western terminus. The maximum flow rate from this bypass system is considerably less than maximum normal flow rates and flood flow rates for the river system. The changes described above altered the historic flow regime of the Withlacoochee River downstream of Inglis Dam, creating environmental impacts.

ES-2 RESTORATION ALTERNATIVES DESCRIPTION

Listed below are the four (4) alternatives that were provided in the District's scope-of-work for this study. Each of the alternatives was evaluated with respect to their impact on flooding, natural systems, water quality, and navigation. Additionally, each alternative was assessed with respect to permitability and implementation costs. Please see **Figure 3** through **Figure 12** for plans and details of these facilities. *It is important to note that the proposed alternatives do not impact water levels in Lake Rousseau. These alternatives simply facilitate redistribution of flows presently carried by the Barge Canal to the lower segment of the river.*

Alternative 1 consists of: (1) removing the Rock Dam; (2) constructing an operable control structure in the Barge Canal; and (3) replacing the US-19 bridge over the Withlacoochee River. Alternative 2 consists of: (1) removing the Rock Dam and replacing it with an operable control structure (at the same location); (2) constructing an operable control structure in the Barge Canal; and (3) constructing a lock in the Barge Canal. Alternative 3 consists of reconstructing the existing Bypass Channel and Spillway with increased discharge capacity. Alternative 4 represents existing conditions with no improvement planned (baseline condition).

ES-3 HYDRAULIC MODEL DEVELOPMENT

HEC-RAS models were developed from previous studies of the Western Terminus area. Separate computer models were developed for each of the four (4) alternatives evaluated as part of this study. Model simulations for long term, 100-year flood and dam failure conditions were

conducted using these models. Results of the long-term simulations were used in the natural systems, flooding and water quality assessments. Results of the 100-year flood and dam failure simulations were used in the flooding assessment.

ES-4 RESTORATION ALTERNATIVES ASSESSMENT

Natural Systems Assessment

A natural systems assessment was conducted to determine the impact that each of the proposed alternatives would have on wetlands and other systems in the West Terminus Cross-Florida Greenway area.

Implementation of any of the three alternatives will increase freshwater down the river. Within the study area, most of the vegetation along the river consists of freshwater species, including the bald cypress (*Taxodium distichum*), red maple (*Acer rubrum*), and loblolly bay (*Gordonia lasianthus*). The increase in freshwater should not affect the community's composition along the river. However, downstream of the study area, the increase in freshwater may decrease salinities within the river.

Finally, depending on construction methodologies, implementation of the alternatives may impact the wetlands within and adjacent to the construction area.

Flooding Assessment

A flood assessment was conducted to determine the impact that each of the proposed alternatives would have on structure flooding within the floodplain of only the upper and lower segments of the Withlacoochee River. The structures that were considered part of this analysis included primarily residential dwellings, with some commercial and publicly owned buildings.

Navigation Assessment

A navigation analysis was conducted to assess the navigational impact of the proposed alternatives in the West Terminus Cross-Florida Greenway area. The navigation analysis compared travel times to the Gulf of Mexico (Gulf) from selected locations within the study area.

Results of the navigation analysis indicate that Alternative 1 would require an additional 2.23 hour travel time relative to existing conditions. The travel time for Alternative 2 will increase by 0.5 hours over existing conditions, and the travel time for Alternative 3 is identical to existing conditions.

Water Quality Assessment

A water quality assessment was conducted to determine the impact on salinity levels of each of the proposed alternatives within the West Terminus Cross-Florida Greenway area. The water quality analysis was limited to a general estimate of the location of the saline-water front within the Withlacoochee River study segment. The saline-water front, determined from the long-term

simulation model results, was taken to be the upstream-most cross-section where negative flows occur.

Water quality is predicted to improve in the Withlacoochee River Lower Segment for all of the proposed alternatives, due to the decrease in the duration of negative flows. Water quality is predicted to improve in the Withlacoochee River Upper Segment, for Alternatives 1 and 2, due to the decrease in the duration of negative flows. However, water quality will decrease under Alternative 3 due to increased duration of negative flows.

IMPLEMENTATION COST

A conceptual level estimate of probable construction costs was developed for each of the proposed alternatives. The conceptual level plans, cross-sections, and details referenced above in the restoration alternatives description were used as a basis for the estimate.

Table ES-1 presents a summary of probable implementation costs for each of the proposed alternatives. This table provides the total cost including real estate, permitting and contingencies.

**Table ES-1
Implementation Cost Summary**

Alternative	Estimated Construction Cost
1	\$41,843,063
2	\$26,311,222
3	\$12,320,751
4	\$0

PERMITTING REQUIREMENTS

All three proposed alternatives will likely require permits from the U.S. Army Corps of Engineers (ACOE) and the Florida Department of Environmental Protection (FDEP).

The Cross-Florida Barge Canal is a federally designated navigable waterway. As such, Alternative 1, which would impede navigation within the Canal, will require a permit pursuant to Sections 9 and 10 of the Rivers and Harbors Act of 1899. De-authorization of the waterway would require approval by the U.S. Congress. Because of the potential effects this alternative may have on the human environment, an EIS will most likely be required.

Alternative 2 will alter navigation in the Cross-Florida Barge Canal just below the Withlacoochee River with the construction of a control structure and lock. This action will not result in the loss of navigation above the proposed structure, will likely result in fewer environmental impacts, and will likely require the development of an Environmental Assessment (EA). Alternative 3 will not result in the loss of navigation on the Florida Barge Canal and as a result, the development of the environmental document for this proposed action would be less complex than either Alternatives 1 or 2.

Based on the ERP regulations, an individual ERP would be required for any of the three proposed alternatives associated with this project.

COMPARISON MATRIX

A comparison matrix was developed as a tool to aid in the evaluation of the proposed alternatives. **Table ES-2** shows the grading matrix. The grading matrix was prepared based on the assessment results as well as implementation costs and permitting requirements.

The comparison matrix provides a numeric value for each alternative by the category shown. Within a particular category the alternatives are graded from 1 to 4 (best to worst) based on the performance criteria for that particular category. The notes at the bottom of **Table ES-2** describe each category's performance criteria.

Table ES-2
Comparison Matrix

Grade Category	Relative Grade Values			
	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Natural Systems ^(a)	1	1	1	2
Flooding ^(b)	2	1	1	1
Navigation ^(c)	3	2	1	1
Water Quality ^(d)	1	1	2	3
Permitability ^(e)	4	3	2	1
Cost ^(f)	4	3	2	1
Values Summation	15	11	9	9

(a) Considers the creation of wetland habitat and improvement to estuary systems.

(b) Considers the number of buildings flooded.

(c) Considers travel time to the Gulf.

(d) Considers the location and duration of salt water in the river.

(e) Considers the feasibility and ease of obtaining permits.

(f) Considers construction, design, permitting and land acquisition dollar costs.



1 GENERAL PROJECT INFORMATION

1.1 Background

The West Terminus Cross-Florida Greenway comprises of a number of facilities within the Cross Florida Barge Canal system. **Figure 1** illustrates the Cross-Florida Barge Canal system and its components. The system was partially constructed in the 1960s and abandoned in the early 1970s. Authorized by the U.S. Congress during the 1940's, the project was intended to facilitate the movement of ocean going vessels traveling between the Atlantic Ocean and the Gulf of Mexico, the Caribbean Sea, and the Panama Canal. The Barge Canal facilities were designed by the U.S. Army Corps of Engineers (ACOE). Significant elements of the overall project completed by the ACOE within the West Terminus area include the following: (1) the portion of the canal from the Gulf of Mexico to the Inglis Lock; (2) the Inglis Lock; (3) the Inglis Dam; (4) the Bypass Channel and Spillway; and (5) the Rock Dam/Flood Control Levee.

Construction of the Barge Canal system was halted during the Nixon administration in 1971 because of concerns related to cost and the project's effect on the environment. Although construction activities ended three decades ago, it was not until 1990 that the official construction de-authorization was approved by Congress and signed by President Bush (after an extensive study by the ACOE). Subsequent to its de-authorization, the Inglis Lock and associated facilities became part of the Cross-Florida Greenway State Recreation and Conservation Area that was established by the Florida State Legislature through the enactment of a law (F.S. 90-328). Currently, the Cross-Florida Barge Canal facilities constructed near Inglis are owned by the Florida Department of Environmental Protection (FDEP). With the exception of the Main Dam and Bypass Channel Spillway, these facilities are operated by FDEP's Office of Greenways and Trails. The dam and spillway are operated and maintained by the Southwest Florida Water Management District (District) under contract with the FDEP.

1.2 Purpose

The portion of the Withlacoochee River downstream of Inglis Dam has undergone significant alteration since the turn of the twentieth century. The construction of the Cross-Florida Barge Canal in the 1960s created additional impacts to the segment of the river downstream of the canal. Construction of the barge canal included a dam on the Withlacoochee River known locally as the "Rock Dam." This dam effectively severs all flows released from the Inglis Dam main gates including large flood flows. The lower segment of the river, downstream of the Rock Dam, receives flows only from the Bypass Channel System via a spillway at its western terminus. The maximum flow rate from this bypass system is estimated to be 1,540 cfs, considerably less than maximum normal flow rates and flood flow rates for the river system. The changes described above have altered the historic flow regime of the Withlacoochee River downstream of Inglis Dam, creating environmental impacts. It should be noted, pursuant to the findings of a previously completed dam safety planning study, the Rock Dam was recently reconstructed as a flood control levee. The flood control levee (FCL) is designed to offer full protection to structures on the lower segment of the Withlacoochee River in case of failure of the Inglis Dam.

The Withlacoochee River Basin Board requested a Basin Initiative in fiscal year 2003 to evaluate restoration alternatives for the portion of the Withlacoochee River downstream of Inglis Dam. The purpose of this study is to carry out this Basin Initiative and evaluate a number of restoration alternatives, intended to mitigate some of the environmental impacts created by the construction of the Cross-Florida Barge Canal system. *It is important to note that the proposed alternatives do not impact water levels in Lake Rousseau. These alternatives simply facilitate redistribution of flows presently carried by the Barge Canal to the lower segment of the river.* Listed below is a summary of alternatives that were evaluated as part of this study. Each of the alternatives was evaluated with respect to their impact on flooding, natural systems, water quality, and navigation. An estimate of the cost to construct the proposed facilities was developed for each alternative. Evaluation results and implementation costs were used to create a comparison matrix to help determine the feasibility of each alternative.

Alternative 1: Remove the Rock Dam/FCL which presently severs the connection of the lower and upper river segments, construct an operable control structure in the Barge Canal, and replace the US-19 bridge over the Withlacoochee River to facilitate navigation. **Figure 3** is a conceptual plan of Alternative 1.

Alternative 2: Replace the Rock Dam/FCL with an operable control structure (at the same location), construct an operable control structure in the Barge Canal, and construct a lock in the Barge Canal for navigation. **Figure 7** is a conceptual plan of Alternative 2.

Alternative 3: Reconstruct the existing Bypass Channel and Spillway with increased discharge capacity to facilitate increased flows to the lower segment of the river. **Figure 10** is a conceptual plan of Alternative 3.

Alternative 4: Represents existing conditions with no improvement planned (baseline condition). **Figure 12** is a conceptual plan of Alternative 4.

The restoration alternatives study was broken down into two work orders. Work Order 1 (WO-1) was previously completed and a report was submitted to the Southwest Florida Water Management District on December 31, 2003. The report contained herein is intended to document the tasks conducted as part of Work Order 2 (WO-2). The tasks are listed below and were taken from the District's Scope of Work. The following sections of this report address each of the tasks listed below (in order).

- 2.3.1 Perform Additional Field Surveys
- 2.3.2 Update Watershed Model
- 2.3.3 Restoration Alternatives Model Evaluation
- 2.3.4 Land Acquisition Requirements and Probable Acquisition Costs
- 2.3.5 Probable Implementation Cost
- 2.3.6 Permit Requirements for Restoration Alternatives
- 2.3.7 Restoration Alternatives Analysis Matrix
- 2.3.8 Report of Findings – Work Order 2



2 DATA COLLECTION AND SUPPLEMENTAL LAND SURVEY

Data originally collected under WO-1 as part of Task 1.1.2.1 were presented in Section 2 of the WO-1 Report. The results of that data collection task were used to identify additional information and land survey requirements. Additional data collected as part of the WO-2 studies are presented in **Table 2-1** below.

The additional land survey requirements were formalized into a survey scope of work under WO-2 as part of Task 2.3.1. A survey subcontractor was retained to carry out this work, which included re-surveying the bank-to-bank portions of 15 existing cross-sections on the Withlacoochee River and Barge canal, obtaining three new cross-sections on the Withlacoochee River and Bypass Channel and conducting a detailed survey of the US-19 bridge over the Withlacoochee River. **Figure 2** illustrates the location and extent of the survey conducted under WO-2.

Table 2-1
Inventory Of Data Collected – Work Order 2

TITLE	SOURCE	DATE
Quarter 1 (1984) Report, Technical Summary and data Appendix	Mote Marine Laboratory	1984
Property Value & Structure Information - Parcel 3038-000-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 3043-000-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 3039-000-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 3037-001-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 3037-002-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 3041-000-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 3037-000-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 03086-000-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 03135-001-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 03135-000-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 03972-000-00	Levy County Soil Survey	May-04
Property Value & Structure Information - Parcel 16-17-02 33000	Citrus County Soil Survey	May-04
Property Value & Structure Information - Parcel 16-17-02 33000	Citrus County Soil Survey	May-04
Property Value & Structure Information - Parcel 16-17-03 22210	Citrus County Soil Survey	May-04
Property Value & Structure Information - Parcel 16-17-03 22220	Citrus County Soil Survey	May-04
Property Value & Structure Information - Parcel 16-17-03 22230	Citrus County Soil Survey	May-04
Property Value & Structure Information - Parcel 16-17-03 22240	Citrus County Soil Survey	May-04
Property Value & Structure Information - Parcel 16-17-12 14110	Citrus County Soil Survey	May-04
Property Value & Structure Information - Parcel 16-17-12 14110	Citrus County Soil Survey	May-04
Property Value & Structure Information - Parcel 16-17-03 22000	Citrus County Soil Survey	May-04



3 RESTORATION ALTERNATIVES DESCRIPTIONS AND DETAILS

The purpose of this study was to carry out an initiative by the Withlacoochee River Basin Board to evaluate a number of restoration alternatives for the Cross-Florida Barge Canal system. This section provides a detailed description of the proposed alternatives and presents the conceptual plans and details developed in Task 2.3.5 of this study. This information was used in the development of hydraulic models whose results form the basis of the assessments conducted as part of this study.

The development of Alternatives 1 through 3 was influenced by the allowable discharge rate in the lower segment of the Withlacoochee River. For the purpose of this study, the allowable discharge rate was assumed to be 2,500 cfs. This discharge rate is approximately equivalent to the estimated maximum flow rate for the 'average year' discharge hydrograph in this segment of the Withlacoochee River. The reader is referred to Section 6.3 of the WO-1 Report for a detailed discussion regarding the selection of the 'average year' hydrograph.

Prior to the development of the proposed alternatives, a study was conducted to assess flood impacts in the lower segment of the river due to flows from the 'average year' discharge hydrograph. The 'average year' discharge hydrograph was routed through the system with the corresponding tide-stage hydrograph serving as the downstream boundary condition. Results of this preliminary study indicated that there was no structural flooding attributable to river flows. Thus, a peak discharge rate of 2,500 cfs was assumed to be the design maximum rate for all future simulations conducted as part of the design and assessment of proposed alternatives. It should be noted that higher flows might be feasible for use in the development of restoration alternatives. However, allowable flow rates, which are based on structure flooding are greatly influenced by tide conditions and additional detailed studies are required to optimize the maximum flow rate.

3.1 Alternative 1

Alternative 1 consists of removing the Rock Dam/FCL, constructing an operable control structure in the Barge Canal, and replacing the US-19 Bridge over the Withlacoochee River. **Figure 3** is a conceptual plan illustrating the location of existing and proposed elements of this alternative. This plan also illustrates the direction and course of normal and flood flows in the system.

The location and extent of the proposed Rock Dam/FCL removal is illustrated on the **Figure 4** Plan view. **Figure 5** illustrates the proposed river cross-section that will be constructed in place of the Rock Dam/FCL. This cross-section was developed from a surveyed cross-section of the river at the location shown on the **Figure 4** Plan view. The proposed removal of the Rock Dam/FCL will allow flows released from Inglis Dam's main gates to pass directly from the Withlacoochee River Upper Segment to the lower segment of the river. Presently, normal flow releases are made primarily to the lower segment of the river via the Bypass Channel Structure, with periodic normal flow releases to the upper segment of the river via the main gates. All main gate releases are then conveyed to the Gulf via the Barge Canal. Removal of the Rock Dam/FCL will allow larger peak flow rates and an increased volume of flow to the lower segment of the

river, as well as increased flows to the upper segment of the river as all discharge will go through the main gates.

The proposed operable control structure will be constructed across the Barge Canal at the approximate location illustrated on the **Figure 4** Plan view. The proposed control structure will consist of earthen embankments, an ogee crest weir and five (5) vertical lift roller gates as illustrated by the **Figure 4** Section views. Under conditions of normal flow, the gates will remain closed, allowing all water to pass to the lower segment of the river. Presently, flood flows are released from the main gates and are conveyed to the Gulf via the Barge Canal. With Alternative 1 in place, a portion of the flood flows will be shunted down the Barge Canal through the gates of the control structure and the remainder of the flows will be conveyed to the lower segment of the river.

Presently, access by water craft to the Withlacoochee River Upper Segment and Lake Rousseau via Inglis Lock is provided by the Cross-Florida Barge Canal. Implementation of Alternative 1 will prevent navigational access to these areas via the Barge Canal due to construction of the Canal Control structure. Instead, navigational access to these areas will be provided via the Withlacoochee River Lower Segment. To accommodate existing vessel size (height) the existing bridges over the Withlacoochee River at US-19 will require replacement. **Figure 6** illustrates the proposed replacement bridge. This design was adopted from proposed FDOT plans for an additional single span bridge over the Barge Canal at US-19, which is part of the Suncoast Parkway expansion. The FDOT Alternative 2 bridge configuration, shown on **Figure 6**, represents a 40-foot high 2-lane vertical clearance facility, which was selected by FDOT based on a Boat User Survey conducted in 2002. The same bridge configuration is proposed for use in Alternative 1 in this study. The primary difference is that two (2) 2-lane bridge spans will be required for the US-19 crossing at the Withlacoochee River.

3.2 Alternative 2

Alternative 2 consists of removing the Rock Dam/FCL and constructing an operable control structure (River Control Structure) in its place, constructing an operable control structure in the Barge Canal (Canal Control Structure), as well as constructing a navigation lock in the Barge Canal. **Figure 7** is a conceptual plan illustrating the location of existing and proposed elements of this alternative. This plan also illustrates the direction and course of normal and flood flows in the system.

The function of Alternative 2 is similar to Alternative 1 with respect to normal flows, but differs from Alternative 1 with respect to flood flows and navigation. The proposed operable River Control Structure will allow normal flows to be conveyed to the lower segment of the river similar to Alternative 1. However, during flood flows this structure can be operated to allow a safe flow rate to be conveyed to the lower segment of the river while the remainder of the flows are shunted down the Barge Canal. This is similar in function to the system under existing conditions. Alternative 2 also provides navigational access to the Withlacoochee River Upper Segment and Lake Rousseau via Inglis Lock, similar to existing conditions by means of a new lock in the Barge Canal.

The proposed operable control structure and lock will be constructed across the Barge Canal at the location illustrated on the **Figure 8** Plan view. The proposed Canal Control Structure will consist of earthen embankments, an ogee crest weir and five (5) vertical lift roller gates as illustrated by the **Figure 8** Section views. The proposed lock will consist of a concrete chamber and upstream and downstream miter gates with through-the-gate filling and emptying as illustrated by the **Figure 8** Section view. The proposed River Control Structure will be constructed in place of the Rock Dam/FCL at the location illustrated on the **Figure 8** Plan view. The proposed River Control Structure will consist of earthen embankments, an ogee crest weir and three (3) vertical lift roller gates as illustrated by the **Figure 9** Section views.

3.3 Alternative 3

Alternative 3 consists of reconstructing the existing Bypass Channel and Bypass Channel Spillway (operable control structure) to provide additional conveyance capacity. **Figure 10** is a conceptual plan illustrating the location of existing and proposed elements of this alternative. This plan also illustrates the direction and course of normal and flood flows in the system.

The function of Alternative 3 is similar to existing conditions (Alternative 4) with respect to normal flow direction, flood flows and navigation. The primary difference in function between Alternative 3 and existing conditions is in normal flow rate and volume. Presently, normal flows up to a maximum discharge rate of 1,540 cfs are discharged to the lower segment of the river via the Bypass Channel System. All required releases above this flow rate are made through Inglis Dam's main gates including major flood releases. The main dam's gates were designed to accommodate flows up to 18,000 cfs, nearly double the 100-year flood flow rate.

Under Alternative 3 proposed conditions, the Bypass Channel System's capacity will be increased to approximately 2,500 cfs (62 percent increase), to accommodate the estimated maximum flow rate for the average year. For this study, the average year was selected to be 1996 based on a statistical analysis of annual runoff volume for the Withlacoochee River system. Section 6.3 of the WO-1 Report provides details of the analyses conducted to determine the average year hydrograph. As a result of increasing the capacity of the Bypass Channel System, normal flow releases from the main gates (rate, volume and frequency) will be decreased, as will flows in the receiving system including the upper segment of the river and Barge Canal. Navigational access and flood flow operations under Alternative 3 conditions will be similar to existing conditions, although flood flows from the main gates will be decreased slightly due to the increased capacity of the Bypass Channel system.

The proposed Bypass Channel System improvements will be constructed as illustrated on the **Figure 11** Plan view. The proposed replacement control structure has been conceptually designed to fit within the confines of the existing structure. The structure will consist of earthen embankments, an ogee crest weir and two (2) vertical lift roller gates as illustrated by the **Figure 11** Section view. The proposed channel improvements consist of widening the channel by approximately 30 over the entire length of the channel (approximately 8,500 linear feet) and providing channel stabilization as illustrated by the **Figure 11** Section view.

3.4 Alternative 4

Alternative 4 represents the existing or baseline condition and is illustrated on **Figure 12**. Section 4 of the WO-1 Report provides a detailed description with photo-documentation of the Cross-Florida Barge Canal system and its components as well as design data for these facilities. Alternative 4 does not propose improvements to the system. **Figure 12** illustrates the direction and course of normal and flood flows in the system. The following is a description of present day system operations.

Presently, normal flows up to a maximum discharge rate of 1,540 cfs are discharged to the lower segment of the river via the Bypass Channel System. All required releases above this flow rate are made through Inglis Dam's main gates including major flood releases. The Dam's main gates were designed to accommodate flows up to 18,000 cfs, which is nearly double the 100-year flood flow rate. Periodic normal flow releases to the upper segment of the river are made through the main gates for water quality purposes. As illustrated on **Figure 12**, flood releases are made through the main gates and are conveyed along the upper segment of the river to the Barge Canal and ultimately to the Gulf.

Presently, access by water craft to the Withlacoochee River Upper Segment and Lake Rousseau via Inglis Lock is provided by the Cross-Florida Barge Canal. Lake Rousseau was designed to provide water to operate the lock system. Inglis Lock has fallen into disrepair and is rarely operated. However, studies and designs for a replacement lock within the present lock chamber have been completed by the State of Florida, and the project awaits construction funding.



4 HYDRAULIC MODEL DEVELOPMENT AND OUTPUT

This section of the report describes: (1) the basis (previous models) for the hydraulic (open-channel) models developed and used in this assessment; (2) updates made to the previous models, which more accurately define the physical characteristics of the Cross-Florida Barge Canal System; (3) specific model revisions and additions made to facilitate modeling the various alternatives; (4) details of model configuration and operating parameters for each simulation by alternative; and (5) model results (output) for each of the simulations by simulation type.

Previous modeling of the Cross-Florida Barge Canal system was conducted using the Army Corps of Engineers' UNET model. The ACOE's HEC-RAS (Version 3.1.1, May 2003) computer model was selected for use in this study. The HEC-RAS unsteady-flow module was built upon the UNET model code, which runs through the RAS interface. The RAS interface simplifies model input and provides superior graphical and tabular output.

4.1 Model Basis, Updates, and Revisions

4.1.1 Model Basis

The open-channel model (UNET) developed as part of previous dam safety planning studies for Lake Rousseau was used as a basis for the HEC-RAS models developed in the present study. The UNET model consists of two reaches representing the Withlacoochee River Lower Segment and the Barge Canal/ Withlacoochee River Upper Segment. The reaches are integrated at the Rock Dam/FCL, as the model was intended to simulate flows and water levels in the system due to a failure of Inglis dam and a consequential failure of the Rock Dam. Geometric elements of the UNET model (cross-sections and model framework) were converted for use in the present study.

The UNET model was developed to simulate high flow rates (dam failure) in the Cross-Florida Barge Canal system. The model studies conducted as part of the West Terminus Assessment require low flow as well as high flow simulations. A number of updates (refinements) were made to the geometric elements of the imported UNET model to facilitate its use in the West Terminus Assessment. These updates are described in Section 4.1.2.

4.1.2 Generic Updates

This section describes the revisions made to the geometric elements of the UNET model to facilitate their use in the present assessment. The UNET geometry files were imported to HEC-RAS, which was used to create the update geometry files. The generic model updates were applicable to the models developed for each alternative.

Cross-Section Revisions

The West Terminus Assessment included long-term low flow simulations of the system, where the majority of the flow was carried within the main channel. The bank-to-bank portion of the cross-sections imported from the previous model was updated to more accurately reflect existing conditions within the channel. Land surveying of the bank-to-bank portion of 15 existing cross-

sections on the Withlacoochee River and Barge Canal as well as three (3) new cross-sections on the Withlacoochee River and Bypass Channel was conducted in February 2004 to obtain this information. **Figure 2** illustrates the location and extent of the cross-section survey.

The surveyed cross-sections were used to update the remaining cross-sections where necessary. **Appendix A** contains the cross-sections used in the West Terminus Assessment model studies for the Withlacoochee River, Barge Canal and a typical cross-section for the Bypass Channel. **Figure 13** illustrates the location and identifies the cross-sections used in these model studies.

River Restoration Section, Cross-Section 12

Alternative 1 requires the use of a cross-section to represent the connection of the upper and lower segments of the Withlacoochee River. This section was incorporated into the model framework, and is illustrated in **Appendix A**.

US-19 Bridge

The US-19 Bridge over the Withlacoochee River was not explicitly represented in the UNET model. As part of the present study, detailed survey data of the bridge was collected and this information was used to specify the physical nature of the bridge within the HEC-RAS models. **Appendix A** contains details of the US-19 Bridge as represented in the models including plan and profile views to illustrate spatial relationships and a cross-section view to illustrate channel and bridge elements. It should be noted that the US-19 Bridge proposed as part of this study is a clear span facility with no obstruction to low flow within the channel. However, due to uncertainty as to the ultimate design of this facility, the bridge in its present configuration was modeled for all alternatives.

Barge Canal Lateral Outflow Areas

The previous UNET model included lateral outflow areas from the Withlacoochee River Upper Segment and from the Barge Canal. The river upper segment outflow areas functioned only for very high flows and were not required for this study. The Barge Canal outflow areas were incorporated into the HEC-RAS models. **Appendix A** contains details of these facilities as represented in the models, including a plan view to illustrate spatial relationships and a cross-section view to illustrate geometry.

Channel Roughness Revisions

The UNET model from the previous studies focused on channel roughness in the overbank areas, due to the high flow nature of these analyses. The West Terminus Assessment model studies include low flow simulations, which require accurate channel roughness within the bank-to-bank portion of the channel. Field reconnaissance was conducted to obtain the information necessary to refine the bank-to-bank channel roughness. Photo-documentation at various location within the Cross-Florida Barge Canal system is presented in the WO-1 Report. **Appendix A** contains a summary of the channel roughness (Manning's Roughness Coefficient 'n') used in current modeling studies.

4.1.3 Alternative Specific Revisions

This section provides documentation of revisions (additions) made to the HEC-RAS models specific to a particular alternative.

Barge Canal Control Structure

Alternatives 1 and 2 require the use a control structure to divert higher than normal flows out of the Withlacoochee River and into the Barge Canal where it can be safely conveyed to the Gulf. **Figure 4** provides details of the location and design of this facility. **Appendix A** contains details of this facility as represented in the models, including a plan view to illustrate spatial relationships and a cross-section view to illustrate geometry. This facility as conceptualized for this study is located within the Barge Canal just downstream of the confluence of the Withlacoochee River Upper Segment. The control structure is represented as a lateral outflow structure (gated-weir), situated on the left bank of the river between Cross-Sections 12 and 27.

The proposed Barge Canal Control Structure consists of a weir and five-20-ft wide vertical lift roller gates. The primary purpose of this structure is to convey flows in excess of normal flow into the Barge Canal, which acts to minimize flooding on the lower segment of the river. A detailed study was conducted to determine the size (capacity) of this facility. This study was conducted using the Alternative 1 model based on a 100-year flood simulation. The study consisted of conducting a number of model runs and varying the number of gates (2 through 10) in the control structure. Model results were reviewed with respect to the number of structures (dwellings) flooded and the feasibility of siting the structure at the selected location. Results of the study showed that six (6) structures flooded if two gates were used, two (2) structures flooded if four to six gates were used and one (1) structure flooded if ten gates were used. As a compromise between cost and minimizing the number of structures flooded, the five (5) gate option was selected for use in the study. It should be noted that hydraulic limitations of the Barge Canal control the flow through the Control Structure. As an example of this, increasing the number of gates in the structure from 5 to 10 decreases the flow to the lower segment of the river from 3,152 cfs to 2,997 cfs for the 100-year flood event.

River Control Structure

Alternative 2 requires the use a control structure within the Withlacoochee River channel (at the present location of the Rock Dam) to divert higher than normal flows out of the Withlacoochee River and into the Barge Canal where it can be safely conveyed to the Gulf. The River Control Structure works in conjunction with the Barge Canal Control Structure. **Figure 8** provides a plan view of the location and alignment of this facility and **Figure 9** provides a section and details of the design of this facility. **Appendix A** contains details of this facility as represented in the models, including a plan view to illustrate spatial relationships and cross-section and profile views to illustrate geometry. This facility as conceptualized for this study is located within the Withlacoochee River channel at Cross-Section 12 and is represented as an inline (gated-weir) structure.

The proposed River Control Structure consists of a weir and three-40-ft wide vertical lift roller gates. The primary purpose of this structure is to regulate flows into the lower segment of the river. Flows in the upper segment of the river, in excess of normal flows can be shunted into the Barge Canal by restricting flows across the River Control Structure and increasing flows across the Barge Canal Control Structure. This operation acts to minimize flooding on the lower segment of the river. A detailed study was conducted to determine the size (capacity) of this facility. This study was conducted using the Alternative 2 model based on the average year flows used for the long-term simulation. The study consisted of conducting model runs and varying the number and size of gates in the control structure so that water levels in the upper segment of the river would not increase over estimated water levels expected if the control structure were not present (baseline condition). The baseline condition was taken as Alternative 1. Model results were reviewed with respect to the number of structures (dwellings) flooded and the feasibility of siting the structure at the selected location. It should be noted that the River Control Structure is designed to convey the peak normal year flow (approximately 2,500 cfs) without increasing headwater levels. However, this structure is capable of conveying much higher flows if necessary. The conveyance capacity of this facility will be limited by the hydraulic capacity of the receiving channel (lower segment of the river) if headwater level restrictions are not imposed.

Bypass Channel Control Structure

Alternative 3 requires the replacement of the control structure at the western terminus of the Bypass Channel. This structure controls discharge from Lake Rousseau while maintaining the lake's normal water level. **Figure 11** provides a plan view of the location and alignment of this facility and a section view with details of the design of this facility. **Appendix A** contains details of this facility as represented in the models, including a plan view to illustrate spatial relationships and cross-section and profile views to illustrate geometry. This facility as conceptualized for this study is located at the downstream end of the Bypass Channel and discharges through a man-made lateral channel to the Withlacoochee River just upstream of Cross-Section 11. This facility is represented as an inline (gated-weir) structure.

The proposed Bypass Channel Control Structure consists of a weir and two-14-ft wide vertical lift roller gates. The replacement structure was designed to fit in the same width as the existing structure. Capacity was increased by lowering the weir elevation and effectively increasing head on the facility. The primary purpose of this structure is to regulate flows into the lower segment of the river directly from Lake Rousseau. A detailed study was conducted to determine the size (capacity) of this facility. This study was conducted using a model developed specifically for the Bypass Channel facility, included an inline gated-weir and 8,500 linear feet of supply canal. The study, run in steady-flow mode, consisted of conducting model runs and varying the flow until the upstream water surface profile matched the normal pool level (27.5 ft-NGVD) in Lake Rousseau.

It should be noted that the Bypass Channel Control Structure required capacity is approximately 2,500 cfs, which is equivalent to the peak discharge of the normal year hydrograph. However, this structure has been designed to convey approximately 3,500 cfs at the given headwater level. The maximum discharge capacity for this structure can be increased by lowering the weir crest

elevation. Studies should be conducted in the design phase to optimize the maximum discharge for this facility.

4.2 Model Concepts

Separate computer models were developed for each of the four (4) alternatives evaluated as part of this study. All of the models include the generic updates documented in Section 4.1.2. Models specific to a particular alternative also include the applicable revision(s) documented in Section 4.1.3. Model simulations for long term, 100-year flood and dam failure conditions were conducted using the models specific to a particular alternative. This section of the report provides details of model configuration and operating parameters for each alternative and simulation type.

4.2.1 Alternative 1

Alternative 1 is described in detail in Section 3.1 of this report and shown schematically on **Figure 3**. The HEC-RAS model for this alternative consists of two (2) river reaches, connected through a lateral outflow structure at the confluence of the Barge Canal and the Withlacoochee River Upper Segment. **Appendix A** contains a plan view of the model framework for Alternative 1. This plan view illustrates cross-sections and their spatial relationship for the entire system. Reach 1 (U Withlacoochee) represents the upper and lower segments of the river from the west end of Yankeetown (RS-0) upstream to Inglis Dam (RS-8.06). Reach 2 (Barge Canal) represents the Barge Canal from the Gulf (RS-0) upstream to the confluence of the Withlacoochee River (RS-5.95). **Figure 13** identifies and illustrates the cross-sections used in the study area and provides a table, which cross references the cross-section ID with the river station. **Appendix A** contains a river profile for the two reaches described above.

Alternative 1, as proposed, includes removing the Rock Dam/FCL to reconnect the upper and lower segment of the river, constructing a control structure in the Barge Canal to divert flood flows to the canal and releasing all flows from Lake Rousseau through Inglis Dam main gates. The river reconnection was modeled through the placement of Cross-Section 12 between Cross-Sections 11 and 27. The Barge Canal Control Structure was modeled using a lateral outflow structure located in the Withlacoochee River and discharging to the Barge Canal. **Appendix A** contains a large-scale plan view of the model framework illustrating the river reconnection section (RS-6.47) and the lateral outflow structure (RS-6.59). **Appendix A** also contains a summary print out of the HEC-RAS model input for Alternative 1 for each of the simulations described below.

For the long-term simulation, an inflow hydrograph representing the average flow year (1996) was input to the system at Cross-Section 26 (RS-8.06). Additionally, a downstream stage hydrograph simulating tidal fluctuations for the same year, was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. Section 6.3 of the WO-1 Report provides detailed documentation regarding the selection of the long-term simulation hydrographs. **Appendix A-Boundary Conditions** contains plots the long-term inflow (Lake Rousseau Long-Term Discharge (Daily)), Alternatives 1 and 2 (Main Gates) and tidal (Long-Term Tide Stage Hydrograph) hydrographs.

For the long-term simulation, the Barge Canal Control Structure was operated with the gates closed during the entire one-year simulation length. This allows the entire flow series to be conveyed down the lower river segment. Please note that lockage flows are insignificant with respect to annual flow volumes and were ignored in this study.

For the 100-year flood simulation, an inflow hydrograph representing discharge from Lake Rousseau (March 1960) was input to the system at Cross-Section 26 (RS-8.06). Additionally a downstream stage hydrograph simulating tidal fluctuations for the same time period, was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. Section 6.4 of the WO-1 Report provides detailed documentation regarding the selection of the 100-year flood simulation hydrographs. **Appendix A-Boundary Conditions** contains plots of the 100-year flood inflow (Lake Rousseau 100-year Discharge (Daily)), Alternatives 1 and 2 (Main Gates) and tidal (100-year Tide Stage Hydrograph) hydrographs.

For the 100-year flood simulation, the Barge Canal Control Structure was operated with the gates fully open during the entire simulation length. This is reasonable given the nature of flood flows on the river and allows the maximum volume of runoff to be conveyed to the Barge Canal, thereby minimizing flows to the lower river segment.

For the Dam Failure simulation, an inflow hydrograph representing a Sunnyday failure of Inglis Dam was input into the system at Cross-Section 26 (RS-8.06). Additionally a downstream stage hydrograph was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. The Sunnyday dam failure hydrograph developed as part of a previous dam safety planning study was adopted without modification for use in this study. The Sunnyday dam failure condition was the basis for the Emergency Action Plan developed for Lake Rousseau. The downstream stage hydrograph was set at a constant elevation (3.4 ft-NGVD) for the entire simulation length. This elevation represents the average tide stage for 1996. **Appendix A-Boundary Conditions** contains a plot of the Sunnyday dam failure inflow hydrograph (Inglis Dam Sunnyday Failure).

For the Dam Failure simulation, the Barge Canal Control Structure was operated with the gates closed for the first hour of the simulation. After which, the gates were opened at a constant rate such that they were fully open within 45 minutes. This operating condition is reasonable given the normal level of vigilance provided by the dam's owner and assumes that the control structure can be operated remotely.

4.2.2 Alternative 2

Alternative 2 is described in detail in Section 3.2 of this report and shown schematically on **Figure 7**. The HEC-RAS model for this alternative consists of two (2) river reaches, connected through a lateral outflow structure at the confluence of the Barge Canal and the Withlacoochee River Upper Segment. Additionally, an inline structure is located between the upper and lower segments of the Withlacoochee River. **Appendix A** contains a plan view of the model framework for Alternative 2. This plan view illustrates cross-sections and their spatial relationship for the entire system. Reach 1 (U Withlacoochee) represents the upper and lower segments of the river from the west end of Yankeetown (RS-0) upstream to Inglis Dam (RS-

8.06). Reach 2 (Barge Canal) represents the Barge Canal from the Gulf (RS-0) upstream to the confluence of the Withlacoochee River (RS-5.95). **Figure 13** identifies and illustrates the cross-sections used in the study area and provides a table, which cross references the cross-section ID with the river station. **Appendix A** contains a river profile for the two reaches described above.

Alternative 2, as proposed, removes the Rock Dam/FCL to reconnect the upper and lower segments of the river and replaces it with a control structure to regulate flows, constructs a control structure in the Barge Canal to divert flood flows to the canal and releases all flows from Lake Rousseau through Inglis Dam main gates. The river reconnection was modeled through the placement of Cross-Section 12 between Cross-Sections 11 and 27 and placing an inline control structure (River Control Structure) at Cross-Section 12. The Barge Canal Control Structure was modeled using a lateral outflow structure located in the Withlacoochee River and discharging to the Barge Canal. **Appendix A** contains a large-scale plan view of the model framework illustrating the inline structure (RS-6.45) and the lateral outflow structure (RS-6.59). **Appendix A** also contains a summary print out of the HEC-RAS model input for Alternative 2 for each of the simulations described below.

For the long-term simulation, an inflow hydrograph representing the average flow year (1996) was input to the system at Cross-Section 26 (RS-8.06). Additionally, a downstream stage hydrograph simulating tidal fluctuations for the same year, was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. Section 6.3 of the WO-1 Report provides detailed documentation regarding the selection of the long-term simulation hydrographs. **Appendix A-Boundary Conditions** contains plots of the long-term inflow (Lake Rousseau Long-Term Discharge (Daily)), Alternatives 1 and 2 (Main Gates) and tidal (Long-Term Tide Stage Hydrograph) hydrographs.

For the long-term simulation, the Barge Canal Control Structure was operated with the gates closed and the River Control Structure was operated with the gates open during the entire one-year simulation length. This allows the entire flow series to be conveyed down the lower river segment. Please note that lockage flows are insignificant with respect to annual flow volumes and were ignored in this study.

For the 100-year flood simulation, an inflow hydrograph representing discharge from Lake Rousseau (March 1960) was input to the system at Cross-Section 26 (RS-8.06). Additionally a downstream stage hydrograph simulating tidal fluctuations for the same time period, was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. Section 6.4 of the WO-1 Report provides detailed documentation regarding the selection of the 100-year flood simulation hydrographs. **Appendix A-Boundary Conditions** contains plots of the 100-year flood inflow (Lake Rousseau 100-year Discharge (Daily)), Alternatives 1 and 2 (Main Gates) and tidal (100-year Tide Stage Hydrograph) hydrographs.

For the 100-year flood simulation, the Barge Canal Control Structure was operated with the gates fully open during the entire simulation length. This is reasonable given the nature of flood flows on the river. The River Control Structure is operated so as to maintain a maximum discharge down the lower segment of the river at or below the maximum flow for the normal year hydrograph. This maximum flow is approximately 2,500 cfs.

For the Dam Failure simulation, an inflow hydrograph representing a Sunnyday failure of Inglis Dam was input into the system at Cross-Section 26 (RS-8.06). Additionally, a downstream stage hydrograph was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. The Sunnyday dam failure hydrograph developed as part of a previous dam safety planning study was adopted without modification for use in this study. The Sunnyday dam failure condition was the basis for the Emergency Action Plan developed for Lake Rousseau. The downstream stage hydrograph was set at a constant elevation (3.4 ft-NGVD) for the entire simulation length. This elevation represents the average tide stage for 1996. **Appendix A-Boundary Conditions** contains a plot of the Sunnyday dam failure inflow hydrograph (Inglis Dam Sunnyday Failure).

For the Dam Failure simulation, the Barge Canal Control Structure was operated with the gates closed for the first hour of the simulation. After which, the gates were opened at a constant rate such that they were fully open within 45 minutes. The River Control Structure was operated with the gates fully open for the first hour of the simulation. After which, the gates were closed at a constant rate until the maximum discharge down the lower segment of the river was at or below the maximum flow for the normal year hydrograph. This maximum flow is approximately 2,500 cfs, and it is assumed that the discharge was achieved within 45 minutes after the commencement of gate closing. This operating condition is reasonable given the normal level of vigilance provided by the dam's owner and assumes that the control structures can be operated remotely.

4.2.3 Alternative 3

Alternative 3 is described in detail in Section 3.3 of this report and shown schematically on **Figure 10**. The HEC-RAS model for this alternative consists of two (2) unconnected river reaches. **Appendix A** contains a plan view of the model framework for Alternative 3. The plan view illustrates cross-sections and their spatial relationship for the entire system. Reach 1 (L Withlacoochee) represents the lower segments of the river from the west end of Yankeetown (RS-0) upstream to the Rock Dam/FCL (RS-6.47). Reach 2 (U Withla & B.C.) represents the Barge Canal and the upper segment of the river from the Gulf (RS-0) upstream to Inglis Dam (RS-7.53). **Figure 13** identifies and illustrates the cross-sections used in the study area and provides a table, which cross references the cross-section ID with the river station. **Appendix A** contains a river profile for the two reaches described above. **Appendix A** also contains a summary print out of the HEC-RAS model input for Alternative 3 for each of the simulations described below.

Alternative 3, as proposed, includes reconstructing the Bypass Channel and Bypass Channel Spillway (operable control structure) to provide additional conveyance capacity. The Bypass Channel and control structure were represented in the Alternative 3 models as an inflow hydrograph, which was input to the system at Cross-Section 12. Information regarding the design of this facility is presented in Section 4.1.3 and details are contained in **Appendix A**.

For the long-term simulation, inflow hydrographs representing the average flow year (1996) were input to the system at Inglis Dam (XS-26/ RS-7.53) and at the Rock Dam/FCL (XS-12/ RS-6.47). The inflow hydrograph at the Rock Dam/FCL simulates inflow to the lower segment of

the river from the Bypass Channel System. Additionally, a downstream stage hydrograph simulating tidal fluctuations for the same year, was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. Section 6.3 of the WO-1 Report provides detailed documentation regarding the selection of the long-term simulation hydrographs. **Appendix A-Boundary Conditions** contains plots of the long-term inflow (Lake Rousseau Long-Term Discharge (Daily)), Alternative 3 (Main Gates and Bypass) and tidal (Long-Term Tide Stage Hydrograph) hydrographs.

For the long-term simulation, the Lake Rousseau controls were operated so that the majority of discharge was through the Bypass Channel System. A 100 cfs baseflow and periodic water quality releases of 400 cfs were made through the main gates.

For the 100-year flood simulation, an inflow hydrograph representing discharge from Lake Rousseau through the main gates was input to the system at Cross-Section 26 (RS-7.53). A second inflow hydrograph representing discharge from Lake Rousseau from the Bypass Channel System was input to the river and at the Rock Dam/FCL (XS-12/ RS-6.47). Additionally, a downstream stage hydrograph simulating tidal fluctuations for the same time period, was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. Section 6.4 of the WO-1 Report provides detailed documentation regarding the selection of the 100-year flood simulation hydrographs. **Appendix A-Boundary Conditions** contains plots of the 100-year flood inflow (Lake Rousseau 100-year Discharge (Daily)), Alternative 3 (Main Gates and Bypass) and tidal (100-year Tide Stage Hydrograph) hydrographs.

For the 100-year flood simulation, the Lake Rousseau controls were operated so that majority of discharge was through the main gates. The Bypass Channel System was operated to provide a near structure capacity discharge of 2,400 cfs to the lower segment of the river.

For the Dam Failure simulation, an inflow hydrograph representing a Sunnyday failure of Inglis Dam was input to the system at Cross-Section 26 (RS-7.53). A second inflow hydrograph representing discharge from Lake Rousseau from the Bypass Channel System was input to the river and at the Rock Dam/FCL (XS-12/ RS-6.47). The Bypass Channel discharge rate was assumed to be 2,400 cfs. Additionally a downstream stage hydrograph was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. The Sunnyday dam failure hydrograph developed as part of a previous dam safety planning study was adopted without modification for use in this study. The Sunnyday dam failure condition was the basis for the Emergency Action Plan developed for Lake Rousseau. The downstream stage hydrograph was set at a constant elevation (3.4 ft-NGVD) for the entire simulation length. This elevation represents the average tide stage for 1996. **Appendix A-Boundary Conditions** contains a plot of the Sunnyday dam failure inflow hydrograph (Inglis Dam Sunnyday Failure).

4.2.4 Alternative 4

Alternative 4, the baseline condition is described in detail in Section 3.3 of this report and shown schematically on **Figure 11**. The HEC-RAS model for this alternative consists of two (2) unconnected river reaches. **Appendix A** contains a plan view of the model framework for Alternative 4. The plan view illustrates cross-sections and their spatial relationship for the entire

system. Reach 1 (L Withlacoochee) represents the lower segments of the river from the west end of Yankeetown (RS-0) upstream to the Rock Dam/FCL (RS-6.47). Reach 2 (U Withla & B.C.) represents the Barge Canal and the upper segment of the river from the Gulf (RS-0) upstream to Inglis Dam (RS-7.53). **Figure 13** identifies and illustrates the cross-sections used in the study area and provides a table, which cross references the cross-section ID with the river station. **Appendix A** contains a river profile for the two reaches described above. **Appendix A** also contains a summary print out of the HEC-RAS model input for Alternative 4 for each of the simulations described below.

For the long-term simulation, inflow hydrographs representing the average flow year (1996) are input to the system at Inglis Dam (XS-26/ RS-7.53) and at the Rock Dam/FCL (XS-12/ RS-6.47). The inflow hydrograph at the Rock Dam/FCL simulates inflow to the lower segment of the river from the Bypass Channel System. Additionally, a downstream stage hydrograph simulating tidal fluctuations for the same year, was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. Section 6.3 of the WO-1 Report provides detailed documentation regarding the selection of the long-term simulation hydrographs. **Appendix A-Boundary Conditions** contains plots of the long-term inflow (Lake Rousseau Long-Term Discharge (Daily)), Alternative 4 (Main Gates and Bypass) and tidal (Long-Term Tide Stage Hydrograph) hydrographs.

The long-term simulation, with respect to discharges from Lake Rousseau, reflects actual operation of the discharge facilities. Under normal flow conditions the majority of discharge is through the Bypass Channel System up to a maximum discharge rate of 1,540 cfs. All releases from Lake Rousseau in excess of this rate are made through the main gates.

For the 100-year flood simulation, an inflow hydrograph representing discharge from Lake Rousseau through the main gates was input to the system at Cross-Section 26 (RS-7.53). A second inflow hydrograph representing discharge from Lake Rousseau from the Bypass Channel System was input to the river and at the Rock Dam/FCL (XS-12/ RS-6.47). Additionally, a downstream stage hydrograph simulating tidal fluctuations for the same time period, was applied to the Barge Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. Section 6.4 of the WO-1 Report provides detailed documentation regarding the selection of the 100-year flood simulation hydrographs. **Appendix A-Boundary Conditions** contains plots of the 100-year flood inflow (Lake Rousseau 100-year Discharge (Daily)), Alternative 4 (Main Gates and Bypass) and tidal (100-year Tide Stage Hydrograph) hydrographs.

The 100-year flood simulation with respect to discharges from Lake Rousseau reflects actual operation of the discharge facilities. Under flood flow conditions, discharges through the Bypass Channel System are made up to a maximum discharge rate of 1,540 cfs. All releases from Lake Rousseau in excess of this rate are made through the main gates.

For the Dam Failure simulation, an inflow hydrograph representing a Sunnyday failure of Inglis Dam was input to the system at Cross-Section 26 (RS-7.53). A second inflow hydrograph representing discharge from Lake Rousseau from the Bypass Channel System was input into the river and at the Rock Dam/FCL (XS-12/ RS-6.47). The Bypass Channel discharge rate was assumed to be 1,540 cfs. Additionally, a downstream stage hydrograph was applied to the Barge

Canal at Cross-Section 32 and to the Withlacoochee River at Cross-Section 1. The Sunnyday dam failure hydrograph developed as part of a previous dam safety planning study was adopted without modification for use in this study. The Sunnyday dam failure condition was the basis for the Emergency Action Plan developed for Lake Rousseau. The downstream stage hydrograph was set at a constant elevation (3.4 ft-NGVD) for the entire simulation length. This elevation represents the average tide stage for 1996. **Appendix A-Boundary Conditions** contains a plot of the Sunnyday dam failure inflow hydrograph (Inglis Dam Sunnyday Failure).

4.3 Model Output

This section of the report describes model results (output) for each of the simulation types conducted as part of this study.

4.3.1 Long-Term Simulations

Results of the long-term simulations were used in the natural systems, flood and water quality assessments conducted as part of this study. Long-term simulation model output included tabular summaries and stage hydrographs at each cross-section. The tabular summary included total discharge, water surface elevation and other hydraulic parameters at each cross-section for the maximum water surface profile. The stage hydrographs provided a history of stage for the one-year simulation period. **Appendix B** contains the long-term simulation model output described above for each of the 4 alternatives addressed as part of this study.

Additionally, included with the long-term simulation results in **Appendix B** is model output for the Bypass Channel simulation. This output includes a table of total discharge, water surface elevation and other hydraulic parameters at each cross-section and a typical cross-section with water surface elevation as well as a profile of the system.

4.3.2 100-Year Flood Simulations

Results of the 100-year flood simulations were used in the flood assessment conducted as part of this study. The 100-year flood simulation model output included tabular summaries and stage/flow hydrographs at selected locations throughout the system. The tabular summary included total discharge, water surface elevation and other hydraulic parameters at each cross-section for the maximum water surface profile. Stage/flow hydrographs were provided at Cross-Sections 26, 11, 3 and 29 as well as at the lateral discharge structure (RS-6.59) and the inline structure (RS-6.45) where applicable. The hydrographs provided a history of stage and flow for the simulation period. **Appendix B** contains the 100-year flood simulation model output described above for each of the 4 alternatives addressed as part of this study.

4.3.3 Dam Failure Simulations

Results of the Dam Failure simulations were used in the flood assessment conducted as part of this study. Dam Failure simulation model output included tabular summaries and stage/flow hydrographs at selected locations throughout the system. The tabular summary included total discharge, water surface elevation and other hydraulic parameters at each cross-section for the maximum water surface profile. Stage/flow hydrographs were provided at Cross-Sections 26, 11,

3 and 29 as well as at the lateral discharge structure (RS-6.59) and the inline structure (RS-6.45) where applicable. The hydrographs provided a history of stage and flow for the simulation period. **Appendix B** contains the Dam Failure simulation model output described above for each of the 4 alternatives addressed as part of this study.



5 RESTORATION ALTERNATIVES EVALUATION

This section of the report describes each of the assessments that were conducted as part of this study.

5.1 Natural Systems Assessment

A natural systems assessment was conducted to determine the impact that each of the proposed alternatives would have on wetlands and other systems in the West Terminus Cross-Florida Greenway area. The results of this assessment were used to grade each of the alternatives. The grading is discussed in detail in Section 7 of this report.

All three proposed alternatives will have an affect on the natural systems along the Withlacoochee River. While the effect will vary from alternative to alternative, each will result in a change in the river's long-term water elevations and the length of time the river will remain at a given elevation. These changes not only vary by alternative, but also by location along the river. The effects on the river are discussed below by alternative and by river segment. For purposes of this study, the river was broken into the upper segment of the river, between Inglis Dam and the Barge Canal (Cross-Sections 27 through 26) and the lower segment of the river, from the Rock Dam/FCL to west of Yankeetown (Cross-Sections 1 through 12). **Figure 13** shows the location of the cross sections along the Withlacoochee River.

Assessment of the effects of the proposed alternatives to the natural systems of the Withlacoochee River was based on review of the long-term simulation composite stage-duration curves, stage hydrographs, topography of the study area, and topographic surveys of the cross-sections modeled in the analysis. **Appendix C-Natural Systems Assessment** contains composite stage-duration curves for each cross-section within the study area. Additionally, selected stage-duration curves were reproduced and included as figures for convenience. **Appendix B** contains stage hydrographs as well as graphic representations of each cross-section within the study area. The effect on the natural resources was evaluated for the three proposed alternatives versus the existing condition (Alternative 4) for the cross-sections located along the upper and lower segment of the Withlacoochee River, as identified above.

5.1.1 *Withlacoochee River Upper Segment*

Alternatives 1 and 2

Alternatives 1 and 2 similarly affects to the river and its natural systems. In the upper segment of the river, Alternative 1 and Alternative 2 result in the river staging (on average) approximately 1 to 3 feet above the existing condition. The increase in stage varies depending on tidal condition, but is always higher than the existing condition. For both alternatives, the resulting increase in river staging is greatest at Inglis Dam (Cross-Section 26) and decreases at each subsequent downstream cross-section to the river's junction with the Barge Canal (Cross-Section 27). **Table 5-1** shows the maximum, minimum and median stage elevation for Alternatives 1 and 2 compared to the existing conditions (Alternative 4). The maximum and minimum stages were determined from the stage hydrographs (presented in **Appendix B**). The median stage was

determined from the long-term simulation composite stage-duration curves presented on **Figure 14** through **Figure 16**.

In addition to the stage changes, the tidal fluctuation ranges also changed. Under the existing condition, on a daily basis tidal fluctuation is typically between 2 and 3 feet. With Alternatives 1 and 2, the tidal fluctuation decreases to between 1 and 2 feet.

Table 5-1
Withlacoochee River Upper Segment Normal Water Elevations – Alts 1 and 2 vs. Alt 4

Alternative	Elevation ft-NGVD (Deviation from Existing Condition)					
	Cross-Section 26			Cross-Section 27		
	Maximum	Minimum	Median	Maximum	Minimum	Median
4 (Existing Condition)	6.5	<1.5	3.8	5.9	<1.5	3.6
1	8.1 (+1.6)	3.9 (+2.4)	6.2 (+2.4)	7.1 (+1.2)	2.9 (+1.4)	5.4 (+1.8)
2	8.3 (+1.8)	4.1 (+2.6)	6.3 (+2.5)	7.3 (+1.4)	3.1 (+1.6)	5.5 (+1.9)

The cross-sections of the upper river segment indicate that the banks of the river are relatively high and steep. In this river segment, bank elevations are approximately 10 ft-NGVD. The resulting increase in water surface elevations for Alternatives 1 and 2 generally will remain within the banks of the river. Any wetland vegetation established on the riverbanks should migrate up the banks and reestablish within the new wetland zone at the tidal interface with the river. **Appendix A** contains illustrations of cross-sections representative of this reach (27 through 26).

However, for Cross-Section 22 the left bank has a top elevation of approximately 5 ft-NGVD. Under the existing condition, the top of bank is overtopped for approximately 500 hours (6%) of the year. Alternatives 1 and 2 stage above the top of bank approximately 6,000 hours (68%) of the year, flooding approximately 150 feet inland, or a 4 acre area beyond the existing condition. This approximate 4 acre area will likely maintain a wetland hydrology and the existing upland vegetation will die off with hydrophytic vegetation being established.

Alternative 3

Alternative 3 will result in slightly lower river stages (0.6 feet) below the existing condition. The decrease in stage varies depending on tidal condition. The resulting change in river stage is greatest near Inglis Dam (Cross-Section 26) and diminishes at each subsequent cross-section downstream to zero change at the river's junction with the Barge Canal (Cross-Section 27). **Table 5-2** shows the maximum, minimum, and median river stages for Alternative 3 versus existing conditions.

Table 5-2
Withlacoochee River Upper Segment Normal Water Elevations – Alt 3 vs. Alt 4

Alternative	Elevation ft-NGVD (Deviation from Existing Condition)					
	Cross-Section 26			Cross-Section 27		
	Maximum	Minimum	Median	Maximum	Minimum	Median
4 Existing Condition	6.5	<1.5	3.8	5.9	<1.5	3.6
3	5.9 (-0.6)	<1.5 (0.0)	3.5 (-0.3)	5.9 (0.0)	<1.5 (0.0)	3.6 (0.0)

Due to the high banks in this portion of the river, the slight lowering of river stage as a result of Alternative 3 should have a negligible effect on the natural systems. Any wetland vegetation established on the riverbanks should migrate down the banks and reestablish within the new wetland zone at the tidal interface with the river.

5.1.2 Withlacoochee River Lower Segment

In the lower segment of the river, Alternative 1 and Alternative 2 result in the river staging (on average) approximately 1 foot above the existing condition at the Rock Dam/FCL. Alternative 3 also stages above the existing condition at this location, but the increase in stage is less, just under 1 foot. For all three alternatives, the elevated river stage decreases at each subsequent cross-section downstream to zero change in stage west of Yankeetown. Downstream of US 19 (i.e. Cross-Section 6), the maximum and minimum stages do not differ from the existing condition, but on average, the river stages within this range are slightly higher, as evidenced by the increase in the median stage. **Table 5-3** shows the maximum, minimum, and median stage elevation for the three alternatives compared to the existing conditions. The maximum and minimum stages were determined from the stage hydrographs, presented in **Appendix B**. The median stage was determined from the long-term simulation composite stage-duration curves presented on **Figure 17** through **Figure 23**.

In addition to the stage changes, the tidal fluctuation ranges also change. Compared to the existing condition near the Rock Dam/FCL, on a daily basis the tidal fluctuation range may be reduced by 0.5 to 1 foot under Alternatives 1 and 2. This deviation also decreases at each subsequent cross-section downstream with zero change west of Yankeetown. The decrease in tidal fluctuation range is not as noticeable in Alternative 3.

Table 5-3
Withlacoochee River Lower Segment Normal Water Elevations – Alts 1, 2 and 3 vs. Alt 4

Alternative	Elevation ft-NGVD (Deviation from Existing Condition)											
	Cross-Section 12			Cross-Section 9			Cross-Section 6			Cross-Section 2		
	Max.	Min.	Med.	Max.	Min.	Med.	Max.	Min.	Med.	Max.	Min.	Med.
4 Existing Condition	6.3	2.1	4.6	6.1	1.5	4.1	6.0	<1.5	3.9	5.9	<1.5	3.6
1	7.1 (+0.8)	2.9 (+0.8)	5.5 (+0.9)	6.3 (+0.2)	2.1 (+0.6)	4.6 (+0.5)	6.0 (0.0)	1.5 (0.0)	4.2 (+0.3)	5.9 (0.0)	<1.5 (0.0)	3.6 (0.0)
2	7.3 (+1.0)	3.0 (+0.9)	5.4 (+0.8)	6.3 (+0.2)	2.1 (+0.6)	4.6 (+0.5)	6.0 (0.0)	1.5 (0.0)	4.2 (+0.3)	5.9 (0.0)	<1.5 (0.0)	3.6 (0.0)
3	7.1 (+0.8)	2.1 (0.0)	5.2 (+0.6)	6.3 (+0.2)	1.7 (+0.2)	4.4 (+0.3)	6.0 (0.0)	1.5 (0.0)	4.1 (+0.2)	5.9 (0.0)	<1.5 (0.0)	3.6 (0.0)

The cross-sections in the lower river segment indicate that the banks of the river are relatively high. The resulting increase in water surface elevations for the three alternatives generally will remain within the banks of the river. Any wetland vegetation established on the riverbanks should migrate up the banks and reestablish within the new wetland zone at the tidal interface with the river. **Appendix A** contains illustrations of cross-sections representative of this reach (1 through 12).

At four locations along the lower segment of the river, water stages above the riverbank. For three of these locations including Cross-Section 4, Cross-Section 2, and Cross-Section 1, the river stages above the riverbank, but the peak elevation and duration of the staging is the same for the three alternatives as under the existing condition. The proposed alternatives will not result in any change in the river's water elevation or the length of time the river will remain at a given elevation at these locations.

However, the top of bank elevation of Cross-Section 10 is approximately 5 ft-NGVD. Under the existing condition, the river overbanks for approximately 2,000 hours of the year (23%). Alternatives 1 and 2 stage above the top of bank approximately 4,200 hours of the year (48%), flooding approximately 50 feet inland, or 1.2 acres, beyond the existing condition. Alternative 3 stages above the top of bank approximately 3,600 hours of the year (41%), flooding approximately 30 feet inland, or 1 acre, beyond the existing condition. This approximate 1 acre additional area will likely maintain a wetland hydrology and the existing upland vegetation will die off with hydrophytic vegetation establishing.

5.1.3 Conclusions

Depending on the location within the study area, river stage and duration increase or decrease to some extent. The change is greatest at Inglis Dam and diminishes downstream to zero change west of Yankeetown. Due to the high and steep slopes of most of the riverbank, the effect on the natural systems will be minimal. Any wetland vegetation established on the riverbanks should migrate up or down the bank accordingly and reestablish within the new wetland zone at the tidal interface with the river.

At two locations (Cross-Sections 10 and 22), the proposed alternatives increase stages and duration of overbank flow compared to existing conditions. This will inundate approximately 5 acres of additional land that would likely maintain a wetland hydrology, causing the existing upland vegetation to die off, and hydrophytic vegetation to establish if any of the proposed alternatives are implemented.

Implementation of any of the three alternatives will result in an increase in freshwater down the river. Within the study area, most of the vegetation along the river consists of freshwater species, including bald cypress (*Taxodium distichum*), red maple (*Acer rubrum*), and loblolly bay (*Gordonia lasianthus*). The increase in freshwater should have not affect the community's make up along the river. However, downstream of the study area, the increase in freshwater may decrease salinity within the river. In addition, depending on construction methodologies, implementation of the alternatives may impact wetlands within and adjacent to the construction area.

5.2 Flood Assessment

A flood assessment was conducted to determine the impact that each of the proposed alternatives would have on flooding within the West Terminus Cross-Florida Greenway area. The assessment area illustrated on **Figure 13** begins at Cross-Section 1 located west of Yankeetown and terminates upstream at Cross-Section 26 located at Inglis Dam. The results of this assessment were used to grade each of the alternatives. The grading is discussed in detail in Section 7 of this report.

5.2.1 Affected Structure Analysis

The flood assessment considered impacts to structures located within the floodplain of only the upper and lower segments of the Withlacoochee River. The structures considered as part of this analysis included primarily residential dwellings with some commercial and publicly owned buildings. For the purpose of this analysis, an impact is defined as floodwater above the finished floor elevation of a particular structure. This assessment did not address the severity of structure flooding in terms of inundation depth and duration. Additionally, this assessment did not assess flood damage to structures in dollar costs.

The affected structure analysis was conducted using a database of structures, which was developed as part of previous dam safety planning studies for Lake Rousseau. The structure database includes 456 structures and their associated finished floor elevations. The finished floor elevations were acquired through land surveys and were taken to be the elevation of the lowest entry point (doorway) into the building. The database also includes a reference to the nearest model cross-section for each of the structures. **Figure 13** illustrates and identifies the cross-sections used in this study. The cross-section reference allows the structure's finished floor elevations to be compared to flood stages within the river.

Flood impacts were analyzed for all four alternatives and for each of the event simulation types, which included normal flow, 100-year flood flow and dam failure flow conditions. Results of the hydraulic modeling, described Section 4.3 and documented in **Appendix B** of this report, were

used in the affected structure analysis. The model output, consisting of maximum water elevation (flood stage) at each cross-section, was imported to spreadsheets containing the structure database. Individual spreadsheets were prepared for each alternative and simulation type. The spreadsheets were used to determine the depth of inundation, if applicable and to tally the number of affected structures. **Appendix C–Flooding Assessment** contains the spreadsheets used in this analysis.

It is important to note that the flooding results considered in this assessment reflect flooding caused by releases from Lake Rousseau (fluvial flooding). Tidal stages for the normal condition and 100-year flood simulations were responsible for a number of structures being flooded. The maximum, normal condition tide level was estimated to be elevation 5.88 ft-NGVD. This elevation caused flooding at ten (10) structures. The maximum, 100-year flood tide level was estimated to be elevation 5.58 ft-NGVD. This elevation caused flooding at three (3) structures. The results computed by the affected structure spreadsheets were adjusted to reflect fluvial flooding only. These results discussed in the following section.

5.2.2 Results and Conclusions

Table 5-4 below summarizes of the results of the affected structure analysis conducted as part of this assessment. The table presents the number of structures flooded for each alternative and by simulation type.

Table 5-4
Flood Assessment Summary

Event Simulation	Number of Structures Flooded ^(a)			
	Alternative 1	Alternative 2	Alternative 3	Alternative 4 ^(e)
Normal Condition Flows ^(b) (Average Flow Year 1996)	0	0	0	0
100-year Flood Flows (Record Flood 1960)	2 ^(c)	0 ^(d)	0 ^(d)	0 ^(d)
Dam Failure Flows (Sunnyday Event)	227	14	14	14

(a) Tidal flooding is ignored for this assessment.

(b) High tide levels cause flooding at 10 structures for all alternatives.

(c) High tide levels cause flooding at 3 structures for this alternative.

(d) High tide levels cause flooding at 1 structure for this alternative.

(e) Baseline Condition, as exists under present system configuration.

As indicated in **Table 5-4**, zero structures are predicted to flood under normal condition flows for existing conditions or for proposed alternative conditions. For Alternative 1, two structures are predicted to flood for the 100-year flood condition. These structures are located on the lower segment of the river, and are protected from flooding under Alternative 2 by the action of the proposed River Control Structure. Similarly, for Alternatives 3 and 4 these structures will be free from flooding because flood flows are shunted down the Barge Canal by the action of the Rock Dam/FCL. Under Dam Failure flow conditions, 227 structures are predicted to flood for

Alternative 1. These structures are located on the lower segment of the river (213) as well as the upper segment of the river (14). The structures located on the lower segment of the river are protected from flooding under Alternative 2 by the action of the proposed River Control Structure and under Alternatives 3 and 4 by the Rock Dam/FCL.

5.3 Navigation Assessment

A navigation analysis was conducted to assess the impact that each of the proposed alternatives would have on navigation in the West Terminus Cross-Florida Greenway area. The analyses conducted as part of this assessment were compared to the baseline condition (Alternative 4), which represents the system as it presently exists. Refer to **Figure 1** for an illustration of the existing system. The results of this assessment were used to grade each of the alternatives. The grading is discussed in detail in Section 7 of this report.

The navigation analysis does not address trafficability of the system with respect to vessel size and frequency of use. Instead, the proposed system improvements were designed in accordance with existing facilities or proposed replacement facilities, which in part were based on the Boat User Survey conducted for the Florida Department of Transportation and issued as Draft on November, 2002. This navigation analysis assumes that the proposed facilities are both feasible to implement and adequate to accommodate the size and frequency of travel of all vessels using the system under similar conditions of the existing and proposed replacement facilities. The navigation analysis conducted as part of this assessment compares travel times to the Gulf of Mexico (Gulf) from selected locations within the West Terminus Cross-Florida Greenway area for each of the alternatives. The locations selected for comparison include Lake Rousseau, at the upstream (east) end of Inglis Lock, and Withlacoochee River Upper Segment at Inglis Dam. Travel times from these locations to the Gulf were computed for each alternative.

5.3.1 Speed Zones and Travel Velocities

Speed zones and travel velocities used in this assessment were developed from information provided by the U.S. Coast Guard Station at Yankeetown. These speed zones, travel velocities, as well as river distances and estimated travel times are illustrated on **Figure 24**. The mixed speed zone from the Gulf to the first home (west of Yankeetown) is approximately three (3) miles long and consists of several 20 miles per hour (mph) zones and 'Slow Speed Manatee Zones'. Based on travel time through this segment of the river, the average speed is estimated to be 6.7 mph. The 'Slow Speed Manatee Zone' is posted at 5 mph and the Barge Canal speed is posted at 25.mph. The 'Idle Speed Zone' does not have a posted speed and thus velocity varies with the type of vessel. For this analysis, a speed of 3 mph is assumed. Also for this analysis, lockage times were assumed to be one-half hour. This assumption was based on a field observation of one lock cycle for Inglis Lock conducted in 1999.

The travel time for the river segments illustrated on **Figure 24** were computed by dividing the estimated river segment lengths by the velocity for the respective zone(s) within that segment. **Table 5-5** provides a summary of travel time for each alternative at each of the selected study reference locations. For example, the travel time from Lake Rousseau to the Gulf is 0.81 hours for Alternative 4 (baseline condition). This time is composed of a lockage time of 0.5 hours plus

travel time through the Barge Canal of 0.31 hours (0.26+0.05). The travel time from Lake Rousseau to the Gulf is 3.04 hours for Alternative 1. This travel time is composed of a lockage time of 0.5 hours plus travel time through the Barge Canal of 0.05 hours plus travel time down the Withlacoochee River Lower Segment of 2.49 hours (1.74+0.3+0.45).

5.3.2 Results and Conclusions

Results of the navigation analysis are summarized in Table 5-5. As indicated in the table, Alternative 1 would have longest travel time, and requires an additional 2.23 hour travel time relative to existing conditions. The travel time for Alternative 2 would increase by 0.5 hours over existing conditions. Alternatives 3 travel times would be identical to existing conditions.

**Table 5-5
 Navigation Assessment Summary**

Study Location	Travel Time (hours) ⁽¹⁾			
	Alternative 1	Alternative 2	Alternative 3	Alternative 4 ⁽²⁾
Lake Rousseau (At Inglis Lock)	3.04	1.31	0.81	0.81
Withlacoochee River Upper Segment (At Inglis Dam)	2.78	1.05	0.55	0.55
Travel Time Greater-Than Baseline Condition (hours)				
Lake Rousseau (At Inglis Lock)	2.23	0.50	0.00	NA
Withlacoochee River Upper Segment (At Inglis Dam)	2.23	0.50	0.00	NA

(1) Travel time is from the Gulf of Mexico to the particular study location.

(2) Baseline Condition, as exists under present system configuration.

Please note that as conceptualized in this study, Alternative 2 requires a navigation lock to be constructed within the Barge Canal. The travel times presented in Table 5-5 reflect this condition. As an alternative, the River Control Structure could be modified to include a navigation lock. In this case, the travel times are expected to increase slightly over the Alternative 1 travel times, reflecting the added lockage time.

5.4 Water Quality Assessment

Previous studies conducted by the Water Management District and others indicate that elevated salinity concentration is a critical water quality concern in the Withlacoochee River downstream of Lake Rousseau. Elevated salinity is attributed to a die-back of Bald Cypress and sea grasses communities in areas of the river downstream of the study reach. Construction and operation of the Cross-Florida Barge Canal System has resulted in increased salinity levels due to the diversion of river flows into the Barge Canal system. The canal itself, which is relatively wide, facilitates the introduction of seawater nearly 10 miles upstream of the river mouth.

A water quality assessment was conducted to determine the impact that each of the proposed alternatives would have on salinity levels within the West Terminus Cross-Florida Greenway

area. The analyses conducted as part of this assessment were compared to the baseline condition (Alternative 4), which represents the system as it presently exists. The assessment area illustrated on **Figure 13** begins at Cross-Section 1 located west of Yankeetown and terminates upstream at Cross-Section 26 located at Inglis Dam. The results of this assessment were used to grade each of the alternatives. The grading is discussed in detail in Section 7 of this report.

5.4.1 Methodology

The water quality analysis conducted as part of this study was limited to an estimate of the location of the saline-water front within the Withlacoochee River study segment. For this simplified study, it is assumed that this point represents the maximum saline intrusion upstream from the coast for a particular alternative. The saline-water front was assumed to be represented by the upstream-most cross-section with negative flows. Negative flows are those that flow up the river from the Gulf.

The long-term models were used in this analysis to simulate normal flows conditions within the river based on the 'Average Year' discharge hydrograph (1996) and corresponding tidal fluctuations. The model simulations were conducted using daily river flow data and 15-minute increment tide-stage data. Model output, consisting of a flow hydrograph at each cross-section, was used to determine the location of the upstream-most negative velocity vector. The hydrograph data was also used to develop flow-duration curve at selected locations within the system. The flow-duration curves formed the basis of the water quality assessment. **Appendix C–Water Quality Assessment** contains model printouts of flow hydrographs at selected locations within the Withlacoochee River for the proposed alternatives and existing conditions. Composite flow-duration curves illustrating all four alternatives are also provided at these selected locations.

5.4.2 Results and Conclusions

The results of the water quality analysis are summarized in **Table 5-6**. The top portion of the table documents the estimated number of hours that negative flows persist at a particular cross-section. The lower portion of the table represents the change in duration at a particular cross-section for the proposed alternatives relative to existing conditions (Alternative 4). As such negative numbers represent improved conditions.

**Table 5-6
 Water Quality Assessment Summary**

River Location	Number of Hours Per Year With Reverse Tidal Flows ⁽¹⁾			
	Alternative 1	Alternative 2	Alternative 3	Alternative 4 ⁽²⁾
Cross-Section 1 (River Mile 0, West Yankeetown)	2,667	2,667	2,747	2,933
Cross-Section 2 (River Mile 0.72, Central Yankeetown)	1,123	1,119	1,119	1,516
Cross-Section 22 (River Mile 6.68/6.15)	0	0	2,098	953
	Improvement Over Baseline Condition (hrs/yr)			
Cross-Section 1	-266	-266	-186	NA
Cross-Section 2	-393	-397	-397	NA
Cross-Section 22	-953	-953	1,145	NA

(1) Based upon normal condition flow simulation (average flow year 1996).

(2) Baseline Condition, as exists under present system configuration.

For the Withlacoochee River Lower Segment, it was found that the saline-water front did not change location for any of the alternatives. Negative flows occurred at Cross-Section 2 under existing and proposed conditions. Cross-Section 3, which is approximately one-mile upstream of Cross-Section 2 experienced no negative flows. However, as indicated in **Table 5-6**, there is a significant decrease in negative flow duration at Cross-Section 2 for the proposed alternatives with respect to existing conditions. Under proposed conditions, negative flows will occur greater than two weeks less than existing conditions. This effect decreases to one week at Cross-Section 1.

For the Withlacoochee River Upper Segment, it was found that the saline-water front did change location with respect to the particular alternative. More specifically, the entire reach (Cross-Section 22 through Cross-Section 26) experienced only positive flows for Alternatives 1 and 2. This is consistent with the results describe above for the lower segment, which found that negative flows ceased at Cross-Section 3. For Alternatives 3 and 4 negative flows were found to exist between Cross-Section 22 and Cross-Section 24 inclusive. Negative flows persist in the upper segment for these alternatives due to the influence of the Barge Canal. The Barge Canal, which is relatively wide and deep, helps to extend the saline-water front much farther upstream than the river channel allows. Cross-Section 22 closely represents conditions within the upper segment of the river and was selected for used in the analysis.

As indicated in **Table 5-6**, there are no negative flows at Cross-Section 22 for Alternatives 1 or 2. This condition reflects a 5.5 week decrease in the duration of negative flows for these alternatives with respect to existing conditions. However, there are negative flows at this location for Alternatives 3 and 4. The table also shows a significant increase in the duration of negative flows between Alternative 3 and existing conditions. The duration of negative flows is nearly 7 weeks longer under Alternative 3 than existing conditions. This condition is due to the increase in the discharge volume from the Bypass Channel System for Alternative 3, which causes a necessary decrease in discharge volume from the main gates into the upper river segment.



6 IMPLEMENTATION COST AND PERMITTING REQUIREMENTS

This section of the report provides details of the estimated cost to plan, design, permit and construct the facilities necessary to implement each of the proposed alternatives. Overall costs are discussed in Section 6.1 and include real estate and permitting dollar costs. Section 6.2 provides specific details of real estate requirements. Section 6.3 provides a summary of the probable permit requirements for each alternative as well as an indication of the feasibility of acquiring these permits. The implementation costs and permitability information was used to grade each of the alternatives. The grading is discussed in detail in Section 7 of this report.

6.1 Construction Costs

This section documents the conceptual level estimate of probable construction costs that were developed for each of the proposed alternatives. The conceptual level plans, cross-sections, and details that were developed as part of this study and presented in detail in Section 3 of this report, were used as a basis for the estimate. The cost estimates included the following general items:

- Mobilization,
- Associated General Costs,
- Construction,
- Utility Relocation,
- Planning, Engineering, Permitting and Design,
- Construction Management,
- Real Estate, and
- Contingency factor applies consistent with the level of details of the estimate.

In general, construction costs were developed from the conceptual plans and details, which were used to estimate quantity takeoffs as necessary to support the estimate. Unit rates for labor and materials were applied based upon information in standard references, information in prior cost studies for similar facilities, and cost estimates from the manufacturer in the case of the vertical gate assemblies. All of the estimates were adjusted to reflect local conditions to the extent possible.

In the case of the US-19 replacement bridge, the estimated construction cost was based on information supplied by FDOT regarding the design and cost of the proposed US-19 bridge over the Barge Canal. As described above, the FDOT bridge design was adopted for use in this study. Costs were adjusted to reflect the need for two spans and real estate requirements. Utility relocations were assumed to be included in the base FDOT estimate. Real estate requirements and costs are discussed in detail in the following section.

Contingency factors were applied to base cost estimates in accordance with the level of detail of the estimate. In general, a 20 percent factor was applied. However, for Alternative 1 a 15 percent factor was applied to reflect the higher level of detail for the U.S.19 bridge estimate and its significance in cost relative to Alternative 1. The escalation factors for Planning, Engineering and Design as well as Construction Management were 15 and 12 percent, respectively. These

factors were adopted from standard ACOE planning guidelines for studies at similar levels of detail. The Planning, Engineering and Design cost also covers permitting requirements.

Table 6-1 summarizes of probable implementation costs for each of the proposed alternatives. This table provides the total cost including real estate, permitting and contingencies. **Appendix D** contains a detailed estimate in table format for each alternative.

Table 6-1
Implementation Cost Summary

Alternative	Estimated Construction Cost
1	\$41,843,063
2	\$26,311,222
3	\$12,320,751
4	\$0

6.2 Land Acquisition Requirements and Costs

This section documents the land acquisition requirements and costs for each of the proposed alternatives. The conceptual level plans, cross-sections, and details that were developed as part of this study, and presented in detail in Section 3 of this report, were used as a basis for the land acquisition requirements. The land acquisition costs documented herein were included in the overall implementation costs documented in the previous section. The following items were considered in this study:

- Land area requirements,
- Property boundary information from applicable county (Maps),
- Parcel information (Owner, ID Number, Acreage, Improvements),
- Market value of land and improvements (Lands and Damages), and
- Public Law 91-646 relocation costs and Administrative costs.

Land requirements for the proposed facilities were determined from the conceptual plans and details for each alternative. The Citrus and Levy County Property Appraiser's database was then accessed to determine property ownership and value information for the proposed facilities.

Results of the database assessment found that all but one of the proposed facilities were to be sited on land owned by the State of Florida as part of the Cross-Florida Greenway area. Only the proposed US-19 replacement bridge would required the purchase of privately owned property. For this study, it was assumed that there would be no costs associated with the use of State owned land.

Table 6-2 presents details of land acquisition requirements and costs for Alternative 1. Land requirements for this alternative consist of area for frontage roads and rights-of-way adjacent to

the bridge. For this assessment, it was assumed that only parcels on the east side of the highway would be required. Additionally, if the land required impacted the use of the parcel for its present purpose, the entire parcel was assumed to be purchased outright. **Figure 28** illustrates the location of the required parcels. The parcels are identified by the Property Number in the table.

The cost to acquire the land and any improvements (Land and Damages) is illustrated at the bottom of the table. These costs were obtained from the Tax Assessor's database as the greater of either Market Value or Last Sale. Escalation factors for acquisition (administrative) and Public Law 91-646 relocation costs were adopted from standard ACOE planning guidelines. The escalation factors are 25 percent and 10 percent, respectively.

**Table 6-2
 Land Acquisition Requirements and Cost**

Property No.	County	Parcel ID	Owner/Address	Acreage (ac)			Market Value (Total Property)	Purchase Price
				Total	Required (ROW)	Purchased		
1	Levy	3038-000-00	Clyde C. Quinby 3800 Airport Pulling Rd. Naples, FL 33942	1.50	0.34	1.50	\$100,500	\$100,500
2	Levy	3043-000-00	Daniel L. Allen P.O. Box 4 Inglis, FL 34449	1.00	0.26	1.00	\$74,705	\$74,705
3	Levy	3039-000-00	Donald J. Crawford P.O. Box 992 Crystal River, FL 34429	0.46	0.11	0.46	\$33,500	\$33,500
4	Levy	3037-001-00	Donald J. Crawford.O. Box 992 Crystal River, FL 34429	0.42	0.11	0.42	\$61,589	\$61,589
5	Levy	3037-002-00	Jeffrey M. Killion Palm Point Dr. Inglis, FL 34449	0.17	0.06	0.17	\$190,000	\$190,000
6	Levy	3041-000-00	Jeffrey M. Killion 23 Palm Point Dr. Inglis, FL 34449	0.27	0.09	0.27	\$83,656	\$83,656
7	Levy	3037-000-00	Joseph Sabel Aldah B. Hitson A. L. Price & Hitson Yankeetown, FL 34498	2.66	0.41	0.41	\$146,447	\$22,573
8	Citrus	16-17-02 33000	Mabel Peters Caruth 5803 Greenville Ave. Dallas, TX 75206-2916	32.00	1.27	1.27	\$440,406	\$17,479
							Total Lands and Damages:	\$584,001
							Acquisition (administrative) Costs:	\$146,000
							Public Law 91-646 Costs:	\$58,400
							Total Real Estate Costs	\$788,402

6.3 Permitting Requirements and Feasibility

All three proposed alternatives will likely require permits from the U.S. Army Corps of Engineers (ACOE) and the Florida Department of Environmental Protection (FDEP). Depending on the resulting effect of the alternative chosen and the extent of any wetland impacts resulting from construction activities associated with implementation of the alternative selected, the permitting effort and requirements will vary.

The complexity of the permitting process will depend greatly on the degree of the impact to jurisdictional wetland areas and the affect the alternative may have on navigation within the waterway. The ACOE regulates the placement of any dredged or fill material within waters of the United States pursuant to Section 404 of the Clean Water Act. As part of their review under Section 404, the ACOE requires the development of an alternatives analysis in compliance with guidelines found within Section 404(b)(1) of the Clean Water Act, including verification that all impacts have first been avoided to the greatest extent possible, that unavoidable impacts have been minimized to the greatest extent possible, and lastly that unavoidable impacts have been mitigated in the form of wetlands creation, restoration, and/or enhancement.

Because the Cross-Florida Barge Canal is a federally designated navigable waterway, implementation of any alternative which would impede navigation within the Canal would require a permit pursuant to Sections 9 and 10 of the Rivers and Harbors Act of 1899. In addition, prior to the approval of any action, which would result in the removal of navigation within a federally designated waterway, de-authorization of the waterway would be required. This de-authorization of the waterway would require approval by the U.S. Congress.

Prior to the recommendation of any modification to a navigational waterway, the ACOE would be required to undertake the development of an environmental document in compliance with guidelines developed by the Council on Environmental Quality (CEQ), pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended. Under this act, effects resulting from the modification or closure of the canal would be assessed to determine the overall impact the project may have on the human and/or natural environment. Depending on the complexity of the proposed action and its environmental effects, the NEPA document may either be a Categorical Exclusion (CatEx), Environmental Assessment (EA) or Environmental Impact Statement (EIS), with the CatEx being the least complex document and the EIS being the most complex document.

The construction of the control structure associated with Alternative 1 will result in the removal of the navigation in the Cross-Florida Barge Canal just below the Withlacoochee River. This alternative will re-route navigation to the Withlacoochee River with removal of the existing Rock Dam/FCL on this river. Because of the potential effects this alternative may have on the human environment, an EIS will most likely be required. Completion of this document could take as long as two to three years and cost over \$1,000,000. Upon completion of the EIS, the project could be deemed not permissible due to the environmental impacts.

Alternative 2 will result in an alteration in navigation in the Cross-Florida Barge Canal just below the Withlacoochee River with the construction of a control structure and lock. This action

will not result in the loss of navigation above the proposed structure, will likely result in fewer environmental impacts, and will likely require the development of an Environmental Assessment (EA). The proposed lock can be designed to maintain current navigational requirements, as such a Finding of No Significant Impact (FONSI) will likely result. While an EA will be less costly and time consuming than an EIA, it could still take up to 18 months and cost over \$500,000.00 to complete.

Alternative 3 will not result in the loss of navigation on the Florida Barge Canal, and as a result, the development of the environmental document for this proposed action would be less complex than either Alternatives 1 or 2.

FDEP requires an Environmental Resource Permit (ERP) when construction of any project results in the creation of a new, or modification of an existing surface water management system or results in impacts to waters of the State or isolated wetlands. As with ACOE permits, the complexity associated with the ERP permitting process will depend on the size of the project, the extent of wetland impacts, and the effects of the projects on drainage and water quality. Based on the ERP regulations, an individual ERP would be required for any of the three proposed alternatives associated with this project.



7 COMPARISON MATRIX

A grading matrix was developed as a tool to aid in the evaluation of the proposed alternatives. The grading matrix was prepared based on the results of the assessments presented in Section 5 of this report, as well as implementation costs and permitting requirements presented in Section 6 of this report.

The comparison matrix provides a numeric value for each alternative by the category shown. Within a particular category the alternatives were graded from 1 to 4 (best to worst) based on the performance criteria for that particular category. The performance criteria are described for each category in the notes at the bottom of **Table 7-1**. As an example of the grading scheme, using the cost category, Alternative 1 is awarded a 4 based on having the highest cost and Alternative 4 is awarded a 1 based on having the lowest cost. In the case where alternatives performed equally, they receive the same value. An example of this is the Natural Systems category where Alternatives 1 through 3 performed equally well and each received a value of 1 and Alternative 4 received a value of 2. For this study no attempt was made to have the grade within a category reflect the absolute level of performance of one alternative versus another. Additionally, no weight was given to reflect the relative importance of one category over another.

Table 7-1 is the comparison matrix developed to grade Alternatives 1 through 4. For convenience, the grades are totaled for each alternative.

**Table 7-1
Comparison Matrix**

Grade Category	Relative Grade Values			
	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Natural Systems ^(a)	1	1	1	2
Flooding ^(b)	2	1	1	1
Navigation ^(c)	3	2	1	1
Water Quality ^(d)	1	1	2	3
Permitability ^(e)	4	3	2	1
Cost ^(f)	4	3	2	1
Values Summation	15	11	9	9

- (a) Considers creation of wetland habitat and improvement to estuary systems.
 (b) Considers the number of buildings flooded.
 (c) Considers travel time to the Gulf.
 (d) Considers the location and duration of salt water in the river.
 (e) Considers the feasibility and ease of obtaining permits.
 (f) Considers construction, design, permitting and land acquisition dollar costs.

As discussed in Section 5.1 of this report, all of the proposed alternatives provide an improvement to the natural systems in the study area. Although Alternative 3 provides less area of wetland creation than Alternatives 1 or 2, its potential for improvements to the estuary area near the mouth of the river is the same as Alternatives 1 and 2. As such all of the proposed alternatives are graded as performing equally followed by Alternative 4 (existing condition), which is graded lower. The maximization of wetland and estuary system improvements can be addressed in future design studies.

The flood assessment is discussed in detail in Section 5.2 of this report. As illustrated in **Table 5-4**, the number of structures flooded under Alternative 1 is greater, for both the 100-year flood and dam failure conditions, than Alternatives 2 through 4. As such, Alternatives 2 through 4 are graded as performing equally and Alternative 1 is graded lower.

The navigation assessment is discussed in detail in Section 5.3 of this report. As illustrated in **Table 5-5**, the travel time under Alternative 1 is the greatest followed by Alternative 2 and then Alternatives 3 and 4, which are equivalent. As such, Alternatives 3 and 4 are graded highest followed by Alternative 2 and Alternative 1 respectively, which are graded sequentially lower.

The water quality assessment is discussed in detail in Section 5.4 of this report. As illustrated in **Table 5-6**, the improvement to water quality is approximately equivalent for all of the proposed alternatives in the lower segment of the Withlacoochee River. In addition, the improvement to water quality in the upper segment of the Withlacoochee River is the same for Alternatives 1 and 2. However, Alternative 3 results in lower water quality in this segment relative to the existing conditions. As such, Alternatives 1 and 2 are graded highest followed by Alternative 3 and Alternative 4 respectively, which are graded sequentially lower.

A discussion of permitting requirements is provided in Section 6-3 of this report. The level of complexity in the required permits is addressed in that section. This grading is based on permit complexity and hence time and capital requirements. Alternative 1 has the most stringent permit requirements and is thus graded the lowest. Alternative 2 and Alternative 3 have progressively less stringent permitting requirements and are graded sequentially higher. Alternative 4 requires no permitting and receives the highest grading.

The construction cost assessment is discussed in detail in Section 6.1 of this report. As illustrated in **Table 6-1**, Alternative 1 has the highest cost followed by Alternative 2 and Alternatives 3 respectively. Alternative 4 is a no cost alternative as it reflects existing conditions. As such, Alternative 4 is graded highest based on having the lowest cost followed by Alternatives 3, 2 and 1, whose progressively higher costs yield lower grades.



1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the success of any business and for the protection of the interests of all parties involved. The text outlines the various methods and systems that can be used to ensure the accuracy and reliability of financial data.

2. The second part of the document focuses on the role of the auditor in verifying the accuracy of the financial statements. It describes the various procedures and techniques used by auditors to identify and correct errors and irregularities. The text also discusses the importance of the auditor's independence and objectivity in performing their duties.

3. The third part of the document discusses the various factors that can affect the accuracy of financial statements. It includes a discussion of the impact of accounting policies, estimates, and judgments on the financial results. The text also addresses the issue of fraud and the steps that can be taken to prevent and detect it.

4. The fourth part of the document discusses the importance of transparency and disclosure in financial reporting. It emphasizes that providing clear and concise information to investors and other stakeholders is essential for building trust and confidence in the financial statements. The text also discusses the various requirements and standards that govern financial reporting.

5. The fifth part of the document discusses the role of the board of directors in overseeing the financial reporting process. It describes the various responsibilities and duties of the board and the steps that can be taken to ensure that the financial statements are accurate and reliable. The text also discusses the importance of the board's independence and objectivity in performing their duties.

FIGURES

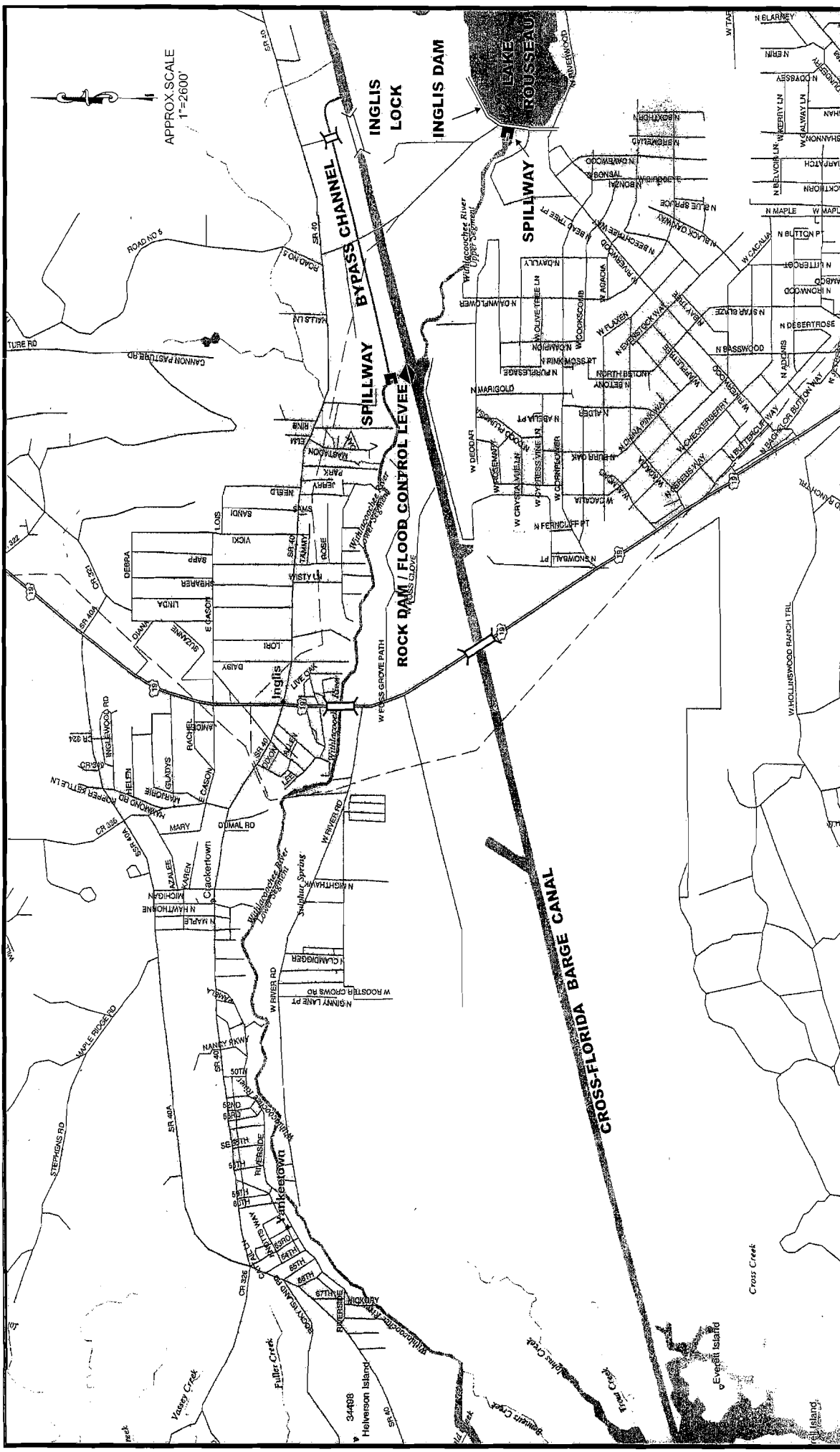
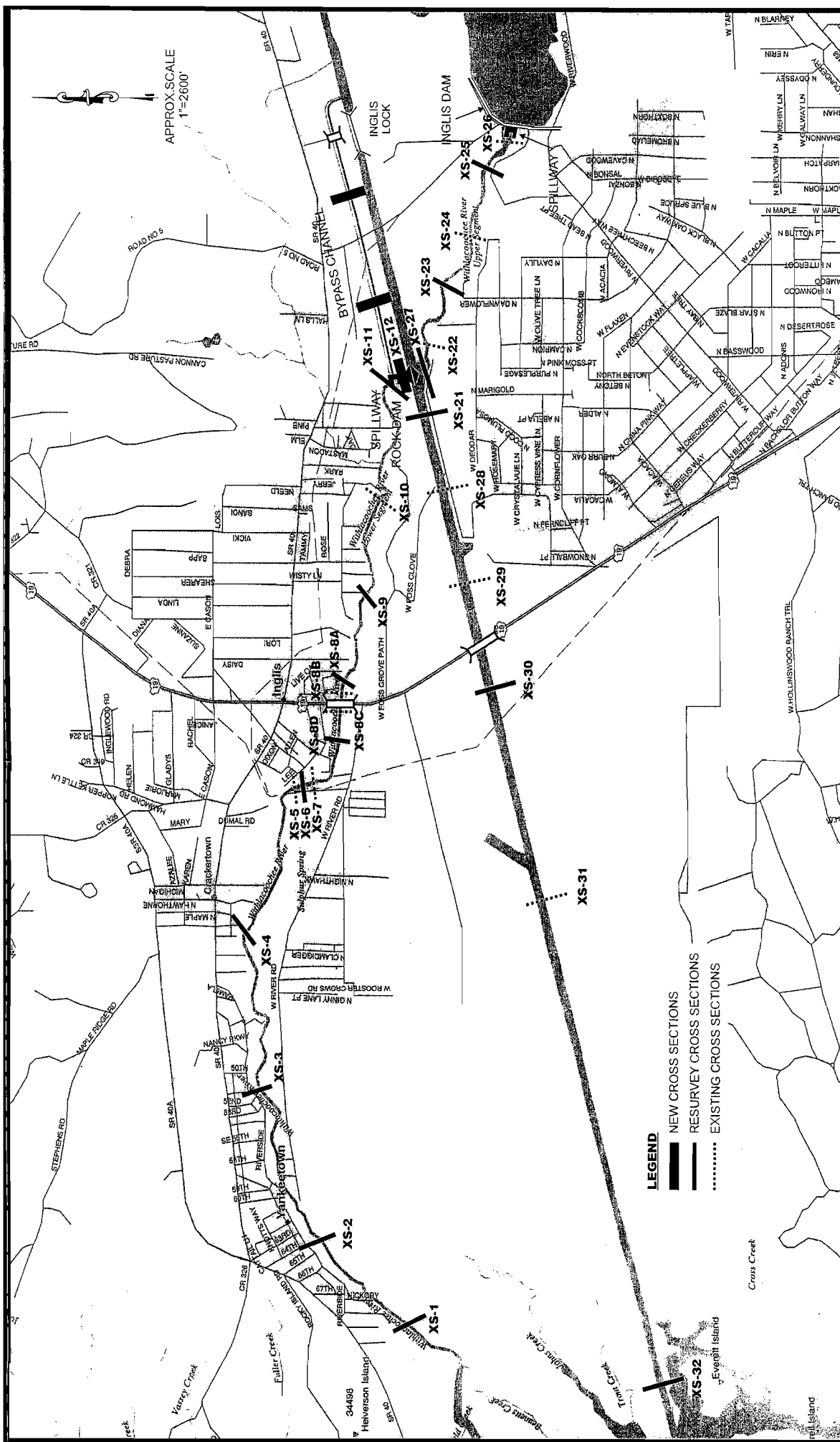


FIGURE 1
CROSS-FLORIDA BARGE CANAL
SYSTEM COMPONENTS

WEST TERMINUS CROSS-FLORIDA GREENWAY ASSESSMENT
Southwest Florida Water Management District





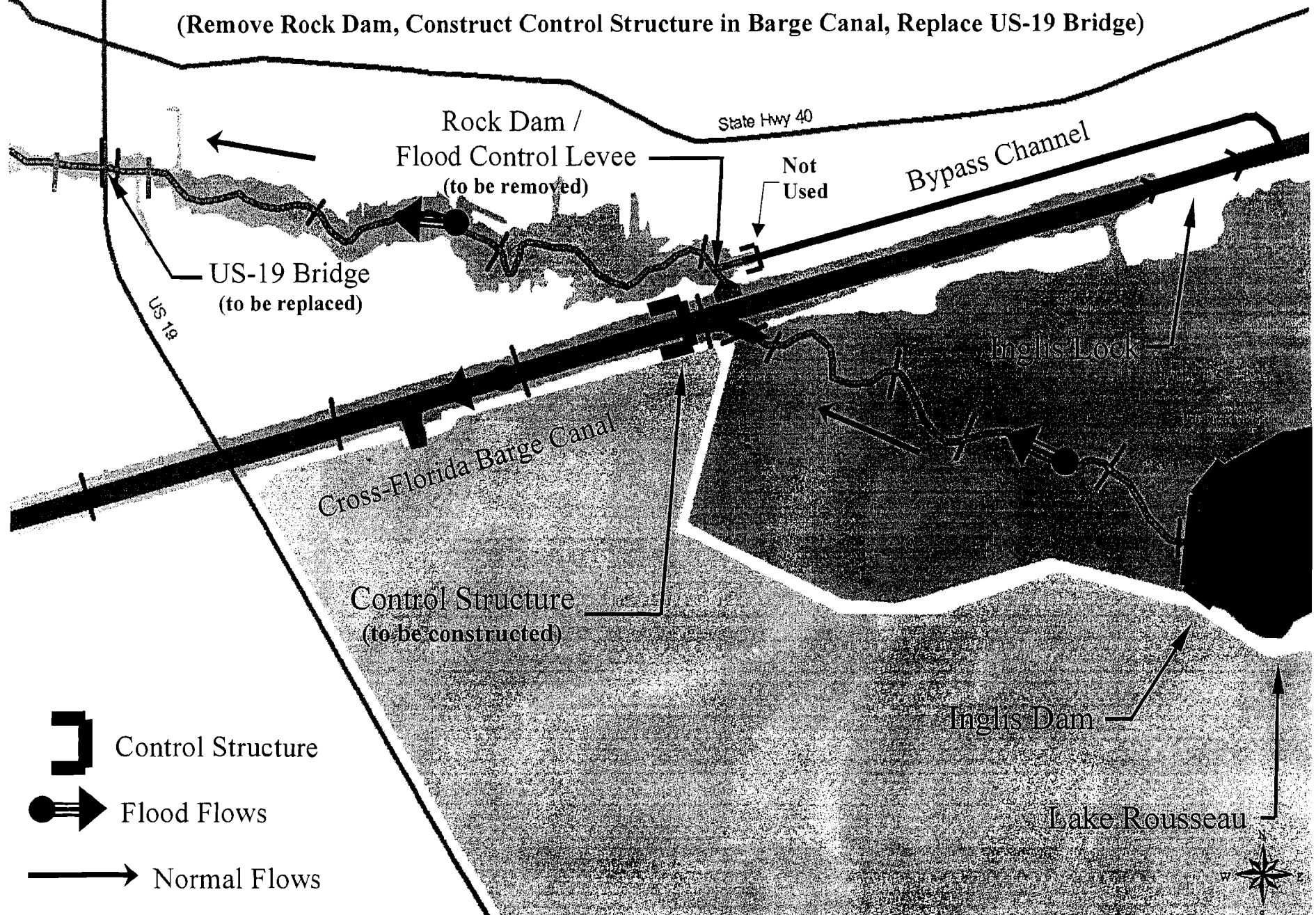
WEST TERMINUS CROSS-FLORIDA GREENWAY ASSESSMENT
Southwest Florida Water Management District

FIGURE 2
ADDITIONAL LAND SURVEY LOCATIONS



ALTERNATIVE - 1

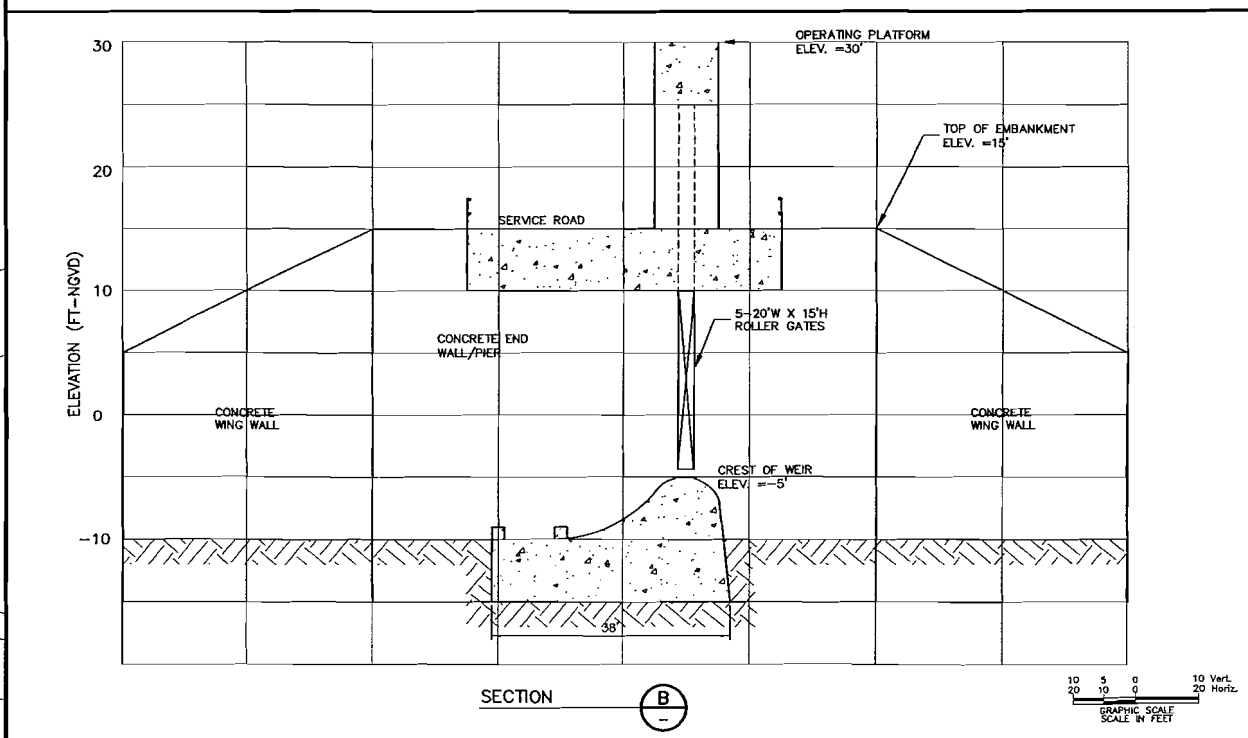
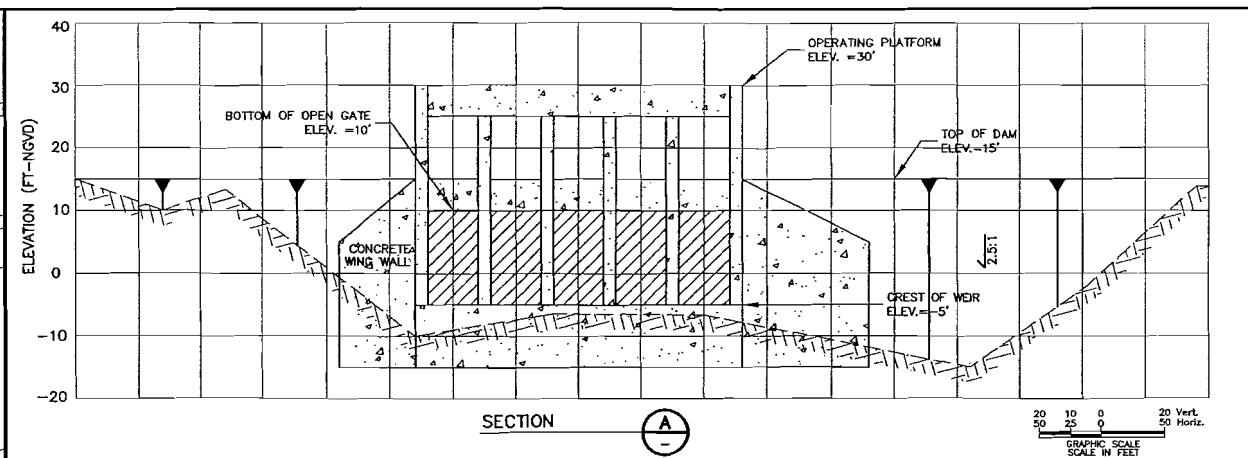
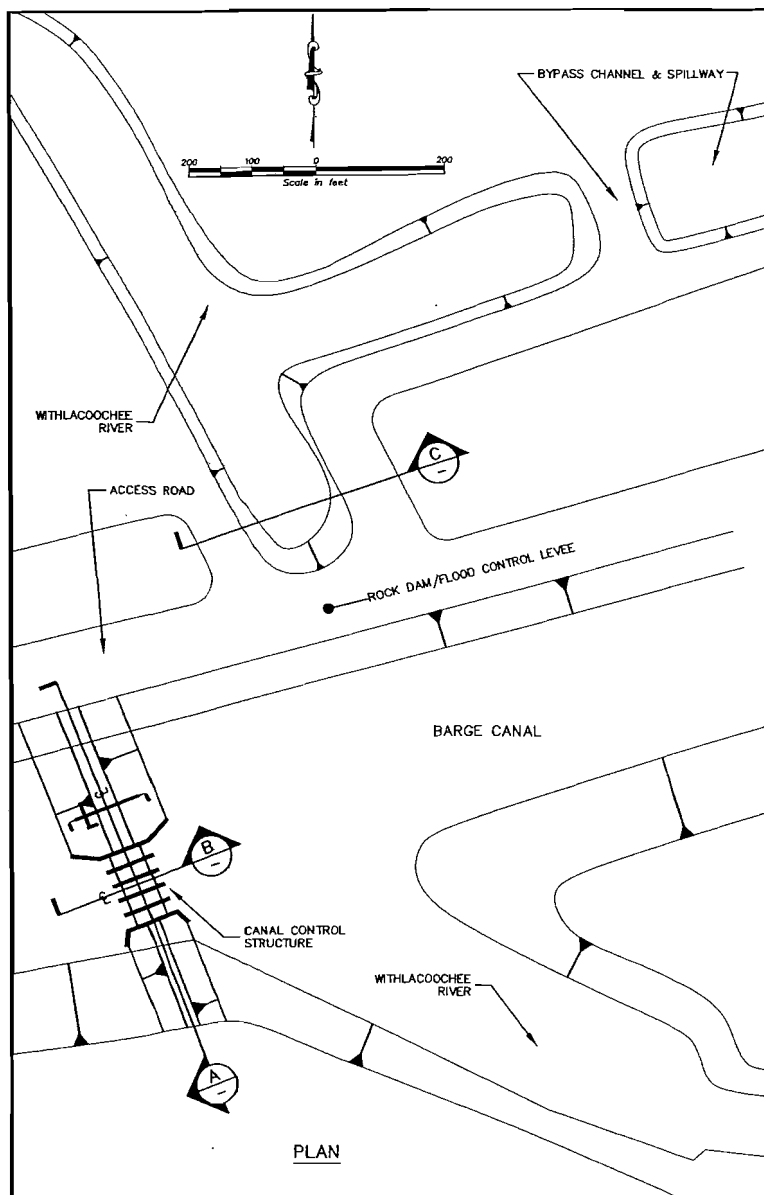
(Remove Rock Dam, Construct Control Structure in Barge Canal, Replace US-19 Bridge)



URS

WEST TERMINUS CFGA STUDY
Southwest Florida Water Management District

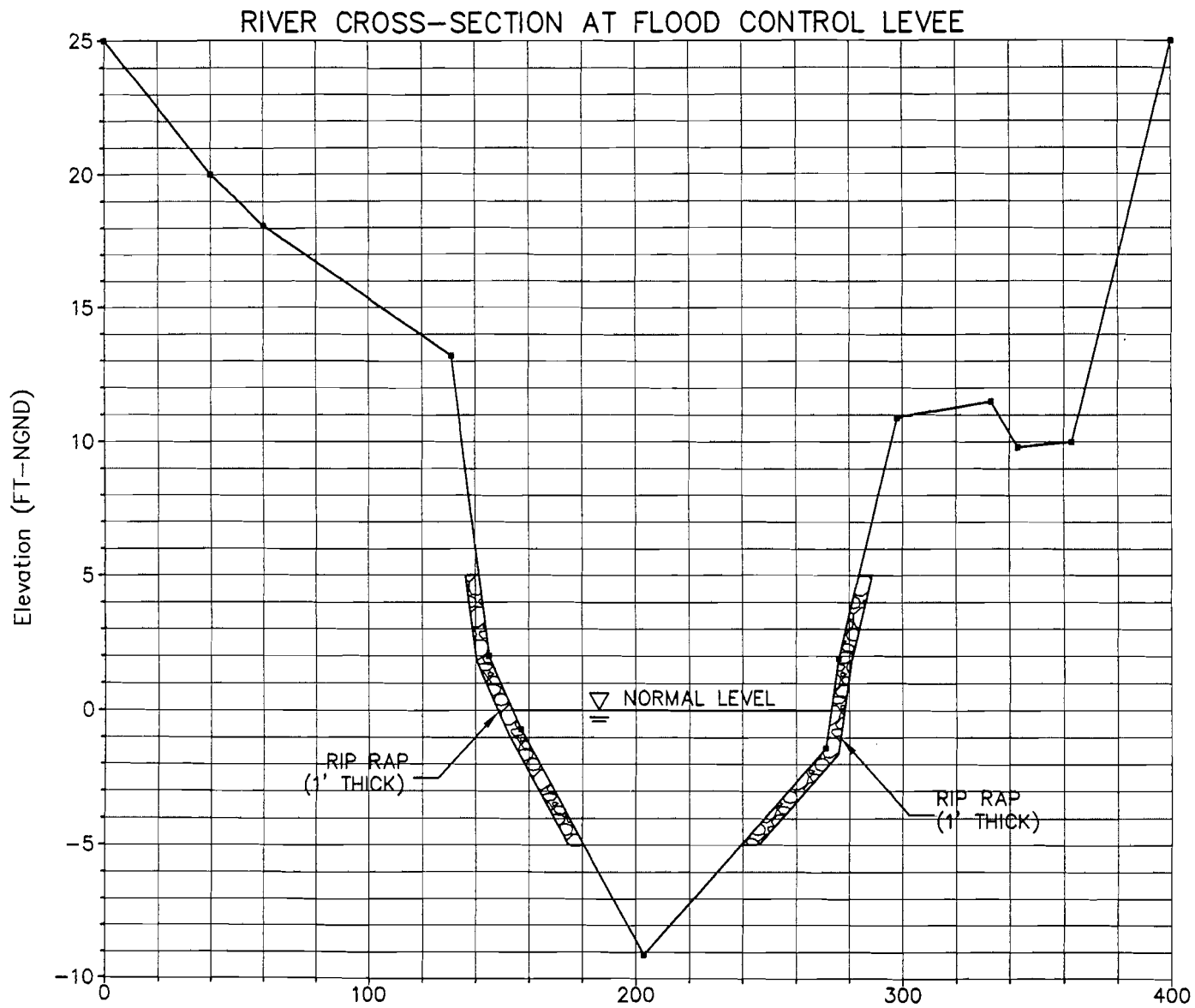
FIGURE 3
ALTERNATIVE 1
CONCEPTUAL PLAN



URS

WEST TERMINUS CFGA STUDY
Southwest Florida Water Management District

FIGURE 4
ALTERNATIVE 1
CANAL CONTROL STRUCTURE
PLAN AND SECTIONS



Source: Cross-Section 11A, February 2004 Survey, BSI and Associates

SECTION
SCALE: N.T.S



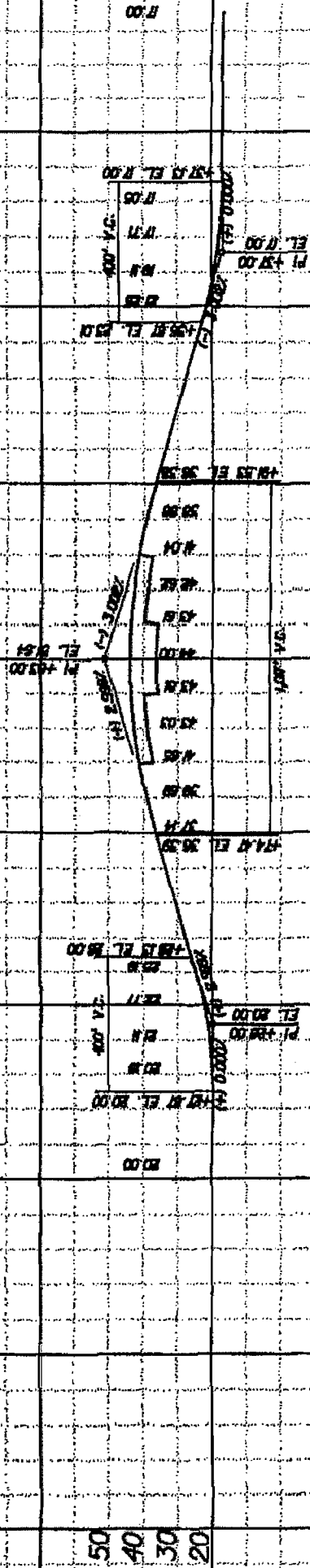
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WEST TERMINUS CFGA STUDY
Southwest Florida Water Management District

FIGURE 5
ALTERNATIVE 1
PROPOSED RIVER CROSS-SECTION

ALTERNATIVE 2

BRIDGE LENGTH - 753'
VERTICAL CLEARANCE - 40'



STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO. COUNTY FINANCIAL PROJECT ID

US 19 CITRUS 257167-1-21-01

US 19 BRIDGE
FLORIDA BARGE CANAL
PD&B STUDY

SHEET
NO.

8

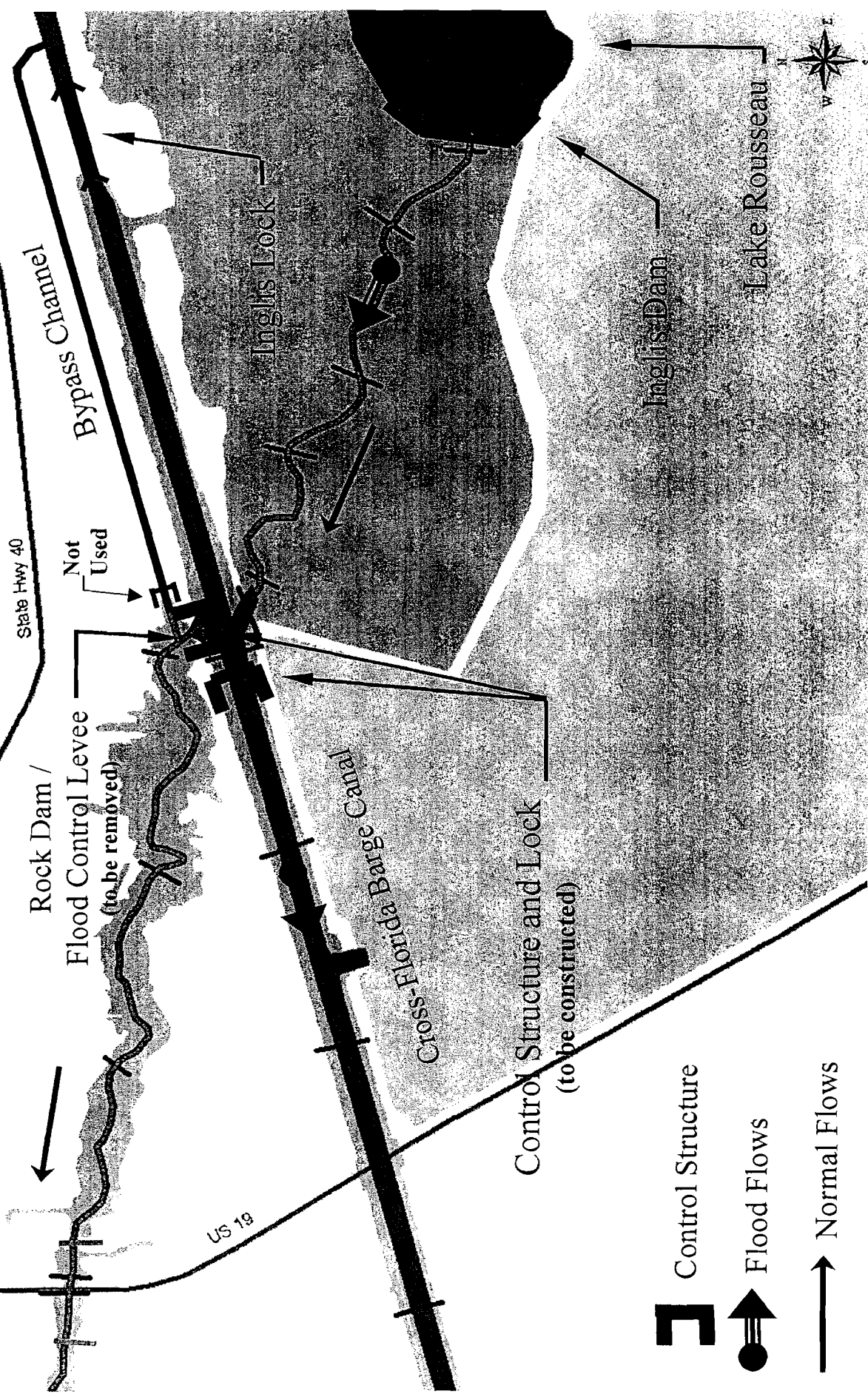
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WEST TERMINUS CROSS - FLORIDA GREENWAY ASSESSMENT
Southwest Florida Water Management District

FIGURE 6
ALTERNATIVE 1
US-19 REPLACEMENT BRIDGE

ALTERNATIVE - 2

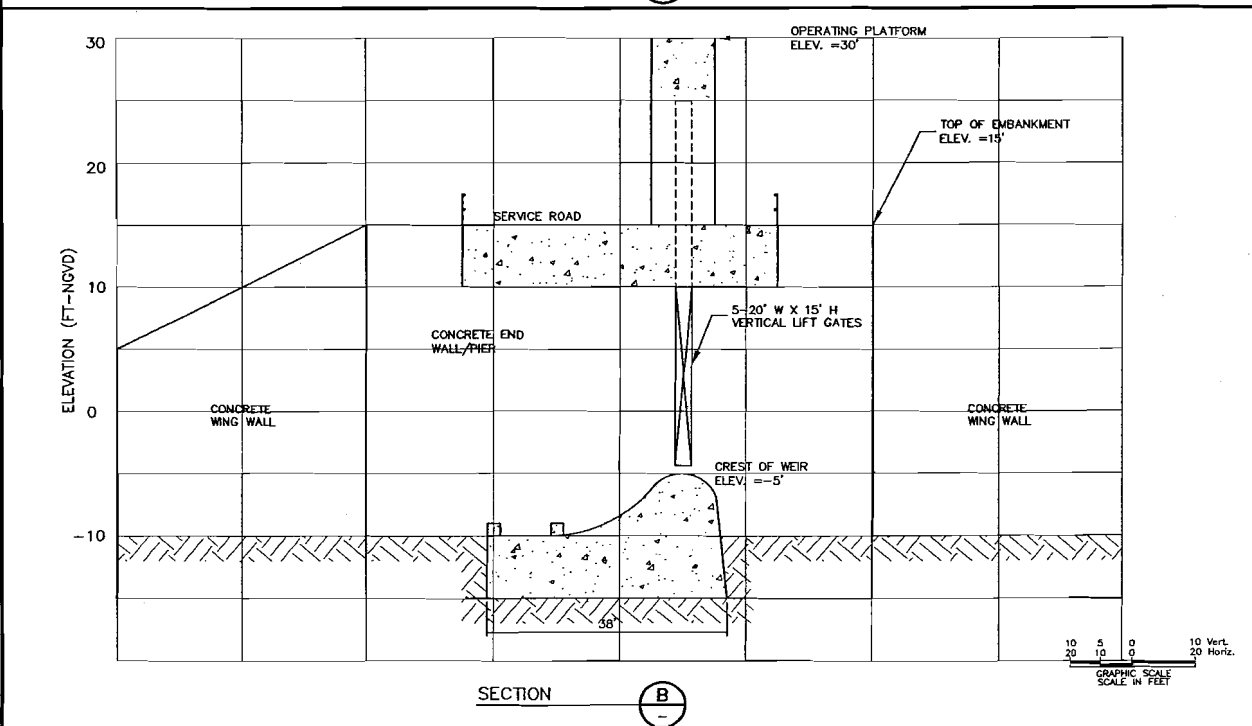
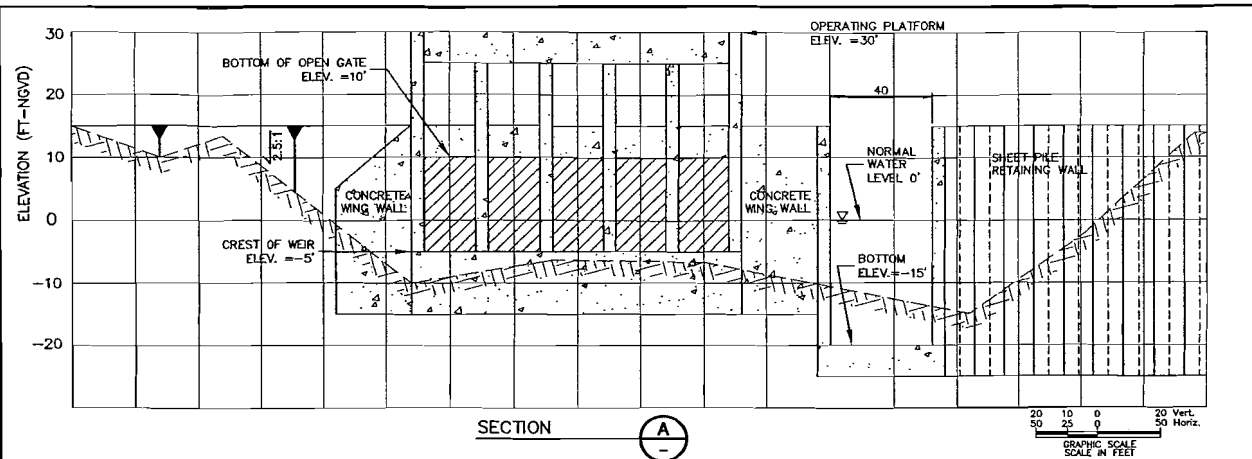
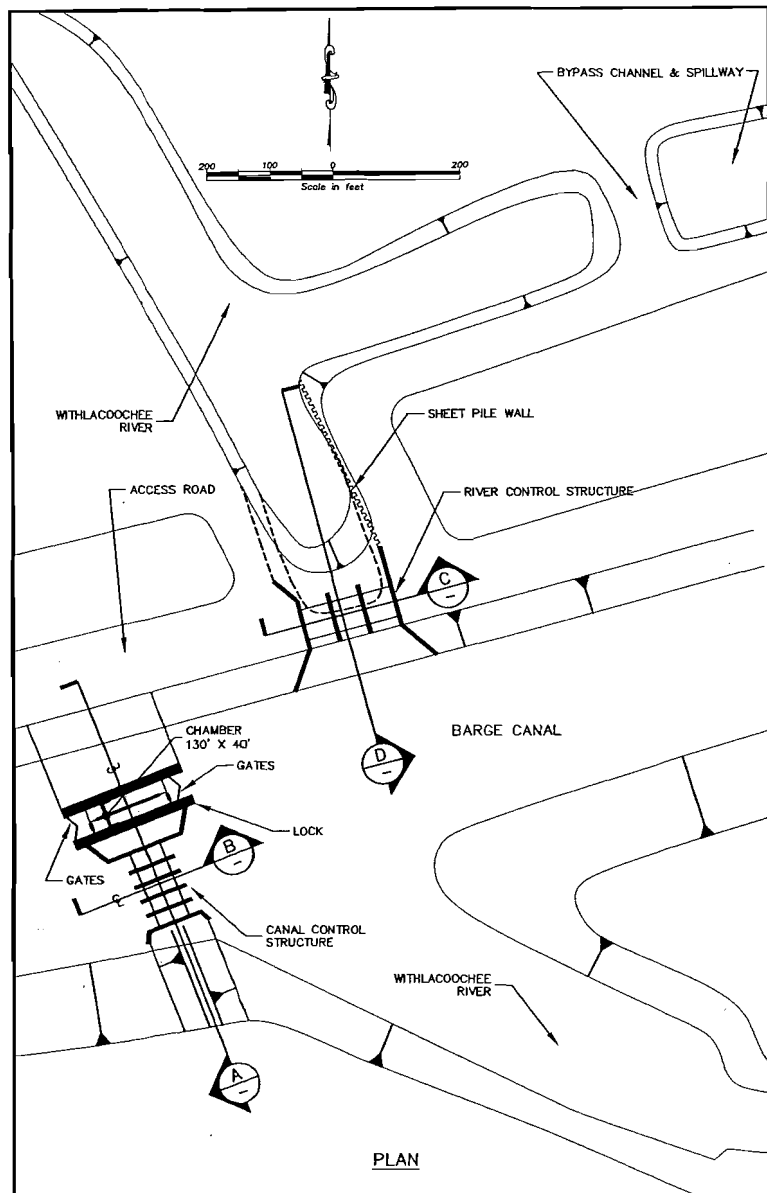
(Construct Control Structure and Lock in Barge Canal, Replace Rock Dam with Control Structure)



URS

WEST TERMINUS CFGA STUDY
Southwest Florida Water Management District

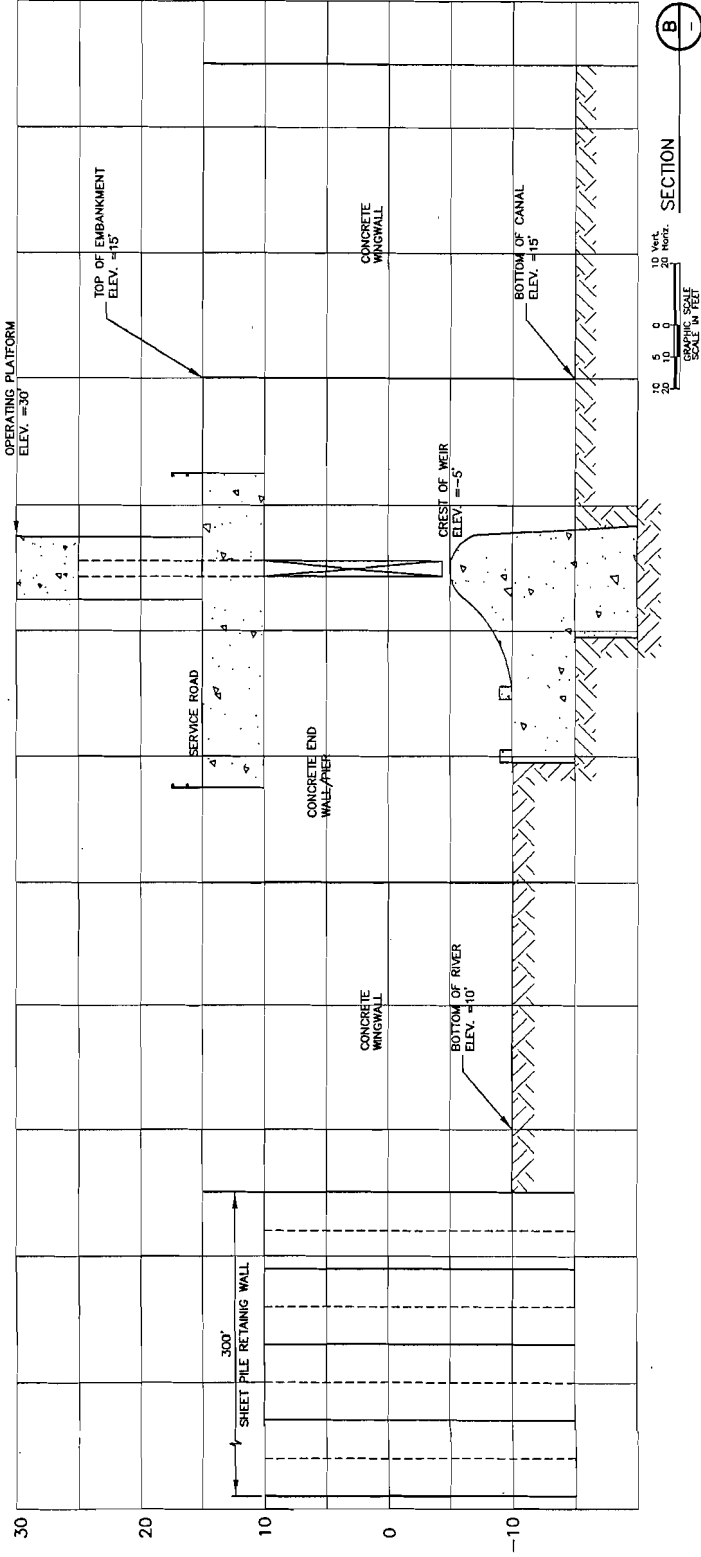
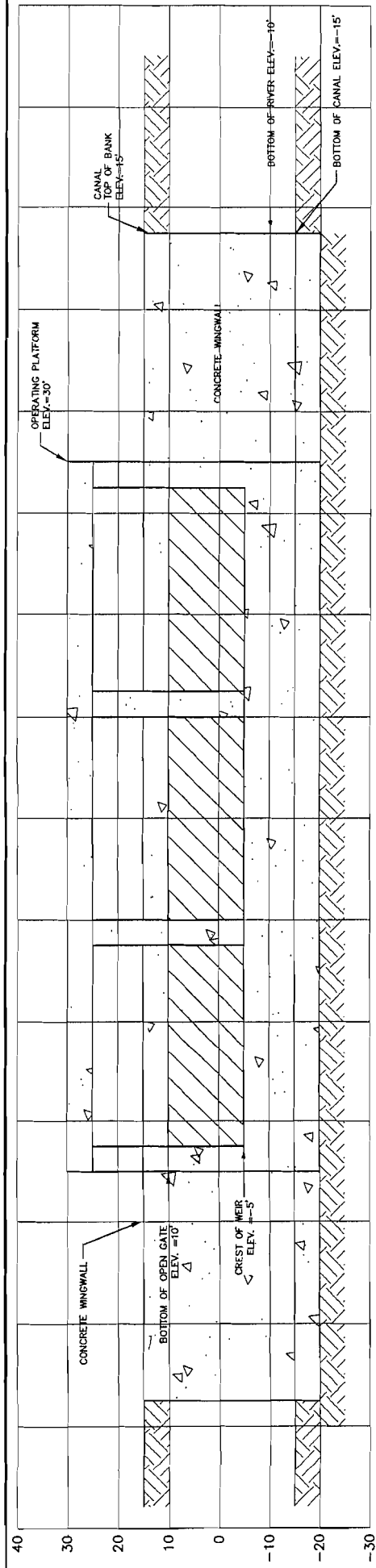
FIGURE 7
ALTERNATIVE 2
CONCEPTUAL PLAN



URS

WEST TERMINUS CFGA STUDY
Southwest Florida Water Management District

FIGURE 8
ALTERNATIVE 2
CANAL AND RIVER
CONTROL STRUCTURES AND LOCK
PLAN AND SECTIONS



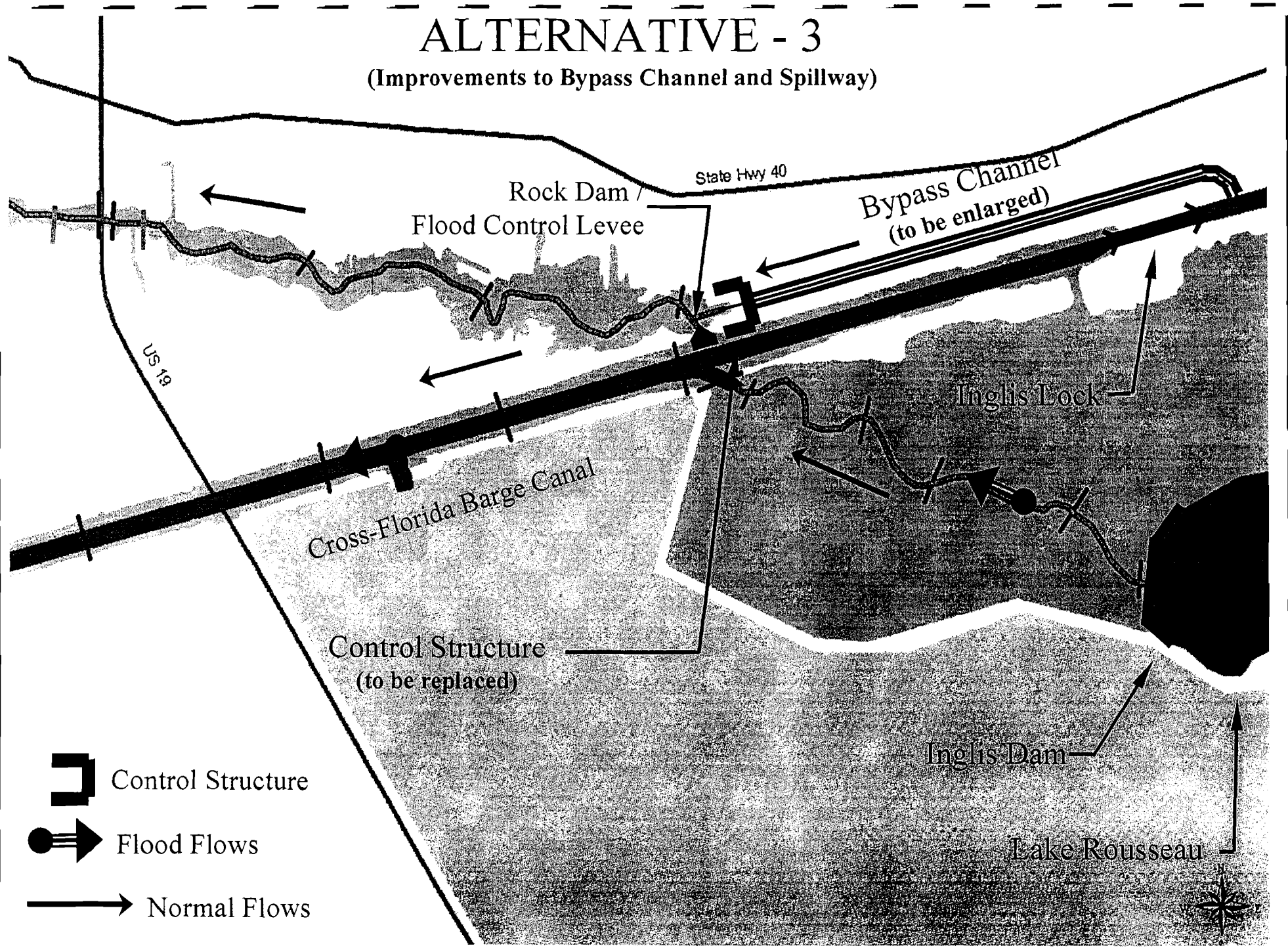
URS

WEST TERMINUS CFGA STUDY
Southwest Florida Water Management District

FIGURE 9
ALTERNATIVE 2
RIVER CONTROL STRUCTURE
SECTIONS

ALTERNATIVE - 3

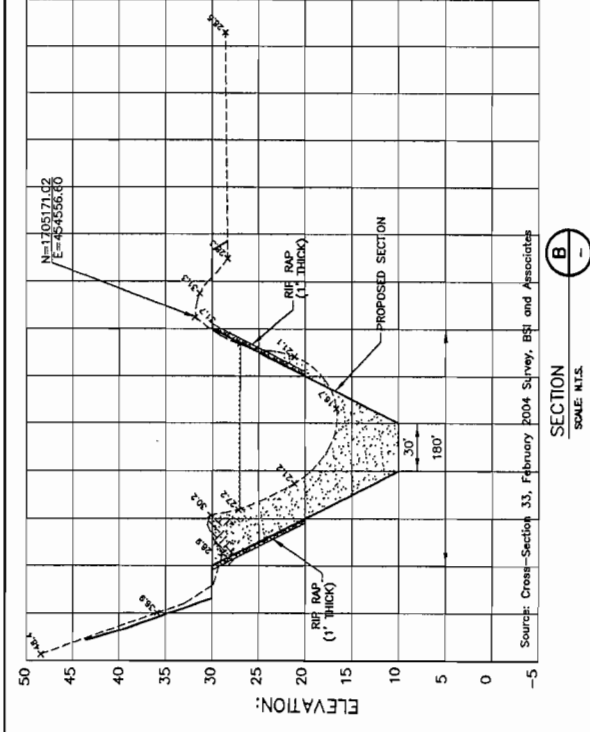
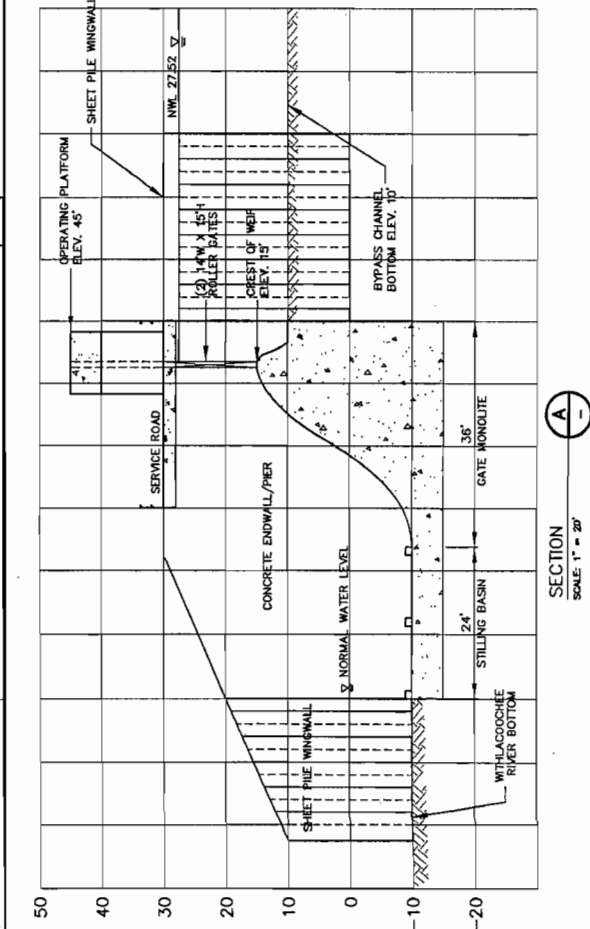
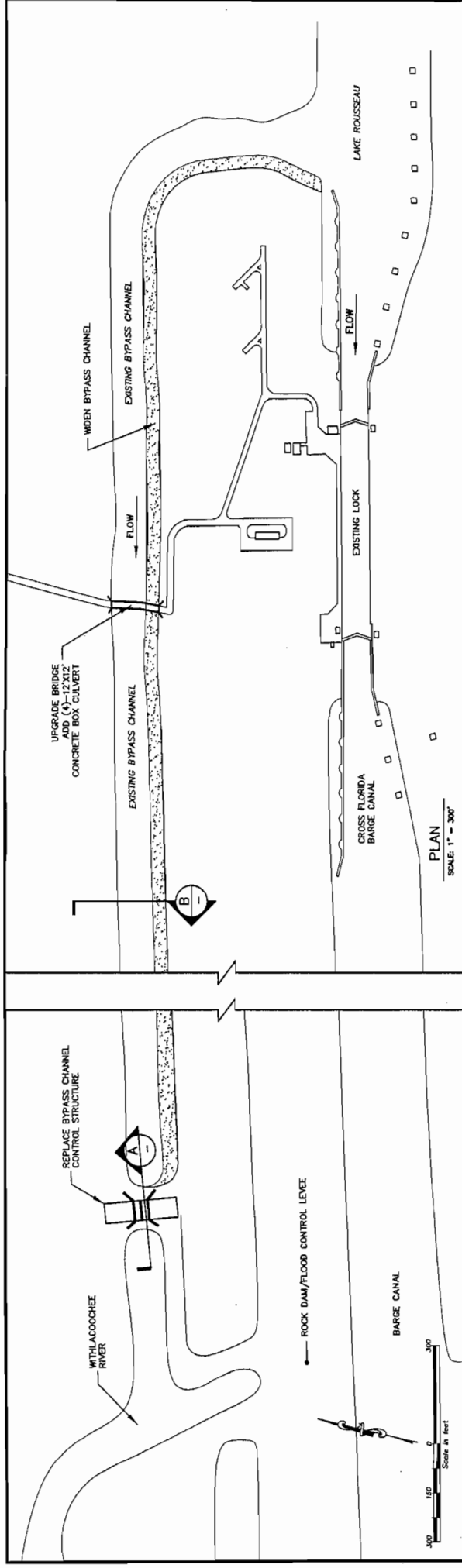
(Improvements to Bypass Channel and Spillway)



URS

WEST TERMINUS CFGA STUDY
Southwest Florida Water Management District

FIGURE 10
ALTERNATIVE 3
CONCEPTUAL PLAN



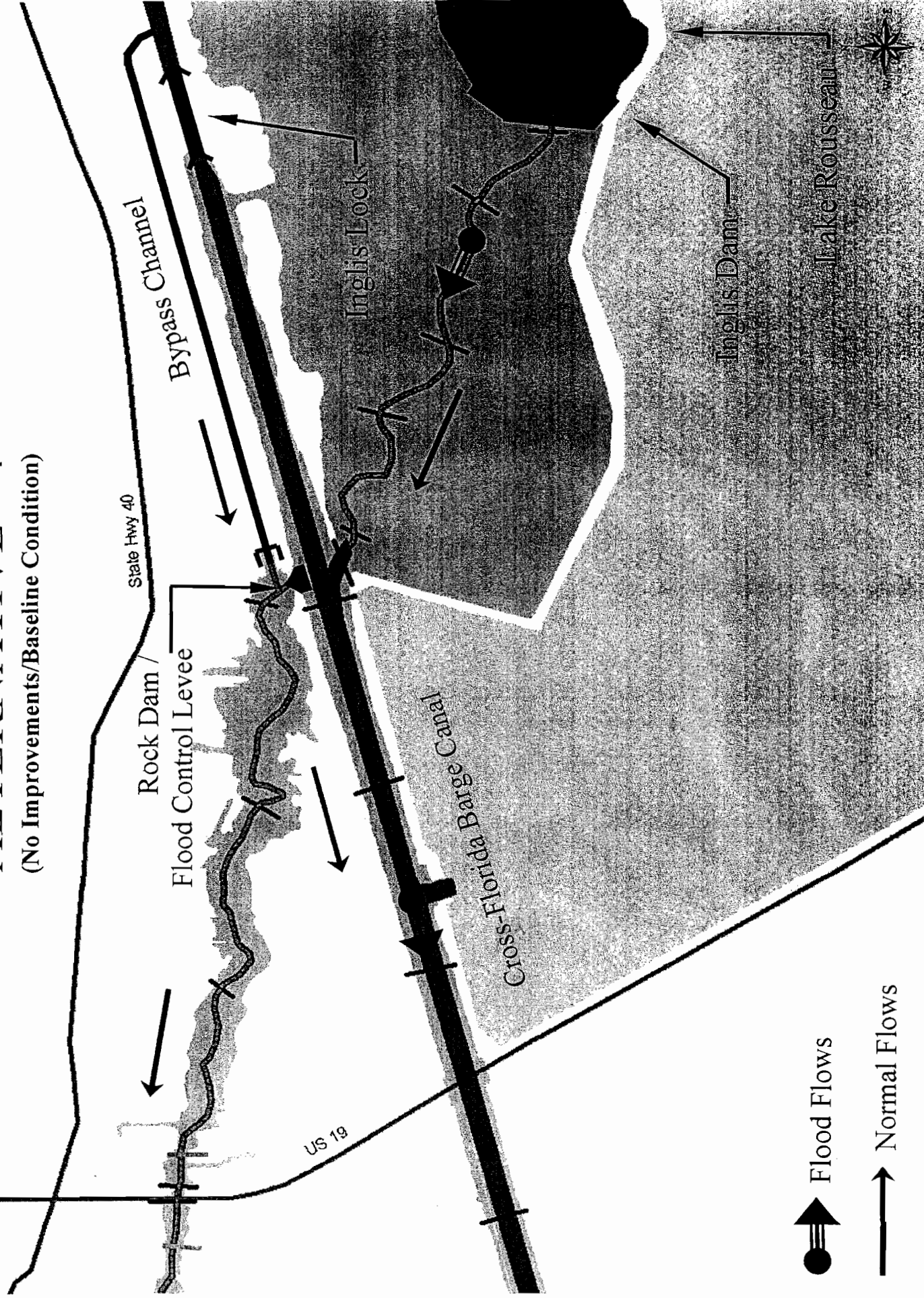
URS

WEST TERMINUS CFGA STUDY
Southwest Florida Water Management District

FIGURE 11
ALTERNATIVE 3
BYPASS CHANNEL AND CONTROL STRUCTURE
PLAN AND SECTION

ALTERNATIVE - 4

(No Improvements/Baseline Condition)



URS

WEST TERMINUS CFGA STUDY
Southwest Florida Water Management District

FIGURE 12
ALTERNATIVE 4
CONCEPTUAL PLAN

LONG-TERM SIMULATION RS-8.06/7.53 (Cross-Section 26)
 Composite Stage-Duration Curve

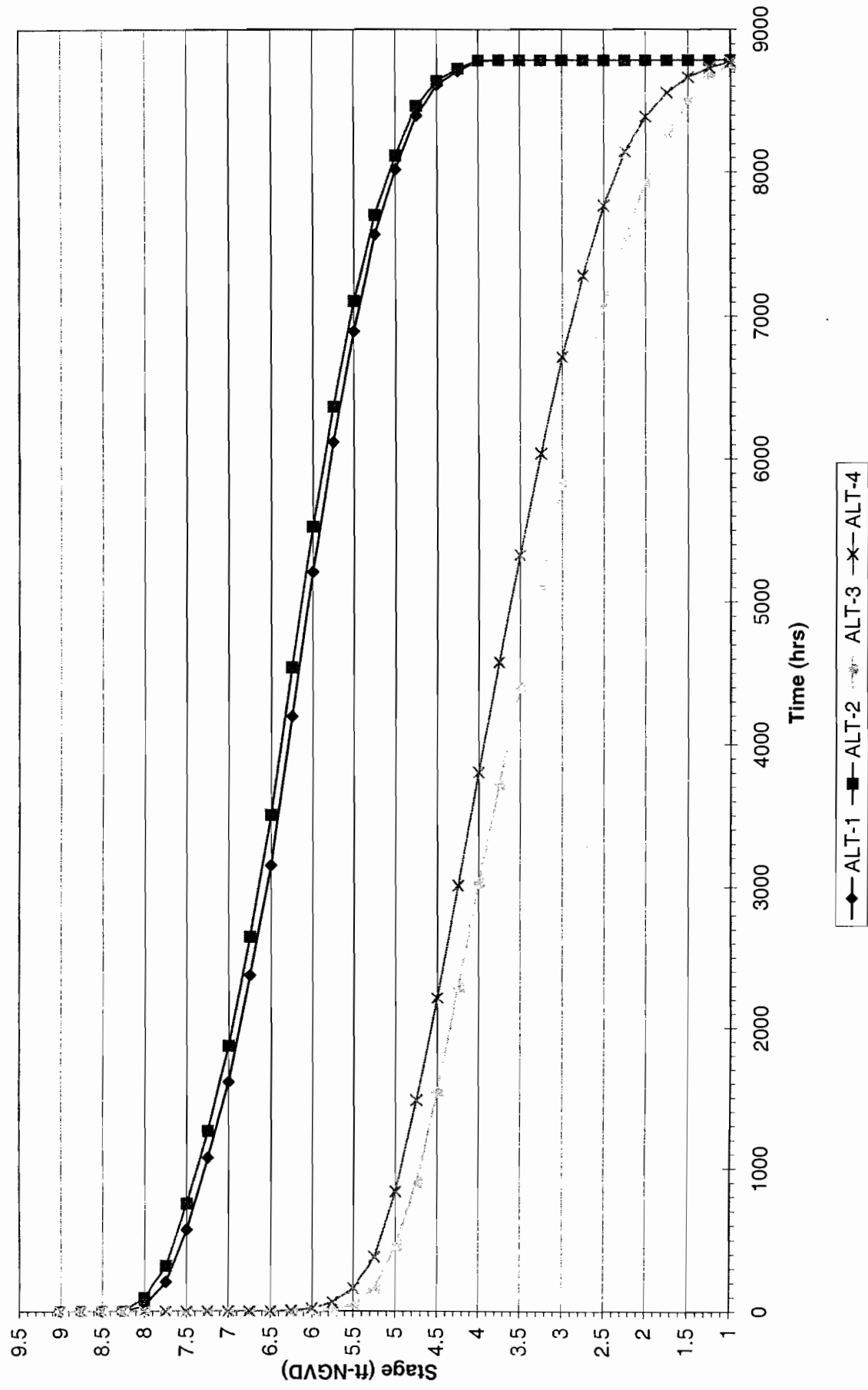


Figure 14

LONG-TERM SIMULATION RS-6.63/6.09 (Cross-Section 27)
Composite Stage-Duration Curve

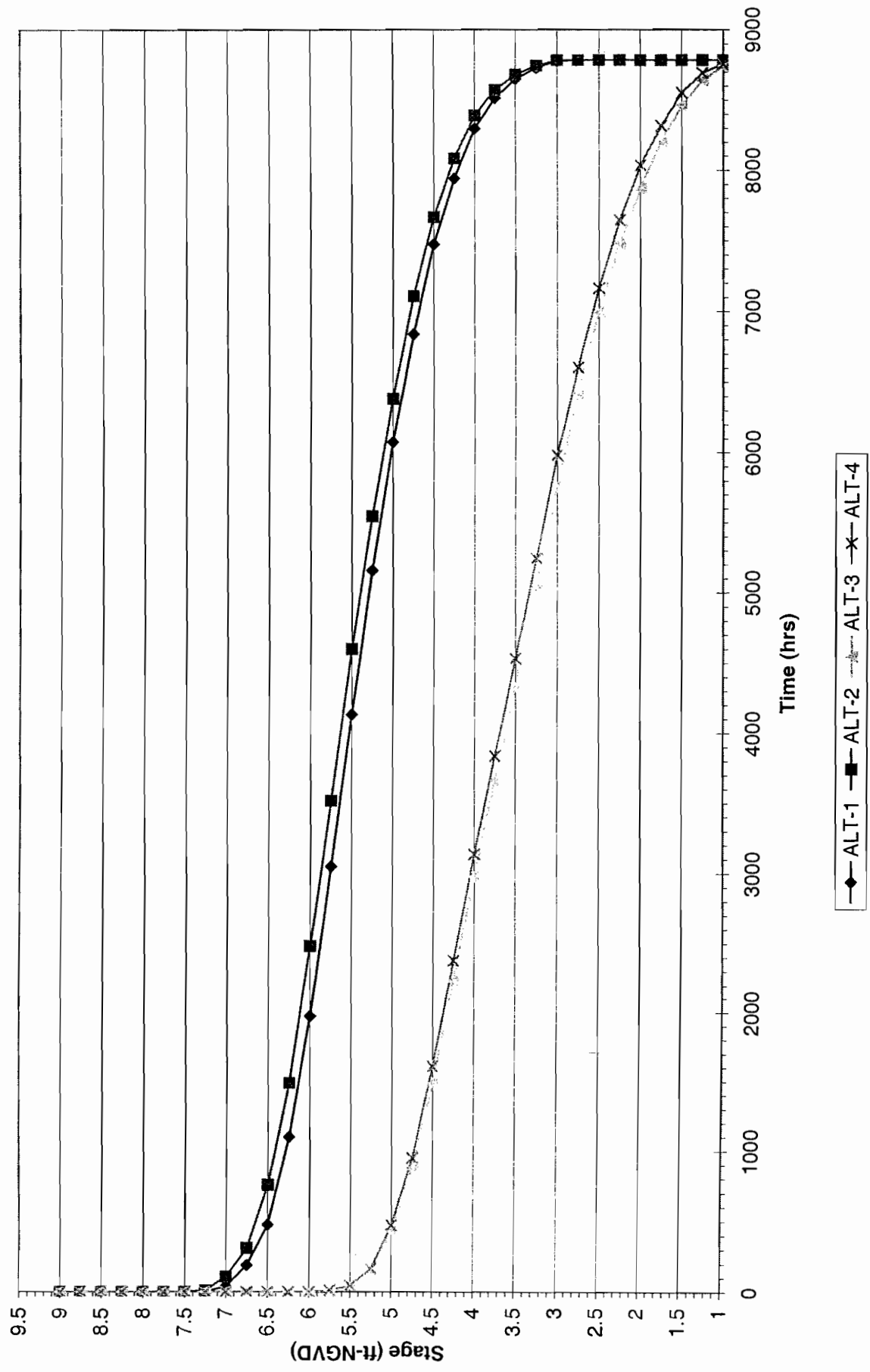


Figure 15

LONG-TERM SIMULATION RS-6.68/6.15 (Cross-Section 22)
 Composite Stage-Duration Curve

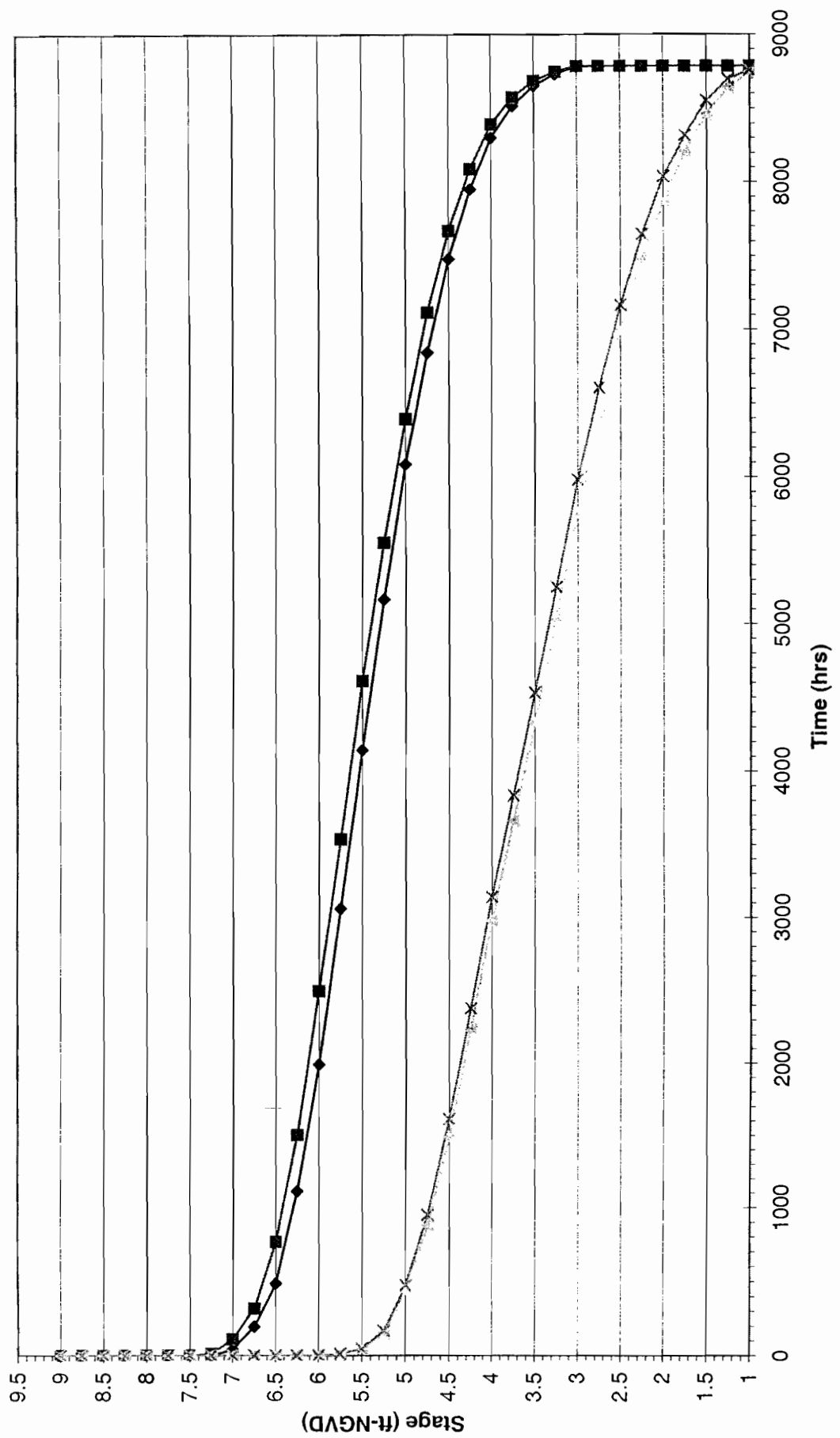


Figure 16

LONG-TERM SIMULATION RS-6.47 (Cross-Section 12)
Composite Stage-Duration Curve

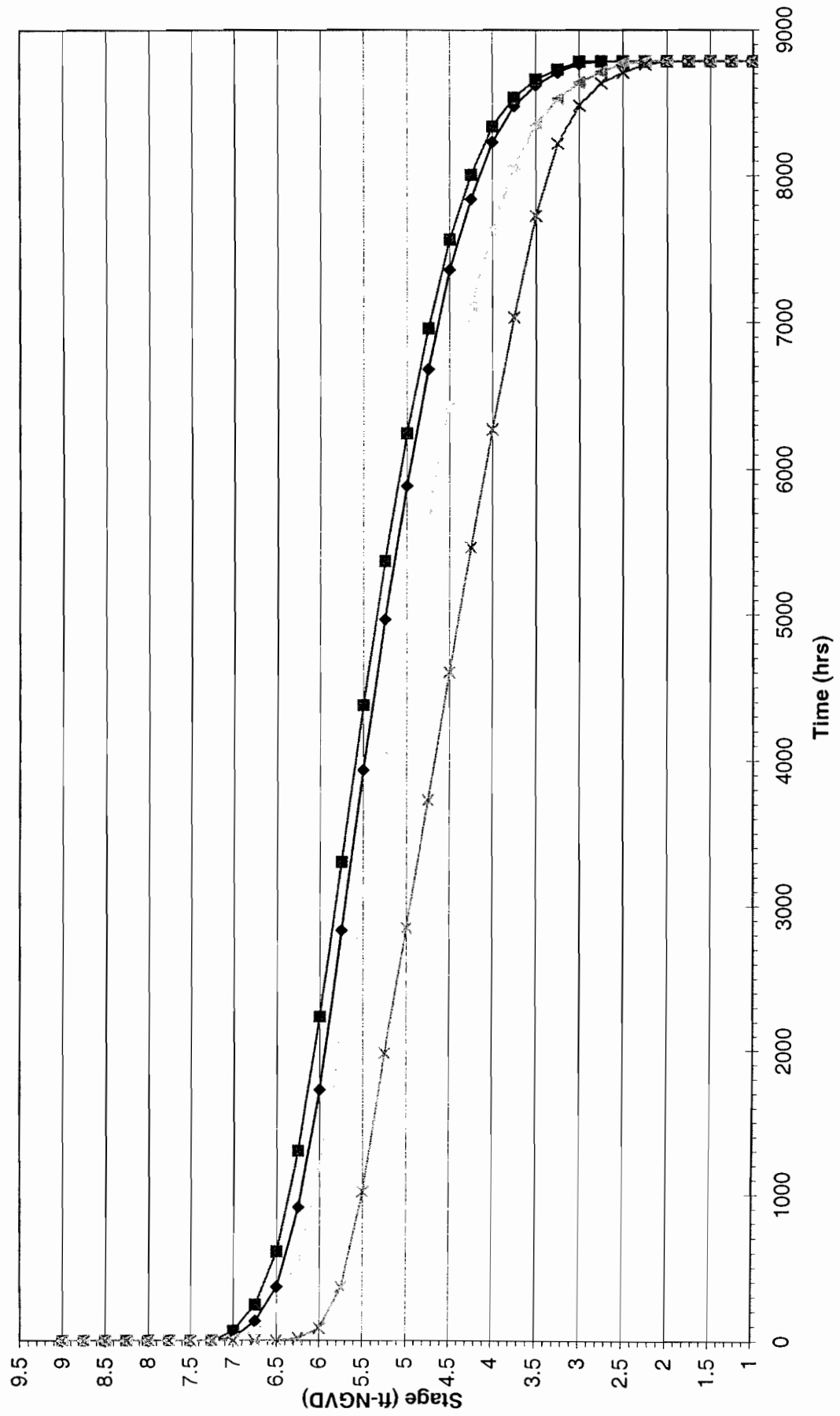


Figure 17

LONG-TERM SIMULATION RS-4.99 (Cross-Section 9)
 Composite Stage-Duration Curve

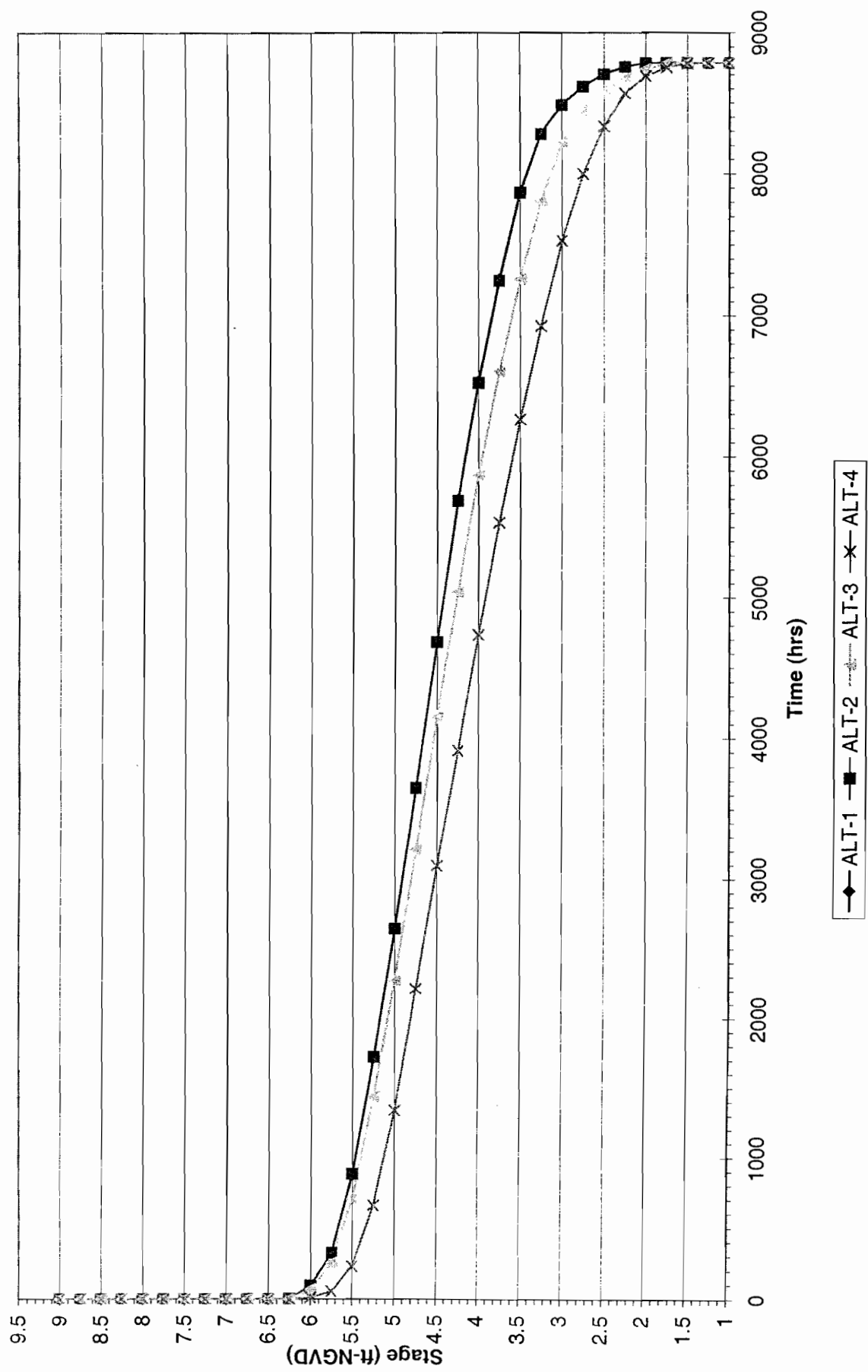


Figure 18

LONG-TERM SIMULATION RS-3.83 (Cross-Section 6)
Composite Stage-Duration Curve

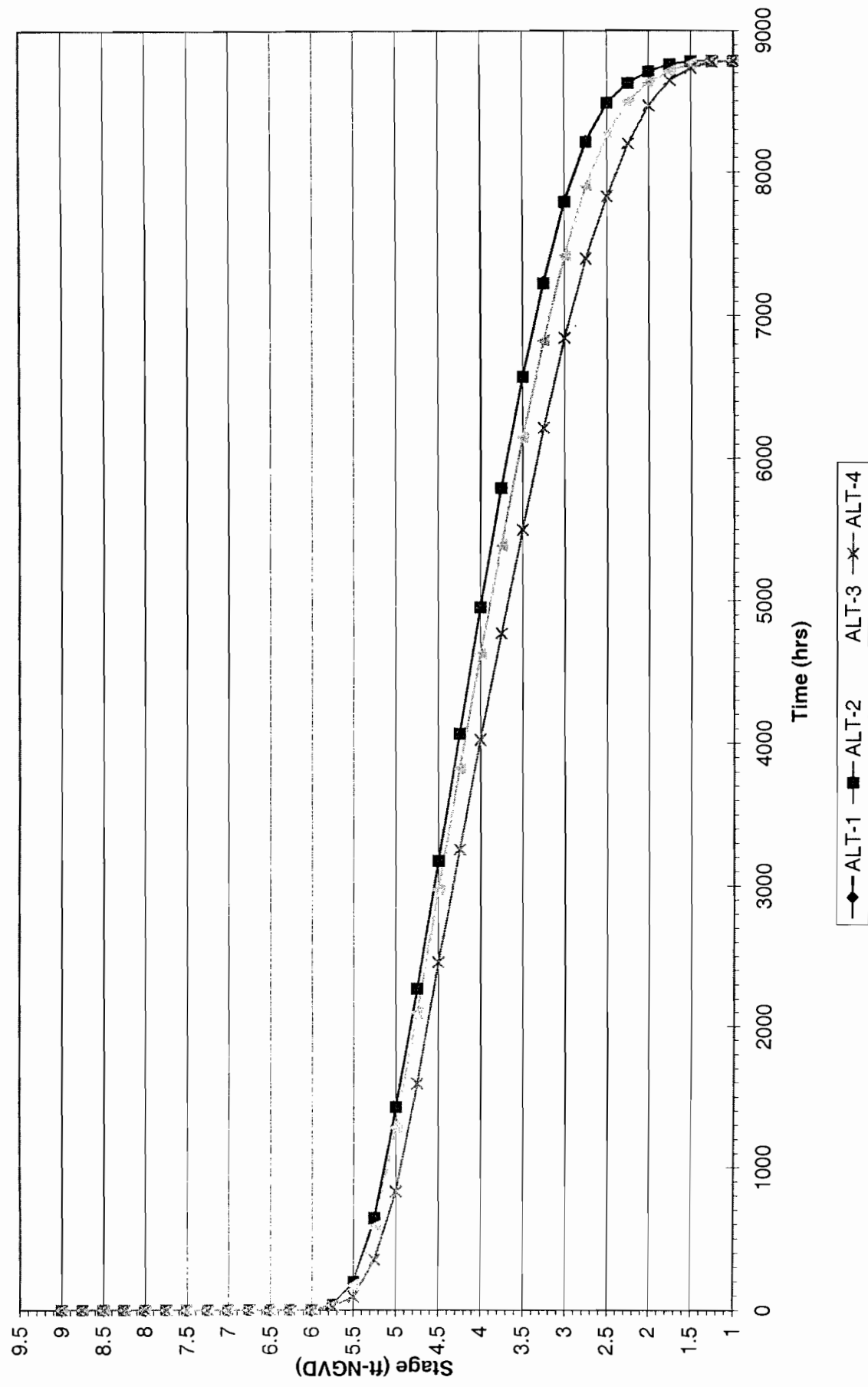


Figure 19

LONG-TERM SIMULATION RS-0.72 (Cross-Section 2)
Composite Stage-Duration Curve

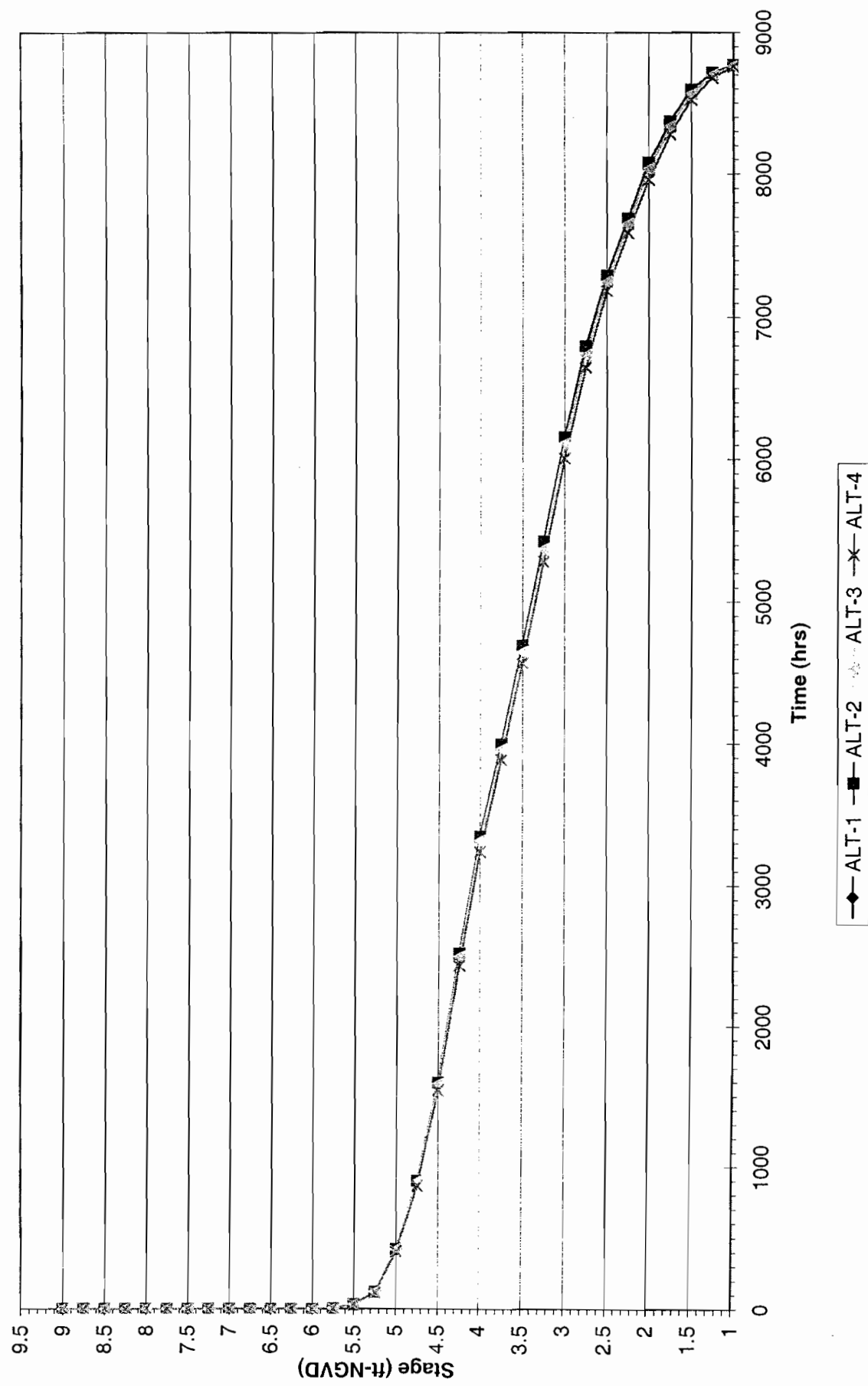


Figure 20

LONG-TERM SIMULATION RS-5.62 (Cross-Section 10)
 Composite Stage-Duration Curve

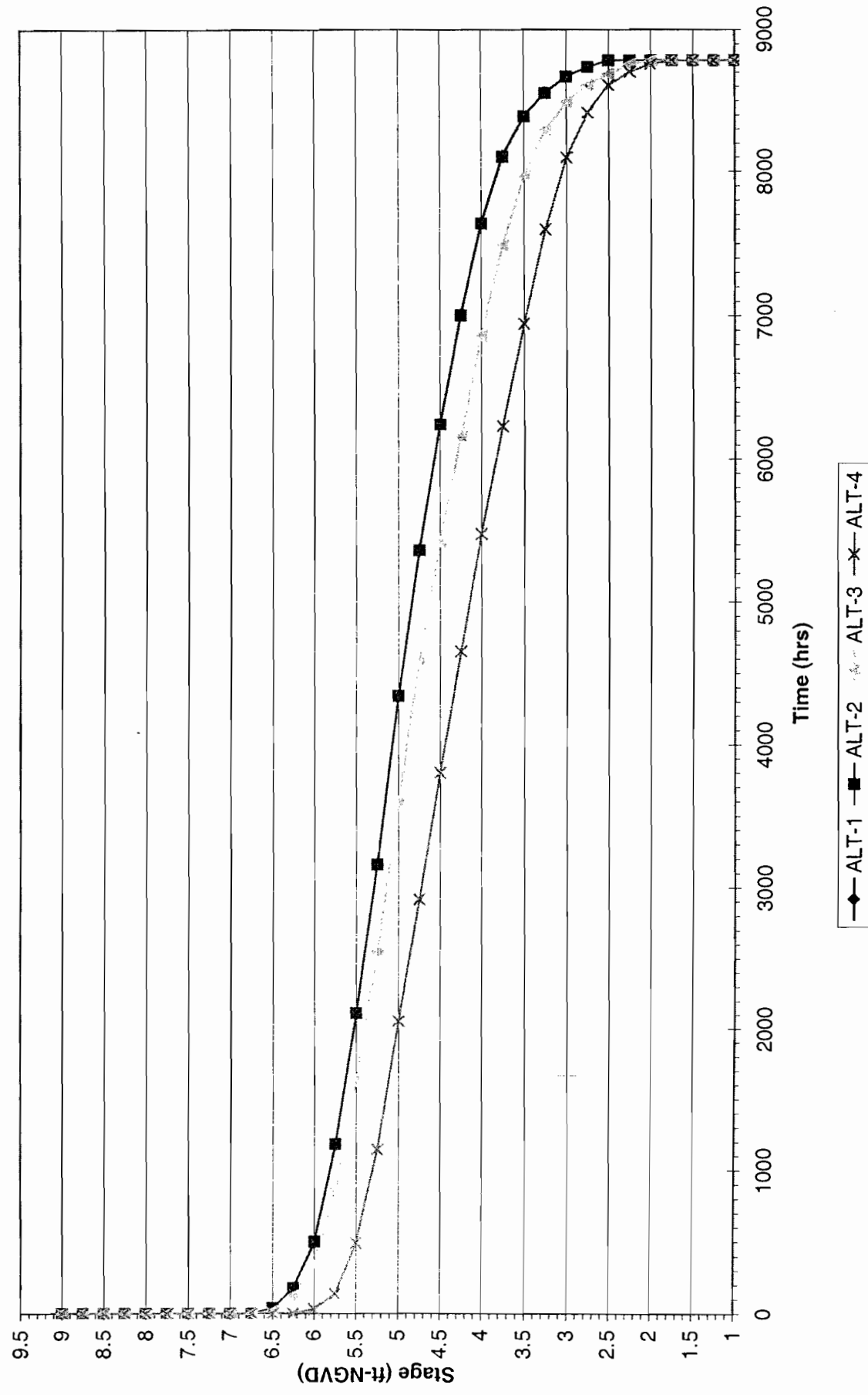


Figure 21

LONG-TERM SIMULATION RS-2.83 (Cross-Section 4)
Composite Stage-Duration Curve

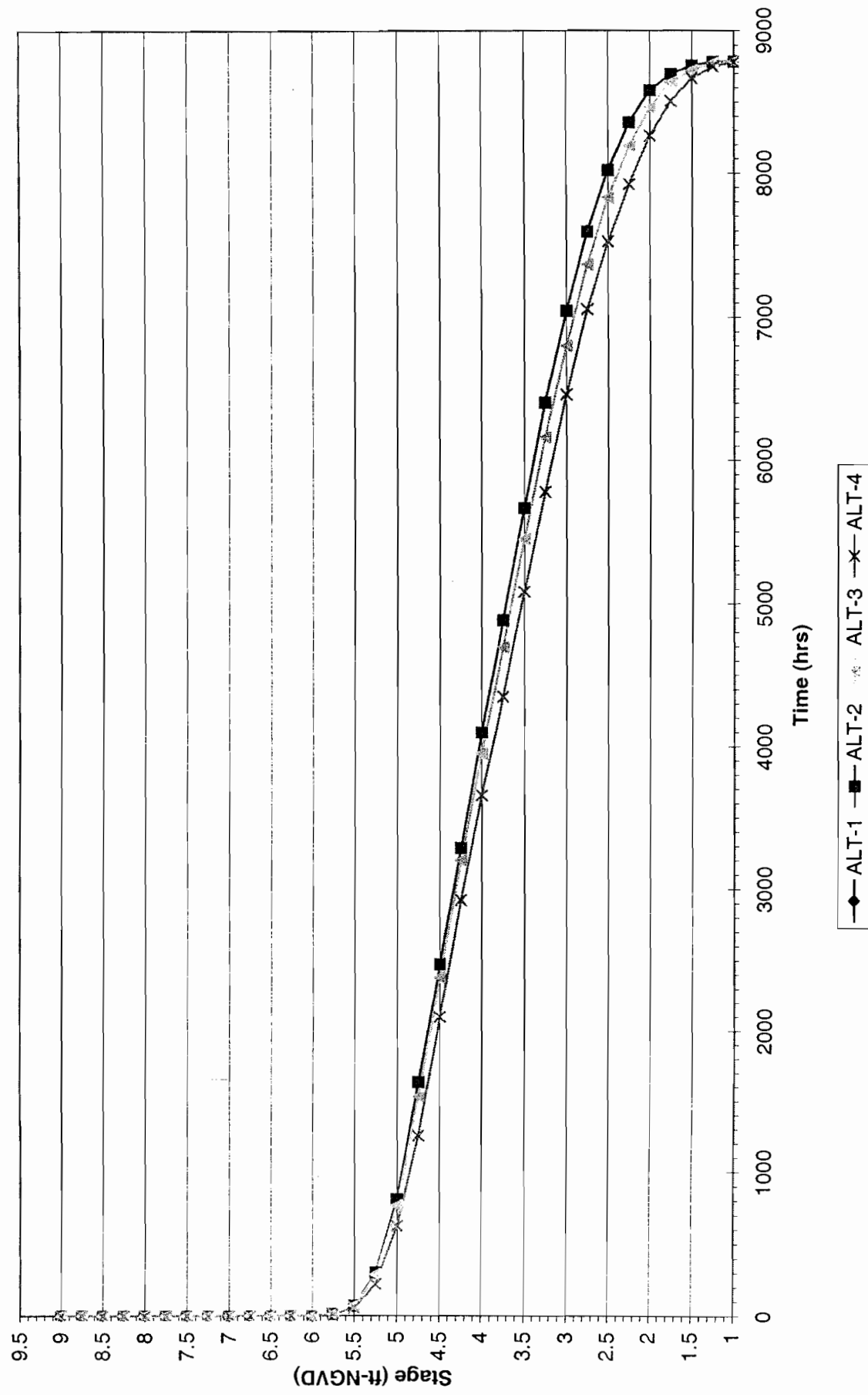


Figure 22

LONG-TERM SIMULATION RS-0 (Cross-Section 1)
 Composite Stage-Duration Curve

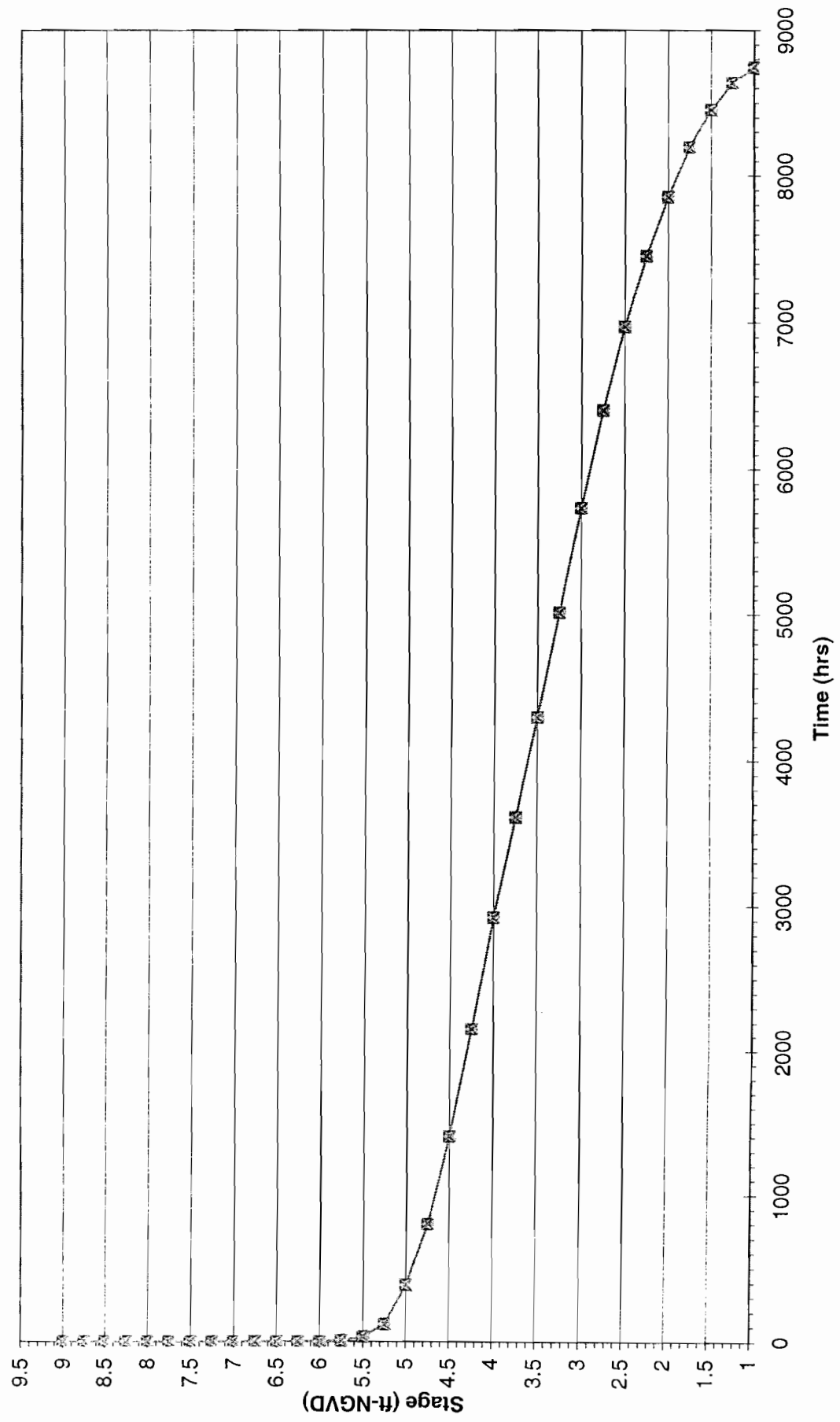
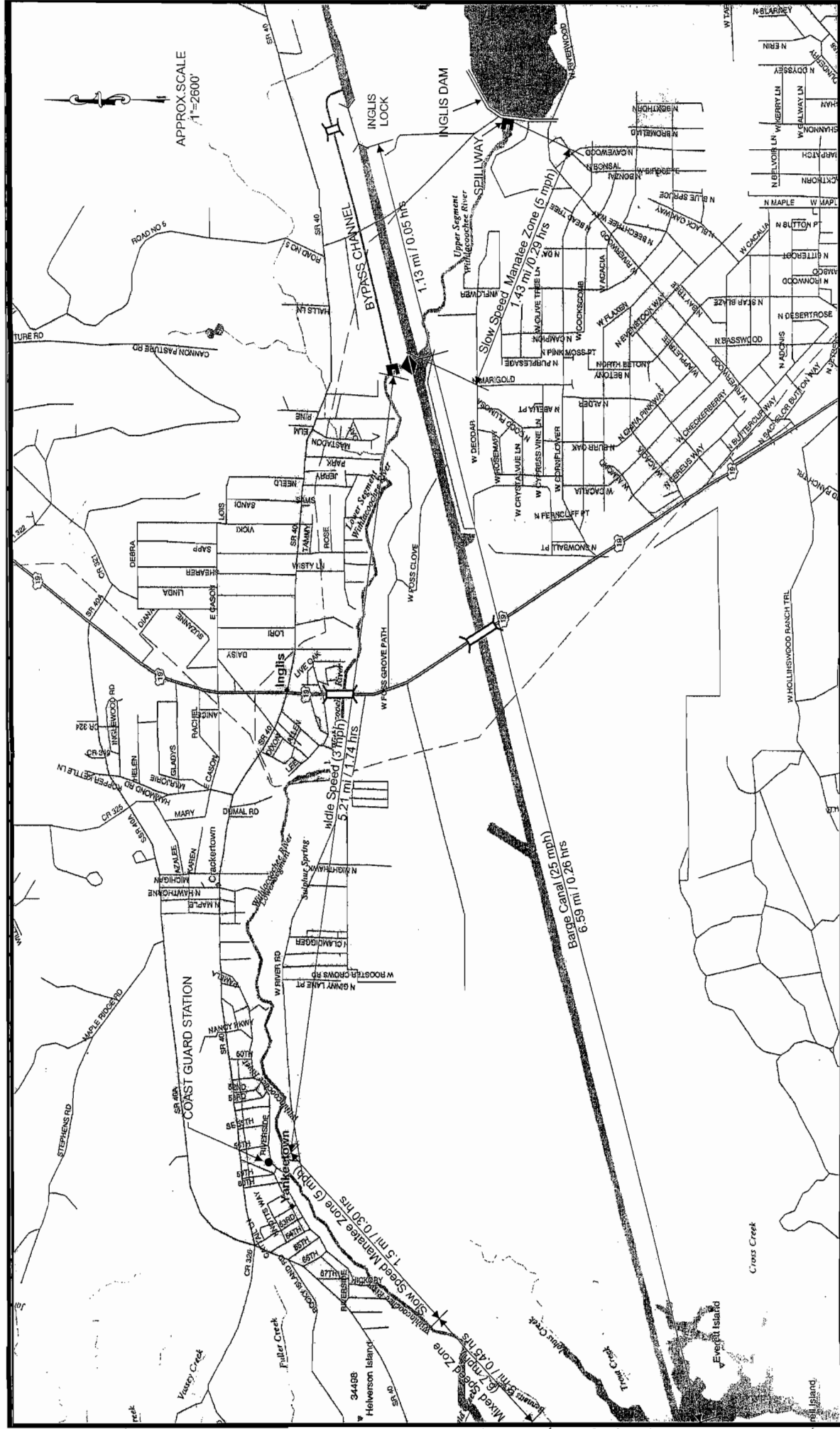


Figure 23



WEST TERMINUS CROSS-FLORIDA GREENWAY ASSESSMENT
 Southwest Florida Water Management District

FIGURE 24
 NAVIGATION ASSESSMENT
 TRAVEL ZONES

0:\WATER\PROJECTS\WFM\MD\Project\WFM\MD\West Terminus Cross Florida Greenway Assessment\FIGURE 24.DWG

LONG-TERM SIMULATION RS-0 (Cross-Section 1)
Composite Flow-Duration Curve

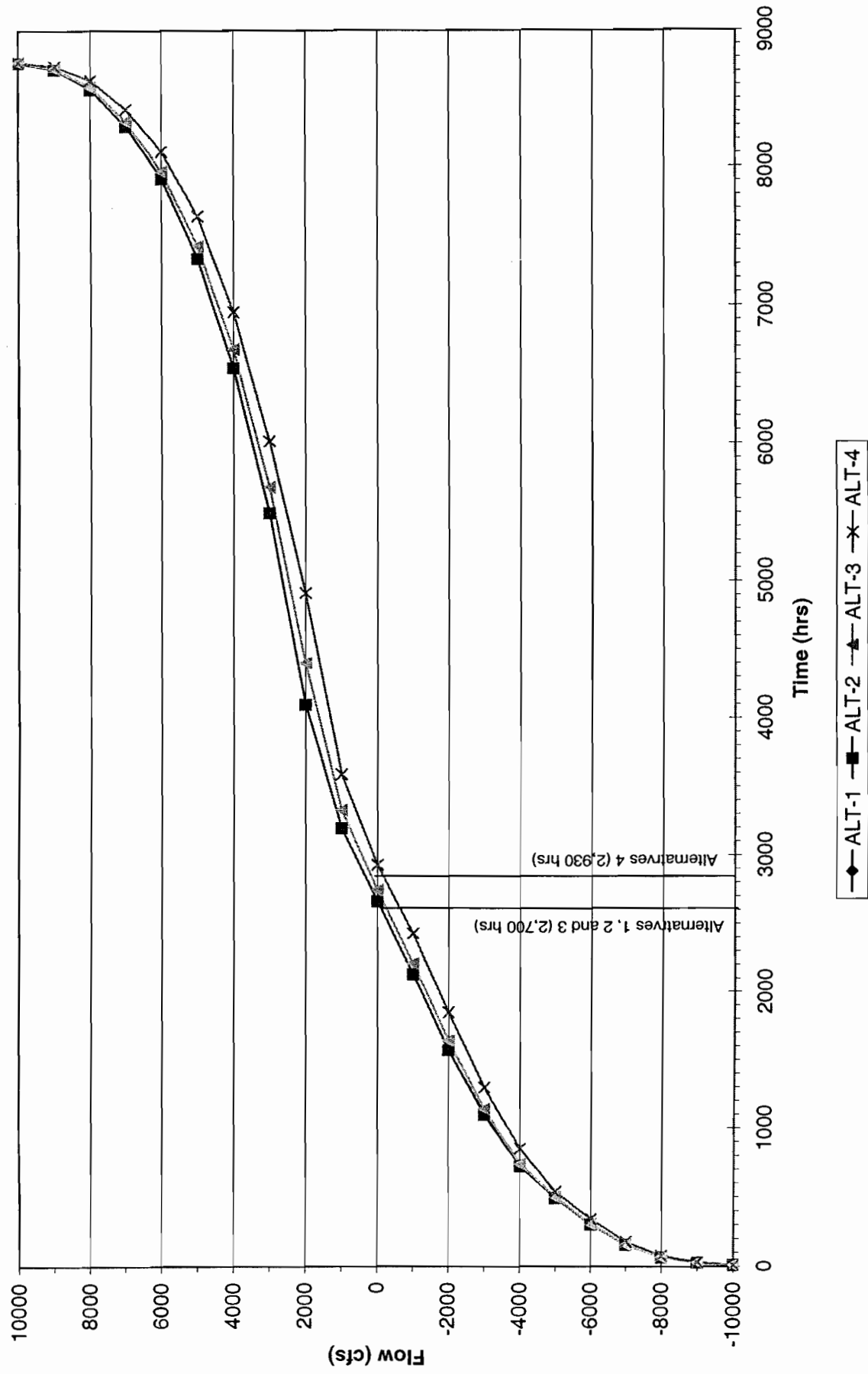


Figure 25

LONG-TERM SIMULATION RS-0.72 (Cross-Section 2)
 Composite Flow-Duration Curve

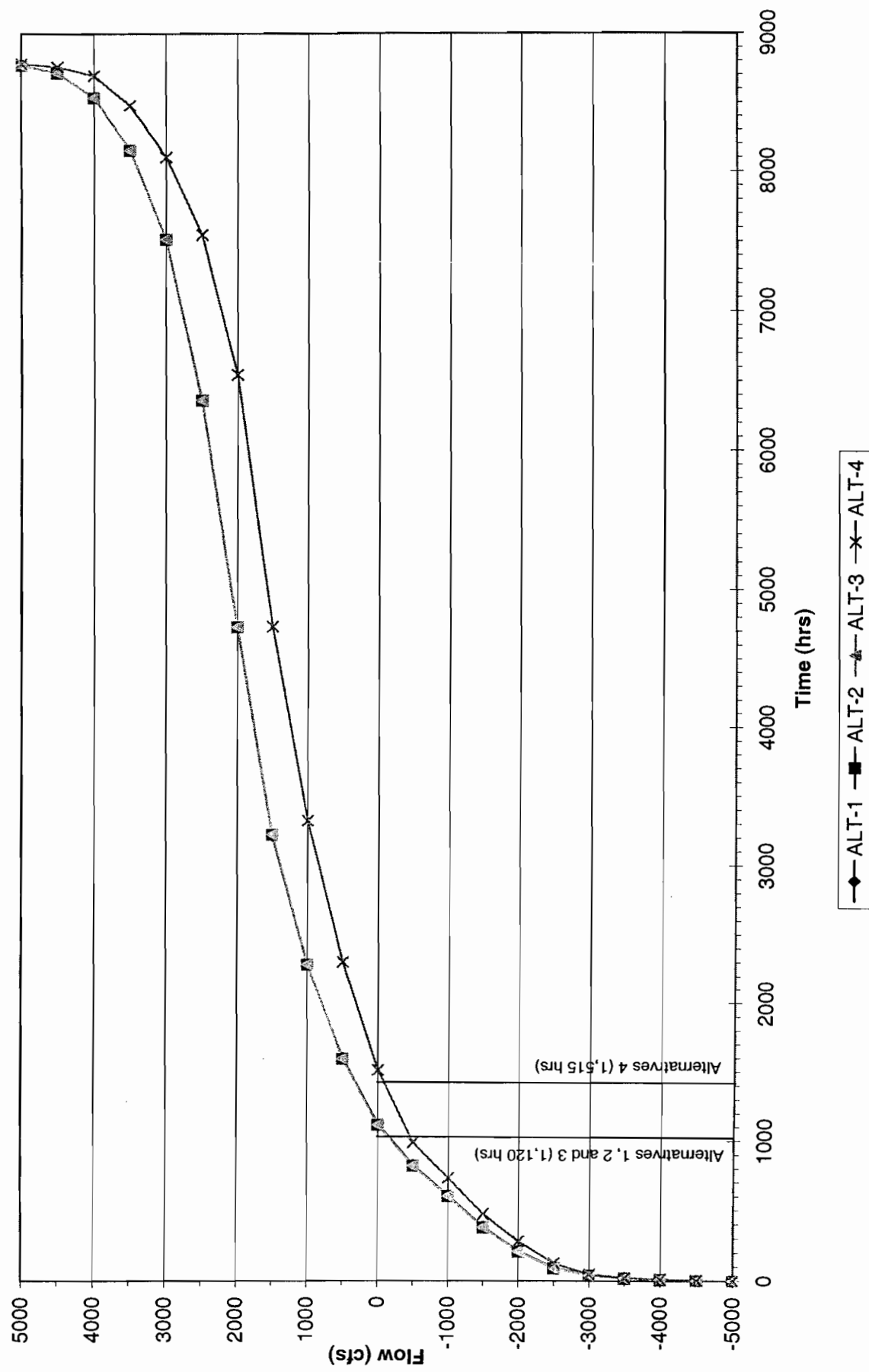


Figure 26

LONG-TERM SIMULATION RS-6.68/6.15 (Cross-Section 22)
 Composite Flow-Duration Curve

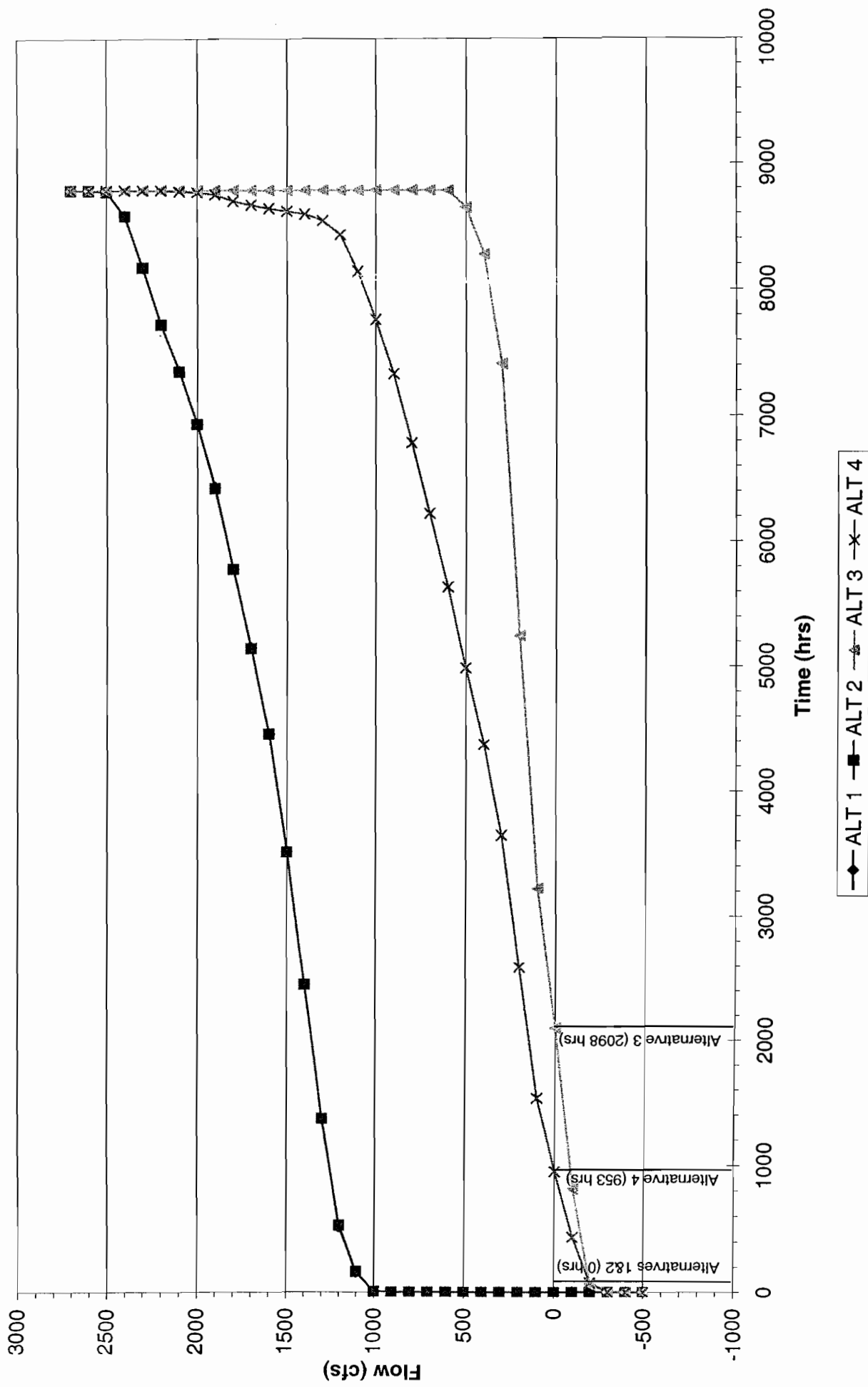


Figure 27

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