Recommended Minimum Flow for Middle Econfina Creek, including Gainer Spring, Williford Spring, and Sylvan Spring Groups

Washington and Bay Counties, Florida

Final

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List of Acronyms and Abbreviations

AMEC	AMEC Environmental and Infrastructure, Inc.
AG	Agriculture
AMO	Atlantic Multidecadal Oscillation
ATM	Applied Technology and Management, Inc.
AWS	Area Weighted Suitability
XS	Cross Section or Transect
cfs	Cubic Feet per Second
CR	County Road
df	Degree of Freedom
DEP	Department of Environmental Protection of Florida
DEM	Digital elevation model
DSS	Domestic Self-Supply
ESA	Environmental Science Associates
FEMA	Federal Emergency Management Agency
ft.	Feet
FDACS	Florida Department of Agriculture and Consumer Services
FWC	Florida Fish and Wildlife Conservation Commission
FNAI	Florida Natural Areas Inventory
FSAID	Florida Statewide Agricultural Irrigation Demand
GSW	Gainer, Sylvan, and Williford Springs
GWCA	Groundwater Contribution Area
HSC	Habitat Suitability Curve
HEC-RAS	Hydrologic Engineering Center River Analysis System
HYSEP	USGS computer program for streamflow hydrograph separation

ICI	Industrial/Commercial/Institutional
in.	Inches
IWUP	Individual Water Use Permit
IFIM	Instream Flow Incremental Methodology
LiDAR	Light Detection and Ranging
MSE	Mean Square Error
µS/cm	Microsiemens per Centimeter
mi^2	miles, squared
mgd	Million Gallons per Day
mg/L	Milligram Per Liter
MFL	Minimum Flow and Level
NOAA	National Oceanographic and Atmospheric Association
NWS	National Weather Service
N	Nitrogen
NAVD	North American Vertical Datum
NWFID	Northwest Florida Identification Number
NWFWMD (District)	Northwest Florida Water Management District
OFS	Outstanding Florida Spring
P or PF	Percentile Flow
PS	Public Supply
QA/QC	Quality Assurance/ Quality Control
R^2	R Squared (coefficient of determination)
rd.	Road
REC	Recreation
SJRWMD	St. Johns River Water Management District

SWFWMD	Southwest Florida Water Management District
Sp. or Spp.	Species
SPI	Standard Precipitation Index
SR	State Road
SAV	Submerged Aquatic Vegetation
SRWMD	Suwannee River Water Management District
SEFA	System for Environmental Flow Analysis
USF	University of South Florida
USGS	United States Geological Survey
WIN	Watershed Information Network
WRV	Water Resource Value
WS	Water Surface Elevation
WSA	Water Supply Assessment
WWP	Weighted Wetted Perimeter
α	alpha, significance level

Acknowledgments

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The authors would also like to recognize personnel from Geosyntec Consultants, Inc. (formerly Applied Technology and Management, Inc.), Environmental Science Associates (formerly Janicki Environmental, Inc.), Southeastern Surveying and Mapping Corporation, and others who contributed to the completion of this project. In particular, the authors would like to recognize Bob Burleson (Geosyntec Consultants, Inc.) and Tony Janicki (Environmental Science Associates) for their continued technical assistance and model development during this project. The authors would also like to thank the Florida Department of Environmental Protection and Florida Fish and Wildlife Conservation Commission for their assistance and guidance throughout this project. We are also grateful to members of the public who took time to provide comments.

Executive Summary

Section 373.042(1), Florida Statutes, provides that the minimum flow for a given water body is defined as "the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area." As such, this minimum flow evaluation focuses solely on the effects of reduced spring flows from surface water and groundwater extraction (i.e. consumptive uses) to the ecology of middle Econfina Creek, inclusive of the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group as well as the associated spring runs. This report provides the technical analysis for determining recommended minimum flows for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group.

The study area encompasses the 11.8-mile portion of Econfina Creek between the Williford Spring Group and Deer Point Lake at the confluence of Econfina Creek and Bear Creek as well as the associated spring runs and is also referred within this report as "middle Econfina Creek" (Figure 1-1). The Gainer Spring Group is one of five first magnitude springs located within the Northwest Florida Water Management District (District) jurisdiction and is designated by the State of Florida as an Outstanding Florida Spring (OFS). Williford Spring Group and Sylvan Spring Group are second magnitude spring groups located within the District-owned Econfina Creek Water Management Area. The portion of Econfina Creek north of the Williford Spring run is not directly influenced by the three spring groups of interest and therefore was excluded from the study area. Likewise, the portion of Deer Point Lake below Bear Creek was excluded as the influence of spring flow on total Econfina Creek flow diminishes below CR 388 due to inflows from several surface water tributaries in the vicinity. Future evaluations may consider portions of Econfina Creek above Williford Spring Group, including the remaining second magnitude springs along Econfina Creek.

Average period of record discharge for the Gainer Spring Group is 165 cubic feet per second (cfs). The Gainer Spring Group comprises two primary spring runs as well as Emerald Spring, which is the largest of 15 vents within the spring group. Average period of record discharge for Williford Spring Group is 42 cfs. Williford Spring Group's primary vent is a single large vent located at the head of its run with a noticeable surface boil. Several smaller vents additionally contribute their discharge to the 450 ft. spring run before it enters Econfina Creek. Average period of record discharge for Sylvan Spring Group is 18 cfs. Sylvan Spring Group consists primarily of a collection of fissure type spring vents in three locations along its spring run.

Econfina Creek, including Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group, is home to numerous wildlife species and is extensively utilized for recreation. The majority of the study area remains in relatively natural condition as development along much of the system is relatively limited compared to other rivers in Florida. Land uses within the Econfina Creek watershed are predominantly natural areas, including upland forest, wetlands, open land, and open water. To protect Econfina Creek and its groundwater contribution zone, the District has acquired and currently manages 41,747 acres of public lands in the Econfina Creek Water Management Area.

The development of minimum flows for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group builds upon methods applied elsewhere in Florida, as well as for minimum flows established for St. Marks River Rise and Wakulla and Sally Ward springs by the District. The District's approach to establishing MFLs for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group is that a hydrologic regime exists such that the system's water resource values are protected from significant harm caused from water withdrawals. The approach is based on quantifiable relationships between spring discharge and multiple physical and ecological features related to specific water resource values (WRVs). Rule 62-40.473, Florida Administrative Code, outlines requirements regarding ten specific WRVs which must be considered in setting MFLs. WRVs determined to be relevant and appropriate to establishment of minimum flows along Middle Econfina Creek are shown in Table E-1 below.

Table E-1. WRVs Relevant to The Establishment of Minimum Flows Along Middle Econfina Creek

Water Resource Value (WRV)	**Relevant to Establishment of MFLs**	**Relevant to Riparian Bank Habitat/ Bankfull Flows/ Out- of- Bank Flows**	**Not Appropriate for Establishment of MFLs**
Recreation in and on the water	**X**		
Fish and wildlife habitats and the passage of fish	**X**		
Estuarine resources			**X**
Transfer of detrital material		**X**	
Maintenance of freshwater storage and supply		**X**	
Aesthetic and scenic attributes		**X**	
Filtration and absorption of nutrients and other pollutants		**X**	
Sediment loads		**X**	
Water quality			**X**
Navigation			**X**

For each WRV used in MFL analysis, quantitative metrics were utilized to relate WRVs to spring flows and to assess potential effects of reductions in flows from middle Econfina Creek, including Gainer, Williford, and Sylvan Spring groups. Recreation was evaluated in terms of the frequency of sufficient water depths for recreational motorized boat and canoe/kayak passage within the Econfina Creek study area. Metrics for fish and wildlife habitat included frequency of sufficient water depths for fish passage and evaluation of instream habitat for numerous fish and mussel species found within Econfina Creek. Metrics pertaining to protection of riparian bank habitat, bankfull flows, and out-of-bank flows were considered since maintaining these characteristics may contribute to preserving the ecological health of Econfina Creek. These metrics included evaluation of the effect of potential reduced spring flows on wetted perimeter inundation as well as frequency of out-of-bank flows above top-of-bank elevations.

Due to the majority of the groundwater contribution area comprising public lands including the Econfina Creek Water Management Area, consumptive withdrawals are minimal. Total groundwater withdrawals within the middle Econfina Creek groundwater contribution area were 1.15 million gallons per day (mgd) in 2020. This area is expected to remain mostly undeveloped, with projected groundwater withdrawals of 1.41 mgd in 2045.

Seasonal fluctuations in spring flow from Gainer, Williford, and Sylvan Spring groups were examined and determined to be small, particularly relative to other Florida rivers. Because seasonal variations are relatively small and the metrics utilized in MFL determination are relevant throughout the year, period of record flows, rather than seasonal flow blocks, were used to develop the proposed minimum flows. Structural alterations were considered, such as backwater effects from Deer Point Lake, which were determined to minimally impact flows within the middle Econfina Creek study area.

Additionally, the effects of Hurricane Michael, which made landfall near Mexico Beach, Florida, on October 10, 2018, as a Category Five storm, was evaluated as part of this MFL assessment. The hurricane cut an intensely destructive path across several counties of the Florida Panhandle. In addition to damaging structures and communities, the storm devastated forests throughout the region. As a result, fallen trees and vegetation debris smothered numerous streams, rivers, and accompanying floodplains, with Econfina Creek being among the hardest hit. Debris within stream channels restricts water flow and reduces stream capacity, therefore altering stream hydrology. Extensive woody debris removal efforts were conducted by DEP following Hurricane Michael within the Econfina Creek channel. Since these efforts were completed, Econfina Creek was restored to a more natural condition representative of the historical hydrologic regime. Hydraulic models utilized for this MFL technical assessment were developed based on conditions following debris cleanup along Econfina Creek and represent a recent period which is also reflective of historical conditions.

Hydraulic (Hydrologic Engineering Center River Analysis System, or HEC-RAS) and in-stream habitat (System for Environmental Flow Analysis, or SEFA) models were used to determine the flow regime needed to prevent significant harm from withdrawals. Although significant harm is not specifically defined in statute, a maximum of 15-percent reduction in water resource value metrics is used in this MFL evaluation. This threshold for significant harm has been implemented as the protection standard for numerous MFLs throughout Florida and has been accepted by more than a dozen MFL peer review panels (Gore et al. 2002, Munson and Delfino 2007, NWFWMD 2021, NWFWMD 2019, SJRWMD 2017, SRWMD 2005, SRWMD 2007, SRWMD 2013, SRWMD 2015, SRWMD 2016a, SRWMD 2016b, SRWMD 2021, SWFWMD 2008, SWFWMD 2010, SWFWMD 2011, SWFWMD 2012a, SWFWMD 2012b, SWFWMD 2017a, SWFWMD 2017b). The implementation of the MFLs for the middle Econfina Creek, inclusive of the Gainer, Williford, and Sylvan Spring groups, will follow an adaptive management approach, with MFLs periodically reviewed and revised by the District as needed to incorporate new data and information.

The reference gauge selected to establish a combined minimum flow for the middle Econfina Creek system, inclusive of flow inputs from Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group, is the USGS station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388). This station was selected as the reference gauge since it is located downstream of all spring groups of interest and has a sufficient period of record which could be utilized to determine historical baseline conditions (October 1, 1935 to October 14, 2023). The middle Econfina Creek baseline flow record was determined by adjusting the historical flow record for USGS station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388) by adding in the estimated 2020 annual average daily withdrawals within the contribution area of 1.15 mgd (1.78 cfs) to all average daily flows in the historical record. This serves as a conservative estimate of withdrawal impacts on middle Econfina Creek baseline flows.

Flow reductions from baseline hydrologic conditions were evaluated for various flows associated with safe boating and fish passage; maintaining riparian bank habitat, bankfull flows, and out-of-bank flows; and protecting instream habitat of aquatic species within middle Econfina Creek (See Section 6 for details). For each metric evaluated, the “critical” flow was determined at specific locations throughout middle Econfina Creek and translated to an equivalent flow (based on flow percentile) at the reference gauge (Econfina Creek @ CR 388). Allowable reductions in middle Econfina Creek flow corresponding to a 15-percent reduction in inundation frequency (e.g., time) were determined for metrics pertaining to safe boating and fish passage. Allowable reductions in middle Econfina Creek flow corresponding to a 15-percent reduction in inundation frequency (e.g., time) as well as a 15-percent reduction in weighted wetted perimeter were determined for metrics pertaining to maintaining riparian bank habitat, bankfull flows, and out-of-bank flows. Allowable reductions in Econfina Creek flow corresponding to a 15-percent reduction in maximum area weighted suitability, a measure of habitat availability, were determined to protect instream habitat of aquatic species.

A summary of the most limiting metrics and the corresponding allowable flow reductions at Econfina Creek @ CR 388 gauge for each WRV metric evaluated are shown in Table E-2 below. Overall, the most limiting metric is instream habitat for fish species comprising the shallow water depth, slow water velocity habitat guild with an allowable flow reduction of 51 cfs associated with a baseline flow at CR 388 of 312.8 cfs. The weighted wetted perimeter top-of-bank inflection point, above HEC-RAS transect 6361, had an allowable flow reduction of 63 cfs, associated with a baseline flow at CR 388 of 633 cfs. A 15% reduction in weighted wetted perimeter at the toe of bank inflection point, above HEC-RAS transect 6361, was met under all flow scenarios and was therefore not a critical metric. Safe power boating was achieved throughout the study area for all but the lowest flow scenarios simulated. The critical HEC-RAS transect for power boating is located in the upper reach of the study area, in the vicinity of Williford Spring, where Econfina Creek is relatively narrow and shallow. An allowable flow reduction of 92 cfs, associated with a baseline flow 420 cfs was determined for safe passage based on this critical transect. Safe canoe/kayak passage and safe fish passage were achieved under all flow scenarios evaluated throughout the study area.

The proposed hydrologic regime for Econfina Creek would shift the baseline flow duration curve downward by the most limiting allowable flow reduction of 51 cfs, across the range of baseline flows for Econfina Creek @ CR 388 gauge. Setting a single minimum flow at the average daily baseline flow for Econfina Creek @ CR 388 gauge provides for adequate protection of middle Econfina Creek including Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group. The recommended minimum flow is an allowable flow reduction of 51 cfs from the Econfina Creek @ CR 388 gauge average baseline flow of 537 cfs. This translates to an allowable reduction of 9.5 percent of average baseline middle Econfina Creek flow, resulting in a minimum average middle Econfina Creek flow of 486 cfs (Table E-3 below).

Table E-2. Summary of WRV Metrics and Allowable Flow Reductions at the Econfina CR 388 Gauge

Indicator	WRV Assessment Method	Critical Flow, cfs (Flow Percentile)	Adjusted Baseline Time Series Flow, cfs (Flow Percentile)	Allowable Flow Reduction, cfs (Percent Reduction in Critical Flow)
safe power boating passage	percent of time achieved	328 (3)	420 (17.6)	92 (21.92)
safe canoe/kayak passage	percent of time achieved	limiting depth never achieved in study area		
safe fish passage	percent of time achieved	limiting depth never achieved in study area		
instream habitat (SEFA)	SEFA/ maximum area weighted suitability	363.8 (7)	312.8 (1.5)	51 (16.3)
riparian bank habitat/ bankfull flow	weighted wetted perimeter toe of bank inflection point, above HEC-RAS transect 6361	15% reduction in weighted wetted perimeter at toe of bank inflection point met under all flow scenarios		
riparian bank habitat/ bankfull flow	weighted wetted perimeter top-of-bank inflection point, above HEC-RAS transect 6361	696 (89)	633 (82)	63 (9.05)

Table E-3. Proposed Combined Minimum Flow for Middle Econfina Creek, Inclusive of Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group

System	Average Baseline Flow at Reference Gauge	Allowable Flow Reduction at Reference Gauge*	Minimum Average Flow at Reference Gauge	Allowable Percent Flow Reduction from Average Baseline Flow
Middle Econfina Creek and Springs (Inclusive of Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group)	537 cfs (347 mgd)	51 cfs (33 mgd)	486 cfs (314 mgd)	9.5%

*Reference gauge is USGS station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388)

1 Introduction

This report provides the technical analysis for determining recommended minimum flows for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group. The Gainer Spring Group is a first magnitude spring (>100 cubic feet per second, cfs); Williford and Sylvan Spring Groups are second magnitude spring groups (between 10 cfs and 100 cfs). These spring groups are located along the middle portion of Econfina Creek in Washington and Bay counties, Florida and collectively comprise approximately 42% of total flow to Econfina Creek as measured at USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388) (Figure 1-1). This assessment focuses on determining the threshold at which consumptive withdrawals would cause significant harm to ecology and water resources of the area.

Section 1 (Introduction) of this report describes the objective, background, and requirements for establishing minimum flows, as well as a description of the study area. Section 2 (Econfina Creek and Watershed) presents a detailed description of the physical setting and contribution zone for Econfina Creek as well as Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group. Section 3 (Hydrology) presents a detailed evaluation of hydrological characteristics of Econfina Creek and its springs as well as a summary of the District's hydrologic data collection along Econfina Creek. Section 4 (Water Resource Values) describes the 10 water resource values defined in Rule 62-40.473, Florida Administrative Code, as they relate to this MFL evaluation, and the associated metrics used to quantify the potential effects of reduced spring flows. Section 5 (Hydrologic Models) describes the development of hydrologic models utilized to evaluate water resource value metrics and determine minimum flows. Section 6 (Evaluation of Water Resource Values) provides the evaluation of the applicable water resource value metrics utilizing hydrologic models to quantify the effects of potential spring flow reductions. Section 7 (Summary and Recommended Minimum Flows) provides the recommended minimum flow regimes for middle Econfina Creek, including the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group. Section 8 (Adaptive Management) describes the District's ongoing and future efforts to assess and protect Econfina Creek and its springs.

1.1 Objective

The objective of this report is to determine recommended minimum flows for middle Econfina Creek, inclusive of spring discharge at the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group, to ensure protection of aquatic habitats, recreation, and other water resource values from significant harm associated with consumptive uses.

1.2 Background

The Northwest Florida Water Management District (District) is required to establish minimum flows and minimum water levels (MFLs) for specific waterbodies located within its boundaries (Section 373.042, Florida Statutes). A map of the District's priority waterbodies for MFL establishment and MFLs previously established can be found on the District's website (www.nwfwater.com). (Sub)Section 373.042 (1), Florida Statutes, says, "The minimum flow for a given water body is defined as the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area." As such, this minimum flow evaluation focuses solely on the effects of reduced spring flows from surface water and groundwater extraction to the ecology of the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group as well as the spring runs associated with these springs and the portion of Econfina Creek influenced by spring flow from these springs. Minimum flows are not intended to offset the effects of sea level rise, changes in precipitation patterns, changes in river hydraulics, or changes in water quality not related to withdrawal impacts.

(Sub)Section 373.042 (1), Florida Statutes, specifies MFLs are to be established using the “best available information.” The best available information was utilized for the establishment of MFLs for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group, including data collected specifically for development of these MFLs. Although not required by statute, the District collected extensive hydrologic and bathymetric data along Econfina Creek and its springs in support of the establishment of MFLs for this system.

In accordance with Rule 62-40.473, Florida Administrative Code, and Section 373.0421, Florida Statutes, the District must consider natural seasonal fluctuations in water flows or levels, non-consumptive uses, structural alterations, and multiple environmental values (referred to as water resource values or WRVs, Table 1-1) when developing the minimum flows. Detailed descriptions of the WRVs and their relevance to middle Econfina Creek and the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group are provided in Section 4.

Water management districts are required to develop and implement either a recovery or prevention strategy at the time of rule adoption if the system is currently not meeting or projected to not meet applicable minimum flows. A recovery strategy is required when a system is currently not meeting MFL criteria, while a prevention strategy is required if the MFL is expected to not be met during the following 20 years based on projected withdrawals. Prevention/recovery strategies may include water conservation measures and additional water supply or water resource development projects.

Table 1-1. Environmental Values (62-40.473, Florida Administrative Code)

Water Resource Value	Description
WRV 1	Recreation In and On the Water
WRV 2	Fish and Wildlife Habitats and the Passage of Fish
WRV 3	Estuarine Resources
WRV 4	Transfer of Detrital Material
WRV 5	Maintenance of Freshwater Storage and Supply
WRV 6	Aesthetic and Scenic Attributes
WRV 7	Filtration and Absorption of Nutrients and Other Pollutants
WRV 8	Sediment Loads
WRV 9	Water Quality
WRV 10	Navigation

1.3 Conceptual Approach

The development of minimum flows for middle Econfina Creek, inclusive of the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group, builds upon methods applied elsewhere in Florida, as well as for minimum flows established for St. Marks River Rise and Wakulla and Sally Ward springs by the District. The District's approach toward establishing MFLs for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group is that a hydrologic regime exists such that the system's water resource values are protected from significant harm caused from water withdrawals. The approach is based on quantifiable relationships between spring discharge and multiple physical and ecological features related to specific water resource values (WRVs). Rule 62-40.473, Florida Administrative Code, outlines requirements regarding specific WRVs which must be considered in setting MFLs (Table 1-1). Additional details regarding WRVs and metric selection are provided in Section 4.

Similar to MFLs established elsewhere in Florida, the District assessed each WRV. Multiple WRVs were considered and evaluated based on the relevancy to the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group and the Econfina Creek system, the potential to be adversely affected by reductions in spring flow, and whether there are measurable and quantifiable relationships that can be used to develop spring flow thresholds for significant harm. These WRVs in relation to the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group and the Econfina Creek system are described in detail in Section 4.

The results from the evaluation of multiple WRV metrics were used to determine the recommended minimum flows for middle Econfina Creek, inclusive of Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group. Although significant harm is not specifically defined in statute, an allowable 15-percent reduction in WRV metrics has been implemented as the protection standard for multiple MFLs throughout Florida. This threshold for significant harm was first proposed by Gore et al. (2002) during their review of the upper Peace River MFL report (SWFWMD 2002). The peer review panel wrote, "In general, instream flow researchers consider a loss of more than 15-percent habitat, as compared to undisturbed or current conditions, to be a significant impact on that population or assemblage." This threshold for significant harm has been subsequently utilized and accepted by more than a dozen MFL peer review panels in the establishment of MFLs for springs and rivers (Munson and Delfino 2007, NWFWMD 2021, NWFWMD 2019, SJRWMD 2017, SRWMD 2005, SRWMD 2007, SRWMD 2013, SRWMD 2015, SRWMD 2016a, SRWMD 2016b, SRWMD 2021, SWFWMD 2008, SWFWMD 2010, SWFWMD 2011, SWFWMD 2012a. SWFWMD 2012b, SWFWMD 2017a, SWFWMD 2017b). The 15-percent threshold is also used in this assessment, recognizing that additional data collection and long-term research to confirm or refine this threshold for MFL assessments in Florida would be beneficial. The implementation of the MFL will follow an adaptive management approach, with MFLs periodically reviewed and reevaluated by the District to reflect new data and information as needed. As new data and information are developed regarding the definition of or threshold for significant harm, the District will consider this information in future MFL re-evaluations.

To establish minimum flows, a detailed understanding of the hydrology of the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group, and the Econfina Creek system is required to quantify effects of spring flow reduction scenarios. Models developed to assess changes in WRV metrics associated with reduced spring discharge include a Hydrologic Engineering Centers River Analysis System (HEC-RAS) model to simulate changes in river depth/inundation in response to changes in flow and a System for Environmental Flow Analysis (SEFA) model to evaluate in-stream habitat suitability for classes of species based on relationships among depth, substrate, and stream velocity. These tools are well-vetted and have been applied across a wide range of conditions and places to establish MFLs in Florida (NWFWMD 2021, NWFWMD 2019, SRWMD 2021, SRWMD 2016b).

1.4 Study Area

The study area for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group MFL evaluation encompasses the 11.8-mile portion of Econfina Creek between the Williford Spring Group and Deer Point Lake at the confluence of Econfina Creek and Bear Creek as well as all spring runs associated with these spring groups (Figure 1-1). The Gainer Spring Group is one of five first magnitude springs located within the District and is designated by the State of Florida as an Outstanding Florida Spring (OFS). Williford Spring Group and Sylvan Spring Group are second magnitude springs located on District-owned land within the Econfina Creek Water Management Area. The portion of Econfina Creek north of the Williford Spring run is not directly influenced by the three spring groups of interest and therefore was excluded from the study area. Likewise, the portion of Deer Point Lake below Bear Creek was excluded as the influence of spring flow on total Econfina Creek flow diminishes below CR 388 due to inputs from several surface water tributaries in the vicinity. Future MFL evaluations may consider portions of Econfina Creek above Williford Spring Group, including the remaining second magnitude springs along Econfina Creek.

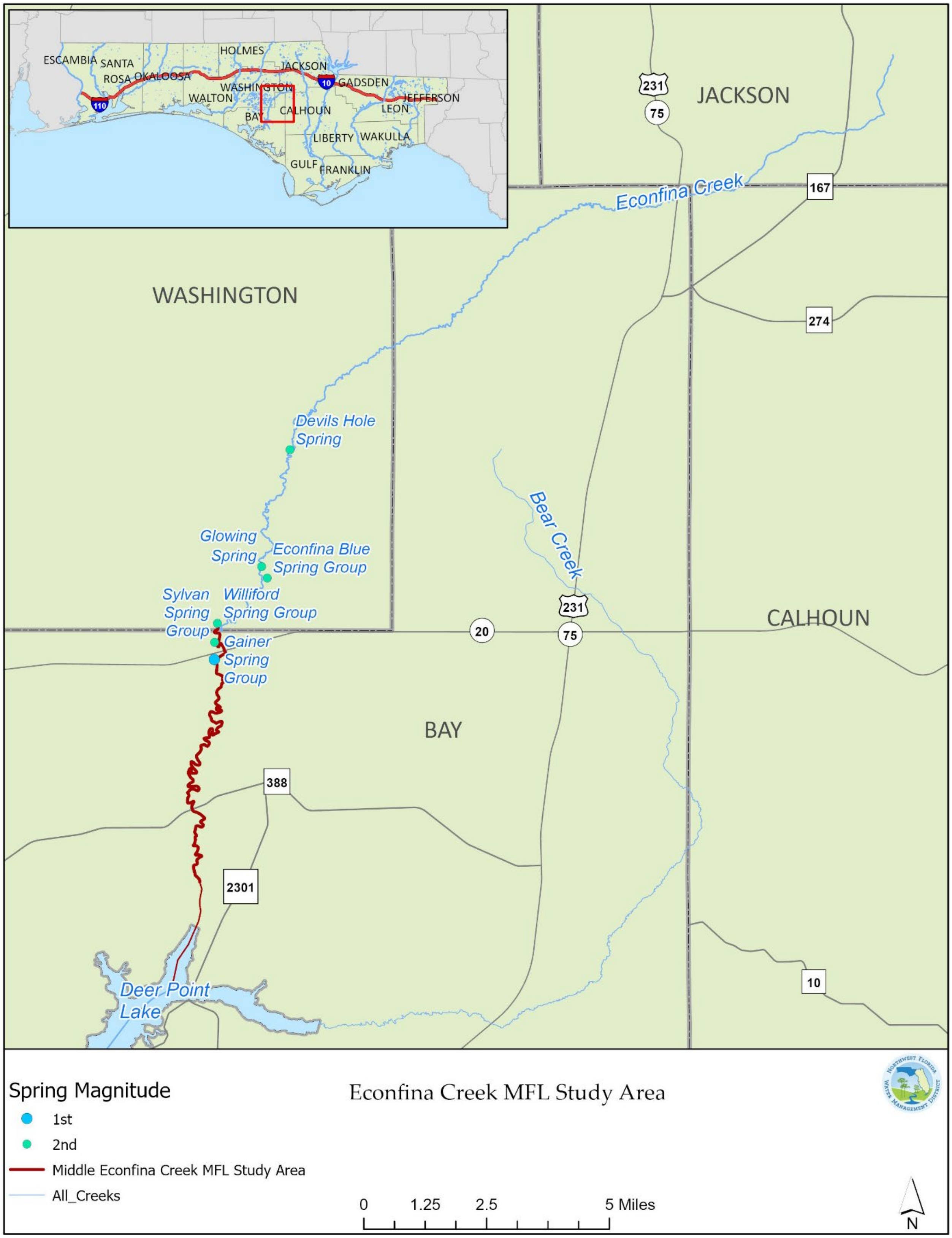


Figure 1-1. Middle Econfina Creek and Springs MFL Study Area

2 Econfina Creek and Watershed

This section presents a detailed physical description of middle Econfina Creek as well as Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group.

2.1 Econfina Creek and Watershed

The Econfina Creek watershed is approximately 188 square miles and is located in the central portion of the Florida Panhandle (Figure 2-1). The watershed lies primarily in Washington and Bay counties with smaller portions in Jackson and Calhoun counties. The Econfina Creek watershed is a sub basin within the Deer Point Lake watershed providing the majority of freshwater inflows to the Deer Point Lake Reservoir, which is the primary water supply for Bay County. Econfina Creek originates in southwestern Jackson County, deriving much of its flow in the upper portion of the creek from surface water runoff including flow from intermittent tributaries such as Buckhorn Creek and Sweetwater Creek in northern Bay County. In its upper reaches, Econfina Creek resembles blackwater creeks typical of the western Florida Panhandle defined by dark tea colored water from tannins released from decayed organic matter.

Econfina Creek continues southwest into eastern Washington County, where much of the inflow is derived from groundwater discharge due to the karst nature of the geology in the region (described further in Sections 2.3, and 2.4). In this area, the creek is incised into the Floridan aquifer, resulting in formation of numerous springs along the creek. Barrios and Chelette (2004) identified 11 springs or spring groups with more than 36 individual vents within the middle portion of Econfina Creek. These springs are concentrated in a relatively small portion of the creek, between the area 0.75 miles north of Walsingham Bridge to 0.5 miles south of SR 20. The largest spring group located along Econfina Creek is Gainer Spring Group, a first magnitude spring group consisting of at least 15 individual spring vents located just south of SR 20 as well as the Bay-Washington County line. In addition, five second magnitude springs or spring groups discharge to Econfina Creek, including Williford Spring Group and Sylvan Spring Group which are located just north of SR 20. (Barrios and Chelette 2004). Detailed descriptions of springs and spring groups along Econfina Creek are provided in Section 2.2.

Below the Gainer Spring Group, Econfina Creek is characterized by steep limestone outcrops and a meandering flow path. Further south approaching CR 388, limestone outcrops give way to more expansive wetlands and a wider channel. Several small intermittent surface water drainage features are present in the vicinity near CR 388, which contribute surface runoff during storm events.

For the most part, the Econfina Creek drainage basin lies within an area of excessively well-drained deep sandy soils (Richards 1997). Due to sandy soils in the region, baseflow derived primarily from spring discharge in the middle reaches of Econfina Creek accounts for the majority of flow in Econfina Creek under low- to moderate-flow conditions. Average estimated baseflow at USGS 2359500 Econfina Creek Nr Bennett (CR 388) is 445 cfs, which represents 83% of the long-term average flow of 536 cfs (10/1/1935-10/14/2023). Small intermittent streams, including Cat Creek and Moccasin Creek located north of CR 388, contribute surface water runoff during high-flow periods. Other inputs contributing to Econfina Creek flow may include diffuse groundwater inflow into the creek channel and seepage springs.

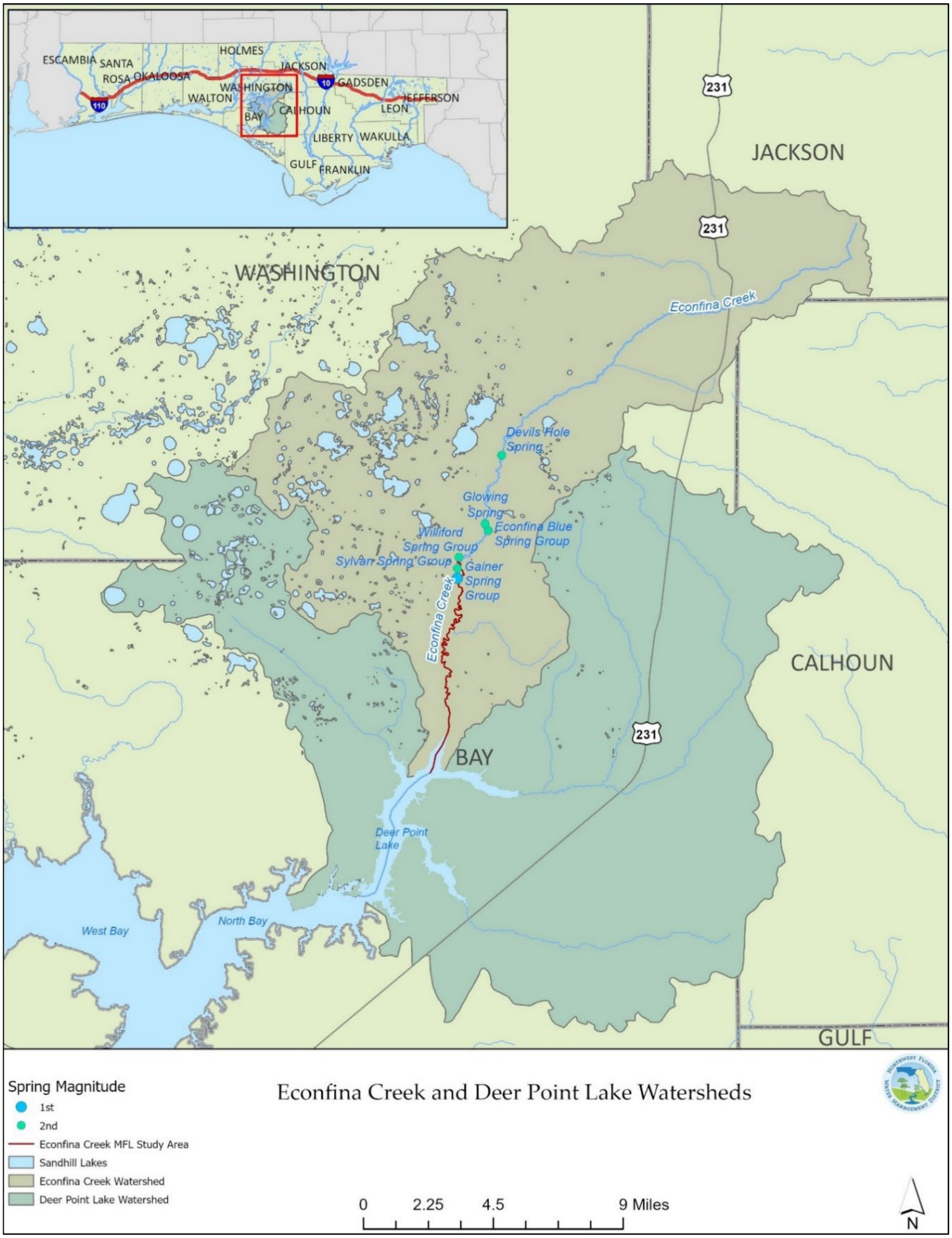


Figure 2-1. Econfina Creek and Deer Point Lake Watersheds

2.2 Econfina Creek Springs

Based on a springs inventory conducted by the District in 2004 (Barrios and Chelette 2004), a total of 11 springs or spring groups, comprised of more than 36 vents, were identified in the Econfina Creek basin (Figure 2-2). These springs are concentrated in the middle portion of Econfina Creek, approximately 0.75 miles north of Walsingham Bridge to 0.5 miles south of SR 20 (Barrios and Chelette 2004). Some springs, such as Deep Spring in Bay County were determined to be surficial aquifer discharge points instead of Floridan Aquifer springs and were not included in the inventory. Springs in the Econfina Creek basin include those with typical fissure-type vents as well as seepage springs which discharge laterally at or near the surface level of the creek.

The largest spring group located along Econfina Creek is Gainer Spring Group, a first magnitude spring group consisting of at least 15 individual spring vents located just south of SR 20 as well as the Bay-Washington County line. In addition, five second magnitude springs discharge to Econfina Creek, including Williford Spring Group and Sylvan Spring Group which are located just north of SR 20. (Barrios and Chelette 2004). These springs are described in detail in the following sections, based primarily on the springs inventory by Barrios and Chelette 2004, as well as a reconnaissance trip conducted by District staff on June 15, 2021.

Figure 2-2. Locations of Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group

2.2.1 Gainer Spring Group

The Gainer Spring Group is a first magnitude spring group consisting of at least 15 individual spring vents located just south of SR 20 as well as the Bay-Washington County line (Figure 2-3). Average period of record discharge for the Gainer Spring Group composite is 165 cfs. The Gainer Springs #1 run is located on the east side of Econfina Creek, entering the creek across from Gainer Spring #2 (Emerald Spring). The Gainer Springs #1 run consists of eight individual spring vents located within 0.29 miles from the confluence of Econfina Creek. Spring vents located along the Gainer Springs #1 run vary from small vents with no noticeable surface boil to larger vents up to 25 feet across with noticeable surface boils. The largest vent along the Gainer Springs #1 run is Gainer Spring #1C, known locally as McCormick Spring, located approximately 0.17 miles up the shallow spring run. This sizable, sandy vent is imbedded in the bottom of a pool approximately 25 feet wide (Figure 2-4a). A gentle surface boil is evident as observed by District staff on June 15, 2021, and multiple other occasions and there is a continual plume of sediment moving in the pool. Maximum depth measured in the vent is 11.5 feet.

The largest vent within the Gainer Spring Group, known as Emerald Spring locally and as Gainer Spring #2 officially, is a crevice at the base of a 25-foot limestone bluff on the west side of the creek (Figure 2-4b). This vent is approximately 0.4 miles south of the SR 20 bridge across from the Gainer Springs #1 run. The cove is approximately 30 feet in diameter with a maximum depth of approximately 12 feet. There is a strong continuous boil at this vent as observed by District staff on June 15, 2021, and multiple other occasions and a crevice in the limestone bluff to the north of the main vent which also discharges groundwater.

Gainer Spring #3 is located along a relatively wide spring run on the west side of the creek just above Gainer Spring #2 and the Gainer Spring #1 run (Figure 2-4c). The run turns north and parallels the creek for 400 feet. The spring pool is located at the head of the spring run, approximately 250 feet in diameter with a small, man-made beach to the north and a small island in the center. There are several vents opening in the bottom, near the edges of the pool. Several of the vents have a surface boil as observed by District staff on June 15, 2021, and multiple other occasions. The maximum depth measured in one of the vents is 11 feet. The vent is on private land and the spring is used for recreation.

Figure 2-3. Gainer Spring Group Vent Locations

A)

B)

C) 

Figure 2-4. Gainer Spring Group **A)** #1C (McCormick Spring) **B)** #2 (Emerald Spring) **C)** #3

2.2.2 Williford Spring Group

Williford Spring Group is located north of the SR 20 bridge, just north of the Bay/Washington county line, and is a popular recreation area (Figure 2-5, Figure 2-6). Average period of record discharge for Williford Spring Group is 42 cfs. Williford Spring Group's primary vent is a single large vent at the head of its run with a noticeable surface boil as observed by District staff on June 15, 2021, and multiple other occasions. Several smaller vents additionally contribute their discharge to the 450 ft spring run before it enters Econfina Creek. The primary spring vent emerges from beneath a submerged limestone ledge into a 40-foot diameter pool. Maximum depth measured at the vent is 12 feet, but the conduit extends further and downward. The District completed a $2.1 million restoration project for Williford Spring in 2015. In 2018, Hurricane Michael caused substantial damage to Williford Spring and the surrounding area, resulting in temporary closure of the District-owned recreation area at the spring. The recreation area has been reopened to the public, however efforts to repair damaged recreation structures and remove debris continue as of the time of this report's preparation.

Figure 2-5. Williford Spring Group Vent Locations

Figure 2-6. Williford Spring (Photo taken prior to impacts associated with Hurricane Michael on October 10, 2018).

2.2.3 Sylvan Spring Group

Sylvan Spring Group is located on the western side of Econfina Creek, north of the SR 20 bridge, just south of Williford Spring Group and is also a popular recreation area (Figure 2-7). Average period of record discharge for Sylvan Spring Group is 18 cfs. Sylvan Spring Group consists primarily of a collection of fissure type spring vents in three locations along its spring run. Groundwater discharges from Sylvan Spring #1 laterally from a series of fissures in the limestone bank and from several vents in the bottom of the pool (Figure 2-8). Three prominent surface boils are apparent in the 50-foot diameter pool. The pool lies at the head of a short 400-foot spring run. Maximum depth in the largest vent is 3.8 feet. Groundwater discharges from Sylvan Spring #2 laterally from a maze of fissures in a collapsed limestone outcrop and from a number of sand boils. The vents combine in a 30-foot diameter pool before flowing 800 feet to converge with the Sylvan main run. Maximum depth in the pool is 0.6 foot. Groundwater discharges from Sylvan Spring #3 laterally from two vents beneath a 20-foot limestone bank. The discharge flows into a pool approximately 15 feet across. The spring run from this set of vents flows into the Sylvan Spring #1 pool. Maximum depth in the pool is 1.3 feet.

Figure 2-7. Sylvan Spring Group Vent Locations

Figure 2-8. Sylvan #1

2.3 Physiography

The primary groundwater contribution area for the Middle Econfina Creek and associated springs encompasses mapproximately 118,000 acres within southern Washington and northern Bay counties (Figure 2-9). This contributing area was developed as part of the Econfina Creek Spring Inventory Study (Barrios and Chelette, July 2004) and was based on the August 1996 potentiometric surface map of the Upper Floridan aquifer that was developed using groundwater level measurements from more than 130 wells (Richards, 1997). The area was delineated by drawing bounding groundwater flow lines that originate on Econfina Creek at the upstream and downstream limits of the reach containing the springs and directed upgradient, perpendicular to the potentiometric surface contour lines.

This groundwater contribution area to the middle reach of Econfina Creek that includes the Gainer-Sylvan-Williford group of springs occurs within two, broad geomorphic areas: the Dougherty Karst Plain District and the Apalachicola Delta Geomorphic District (Rupert and Means, 2009). The Dougherty Karst Plain District extends northwestward into Jackson County, Florida and southwestern Georgia, and is described by Rupert and Means (2009) as "... comprised of a flat-to-gently-rolling, southwestward sloping plain generally characterized by karst terrain." The western and central parts of the Middle Econfina Creek groundwater contributing area (MEC GWCA) occurs within the southern part of the Vernon Karst Hills Province of the Dougherty Karst Plain Geomorphic District (Rupert and Means, 2009). This area is also known locally as the Sand Hill Lakes area (Richards, 1997) and has a generally flat, karst topography with numerous sinks, closed topographic depressions, and few streams. Of particular note are the numerous sinkhole lakes that occur in the area and sinks that are deeper and steeper-sided than other parts of Washington County (Rupert and Means, 2009). These sinks and sinkhole lakes coincide with the (sometimes coalescing) circular, closed depression features in the area west of Econfina Creek and within the groundwater contributing area to the middle reach of Econfina Creek that contains the Gainer, Sylvan, and Williford springs groups, as shown in Figure 2-9.

Rupert and Means (2009) described the area east of the Econfina Creek and Gainer-Williford-Silvan Springs complex as being part of the High-Level Deltas and River Terraces province of the Apalachicola Delta Geomorphic District, and described this area as being "… generally characterized by a well-drained, gently rolling topography" with local hills formed by deltaic deposits from the Citronelle Formation.

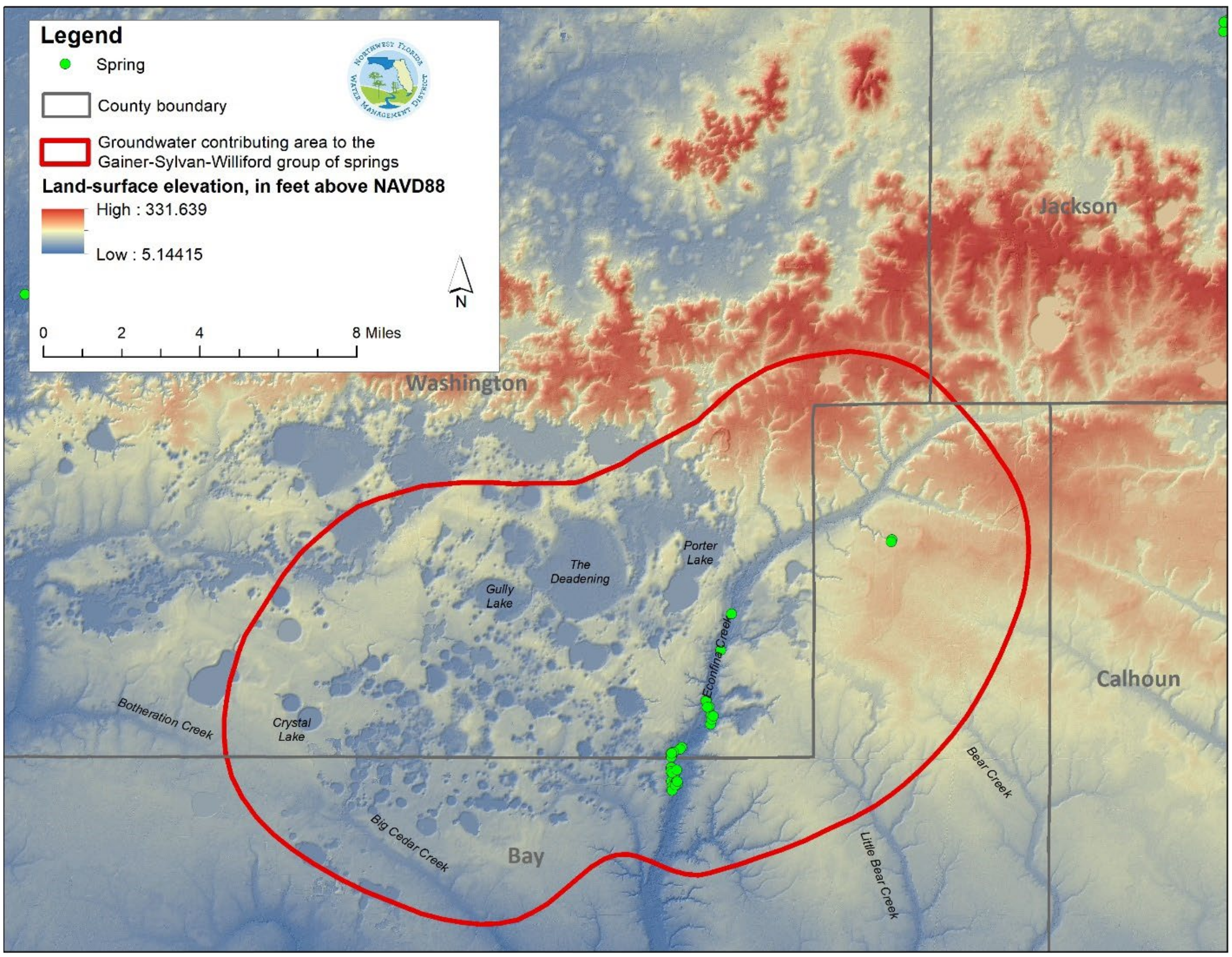


Figure 2-9. Land Surface Elevations Within and Adjacent to the Groundwater Contributing Area to the Middle Reach of Econfina Creek and Associated Springs.

2.4 Hydrogeology

The karst topography, closed surface-water drainage basins, and sandy soils in the Sand Hill Lakes part of the contributing area enhance the potential for groundwater recharge, which directly contributes to the spring discharge to Econfina Creek (Richards, 1997). The sandy soils and high recharge rates of the Sand Hill Lakes area also make it highly susceptible to potential surface contamination if not properly protected.

The hydrogeologic units underlying the study area consist of a thick sequence of rocks that constitute the Floridan aquifer system and overlying unconsolidated sediments that constitute (in order of decreasing depth) the upper confining unit of the Floridan aquifer system and the surficial aquifer system. The hydrogeology of the Floridan aquifer system and overlying hydrogeologic units in the study area have been described and mapped in studies by the U.S. Geological Survey (see, for example, Williams and Kunianski, 2016; Miller, 1986), Florida Geological Survey (Campbell, 1993a and 1993b; Rupert and Means, 2009; Schmidt and Wiggs Clark, 1980), and the District (Richards, 1997; Pratt and others, 1996), among others. This section provides a brief description of more detailed information that can be found in these references.

The surficial aquifer system extends from land surface to the top of the upper confining unit of the Floridan aquifer system and generally consists of sediments of the Citronelle Formation and Pliocene-age portion of the Alum Bluff Group. These sediments can be quite permeable in the Sand Hill Lakes area, where the soils and shallow subsurface consist of excessively-well drained sands. The surficial aquifer system is an unconfined 'water-table' aquifer and is present wherever the depth and permeability of the system are capable of delivering usable quantities of water, although it is not a primary source of water in the study area. The thickness of the surficial aquifer system is generally less than 100 feet thick but ranges in thickness from approximately 0 to 220 feet and thins in a southwest-to-northeast trending direction in the study area (Figure 2-10) based on data published by Williams and Dixon (2015).

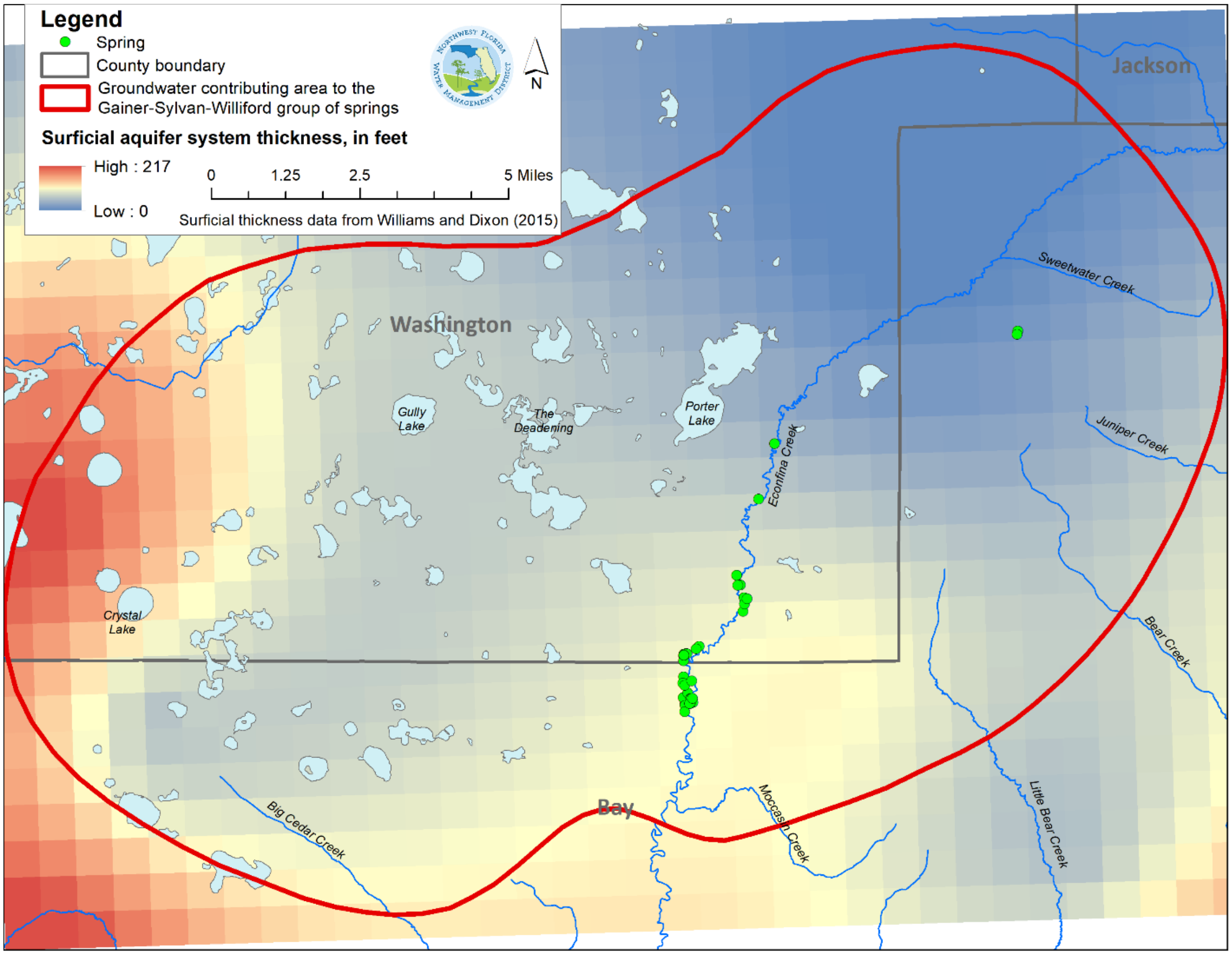


Figure 2-10. Estimated Thickness of The Surficial Aquifer System in the Vicinity of the Contributing Area to The Middle Reach of Econfina Creek and Associated Springs, Based on Data from Williams and Dixon (2015)

As implied by its name, the upper confining unit of the Floridan aquifer system is generally defined by lower-permeability sediments that limit the vertical movement of groundwater to or from the underlying Floridan aquifer system. In Florida, the upper confining unit is typically referred to as the intermediate confining unit/aquifer system. In the study area, this unit consists of clays as noted by Musgrove and others (1965), this confining unit is present throughout the Econfina Creek basin "… except where it has been breached by a collapse into solution chambers or by erosion along Econfina Creek." The thickness of the upper confining unit ranges from about 0 to 220 feet within and adjacent to the groundwater contributing area to the middle reach of Econfina Creek and associated springs (Figure 2-11).

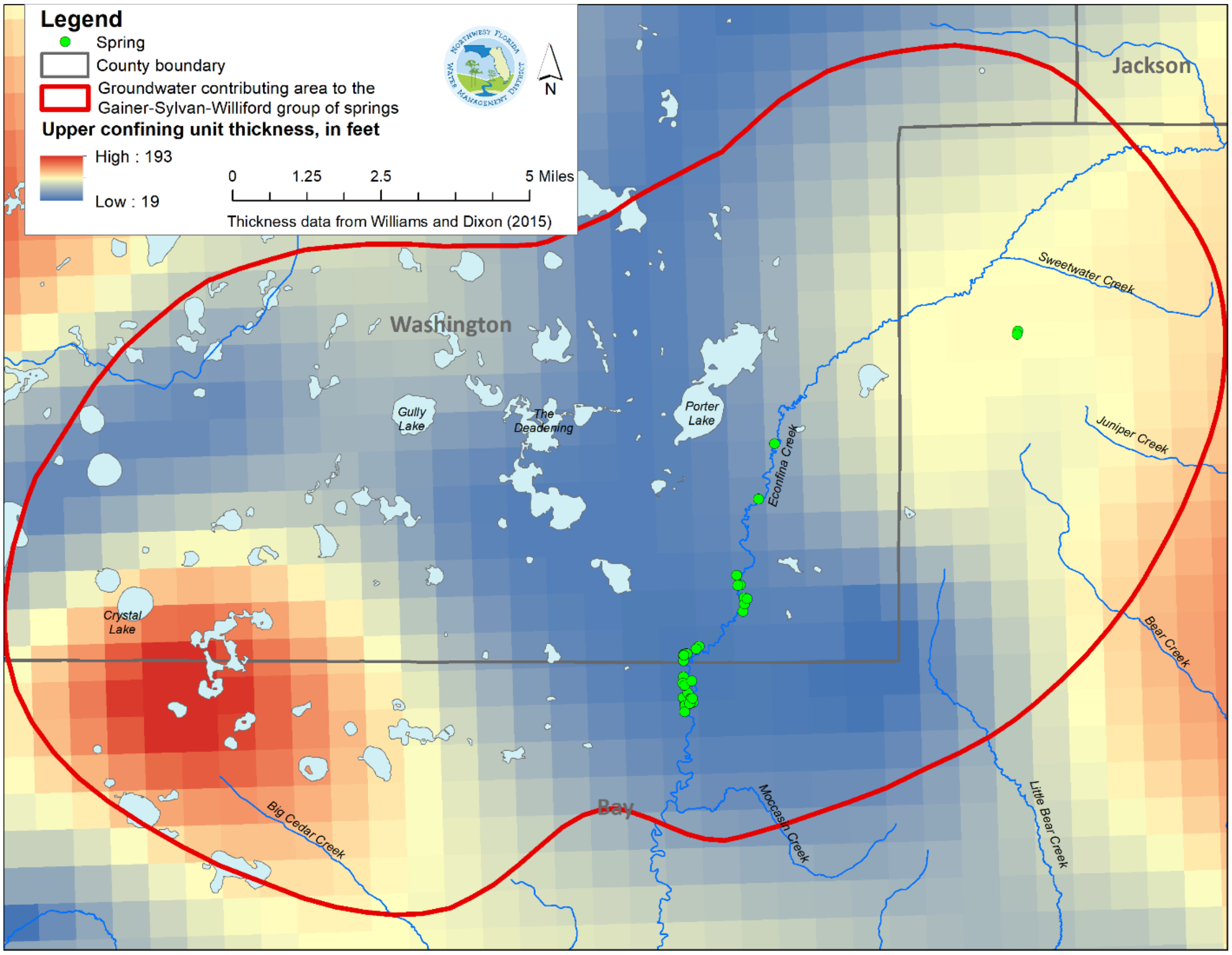


Figure 2-11. Estimated Thickness of the Upper Confining Unit of the Floridan Aquifer System in the Vicinity of the Contributing Area to the Middle Reach of Econfina Creek and Associated Springs, Based on Data From Williams And Dixon (2015)

The Floridan aquifer system is a thick sequence of permeable carbonate (limestone and dolostone) rocks that underly Florida and parts of Alabama, Georgia, and South Carolina. This aquifer system is highly productive and is the principal water supply for much of the area where it occurs. In many areas the Floridan aquifer system is separated into an Upper and Lower Floridan aquifer by one or more lower permeability zones. Within the study area, the Upper Floridan aquifer is the primary source of drinking water, affects the levels in many of the area lakes, and sustains the flow of Econfina Creek through concentrated groundwater discharge to springs like Gainer, Sylvan, and Williford spring groups, as well as through more diffuse groundwater discharge to the creek. The thickness of the Upper Floridan aquifer ranges from about 170 to 360 feet in and adjacent to the groundwater contributing area to the Gainer, Sylvan, and Williford springs groups (Figure 2-12).

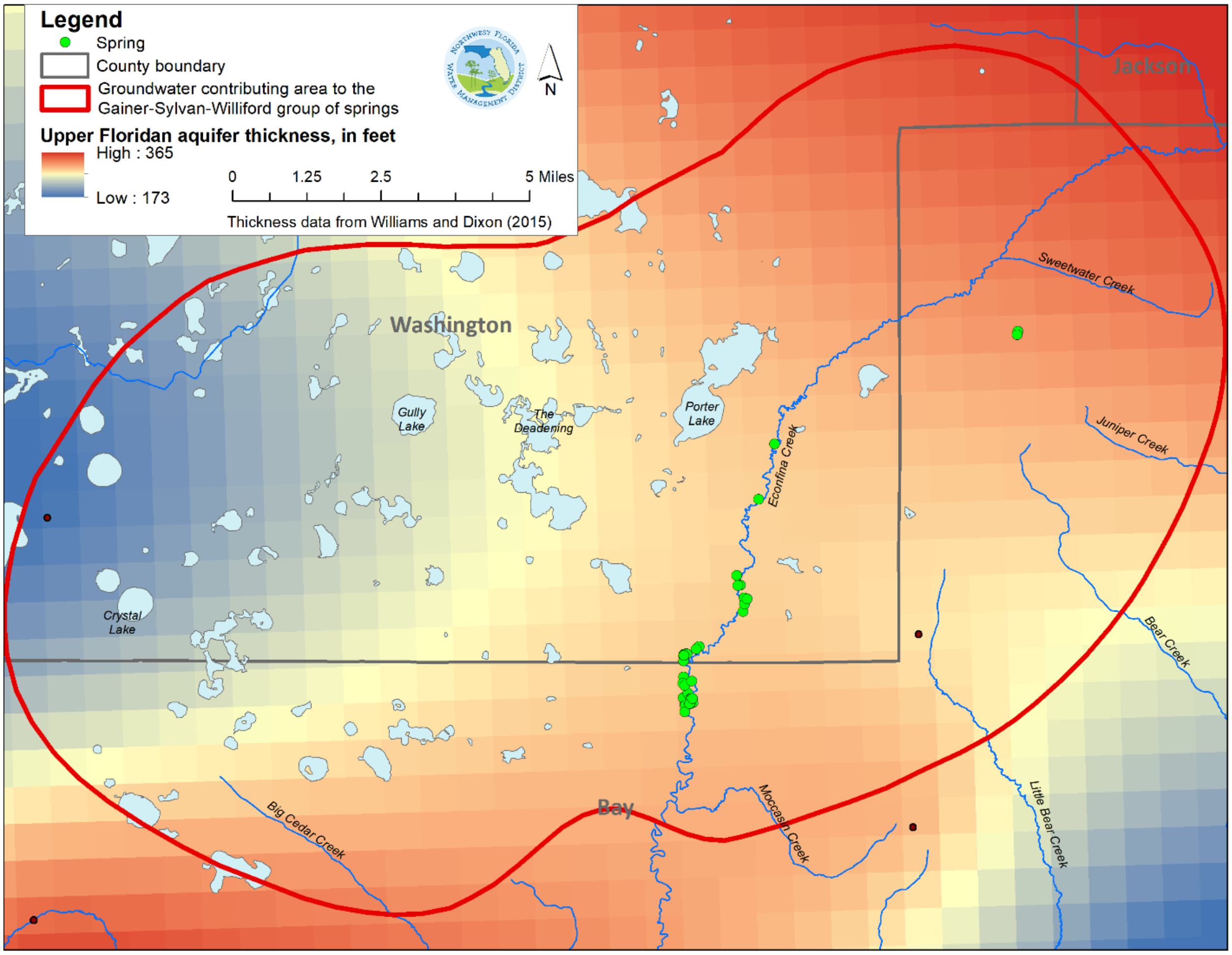


Figure 2-12. Estimated Thickness of the Upper Floridan Aquifer in the Vicinity of the Contributing Area to the Gainer-Sylvan-Williford Group of Springs, Based on Data from Williams and Dixon (2015)

2.5 Land Use, Population and Structural Alterations

The population residing within Bay and Washington counties was 195,339 and 26,094 individuals respectively as of 2020 (NWFWMD 2023). However, most of the population in the area resides in coastal Bay County including Panama City, which is located outside the Econfina Creek watershed. The population of Bay County is expected to increase to 232,512 by 2045, although much of the anticipated growth in the area is located along the coast, outside the Econfina Creek watershed. The population of Washington County is expected to remain relatively stable, with a projected 2045 population of 28,943. Based on 2020 U.S. Census block data provided by the U.S. Department of Commerce Census Bureau, the population within the middle Econfina Creek groundwater contribution area was 10,041 as of 2020, which is approximately 4.5% of total 2020 population within Bay and Washington counties (U.S Census Bureau 2022).

Land uses within the Econfina Creek watershed are predominantly natural areas (86.93 percent) including upland forest (56.39 percent), wetlands (20.45 percent), open land (5.80 percent), and open water (4.29 percent) (Table 2-1, Figure 2-13). Agriculture (7.23 percent) and developed areas (5.84 percent) represent a relatively small portion of land use within the watershed. To protect Econfina Creek and its contribution zone, the District has acquired and currently manages 41,747 acres of public lands in the Econfina Creek Water Management Area, which accounts for approximately 40% of the watershed area (Figure 2-14). This acreage total includes the Sand Hill Lakes Mitigation Bank, also known as the Fitzhugh Carter Tract.

The most significant structural alteration to Econfina Creek is the Deer Point Lake Reservoir, located at the southern terminus of Econfina Creek and Deer Point Lake. (Deer Point Lake Reservoir is described in more detail in Section 2.5.1). Other structural alterations include bridge crossings located at Scott Rd., Walsingham Bridge Rd., SR 20, and CR 388. Bridges located at SR 20 and CR 388 were represented in the HEC-RAS model, described in Chapter 5. Backwater effects from the Deer Point Lake Reservoir were considered as part of this MFL evaluation, described in more detail in Section 2.5.1.

Additionally, the extensive woody debris removal conducted by the Florida Department of Environmental Protection (DEP) following Hurricane Michael likely altered the instream channel substrate and woody habitat in many areas (Section 2.8). Since these efforts were completed, additional woody debris has begun being deposited within the Econfina Creek channel restoring the system to a more natural condition.

Table 2-1. Econfina Creek Watershed Land Use

Land Use Category*	Total Area (mi^2)	Percent Watershed Area (%)
Agriculture	11.77	7.23
Developed	9.51	5.84
Open Land	9.44	5.80
Upland Forest	91.83	56.39
Open Water	6.99	4.29
Wetlands	33.30	20.45
Total	**162.83**	**100**

*Based on 2019 land use data for NWFWMD (FDEP 2019)

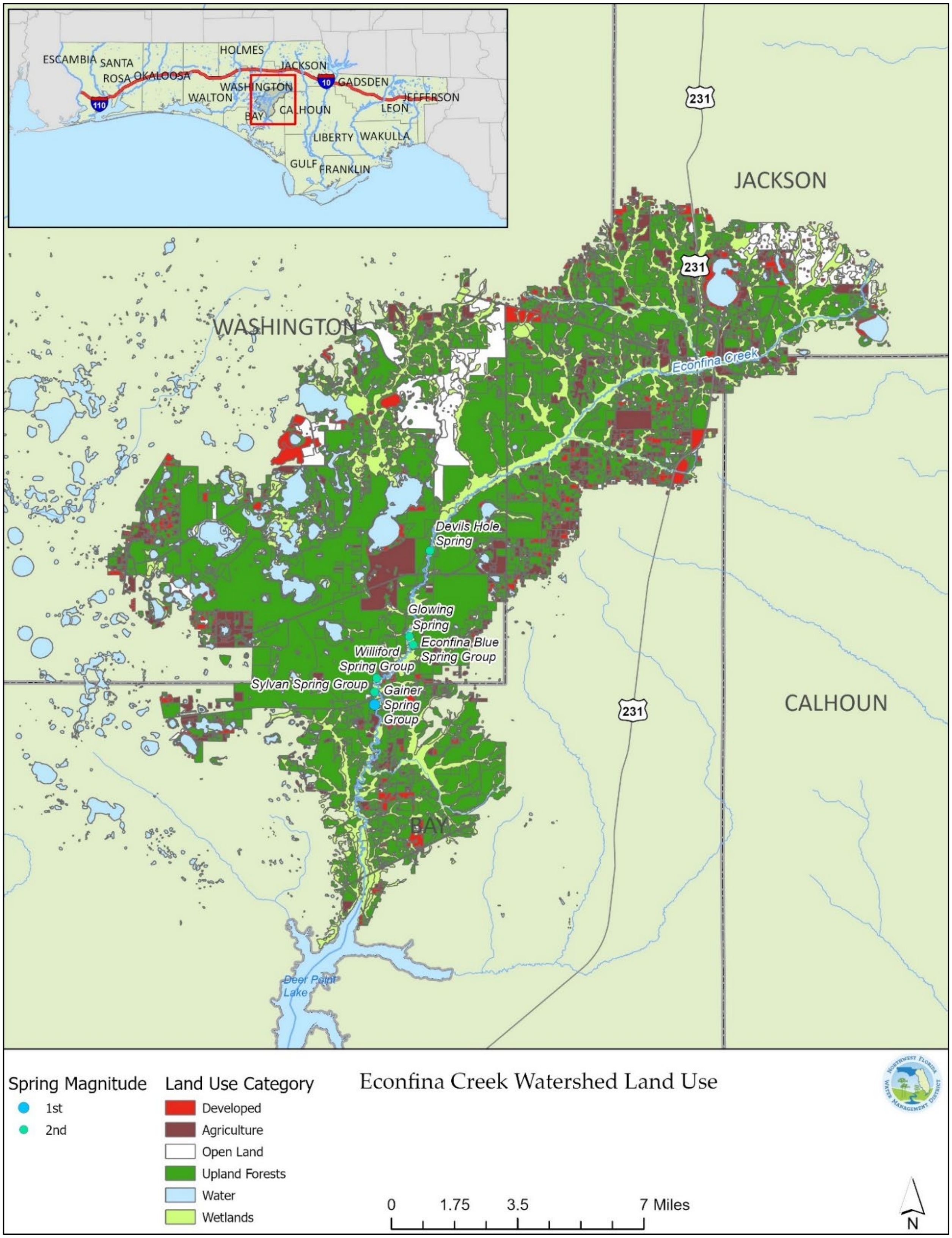


Figure 2-13. Econfina Creek Watershed Land Use (2019 Land Use Data, DEP 2019)

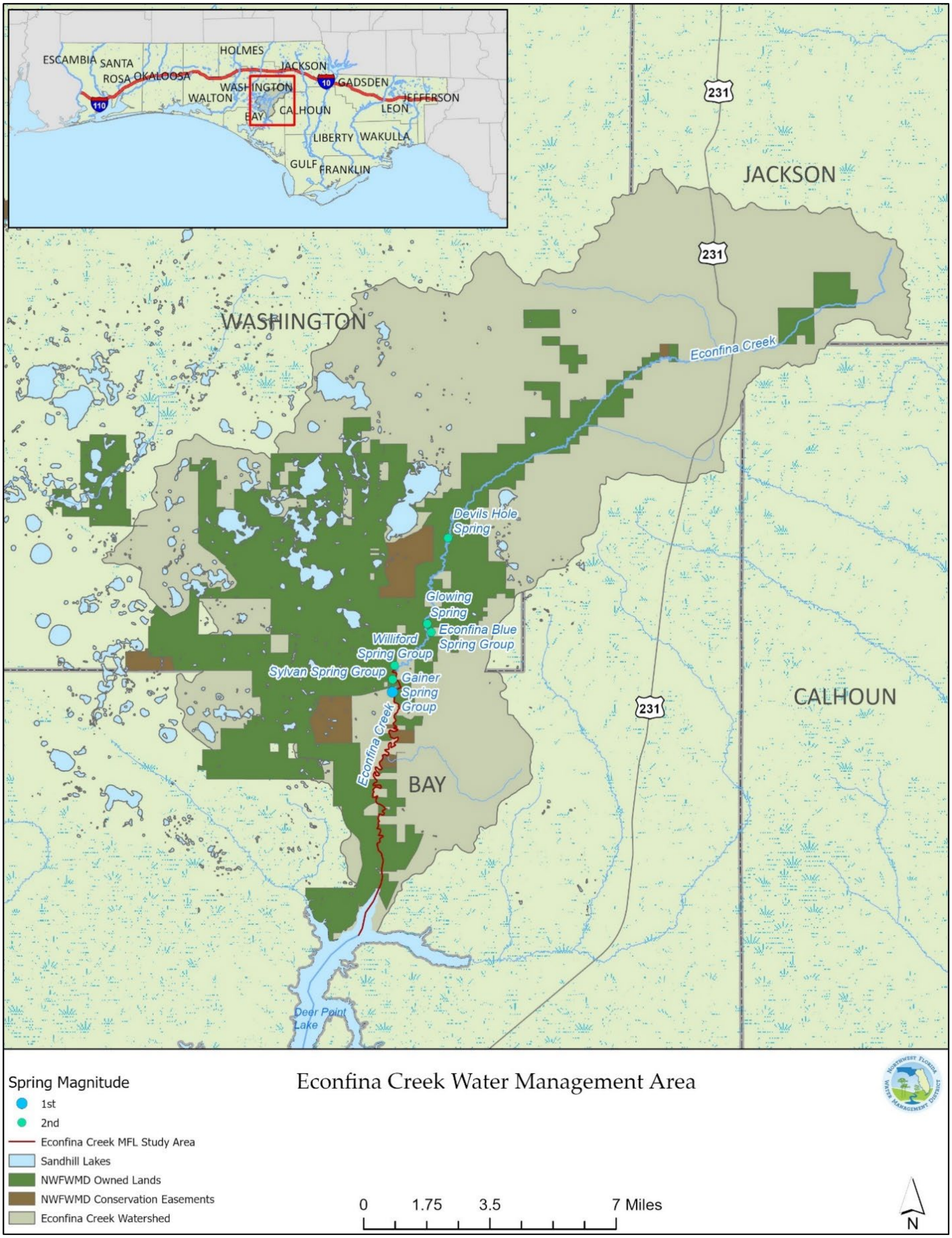


Figure 2-14. Econfina Creek Water Management Area

2.5.1 Deer Point Lake Reservoir

Deer Point Lake Reservoir is a 5,000-acre impoundment located seven miles north of Panama City in the upper reach of North Bay and is the major source of potable water for Bay County. The reservoir was created in 1961 through construction of a dam across North Bay at Deer Point (NWFWMD 2017). When the dam was constructed, saltwater which naturally occurred in the upper reaches of North Bay was flushed out of the system forming the water supply reservoir and Deer Point Lake. The reservoir receives freshwater flow from Econfina, Bear, and Cedar creeks and Bayou George and discharges water to North Bay. On average, Deer Point Dam discharges approximately 800 cfs (517 mgd), to North Bay (Crowe et al. 2008).

An agreement was established in 1991 between NWFWMD and the Board of County Commissioners of Bay County to set the average and maximum withdrawals of fresh water from the Deer Point Reservoir. The agreement specifies the daily average withdrawal is not to exceed 69.5 mgd and a daily maximum of 82 mgd through 2010. In an extension of the agreement to 2040, the daily average withdrawal is not to exceed 98 mgd, with a maximum daily withdrawal of 107 mgd. The original pump station and intake for Bay County was located at the southern end of Deer Point Lake near the dam. In 2015, construction of an alternative intake, located in the northern end of Deer Point Lake near the terminus of Econfina Creek, was completed to address concerns of the potential for saltwater intrusion from dam overtopping during hurricanes. The surface water intake system and transmission pipeline has a capacity to deliver approximately 30 mgd of raw water to the Bay County Water Treatment Plant.

The water surface elevation of Deer Point Lake is controlled by the Bay County Water Division and was typically held constant between 4.8 and 5.0 ft., NAVD88 prior to July 2015 (Figure 2-15). Since August 2015, lake levels have remained between 4.4 and 4.6 ft., with only brief excursions below or above that range. Bay County commonly drops the lake several feet every winter to facilitate clearing of near-shore submerged vegetation by exposing it to freezing temperatures. Aside from the controlled drawdown events, Deer Point Lake elevation remains relatively constant.

Lake levels from District station 8544 (Deer Point Lake Near Dam) were compared with Econfina Creek stage at USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388), located several miles upstream of Deer Point Lake to determine the extent of backwater effects (Figure 2-15). Visual examination of Figure 2-15 suggests no noticeable effect of lake level fluctuations on stage at Econfina Creek @ CR 388. This lack of effect is particularly noticeable during scheduled lake winter drawdowns where lake levels drop by several feet for several months while stages along Econfina Creek remain stable. This suggests that Econfina Creek stages at CR 388 are controlled predominantly by flow inputs upstream rather than backwater effects caused by Deer Point Lake Reservoir.

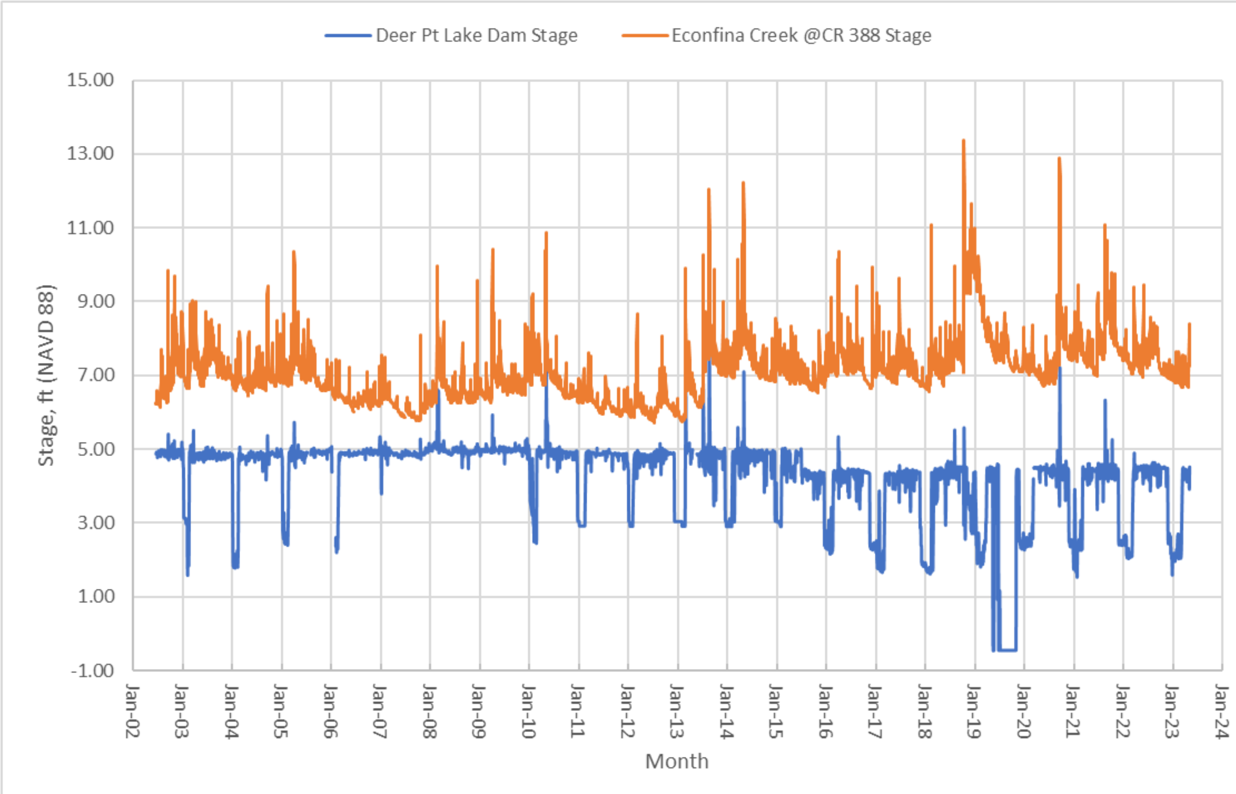


Figure 2-15. Comparison of Deer Point Lake levels with Econfina Creek Stage

2.6 Precipitation

Annual precipitation averaged 59.1 inches at National Weather Service (NWS) station USC00086842 located in Panama City, FL, between 1914 and 2023. Precipitation data from NWS station USW00073805 located at the Northwest Florida Beaches International Airport was utilized for September 2023-December 2023 since data at USC00086842 was unavailable for these months. During the period from 1914-2023, annual precipitation ranged between 35 inches (1968) and 87 inches (2013) (Figure 2-16). Precipitation displays bimodal seasonality with highest mean monthly precipitation occurring during the summer months of July and August (7.8-8.0 inches), along with a smaller peak during March (5.1 inches) (Figure 2-17). Monthly mean precipitation minimums were observed during the months of May (3.1 inches) and October (3.3 inches).

In addition to short-term fluctuations among and within years, the Atlantic Multidecadal Oscillation (AMO) is long-term fluctuation in sea surface temperature that has direct effects on long-term precipitation and temperature patterns in north Florida (NOAA 2020). Northwest Florida tends to receive less rainfall during warm periods and more rainfall during relatively cold periods. Since the mid-1990s the Atlantic has been in a warm period.

To assess periods of above and below average rainfall, the 12-month standard precipitation index (SPI) was computed for the NWS Station USC00086842 located in Panama City, FL and NWS station USW00073805 located at the Northwest Florida Beaches International Airport (Sept 2023-Dec 2023) (Figure 2-18) using the SPI generator available from the National Drought Mitigation Center Standardized

Precipitation Index | National Drought Mitigation Center (unl.edu). The purpose of this analysis was to characterize periods of drought vs. rainfall surplus in the study area for context in this MFL evaluation. Over long periods of time, the SPI index can be related to groundwater storage in the region, affecting potential baseflow to Econfina Creek and its spring groups. The SPI is calculated from the historical precipitation record, where precipitation accumulation over a specified period of time is compared to that same period of time throughout the historical record at that location. Positive SPI values represent wet conditions; the higher the SPI, the wetter the hydrologic conditions. Negative SPI values represent dry conditions; the lower the SPI, the more unusually dry a period is. A 12-month SPI was utilized to evaluate decadal climatic trends.

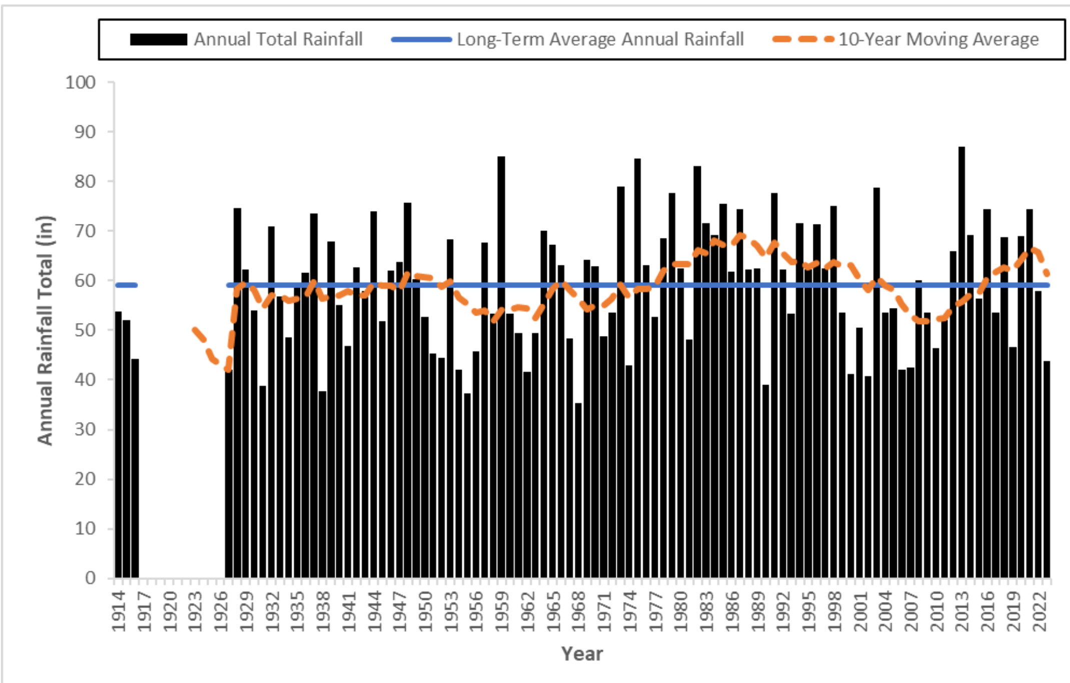


Figure 2-16. Annual Precipitation Totals and Long-Term Annual Average Precipitation for NWS Station USC00086842 Located in Panama City, FL and NWS station USW00073805 Located at the Northwest Florida Beaches International Airport (September 2023 - December 2023)

Figure 2-18 illustrates a period of less precipitation from 1927 to the early 1960's coinciding with a warm AMO, followed by a period of higher precipitation to 1998 coinciding with a cool AMO and again a period of lower precipitation from 1998 through 2013 coinciding with the recent warm AMO. The period of record extending from 1998 through 2013 had only two years with precipitation totals exceeding 59.1 inches at the NWS Panama City station. The 10-year moving average annual precipitation totals show that precipitation has been below the long-term average for much of the 2000s decade. (Figure 2-16). This indicates the area was in a precipitation deficit for an extended period possibly associated with the AMO cycle. However, several years of above average rainfall occurred from 2013-2021 including record rainfall of 87 inches in 2013, resulting in a period of rainfall surplus based on the 10-year moving average rainfall. Recently, 2021 was a wet year with 74.4 inches total, including 20 inches in August 2021 in part due to Tropical Storm Fred.

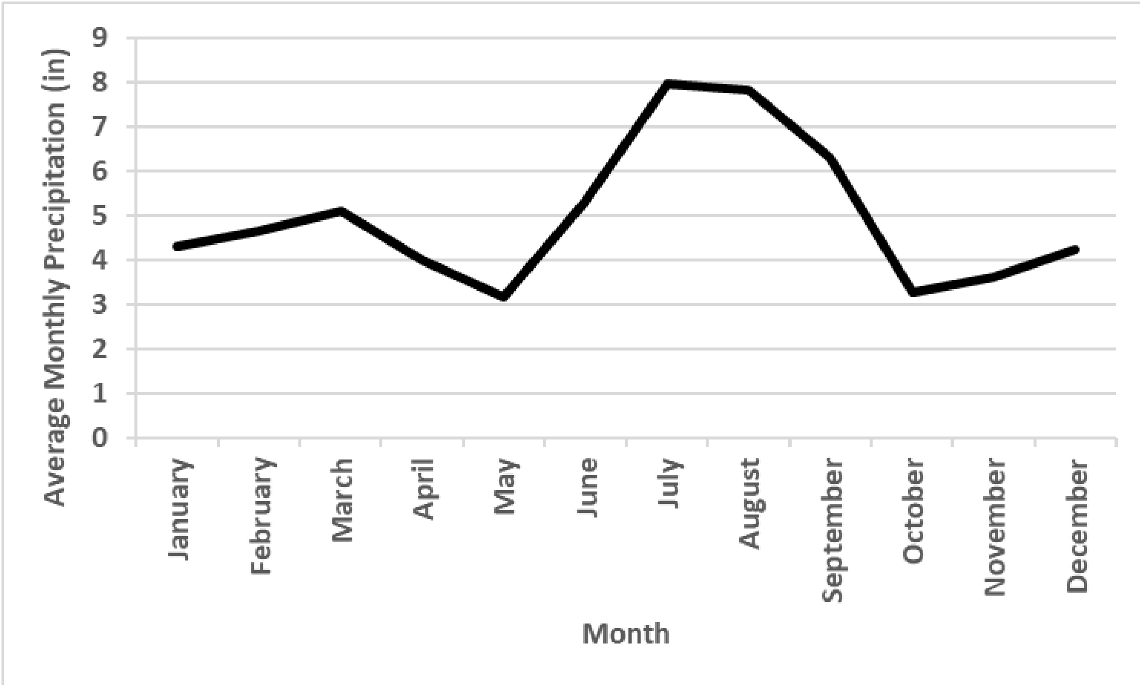


Figure 2-17. Monthly Precipitation Averages for NWS Station USC00086842 Located in Panama City, FL and NWS station USW00073805 located at the Northwest Florida Beaches International Airport (September 2023 - December 2023)

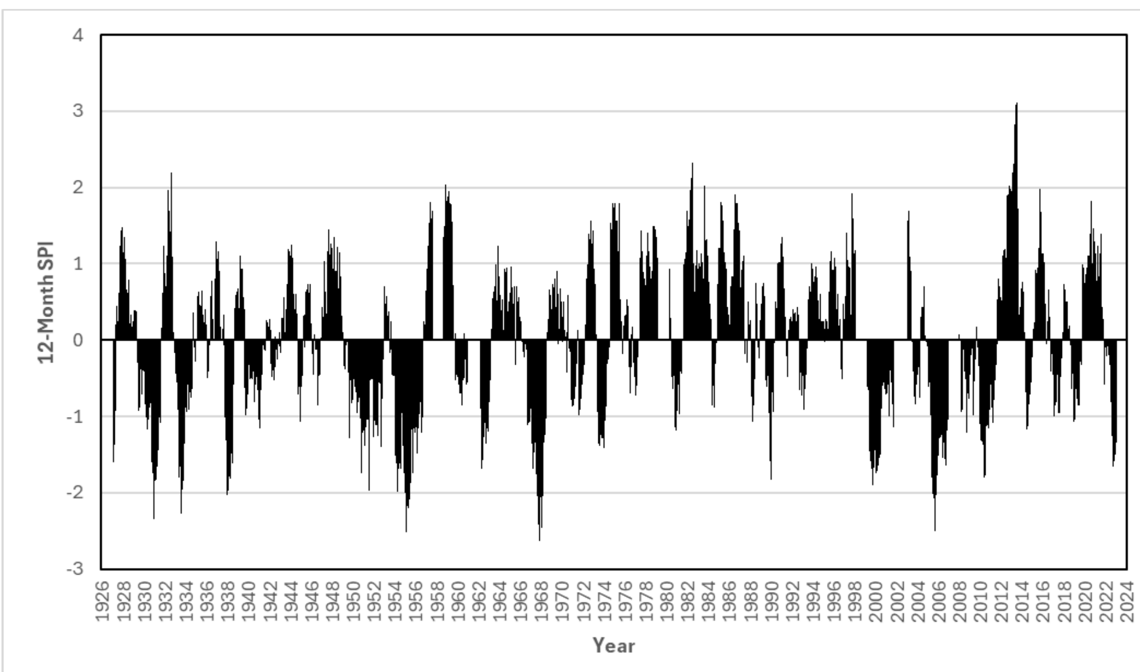


Figure 2-18. Twelve Month Standard Precipitation Index for NWS Station USC00086842 Located in Panama City, FL and NWS station USW00073805 Located at the Northwest Florida Beaches International Airport (September 2023 - December 2023)

2.7 Water Quality

The Econfina Creek watershed is largely undeveloped with little projected growth through 2045. Additionally, the District manages the Econfina Creek Water Management Area protecting most of the recharge area to the Econfina Creek and springs including the Sand Hill Lakes area. Otherwise, in this region, silvicultural activities, landscape erosion, and unpaved roads contribute to nonpoint source pollution within the watershed (NWFWMD 2017).

Water quality data has been collected for Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group as a collaborative effort by the District, DEP, and USGS over the past several decades. Quarterly lab-processed grab samples have been collected for Gainer Spring Group since 2001, with periodic samples taken prior to 2001. Samples are taken at one or more individual vents, with the majority of samples being taken at either Gainer Spring #1C (McCormick Spring) or Gainer Spring #2 (Emerald Spring). Water quality data presented in this report for Gainer Spring Group represent the composite spring group utilizing all available measurements for all vents to represent Gainer Spring Group water quality. Measurements recorded on the same day were averaged to determine the Gainer Spring Group composite daily average value. Periodic grab samples have been collected at Williford Spring Group, with the majority of measurements occurring between 2011 and 2023. Few sporadic water quality samples are available for Sylvan Spring Group. No continuous data loggers have been implemented to collect water quality data for Econfina Creek or its springs. Tables 2-2, 2-3, and 2-4 summarize water quality measurements taken at the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group. Time series plots of nitrate concentration, specific conductance, and dissolved oxygen for Gainer Spring Group and Williford Spring Group are presented in Figures 2-19 and 2-20. Average nitrite + nitrate concentration for Gainer Spring Group (0.20 mg/L) and Williford Spring (0.08 mg/L) are well below the numeric nutrient standard of 0.35 mg/L for Florida Springs (Rule 62- 302.531 Florida Administrative Code).

Table 2-2. Gainer Spring Group Water Quality Summary Statistics

Parameter	Period of Record	Number of measurement dates	Minimum	Maximum	Average	Median
Nitrate + Nitrite (Total as N)*	1962, 1972, 1985, 2001 - 2023	97	0.01 mg/L	0.25 mg/L	0.20 mg/L	0.20 mg/L
Specific Conductivity*	1962, 1972, 1985, 2001 - 2024	104	86 µS/cm	166 µS/cm	136 µS/cm	133 µS/cm
Dissolved Oxygen*	1972, 1985, 2001 - 2023	99	0.71 mg/L	4.37 mg/L	1.71 mg/L	1.74 mg/L

*Data collected by the NWFWMD Florida DEP, and USGS. Data is available from NWFWMD databases, DEP WIN, and Storet. Values represent average for all spring vents.

Table 2-3. Williford Spring Water Quality Summary Statistics

Parameter	Date Range	Number of measurement dates	Minimum	Maximum	Period of Record Avg	Median
Nitrate + Nitrite (Total as N)*	1972, 1994, 2002, 2009 - 2023	50	0.04 mg/L	0.16 mg/L	0.08 mg/L	0.08 mg/L
Specific Conductivity*	1962, 1972, 1994, 2002 - 2023	40	82 µS/cm	150 µS/cm	135 µS/cm	137 µS/cm
Dissolved Oxygen*	1972, 1994, 2002 - 2023	37	0.21 mg/L	2.90 mg/L	0.75 mg/L	0.65 mg/L

*Data collected by the NWFWMD Florida DEP, and USGS. Data is available from NWFWMD databases, DEP WIN, and Storet.

Table 2-4. Sylvan Spring Water Quality Summary Statistics

Parameter	Date Range	Number of measurement dates	Minimum	Maximum	Period of Record Avg	Median
Nitrate + Nitrite (Total as N)*	2009	1	-	-	0.20 mg/L	-
Specific Conductivity*	2003, 2009	3	127 µS/cm	132 µS/cm	129 µS/cm	128 µS/cm
Dissolved Oxygen*	2003, 2009	3	1.40 mg/L	2.31 mg/L	1.80 mg/L	1.70 mg/L

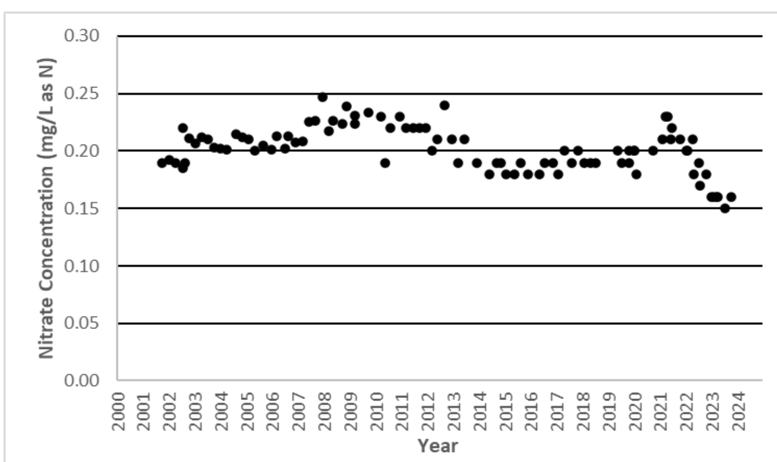
* Data collected by the NWFWMD Florida DEP, and USGS. Data is available from NWFWMD databases, DEP WIN, and Storet.

Temporal trends in Gainer Spring Group nitrate concentration (nitrate + nitrite total mg/L as N), specific conductance (µs/cm), and dissolved oxygen (mg/l) were evaluated to assess long-term increases or decreases with time (Figure 2-19, Table 2-5). Insufficient data was available for Williford (Figure 2-20) and Sylvan Spring to assess water quality trends for these springs. Although more than 30 samples were collected for each water quality parameter for Williford these samples were mostly within the last few years and within a few years in the mid-2010s making trend testing undesirable. Trends were assessed using a two-sided Mann-Kendall test with a significance level (α) of 0.05, based on methods presented in Helsel et al. 2020. Flow adjustments were considered for Gainer Spring Group but were not needed as these parameters did not display a relationship with Gainer Spring Group composite flow (Figure 2-21). Insufficient data was available for Williford and Sylvan Spring to assess relationships between flow and water quality parameters for these springs. Trends were evaluated from 2001–2023 for Gainer Spring Group due to sporadic measurements prior to 2001. Trend tests were based on annual median values to reduce the effect of serial correlation.

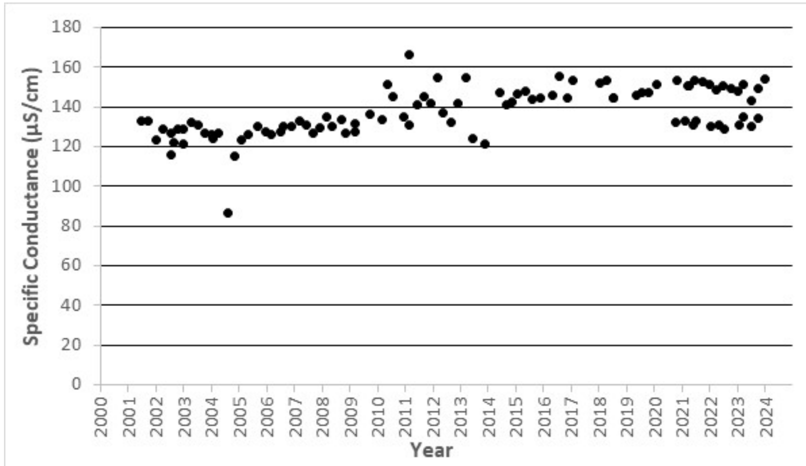
Based on the results in Table 2-5, Gainer Spring Group nitrate concentration displayed no statistically significant trend from 2001-2023. However, specific conductance displayed an increasing trend while dissolved oxygen displayed a decreasing trend from 2001-2023. Although specific conductance displayed an increasing trend, values are still well below thresholds which would cause concern to freshwater ecology for the Gainer Spring Group. Low dissolved oxygen within freshwater spring systems in Florida such as Gainer Spring Group is typical and is not of concern. Furthermore, all parameters displayed no trend with Gainer Spring Group discharge, indicating potential reductions in flow caused from groundwater withdrawals would likely not significantly affect water quality for the Gainer Spring Group and Econfina Creek (Figure 2-21). As a result, potential drivers for changes in water quality parameters not associated with reductions in discharge were not investigated as part of the MFL development process.

Table 2-5. Trends in Gainer Spring Group Water Quality

Parameter	Date Range	N	Kendal Tau Statistic	p value	Sen Slope	Trend
Nitrate + Nitrite (Total as N, mg/L)	2001-2023	23	-0.229	0.1281	-8.55E-04	no trend
Specific Conductivity, µS/cm	2001-2023	21	0.6	0.0002	1.451	increasing
Dissolved Oxygen, mg/L	2001-2023	21	-0.671	0.0000	-4.7E-02	declining



A)



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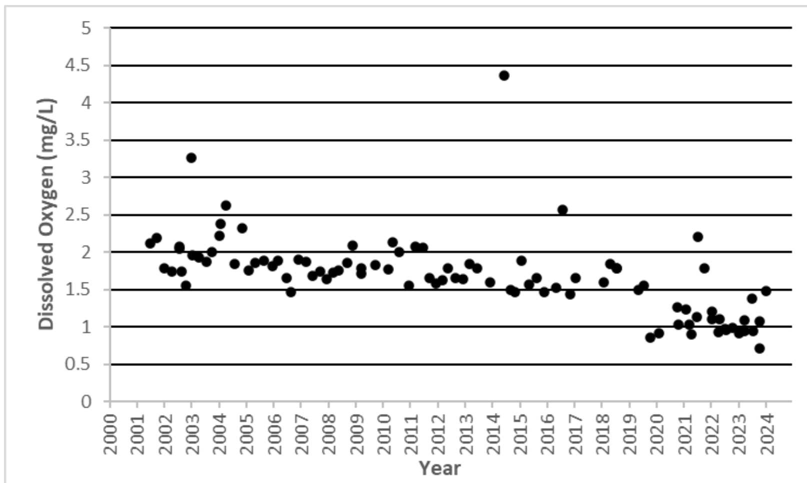
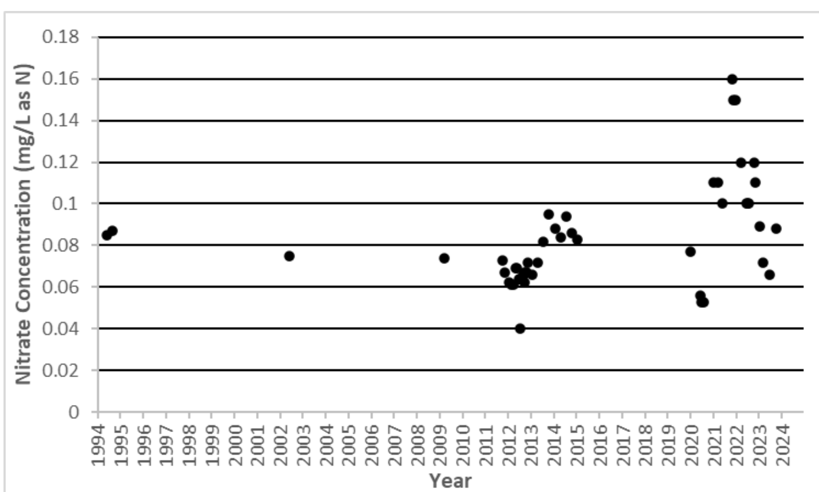
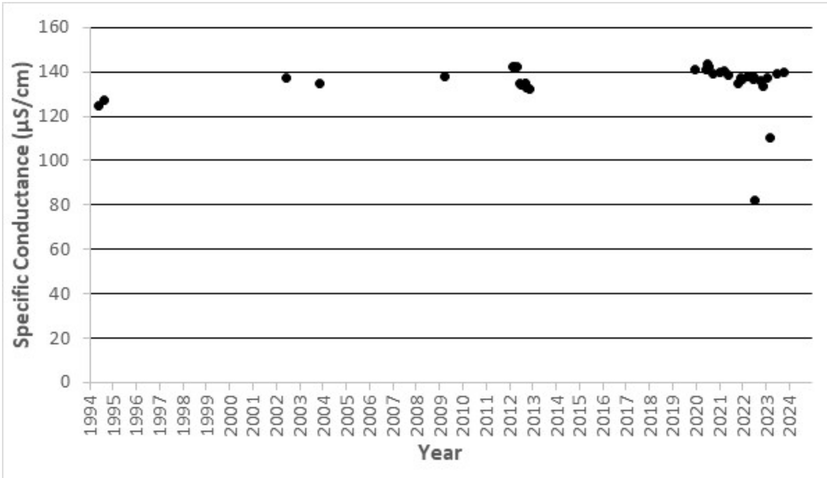


C)

Figure 2-19. A) Nitrate Concentration at Gainer Spring Group between 2001 and 2023 **B)** Specific Conductance at Gainer Spring Group between 2001 and 2024 **C)** Dissolved Oxygen at Gainer Spring Group between 2001 and 2024



A)



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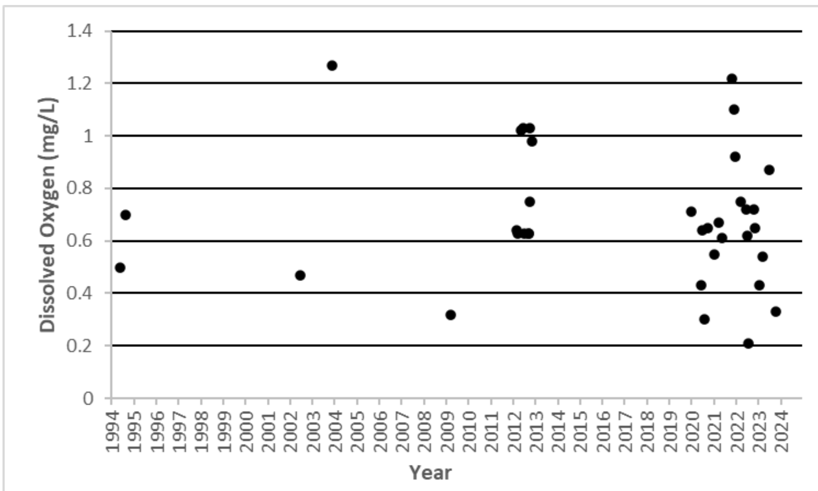
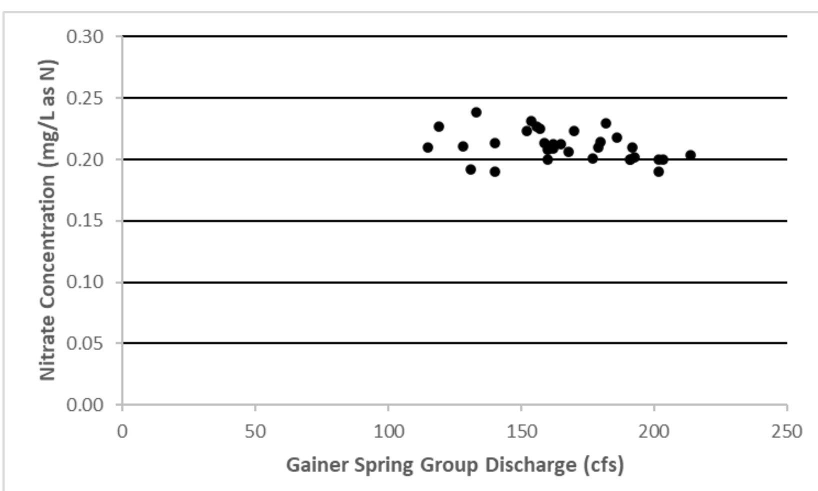


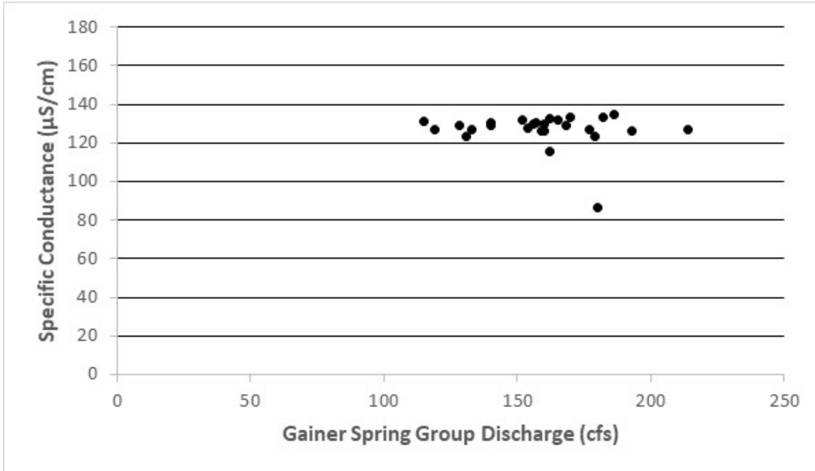
C)

Figure 2-20. A) Nitrate Concentration at Williford Spring between 1994 and 2023 **B)** Specific Conductance at Williford Spring between 1994 and 2023 **C)** Dissolved Oxygen at Williford Spring between 1994 and 2023



A)

B)



C)

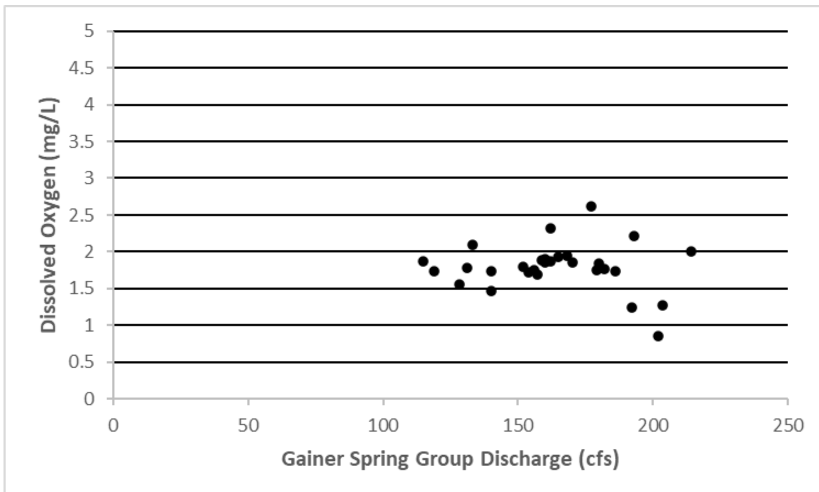


Figure 2-21. A) Nitrate Concentration versus Gainer Spring Group Composite Discharge **B)** Specific Conductance versus Gainer Spring Group Composite Discharge **C)** Dissolved Oxygen versus Gainer Spring Group Composite Discharge

2.8 Impact from Hurricane Michael on Econfina Creek

Hurricane Michael made landfall near Mexico Beach, Florida, on October 10, 2018, as a Category Five storm. The hurricane cut an intensely destructive path across several counties of the Florida Panhandle. In addition to damaging structures and communities, the storm devastated forests throughout the region. As a result, fallen trees and vegetation smothered numerous streams, rivers, and accompanying floodplains, with Econfina Creek being among the hardest hit (Figure 2-22). Debris within stream channels restricts water flow and reduces stream capacity, which can back up water into the floodplain and surrounding areas. Debris within floodplains compounds this impact by further slowing drainage, causing flooding to persist and in some cases causing additional localized flooding due to widespread impoundment. Both flood levels and frequency are increased. Hydrographs displaying stage data from Econfina Creek demonstrate the degree to which hydrologic conditions were impaired from the storm (Figure 2-23).

Figure 2-22. Econfina Creek and Floodplain, November 10, 2018

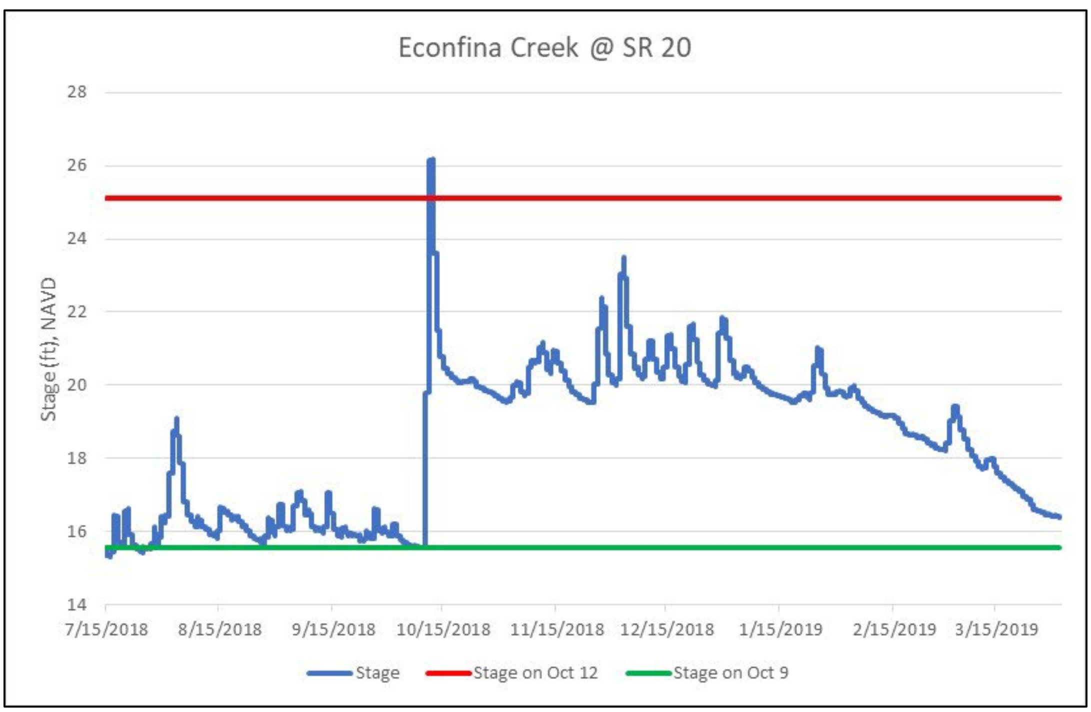


Figure 2-23. Econfina Creek Stage @ SR 20 from 7/15/2018 to 4/1/2019. The stage on October 12 (red line) depicts the average daily water surface elevation on October 12, 2018. The stage on October 9 (green line) depicts the average daily water surface elevation on October 9, 2018.

In support of DEP, the Northwest Florida Water Management District evaluated stream conditions through aerial surveys and analysis of aerial photography and stage data. Stream segments were prioritized for cleanup based on continuing flooding impacts to residents and roadways. To facilitate cooperative analysis and public outreach, the District established an interactive online damage and recovery assessment map and a public photograph submission tool (https://www.nwfwater.com/Water-Resources/Hurricane-Michael).

The top priorities identified for stream channel debris cleanup included two proposed phases of work in Econfina Creek. From February 1 to March 29, 2019, DEP tasked contractors to remove debris from the identified first phases of work in Econfina Creek. Approximately 82,532 cubic yards were removed from Econfina Creek from this effort. In Econfina Creek, the in-channel removal target was 100% (i.e. from bank to bank). Approximately 13.49 miles of channel was cleared during this effort (Figure 2-24). The second phase of this effort as depicted in Figure 2-24 has not been completed.

The northern portion of Econfina Creek and much of the floodplain remains obstructed (Figure 2-25). The main channel in the portion of Econfina Creek below Williford Spring, inclusive of the MFL study area, remains relatively clear due to debris removal efforts. The floodplain has sparse trees due to hurricane damage, with increasing vegetative cover in some areas (Figure 2-26). The impact of downed debris resulting from Hurricane Michael as well as the impact of debris removal efforts on Econfina Creek hydrology is discussed in more detail in Sections 3.4.3 and 3.5.3.

In December 2023, District contractors started stream debris assessments on the lower and upper Econfina Creek to document and quantify the debris within the waterway. The assessments were completed in January 2024 and data was used by a District-contracted engineering firm to model the current stream conditions. The modeling was completed in December 2024 and the results showed the need to remove debris blockages and restore stream function. In conjunction with the stream debris modeling, the District released a Request for Proposals for waterway debris removal services. On August 8, 2024, the Governing Board approved the District to contract with the top six waterway debris removal contractors. All six contracts have been executed and the plan is to start the waterway debris removal in Spring 2025. The waterway debris removal schedule will be determined by priorities, so work is expected to begin with Bayou George Creek and Bear Creek before work begins on Econfina Creek.

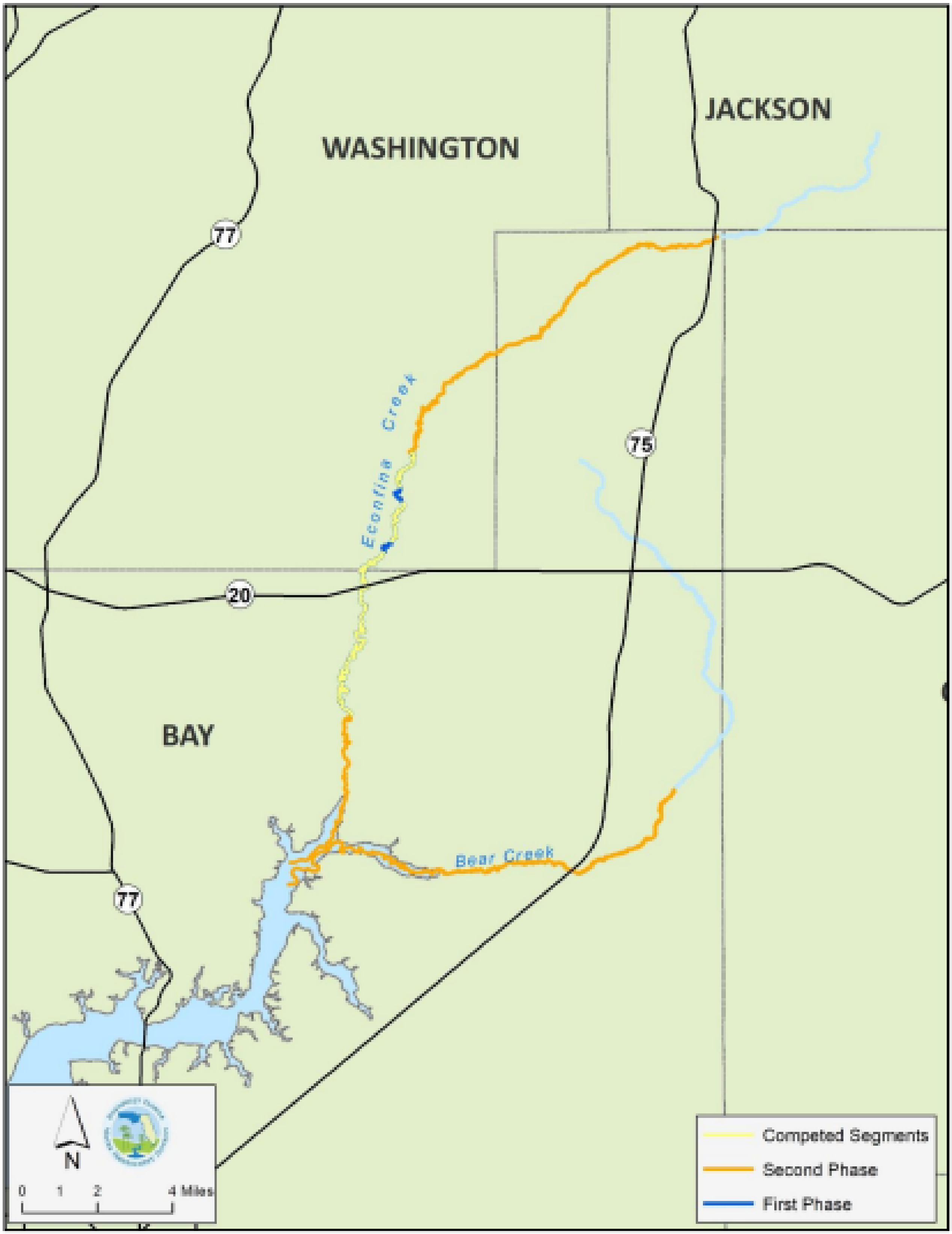


Figure 2-24. Debris Removal on Econfina Creek (as of 3/29/2019)

Figure 2-25. Econfina Creek near Scott Rd., April 2023

Figure 2-26. Econfina Creek between SR 20 and CR 388, January 2023

2.9 Natural Resources

Compared with many other systems in Florida, Econfina Creek remains in a relatively natural condition. Within the Econfina Creek watershed and the groundwater contribution area of the Econfina Creek Springs there is little development (Section 2.5) or groundwater extraction (Section 3.7). In addition, the majority of the floodplain is under public ownership and protected from development (Figure 2-14).

2.9.1 Instream Habitats

Multiple types of instream habitat are present along the Econfina Creek study area including spring pools, bare sand substrate, woody debris, and submerged aquatic/littoral vegetation. Multiple springs are located in the study area of Econfina Creek (Section 2.2). These springs either discharge directly into (Emerald Spring) or have a short spring run before joining Econfina Creek. The majority of the instream creek substrate present along the study area of Econfina Creek consists of sand with little organic matter. River runs with areas of relatively consistent depth and water velocity are abundant. On the far edge of large bends in the creek, erosion has created areas of deep-water habitat. In addition, depositional habitats such as shoals, points, and sand bars are present throughout the system.

Two types of instream woody habitat were observed along Econfina Creek. Dead woody debris consists of tree stumps and fallen logs/branches present and inundated along the edge of the river channel. Live roots include tree roots, cypress knees, etc. found along the river edge that are routinely inundated by river flow or have become exposed due to erosion from water flow. Dead woody debris tends to be found deeper in the river channel and at a lower elevation on average than live roots which tend to be found on the creek channel/riparian corridor interface. Hurricane Michael and subsequent restoration activities had a significant impact on woody debris habitat in Econfina Creek. Immediately following Hurricane Michael, the high winds associated with the category 5 hurricane deposited extensive woody debris in the system resulting in increased resistance to river flows and extensive flooding (Figure 2-19) (NWFWMD 2020). DEP subsequently conducted extensive debris-removal activities to alleviate flooding and restore access to the system, resulting in little woody habitat remaining in the system (Figure 2-23). Since this time, woody debris has continued to be deposited through natural processes in Econfina Creek and appears to be returning to more stable conditions.

Submerged aquatic vegetation (SAV) is limited along the Econfina Creek study area. The majority of SAV consists of isolated patches of coontail (*Ceratophyllum demersum*) and, where present, this species was estimated to comprise less than 0.1 percent cover during multiple surveys between 2019 and 2023. Other common types of SAV such as eel grass (*Vallisneria americana*) were not observed in the study area.

The majority of the Econfina Creek study area shoreline is in natural condition although littoral vegetation is limited. The majority of the Econfina Creek shoreline is comprised of steep drop-offs eroded from creek flows with little to no littoral shelf. During multiple surveys between 2019 and 2023, District staff noted areas where littoral vegetation capable of growth have become inhabited by species such as cattail (*Typha* sp.), pennywort (*Hydrocotyle umbellata*), arrowhead (*Sagittaria lancifolia*), (*Sagittaria graminea*), green briar (*Smilax* sp.), climbing hempvine (*Mikania scandens*), and pickerelweed (*Pontideria cordata*).

2.9.2 Riparian/Floodplain Habitats

The Econfina Creek floodplain remains largely in an impacted and early transitional period following Hurricane Michael. Prior to Hurricane Michael, the floodplain consisted of mature wetland tree species such as cypress (*Taxodium* spp.), however Hurricane Michael destroyed most of the mature trees in October 2018. As a result, the Econfina Creek floodplain consists primarily of shrub and young tree species with extensive amounts of dead woody debris in areas. Few specimens remain in the canopy stratum and the successional trajectory of the Econfina Creek floodplain remains uncertain.

Detailed vegetation surveys of the Econfina Creek floodplain after Hurricane Michael are unavailable. Qualitative surveys by District staff identified limited quantities of mature cypress (*Taxodium* sp.), slash pine (*Pinus elliottii*), laurel oak (*Quercus laurifolia*), tupelo (*Nyssa* spp.), and cabbage palm (*Sabal palmetto*) in the canopy strata. However, it is unclear how many of these specimens are located in the historical floodplain or in other community types located at higher elevations near the creek channel. Sub-canopy species observed include saltbush (*Baccharis* sp.), cabbage palm, cypress, St. Johns wort (*Hypericum* sp.), and saw palmetto (*Serenoa repens*) growing along the water's edge.

2.9.3 Wildlife

The relatively natural condition of Econfina Creek makes it important habitat for a wide variety of organisms. The following section describes confirmed species observed utilizing Econfina Creek, its floodplain, and springs. Species lists were assembled based upon direct observations by District staff, observations from the Florida Natural Areas Inventory (FNAI) Biodiversity Matrix, Florida Fish and Wildlife Conservation Commission collections, and the University of Florida Ichthyology Collection. No listed mammal or amphibian/reptile species have been documented in Econfina Creek and mammals potentially using the springs as a thermal refuge are excluded due to the construction of Deer Point Lake.

2.9.3.1 Fish Species

A total of 42 fish species have been documented along Econfina Creek, none of which are listed federally or by the state of Florida (Table 2-6). Of these species, largemouth bass (*Micropterus salmoides*) are the deepest bodied native fish and have the greatest potential to have their passage across shallow areas limited by low water levels.

Due to the presence of the water control structure forming Deer Point Lake Reservoir, diadromous fish species such as gulf sturgeon (*Acipenser oxyrinchus desotoi*) and striped bass (*Morone saxatilis*), which are present in other spring and river systems of the Florida panhandle, are not capable of utilizing Econfina Creek. There were two collections of American eel (*Anguilla rostrata*), a catadromous species, in Econfina Creek in 1957 (FMIC Ichthyology Collection), however, the Deer Point Lake water control structure was completed in 1961 after these individuals were documented.

Grass carp (*Ctenopharyngodon Idella*) have been observed by District staff in the Sylvan Spring run. Grass carp are an exotic species native to the large coastal rivers in Siberia such as the Amur River (FWC 2024, https://myfwc.com/wildlifehabitats/profiles/freshwater/grass-carp/). This species is listed as a conditional, non-native species by the state of Florida (chapter 68-5.004, Florida Administrative Code), whose legal introductions into a waterbody for vegetation control require a permit from the FWC (Rule 68-5.005, Florida Administrative Code). The FWC has not issued a permit for grass carp in Econfina Creek and it is assumed that these individuals escaped from another location or were illegally introduced into the system.

Table 2-6. List of Fish Species Documented Along Econfina Creek.
**Indicates mussel host fish species as documented in Table 2-7.*

Species	Common Name	Species	Common Name
Ameiurus serracanthus	Spotted bullhead	*Lepomis auratus*	Redbreast sunfish
Anguilla rostrata	American eel	*Lepomis gulosus*	Warmouth
Aphredoderus sayanus	Pirate perch	*Lepomis macrochirus**	Bluegill
Ctenopharyngodon idella	Grass carp	*Lepomis marginatus*	Dollar sunfish
Cyprinella venusta	Blacktail shiner	*Lepomis microlophus**	Redear sunfish
Cypreinella venusta cercostigma		*Lepomis punctatus**	Spotted sunfish
Elassoma evergladei	Everglades pygmy sunfish	*Lucania goodei*	Bluefin killifish
Enneacanthus gloriosus	Bluespotted sunfish	*Micropterus salmoides**	Largemouth bass
Erimyzon sucetta	Lake chubsucker	*M. salmoides floridanus x salmoides*	Largemouth bass hydrid
Esox americanus	Redfin pickerel	*Minytrema melanops*	Spotted sucker
Esox americanus x vericulatus	Grass pickerel	*Moxostoma poecilurum*	Blacktail redhorse
Esox niger	Chain pickerel	*Notropis harperi*	Redeye chub
*Etheostoma edwini**	Brown darter	*Notropis longirostris*	Longnose shiner
Etheostoma swaini	Gulf darter	*Notropis petersoni*	Coastal shiner
Fundulus escambiae	Eastern starhead minnow	*Notropis texanus*	Weed shiner
*Gambusio holbrooki**	Mosquitofish	*Noturus funebris*	Black madtom
Heterandria Formosa	Least killifish	*Noturus gyrinus*	Tadpole madtom
Ichthyomyzon gagei	Southern brook lamprey	*Noturus leptacanthus*	Speckled madtom
Ictoalurus punctatus	Channel catfish	*Percina nitrofasciata**	Blackbanded darter
Labidesthes sicculus	Brook silverside	*Pteronotropis hypselopoterus**	Sailfin shiner
Labidesthes sicculus vanhyningi	Silverside	*Pteronotropis signipinnis*	Flagfin shiner
Lepisosteus oculatus	Spotted gar		

2.9.3.2 Freshwater Mussels

The FWC reported seven mussel species along Econfina Creek (Table 2-7). Many freshwater mussel species inhabit streams and rivers with shallow, sandy bottoms such as those found along Econfina Creek. Mussels are filter feeders which remove algae, bacteria, and other organic material from the water column; and by doing so can help clean the water they inhabit. Mussels can also provide food sources for other animals and serve as sentinel species as indicators of water quality.

While relatively little is known about the life history of most mussel species, many utilize host fish for their larvae (glochidia) to attach to and parasitize for a period of time. While additional research is needed in determining mussel host fish species, host fish for several species found in Econfina Creek have been identified and include centrarchid (sunfish), darter, and several members of the Poeciliidae family (Table 2-7).

Currently there are two listed species which have been documented in Econfina Creek: Gulf moccasinshell (Figure 2-27a) and oval pigtoe (Figure 2-27b). Both species are federally designated endangered mussels (invertebrates) which live buried in the creek substrate. Within their range, primary threats to both mussel species include effects from human development and increased populations such as freshwater impoundments resulting in sediment accumulation, habitat fragmentation, and loss of food and host fish (FWC 2019a, FWC 2019b). In addition, competition with invasive species such as the Asian clam (*Corbicula fluminea*) and pollution from pesticides and chemicals are known to pose significant threats to native mussel species in Florida.

The gulf moccasinshell (*Medionidus penicillatus*) (Figure 2-27a) is a small freshwater mussel reaching a maximum length of 2.2 inches (FWC 2019a). This species inhabits creeks and large rivers with a sandy/gravel substrate and moderate currents and is known to inhabit Econfina Creek, Chipola River, Choctawhatchee River, Apalachicola River, and Yellow River in Florida. While the host fish for gulf moccasinshell glochidia are currently unknown, there is agreement that species of the genus *Medionidus* are specialists which use darters as their host species (O'Brien and Williams 2002, Williams et al. 2014). Three darter species have been identified in Econfina Creek: brown darter (*Etheosoma edwini*), gulf darter (*E. swaini*), and blackbanded darter (*Percina nitrofasciata).*

The oval pigtoe (*Pleurobema pyriforme*) (Figure 2-27b) is a small freshwater mussel reaching a maximum length of 2.4 inches (FWC 2019b). This species inhabits small creeks and mid-sized rivers with substrates ranging from sandy silts to gravel and slow to moderate currents. The eastern mosquitofish (*Gambusia holbrooki*) and sailfin shiner (*Pteronotropis hypselopterus*) are the primary host fish for oval pigtoe glochidia, with both host fish being documented in the Econfina Creek system. Oval pigtoe are known to inhabit Econfina Creek, Chipola River, Ochlockonee River, and Suwannee River in Florida.

A) 

B) 

Figure 2-27. A) Gulf Moccassinshell (*Medionidus penicillatus)* and **B)** Oval Pigtoe (*Pleurobema pyriforme*). Photos Provided by the Florida Fish and Wildlife Conservation Commission

Table 2-7. List of Mussels Documented in Econfina Creek and Their Known Host Fish Species. *Species in Bold are Listed as Federally Endangered. Host Fish Species Identified from: Freshwater Mussel Host Database, Illinois Natural History Survey Mollusk Collection.* https://mollusk.inhs.illinois.edu/57-2/

Species	Common Name	Known Host Fish Species
Elliptio pullata	Gulf Spike	*Lepomis macrochirus, Micropterus salmoides*
Medionidus penicillatus	**Gulf Moccasinshell**	***Etheosoma edwini, Percina nigrofasciata, Gambusia holbrooki, Poecilia reticulata***
Pleurobema pyriforme	**Oval Pigtoe**	***Pteronotropis hypselopterus, Gambusia holbrooki, Poecilia reticulata***
Strophitus radiatus	Rayed Creekshell	Unknown
Toxolasma paulum	Iridescent Lilliput	Unknown
Villosa vibex	Southern Rainbow	*Lepomis cyanellus, Fundulus olivaceus, Micropterus coosae, Micropterus salmoides, Micropterus punctulatus, Lepomis megalotis*
Villosa lienosa	Little Spectaclecase	*Lepomis cyanellus, Lepomis humilis, Lepomus macrochirus, Lepomis megalotis, Lepomis microlophus, Micropterus salmoides*

2.9.3.3 Invertebrates

The Florida Natural Areas Inventory lists eight invertebrate insect species (Table 2-8). None of these species are listed federally or by the state of Florida.

Table 2-8. List of Documented Invertebrate Species along Econfina Creek.

Species	Common Name	Occurrence
Baetisca rogersi	A Mayfly	Documented
Hydroptila berneri	Berner's microcaddisfly	Documented
Sphodros abboti	Blue Purse-Web Spider	Documented
Orthotrichia dentata	Dentate Orthotrichian Microcaddisfly	Documented
Oxyethira janella	Little-entrance Oxyethiran Microcaddisfly	Documented
Oxyethira pescadori	Pescador's Bottle-Cased Caddisfly	Documented
Sphodros rufipes	Red-Legged Purse-Web spider	Documented
Dromogomphus armatus	Southeastern Spinyleg	Documented

2.10 Recreation

The main use of Econfina Creek is for recreation. Lands surrounding much of the system are under public ownership and managed for low-impact uses such as swimming, hiking, fishing, and birding as well as hunting. (Figure 2-14)(NWFWMD 2022).

The cool, clear waters of the many springs and relatively undeveloped nature of the floodplain along Econfina Creek make canoeing and kayaking perhaps the largest recreational use of Econfina Creek. Econfina Creek is a state-designated canoe trail and has several locations where canoes and kayaks can be launched including Scott Road, Walsingham Bridge, SR 20, and CR 388 (Figure 2-28). Canoe and kayak rentals are available to the public from a privately owned livery located along the creek near SR 20.

While relatively limited, power boating does occur along the Econfina Creek study area. Primary reasons for power boating along Econfina Creek include fishing and transportation to the many springs for recreation. Public boat launches are located further downstream at CR 388 and along Deer Point Lake. Large power boats have not been observed by District staff likely due to the relatively narrow and shallow nature of portions of Econfina Creek. This is particularly evident moving upstream toward SR 20 where the creek narrows considerably, making it potentially difficult for power boats to pass each other in areas.

The District operates and maintains several recreation areas within the Econfina Creek Water Management Area including the Pitt and Sylvan Spring and Williford Spring Recreation areas. The 10-acre Pitt and Sylvan Spring recreation area includes a trail and boardwalk system leading from Pitt Spring to the Sylvan Spring area and includes an overlook and a tubing put-in dock. A tubing take-out dock is at the confluence of Pitt Spring run and Econfina Creek. The Williford Spring recreation area features a boardwalk system that takes users around the spring and to Econfina Creek, and a nature trail that leads users to the nearby Pitt and Sylvan Springs recreation area (Figure 2-29). In addition to the District-maintained recreation areas, several of the Gainer Spring Group springs are utilized for swimming and recreation including Emerald Spring, which features a cove carved into the bank with a small, man-made "beach" to the south and the springs along the wide spring run on the west side of Econfina Creek just above Emerald Spring.

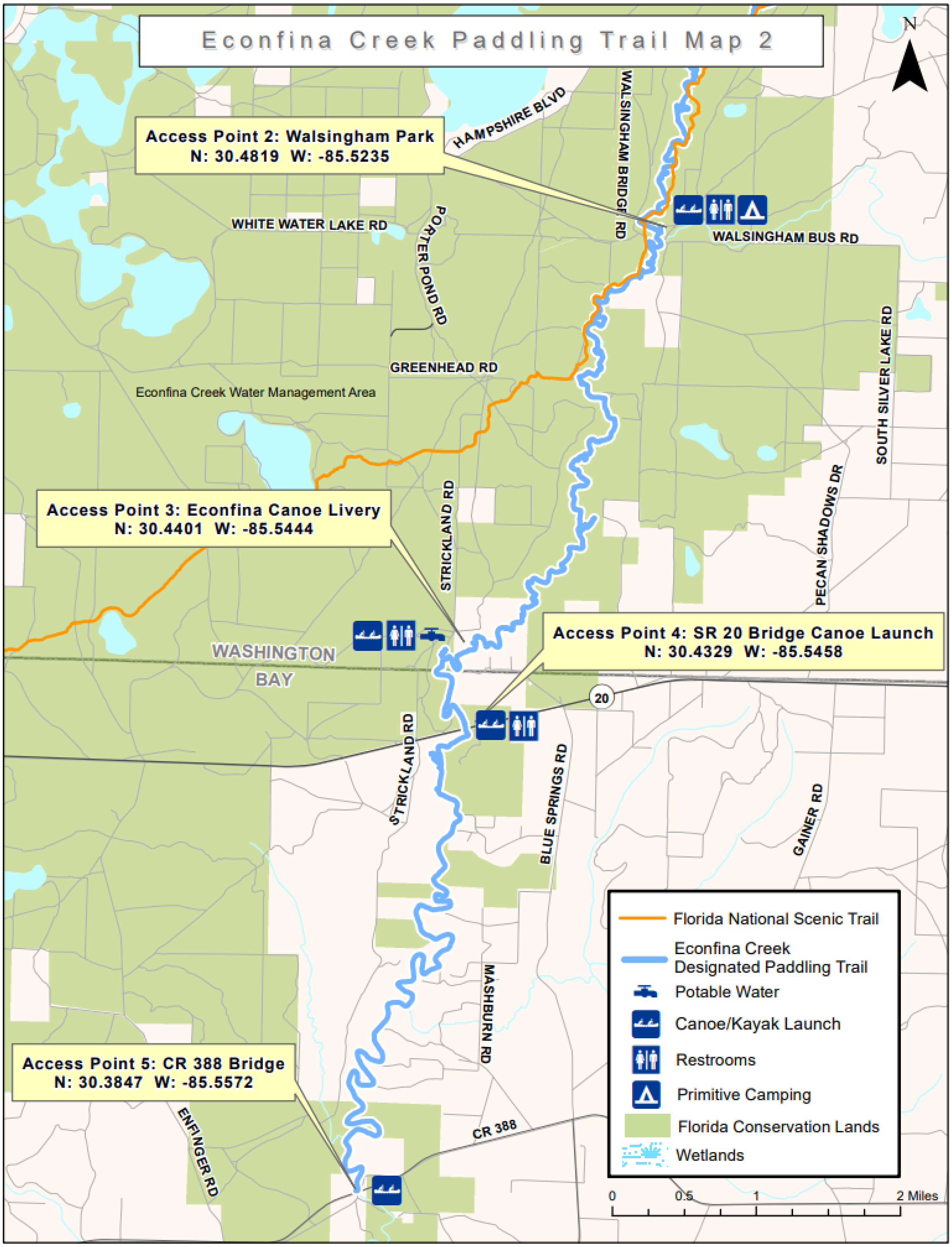


Figure 2-28. Econfina Creek Paddling Trail (Reprinted from FDEP Econfina Creek Paddling Guide, 2023)

Figure 2-29. Williford Spring Recreation Area (Photo taken post Hurricane Michael)

3 Hydrology

This section presents a detailed evaluation of hydrological characteristics of Econfina Creek and its springs as well as a summary of District's hydrologic data collection along Econfina Creek.

3.1 Hydrologic Data Collection

Surface water flow and stage are measured at multiple locations along Econfina Creek (Figure 3-1). The District maintains three stream gauging stations measuring continuous stage and discharge: Econfina Creek @ SR 20 (NWFID 8458), Econfina Creek @ Walsingham Bridge (NWFID 8558), and Econfina Creek @ Scott Road (NWFID 8557). All District discharge data collection follows USGS Techniques and Methods 3A-22, 2014 guidelines (USGS 2014). Additionally, the USGS maintains a stream gauging station measuring continuous stage and discharge at the USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388). The period of record for each station is presented in Table 3-1. Continuous daily average discharge and stage is available at the USGS Station 2359500 Econfina Creek Near Bennett, FL from October 1935 to present and October 1971 to present, respectively, although a data gap persists between October 1994 and September 1998. Continuous discharge and stage data are available at the District's Econfina Creek @ SR 20 station from November 1992 to present, although a data gap persists between August 1994 to August 1998. Continuous discharge and stage data are available at the District's Econfina Creek @ Walsingham Bridge and Econfina Creek@ Scott Rd. stations from August 1998-present. For all District stations, data is unavailable from October 11, 2018, through March 30, 2019, due to the effects of Hurricane Michael on Econfina Creek in the vicinity of these stations. Continuous discharge and stage data is available for this time period at the USGS Econfina Creek @ CR 388 station, allowing for assessment of hydrologic impacts caused by Hurricane Michael on Econfina Creek.

Spring discharge is measured by the District for several springs along Econfina Creek including: Gainer Spring Group, Williford Spring Group, Sylvan Spring Group, Devil's Hole, and Econfina Blue Spring (Table 3-1). Discharge measurements for Gainer Spring Group represent composite discharge of all spring vents within the spring group. Quarterly discharge has been measured for Gainer Spring Group from 2002 to present. Periodic discharge has been measured at Williford Spring Group and Sylvan Spring Group with the majority of measurements occurring from 2015 to present. The District has established a continuous recorder above and below the Gainer Spring Group, measuring the composite discharge of all 15 spring vents associated with the spring group. Continuous Gainer Spring Group discharge is available from March 2019 - May 2019 and November 2019 to present for this station.

Within the Econfina Creek watershed, the District collects quarterly groundwater levels at six sites (Table 3-2). NWFID 3216 (Greenhead) has the longest continuous groundwater level record in the region, with quarterly to monthly measurements from 1982 to present. Quarterly levels have been collected at NWFID 5960 (Porter Pond) and NWFID 5958 (George's 40) monitor wells from May 2008 to present. Quarterly groundwater levels have been collected at NWFID 5953 (Powerline) from March 2009 to present. The District recently begun collecting quarterly levels at wells NWFID 5950 (Trapp Pond) and NWFID 5961 (Section 20) from Jan 2017 to present.

Table 3-1. Summary of Surface Water Hydrologic Data Collection for Econfina Creek and Deer Point Lake Watersheds

Station Number	Site Name	Parameter: Period of Record
USGS 02359500	Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388)	Discharge: Oct. 1935 - Oct. 1994, Sept. 1998 -present Stage: Oct 1971 - Oct. 1994, Sept. 1998 – present
NWFID 8548	Econfina Creek @ SR 20	Discharge: Nov. 1992 - Aug. 1994, Aug. 1998 - present Stage: Nov. 1992 - Aug. 1994, Aug. 1998- present
NWFID 8558	Econfina Creek @ Walsingham Bridge	Discharge: Aug. 1998 - present Stage: Aug 1998 - present
NWFID 8557	Econfina Creek @ Scott Rd.	Discharge: Aug. 1998 - present Stage: Aug 1998 - present
NWFID 8099	Econfina Creek Above Gainer Spring Group	Discharge: Mar. 2019 - May 2019, Nov. 2019 - present Stage: Jun 2018 - present
NWFID 8100	Econfina Creek Below Gainer Spring Group	Discharge: Mar. 2019 - May 2019, Nov. 2019 - present Stage: Jun 2018 - present
NWFID 10128	Gainer Spring Group Composite	Continuous Discharge: Mar. 2019 - May 2019, Nov. 2019 - present Field Visit Discharge Measurements: Seven measurements prior to 2002; quarterly measurements 2002 - present
NWFID 8677	Williford Spring	Field Visit Discharge Measurements: 31 total measurements, majority of measurements 2015 - present.
NWFID 8727	Sylvan Spring	Field Visit Discharge Measurements: 35 total measurements, majority of measurements 2016 - present.
NWFID 8908	Devil's Hole	Field Visit Discharge Measurements: Eight total measurements
NWFID 8730	Econfina Blue Spring	Field Visit Discharge Measurements: 28 total measurements, majority of measurements 2016- present.
NWFID 8571	Bear Creek @ US 231	Discharge: Aug 1998 - present Stage: Aug 1998 - present
NWFID 8549	Little Bear Creek @ CR 388	Discharge: Aug 1998 - present Stage: Aug 1998 - present
NWFID 8544	Deer Point Lake, Near Dam	Stage: Jun 2002 - present

Table 3-2. Summary of Groundwater Hydrologic Data Collection for Econfina Creek Watershed

Station Number	Site Name	Parameter: Period of Record
NWFID 3216	USGS-422A Near Greenhead/S834	Quarterly to Monthly Groundwater Levels: May 1982 - present, two measurements in 1962
NWFID 5960	Porter Pond East	Quarterly Groundwater Levels: May 2008 - present, periodic previously
NWFID 5958	George's 40 Floridan	Quarterly Groundwater Levels: May 2008 - present, periodic previously
NWFID 5950	Trapp Pond	Quarterly Groundwater Levels: Jan 2017 - present, periodic previously
NWFID 5961	Section 20	Quarterly Groundwater Levels: Jan 2017 - present, periodic previously
NWFID 5953	Powerline/S731	Quarterly Groundwater Levels: Mar 2009 - present, periodic previously

Figure 3-1. Econfina Creek Surface Water Monitoring Stations and Groundwater Monitoring Wells

3.2 Econfina Creek Discharge

Flow frequency curves, based on period of record daily average flows for the four surface water stations on Econfina Creek are presented in Figure 3-2. A comparison of flows for select flow percentiles is shown in Tables 3-3 and 3-4. Median flow at Econfina Creek @Scott Rd. is 44 cfs, representing 9% of total flow measured at Econfina Creek @ CR 388. Flow measured at the Scott Rd. station is derived primarily from surface water runoff including flow from several intermittent tributaries. Econfina Creek flow increases significantly heading downstream with much of the flow being derived from groundwater discharge. Median flow is 134 cfs at Econfina Creek @ Walsingham Bridge (located north of Williford, Sylvan, and Gainer spring groups) and 264 cfs at Econfina Creek @ SR 20 (located south of Williford and Sylvan spring groups, but north of Gainer Spring Group), respectively. Median flows at these stations represent approximately 26% and 52% respectively of total flow measured at Econfina Creek @ CR 388. Median flow at Econfina Creek @ CR 388 is 506 cfs, approximately double the median flow at SR 20, approximately seven miles north. Much of the flow in the portion of Econfina Creek between SR 20 and CR 388 is derived from the Gainer Spring Group with the remaining flow being derived from surface water inputs from intermittent streams located north of CR 388.

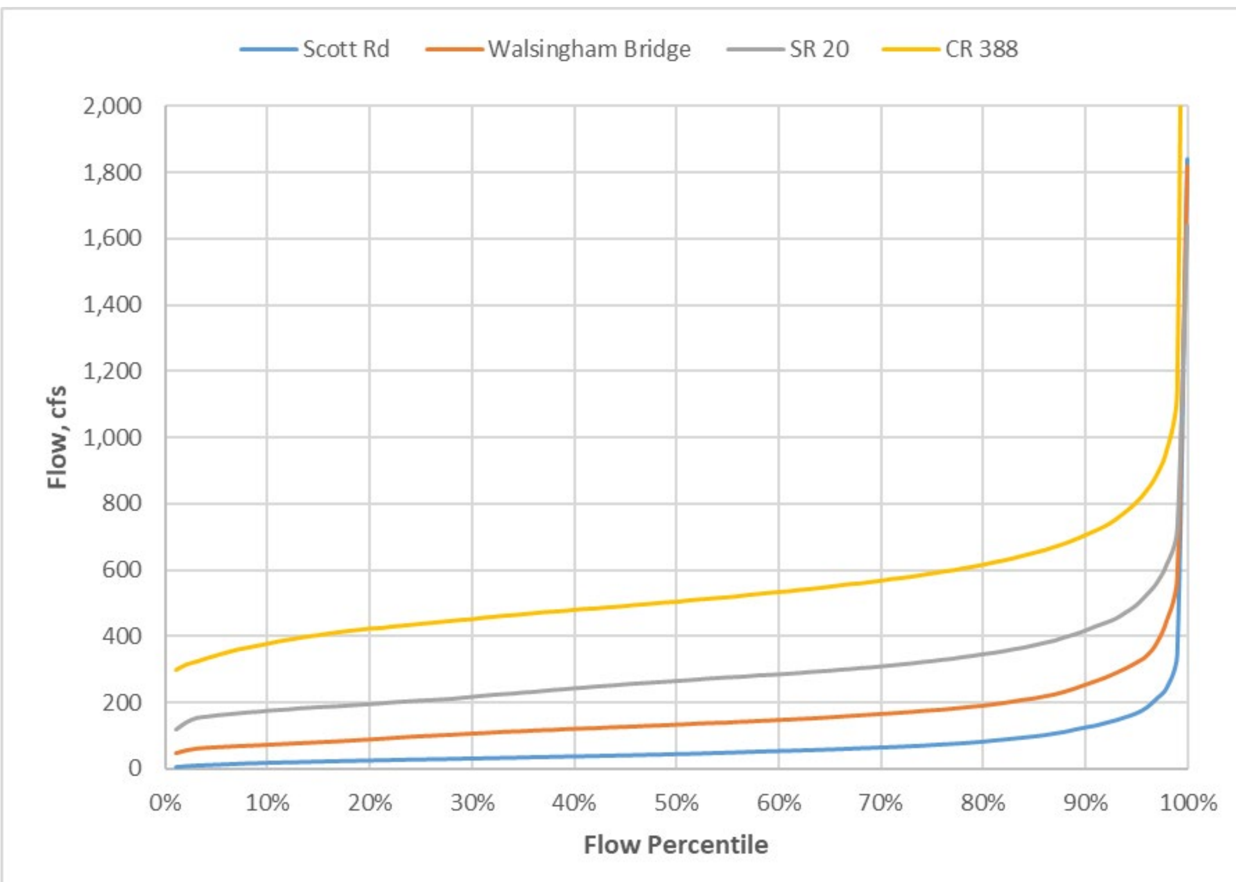


Figure 3-2. Flow Frequency Curves for Econfina Creek Surface Water Stations

Table 3-3. Flow Comparison for Econfina Creek Surface Water Stations (cfs)

Flow Percentile	Econfina Creek at CR 388	Econfina Creek at SR 20	Econfina Creek at Walsingham Bridge	Econfina Creek at Scott Rd.
5%	345	160	66	12
10%	380	174	73	17
20%	426	194	89	25
30%	454	216	107	31
40%	482	242	121	37
50%	506	264	134	44
60%	536	284	148	53
70%	570	308	166	64
80%	618	345	191	82
90%	707	416	254	125
95%	806	493	321	167

Table 3-4. Percent of Flow for Econfina Creek Surface Water Stations Relative to CR 388 Station

Flow Percentile	Econfina Creek at SR 20	Econfina Creek at Walsingham Bridge	Econfina Creek at Scott Rd.
5%	46%	19%	3%
10%	46%	19%	5%
20%	46%	21%	6%
30%	48%	24%	7%
40%	50%	25%	8%
50%	52%	26%	9%
60%	53%	28%	10%
70%	54%	29%	11%
80%	56%	31%	13%
90%	59%	36%	18%
95%	61%	40%	21%

3.3 Econfina Creek Spring Discharge

Discharge for first and second magnitude springs located along Econfina Creek is summarized in Table 3-5. Mean and median discharge for the Gainer Spring Group composite was 165 cfs and 167 cfs respectively. Median discharge was 42 cfs for Williford Spring Group and 18 cfs for Sylvan Spring Group. Mean and median discharges were similar for all springs, indicating a symmetrical non-skewed distribution of spring discharge. A flow frequency curve for Gainer Spring Group composite discharge is shown in Figure 3-3. Flows for Gainer Spring Group composite range between 30 cfs and 224 cfs, with a relatively linear flow frequency curve further indicating a symmetrical non-skewed distribution of spring discharge.

Table 3-5. Econfina Creek Spring Discharge Summary (cfs)

Spring	Number of Discharge Measurements	Mean	Median	Min	Max
Gainer Spring Group Composite	92	165	167	30	224
Williford Spring Group	31	42	42	23	72
Sylvan Spring Group	35	18	18	11	21

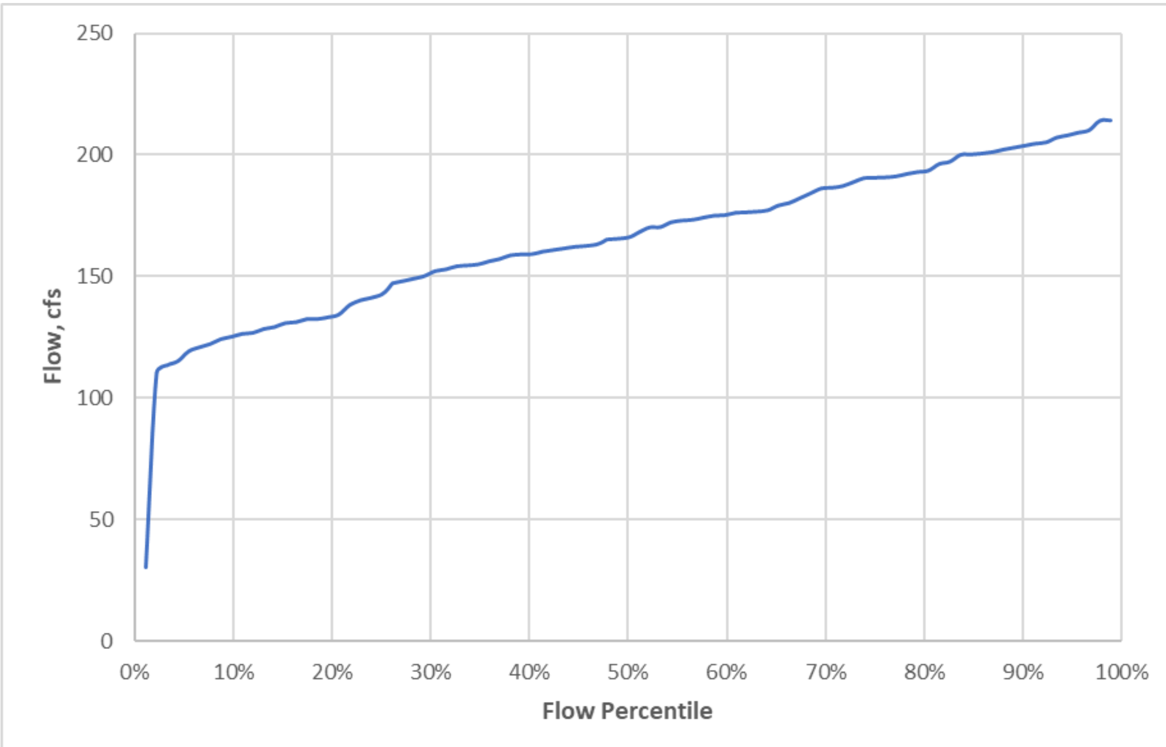


Figure 3-3. Flow Frequency Curve for Gainer Spring Group Composite Discharge

In order to determine the relative contributions of spring discharge to total flow in Econfina Creek, measured spring discharge was compared to total flow pickup between stations for the reach where the spring contributes to Econfina Creek flow. Based on Table 3-6, the combined Williford and Sylvan spring groups median flow of 60 cfs represents approximately 46% of the median flow pickup (130 cfs) between the Walsingham Bridge and SR 20 stations. Based on Table 3-7, the Gainer Spring Group composite median flow of 167 cfs represents approximately 69% of the median flow pickup (242 cfs) between the SR 20 and CR 388 stations. The remaining 31% of pickup between these stations comes from a combination of surface runoff and diffuse groundwater flow.

Table 3-6. Median flow Comparison between SR 20 and Walsingham Bridge (cfs)

Econfina Creek at SR 20 median flow	Econfina Creek at Walsingham Bridge median flow	Difference in Median Flow Between Econfina Creek at SR 20 and Walsingham Stations	Combined Williford and Sylvan Spring Groups median flow	Remaining flow pickup
264	134	130	60	70

Table 3-7. Flow Comparison among CR 388, SR 20, and Gainer Spring Group

Flow Percentile	Flow difference between CR 388 and SR 20	Gainer Spring Group composite flow	Remaining flow pickup
5%	185	120	65
10%	206	126	80
20%	232	135	97
30%	238	152	86
40%	240	159	81
50%	242	167	75
60%	252	176	76
70%	262	186	76
80%	273	193	80
90%	291	203	88
95%	313	208	105

3.4 Hydrologic Evaluation for USGS Station 2359500 Econfina Creek Near Bennett, FL

This section presents a detailed hydrologic evaluation of observed trends in flow and stage from USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388). The purpose of this evaluation was to determine the relationship between observed changes in flow and stage with changes in climatic conditions and groundwater levels in the vicinity of Econfina Creek. Additionally, hydrologic impacts associated with Hurricane Michael are also presented here. This hydrologic assessment was also used for determination of a representative baseline flow time series for Econfina Creek.

3.4.1 Trends in Baseflow, Seasonality, and Climatic Conditions

Daily average flow at the USGS station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388) is shown in Figure 3-4. Flows at this location have been relatively stable over time, with no long-term increasing or decreasing trend although short-term fluctuations occur due to climatic variability. Average flow at this location over the period of record was 536 cfs with annual average flows ranging between 343 cfs and 741 cfs. Seasonality in flows at this location was assessed by comparing average monthly discharge for the period of record (Figure 3-5). Average monthly flow for Econfina Creek @ CR 388 was highest in March (572 cfs) and August (573 cfs) corresponding to periods of lower evapotranspiration rates in March and periods of higher rainfall in August. Average monthly flow for Econfina Creek @ CR 388 was lowest during May-June and October-November, with average flows around 500 cfs during these months.

In order to determine baseflow at Econfina Creek @ CR 388, the baseflow separation technique referred to as the "USF Method" developed by Perry (1995) was utilized, which is a low-pass filter for a specific time window. This method is a modified version of the USGS HYSEP baseflow separation technique allowing for modified window lengths to better represent baseflow processes typical of Florida streams. A 61-day averaging period was chosen to represent average baseflow processes in Econfina Creek, which represents 30 days prior to a specified date, the specified date, and 30 days after the specified date. A 61-day minimum flow is calculated on a daily basis moving forward one day at a time. After the minimum flow has been calculated for each day, a second 61-day moving window averages the minimum flows resulting in a smoothed time series that is assumed as baseflow. Baseflow for Econfina Creek @ CR 388 computed using the USF method with a 61-day window is shown in Figure 3-4. Due to sandy soils, high recharge rates, and karst hydrogeology in the study area, baseflow derived primarily from spring discharge in the middle reaches of Econfina Creek accounts for the majority of flow in Econfina Creek under low- to moderate-flow conditions. Average estimated baseflow at USGS 2359500 Econfina Creek Nr Bennett (CR 388) is 445 cfs, which represents 83% of the long-term average flow of 536 cfs.

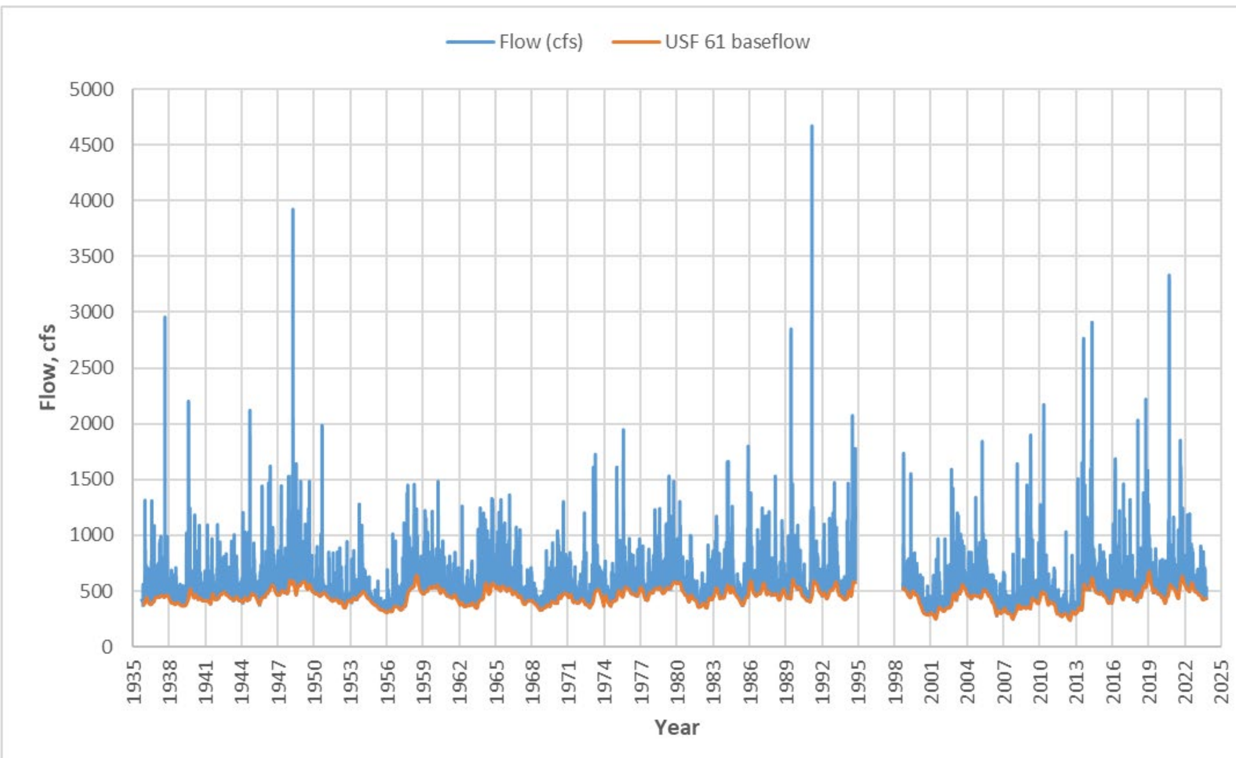


Figure 3-4. Daily Flow Hydrograph and Baseflow Hydrograph at the USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388)

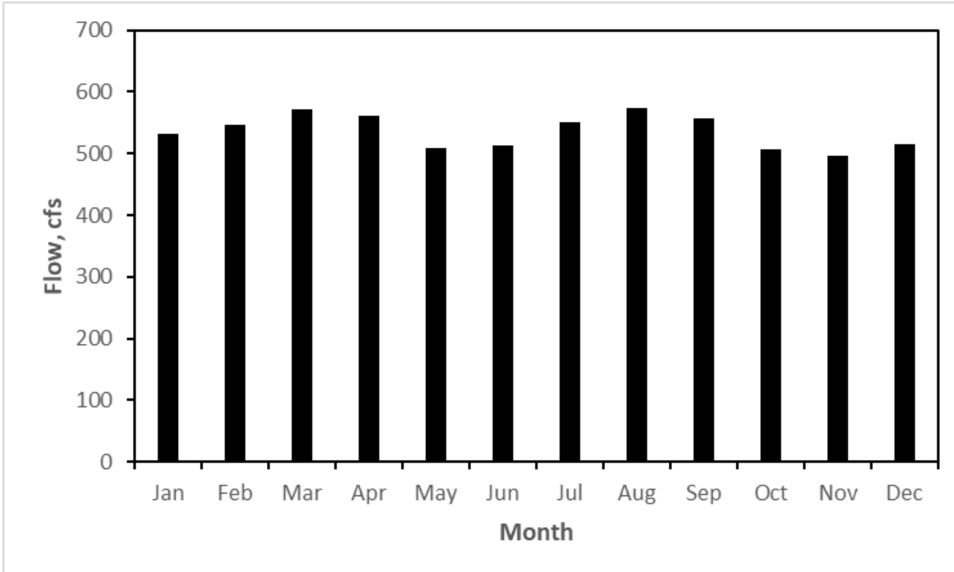


Figure 3-5. Average Monthly Flow at the USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388)

A careful examination of Figure 3-4 shows an increase in both baseflow and total flow at the Econfina Creek @ CR 388 station from January 2013 to present as compared to previous time periods, particularly the mid-2000s when several years of below-average flow occurred. To determine if increased baseflow correlates to climatic variability, baseflow was compared to historical cumulative precipitation and groundwater levels. Baseflow at Econfina Creek @ CR 388 was compared to the preceding two-year moving average monthly total rainfall from the National Weather Service station USC00086842 located in Panama City, Florida (Figure 3-6). A two-year moving average was utilized to account for the effect of antecedent rainfall conditions on baseflow. As demonstrated in Figure 3-6, fluctuations in baseflow are consistent with fluctuations in cumulative rainfall, although some variability is present, likely due to uncertainty in computed baseflow and differences in recharge rates and time of travel within the watershed, which may not correspond directly to a two-year moving average rainfall.

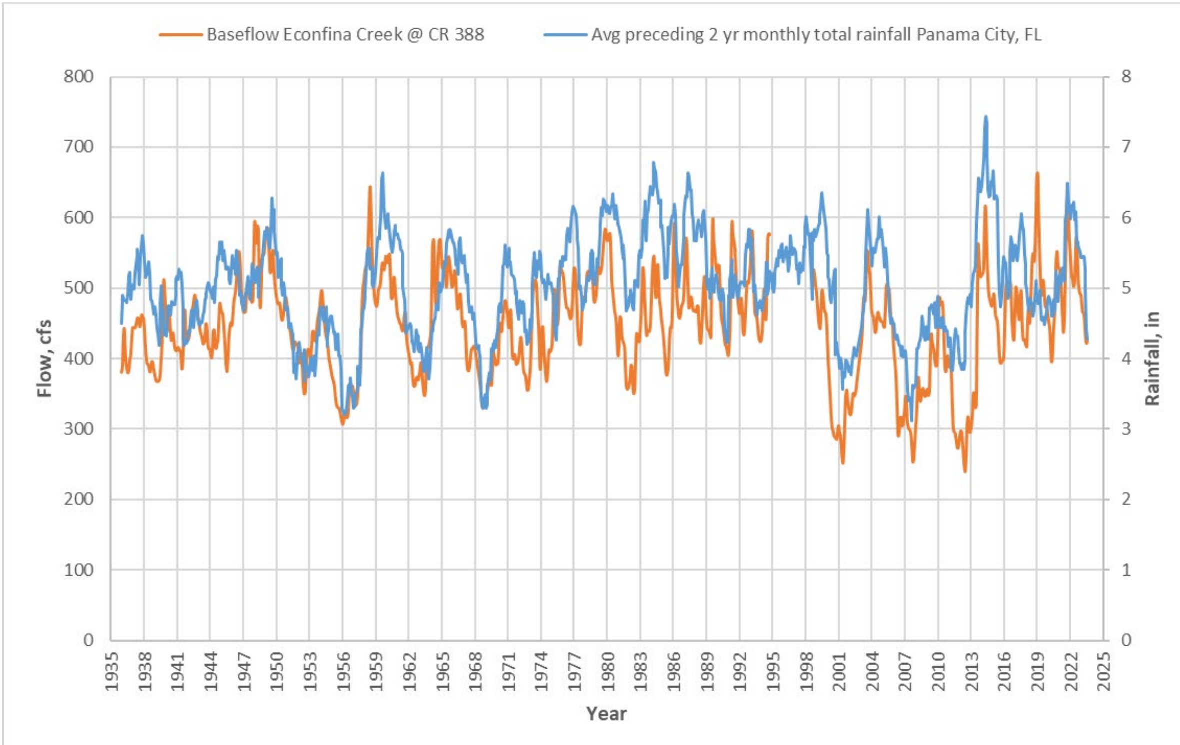


Figure 3-6. Baseflow at the USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388) versus Preceding Two-year Moving Average Monthly Total Rainfall from the National Weather Service Station USC00086842 Located in Panama City, Florida

In addition to precipitation, baseflow at Econfina Creek @ CR 388 was compared to groundwater levels from the Greenhead Floridan aquifer monitoring well (NWFID 3216) from 1998 to present (Figure 3-7). The Greenhead Floridan aquifer well has the longest groundwater level record in the vicinity of Econfina Creek and is generally representative of groundwater level patterns in the region. Similar to cumulative rainfall, fluctuations in baseflow are consistent with fluctuations in regional groundwater levels. A linear regression between baseflow and groundwater levels showed a consistent relationship between the two variables from 1998-present, with an R^2 value of 0.8223 (Figure 3-8). For this linear regression, only dates with concurrent baseflow estimates and groundwater level measurements were utilized.

Analysis of baseflow, cumulative rainfall, and groundwater levels at the Greenhead monitoring well shows consistent increase in all three variables from January 2013 to present compared to the period of 1998 to 2013, which included several years of below average rainfall. Observed total annual rainfall in 2013 was 87 in. which is the highest annual total on record for the Panama City station. The average annual rainfall for this station is 59 in. This high rainfall during 2013 contributed to an increase in both groundwater levels and corresponding baseflow from January 2013 to present. Recently, rainfall has been above average, with observed total annual rainfall of 69 in. for 2020. Rainfall was well above average in 2021 (74 in.), including 20 in. recorded for August 2021 compared to the long-term average of 7.8 in for August for this station. As a result, groundwater levels and baseflow have remained elevated. Similar conditions of above average rainfall and elevated baseflow were observed in the 1970s and 1980s suggesting that current conditions, although occurring infrequently, are not atypical for this region (Figure 3-4).

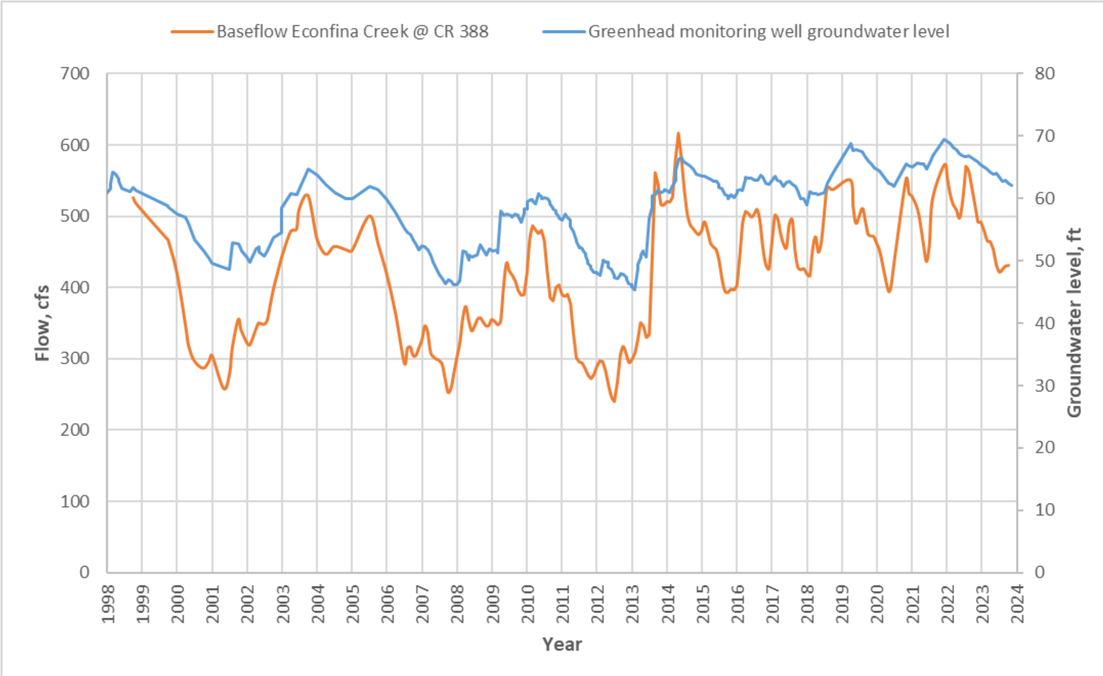


Figure 3-7. Baseflow at the USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388) versus Groundwater Level at Greenhead Floridan Monitoring Well (NWFID 3216) from 1998 to Present

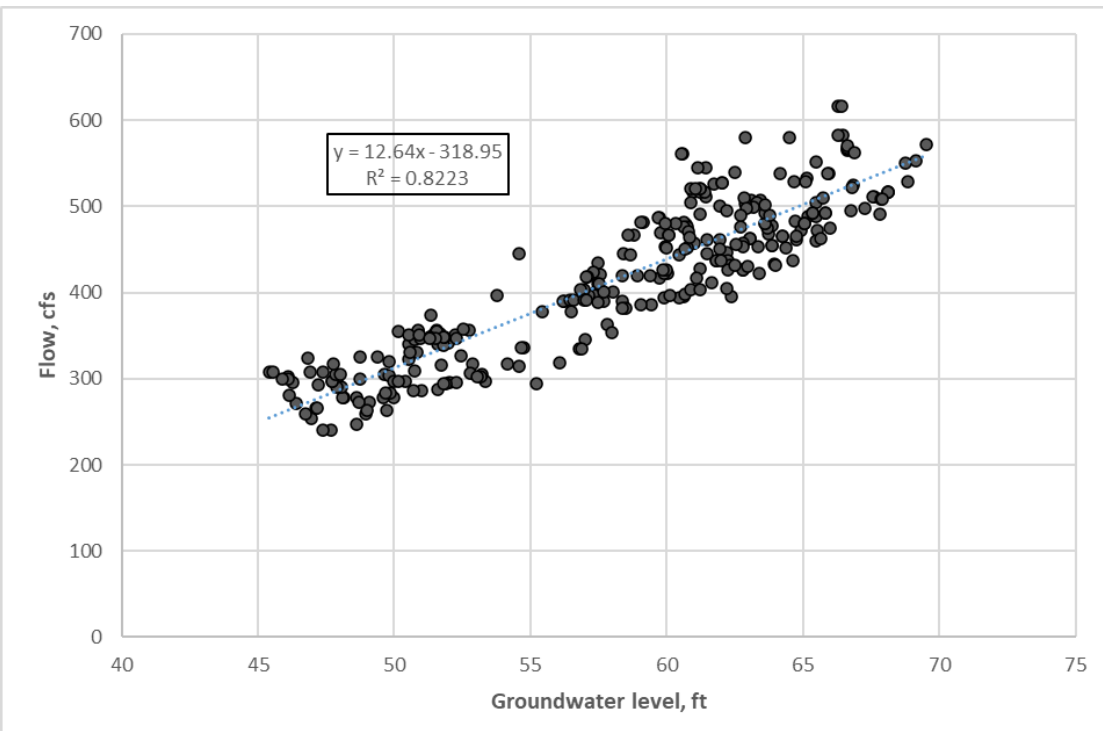


Figure 3-8. Linear Regression Between Baseflow at the USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388) and Groundwater Level at Greenhead Floridan Monitoring Well (NWFID 3216) from 1998 to Present

3.4.2 Flow Frequencies Post-Hurricane Michael

Flow frequency curves were developed for Econfina Creek @ CR 388 to determine the extent and nature of increased flows post-Hurricane Michael as compared to the historical record prior to the hurricane (Figure 3-9). Figure 3-9 shows flows have been higher across all flow percentiles post-Hurricane Michael (after 10/10/2018) as compared to the historical period of record. Flow increases are on the order of 50-100 cfs for most flow percentiles. This is consistent with the analysis shown in the previous section, indicating that flows have increased from 2013 to 2023 due to above average rainfall and elevated groundwater levels.

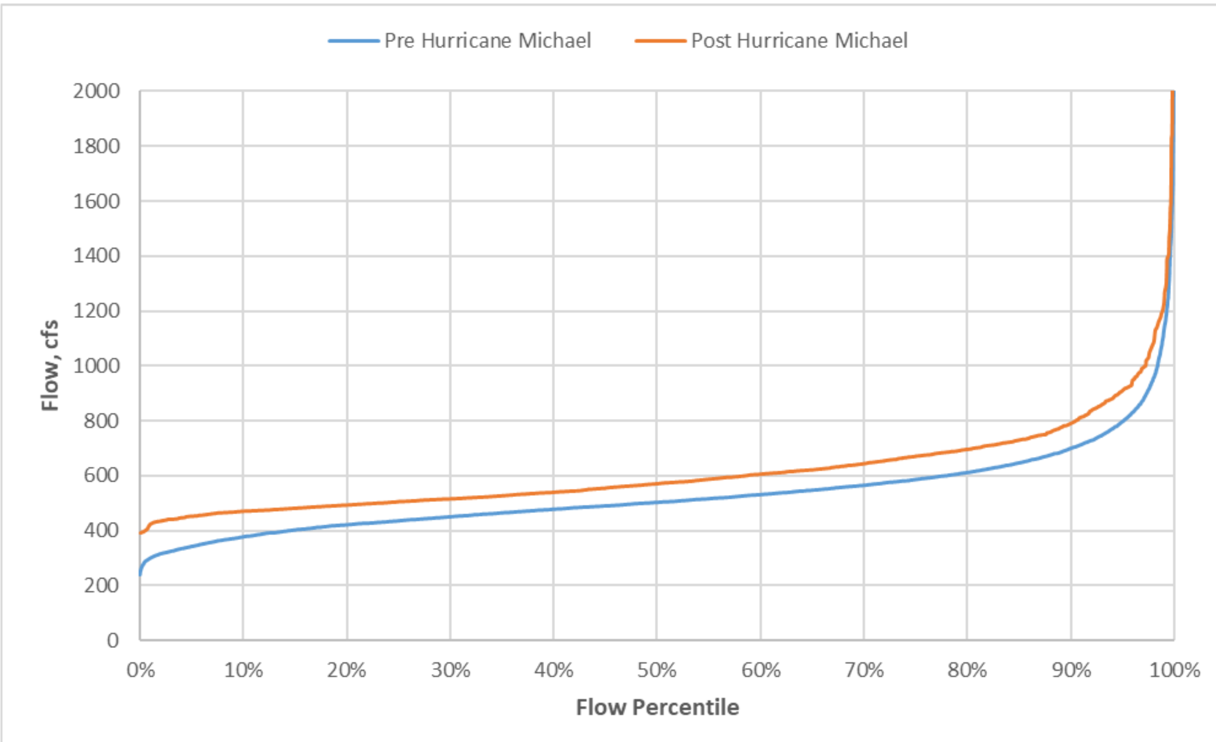


Figure 3-9. Flow Frequency Curve for the USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388)

To further investigate the nature of observed flow increases post-Hurricane Michael, flow frequencies for the surface water component of total flow were determined. Flow for Econfina Creek can be divided into two components: baseflow derived primarily from spring discharge and surface water runoff derived primarily from surface runoff. Surface water runoff was determined as the difference between daily average streamflow and estimated baseflow from the USF 61 methodology described previously. As shown in Figure 3-10, flow frequencies for surface water inputs along Econfina Creek are similar pre- and post-Hurricane Michael, indicating that increased baseflow is the primary contributor of increased flows post-Hurricane Michael. This indicates that observed increased flows post-Hurricane Michael are largely due to climatic factors.

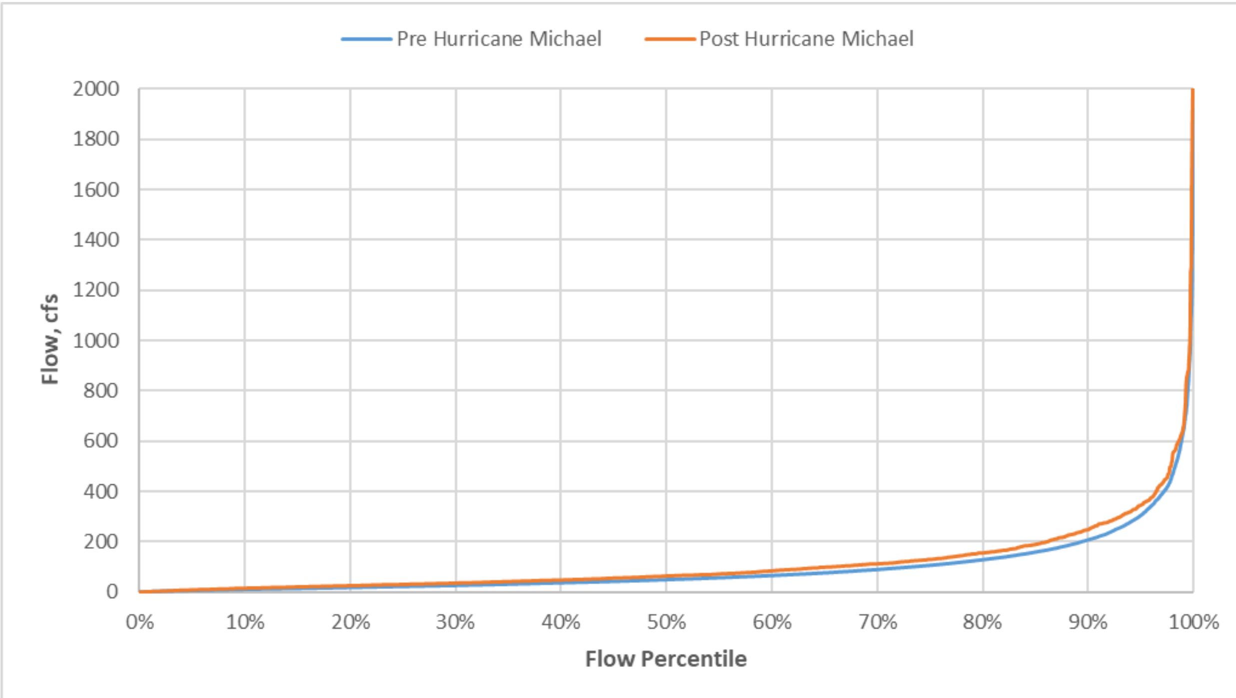


Figure 3-10. Flow Frequency Curve for Surface Water Inputs for the USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388)

3.4.3 Stage Discharge Relationships Post-Hurricane Michael

Large amounts of debris fell into Econfina Creek and surrounding floodplain areas from Hurricane Michael, causing changes to the hydrology of Econfina Creek. Downed trees in the channel and floodplain resulted in less conveyance area, resulting in slower water velocities and increased river stage for a given flow. In hopes of restoring Econfina Creek to pre-hurricane conditions, debris was removed from portions of the main channel of Econfina Creek, within the MFL study area. No debris removal was conducted in the floodplains.

Analysis of stage-discharge relationships was conducted for three periods, shown in Figure 3-11:

- Pre-hurricane conditions (before 10/10/2018)
- Post-hurricane conditions prior to completion of debris clearing (10/10/2018-3/31/2019)
- Post-hurricane conditions after completion of debris clearing (4/1/2019-present)

Review of Figure 3-11 shows substantial increases in stage for a given flow following Hurricane Michael as compared to historical conditions pre-hurricane. However, upon completion of debris removal in the Econfina Creek channel, the stage-discharge relationship returned to conditions similar to historical, although stages remain slightly elevated for a given flow, likely due to remaining debris upstream and/or in the floodplain. This indicates the benefit of debris removal in restoring historical hydrologic regimes of Econfina Creek, and reducing flooding risk in the vicinity. Similar results were achieved in other sections along Econfina Creek and Chipola River where debris removal efforts commenced (NWFWMD 2020). Likewise, areas where debris removal efforts were not conducted show continued elevated stages relative to historical conditions. Therefore, continued debris removal efforts in affected areas by Hurricane

Michael would be anticipated to further restore historical hydrologic regimes of Econfina Creek and surrounding waterbodies, and potentially reduce flooding risk in the vicinity.

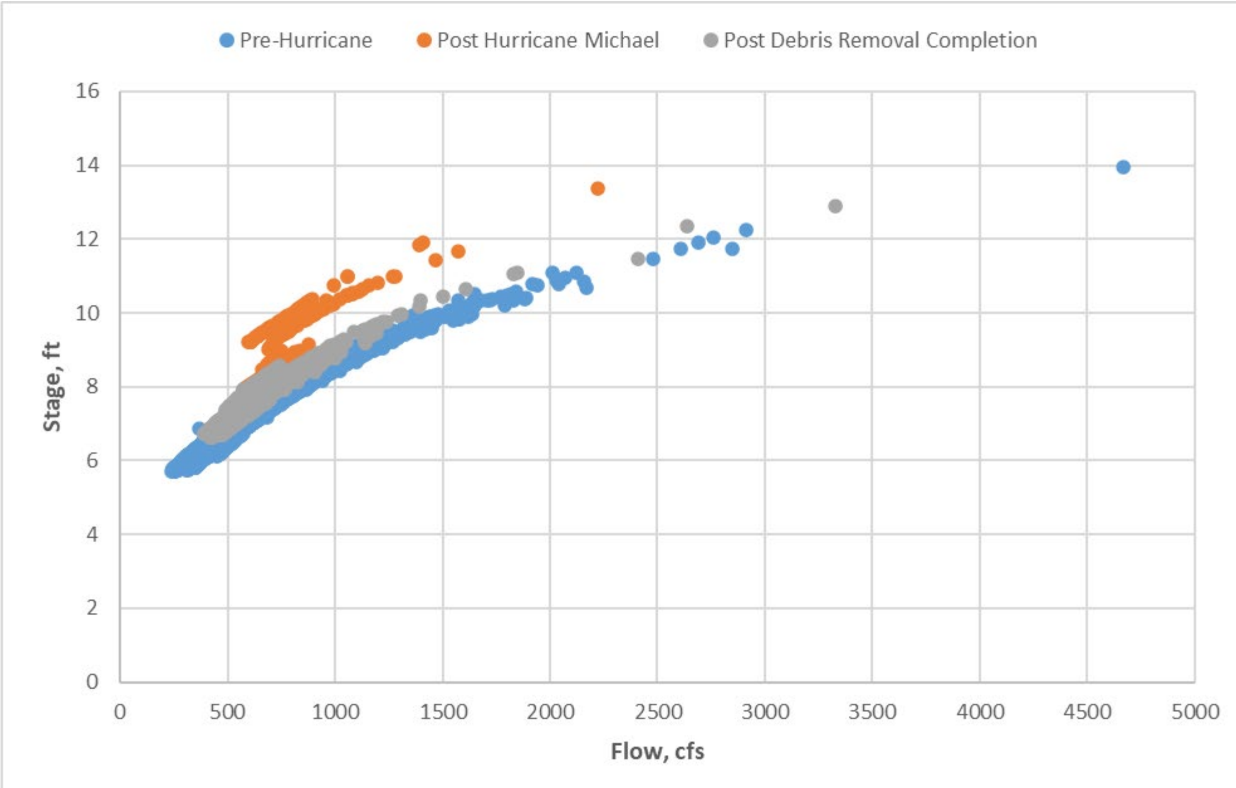


Figure 3-11. Comparison of Stage-Discharge Relationships for the USGS Station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388)

3.5 Hydrologic Evaluation for NWFWMD Station 8458 Econfina Creek @SR 20

This section presents a detailed hydrologic evaluation of observed trends in flow and stage from NWFWMD station 8458 Econfina Creek @SR 20. The purpose of this evaluation was to determine the relationship between observed changes in flow and stage with changes in climatic conditions and groundwater levels in the vicinity of Econfina Creek. Additionally, hydrologic impacts associated with Hurricane Michael are also presented here. This hydrologic assessment was also used for determination of a representative baseline flow time series for Econfina Creek.

3.5.1 Trends in Baseflow, Seasonality, and Climatic Conditions

Daily average flow at the NWFWMD station 8458 Econfina Creek @ SR 20 is shown in Figure 3-12. Similar to Econfina Creek @ CR 388, flows at this location have been relatively stable over time, with no long-term increasing or decreasing trend although short-term fluctuations can occur due to climatic variability. Average flow at this location over the period of record was 284 cfs with annual average flows ranging between 148 cfs (2007) and 408 cfs (2021). Seasonality in flows at this location was assessed by comparing average monthly discharge for the period of record (Figure 3-13). Average monthly flow for Econfina Creek @ SR 20 was highest in April (306 cfs) corresponding to a period of lower evapotranspiration rates.

Average monthly flow for Econfina Creek @ CR 388 was lowest during October-November, with average flows around 260 cfs during these months.

Baseflow for Econfina Creek @ SR 20 computed using the USF method with a 61-day window is shown in Figure 3-12. Due to sandy soils, high recharge rates, and karst hydrogeology, baseflow derived primarily from spring discharge in the middle reaches of Econfina Creek accounts for the majority of flow for this station under low to moderate flow conditions. Average baseflow over the period of record is 224 cfs, which represents 79% of the long-term average flow of 284 cfs.

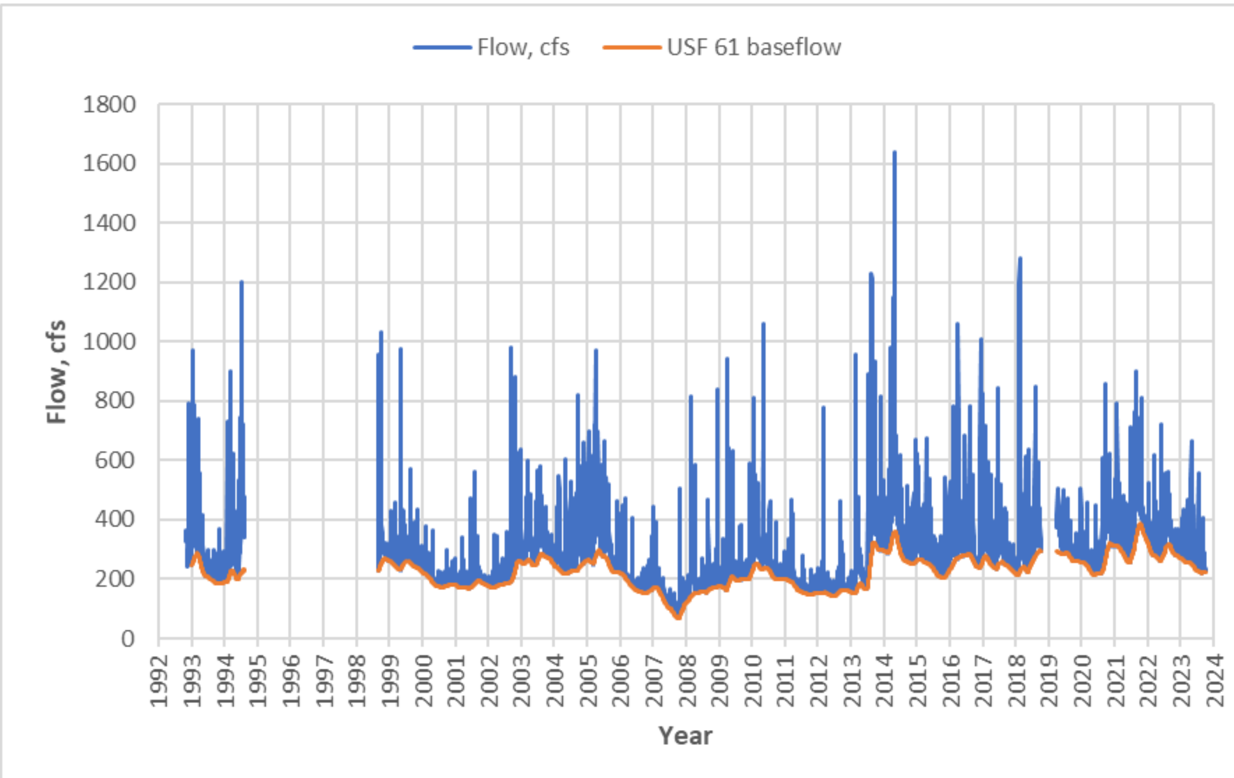


Figure 3-12. Daily Flow Hydrograph and Baseflow Hydrograph at the NWFWMD Station 8458 Econfina Creek @ SR 20

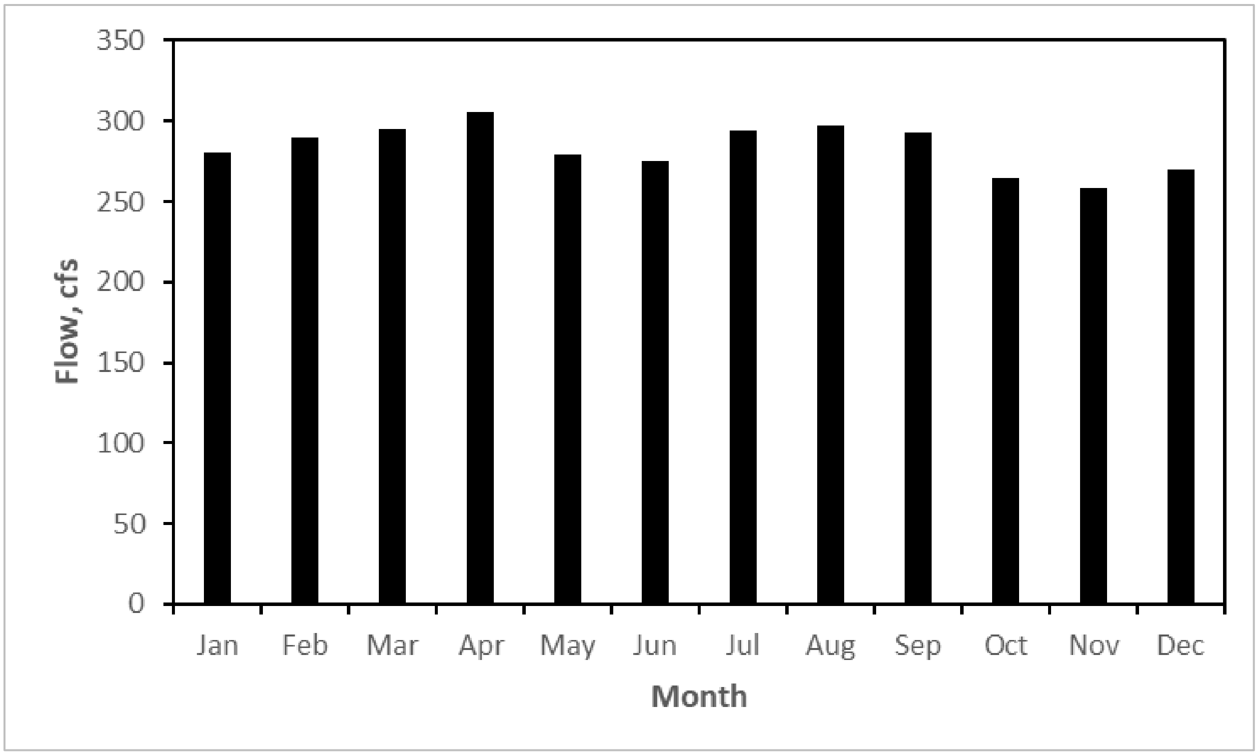


Figure 3-13. Average Monthly Flow at NWFWMD Station 8458 Econfina Creek @ SR 20

Similar to Econfina Creek @ CR 388, both total streamflow and baseflow for Econfina Creek @ SR 20 increased from January 2013-2023 as compared to previous time periods due to periods of above average rainfall including record rainfall in 2013. Baseflow at Econfina Creek @ SR 20 was compared to groundwater levels from the Greenhead Floridan monitoring well (NWFID 3216) from 1998 to present (Figure 3-14). Figure 3-14 shows trends in Econfina Creek @ SR 20 baseflow are consistent with regional groundwater level trends. A linear regression between baseflow and groundwater levels showed a consistent relationship between the two variables from 1998 -2023, with an R^2 value of 0.8127 (Figure 3-15). For this linear regression, only dates with concurrent baseflow estimates and groundwater level measurements were utilized.

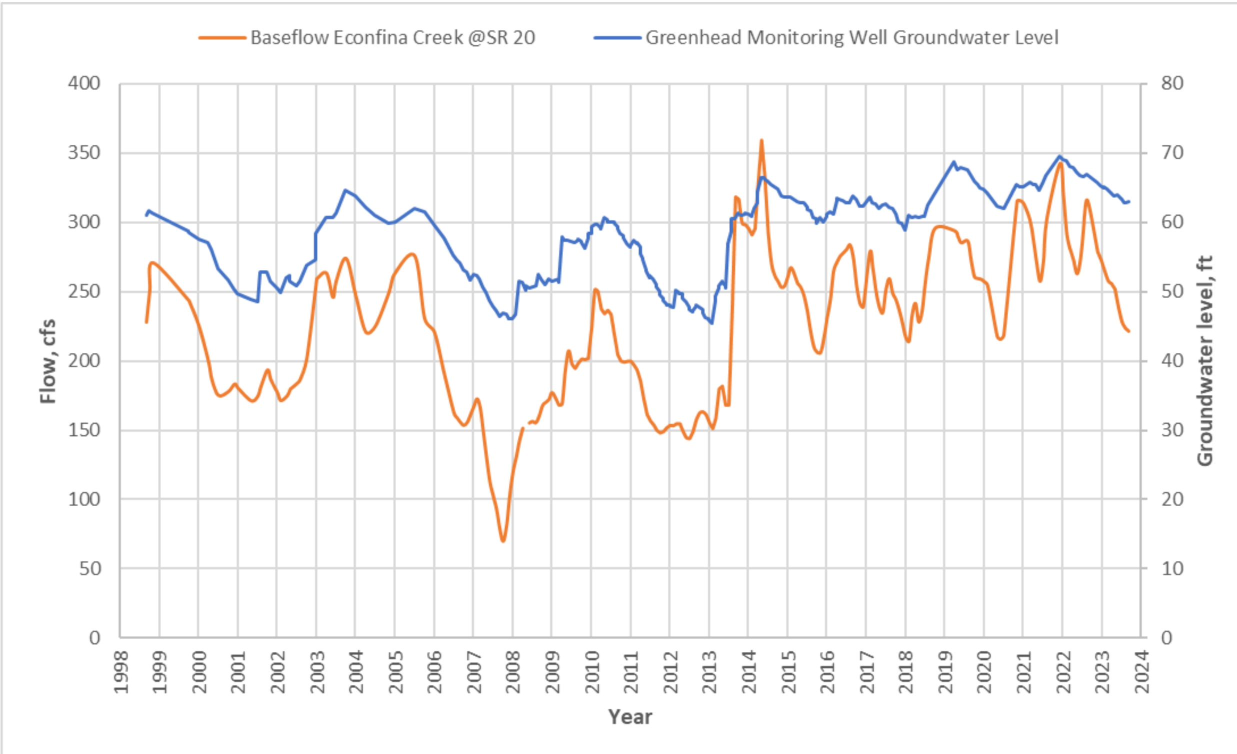


Figure 3-14. Baseflow at the NWFWMD Station 8458 Econfina Creek @ SR 20 versus Groundwater Level at Greenhead Floridan Monitoring Well (NWFID 3216) from 1998 to 2023

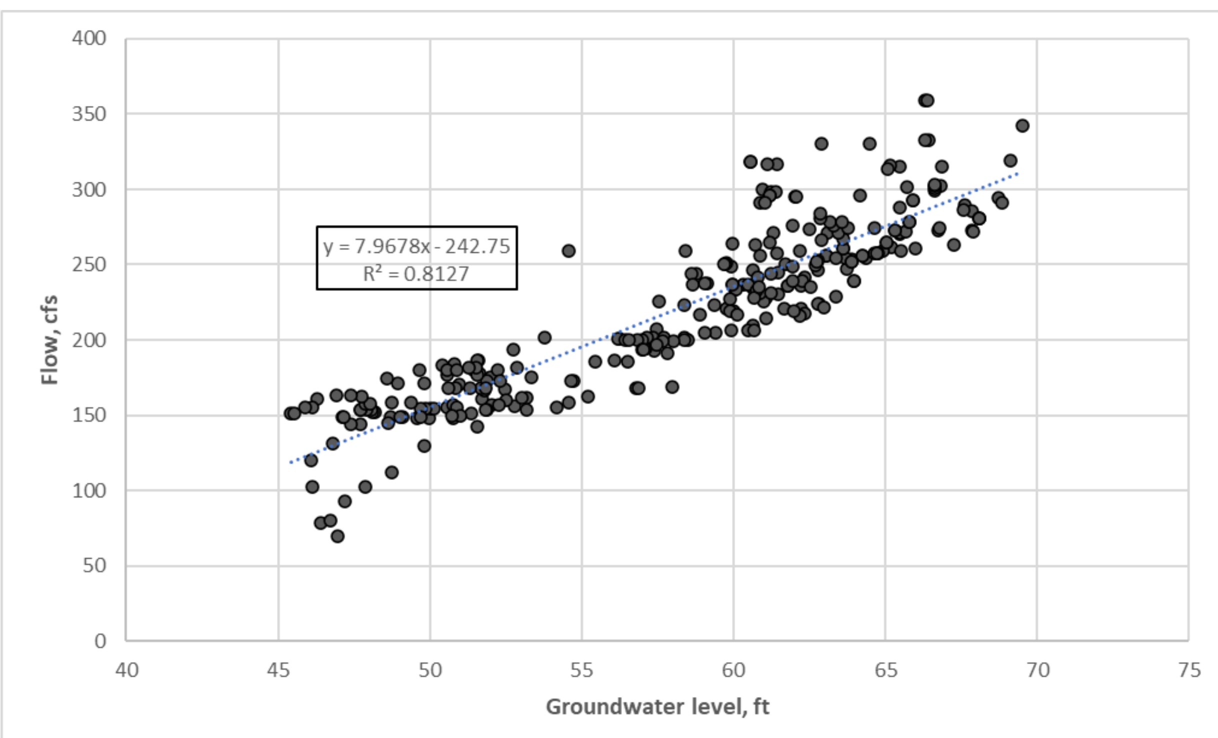


Figure 3-15. Linear Regression Between Baseflow at the NWFWMD Station 8458 Econfina Creek @ SR 20 and Groundwater Level at Greenhead Floridan Monitoring Well (NWFID 3216) from 1998 to 2023

3.5.2 Flow Frequencies Post-Hurricane Michael

Similar to Econfina Creek @ CR 388, flow frequency curves were developed for the Econfina Creek @ SR 20 station to determine the extent and nature of increased flows post-Hurricane Michael as compared to the historical record prior to the hurricane (Figure 3-16). Figure 3-16 shows flows have been higher across all flow percentiles post-Hurricane Michael (after 10/10/2018) as compared to the historical period of record. Flow increases are on the order of 50-100 cfs for most flow percentiles. This is consistent with the analysis conducted for CR 388, indicating that flows have increased from 2013 - 2023 due to above average rainfall and elevated groundwater levels.

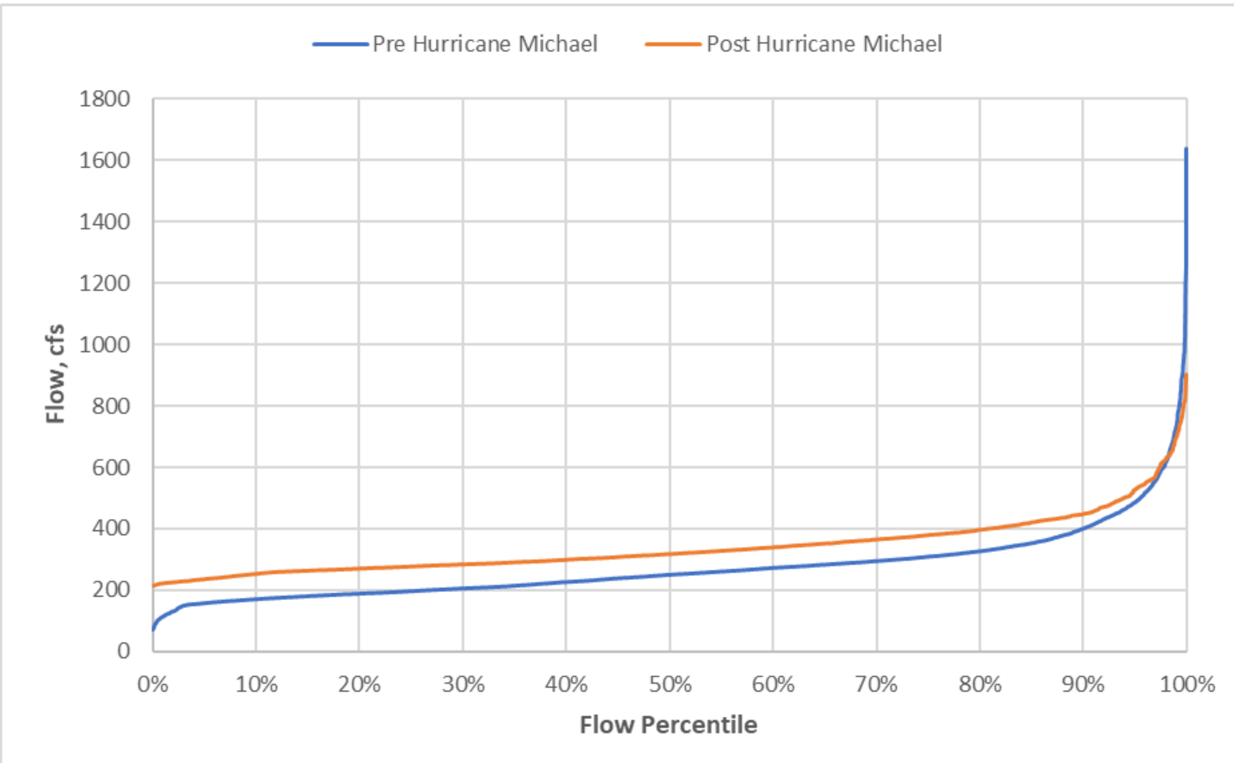


Figure 3-16. Flow Frequency Curve for the NWFWMD Station 8458 Econfina Creek @ SR 20

Similar to Econfina Creek @ CR 388, flow frequencies for the surface water component of total flow were determined for Econfina Creek @ SR 20 to further investigate the nature of observed flow increases post-Hurricane Michael. Surface water runoff was determined as the difference between daily average streamflow and estimated baseflow from the USF 61 methodology described previously. As shown in Figure 3-17, flow frequencies for surface water inputs at Econfina Creek @ SR 20 are similar pre and post-Hurricane Michael, indicating increased baseflow is a primary contributor of increased flows post-Hurricane Michael.

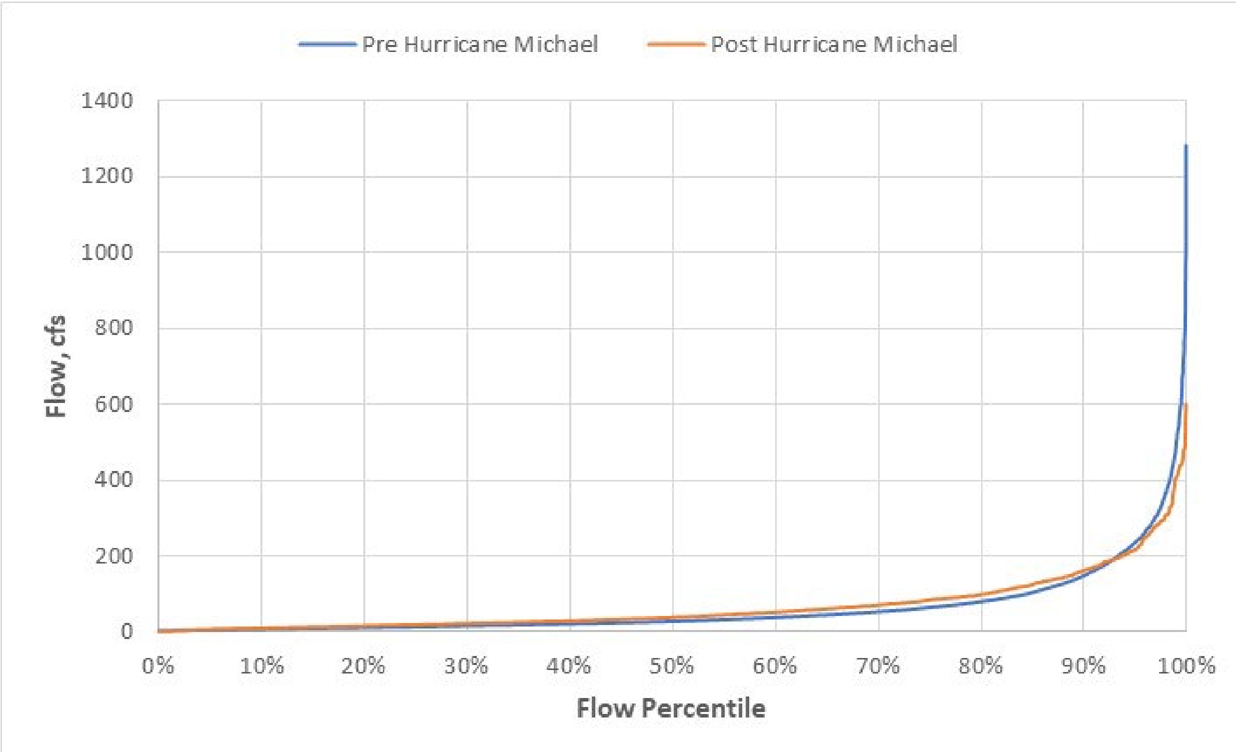


Figure 3-17. Flow Frequency Curve for Surface Water Inputs for the NWFWMD Station 8458 Econfina Creek @ SR 20

3.5.3 Stage-Discharge Relationships Post-Hurricane Michael

Large amounts of debris fell into Econfina Creek and surrounding floodplain areas from Hurricane Michael, causing changes to the hydrology of Econfina Creek. Downed trees in the channel and floodplain resulted in less conveyance area for a given flow, resulting in slower water velocities and increased river stage. In hopes of restoring the Econfina Creek to pre-hurricane conditions, debris was removed from portions of the main channels of Econfina Creek, including the MFL study area. No debris removal was conducted in the floodplains.

Analysis of stage- discharge relationships was conducted for two periods, shown in Figure 3-18:

- Pre-hurricane conditions (before 10/10/2018)
- Post-hurricane conditions after completion of debris clearing (3/30/2019-present)

Data from 10/10/2018 to 3/29/2019 was unavailable at this station due to damage from the storm. Review of Figure 3-18 shows the stage-discharge relationship upon completion of debris removal in the Econfina Creek channel similar to historical, although stages remain slightly elevated, likely due to remaining debris in the floodplain. This result is consistent with that for Econfina Creek @ 388 as well as in sections along Chipola River where debris removal efforts commenced (NWFWMD 2020). Likewise, areas where debris efforts were not conducted show continued elevated stages relative to historical conditions. This indicates the benefit of debris removal in restoring historical hydrologic regimes of Econfina Creek, and reducing flooding risk in the vicinity.

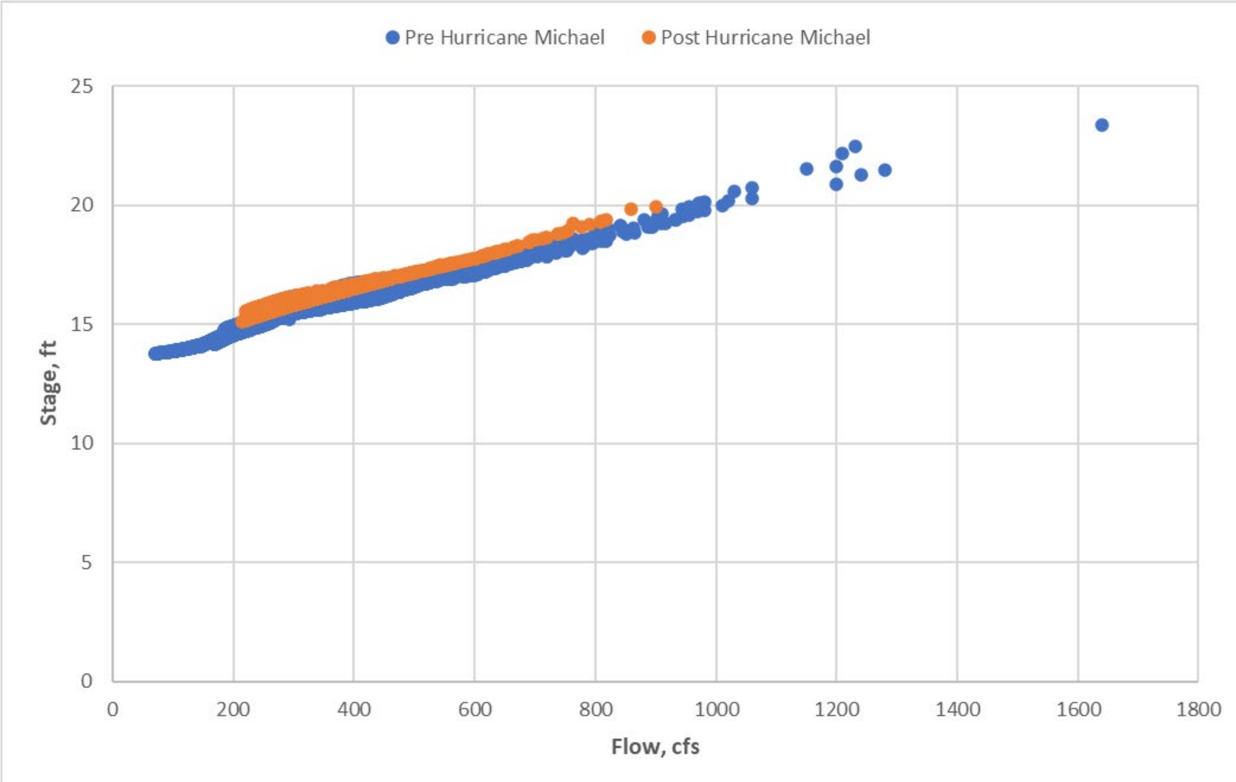


Figure 3-18. Comparison of Stage-Discharge Relationships for the NWFWMD Station 8458 Econfina Creek @ SR 20

3.6 Gainer Spring Group Discharge Trends

Trends in Gainer Spring Group discharge were assessed using a Mann-Kendall trend test. The Mann Kendall trend test was based on annual median discharge to reduce the effect of serial correlation. Results of the trend test showed a statistically significant increasing trend from 2002-2022, based on a based on a significance level of α=0.05 (Kendal tau =0.533, p-value= 0.0008). The observed increase in spring discharge is likely due to increased precipitation, with several drought periods occurring toward the beginning of discharge record analyzed in the 2000s, and several years of above-average rainfall occurring from 2013-2022. Increases in Gainer Spring Group discharge are consistent with trends presented previously for Econfina Creek stream flow and baseflow, as well as groundwater levels in the vicinity. Summary statistics for Gainer Spring Group composite discharge are presented in Table 3-8. Gainer Spring Group composite discharge measurements are presented for the full period of record in Figure 3-19 and for 2002-2022 in Figure 3-20. A significant data gap exists prior to 2002 when flow measurements were collected inconsistently by entities other than the District.

Table 3-8. Gainer Spring Group Composite Discharge Summary Statistics

Time Period	Number of Discharge Measurements	Average	Median	Minimum	Maximum
Period of Record	92	165	167	30	224
2002-2022	85	166	170	30	224
2002-2013	46	149	155	30	214
2013-2022	39	186	190	110	224

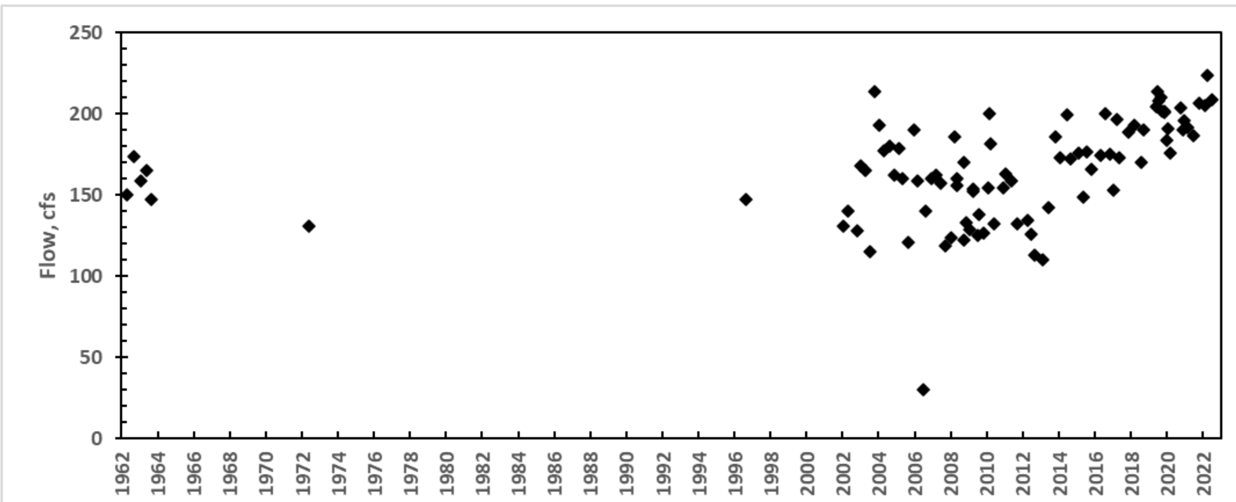


Figure 3-19. Gainer Spring Group Composite Discharge Measurements (1962-2022)

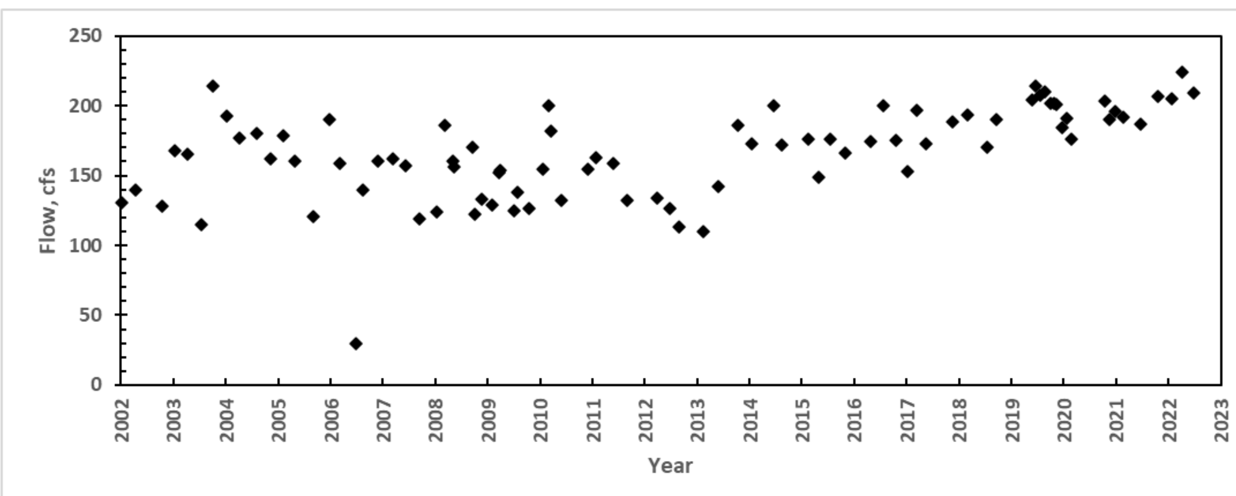


Figure 3-20. Gainer Spring Group Composite Discharge Measurements (2002-2022)

3.7 Groundwater Withdrawals and Considerations for Baseline Flow Records

The best available data was utilized to determine groundwater withdrawals within the contribution area. District staff compiled or estimated groundwater withdrawals for public supply (PS), industrial/commercial/institutional (ICI), domestic self-supply (DSS), recreation (REC), and agriculture (AG) water use categories for the years 2015 and 2020 as well as 2045 projections. Groundwater withdrawal estimates prior to 2015 were not determined since spatially distributed withdrawals for all water use categories before 2015 were unavailable at the time of this assessment.

3.7.1 Public Supply, Industrial/Commercial/Institutional, and Recreation Groundwater Withdrawals

Groundwater withdrawals for PS, ICI, and REC water use categories within the middle Econfina Creek GWCA were developed by District staff. These estimates were derived from reported groundwater withdrawals by permittees with Individual Water Use Permits (IWUPs). Groundwater withdrawals are reported and stored in the District's hydrologic database at the station level, where a station generally represents an individual well. Quality assurance/quality control (QA/QC) measures were taken to ensure accuracy of groundwater withdrawal data in the District's hydrologic database for years 2015 and 2020. This includes ensuring all provided records were entered into the District's database and cross-checking totals with independent IWUP pumpage audits performed by regulatory staff. No permitted power generation use is contained within the middle Econfina Creek GWCA.

Groundwater withdrawal estimates for year 2045, for PS, ICI, and REC water use categories, were determined based on projected water use by category and county from the 2023 NWFWMD Water Supply Assessment (WSA) (NWFWMD 2023). The rates of change for the PS, REC, and ICI categories, by county, are shown in Table 3-9. Rates of change from the 2020 base year estimates to projected 2045 use from this assessment were applied to the 2020 withdrawal estimates per county and use type within the middle Econfina Creek GWCA to determine 2045 projections within the middle Econfina Creek GWCA. This calculation is shown in Table 3-10. ICI within the Bay County portion of the middle Econfina Creek GWCA was held constant from 2020 to 2045 since the projected decrease is due in large part to a single large facility ceasing operations located outside the GWCA.

Table 3-9. Water Use Projections for Counties Within Middle Econfina Creek GWCA from 2023 NWFWMD Water Supply Assessment (NWFWMD 2023)

Bay County				
Use Category	**Estimates 2020, mgd**	**Projections 2045, mgd**	**2020-2045 mgd**	**Change %**
Public Supply	29.36	33.65	4.29	14.6%
ICI	26.48	6.54	(19.94)	-75.3%
Recreation	2.15	2.56	0.41	19.0%

Washington County				
Use Category	**Estimates 2020, mgd**	**Projections 2045, mgd**	**2020-2045 mgd**	**Change %**
Public Supply	1.01	1.10	0.09	8.6%
ICI	0.28	0.59	0.31	109.9%
Recreation	0.31	0.34	0.03	10.9%

Table 3-10. Estimated 2045 Water Use Projections for Portion of Counties Within Middle Econfina Creek GWCA

Bay County				
Use Category	Estimated use within GWCA 2015, mgd	Estimated use within GWCA 2020, mgd	County Wide Percent change 2020-2045 from WSA 2023 %	Estimated projected use, within GWCA 2045, mgd
Public Supply	0	0	14.6%	0
ICI*	0.001	0.007	n/a	0.007
Recreation	0	0.003	19.0%	0.004

Washington County				
Use Category	Estimated use within GWCA 2015, mgd	Estimated use within GWCA 2020, mgd	County Wide Percent change 2020-2045 from WSA 2023 %	Estimated projected use, within GWCA 2045, mgd
Public Supply	0.001	0.001	8.6%	0.001
ICI	0.386	0.264	109.9%	0.554
Recreation	0	0	10.9%	0

TOTAL USE				
County	Estimated use within GWCA 2015, mgd	Estimated use within GWCA 2020, mgd	County Wide Percent change 2020-2045 from WSA 2023 %	Estimated projected use, within GWCA 2045, mgd
Bay	0.001	0.010	n/a	0.011
Washington	0.387	0.265		0.555
Middle Econfina Creek GWCA Total	**0.388**	**0.275**	**n/a**	**0.566**

*ICI use held constant for Bay County portion of middle Econfina Creek GWCA

3.7.2 Domestic Self-Supply Groundwater Withdrawals

The domestic self-supply (DSS) category includes individual residences supplied by private wells. Groundwater withdrawal estimates for DSS are typically evaluated at the county level. DSS for individual residences is not regulated through the District's Water Use Permitting program and is therefore not reported to the District. However, groundwater withdrawals were estimated for this category as it may comprise a significant percent of total groundwater withdrawals in some areas.

The 2015 and 2020 county-wide DSS estimates from the District's 2018 and 2023 Water Supply Assessment updates were utilized for this analysis (NWFWMD 2018, NWFWMD 2023) (Table 3-11). These estimates were utilized to ensure consistency with recently published District groundwater withdrawal estimates. All estimated DSS use is assumed to be from groundwater sources. Additionally, 2045 county-wide projected DSS estimates from the 2023 Water Supply Assessment updates were utilized for this analysis (NWFWMD 2023).

County DSS groundwater withdrawal estimates were spatially distributed uniformly to all active DSS wells per county. Active DSS wells were determined based on a query of the District's well construction inventory. Although the exact number of wells actively being used for DSS groundwater withdrawal is unknown, several fields within the well construction inventory were utilized to determine a reasonable estimate of actively used wells, including:

- Including only well permits issued for domestic self-supply water use
- Removing wells associated with an IWUP
- Including wells with an active construction permit and excluding wells with an abandonment permit

DSS groundwater withdrawals were assigned to each well based on county and year constructed for 2015 and 2020. Groundwater withdrawals were distributed uniformly among all active DSS wells for each county and year. Wells constructed after a given year were not assigned groundwater withdrawal for that year. For example, a well-constructed in 2020 would be assigned groundwater withdrawal for 2020 but not for 2015. All wells constructed in the year 2020 or earlier were utilized for spatial distribution of 2045 county level DSS projections to individual well locations. A spatial selection was performed in ArcGIS to determine the subset of DSS wells within the middle Econfina Creek GWCA. DSS use within Econfina GWCA was determined as the summation of water use for this subset of wells (Table 3-12). A total of 3,076 active DSS wells were estimated to be within the middle Econfina Creek GWCA.

Table 3-11. DSS Water Use Estimates and Projections for Counties Within Middle Econfina Creek GWCA from 2018 and 2023 NWFWMD Water Supply Assessment (NWFWMD 2018, NWFWMD 2023)

County	Estimates 2015, mgd	Estimates 2020, mgd	Projections 2045, mgd
Bay	1.58	2.39	1.94
Washington	1.67	1.70	1.84

Table 3-12. DSS Water Use Estimates and Projections for DSS Wells Within Middle Econfina Creek GWCA

County	Estimates 2015, mgd	Estimates 2020, mgd	Projections 2045, mgd
Bay	0.26	0.40	0.32
Washington	0.46	0.47	0.51
Middle Econfina Creek GWCA Total	**0.72**	**0.87**	**0.83**

3.7.3 Agriculture Groundwater Withdrawals

Since some agricultural water users are not required to report withdrawals to the District, using only reported data will underestimate agricultural water use. Starting in 2013, the Florida Statewide Agricultural Irrigation Demand (FSAID) project was initiated as a joint effort between Florida Department of Agricultural and Consumer Services (FDACS) and all five water management districts to estimate and project agricultural water demands throughout the entire state of Florida. Estimates are developed and updated on an annual basis providing baseline estimates and projections every five years for a 20-year horizon. The end-product of the FSAID project is a GIS dataset of irrigated areas with attributes specifying crop type and baseline and projected water demand. Aggregate information by county and water management district is also provided. (For details, please refer to FDACS 2015, and FDACS 2022).

For this analysis, agricultural water demands contained within the Irrigated lands geodataset from FSAID II (for 2015 AG use estimates) and FSAID IX (for 2020 AG use estimates and 2045 projections) was utilized to estimate groundwater withdrawals within the middle Econfina Creek GWCA (FDACS 2015, FDACS 2022). A spatial selection was performed in ArcGIS to determine the subset of irrigated lands within the middle Econfina Creek GWCA. All AG water use was assumed to be derived from groundwater sources within this region. Agricultural water use is minimal in this region, with only five irrigated fields present in 2015 and two irrigated fields present in 2020 and 2045 (Table 3-13).

Table 3-13. Agriculture Water Use Estimates and Projections for Irrigated Fields Within Econfina GWCA

County	Estimates 2015, mgd	Estimates 2020, mgd	Projections 2045, mgd
Bay	0.05	0.01	0.01
Washington	0	0	0
Middle Econfina Creek GWCA Total	**0.05**	**0.01**	**0.01**

3.7.4 Groundwater Withdrawal Summary

Withdrawals within the middle Econfina Creek GWCA are presented in Table 3-14 for 2015 and 2020 as well as 2045 projections. Due to the majority of the groundwater contribution area comprising public lands including the Econfina Creek Water Management Area, withdrawals are minimal. Total groundwater withdrawals within the middle Econfina Creek GWCA were 1.16 mgd in 2015, and 1.15 mgd in 2020. This area is expected to remain mostly undeveloped, with projected groundwater withdrawals of 1.41 mgd in 2045.

Table 3-14. Groundwater Withdrawal Estimates and Projections Within Middle Econfina Creek GWCA

Water Use Category	Estimates 2015, mgd	Estimates 2020, mgd	Projections 2045, mgd
PS, ICI, REC	0.39	0.28	0.57
DSS	0.72	0.87	0.83
AG	0.05	0.01	0.01
Middle Econfina GWCA Total (mgd)	**1.16**	**1.15**	**1.41**
Middle Econfina GWCA Total (cfs)	**1.79**	**1.78**	**2.18**

3.7.5 Considerations for Baseline Flow Record

The Econfina Creek baseline flow record was determined by adjusting the historical reference flow record for USGS station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388) adding in estimated 2020 withdrawals in the contribution area of 1.15 mgd (1.78 cfs) to all flows in the historical record. This serves as a conservative estimate of withdrawal impacts on Econfina Creek baseline flows as the observed effects of these pumping volumes on Econfina Creek baseflow would most likely be considerably lower due to the distance of groundwater withdrawals from the creek. Based on the evaluation presented in this section, the full period of record of continuous discharge measurements for all Econfina Creek surface water stations was determined to represent reference conditions for this system. Additionally, the full period of record of manual discharge measurements for Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group were utilized to represent reference conditions for these springs.

4 Water Resource Values and Metric Determination

The following section presents the consideration of water resource values utilized in the MFL evaluation of middle Econfina Creek inclusive of Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group, and the metrics designed to maintain and protect the ecology and water resources of the system. Quantitative data analyses and the methodology for determining the minimum flows that are protective of WRV metrics are provided in Sections 5 and 6.

Section 62-40.473, Florida Administrative Code, lists 10 environmental or water resource values (WRVs) that must be considered in the establishment of MFLs (Table 1-1). While all listed WRVs must be considered, not all may be appropriate for establishing minimum flows for middle Econfina Creek including Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group. To determine which WRVs were most appropriate for these springs, District staff reviewed each WRV based upon three criteria:

1. Potential for significant harm to the WRV as a result of spring flow reductions
2. Relevance to middle Econfina Creek and Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group and associated spring runs
3. Measurable, quantifiable relationship with flow, and can be characterized with available data

All WRVs are discussed below with respect to the three criteria listed above. For each WRV determined to be relevant for establishment of MFLs for middle Econfina Creek, one or more quantifiable indicators were identified to evaluate the potential for significant harm. For each indicator, a quantifiable metric was determined as the limiting or critical value of a given indicator beyond which significant harm to the waterbody would be experienced.

4.1 Recreation In and On the Water

Econfina Creek provides extensive recreational opportunities including boating, swimming, tubing, and fishing. As indicated previously, the District operates and maintains several recreation areas within the Econfina Creek Water Management Area including the Pitt and Sylvan Spring and Williford Spring recreation areas. The 10-acre Pitt and Sylvan Spring recreation area includes a trail and boardwalk system leading from Pitt Spring to the Sylvan Spring area and includes an overlook and a tubing put-in dock. A tubing take-out dock is at the confluence of Pitt Spring run and Econfina Creek.

Safe Boat Passage – Econfina Creek is utilized by recreational boaters including both power boats and canoes/kayaks. Reduced water levels can increase the chances of damage to river substrates and damage to outboard motors from hard substrates such as the limestone outcroppings present along many parts of Econfina Creek. The intensive recreational boat use along portions Econfina Creek makes safe boat passage an important metric for the recreation WRV. Boat use along the Williford Spring run is not permitted. For minimum flow determination, two separate boat passage metrics were utilized to account for different uses along Econfina Creek.

Power Boats – Private power boat use along Econfina Creek below the SR 20 bridge is a popular recreational activity. A public boat ramp located at the CR 388 bridge crossing provides access to Econfina

Creek for power boats. The portion above SR 20 is typically not used for power boating as the Creek becomes narrow and shallow. For private recreational boat use along Econfina Creek below SR 20, a minimum water depth of 2.0 ft. across a continuous channel width of 30 ft. was used as the metric to evaluate safe boat passage. This metric has been used in previous MFL assessments and has been previously approved by scientific peer review (NWFWMD 2021, NWFWMD 2019, SRWMD 2016a). Although the portion of Econfina Creek above SR 20 is typically not used for power boating, a minimum water depth of 2.0 ft. across a continuous channel width of 15 ft. was used as the metric to allow passage for a single boat in this reach. This portion of Econfina Creek is considerable narrower and does not facilitate the passage of two power boats as is possible in the lower portions of the creek.

Canoe/Kayaks – Econfina Creek is commonly used for canoeing and kayaking. The DEP has identified Econfina Creek as a Florida Designated Paddling Trail from the Scott Rd. bridge to the CR 388 bridge. However, debris remaining from Hurricane Michael currently prevents kayaking above Williford Spring Group. A privately owned canoe/kayak rental business located along Econfina Creek near Williford Spring is a popular destination for recreational users. In addition, the Sylvan and Gainer Spring runs are popular kayaking destinations. Kayaking along the Williford Spring run is not permitted. The extensive use of Econfina Creek for canoeing/kayaking makes safe canoe and kayak passage an appropriate metric for this system.

A minimum thalweg depth of 1.5 ft. was used as the metric for safe canoe/kayak passage, similar to previous MFL evaluations (NWFWMD 2021, NWFWMD 2019, SRWMD 2013). This metric was assessed along Econfina Creek through study area from just above Williford Spring Group to Deer Point Lake.

4.2 Fish and Wildlife Habitat and the Passage of Fish

The abundant wildlife and extensive natural vegetation communities within Econfina Creek make Fish and Wildlife Habitat and the Passage of Fish a relevant WRV. Numerous metrics were considered for MFL evaluation as described below.

4.2.1 Fish Passage

Maintaining connectivity between upstream and downstream portions of Econfina Creek during low-flow conditions is important to allow fish physical access up and/or downstream a river to areas of deeper water to escape predation or to access food sources and/or spawning habitat. In Florida MFL evaluations, this metric is often referred to as ”fish passage” and has been used in varying forms across multiple minimum flow evaluations throughout the state (NWFWMD 2019, NWFWMD 2021, SRWMD 2016a, SWFWMD 2017a).

Econfina Creek provides habitat to numerous recreationally important fish species such as largemouth bass (Table 2-6). A screening of the fish species known to inhabit Econfina Creek (Table 2-6) revealed that largemouth bass are the native fish species capable of reaching the largest body depth. The largest bodied fish documented in Econfina Creek is grass carp, *Ctenopharyngodon Idella.* These are an exotic species (FWC 2021) and are listed as a conditional, non-native species by the State of Florida (chapter 68-5.004, Florida Administrative Code). The legal introduction of grass carp requires a permit from the FWC (Rule 68-5.005, Florida Administrative Code), however no permit exists for grass carp in Econfina Creek and it is assumed these individuals escaped from another location or were illegally introduced into the system. As a result, this species was not considered further for MFL evaluation.

Historically, larger-bodied native, anadromous/catadromous species such as Gulf Sturgeon and Striped Bass may have utilized Econfina Creek. These species require migrations between fresh and salt water to complete their life cycle. In 1961, a water control structure was completed at the downstream end of Econfina Creek to create Deer Point Lake which serves as the primary source of potable water for Bay County. If these species had been present, this structure blocked the migration for anadromous/catadromous species preventing them from reaching their spawning grounds. Neither Gulf sturgeon nor striped bass have been documented in Econfina Creek before or since the construction of Deer Point Lake. As a result, these species were not considered further for MFL evaluation.

Little information is available concerning the requirements for fish passage for warm water species. Multiple MFL assessments have used a water depth of either 0.6 ft. or 0.8 ft. across as much as 25 percent of the river width as a fish passage criterion (SRWMD 2016a, SWFWMD 2017a). These depths were initially devised to protect anadromous fish (salmon and large trout) passage in the Pacific Northwest (Stalnaker and Arnette 1976) and represented the best available data at the time. In 2002, the SWFWMD determined that 0.6 ft. was most representative of the body depth of most individuals of the largest fish species known to inhabit the Peace River (largemouth bass, *Microptera salmoides*). Since largemouth bass are the deepest bodied, native fish species documented in Econfina Creek, a minimum fish passage depth of 0.6 ft. at the channel thalweg was utilized for the fish passage metric as has been used in previous MFL assessments (NWFWMD 2019, NWFWMD 2021). Largemouth bass are not known to gather in larger aggregations for long spawning runs similar to the anadromous species the metrics were initially designed for. As a result, a minimum channel width was not utilized in combination with the required depth. This metric was assessed through the Econfina Creek study area from just above Williford Spring to Deer Point Lake.

4.2.2 Instream Woody Habitat Inundation

Submerged woody habitat has been identified as being important as habitat and food for invertebrate species in streams of the southeastern United States (Benke et al. 1984, Benke et al. 1985). These macroinvertebrates then provide food for larger fauna including the recreationally important sunfishes and largemouth bass. In addition, woody habitat alters streamflow characteristics and helps create multiple habitat types including pools and bars habitat (Abbe and Montgomery 1996).

Two types of instream woody habitat were observed along Econfina Creek. Dead woody debris consists of tree stumps and fallen logs/branches present and inundated along the edge of the river channel. Live roots include tree roots, cypress knees, etc. found along the river edge that are routinely inundated by river flow or have become exposed due to erosion from water flow. Dead woody debris tends to be found deeper in the river channel and at a lower elevation than live roots. Due to the abundance of shoreline woody habitats and their importance to aquatic species, the length of time that woody habitats are inundated and accessible to aquatic species was considered an appropriate metric.

Woody debris habitats can be considered transient. Dead woody debris can be deposited as a result of tree/limb fall during storm events, following erosion, etc. These habitats degrade/decompose through time or get transported downstream and into the floodplain following high flow events. These debris are replaced by new debris creating a turnover of new and old debris. Live roots are created as sediments are eroded from around the roots of established trees and new trees and their associated structures such as cypress knees recruit near the channel. As described previously in Section 2.8, extensive debris cleanup was conducted along Econfina Creek, removing the majority of woody debris within Econfina Creek including submerged trees which were present historically. As a result, much of Econfina Creek currently has little woody debris present, which is likely not representative of historical conditions.

As previously discussed, spring flows are relatively stable and represent only a portion of the Econfina Creek flows in the study area (Section 3.3). It is unknown whether water velocities associated with flows arising from Gainer, Williford, and Sylvan spring groups are sufficient to result in the erosion needed to help create live root habitat. During periods of reduced water levels, wetland trees can recruit near the stream channel and create new live root habitat when water levels return. Dead woody debris is routinely created and deposited in the creek and may have little to do with spring flows.

Due to the transient nature of instream woody habitat and impact from Hurricane Michael and debris cleanup efforts, woody debris was determined to not be appropriate for this MFL evaluation at this time and was not considered further.

4.2.3 Floodplain Vegetation Inundation

Following Hurricane Michael large portions of the Econfina Creek floodplain habitat were severely damaged, as described previously in Section 2.8. As a result, floodplain communities currently present may not be representative of what they were historically. The floodplain communities are likely to undergo rapid succession into a more stable community during the next decade and may exhibit changes in community structure compared to the early successional floodplain communities currently present. In addition, the high concentration of dead and leaning trees in the floodplain presents numerous safety concerns and precluded floodplain sampling. As a result, the sampling of trees in the floodplain was not conducted.

Although floodplain vegetation inundation was not directly evaluated, this indicator was addressed by considering the frequency of out-of-bank flows as a function of streamflow along Econfina Creek. Maintaining out-of-bank flows along Econfina Creek is expected to provide protection to riparian and wetland systems allowing for protection of this indicator and was considered in establishing MFLs for the middle Econfina Creek including Gainer, Williford, and Sylvan spring groups. Detailed methodologies for assessing out-of-bank flows are presented in Section 6.2.

4.2.4 In Stream Habitat of Aquatic Species

Since Econfina Creek provides habitat for numerous aquatic species, metrics pertaining to instream habitat of aquatic species are relevant for this MFL evaluation. Habitat suitability is defined based on relationships among depth, substrate, and stream velocity at specific transect locations. Through a series of subroutine programs in the System for Environmental Flow Analysis (SEFA) software, a prediction of the amount of available habitat (Area Weighted Suitability (AWS)) for target organism(s) over a range of stream flow conditions is created. The effects of flow reduction scenarios on AWS can be evaluated to quantify in-stream habitat metrics. Details regarding SEFA model development are presented in Section 5.2.

4.3 Estuarine Resources

Estuarine conditions are not present within the study area. Therefore, this WRV was not considered further for metric development and MFL evaluation.

4.4 Transfer of Detrital Material

Detrital material is comprised of dead organic material (largely vegetation) in the process of decomposition. Plant detritus comprises a large portion of the food base in aquatic and wetland ecosystems. Little quantifiable data is available regarding the transport of detrital material in Econfina Creek or its relationship to flow characteristics. In addition, spring water is typically very low in detritus. As a result, this WRV was unable to be associated with a directly quantifiable metric.

Although transfer of detrital material was not directly evaluated, this WRV was addressed by considering the frequency of riparian bank habitat inundation, bankfull flows, and out-of-bank flows as a function of streamflow along Econfina Creek. Maintaining these characteristics along Econfina Creek is expected to provide protection to riparian and wetland systems allowing for protection of this WRV and was considered in establishing MFLs for Gainer, Williford, and Sylvan Spring Groups. Detailed methodologies for assessing riparian bank habitat inundation, bankfull flows, and out-of-bank flows are presented in Section 6.2.

4.5 Maintenance of Freshwater Storage and Supply

Maintaining long-term freshwater storage for non-consumptive uses and environmental resources is the prime objective for establishing a MFL flow regime. Freshwater storage and supply for the natural system is addressed as part of the overall minimum flow regime, which protects water availability for multiple WRVs.

Although maintenance of freshwater storage and supply was not directly evaluated, this WRV was addressed by considering the frequency of riparian bank habitat inundation, bankfull flows, and out-of-bank flows as a function of streamflow along Econfina Creek. Maintaining these characteristics along Econfina Creek is expected to sustain riverine fluvial dynamics, and therefore freshwater storage and supply, allowing for protection of this WRV and was considered in establishing MFLs for Gainer, Williford, and Sylvan Spring Groups. Detailed methodologies for assessing riparian bank habitat inundation, bankfull flows, and out-of-bank flows are presented in Section 6.2.

4.6 Aesthetic and Scenic Attributes

Aesthetic and scenic attributes refer to passive uses of the river such as nature viewing, hiking, and photography. These uses are one of the main reasons for the popularity of Econfina Creek for recreational uses. Active recreational uses are described in Section 2.9. The vegetation (instream and riparian) and wildlife are addressed under WRV2 Fish and Wildlife Habitats and the Passage of Fish. Therefore, protection of this WRV is incorporated in metrics pertaining to Recreation and Fish and Wildlife Habitats.

Previous MFL assessments have described an increase in filamentous algal cover on submerged aquatic vegetation in rivers as a decrease in the aesthetics of a system (SRWMD 2013). The relationship between algal cover and water velocity has been described as a subsidy-stress relationship where changes in water velocity can promote algal growth through increased nutrient uptake but also impede algal growth through shearing (Horner and Welch 1981, Stevenson 1996, Biggs et al. 1998, King 2012). A minimum average channel velocity of 0.8 ft/s in locations with surveyed submerged aquatic vegetation (SAV) was utilized as the metric for impediment of algal growth on SAV for the Lower Sante Fe and Ichetucknee River MFL and Silver River MFL (SRWMD 2021, SJRWMD 2017). However, little SAV is present along the Econfina Creek study area (Section 2.9.1) and instream woody habitat has been severely reduced through clearing leaving little areas for filamentous algae to attach and grow. As a result, this metric was not considered further for this MFL evaluation. Similar to excessive algal cover, nuisance and exotic vegetation can decrease the aesthetics of an aquatic system. Currently, little nuisance and exotic vegetation exists along Econfina Creek.

As a result of the lack of SAV, instream woody habitat, and nuisance/exotic vegetation, this water resource value was not considered further for MFL analysis.

4.7 Filtration and Absorption of Nutrients and Other Pollutants

Nutrients are taken up by aquatic plants where they are stored, and in some cases transported out of the aquatic system. Floodplains and wetland soils also provide areas for nitrogen mineralization and denitrification. Information concerning the filtration and absorption of nutrients and other pollutants is currently unavailable for Econfina Creek. As a result, this WRV was unable to be associated with a directly quantifiable metric.

Although filtration and absorption of nutrients and other pollutants was not directly evaluated, this WRV was addressed by considering the frequency of riparian bank habitat inundation, bankfull flows, and out-of-bank flows as a function of streamflow along Econfina Creek. Maintaining these characteristics along Econfina Creek is expected to provide protection to riparian and wetland systems allowing for protection of this WRV and was considered in establishing MFLs for Gainer, Williford, and Sylvan spring groups. Detailed methodologies for assessing riparian bank habitat inundation, bankfull flows, and out-of-bank flows are presented in Section 6.2.

4.8 Sediment Loads

The importance of sediment transport in the maintenance of Econfina Creek geomorphology and its associated ecological communities was considered as a WRV for this MFL evaluation. Information concerning sediment size and transport downstream is currently unavailable for Econfina Creek. As a result, this WRV was unable to be quantified. Given the karst nature of Econfina Creek and the associated limestone outcroppings and mix of coarse sand, shell, and gravel substrate that are present along the middle portion of the creek, it is probable most of the creek's sediment load is carried at higher flows.

Although sediment transport was not directly evaluated, this WRV was addressed by considering the frequency of riparian bank habitat inundation, bankfull flows, and out-of-bank flows as a function of streamflow along Econfina Creek. Maintaining these characteristics along Econfina Creek is expected to provide protection to sediment transport processes which are more likely to occur at higher flows allowing for protection of this WRV and was considered in establishing MFLs for Gainer, Williford, and Sylvan spring groups. Detailed methodologies for assessing riparian bank habitat inundation, bankfull flows, and out-of-bank flows are presented in Section 6.2.

4.9 Water Quality

Based on the water quality data analyses presented in Section 2.7, metrics pertaining to water quality were not utilized in the MFL determination for the Gainer Spring Group, Williford Spring Group, or Sylvan Spring Group. As indicated previously, levels of nitrate at Gainer Spring Group are relatively low, with an average concentration of 0.20 mg/L. Average specific conductance at Gainer Spring was 136 µS/cm indicating minimal salinity impacts. Neither parameter has a statistically significant relationship with spring flow or stream flow. Additionally, due to the extensive efforts by the District to protect Econfina Creek watershed through land acquisition coupled with minimal projected growth in the area, water quality is not anticipated to be of concern for this system.

4.10 Navigation

The District has defined this WRV as the navigation of commercial vessels within the study area. Econfina Creek is not used for commercial navigation making the Navigation WRV inappropriate for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group minimum flows determination.

4.11 Selection of Water Resource Values and Associated Metrics

After carefully considering all 10 WRVs, the WRVs evaluated explicitly for the determination of minimum Econfina Creek spring flows are:

- Recreation In and On the Water
- Fish and Wildlife Habitat and the Passage of Fish

An assessment of riparian bank habitat inundation, bankfull flows, and out-of-bank flows was also considered providing protection for several WRVs including:

- Transfer of Detrital Material
- Maintenance of Freshwater Storage and Supply
- Filtration and Absorption of Nutrients and Oher Pollutants
- Sediment Loads
- Aesthetic and Scenic Attributes

Three WRVs were considered not appropriate for the establishment of MFLs for Econfina Creek springs including:

- Estuarine Resources
- Navigation

- Water Quality

A summary of WRVs, indicators, and associated metrics utilized to determine minimum flows for middle Econfina Creek and associated spring groups is shown in Table 4-1.

Table 4-1. Selected Water Resource Values, Indicators, and Metrics Utilized to Determine Minimum Flows for Middle Econfina Creek and Associated Spring Groups

Water Resource Value	Indicator	Metric(s)
Recreation in and on the water	Canoe/kayak passage	Percent of time flows maintaining a minimum thalweg depth of 1.5 ft. at all transects in the study area is achieved.
Recreation in and on the water	Power boat passage	Percent of time flows maintaining a 2 ft. depth across a 30 ft. width at all transects below SR 20 is achieved (2 boats side by side). Percent of time flows maintaining a 2 ft. depth across a 15 ft. width at all transects in the study area above SR 20 is achieved.
Fish and Wildlife Habitat and the Passage of Fish	Fish passage	Percent of time flows maintaining a minimum thalweg depth of 0.6 ft. at all transects in the study area is achieved.
Fish and Wildlife Habitat and the Passage of Fish	Floodplain vegetation inundation	Relative weighted wetted perimeter associated with inflection point(s) of streamflow versus weighted wetted perimeter within the study area.
Fish and Wildlife Habitat and the Passage of Fish	Instream habitat of aquatic species	Area weighted suitability (AWS) versus streamflow for select aquatic species using SEFA.
Transfer of Detrital Material	Riparian habitat and floodplain inundation	Relative weighted wetted perimeter associated with inflection point(s) of streamflow versus weighted wetted perimeter within the study area.
Maintenance of Freshwater Storage and Supply	Riverine fluvial dynamics	Relative weighted wetted perimeter associated with inflection point(s) of streamflow versus weighted wetted perimeter within the study area.
Filtration and Absorption of Nutrients and Other Pollutants	Riparian habitat and floodplain inundation	Relative weighted wetted perimeter associated with inflection point(s) of streamflow versus weighted wetted perimeter within the study area.
Sediment Loads	Riparian habitat and floodplain inundation	Relative weighted wetted perimeter associated with inflection point(s) of streamflow versus weighted wetted perimeter within the study area.

5 Models Used in Minimum Flow Determination

In order to assess the effect of changes in spring flow from Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group on WRV indicators and associated metrics, extensive data collection and modeling efforts were performed. Two models were developed for MFL assessment including a Hydraulic Engineering Centers River Analysis System (HEC-RAS) model for assessing low flow (passage) metrics as well as bankfull/out-of-bank flow metrics, and a System for Environmental Flow Analysis (SEFA) model for evaluating instream habitat metrics. Model development and associated data collection for both the HEC-RAS and SEFA models utilized in this MFL assessment are described below.

5.1 HEC-RAS Model Development and Calibration

The Hydrologic Engineering Centers River Analysis System (HEC-RAS) model is a widely used one-dimensional model for hydraulic analysis of river channels and associated floodplains. The stream channel geometry and properties are represented by a series of attributed cross-sections (XS). The HEC-RAS model enables the calculation of water surface profiles for steady and unsteady (transient) flow profiles. Calculations are based on computed energy losses between adjacent cross-sections.

A HEC-RAS model of the Econfina Creek MFL study area was developed for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group MFL evaluation, using HEC-RAS version 6.3.1. A summary of the development and calibration of the HEC-RAS model used for this evaluation is presented below. Further details are provided in Appendix A of this report.

A steady-state HEC-RAS (HEC-RAS Version 6.3.1) model of the middle (between Williford Spring Group and CR 388 bridge) and lower (Below CR 388 bridge) portions of Econfina Creek was developed by District staff with support from ATM, a Geosyntec Company (ATM) in support of MFL development for Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group. The model was constructed with the best available data, including high resolution Digital Elevation Model (DEM), recent cross-sectional survey data throughout the model domain, and hydrologic data from all available stations along Econfina Creek. Although a HEC-RAS model had previously been developed in 2006 for the middle and lower portions of Econfina Creek for performing Federal Emergency Management Agency (FEMA) flood evaluations, a new model was constructed for purposes of MFL evaluation due to the required model resolution at low flows as well as newly available DEM, survey, and hydrologic data along with significant changes to the system resulting from Hurricane Michael impacts. Surveyed bridge dimensions for the SR 20 and CR 388 Econfina Creek bridge crossings obtained from Florida Department of Transportation, as well as dimensions contained in the existing FEMA model, were utilized for the updated MFL HEC-RAS model.

The model domain extends from immediately north of Williford Spring to the northern portion of Deer Point Lake at the confluence of Econfina Creek and Bear Creek, encompassing all spring group flow contributions considered for MFL evaluation. The model was extended just above Williford Spring to allow for Williford spring flow to be included as an independent flow input from upstream flows. The model was extended to Deer Point Lake to allow for adequate representation of a downstream model boundary condition (Figure 5-1).

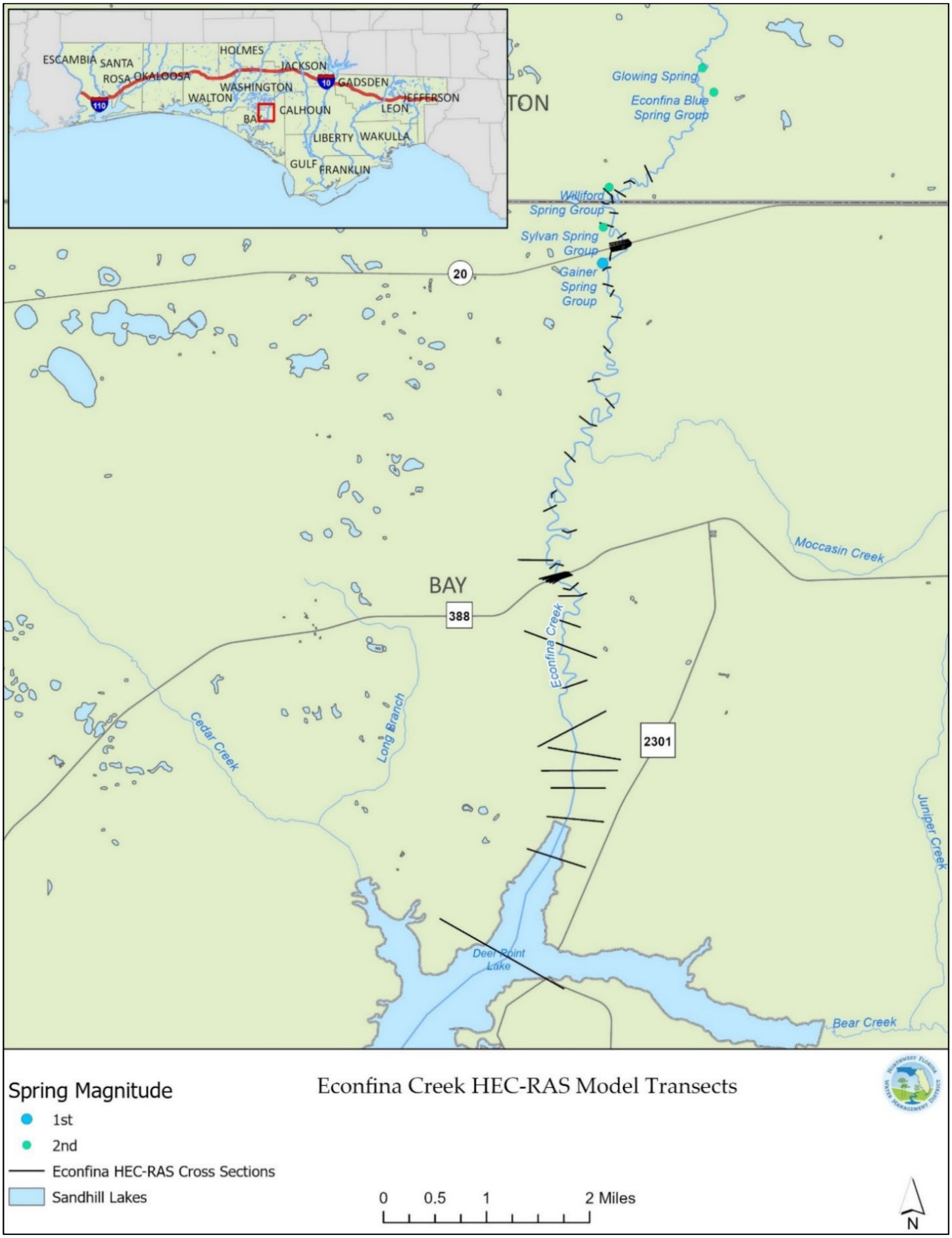


Figure 5-1 A) Econfina Creek and Springs MFL HEC-RAS Model Extent

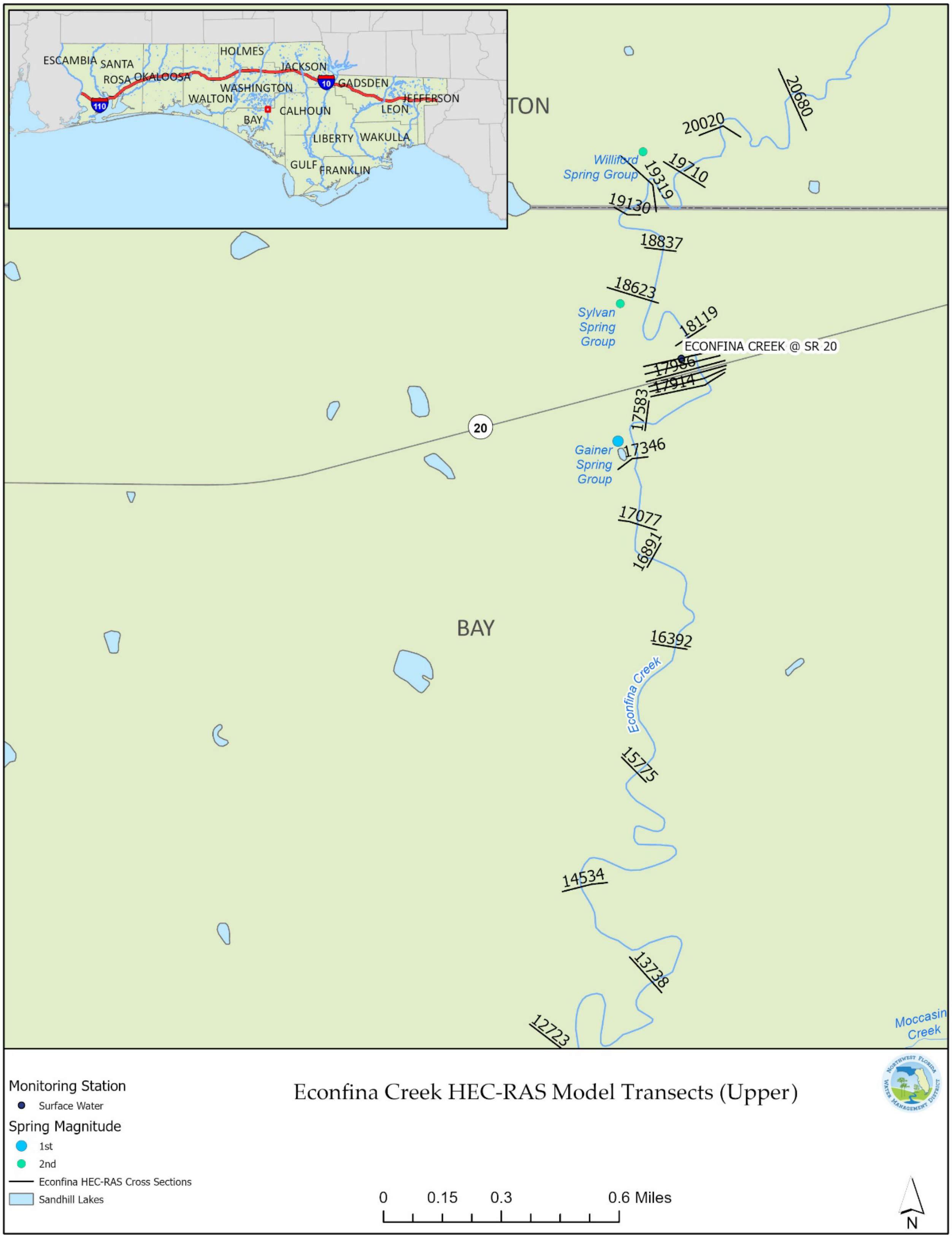


Figure 5-1 B) Econfina Creek and Sprins MFL HEC-RAS Model Extent – Upper Creek

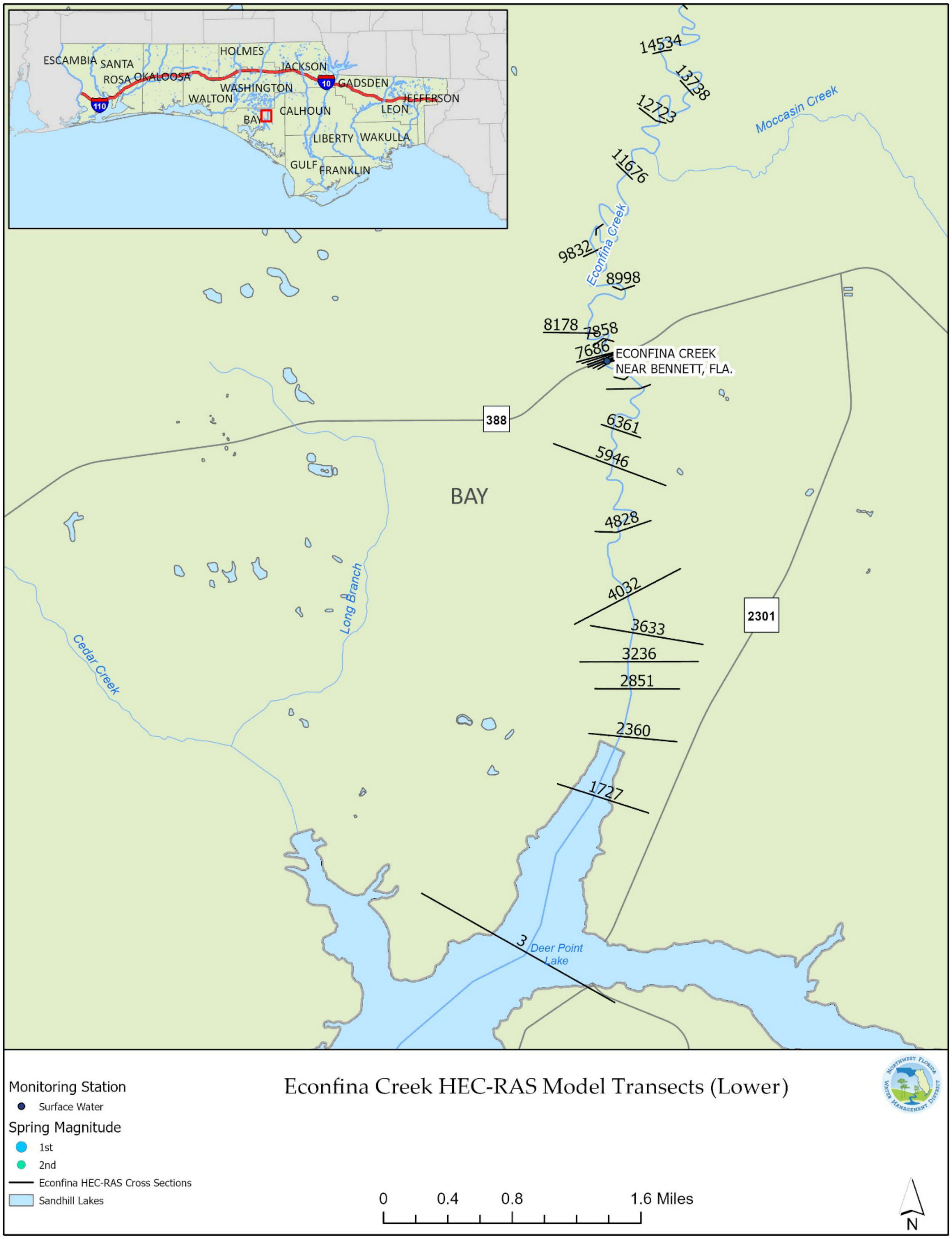


Figure 5-1 C) Econfina Creek and Spring MFL HEC-RAS Model Extent – Lower Creek

Based on an initial review of the previous Econfina Creek FEMA model, District staff in conjunction with ATM determined that all existing transect locations would need to be resurveyed to ensure the channel was represented with appropriate precision to accurately represent low flow conditions. Additionally, Econfina Creek had undergone extensive scouring and deposition as a result of Hurricane Michael, which needed to be reflected by more recent channel bathymetry. Additional survey transect locations were also needed to better represent Econfina Creek in the vicinity of the springs and spring runs, extend the model domain north to Williford Spring and south to Deer Point Lake, capture river bathymetry in areas with sparse representation, and better represent bridge crossings within the model. District staff, along with ATM and Janicki Environmental, Inc. conducted a field reconnaissance on June 15, 2021, to identify potential additional survey transect locations (Figure 5-2). A total of 20 additional locations were identified between immediately above Williford Spring Group and the CR 388 bridge crossing based on the above criteria (ATM 2021).

In 2021, Southeastern Surveying and Mapping, Corporation (Southeastern) performed 37 cross-section elevation surveys between Williford Spring and CR 388 bridge (Southeastern 2021a, Southeastern 2021b). Each transect included the stream channel and extended five feet upland of the top-of-bank on either side of the channel. The work included some surveys along spring runs in case it became necessary to represent the spring runs within the model. Initially, model transects below CR 388 were taken from the existing FEMA model. After initial model testing had begun, it became apparent updated survey of these transects would significantly improve model accuracy in the lower reach of the model domain. In 2023, Southeastern was contracted to perform an additional 12 cross-section elevation surveys below CR 388 extending to the end of the model domain in Deer Point Lake (Southeastern 2023).

A total of 40 cross sections were digitized within RAS Mapper extending sufficiently into the floodplain to accommodate high flow scenarios. Elevation survey points were utilized to replace the terrain-derived elevations within the channel for all cross sections where survey was available.

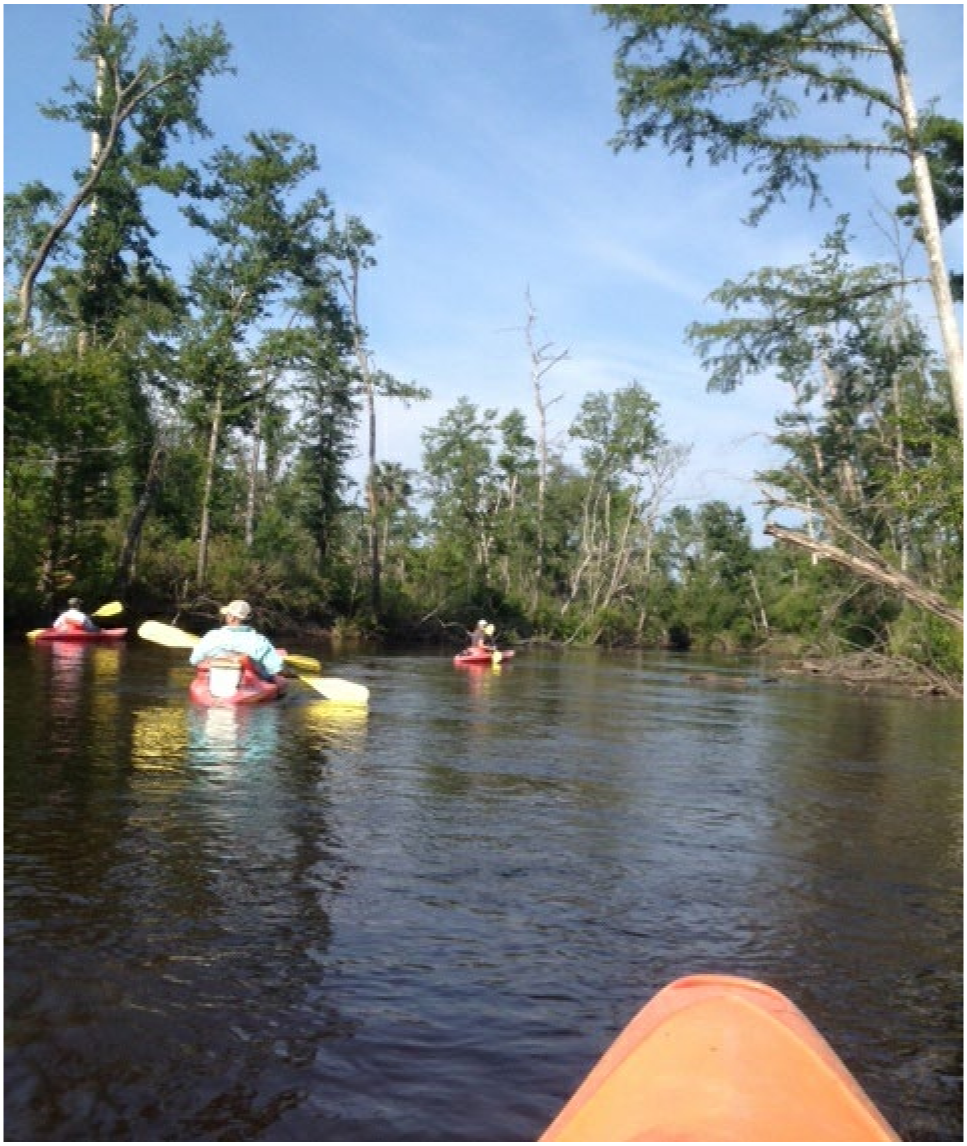


Figure 5-2. Econfina Creek Field Reconnaissance, June 2021

Flow inputs for the Econfina Creek HEC-RAS model consist of Econfina Creek flow immediately upstream of the confluence with the Williford Spring Group run, spring flow contributions from Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group, and lateral inflow pickup between Gainer Spring Group and the CR 388 bridge (Figure 5-3). The Deer Point Lake water surface elevation was utilized as the downstream stage boundary condition. These inputs were derived based on surface water monitoring stations along Econfina Creek maintained by the District and USGS including:

- USGS 02359500 Econfina Creek Near Bennet, FL (Econfina Creek @ CR 388)
- NWFWMD 8548 Econfina Creek @ SR 20
- NWFWMD 8099 Econfina Creek Above Gainer Spring
- NWFWMD 8100 Econfina Creek Below Gainer Spring
- NWFWMD 8544 Deer Point Lake Near Dam

Figure 5-3. Econfina Creek Monitoring Stations Utilized to Develop Model Boundary Conditions

The steady state HEC-RAS model was calibrated by adjusting model parameters to observed stages and flows at three locations with sufficient data along Econfina Creek. The primary model parameters adjusted were channel and floodplain roughness coefficients (Manning's n). Other adjustments included addition of interpolated cross sections to improve model stability near bridge crossings, adjustments to ineffective flow areas, and modifications to channel cross-section geometry.

Based on the evaluation of stage-discharge relationships for Econfina Creek presented in Section 3.4 and 3.5, a calibration period of April 1, 2019, to September 18, 2023, was selected as the period of best available data record at the time of model calibration which represents the current stage-discharge relationship for Econfina Creek. This period is reflective of debris removal completion and recovery of the system to a stable rating from the impact of Hurricane Michael. Fluctuations in stage-discharge relationships will continue to be monitored for this system as it continues to recover from Hurricane Michael impacts and floodplain and instream communities continue to recuperate.

The performance of Econfina Creek MFLs HEC-RAS model was evaluated by comparing the model predicted stage-discharge rating to the observed stage-discharge rating for all available data from April 1, 2019 through September 18, 2023, for all three stations listed in Table 5-1. The Gainer Spring Group composite station had a data gap during the calibration period from September 10, 2020 through June 9, 2021. Suitable data was available at all three locations to allow for comparison of ratings across a wide range of flow conditions, allowing for suitable calibration target datasets.

Table 5-1. Surface Water Stations and Available Period of Record for Calibration of the Econfina Creek MFLs HEC-RAS Model

Station Number	Site Name	Period of Record Available for Stage-Discharge Rating Calibration
USGS 02359500	Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388)	April 1, 2019 – September 18, 2023
NWFWMD 8548	Econfina Creek @ SR 20	April 1, 2019 – September 18, 2023
NWFWMD 8100	Econfina Creek Below Gainer Spring	October 28, 2019 - September 9, 2020; June 10, 2021- September 18, 2023

Goodness of fit was determined by graphical comparison of simulated to measured rating curves (Figures 5-4, 5-5, and 5-6). Graphical comparisons indicate the simulated rating curves replicate measured rating curves sufficiently at all three calibration locations. The simulated ratings are contained within the range of the measured ratings for all simulated percentile flows that could be compared. A slight inflection point around 450 cfs for the NWFWMD 8100 rating is due to a shift in the rating curve under low flow conditions, which was unable to be depicted by the model. As described previously, the flow regime during the calibration period (April 1, 2019, through September 18, 2023) was higher than historical conditions due to increased precipitation and groundwater levels. Therefore, simulated historical conditions could not be compared under low flow conditions to measured data during the calibration period, although the majority of the flow regime coincides.

Computation of statistical model performance metrics including: mean squared error (MSE), correlation coefficient, R-squared, and Nash-Sutcliffe efficiency was determined for the Econfina Creek @ SR 20 and Econfina Creek below Gainer stations by defining a base rating curve for each station, defined to be the current rating curve associated with normal hydrologic conditions for a riverine system (Table 5-2). Details regarding rating curve development and derivation of base rating curves is presented in Appendix A.

For Econfina Creek @ CR 388, only the current rating curve is available from the USGS. Therefore, a base rating curve could not be determined and performance metrics were not computed for the model fit to this station.

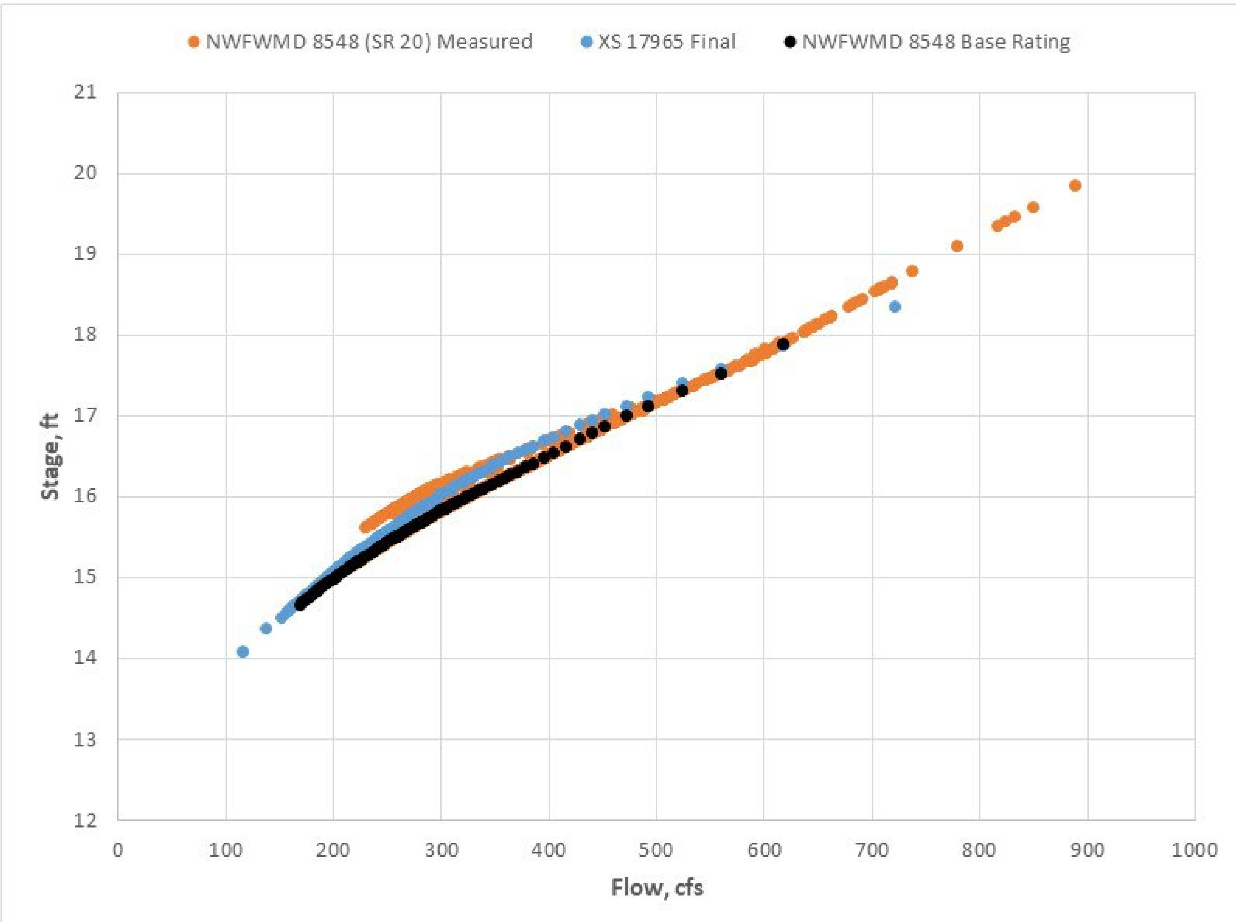


Figure 5-4. Comparison of Measured Stage-Discharge Rating at NWFWMD 8548 (Econfina Creek @ SR 20 With Final Simulated Stage-Discharge Rating at XS 17965 (Nearest XS to Econfina Creek @ SR 20 Station) for Calibration Period from 4/1/2019 through 9/18/2023

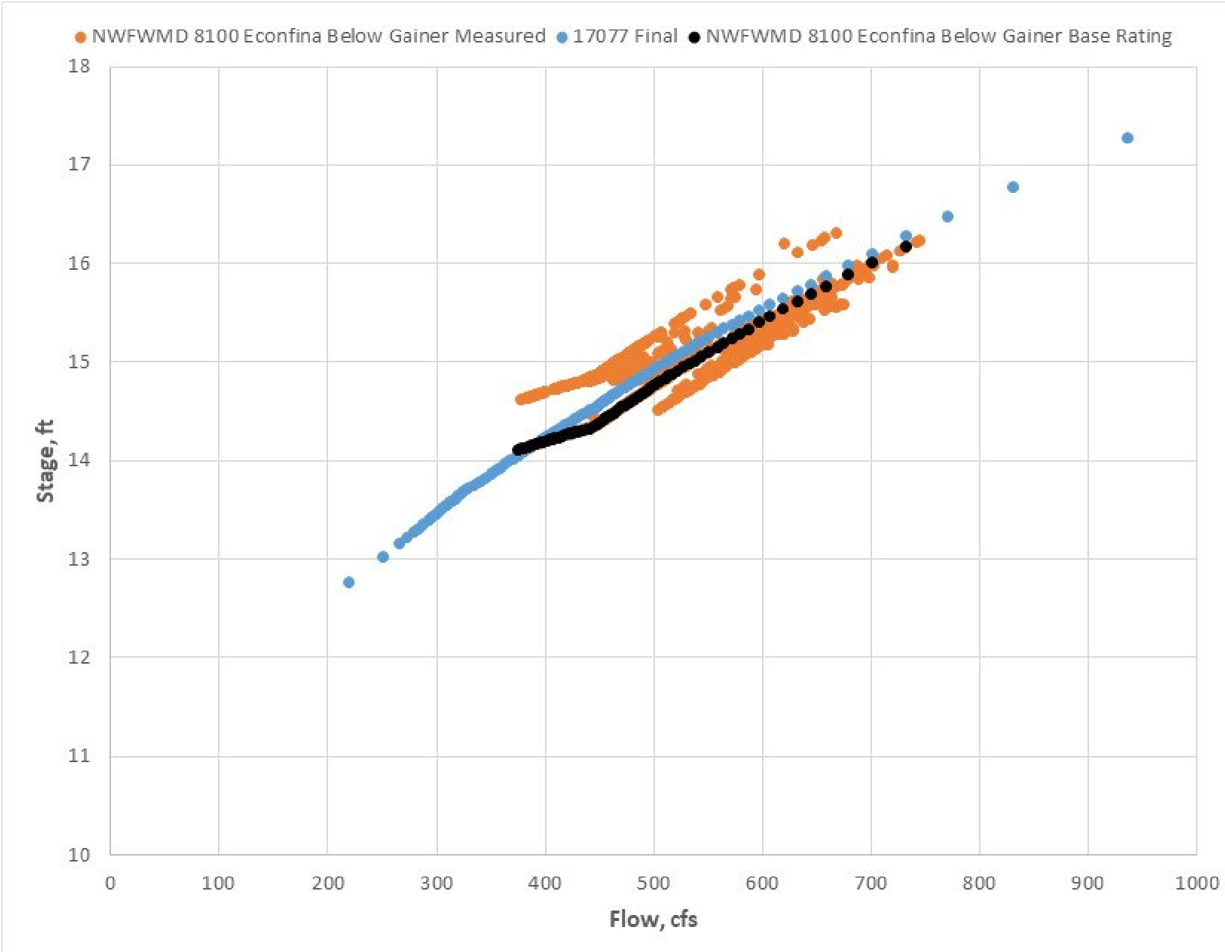


Figure 5-5. Comparison of Measured Stage-Discharge Rating at NWFWMD 8100 (Econfina Creek Below Gainer Spring Group) With Final Simulated Stage-Discharge Rating at XS 17077 (Nearest XS to Econfina Creek Below Gainer Spring Group) for Calibration Period from 4/1/2019 through 9/18/2023

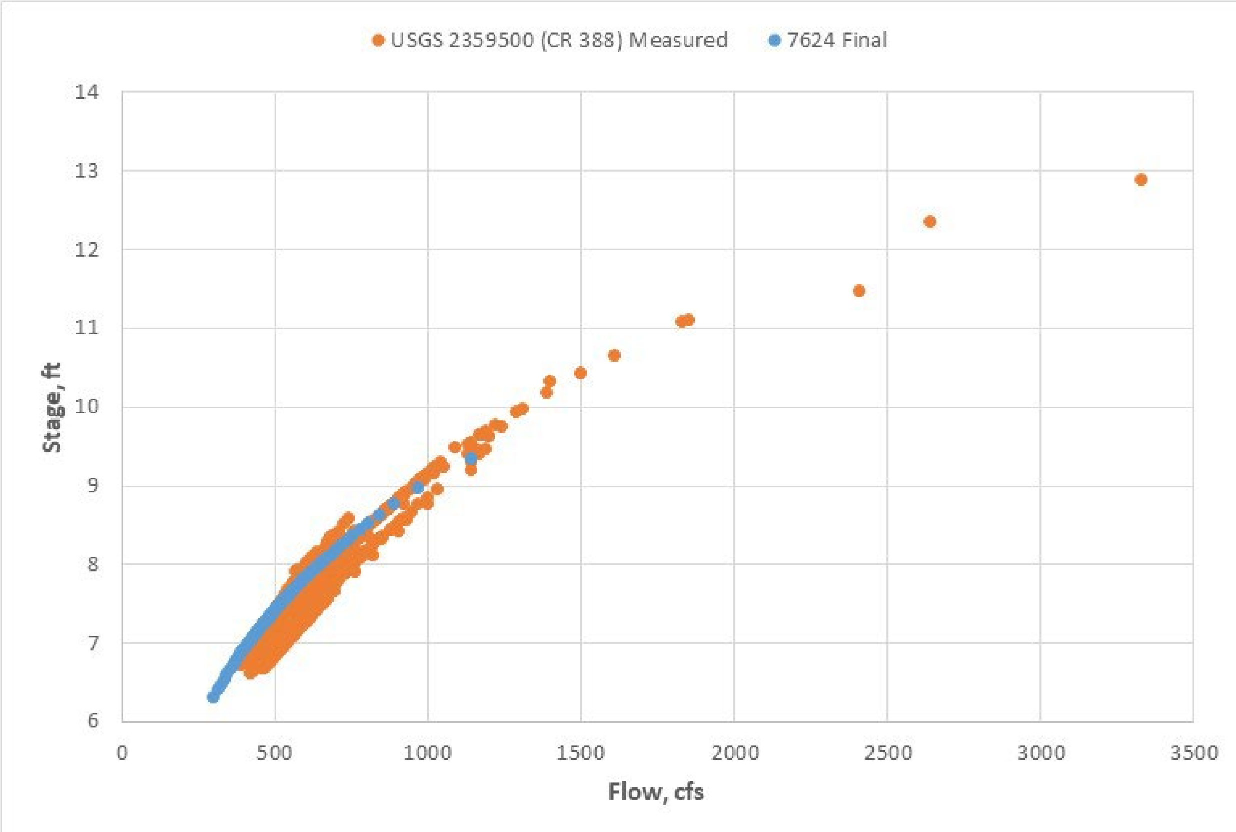


Figure 5-6. Comparison of Measured Stage-Discharge Rating at USGS 2359500 (Econfina Creek @ CR 388) With Final Simulated Stage-Discharge Rating at XS 7624 (Nearest XS to Econfina Creek @ CR 388 Station) for Calibration Period from 4/1/2019 through 9/18/2023

Table 5-2. Model Calibration Performance Metrics

Model Performance Metric	NWFID 8548 (Econfina Creek @ SR 20)	NWFID 8100 (Econfina Creek Below Gainer Spring Group
MSE (ft^2)	0.0239	0.0195
Correlation Coefficient	0.9974	0.9932
R-squared	0.9947	0.9863
Nash- Sutcliffe	0.9474	0.9301

5.2 SEFA Model

SEFA (System for Environmental Flow Analysis) (Aquatic Habitat Analysts, Inc. 2012) is a Windows-based program that was developed as a tool for use in studies that utilize the Instream Flow Incremental Methodology (IFIM). The Instream Flow Incremental Methodology is a framework developed by the U.S. Fish and Wildlife Services in the 1970s for determining the relationship between stream flows and fish habitat. SEFA is current software that implements the IFIM framework. SEFA utilizes hydraulic models coupled with habitat suitability relationships for specific classes of species to determine relationships between streamflow and available habitat. Habitat suitability is defined based on relationships among depth, substrate, and stream velocity at specific transect locations. Through a series of subroutine programs in SEFA, a prediction of the suitability index of available habitat (Area Weighted Suitability (AWS) for target organism(s) over a range of streamflow conditions is created.

The SEFA methodology has been applied to support the development of environmental flow regimes as required by Florida's MFL statutes. Specifically, SEFA has been applied to support MFL development for lotic ecosystems (i.e., rivers and creeks) by four of the Florida water management districts – Southwest, St. Johns River, Suwannee River, and more recently Northwest. Examples of waterbodies for which SEFA was utilized to support MFL development include the Lower Sante Fe and Ichetucknee Rivers and the Little Manatee River (SRWMD 2021, SWFWMD 2023).

SEFA habitat modeling utilizes habitat suitability curves (HSCs), which relate physical habitat variables including depth, velocity, and substrate (if applicable) to an index of habitat suitability for a selected guild/species/life stage. HSCs can represent individual species, life stages such as juveniles or adults, and/or habitat guilds which include species with similar habitat requirements. The HSC index values vary between 0 (least suitable) and 1 (optimal suitability) and provide a probability measure on how suitable a habitat is for a selected guild/species/life stage.

The SEFA model uses riverine hydraulics (cross-sectional elevation profiles, water surface elevation, and velocity) in conjunction with HSCs to calculate AWS, a suitability index that reflects habitat quality and quantity expressed in units of square feet of habitat per linear foot of creek length (ft^2/ ft). Although AWS is expressed in units of ft^2/ft, it is considered a weighted measure of habitat suitability, and not an area or volume with direct physical interpretation (Herrick 2021). Riverine hydraulic information for purposes of SEFA modeling can be determined through field measurements of channel bathymetry, water depth, velocity, flow, and substrate (if applicable) at specified cross sections, from a HEC-RAS (Hydrologic Engineering Center River Analysis System) model of the system if available, or both. For a given flow, SEFA calculates depth and velocity at each point along a cross section based on input riverine hydraulics and determines habitat suitability for each variable (depth, velocity, and substrate if applicable) based on input habitat suitability curves. The combined suitability index for a given flow at a specific point along cross section or transect is then determined as the product of the suitability of depth, velocity, and, if applicable, substrate (Herrick 2021). Substrate was not utilized in the Econfina Creek evaluation as it consisted exclusively of sands and displayed no spatial variability.

The AWS is calculated by multiplying the combined suitability index at each point along all cross sections of interest by the proportion of the reach area represented by that specific point and summing over the reach of interest (Herrick 2021). The AWS can be modeled for an individual cross section, or in aggregate for any number of cross sections or the entirety of the model domain. For the purposes of this study, an aggregate AWS was calculated for the entire middle Econfina Creek HEC-RAS model domain utilizing all available transects. The aggregate AWS describes the relative suitability for a given guild/species/life stage throughout the model domain (i.e. the entire study area or Middle Econfina Creek) for a given flow.

The SEFA model can be run to compute aggregate AWS for each flow in a streamflow time series. The model output is a curve relating flow to AWS, with each value of flow having a single corresponding aggregate AWS value for the model domain. Therefore, a series of flow values can be converted into a series of AWS values for each taxon/life history stage or habitat guild that comprise a given habitat suitability group. Alternative scenarios, for example time series of flows under baseline (unimpacted) conditions, can be compared to flow-reduction scenarios to determine change in AWS associated with changes in flows (Herrick, 2021).

The District contracted with Geosyntec Consultants, Inc., d/b/a Applied Technology and Management, Inc. (ATM) to develop a System for Environmental Flow Analysis (SEFA) model for the Econfina Creek system. Environmental Science Associates (ESA), a subcontractor, worked with ATM to satisfy the objectives of this project. The goal of this task was to examine the extent to which reductions in streamflow affect the habitat availability, as indicated by AWS, for relevant species within the Econfina Creek Spring Group MFLs study area.

The fish species documented to occur in Econfina Creek are presented in Table 2-6 based on available literature. Habitat suitability curves were identified by cross-referencing the species in Table 2-6 from a series of existing curves found in either the Gore library or Nagid Library. The Gore Library includes curves used in the Little Manatee River and Wekiva River MFL evaluations (SWFWMD 2023, SJRWMD 2024). The Nagid library includes curves found in the Florida Handbook of Habitat Suitability Indices (Nagid 2022a, Nagid 2022b). Based upon the relevant fish species identified in Table 5-3 and the availability of corresponding HSCs, HSCs for nine fish species were incorporated into the SEFA modeling. In addition, habitat suitability curves for several macroinvertebrate species were utilized during instream habitat modeling including Ephemeroptera, Plecoptera, Tricoptera, and EPT (Ephemeroptera, Plecoptera, Tricoptera, hybrid). HSCs were unavailable for the two listed mussel species documented in Econfina Creek (Gulf Moccasinshell and Oval Pigtoe) and many of the specific host species utilized by the mussels. While HSC curves for the mussel and their host species have not been developed, the District utilized available curves for all documented species in the creek, in addition to four distinct habitat guilds (deep fast water, deep slow water, shallow fast water, and shallow slow water). Although additional research is needed to better define the water velocity and depth requirements needed by gulf moccasinshell, oval pigtoe, and their host species, by utilizing available HSC curves including fish species, macroinvertebrate species, and habitat guilds, the District is utilizing the best available information and the number of curves analyzed is assumed to be protective of these species.

6 Evaluation of Water Resource Values and Results

This section describes the evaluation of water resource value metrics presented in Section 4 and the resulting allowable flow reductions.

6.1 Passage (Low Flow) Metrics Evaluation

6.1.1 Methodology

The calibrated steady state HEC-RAS model described in Section 5 was utilized to evaluate effects of spring flow reductions for passage (low flow) metrics including canoe/kayak passage, power boat passage, and fish passage within the Econfina MFL study area. Modeling scenarios for purposes of WRV metric analysis consisted of one model scenario for each flow percentile, based on period of record flows for all model inputs. Therefore, a total of 99 steady state model scenarios were run (P1 - P99). This allows for determination of precise critical flow percentiles associated with a given WRV metric.

The period of record flow (10/1/1935 through 10/13/2023) for the Econfina Creek @ CR 388 station (USGS 02359500) was selected as the reference time series to assess WRV metrics due to its long-term period of record. As described in Section 3.7, an adjustment of +1.78 cfs (representative of total 2020 groundwater withdrawals within the Econfina GWCA) was added to all dates of the reference time series as a conservative estimate of baseline flows (flows unimpacted by groundwater withdrawals). This adjusted baseline timeseries was utilized to assess exceedance frequencies associated with critical flows for each WRV metric for conditions unimpacted by groundwater withdrawals.

In order to perform scenarios reflective of baseline conditions accounting for groundwater withdrawal impacts, 1.78 cfs was added to all reference flow percentiles previously utilized for model development and calibration at all flow input locations in the model. The resultant water surface profile from these model scenarios reflects baseline conditions in absence of groundwater withdrawal impacts and was utilized for determination of critical flow percentiles associated with critical depths for each water resource value metric.

The methodology and results for each WRV metric are described below. The methodology used to determine allowable streamflow reduction associated with a 15-percent reduction in the frequency of occurrence for each WRV metric is described below. A 15-percent reduction in the percent of time in a WRV metric has been observed has been implemented as the protection standard for numerous MFL assessments throughout Florida and is also used in this assessment.

<u>Minimum Flow Determination Methodology</u>

1. Perform steady state model scenarios utilizing adjusted flow inputs, adding 1.78 cfs to all reference flow percentiles previously utilized for model development and calibration at all flow input locations
2. Determine critical elevation (e.g., river stage associated with sufficient depth) for the metric at each HEC-RAS transect.

3. Using the HEC-RAS model output (water surface elevation, streamflow, and flow percentile), determine the critical flow percentile for each model transect as the minimum flow which results in a water surface elevation exceeding the critical elevation.
4. Using the flow percentile from step 3, determine the critical flow at USGS 02359500 Econfina Creek @CR 388 for each transect.
5. Determine the number of days in the period of record the critical flow at USGS 02359500 Econfina Creek @CR 388 was achieved based on the flow percentile.
6. Reduce the number of days the critical flow was achieved by 15 percent.
7. Determine the flow percentile associated with the reduced number of days and determine the associated flow based on the baseline timeseries for USGS 02359500 Econfina Creek @CR 388.
8. Calculate the allowable reduction in streamflow (cfs) associated with the reduced frequency of occurrence by subtracting the flow determined in step 7 from that in step 4.
9. Determine the allowable percent streamflow reduction using the result from step 8.

6.1.2 Safe Boat Passage

As described in Section 4, safe boat passage was determined to be a relevant indicator for WRV 1-Recreation In and On The Water. Specific metrics were defined for safe canoeing/kayaking and safe power boating.

Safe canoeing/kayaking - A minimum thalweg depth of 1.5 ft. was used as the metric for safe canoe/kayak passage. The critical elevation (NAVD 88) for the safe passage of canoe/kayak vessels was determined by adding 1.5 ft. to the thalweg elevation (minimum elevation in a channel) for each transect (Figure 6-1 and Table 6-1). This metric was assessed for all transects in the study area utilizing the methodology described above in section 6.1.1.

Based on this methodology, safe canoe and kayak passage was possible at all river transects evaluated in the study area under all flow scenarios (Figure 6-1 and Table 6-1). Even under the lowest flow scenario, modeled water depth was above critical depth at the most restrictive transect (18040). Under the lowest flow scenario at the most restrictive transect, water levels were simulated to be 0.95 ft. above critical depth. Since flows limiting non-motorized boat passage were not observed during the baseline time period, this metric was not considered further for MFL determination.

Safe Power Boating - For recreational boat use along Econfina Creek above SR 20, a minimum water depth of 2.0 ft. across a continuous channel width of 15 ft. was used as the metric to evaluate safe boat passage to allow passage for a single boat in this reach. For model transects below SR 20 within the study area, the critical elevation was determined by adding a water depth of 2.0 ft. to the minimum channel elevation with a continuous 30 ft. width across the channel as has been done in multiple other MFL assessments throughout the state (Figure 6-2 and Table 6-2). This metric was assessed for all transects in the study area utilizing the methodology described above in section 6.1.1.

Based on this methodology, for all but three transects assessed, safe power boat passage was possible under all flow scenarios, including all transects below Gainer Spring Group (Figure 6-2 and Table 6-2). The remaining three transects had a critical flow at either the 2nd (P2) or 3rd (P3) flow percentile (98th or 97th

percent exceedance), indicating the safe power boat passage metric was not achieved under very low flow conditions under baseline conditions. Therefore, the most limiting flow at the Econfina Creek @ CR 388 station is 328 cfs, associated with the P3 flow scenario, to achieve safe power boat passage at the most restrictive transect (19710). For a 15% reduction in number of days critical boat passage depth at these transects is achieved, an allowable flow reduction of 92 cfs (21.92%) was determined (Table 6-3).

Table 6-1. Results for Evaluation of Canoe and Kayak Passage Metrics. Metric defined as a 1.5 ft. depth at transect thalweg

Metric				Model Results		
Transect	Minimum Substrate Elevation (NAVD 88)	Critical Depth (ft.)	Critical Water Surface Elevation (NAVD 88)	Critical Percentile Flow	Critical Streamflow at Transect, (cfs)	Water Surface Elevation (NAVD 88)
20680	14.07	1.5	15.57	<P1	58.95	17.32
20020	13.18	1.5	14.68	<P1	58.95	16.31
19710	11.13	1.5	12.63	<P1	58.95	15.7
19319	11.52	1.5	13.02	<P1	58.95	15.25
19130	11.52	1.5	13.02	<P1	101.12	15.14
18837	11	1.5	12.5	<P1	101.12	14.99
18623	11.76	1.5	13.26	<P1	101.12	14.88
18119	10.93	1.5	12.43	<P1	118.79	14.54
18040	11.98	1.5	13.48	<P1	118.79	14.43
18013	11.57	1.5	13.07	<P1	118.79	14.38
17986	11.15	1.5	12.65	<P1	118.79	14.36
17965	9.94	1.5	11.44	<P1	118.79	14.1
17937	10.56	1.5	12.06	<P1	118.79	14.07
17914	11.18	1.5	12.68	<P1	118.79	14.03
17583	8.5	1.5	10	<P1	118.79	13.68
17346	10.16	1.5	11.66	<P1	118.79	13.4
17077	9.52	1.5	11.02	<P1	221.64	12.78
16891	8.74	1.5	10.24	<P1	221.64	12.48
16392	7.32	1.5	8.82	<P1	228.52	11.9
15775	4.78	1.5	6.28	<P1	228.52	11.64
14534	5.98	1.5	7.48	<P1	247.18	11.01
13738	4.77	1.5	6.27	<P1	247.18	10.16
12723	3.67	1.5	5.17	<P1	265.37	9.4
11676	3.08	1.5	4.58	<P1	288.48	8.83
10170	1.89	1.5	3.39	<P1	291.01	7.98
9832	2.35	1.5	3.85	<P1	291.01	7.83
8998	0.33	1.5	1.83	<P1	302.78	7.33

8178	1.77	1.5	3.27	<P1	302.78	6.79
7858	0.19	1.5	1.69	<P1	302.78	6.6
7686	-0.65	1.5	0.85	<P1	302.78	6.52
7669	0	1.5	1.5	<P1	302.78	6.52
7649	0.02	1.5	1.52	<P1	302.78	6.52
7624	0.03	1.5	1.53	<P1	302.78	6.32
7608	-0.03	1.5	1.47	<P1	302.78	6.31
7586	-0.27	1.5	1.23	<P1	302.78	6.31
7322	-2.03	1.5	-0.53	<P1	302.78	6.22
7137	-0.77	1.5	0.73	<P1	302.78	6.16
6361	-0.31	1.5	1.19	<P1	302.78	5.9
5946	-1.19	1.5	0.31	<P1	302.78	5.75
4828	-0.15	1.5	1.35	<P1	302.78	5.24
4032	0.01	1.5	1.51	<P1	302.78	4.95
3633	-1.79	1.5	-0.29	<P1	302.78	4.77
3236	0.04	1.5	1.54	<P1	302.78	4.51
2851	-4.39	1.5	-2.89	<P1	302.78	4.51
2360	-2.25	1.5	-0.75	<P1	302.78	4.51
1727	-2.77	1.5	-1.27	<P1	302.78	4.5
3	-5	1.5	-3.5	<P1	302.78	4.5

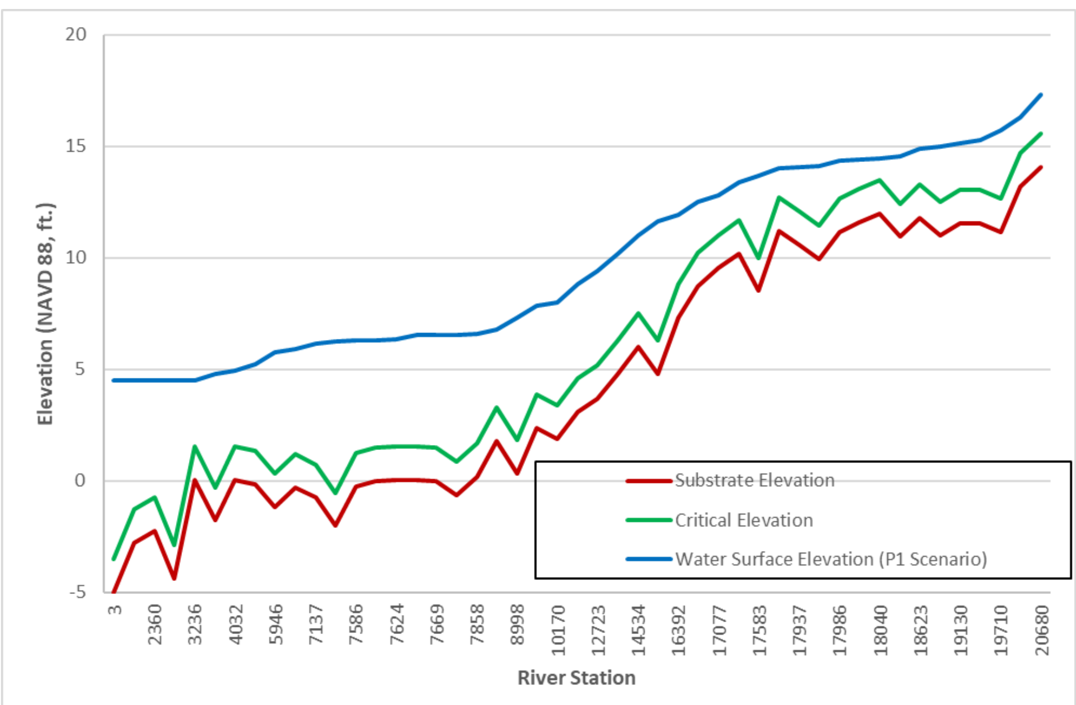


Figure 6-1. Critical Elevation and Minimum Modeled Water Levels for Safe Canoe/Kayak Passage Along Econfina Creek

Table 6-2. Results for Evaluation of Power Boat Passage Metrics. Metric defined as: (1) Minimum 2 ft. depth across a 15 ft. continuous width for transects 18013 and above, and (2) Minimum 2 ft. depth across a 30 ft. continuous width for transect 17986 and below.

Metric				Model Results		
Transect	Minimum Substrate Elevation (NAVD 88)	Critical Depth (ft.)	Critical Water Surface Elevation (NAVD 88)	Critical Percentile Flow	Critical Streamflow at Transect, (cfs)	Water Surface Elevation (NAVD 88)
20680	15.62	2	17.62	2	80.53	17.72
20020	14.1	2	16.1	<P1	58.95	16.31
19710	14.2	2	16.2	3	93.95	16.3
19319	12.6	2	14.6	<P1	58.95	15.25
19130	12.2	2	14.2	<P1	101.12	15.14
18837	11.44	2	13.44	<P1	101.12	14.99
18623	12.1	2	14.1	<P1	101.12	14.88
18119	11.4	2	13.4	<P1	118.78	14.54
18040	12.18	2	14.18	<P1	118.78	14.43
18013	12.11	2	14.11	<P1	118.78	14.38
17986	12.26	2	14.26	<P1	118.78	14.36
17965	12.01	2	14.01	<P1	118.78	14.1
17937	12.16	2	14.16	2	140.36	14.35
17914	11.62	2	13.62	<P1	118.78	14.03
17583	10.4	2	12.4	<P1	118.78	13.68
17346	11.3	2	13.3	<P1	118.78	13.4
17077	9.77	2	11.77	<P1	221.64	12.78
16891	9.03	2	11.03	<P1	221.64	12.48
16392	8.6	2	10.6	<P1	228.52	11.9
15775	6.03	2	8.03	<P1	228.52	11.64
14534	7.59	2	9.59	<P1	247.18	11.01
13738	5.95	2	7.95	<P1	247.18	10.16
12723	4.55	2	6.55	<P1	265.37	9.4
11676	4.24	2	6.24	<P1	288.48	8.83
10170	2.32	2	4.32	<P1	291.01	7.98
9832	2.8	2	4.8	<P1	291.01	7.83
8998	2.39	2	4.39	<P1	302.78	7.33
8178	1.93	2	3.93	<P1	302.78	6.79
7858	2.09	2	4.09	<P1	302.78	6.6
7686	1.33	2	3.33	<P1	302.78	6.52
7669	0.07	2	2.07	<P1	302.78	6.52
7649	0.44	2	2.44	<P1	302.78	6.52
7624	0.2	2	2.2	<P1	302.78	6.32
7608	0.15	2	2.15	<P1	302.78	6.31

7586	1.1	2	3.1	<P1	302.78	6.31
7322	2.1	2	4.1	<P1	302.78	6.22
7137	0.88	2	2.88	<P1	302.78	6.16
6361	0.79	2	2.79	<P1	302.78	5.9
5946	0.59	2	2.59	<P1	302.78	5.75
4828	0.53	2	2.53	<P1	302.78	5.24
4032	0.48	2	2.48	<P1	302.78	4.95
3633	1.25	2	3.25	<P1	302.78	4.77
3236	2.26	2	4.26	<P1	302.78	4.51
2851	-2.44	2	-0.44	<P1	302.78	4.51
2360	0.52	2	2.52	<P1	302.78	4.51
1727	-0.22	2	1.78	<P1	302.78	4.5
3	0.25	2	2.25	<P1	302.78	4.5

Table 6-3. Calculation of Allowable Flow Reductions for Critical Boat Passage Transects

Model Results				15% Decrease		Allowable Flow Reduction	
Transect	**Critical Percentile Flow**	**Critical Streamflow at Transect (cfs)**	**Critical Streamflow at Econfina Creek@ CR 388 (cfs)**	**Adjusted Percentile Flow for a 15% Reduction in Days Exceeded**	**Flow Associated with 15% reduction in days Exceeded (cfs)**	**Allowable flow reduction at Econfina Creek@ CR 388**	**Percent Change**
20680	P2	80.53	318.78	16.7	415.78	97.00	23.33
19710	P3	93.95	327.78	17.6	419.78	92.00	21.92
17937	P2	140.36	318.78	16.7	415.78	97.00	23.33

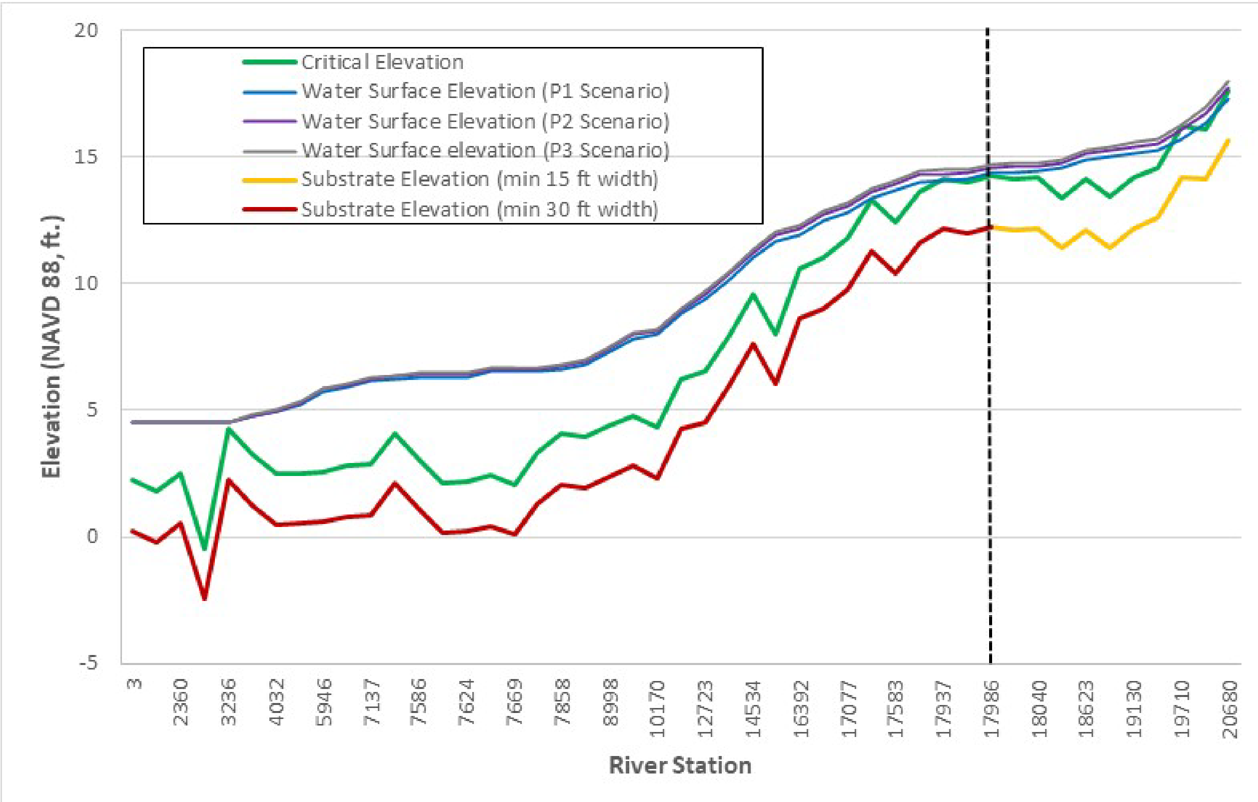


Figure 6-2. Critical Elevation and Minimum Modeled Water Levels for Safe Power Boat Passage Along Econfina Creek. Substrate Elevation (min 15 ft width) (yellow line) indicates transects upstream of transect 17965 where a minimum 2 ft depth across a continuous 15 ft transect width was used as the metric. Substrate Elevation (min 30 ft width) (red line) indicates the substrate elevation at or below transect 17965 where a minimum 2 ft depth across a continuous 30 ft transect width was used as the metric.

6.1.3 Fish Passage

As described in Section 4, fish passage was determined to be a relevant indicator for WRV 2- Fish and Wildlife Habitat and the Passage of Fish. A minimum thalweg depth of 0.6 ft. was used as the metric for safe fish passage. The critical elevation (NAVD 88) for fish passage was determined by adding 0.6 ft. to the thalweg elevation (minimum elevation in a channel) for each transect (Figure 6-3 and Table 6-4). This metric was assessed for all transects in the study area utilizing the methodology described above in section 6.1.1.

Based on this methodology, safe fish passage was possible at all transects evaluated in the study area under all flow scenarios (Figure 6-3 and Table 6-4). Even under the lowest flow scenario, modeled water depth was above critical depth at the most restrictive transect (18040). Under the lowest flow scenario at the most restrictive transect, water levels were simulated to be 1.85 ft. above critical depth. Since flows limiting fish passage were not observed during the baseline time period, this metric was not considered further for MFL determination.

Table 6-4. Results for Evaluation of Fish Passage. Metric defined as a 0.6 ft. depth at transect thalweg.

Metric				Model Results		
Transect	Minimum Substrate Elevation (NAVD 88)	Critical Depth (ft.)	Critical Water Surface Elevation (NAVD 88)	Critical Percentile Flow	Critical Streamflow at Transect (cfs)	Water Surface Elevation (NAVD 88)
20680	14.07	0.6	14.67	<P1	58.95	17.32
20020	13.18	0.6	13.78	<P1	58.95	16.31
19710	11.13	0.6	11.73	<P1	58.95	15.7
19319	11.52	0.6	12.12	<P1	58.95	15.25
19130	11.52	0.6	12.12	<P1	101.12	15.14
18837	11	0.6	11.6	<P1	101.12	14.99
18623	11.76	0.6	12.36	<P1	101.12	14.88
18119	10.93	0.6	11.53	<P1	118.78	14.54
18040	11.98	0.6	12.58	<P1	118.78	14.43
18013	11.57	0.6	12.17	<P1	118.78	14.38
17986	11.15	0.6	11.75	<P1	118.78	14.36
17965	9.94	0.6	10.54	<P1	118.78	14.1
17937	10.56	0.6	11.16	<P1	118.78	14.07
17914	11.18	0.6	11.78	<P1	118.78	14.03
17583	8.5	0.6	9.1	<P1	118.78	13.68
17346	10.16	0.6	10.76	<P1	118.78	13.4
17077	9.52	0.6	10.12	<P1	221.64	12.78
16891	8.74	0.6	9.34	<P1	221.64	12.48
16392	7.32	0.6	7.92	<P1	228.52	11.9
15775	4.78	0.6	5.38	<P1	228.52	11.64
14534	5.98	0.6	6.58	<P1	247.18	11.01
13738	4.77	0.6	5.37	<P1	247.18	10.16
12723	3.67	0.6	4.27	<P1	265.37	9.4
11676	3.08	0.6	3.68	<P1	288.48	8.83
10170	1.89	0.6	2.49	<P1	291.01	7.98
9832	2.35	0.6	2.95	<P1	291.01	7.83
8998	0.33	0.6	0.93	<P1	302.78	7.33
8178	1.77	0.6	2.37	<P1	302.78	6.79
7858	0.19	0.6	0.79	<P1	302.78	6.6
7686	-0.65	0.6	-0.05	<P1	302.78	6.52
7669	0	0.6	0.6	<P1	302.78	6.52
7649	0.02	0.6	0.62	<P1	302.78	6.52
7624	0.03	0.6	0.63	<P1	302.78	6.32
7608	-0.03	0.6	0.57	<P1	302.78	6.31
7586	-0.27	0.6	0.33	<P1	302.78	6.31
7322	-2.03	0.6	-1.43	<P1	302.78	6.22

7137	-0.77	0.6	-0.17	<P1	302.78	6.16
6361	-0.31	0.6	0.29	<P1	302.78	5.9
5946	-1.19	0.6	-0.59	<P1	302.78	5.75
4828	-0.15	0.6	0.45	<P1	302.78	5.24
4032	0.01	0.6	0.61	<P1	302.78	4.95
3633	-1.79	0.6	-1.19	<P1	302.78	4.77
3236	0.04	0.6	0.64	<P1	302.78	4.51
2851	-4.39	0.6	-3.79	<P1	302.78	4.51
2360	-2.25	0.6	-1.65	<P1	302.78	4.51
1727	-2.77	0.6	-2.17	<P1	302.78	4.5
3	-5	0.6	-4.4	<P1	302.78	4.5

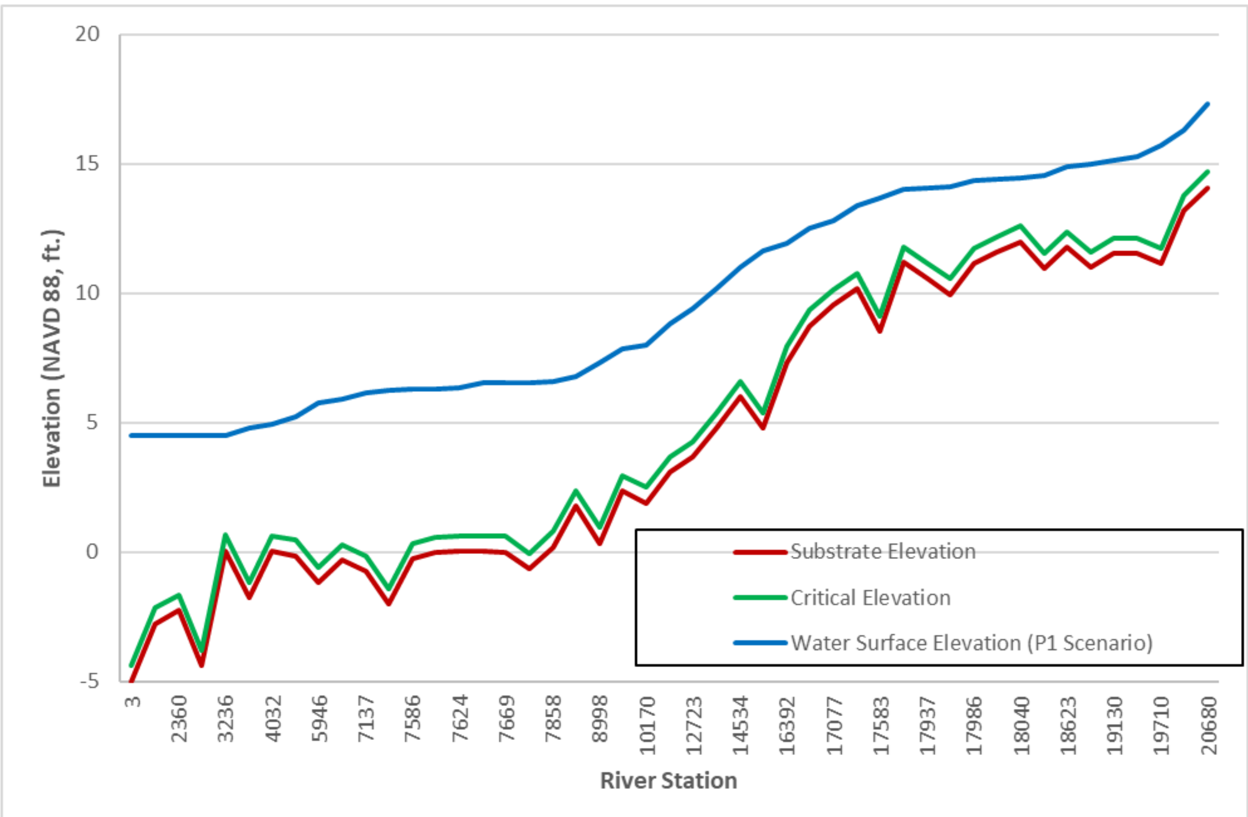


Figure 6-3. Critical Elevation and Minimum Modeled Water Levels for Safe Fish Passage Along Econfina Creek

6.2 Riparian Bank Habitat, Bankfull Flow, and Out-of-Bank Flow Evaluation

Bankfull flow is defined as the streamflow resulting in river stage at the interface between the open channel and the alluvial floodplain (AMEC 2012). Out-of-bank flows are therefore flows resulting in river stages in excess of that for bankfull flow, which begins to inundate floodplain communities. Riparian bank habitat, or the riparian zone, includes habitat which borders the river shoreline below the top-of-bank. The riparian zone includes the floodplain, woody debris and snag habitat as well as littoral (submerged) bank areas which may provide fish habitat (SRWMD 2021). Protection of riparian, bankfull and out-of-bank flows may contribute to preserving the ecological health of Econfina Creek. These flow conditions allow for inundation of riparian and floodplain communities, which allows support of the extent and integrity as well as improved overall productivity of these communities (SRWMD 2015). Floodplain inundation also provides additional nutrients to the river, through transfer of detrital matter (SRWMD 2013). Additionally, bankfull flow is effective at maintaining channel dimensions and overall integrity or fluvial geomorphology of riverine systems (AMEC 2012). One aspect of this is maintenance of sediment transport mechanisms, which allows for maintenance of a riverine system's dynamic equilibrium, which in turn maintains the overall integrity of the system. If this balance is not maintained, excessive scour and/or deposition could occur altering the dynamic equilibrium of the system (SRWMD 2021). Given the karst nature of Econfina Creek, it is probable most of the creek's sediment load is carried at higher flows. Therefore, protection of bankfull and out-of-bank flows are anticipated to protect sediment transport along Econfina Creek.

An assessment riparian bank habitat, bankfull and of out-of-bank flows was considered for the establishment of Econfina Creek MFLs providing protection for several WRVs including:

- Fish and Wildlife Habitat and the Passage of Fish: Inundation of Floodplain Communities
- Transfer of Detrital Material
- Maintenance of Freshwater Storage and Supply
- Filtration and Absorption of Nutrients and Other Pollutants
- Sediment Loads

Based on an extensive literature review of methods used to assess riparian bank habitat, bankfull and out-of-bank flows in previous MFL assessments, two methodologies were considered for this assessment based on applicability to Econfina Creek:

- Evaluation of wetted perimeter to assess riparian bank habitat and bankfull flow conditions
- Evaluation of top-of-bank elevations to evaluate bankfull and out-of-bank flow conditions

Details are presented in the sections below.

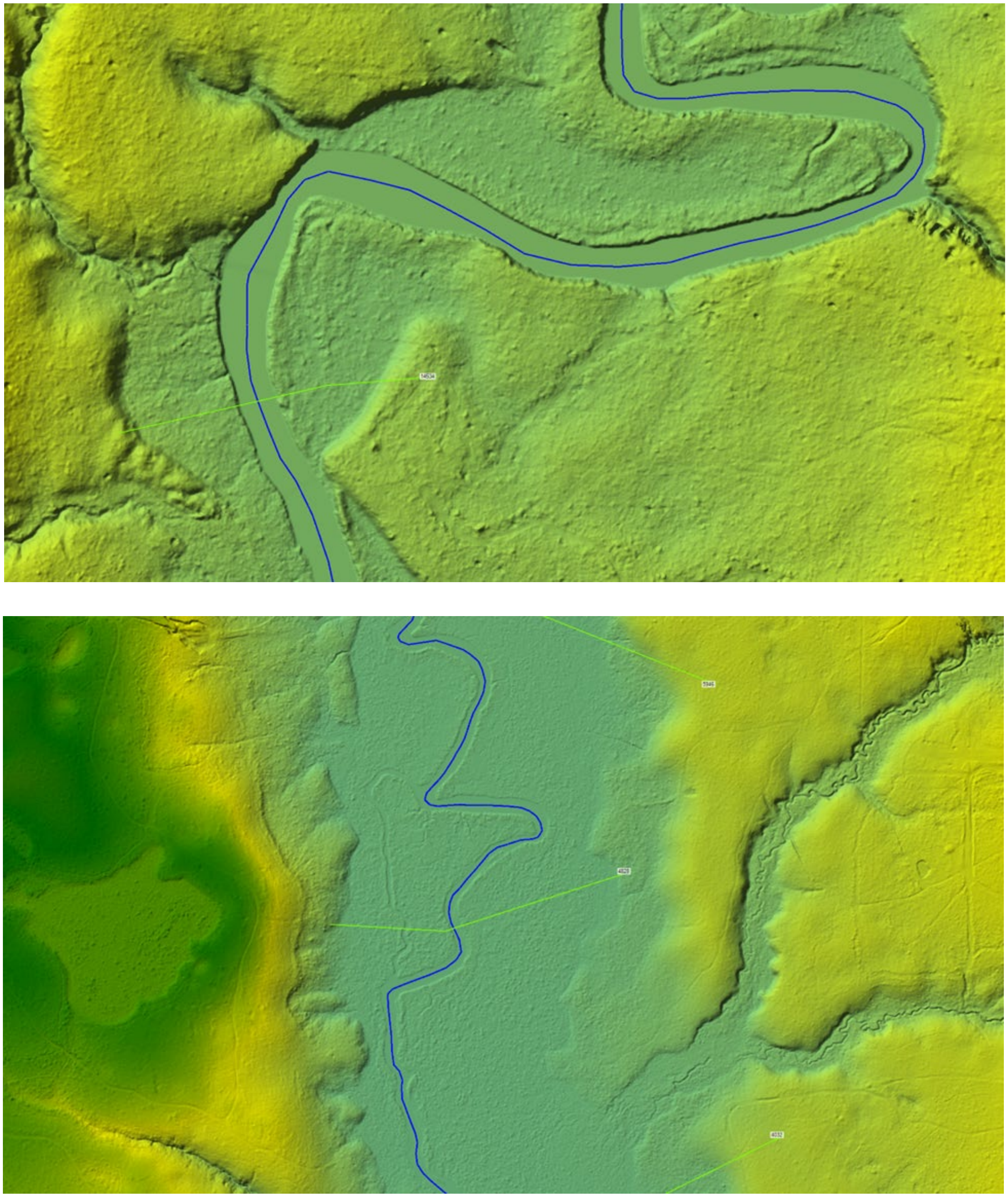
6.2.1 Evaluation of Wetted Perimeter to Assess Riparian Bank Habitat and Bankfull Flow Conditions

Wetted perimeter is defined as the distance along the stream bed and banks where contact with water is made along a cross-section. Evaluation of the relationship of wetted perimeter versus flow can be utilized to identify portions of a cross section with minimal increase in wetted perimeter per unit flow increase (e.g. river bank) as well as portions of a cross section with large increases in wetted perimeter per unit flow increase (e.g. river bed or floodplain). Inflection points can be identified at the toe-of-bank, top-of-bank, and potentially elsewhere where changes in the relationship between wetted perimeter and flow occur.

Evaluation of wetted perimeter to evaluate riparian bank habitat was conducted for development of previous MFL assessments including the Aucilla/Wacissa River MFL, and the Rainbow River MFL (SRWMD 2016a, SWFWMD 2017b). Based on review of these assessments, a similar evaluation was conducted for the development of Econfina Creek MFLs. Evaluation of wetted perimeter based on assessment of wetted perimeter for individual cross sections vs. utilizing a weighted wetted perimeter approach was considered. Review of individual cross section wetted perimeter plots showed a high degree of variability amongst cross sections. Additionally, the complex topography of Middle Econfina Creek resulted in wetted perimeter plots which were challenging to select well defined inflection points at some cross section locations. Therefore, for this assessment, a weighted wetted perimeter approach was selected to reduce uncertainty from inflection point selection at individual cross sections.

Output from each of the 99 flow scenarios simulated in HEC-RAS (P1-P99) was utilized to determine the wetted perimeter for each transect within the Econfina MFL study area as a function of flow. Transects in the lower portion of the domain below XS 6361 were assessed separately from the rest of the model domain since below this location, Econfina Creek widens as it transitions into Deer Point Lake Reservoir resulting in wetted perimeter on the order of 10-20 times that of the transects throughout most of the model domain. In addition, the topography in the upper portion of the model domain is much steeper than in the lower domain, resulting in portions of the upper domain achieving bankfull flow only at high flows while the lower portion of the model domain achieves bankfull flows regularly. For these reasons, these transects were separated from the rest of the model domain to avoid bias in the weighted wetted perimeter computation from the few transects in the lowest portion of the domain.

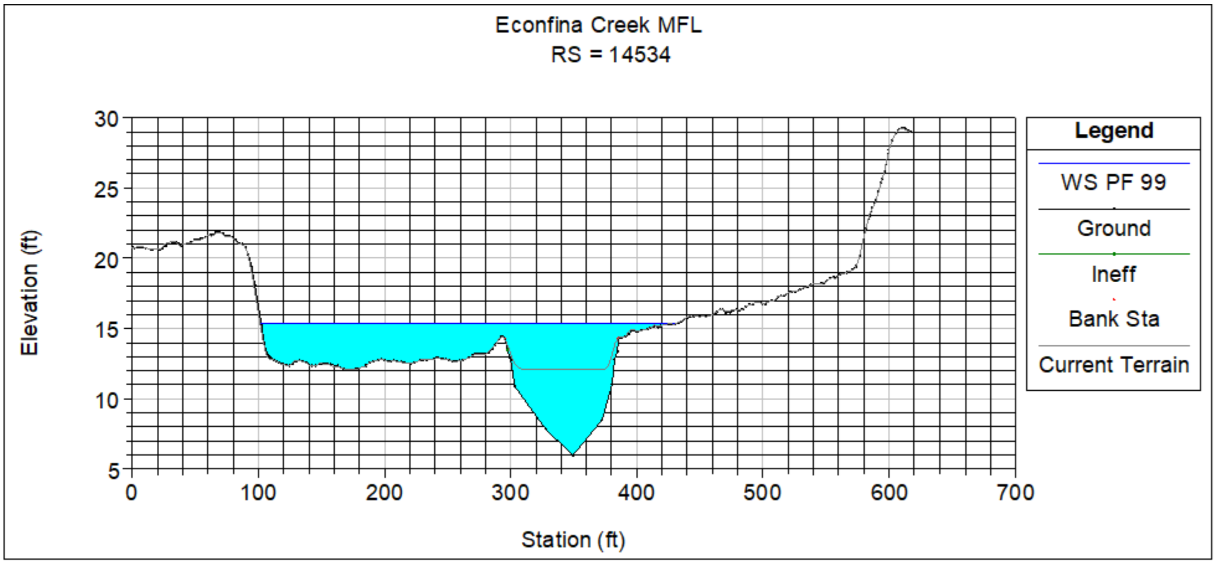
To illustrate these differences, an example transect in the upper and lower portion of the modal domain are contrasted in Figures 6-4a, 6-4b, and 6-5. In the vicinity of transect 14534 in the upper portion of the domain, Econfina Creek is sinuous with steep banks and minimal floodplain surrounding the creek. Bankfull flows are achieved only for the 96th percentile flow at this location. In contrast, in the vicinity of transect 4828 in the lower portion of the domain, Econfina Creek is wide and flat with an extensive floodplain and less defined banks. Bankfull flows are achieved above the 15th percentile flow, with wetted perimeter approximately 10 times that of transect 14534 once bankfull flow is achieved at transect 4828.



A) B)

Figure 6-4. Example Topography in the Upper and Lower Portion of the Domain **A)** Cross Section 14534 **B)** Cross Section 4828

A)



B)

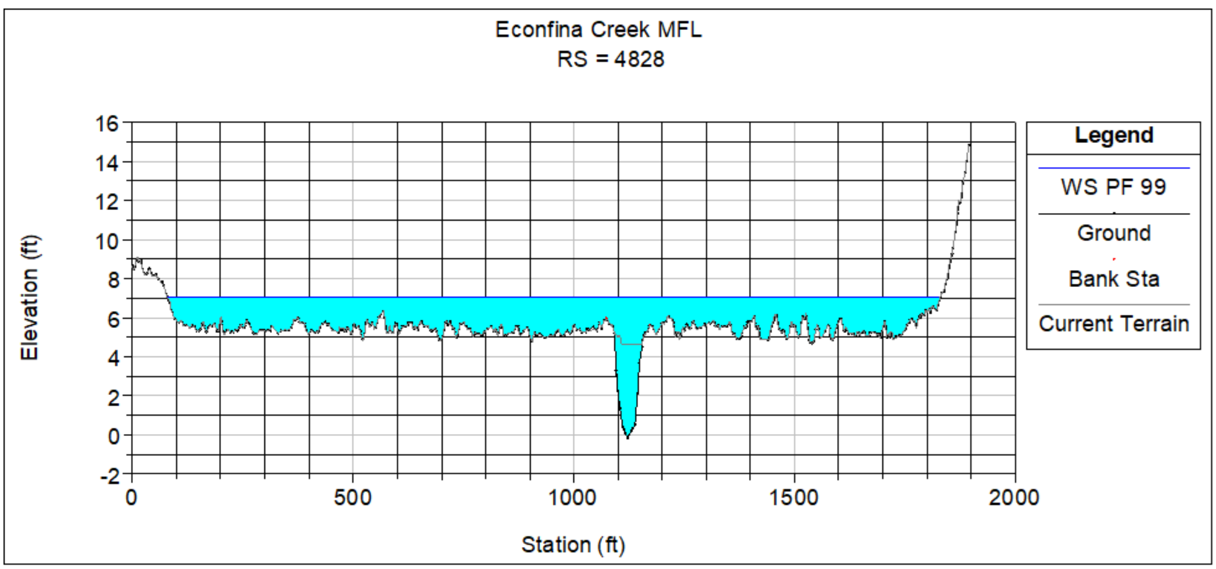


Figure 6-5. Example Model Transect in the Upper and Lower Portion of the Domain. Flows depicted are for the 99 percent percentile **A)** Cross Section 14534] **B)** Cross Section 4828

For each flow scenario, the average wetted perimeter per subreach was computed as the average wetted perimeter for the immediate upstream and downstream transect. A subreach is defined as the distance between adjacent transects. For each flow scenario, the weighted wetted perimeter for the study area was computed by summing the product of average subreach wetted perimeters and subreach lengths and dividing that quantity by the total river reach length. The resulting plot of weighted wetted perimeter versus flow at Econfina Creek @ CR 388 for all model transects including and above XS 6361 is shown in Figure 6-6. The resulting plot of weighted wetted perimeter versus flow at Econfina Creek @ CR 388 for all model transects below XS 6361 is shown in Figure 6-7. Review of Figure 6-6 showed an inflection point at 696 cfs (P89 scenario) suggesting the top-of-bank. An inflection point at 328 cfs (P3) was identified suggesting the toe-of-bank. Further inflection points were not identified anywhere else within the riparian bank (between toe and top-of-bank).

For the identified inflection points, the allowable change in flow was determined based on a 15% reduction in weighted wetted perimeter. For the upper inflection points, this would be protective of riparian bank habitat in the vicinity of the top-of-bank, providing protection to WRVs associated with bankfull flows including sediment transport and fluvial geomorphology. For the lower inflection points, this would be protective of snag and root and similar woody habitat occurring near the toe of bank. For the top-of-bank inflection points, a 15% reduction in weighted wetted perimeter resulted in an allowable flow reduction of 10.78%, based on the analysis of model transects including and above XS 6361 (Table 6-5). For the toe of bank inflection points, a 15% reduction in weighted wetted perimeter resulted in a weighted wetted perimeter which was met under all flow scenarios modeled. Therefore, the toe of bank inflection point was not considered further for MFL determination.

Review of Figure 6-7 indicated flows in excess of top-of-bank likely occur at cross sections below 6361 under most flow conditions simulated due to the initial slope of the curve. The curve flattens out at higher flows when approaching upland areas. This is consistent with Figures 6-4 and 6-5 showing a wide flat floodplain in this reach. Since water levels in this vicinity may be influenced by backwater effects from Deer Point Lake Dam as opposed to changes in spring flow, metrics pertaining to riparian bank habitat and bankfull flows below cross section 6361 were not further considered in establishing the Middle Econfina Creek minimum flow.

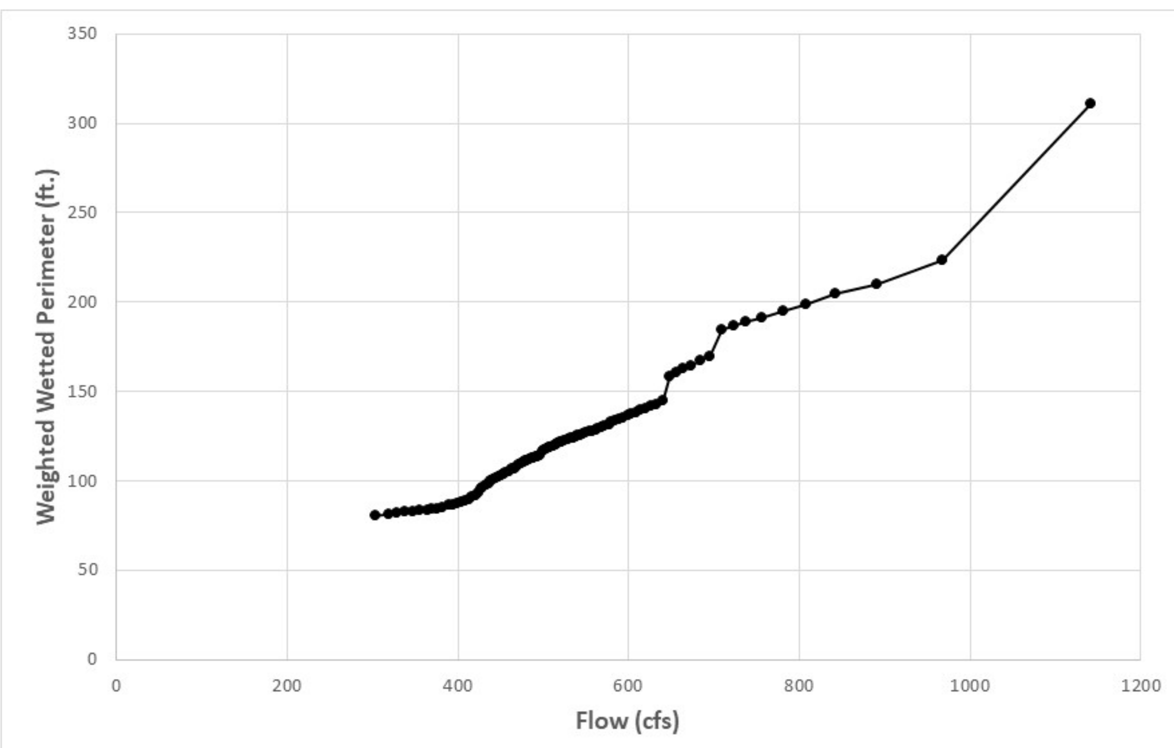


Figure 6-6. Average Transect Weighted Wetted Perimeter versus Flow at Econfina Creek @ CR 388, above XS 6361

Table 6-5. Flow Reduction Associated with 15% Reduction in Weighted Wetted Perimeter (WWP), above XS 6361

Model Results			15% Decrease		Allowable Flow Reduction	
Inflection Point	WWP, ft.	Adjusted streamflow at Econfina Creek@ CR 388 (cfs)	Flow Associated with 15% reduction in WWP (cfs)	Reduced WWP, ft.	Allowable flow reduction at Econfina Creek@ CR 388	Percent Change
Top-of-bank (P89)	169.39	695.78	632.8	143.98	63	9.05
Toe of Bank* (P3)	82.25	327.78	<303	69.91	n/a	n/a

*For the Toe of Bank, the lowest modeled WWP was 80.25 ft. for the P1 scenario (303 cfs). Therefore, this condition is always met.

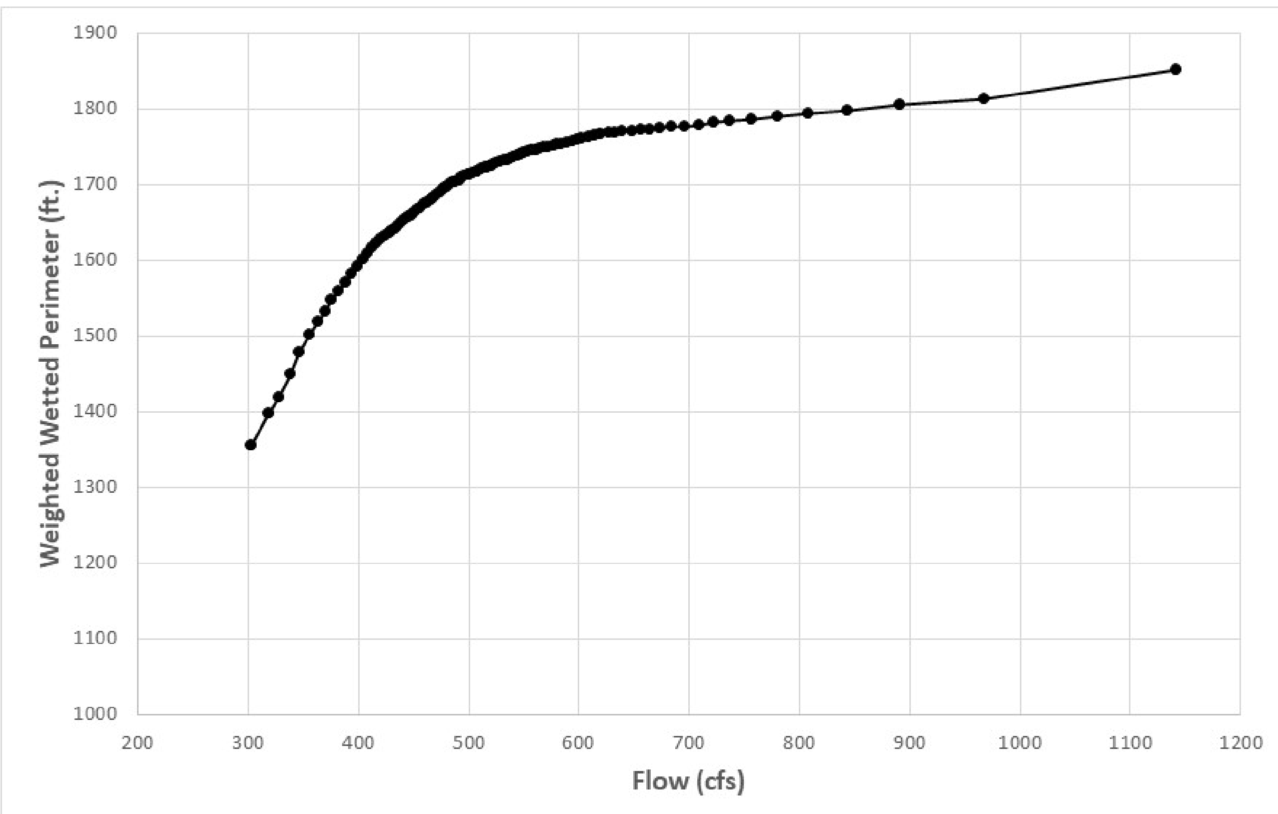


Figure 6-7. Average Transect Weighted Wetted Perimeter versus Flow at Econfina Creek @ SR 20 below XS 6361

6.2.2 Evaluation of Top-of-Bank Elevations to Evaluate Bankfull and Out-of-Bank Flow Conditions

An alternative method of evaluating bankfull and out-of-bank flows is to evaluate flows required to achieve water surface elevations which meet or exceed top-of-bank elevations. This approach has been utilized in several previous MFL assessments, including the Lower Sante Fe and Ichetucknee Rivers MFL, the Middle Suwannee River MFL, and Econfina River MFL (SRWMD 2021, SRWMD 2016c, SRWMD 2015). The first step of this method is to determine right and left top-of-bank elevations along the river, defined as the elevation at which the stream just begins to overflow onto the floodplain. These elevations can be determined through field investigations of bankfull indicators such as the elevation where the slope becomes level, inflections or breaks in the slope of the bank, and scour lines and undercuts in the bank found around plant roots (AMEC 2012).

For the purposes of determining top-of-bank elevations for evaluation of bankfull flows for Econfina Creek MFLs, the high-resolution generated terrain with RAS-Mapper combined with elevation transects performed by Southeastern Surveying and Mapping Corporation provided sufficient depiction of Econfina Creek topography within the model domain. High resolution post-Hurricane Michael light detection and ranging (LiDAR) was received by the District in August 2022 which consisted of raster files with 0.76 meter grid cell resolution for the majority of the District, including the study area in the vicinity of Econfina Creek. Post-Hurricane Michael LiDAR for this area was flown between December 2019 and October 2020. District staff developed a mosaic DEM from provided raster files. This DEM was utilized to develop a terrain layer in RAS Mapper which was utilized to determine bank lines and top bank elevations. In 2021, Southeastern Surveying and Mapping, Corporation (Southeastern) performed 37 cross-section elevation surveys extending from five feet upland of top-of-bank on either side of the channel between Williford Spring and CR 388 bridge, including notation of top-of-bank elevation (Southeastern 2021a, Southeastern 2021b). In 2023, Southeastern was contracted to perform an additional 12 cross-section elevation surveys below CR 388 extending to the end of the model domain in Deer Point Lake (Southeastern 2023). These elevation surveys were utilized to refine model cross section geometry, including top-of-bank elevations.

The minimum of the right and left top-of-bank elevation above XS 6361, as well as the lowest simulated flow required to achieve bankfull flow based on baseline flow simulations from the Middle Econfina Creek HEC-RAS model is presented in Table 6-6. Similar to the wetted perimeter assessment, transects below 6361 were excluded due to water levels possibly being primarily influenced by backwater effects from Deer Point Lake Dam as opposed to changes in spring flow. Review of Table 6-6 indicates that bankfull and out-of- bank flows occur relatively infrequently throughout Middle Econfina Creek, with several cross sections not achieving bankfull flow under any flow scenarios considered. These results are consistent with the relatively steep banks with limestone outcrops found throughout this section of Econfina Creek. Due to infrequent flooding combined with a relatively narrow floodplain in this reach as well as ongoing changes to wetland communities in response to Hurricane Michael, further assessment of out-of-bank or floodplain metrics was not conducted for this assessment. Future evaluations may consider further evaluation of floodplain metrics, including floodplain inundation analysis, as additional information becomes available, and the system continues to recover from Hurricane Michael.

Table 6-6. Simulated Water Surface Elevations to Achieve Bankfull Conditions above XS 6361

Metric		Model Results		
Transect (ft)	Minimum Right, Left Top-of-Bank Elevation (NAVD 88)	Bankfull Percentile Flow	Bankfull Streamflow at Transect, cfs	Water Surface Elevation (NAVD 88)
20680	20.73	94	413.95	20.78
20020	20.08	95	434.95	20.15
19710	22.37	>99	663.16	20.55
19319	20.05	>99	663.16	19.76
19130	21.37	>99	705.33	19.55
18837	20.09	>99	705.33	19.25
18623	21.12	>99	705.33	19.02
18119	19.21	>99	722.99	18.52
18040	19.42	>99	722.99	18.43
18013	20.44	>99	722.99	18.39
17986	21.28	>99	722.99	18.37
17965	21.3	>99	722.99	18.34
17937	20.38	>99	722.99	18.32
17914	17.75	98	619.78	17.83
17583	16.66	94	473.78	16.7
17346	16.14	91	430.78	16.15
17077	16.84	>99	937.89	17.28
16891	16.8	>99	937.89	17.08
16392	16.78	>99	955.18	16.6
15775	14.64	91	642.52	14.67
14534	14.27	96	769.1	14.4
13738	13.59	96	769.1	13.76

12723	14.71	>99	1047.77	14.09
11676	10.81	75	562.65	10.82
10170	10.91	95	792.6	10.98
9832	13.27	>99	1112.2	12
8998	12.21	>99	1141.78	10.99
8178	10.44	>99	1141.78	10.03
7858	8.68	93	756.78	8.74
7686	8.14	81	626.78	8.15
7669	8.51	92	737.26	8.51
7649	9.03	98	968.02	9.16
7624	11.72	>99	1141.78	9.34
7608	12.39	>99	1141.78	9.31
7586	11.05	>99	1141.78	9.3
7322	8.06	91	722.78	8.09
7137	10.1	>99	1141.78	8.94
6361	7.04	71	576.78	7.04

6.3 Evaluation of In Stream Habitat

Output from the SEFA model, described in Section 5.2, was utilized to determine the relationship between Econfina Creek flow and the area weighted suitability (AWS) for aquatic species and guilds including fish and macroinvertebrate species. Appendix B presents the SEFA results for the baseline flow scenarios simulated. The mean, median, and maximum AWS and associated Econfina Creek flow at the CR 388 gauge are presented.

Since the SEFA analysis provides an estimate for aggregate AWS for each flow simulated, the relationship between flow and AWS can be used to estimate the reduction in flow that would result in a 15% reduction in AWS for the most sensitive species or guild. Similar to other WRV metrics assessed, a threshold of 15% reduction in AWS was utilized as the protection standard for instream habitat for establishment of MFLs for this assessment. The maximum AWS was selected as the metric of interest as a conservative assumption to protect Econfina Creek instream habitat. Figure 6-8 presents a conceptual depiction of the estimation of the flow that results in a 15% reduction in the maximum AWS for a species or guild of interest.

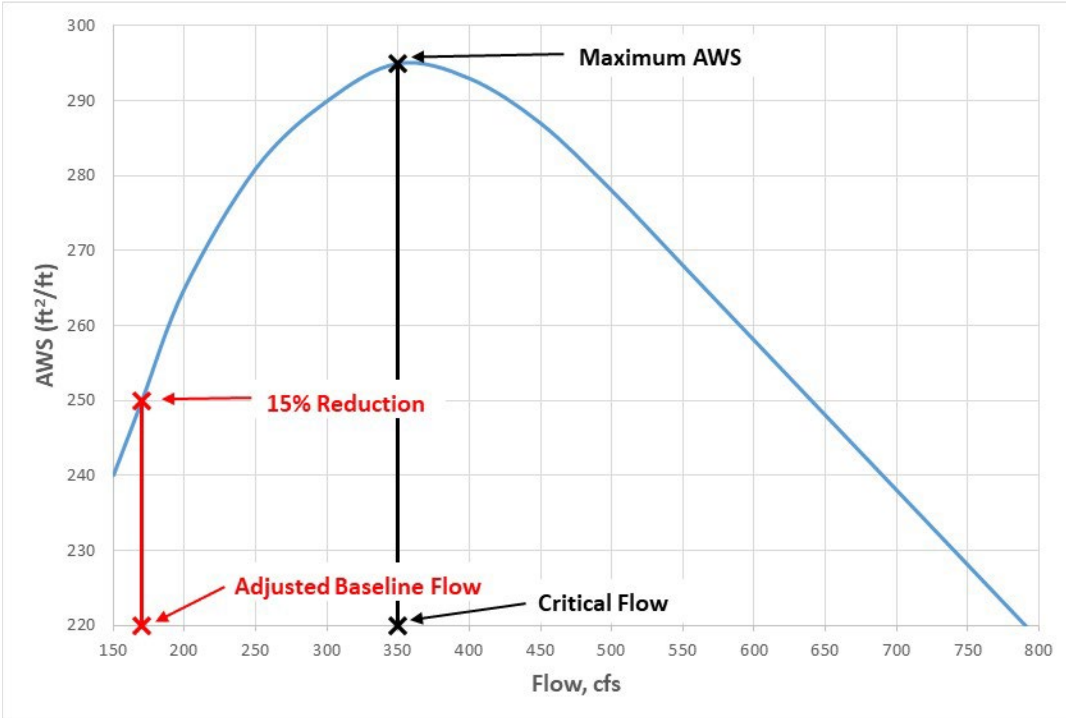


Figure 6-8. Conceptual Depiction of the Estimation of the Critical Flow Resulting in a 15% Reduction in AWS.

The relationship between the AWS and flow for each species or guild assessed is shown in Appendix B (an example for the habitat guild for fish utilizing shallow water depth and slow water velocity is provided in Figure 6-10). The aggregate AWS for each simulated flow is displayed by the yellow markers for each graphic in Appendix B. The blue curve represents a best fit curve through all computed values of AWS vs. flow. The uppermost red point represents the maximum AWS and corresponding flow for a given fish species or guild. The lower red point and vertical line indicates a 15% reduction in the maximum AWS and corresponding flow associated with a 15% reduction in the maximum AWS. Species or guilds which displayed an increase in AWS with reduced flow are not displayed and were excluded from further analysis. The flow range that defines the X-axis is the range from simulated baseline flows (P1 - P99) presented in Appendix B.

Species or guilds which displayed an increase in AWS with reduced flow (i.e. redbreast sunfish juvenile, redbreast sunfish spawning, and channel catfish juvenile fall) were excluded from further analysis and are not described in in this technical assessment, however, the results of the analysis are provided in Appendix B. Additionally, species or guilds for which a 15-percent reduction in maximum AWS resulted in a reduced flow below the lowest simulated baseline flow scenario were excluded from further analysis (i.e. bluegill Juvenile, channel catfish juvenile warm water and spotted sunfish fry) (Appendix B). For each of the relevant species or guilds, the maximum AWS as well as the flow associated with a 15-percent reduction in the maximum AWS are shown in Table 6-7. These critical points are also indicated on the graphics in Appendix B. For each relevant species or guild, allowable flow reduction was determined as the difference between the flow associated with the maximum AWS and the reduced flow associated with a 15-percent reduction in maximum AWS.

Based on Table 6-7, the maximum AWS for many of the fish taxa/life stages occurred at the P99 flow (1141.8 cfs). These results generally reflect lack of sensitivity in most of the taxa/life stages as relatively large flow reductions are required to achieve a 15% allowable reduction in AWS. The slow shallow guild taxa displayed the greatest sensitivity to flow change of the taxa assessed, and is therefore the critical guild of interest for MFL considerations. A 15% reduction in max AWS for the slow shallow guild translates to an allowable flow reduction of 51 cfs (363.8 cfs- 312.8 cfs). The graphical relationship between flow and AWS for the slow shallow guild is shown in Figure 6-9. The results of other fish and macroinvertebrate species/guild analyses can be found in Table 6-7 and Appendix B.

The shallow slow habitat guild describes a set of habitat characteristics shared by many species and life history stages and was defined and utilized previously for instream habitat modeling of the Little Manatee River (Herrick, 2021). These species have similar taxonomic, functional, and life history characteristics and as a result have similar habitat suitability curves for velocity, depth, and substrate/cover. These species include:

- Redbreast Sunfish (*Lepomis auritus*)
- Bluegill (*Lepomis macrochirus*)
- Largemouth Bass (*Micropterus salmoides*) (juveniles)
- Spotted Sunfish (*Lepomis punctatus*)
- Warmouth (*Lepomis gulosus*)
- Eastern Mosquitofish (*Gambusia holbrooki*)

As previously stated, detailed Habitat Suitability information for mussels remains unavailable at the time of this documents preparation which precludes the direct inclusion of these species in SEFA modeling and instream habitat evaluation. As a result, the effects of flow reductions on mussel species present in Econfina Creek were analyzed indirectly using the mussel host fish species listed in Table 2-7. Of the 14 host fish species listed, habitat suitability curves were available for five species, taxa including bluegill, spotted sunfish, largemouth bass, blackbanded darters, and generic darters (Table 6-7). A 15 percent reduction in the maximum AWS for these species resulted in allowable flow reductions ranging from 99 cfs (30 percent) for bluegill, *Lepomis macrochirus*, spawning to 815 cfs (249 percent) for adult blackbanded darters, *Percina nitrofasciata*.

A total of five macroinvertebrate habitat suitability curves were available for the Instream Flow Analysis using SEFA (Table 6-7). Overall, macroinvertebrate species were relatively insensitive to Econfina Creek flow reductions as the maximum AWS for most species occurred at the P99 flow (1141.8 cfs). Allowable flow reductions for macroinvertebrate species ranged from 507 cfs (80 percent) for caddisflies, *Tricoptera* to 797 cfs (231 percent) for mayflies, *Ephemeroptera*. One macroinvertebrate guild (Low Gradient Macroinvertebrates) was excluded from analysis as its allowable flow reduction was below the modeled and observed flows in Econfina Creek.

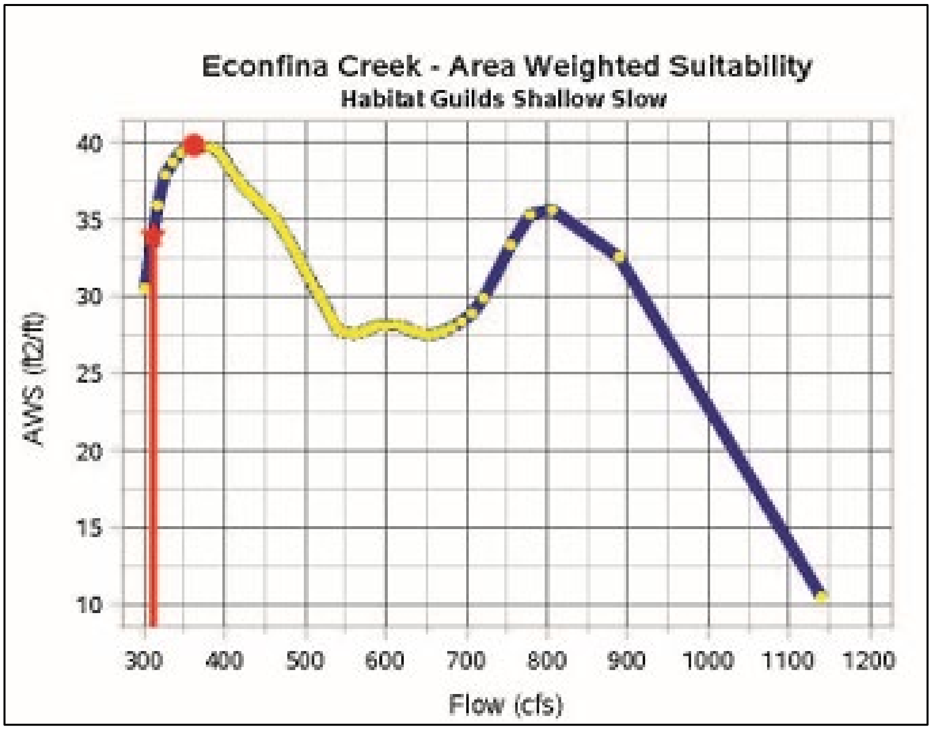


Figure 6-9. Relationship between Flow at Econfina Creek @ CR 388 and AWS for the Critical Guild.

Table 6-7. Flow Reduction Associated with 15% Reduction in Maximum Area Weighted Suitability (AWS).

Taxon	Max. AWS	Econfina Creek @CR 388 Flow @ Maximum AWS, cfs	15% Reduction in Maximum AWS	Econfina Creek @CR 388 Flow @ Reduced Maximum AWS, cfs	Allowable Flow Reduction, cfs	Allowable Flow Reduction Percent Change (From Adjusted Baseline Flow)
Habitat Guilds Shallow Slow	40	363.8	34	312.8	51	16.3%
Bluegill Spawning*	173	423.8	147	325	98.8	30.4%
Spotted Sunfish Spawning*	36	407.8	31	302.8	105	34.7%
Bluegill Fry*	161	613.8	137	472	141.8	30.0%
Spotted Sucker Juvenile	144	602.8	122	384.8	218	56.7%
Bluegill Adult*	112	1141.8	95	879	262.8	29.9%
Channel Catfish Spawning	136	1141.8	116	862	279.8	32.5%
Largemouth Bass Juvenile*	183	632.8	155	305.8	327	106.9%
Largemouth Bass Spawning*	159	780.8	135	420.8	360	85.6%
Channel Catfish Adult	129	1141.8	110	764	377.8	49.5%
Redbreast Sunfish Fry	141	1141.8	120	705.8	436	61.8%
Generic Darters Adult*	167	1141.8	142	697	444.8	63.8%
Largemouth Bass Adult*	212	1141.8	180	676.8	465	68.7%
Tricoptera	259	1141.8	220	634.8	507	79.9%
Channel Catfish Fry	170	1141.8	144	626	515.8	82.4%
Redbreast Sunfish juvenile	280	890.8	238	328.8	562	170.9%

Channel Catfish Juvenile Summer	140	1141.8	119	566	575.8	101.7%
Speckled Madtom	140	1141.8	119	548.8	593	108.1%
EPT Total	38	1141.8	32	537.8	604	112.3%
Habitat Guilds Shallow Fast	4	1141.8	3.4	495.8	646	130.3%
Redeye Chub	227	1141.8	193	495.8	646	130.3%
Habitat Guilds Deep Fast	84	1141.8	71	455	686.8	150.9%
Plecoptera	188	1141.8	160	453.8	688	151.6%
Pirate Perch	271	1141.8	230	448.8	693	154.4%
Habitat Guilds Deep Slow	243	1141.8	207	438.8	703	160.2%
Redbreast Sunfish Adult	243	1141.8	207	438.8	703	160.2%
Ephemeroptera	152	1141.8	129	344.8	797	231.1%
Blackbanded Darters Adult*	159	1141.8	135	327	814.8	249.2%
Spotted Sucker Adult	61	1141.8	52	326.8	815	249.4%

*Indicates a mussel host fish species

7 Summary and Recommended Minimum Flow

The development of minimum flows for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group builds upon methods applied elsewhere in Florida, as well as for minimum flows established for the St. Marks River Rise and Wakulla and Sally Ward springs by the District. The District's approach toward establishing MFLs for the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group is that an alternative hydrologic regime exists such that the system's water resource values are protected from significant harm caused from water withdrawals. The approach is based on quantifiable relationships between spring discharge and multiple physical and ecological features related to specific water resource values (WRVs). Rule 62-40.473, Florida Administrative Code, outlines requirements regarding specific WRVs which must be considered in setting MFLs (Table 1-1).

The results from the evaluation of multiple WRV metrics were used to determine the recommended minimum flow for Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group. Although significant harm is not specifically defined in statute, an allowable 15-percent reduction in WRV metrics has been implemented as the protection standard for multiple MFLs throughout Florida. The 15-percent threshold is also used in this assessment, recognizing additional data collection and long-term research to confirm or refine this threshold for MFL assessments in Florida would be beneficial. The MFL implementation will follow an adaptive management approach, with MFLs periodically reviewed and reevaluated by the District to reflect new data and information. As new data and information are developed regarding the definition of threshold for significant harm, the District will consider this information in future MFL re-evaluations.

The reference gauge selected to establish a combined minimum flow for the middle Econfina Creek system, inclusive of flow inputs from Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group, is the USGS station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388). This station was selected as the reference gauge since it is located downstream of all spring groups of interest and has a sufficient period of record which could be utilized to determine historical baseline conditions (10/1/1935 through 10/14/2023). The Econfina Creek @ SR 20 station was not selected as a reference gauge due to a shorter period of record (11/5/1992 through 10/3/2023) as well as anticipated construction on SR 20 which may require temporarily removing this gauge. In addition, flows at this location are not inclusive of flows at the Gainer Spring Group.

Due to limited flow measurements and absence of long-term continuous flow record for the spring groups of interest, particularly for Williford Spring Group and Sylvan Spring Group, establishment of spring group specific MFLs is not possible currently. The combined average discharge of Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group represents approximately 42 percent of the long-term baseline average flow at the Econfina Creek @ CR 388 station. Therefore, the establishment of an MFL at the Econfina Creek @ CR 388 station will be protective of spring discharge from these spring groups.

The Econfina Creek baseline flow record was determined by adjusting the historical flow record for USGS station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388) by adding in estimated 2020 withdrawals in the contribution area of 1.15 mgd (1.78 cfs) to all flows in the historical record. The value of 1.78 cfs is a conservative estimate of withdrawal impacts on Econfina Creek baseline flows.

Flow reductions from baseline hydrologic conditions were evaluated at critical flows associated with safe boating and fish passage, maintaining bankfull flows, and protecting instream habitat of aquatic species for Econfina Creek (See Section 6 for details). For each metric evaluated, the critical flow was determined at specific locations throughout Econfina Creek and were translated to an equivalent flow (based on flow percentile) at the reference gauge (Econfina Creek @ CR 388). Allowable reductions in Econfina Creek flow corresponding to a 15-percent reduction in inundation frequency (e.g., time) were determined for metrics pertaining to safe boating and fish passage. Allowable reductions in Econfina Creek flow corresponding to a 15-percent reduction in inundation frequency (e.g., time) as well as a 15-percent reduction in weighted wetted perimeter were determined for metrics pertaining to maintaining bankfull flows. Allowable reductions in Econfina Creek flow corresponding to a 15-percent reduction in maximum area weighted suitability were determined to protect instream habitat of aquatic species.

A summary of allowable flow reductions at Econfina Creek @ CR 388 gauge for each WRV metric evaluated is shown in Table 7-1. The most limiting metric is instream habitat associated with shallow water, low velocity fish species, with an allowable flow reduction of 51 cfs associated with a baseline flow at CR 388 of 312.8 cfs. The weighted wetted perimeter top-of-bank inflection point, above HEC-RAS transect 6361, had an allowable flow reduction of 63 cfs, associated with a baseline flow at CR 388 of 632.8 cfs. A 15% reduction in weighted wetted perimeter at the toe of bank inflection point, above HEC-RAS transect 6361, was met under all flow scenarios and was therefore not a critical metric. Safe power boating was achieved throughout the study area for all but the lowest flow scenarios simulated. The critical HEC-RAS transect for power boating is located in the upper reach of the study area, in the vicinity of Williford Spring, where Econfina Creek is relatively narrow and shallow. An allowable flow reduction of 92 cfs, associated with a baseline flow 419.78 cfs was determined for safe passage based on this critical transect. Safe canoe/kayak passage and safe fish passage were achieved under all flow scenarios evaluated throughout the study area. Figures 7-1 and 7-2 show collectively the allowable flow reductions associated with each metric evaluated across the range of baseline flows at Econfina CR 388 gauge.

The proposed alternative hydrologic regime for Econfina Creek would shift the baseline flow duration curve downward by the most limiting allowable flow reduction of 51 cfs, across the range of baseline flows for Econfina Creek CR 388 gauge. Setting a single minimum flow at the average daily baseline flow for Econfina Creek CR 388 gauge provides for adequate protection of middle Econfina Creek including Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group. The recommended minimum flow is an allowable flow reduction of 51 cfs from the Econfina Creek @ CR 388 gauge long-term average baseline flow of 537 cfs. This translates to an allowable reduction of 9.5 percent of the average baseline middle Econfina Creek flow, resulting in a minimum average middle Econfina Creek flow of 486 cfs (Table 7-2).

Table 7-1. Summary of WRV Metrics and Allowable Flow Reductions at the Econfina CR 388 Gauge

Indicator	WRV Assessment Method	Critical Flow, cfs (Flow Percentile)	Adjusted Baseline Time Series Flow, cfs (Flow Percentile)	Allowable Flow Reduction, cfs (Percent Reduction)
safe power boating passage	percent of time achieved	327.78 (3)	419.78 (17.6)	92 (21.92)
safe canoe/kayak passage	percent of time achieved	limiting depth never achieved in study area		
safe fish passage	percent of time achieved	limiting depth never achieved in study area		
instream habitat (SEFA)	SEFA/ maximum area weighted suitability	363.8 (7)	312.8 (1.5)	51 (16.3)
riparian bank habitat/ bankfull flow	weighted wetted perimeter toe of bank inflection point, above HEC-RAS transect 6361	15% reduction in weighted wetted perimeter at toe of bank inflection point met under all flow scenarios		
riparian bank habitat/ bankfull flow	weighted wetted perimeter top-of-bank inflection point, above HEC-RAS transect 6361	695.78 (89)	632.8 (82)	63 (9.05)

Table 7-2. Recommended Minimum Flow for Middle Econfina Creek, Inclusive of Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group

System	Average Baseline Flow at Reference Gauge	Allowable Flow Reduction at Reference Gauge*	Minimum Average Flow at Reference Gauge	Allowable Percent Flow Reduction from Average Baseline Flow
Middle Econfina Creek and Springs (Inclusive of Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group)	537 cfs (347 mgd)	51 cfs (33 mgd)	486 cfs (314 mgd)	9.5%

*Reference gauge is USGS station 2359500 Econfina Creek Near Bennett, FL (Econfina Creek @ CR 388).

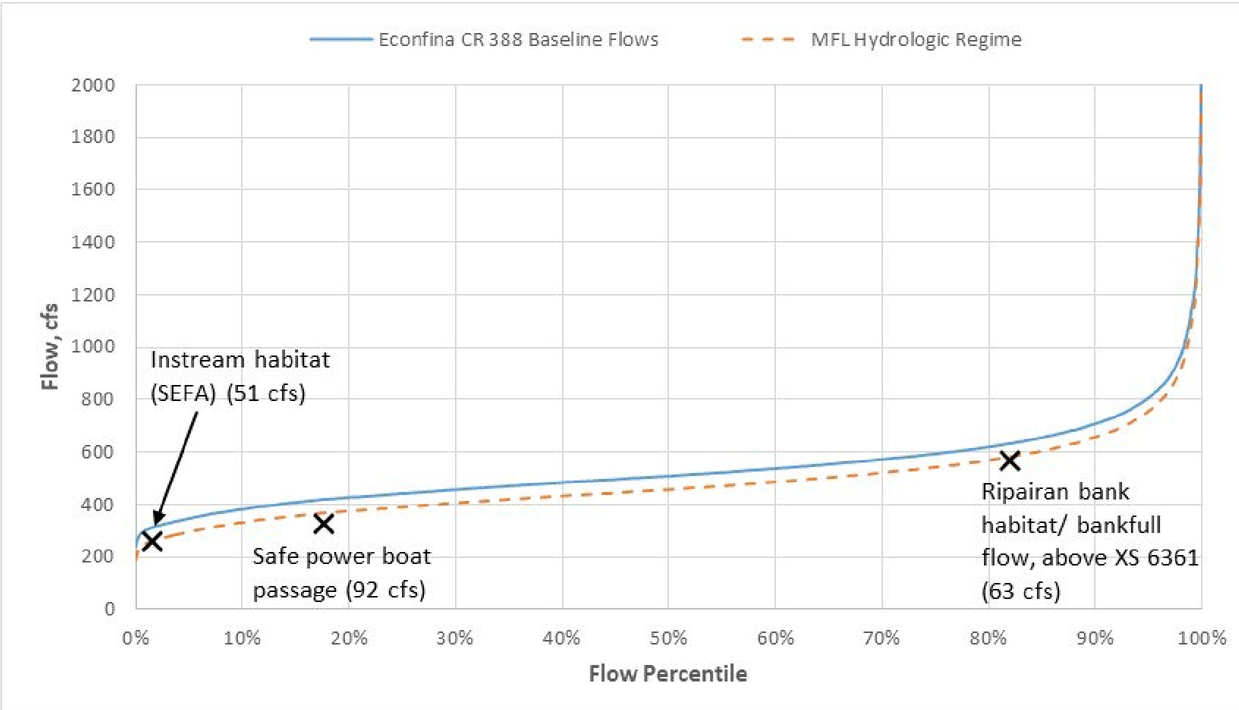


Figure 7-1. Proposed MFL Flow Frequency Curve for Econfina Creek @ CR 388 for WRV Metrics Evaluated

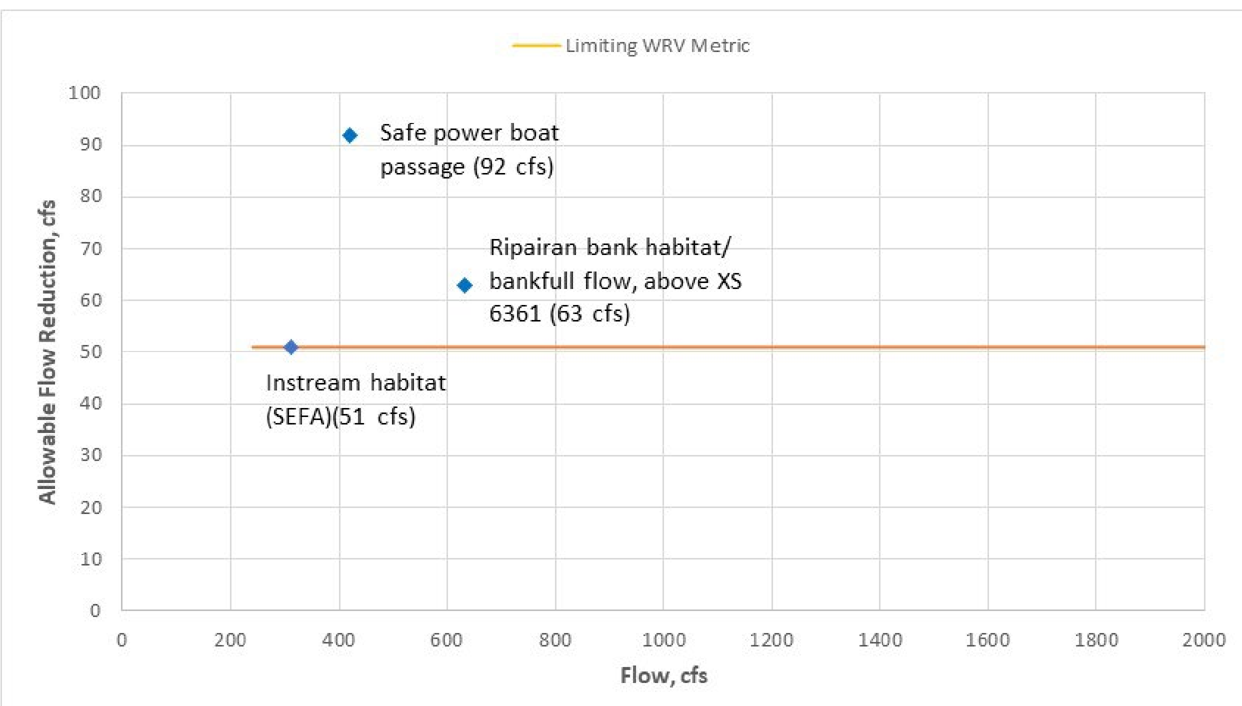


Figure 7-2. Allowable Flow Reductions at Econfina Creek @ CR 388 for WRV Metrics Evaluated

8 Adaptive Management

The District is committed to taking an adaptive management approach to the Gainer Spring Group, Williford Spring Group, and Sylvan Spring Group MFL assessment. Environmental systems and resources are dynamic systems which are constantly changing. An adaptive management strategy will help ensure that the Econfina Creek Springs Groups are protected from consumptive uses well into the future. As such, the established MFL will be periodically evaluated to check the status of the creek and springs flows in relation to the minimum flow. If warranted, a re-evaluation of the MFL for the system may be recommended. Multiple efforts have already been implemented prior to the completion of this MFL technical assessment to ensure improved monitoring and assessment of the system moving forward. These efforts include, but are not limited to:

1. Continued data collection of ground water levels from wells that have been constructed or instrumented with data loggers to increase the spatial and temporal resolution of aquifer level data within the Econfina Creek watershed,
2. Continued data collection of continuous stage and discharge at Econfina Creek @ SR 20, and Econfina Creek above and below Gainer Spring group stations,
3. Review and/or enhance as appropriate available models used for MFL technical assessments,
4. Continued evaluation of changes in river flows and hydraulics, including continued effects from Hurricane Michael,
5. Review additional data concerning floodplain habitat and woody debris along Econfina Creek as it becomes available and consider for future MFL evaluations.

Additional available data will be incorporated into future MFL reevaluations as appropriate and changes to MFL metrics may be considered.

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10 Appendices

10.1 Appendix A: Update and Calibration of the Hydrologic Engineering Center River Analysis System (HEC-RAS) Model: Econfina Creek System.

10.2 Appendix B: SEFA Model Development and Evaluation of Instream Habitat Metrics for Middle Econfina Creek Minimum Flows.