Northwest Florida Water Management District

Recommended Minimum Flow for Jackson Blue Spring
Jackson County, Florida
February 2026
Publication Number: PDS 26-01

Jackson Blue Spring

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Jackson County, Florida

FINAL

PROGRAM DEVELOPMENT SERIES 26-01
February 2026

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For Additional Information, write or call:
Northwest Florida Water Management District
81 Water Management Drive
Havana, Florida 32333
850-539-5999
www.nwfwater.com

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 withdrawals (i.e. consumptive uses) to the ecology of Jackson Blue Spring, Merritts Mill Pond, and Spring Creek. This report describes the technical analyses used to determine a recommended minimum flow for Jackson Blue Spring.

The study area consists of Jackson Blue Spring, the 202-acre and 4-mile-long Merritts Mill Pond, and Spring Creek from U.S. Highway 90 to the confluence with the Chipola River in Jackson County, Florida. Jackson Blue Spring is one of five first magnitude springs (greater than or equal to 100 cubic feet per second) within the Northwest Florida Water Management District and is designated as an Outstanding Florida Spring. The average discharge for Jackson Blue Spring for the period of record is 104 cubic feet per second (cfs). The spring is connected to approximately 5.5 miles of mapped caves and consists of a single vent, where discharge from the spring emerges under a limestone ledge. Jackson Blue Spring discharges directly into Merritts Mill Pond at the upstream limit of the pond. Groundwater discharge to Merritts Mill Pond also occurs from other, minor springs and as diffuse (non-spring) leakage from the Upper Floridan aquifer into the pond, both of which contribute to the total discharge from the pond that flows over a small dam at the downstream terminus of the pond at U.S. Highway 90. Discharge over the dam creates the headwaters of Spring Creek, which extends downstream approximately 2 miles until reaching its confluence with the Chipola River.

Jackson Blue Spring is a popular location for recreation including swimming, kayaking, and boating. The cave system connected to Jackson Blue Spring is a popular location for cave diving, attracting divers from around the world. Merritts Mill Pond is also a popular location for fishing for multiple species including largemouth bass, bluegill, and is the site where a previous record size, redear sunfish was caught.

The development of minimum flows for Jackson Blue Spring is consistent with methods used in other locations in Florida, including other MFLs in the District. The methods used to establish an MFL on Jackson Blue Spring are intended to ensure that the hydrologic regime (i.e. range of flows) proposed will protect the system's water resource values (WRVs) from significant harm caused by consumptive withdrawals. Rule 62-40.473, Florida Administrative Code, outlines requirements regarding ten specific WRVs which must be considered in setting MFLs. The water resource values determined to be relevant and appropriate for establishing minimum flow(s) for Jackson Blue Spring are in Table E-1 below.

Table E-1. Water resource values relevant to the establishment of minimum flows on Jackson Blue Spring

Water Resource Value (WRV)	Relevant for Establishing MFLs at Jackson Blue Spring	Not Appropriate for Establishing MFLs at Jackson Blue Spring
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 used to relate WRVs to spring flows and to assess potential effects of reductions in flows from Jackson Blue Spring. Recreation was evaluated in terms of the frequency of sufficient water depths and stream widths for recreational motorized boat passage, as well as sufficient water depths for canoe, kayak and tubing passage within the Jackson Blue Spring study area. Metrics for fish and wildlife habitat included frequency of sufficient water depths for fish passage and evaluation of the suitability of instream habitat for numerous fish species found within Jackson Blue Spring, Merritts Mill Pond, and Spring Creek under various flow reduction scenarios. Metrics pertaining to protection of riparian bank habitat, bankfull flows (i.e. flows which result in a river's water level to be at the top of its banks), and out-of-bank flows (i.e. flows which result in flooding) were considered since maintaining these characteristics may contribute to preserving the ecological health of Merritts Mill Pond and Spring Creek and their associated floodplains. These metrics included evaluation of the effect of potential reduced spring flows on wetted perimeter inundation (i.e. length of substrate or riverbed in contact with water) as well as floodplain and riparian wetland inundation area. Since wetted perimeter is a measure of inundated substrate, it is also a measure of habitat for aquatic organisms. The relationship between wetted perimeter and streamflow can be used to identify areas of critical habitat along the riverbed and banks. Protection of wetted perimeter aims to ensure that these riparian habitat areas are maintained. Floodplain and riparian wetland inundation refers to the periodic flooding of areas adjacent to the river channel, including sensitive wetlands which provide numerous benefits to riverine systems. Floodplain and riparian wetland inundation for Spring Creek provides several benefits including water quality improvements, maintenance of wetland habitat, and maintenance of channel integrity.

The consumptive use of groundwater in the Jackson Blue Spring groundwater contribution area is largely for agricultural uses. Total groundwater withdrawals were approximately 41.13 million gallons per day (mgd) in 2020 and are projected to increase to 53.99 mgd by 2045 in the area represented by the North-Central District Groundwater Flow Model that was used to help develop the Jackson Blue Spring MFL.

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 2025, 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 MFL for Jackson Blue Spring 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 gage selected to establish a minimum flow(s) for Jackson Blue Spring, is the District station NWF 005042 Jackson Blue Spring. This station was selected as the reference gage since it is located at the Jackson Blue Spring vent and is where discharge measurements are performed by NWFWMD. The Jackson Blue Spring baseline record (i.e. historical period where consumptive withdrawals were minimal in the study area) was computed by estimating pumping impacts to the spring with the North-Central District Groundwater Flow Model and then removing these estimated impacts from the historical flow record for NWF 005042 Jackson Blue Spring. This was accomplished by adding the absolute value of these estimated pumping impacts to the daily flows from the historical spring flow record for Jackson Blue Spring.

A summary of the allowable flow reductions for Jackson Blue Spring flow for each WRV metric evaluated is provided in Table E-2. Floodplain and riparian wetland inundation area was found to be the most sensitive WRV metric, with an average allowable spring flow reduction of 11.1 cfs (10.7% of the median baseline Jackson Blue Spring).

The most limiting result for the assessment of motorboat passage in Spring Creek suggested a maximum allowable flow reduction of 12.9 cfs to prevent significant harm to recreation by providing a typical motorboat ample passage and draft in the narrowest and shallowest portion of Spring Creek. Sufficient water depths for safe canoe/kayak passage, tubing, and fish passage were achieved under all flow scenarios evaluated throughout the study area. Additionally, safe motorboat passage was achieved under all flow scenarios for Merritts Mill Pond.

The two MFL metrics corresponding to the assessments of wetted perimeter both represent aggregated thresholds throughout Spring Creek and suggest Jackson Blue Spring discharge could be reduced by 35.4 cfs and 30.5 cfs, respectively, without exceeding the 15% reduction threshold associated with significant harm. This is similar to the allowable flow reduction of 34.7 cfs indicated by the suitability of instream habitat assessment. Metrics associated with ecologically relevant zones for wading birds and game fish spawning in Merritts Mill Pond assessed using the hydroperiod tool were not relevant for MFL establishment since all response functions had an inverse relationship with flow, meaning no harm is indicated by decreasing flow.

The proposed minimum allowable hydrologic regime for Jackson Blue Spring would shift the baseline flow duration curve downward by the most limiting allowable flow reduction of 11.1 cfs, across the range of baseline flows for Jackson Blue Spring. Setting a single minimum flow at the median baseline flow for Jackson Blue Spring provides for adequate protection of the Jackson Blue Spring study area, including Merritts Mill Pond and Spring Creek. The recommended minimum flow is an allowable flow reduction of 11.1 cfs from the Jackson Blue Spring (District Station 005042 Jackson Blue Spring) median baseline flow of 103.3 cfs. This translates to an allowable reduction of 10.7 percent of the median baseline Jackson Blue Spring flow, resulting in a minimum median Jackson Blue Spring flow of 92.2 cfs (Table E-3).

Table E-2. Summary of WRV metrics and allowable Jackson Blue Spring flow reductions

Metric	Allowable Spring Flow Reduction (cfs)	Minimum Allowable Median Jackson Blue Spring Flow (cfs)	Percent Flow Reduction (%) from Median Jackson Blue Spring Flow
Fish Passage	NA	NA	NA
Tubing Passage	NA	NA	NA
Canoe/Kayak Passage	NA	NA	NA
Motorboat Passage in Merritts Mill Pond	NA	NA	NA
Motorboat Passage in Spring Creek	12.9	90.4	12.5
Weighted Wetted Perimeter	35.4	67.9	34.2
Detailed Wetted Perimeter	30.5	72.8	29.5
Floodplain and Riparian Wetland Inundation	11.1	92.2	10.7
Area Weighted Instream Habitat Suitability Indices	34.7	68.6	33.6
Wetland Hydroperiod	NA	NA	NA

NA = Not Applicable; Minimum allowable median Jackson Blue Spring flow is equal to the difference between the median baseline spring flow and the allowable spring flow reduction

Table E-3. Proposed minimum flow for Jackson Blue Spring

System	Median Baseline Flow at Reference Gage	Allowable Flow Reduction at Reference Gage	Minimum Allowable Median Flow at Reference Gage	Allowable Percent Flow Reduction from Median Baseline Flow
Jackson Blue Spring	103.3	11.1	92.2	10.7

*Reference gage is District Station 005042 Jackson Blue Spring

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List of Acronyms

ACF	Apalachicola, Chattahoochee, Flint
AgBMP	Agricultural Best Management Practices
ag_irr	Agricultural irrigation
AMO	Atlantic Multidecadal Oscillation
ATM	Applied Technology and Management, Inc.
AWS	Area Weighted Suitability
BEBR	Bureau of Economic and Business Research
BMAP	Basin Management Action Plans
cfs	Cubic Feet per Second
cii	Commercial, industrial, and institutional water use
CR	County Road
DEM	Digital Elevation Model
DEP	Department of Environmental Protection of Florida
dss	Domestic self-supply water use
ESA	Environmental Science Associates
F.A.C.	Florida Administrative Code
FACW	Facultative Wetland Species
FEMA	Florida Emergency Management Agency
cfs	Cubic Feet per Second
F.A.C.	Florida Administrative Code
FEMA	Florida Emergency Management Agency
FL	Florida
FMNH	Florida Museum of Natural History
FNAI	Florida Natural Areas Inventory
F.S.	Florida Statutes
ft	Feet
ft/s	Feet per Second
F.S.	Florida Statutes
FWC	Florida Fish and Wildlife Conservation Commission
GIS	Geographic Information Systems
GPM	Gallons per Minute
GWCA	Groundwater Contribution Area
HEC-RAS	Hydrologic Engineering Center River Analysis System
HG	Habitat Guild
HSC	Habitat Suitability Curve
HUC	Hydrologic Unit Code
HWY	Highway
IFIM	Instream Flow Incremental Methodology
in/yr	Inches per year
Inc.	Incorporated
JBS	Jackson Blue Spring

LOESS	Locally estimated scatterplot smoothing
lbs	pounds
Lb-N/yr	Pounds of nitrogen per year
livstk_aqua	Livestock and aquaculture water use
LLC	Limited Liability Company
m	meters
mgd	Million Gallons per Day
mg/L	Milligram per Liter
MFL	Minimum Flow and Level
MSE	Mean Square Error
MODFLOW-NWT	U.S. Geological Survey modular finite-difference flow model
N	nitrogen
NAVD 88	North American Vertical Datum of 1988
NCDM	North Central District Model
NOAA	National Oceanographic and Atmosphere Association
NSILT	Nitrogen Source Inventory Loading Tool
NTU	Nephelometric Turbidity Unit
NWFWMD (District)	Northwest Florida Water Management District
NWS	National Weather Service
OBL	Obligate Wetland Species
OSTDS	Onsite Sewage Treatment and Disposal Systems
P or PF	Percentile Flow
ppt	Parts per Thousand
ps	Public supply water use
pwr	Power generation water use
rec	Water use at recreational facilities
RV	Recreational Vehicle
RMSE	Root Mean Square Error
SAV	Submerged Aquatic Vegetation
SEFA	System for Environmental Flows Analysis
SJRWMD	St. Johns River Water Management District
SPI	Standard Precipitation Index
Sp. Spp.	Species
Sq. Mi.	Square miles
SR	State Road
SRWMD	Suwannee River Water Management District
SWMP	Strategic Water Management Plan
TMDL	Total Maximum Daily Load
UPL	Upland Species
U.S. Hwy	United State Highway
USGS	United States Geological Survey
WMD	Water Management District

WRV	Water Resource Value
WSA	Water Supply Assessment
XS	Cross-section or Transect
α	alpha, significance level
μS/cm	Microsiemens per Centimeter

Acknowledgments

This technical assessment was developed by the Northwest Florida Water Management District (NWFWMD) to establish minimum flows for Jackson Blue Spring (Jackson County, Florida) in accordance with Section 373.042, Florida Statutes. The report was prepared under the supervision and oversight of Lyle Seigler, Executive Director.

The authors would like to recognize personnel from Geosyntec Consultants, Inc. (formerly Applied Technology and Management, Inc.), Environmental Science Associates (formerly Janicki Environmental, Inc.), Verdantas LLC, and others who contributed to the completion of this project. In particular, the authors would like to recognize Bob Burleson and Barrett Carter from Geosyntec Consultants, Inc. and Tony Janicki and Jon Perry from Environmental Science Associates for their technical assistance and model development during this project. Rett Daniels (Jackson County, FL. Deputy County Administrator) was instrumental in obtaining information regarding the operation of the water control structure at the Merritts Mill Pond outfall. The authors would also like to thank the Florida Department of Environmental Protection (DEP) and Florida Fish and Wildlife Conservation Commission (FWC) for their assistance and guidance throughout this project. We are also grateful to members of the public who took time to provide comments.

1 Introduction

This report describes technical analyses for determining the recommended minimum flow(s) for Jackson Blue Spring (JBS) located in Jackson County, Florida. Jackson Blue Spring is a first magnitude spring (average flow greater than 100 cubic feet per second) and is designated as an Outstanding Florida Spring by the State of Florida (section 373.802(4) Florida Statutes.). This spring is located at the northeastern most point of Merritts Mill Pond, acting as the 'headwaters' of the pond (Figure 1-1). Merritts Mill Pond extends four miles to the southwest to a small dam at U.S. Highway 90. Outflow from Merritts Mill Pond flows over the structure and into Spring Creek where it continues nearly two miles before joining the Chipola River. This assessment focuses on determining the thresholds at which consumptive withdrawals could cause significant harm to ecology and water resources of the Jackson Blue Spring study area (Merritts Mill Pond and Spring Creek) (described in Section 2).

Section 1 (Introduction) of this report describes the objective, background, and requirements for establishing minimum flows. Section 2 provides a description of the Jackson Blue Spring minimum flows and water levels (MFLs) evaluation study area including descriptions of the physical, hydrologic, hydrogeologic, land and water use, wetland, wildlife, and recreational aspects of the area. Section 3 (Water Quality) describes the water quality of the Jackson Blue Spring system, as well as management activities that are focused on improving the water quality of the spring and associated groundwater contribution zone. Section 4 provides a more detailed description of the hydrology and groundwater withdrawals in the study area. Section 5 (Water Resource Values) describes the 10 water resource values defined in Rule 62-40.473, Florida Administrative Code (F.A.C.), as they relate to this MFL evaluation, and the associated metrics used to quantify the potential effects of reduced spring flows. Section 6 (Hydrologic Models) describes the development of hydrologic models that were used in this technical assessment. Section 7 (Evaluation of Water Resource Values) provides the evaluation of the applicable water resource value metrics, using hydrologic models to estimate the effects of potential spring flow reductions. Section 8 (Summary and Recommended Minimum Flow) provides the recommended minimum flow regime for Jackson Blue Spring. Section 9 (Adaptive Management) describes the District's ongoing and future efforts to assess and protect Jackson Blue Spring.

Figure 1-1. Jackson Blue Spring MFL study area.

1.1 Objective

The objective of this report is to determine recommended minimum flow(s) for Jackson Blue Spring 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) (Figure 1-2). Per (Sub) Section 373.042 (1), Florida Statutes, "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 on the ecology of Jackson Blue Spring, Merritts Mill Pond, and Spring Creek arising from consumptive uses. Minimum flows are not intended to offset changes in sea level rise, precipitation patterns, or river hydraulics not related to consumptive uses or withdrawal impacts.

(Sub) Section 373.042 (1), Florida Statutes (F.S.), specifies MFLs are to be established using the "best available information." The best available information was used for the establishment of MFLs for Jackson Blue, including data collected specifically for the development of this assessment. Although not required by statute, the District collected extensive hydrologic and bathymetric data in the study area in support of the establishment of the recommended MFL for this system.

In accordance with Rule 62-40.473, F.A.C, and Section 373.0421, F.S., 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 applicability to Jackson Blue and the MFL technical assessment study area are provided in Section 5.

Water management districts (WMDs) 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 does not meet MFL criteria at the time of rule adoption, 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.

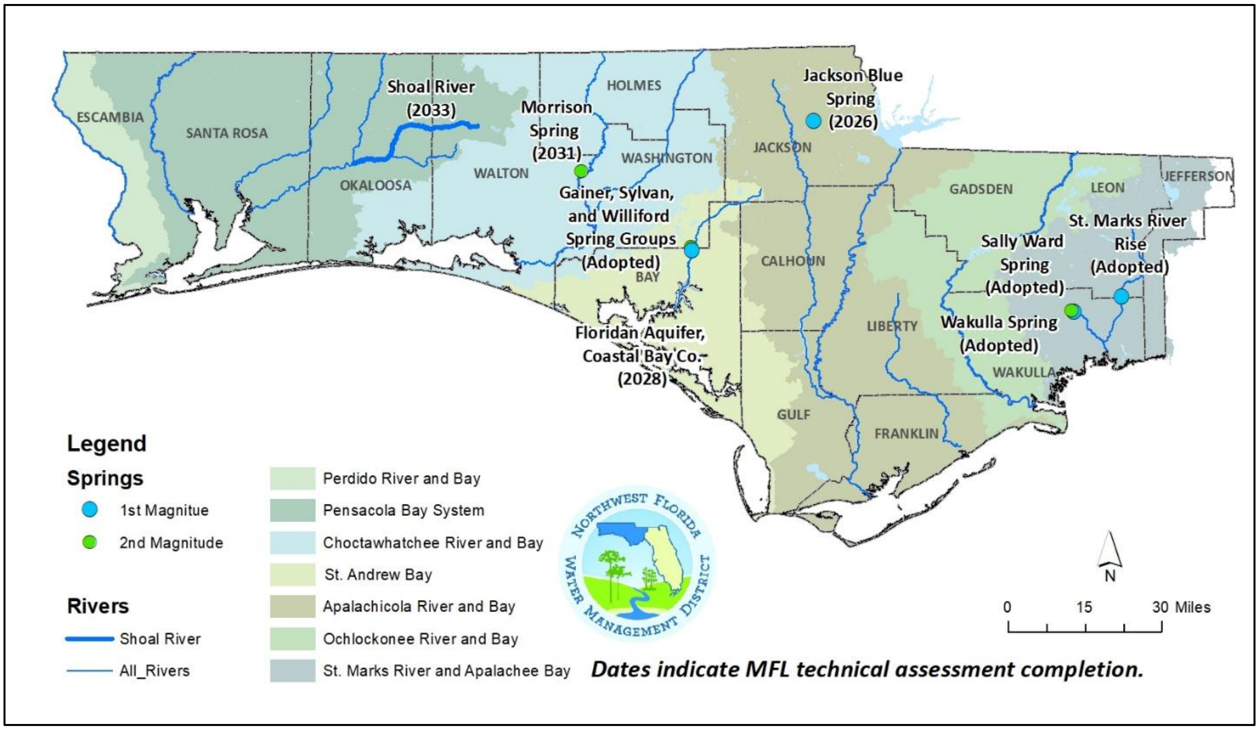


Figure 1-2. NWFWMD 2024-2025 MFL priority list water bodies, Including water bodies with previously established MFLs

Table 1-1. Environmental values (62-40.473, F.A.C.)

Water Resource Value (WRV) or Environmental Value	WRV 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 Jackson Blue builds upon methods applied elsewhere in Florida, including minimum flows established for St. Marks River Rise, Wakulla and Sally Ward springs, and the Middle Econfina Creek by the District (NWFWMD 2019, NWFWMD 2021, NWFWMD 2025). Establishing MFLs for Jackson Blue Spring protects the system's water resource values from the potential for significant harm caused from groundwater 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, F.A.C., outlines requirements regarding specific WRVs that must be considered when establishing MFLs including the 10 WRVs (Table 1-1).

Similar to MFLs established elsewhere in Florida, the District assessed each WRV based on its relevance to Jackson Blue and the MFL study area, 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 Jackson Blue, including the development of quantitative metrics to assess the effects of spring flow reductions on Jackson Blue Spring, are described in detail in Section 7.

The results from the evaluation of multiple WRV metrics were used to determine the recommended minimum flow for Jackson Blue. 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 2019, NWFWMD 2021, NWFWMD 2025, 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). Similarly, a 15-percent threshold is 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 Jackson Blue 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 Center River Analysis System (HEC-RAS; U.S. Army Corps of Engineers, Hydrologic Engineering Center, 2021) model to simulate changes in river depth/inundation in response to changes in flow and a System for Environmental Flow Analysis (SEFA; Payne and Jowett, 2013) model to evaluate in-stream habitat suitability for classes of species as a function of depth and stream velocity. In addition, a groundwater model was developed to estimate changes in spring flow associated with consumptive groundwater uses within the basin. These tools are well-vetted and have been applied across a wide range of conditions and places to establish MFLs in Florida (NWFWMD 2019, NWFWMD 2021, NWFWMD 2025, SRWMD 2021, SRWMD 2016b). Additional information regarding model selection and development can be found in Section 6 and appendices A, B, and C.

2 Study Area

This section describes the Jackson Blue Spring System watershed, physiography, land use, population, and other aspects of the Jackson Blue Spring System. The Jackson Blue Spring MFL study area extends from Jackson Blue Spring to the confluence of Spring Creek and the Chipola River. Two distinct waterbodies are present in the study area: Merritts Mill Pond and Spring Creek (Figure 1-1). Water from Merritts Mill Pond discharges through a water control structure, where it flows into Spring Creek. Both Merritts Mill Pond and Spring Creek receive approximately half of their inflows from Jackson Blue Spring and were therefore included within the study area. The Chipola River was excluded from the study area because the influence of Jackson Blue Spring flow on overall river flow is minimal.

2.1 Jackson Blue Spring

Jackson Blue Spring, the primary focus of this MFL Technical Assessment, is a first magnitude spring with an average discharge of 104 cfs (Section 4.4). JBS is located at the northeastern end of Merritts Mill Pond and constitutes the single largest point source of flow into the JBS system. Jackson Blue Spring is located in Marianna, Florida on property owned by the State of Florida and managed by Jackson County. Additional details regarding the hydrology of JBS can be found in Section 4.4.

JBS is characterized by a single large vent with a visible surface boil. The vent is a large conduit opening under a limestone ledge (Figure 2-1). The maximum depth at the spring vent is approximately 16 ft. The spring vent leads to approximately 30,000 feet of explored cave passages with a maximum penetration distance of approximately 10,000 feet and is a popular location for cave diving (AECOM, 2017).

The JBS spring pool measures approximately 200 ft by 200 ft and is located within the Blue Springs Recreation Area, which is managed by Jackson County, Florida. The park offers public access to JBS and Merritts Mill Pond and amenities including canoe and kayak rentals, swimming, and a diving platform over the spring. The spring pool is surrounded by docks, seawalls, and a created/maintained beach (Figure 2-2).

Figure 2-1. Jackson Blue Spring vent

Figure 2-2. Jackson Blue Spring and spring pool, located at the Blue Springs Recreation Area.

2.2 Merritts Mill Pond

Merritts Mill Pond is a 202-acre, spring-fed impoundment located in Marianna, Jackson County, Florida (Figure 1-1). The pond is over four miles in length and extends from Jackson Blue Spring to a water control structure (dam) located at U.S. Highway 90 (U.S. Hwy 90; Figure 2-3, Figure 2-4). Initially, a dam for a grist mill was constructed in the early 1800s located near Jackson Blue Spring. Subsequently the dam was moved several times and has been in its present location near U.S. Hwy 90 since the late 1800s.

Prior to the construction of the Merritts Mill Pond dam, Jackson Blue and additional minor springs in the vicinity flowed into a spring run which was contiguous with and upstream from Spring Creek. After construction of the dam, upstream water levels increased, flooding low elevation and riparian areas along the creek floodplain. Although large cypress trees can withstand prolonged periods of flooding, many individual trees in deeper areas perished or were cut. As a result, many large tree stumps remain just below the water surface, providing aquatic habitat for fish and wildlife species, as well as creating navigation hazards for boaters. Cypress and other wetland trees characteristic of floodplain communities are established in the shallow riparian zone created by the higher water levels created by the water control structure. Additional details regarding floodplain, littoral, and submerged aquatic vegetation are provided in Section 2.9 (Natural Resources).

Groundwater is the primary source of water for Merritts Mill Pond. Jackson Blue Spring is the largest point source of water into Merritts Mill Pond, accounting for approximately 49% of total flow within the pond. In addition to Jackson Blue Spring, several minor springs contribute flow to Merritts Mill Pond (Figure 2-4 through Figure 2-7). These include third-magnitude springs (flow ≥1 to 10 cfs) Shangri La (Figure 2-5), Twin Caves (Figure 2-6), and Hole in the Wall; fourth-magnitude (≥100 gallons per minute or gpm to 1 cfs) Gator Hole Spring (Figure 2-7); fifth-magnitude (≥10 gpm to 100 gpm) Heidi Hole Spring, and two unclassified springs: Lamar's Landing and Indian Washtub springs. Merritts Mill Pond also receives a significant amount of diffuse groundwater discharge from the adjacent Floridan aquifer between the Jackson Blue Spring vent and the control structure at Highway US 90. Additional details concerning the hydrology of Merritts Mill Pond can be found in Section 4 (Hydrology).

Water depths along Merritts Mill Pond tend to be shallowest in upstream areas closest to Jackson Blue Spring, where they generally range between 5 and 8 ft in depth depending on location and water surface elevation. Depths at the downstream end of the pond closest to U.S. 90 generally range between 9 and 12 ft.

Figure 2-3. Merritts Mill Pond, looking southwest.

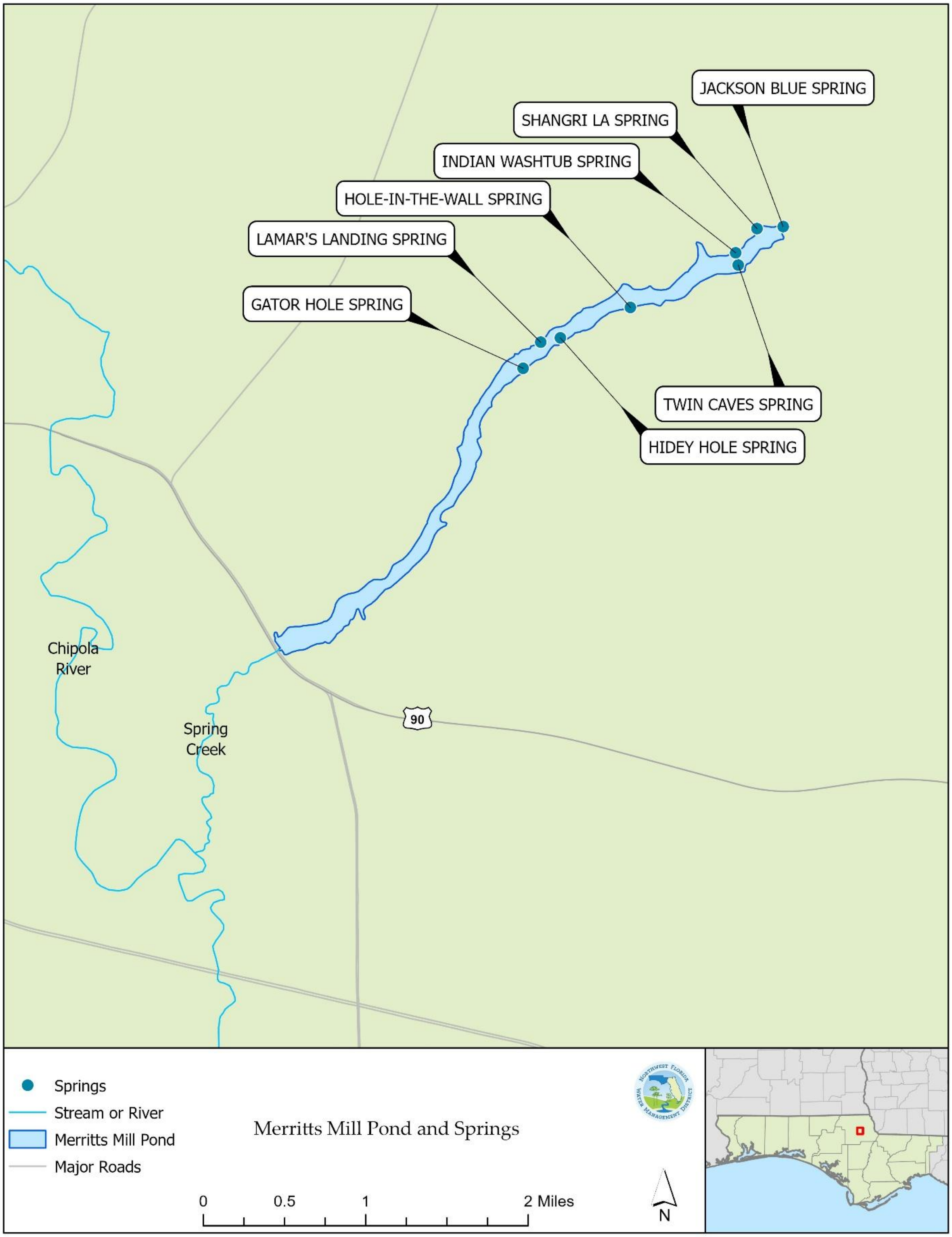


Figure 2-4. Locations of springs along Merritts Mill Pond and Spring.

Figure 2-5. Shangri-La Spring

Figure 2-6. Twin Caves Spring

Figure 2-7. Gator Hole Cave and Spring

2.3 Spring Creek

Spring Creek originates from the outfall of the Merritts Mill Pond water control structure and extends 1.9 miles downstream to its confluence with the Chipola River. Water levels at the upper portion of Spring Creek are typically approximately 7 ft below water levels at the downstream end of Merritts Mill Pond due to the structure. In contrast to Merritts Mill Pond, which is relatively wide and deep with slow water velocities, Spring Creek is relatively narrow and shallow with higher water velocities (Figure 2-8). Maximum water depths along Spring Creek range from approximately 3 ft to 7 ft near U.S. Hwy 90 to 6 ft to 17 ft near the Chipola River depending on flow in Spring Creek and the Chipola River water levels. Spring Creek is characterized by numerous shallow areas with sills and/or limestone outcroppings, causing increased water velocities and supercritical flow under certain circumstances. Flow pickup along Spring Creek between the outfall of the control structure and the Chipola River is minimal, with one observed small tributary contributing an estimated flow of 0.5 cfs.

The stage of Spring Creek is influenced by the stage of the Chipola River to varying degrees. The Chipola River has a much larger drainage basin than Spring Creek and the flow and stage in the river can be highly variable, especially during periods of high precipitation. When the stage of the Chipola River is sufficiently high, it can create 'backwater conditions' in Spring Creek, raising the stages along the creek. Most of the time, only the lower reaches are affected by the Chipola River. However, stages in the Chipola River have been high enough (under flooding conditions) to influence stages along Spring Creek as far upstream as the Merritts Mill Pond dam at U.S. Hwy 90.

Figure 2-8. Spring Creek

2.4 Watersheds

The Jackson Blue Spring study area is located within the Merritts Mill Pond sub-watershed (Hydrologic Unit Code (HUC) 031300120405), which is itself is located in the Chipola River watershed (HUC 03130012) and Apalachicola Basin (HUC 031300) (Figure 2-9 and Table 2-1), as defined by the USGS (USGS, 1987). The Merritts Mill Pond sub-basin encompasses 48 square miles (sq. mi.), and is located entirely in Jackson County, Florida. This sub-watershed encompasses the entire Jackson Blue Spring MFL study area and includes both Merritts Mill Pond, Spring Creek, and a portion of the Chipola River (Figure 2-9 and Table 2-1). The Merritts Mill Pond-Chipola River Watershed is the next smallest unit encompassing a total of 178 sq. mi. in Jackson County, Florida. This watershed includes the Merritts Mill Pond sub-watershed as well as several others draining into the upper portion of the Chipola River. The Chipola River (HUC level 8) watershed encompasses 1,270 sq. mi. and the entire Chipola River drainage basin. The Chipola River level 8 HUC watershed lies within the Apalachicola HUC 6 and HUC 4 sub-basin and basin, respectively, which drain into Apalachicola Bay. Direct surface runoff is minimal within the Merritts Mill Pond sub-watershed, with the majority of inflow to the system originating from spring discharge and diffuse groundwater inflow.

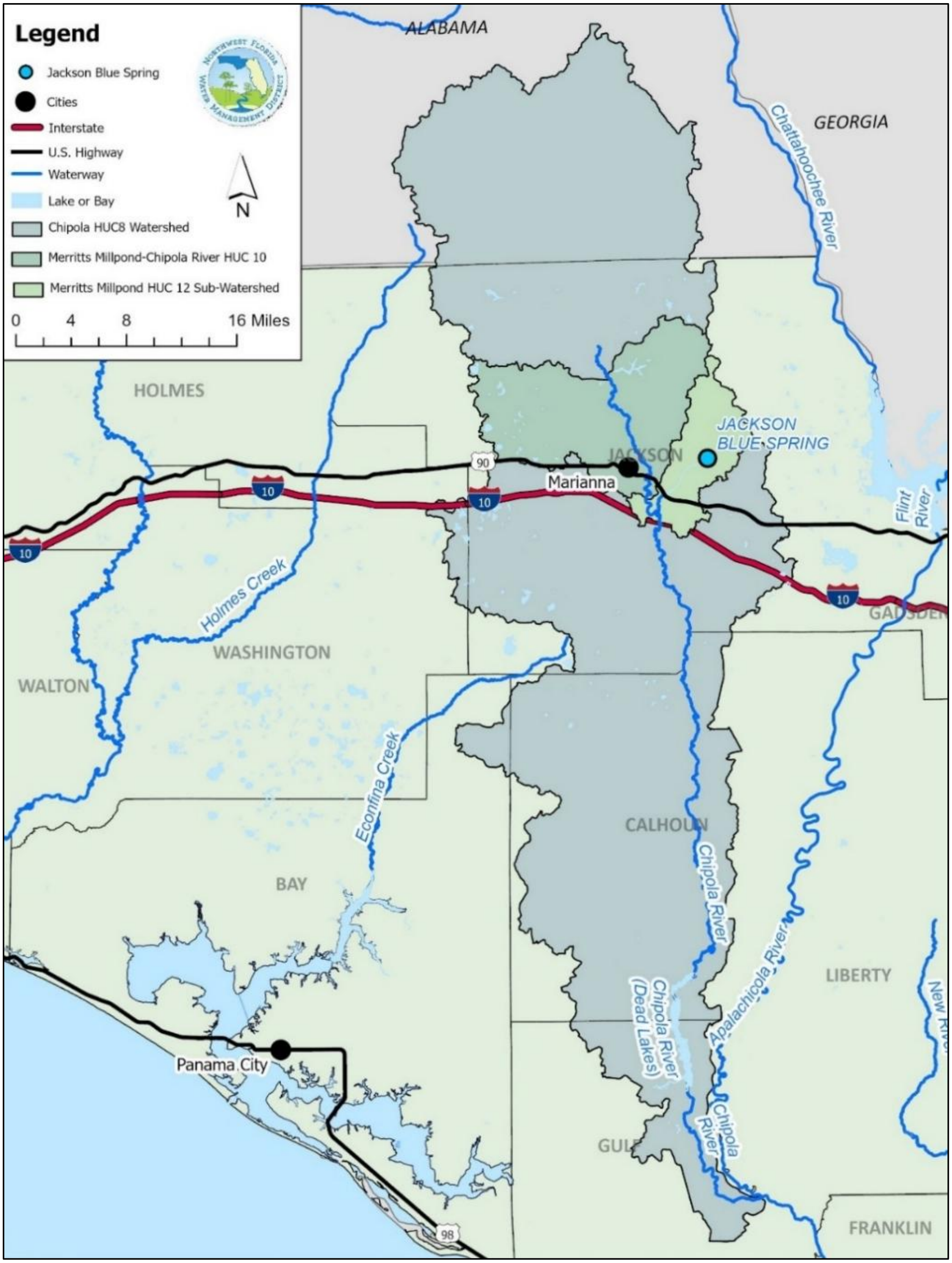


Figure 2-9. Level 8, 10, and 12 hydrologic unit code watersheds encompassing the Jackson Blue Spring study area.

Table 2-1. Hydrologic unit codes (HUC) basins and watersheds associated with the Jackson Blue Spring study area.

Hydrologic Unit Code (HUC)	Hydrologic Unit Code Number	Basin Name	Area (sq. mi)
HUC 2	03	South Atlantic - Gulf	141,984
HUC 4	0313	Apalachicola	20,500
HUC 6	031300	Apalachicola	20,500
HUC 8	03130012	Chipola	1,270
HUC 10	0313001204	Merritts Mill Pond – Chipola River	178
HUC 12	031300120405	Merritts Mill Pond	48

2.5 Groundwater Contribution Area

The Jackson Blue Spring groundwater contribution area (GWCA) is a boundary that has been delineated to estimate the groundwater capture zone for Jackson Blue Spring, based on a potentiometric surface map of conditions during March 2007. This potentiometric surface map was created using groundwater levels measured at 77 wells, and that ranged from 77 feet to 111 feet above mean sea level (MSL, NAVD88). The Jackson Blue Spring GWCA is approximately 126 square miles in area and extends from the Jackson Blue Spring vent, east of Marianna, Florida to southern Houston County, Alabama (Figure 2-10; Northwest Florida Water Management District, 2011). The portion of the Jackson Blue Spring GWCA in Alabama is approximately 13 square miles, or approximately 10% of the total area.

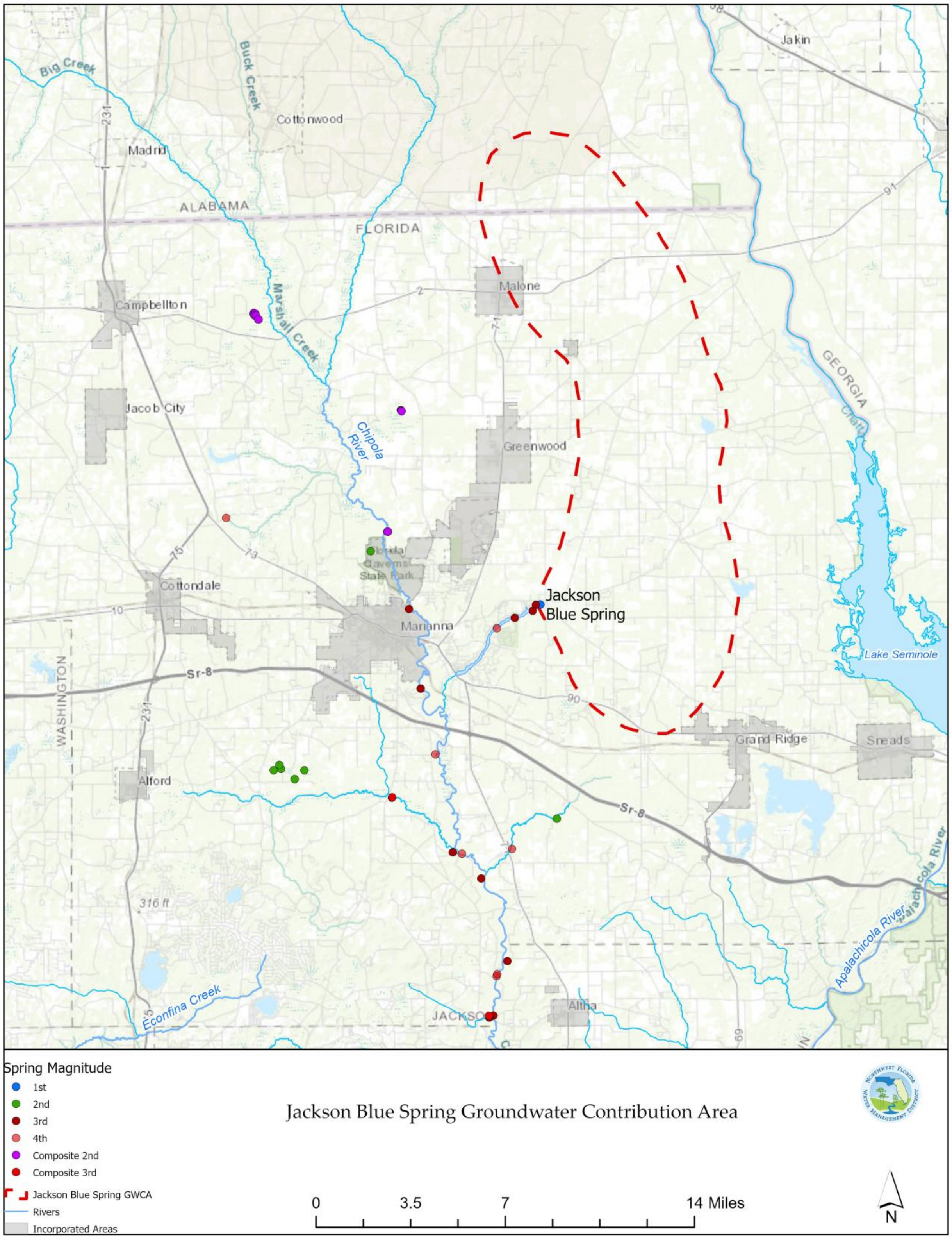


Figure 2-10. Jackson Blue Spring groundwater contribution area and springs in surrounding region. (Composite magnitudes indicate the magnitude of the cumulative discharge from a spring group.)

2.6 Hydrogeology

The hydrogeology of the region encompassing the Jackson Blue Spring GWCA generally consists of the following hydrogeologic units in descending order of depth: the surficial aquifer system (SAS), the upper confining unit (UCU), the Upper Floridan aquifer (UFA), the middle confining unit (MCU) and the Lower Floridan aquifer (LFA) (Miller, 1986; Williams and Kuniansky, 2015).

The surficial aquifer system (SAS) generally consists of Citronelle Formation and undifferentiated clastic deposits of Plio-Pleistocene to Holocene age. In the Dougherty Karst District, the surficial aquifer can be thin or absent and is comprised of limestone residuum consisting of weathered carbonate rocks. The SAS is generally considered to be an insignificant source of water for most uses in the Dougherty Karst District. The thickness of the SAS varies throughout the Jackson Blue Spring GWCA, ranging from approximately 35 feet to approximately 85 feet (Figure 2-11).

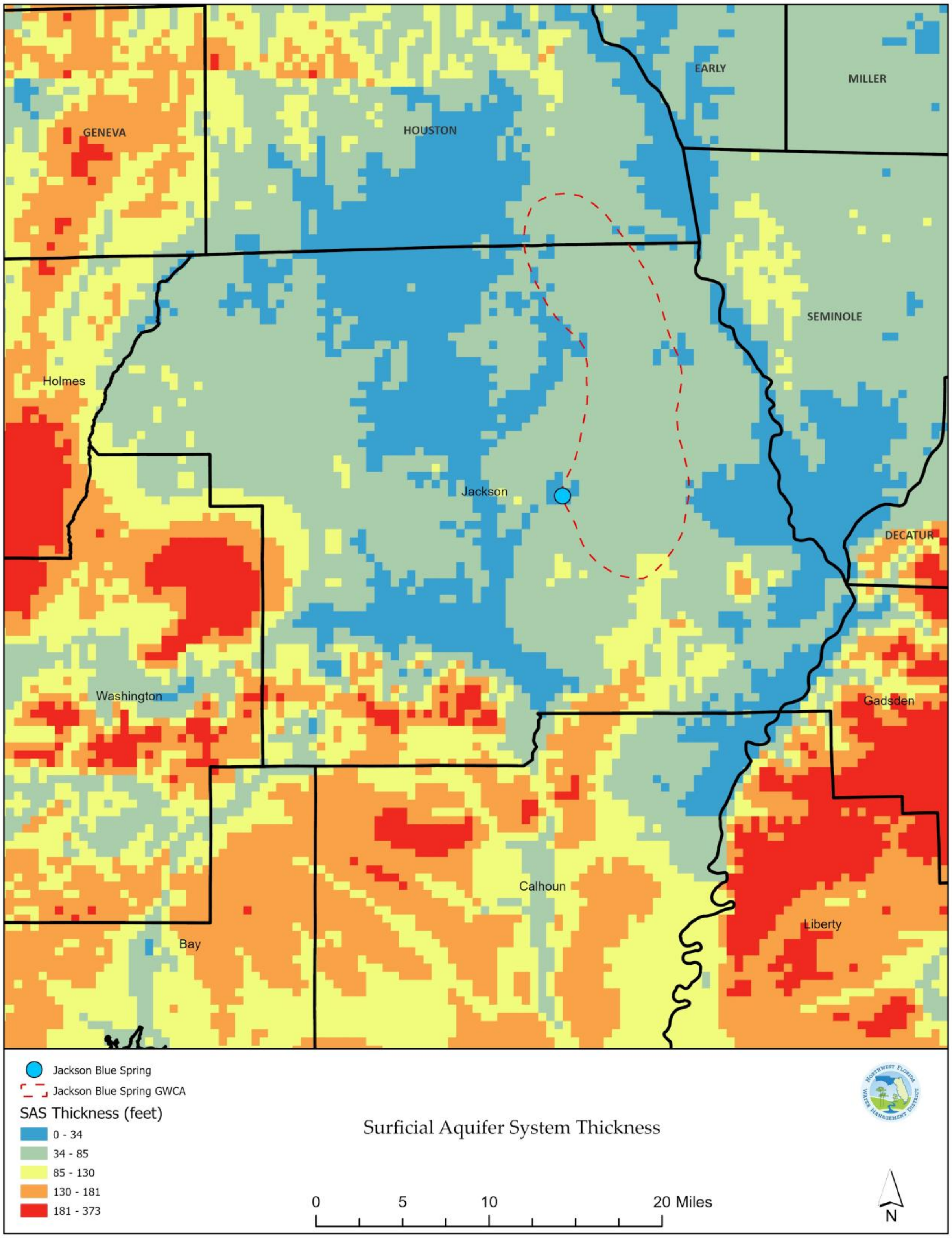


Figure 2-11. Surficial aquifer system thickness.

The upper confining unit (UCU) is generally classified as a confining unit in Jackson County, where it is present. The UCU overlies the Upper Floridan aquifer system and is comprised of low-permeability sediments of middle- to late-Miocene age (Figure 2-12). In the Dougherty Karst District, the UCU is thin to absent and frequently breached by karst features. Limestone residuum may create localized semi-confining conditions in areas within the Dougherty Karst District (Crandall et al., 2013). In the Apalachicola Delta District, the thickness of the UCU can range from approximately 20 to 200 feet (Williams and Kuniansky, 2015).

The sediments that constitute the UCU generally consist of low-permeability, clastic deposits with higher-permeability interbedded carbonates and coarser-grained sediments of Miocene age. Where the UCU is present, these beds of higher-permeability sediments can provide relatively minor amounts of water and are primarily used for domestic use (NWFWMD, 1996).

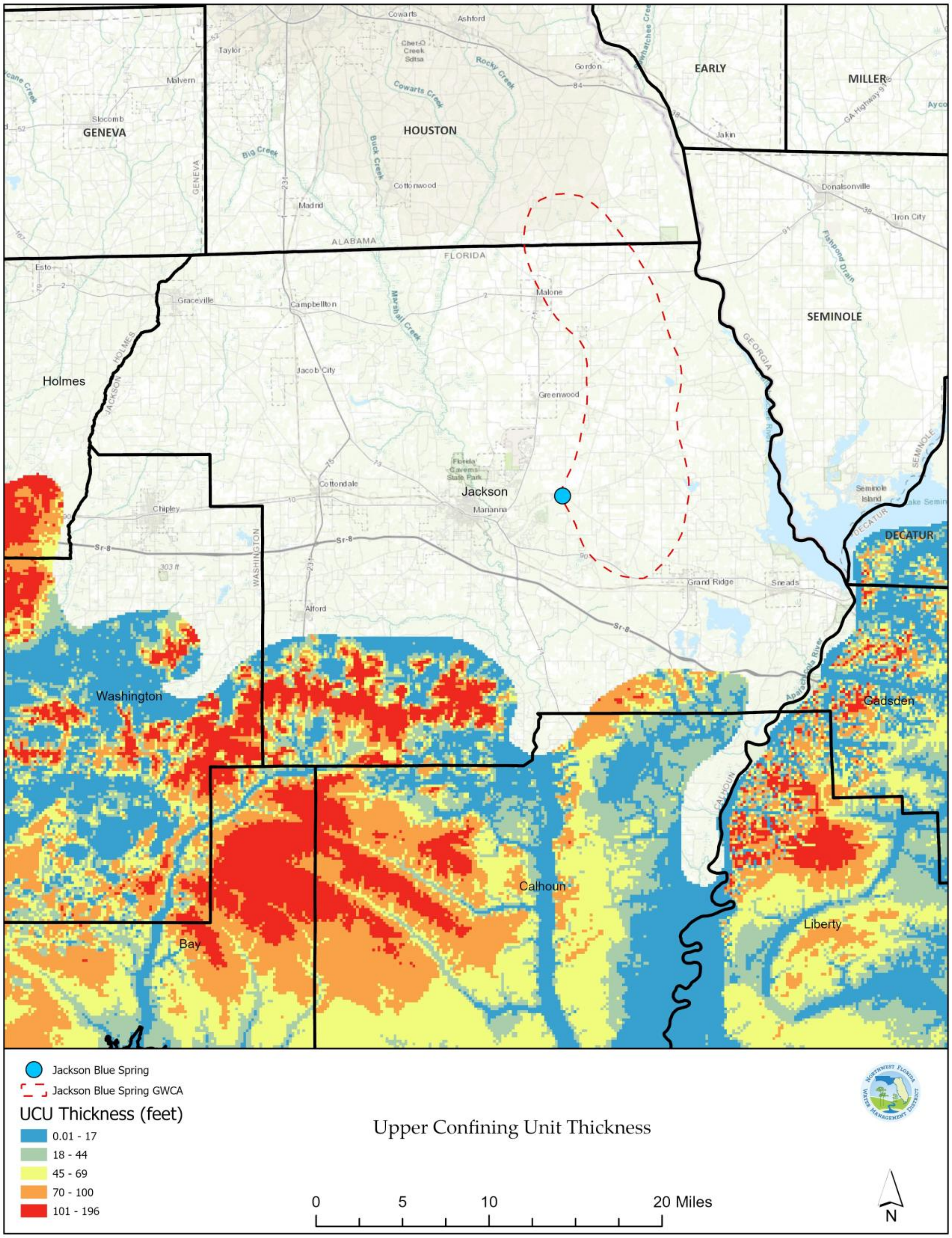


Figure 2-12. Upper confining unit thickness

In Jackson County, the Upper Floridan Aquifer system is comprised of multiple carbonate geologic units: the Miocene-aged Chattahoochee Formation, the Oligocene-aged Suwannee and Marianna formations, and the late Eocene-aged Ocala Formation. Due to the interaction with rainwater, the Floridan aquifer has been subject to dissolution processes resulting in extensive development of secondary porosity and karst features such as sinkholes, swallets, and springs. Regionally, the Floridan aquifer system (FAS) dips from north to south, resulting in a deeper and thicker FAS in the southern part of the region and a shallower and thinner FAS in the northern region (Figure 2-13). Within the Dougherty Karst Plain District, the Upper Floridan aquifer has well developed secondary porosity where the UCU is thin or absent. The UFA crops out in southern Alabama and continues to thicken and become more confined from north to south as it transitions from the Dougherty Karst Plain to the Apalachicola Embayment Region (NWFWMD, 1996).

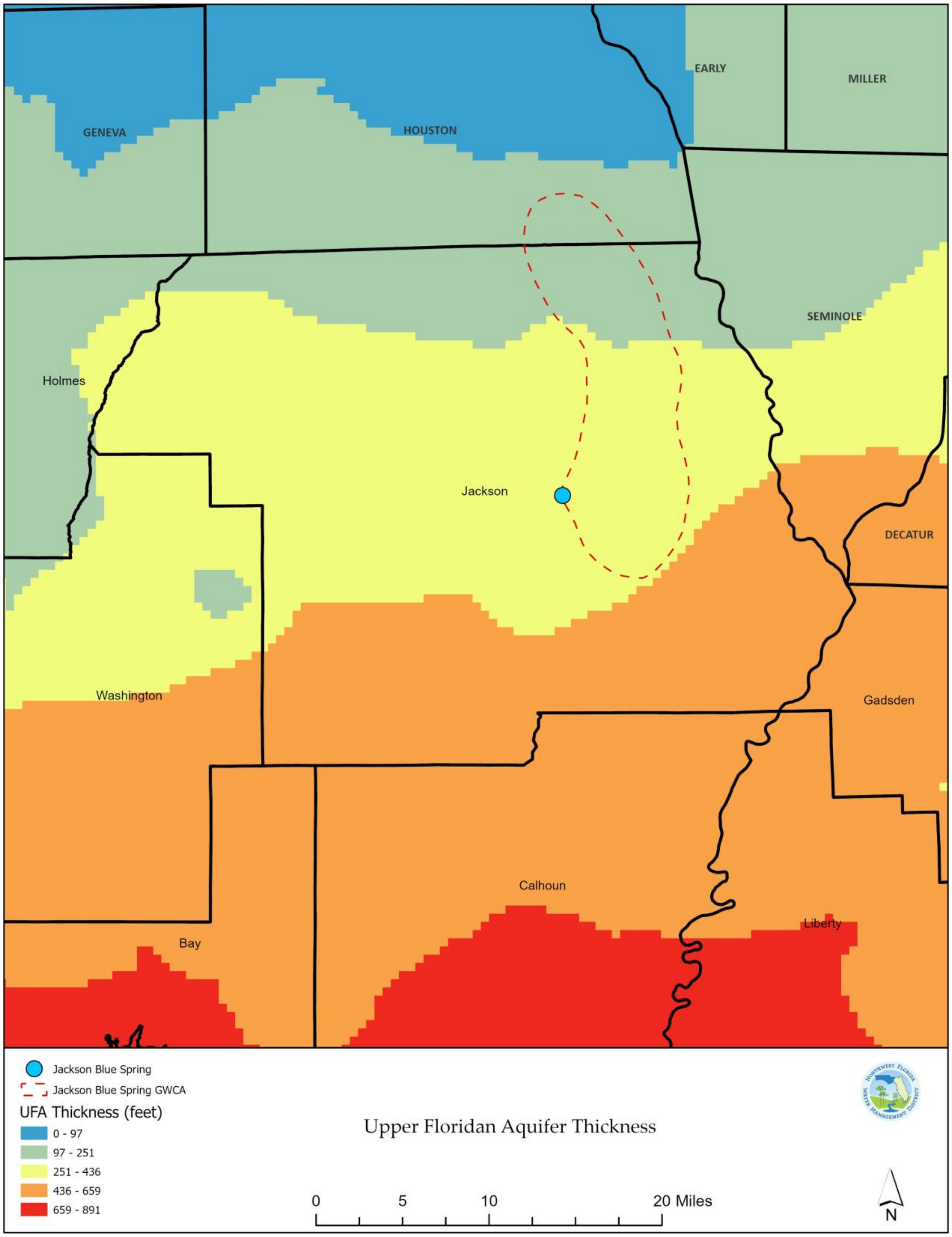


Figure 2-13. Upper Floridan aquifer thickness

The Lisbon-Avon Park Composite Unit (LISAPCU; Williams and Kuniansky, 2015) is a lower-permeability hydrogeologic unit that separates the Upper Floridan aquifer and the lower Floridan aquifer in northern Florida, southern Georgia, and southern Alabama. In this region, the LISAPCU is equivalent to the middle confining unit (MCU) described in Miller (1986). The LISAPCU is middle Eocene aged and generally consists of well-indurated sand and clays and fine-grained carbonate rocks. The LISAPCU is laterally continuous across Jackson County and likely acts as a confining or semi-confining unit between the upper and lower Floridan aquifer.

The lower to middle Eocene-aged Lower Floridan aquifer (LFA) in Jackson County consists of undifferentiated carbonate rocks such as limestone and dolomite and generally has lower permeability than the Upper Floridan aquifer. The Lower Floridan aquifer crops out in southern Alabama and represents the northern extent of the Floridan aquifer system in this region. The thickness of the lower Floridan aquifer ranges from approximately 400 feet in the northern part of Jackson County and approximately 550 feet to the south (Williams and Kuniansky, 2015). In southern Alabama and southwestern Georgia, the lower Floridan aquifer equivalent is the Claiborne aquifer. The Claiborne aquifer is defined as the permeable portions of the Lisbon and Tallahatta Formations and are part of the Claiborne Group of middle Eocene age (Williams and Kuniansky, 2015).

Most of the area in and adjacent to the Jackson Blue Spring GWCA has little to no surficial drainage in the form of streams or rivers, indicating that most of the rainfall flows out of the area through the subsurface. Regionally, groundwater flows from north to south with discharge to Lake Seminole or the Apalachicola River to the east, the Chipola River and associated tributaries to the west, Jackson Blue Spring and Merritts Mill Pond.

2.7 Physiography

The Jackson Blue Spring GWCA and surrounding area lies within the Dougherty Karst Plain District, which is characterized by karst terrain, including sinking streams, sinkholes, caves, and springs. Land surface elevations in the Dougherty Karst Plain District range from approximately 50 feet to 240 feet NAVD 88. The topography is generally flat in the northern portion of the Dougherty Karst Plain District, with steeper terrain to the south where streams and rivers have incised through surficial sediments or where karst landforms have developed (Figure 2-14; modified from Ebersole, 2019, Clark, 1976, Williams, 2022).

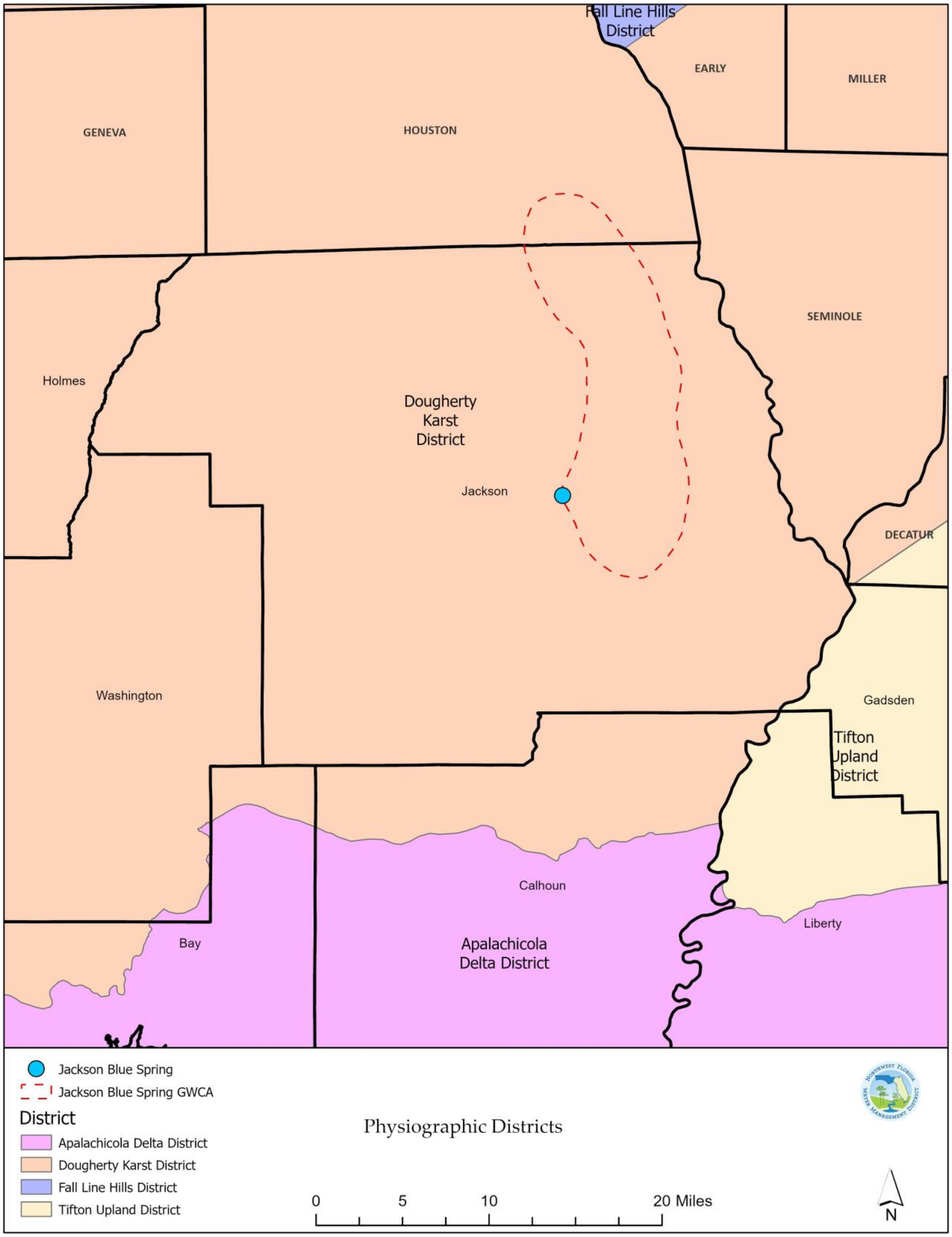


Figure 2-14. Physiographic districts within the Jackson Blue Spring MFL study area

2.8 Land Use, Population, and Structural Alterations

Land Use The land use within the Jackson Blue Spring groundwater contribution area consists primarily of agriculture, accounting for an estimated 48% (37,474 acres) of the total land area in the Florida portion of the Jackson Blue GWCA (Figure 2-15 and Table 2-2; FDEP, 2022). The second largest land use in the Florida portion of the Jackson Blue Spring GWCA is upland forest (38 percent, 29,395 acres), followed by developed land (8 percent, 6,420 acres), wetlands (3 percent, 2,691 acres), open land (1 percent, 1,007 acres), and open water (0.4 percent, 339 acres).

Population The entire Florida portion of the Jackson Blue Spring study area lies within Jackson County. During 2024, the estimated population of Jackson County was 49,345 individuals (BEBR 2025a). The population of Jackson County is projected to remain relatively stable, with a projected population of 50,908 individuals by 2045 and 51,194 individuals by 2050, (BEBR 2025b). Based on 2020 U.S. Census block data provided by the U.S. Department of Commerce Census Bureau, the population within the Jackson Blue GWCA was 4,747 as of 2020, which is approximately 10% of total 2020 population within Jackson County of 47,319 (U.S Census Bureau 2020). Jackson County residents receive their potable water from a combination of public supply and domestic self-supply wells (NWFWMD 2023).

Structural Alterations Several structural alterations are present in the Jackson Blue Spring study area. Structural alterations must be considered as part of the establishment and implementation of MFLs according to section 373.0421, F.S. This section describes the major structural alterations known or likely to have occurred within the JBS study area. For the purposes of this MFL evaluation, these structural alterations are assumed to be permanent features and are included as part of the MFL evaluation process. Minor alterations such as the construction of docks and boat ramps are not described.

The Blue Springs Recreation area has undergone several structural alterations as part of the park development (Figure 2-2). Boat access to the spring pool has been restricted by a floating barrier. A retaining wall has been constructed around much of Jackson Blue Spring in place of a natural shoreline to help prevent erosion associated with public recreation use. On the western side of the spring, a sand beach has been constructed for recreational access to the spring pool. A permanent diving platform has also been installed just above the Jackson Blue Spring vent.

At the downstream end of Merritts Mill Pond on the northern side of the pond, an area may have been dredged and/or filled to create space for docks and boat mooring associated with an area now managed as a recreational vehicle (RV) resort. Additionally, fill appears to have been added to the downstream end of Merritts Mill Pond to create stability for the U.S. Hwy 90 bridge over Merritts Mill Pond.

The Merritts Mill Pond dam, including Spring Creek Park, is another significant structural alteration present in the MFL study area. The current water control structure has been present in some form since the mid to late 1800s and is responsible for the creation of Merritts Mill Pond. Seawalls have been built around the water control structure. The control structure is located at the southern end of Merritts Mill Pond, just below the U.S. Hwy 90 bridge. The current control structure configuration at the pond outlet consists of a modified rectangular notch weir over three sluice gates. The weir is 22.5 ft wide and the notch is 7 ft wide. The elevation of the top of the weir is 76.64 ft above NAVD 88. The elevation of the notch is 73.64 ft above NAVD 88 when no stop logs are present. Outfall from the control structure enters a spillway discharging into (and forming the headwaters of) Spring Creek.

The control structure is maintained and operated by the Jackson County, Florida Department of Public Works. A fish barrier just upstream of the weir and gates serves to limit downstream migration of fish. Historically, the fish barrier was lifted and cleaned daily, with the fish barrier completely lowered at all other times. To reduce accumulation of debris and frequency of required cleaning, the county currently maintains the fish barrier in a slightly raised position, allowing some debris to pass while still protecting from fish entering the outfall. The fish barrier is periodically lifted and cleaned to remove accumulated vegetation and other debris. Although the fish barrier is not designed as a hydraulic control, water level is slightly impacted when the fish barrier is raised and cleaned as accumulated debris is released downstream. The county staff estimate a temporary drop in water level of approximately 0.5 inches when the fish barrier is raised and cleaned. Water levels remain slightly lower until debris has accumulated behind the fish barrier.

A hydraulic control gate, located just behind the fish barrier, controls the outfall flow rate and the water level in Merritts Mill Pond (Figure 2-16). Typically, the county staff maintain the gate in the "closed" position, with flow passing through the gate (when open) and over weir into the outfall. County staff prefer to maintain the water level at or below an elevation of 78.3 feet above NAVD 88. When the water level is above an elevation of 78.3 feet (20 inches below the top of the wing wall), the County opens the gate up to a maximum height of 10 to 12 inches until the water level declines below that elevation. Additionally, the County staff periodically opens the gates to lower the water level in the pond in preparation for an expected hurricane or major storm event.

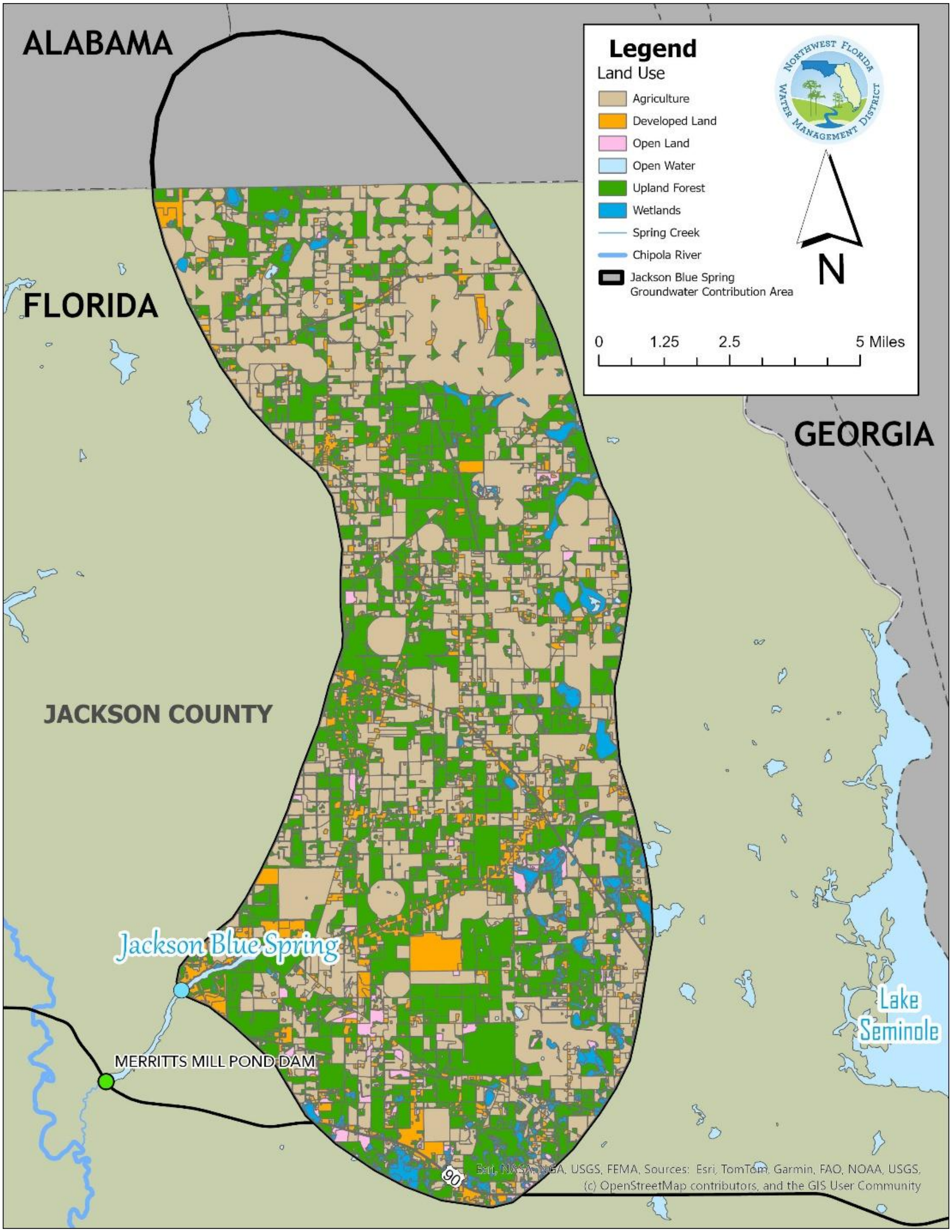


Figure 2-15: Land use within the Florida portion of the Jackson Blue Spring groundwater contribution area, based on the 2022 Florida Department of Environmental Protection (DEP) Division of Environmental Assessment and Restoration Landcover Dataset.

Figure 2-16. Water Control Structure (on right) and Adjacent Building (on left) Located at the Merritts Mill Pond/Spring Creek Confluence at U.S. Hwy 90. View from Spring Creek.

Table 2-2: Land Use Within the Florida Portion of the Jackson Blue Spring GWCA.

Land Use	Acreage	Percent of Groundwater Contribution Area (%)
Agriculture	37,473.71	48.46
Developed Land	6,419.96	8.30
Open Land	1,007.48	1.30
Upland Forest	29,394.58	38.02
Open Water	338.93	0.44
Wetlands	2,690.79	3.48
Total	**77,325.45**	**100**

2.9 Natural Resources

The goal of this MFL evaluation is to establish a flow or level to help manage the system and protect it from significant harm, based on functional requirements of the system's natural resources and ecology. This section outlines natural resources and local ecology within Merritts Mill Pond and Spring Creek, both of which are in the Merritts Mill Pond subwatershed.

2.9.1 Instream and Wetland Habitats

The aquatic and wetland habitats along Merritts Mill Pond and Spring Creek are noted within their corresponding section below (2.9.1.1 and 2.9.1.2). Terrestrial vegetation in the study area, particularly along Spring Creek, has undergone significant changes since the passage of Hurricane Michael in October 2018. The descriptions of forested vegetation communities below represent conditions before Hurricane Michael, while herbaceous vegetation descriptions are reflective of recent conditions observed in 2025.

2.9.1.1 Merritts Mill Pond

The shoreline and littoral habitat present along Merritts Mill Pond is relatively limited and narrow in width. Because of the water control structure present at U.S. Hwy 90 and the relatively stable nature of spring flows, water levels in the pond are relatively stable and do not display much variation. This reduction in water level fluctuation, combined with the relatively steep banks in many areas along the pond, precludes the development of extensive shoreline and littoral habitats present in more dynamic lacustrine or riparian systems.

Tree and shrub communities comprising the canopy and subcanopy layers were sampled and assessed during the winter of 2016, prior to Hurricane Michael. During December 2016, a total of 14 woody species comprising 156 individuals were sampled at Merritts Mill Pond (NWFWMD 2017a). Of these species, cypress (*Taxodium distichum)* was the most abundant, comprising 50% of all sampled trees. Black gum (*Nyssa sylvatica* var. *biflora,* 26%) and American hornbean (*Carpinus caroliniana*, 8%) were the subdominant species. All remaining species comprised less than 4% of trees sampled. The canopy species present along Merritts Mill Pond were not adversely affected to the extent that vegetation along Spring Creek was during Hurricane Michael. As a result, the characterization of woody habitat completed during 2016/2017 remains indicative of current conditions at the Mill Pond.

Wetland trees present in Merritts Mill Pond primarily occur along the shoreline, but are also located in the pond where water levels are low enough to support tree growth. In many cases these trees are found several hundred feet from shore, although they occur at relatively low densities compared to the shoreline (Figure 2-17).

Herbaceous vegetation present along the littoral shelf and fringing wetlands of Merritts Mill Pond includes manicured lawns and native vegetation. Native vegetation along the shore of the pond include native wetland species such as bulltongue arrowhead (*Sagittaria lancifolia*), pickerelweed (*Pontederia cordata*), bullrush (*Scirpus* sp.), climbing hempvine (*Mikania scandens*), false nettle (*Boemeria cylindrica*), and pennywort (*Hydrocotyle* sp.).

Nuisance, invasive, exotic species are present along the littoral zone of Merritts Mill Pond. These species identified along the MMP littoral zone include wild taro (*Colocasia esculenta*), hydrilla (*Hydrilla verticilata*), alligator weed (*Alternanthera philoxeroides*), cattail (*Typha* sp.), water lettuce (*Pistia stratiotes*), and water hyacinth (*Eichhornia crassipes*). To help manage the presence of invasive vegetation, The Fish and Wildlife Commission (FWC) regularly conducts herbicide treatments in Merritts Mill Pond to control hydrilla and other invasive species.

Three primary types of instream habitat were observed in Merritts Mill Pond: spring vents and boils, submerged aquatic vegetation (SAV) communities, and bare substrate. Multiple spring boils are present along the pond. These springs all discharge directly into the pond and as a result have no spring runs associated with them. Most spring boils are associated with karst limestone features surrounded by bare substrate and SAV. Bare substrate habitats consist of areas of sandy substrates with little to no SAV. Dense patches of SAV occur in other parts of Merritts Mill Pond (Figure 2-18). Eelgrass (*Vallisneria americana*) is the dominant SAV species but hydrilla is found throughout the pond and can become dense. In relatively shallow areas of the pond, eelgrass can reach the surface and support mats of dense floating aquatic vegetation like duckweed (*Lemna* sp.) and water spangles (*Salvinia minima*), in addition to algae (Figure 2-19). Woody habitat, including dead tree trunks and woody debris, along with live roots such as living trees and cypress knees are also present throughout the pond. In general, dead wood tends to be found further into the pond and in deeper water than live roots and trees.

Figure 2-17: Cypress, Taxodium sp., trees present along the Merritts Mill Pond shoreline and littoral shelf

Figure 2-18: Submerged aquatic vegetation in Merritts Mill Pond

Figure 2-19: Algae and floating aquatic vegetation on Merritts Mill Pond. Photo taken on August 24, 2023.

2.9.1.2 *Spring Creek*

Unlike Merritts Mill Pond which functions largely as a lake with relatively stable water levels and low water velocities, Spring Creek is relatively narrow with high water velocities and fluctuating water levels. Flows in Spring Creek are provided by Merritts Mill Pond as water flows over the control structure at U.S. Hwy. 90.

The shoreline and littoral habitat present along Spring Creek remains in a mostly natural condition with few structures and alterations. Unlike habitats in and along Merritts Mill Pond, those along Spring Creek were severely impacted by Hurricane Michael in October 2018 (Refer to Section 4.2 for details regarding impacts from Hurricane Michael to the study area). Prior to Hurricane Michael, a total of 20 woody species totaling 272 individuals were identified during floodplain sampling along Spring Creek in December 2016 (

Table 2-3). Of these species, *Carpinus caroliniana* (American hornbeam) was the most abundant species encountered comprising 28% of all trees. *Acer rubrum* (red maple) (12%), *Liquidambar styraciflua* (sweetgum) (10%), *Nyssa sylvatica* var. *biflora* (swamp tupelo) (8%), and *Quercus laurifolia* (laurel oak) (8%) were among the subdominant species. Each remaining species comprised less than 6% of trees sampled. Wetland tree species comprised 75% of the 20 species encountered along Spring Creek. These trees were largely mature across an extensive floodplain (Figure 2-20). As previously stated, mature woody vegetation along Spring Creek was largely destroyed during Hurricane Michael. As a result, the canopy of riparian wetlands along the creek are no longer present and currently consist of young sub-canopy trees and shrub species with few mature wetland trees remaining (Figure 2-21). The successional/recovery trajectory of canopy species remains uncertain.

Prior to Hurricane Michael (October 2018), herbaceous species present along the riparian corridor were limited, presumably due to the dense canopy of wetland trees reducing sunlight. Once mature canopy trees were removed from the floodplain, herbaceous species rapidly expanded in cover. Currently, the shoreline of Spring Creek consists primarily of native species such as bulrush (*Scirpus* sp.), spider lily (*Hymenocallis latifolia*), sedges and other grass species including pickerelweed, bulltongue arrowhead, and St. Johns Wort (*Hypericum* sp.)

The SAV along the creek is relatively limited (Figure 2-22). Eelgrass (*Vallisneria americana*) is the dominant SAV species present, along with lesser amounts of parrot feather (*Myriophyllum aquaticum*). The presence of eel grass and other SAV is found primarily in the upstream portions of the stream where limestone outcrops are less abundant. Limestone outcrops can be found in areas throughout Spring Creek but are more abundant in the downstream portions as the creek approaches the Chipola River (Figure 2-23). Woody habitat, including dead tree trunks and debris, along with live roots such as living trees and cypress knees are also present throughout Spring Creek. In general, dead wood tends to be found further into the creek and in deeper water than live roots and trees.

Nuisance species are present along Spring Creek although in lesser densities than in Merritts Mill Pond. Some nuisance species identified include hydrilla, wild taro, alligator weed, cattail, water lettuce, and water hyacinth. As understood by the District, Spring Creek is not directly treated with herbicide by FWC to control nuisance vegetation.

Figure 2-20. Spring Creek floodplain prior to Hurricane Michael. Photo taken during December 2016

Figure 2-21. Spring Creek riparian corridor. Photo taken on June 4, 2025

Figure 2-22. Spring Creek ecotone with SAV. Photo taken on June 4, 2025

Figure 2-23. Confluence of Spring Creek and the Chipola River. Photo taken on June 4, 2025

Table 2-3: Tree species identified in the Merritts Mill Pond and Spring Creek floodplain during December 2016 (NWFWMD 2017a)

Species	Common Name	F.A.C. 62-340 Classification	Merritts Mill Pond	Spring Creek
Acer floridanum	Florida maple	-		X
Acer rubrum	Red maple	FACW		X
Carpinus caroliniana	American hornbeam	FACW		X
Carya glabra	Pignut hickory	-		
Celtis laevigata	Sugar hackberry	FACW	X	X
Fagus grandifolia	American beech	UPL	X	X
Fraxinus caroliniana	Carolina ash	OBL		X
Fraxinus sp.	Ash	-		X
Ilex cassine	Dahoon holly	OBL		X
Liquidambar styraciflua	sweetgum	FACW	X	X
Magnolia gradiflora	Southern magnolia	-	X	
Magnolia virginiana	Sweetbay	OBL	X	X
Nyssa sylvatica var. *biflora*	Black gum	OBL	X	X
Ostrya virginiana	Eastern hophornbeam	UPL	X	X
Persea palustris	Swamp bay	OBL	X	X
Pinus glabra	Spruce pine	FACW		X
Quercus laurifolia	Laurel oak	FACW		X
Quercus michauxII	Swamp chestnut oak	FACW		X
Quercus nigra	Water oak	FACW		X
Quercus sp.	Oak	-		X
Taxodium distichum	Cypress	OBL	X	X
Ulmus americana	American elm	FACW	X	X

FACW =Facultative (wet) wetland species, OBL = obligate wetland species, UPL = upland species

2.9.2 Wildlife

Wildlife, particularly aquatic species, are abundant throughout Merritts Mill Pond and Spring Creek. This section describes the faunal species observed within the Jackson Blue MFL study area.

2.9.2.1 Fish Species

A total of 31 fish species were identified by the Florida Museum of Natural History (FMNH) and/or FWC in the Jackson Blue Spring system (Table 2-4). None of these species are listed on the State of Florida's List of Endangered and Threatened Species list (FWC 2023).

A total of 15 fish species were documented in Merritts Mill Pond by the FMNH and FWC (Table 2-4). Of these species, largemouth bass (*Microptera salmoides*), bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophis*), warmouth (*Lepomis gulosus*), and spotted sunfish (*Lepomis punctatus*) are monitored by the FWC and considered valuable sportfish for the system. Grass carp, *Ctenopharyngodon* *idella*, are the largest fish known to inhabit Merritts Mill Pond; however, largemouth bass are the largest bodied, native fish species documented in the system.

A total of 22 fish species were documented in Spring Creek by the FMNH and Florida Fish and Wildlife Conservation Commission (Table 2-4). Largemouth bass, redfin pickerel (*Esox americanus*), redbreast sunfish (*Lepomis auritus*), bluegill, dollar sunfish (*Lepomis marginatus*), and redear sunfish are the recreationally important species documented from Spring Creek. In addition, numerous black bass (*Micropterus* sp.) were observed during ecological monitoring but were not identified to the species level. Black bass are the largest bodied, native fish species present in the system. A close relative of largemouth bass is the Florida bass (FWC 2025a). The Florida bass is a recently designated species separate from largemouth bass, but due to their lack of morphological differences and cohabitation, their habitat suitability curve (for use in SEFA modeling) was represented by the largemouth bass.

Shoal bass, *Micropterus cataractae*, are a native, lotic black bass species limited to the Apalachicola, Chattahoochee, Flint (ACF) watershed. In Florida, shoal bass are primarily limited to the Chipola River and its tributaries (FWC 2022a, FWC 2022b, FWC 2022c). Primary habitat for this species consists of exposed limestone outcroppings such as relatively shallow, fast-moving riffles/runs and deeper pools near the shoals, although habitat use can vary among shoal bass size classes, years, seasons, and river flows (Johnson and Kennon 2007). Although the Chipola River is the primary habitat for shoal bass in Florida, at the time of this documents preparation, this species has not been confirmed in the Jackson Blue Spring MFL study area (i.e. Spring Creek or Merritts Mill Pond) by regular scientific surveys or fish collections conducted by FWC or the Florida Museum of Natural History. Due to the lack of habitat suitability curves (HSCs) describing the habitat preferences of the species in relation to instream habitat, instream habitat modeling was not possible. As a result, shoal bass was not capable of being considered further for the development of MFL evaluation metrics at this time.

Gulf sturgeon, *Acipenser oxyrhinchus desotoi*, is a large anadromous fish species found in the northern Gulf of America. This species is listed as a Species of Special Concern by the State of Florida and Threatened by the Federal Government (U.S. Fish and Wildlife Service 2025). Traditionally found along the Gulf of America coast and rivers from Tampa Bay to the Mississippi River, the Gulf sturgeon's range has since been reduced to between the Suwannee River, FL and Lake Pontchartrain, LA (Figure 2-24, NOAA 2022a). Currently, the Suwannee River, Apalachicola River, Choctawhatchee River, Yellow River, Blackwater River, and Escambia River have been designated as critical habitat for Gulf sturgeon in the State of Florida (NOAA 2022b). Although the Apalachicola River is designated as critical habitat for Gulf sturgeon, the species has not been documented in the Chipola River or any of its tributaries like Spring Creek. As a result, Gulf sturgeon was not considered for the development of MFL evaluation metrics.

Table 2-4. Fish species documented in Merritts Mill Pond and Spring Creek by the Florida Fish and Wildlife Conservation Commission and Florida Museum of Natural History

Species Name	**Common Name**	**Location**	
		Merritts Mill Pond	**Spring Creek**
Ameiurus nebulosis	Brown bullhead	X	
Aphredoderus sayanus	Pirate perch	X	X
Ctenopharyngodon idella	Grass carp	X	X
Cyprinella venusta cercostigma	Eastern blacktail shiner		X
Cyprinus carpio	Common Carp	X	
Elassoma evergladei	Everglades pygmy sunfish	X	
Elassoma gilberti	Gulf coast pygmy sunfish		X
Esox americanus	Redfin pickerel		X
Etheostoma edwini	Brown darter		X
Etheostoma swaini	Gulf darter		X
Gambusia holbrooki	Mosquitofish	X	X
Labidesthes sicculus	Brook silverside	X	X
Lepomis auritus	Redbreast sunfish		X
Lepomis gulosus	Warmouth	X	
Lepomis macrochirus	Bluegill	X	X
Lepomis marginatus	Dollar sunfish		X
Lepomis microlophus	Redear sunfish	X	X
Lepomis punctatus	Spotted sunfish	X	
Lucania goodei	Bluefin killifish	X	X
Micropterus salmoides	Largemouth bass	X	
Micropterus sp.	Unidentified black bass		X
Minytrema melanops	Spotted sucker		X
Notropis cummingsae	Dusky shiner		X
Notropis harperi	Redeye chub	X	X
Notropis petersoni	Coastal shiner		X
Notropis texanus	Weed shiner	X	X
Noturus gyrinus	Tadpole madtom		X
Noturus leptacanthus	Speckled madtom		X
Percina nigrofasciata	Blackbanded darter		X
Pteronotropis grandipinnis	Apalachee shiner		X
Grand Total Documented		**15**	**22**

Figure 2-24. Gulf Sturgeon, Acipenser oxyrhinchus desotoi critical habitat map

2.9.2.2 Freshwater Mussels

Freshwater mussels are filter feeders that reside on sandy shallow river bottoms and remove organic material from the water column. On stream bottoms, they filter water and become a food source for other animals. Some species of freshwater mussels are indicators for water quality.

Twenty-one species of freshwater mussels are documented within the study area, including three historically documented species, fourteen documented species, three likely occurring species, and one potentially occurring species (Table 2-5) (FNAI 2025a, FWC 2025b-e). Three of the four listed mussel species are designated as endangered, all of which are historically documented (D-H) in the basin: including the Shinyrayed pocketbook (*Hamiota subangulata*), Gulf moccasinshell (*Medionidus penicillatus*), and Oval pigtoe (*Pleurobema pyriforme*). Also, likely to occur, and threatened, is the Chipola slabshell (*Elliptio chipolaensis*). The Chinese basket clam (*Corbicula fluminea*) is a non-native species found within the system, which is historically from Asia.

Freshwater mussels use host fish for their larvae (glochidia) development and dispersal. During this time, they parasitize the fish gills before detaching and settling into the substrate for maturation and growth. Although additional research is needed to determine and confirm the primary host fish species for many mussel species, best available data indicates that many potential host fish species have been documented in the study area (Table 2-6) (Freshwater Mussel Host Database 2025, Fritts et al. 2014, Williams et al. 2014).

Table 2-5. List of mussel species documented (D), historically documented (D-H), likely to be found (L), or potentially found (P) in the vicinity of Merritts Mill Pond and/or Spring Creek

Source	*Species*	Common Name	Federal Listing	State Listing
D-H[2]	*Elliptio arctata*	Delicate spike	N	N
D[2]	*Elliptio crassidens*	Elephantear	N	N
D[2]	*Elliptio fumata*	Gulf slabshell	N	N
D[2]	*Elliptio jayensis*	Florida spike	N	N
D[2]	*Elliptio pullata*	Gulf spike	N	N
D[2]	*Elliptio purpurella*	Inflated spike	N	N
D[2]	*Hamiota subangulata*	Shinyrayed pocketbook	E	E
D[2]	*Lampsilis straminea*	Southern fatmucket	N	N
D[2]	*Leaunio lienosus*	Little Spectaclecase	N	N
D-H[2]	*Medionidus penicillatus*	Gulf moccasinshell	E	E
D-H[2]	*Pleurobema pyriforme*	Oval pigtoe	E	E
D[2]	*Pyganodon grandis*	Giant floater	N	N
D[2]	*Toxolasma paulum*	Iridescent lilliput	N	N
D[2]	*Uniomerus columbensis*	Apalachicola pondhorn	N	N
D-H[2]	*Utterbackia imbecillis*	Paper pondshell	N	N
D-H[2]	*Utterbackia peggyae*	Florida floater	N	SGCN
D[2]	*Villosa vibex*	Southern rainbow	N	N
D[2]	*Villosa villosa*	Downy rainbow	N	N
L[2]	*Corbicula fluminea*	Chinese basket clam	N	N
L[1]	*Elliptio chipolaensis*	Chipola slabshell	T	T
D[2]	*Pustulosa infucata*	Sculptured pigtoe	N	SGCN
P[2]	*Strophitus radiatus*	Rayed creekshell	N	SGCN
P[1]	*Megalonaias nervosa*	Washboard	N	N

Data sources include: Florida Natural Areas Inventory[1] and Florida Fish and Wildlife Conservation Commission[2]. Species are also indicated by the Federal and State Listing where E= endangered, T= threatened, SGCN= species of greatest conservation need, SSC= species of special concern and N= not listed

Table 2-6. List of mussel species and their host fish.

Mussel Species	Mussel Common Name	Host Fish Species	Host Fish Common Name
Elliptio arctata	Delicate spike	Unknown	Unknown
Elliptio crassidens	Elephantear	*Alosa chrysochloris, Alosa alabamae*	Skipjack herring, Alabama shad
Elliptio fumata	Gulf slabshell	Unknown	Unknown
Elliptio jayensis	Florida spike	*Micropterus salmoides, Lepomis macrochirus, Lepisosteus platyrhincus*	Largemouth bass, Bluegill, Florida gar
Elliptio pullata	Gulf spike	*Micropterus salmoides, Lepomis macrochirus*	Largemouth bass, Bluegill
Elliptio purpurella	Inflated spike	*Unknown*	Unknown
Hamiota subangulata	Shinyrayed pocketbook	*Micropterus salmoides, Micropterus cataractae, Micropterus coosae, Lepomis macrochirus, Micropterus punctatus, Gambusia holbrooki,*	Largemouth bass, Shoal bass, Redeye bass, bluegill, Spotted bass, Eastern mosquitofish
Lampsilis straminea	Southern fatmucket	*Micropterus salmoides, Micropterus sp. cf. punctulatus, Lepomis macrochirus, Ictalurus punctatus, Notropis texanus, Lepomis punctatus, Ambloplites ariommus, Notemigonus crysoleucus*	Largemouth bass, Choctaw bass, Bluegill, Channel catfish, Weed shiner, Spotted sunfish, Shadow bass, Golden shiner
Leaunio lienosus	Little Spectaclecase	*Micropterus salmoides, Lepomis macrochirus, Ameiurus nebulosus, Lepomis cyanellus, Lepomis megalotis, Lepomis humilis, Lepomis microlophus, Lepomis punctatus, Lepomis macrochirus, Cyprinella venusta, Aphredoderus sayanus, Ictalurus punctatus,*	Largemouth bass, Bluegill, Brown bullhead, Green sunfish, Longear sunfish, Orangespotted sunfish, Redear sunfish, Spotted sunfish, Bluegill, Blacktail shiner, Pirate perch, Channel catfish
Medionidus penicillatus	Gulf moccasinshell	*Percina nigrofasciata, Gambusia holbrooki, Poecilia reticulata, Etheostoma edwini, Etheostoma inscriptum, Etheostoma swaini,*	Blackbanded darter, Eastern mosquitofish, Guppy, Brown darter, Turquoise darter, Gulf darter,

		Percina crypta	Halloween darter
Pleurobema pyriforme	Oval pigtoe	*Pteronotropis hypselopterus, Gambusia holbrooki, Poecilia reticulata, Cyprinella venusta, Nocomis leptocephalus, Ericymba amplamala, Notropis lutipinnis, Pimephales promelas, Semotilus atromaculatus*	Sailfin shiner, Eastern mosquitofish, Guppy, Blacktail shiner, Bluehead chub, Longjaw minnow, Yellowfin shiner, Fathead minnow, Creek chub
Pustulosa infucata	Sculptured pigtoe	Unknown	Unknown
Pyganodon grandis	Giant floater	*Micropterus salmoides, Lepomis macrochirus, Lepomis megalotis, Lepomis microlophus, Alosa chrysochloris, Lepisosteus osseus, Luxilis cornutus, Lepomis humilis, Perca flavescens, Etheostoma nitrum, Cyprinus carpio, Pomoxi annularis, Ampbloplites rupestris, Rutilus rutilus, Luxilus chrysocephalus, Fundulus chrysotus, Fundulus diaphanous, Lepomis cyanellus, Lythrurus umbratilis, Pomoxis nigromaculatus, Ameiurus natalis, Morone chrysops, Dorosoma cepedianum, Aplodinotus grunniens, Semotilus atromaculatus*	Largemouth bass, Bluegill, Longear sunfish, Redear sunfish, Skipjack herring, Longnose gar, Common shiner Orangespotted sunfish Yellow perch Johnny darter Common carp White crappie Rock bass, Roach, Striped Shiner, Golden topminnow Banded killifish, Green sunfish, Redfin shiner, Black crappie, Yellow bullhead, White bass, Gizzard shad, Freshwater drum, Creek chub
Toxolasma paulum	Iridescent lilliput	*Lepomis marginatus, Lepomis auritus, Lepomis punctatus*	Dollar sunfish, Redbreast sunfish, Spotted sunfish
Uniomerus columbensis	Apalachicola pondhorn	Unknown	Unknown

Utterbackia imbecillis	Paper pondshell	*Micropterus salmoides,* *Lepomis macrochirus,* *Pomoxis nigromaculatus,* *Cyprinella spiloptera,* *Etheostoma lepidum,* *Ictalurus punctatus,* *Notemigonus crysoleucas,* *Lepomis megalotis,* *Lepomis marginatus,* *Lepomis gulosus,* *Perca flavescens,* *Lepomis cyanellus,* *Ambloplites rupestris,* *Fundulus diaphanus,* *Percina nigrofasciata,* *Pteronotropis grandipinnis*	Largemouth bass, Bluegill, Black crappie, Spotfin shiner, Greenthroat darter, Channel catfish, Golden shiner, Longear sunfish, Dollar sunfish, Warmouth, Yellow perch, Green sunfish, Rock bass, Banded killifish, Blackbanded darter, Apalachee shiner
Villosa vibex	Southern rainbow	*Micropterus salmoides,* *Lepomis cyanellus,* *Fundulus olivaceus,* *Micropterus coosae,* *Micropterus punctulatus,* *Lepomis megalotis,* *Esox niger,* *Esox americanus*	Largemouth bass, Green sunfish, Blackspotted topminnow, Redeye bass, Spotted bass, Longear sunfish, Chain pickerel, Redfin pickerel
Villosa villosa	Downy rainbow	*Micropterus salmoides,* *Lepomis macrochirus,* *Lepomis cyanellus,* *Fundulus olivaceus,* *Micropterus coosae,* *Micropterus punctulatus,* *Lepomis megalotis,* *Esox niger,* *Esox americanus*	Largemouth bass, Bluegill, Green sunfish, Blackspotted topminnow, Redeye bass, Spotted bass, Longear sunfish, Chain pickerel, Redfin pickerel
Corbicula fluminea	Asian clam	No host	No host
Elliptio chipolaensis	Chipola slabshell	*Micropterus salmoides,* *Lepomis macrochirus*	Largemouth bass, Bluegill
Megalonaias nervosa	Washboard	*Micropterus salmoides,* *Numerous others*	Largemouth bass, Numerous others

Data sources include: Florida Fish and Wildlife Conservation Commission and The Freshwater Mussel Host Database, Arey 1932, Clarke and Berg 1959, Fritts and Bringolf 2014, Fuller 1978, Haag et al. 1997, Harriger et al. 2015, Jansen 1991, Kakonge 1972, Lefevre and Curtis 1910, Penn 1939, Robinson et al. 2025, Trdan and Hoeh 1982, Watters et al. 2005, Williams et al. 2014, and Wilson 1916

2.9.2.3 Other Aquatic Invertebrates

Aquatic macroinvertebrates excluding freshwater mussels present within the Jackson Blue MFL study area are presented in Table 2-7. No aquatic invertebrates documented within the study area are federally or state listed by the Florida Fish and Wildlife Conservation Commission. Among the aquatic macroinvertebrates found within the study area is the federally petitioned *Southern snaketail dragonfly (Ophiogomphus australis).* The Dougherty Plains cave crayfish *(Cambarus cryptodytes*) and the Jackson County cave amphipod (*Crangonyx manubrium*) are found in and around Twin Cave, an underwater cave in Merritts Mill Pond. The Dougherty Plains cave crayfish is a medium-sized crayfish and is the only known cave crayfish occurring west of the Ochlockonee River (FNAI 2025b). The species is primarily known in cave systems located in Jackson and Washington Counties, Florida. The cave amphipod is a small (3-6.5 mm) species only known to inhabit seven aquatic caves in Jackson County, Florida although they are thought to have a range extending throughout the Dougherty Karst Plan including southwest Georgia (FNAI 2025c). Little information is known about the hydrologic requirements of either cave species.

Table 2-7. List of aquatic invertebrates, excluding mussels, documented (D), historically documented (D-H), likely to be found (L), or potentially found (P) in the vicinity of Merritts Mill Pond and/or Spring Creek.

Source	Species	Common Name	Federal Listing	State Listing
D[3]	*Acroneuria arenosa*	Eastern stone stonefly	N	N
D[3]	*Atteneuria ruralis*	Giant stone stonefly	N	N
D-H[3]	*Cambarellus schmitti*	Frontal dwarf crayfish	N	N
D-H[3]	*Cambarus cryptodytes*	Dougherty plains cave crayfish	N	SGCN
D-H[3]	*Cambarus diogenes*	Devil crayfish	N	N
D[3]	*Cambarus striatus*	Ambiguous crayfish	N	N
D[3]	*Cheumatopsyche campyla*	Caddisfly	N	N
D[3]	*Coptotomus interrogatus*	Diving beetle	N	N
D[3]	*Coptotomus venustus*	Diving beetle	N	N
D[1]	Crangonyx manubrium	Jackson county cave amphipod	N	N
D-H[3]	*Creaserinus byersi*	Lavender burrowing crayfish	N	N
D[3]	*Elimia athearni*	Knobby elimia snail	N	N
D[3]	*Elimia doolyensis*	Graphite elimia snail	N	N
D[3]	*Elimia floridensis*	Rasp elimia snail	N	N
D-H[1]	*Hetaerina americana*	American rubyspot damselfly	N	N
D[3]	*Hydropsyche simulans*	Caddisfly	N	N
P[4]	*Lacunicambarus dalyae*	Jewel mudbug	N	N
D[3]	*Macrostemum carolina*	Zebra caddisfly	N	N
D[3]	*Mexistenasellus floridensis*	Marianna cave isopod	N	SGCN
D[3]	*Notogillia wetherbyi*	Alligator slitsnail	N	N
D[3]	*Oecetis parva*	Little oecetis longhorn caddisfly	N	N
D[3]	*Ophiogomphus australis*	Southern snaketail dragonfly	N	SGCN
D[3]	*Palaemonetes paludosus*	Freshwater shrimp	N	N
D[3]	*Perlesta shubuta*	Cloudy stone stonefly	N	N

D[3]	*Pomacea paludosa*	Florida applesnail	N	N
D[3]	*Procambarus paeninsulanus*	Peninsular crayfish	N	N
D[3]	*Procambarus spiculifer*	White tubercled crayfish	N	N
D[3]	*Pseudocloeon bimaculatus*	Mayfly	N	N
D[3]	*Pseudosinella pecki*	Peck's cave springtail	N	SGCN
D[3]	*Stygobromus doughertyensis*	Doughery plain cave amphipod	N	SGCN
D[5]	*Stygobromus floridanus*	Dougherty plain cave amphipod	N	SGCN
D[3]	*Viviparus georgianus*	Banded mystery snail	N	N

Data sources include: Florida Natural Areas Inventory1, State of Florida list of imperiled species based on county of occurrence2, Florida Fish and Wildlife Conservation Commission3 , 4 Glon et al. 2019, and 5 Cannizzaro et al. 2019. Species are also indicated by the Federal and State Listing where E= endangered, T= threatened, SSC= species of special concern, SGCN= Species of greatest conservation need according to FWC 2019, and N= not listed.

2.9.2.4 Non-fish Vertebrates

There are nine documented, three likely found, and eight potentially found vertebrate species, excluding fish, found in or around the vicinity of the system (Table 2-8). Of the documented species, the reticulated flatwoods salamander (*Ambystoma bishop*) is federally and state listed as endangered. Within the likely to occur category are three state listed, and two federally listed threatened species. Barbour's map turtle (*Graptemys barbouri*) is state listed but lacks the federal status, while the Eastern indigo snake (*Drymarchon couperi*) and Wood Stork (*Mycteria americana*) maintain both levels of threatened status. Of the potentially found species, the gopher tortoise (*Gopherus polyphemus*) is state listed. The only species in the potentially found category that maintains an endangered status both at the federal and state level is the grey bat (*Myotis grisescens*).

The reticulated flatwoods salamander (*Ambystoma bishop*) inhabits small ponds and wetlands among slash and longleaf pine flatwoods (FWC 2025f). The Barbour's map turtle (*Graptemys barbouri*) nests along the Chipola River and lives in rapidly flowing waters including Spring Creek (FWC 2025g). The Eastern indigo snake (*Drymarchon couperi*) is a commensal species of the Gopher tortoise (*Gopherus polyphemus*) and primarily inhabits upland habitats (FWC 2025h). The Wood Stork (*Mycteria americana*) primarily uses standing water and water with a depth of less than twelve inches. In the Wood Stork's riparian feeding zone, they primarily eat medium-sized fish, crayfish, and small amphibians and reptiles (FWC 2025i).

Table 2-8. List of vertebrate species, excluding fish, documented (D), historically documented (D-H), likely to be found (L), or potentially found (P) in the vicinity of Merritts Mill Pond and/or Spring Creek.

Source*	Class	*Species*	Common Name	Federal Listing	State Listing
D[4]	Bird	*Nycticorax nycticorax*	Black Crowned Night heron	N	SSC
D[4]	Bird	*Eudocimus alba*	White Ibis	N	N
D[4]	Bird	*Ardea alba*	Great egret	N	N
D[4]	Bird	*Caragyps atratus*	Black vulture	N	N
D[4]	Bird	*Melanerpes erythrocephalus*	Red-headed woodpecker	N	N
D[4]	Bird	*Agelaius phoeniceus*	Red-winged blackbird	N	N
D[4]	Bird	*Ardea herodias*	Great blue heron	N	N
D[1]	Amphibian	*Ambystoma bishop*	Reticulated flatwoods salamander	E	E
D-H[1]	Amphibian	*Amphiuma pholeter*	One-toed amphiuma	N	N
P[3]	Amphibian	*Eurycea wallacei*	Georgia blind salamander	N	T
L[1]	Reptile	*Drymarchon couperi*	Eastern indigo snake	T	T
L[1,3]	Reptile	*Graptemys barbouri*	Barbour's map turtle	N	T
L[1]	Bird	*Mycteria americana*	Wood stork	T	T
P[1]	Mammal	*Corynorhinus rafinesquii*	Raginesque's big-eared bat	N	N
P[1,2]	Reptile	*Gopherus polyphemus*	Gopher tortoise	N	T
P[1]	Reptile	*Heterodon simus*	Southern hognose snake	N	N
P[1,2]	Mammal	*Myotis grisescens*	Grey bat	E	E
P[1]	Mammal	*Myotis austroriparius*	Southeastern myotis	N	N
P[1]	Bird	*Peucaea aestivalis*	Bachman's sparrow	N	N
P[1]	Reptile	*Pseudemys concinna suwanniensis*	Suwannee cooter	N	N

** As reported by: Florida Natural Areas Inventory1, 2 State of Florida list of imperiled species based on county of occurrence2, Florida Fish and Wildlife Conservation Commission3, and the Water Management District MFL Team4. Species are also indicated by the Federal and State Listing where E= endangered, T= threatened, SSC= species of special concern and N=not listed.*

2.10 Recreation

The Jackson Blue Spring MFL study area is widely utilized for recreation. The relatively clear, cool water, abundant wildlife, and habitat make it a popular destination for public recreational activities.

Merritts Mill Pond – Blue Springs Recreation Area is managed by Jackson County and is located around the Jackson Blue Spring and spring pool (Figure 2-25). The Jackson Blue Spring vent is located in the swimming area under the diving platform. The park is a popular recreation area during warmer months and is generally closed to visitors in the winter between Labor Day and Memorial Day (September - May). Canoe and paddle boat rentals are available for use on the pond.

Merritts Mill Pond is commonly used for recreational boating and fishing. Several boat ramps are available for public boat access to the pond including a public ramp and at least one private ramp. Multiple waterfront homes have private docks for recreational use of the pond.

Redear sunfish (*Lepomis microlophus*) draw numerous anglers to Merritts Mill Pond (FWC 2017). The pond currently holds the Florida state record for redear sunfish (caught in 1986) and was until recently, the world record (Figure 2-26).The exceptional fishing is due in part to it being managed as a Fish Management Area by the Florida Fish and Wildlife Conservation Commission. Fish Management Areas are water bodies established for the management of freshwater fish as a partnership effort with a local entity (Jackson County, FL.) (FWC 2022d). Other popular gamefish species found in the pond include largemouth bass, bluegill, warmouth, and spotted sunfish.

Merritts Mill Pond is unique due to the accessibility of multiple springs popular for cave diving. Jackson County offers permits for diving Jackson Blue Spring and at least six other springs located in the pond. These caves provide rare opportunities for individuals to explore Florida's karst aquifers and have attracted divers from all 50 states and at least 28 different countries (Jackson County 2022).

Figure 2-25 Jackson Blue Spring pool recreation area. Photo taken from the diving platform.

Figure 2-26. State record redear sunfish, Lepomis microlophis, caught at Merritts Mill Pond in 1986. Photo provided by the Florida fish and Wildlife Conservation Commission.

Spring Creek – Perhaps the most popular recreational uses of Spring Creek are canoeing, kayaking, and tubing. A commercial outfitter provides rental equipment at the headwaters of Spring Creek for float trips that extend the entire length of the creek and a portion of the Chipola River. Spring Creek Park is located off U.S. Hwy 90 at the Merritts Mill Pond outfall and provides public access to the creek (Figure 2-27,Figure 2-28, and Figure 2-29). This park provides access to upper Spring Creek via hand launch canoe and kayaks, as well as additional amenities. Fishing is a popular activity along the seawall, dock, and boardwalk structures constructed at Spring Creek Park.

No boat ramps are located along Spring Creek, and as a result access to the creek by larger motorboats must be from the Chipola River, where several public boat launches are present. However, much of Spring Creek is shallow, which may preclude the use of many larger motorboats, particularly during low flow periods on Spring Creek and the Chipola River. A limestone sill is present at the mouth of Spring Creek which also likely provides a barrier to boats with outboard motors trying to access Spring Creek, particularly during low flow periods.

Figure 2-27. Spring Creek Park and the water control structure at U.S. Hwy 90.

Figure 2-28: Dock, boardwalk structure present at Spring Creek Park.

Figure 2-29: Kayakers on Spring Creek. Photo taken on June 4, 2025.

3 Water Quality

The Chipola River Watershed is a subbasin of the Apalachicola River and Bay Watershed, and includes Jackson Blue Spring, Merritts Mill Pond, Spring Creek, and the Chipola River. The Chipola River and Apalachicola River and Bay Watersheds face several water quality challenges due to nonpoint source pollution, primarily from agriculture and silviculture practices, as well as runoff from unpaved roads and developed communities. Additionally, pollution associated with impacts from septic tanks is a concern throughout much of the watershed (NWFWMD 2017b). The Chipola River is designated as an impaired Outstanding Florida Water (Section 62-302.700, F.A.C.). Currently, several sections of the Chipola River, including the segment where Spring Creek empties into the river, are listed as impaired for total nitrogen and algal mats (DEP 2023). In addition, Jackson Blue Spring was identified as an impaired Outstanding Florida Spring for nutrients (Chapter 373, Part VIII, Florida Statutes [F.S.], FL). In accordance with Section 403.067, F.S. (Establishment and Implementation of Total Maximum Daily Loads) and Chapter 62-303, F.A.C. (Florida's Identification of Impaired Surface Waters Rule), a total maximum daily load (TMDL) corresponding to a nitrate concentration for Jackson Blue Spring and Merritts Mill Pond of 0.35 mg/L was established in 2013 (DEP 2013). Subsequently, a Basin Management Action Plan (BMAP) was developed by FDEP to reduce nitrate loading within the groundwater contributing areas to Jackson Blue Spring and Merritts Mill Pond to achieve the target 0.35 mg/L nitrate concentration over a 20-year horizon (DEP 2025). As described in Section 3.1, several projects have been implemented to help achieve the nutrient reduction goal.

3.1 Jackson Blue Spring Basin Management Action Plan and Springs Protection Projects

Adopted TMDLs are implemented through the establishment of a Basin Management Action Plan (BMAP) by FDEP which identifies cost-effective strategies and projects aimed at reducing and preventing pollutant discharges into impaired water bodies. The goal of a BMAP is to achieve the TMDL within 20 years of BMAP adoption with 5-, 10-, and 15-year target interim nitrate reduction goals. Note that the programs that establish the BMAP and TMDLs are managed by the FDEP, not the NWFWMD.

The FDEP adopted an updated BMAP in 2025 for Jackson Blue Spring and Merritts Mill Pond with the goal of reducing nitrate levels to 0.35 mg/L over a 20-year horizon. Based on nitrogen loading at the spring vent, an estimated reduction of 664,086 lb-N/yr over the 20-year planning horizon was required to achieve the target nitrate level for Jackson Blue Spring (DEP 2025). This equates to a 90% target nitrate reduction goal from current nitrogen loading to Jackson Blue Spring. FDEP developed a Nitrogen Source Inventory Loading Tool (NSILT) to estimate the major sources of nitrogen in the Jackson Blue Spring groundwater contributing area (DEP 2025). The NSILT is a geographic information system (GIS) and spreadsheet-based tool that provides spatial estimates of contributions from major nitrogen sources. This information was used to determine major sources of nitrogen loading within the groundwater contribution area which were then used to identify and prioritize projects to meet the nitrate reduction goals within the planning horizon. Based on the NSILT analysis, irrigated and non-irrigated farm fertilizer were estimated to account for 83.3% of nitrogen loading within the groundwater contribution area. Other sources of nitrogen loading within the groundwater contribution area include livestock waste (6.2%), atmospheric deposition (4.9%), and septic systems and urban turfgrass fertilizer (5.1%).

Several projects have been implemented to help reduce nitrogen loading within the groundwater contribution area, primarily focused on best management practices (BMPs) to reduce nitrogen loading from agricultural fertilizer based on crop type and individual farm practices. Other strategies include improved practices specific to livestock waste, sod-based crop rotation, land acquisition, and expanded central sewer service and conversion of residential septic systems to central sewer. For more details, please refer to the Jackson Blue Spring and Merritts Mill Pond BMAP (DEP 2025).

3.2 Trend Analysis

Water quality data has been collected for Jackson Blue Spring as a collaborative effort by the District, FDEP, and USGS over the past several decades. Quarterly, lab-processed, grab samples for nitrates have been collected for Jackson Blue Spring since 1989, with periodic samples taken prior to 1989 and the earliest measurement in 1960. However, a data gap exists between October 1994 through September 2001, with only one sample collected in that period. Quarterly, lab-processed, grab samples for specific conductance and dissolved oxygen have been collected for Jackson Blue Spring since 2011, with periodic samples taken prior to 2011 and the earliest measurements of specific conductance and dissolved oxygen made in 1960 and 1972, respectively. Turbidity data was collected at Jackson Blue Spring between 2002 and 2024, with a gap in data collection between 2010 – 2012. During this time, a total of 264 samples were collected with a mean turbidity of 0.33 NTU for the period of record. Water quality measurements recorded on the same day were averaged to determine the Jackson Blue Spring daily average value. Table 3-1 summarizes water quality measurements taken at Jackson Blue Spring. Time series plots of nitrate concentration, specific conductance, dissolved oxygen, and turbidity for Jackson Blue Spring are presented in Figure 3-1. Average nitrite + nitrate concentration for Jackson Blue Spring (3.43 mg/L) is currently above the numeric nutrient standard of 0.35 mg/L for Florida Springs (Rule 62- 302.531 F.A.C.).

Table 3-1. Jackson Blue Spring water quality summary statistics

Parameter	Period of Record	Number of Measurement Dates	Minimum	Maximum	Average	Median
Nitrate + Nitrite (Total as N, mg/L)*	1960 - 2024	174	0.34	4.42	3.43	3.51
Specific Conductance (µS/cm)*	1960 - 2024	176	197	294	274	276
Dissolved Oxygen (mg/L) *	1972 - 2024	170	6.49	10.30	7.35	7.29
Turbidity (NTU)*	2002 - 2024	264	0.06	4.73	0.33	0.20

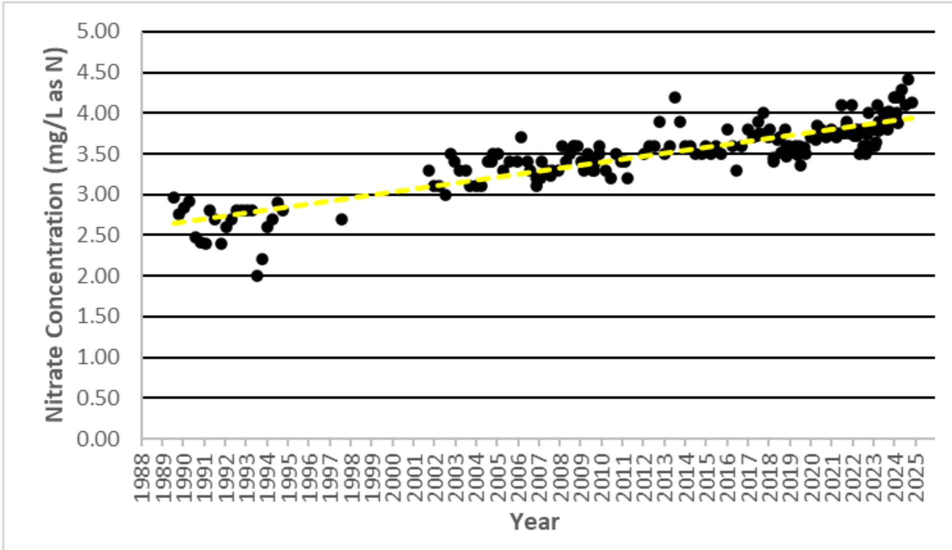
**Data collected by the NWFWMD, Florida DEP, and USGS. Data is available from NWFWMD databases, FDEP WIN, and for USGS station 02358795.*

Temporal trends in Jackson Blue Spring nitrate concentration (nitrate + nitrite total mg/L as N), specific conductance (µS/cm), dissolved oxygen (mg/L), and turbidity (NTU) were evaluated to assess long-term increases or decreases with time (Figure 3-1 and Table 3-2). Trends were assessed using a two-sided Mann-Kendall test with a significance level (α) of 0.05, based on methods presented in Helsel and others (2020). Flow adjustments were considered but were not needed as these parameters did not display a relationship with Jackson Blue Spring flow (Figure 3-2). Trends were evaluated for the period from 1989 to 2024 for nitrate concentration, and from 2013 to 2024 for specific conductance and dissolved oxygen due to sporadic measurements prior to these dates. Trend tests were based on annual median values to reduce the effect of serial correlation.

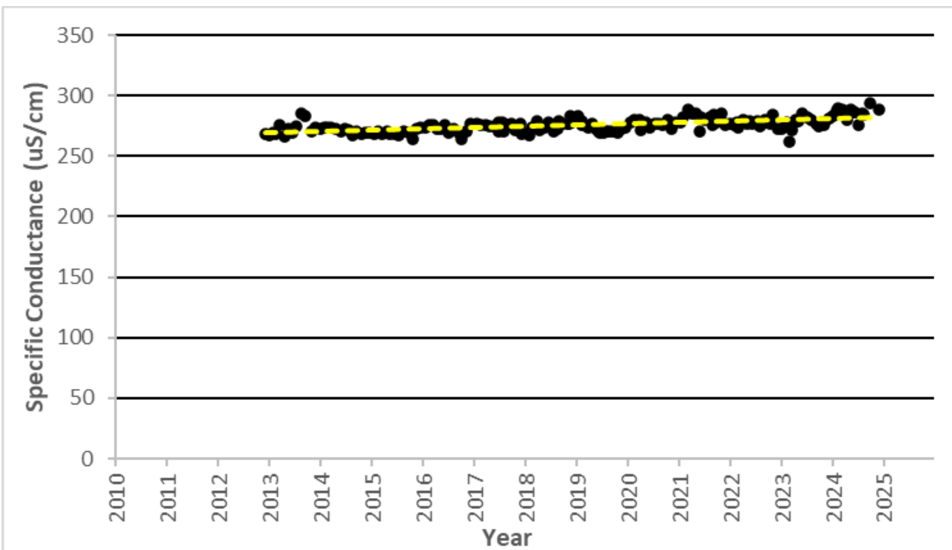
The results of these trend tests are summarized in Table 3-2. Jackson Blue Spring nitrate concentration exhibited an increasing trend from 1989 to 2024. As discussed previously, a BMAP for Jackson Blue Spring and Merritts Mill Pond has been established to address this issue. Specific conductance exhibited an increasing trend while dissolved oxygen exhibited a declining trend from 2013 to 2024. Although specific conductance displayed an increasing trend, values are still well below thresholds which would cause concern to freshwater ecology for Jackson Blue Spring or Merritts Mill Pond. Although dissolved oxygen displayed a declining trend, Jackson Blue Spring has among the highest dissolved oxygen concentrations of spring systems throughout Florida and is not of concern (DEP 2010). Although turbidity displayed an increasing trend, turbidity levels are much less than water quality standards for Class III waters (29.0 NTU), indicating Merritts Mill Pond is relatively clear (FDEP, 2025). Furthermore, all parameters displayed no statistically significant correlation with Jackson Blue Spring discharge, indicating potential reductions in flow caused from groundwater withdrawals would likely not significantly affect water quality for Jackson Blue Spring and Merritts Mill Pond. Additionally, since nitrate concentrations are currently well above the TMDL of 0.35 mg/L, the extensive BMAP efforts to reduce nitrogen source loading would be anticipated to have a significantly greater impact on nitrate concentrations at Jackson Blue Spring than flow reductions associated with the proposed MFL. Furthermore, Jackson Blue Spring discharge displayed no statistically significant trend from 2005 to 2024 (discussed further in Section 4.5).

Table 3-2. Trends in Jackson Blue Spring Water Quality.

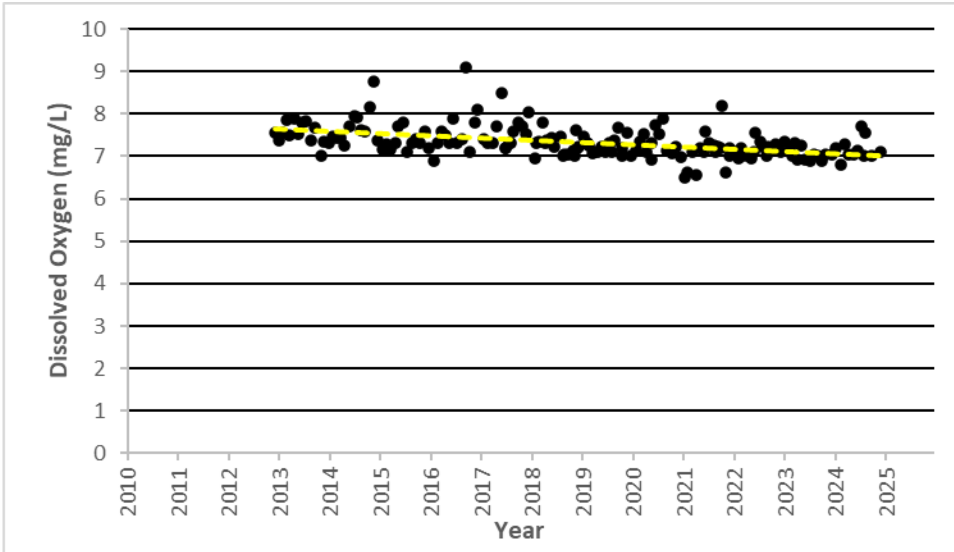
Parameter	Date Range	N	Mann Kendall Test Statistic (S)	p value	Sen Slope	Trend
Nitrate + Nitrite (Total as N, mg/L)	1989—2024	34	348	0.0000	0.04	increasing
Specific Conductance (µS/cm)	2013—2024	12	46	0.0017	1.016	increasing
Dissolved Oxygen (mg/L)	2013—2024	12	-54	0.0003	-0.048	decreasing
Turbidity (NTU)	2002 - 2024	21	112	0.0007	0.006	increasing
Jackson Blue Spring Flow (cfs)	2005—2024	20	-6	0.8711	-0.1840	no trend


Nitrate Concentration (mg/L as N)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Year

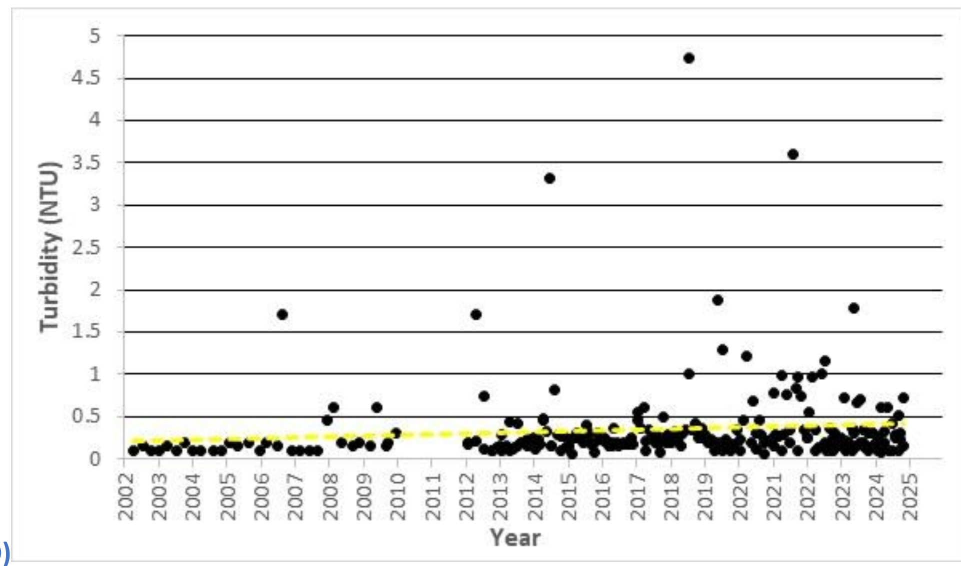
(A)


Specific Conductance (uS/cm)
350
300
250
200
150
100
50
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Year

(B)

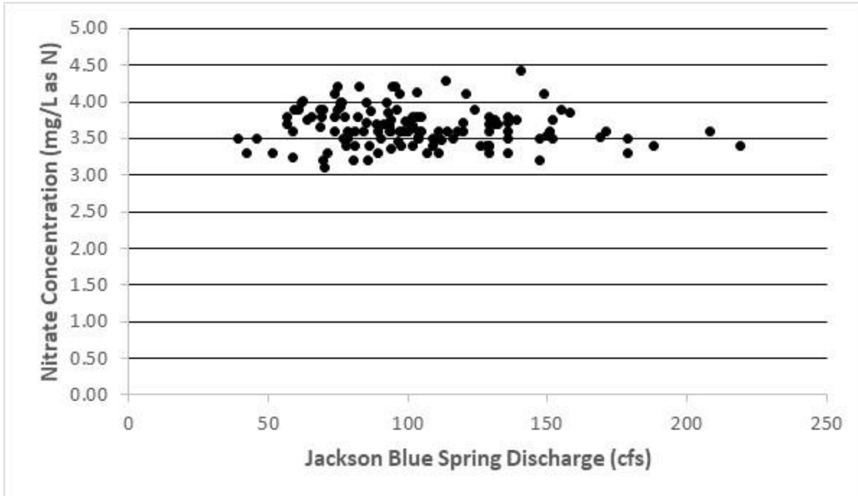


(C)



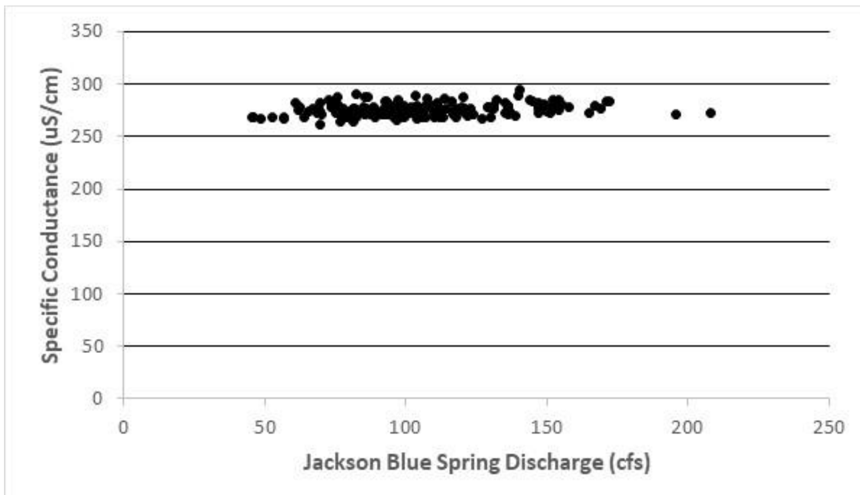
(D)

Figure 3-1. (A) Nitrate concentration at Jackson Blue Spring between 1989 and 2024, (B) specific conductance at Jackson Blue Spring between 2013 and 2024, (C) dissolved oxygen at Jackson Blue Spring between 2013 and 2024, and (D) turbidity at Jackson Blue Spring between 2002 and 2024



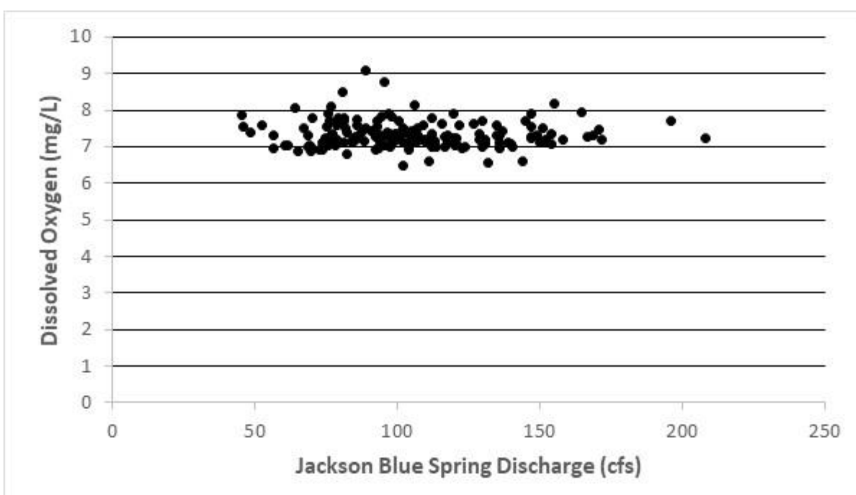
Nitrate Concentration (mg/L as N)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
50
100
150
200
250
Jackson Blue Spring Discharge (cfs)

(A)



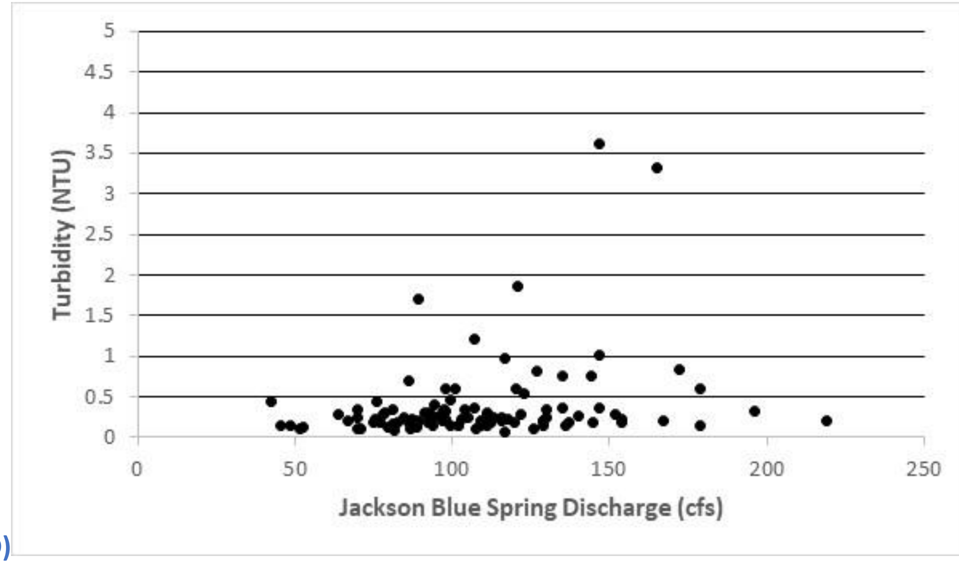
Specific Conductance (uS/cm)
350
300
250
200
150
100
50
0
0
50
100
150
200
250
Jackson Blue Spring Discharge (cfs)

(B)



Dissolved Oxygen (mg/L)
10
9
8
7
6
5
4
3
2
1
0
0
50
100
150
200
250
Jackson Blue Spring Discharge (cfs)

(C)



(D)

Figure 3-2. (A) Nitrate concentration versus Jackson Blue Spring Discharge (B) specific conductance versus Jackson Blue Spring Discharge, (C) Dissolved oxygen versus Jackson Blue Spring discharge, and (D) turbidity versus Jackson Blue Spring discharge.

3.3 Evaluation of Residence Time on Water Clarity

In addition to reviewing available turbidity data, water clarity was also assessed by reviewing the change in reservoir residence time in Merritts Mill Pond from the baseline median discharge to the recommended minimum flow for Jackson Blue Spring. Due to the relatively high nitrate levels, a longer residence time within Merritts Mill Pond may promote increased buildup of phytoplankton biomass resulting in lower water clarity.

The average reservoir residence time or turnover time in Merritts Mil Pond was evaluated to estimate the average amount of time water discharged from Jackson Blue Spring takes to flow through and discharge from Merritts Mill Pond. The method used to estimate residence time assumes steady-state conditions (i.e. inflow equals outflow) and therefore represents a typical residence time. The residence time is estimated as the total volume of Merritts Mill Pond divided by volumetric flow rate (discharge). The residence time was estimated using both the Jackson Blue Spring median baseline discharge and the proposed Jackson Blue minimum flow. The volume of Merritts Mill Pond was determined using bathymetry data collected by the Florida Fish and Wildlife Conservation Commission (FWC, 2015).

Based on the bathymetric data, Merritts Mill Pond has a maximum depth of 9.7 feet and an average depth of 4.4 feet. The total volume of the pond is approximately 1,075.2 acre-ft or 46,835,168.8 ft^3. The median baseline Jackson Blue Spring discharge is 103.3 ft^3/s, and the proposed minimum flow is 92.2 ft^3/s. The calculated average residence time using the median baseline Jackson Blue Spring median discharge and the proposed minimum flow is approximately 5.25 days and 5.88 days, respectively. The proposed minimum flow for Jackson Blue Spring is described in Section7 and Section 8, below.

Since Merritts Mill Pond outflow includes a significant amount of flow from other minor springs and diffuse discharge, the outflow from the pond is greater than the inflow. Since the outflow at the end of

Merritts Mill Pond is greater than the inflow, using Jackson Blue Spring discharge will result in a more conservative estimate of residence time within the pond. With such a small change in residence time from baseline discharge to the recommended minimum flow, it is not expected that water clarity will be negatively impacted by the proposed MFL.

4 Hydrology

This section presents a detailed evaluation of hydrological characteristics of the Jackson Blue Spring MFL study area as well as a summary of District's hydrologic data collection pertaining to the MFL study area.

4.1 Precipitation

Long term precipitation patterns for National Weather Service (NWS) station USC00081544 located in Chipley, FL was investigated to assess precipitation patterns for the Jackson Blue study area. This station was utilized since it represented the closest precipitation station to the study area with a long-term, nearly continuous record from 1939-2024. The NWS station located at the Marianna, FL municipal airport was considered although it was not utilized for this assessment due to significant data gaps in the record. Annual precipitation averaged 57.0 inches at National Weather Service (NWS) station USC00081544 located in Chipley, FL between 1939 and 2024. During this period annual precipitation ranged between 29 inches (1954) and 82 inches (2013) (Figure 4-1). Precipitation displays bimodal seasonality, with highest mean monthly precipitation occurring during the summer months of July and August (6.9 inches and 6.0 inches respectively), along with a smaller peak during March (5.7 inches) (Figure 4-2). Minimum monthly mean precipitation occurred during the months of May (4.1 inches) and October (2.9 inches).

The El Niño-La Niña Southern Oscillation (ENSO) cycle of warmer (El Niño conditions) and cooler (La Niña conditions) water in the tropical Pacific Ocean (NOAA Ocean Service, 2025a) affects rainfall patterns in northern Florida, through its effect on the Pacific Jet Stream. Wetter periods in northern Florida typically occur during El Niño periods, particularly during the winter months, and drier periods typically occur during La Niña periods (National Weather Service, 2025; NOAA, 2025b; FSU Center for Ocean-Atmospheric Prediction Studies, 2025). ENSO effects on rainfall can be quite dramatic. Examples include periods of extreme flooding during the El Niño period during the winter of 1998, followed by an extended period of extreme drought during the ensuing La Niña period (National Weather Service Climate Prediction Center, 2025; U.S. Geological Survey, 2025).

To determine periods of above and below average rainfall, the 12-month standard precipitation index (SPI) was computed for the NWS station USC00081544 Chipley, FL (Figure 4-3) using the SPI generator available from the National Drought Mitigation Center SPI Program | National Drought Mitigation Center. 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 4-3 illustrates a period of less precipitation from 1940 to the early 1960's, followed relatively stable conditions, with a mix of wet and dry years from the early 1960's through 2004. A period of lower precipitation occurred from 2005 to 2013. Note that precipitation data are missing at the Chipley weather station for portions of 2000 and 2001, and other data in the region indicate that this was a very dry year. Several years of above average rainfall occurred from 2013-2021 including record rainfall of 82 inches in 2013, resulting in a period of rainfall surplus based on the 10-year moving average rainfall. Recently, rainfall totals in 2022 (43 inches total precipitation) and 2023 (41 inches total precipitation) were below average, while the 2024 total was slightly above average (63 inches total precipitation).

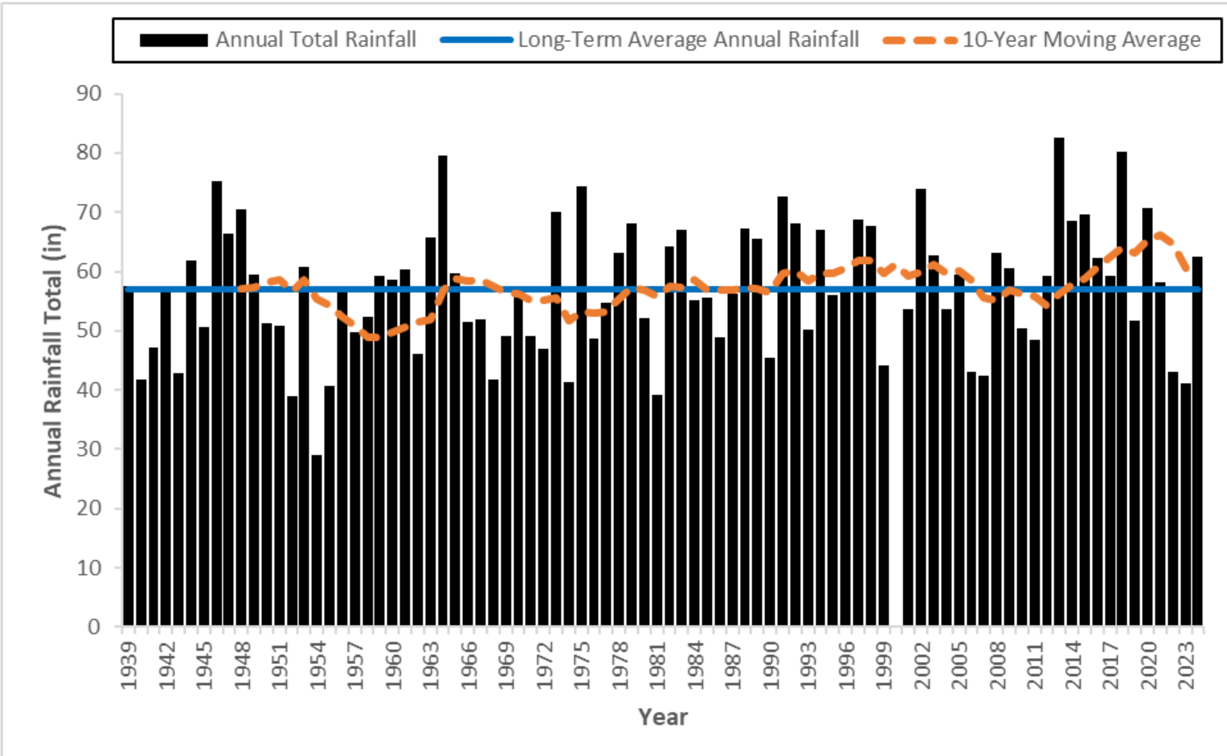


Figure 4-1. Annual precipitation totals and long-term annual average precipitation for NWS Station USC00081544, located in Chipley, FL.

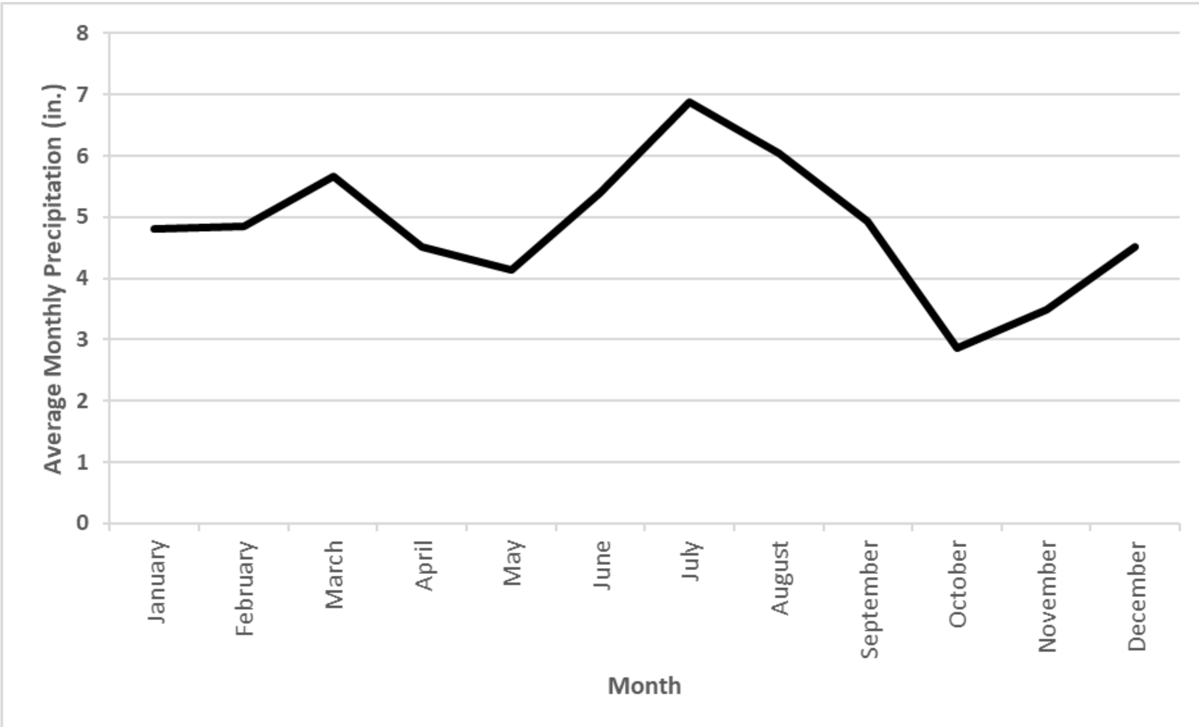


Figure 4-2. Monthly precipitation averages for NWS Station USC00081544, located in Chipley, FL.

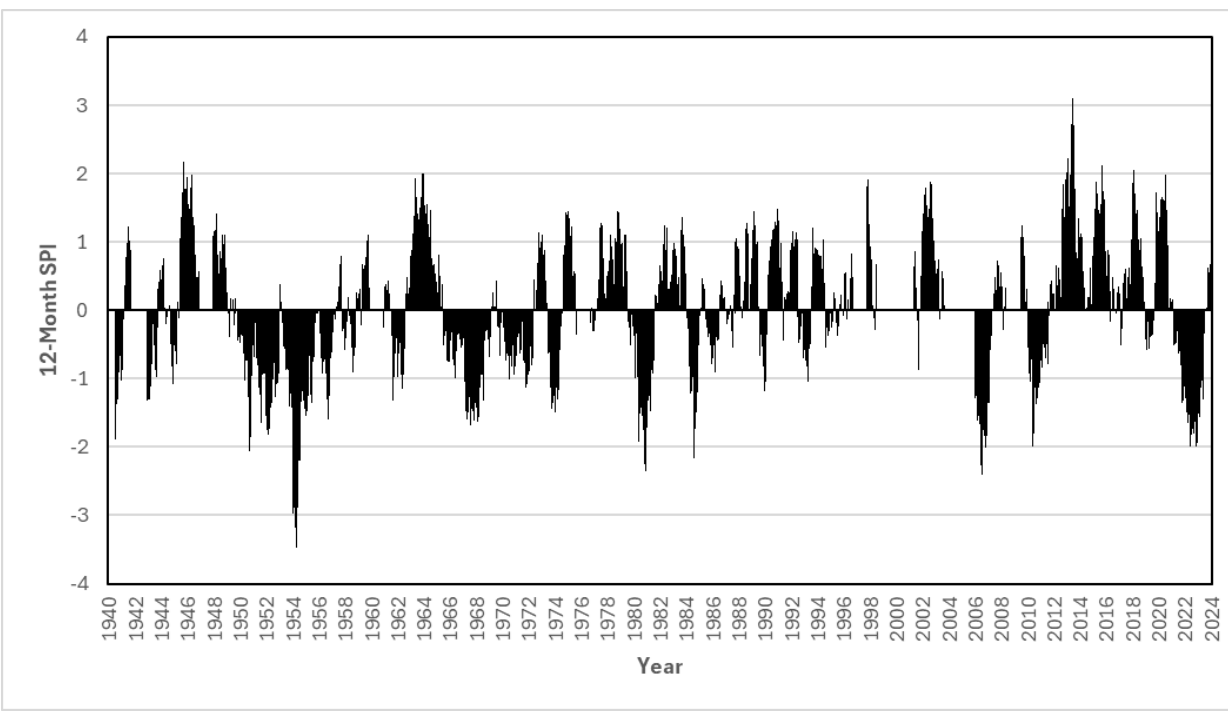


Figure 4-3. Twelve month standard precipitation index for NWS Station USC00081544, located in Chipley, FL.

4.2 Hurricane Michael

On October 10, 2018, Hurricane Michael made landfall in the Florida panhandle between Mexico Beach and Panama City in Bay County, Florida. Upon landfall Hurricane Michael was a category 5 storm with sustained winds in excess of 160 mph (NOAA 2019). The hurricane cut an intensely destructive path across several counties of the Florida Panhandle (Figure 4-4). 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 the Chipola River and its tributaries, such as Spring Creek, being among the hardest hit. Debris within stream channels restricts water flow and reduces stream capacity to convey water, which backs up water into the floodplain and surrounding areas. Debris within floodplains compounds this impact by further slowing drainage, causing flooding to persist. Both flood levels and frequency are increased. Hydrographs displaying stage data from the Chipola River demonstrate the degree to which hydrologic conditions were impaired from the storm (Figure 4-5).

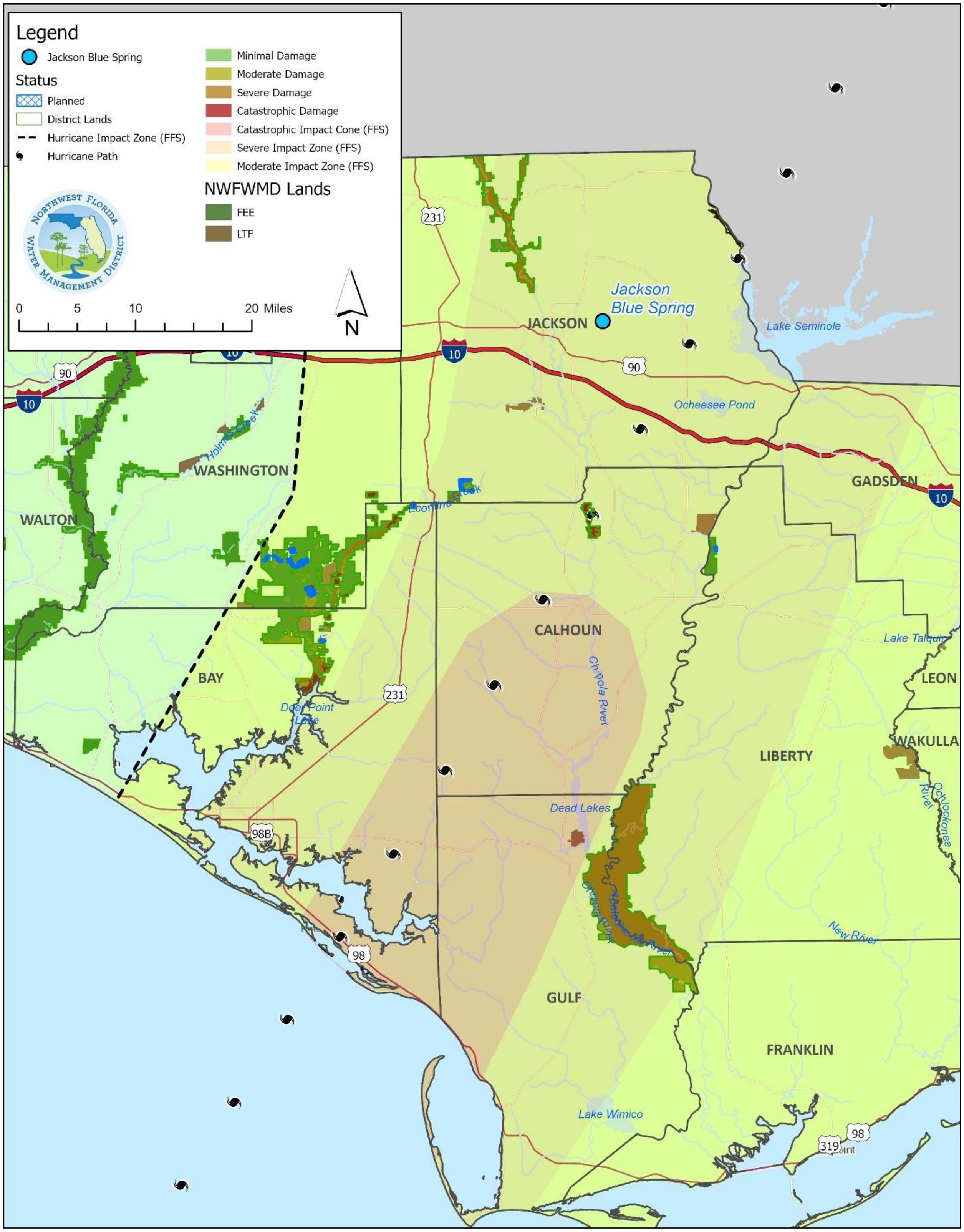


Figure 4-4. Path of Hurricane Michael on October 10, 2018.

Figure 4-5. Chipola River Stage at USGS 02358789 Chipola River at Marianna from July 15, 2018 to April 1, 2019.

With funding support from FDEP, 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. The top priorities identified for stream channel debris cleanup included two proposed phases of work for the Chipola River. From February 1 to March 29, 2019, FDEP tasked contractors to remove debris from the identified first phases of work for the Chipola River. Approximately 110,000 cubic yards of debris were removed from the Chipola River from this effort. For this effort within the Chipola River, the in-channel removal target was 60-100% (i.e. from bank to bank). Clearing efforts were not conducted in the floodplain. Approximately 12.96 miles of channel were cleared during this effort (Figure 4-6.). The second phase of this effort as depicted in Figure 4-6. has not been completed. Portions of the Chipola River remain obstructed to date. However, the Chipola River in the vicinity of Spring Creek, as well as Spring Creek and Merritts Mill Pond are currently navigable. The impact of downed debris resulting from Hurricane Michael as well as the impact of debris removal efforts on hydrology within the study area is discussed in more detail in Section 4.7.3.

Figure 4-6. Debris removal on the Chipola River (as of April 2019).

4.3 Hydrologic Data Collection

Spring discharge, surface water flow, and stage are measured at multiple locations through the Jackson Blue Spring MFL study area by the District as well as the USGS (Table 4-1, Figure 4-7). The District has had a program of recurring discharge measurements at Jackson Blue Spring (NWFID 005042 Jackson Blue Spring) since 2001, with sporadic discharge measurements taken prior to 2001. Additionally, the District has collected quarterly discharge measurements at Merritts Mill Pond just upstream from the control structure (NWFID 11107 Merritts Mill Pond @ US 90) since 2013 as well as quarterly discharge measurements just downstream from the control structure on Spring Creek (NWFID 12744 Spring Creek Park) since 2016. These measurements are typically performed concurrently to estimate potential losses through the structure and as a QA/QC measure. The District also collected quarterly discharge measurements from 2016 to 2020 on the Chipola River above and below the confluence with Spring Creek to estimate Spring Creek flow as well as to determine flow pickup along Spring Creek between the control structure and the confluence with the Chipola River (NWFID 12820 Chipola River above Spring Creek, NWFID 12821 Chipola River below Spring Creek).

The District currently maintains two stream gaging stations measuring continuous stage in the study area: NWFID 11107 Merritts Mill Pond @ US 90 measuring stage just before the control structure on Merritts Mill Pond and NWFID 12744 Spring Creek Park measuring stage just below the control structure on Spring Creek. A temporary station was installed from 2020 to 2023 along the Chipola river just above the confluence with Spring Creek (NWFID 12820 Chipola River above Spring Creek) to provide water surface levels for determining the downstream boundary condition of a HEC-RAS model of the study area. Additionally, the USGS maintains a gaging station at Jackson Blue Spring measuring continuous stage (USGS 02358795 Jackson Blue Spring Near Marianna, FL). The period of record for each station is shown in Table 4-1. Continuous stage data are available at NWFID 11107 Merritts Mill Pond @ US 90 from April 2015 to November 2022 and from January 2025 to present. Continuous stage data are available from September 2020 to June 2022 and from October 2024 to present at NWFID 12744 Spring Creek Park. Both stations were temporarily removed in late 2022 but have been recently re-installed. Continuous spring pool stage is available at USGS 02358795 Jackson Blue Spring Near Marianna, FL from April 2003 to July 2010, and from January 2017 to present.

Although not directly in the MFL study area, continuous stage and flow from USGS stream gaging station 2358789 Chipola River Near Marianna, FL were used to evaluate long-term hydrologic trends and patterns indicative of the region. Continuous stage and discharge are available from October 1999 to present at this gage.

The District developed continuous discharge records at the NWFID 11107 Merritts Mill Pond @ US 90 and NWFID 5042 Jackson Blue Spring gages using two different rating curve approaches. For Merritts Mill Pond at US Hwy 90, an index velocity rating curve approach was used, where discharge is estimated from a continuous series of cross-sectional area and mean velocity estimates (Ruhl and Simpson, 2005). The root-mean square error in this rating was approximately 25 cfs. Continuous discharge at NWFID 5042 Jackson Blue Spring was estimated with a groundwater level discharge rating approach, in which discharge is estimated from a continuous series of groundwater level measurements. Continuous discharge from

Jackson Blue Spring was estimated using statistical (line of organic correlation; Helsel and Hirsch, 2020) regression relationships between field visit discharge measurements at Jackson Blue Spring and continuous groundwater levels from multiple wells in the vicinity of the spring. This approach was used because of logistical issues at the Jackson Blue site regarding the index-velocity approach, and the 'variable backwater' conditions caused by the dam, making the stage-discharge approach less desirable. Most of the discharge record at Jackson Blue Spring is based on continuous groundwater level records from the long-term groundwater level recorder at the NWFWMD-PITTMAN VISA/S661 well (NWFID 05266), although groundwater level data from the recorder at the NWFWMD-BAXTER SAND PIT VISA (NWFWMD 005226) well were used for the period between September 2016 through June 2021 to more easily accommodate periods of missing data at the Pittman well. The root-mean square error in this rating ranged from approximately 18 to 24 cfs, depending on the well and set of field discharge measurements associated with a given rating period. Continuous discharge at NWFID 5042 Jackson Blue Spring is available from December 2004 to present, with a gap of about three months in 2010. Continuous discharge is available at NWFID 11107 Merritts Mill Pond @ US 90 from May 2017 to November 2022, although several data gaps are present in the flow record at this location.

Table 4-1. Summary of hydrologic data collection within the Jackson Blue Spring MFL study area.

Station Number	Site Name	Parameter: Period of Record
USGS 02358789	Chipola River @ Marianna, FL	Continuous Discharge: Oct. 1999 – present Continuous Stage: Oct 1999 – present
USGS 02358795	Jackson Blue Spring Near Marianna, FL (at same location as "Jackson Blue Spring" on Figure 4-7)	Stage: April 2003-July 2010, Jan. 2017- present
NWFWMD 005042	Jackson Blue Spring	Continuous Discharge: Dec 21, 2004 – Jan 28, 2010 and April 27, 2010 – present field visit discharge measurements: 12 measurements prior to 2001; measurements at various frequencies 2001 – present
NWFWMD 11107	Merritts Mill Pond @ US 90	Continuous Discharge: May. 2017 – July 2017, Aug. 2018 – Oct 2020, Dec 2020- Mar. 2021, June 2021 –Nov. 2022 field visit discharge measurements: quarterly measurements Aug 2013- Nov. 2022, Dec. 2024 – present Continuous Stage: April 2015 – Nov. 2022, Jan. 2025 – present
NWFWMD 12744	Spring Creek @ Spring Creek Park	field visit discharge measurements: quarterly measurements Nov 2016 – present Continuous Stage: Sept 2020 – Jun. 2022, Oct. 2024 – present
NWFWMD 12820	Chipola River above Spring Creek	field visit discharge measurements: 18 quarterly measurements April 2016 – Jan. 2020 Continuous Stage: Sept. 2020 – Mar. 2023
NWFWMD 12821	Chipola River below Spring Creek	field visit discharge measurements: 19 quarterly measurements April 2016 – Feb. 2020

NWFWMD 5266	Pittman VISA/S661 Upper Floridan aquifer monitoring well	Continuous groundwater level data available for the period from July 1990 – November 1993 and from December 2004 to present
NWFWMD 5226	Baxter Sand Pit VISA Upper Floridan aquifer monitoring well	Continuous groundwater level data available for the period from September 2016 to present

Figure 4-7. Jackson Blue Spring MFL study area surface water monitoring stations.

4.4 Jackson Blue Spring Discharge

For the purposes of this MFL evaluation, the continuous daily mean discharge estimates at JBS described in the previous section were used to evaluate trends and patterns in spring discharge. Summary statistics from the continuous discharge dataset are presented in Table 4-2. Summary statistics are presented for the period from 12/21/2004 to 12/31/2024, representing the period of available continuous discharge data (through 2024), 1/1/2013-12/31/2024, representing a period of above average cumulative rainfall throughout the central portion of the District, and 10/10/2018 through 12/31/2024, representing conditions post Hurricane Michael. Summary statistics are similar for all periods. Period of record average and median discharge were 104 cfs and 99 cfs, respectively. The period of record minimum and maximum discharge values for Jackson Blue Spring were 37 cfs (2/18/2012) and 250 cfs (8/11/2005) respectively.

Flow-frequency curves were developed for Jackson Blue Spring discharge to compare historical discharge before and after the passage of-Hurricane Michael. Figure 4-8 and Table 4-3 show that spring discharge in the periods before and after Hurricane Michael were generally quite similar, although discharge was less variable towards the more extreme (low- and high-flow) parts of the frequency curve for conditions after Hurricane Michael. This is consistent with the fact that the pre-Hurricane Michael period of record is more than twice as long as the post-Hurricane Michael period of record, and therefore more likely to contain extreme events.

Table 4-2. Jackson Blue Spring Discharge summary statistics.

Time Period	Description	Average (cfs)	Median (cfs)	Minimum (cfs)	Maximum (cfs)
12/21/2004- 12/31/2024	Period of available continuous discharge	104	99	37	250
1/1/2013- 12/31/2024	Period of above average cumulative rainfall	105	101	45	237
10/10/2018- 12/31/2024	Post Hurricane Michael	107	102	58	180

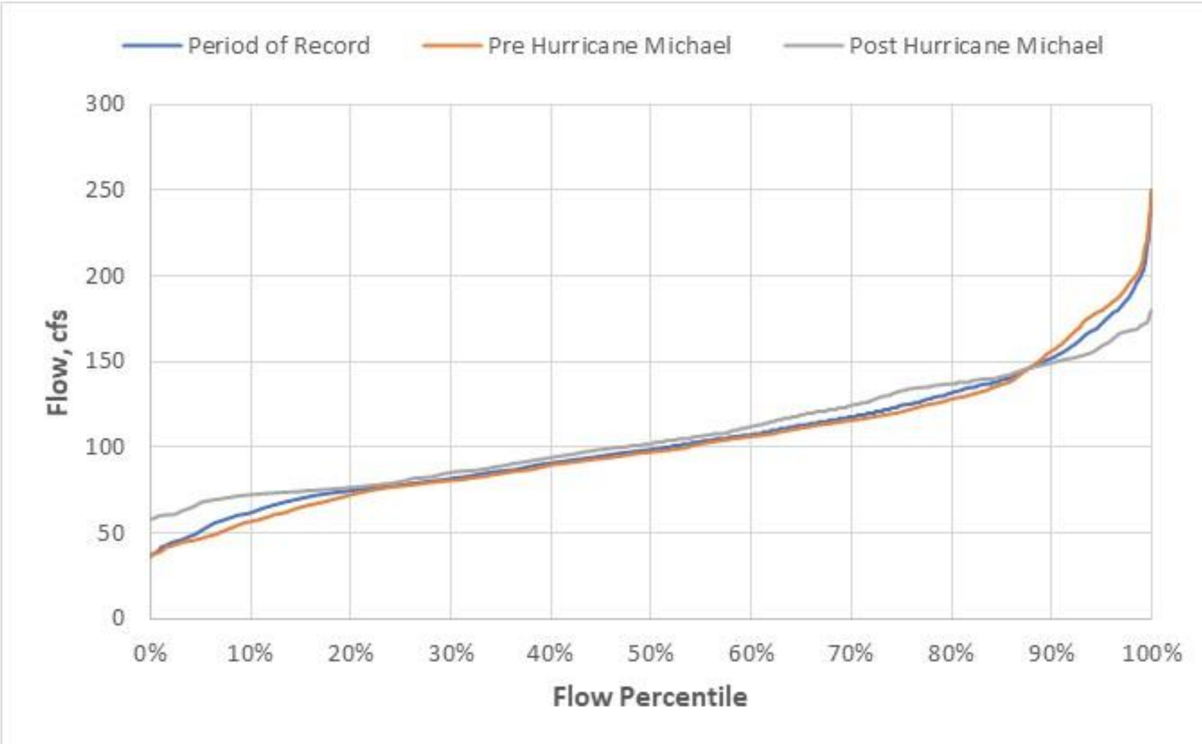


Figure 4-8. Jackson Blue Spring Discharge flow duration curves.

Table 4-3. Jackson Blue Spring discharge flow percentile comparison.

Flow Percentile	Period of Record (cfs)	Pre Hurricane Michael (cfs)	Post Hurricane Michael (cfs)
5%	51	47	68
10%	62	57	72
20%	75	72	77
30%	82	81	85
40%	91	90	94
50%	99	97	102
60%	107	106	112
70%	118	115	124
80%	132	128	137
90%	152	156	149
95%	172	179	159

4.5 Jackson Blue Spring Discharge Trends

Trends in Jackson Blue Spring discharge were assessed using a Mann-Kendall trend test. The Mann Kendall trend test was based on annual average discharge to mitigate against serial correlation adversely affecting significance testing. Results of the trend test showed no statistically significant trend for the period from 2005 to 2024, based on a significance level of $\alpha=0.05$ (S = -6, p-value = 0.8711). Although discharge has been relatively stable over time, with no long-term increasing or decreasing trend, short-term fluctuations can occur due to climatic variability (Figure 4-9 and Figure 4-10). A boxplot of discharge (Figure 4-11) shows a noticeable year-to-year as well as within-year variability in discharge from Jackson Blue Spring. This variability is primarily associated with variations in regional groundwater levels arising from short term climatic variability. Annual average discharge was lowest in calendar years 2007, 2011, 2012, and 2023, ranging between 64 and 70 cfs (Figure 4-12,Table 4-4). Annual average discharge was highest in 2005, 2009, 2014, and 2021, ranging between 134 and 163 cfs.

Seasonality in the discharge from Jackson Blue Spring is evident in the values of average monthly discharge for the period of record (Figure 4-13, Table 4-5). Average monthly flow for Jackson Blue Spring was highest in April and May (119, 120 cfs), when evapotranspiration rates are lower than in the summer months and following the winter and early spring periods, when groundwater levels can rise in response to rainfall from passing cold fronts and lower wintertime evapotranspiration losses. Rainfall totals are typically lower in the fall in northern Florida, which is consistent with November and December being the months with the lowest average flows (89, 90 cfs during these months).

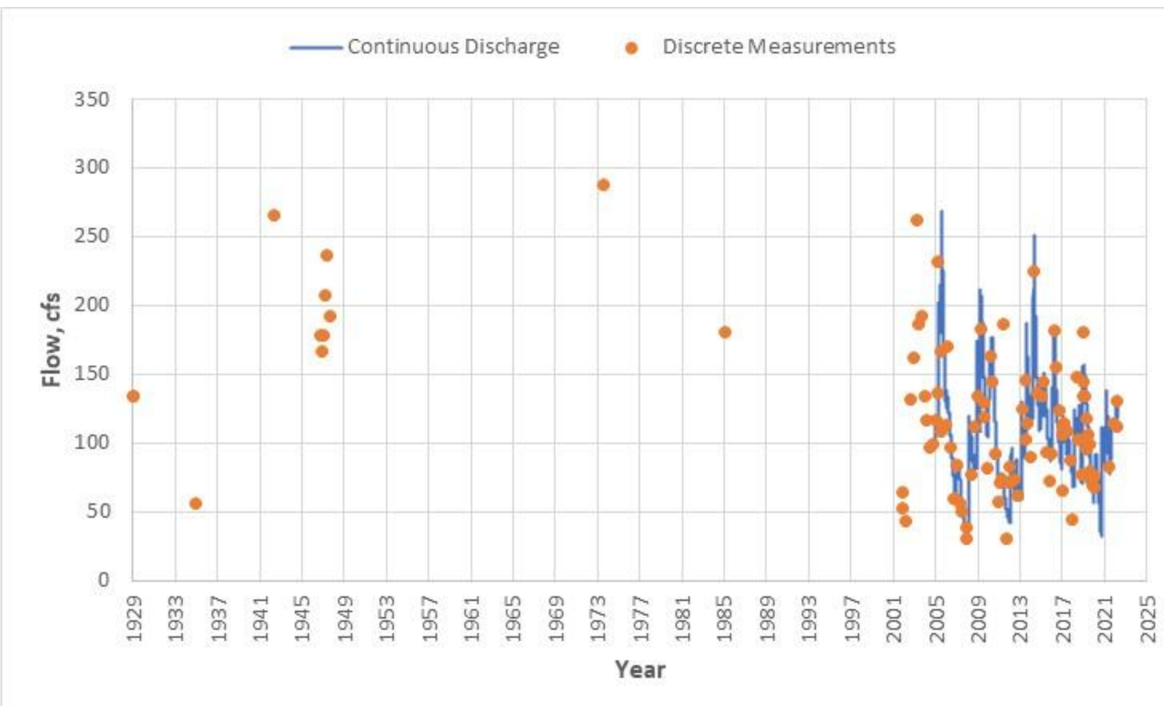


Figure 4-9. Continuous daily average and discrete discharge measurements at Jackson Blue Spring.

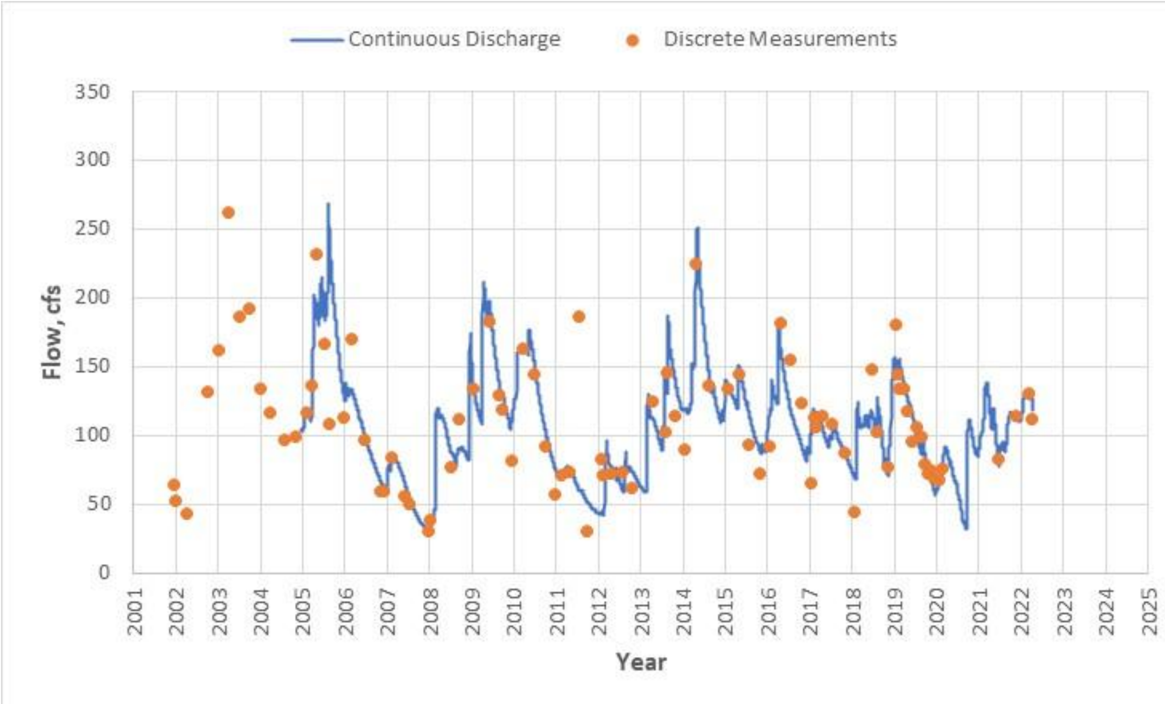


Figure 4-10. Continuous daily average and discrete discharge measurements at Jackson Blue Spring (2001 - 2024).

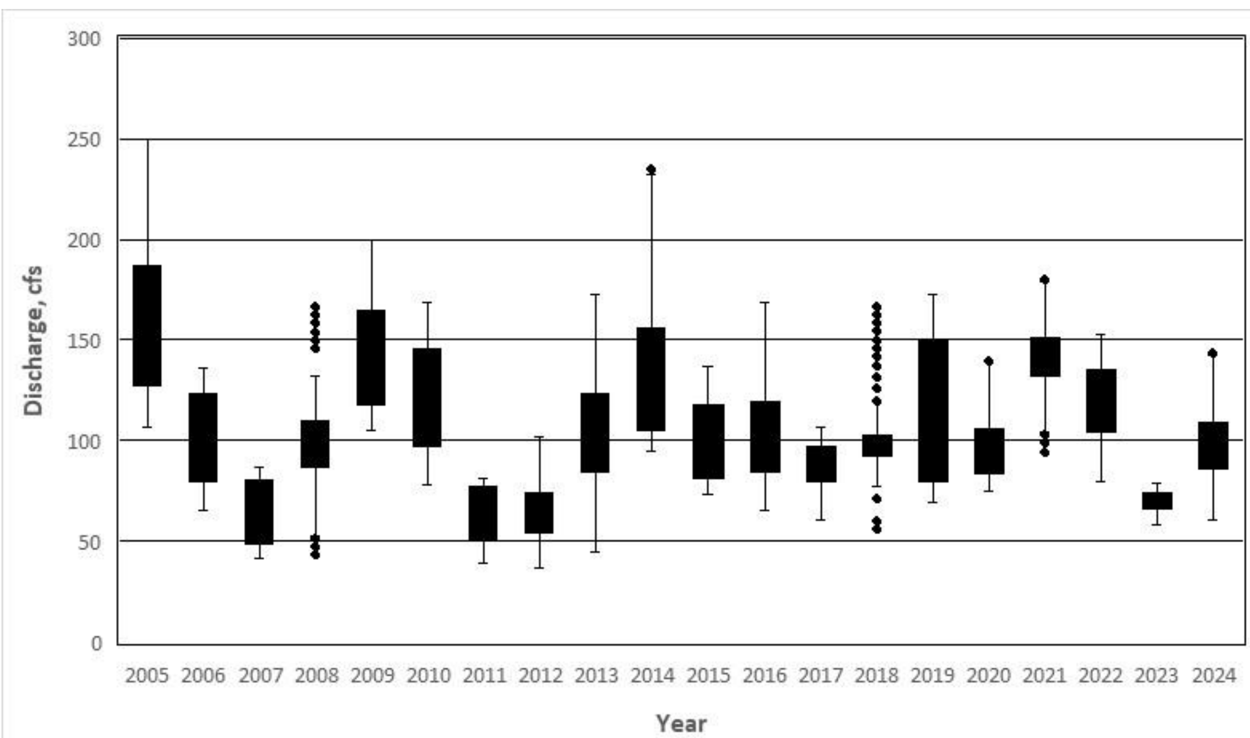


Figure 4-11. Boxplot of Jackson Blue Spring discharge.

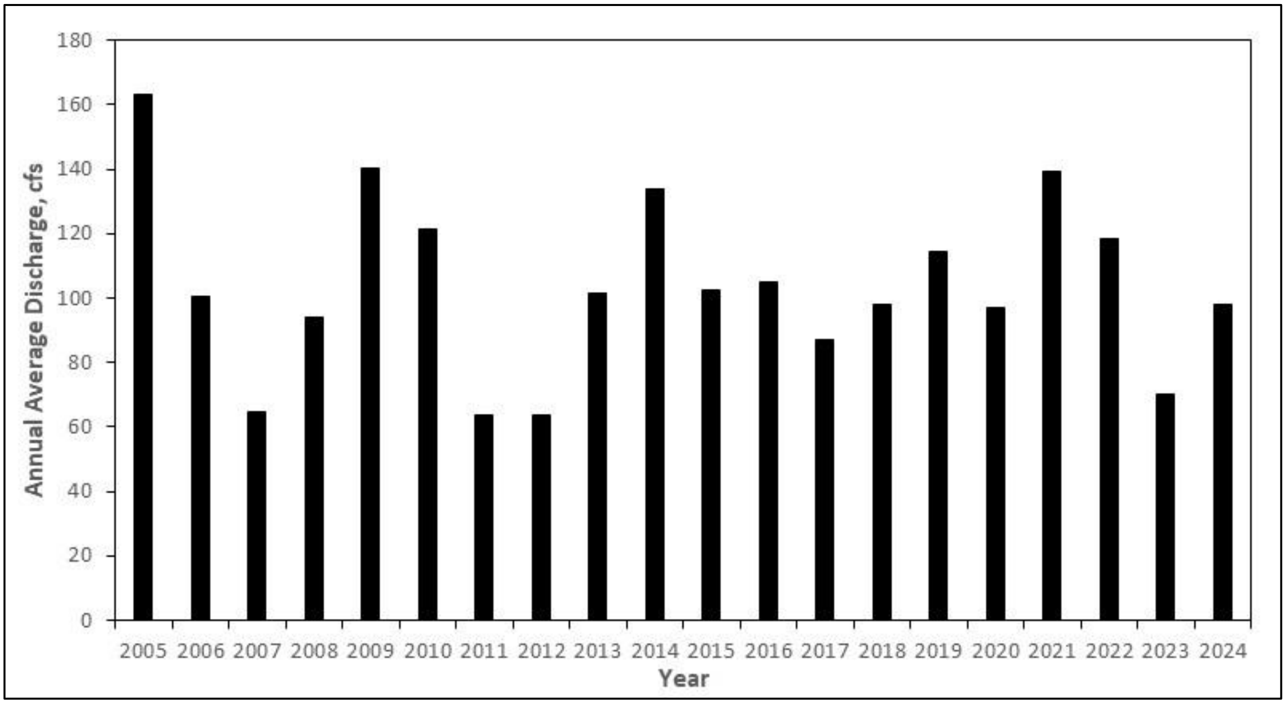


Figure 4-12. Jackson Blue Spring annual average discharge (2005-2024).

Table 4-4. Jackson Blue Spring annual average discharge (2005-2024).

Year	Annual Average Discharge (cfs)
2005	163
2006	100
2007	65
2008	94
2009	140
2010	122
2011	64
2012	64
2013	102
2014	134
2015	103
2016	105
2017	87
2018	98
2019	114
2020	97
2021	139
2022	119
2023	70
2024	98

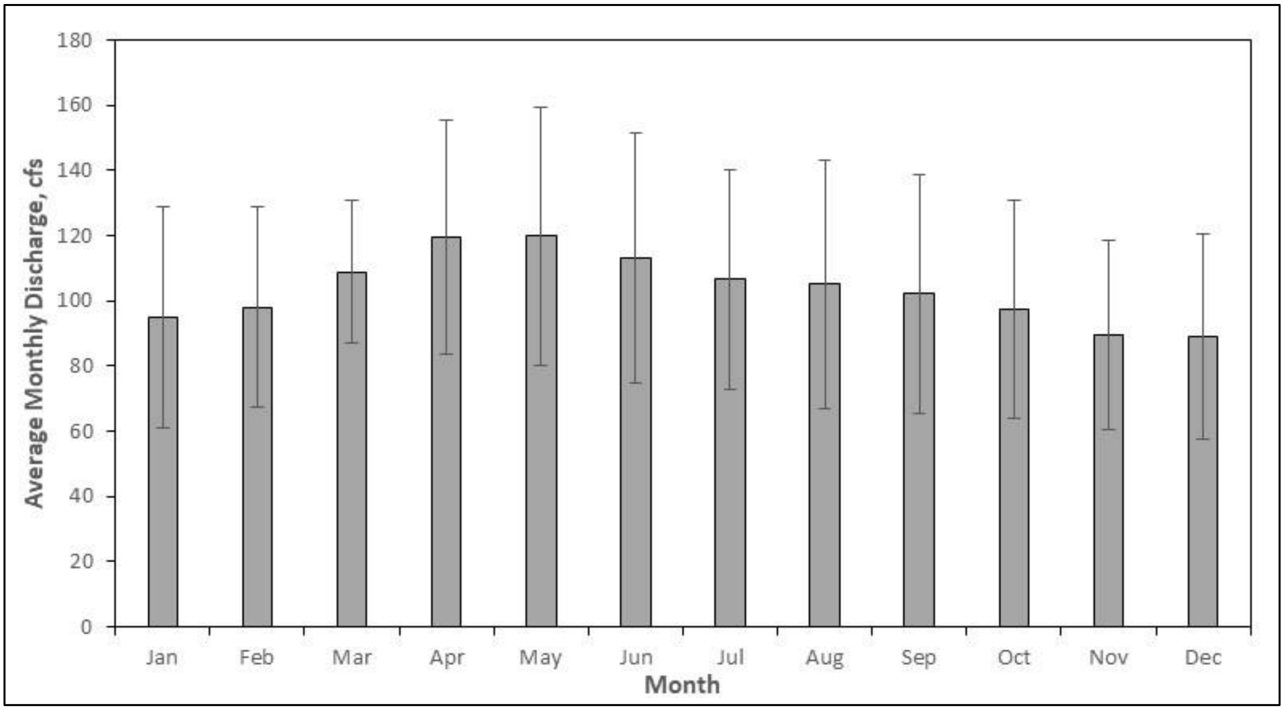


Figure 4-13. Average Monthly Jackson Blue Spring discharge.

Table 4-5. Average Monthly Jackson Blue Spring discharge (2005-2024).

Month	Monthly Average Discharge (cfs)	Standard Deviation
Jan	95	34
Feb	98	31
Mar	109	22
Apr	119	36
May	120	40
Jun	113	38
Jul	107	34
Aug	105	38
Sep	102	37
Oct	97	33
Nov	90	29
Dec	89	32

4.6 Relationship between Precipitation and Jackson Blue Spring Discharge

This section presents a comparison between Jackson Blue Spring discharge and monthly total rainfall from the National Weather Service station USC00081544 located in Chipley, Florida (NWS Chipley). The NWS Chipley station is the closest rainfall gage to the MFL study area with long-term, monthly rainfall data, with a period of record extending from April 1939 to the present. Figure 4-14 shows that spring discharge generally corresponds to fluctuations in rainfall, with higher spring discharge following periods of higher precipitation and lower spring discharge following periods of lower precipitation. Monthly average spring discharge was at a minimum in 2007 and 2011 corresponding to years with below average rainfall, while monthly average spring discharge was at a maximum in 2005 and 2014, corresponding to years with above average rainfall.

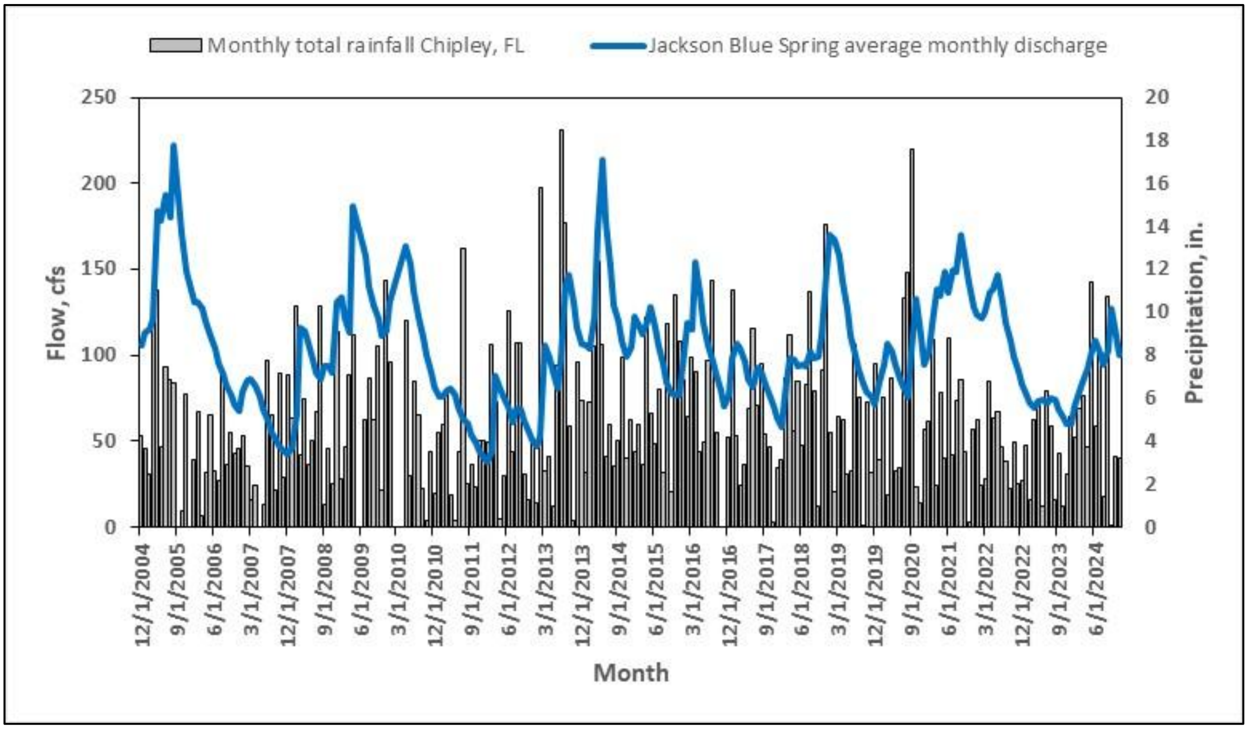


Figure 4-14. Comparison of monthly total rainfall at NWS Chipley, FL and Jackson Blue Spring average monthly discharge.

To further evaluate the correlation between Jackson Blue Spring discharge and climatic variability, cumulative spring discharge was compared to historical cumulative precipitation. The 12-month moving average spring discharge was compared to the preceding 24-month moving average monthly total rainfall from the National Weather Service station USC00081544 located in Chipley, Florida (Figure 4-15). A 12-month moving average was applied to spring discharge due to the variable nature of daily average Jackson Blue Spring discharge, providing for a better comparison to long term cumulative rainfall patterns. A 24-month moving average of monthly rainfall totals was used to account for the effect of antecedent rainfall conditions on spring discharge. A scatter plot and linear regression line between these two variables is shown in Figure 4-16. Correlation between the two variables is evident, additional variability is also evident and likely due to complexities not represented by a 24-month moving average at a point location, such as spatial variations in rainfall (and therefore recharge).

Further inspection of Figure 4-15 indicates that the relative magnitude of Jackson Blue Spring discharge has declined slightly relatively to cumulative rainfall at the Chipley weather station in recent years. Prior to 2013, spring discharge variability corresponded well to fluctuations in cumulative rainfall at the Chipley weather station. However, in 2013 (a year with record rainfall), spring discharge did not increase to the degree that might be expected based on the relationship prior to 2013. Spring discharge has fluctuated relatively consistently with cumulative precipitation since 2013. Relatively dry conditions from 2022-2024 have resulted in low Jackson Blue Spring discharge in recent years. A double mass curve between cumulative precipitation and spring discharge showed no significant departures between cumulative spring discharge and cumulative precipitation from 2005-2024 (Figure 4-17).

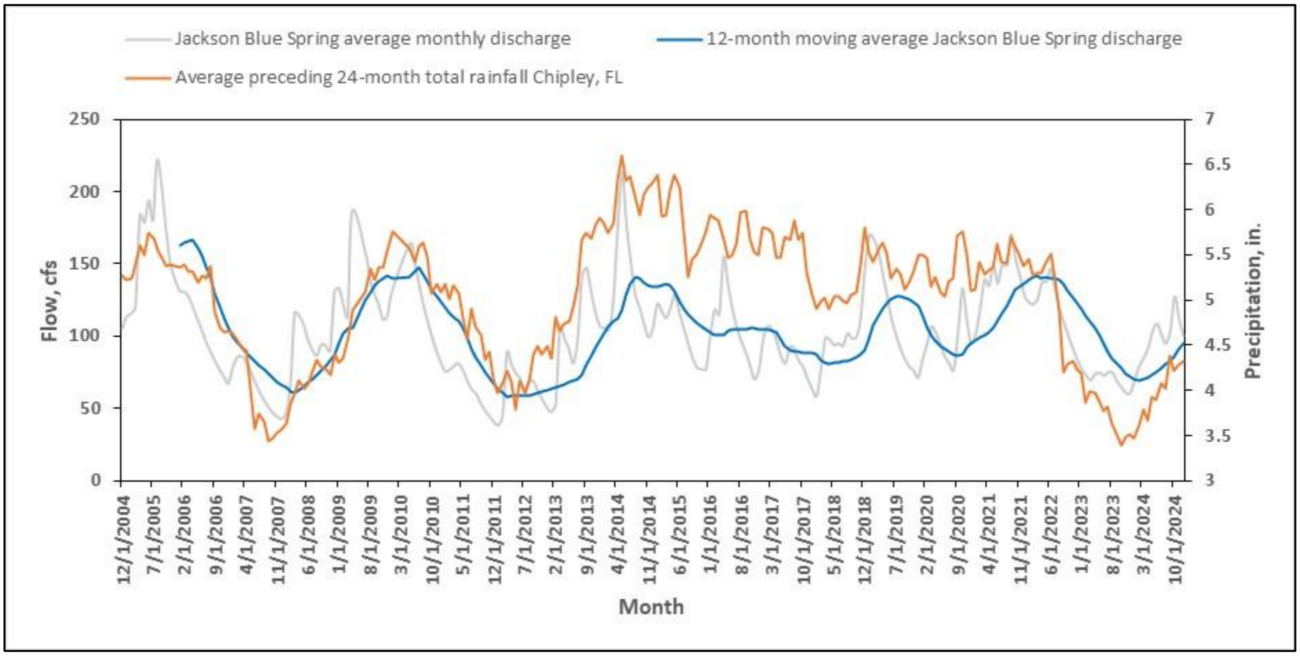


Figure 4-15. Comparison of average preceding 24-month total rainfall at NWS Chipley, FL and annual average Jackson Blue Spring discharge.

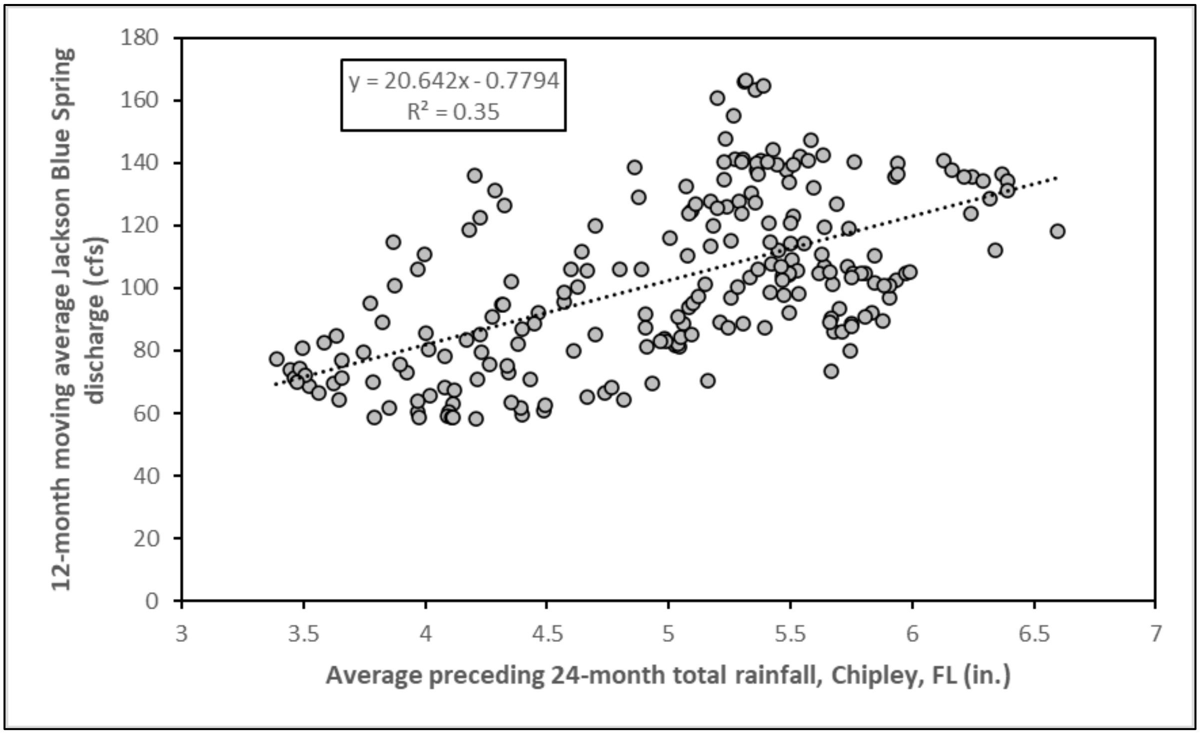


Figure 4-16. Linear regression between average preceding 24-month total rainfall at NWS Chipley, FL and 12-month moving average Jackson Blue Spring discharge.

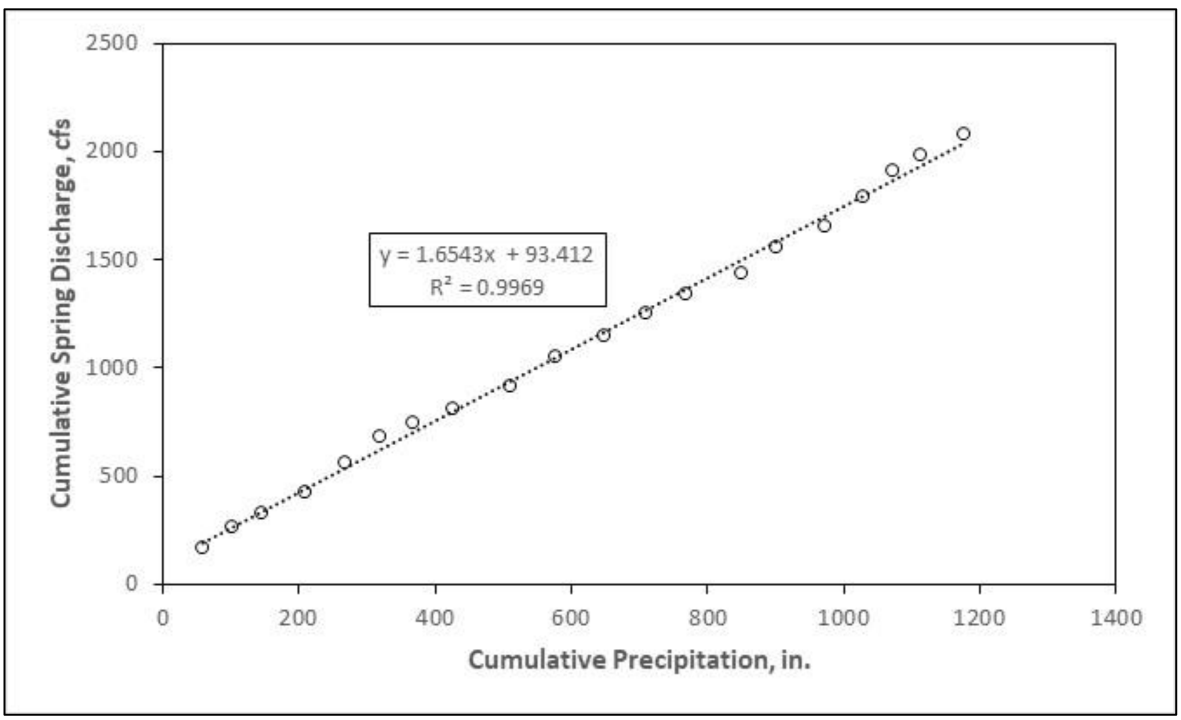


Figure 4-17. Double mass curve between cumulative precipitation at NWS Chipley, FL and cumulative Jackson Blue Spring discharge

4.7 Baseflow Characteristics and Stage-Discharge Relations for USGS Station 2358789 Chipola River Near Marianna, FL

This section provides background information describing baseflow characteristics and stage-discharge relations at USGS Station 2358789 Chipola River Near Marianna, FL. Hydrologic impacts associated with Hurricane Michael are also described. Since this station represents the closest long-term USGS gage to the Jackson Blue Spring MFL study area, long-term trends and patterns observed at this station are assumed to be indicative of the region, including Jackson Blue Spring, Merritts Mill Pond, and Spring Creek. The relation between trends in Jackson Blue Spring discharge and estimated baseflow for USGS Station 2358789 Chipola River Near Marianna, FL is also presented.

4.7.1 Trends in Baseflow, Seasonality, and Climatic Conditions

Daily average flow at the USGS Station 2358789 Chipola River Near Marianna, FL (USGS Chipola Near Marianna, FL) is shown in Figure 4-18. 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 771 cfs with annual average flows ranging between 216 cfs (2011) and 1,214 cfs (2013).

Baseflow was estimated at USGS Chipola Near Marianna, FL using a baseflow separation technique referred to as the "USF Method" and developed by Perry (1995), which is effectively a low-pass filter in which the variability of the resulting baseflow estimates depend on a user-specified 'time-window' over which moving-minimum values (in the first pass of the filter) and moving-average values (in the second pass of the filter) are computed. This method is similar to the USGS HYSEP (Sloto and Crouse, 1996) baseflow separation technique but allows for modified window lengths to better represent baseflow processes typical of Florida streams. A 61-day time window was chosen to estimate baseflow at USGS Chipola Near Marianna, FL gage, and moving-minimum or moving-average values for a given date are calculated with data on from that date, as well as 30 days prior to- and 30 days after that date. Baseflows are estimated by first calculating 61-day, moving minimum flows on a daily basis (moving forward one day at a time). After these minimum flows have been calculated for each day, a second 61-day moving window averages these minimum flows, resulting in a smoothed time series that is represents estimated baseflow. The selected 61-day window represents average baseflow processes for the Chipola River, typical for a spring fed system. An estimated baseflow time series for the USGS Chipola Near Marianna station computed using the USF method with a 61-day window is shown in Figure 4-19. Average estimated baseflow at USGS Chipola Near Marianna, FL is 348 cfs, which represents 45% of the long-term average stream flow of 771 cfs.

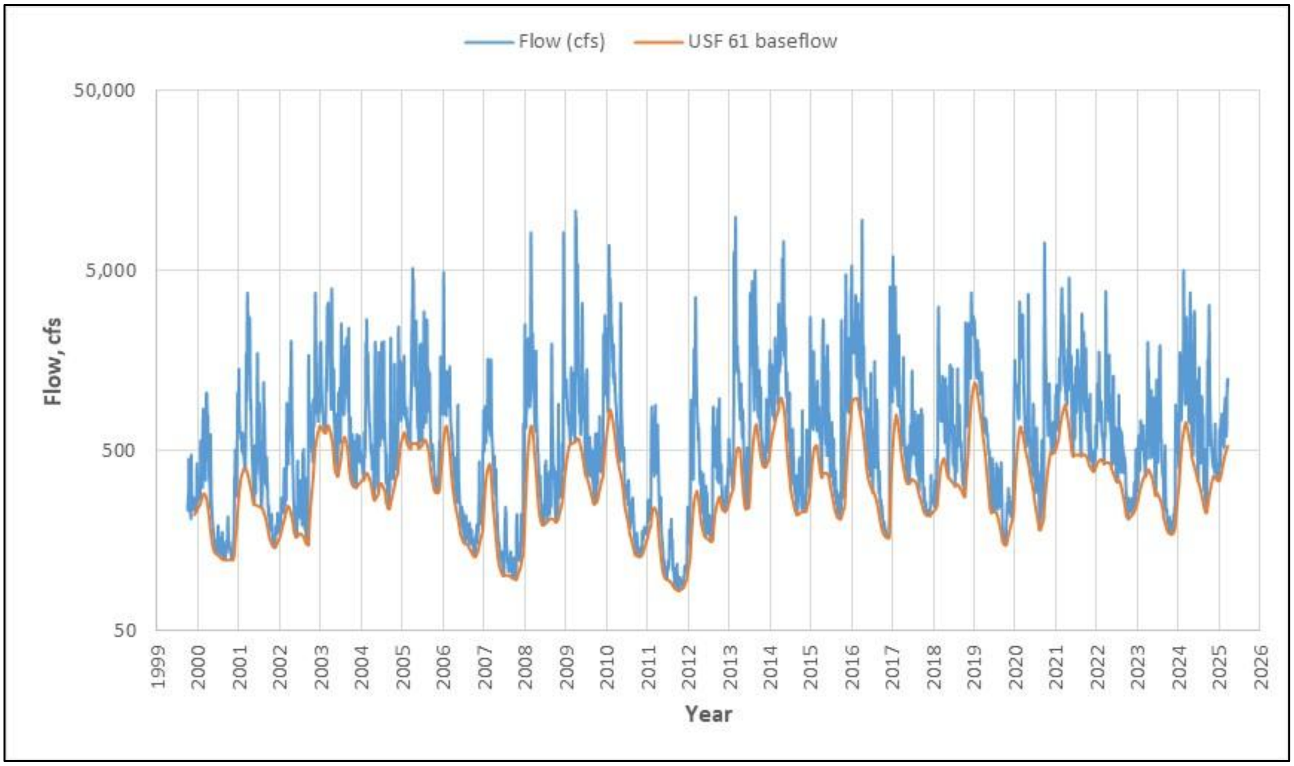


Figure 4-18. Daily flow hydrograph and baseflow hydrograph at the USGS Station 2358789 Chipola River near Marianna, FL.

A careful examination of Figure 4-19 shows an increase in both baseflow and total flow at USGS Chipola River Near Marianna, FL from January 2013 to December 2024 as compared to previous time periods, particularly the mid 2000's which experienced several years of below average flow. The degree to which baseflow correlates to climatic variability was evaluated by comparing baseflow to historical cumulative precipitation. The 24-month moving average baseflow at USGS Chipola River Near Marianna, FL was compared to the preceding 24-month moving average monthly total rainfall from the National Weather Service station USC00081544 located in Chipley, Florida (Figure 4-19). A 24-month moving average was applied to computed baseflow due to the variable nature of Chipola River flows, providing for a better comparison to long term cumulative rainfall patterns. A 24-month moving average of monthly rainfall totals was utilized to account for the effect of antecedent rainfall conditions on baseflow. Upon further inspection, a lag between cumulative rainfall and Chipola River baseflow was apparent. An optimal lag of 7 months was determined to minimize error between preceding 24-month moving average monthly total rainfall for NWS Chipley, FL, and 24-month moving average Chipola River computed baseflow. The optimal lag was determined by finding the lag which minimized the sum of squared errors (SSE) in the ordinary least squares (OLS) regression between cumulative rainfall and Chipola River baseflow. The resulting linear regression between these two variables had an R^2 of 0.53 and is shown in Figure 4-20. As shown in 4-19 and 4-20, fluctuations in baseflow are positively correlated with fluctuations in cumulative rainfall. The 'noise' in the relation between these two variables is likely due to factors such as uncertainties in estimating baseflows and to spatial and temporal variations in recharge and direct runoff rates or other complexities that are not completely captured with the 24-month moving average rainfall computed at a single weather station. It should be noted that this regression analysis is presented here for illustrative purposes only and was not used to make further inferences.

Chipola River baseflow and cumulative rainfall values at Chipley, FL were higher in the period from January 2013 to December 2022 compared to the period from 2000 to 2013. The period from 2000 to 2013 included several years of below average rainfall. Observed total annual rainfall in 2013 was 82 inches which is the highest annual total on record for the Chipley station. The average annual rainfall for this station is 57 inches. The above average rainfall during 2013 contributed to an increase in baseflow beginning January 2013. Baseflow remained elevated from 2013 to 2022, with average or above average rainfall occurring in all years in this timeframe except in year 2019, which had 51 inches of total precipitation at the Chipley station. More recently, below average rainfall totals of 43 and 41 inches occurred in years 2022 and 2023, respectively, with corresponding declines in baseflow. Rainfall in the year 2024 was slightly above average (63 inches total precipitation), resulting in baseflows that have recently begun returning to normal levels.

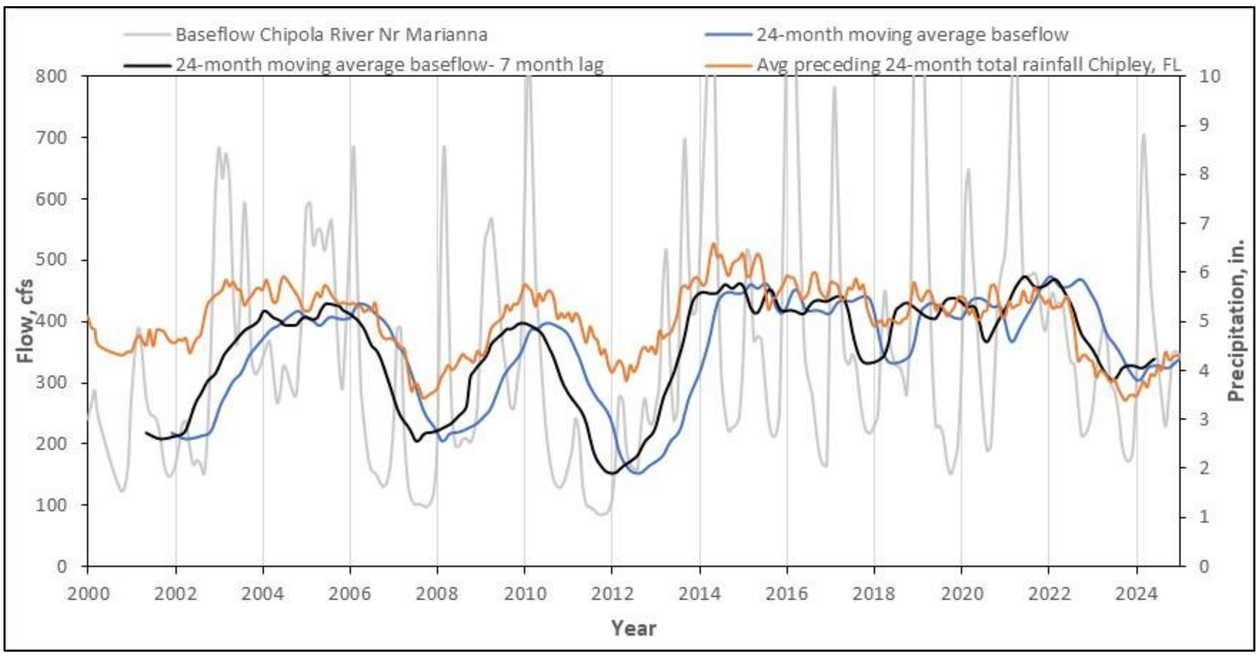


Figure 4-19. Baseflow at the USGS station 2358789 Chipola River Near Marianna, FL compared with preceding 24-month moving average monthly total rainfall from the National Weather Service station USC00081544, located in Chipley, Florida.

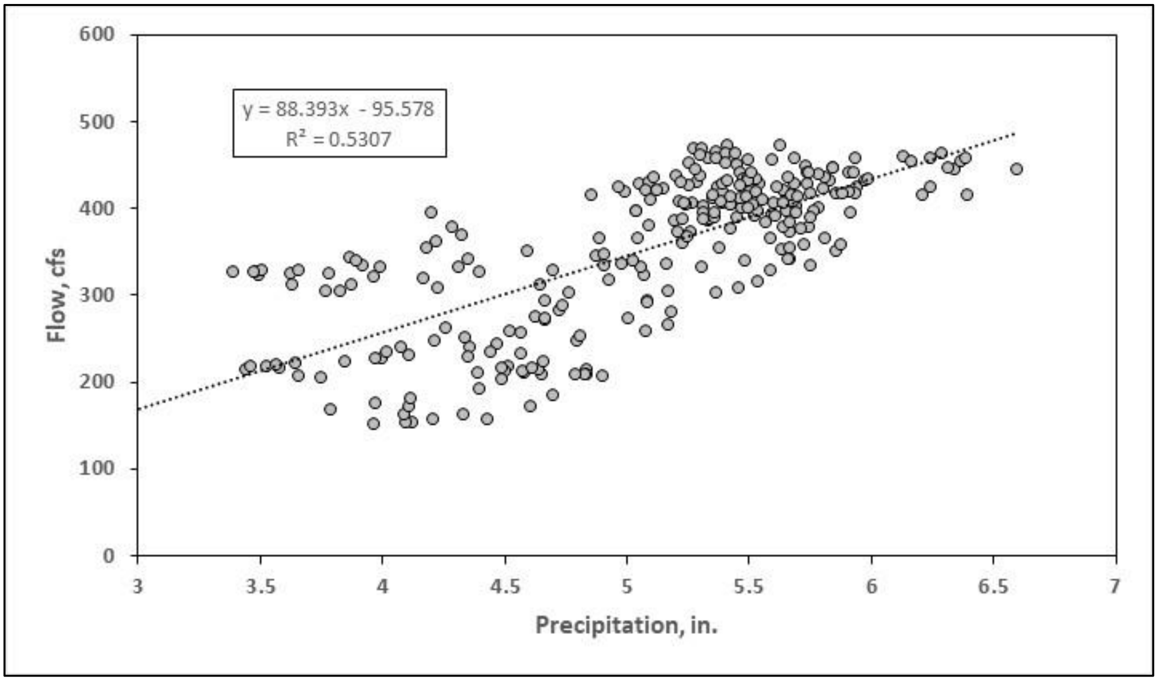


Figure 4-20. Linear Regression between preceding 24-month moving average monthly total rainfall from the National Weather Service station USC00081544 located in Chipley, Florida and 7-month lagged, 24-month moving average baseflow at the USGS Station 2358789 Chipola River Near Marianna, FL

4.7.2 Relation between baseflow, precipitation, and Jackson Blue Spring Discharge

The relation between estimated baseflow at USGS Chipola River Near Marianna, FL and Jackson Blue Spring discharge was evaluated to compare hydrologic trends between Jackson Blue Spring discharge and a riverine system in close proximity to the spring. Because of the proximity of Jackson Blue Spring to the USGS station Chipola River Near Marianna, FL, trends at these two sites could be expected to show similarities due to similar climatic conditions influencing both systems. The 24-month moving average baseflow at USGS Chipola River Near Marianna, FL was compared to the 12-month moving average Jackson Blue Spring discharge (Figure 4-21). Prior to 2013, fluctuations in Jackson Blue Spring discharge correspond well to changes in Chipola River baseflow. However, from 2014 to 2024 spring discharge diverges slightly from Chipola River baseflow. The timing and magnitude of increased groundwater withdrawals don't appear to explain these differences. One possible explanation for decreased Jackson Blue Spring discharge in recent years (relative to Chipola River baseflow) is that rainfall in the region west of the Chipola River may have been higher than that east of the river.

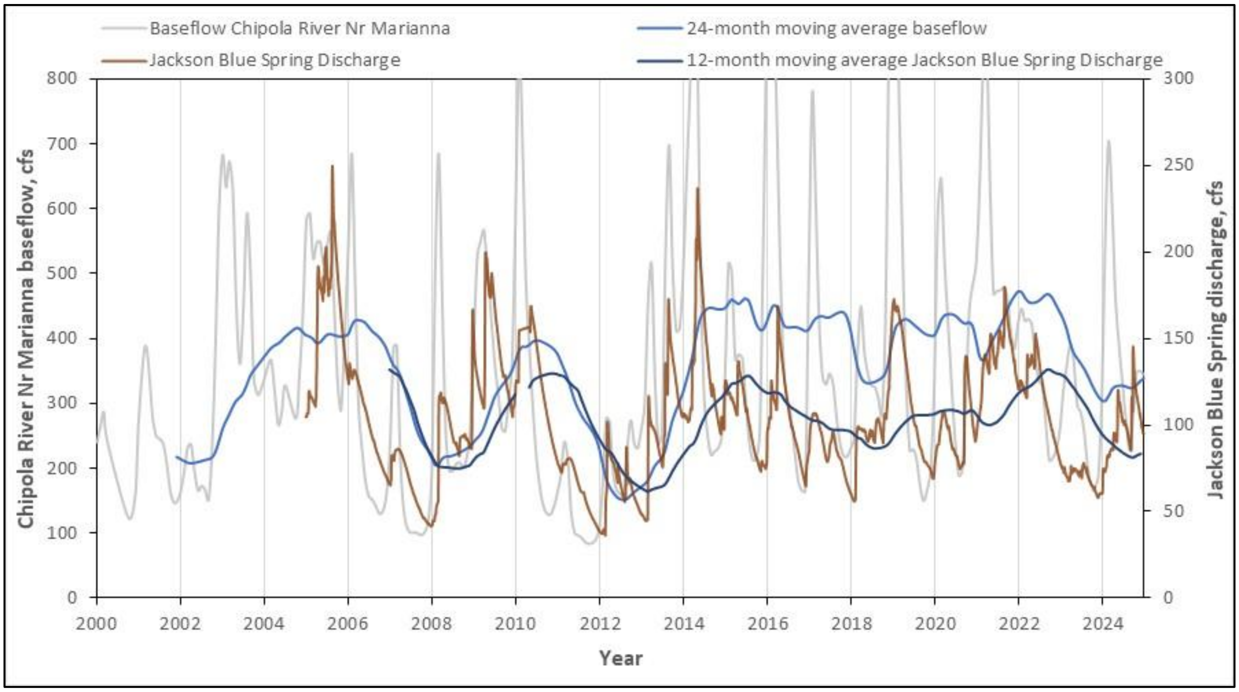


Figure 4-21. Comparison of 12-month moving average Jackson Blue Spring discharge with 24-month moving average baseflow at the USGS Station 2358789 Chipola River near Marianna, FL.

4.7.3 Evaluation of Stage-Discharge Relationships for Chipola River and Selection of Model Calibration Period

An evaluation of potential changes to Chipola River stage-discharge relationships over time was conducted to determine an appropriate period for calibrating an open-channel hydraulic model that reflects current riverine hydrodynamics and expected future conditions to ensure model results and simulations are protective of the system. In particular, changes caused as a result of downed trees in the channel and floodplain from Hurricane Michael and subsequent debris removal were evaluated. Large amounts of debris fell into Merritts Mill Pond, Spring Creek, and Chipola River and surrounding floodplain areas from Hurricane Michael, causing changes to the Jackson Blue Spring MFL study area. Downed trees in the channel and floodplain resulted in less conveyance area, resulting in increased river stage for a given flow. In an effort to restore the hydrology of the system to pre-hurricane conditions, debris was removed from portions of the main channels of Spring Creek and Chipola River. As indicated previously, no debris removal was conducted in the floodplains.

USGS station 02358789 Chipola River @ Marianna stream gaging station represents the closest long-term USGS gage to the Jackson Blue Spring MFL study area, long term trends and patterns observed at this station were assumed to be indicative of the region, including Jackson Blue Spring, Merritts Mill Pond, and Spring Creek. Stage-discharge relationships at the 02358789 Chipola River @ Marianna gage were evaluated for three periods (Figure 4-22):

- Pre Hurricane Michael conditions (pre 10/10/2018)

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

Review of Figure 4-22 shows substantial increases in stage for a given flow following Hurricane Michael as compared to pre-hurricane historical conditions. However, upon completion of debris removal in the Chipola River, the stage-discharge relationship returned to historical conditions similar to those prior to the hurricane, although stages remain slightly elevated for a given flow, potentially due to remaining debris in the floodplain.

Based on this evaluation, a model simulation period for calibration beginning April 1, 2019, was selected to represent the current stage-discharge relationship for the Jackson Blue Spring system. 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 and associated floodplain and instream communities continue to recover from Hurricane Michael impacts.

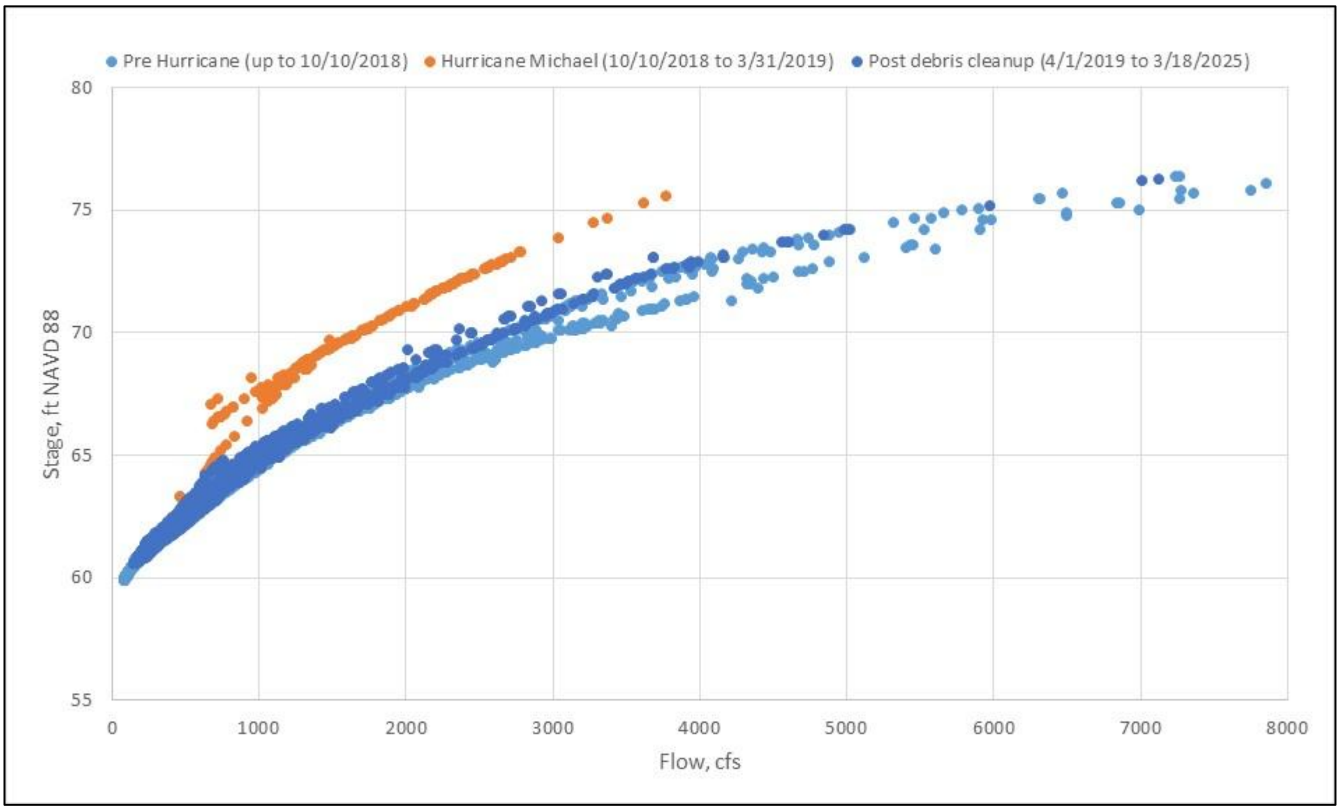


Figure 4-22. Comparison of stage-discharge relationships for the USGS station 02358789 Chipola River at Marianna.

4.8 Flow Pickup Along Merritts Mill Pond

Concurrent, continuous mean daily discharge at NWFWMD station 5042 Jackson Blue Spring and NWFWMD station 11107 Merritts Mill Pond @ US 90 was compared to evaluate flow pickup along the pond from Jackson Blue Spring to the end of the pond at the control structure. Flow pickup along the pond was calculated as the difference in mean daily discharge between these stations, for all days where concurrent discharge was available at both stations. As indicated in Figure 4-23, flow increases significantly along Merritts Mill Pond, with an average pickup of 117 cfs, compared to the average Jackson Blue Spring discharge of 111 cfs for dates with concurrent flows at both stations (with the Jackson Blue Spring discharge therefore accounting for 49% of total flow at the outfall of Merritts Mill Pond). This figure also shows an estimated time series of flow from Merritts Mill Pond that was based on a Locally Estimated Scatterplot Smooth (LOESS) regression between Jackson Blue Spring flow and the flow pickup along Merritts Mill Pond. This regression is described later in this section. Figure 4-24 shows significant variability in pickup, ranging between 0 and 411 cfs, with a median value of 99 cfs.

Figure 4-25 compares concurrent discrete flow measurements at NWFWMD station 5042 Jackson Blue Spring and NWFWMD station 11107 Merritts Mill Pond @ US 90. The results were similar to those from the continuous flow data: the average pickup on dates where discrete measurements were made at both stations was 135 cfs compared to an average Jackson Blue Spring discrete discharge of 110 cfs (45% of the flow at 11107 Merritts Mill Pond @ US 90). Pickup along Merritts Mill Pond from these discrete measurements varied with a range of 26 cfs and 353 cfs.

The magnitude and variability of flow pickup along Merritts Mill suggests that diffuse groundwater inflow occurs along the pond, in addition to contributions from minor springs, as well as possible contributions from surface runoff. Collectively these inflows, on average, slightly exceed the contribution from Jackson Blue Spring. Short-term variations in pickup are also associated with operations of the Merritts Mill Pond dam and the effect of vegetation accumulation and turbulence at the control structure on velocity readings at the US 90 gage.

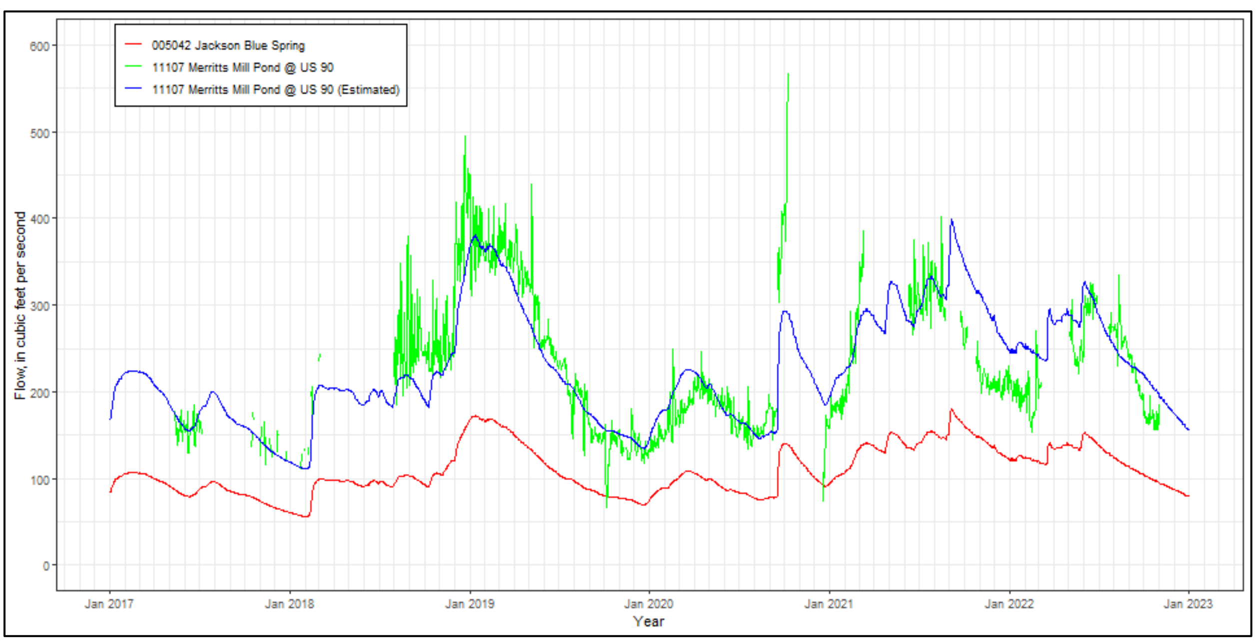


Figure 4-23. Comparison of discharge at NWFID 5042 Jackson Blue Spring with discharge at NWFID 11107 Merritts Mill Pond at US Highway 90.

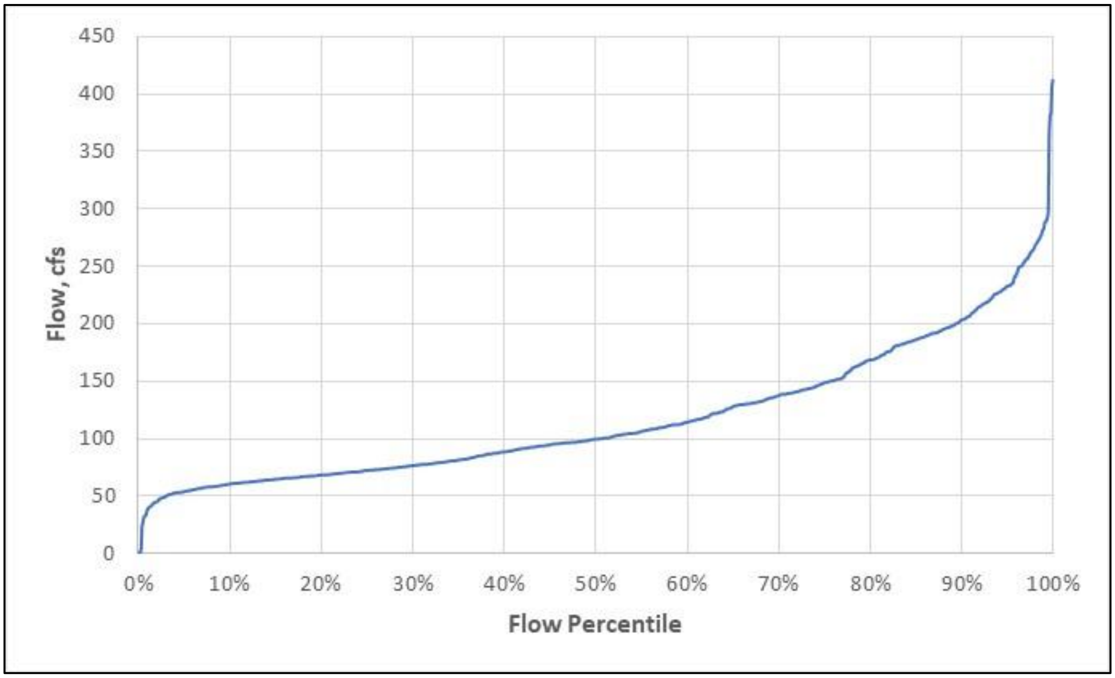


Figure 4-24. Flow duration curve of flow pickup along Merritts Mill Pond between Jackson Blue Spring and the downstream control structure at US Highway 90.

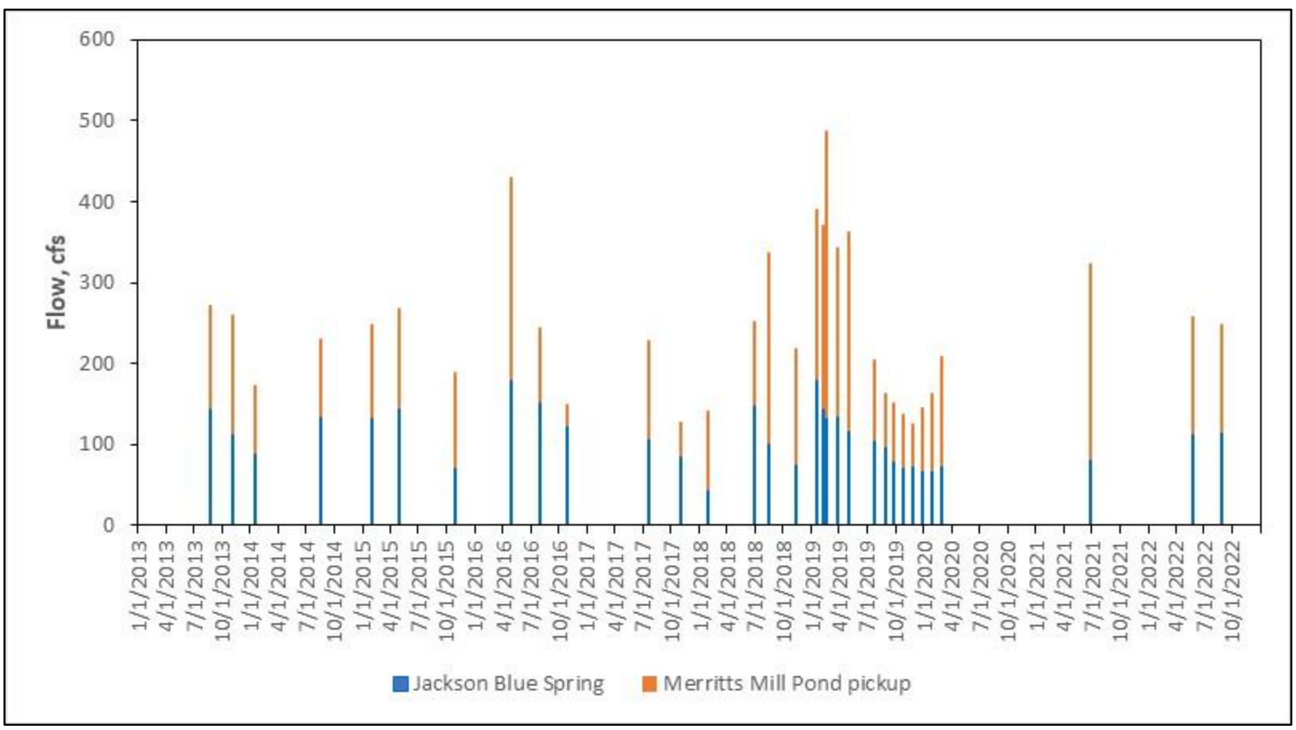


Figure 4-25. Comparison of concurrent discrete discharge measurements at NWFID 5042 Jackson Blue Spring with discharge at NWFID 11107 Merritts Mill Pond at US 90

Flow pickup along Merritts Mill Pond was also estimated for a 'baseline' period from January 1, 2005 to December 31, 2024, to develop an extended record of flow pickup along the pond to assess potential impacts from flow reduction along the pond. This was implemented by first fitting a locally estimated scatterplot smoothing (LOESS) regression relation between concurrent daily mean values of Merritts Mill Pond pickup and the daily mean flows from Jackson Blue Spring (Figure 4-26). The root-mean square error of this relation was about 40 cfs.

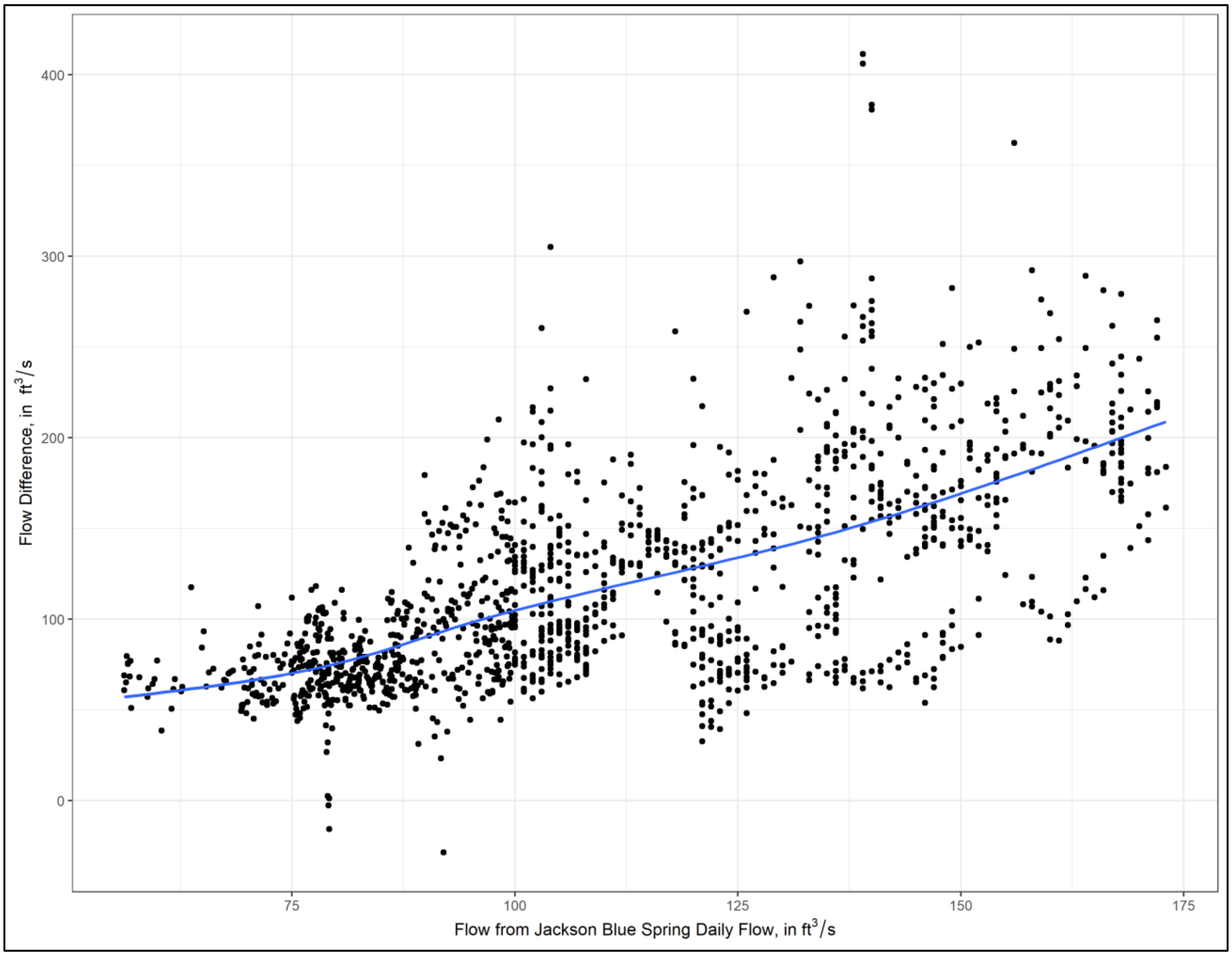


Figure 4-26. Scatterplot with LOESS regression fit of daily mean Merritts Mill Pond pickup versus concurrent daily mean Jackson Blue Spring flows

Jackson Blue Spring flows during the baseline period were lower than the minimum value of the dataset of concurrent values used to fit the relation between Merritts Mill Pond and Jackson Blue Spring about five percent of the time, and higher than the maximum value about six percent of the time. During these conditions, Merritts Mill Pond pickup values were estimated by extrapolating along a line extending from the segment of the LOESS curve associated with the lowest (for estimation at lower flows) or highest (for estimation at higher flows) 10 cfs of Jackson Blue Spring flows used to fit the LOESS curve. A plot of the estimated time series of Merritts Mill Pond flow pickup values is shown in Figure 4-27.

The LOESS relation fits the central tendency of the relation between JBS flow and the flow pickup along MMP, which supports its use for estimating lateral inflows to the steady-state HEC-RAS models discussed later in this report and in the report appendices. Variability associated with the LOESS relation introduces some degree of uncertainty into the percentile flows in MMP and Spring Creek. However, multiple factors mitigate against the effect of this variability on those percentiles. First, as noted above, the LOESS model reasonably estimates the central tendency of the relations between JBS discharge and MMP discharge. Second, variations about this central tendency tend to cancel each other because of the symmetry of the errors about the LOESS model. Finally, the MFL analysis was based on a range of flows representing typical conditions in the system and was not designed to account for extreme conditions.

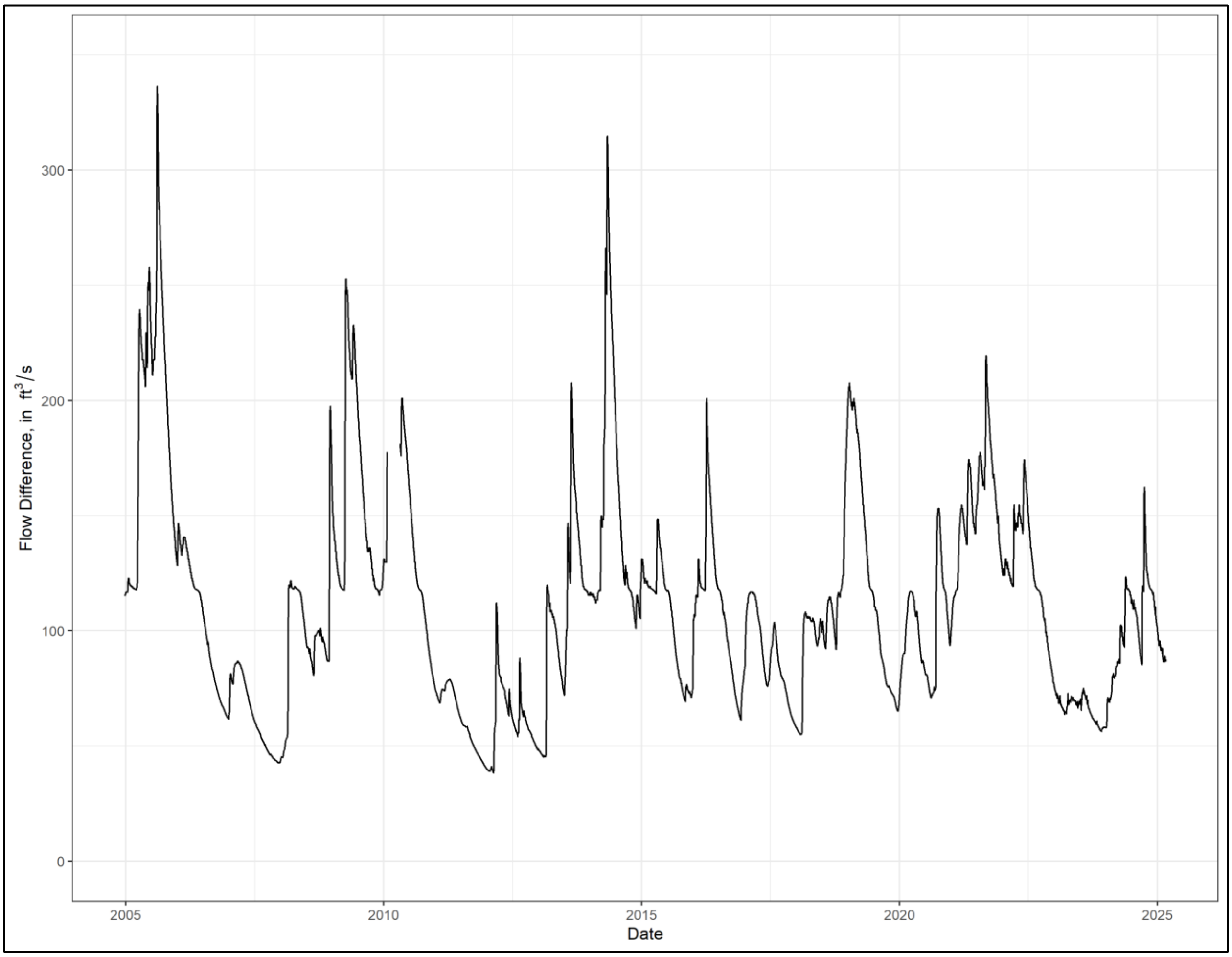


Figure 4-27. Time series of estimated daily Merritts Mill Pond flow difference (pickup) values for the period from January 1, 2005 through December 31, 2024.

4.9 Flow Pickup Along Spring Creek

Flow pickup along Spring Creek was evaluated using concurrent (same day) discharge measurements at NWFID 11107 Merritts Mill Pond @ US 90, NWFID 12820 Chipola River Above Spring Creek, and NWFID 12821 Chipola River Below Spring Creek (Table 4-6). A total of 13 measurement dates had concurrent flow measurements at all three locations. Flow at the mouth of Spring Creek was estimated by subtracting the flow in the Chipola River Above Spring Creek (NWFID 12820) from the flow in the Chipola River Below Spring Creek (NWFID 12821). The pickup was then computed by subtracting the flow at NWFID 11107 Merritts Mill Pond @ US 90 from the estimated flow at the mouth of Spring Creek (Table 4-6). Based on these discharge measurements, Spring Creek has minimal flow pickup along its 2-mile length between the Merritts Mill Pond control structure and the confluence with the Chipola River. The average pickup estimate from these discharge estimates was 2 cfs. Four of the 13 pickup estimates had negative values, with the remaining nine being positive. However, none of these 13 pickup estimates of flow pickup along Spring Creek appear to be significant at a 95-percent confidence level, based on an assumed uncertainty (coefficient of variation of the measurement error) of at least five percent in the component discharge measurements used to estimate flow pickup.

Table 4-6. Estimated flow pickup along Spring Creek (cfs).

Date	NWFID 11107 Merritts Mill Pond @ US 90	NWFID 12820 Chipola River Above Spring Creek	NWFID 12821 Chipola River Below Spring Creek	Estimated flow at mouth of Spring Creek (site 12821 minus site 12820)	Estimated Flow Pickup Along Spring Creek
4/7/2016	425	1520	2104	584	159
7/27/2016	244	795	994	199	-45
10/26/2016	148	198	334	136	-12
5/18/2017	153	331	492	161	8
6/27/2017	164	1200	1320	120	-44
1/29/2018	141	391	509	118	-23
8/10/2018	337	724	1040	316	-21
6/25/2019	242	259	488	229	-13
9/25/2019	151	184	318	134	-17
10/23/2019	147	276	379	103	-44
11/25/2019	125	259	364	105	-20
12/26/2019	129	1050	1211	161	32
1/28/2020	152	861	1030	169	17

4.10 Stage Along Merritts Mill Pond

Daily average stage, measured at USGS 2358795 Jackson Blue Spring near Marianna, is presented in Figure 4-28. Because of the control structure at the end of the pond, stage fluctuations are minimal, although some variability is present and corresponds with periods of higher and lower spring flow. For example, stage in the pond reached local minima of approximately 75.8 ft in years 2008, 2018, and 2020, which correspond to periods of minimum spring discharge. Similarly, stage reached local maxima of approximately 78 ft during 2005, 2009, 2019, and 2021, which correspond to periods of maximum spring discharge. Average stage over the period of record was 76.71 ft, ranging between 74.73 ft and 77.91 ft.

Stage frequency curves from the pre- and post-Hurricane Michael periods were similar, with the largest differences being toward the lower end of the curve, although differences were still minimal (Figure 4-29). Note that daily stage values at Jackson Blue Spring are not available for the period from July 2010 to January 2017 (Figure 4-28).

A comparison of stage measured at USGS 2358795 Jackson Blue Spring Near Marianna with stage measured at NWFWMD station 11107 Merritts Mill Pond @ US 90 shows minimal difference in stage along the pond (Figure 4-30). A scheduled drawdown of Merritts Mill Pond occurred from October 2020-December 2020 in order to perform maintenance and renovations at the Jackson Blue Spring county park. Stage at Jackson Blue Spring was unavailable for this period because of the renovations. During the drawdown, stage was lowered in the pond to approximately 69 ft.

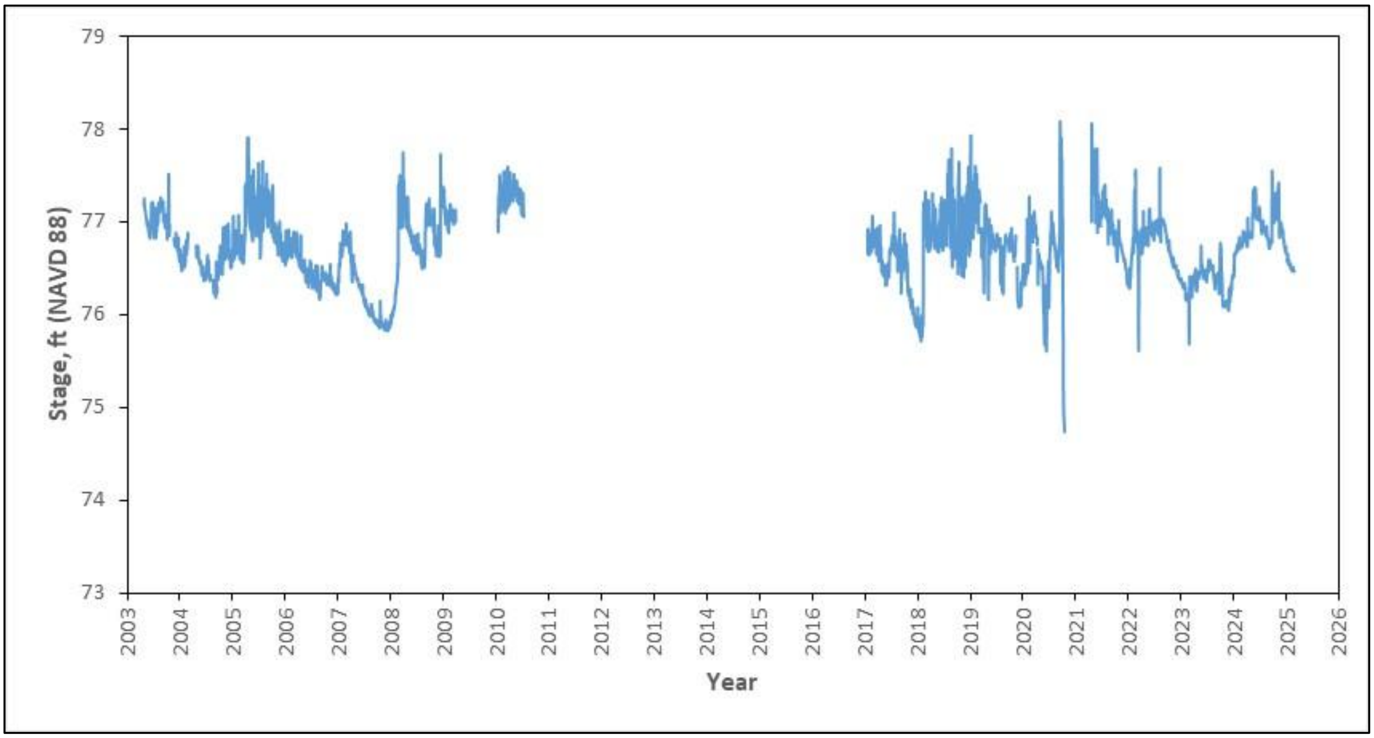


Figure 4-28. Daily average stage at USGS 2358795 Jackson Blue Spring near Marianna.

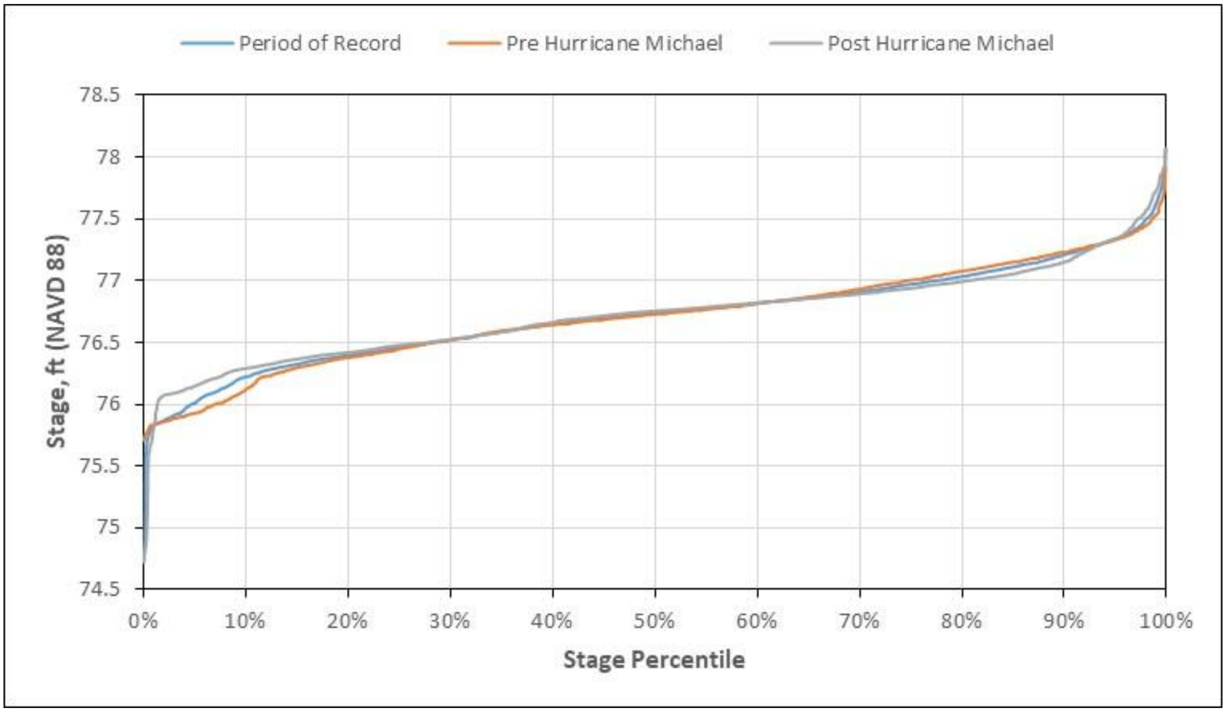


Figure 4-29. Stage duration curves at USGS 2358795 Jackson Blue Spring near Marianna.

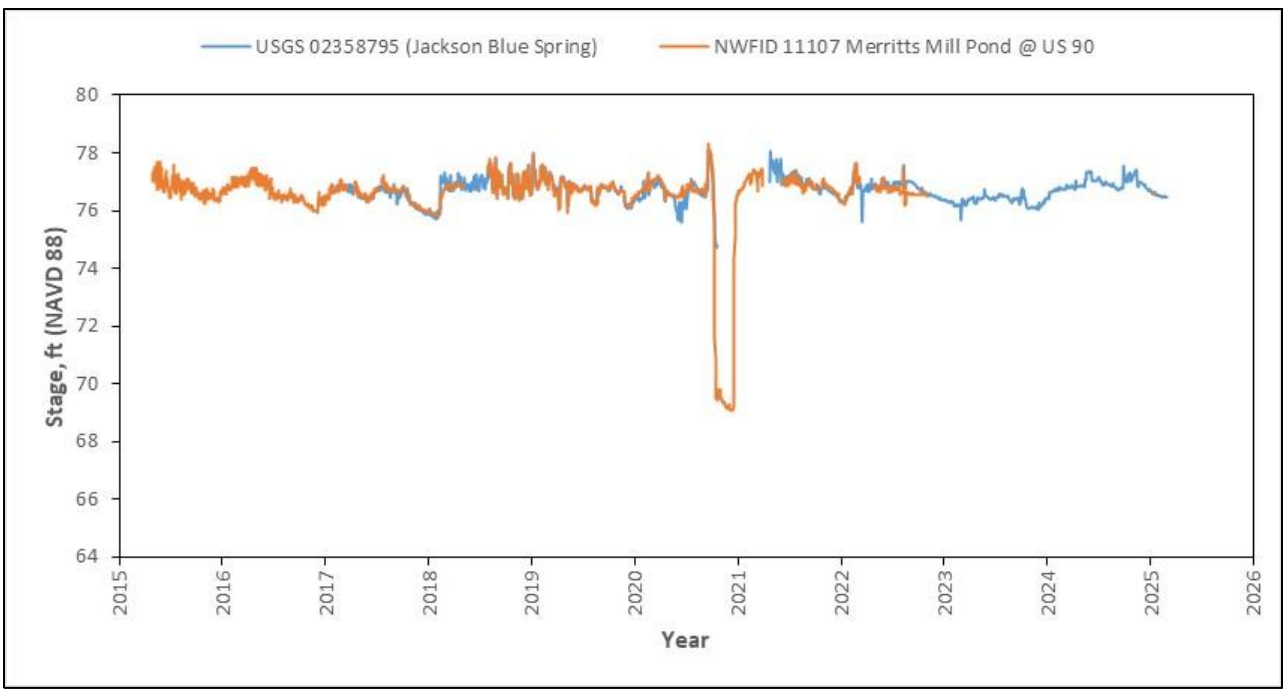


Figure 4-30. Comparison of stage at USGS 2358795 Jackson Blue Spring near Marianna with stage at NWFID 11107 Merritts Mill Pond at US 90.

4.11 Groundwater Withdrawals

Estimates of the location and rates of historical pumping within the active North Central District groundwater flow model (NCDM) domain (shown in Figure 4-31) surrounding Jackson Blue Spring were computed for calendar years 2000, 2005, 2010, 2015, 2020 and 2045. Note that the NCDM is described further in Section 6.1 and Appendix A of this report. The estimation methods for various water use categories, years of interest, and regions, varied depending on data availability and are described in a report by The Balmoral Group (2024). These estimates are shown in Table 4-7 and Figure 4-31 for each category of water use. These data indicate that most groundwater withdrawals within the NCDM domain are for agricultural uses, and that most of the historical and projected growth in groundwater withdrawals are for agricultural uses. Average groundwater withdrawal rates for the period from January 1, 2017, through December 31, 2019, were also computed for the NCDM, and the geographic distribution of withdrawals during this time period is shown in Figure 4-32.

Table 4-7. Historical and projected water use for the NCDM groundwater flow model domain.

Use Type	Annual Groundwater Withdrawal (mgd)					
	2000	2005	2010	2015	2020	2045
Agricultural Irrigation	20.01	20.29	32.55	30.23	29.97	42.18
Livestock or Aquaculture	0.64	0.81	0.97	2.69	2.69	2.69
Public Supply	3.45	3.68	5.59	4.37	4.98	5.26
Domestic Self Supply	4.24	3.88	3.77	4.36	3.34	3.7
Commercial-Industrial-Institutional	0.17	0	0	0.01	0	0
Recreational Irrigation	0.03	0	0.03	0.06	0.02	0.02
Power Generation	0	0.26	0.28	0.23	0.13	0.14
Total	**28.54**	**28.92**	**43.19**	**41.95**	**41.13**	**53.99**

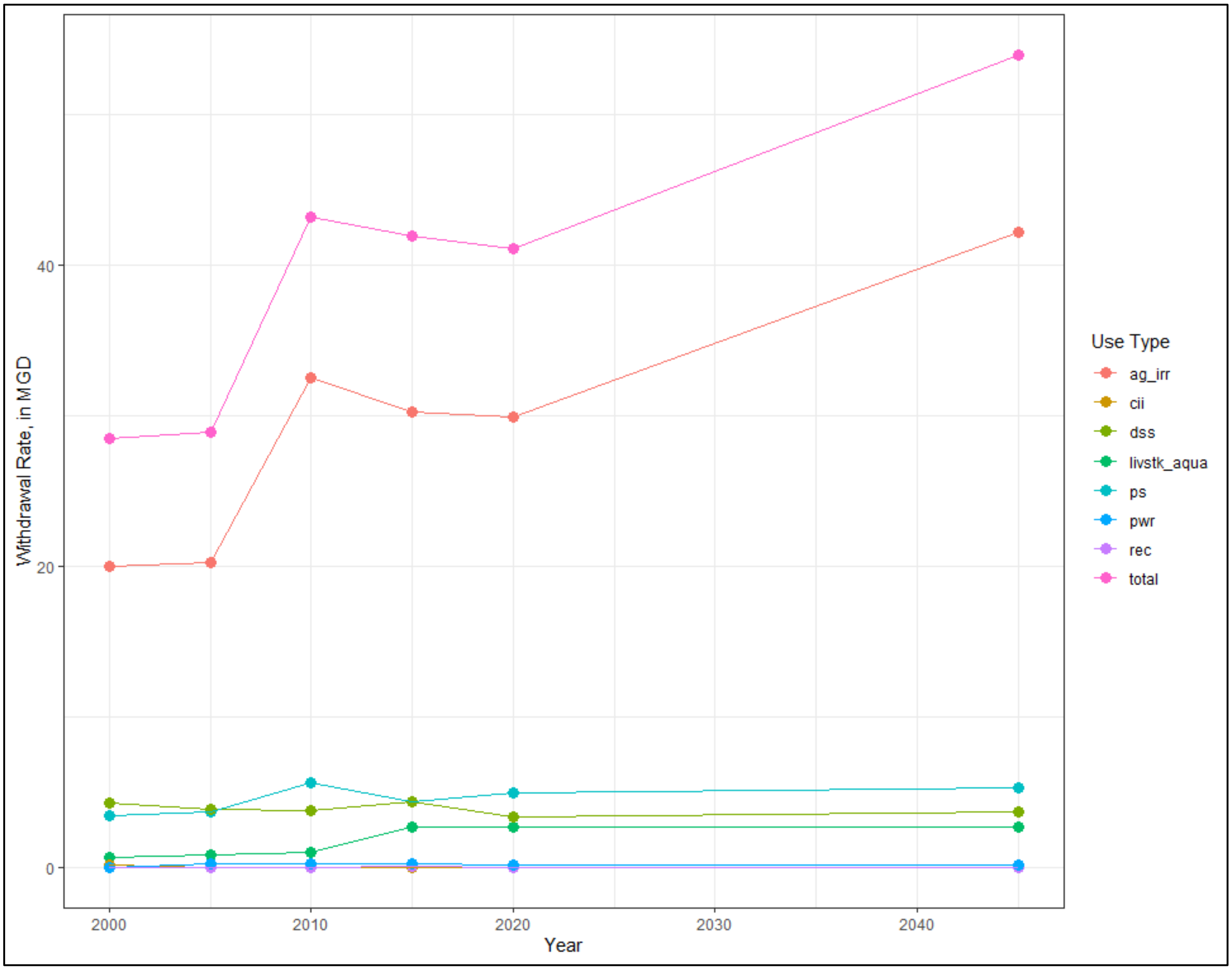


Figure 4-31. NCDM groundwater withdrawal estimates for selected years by water-use type (agg_irr, agricultural irrigation; cii, commercial-industrial-institutional; dss, domestic self-supply; livstk_aqua, livestock and aquaculture; ps, public supply; pwr, power generation; rec, recreational; total, total use across all use types).

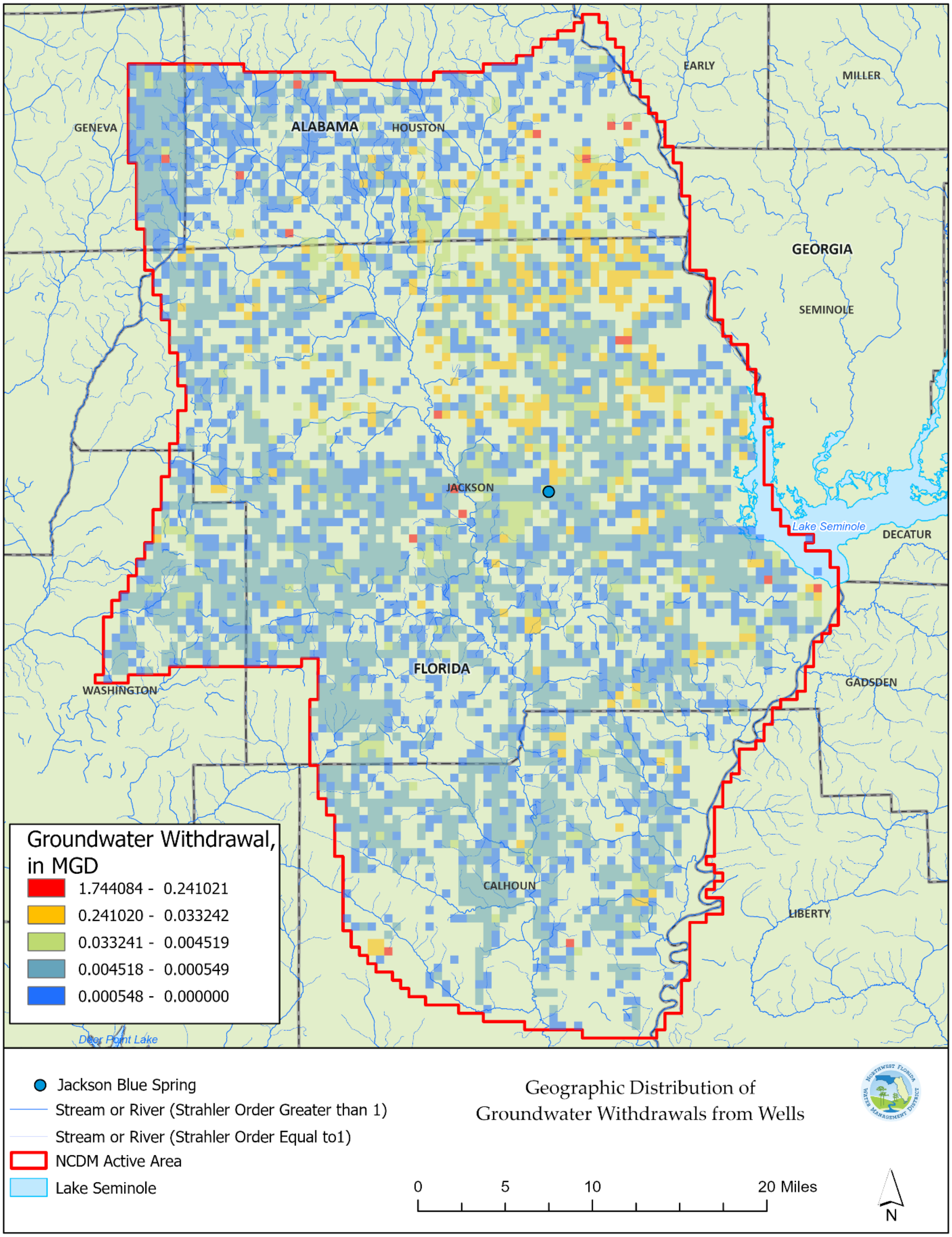


Figure 4-32. Geographic distribution of average groundwater withdrawal rates in the NCDM domain during 2017-2019.

5 Water Resource Values

The following section presents the consideration of WRVs used in the MFL evaluation of Jackson Blue Spring and associated metrics designed to maintain and protect the ecology and water resources of the system. Quantitative data analyses and the methods for determining the minimum flows that are protective of WRVs are provided in Sections 6 and 7.

Section 62-40.473, F.A.C., lists ten environmental or water resource values (WRVs) that must be considered when establishing MFLs (Table 1-1). While all listed WRVs must be considered, not all may be appropriate for establishing minimum flows for Jackson Blue Spring. To determine which WRVs were most appropriate for the Jackson Blue Spring system, 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 the Jackson Blue Spring system
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 establishing MFLs for the Jackson Blue Spring system, one or more quantifiable metrics were identified to evaluate the potential for significant harm. For each metric, quantifiable criteria were determined as the limiting or critical value beyond which significant harm to the waterbody would be experienced.

5.1 Water Resource Value Definitions and Consideration

This section describes the ten Water Resource Values (or Environmental Values) that must be considered per Florida Statute (62-40.473, F.A.C.).

WRV 1. Recreation In and On the Water – As previously described in Section 2.10 (Recreation), the Jackson Blue Spring study area is heavily used for recreation. Public access to the study area is available through multiple public parks, public boat ramps, and private businesses offering rentals. Primary recreational activities occurring on the Jackson Blue Spring System include power boating, canoeing/kayaking, tubing, fishing, swimming, and cave diving.

Safe Boat Passage – The Jackson Blue Spring MFL study area is used by recreational boaters including both power boats and canoes/kayaks. Reduced water levels can increase the chances of damage to ecosystem substrates and damage to outboard motors from hard substrates such as limestone shoals. The intensive recreational boat use along Merritts Mill Pond and Spring Creek makes safe boat passage an important metric for the recreation WRV. Two separate boat passage metrics were used for minimum flow determination.

Safe Power Boating – Private power boat use along Merritts Mill Pond and Spring Creek is a popular recreational activity. Multiple boat ramps are available for public access to Merritts Mill Pond and Spring Creek, although the relevant boat ramps for access to Spring Creek are located on the Chipola River. For private recreational power boat use along Merritts Mill Pond, a minimum water depth of 2.0 feet across a continuous channel width of 30 feet 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, NWFWMD 2025).

During multiple site visits conducted by District staff, power boat use along Spring Creek was limited. This is likely due to the presence of a limestone shoal located at the confluence of the Chipola River and Spring Creek which inhibits access to Spring Creek during periods of low Chipola River water levels. In addition, numerous other limestone shoals were present throughout Spring Creek which likely deter power boating in the system. Because of limited power boat usage and the relatively narrow width of Spring Creek where passage is possible, a minimum water depth of 2.0 feet across a continuous channel width of 15 feet was used as the metric to evaluate safe boat passage along Spring Creek allowing for passage of a typical power boat. This metric was previously used for portions of the Econfina Creek MFL assessment where power boat passage was limited (NWFWMD 2025).

Safe Canoe/Kayak Passage – Merritts Mill Pond and Spring Creek are both extensively used for canoeing and kayaking. Rental of canoes, kayaks, paddleboats, etc. are available from several vendors along the system. The extensive use of both Merritts Mill Pond and Spring Creek for canoeing and kayaking makes safe canoe and kayak passage an appropriate metric for this system. A minimum thalweg depth of 1.5 feet was used as the metric for safe canoe and kayak passage, similar to previous MFL evaluations (NWFWMD 2025, NWFWMD 2021, NWFWMD 2019, SRWMD 2013). A thalweg is the location with the lowest elevation or deepest water depth of a waterway's cross section. This metric was assessed along the entire Jackson Blue Spring MFL study area from Jackson Blue Spring to the Spring Creek confluence with the Chipola River.

Safe Tubing Passage – Spring Creek is commonly used for tubing during the summer months. Float tubes are available for rental from a private canoe, kayak, and tube vendor on Spring Creek at U.S. Hwy 90, and many individuals access Merritts Mill Pond for tubing and rafting at the Jackson Blue Springs Recreation Area. The extensive use of the Jackson Blue system for tubing makes safe tubing passage an appropriate metric for this system. Safe tubing depth has been used in evaluating minimum flows for the Ichetucknee River in order to prevent damage to submerged aquatic vegetation from tubers (SRWMD 2013, SRWMD 2021). In these previous evaluations, it was determined that a single user tube with an occupant weighing greater than 200 lbs would require approximately 1.05 feet of water above the thalweg elevation. Similarly, a minimum water depth of 1.05 feet above the thalweg was used to protect vegetation and provide safe tube passage in this MFL evaluation. This metric was assessed along the Spring Creek portion of the study area, where tubing is most prevalent. Information concerning available water above submerged aquatic vegetation was not available for Spring Creek to further refine safe tubing depth requirements. Future evaluations may consider alternative tubing metrics if further information becomes available.

Fishing – Fishing is a primary recreational use of the Jackson Blue Spring MFL study area and as a result is an appropriate metric to consider for MFL establishment. However, little information is available concerning the hydrologic requirements (water levels and flows) for fishing. This recreational use was addressed by considering safe boat passage and protection of fish passage and habitat. Access to fishing areas is expected to be protected through the safe power boat passage and canoe/kayak passage metrics described above. Recreationally important fish populations are expected to be protected under the metrics associated with the Fish and Wildlife Habitat and the Passage of Fish WRV (see Safe Fish Passage, Instream Habitat of Aquatic Species, Wetted Perimeter, Floodplain and Riparian Wetland Inundation).

Cave Diving – Jackson Blue Spring is unique among many Florida springs in that cave diving is a primary recreational activity and was therefore an appropriate consideration for MFL establishment. Although minimum flow metrics for safe cave diving have not been established in the state, reductions in Jackson Blue Spring flow are not anticipated to result in conditions less conducive to cave diving such as reduced water clarity or increased water velocity. As a result, minimum flow metrics assessing the effects of Jackson Blue Spring flow reductions on this recreational use were not considered further.

WRV 2. Fish and Wildlife Habitat and the Passage of Fish - The abundant wildlife and extensive natural vegetation communities within the Jackson Blue Spring MFL study area make Fish and Wildlife Habitat and the Passage of Fish a relevant WRV. Numerous metrics were considered for MFL evaluation as described below.

Safe Fish Passage – Maintaining connectivity between upstream and downstream portions of Merritts Mill Pond and Spring Creek during low flow conditions is important to provide fish physical access up and/or downstream to areas of deeper water to escape predation and 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 2025, NWFWMD 2021, NWFWMD 2019, SWFWMD 2017a, SRWMD 2016a).

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, *Micropterа salmoides*).

Native Fish Passage – Merritts Mill Pond and Spring Creek provide habitat to numerous recreationally important fish species such as largemouth bass (Table 2-4). A screening of the fish species documented in Merritts Mill Pond and Spring Creek revealed that largemouth bass are the native fish species capable of reaching the largest body depth within the study area. Nagid (2022a) demonstrated that a 0.6 ft depth was sufficient to allow for 99.6 percent of all Florida/largemouth bass to safely pass over a shoal or other shallow habitat. Since largemouth bass are the deepest-bodied, native fish species documented in Merritts Mill Pond and Spring Creek, a minimum fish passage depth of 0.6 ft at the channel thalweg throughout the study area was utilized for the fish passage metric. This metric has also been used in previous MFL assessments within the District (NWFWMD 2019, NWFWMD 2021, NWFWMD 2025). 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 entire MFL study area from Jackson Blue Spring to the Spring Creek confluence with the Chipola River.

Exotic Species Consideration – The largest bodied fish documented in Merritts Mill Pond is grass carp, *Ctenopharyngodon Idella.* These are an exotic species and are listed as a conditional, non-native species by the State of Florida and may be introduced into a water body for the purposes of aquatic vegetation control (Chapter 68-5.004, F.A.C.). The legal introduction of grass carp requires a permit from the FWC (Rule 68-5.005, F.A.C.). Grass carp legally introduced into a water body must be certified as tripoid to ensure the species is incapable of reproduction in the wild. Because grass carp are an introduced, non-reproducing population, this species was not considered further for MFL evaluation.

Other Fish Passage Considerations – Historically, larger-bodied native, anadromous/catadromous species such as Gulf Sturgeon and Striped Bass may have utilized Spring Creek. However, these species have not been documented in either Merritts Mill Pond or Spring Creek. As a result, these species were not considered further for the safe fish passage metric. Although the Chipola River is the primary habitat for shoal bass in Florida, the species has not been documented in the Jackson Blue Spring MFL study area (i.e. Spring Creek or Merritts Mill Pond). In addition, specific habitat requirements needed to determine fish passage requirements for this species are not available. As a result, this species was not considered further for the safe fish passage metric.

Instream Woody Habitat Inundation – Submerged woody habitat has been identified as being important as habitat and food for macroinvertebrate 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 affects streamflow characteristics and helps create multiple habitat types including pools and bars (Abbe and Montgomery 1996).

Woody debris habitats can be considered transient, however. 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 can also provide habitat/structure as sediment is eroded leaving exposed roots within the system. In addition, structures such as cypress knees can provide similar habitat while inundated. Due to the transient nature of instream woody habitat, instream woody habitat inundation was determined to not be appropriate for this MFL evaluation at this time and was not considered further. Additionally, the hydraulic control gate of the dam is periodically raised to allow accumulated vegetation to flow downstream adding to the transient nature of woody debris.

Floodplain and Riparian Wetland Vegetation Inundation – Much of the floodplain in the Jackson Blue Spring MFL study area remains in a relatively natural condition, making the protection of floodplain vegetation communities a relevant metric for MFL assessment. Following Hurricane Michael large portions of the Spring Creek floodplain habitat were severely damaged, while Merritts Mill Pond displayed significantly less damage. As a result, floodplain communities currently present along Spring Creek are not representative of historical conditions as described in Section 4.2. These floodplain communities are likely to undergo continued succession into a more stable community during the next several decades and may exhibit significant 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 the resampling of floodplain communities post-Hurricane Michael. As a result, the sampling of trees in the floodplain after Hurricane Michael was not conducted.

Although floodplain vegetation surveys were not conducted, this metric was addressed by evaluating total area inundated encompassing hydric soils and historical wetland vegetation along Spring Creek based on best available data. Additionally, a hydroperiod analysis tool was utilized to assess inundation of fringe and upland areas along Merritts Mill Pond. These metrics are protective of the flows required to inundate wetlands and floodplains independent of current community structure. Detailed description of methods for assessing riparian wetland and floodplain inundation and inundation of fringe and upland areas using the hydroperiod tool are presented in Section 7.

Instream Habitat of Aquatic Species – Since the Jackson Blue Spring MFL study area provides habitat for numerous aquatic species, metrics pertaining to instream habitat of aquatic species are relevant for this MFL evaluation. The instream habitat for documented species is assessed using habitat suitability metrics. Habitat suitability is defined as a function of stream depth and velocity at specific transect locations. The SEFA software uses these habitat suitability functions (habitat suitability curves) and simulated water-surface elevation and velocity data to compute values of a suitability index of available habitat (Area Weighted Suitability; AWS) for target organisms over a range of streamflow conditions. The effects of flow reduction scenarios on AWS can then be evaluated to quantify in-stream habitat metrics. Details regarding instream habitat modeling and metric analysis are presented in Sections 6 and 7.

WRV 3. Estuarine Resources – Estuaries are aquatic habitats located where freshwater mixes with saline marine waters and are defined as coastal waters of reduced salinity. The Florida Natural Areas Inventory (FNAI) defines estuaries as having salinities greater than 0.5 ppt (FNAI, 2010). Estuarine zones are characterized by highly fluctuating, but overall reduced, salinity levels. Estuaries are extremely important to both vegetation and wildlife, many species of which have evolved to thrive primarily in waters with highly variable salinity.

No estuarine waters are present within the Jackson Blue Spring study area. However, flows from Jackson Blue Spring ultimately drain into Apalachicola Bay via Merritts Mill Pond, Spring Creek, the Chipola River and Apalachicola River. Flows originating from Jackson Blue Spring and reaching the Apalachicola River represent a minute percentage of the total Apalachicola River flows. The long-term average Jackson Blue Spring discharge is 104 cfs, which comprises less than 0.5 percent of the average daily flow of 22,648 cfs measured at the Apalachicola River Sumatra station (NWFWMD 2017b). Because Jackson Blue Spring flow represents such a small portion of the flows flowing into the Apalachicola River, Estuarine Resources were not considered an appropriate WRV for Jackson Blue Spring MFL establishment.

WRV 4. Transfer of Detrital Material – Detrital material is comprised of dead organic material (largely vegetation) in the process of decomposition. Plant detritus can comprise large portions of the food base in aquatic and wetland ecosystems. Little quantifiable data is available regarding the transport of detrital material in Merritts Mill Pond or Spring 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, riparian wetland, and floodplain habitat inundation as a function of spring flow along the MFL study area. Maintaining these characteristics is expected to provide protection to riparian and wetland systems allowing for protection of this WRV and was considered in establishing MFLs for Jackson Blue Spring. Detailed descriptions of methods for assessing riparian bank, riparian wetland, and floodplain habitat inundation are presented in Section 7.

WRV 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, riparian wetland, and floodplain habitat inundation as a function of streamflow along Merritts Mill Pond and Spring Creek. Maintaining these characteristics 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 Jackson Blue Spring. Detailed methods for assessing riparian bank, riparian wetland, and floodplain habitat inundation are presented in Section 7.

WRV 6. Aesthetic and Scenic Attributes – Aesthetic and scenic attributes of the Jackson Blue MFL study area are defined as passive uses of the river such as nature viewing and photography. Passive uses are one of the main reasons for the popularity of Jackson Blue Spring, Merritts Mill Pond and Spring Creek and is therefore relevant to this MFL evaluation. Numerous habitat-based metrics which could be associated with passive uses such as native vegetation (instream and riparian) and wildlife are addressed under WRV2 Fish and Wildlife Habitats and the Passage of Fish. Therefore, protection of metrics under WRV2 Fish and Wildlife Habitats and the Passage of Fish also provides protection for WRV6 Aesthetic and Scenic Attributes.

Previous MFLs have described an increase in filamentous algal cover 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 algae from substrates they attach to (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 used 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, water velocities in Merritts Mill Pond are consistently below the 0.8 ft/s threshold described above due to the impoundment. Because water velocities in Merritts Mill Pond are routinely below the algal growth impediment threshold on 0.8 ft/s and submerged aquatic vegetation in Spring Creek was largely absent, this metric was not considered further for MFL analysis.

Similar to excessive algal cover, nuisance and exotic vegetation can decrease the aesthetics of an aquatic system. Nuisance and exotic vegetation can be abundant in Merritts Mill Pond at times and is treated with herbicide as needed. The presence of nuisance and exotic vegetation is likely related to the elevated nitrate (NO_3) concentrations present in the pond arising from the Floridan aquifer. These nitrate levels are currently being addressed by FDEP through the BMAP process. The relation between nitrate levels and Jackson Blue Spring flow are not statistically significant, indicating that a reduction in spring flow is not likely to adversely affect the presence of nuisance, exotic vegetation (via water quality impairments). As a result, this metric was not considered further for MFL analysis.

WRV 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 Merritts Mill Pond and Spring Creek. As a result, this WRV was unable to be associated with a directly quantifiable metric related to spring flow.

Although filtration and absorption of nutrients and other pollutants was not directly evaluated, this WRV was addressed indirectly by considering the frequency of riparian bank, riparian wetland, and floodplain habitat inundation as a function of spring flow along the MFL study area. Maintaining these characteristics along Merritts Mill Pond and Spring Creek is expected to provide protection to riparian and wetland systems allowing for protection of this WRV and was considered in establishing MFLs for Jackson Blue Spring. Detailed description of methods for assessing riparian bank, riparian wetland, and floodplain habitat inundation are presented in Section 7.

WRV 8. Sediment Loads – The importance of sediment transport in the maintenance of Merritts Mill Pond and Spring Creek geomorphology and its associated ecological communities was considered as a WRV for this MFL evaluation. However, while sediment transport can occur during all flows, net sediment transport in a river is often a function of the frequency and intensity of flow at flood stages (Wolman and Miller 1960). Information concerning sediment size and transport downstream is currently unavailable for both Merritts Mill Pond and Spring Creek. As a result, this WRV was unable to be associated with a directly quantifiable metric.

Although sediment transport was not directly evaluated, this WRV was addressed indirectly by considering the frequency of riparian bank, riparian wetland, and floodplain habitat inundation as a function of spring flow along Merritts Mill Pond and Spring Creek. Maintaining these characteristics along the system is expected to provide protection to sediment transport processes which are more likely to occur at higher flows allowing for protection of this WRV. Detailed descriptions of the methods for assessing riparian bank, riparian wetland, and floodplain habitat inundation are presented in Section 7.

WRV 9. Water Quality – Based on the water quality data analyses presented in Section 3, metrics pertaining to water quality were not utilized in the MFL determination for the Jackson Blue system. As discussed previously, Jackson Blue Spring nitrate levels displayed an increasing trend from 1989 through 2024 and are currently being addressed through a BMAP for Jackson Blue Spring and Merritts Mill Pond. Specific conductance displayed an increasing trend while dissolved oxygen displayed a declining trend from 2013 through2024. Although specific conductance displayed an increasing trend, values are still well below thresholds which would cause concern to freshwater ecology for Jackson Blue Spring or Merritts Mill Pond. Low dissolved oxygen within freshwater spring systems in Florida such as Jackson Blue Spring is typical and is not of concern. Although turbidity displayed an increasing trend, turbidity levels are much less than water quality standards for Class III waters (29.0 NTU), indicating Merritts Mill Pond is relatively clear. Furthermore, all parameters displayed no correlation with Jackson Blue Spring discharge, indicating that potential reductions in flow caused from groundwater withdrawals are unlikely to significantly affect water quality for Jackson Blue Spring and Merritts Mill Pond.

WRV 10. Navigation – This WRV refers to the navigation of commercial vessels within the study area. The Jackson Blue Spring System is not used for commercial navigation, making the Navigation WRV inappropriate for minimum flows determination for this system. Both Merritts Mill Pond and Spring Creek do support economic activities such as boat rentals for recreational use. However, these uses are addressed in Water Resource Value 1 – Recreation in and on the Water.

5.2 Water Resource Values Selected for MFL Development

After carefully considering all ten WRVs, the WRVs determined to be most appropriate for the establishment of minimum spring flows are as follows:

- Recreation In and On the Water
- Fish and Wildlife Habitat and the Passage of Fish
- Recreation In and On the Water
- Fish and Wildlife Habitat and the Passage of Fish
- Transfer of Detrital Material
- Maintenance of Freshwater Storage and Supply
- Filtration and Absorption of Nutrients and Other Pollutants
- Sediment Loads
- Aesthetic and Scenic Attributes

Three WRVs were considered not appropriate for the establishment of MFLs for Jackson Blue including:

- Estuarine Resources
- Navigation
- Water Quality

A list of Water Resource Values and associated metrics utilized in the assessment of Jackson Blue Spring MFLs is provided in Table 5-1.

Table 5-1. Summary of water resource values and metrics considered for Jackson Blue Spring MFL evaluation.

Metric	Criteria	Extent	Water Resource Value
Canoe/kayak passage	Maintain a minimum depth of 1.5 ft above thalweg	Entire study area	Recreation in and on the water
Power boat passage	Maintain a minimum depth of 2 ft across a 30-ft width	Merritts Mill Pond only	Recreation in and on the water
Power boat passage	Maintain a minimum depth of 2 ft across a 15-ft width	Spring Creek only	Recreation in and on the water
Tubing passage	Maintain minimum depth of 1.05 ft above thalweg	Spring Creek only	Recreation in and on the water
Fish passage	Maintain minimum depth of 0.6 ft above thalweg	Entire study area	Fish and wildlife habitat and the passage of fish
Instream habitat of aquatic species	Maximum area weighted suitability (AWS) versus streamflow for select aquatic species using SEFA	Entire study area	Fish and wildlife habitat and the passage of fish
Riparian wetland and floodplain inundation	Total inundated area containing hydric soils or wetland vegetation	Spring Creek only	Fish and wildlife habitat and the passage of fish; transfer of detrital material; maintenance of freshwater storage and supply; aesthetic and scenic attributes; filtration and absorption of nutrients and other pollutants; sediment loads; and water quality
Lacustrine hydroperiod	Total area of ecologically or socially relevant zones defined by critical depths	Merritts Mill Pond only	Recreation in and on the water; fish and wildlife habitat and the passage of fish; transfer of detrital material; maintenance of freshwater storage and supply; aesthetic and scenic attributes;

Metric	Criteria	Extent	Water Resource Value
			filtration and absorption of nutrients and other pollutants; sediment loads; and water quality
Weighted wetted perimeter	Water elevations at changepoints in the relationship between wetted perimeter and flow, aggregated for all cross sections, weighted by longitudinal distance	Entire study area	Fish and wildlife habitat and the passage of fish; transfer of detrital material; maintenance of freshwater storage and supply; aesthetic and scenic attributes; filtration and absorption of nutrients and other pollutants; sediment loads; and water quality
Detailed wetted perimeter	Water elevations at changepoints in the relationship between wetted perimeter and flow, separately for each cross section	Entire study area	Fish and wildlife habitat and the passage of fish; transfer of detrital material; maintenance of freshwater storage and supply; aesthetic and scenic attributes; filtration and absorption of nutrients and other pollutants; sediment loads; and water quality

6 Models Used in Minimum Flow Determination

This section provides a general summary of the models used in used in this technical assessment to support development of the recommended minimum flows for Jackson Blue Spring. Detailed technical documentation of these models is provided in Appendices A through C. Each report and corresponding appendix describes the selection, development, calibration, and use of the models in this MFL analysis.

6.1 North Central District Model (NCDM)

A steady-state, groundwater flow model was developed to support regional water supply planning, minimum flow and minimum water levels evaluations, and water use permitting evaluations for waterbodies in the north-central area of the District. This model is referred to as the North Central District Model (NCDM) and is intended primarily to support the establishment of a minimum flow for Jackson Blue Spring by providing a tool for estimating changes in the flows of the spring in response to changes in groundwater withdrawals from wells. The NCDM was implemented using the U.S. Geological Survey MODFLOW-NWT (Niswonger and others, 2011) computer program for solving the three-dimensional groundwater flow equation. A summary of the development and calibration of the NCDM is presented below. Detailed documentation of the development and application of the NCDM is provided in Appendix A of this report. Steady-state models have been used to support development of MFLs for springs, spring-fed river reaches, and lakes (ECT, November 2022; HSW Engineering, January 2021; Sutherland and others, 2020). Use of a steady-state model was considered appropriate for the development of Jackson Blue Spring MFL because its application in this context was to estimate average changes in the flow from the spring in response to pumping, rather than as a tool for estimating absolute flows and changes in flows over relative short periods, such as seasonal simulations.

6.1.1 Model Development

Development of the NCDM essentially consisted of two steps. In the first step, an initial, uncalibrated version of the NCDM was constructed. In the second step, this initial version of the NCDM was refined by adjusting hydraulic property and boundary condition values within plausible ranges to improve the correspondence between historical observations (calibration targets) and their model-simulated equivalents.

Construction of the model began with the definition of the active area of the NCDM, which extends across an approximately 1,600 square mile area that includes parts of Jackson, Calhoun, Holmes, and Washington Counties in Florida, and parts of Houston and Geneva Counties in Alabama (Figure 6-1). The northern extent of the NCDM coincides with the approximate updip limit of the productive part Floridan aquifer system as delineated by Williams and Kunianski (2015). The eastern boundary of the NCDM coincides with the Chattahoochee and Apalachicola Rivers, and most of the western and southwestern boundaries coincide with regional groundwater flow paths that define no-flow boundaries at distances intended to be sufficient to minimize their effect on simulated changes in flow at and near Jackson Blue Spring. Limited areas of the western and southern boundaries are defined by constant head boundaries, where water flows out of the NCDM.

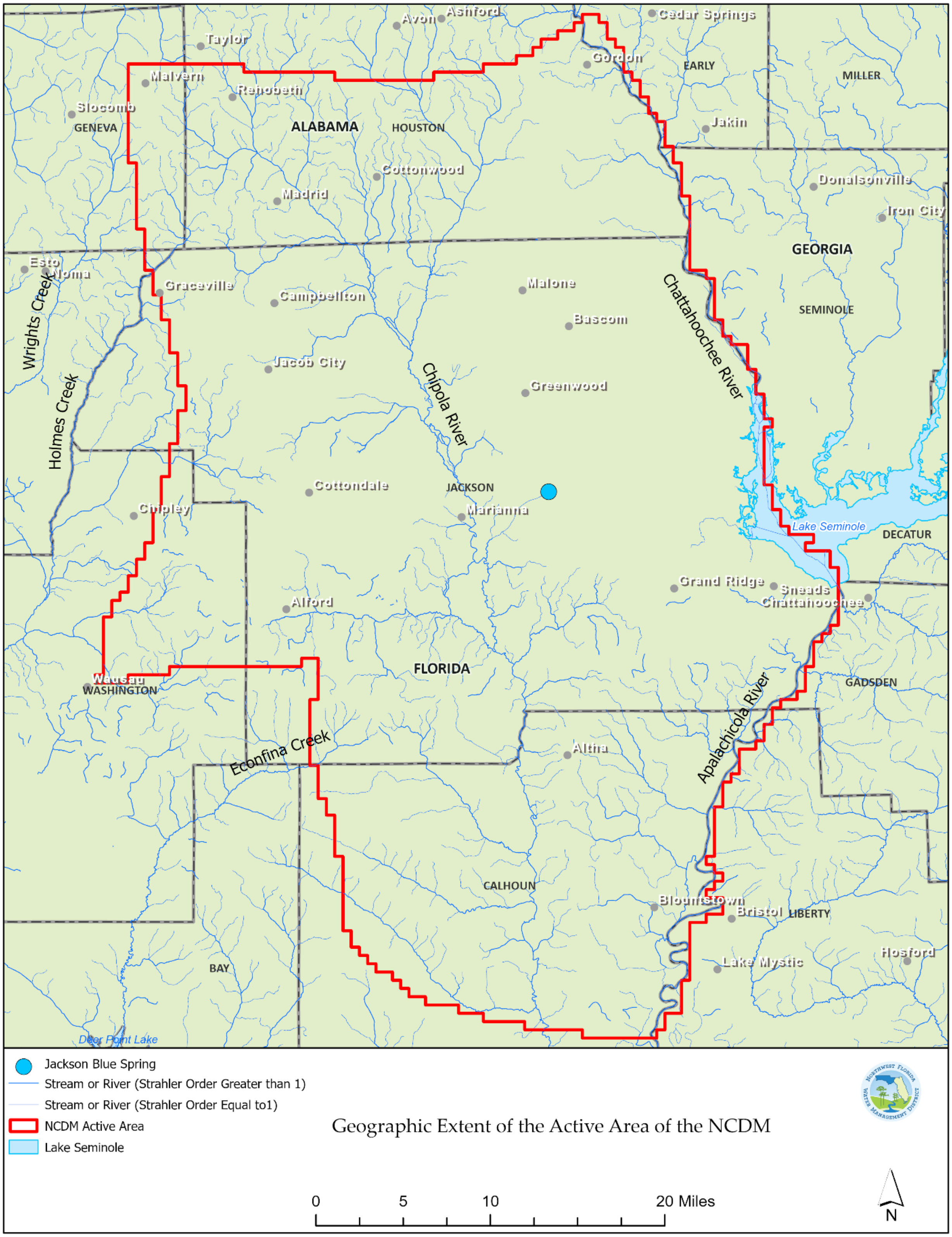


Figure 6-1. Geographic extent of the NCDM groundwater flow model.

The NCDM was discretized horizontally into square grid cells that are 2,500 feet on each side (Figure 6-2). The NCDM actively simulates groundwater levels and flows within each of the five major hydrogeologic units in this region: the surficial aquifer system, the upper confining unit of the Floridan aquifer system, the Upper Floridan aquifer, the middle confining unit of the Floridan aquifer system, and the Lower Floridan aquifer. The NCDM is discretized vertically into five layers that generally correspond to these hydrogeologic units, and this vertical discretization was based on the elevations of the tops and bottoms of these units.

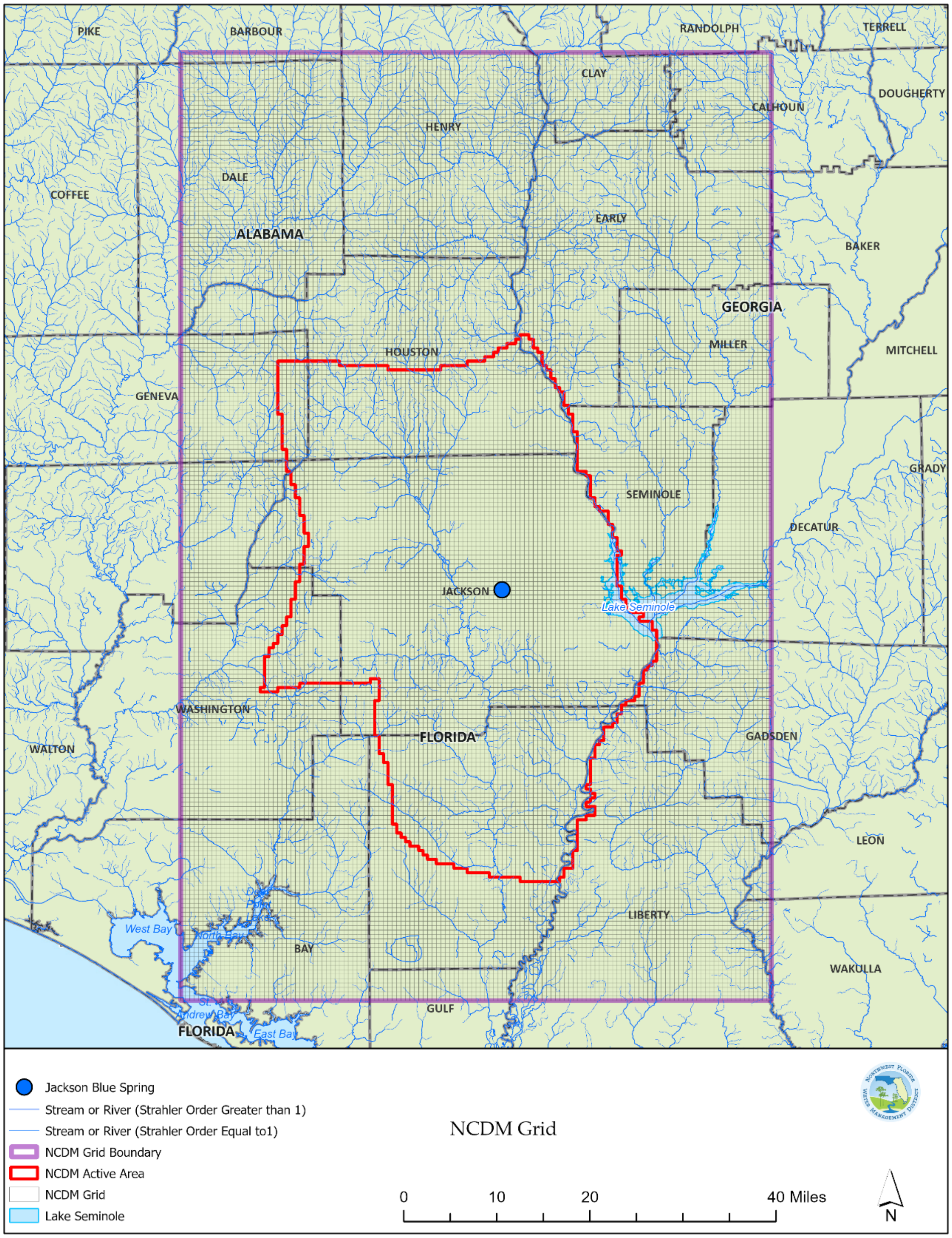


Figure 6-2. NCDM model grid.

The NCDM was developed as a steady-state model, and calibrated to average conditions occurring from January 1, 2017, through December 31, 2019. Model calibration consisted of adjusting initial estimates of hydraulic conductivity, conductance of subsurface connections with river, stream, and spring features, recharge rates, and maximum rates of direct evapotranspiration from the water table to better match calibration targets defined by groundwater levels, groundwater level-differences, springflows, and stream and river baseflows during the calibration period, and to also minimize the occurrence of cells where shallow groundwater levels exceeded land surface (through flooding penalty targets). Summary statistics of differences between these target values and their model-simulated equivalents (residuals; Table 6-1) indicated a relatively unbiased, well-fit model, particularly for the head and spring flow targets, which were treated as higher-priority targets during the NCDM development. Scatterplots illustrating the relation between calibration targets and their simulated equivalents for groundwater level and springflow targets are shown in Figure 6-3 and Figure 6-5, respectively. Maps of residual values for groundwater level and springflow targets are shown in Figure 6-4 and Figure 6-6, respectively. Baseflow targets and corresponding simulated residual values are shown in Table 6-2. Calibration targets were generally most sensitive to parameters associated with the hydraulic conductivity of the Upper Floridan aquifer and groundwater recharge, which is typical of groundwater flow models of the Upper Floridan aquifer.

Table 6-1. Statistical summary of calibration target residuals of the NCDM.

Calibration Target Group Name	*Count*	*Minimum*	*25th Percentile*	*Mean*	*Median*	*Standard Deviation*	*Mean Absolute Value*	*75th Percentile*	*Maximum*
Horizontal Head Differences	5	-1.4	-0.7	-0.6	-0.4	0.5	0.6	-0.3	-0.2
Vertical Head Differences	8	-1.9	-0.1	1.0	0.9	1.9	1.7	2.4	3.7
Groundwater Levels	46	-3.9	-0.5	0.4	0.4	2.1	1.4	1.2	9.2
Flooding Penalty	7205	0.0	0.0	0.0	0.0	0.7	0.0	0.0	31.6
Spring Flows	39	-24.8	-1.8	-1.1	0.0	5.1	2.6	0.6	8.7
River and Stream Base Flows	5	-6.3	7.7	55.0	21.7	66.0	57.6	115.2	136.9

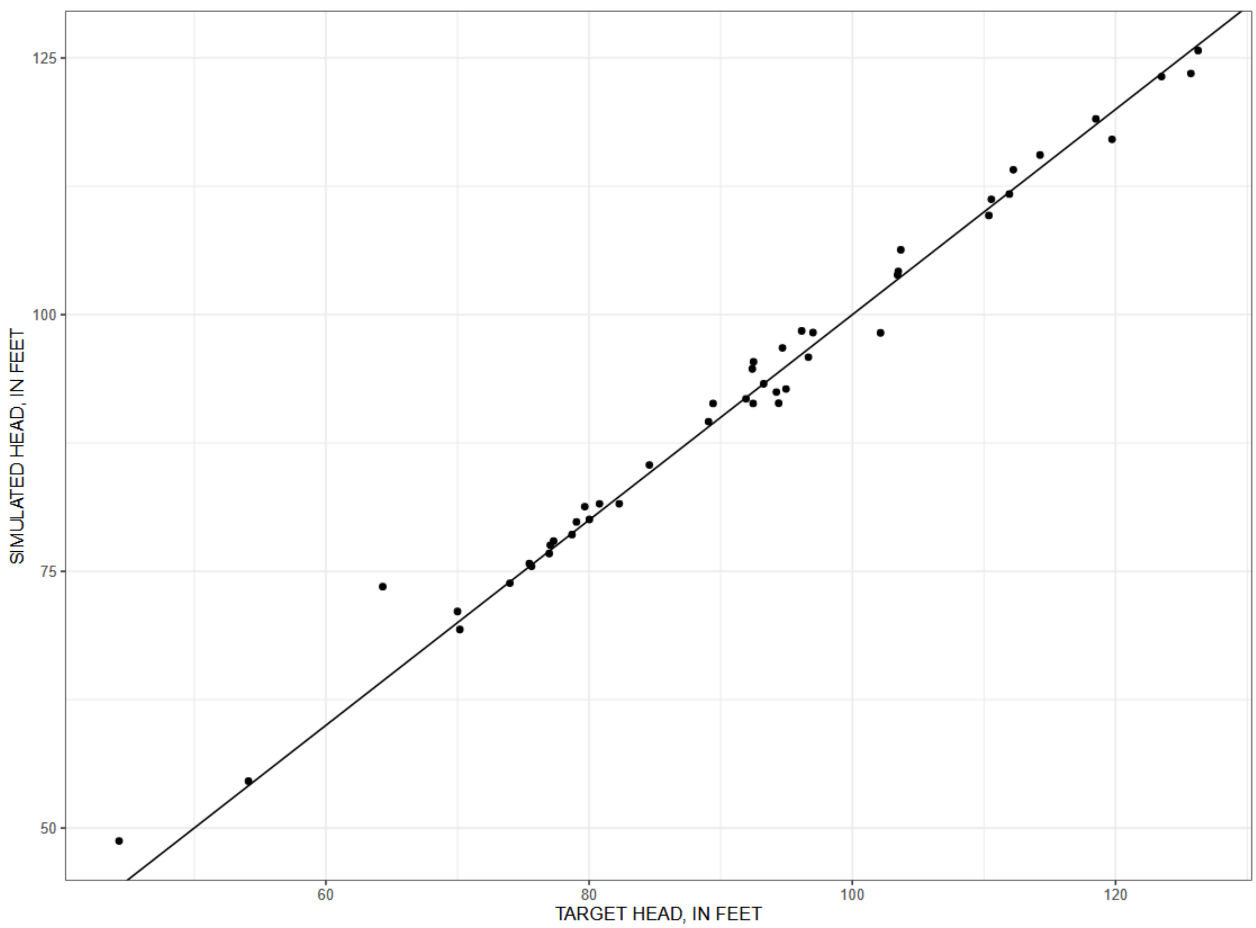


Figure 6-3. Plot of simulated versus calibration target values of groundwater levels.

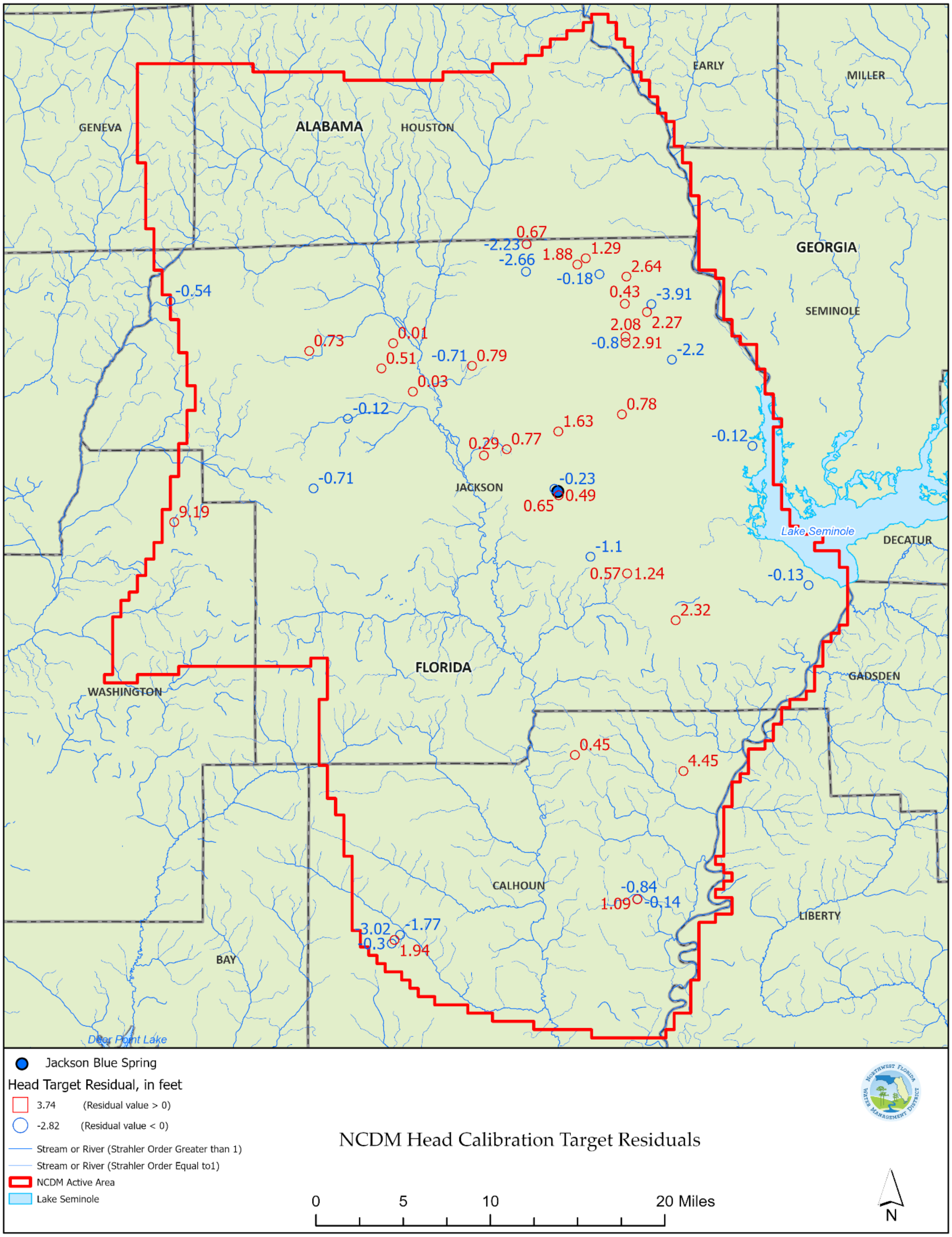


Figure 6-4. Map of differences (residuals) between simulated and calibration target values of groundwater levels.

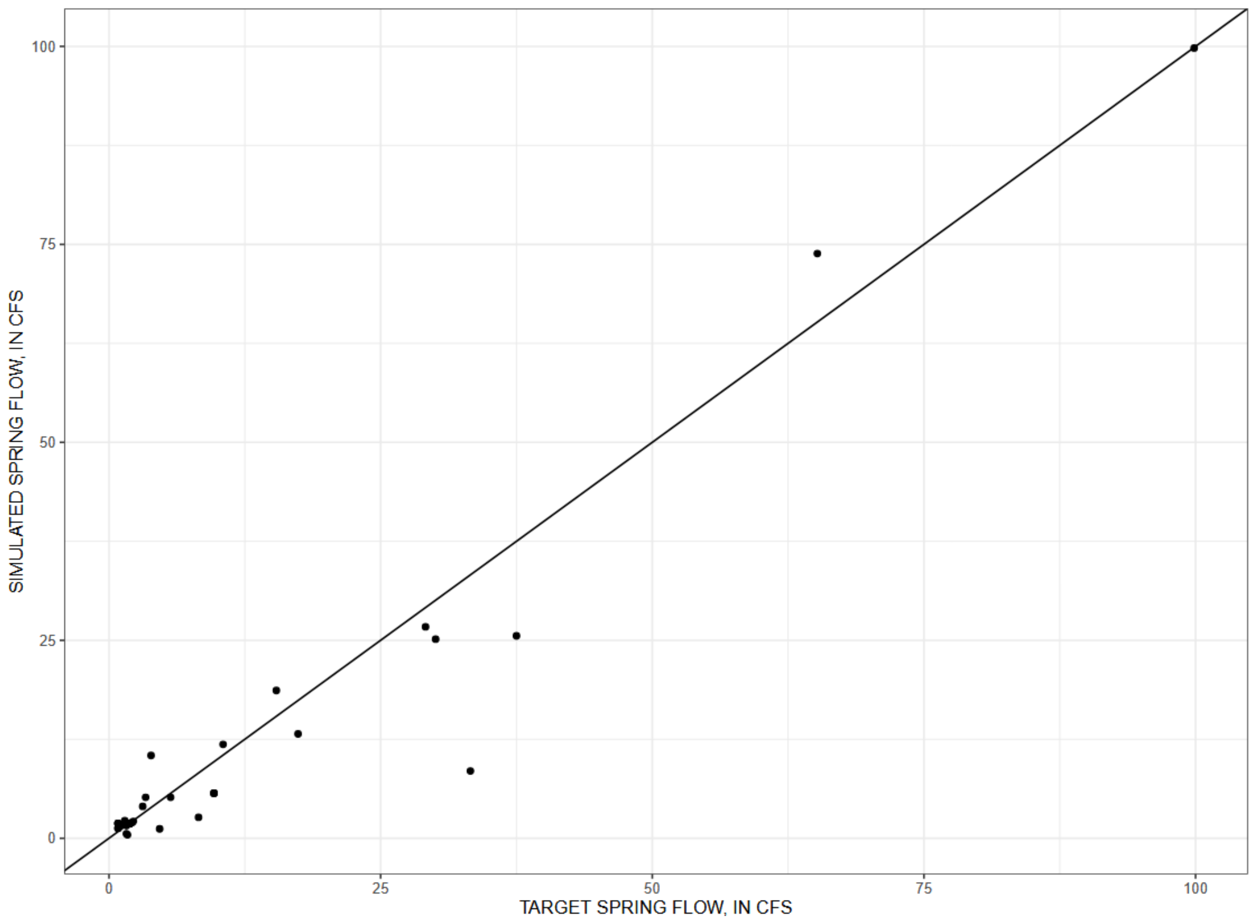


Figure 6-5. Plot of simulated versus calibration target values of spring flows.

Table 6-2. Baseflow target locations and values, and corresponding simulated and residual values.

Reach Description	*Target Value, in cfs*	*Simulated Value, in cfs*	*Residual Value, in cfs*
Reaches contributing to flow to the Chipola River at Marianna gage (02358789)	551	573	21.7
Reaches contributing flow to the Chipola River near Altha gage (02359000) but downstream from the Chipola River at Marianna gage (02358789)	609	724	115
Reaches contributing flow to the Chipola River near Altha gage (02359000)	1160	1296	137
Merritts Mill Pond, including contributions from Jackson Blue Spring	239	233	7
Spring Creek, excluding flows from Merritts Mill Pond	0	7.7	7.7

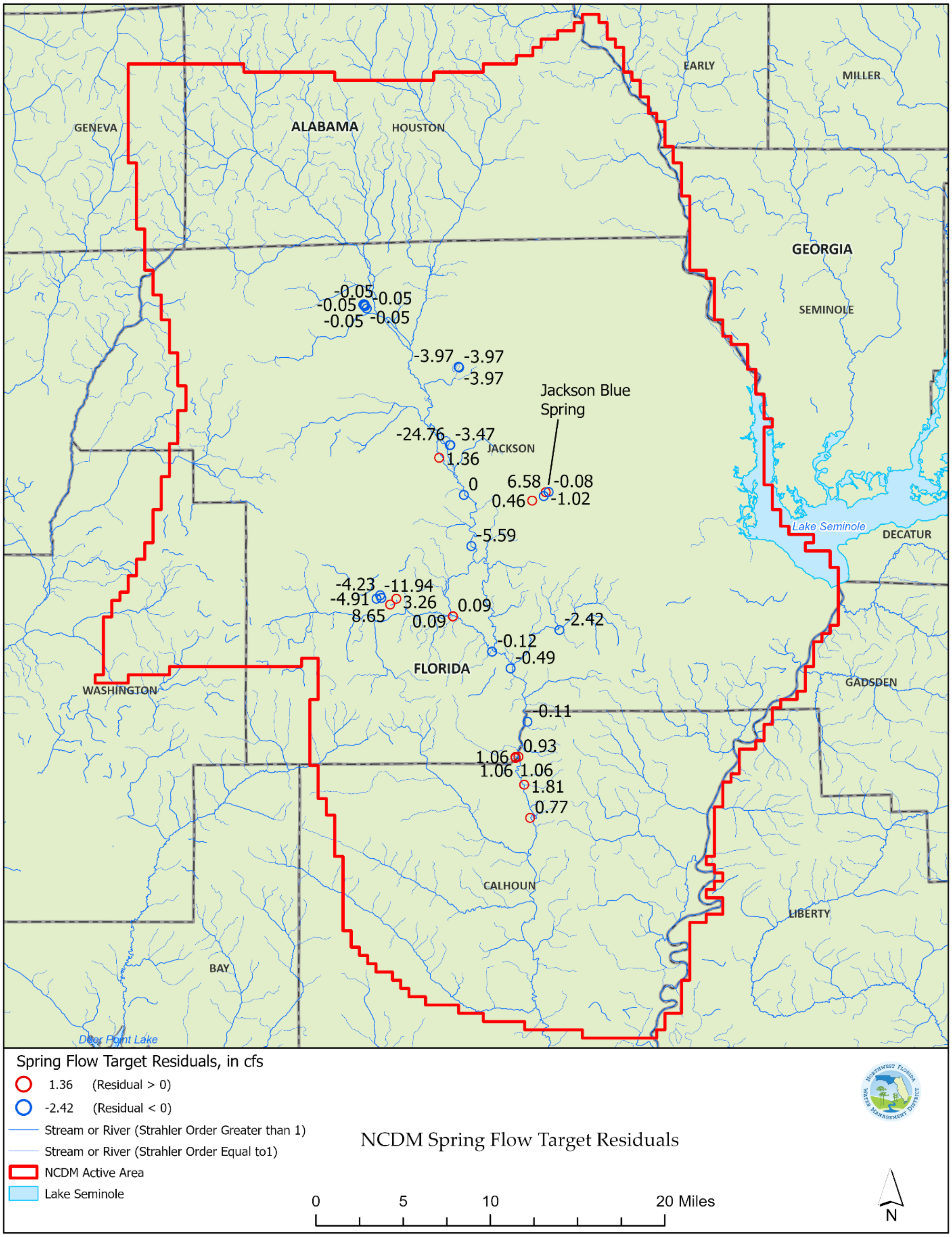


Figure 6-6. Map of differences (residuals) between simulated and calibration target values of spring flows.

6.1.2 Estimation of Pumping Impacts on Groundwater Flow to Jackson Blue Spring and Merritts Mill Pond

The NCDM was used to estimate historical and projected impacts of pumping on groundwater flow to Jackson Blue Spring and to Merritts Mill Pond by executing a set of simulations representing groundwater pumping conditions in calendar years 2000, 2005, 2010, 2015, 2020 and projected conditions in 2045. In each of these simulations, the locations and rates of pumping were varied to reflect withdrawals occurring in a given year, while keeping all other aspects of the model constant. An additional 'no-pumping' simulation was executed in which no pumping was simulated, while again keeping all other aspects of the model constant. Simulated groundwater flows to Jackson Blue Spring and Merritts Mill Pond from each simulation, representing historical or projected pumping condition in a given year, were then subtracted from corresponding simulated groundwater flows under the no-pumping simulation, resulting in an estimated pumping impact for that year. In this way, pumping effects are isolated from other time-varying factors that could affect groundwater flows to Jackson Blue Spring and Merritts Mill Pond. As such these simulations were only intended to estimate pumping impacts and not intended to simulate the actual flows that occurred in a given year.

As noted above, differences between 'pumps-on' and 'pumps-off' values of simulated flows were used to estimate the impact of pumping in a given year. For example, the estimated impact of pumping on flows to Jackson Blue Spring under the year 2005 pumping conditions was computed as follows:

1. The NCDM is run with pumping at rates and locations associated with those in calendar year 2005 and the simulated groundwater flow to Jackson Blue Spring is obtained.
2. The NCDM is run without any pumping simulated and the corresponding simulated groundwater flow to Jackson Blue Spring is obtained.
3. The simulated flow obtained in the first step is subtracted from that obtained in the second step, thereby providing an estimate of the impact of pumping on the groundwater flow to Jackson Blue Spring in 2005.

The above steps were repeated for each of the 'pumps-on' conditions (pumping locations and rates in years 2000, 2005, 2010, 2015, 2020 and 2045). An identical procedure was used to estimate simulated pumping impacts on groundwater flow to Merritts Mill Pond. The resulting estimated pumping impacts are shown in Table 6-3. Note that the simulated impacts shown in Table 6-3 for Merritts Mill Pond do not include pumping impacts on Jackson Blue Spring (those are already accounted for the column labeled 'Jackson Blue Discharge' in Table 6-3). The total simulated pumping impacts on the outflow from Merritts Mill Pond are therefore equal to the sum of the Jackson Blue Spring and Merritts Mill Pond pumping impacts shown in Table 6-3.

Table 6-3 Estimated pumping impacts on flows to Jackson Blue Spring and Merritts Mill Pond in years 2000, 2005, 2010, 2015, 2020, and 2045.

Pumping Condition	Simulated Pumping Impact, in cubic feet per second	
	Jackson Blue Spring Discharge	Merritts Mill Pond Inflow (excluding Jackson Blue Spring)
2000	3.3	3.8
2005	3.0	3.5
2010	4.7	5.3
2015	4.5	5.2
2020	4.5	5.3
2045	5.8	6.7

6.2 Hydrologic Engineering Center – River Analysis System (HEC-RAS) Model

The Hydrologic Engineering Centers River Analysis System (HEC-RAS; U.S. Army Corps of Engineers, 2021) model is a widely used one-dimensional, open-channel flow model for hydraulic analysis of river channels and associated floodplains. 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 conditions. Calculations are based on computed energy losses and changes in storage between adjacent cross sections.

A HEC-RAS model of the Jackson Blue Spring MFL study area was developed using HEC-RAS version 6.4.1. A summary of the development and calibration of the HEC-RAS model used for this evaluation is presented below. Further details documenting HEC-RAS model development, testing, calibration, and verification are provided in Appendix B of this report.

The unsteady-state HEC-RAS model of the study area (between Jackson Blue Spring and the Spring Creek confluence with the Chipola River) was developed by ATM, a Geosyntec Company (ATM) in support of MFL development for Jackson Blue Spring, with initial modeling efforts conducted by Verdantas. The model was constructed with the best available data. This included high-resolution, land-surface digital elevation model (DEM) data, recent cross sectional survey data throughout the model domain, and hydrologic data from all available stations along Merritts Mill Pond and Spring Creek, with additional data from the Chipola River. Although a HEC-RAS model had previously been developed in 2015 for Merritts Mill Pond and a portion of Spring Creek for performing FEMA flood evaluations, a new model was constructed for purposes of MFL evaluation to implement the required model resolution at low flows, and to incorporate newly available DEM, survey, and hydrologic data, including data reflecting significant changes to the system resulting from Hurricane Michael impacts. Surveyed US 90 bridge and hydraulic control structure dimensions contained in the existing FEMA model were utilized for the updated MFL HEC-RAS model. An additional survey of control structure dimensions was also performed in 2016 to obtain additional dimensions not included in the existing model (DRMP, 2017).

6.2.1 Model Construction

The study area for the Jackson Blue Spring MFL and HEC-RAS model encompasses the entire 6.1-mile reach that defines the study area: from Jackson Blue Spring to the confluence of Spring Creek and the Chipola River (Figure 6-7). This includes the entirety of Merritts Mill Pond, approximately 4.3 miles in length, from Jackson Blue Spring to the control structure at U.S. 90, as well as the entirety of Spring Creek, approximately 1.8 miles in length, from the control structure at U.S. 90 to its terminus at the confluence with the Chipola River.

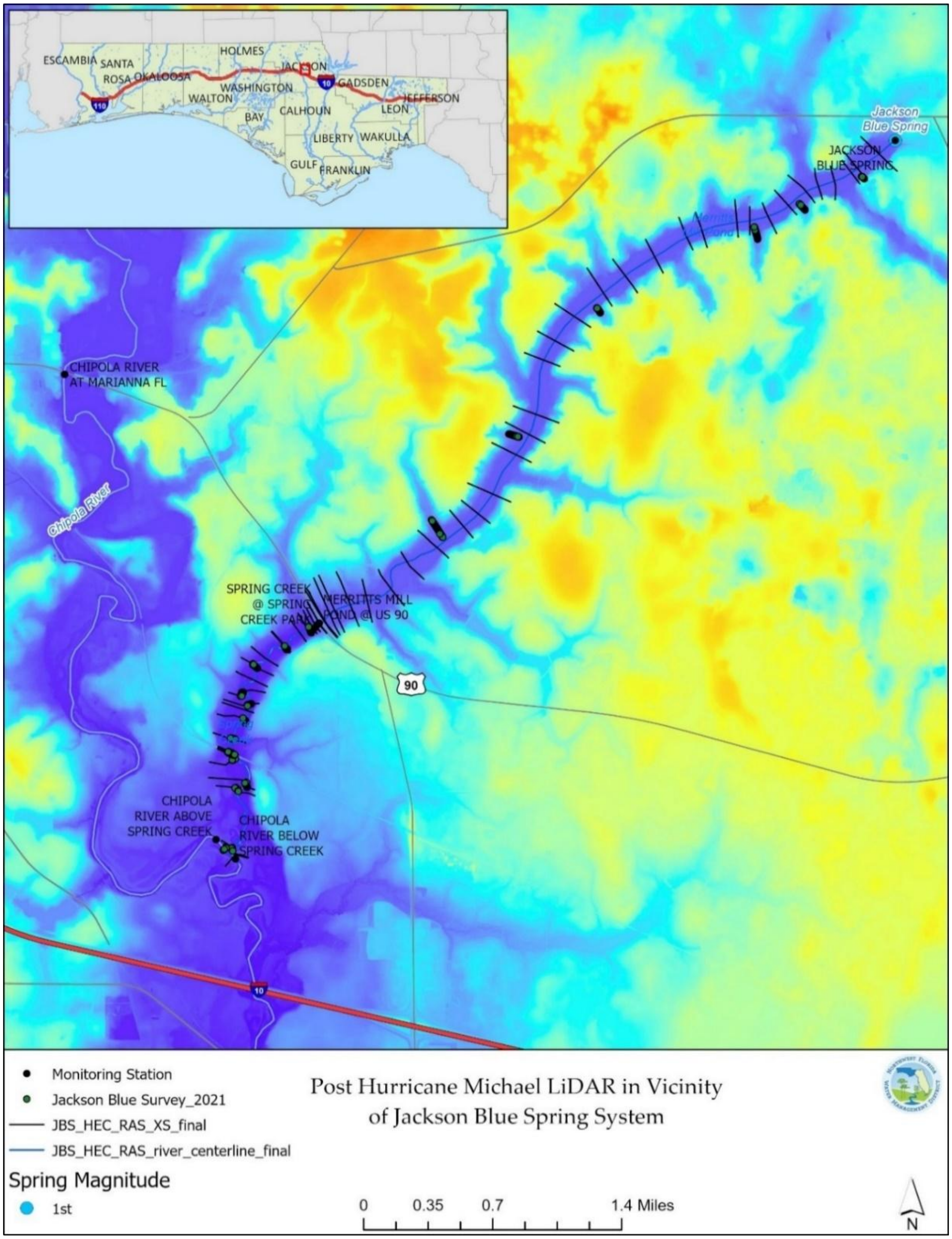


Figure 6-7. HEC-RAS model domain and Post-Hurricane Michael LiDAR-derived land surface elevations in the vicinity of Jackson Blue Spring.

A total of 57 cross-sections were digitized using the RAS Mapper software (U.S. Army Corps of Engineers, 2021), extending sufficiently into the floodplain to accommodate high flow scenarios. Cross sections were digitized to coincide with survey locations as well as locations of transects from the FEMA model where applicable. Elevations for all transects were initially determined based on the terrain generated from the post-Michael DEM. Elevation survey points were used to replace the terrain-derived elevations within the channel at all cross sections where survey data were available (Figure 6-8). Channel geometry for the remaining cross sections was determined either from existing model bathymetry or interpolated based on the adjacent upstream and downstream transect. For all cross sections, terrain-generated elevations were used for overbank (floodplain) areas. After cross sections were defined in RAS Mapper, each cross section was reviewed in the geometry editor within HEC-RAS. A few minor adjustments were made to the generated elevations from RAS Mapper to be consistent with survey elevations using the geometry editor tools.

The existing model representation of the Merritts Mill Pond control structure was assessed to confirm structure physical dimensions and representation in the model, including overflow/invert elevations. This was accomplished by comparing structure rehabilitation plans and as-built documents to the existing model representation. Review of the plans, as-built documents, and dimensions measured by DRMP in 2016, indicated that all information needed to incorporate the control structure as an inline structure in HEC-RAS was present. Therefore, additional surveying of the control structure was not required.

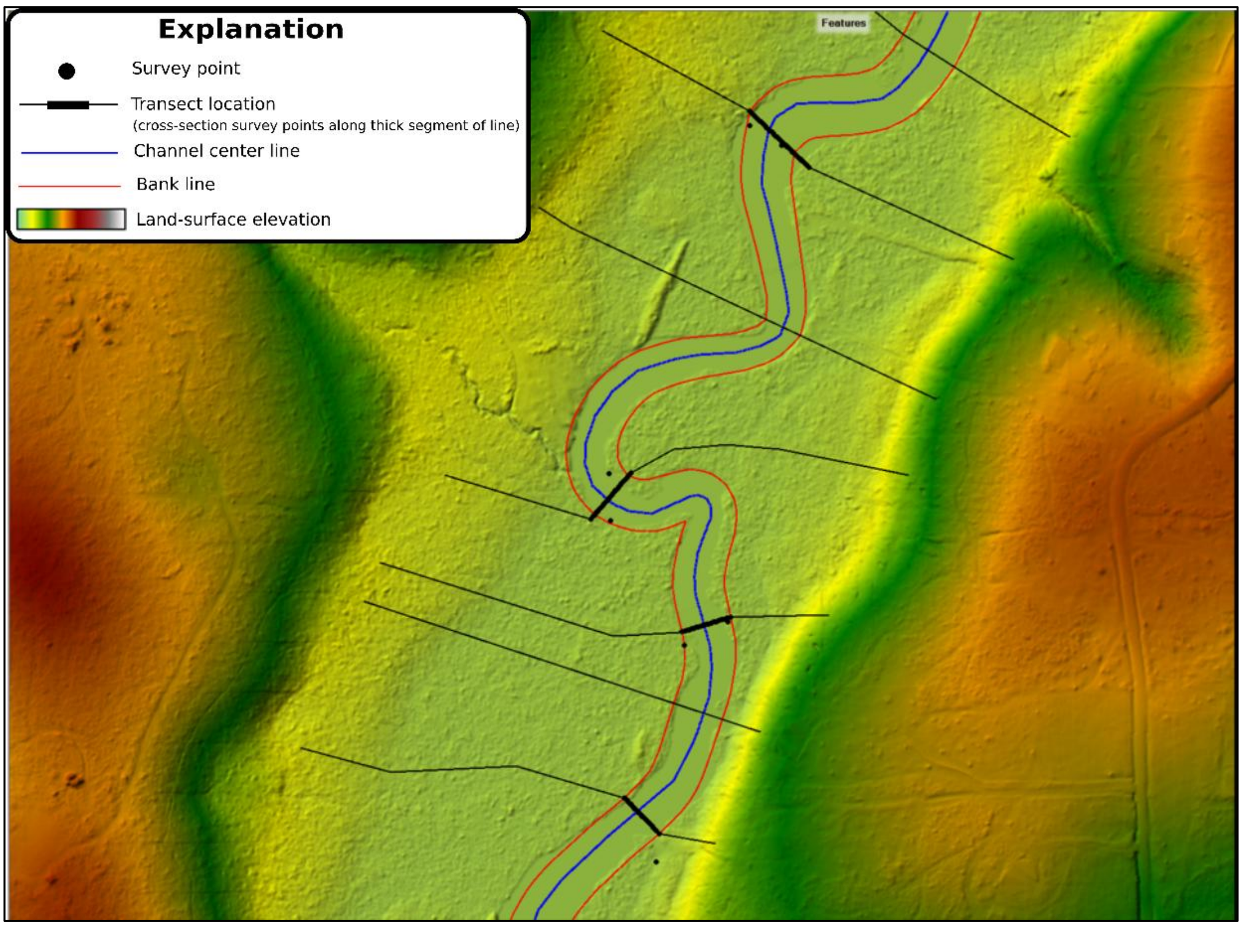


Figure 6-8. Digitization of cross sections overlaying survey points in RAS Mapper.

Four boundary conditions (three flow, and one stage) were used in the model setup. Data necessary to implement these boundary conditions were obtained from surface water monitoring stations along

Merritts Mill Pond, Spring Creek, and the Chipola River maintained by the District and USGS and presented in Table 6-4 and Figure 6-7, including:

- USGS 02358789 Chipola River Near Marianna, FL
- NWFWMD 005042 Jackson Blue Spring
- NWFWMD 011107 Merritts Mill Pond @ US 90
- NWFWMD 012820 Chipola River above Spring Creek

Table 6-4. Summary of surface water monitoring stations utilized to determine model inputs.

Station Number	Site Name	Period of Record
USGS 02358789	Chipola River Near Marianna, FL	Continuous Discharge: Oct. 1999 – present Continuous Stage: Oct 1999 – present
NWFWMD 005042	Jackson Blue Spring	Continuous Discharge: Dec. 2004 – present Field Visit Discharge Measurements: 12 measurements prior to 2001; quarterly measurements 2001 – present
NWFWMD 011107	Merritts Mill Pond @ US 90	Continuous Discharge: May. 2017 – July 2017, Aug. 2018 – Oct 2020, Dec 2020 – Mar. 2021, June 2021 – Nov. 2022 Field Visit Discharge Measurements: quarterly measurements Aug 2013 – Nov. 2022 Continuous Stage: April 2015 – present
NWFWMD 12820	Chipola River above Spring Creek	Continuous Stage: Sept. 2020 – Mar. 2023

The HEC-RAS model was implemented with the following four boundary conditions and corresponding datasets:

- Jackson Blue Spring Discharge – inflow hydrograph at the upstream boundary of the model, based on the Jackson Blue Spring daily discharge time series provided by the District. This time series was converted to a 15-minute discharge time series for input into the model.
- Additional flow between Jackson Blue Spring and US 90 – measured as the difference between flow measured at the Merritts Mill Pond @ US 90 gage near the control structure and Jackson Blue Spring discharge. This flow pickup along the pond was specified as a time-varying, uniform lateral inflow hydrograph between the spring vent and the control structure. The flow pickup along Merritts Mill Pond occurs as diffuse groundwater seepage, discharge from minor spring vents, and surface runoff during large storm events.
- Merritts Mill Pond Control Structure – represented with appropriate hydraulic equations depending on the gate opening. A time series of gate openings for the inline structure was used

as input and was based on gate operation logs provided by Jackson County, who operate and maintain the structure.

- Chipola River Stage – downstream boundary-condition stage hydrograph, based on stage data from NWFWMD 12820 Chipola River above Spring Creek. Missing data were estimated based on measured water surface elevations at the USGS gage 02358789 Chipola River at Marianna, which is about five miles upstream from the District's Chipola River above Spring Creek gage (Verdantas, 2022).

6.2.2 Model Testing and Calibration

A model simulation period for testing and calibration beginning April 1, 2019, was determined to represent the current stage-discharge relationship for the Jackson Blue Spring system based on the evaluation of stage-discharge relations for USGS station 02358789 Chipola River near Marianna. As discussed in detail in Section 4.7.3, this period is reflective of debris removal completion and recovery of the system to a stable rating from the impact of Hurricane Michael. The Jackson Blue MFL HEC-RAS model was tested by simulating the period from April 2019 to October 2020 to assess model execution and performance, including model stability, continuity error, and computational errors and warnings. The period from April 2019 to October 2020 represented the longest continuous time period of concurrent data for all necessary model inputs (Jackson Blue discharge, flow pickup along Merritts Mill Pond, gate operation records, and downstream stage boundary condition) after April 2019.

Testing of the initial version of the model revealed several areas of model instability, particularly in the vicinity of the US 90 bridge, Merritts Mill Pond inline control structure, and the railroad bridge crossing on Spring Creek. These model instabilities resulted in the model not executing to completion for the duration of the model testing simulation period. In order to address these issues, a sequential diagnostic approach was utilized to isolate and address model instabilities.

First, the U.S. 90 bridge and inline structure were removed from the model to assess instabilities in the vicinity of the railroad bridge. After extensive testing, it was determined that model instabilities in the vicinity of the railroad bridge were due to inaccurate representation of this feature in the previous version of the model. Removal of the railroad bridge located on Spring Creek near the Chipola River from the model resulted in a stable simulation, executing to completion over the simulation period. The railroad bridge was not included in the final version of the model since surveyed bridge details were not available and the bridge was resulting in model instability. However, the immediate upstream and downstream cross sections at the bridge were surveyed and were included in the model. Given the high elevation of the bridge low chord and the minimal channel constriction at the bridge, it was determined that the bridge would likely affect flow only during the most extreme high flow events. To further validate this assumption, LiDAR topographic data were used to approximate the elevation of the bridge and compared with output from the completed steady state HEC-RAS model to determine what flow condition would result in water levels reaching the low chord of the bridge. The highest simulated stage at the bridge was 65.36 feet, and this was for the 99th percentile Jackson Blue Spring flow (upstream boundary condition) and 90th percentile downstream stage (at the mouth of Spring Creek) boundary condition. LiDAR topographic data indicate that the elevation of the roadway approach to the bridge is about 83 feet.

Assuming the elevation of the bridge deck is no lower than the roadway approach, then the low chord elevation would have to be about 18 feet below the bridge deck for it to be at this highest simulated stage, which seems very unlikely. Based on this, it is very unlikely that the highest simulations could have reached the low chord elevation of the bridge and therefore have been impacted by excluding the bridge from the HEC-RAS model. Therefore, the removal of the railroad bridge was considered justified. Next, model instabilities in the vicinity of the U.S. 90 bridge and inline control structure were assessed by adding these features back into the model, performing numerous simulations. Associated cross sections upstream and downstream of the control structure were reviewed to ensure their location with respect to the structure met HEC-RAS guidelines, and ineffective flow area definitions were added. Additionally, cross sections upstream and downstream of the U.S. 90 bridge were added to the model, per HEC-RAS guidelines. Weir and gate discharge coefficients and exponents for the control structure were reviewed, and minor adjustments were made based on field observations and professional judgment. As mentioned previously, physical representation of the structure was reviewed and determined to be properly represented in the model based on as-built documents and measured dimensions. These updates to the model files resulted in a fully parameterized model which executed to completion for the simulation period from April 2019 to October 2020. It should be noted that the model eventually became unstable during rapidly changing conditions that occurred near the end of the simulation period in which the gate was opened dramatically, dropping stage in the pond more than 5 ft during the scheduled drawdown event which occurred from October 2020 to December 2020. Due to the rapidly changing system conditions during this time, model testing was not performed during the drawdown event as the model would become unstable.

Review of initial model results showed that flow transitioned from subcritical to supercritical flow in shallow areas of Spring Creek, as well as in the vicinity of the railroad bridge. Supercritical flow is characterized by very high velocity (when the water velocity is faster than the rate at which water waves can travel) as opposed to subcritical flow which is characterized by a slower, more tranquil flow regime. Initially, shallow portions of Spring Creek resulting in supercritical flow were causing model instabilities. The model was run in ‘mixed flow regime’ mode, which resulted in a more stable model solution. A field reconnaissance trip was conducted on December 6, 2023, to confirm the depths at shallow locations along Spring Creek resulting in supercritical flow (Figure 6-9). Modifications were made to several cross sections in the Spring Creek portion of the model to better match both field surveys and observations. Additionally, modifications were made to roughness (Manning’s n) coefficients to better match field observations, reflecting a somewhat straight and clean channel. These modifications resulted in a stable model, which could be run in both subcritical and mixed flow mode, allowing for a more comprehensive assessment of model performance.

Figure 6-9. Spring Creek during the December 6, 2023 field reconnaissance.

The updated HEC-RAS unsteady-state model was calibrated to the best available water level data as provided by the District. Based on model set up and data availability, the model was calibrated to stage at two locations: Merritts Mill Pond @ US 90 gage (Station ID NWFWMD 011107) and Spring Creek at Spring Creek Park (Station ID NWFWMD 012744). As described previously, the period from April 1, 2019, through October 4, 2020, was the longest time period available with concurrent data for all inputs as well as stage data for calibration and was used as the simulation period for model testing and calibration. The focus of this calibration effort was the parameterization of the Merritts Mill Pond control structure (weir and gate coefficients) and Manning's n values in Spring Creek. An iterative approach was utilized, adjusting parameters sequentially and performing numerous simulations to achieve best fit to measured data. The sluice gate coefficient was reduced from an initial value of 0.6 to a final value of 0.57 to achieve the best fit, based on graphical comparison of observed and measured stage during the calibration period. This is within the typical range for a sluice gate coefficient of 0.5 to 0.7 per HEC-RAS guidance. This value is in the lower range for this coefficient, which possibly reflects the additional flow resistance through the fish barrier. Figure 6-10 compares the stage frequency curves for the observed and simulated Merritts Mill Pond stages at the US 90 bridge. The curves match very well for the calibration period. This supports the conclusion that the model is responding to the boundary forcings appropriately. Model errors appear to be associated with periods when gate operation records may have missing entries.

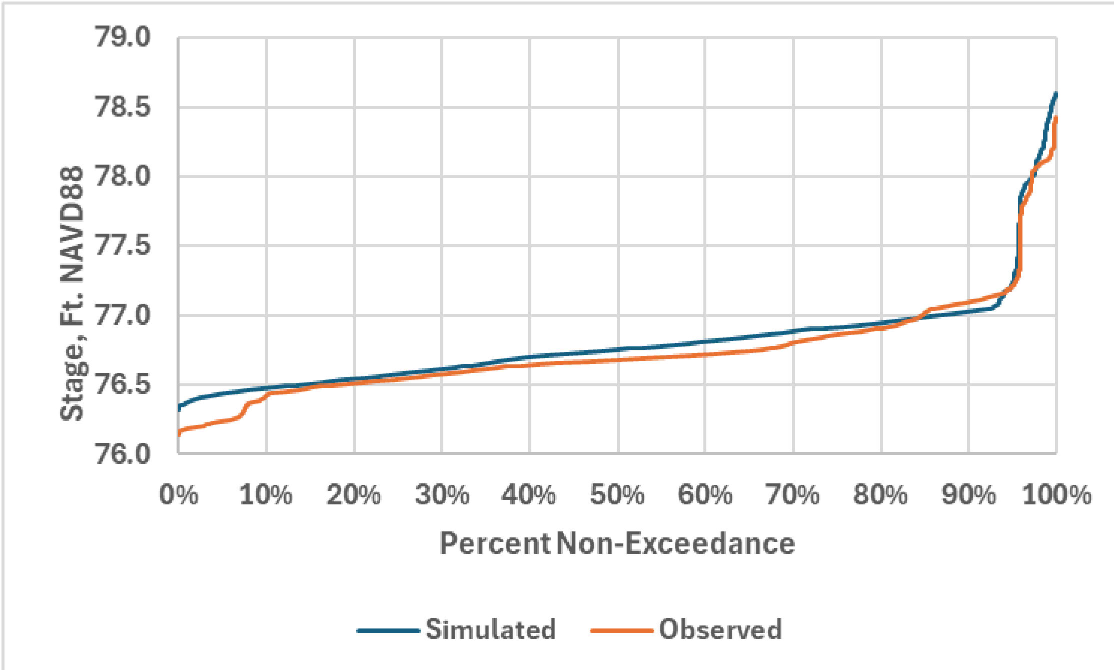


Figure 6-10. Stage duration curves for the calibration simulation, comparing observed and simulated stages at the US 90 Bridge on Merritts Mill Pond.

Calibration of the model in the Spring Creek reach involved adjustments to in-channel and floodplain roughness (Manning's n) values. Initially in-channel and floodplain Manning's n values were 0.03 and 0.08, respectively. The final in-channel values along Spring Creek ranged from 0.055 near the control structure to 0.045 in the lower third of Spring Creek. Floodplain values were set at 0.22, which reflects the amount of debris observed along the reach based on the December 6, 2023, field reconnaissance trip. Figure 6-11 compares the observed and simulated Merritts Mill Pond stages at the Spring Creek @ Spring Creek Park station. The curves match well for the majority of the calibration period. Large model residuals apparent in late 2020 were determined to be primarily due to measurement uncertainty as opposed to model parameterization.

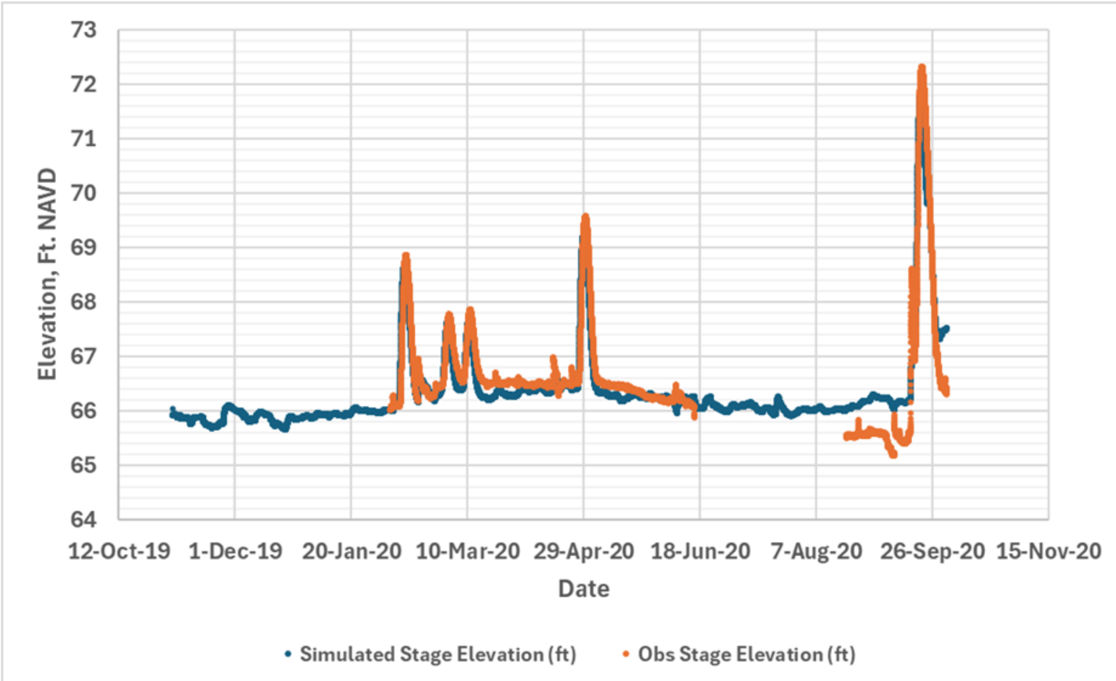


Figure 6-11. Stage time series plot for the calibration simulation, comparing observed and simulated stages at the Spring Creek @ Spring Creek Park gage.

Model performance was assessed by evaluating stage residuals across a range of flows and graphical comparison of HEC-RAS simulated stage-frequency curves with those developed from measured stage data. Stage data measured at the Merritts Mill Pond @ US 90 gage were used to calculate model performance statistics and assess the model performance. Model performance statistics were not calculated at the Spring Creek @ Spring Creek gage due to the short continuous record available. Quantitative goodness of fit values including mean error, coefficient of determination (R^2), root-mean-squared error (RMSE) and RMSE-observations standard deviation ratio (RSR) were calculated and evaluated. It should be noted that uncertainties in the gate operation records may limit the utility of these quantitative measures for evaluating model performance.

Table 6-5 presents the model statistics for the model calibration based on 15-minute observed and simulated time series. Review of the R^2 and RSR statistics indicate that the model is doing a satisfactory job predicting stages in Merritts Mill Pond, given the relatively small simulation period evaluated and the uncertainty in the gate operations record and periodic cleaning of the fish barrier and vegetation removal upstream of the structure. Approximately half of the variability in the MMP stage was explained by the model (indicated by a R^2 of 0.48). The model was unbiased (indicated by a difference of 0.06 ft between the simulated mean and the observed mean), represented the overall variability in water level with reasonable accuracy (indicated by an RMSE of 0.30 ft or 13% of the observed range), and represented the extreme stages with reasonable accuracy (indicated by differences of 0.17 ft and 0.18 ft between the simulated and observed maximum and minimum stages, respectively). The model performance was reasonable considering the high level of variation in the stage-discharge relationship observed at the MMP US 90 gage (Appendix C, Figure 6), which was likely caused by gate adjustments of unknown timing and magnitude, periodic vegetation removal directly upstream of the structure, and periodic cleaning of the fish barrier. Further, for the WRV assessments, the HEC-RAS model was used to generate steady-state profiles based on JBS discharge statistics while assuming a constant gate condition, and the calibration of the unsteady model indicated that it was accurately simulating MMP stage statistics (e.g., the mean, maximum, and minimum stages).

For further details regarding model parameterization and calibration, as well as discussion of model verification simulations, please refer to Appendix B.

Table 6-5. Model performance statistics for 15-minute time series data at the Merritts Mill Pond @ US 90 gage (Station ID NWFWMD 11107).

Location	River Station	Variable	Mean Stage (ft-NAVD88)	Max Stage (ft-NAVD88)	Min Stage (ft-NAVD88)	R^2	RMSE (ft)	RSR
Merritts Mill Pond @ US 90	4669	Obs	76.73	78.43	76.14	0.48	0.30	0.785
		Sim	76.79	78.60	76.32			
		Diff	0.06	0.17	0.18			

6.3 System for Environmental Flows (SEFA) Model

The System for Environmental Flow Analysis (SEFA; 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 Service in the 1970s for determining relations between stream flows and fish habitat, and SEFA is software that implements this framework. SEFA utilizes hydraulic models coupled with habitat suitability relations for specific classes of species to define relations between streamflow and available habitat. Habitat suitability is defined as a function of depth, substrate, and stream velocity at specific transect locations. The SEFA software computes values of Area Weighted Suitability (AWS), which is a suitability index of available habitat for target organisms, over a range of streamflow conditions.

The SEFA software and IFIM have 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 (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, the Little Manatee River, and Middle Econfina Creek (SRWMD 2021, SWFWMD 2023, NWFWMD 2025).

SEFA 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. The 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 relative measure of how suitable a habitat is for a selected guild/species/life stage.

The SEFA model uses riverine hydraulic variables (depth 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 uses the depth and velocity values from a set of evenly-spaced points along a given cross section and computes corresponding habitat suitability values at these points for each variable (depth, velocity, and substrate if applicable), based on input habitat suitability curves. A combined suitability index for a given flow at a specific subsection along cross section or transect is then determined as the product of the suitability of depth, velocity, and, if applicable, substrate (Herrick 2021). Information concerning substrate types at specific transect locations was not available and therefore was unable to be used in the instream habitat analysis.

For a given stream reach, the AWS is calculated within SEFA by (1) dividing the cross section associated with the reach into subsections where combined habitat suitability values are assigned, (2) computing an area-weighted suitability for each subsection by multiplying the combined habitat suitability value at each subsection by the corresponding 'surface area' (subsection width multiplied by the reach length) of that subsection, and (3) calculating the sum of the area-weighted suitability values obtained in step (2). 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 Merritts Mill Pond and Spring Creek model domain using all available transects. The aggregate AWS describes the relative suitability for a given guild/species/life stage throughout the model domain 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, taxon life-history stage, or groups of species that prefer a particular set of depth and velocity conditions (shallow depth and fast water, etc.). 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 SEFA model for Merritts Mill Pond and Spring Creek. 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 Jackson Blue Spring MFL study area.

The fish species documented to occur in Merritts Mill Pond and Spring Creek are presented in Table 6-6 based on available literature. Habitat suitability curves were identified by cross-referencing the species in Table 6-6 from a series of existing curves found in either the Gore library or Nagid Library. These libraries are aggregations of known habitat suitability curves utilized for MFL assessments in Florida. 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 and the availability of corresponding HSCs, HSCs for nine fish species were incorporated into the SEFA modeling (Table 6-6). 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 mussel species documented in Merritts Mill Pond and Spring Creek as well as many of the specific host species utilized by the mussels (listed in Table 2-6). While HSC curves for the mussel and many host species have not been developed, the District utilized available curves for all documented species in the system and 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 mussel species and their host species, by utilizing available HSC curves including fish species, macroinvertebrate species, and habitat guilds, the District is using the best available information and the number of curves analyzed is assumed to be protective of these species.

Table 6-6. Fish taxa found in the Jackson Blue Spring system for which habitat suitability curves have been developed.

Species Name	**Common Name**	**Location**		**HSC**
		Merritts Mill Pond	**Spring Creek**	
Ameiurus nebulosis	Brown bullhead	X		
Aphredoderus sayanus	Pirate perch	X	X	X
Ctenopharyngodon idella	Grass carp	X		
Cyprinella venusta cercostigma	Eastern blacktail shiner		X	
Cyprinus carpio	Common Carp	X		
Elassoma evergladei	Everglades pygmy sunfish	X		
Elassoma gilberti	Gulf coast pygmy sunfish		X	
Esox americanus	Redfin pickerel		X	
Etheostoma edwini	Brown darter		X	

Species Name	Common Name	Location		HSC
		Merritts Mill Pond	Spring Creek	
Etheostoma swaini	Gulf darter		X	
Gambusia holbrooki	Mosquitofish	X	X	
Labidesthes sicculus	Brook silverside	X	X	
Lepomis auritus	Redbreast sunfish		X	X
Lepomis gulosus	Warmouth	X		
Lepomis macrochirus	Bluegill	X	X	X
Lepomis marginatus	Dollar sunfish		X	
Lepomis microlophus	Redear sunfish	X	X	
Lepomis punctatus	Spotted sunfish	X		X
Lucania goodei	Bluefin killifish	X	X	
Micropterus cataractae	Shoal bass			
Micropterus salmoides	Largemouth bass	X		X
Micropterus sp.	Unidentified black bass		X	
Minytrema melanops	Spotted sucker		X	X
Notropis cummingsae	Dusky shiner		X	
Notropis harperi	Redeye chub	X	X	X
Notropis petersoni	Coastal shiner		X	
Notropis texanus	Weed shiner	X	X	
Noturus gyrinus	Tadpole madtom		X	
Noturus leptacanthus	Speckled madtom		X	X
Percina nigrofasciata	Blackbanded darter		X	X

Species Name	Common Name	Location		HSC
		Merritts Mill Pond	Spring Creek	
Pteronotropis grandipinnis	Apalachee shiner		X	
Grand Total Documented		**15**	**22**	**9**

In addition to the habitat suitability curves, the SEFA application requires riverine hydraulic information to quantify water depths and velocities as a function of streamflow. The calibrated steady state HEC-RAS model described in Section 6.2 was utilized to derive cross-sectional estimates of both the area of inundated channel as well as depths and velocities at specific channel locations across the main channel. For purposes of assessing Water Resource Values, including instream habitat metrics, the HEC-RAS model was converted to a steady-state model, with input Jackson Blue Spring and Merritts Mill Pond pickup flow percentiles based on a near continuous 20-year time period from January 1, 2005, to December 31, 2024, adjusted to reflect impacts from historical pumping (See Appendix C for details). Modeling scenarios for purposes of this evaluation consisted of one model scenario for each flow percentile. Model simulations were performed for two downstream stage boundary conditions representing the 10^{th} and 50^{th} percentile Chipola River stage (based on stage from January 1, 2005, to December 31, 2024) to account for backwater effects of Chipola River stage on Spring Creek stage. Therefore, a total of 99 steady-state model scenarios were run (P1 - P99) for each downstream stage boundary condition and were the basis for estimating relations between flow and AWS.

The steady-state, baseline flow scenarios were simulated with the HEC-RAS model and the resultant water surface profiles and velocity distributions from all model transects in the model domain were utilized within the SEFA model. The SEFA model simulations were run based on output from each baseline model scenario simulation with the HEC-RAS model, resulting in estimated aggregate AWS for each fish species or guild as a function of flow for the baseline time series. For purposes of this analysis, Merritts Mill Pond and Spring Creek were considered separate reaches, with AWS versus flow relationships assessed independently within each reach for a given fish species of interest.

Appendix C presents the SEFA results for the baseline flow scenarios simulated. The maximum AWS and associated Jackson Blue Spring flow are presented, for both Merritts Mill Pond and Spring Creek reaches. Application of these results for the instream habitat WRV assessment is described in Section 7.5.

7 Evaluation of Water Resource Values and Results

This section describes the methods and results of the Water Resource Value (WRV) metric evaluation. The selection of appropriate Water Resource Values and metrics is described in Section 5.

All WRV metrics were evaluated based on information exported from the steady-state HEC-RAS model and the baseline flow timeseries for Jackson Blue Spring. Development of the Jackson Blue Spring baseline time series is described in Section 7.1. Details of the low flow metric, riparian bank habitat, riparian wetland and floodplain habitat, and instream habitat metric evaluations are presented in Sections 7.2, 7.3, and 7.4, respectively. Application of a hydroperiod analysis tool to Merritts Mill Pond is described in Section 7.5

Allowable flow reductions were calculated using a 15-percent reduction in each WRV metric from baseline conditions. The allowable flow reductions were applied to the median, pumping-corrected JBS flow of 103.3 cfs to determine a minimum median flow for the spring. Allowable flow reductions are expressed in this report as volumetric rates as well as percentages of the median JBS flow.

7.1 Baseline Time Series Development

A time series for flows from Jackson Blue Spring was developed for the baseline period, defined as January 1, 2005, through December 31, 2024. Development of the time series essentially consisted of two steps. In the first step, a daily series of impacts on spring flow are estimated for the baseline period. This was accomplished by first estimating impacts from pumping conditions in 2000, 2005, 2010, 2015, 2020, and 2045 using the results of a series of groundwater model simulations, as described in section 6.1.2 of this report. The estimated impacts from pumping conditions in each of these years are then assigned to the middle of the year associated with a given pumping condition. For example, the estimated impact of pumping on the flow from Jackson Blue Spring under pumping conditions present during 2005 was assigned to June 30, 2005. A daily time series of these pumping impacts on groundwater flow to Jackson Blue Spring and Merritts Mill Pond was then estimated for the baseline period by linearly interpolating (through time) between the pumping impacts assigned to the middle of the year for each of the 'pumps on' simulations (years 2000, 2005, 2010, 2015, 2020 and 2045).

In the second step, the absolute values of these estimated pumping impacts were added to the historical daily time series of flows to the spring, resulting in a baseline time series representative of unimpacted flows for Jackson Blue Spring. A baseline time series of lateral inflows to Merritts Mill Pond (not including flow from Jackson Blue Springs) was developed using a process analogous to that used to develop the Jackson Blue Spring baseline flow time series. Time series plots of historical (unadjusted for impacts) and baseline (adjusted for estimated impacts) flows from Jackson Blue Spring and lateral inflows to Merritts Mill Pond are shown in Figure 7-1 and Figure 7-2, respectively. Corresponding cumulative probability plots for Jackson Blue Spring and Merritts Mill Pond are shown in Figure 7-3 and Figure 7-4, respectively.

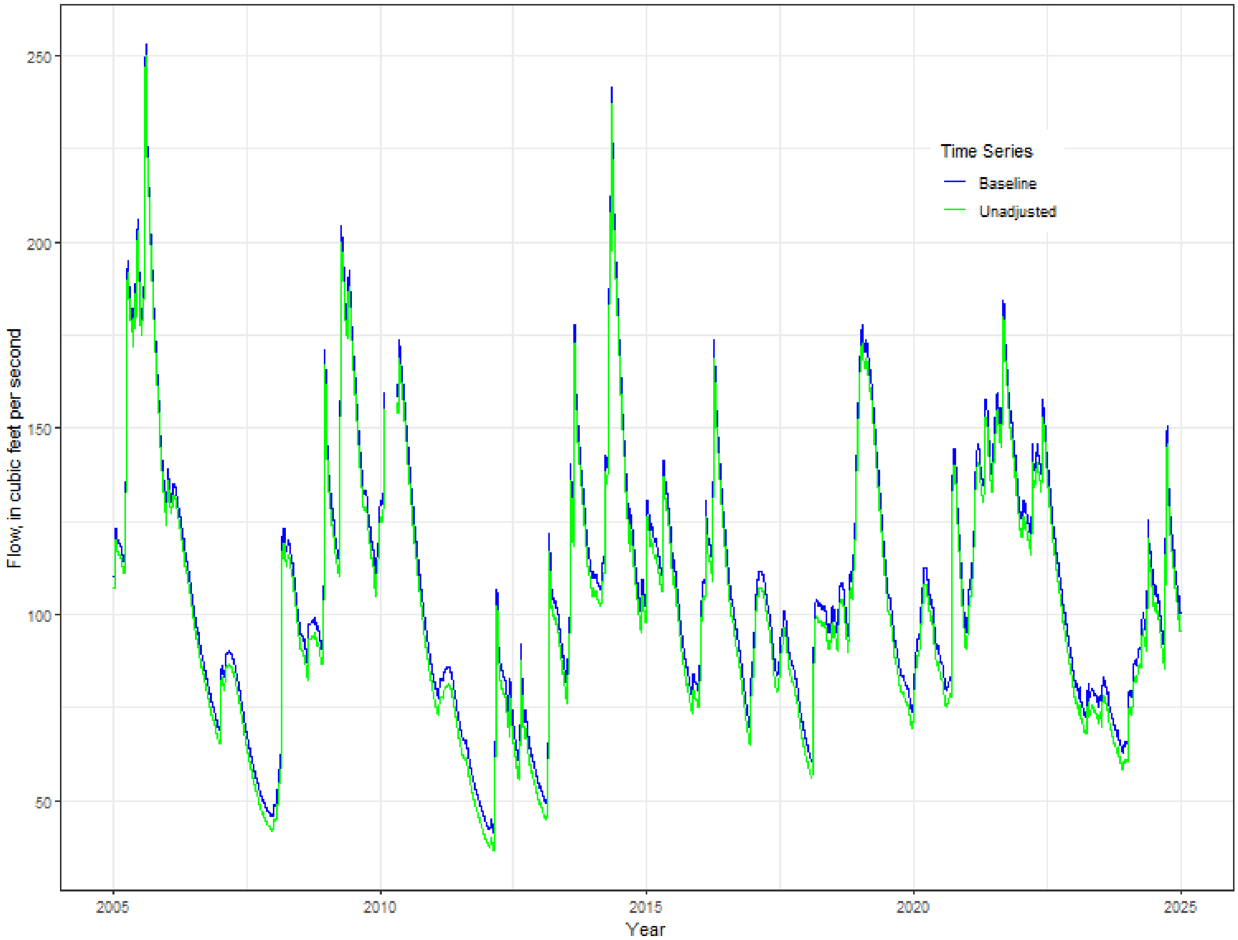


Figure 7-1. Time-series plot of baseline and unadjusted Jackson Blue Spring flows.

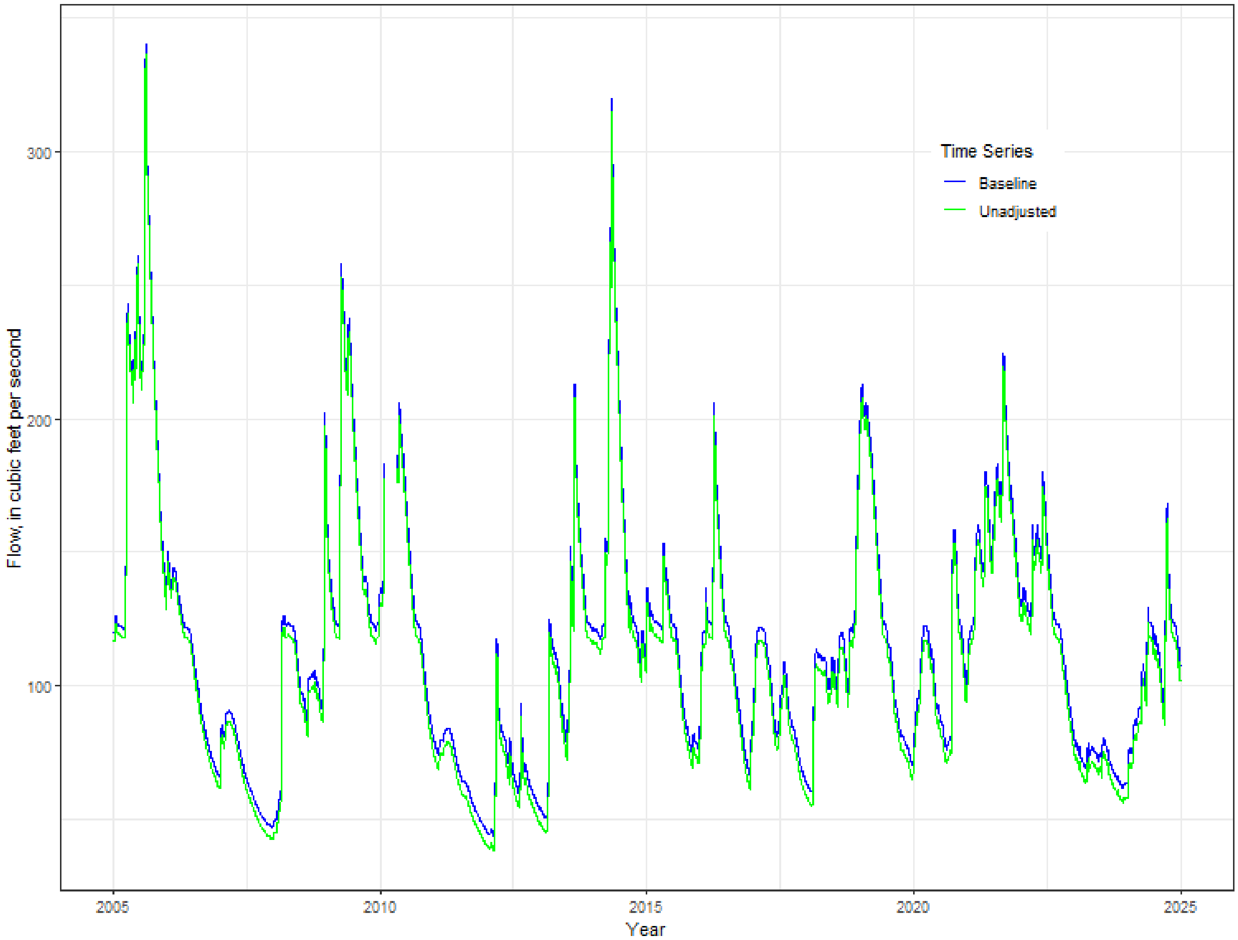


Figure 7-2. Time-series plot of baseline and unadjusted lateral inflows to Merritts Mill Pond.

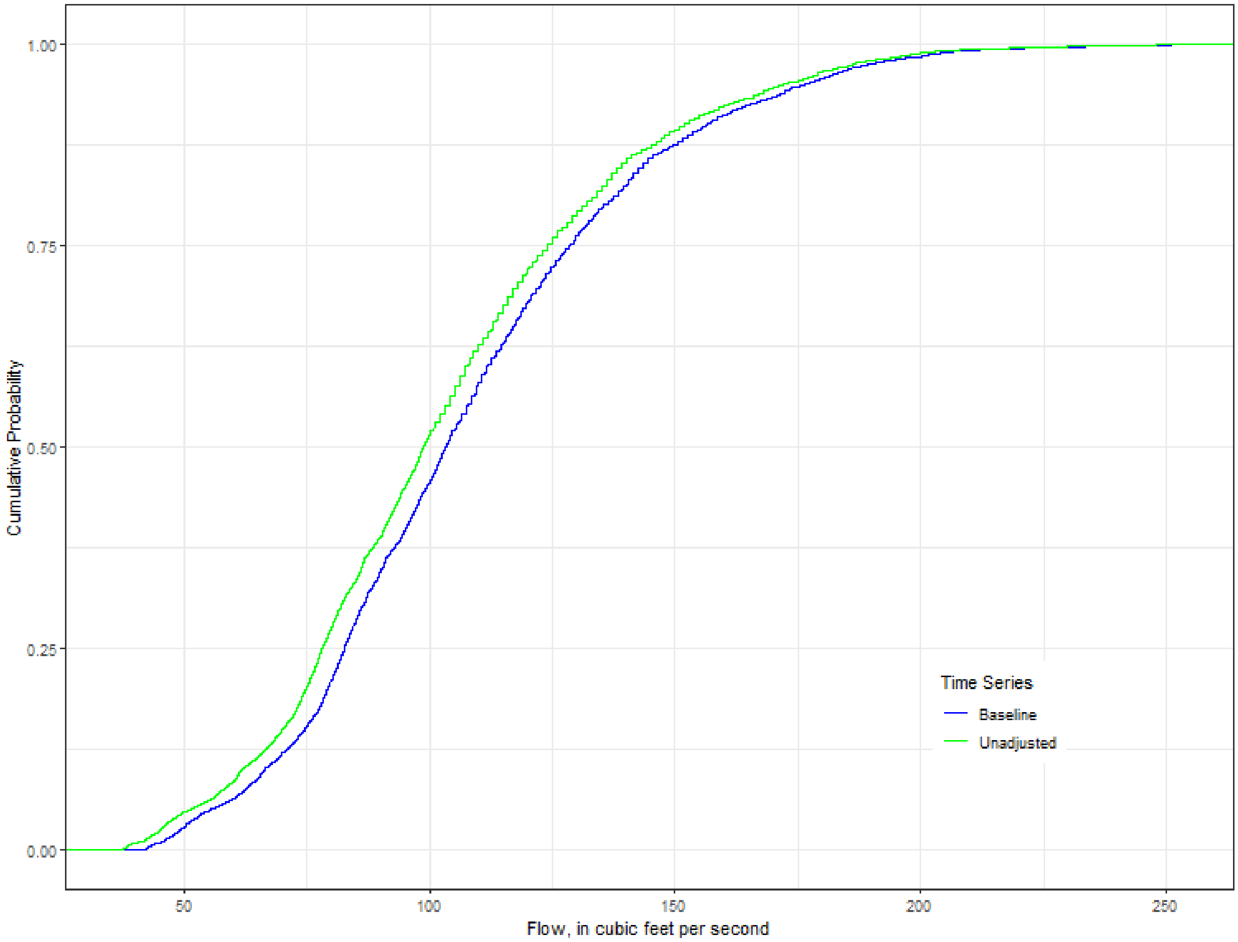


Figure 7-3. Cumulative probability plots of daily values from unadjusted and baseline time series of Jackson Blue Spring flows.

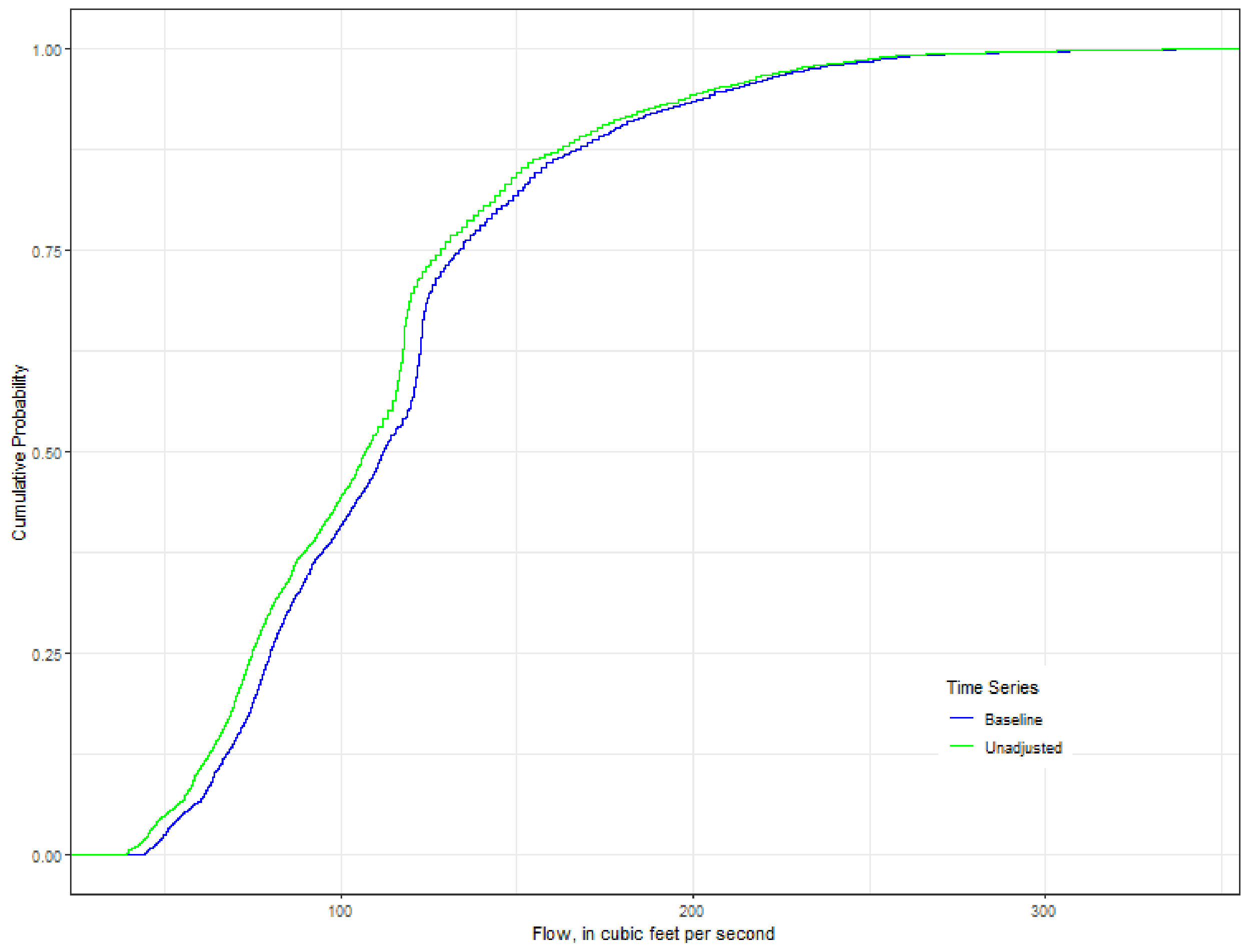


Figure 7-4. Cumulative probability plots of daily values from unadjusted and baseline time series of lateral inflows to Merritts Mill Pond.

7.2 Low Flow Metric Evaluation

Low flow metrics are used to assess the safe passage of recreational watercraft and fish species across shallow areas during periods of low water levels/spring flows. Three metrics were considered as part of WRV1 – Recreation in and on the Water: Safe power boat passage, safe canoe/kayak passage, and safe tubing passage. One metric was considered as part of WRV-2 Fish and Wildlife Habitats and the Passage of Fish: safe fish passage. In addition, these metrics help ensure hydrologic connectivity between upstream and downstream portions of the water body to prevent anoxia and increased/decreased water temperatures during periods of extreme weather, making these metrics relevant to WRV-9 Water Quality.

7.2.1 Low Flow Metric Evaluation Methodology

The calibrated HEC-RAS model described in Section 6.2 was utilized to evaluate effects of spring flow reductions for passage (low flow) metrics, including canoe/kayak passage, tubing, power boat passage, and fish passage within the Jackson Blue MFL study area. For purposes of assessing Water Resource Values, the HEC-RAS model was converted to a steady-state model, with input Jackson Blue Spring and Merritts Mill Pond pickup flow percentiles based on a near-continuous 20-year time period from January

1, 2005, through December 31, 2024, adjusted to reflect impacts from historical pumping (See Appendix C for details).

In an effort to further validate the steady-state HEC-RAS model prior to evaluating WRV metrics, biweekly manual discharge and stage measurements were collected at three locations along Spring Creek during Jan 2025-Feb 2025. This data was utilized to validate the model by comparing simulated water surface profiles in Spring Creek to the recently collected manual measurements. This was done by creating simulated profiles for each date of data collection, utilizing the Chipola River stage on that date as the downstream boundary condition, and the percentile flow scenario that matched the average flow measured on that day. Interpolation of water surface profiles between flow scenarios was necessary if the measured flow on the date of data collection did not match exactly with one of the P1-P99 flow scenarios run. As described in more detail in Section 2.3.2 of Appendix C, initial model comparisons to measured stage along Spring Creek indicated a slight underestimation of upstream water surface elevations, with an overall root mean square error of 0.10 ft. Slight adjustments to Manning's n values in Spring Creek were made to minimize the error resulting in a final root mean square error of 0.05 ft. Profiles based on the model with adjusted Manning's n values were utilized in the Jackson Blue Spring WRV assessments (See Appendix C for more details).

Modeling scenarios for purposes of this evaluation consisted of one model scenario for each flow percentile. Model simulations were performed for two downstream stage boundary conditions representing the 10^{th} and 50^{th} percentile Chipola River stage (based on stage from January 1, 2005, through December 31, 2024) to account for backwater effects of Chipola River stage on Spring Creek stage. Therefore, a total of 99 steady-state model scenarios were run (P1 - P99) for each downstream stage boundary condition. These two downstream stage boundary conditions span the range where Spring Creek water levels are least sensitive to Chipola River stages and therefore most sensitive to Jackson Blue Spring flows. Additionally, an assessment of the effects of backwater effects from the Chipola River on Spring Creek water levels indicated that water levels at the two transects closest to the Chipola River (XS 0.0247 and XS 0.0615) were insensitive to Jackson Blue Spring flows (Appendix C). As a result, these two transects were not included as potential transects for MFL evaluation even though they are depicted in some of the figures and tables in this section. The locations of the cross-sections within the HEC-RAS model used for this evaluation is shown in Figure 7-5.

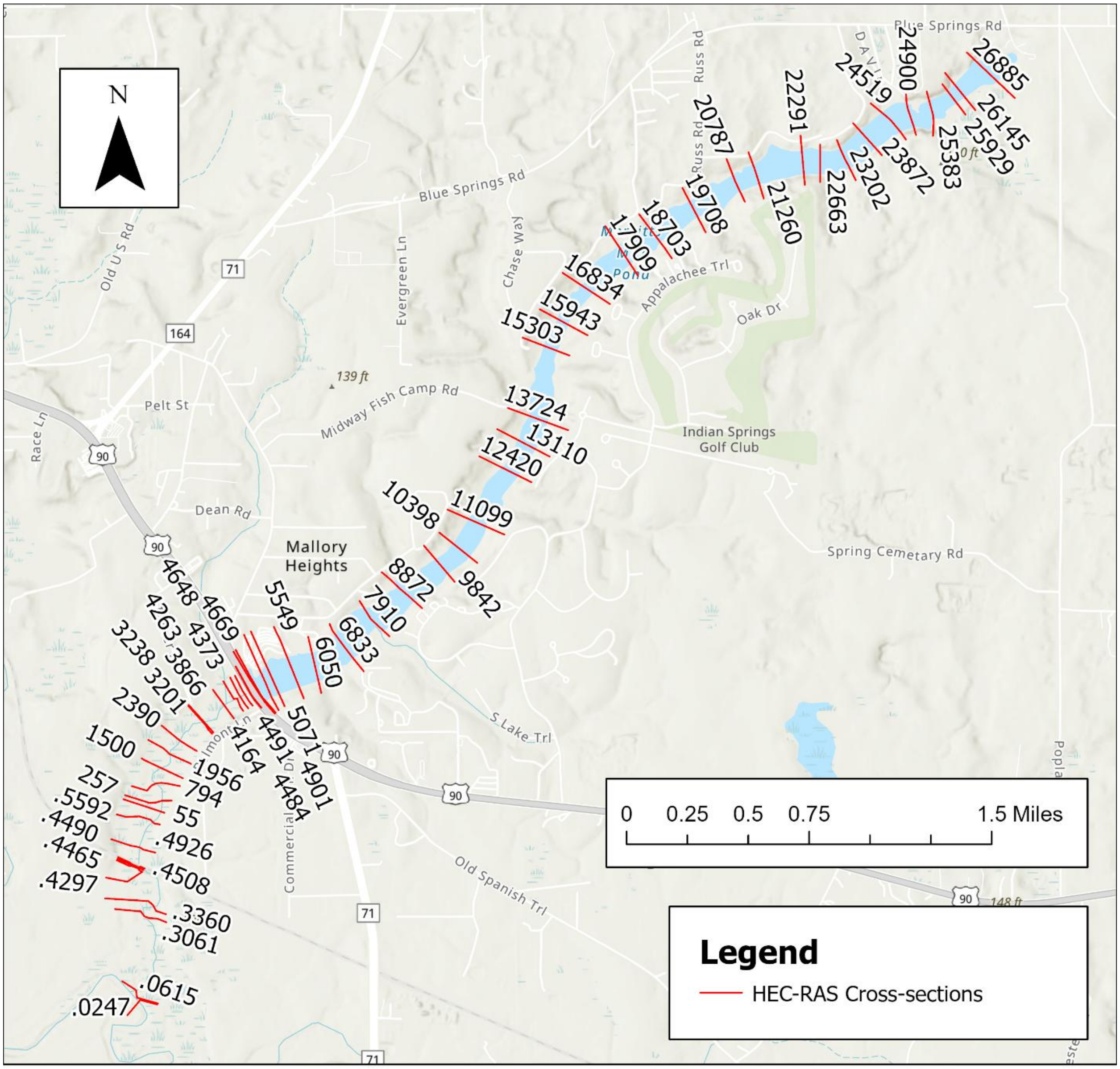


Figure 7-5. Locations of HEC-RAS cross sections labelled with identifiers used in the model.

The methods and results associated with each WRV metric are described below. This includes descriptions of the methods used to determine an allowable spring flow reduction associated with a 15-percent reduction in the frequency of occurrence for each WRV metric. A conceptual diagram depicting allowable flow reduction calculations is shown in Figure 7-6.

The method used to determine the minimum flow for a given metric was as follows:

1. Perform steady-state model scenarios utilizing baseline flow inputs, for all percentile flows (P1 through P99) for each of the two downstream (Chipola River) boundary conditions.
2. Determine critical elevation (e.g., river stage associated with sufficient depth) for the metric of interest at each applicable 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 Jackson Blue Spring for each transect.
5. Determine the number of days in the period of record the critical flow at Jackson Blue Spring 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 time series for Jackson Blue Spring.
8. Calculate the allowable reduction in spring flow (cfs) associated with the reduced frequency of occurrence by subtracting the flow determined in step 7 from the critical flow calculated in step 4.
9. Determine the allowable percent spring flow reduction using the result from step 8, expressed as a percentage of the median Jackson Blue Spring baseline flow (103.3 cfs).

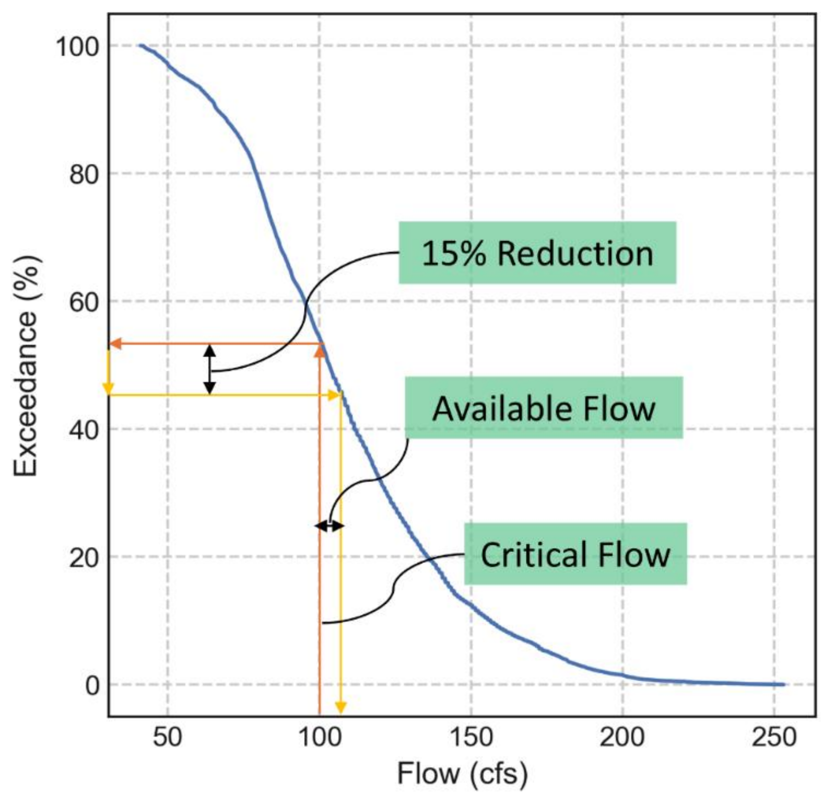


Figure 7-6. Example calculation of the allowable flow reduction and available flow, based on a 1-percent decrease in the percentage of time that a critical flow is exceeded, which was applied to multiple WRV metrics in this analysis.

7.2.2 Safe Power Boat Passage

For safe power boat use within the Jackson Blue MFL study area, a minimum water depth of 2.0 ft. across a continuous channel width of 30 ft. was used to allow passage for two boats side-by-side within Merritts

Mill Pond. A minimum depth of 2.0 ft. across a continuous channel width of 15 ft. was used allow passage for a single boat within Spring Creek as discussed previously. This metric was assessed for all transects in the study area, using the method described above in section 7.2.1. At each transect, the critical elevation was determined as the minimum elevation which satisfied the safe power boat passage depth and channel width criteria, based on transect geometry within the HEC-RAS model.

As shown in Table 7-1, the critical flows limiting motorboat passage in Merritts Mill Pond were below the 1st percentile for all cross-sections except for the two most downstream cross-sections. The flows below the 1st percentile were deemed too infrequent to serve as a basis for MFL determination. Also, the close proximity of the two limiting cross-sections to the Merritts Mill Pond control structure meant that it was inappropriate for them to serve as a basis for MFL determination since boat passage is limited at this location. Thus, no MFL metrics were utilized based on motorboat passage in Merritts Mill Pond. It should be noted that cypress knees and submerged logs and stumps are passage hazards at all MMP elevations.

Table 7-1. Motorboat passage in Merritts Mill Pond WRV assessment results.

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs); Downstream Condition = Chipola River P10	Critical Flow (cfs); Downstream Condition = Chipola River P50
26885	73.40	<P1	<P1
26145	74.30	<P1	<P1
25929	74.70	<P1	<P1
25383	74.06	<P1	<P1
24900	74.11	<P1	<P1
24519	73.36	<P1	<P1
23872	73.38	<P1	<P1
23202	73.47	<P1	<P1
22663	74.55	<P1	<P1
22291	73.38	<P1	<P1
21260	72.25	<P1	<P1
20787	72.12	<P1	<P1
19708	71.71	<P1	<P1
18703	71.88	<P1	<P1
17909	72.85	<P1	<P1
16834	70.71	<P1	<P1
15943	70.58	<P1	<P1
15303	71.38	<P1	<P1

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs); Downstream Condition = Chipola River P10	Critical Flow (cfs); Downstream Condition = Chipola River P50
13724	71.19	<P1	<P1
13110	72.27	<P1	<P1
12420	70.12	<P1	<P1
11099	70.61	<P1	<P1
10398	70.92	<P1	<P1
9842	73.21	<P1	<P1
8872	70.08	<P1	<P1
7910	70.42	<P1	<P1
6833	72.84	<P1	<P1
6050	69.74	<P1	<P1
5549	68.92	<P1	<P1
5071	69.28	<P1	<P1
4901	69.18	<P1	<P1
4669	71.75	<P1	<P1
4648	71.01	<P1	<P1
4491	77.13	55.4	55.4
4484	79.02	188.3	188.3

As shown in Table 7-2, critical flows from 12 of the 20 cross-sections from Spring Creek were below the 1st percentile under both downstream boundary conditions. These low flows were deemed too infrequent to serve as a basis for MFL determination, and thus, no MFL metrics were utilized based on motorboat passage for those cross-sections. The remaining eight cross sections were found to have critical flows ranging from 47 cfs to 87 cfs. MFL metrics were calculated for the cross sections exhibiting valid critical flows (Table 7-3, Table 7-4., Table 7-5., and Figure 7-7).

Table 7-2. Motorboat passage WRV Assessment results for Spring Creek.

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs); Downstream Condition = CR P10	Critical Flow (cfs); Downstream Condition = CR P50
4373	64.92	<P1	<P1
4263	64.84	<P1	<P1

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs); Downstream Condition = CR P10	Critical Flow (cfs); Downstream Condition = CR P50
4164	66.16	87.0	87.0
3866	64.95	<P1	<P1
3238	64.79	<P1	<P1
3201	65.26	67.6	67.6
2390	63.49	<P1	<P1
1956	63.97	<P1	<P1
1500	63.35	<P1	<P1
794	63.32	<P1	<P1
257	63.37	<P1	<P1
55	63.31	<P1	<P1
0.5592	63.09	47.0	49.2
0.4926	62.46	<P1	<P1
0.4508	62.79	51.2	57.3
0.449	62.76	49.8	56.0
0.4465	63.04	66.2	73.2
0.4297	62.53	<P1	50.4
0.336	61.38	<P1	<P1
0.3061	61.75	<P1	56.2

Table 7-3. MFL Metrics for HEC-RAS cross-sections limiting motorboat passage in Spring Creek under the CR P10 downstream condition.

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs)	Baseline Days Exceeded	Reduced Days Exceeded	Minimum Allowable Flow (cfs)	Allowable Flow Reduction (cfs)	Percent Flow Reduction (%)[1]
4164	66.2	87.0	4931	4190	93.8	9.5	9.2
3201	65.3	67.6	6419	5457	88.9	14.4	13.9
0.5592	63.1	47.0	7068	6005	74.2	29.1	28.2
0.4508	62.8	51.2	6926	5892	76.8	26.5	25.7
0.449	62.8	49.8	6990	5940	76.0	27.3	26.5
0.4465	63.0	66.2	6469	5504	87.9	15.4	14.9

[1] Percent flow reductions are percentages of the median baseline Jackson Blue Spring Flow (103.3 cfs).

Table 7-4. MFL Metrics for cross-sections limiting motorboat passage in Spring Creek under the CR P50 downstream condition.

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs)	Baseline Days Exceeded	Reduced Days Exceeded	Minimum Allowable Flow (cfs)	Allowable Flow Reduction (cfs)	Percent Flow Reduction (%)[1]
4164	66.2	87.0	4931	4190	93.8	9.5	9.2
3201	65.3	67.6	6419	5457	88.9	14.4	13.9
0.5592	63.1	49.2	7003	5957	75.6	27.7	26.9
0.4508	62.8	57.3	6783	5768	81.7	21.6	21.0
0.449	62.8	56.0	6808	5796	80.6	22.7	22.0
0.4465	63.0	73.2	6175	5249	92.8	10.5	10.2
0.4297	62.5	50.4	6950	5908	76.2	27.1	26.2
0.3061	61.7	56.2	6803	5784	80.8	22.5	21.8

[1] Percent flow reductions are percentages of the median baseline Jackson Blue Spring Flow (103.3 cfs).

Table 7-5. MFL metric statistics for cross sections limiting motorboat passage in Spring Creek under both downstream conditions.

	Mean			Range			
Cross-Section	Percent Flow Reduction (%)[1]	Minimum Allowable Flow (cfs)	Allowable Flow Reduction (cfs)	Percent Flow Reduction (%)	Minimum Allowable Flow (cfs)	Allowable Flow Reduction (cfs)	Downstream Conditions
4164	9.2	93.8	9.5	0	0	0	CR P50, CR P10
3201	13.9	88.9	14.4	0	0	0	CR P50, CR P10
0.5592	27.5	74.9	28.4	1.3	1.4	1.4	CR P50, CR P10
0.4508	23.3	79.2	24.1	4.7	4.9	4.9	CR P50, CR P10
0.449	24.2	78.3	25.0	4.5	4.6	4.6	CR P50, CR P10
0.4465	12.5	90.4	12.9	4.7	4.9	4.9	CR P50, CR P10
0.4297	26.2	76.2	27.1	NA	NA	NA	CR P50
0.3061	21.8	80.8	22.5	NA	NA	NA	CR P50

[1] Percent flow reductions are percentages of the median baseline Jackson Blue Spring Flow (103.3 cfs).

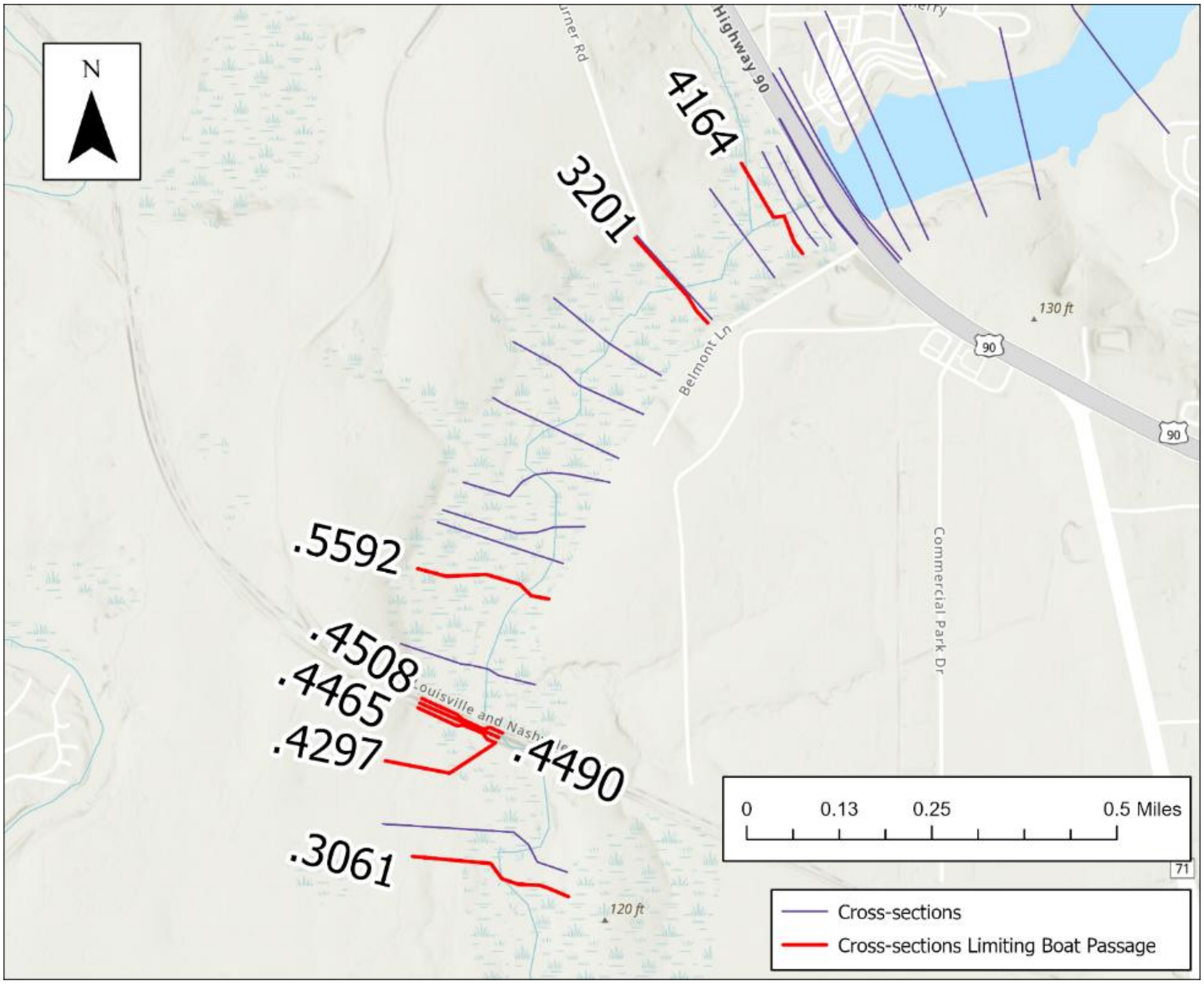


Figure 7-7. Map showing the eight cross sections with limiting critical flows for motorboat passage on Spring Creek.

7.2.3 Safe Canoe/Kayak Passage

A minimum thalweg depth of 1.5 ft. was used as the metric for safe canoe/kayak passage. The critical elevation (NAVD88) 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. This metric was assessed for all transects in the study area utilizing the methodology described above in section 7.2.1. For each transect, critical elevation was determined as the minimum elevation which satisfied the safe canoe/kayak passage depth criteria, based on transect geometry within the HEC-RAS model.

As shown in Table 7-6. Canoe/kayak passage WRV assessment results, all critical flows limiting canoe/kayak passage were below the 1st percentile. These flows were deemed too infrequent to serve as a basis for MFL determination, and thus, no MFL metrics were utilized based on canoe/kayak passage.

Table 7-6. Canoe/kayak passage WRV assessment results.

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs); Downstream Condition = CR P10	Critical Flow (cfs); Downstream Condition = CR P50
26885	72.87	<P1	<P1
26145	73.44	<P1	<P1
25929	74.09	<P1	<P1
25383	73.54	<P1	<P1
24900	73.56	<P1	<P1
24519	72.84	<P1	<P1
23872	72.85	<P1	<P1
23202	72.91	<P1	<P1
22663	74.04	<P1	<P1
22291	72.85	<P1	<P1
21260	71.70	<P1	<P1
20787	71.59	<P1	<P1
19708	71.01	<P1	<P1
18703	71.32	<P1	<P1
17909	71.72	<P1	<P1
16834	69.97	<P1	<P1
15943	69.95	<P1	<P1
15303	70.74	<P1	<P1
13724	70.60	<P1	<P1
13110	71.74	<P1	<P1
12420	69.54	<P1	<P1
11099	70.02	<P1	<P1
10398	70.38	<P1	<P1
9842	72.64	<P1	<P1
8872	69.15	<P1	<P1
7910	69.64	<P1	<P1
6833	72.24	<P1	<P1
6050	69.17	<P1	<P1
5549	68.36	<P1	<P1
5071	68.63	<P1	<P1
4901	68.57	<P1	<P1

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs); Downstream Condition = CR P10	Critical Flow (cfs); Downstream Condition = CR P50
4669	71.15	<P1	<P1
4648	70.50	<P1	<P1
4491	70.50	<P1	<P1
4484	70.50	<P1	<P1
4373	64.36	<P1	<P1
4263	64.28	<P1	<P1
4164	65.25	<P1	<P1
3866	64.27	<P1	<P1
3238	63.94	<P1	<P1
3201	64.54	<P1	<P1
2390	62.65	<P1	<P1
1956	63.07	<P1	<P1
1500	62.58	<P1	<P1
794	62.32	<P1	<P1
257	62.72	<P1	<P1
55	62.52	<P1	<P1
0.5592	62.23	<P1	<P1
0.4926	61.52	<P1	<P1
0.4508	62.12	<P1	<P1
0.449	62.25	<P1	<P1
0.4465	62.32	<P1	<P1
0.4297	61.73	<P1	<P1
0.336	60.41	<P1	<P1
0.3061	61.02	<P1	<P1

7.2.4 Safe Tubing Passage

A minimum thalweg depth of 1.05 ft. was used as the metric for safe tubing passage. The critical elevation (NAVD88) for safe tubing passage was determined by adding 1.05 ft. to the thalweg elevation (minimum elevation in a channel) for each transect. This metric was assessed for all transects within Spring Creek utilizing the methodology described above in section 7.2.1. For each transect, critical elevation was determined as the minimum elevation which satisfied the safe tubing passage depth criteria, based on transect geometry within the HEC-RAS model.

As shown in Table 7-7. Tubing passage WRV assessment results, all critical flows limiting tubing passage were below the 1st percentile. These flows were deemed too infrequent to serve as a basis for MFL determination, and thus, no MFL metrics were utilized based on tubing passage.

Table 7-7. Tubing passage WRV assessment results.

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs); Downstream Condition = CR P10	Critical Flow (cfs); Downstream Condition = CR P50
4373	63.91	<P1	<P1
4263	63.83	<P1	<P1
4164	64.80	<P1	<P1
3866	63.82	<P1	<P1
3238	63.49	<P1	<P1
3201	64.09	<P1	<P1
2390	62.20	<P1	<P1
1956	62.62	<P1	<P1
1500	62.13	<P1	<P1
794	61.87	<P1	<P1
257	62.27	<P1	<P1
55	62.07	<P1	<P1
0.5592	61.78	<P1	<P1
0.4926	61.07	<P1	<P1
0.4508	61.67	<P1	<P1
0.449	61.80	<P1	<P1
0.4465	61.87	<P1	<P1
0.4297	61.28	<P1	<P1
0.336	59.96	<P1	<P1
0.3061	60.57	<P1	<P1

7.2.5 Safe 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 (NAVD88) for fish passage was determined by adding 0.6 ft. to the thalweg elevation (minimum elevation in a channel) for each transect. This metric was assessed for all transects in the study area utilizing the methodology described above in section 7.2.1. For each transect, critical elevation was determined as the minimum elevation which satisfied the safe fish passage depth criteria, based on transect geometry within the HEC-RAS model.

As shown in Table 7-8, all critical flows limiting fish passage were below the 1st percentile. These flows were deemed too infrequent to serve as a basis for MFL determination, and thus, no MFL metrics were utilized based on fish passage.

Table 7-8. Fish passage WRV assessment results.

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs); Downstream Condition = CR P10	Critical Flow (cfs); Downstream Condition = CR P50
26885	71.97	<P1	<P1
26145	72.54	<P1	<P1
25929	73.19	<P1	<P1
25383	72.64	<P1	<P1
24900	72.66	<P1	<P1
24519	71.94	<P1	<P1
23872	71.95	<P1	<P1
23202	72.01	<P1	<P1
22663	73.14	<P1	<P1
22291	71.95	<P1	<P1
21260	70.80	<P1	<P1
20787	70.69	<P1	<P1
19708	70.11	<P1	<P1
18703	70.42	<P1	<P1
17909	70.82	<P1	<P1
16834	69.07	<P1	<P1
15943	69.05	<P1	<P1
15303	69.84	<P1	<P1
13724	69.70	<P1	<P1
13110	70.84	<P1	<P1
12420	68.64	<P1	<P1
11099	69.12	<P1	<P1

Cross-Section	Critical Elevation (ft-NAVD88)	Critical Flow (cfs); Downstream Condition = CR P10	Critical Flow (cfs); Downstream Condition = CR P50
10398	69.48	<P1	<P1
9842	71.74	<P1	<P1
8872	68.25	<P1	<P1
7910	68.74	<P1	<P1
6833	71.34	<P1	<P1
6050	68.27	<P1	<P1
5549	67.46	<P1	<P1
5071	67.73	<P1	<P1
4901	67.67	<P1	<P1
4669	70.25	<P1	<P1
4648	69.60	<P1	<P1
4491	69.60	<P1	<P1
4484	69.60	<P1	<P1
4373	63.46	<P1	<P1
4263	63.38	<P1	<P1
4164	64.35	<P1	<P1
3866	63.37	<P1	<P1
3238	63.04	<P1	<P1
3201	63.64	<P1	<P1
2390	61.75	<P1	<P1
1956	62.17	<P1	<P1
1500	61.68	<P1	<P1
794	61.42	<P1	<P1
257	61.82	<P1	<P1
55	61.62	<P1	<P1
0.5592	61.33	<P1	<P1
0.4926	60.62	<P1	<P1
0.4508	61.22	<P1	<P1
0.449	61.35	<P1	<P1
0.4465	61.42	<P1	<P1
0.4297	60.83	<P1	<P1
0.336	59.51	<P1	<P1
0.3061	60.12	<P1	<P1

7.3 Riparian Bank Habitat and Riparian Wetland and Floodplain Inundation Evaluation

An assessment of riparian bank habitat and riparian wetland and floodplain inundation was considered for the establishment of the Jackson Blue MFL and 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
- Aesthetic and Scenic Attributes
- Filtration and Absorption of Nutrients and Other Pollutants
- Sediment Loads

Wetland and floodplain inundation and bankfull flow metrics serve as useful proxies for these WRVs. Bankfull flow is defined as the streamflow resulting in a stage at the interface between the open channel and the alluvial floodplain (AMEC 2012). Flows greater than bankfull flow therefore begin to inundate riparian floodplain communities and are referred to as 'out-of-bank flows.' Riparian bank habitat, or the riparian zone, includes habitat which borders the shoreline below the top-of-bank. The riparian zone includes woody debris and snag habitat, and 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 the Jackson Blue Spring system. These flow conditions allow for inundation of riparian and floodplain communities and maintain the extent, integrity, ecosystem functions, and productivity of these communities (SRWMD 2015). Wetland and floodplain inundation also provides additional nutrients to Spring Creek, 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 helps maintain the system's dynamic equilibrium and balances phases of channel scour and aggradation. If this balance is not maintained, excessive scour and/or deposition could occur altering the dynamic equilibrium of the system (SRWMD 2021).

Based on an extensive literature review of methods used to assess riparian bank habitat, bankfull flow, and riparian wetland and floodplain inundation in previous MFL assessments, two methods were used for this assessment based on applicability to Jackson Blue:

- Evaluation of wetted perimeter to assess riparian bank habitat and bankfull flow conditions
- Evaluation of riparian wetland and floodplain inundation along Spring Creek

Details are presented in the sections below.

An evaluation of top-of-bank elevations to assess bankfull and out-of-bank flow conditions was also considered. However, this metric was not used for Jackson Blue Spring MFL establishment because variability in topography along the riverbank resulted in a high degree of uncertainty of bankfull flow results at individual cross sections. Additionally, the riparian wetland and floodplain inundation metric provides protection for all of the above WRVs and also provides a more robust evaluation of bankfull and out-of-bank flow conditions because of the larger sample size of elevations used to compute the riparian wetland and floodplain inundation metric. Protective benefits for these WRVs are also provided by the wetted perimeter metric.

7.3.1 Wetted Perimeter

Wetted perimeter is defined as the length of the interface between the conveying material (e.g., the stream bed) and the water being conveyed in a cross section, perpendicular to the direction of flow. Since wetted perimeter is a measure of inundated substrate, it is also a measure of habitat for aquatic organisms. The relationship of wetted perimeter with stage or flow rate is a function of the geometry of the cross section, and changes in that relationship are indicative of changes in geometry, which is also indicative of changes in hydroecological niches. For instance, the rate of change of wetted perimeter with respect to stage when the water surface is in the main stream of the channel is less than that when the water surface is in the floodplain because the slope of the floodplain land surface is much less than that in the main channel. Thus, a changepoint is observed in the relationship between wetted perimeter and stage for the stage at which water first starts entering the floodplain. This changepoint can be defined as a significant increase in the slope of the line representing the relationship between wetted perimeter and stage. Inflection points (change 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.

Two WRV metrics were considered involving wetted perimeter for this evaluation: (1) weighted-wetted perimeter and (2) detailed wetted perimeter. Weighted-wetted perimeter is an aggregate measure of wetted perimeter at individual transect locations and is a weighted average of wetted-perimeter values of cross-sections in a given reach, where the weights are the respective lengths of subreaches associated with a given reach. A detailed wetted perimeter value is simply the wetted perimeter value at a given cross section. Both assessments utilized flow-dependent, cross section wetted perimeter data produced by the Jackson Blue MFL HEC-RAS model. The same basic method for determining critical flows was used for the wetted perimeter metrics, with the calculation of each based on change points in the relationship between wetted perimeter and Jackson Blue Spring flow rate. Wetted perimeter-based flow reductions were calculated based on a 15 percent reduction in wetted perimeter at the identified critical flow. These analyses were done separately for Merritts Mill Pond and Spring Creek.

The weighted wetted perimeter analysis involved calculating an average wetted perimeter between all cross sections, weighted by longitudinal distance (parallel to the shoreline) between cross sections. This resulted in one weighted wetted perimeter versus flow relationship for each sub-system (Merritts Mill Pond and Spring Creek) which was then analyzed for change points to determine critical flows and calculate MFL metrics (Figure 7-8). Details of the methods used to identify changepoints for the weighted wetted perimeter analysis are presented in Appendix C.

In the detailed wetted perimeter analysis, wetted perimeter versus flow relationships were developed, changepoints were identified, and allowable flow reductions were calculated individually for each cross section based on transect-specific change points. Note that cross sections which did not exhibit distinct change points were excluded from this analysis. Summary statistics of the MFL metrics at valid cross sections were then computed. Details of the methods used to identify changepoints in the detailed wetted perimeter analysis are presented in Appendix C.

The weighted-wetted perimeter (WWP) analysis was performed using cross sections on Merritts Mill Pond and Spring Creek (separately and as a combination of the two), to calculate allowable flow reductions based on a 15 percent reduction in weighted wetted perimeter (Figure 7-8). Note that, because of increased water elevations caused by the control structure, WWP values in Merritts Mill Pond are significantly higher than those in Spring Creek, and also less sensitive to JBS flow. Since changes in water levels are relatively small with changes in flow in Merritts Mill Pond, WWP is also less sensitive in the pond to changes in flow since WWP is highly correlated with water levels. As a result, flows resulting in a 15-percent reduction in WWP for Merritts Mill Pond were below the 1st percentile (lowest flow scenario considered) since a large change in flow is required for significant change in WWP in the pond. These flows were deemed too infrequent to serve as a basis for MFL and therefore no MFL metrics were calculated based on WWP for either Merritts Mill Pond or the combined reaches of Merritts Mill Pond and Spring Creek (Table 7-9).

Results of the detailed wetted perimeter analysis are shown in Appendix C. It should be noted that some cross sections did not exhibit distinct changepoints in their relationship between wetted perimeter and Jackson Blue Spring flow, and some cross sections exhibited multiple distinct changepoints. An example of a cross section with multiple changepoints and the flow reduction calculation for one of those changepoints is shown in Appendix C (Figures 29 and 30, p. 71-73). Also, similar to the weighted wetted perimeter results for Merritts Mill Pond, allowable flow reductions could not be calculated for many cross sections (primarily in Merritts Mill Pond) since the flow resulting in a 15% reduction in wetted perimeter was less than the 1st percentile baseline flow. Statistics describing the MFL metrics resulting from all valid changepoints are shown in Table 7-10.

Results from both the weighted wetted perimeter and detailed wetted perimeter assessments indicated that changes in wetter perimeter were relatively insensitive to changes in Jackson Blue Spring flow. Based on the weighted wetted perimeter assessment, a 15% reduction in WWP for Spring Creek was equivalent to allowable flow reductions of 36.1 cfs (P10 Chipola River stage scenario) and 34.7 cfs (P50 Chipola River stage scenario). Based on the detailed wetted perimeter assessment from transects with valid wetted perimeter change points, a 15% reduction in wetted perimeter at all valid change points was equivalent to a mean allowable flow reduction of 30.5 cfs. The mean and median allowable flow reductions calculated based on the detailed wetted perimeter analysis (30.5 cfs and 24.4 cfs, respectively) were both less than the average for the weighted wetted perimeter analysis. This may be due to the ability of the detailed wetted perimeter analysis to account for less pronounced changepoints in individual cross sections at flow rates less than 124 cfs, which was the changepoint for Spring Creek determined in the weighted wetted perimeter analysis.

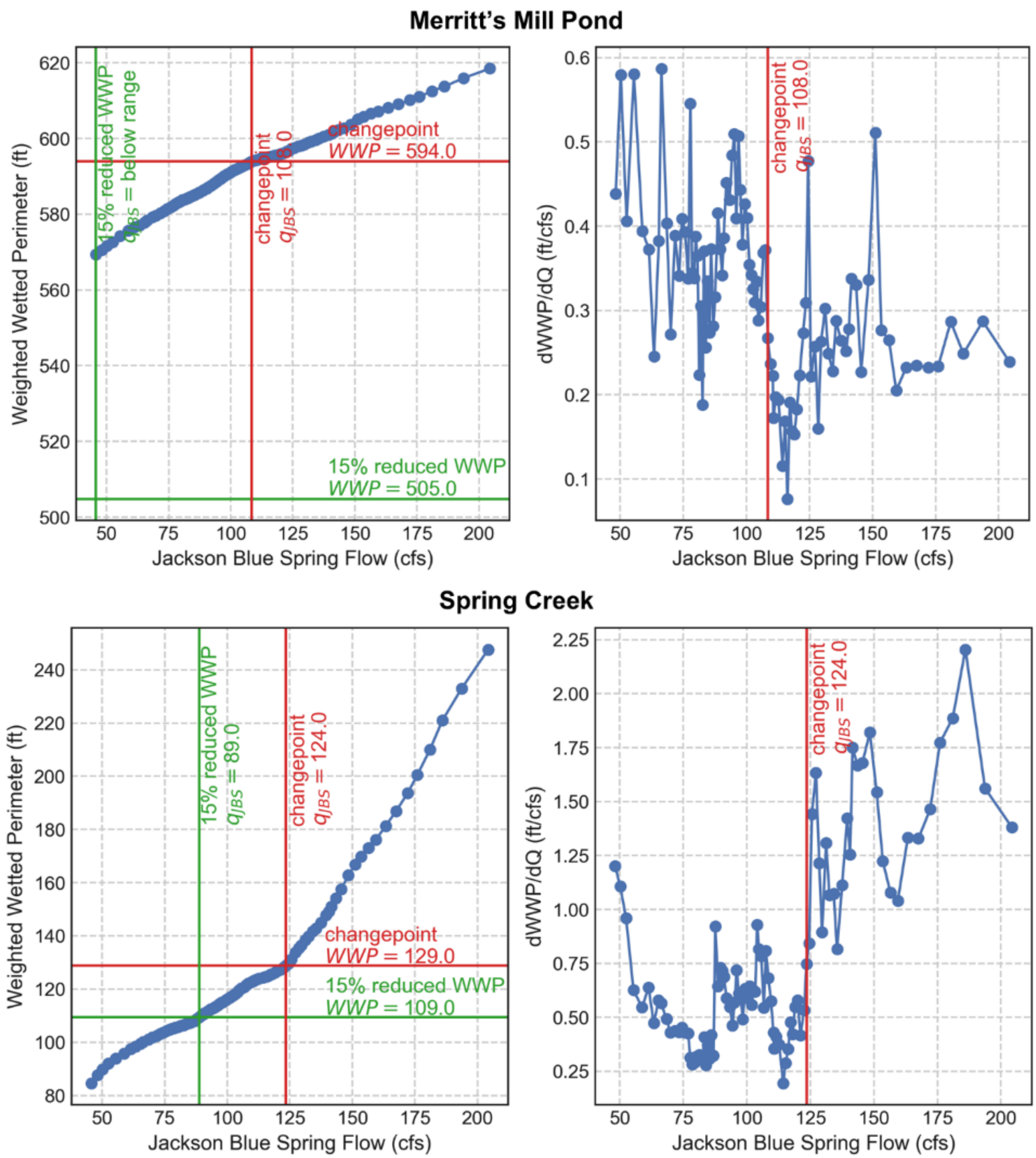


Figure 7-8. Plots showing the relationship between weighted wetted perimeter (WWP) and Jackson Blue Spring flow (left side) and the discrete first derivative of that relationship (right side) for Merritts Mill Pond (top) and Spring Creek (bottom), which were used to determine critical flows based on changepoints and flow reductions based on a 15 percent reduction in WWP.

Table 7-9. Results of the weighted wetted perimeter (WWP) WRV assessment.

Reach	Downstream Condition	Critical Flow (cfs)	WWP (ft)	15% Reduced WWP (ft)	Flow at Reduced WWP (cfs)	Minimum Allowable Flow (cfs)	Allowable Flow Reduction (cfs)	Percent Flow Reduction (%)[1]
MMP and SC	CR P10	123.5	468.8	398.5	<P1	NA	NA	NA
MMP	CR P10	108.5	593.9	504.8	<P1	NA	NA	NA
SC	CR P10	123.5	132.1	112.3	87.4	67.2	36.1	34.9
MMP and SC	CR P50	123.5	467.9	397.7	<P1	NA	NA	NA
MMP	CR P50	108.5	593.9	504.8	<P1	NA	NA	NA
SC	CR P50	123.5	128.8	109.4	88.8	68.6	34.7	33.6

[1] Percent flow reduction is a percentage of the median of the baseline Jackson Blue Spring discharge (103.3 cfs).

Table 7-10. Statistics describing the MFL metrics calculated from all valid changepoints in the detailed wetted perimeter analysis.

Statistic	Minimum Allowable Flow (cfs)	Allowable Flow Reduction (cfs)	Percent Flow Reduction (%)[1]
Count	39	39	39
Mean	72.8	30.5	29.5
Standard Deviation	22.7	22.7	22.0
Minimum	13.7	4.7	4.6
15th Percentile	56.2	13.4	13.0
25th Percentile	59.5	14.0	13.5
50th Percentile	78.9	24.4	23.6
75th Percentile	89.3	43.8	42.4
85th Percentile	89.9	47.1	45.6
Maximum	98.6	89.6	86.7

[1] Percent flow reductions are percentages of the median baseline Jackson Blue Spring Flow (103.3 cfs).

7.3.2 Riparian Wetland and Floodplain Inundation

The inundation of riparian wetlands and floodplains due to various flow rates/water levels in adjacent streams is a useful metric for protecting multiple water resource values such as flood mitigation, water quality improvements, transfer of detrital material, and the maintenance of habitat for wetland species. A riparian wetland and floodplain inundation analysis was performed on Spring Creek using geospatial datasets mapping wetland vegetation, hydric soils, and the extent of inundated areas from flow-dependent water surfaces (Table 7-11). This analysis was performed for Spring Creek only, because stage fluctuations on Merritts Mill Pond are minimal, and large areas of the riparian wetland and floodplain that existed prior to construction of the Merritts Mill Pond control structure are inundated at all flows because of the control structure. A flow versus inundated riparian wetland and floodplain area relationship was developed for Spring Creek by intersecting each water surface layer from the HEC-RAS model corresponding to a specific Jackson Blue flow percentile with the floodplain geospatial layers within GIS.

The water surface layers represent the extent of the water surface at a given flow rate. Inundated area was calculated for each flow rate as the area of the intersection of the corresponding water surface layers with the riparian wetland and floodplain layers representing wetland vegetation and hydric soils. Relationships between Jackson Blue Spring flow and inundated riparian wetland and floodplain area were developed using multiple representations of the riparian wetland and floodplain (wetlands and hydric soils, wetlands only, and hydric soils only) and two downstream boundary conditions (CR P10 and CR P50, Figure 7-9).

Critical flows were determined based on changepoints in the flow versus inundated riparian wetland and floodplain area relationship. Based on the relationships of flow versus inundated area shown in Figure 7-9, changepoints occurred at the 20th and 70th percentiles. In addition, the median flow (P50) and maximum flow (P99) were also considered because of their hydrologic significance. A total of 24 critical flows were assessed for all possible combinations of floodplain layers and downstream boundary conditions. Allowable flow reductions were calculated based on a 15 percent reduction in inundated floodplain area at the critical flows of interest (Table 7-12).

Review of results in Table 7-12 indicated that inundated riparian wetland and floodplain area is relatively sensitive to changes in Jackson Blue Spring flow. Allowable flow reductions ranged from a minimum of 8.7 cfs (8.4% flow reduction of the median baseline JBS discharge) to a maximum of 26.7 cfs (25.8% flow reduction of the median baseline JBS discharge) based on the scenarios evaluated. For purposes of MFL determination, the average of the CR P10 and CR P50 boundary condition scenarios, with the union of best available delineations of wetland vegetation and hydric soils, was utilized. Of the four critical percentiles representing appropriate changepoints in flow versus inundated riparian wetland and floodplain area, the P50 scenario was most limiting for both the CR P10 downstream boundary (11.0 cfs allowable flow reduction), and the CR P50 downstream boundary (11.1 cfs allowable flow reduction). The average of these two scenarios results in an allowable flow reduction of 11.1 cfs (10.7% reduction of the median baseline JBS discharge).

While the riparian wetland and floodplain inundation assessment including only wetland vegetation suggested a lower allowable flow reduction, that is based on a less comprehensive definition of wetlands and may neglect areas which provide wetland functions like nutrient cycling and flood mitigation, but do not currently harbor wetland vegetation. Thus, it was determined that the MFL metrics derived from the more comprehensive definition of wetlands surrounding Spring Creek were more reliable indicators of thresholds for significant harm to WRVs provided by wetland inundation.

Table 7-11. Geospatial datasets used for the riparian wetland and floodplain inundation analysis performed on Spring Creek.

Dataset	Description	Source
Wetland Vegetation	Subset based on LEVEL 1 LANDUSE DESCRIPTION = "Wetlands"	Florida Statewide Land Use Land Cover (accessed Sept. 2024): https://geodata.dep.state.fl.us/datasets/statewide-land-use-land-cover/explore
Hydric Soils	Subset based on Hydric soil rating = "Yes"	NRCS Web Soil Survey (October 2021): https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Water Surface	One layer for each of 11 flow rates ranging from 1st to 99th percentile and every 10^{th} flow percentile, for each downstream boundary condition	Steady-state HEC-RAS model

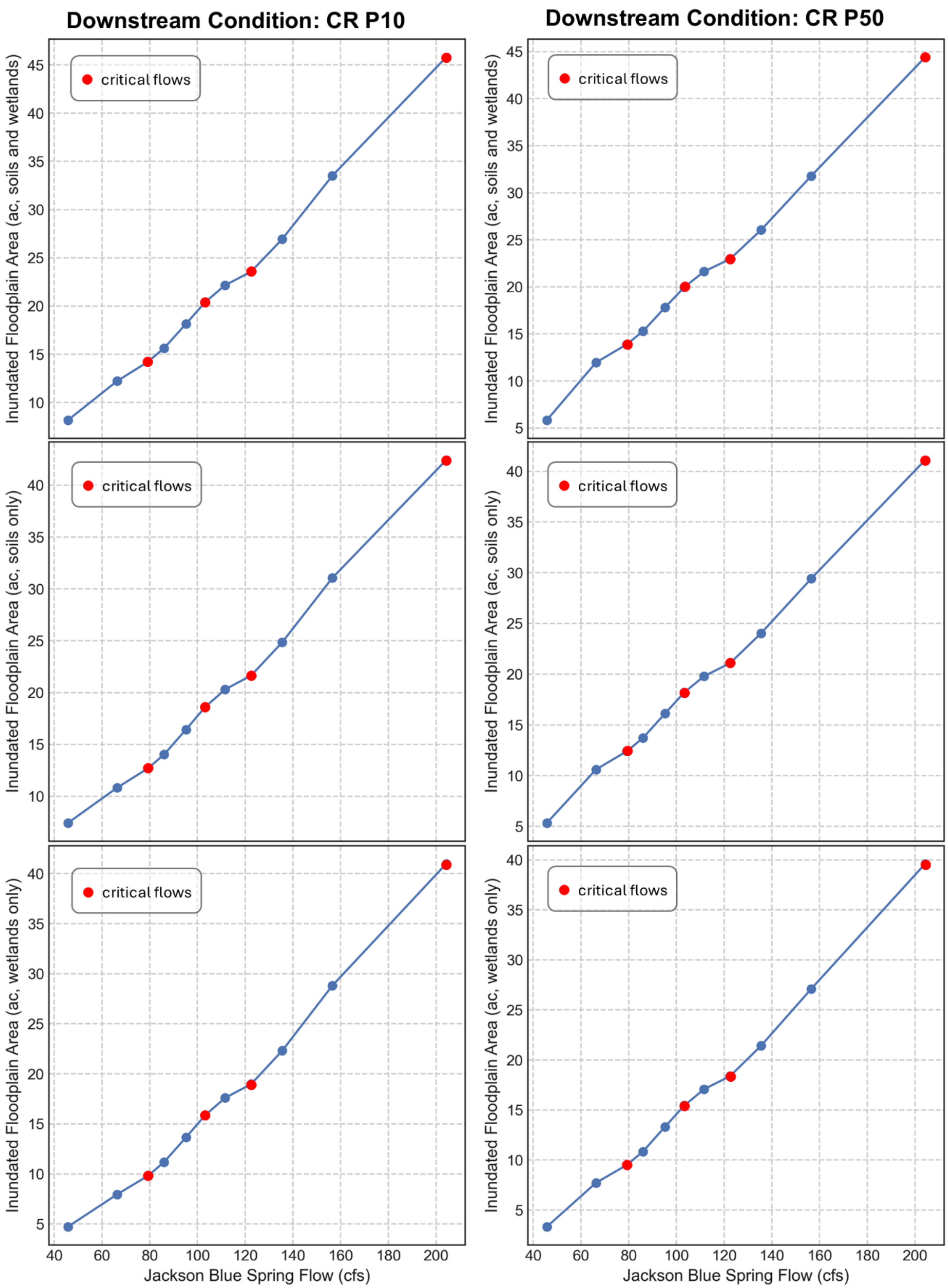


Figure 7-9. Relationships between Jackson Blue Spring flow and inundated riparian wetland and floodplain area based on both wetlands and soils (top row), soils only (middle row), and wetlands only (bottom row) with a downstream boundary condition equal to CR P10 (left column) and CR P50 (right column).

Table 7-12. Results of the riparian wetland and floodplain inundation analysis.

Downstream Condition	Riparian Wetland and Floodplain Representation	Critical Percentile (%)	Critical Area (ac)	Critical Flow (cfs)	15%-Reduced Area (ac)	Reduced Flow (cfs)	Minimum Allowable Flow (cfs)	Allowable Flow Reduction (cfs)	Percent Flow Reduction (%)
CR P10	Hydric soils and wetlands	20	14.2	79.3	12.1	65.7	89.7	13.6	13.2
CR P10	Hydric soils and wetlands	50	20.4	103.3	17.4	92.3	92.3	11.0	10.7
CR P10	Hydric soils and wetlands	70	23.6	122.5	20.0	101.9	82.7	20.6	19.9
CR P10	Hydric soils and wetlands	99	45.8	204.3	38.9	177.6	76.6	26.7	25.8
CR P10	Hydric soils only	20	12.7	79.3	10.8	66.1	90.1	13.2	12.7
CR P10	Hydric soils only	50	18.6	103.3	15.8	92.9	92.9	10.4	10.1
CR P10	Hydric soils only	70	21.6	122.5	18.4	102.5	83.3	20.0	19.4
CR P10	Hydric soils only	99	42.4	204.3	36.1	177.6	76.6	26.7	25.9
CR P10	Wetlands only	20	9.8	79.3	8.3	69.0	93.0	10.3	9.9
CR P10	Wetlands only	50	15.9	103.3	13.5	94.6	94.6	8.7	8.4
CR P10	Wetlands only	70	19.0	122.5	16.1	104.5	85.3	18.0	17.4
CR P10	Wetlands only	99	41.0	204.3	34.8	180.2	79.2	24.1	23.3
CR P50	Hydric soils and wetlands	20	13.9	79.3	11.8	65.8	89.8	13.5	13.0
CR P50	Hydric soils and wetlands	50	20.0	103.3	17.0	92.2	92.2	11.1	10.8
CR P50	Hydric soils and wetlands	70	23.0	122.5	19.5	101.6	82.4	20.9	20.2

Downstream Condition	Riparian Wetland and Floodplain Representation	Critical Percentile (%)	Critical Area (ac)	Critical Flow (cfs)	15%-Reduced Area (ac)	Reduced Flow (cfs)	Minimum Allowable Flow (cfs)	Allowable Flow Reduction (cfs)	Percent Flow Reduction (%)
CR P50	Hydric soils and wetlands	99	44.4	204.3	37.8	179.1	78.1	25.2	24.4
CR P50	Hydric soils only	20	12.4	79.3	10.6	66.1	90.1	13.2	12.8
CR P50	Hydric soils only	50	18.2	103.3	15.5	92.7	92.7	10.6	10.2
CR P50	Hydric soils only	70	21.1	122.5	17.9	102.2	83.0	20.3	19.6
CR P50	Hydric soils only	99	41.1	204.3	34.9	179.1	78.1	25.2	24.4
CR P50	Wetlands only	20	9.5	79.3	8.1	69.0	93.0	10.3	10.0
CR P50	Wetlands only	50	15.4	103.3	13.1	94.5	94.5	8.8	8.5
CR P50	Wetlands only	70	18.4	122.5	15.6	104.2	85.0	18.3	17.7
CR P50	Wetlands only	99	39.6	204.3	33.7	181.6	80.6	22.7	22.0

7.4 Instream Habitat Metric Evaluation

Output from the SEFA model, described in Section 6.3, was utilized to determine the relationship between Jackson Blue Spring flow and the area weighted suitability (AWS) for aquatic species and guilds of interest including fish and macroinvertebrate species, as well as mussels and host fish. Appendix C presents the SEFA results for the baseline flow scenarios simulated with the HEC-RAS model. The maximum AWS and corresponding Jackson Blue Spring flow are presented for each species and guild of interest. Merritts Mill Pond and Spring Creek were considered separate reaches for the purpose of this analysis and were assessed independently within SEFA.

Since the SEFA analysis provides an estimate of aggregate AWS for each flow simulated, the relation 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 used as the protection standard for instream habitat for establishing MFLs for this assessment. The maximum AWS was selected as the metric of interest as a conservative assumption to protect Jackson Blue instream habitat. Figure 7-10 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.

The relation between the AWS and flow for each species or guild assessed within the Merritts Mill Pond and Spring Creek subreaches is shown in Appendix C. An example of an AWS-flow relation is shown for the spotted sunfish, spawning life stage in Figure 7-11. The aggregate AWS for each simulated flow is displayed by the yellow markers for each graphic in Appendix C. The blue curve represents a best fit curve through all the computed AWS versus flow values. 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. The flow range that defines the X-axis is the range from simulated baseline flows (P1 - P99) is presented in Appendix C.

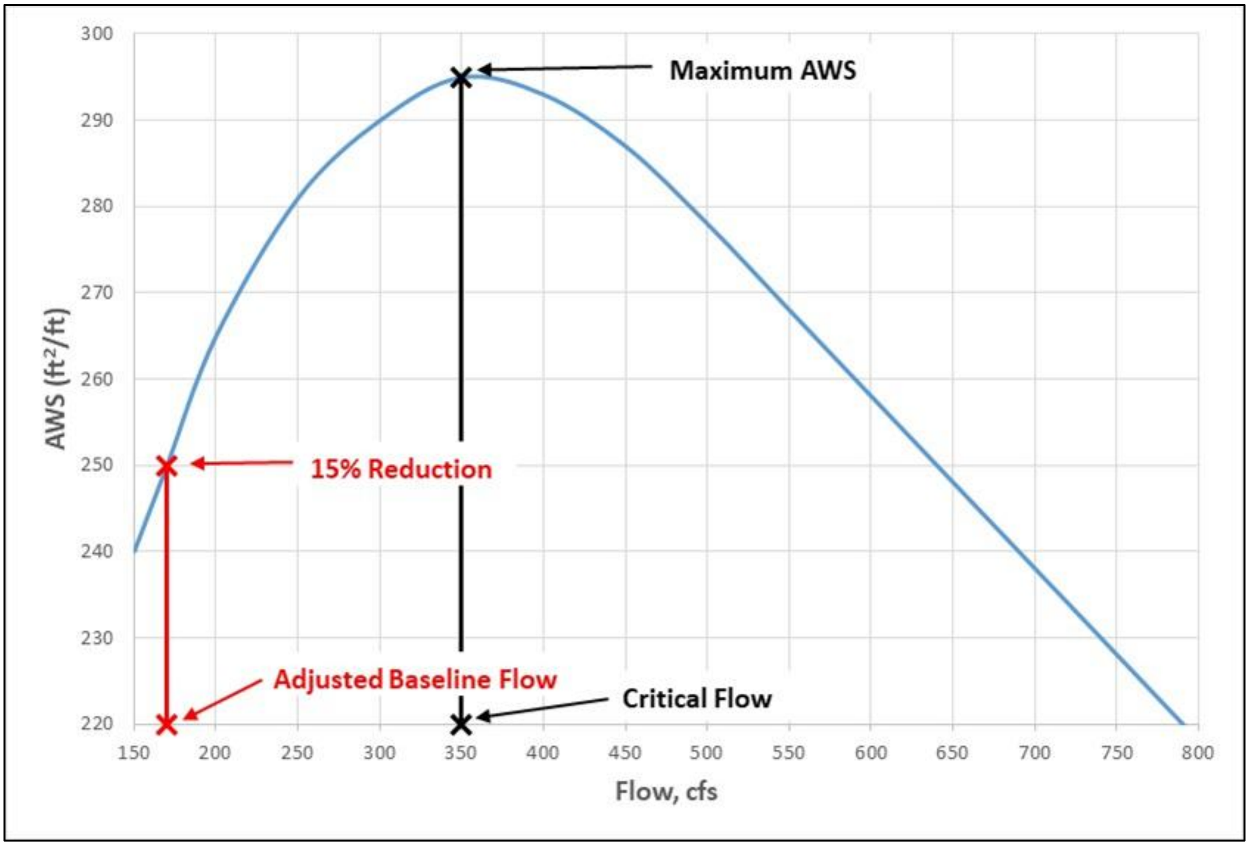


Figure 7-10. Conceptual diagram of the estimation of the critical flow resulting from a 15-percent reduction in Area Weighted Suitability (AWS).

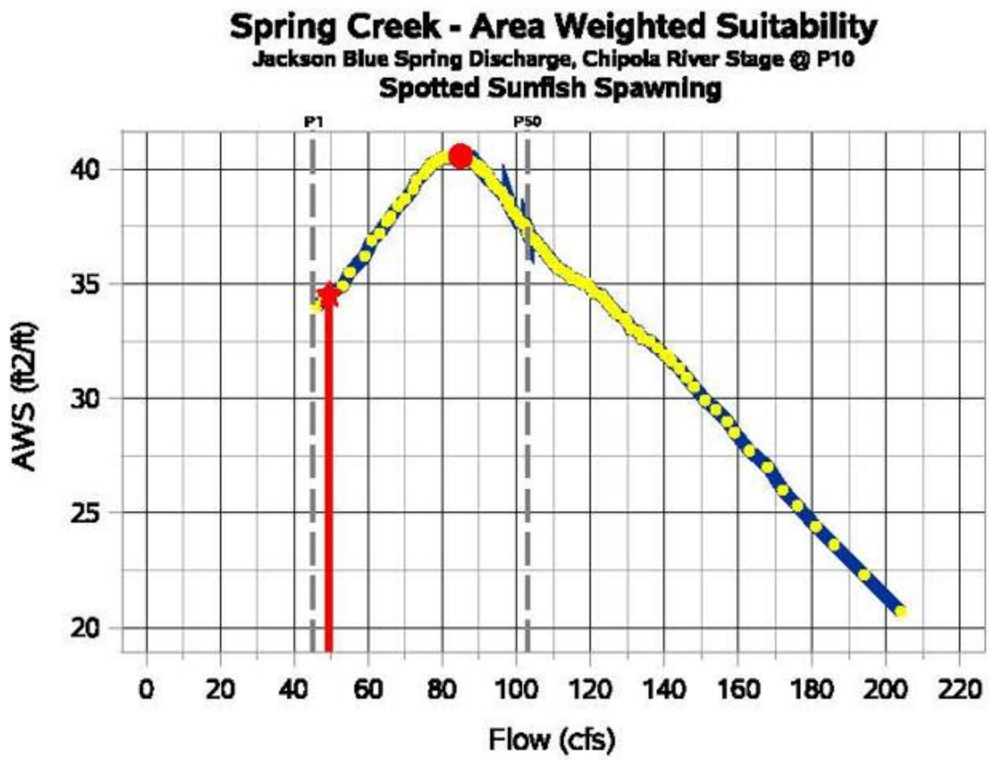


Figure 7-11. Relationship between flow and AWS for spotted sunfish spawning.

Species or guilds which displayed an increase in AWS with reduced flow were excluded from further analysis and are not described in in this technical assessment; however, the results of the analysis are provided in Appendix C. 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 (Appendix C). 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 7-13, Table 7-14, and Table 7-15 for Spring Creek and Merritts Mill Pond subreaches for both downstream Chipola River stage boundary conditions considered (P10 and P50 Chipola River stage). Results within Merritts Mill Pond were identical under either downstream stage boundary condition, due to lack of sensitivity of pond stage to changes in Chipola River stage. These critical points are also indicated on the graphics in Appendix C. For each relevant species or guild, the 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.

Spring Creek Results – Because water levels in Spring Creek can be significantly affected by backwater effects from the Chipola River, two different downstream boundary conditions were investigated including the P10 and P50 Chipola River stages. Modeling results from both downstream boundary conditions resulted in a total of 17 Habitat Suitability Curves displaying reductions in AWS associated with reductions in flow. For the lower downstream boundary condition (P10 Chipola River Stage), the maximum allowable flow reductions from the median Jackson Blue Spring baseline flow of 103.3 cfs (corresponding to a 15 percent reduction in AWS) ranged from 35.7 cfs for the most sensitive taxon, spotted sunfish (*Lepomis punctatus*) spawning, to 93.3 cfs for least sensitive taxon, Tricoptera (caddisflies). AWS versus flow relations based on simulations using the median downstream boundary condition (P50 Chipola River stage) yielded similar results, with the maximum allowable flow reduction ranging from 33.7 cfs for spotted sunfish (*Lepomis punctatus*) spawning to 93.3 cfs for Tricoptera (caddisflies). Overall, these results indicate AWS is relatively insensitive to changes in Jackson Blue Spring flow in Spring Creek.

Merritts Mill Pond Results – Overall, AWS was minimally sensitive to changes in Jackson Blue Spring Flow in Merritts Mill Pond. Five taxa displayed reductions in Area Weighted Suitability (AWS) with reduced Jackson Blue Spring flow in Merritts Mill Pond. The most sensitive taxon was generic adult darter species which displayed an allowable flow reduction of 40 cfs from a median Jackson Blue Spring flow of 103.3 cfs. Three taxa displayed allowable flow reductions greater than the median Jackson Blue Spring baseline flow.

Table 7-13. Flow Reduction associated with a 15-percent reduction in maximum area weighted suitability (AWS) for Spring Creek for P10 Chipola River stage.

Taxon	Maximum AWS	Flow @ Maximum AWS (cfs)	15% Reduction in Maximum AWS	Flow @ Reduced Maximum AWS (cfs)	Percent Reduction in Flow	Allowable Flow Reduction (cfs)	Percent Departure from the median JBS flow (103.3 cfs)
Spotted Sunfish Spawning	40.6	85.0	34.5	49.3	42.0	35.7	34.5
Spotted Sucker Adult	28.1	131.0	23.9	90.5	30.9	40.5	39.2
Habitat Guilds Shallow Fast	51.4	99.0	43.7	56.6	42.8	42.4	41.0
Largemouth Bass Adult	38.5	126.0	32.7	70.5	44.0	55.5	53.7
Ephemeroptera	79.3	204.0	67.4	147.8	27.6	56.3	54.5
Plecoptera	71.9	148.0	61.1	91.3	38.3	56.7	54.9
Spotted Sunfish Adult	82.9	130.0	70.4	65.7	49.5	64.3	62.3
Redeye Chub	60.0	131.0	51.0	61.8	52.8	69.2	67.0
Blackbanded Darter Adult	81.3	129.0	69.1	53.5	58.5	75.5	73.0
Habitat Guilds Deep Fast	86.2	186.0	73.3	108.0	41.9	78.0	75.5
Habitat Guilds Deep Slow	97.0	168.0	82.4	87.8	47.8	80.3	77.7
Redbreast Sunfish Adult	97.0	168.0	82.4	87.8	47.8	80.3	77.7
Speckled Madtom	107.0	204.0	90.9	122.0	40.2	82.0	79.4
EPT Total	82.5	136.0	70.1	53.8	60.4	82.2	79.5

Taxon	Maximum AWS	Flow @ Maximum AWS (cfs)	15% Reduction in Maximum AWS	Flow @ Reduced Maximum AWS (cfs)	Percent Reduction in Flow	Allowable Flow Reduction (cfs)	Percent Departure from the median JBS flow (103.3 cfs)
Generic Darters Adult	80.9	146.0	68.8	59.7	59.1	86.3	83.6
Redbreast Sunfish Fry	9.4	146.0	8.0	56.0	61.6	90.0	87.1
Tricoptera	111.1	204.0	94.4	110.7	45.8	93.3	90.4

Table 7-14. Flow Reduction associated with a 15-percent reduction in maximum area weighted suitability (AWS) for Spring Creek for P50 Chipola River Stage.

Taxon	Maximum AWS	Flow @ Maximum AWS (cfs)	15% Reduction in Maximum AWS	Flow @ Reduced Maximum AWS (cfs)	% Reduction in Flow	Allowable Flow Reduction (cfs)	Percent Departure from the median JBS flow (103.3 cfs)
Spotted Sunfish Spawning	40.2	83	34.2	49.3	40.6	33.7	32.6
Spotted Sucker Adult	27.7	131	23.5	89.8	31.5	41.3	39.9
Habitat Guilds Shallow Fast	51.5	100	43.8	56.0	44.0	44.0	42.6
Ephemeroptera	79.5	204	67.6	148.5	27.2	55.5	53.7
Largemouth Bass Adult	38.0	127	32.3	70.5	44.5	56.5	54.7
Plecoptera	71.5	148	60.8	91.3	38.3	56.7	54.9
Spotted Sunfish Adult	82.5	130	70.1	65.8	49.4	64.3	62.2
Redeye Chub	59.5	131	50.6	61.4	53.1	69.6	67.4
Blackbanded Darter Adult	80.9	129	68.8	53.5	58.5	75.5	73.1
Habitat Guilds Deep Fast	86.0	186	73.1	108.5	41.7	77.5	75.0
Habitat Guilds Deep Slow	96.2	168	81.8	87.5	47.9	80.5	77.9

Taxon	Maximum AWS	Flow @ Maximum AWS (cfs)	15% Reduction in Maximum AWS	Flow @ Reduced Maximu m AWS (cfs)	% Reduction in Flow	Allowable Flow Reduction (cfs)	Percent Departure from the median JBS flow (103.3 cfs)
Redbreast Sunfish Adult	96.2	168	81.8	87.5	47.9	80.5	77.9
Speckled Madtom	106.7	204	90.7	122.3	40.0	81.7	79.1
EPT Total	82.3	138	70	54.0	60.9	84.0	81.3
Generic Darters Adult	80.6	146	68.5	59.5	59.2	86.5	83.7
Redbreast Sunfish Fry	9.3	146	7.9	56.0	61.6	90.0	87.1
Tricoptera	110.7	204	94.1	110.7	45.8	93.3	90.4

Table 7-15 Flow Reduction associated with a 15 percent reduction in maximum area weighted suitability (AWS) for Merritts Mill Pond for P10 and P50 Chipola River Stage.

Taxon	Maximum AWS	Flow @ Maximum AWS (cfs)	15% Reduction in Maximum AWS	Flow @ Reduced Maximum AWS (cfs)	Percent Reduction in Flow	Allowable Flow Reduction (cfs)	Percent Departure from the median JBS flow (103.3 cfs)
Generic Darter Adult	77.5	204.0	65.8	164.0	19.6	40.0	38.7
Bluegill Adult	166.6	134.0	141.6	47.7	64.4	86.3	83.5
Habitat Guilds Deep Fast	11.3	168.0	9.6	49.7	70.4	118.3	114.6
Tricoptera	303.0	204.0	257.6	73.9	63.8	130.1	125.9
Spotted Sucker Adult	118.6	204.0	100.8	62.5	69.4	141.5	137.0

7.5 Application of the Hydroperiod Tool to the Jackson Blue Spring System

As noted previously, two reaches within the Jackson Blue Spring System are affected by flows from Jackson Blue Spring: Merritts Mill Pond and Spring Creek (Figure 7-12). To ensure that MFLs developed for Jackson Blue Spring will protect both reaches, two analytical approaches have been employed to protect instream habitat. Given that Spring Creek is a lotic system (i.e., a flowing water system) a SEFA analysis approach was taken for that reach to assess instream habitat, as described in Section 7.4. In contrast, Merritts Mill Pond displays characteristics of both a lotic system with relatively low water velocities and a lentic system (i.e., a lake or ponded water system). In order to be as protective as possible, Merritts Mill Pond was evaluated using metrics traditionally used for both lotic systems (SEFA analysis, passage metrics, etc.) and lentic systems (hydroperiod tool). The Hydroperiod Tool (Jennewein et al., 2020; Leeper et al. 2001, Shadik et al., 2025; Sutherland et al., 2021) developed by the St. Johns River Water Management was used to evaluate the effects of water level changes on the average area of various fish and wildlife habitats in Merritts Mill Pond as a function of Jackson Blue Spring discharge. The Hydroperiod Tool was created for use within ArcGIS software to assess metrics related to depth, aerial coverage, and seasonality of wetland inundation, and has been used in several applications in Florida. The hydroperiod tool can also be utilized to evaluate changes in ponded depth relating to fish and wildlife habitat (Leeper et al. 2001, SJRWMD 2025)). Since Merritts Mill Pond has relatively low velocity with little spatial variability, the hydroperiod tool was evaluated to assess potential effects of water level decline on the average area of various fish and wildlife habitats in the pond as a function of Jackson Blue Spring discharge.

The first step in the analysis was to create a digital elevation model (DEM) of the elevation of the bottom of Merritts Mill Pond. This was achieved using the same cross sections and associated elevations that were used to develop the HEC-RAS model (Figure 7-12). Within a geographic information system (ESRI ArcGIS Pro 3.5), the transects and the elevations along the lines were plotted. Various interpolation techniques were tested. The spline with boundary tool, using the outline of the pond as the boundary was selected to create the DEM of Merritts Mill Pond (Figure 7-13). Use of the spline with boundary tool constrained the interpolation to the area of the pond while the other techniques worked beyond the pond and caused non-neighboring areas to affect one another in the interpolation. The tool creates a continuous raster of bottom elevations within Merritts Mill Pond based on the elevations from the HEC-RAS cross sections.

A set of bathymetric maps of the pond were then created, utilizing the HEC-RAS water surface elevation (WSE) profiles determined for the P1, P5, P10, P15, P20, P30, P40, P50, P60, P70, P80, P90, and P99 percentile flows for Jackson Blue Spring. The depth was calculated as the difference between the WSE and the bottom elevation using the Raster Calculator within the ArcGIS Pro software. An example bathymetric map is shown in Figure 7-14.

The next step was to identify the species that would be analyzed. Compared with the HSCs available for the SEFA metrics, detailed hydrologic information for the Hydroperiod Tool as it relates to organisms of interest are not available. Small and large wading birds, along with spawning game fish were chosen as the metrics that would be analyzed. Depth ranges for wading birds and game fish spawning within Merritts Mill Pond were unavailable. Critical depth ranges for these metrics have been used in previous MFLs (Jennewein et al., 2020; Shadik et al., 2025; Sutherland et al., 2021), based on literature review. These depth ranges were used in this analysis (Table 7-16), however other factors such as substrate, temperature, SAV presence, etc. influence preferred spawning habitat. In addition, different game fish species may exhibit differences in preferred spawning habitat not captured in this metric. These depth ranges were then entered into the GIS system to reclassify the depth raster and identify the areas within the range of critical depths for each of the metrics. The reclassified areas were then tabulated for each Jackson Blue Spring percentile flow listed above for further analysis. An example of the reclassified areas for game fish spawning depths for the 50th percentile flow is shown in Figure 7-15. Depths in Merritts Mill Pond exceeded maximum critical depths in most areas of the pond. A shallow area in the middle of the pond is evident, providing habitat to wading birds and game fish spawning. The mean depth in Merritts Mill Pond for the 50th percentile flow scenario is 5.94 ft.

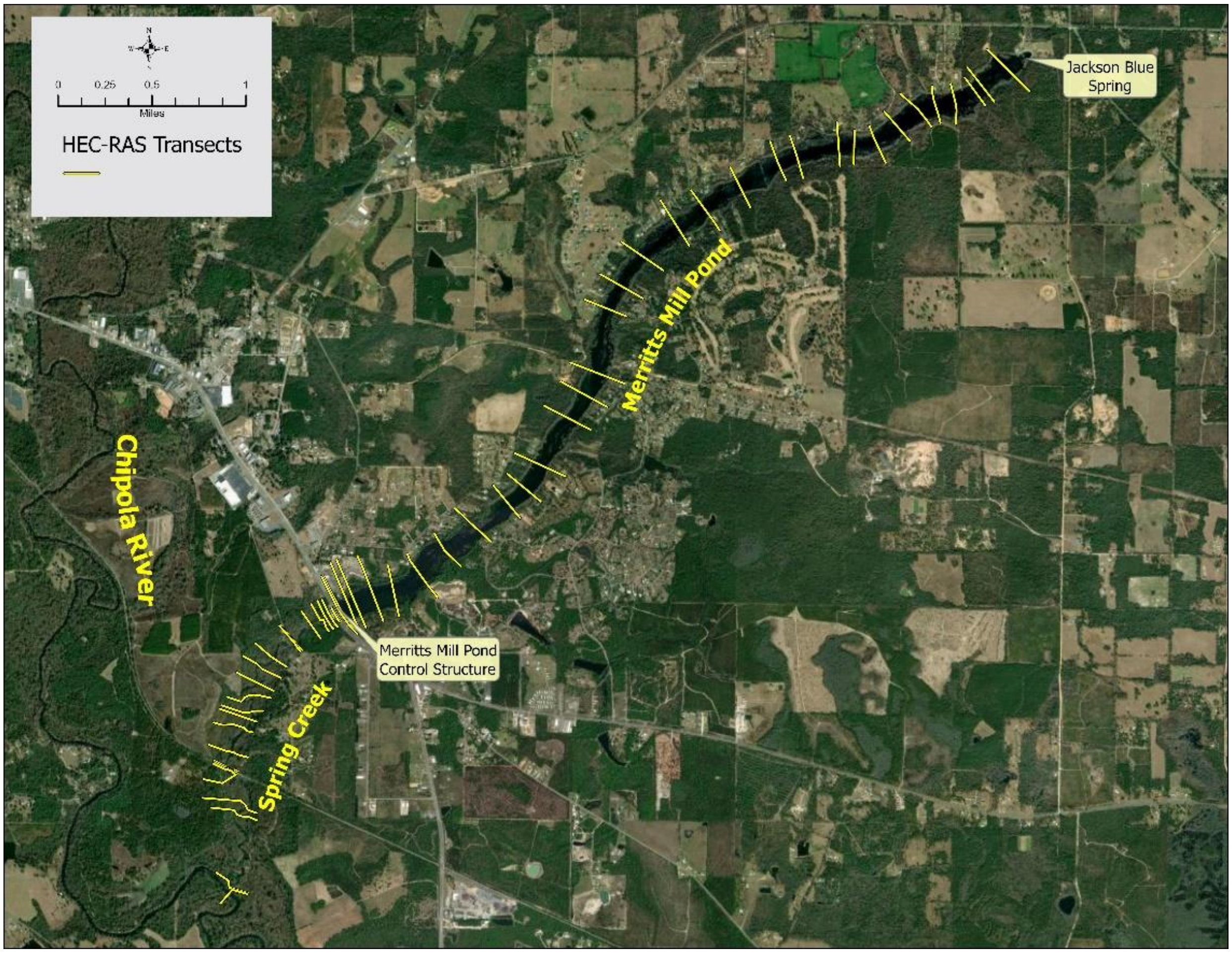


Figure 7-12. Transect locations in Merritts Mill Pond and Spring Creek.

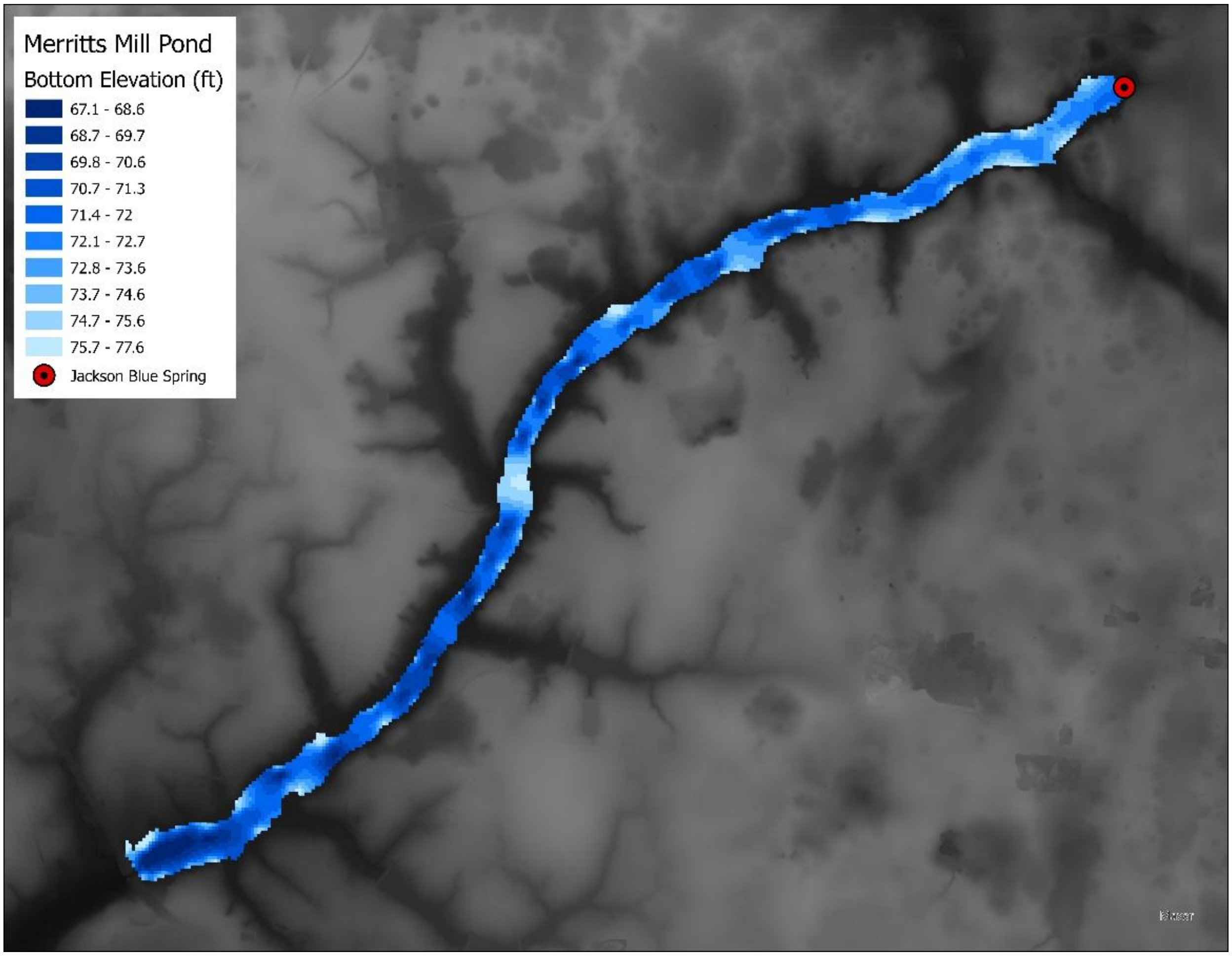


Figure 7-13. Interpolated bottom elevations within Merritts Mill Pond.

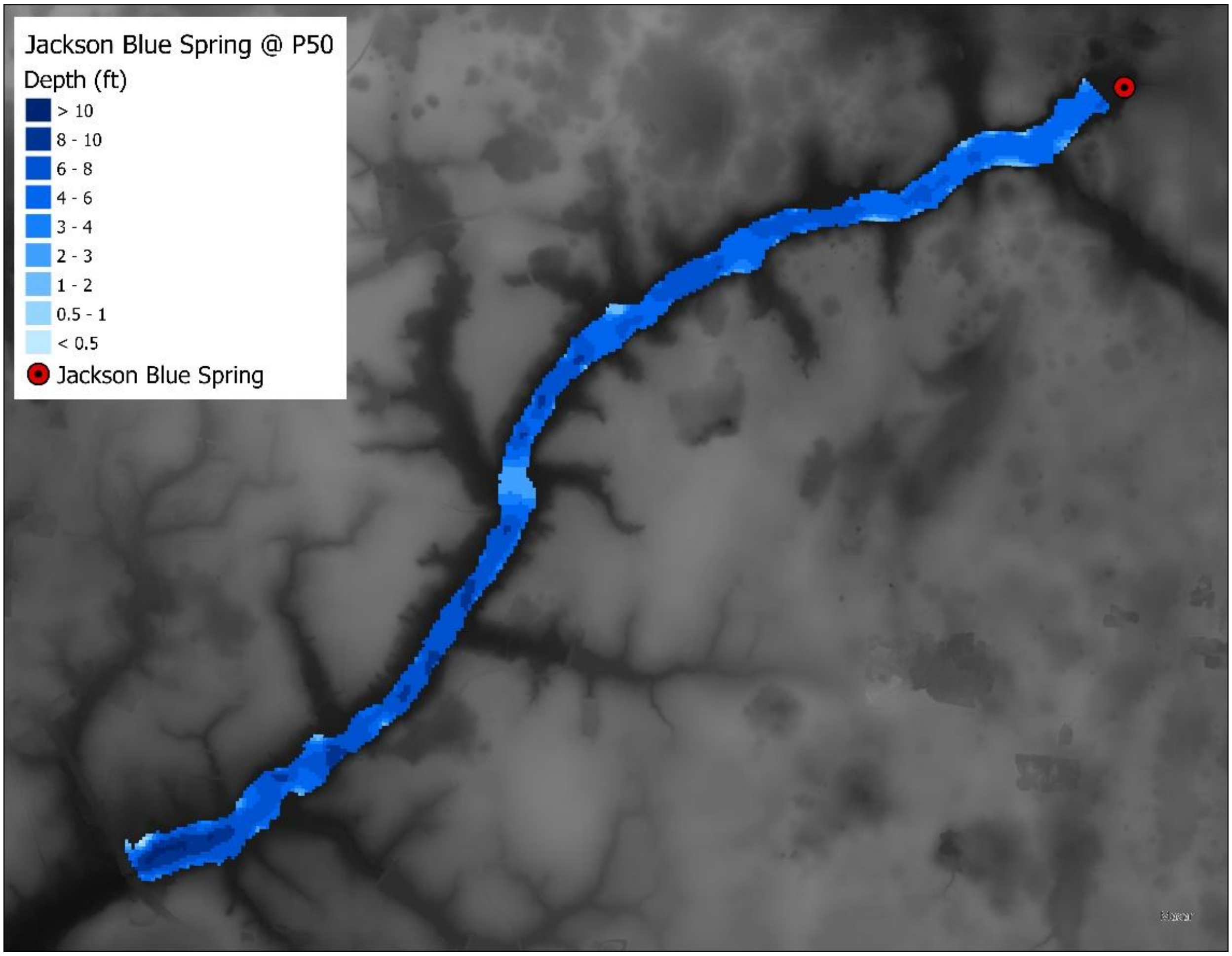


Figure 7-14. Calculated depths in Merritts Mill Pond for the P50 discharge from Jackson Blue Spring.

Table 7-16. Critical depths for selected species.

Species	Critical Depth Range (ft)
Small Wading Birds	
Snail Kite	
Snowy Egret	0.1 – 0.5
Tricolored Heron	
Green Heron	
Large Wading Birds	
Great Blue Heron	
Wood Stork	
White Ibis	0.1 – 1.0
Great Egret	
Sandhill Crane	
Game Fish Spawning (e.g., largemouth bass)	1 – 4

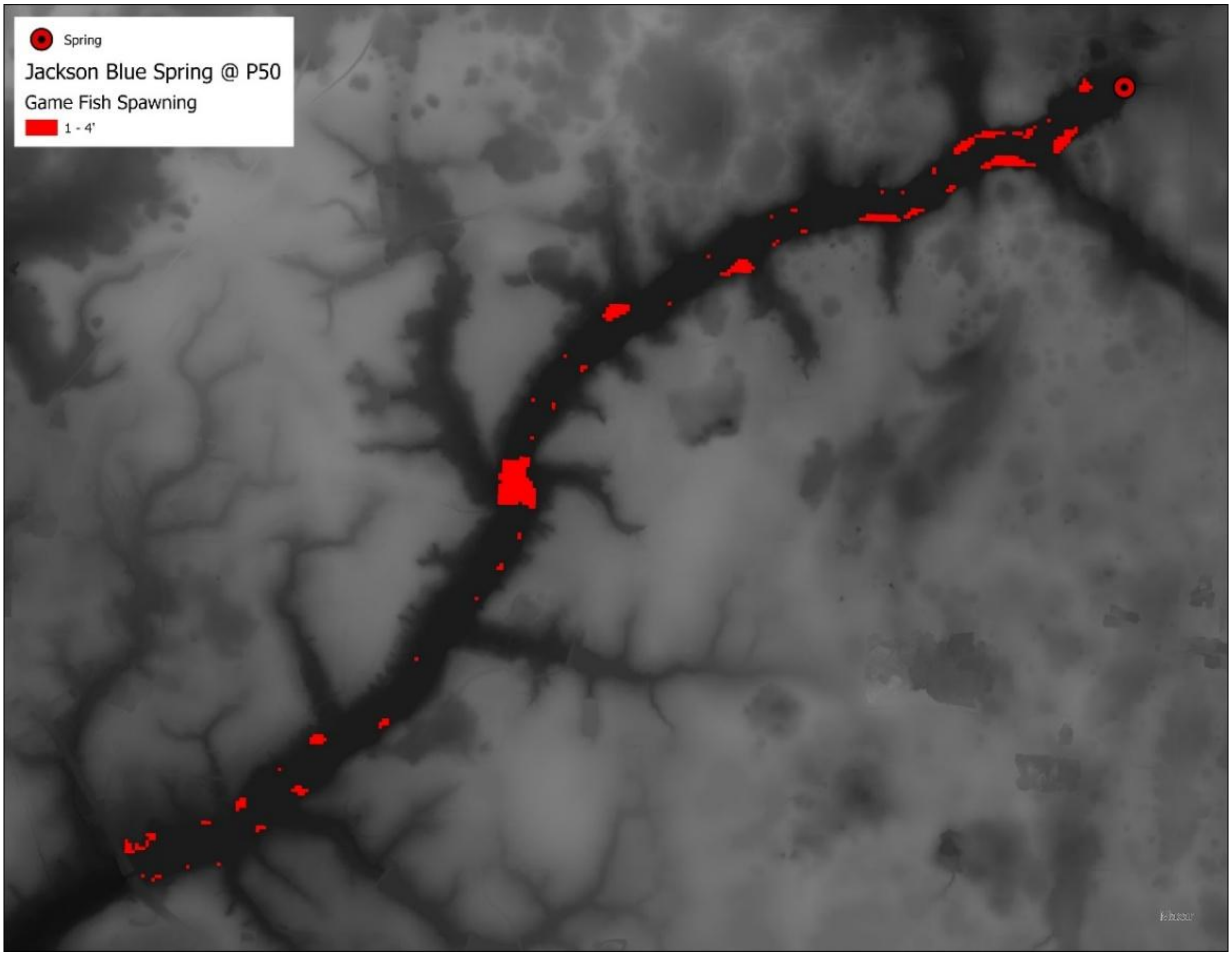


Figure 7-15. Areas within the game fish spawning critical depth range at the median baseline flow.

The results from the hydroperiod analysis are shown in Table 7-17 and Figure 7-16. The maximum area of suitable habitat for each of the categories tested occurred at the elevation associated with the P1 percentile flow (45.7 cfs) from Jackson Blue Spring. Since wading birds and game fish spawning tends to require relatively shallow depths, suitable habitat increased with decreasing flows, since higher flows resulted in depths greater than critical depths for these species. Therefore, maximum area of suitable habitat occurred at the lowest observed flow. To achieve a 15% reduction in area would require an extrapolation to flows never observed within the system. Because of this, the results from the Hydroperiod Tool analysis were not considered further for MFL development.

Table 7-17. Hydroperiod results for Merritts Mill Pond.

Category	Maximum Area (ft²)	Flow @ Maximum Area (cfs)	15% Reduction in Maximum Area (ft²)	Flow @ Reduced Maximum AWS (cfs)	Difference from Max Area Flow	% Reduction in Flow
Game Fish (Spawning)	2,470,291	45.7	2,099,747	<P1	N/A	N/A
Large Wading Birds	106,823	45.7	90,800	<P1	N/A	N/A
Small Wading Birds	33,382	45.7	28,375	<P1	N/A	N/A

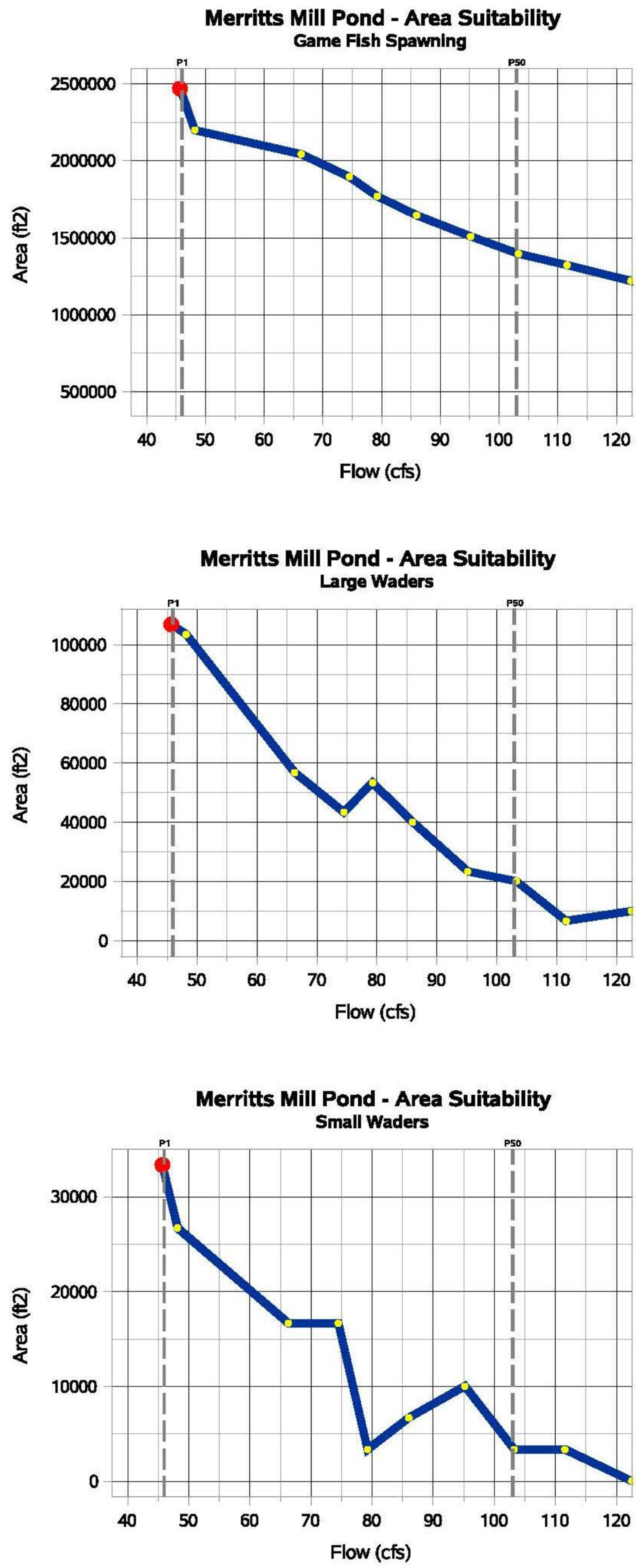


Figure 7-16. Suitable area for game fish (spawning) and wading birds as a function of flow from Jackson Blue Spring.

8 Summary and Recommended Minimum Flows

The development of minimum flows for Jackson Blue Spring builds upon methods applied elsewhere in Florida (outside of the District), as well as for minimum flows established for the St. Marks River Rise, Wakulla and Sally Ward springs, and the Middle Econfina Creek by the District. Establishing MFLs for Jackson Blue Spring protects the system's water resource values from the potential for significant harm caused from water withdrawals. The approach for establishing MFLs is based on quantifiable relationships between spring discharge and multiple physical and ecological features related to specific WRVs. Rule 62-40.473, F.A.C., outlines requirements regarding specific WRVs which must be considered in setting MFLs (Table 1-1) and those WRVs were considered in this assessment.

The results from the evaluation of multiple WRV metrics were used to determine the recommended minimum flow for Jackson Blue Spring. 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 gage selected to establish a minimum flow for Jackson Blue Spring is the District station 005042 Jackson Blue Spring. This station was selected as the reference gage since it currently provides the best estimate of flows from Jackson Blue Spring. A baseline time series of flows from Jackson Blue Spring was developed for the period from January 1, 2005, through December 31, 2024, (baseline period) by estimating historical impacts of groundwater withdrawals on flow from the spring, and adding these impact estimates to the historical flow record for the District Station 005042 Jackson Blue Spring. The estimates of historical impacts on the spring ranged from about 3 to 5 cfs, and projected impacts in year 2045 were estimated to be 5.8 cfs.

Flow reductions from baseline hydrologic conditions were evaluated at critical flows associated with safe boating (including both power boating and canoe/kayaks), tubing, and fish passage, maintaining riparian bank habitat and bankfull flows, riparian wetland and floodplain inundation, instream habitat of aquatic species, and protecting ecologically or socially relevant zones defined by critical depths for specific species within Merritts Mill Pond (See Section 7 for details). For each metric evaluated, the critical flow was determined at specific locations throughout the study area and were translated to an equivalent spring flow (based on flow percentile) at the reference gage (District Station 005042 Jackson Blue Spring). Allowable reductions in Jackson Blue Spring flow corresponding to a 15-percent reduction in inundation frequency (time) were determined for metrics pertaining to safe boating, tubing, and fish passage. Allowable reductions in Jackson Blue Spring flow corresponding to a 15-percent reduction in weighted-wetted perimeter and detailed-wetted perimeter were determined for metrics pertaining to maintaining riparian bank habitat and bankfull flows. Allowable reductions in Jackson Blue Spring flow corresponding to a 15-percent reduction in riparian wetland and floodplain inundation area were determined to serve as a metric protecting riparian wetland and floodplain inundation. Allowable reductions in Jackson Blue Spring flow corresponding to a 15-percent reduction in maximum area-weighted suitability were determined to protect instream habitat of aquatic species using SEFA. Allowable reductions in Jackson Blue Spring flow corresponding to a 15-percent reduction in total area of ecologically or socially relevant zones defined by critical depths for specific species of wading birds and game fish spawning were determined using the hydroperiod tool but determined to not be appropriate for Merritts Mill Pond.

A summary of allowable flow reductions for Jackson Blue Spring flow for each WRV metric evaluated is shown in Table 8-1. Riparian wetland and floodplain inundation was found to be the most sensitive WRV metric with an average allowable flow reduction of 11.1 cfs (10.7% of the median baseline JBS discharge). This is based on the analysis which defined the riparian wetland and floodplain using the union of best available delineations of wetland vegetation and hydric soils in the portion of Spring Creek most sensitive to JBS discharge. While the riparian wetland and floodplain inundation assessment including only wetland vegetation suggested a lower allowable flow reduction, that is based on a less comprehensive definition of wetlands and may neglect areas which provide wetland functions (i.e., nutrient cycling and flood mitigation) but do not currently harbor wetland vegetation. Thus, it was determined that the MFL metrics derived from the more comprehensive definition of wetlands surrounding Spring Creek were more reliable indicators of thresholds for significant harm to WRVs provided by wetland inundation.

The most limiting result for the assessment of motorboat passage in Spring Creek suggested a maximum allowable flow reduction of 12.9 cfs to prevent significant harm to recreation provided by motorboating. This corresponds to the average allowable flow reduction calculated at HEC-RAS cross section 0.4465. While the assessment indicated that the threshold for significant harm for motorboat passage at cross section 4164 was associated with a slightly lower flow reduction (9.5 cfs, on average), limited boat passage at that cross section would not restrict access to a significant portion of Spring Creek due to its location adjacent to the water control structure. Safe canoe/kayak passage, safe tubing, and safe fish passage were achieved under all flow scenarios evaluated throughout the study area. Additionally, safe motorboat passage was achieved under all flow scenarios for Merritts Mill Pond.

The MFL metrics corresponding to the assessments of weighted wetted perimeter and detailed wetted perimeter both represent aggregated thresholds for all cross sections representing Spring Creek and suggest JBS discharge could be reduced by 35.4 cfs and 30.5 cfs, respectively, without exceeding the threshold for significantly harm for WRV's dependent on wetted perimeter. This is similar to the allowable flow reduction of 34.7 cfs indicated by the weighted habitat suitability assessment. Metrics associated with ecologically or socially relevant zones for wading birds and game fish spawning in Merritts Mill Pond assessed using the hydroperiod tool were not considered in MFL establishment since all response functions had an inverse relationship with flow, meaning no harm is indicated by decreasing flow.

The proposed hydrologic regime for Jackson Blue Spring would shift the baseline flow duration curve downward by the most limiting allowable flow reduction of 11.1 cfs, across the range of baseline flows for Jackson Blue Spring. Setting a single minimum flow at the median baseline flow for Jackson Blue Spring provides for adequate protection of the Jackson Blue Spring study area including Merritts Mill Pond and Spring Creek. The recommended minimum flow is an allowable flow reduction of 11.1 cfs from the Jackson Blue Spring (District Station 005042 Jackson Blue Spring) median baseline flow of 103.3 cfs. This translates to an allowable reduction of 10.7 percent of the median baseline Jackson Blue Spring flow, resulting in a minimum median Jackson Blue Spring flow of 92.2 cfs (Table 8-2).

Table 8-1. Allowable flow reductions at Jackson Blue Spring for each WRV metric.

Metric	Minimum Allowable Flow (cfs)	Allowable Flow Reduction (cfs)	Percent Flow Reduction (%)	Comments
Fish Passage	NA	NA	NA	No valid limiting cross sections
Tubing Passage	NA	NA	NA	No valid limiting cross sections
Canoe/Kayak Passage	NA	NA	NA	No valid limiting cross sections
Motorboat Passage in Merritts Mill Pond	NA	NA	NA	No valid limiting cross sections
Motorboat Passage in Spring Creek	90.4	12.9	12.5	Based on average results for both downstream boundary conditions at most limiting cross section (0.4465)
Weighted Wetted Perimeter	67.9	35.4	34.2	Based on average results for both downstream boundary conditions in Spring Creek only
Detailed Wetted Perimeter	72.8	30.5	29.5	Based on average of all valid results under both downstream boundary conditions
Riparian Wetland and Floodplain Inundation	92.2	11.1	10.7	Based on average results for both downstream boundary conditions at the median JBS flow
Weighted Habitat Suitability	68.6	34.7	33.6	Based on average results for Spotted Sunfish Spawning in Spring Creek under both downstream boundary conditions
Hydroperiod	NA	NA	NA	All response functions were found to have a inverse relation with flow

Table 8-2. Recommended allowable flow reduction for Jackson Blue Spring.

System	Median Baseline Flow at Reference Gage (cfs)	Allowable Flow Reduction at Reference Gage (cfs)	Minimum Median Flow at Reference Gage (cfs)	Allowable Percent Flow Reduction from Median Baseline Flow
Jackson Blue Spring	103.3	11.1	92.2	10.7

*Reference gage is District Station 005042 Jackson Blue Spring

9 Adaptive Management

The District is committed to taking an adaptive management approach to setting and assessing the Jackson Blue Spring in relation to MFLs. Environmental systems and resources are dynamic systems that are constantly changing. An adaptive management strategy will help ensure that the water resources affected by Jackson Blue Spring are protected from consumptive uses well into the future. 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. Continuing 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 Jackson Blue Spring GWCA,
2. Continuing data collection of continuous stage and discharge at U.S. Hwy 90 in Merritts Mill Pond and continuous stage at Spring Creek just below the control structure,
3. Reviewing and/or enhancing as appropriate available models used for MFL technical assessments,
4. Continuing evaluation of changes in river flows and hydraulics, including continued effects from Hurricane Michael,
5. Reviewing additional data concerning riparian habitat along Merritts Mill Pond and Spring Creek as it becomes available and consider for future MFL evaluations.

The established MFLs will be periodically evaluated to check the status of Jackson Blue Spring flows in relation to the minimum flow. If warranted, a re-evaluation of the MFL for the system may be recommended. Additional available data will be incorporated into future MFL reevaluations as appropriate.

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11 Appendices

Appendix A – North Central District Model Development

Appendix B – Hydrologic Engineering Center – River Analysis System (HEC-RAS) Model Development and Application

Appendix C – Water Resource Value Assessment for Jackson Blue Spring