Technical Memorandum

Prepared for: Suwannee River Water Management District
Project Title: Independent Technical Peer Review of the Recommended Minimum Flows for the Upper Segment of the Suwannee River.

Project No:

Subject: Draft Suwannee River Upper Segment Minimum Flows and Levels Peer Review Report

Date: May 5, 2023

To: Sean King, MFL Office Chief, Office of Minimum Flows and Minimum Water Levels

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List of Abbreviations

ADCP	acoustic Doppler current profiler
ATM	Applied Technology and Management
BMAP	Basin Management Action Plan
cfs	cubic foot/feet per second
District	Northwest Florida Water Management District
EFDC	Environmental Fluid Dynamics Code
F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FEMA	Federal Emergency Management Agency
F.S.	Florida Statutes
FFWCC	Florida Fish and Wildlife Conservation Commission
GWCA	groundwater Contribution Area
HEC-RAS	River Analysis System
IUCN	International Union for Conservation of Nature
IV	importance value
LiDAR	light detecting and ranging
MFL	minimum flow and level
MGD	million gallons per day
NAVD88	North American Vertical Datum of 1988
NWFWMD	Northwest Florida Water Mangement Districts
NWI	National Wetlands Inventory
Panel	Peer Review Panel
PHABSIM	Physical Habitat Simulation Model
POR	period of record
ppt	part(s) per thousand
RPI	Research Planning Inc.
SAV	submerged aquatic vegetation
SEFA	System for Environmental Flows Analysis
SJRWMD	St. Johns River Water Management District
SKT	Seasonal Kendall Test
SRWMD	Suwannee River Water Management District
SWFWMD	Southwest Florida Water Management District
TMDL	Total Maximum Daily Load
USGS	U.S. Geological Survey
WRV	water resource value

Executive Summary

Introduction

The Suwannee River Water Management District (District) contracted technical experts to provide independent scientific peer review of the report titled "Minimum Flows and Levels Assessment for the Upper Suwannee River".

The Peer Review Panel (Panel) received the MFL Report and its appendices in early March, 2023 and began its review. The Panel participated in an in-person public kickoff meeting with District staff and members of various stakeholder groups at the District's headquarters in Live Oak, Florida, on March 15, 2023. District staff delivered a presentation on all aspects of the process to develop a minimum flow for the river segments. Following the meeting, the Panel reviewed the MFL Report, appendices, and other pertinent documents, and prepared its reviews. ?? additional virtual public meetings were held on April 18, ??, and ??. During the public meetings, the Panel members discussed various aspects of the report and asked questions of District staff.

The Panel Chair compiled the reviews into a single document, which was reviewed and edited by all Panel members and the Panel Chair into the Draft Peer Review Report. Peer Review comment forms, which are a compilation of the comments each Panel member included in the Peer Review Report, were also submitted to the District.

Peer Review Panel

The District assembled a Panel consisting of the following staff with expertise in hydrology, hydrogeology, statistics, modeling, riverine and wetlands ecology, and fisheries:

- Gregg Jones, Ph.D., P.G.: (Panel Chair): karst hydrogeology, groundwater quality
- Adam Munson, Ph.D.: hydrology, statistics
- Marty Hammel, Ph.D. Fisheries?

As per the task order, the Panel has prepared a draft report of the findings and recommendations related to the peer review of the MFL Report. The following is a summary of the Panel's major findings.

Major Findings

The Panel concludes …

The District evaluated the WRV metrics most likely to be limiting across the range of flows to develop the recommended minimum flows for the Upper Segment of the Suwannee River.

A single metric (Gulf Sturgeon passage during the fall spawning period) at USR transect ??? was found to be the most limiting, allowing for a flow reduction of 82.3 cfs (12.2% reduction) at the White Springs gage and 96.8 cfs (11.0% reduction) at the Suwannee Springs gage.

After a thorough review of the MFL Report, appendices, and supporting documents, the Panel finds the

District's approach to developing the minimum flow based on the Gulf Sturgeon passage during the fall spawning period to be ????

The Panel has identified a number of technical issues that are elaborated on in the following sections and made recommendations as to how these issues might be addressed.

Introduction

Background

The Suwannee River Water Management District (District) is mandated by the Florida Statutes (F.S.) to establish minimum flows and levels (MFLs) for priority surface waters and aquifers within its boundaries for the purpose of protecting the water resources and ecology of the aquatic ecosystems from "significant harm" (F.S. §373.042, 1972 as amended). In this report, minimum flows are proposed for the Upper Segment of the Suwannee River, which extends approximately 79 miles from the Florida/Georgia Border to the confluence of the Withlacoochee River at Ellaville.

Under the statutes, MFLs are defined as follows:

- A minimum flow is the flow of a watercourse below which further water withdrawals will cause significant harm to the water resources or ecology of the area
- A minimum level is the level of water in an aquifer or surface water body at which further water withdrawals will cause significant harm to the water resources of the area

The statutes require the District to annually develop and update a list of priority water bodies for which MFLs are to be established and identify those that will be subjected to a voluntarily independent scientific review. The District's Governing Board is committed to voluntarily submit MFLs determinations for independent scientific peer review.

The Florida Statutes also provide for the MFLs to be established using the "best available information," for the MFLs "to reflect seasonal variations," and for the District's Governing Board, at its discretion, to provide for "the protection of non-consumptive uses." In addition, F.S. §373.0421 states that the District's Governing Board "shall consider changes and structural alterations to watersheds, surface waters and aquifers, and the effects such changes or alterations have had, and the constraints such changes or alterations have placed on the hydrology of the affected watershed, surface water, or aquifer…."

The State Water Resources Implementation Rule (Florida Administrative Code [F.A.C.] Chapter 62-40.473) contains additional guidance for the establishment of MFLs, providing that "…consideration shall be given to the protection of water resources, natural seasonal fluctuations, in water flows or levels, and WRVs associated with coastal, estuarine, aquatic and wetlands ecology, including:

1. Recreation in and on the water;
2. Fish and wildlife habitats and the passage of fish;
3. Estuarine resources;
4. Transfer of detrital material;
5. Maintenance of freshwater storage and supply;
6. Aesthetic and scenic attributes;
7. Filtration and absorption of nutrients and other pollutants;
8. Sediment loads;
9. Water quality; and
10. Navigation."

Peer Review Panel

The District assembled a Peer Review Panel (Panel) consisting of the following staff with expertise in hydrology, hydrogeology, statistics, modeling, and riverine and wetlands ecology:

- Gregg Jones, Ph.D, P.G.: (Panel Chair): karst hydrogeology, groundwater quality
- Adam Munson, Ph.D.: hydrology, statistics
- Marty Hammel, PhD

As per the task order, the Panel has prepared a report of the findings and recommendations related to the peer review of the Recommended Minimum Flows for the Upper Segment of the Suwannee River. The following is a summary of the Panel's major findings.

Review Required by the District

1. Determine whether the methods used for establishing the minimum flows are scientifically reasonable.

   A. Supporting Data and Information: Review the data and information that supports the methods and proposed minimum flows as appropriate. The reviewer shall assume the following:

      1. The data and information used were properly collected
      2. Reasonable quality assurance assessments were performed on the data and information

   B. Technical Assumptions: Review the technical assumptions inherent in the methodology and determine:

      1. If the assumptions are clearly stated, reasonable and consistent with the best information available; and
      2 Assumptions were eliminated to the extent possible based on available information.

   C. Procedures and Analyses: Review the procedures and analyses used in developing quantitative measures and determine qualitatively whether:

      1. The procedures and analyses were appropriate and reasonable, based on the best information available;
      2. The procedures and analyses incorporate appropriate factors;
      3. The procedures and analyses were correctly applied;
      4. Limitations and imprecision in the information were reasonably handled;
      5. The procedures and analyses are repeatable;
      6. Conclusions based on the procedures and analyses are supported by the data.

2. If a proposed method used in the MFL report is not scientifically reasonable, the reviewer shall:
   A. Deficiencies: List and describe scientific deficiencies;
   B. Remedies: Determine if the identified deficiencies can be remedied and provide suggested remedies;
   C. If the identified deficiencies can be remedied, then describe the necessary corrections and, if possible provide an estimate of time and effort required to develop and implement; and
   D. If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable, based on published literature to the extent feasible.

Review Constraints

The Peer Reviewer shall acknowledge the statutory constraints and conditions (Sections 373.042 and 373.0421, Florida Statutes) affecting the District's development of MFLs. The Peer Reviewer shall also acknowledge that review of certain assumptions, conditions, and established legal and policy interpretations of the Governing Board is not included in the scope of work. These include:

1. The selection of waterbodies or aquifers for which minimum flow and/or levels have been proposed;
2. The consideration given to changes and structural alterations to watersheds, surface waters, and aquifers, and the effects and constraints that such changes or alterations have had on the hydrology of a given watershed, surface water, or aquifer;
3. The method(s) used for establishing MFLs for other waterbodies and aquifers;
4. The selection and determination of the best available models used for MFL analyses such as the HEC-RAS surface water model and North Florida Southeast Georgia (NFSEG) regional groundwater model; and
5. Standard procedures used as part of institutional programs that have been established for the purpose of collecting data, such as the USGS and SRWMD hydrologic monitoring networks.

The Panel received the MFL Report and its supporting appendices and began its review in early March, 2023. The Panel participated in an in-person public kickoff meeting at the District's headquarters in Live Oak, Florida, with District staff and members of various stakeholder groups on March 15, 2023. District staff delivered a presentation on all aspects of the process to develop a minimum flow for the river segments. Following the meeting, the Panel reviewed the MFL Report, appendices, and other pertinent documents, and prepared its reviews. ?? additional virtual public meetings were held on April 18, ??, and ??. During the public meetings, the Panel members discussed various aspects of the report and asked questions of District staff.

The Panel Chair compiled the reviews into a single document, which was reviewed and edited by all Panel members and the Panel Chair into the Draft Peer Review Report. Peer Review comment forms, which are a compilation of the comments each Panel member included in the Peer Review Report, were also submitted to the District.

The Panel has evaluated the information that pertained to data collection, use, quality assurance, and availability that was included in the Minimum Flow Report and its appendices. The following is the Panel's assessment of the data in terms of the District's evaluation criteria listed above.

Section 1: Supporting Data and Information

1. *The data and information used were properly collected*
2. *Reasonable quality assurance assessments were performed on the data and information*

1.1 Introduction

The following is a summary of the Panel's findings on the quality of supporting data and information.

1.2 Data: River Flow, Rainfall, ET, Groundwater Withdrawals, Water-Quality

River flow and stage data was collected by the USGS, which sets the standard for data collection. Groundwater level data was collected by the USGS and District staff. Surface water quality data were collected by the USGS, the District, and the Florida Department of Environmental Protection (FDEP). Parameter-elevation Relationships on Independent Slopes Model (PRISM) monthly time series rainfall data for the USR watershed were provided by the SRWMD. This gridded dataset was developed by the PRISM Climate Group at Oregon State University (PRISM Climate Group, 2014) using local and national resources such as the Florida Automated Weather Network (FAWN) and NOAA's Cooperative Observer Network (COOP). Monthly average temperature data also were obtained using PRISM for a location near Fargo for general background climate information and for another location near the Nutrien phosphate mine near White Springs.

Example Summary Statement - The Panel concludes that based on the documentation in the reports, the data used in the Districts analyses was the best available. The Panel believes the acknowledged expertise and long-term experience of the agencies and organizations listed above that were involved in the collection of data ensures the data are of high quality.

Example lead in to Comments - The following are the Panel's comments.

1.3 Water Resource Values

The following is a discussion of the Panel's review of supporting data and information for the District's priority water resource values that were used to develop the minimum flow. These include:

- Recreation in and on the Water
- Fish and Wildlife Habitats and the passage of fish
- Sediment Loads
- Water Quality

1.3.1 Recreation in and on the Water

For this WRV, the District relied upon general criteria for safe and comfortable boat passage on the river. The criteria used were obtained from the literature and from discussions with paddle sports outfitters. The Panel evaluated the data collected to support the safe boating criteria for private recreational power boat use and comfortable canoe and kayak paddling. Data on river dimensions that was obtained from cross sections

across the shoals where depth profiles were measured and the thalweg for canoes and kayaks determined was also reviewed. Fish and Wildlife Habitats and the Passage of Fish

For this WRV, the District evaluated passage and spawning for Gulf Sturgeon and the general fish community, in-channel flows that maintain stream banks and channels and inundates snags, overbank flows that maintain riparian habitats, and flood flows that determine the boundary and shape of floodplain and valley features.

Summary Statement

The following are the Panel's comments:

1.3.2 Sediment Load

The primary sediment load related features of the USR to be protected are the hydraulic stage, velocity, and bed shear stress associated with maintaining the main channel geomorphology, with a focus on the transport of inorganic sediment. It is also important to protect connectivity between the river and the adjacent floodplains, which can be defined by bankfull stage for which modest increases in water level will cause proportionally larger increases in wetted perimeter associated with floodplain inundation. By protecting the bankfull condition, both detrital transfer associated with floodplain connectivity and channel geomorphology are protected.

The District used channel geometry data determined by field surveys and the steady state HEC-RAS model of the river as the best information available for characterizing bankfull conditions. The bankfull condition characteristic of the entire study reach is indicated by the distinct change in slope of the flow-area association. The inundation area is the area of the water surface for the length of the study reach associated with a prescribed flow condition at White Springs that was simulated using HEC-RAS. While the actual stage at any location associated with the bankfull condition may be higher or lower than the top of bank, the graph depicts an overall condition for the entire study reach.

Summary Statement

The following are the Panel's comments:

1.3.3 Water Quality

For this WRV analysis, water quality was defined as the chemical and physical properties of the aqueous phase within the USR. The chemical and physical properties of the water that support the aquatic community serve as indicators for protection of water quality. The Gulf sturgeon and Suwannee bass are species of particular interest to this MFLs assessment. The specific indicators of protection are the concentrations of key water quality parameters influenced by flow. Water quality parameters known to influence the fecundity of key species are of particular interest.

Dissolved oxygen (DO), calcium ions, conductivity, and pH are the major water quality parameters of concern for the Gulf sturgeon in the USR. The current State DO criteria identify a baseline DO concentration of 5.7 mg/L within the Ellaville to White Sulphur Springs reach below which young Gulf sturgeon may become stressed. The District maintains a water quality monitoring station (SUW070C1) in this reach that has substantially more DO measurements than any other monitoring location within the reach. DO measurements (296 in total) for this station were downloaded from WinStoret for the period 2/1989 – 2/2017, and daily river flows at the Suwannee Springs gage were obtained for those dates.

It has been determined that a slightly alkaline pH, calcium concentration between 6-18 milligrams per liter (mg/L), conductivity between 40 and 110 microsiemens per centimeter at 25 °C (µS/cm), and a steady flow rate (to provide a more predictable and adequate DO supply) were characteristics within the areas of the river containing known spawning beds. Spawning appears to cease when water temperatures reach 21-22 °C.

Conductivity, calcium, pH, and Secchi transparency depth are associated with flow. If a suitable relationship exists between flow and a specific parameter, the endpoints of a range represent indicators that can be used to determine a range in flow suitable for spawning. The water quality data used to evaluate the relationships of these four water quality parameters of interest and flow were collected independently by SRWMD at gage SUW070C1 from 1979 through 2015 and by the USGS at gage 02315550 from 1956 through 1988. The data were examined to confirm consistency and eliminate duplicate records then combined into a single dataset to determine the relationship between a given water quality parameter and flow.

Summary Statement

The following are the Panel's comments:

Section 2: Technical Assumptions

1. *The assumptions are clearly stated, reasonable and consistent with the best information available; and*
2 Assumptions were eliminated to the extent possible based on available information.

2.1 Introduction

The following is a summary of the Panel's findings on the District's technical assumptions used for developing the minimum flows.

2.2 Reference Timeframe

A critical component of establishing a minimum flow for the USR was to develop baseline flow and Upper Floridan Aquifer (UFA) groundwater level records that reflect unimpacted or minimally impacted historical conditions over representative long-term hydrometeorological cycles. In other words, the Reference Timeframe (RTF) is a time-series of Suwannee River flow from which any impacts of groundwater withdrawals are removed. To assist with estimating the impacts of withdrawals on historical flows and water levels, the District and the St. Johns River Water Management District, developed the North Florida Southeast Georgia (NFSEG) regional groundwater

The use of a groundwater flow model to determine long-term impacts on USR flow from groundwater withdrawals was a recommendation of the Peer Review Panel that conducted the original review of the USR proposed minimum flow in 2017. The current panel is pleased to see that this recommendation was implemented and that it was implemented through a cooperative effort between the Districts, the USGS, the State of Georgia, and other entities.

Summary Statement

The following are the Panel's comments:

1) Developing the RTF required a number of steps, each of which required development of estimates based on data records that were incomplete to varying degrees. Gaps in data records were reconstructed or hindcasted using various statistical techniques.

The assumption inherent in each step was that sufficient accuracy was obtained to allow the results to be used in the NFSEG model (which has its own inherent error) and that the results of the model calculation would also be sufficiently accurate. The concern is that error inherent in each step is carried forward and compounded in subsequent steps.

Because the RTF flows are integral to the development of the proposed minimum flow, the District should conduct an analysis to evaluate the error inherent in the process and determine the degree to which the error could affect the calculation of the minimum flows.

2.3 Water Resource Values

The following is the Panel's review of the District's assumptions relating to the District's evaluation of WRVs that were selected to develop the minimum flow.

2.3.1 Recreation in and on the Water

2.3.2 Fish and Wildlife Habitat and the Passage of Fish

2.3.3 Sediment Load

2.3.4 Water Quality

2.4 Appendix D. Hydrodynamic Model Development and Calibration

2.5 Other Assumptions

Section 3: Procedures and Analyses

Review the procedures and analyses used in developing quantitative measures and determine qualitatively whether:

1. *The procedures and analyses were appropriate and reasonable, based on the best information available;*
2. *The procedures and analyses incorporate appropriate factors;*
3. *The procedures and analyses were correctly applied;*
4. *Limitations and imprecision in the information were reasonably handled;*
5. *The procedures and analyses are repeatable;*
6. *Conclusions based on the procedures and analyses are supported by the data.*

3.1 Introduction

The following is a summary of the Panel's findings on the District's procedures and analyses used for development of the MFL.

3.2 Reference Time Frame

A critical component of establishing a minimum flow for the USR was to develop baseline flow and Upper Floridan Aquifer (UFA) groundwater level records that reflect unimpacted or minimally impacted historical conditions over representative long-term hydrometeorological cycles.

Summary Statement

The following are the Panel's comments:

3.3 Missing Records and Records Extension

The equipment used to monitor streamflow and other environmental variables malfunctions at times or may be damaged by natural events or vandalism. Also, monitoring programs can change. Such occurrences may result in gaps in a particular time series. In addition, not all the monitored environmental variables have the same period of record. Appropriate techniques (e.g., interpolation and extraction, exceedance duration, and regression) were used in some instances to allow comparison of the White Springs and Suwannee Springs river gage data sets resulting in some infilling and record-extension of the Suwannee Springs record (Helsel & Hirsch, 2000).

Summary Statement

The following are the Panel's comments:

3.4 Weight of Evidence Approach

The District's overall approach for setting MFLs for the USR is characterized as a weight-of-evidence approach that begins with identifying specific water resource values particularly relevant to the river, followed by an analysis of possible flow reductions that would remain protective of the WRVs. Not all WRVs are of equal relevance or sensitivity to flow reductions, and some are so closely linked to others that protection of the more highly-relevant or sensitive WRV is assumed to protect a related WRV as well. Thus, establishing limits for flow reductions over the entire range of the flow duration curve affords a level of protection to all the relevant WRVs and is assumed to provide a level of protection to those not explicitly evaluated.

Summary Statement

The following are the Panel's comments:

3.5 Water Resource Values

General Comments. The District determined that the four WRVs that were most appropriate for the establishment of the MFL for the USR were: 1) recreation in and on the water, 2) fish and wildlife habitats and the passage of fish, 3) sediment load and 4) water quality. These WRVs were selected by the District because they were considered to be the most relevant to the USR, had the potential to be affected by flow reductions, and sufficient data for the WRV was available for an assessment.

For each of these four WRVs, quantitative metrics were utilized to relate WRVs to river flows and to assess potential effects of reductions in flows.

Summary Statement

The following are the Panel's comments:

3.5.1 Recreation in and on the Water

3.5.2 Fish and Wildlife Habitat and Passage of Fish

3.5.3 Sediment Load

3.5.4 Water Quality

3.6 Modeling

3.7 Adaptive Management

Adaptive management is a standard approach for reducing the inherent uncertainty associated with natural resource management and is recommended by the U.S. Department of the Interior for decision making in the face of uncertainty about management impacts. Adaptive management is a systematic, iterative approach to meeting management objectives in the face of uncertainty through continued monitoring and refinement of management actions based on consideration of alternatives and stakeholder input.

This evaluation of minimum flows is closing the loop on an iteration of the adaptive management process by assembling, evaluating, and using the best information currently available to develop recommended minimum flows for the USR system. The minimum flow recommendations resulting from this evaluation are made while acknowledging the continued, unavoidable uncertainty in our understanding of natural patterns and processes inherent to the system as well as uncertainty associated with predicting the consequences of future water withdrawals. The continued adaptive management of the USR system will require ongoing monitoring, assessment, and periodic re-evaluation of minimum flows.

Summary Statement.

The following are the Panel's comments:

3.8 Uncertainty

Setting and periodically re-evaluating minimum flows in the USR system reflects the application of an adaptive management strategy for dealing with uncertainty in this complex, dynamic river system and associated stochastic processes. Uncertainty is an unavoidable consequence of the ever-changing natural and anthropogenic processes within and affecting the USR system. From both scientific and management perspectives, there is uncertainty associated with determining withdrawal impacts on physical, biological, and chemical aspects of the system. Non-stationarity in climate and other environmental conditions, such as temperature and nutrients, and ecological features such as non-native species spread also represent challenges to environmental flow assessments.

Uncertainties are widely acknowledged but they are rarely quantified in the MFL setting process, and it is not the District's intent to do so in this report. However, identifying sources of uncertainty can help with reducing uncertainty by collecting additional data and through additional targeted studies and adaptive management

Summary Statement:

The following are the Panel's comments:

Section 4: Deficiencies and Remedies

If a proposed method used in the MFL report is not scientifically reasonable, the reviewer shall:

1. *Deficiencies: List and describe scientific deficiencies;*
2. *Remedies: Determine if the identified deficiencies can be remedied and provide suggested remedies;*
3. *If the identified deficiencies can be remedied, then describe the necessary corrections and, if possible provide an estimate of time and effort required to develop and implement; and*
4. *If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable, based on published literature to the extent feasible.*

4.1 Introduction

The following is a compilation of deficiencies in the District's MFL Report and Appendices identified by the Panel and deemed to be significant. The Panel identified numerous minor issues that include changes to text and figures to provide clarity, lack of or incorrect citations, editorial and readability comments, etc. These are listed on the Peer Review Comment forms for each Panel member but are not included in this section.

4.2 Supporting Data and Interpretation (Section 1)

Deficiency:
Remedy:

4.3 Technical Assumptions (Section 2)

4.3.1 Water Resource Values (General)

Deficiency:
Remedy:

4.3.2 Fish and Wildlife Habitat and the Passage of Fish

Deficiency:
Remedy:

4.3.3 Water Resource Values (General)

Deficiency:
Remedy:

4.3.4 Fish and Wildlife Habitat and the Passage of Fish

Deficiency:
Remedy:

4.3.3 Other Assumptions

Deficiency:
Remedy:

4.4 Procedures and Analyses (Section 3)

4.4.1 Reference Time Frame

4.4.2 Water Resource Values

4.4.2.1 Recreation in and on the Water

4.4.2.2 Fish and Wildlife Habitat and Passage of Fish

4.4.2.3 Other Fish and Wildlife Habitat Considerations

4.4.1.3 Sediment Load

4.4.1.4 Water Quality

4.4.2 Adaptive Management

4.4.6 Uncertainty

Section 5: References

Appendix A Peer Review Panel Comment Form – Gregg Jones

Appendix B Peer Review Panel Comment Form – Paul Leonard

Appendix C Peer Review Panel Comment Form – Adam Munson