Final Peer Review Report

For the District's

Recommended Minimum Flows for Charlie Creek

AGREEMENT NUMBER: 23CN0004217

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
2379 BROAD STREET
BROOKSVILLE, FLORIDA 34604

NOVEMBER 2023

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1. INTRODUCTION

1.1. Background

The Southwest Florida River Water Management District (District or SWFWMD) 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, new minimum flows are proposed for Charlie Creek, a tributary to the Peace River.

Under the statutes, a minimum flow for a given watercourse is defined as the limit at which further withdrawals would be significantly harmful to the water resources or ecology 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 Florida Statutes also require that MFLs be established using the “best available information,” for the MFLs “to reflect seasonal variations,” 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 (specifically, Rule 62-40.473, Florida Administrative Code [F.A.C.]) 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 environmental values 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.

1.2. Peer Review Panel

The District assembled an independent Peer Review Panel (Panel) with expertise in hydrology, hydrogeology, water quality, statistics, modeling, fisheries, and riverine and wetland ecology to provide a technical review of the proposed minimum flows for Charlie Creek. The Panel brought a wide base of expertise to the review that overlapped in some areas, while specific knowledge and experience was also individually noted. The Peer Review Panel included:

- Harry Downing, M.S., P.E.; (Panel Chair): surface and groundwater modeling, statistical analysis, hydrology, flood risk assessment, MFL experience.

- Adam Munson, Ph.D., P.E.; Statistical modeling, ecological expertise, engineering experience, MFL experience.

- John Kiefer, Ph.D., P.E.; SrPWS: Restoration enhancement, and assessment of aquatic ecosystems, hydrogeology, MFL experience.

1.3. <u>Overview of Charlie Creek</u>

The "Draft Recommended Minimum Flows for Charlie Creek June 2023" report, along with appendices contain detailed information and evaluation processes used to establish the minimum flows. The purpose of this section is to provide a general overview of the characteristics of the watershed and creek derived from various sources.

The Charlie Creek watershed encompasses approximately 333.92 square miles (864.86 square kilometers) mostly located in Eastern Hardee County, with portions in Polk, Highlands, and DeSoto Counties. Charlie Creek extends from South Central Polk County through Hardee County to the confluence of the Peace River in Hardee County just north of the DeSoto County Line. It is one of several tributaries contributing flow to the Peace River (**Figure 1**). Forty-two miles of Charlie Creek conveys surface runoff to the Peace River. The United States Geological Survey (USGS) gage near Gardner, FL (No. 02296500) has the longest-term flow recorder in the watershed (1950 to present). The other USGS station on the creek is located 16-miles upstream at Crewsville (USGS Gage No. 02296260) with a record from 2004 to present. Flows at the Gardner gage have ranged from 0.6 to 9,160 cfs and with an average daily flow of 262 cfs; while flows at the Crewsville gage have ranged from 0 to 6,670 cfs, and averaged 141 cfs. The flow at Crewsville suggest that critical habitat can be affected by flows above this gauge.

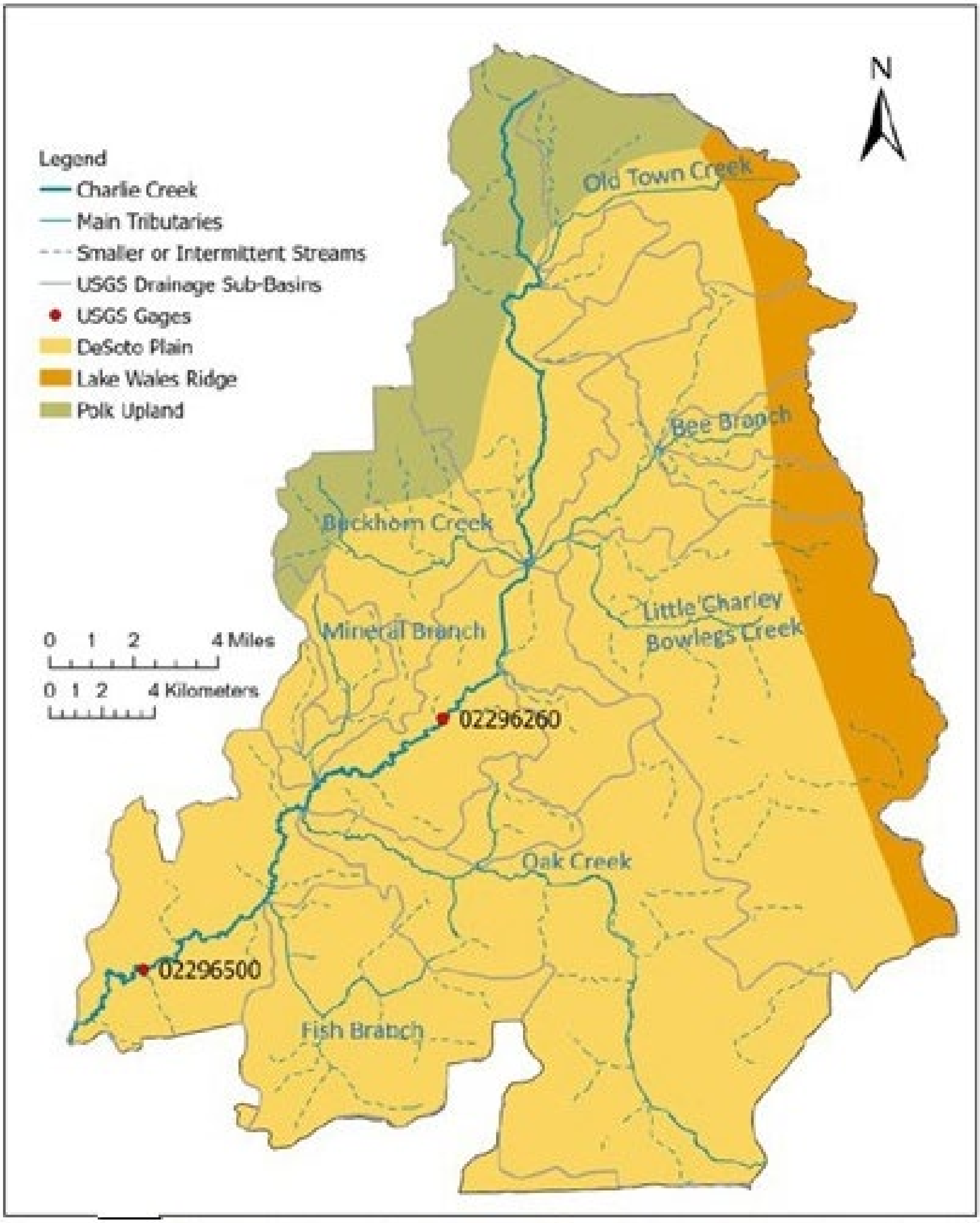


Figure 1: Map of the Charlie Creek watershed showing the Charlie Creek mainstem, named tributaries, smaller and intermitted streams. USGS drainage sub-basins, USGS gage stations, and physiographic regions (Deak et al., 2023).

Land surface elevations within the watershed range from 80 feet north of SR 64 at the headwaters to 30 feet near the confluence with the Peace River. Due to confinement between the Surficial and Upper Florida Aquifers, the watershed exhibits relatively high runoff potential, which is also exhibited by the National Resource Conservation Service soil descriptions by the predominance of A/D and B/D soils. These soils are indicative of poorly drained soils exhibiting high water tables that have been drained. The United States Geological Survey National Hydrography Dataset identifies seven tributaries to Charlie Creek: Old Town Creek, Bee Branch, Little Charley Bowlegs Creek, Buckhorn Creek, Mineral Creek, Oak Creek, and Fish Branch. Tributary abundance in the watershed defines an elaborate network of natural drainage systems that include palustrine, riverine, and some lacustrine habitats. This labyrinth of natural drainage systems suggests the significance of runoff within the watershed. This is in contrast to karst areas where natural drainage systems are limited.

Approximately 24.43% of the watershed is classified as wetland. For minimum flows development, the evaluation of hydroperiods supporting the wetlands along the Charlie Creek corridor is of utmost importance, as is consideration of instream habitats. Other land cover classifications include: agricultural land (55.57% of the watershed), upland forest (7.33%), urban (6.89%) and rangeland (4.87%). As of 2020, no phosphate mining activity has occurred in the watershed. However, a permit for phosphate mining at the South Fort Meade Mine Eastern extension in the northern portion of Charlie Creek was approved by the Hardee Board of County Commissioners in July 2023.

The Critical Lands and Waters Identification Project (CLIP; UF 2016) indicated that 46.49% of the watershed is characterized as low priority in terms of biodiversity resources, while high priority lands for biodiversity account for 29.86% of the watershed. The CLIP also produced a landscape integrity index where 26.54% of the watershed has high landscape integrity, 42.33% has medium landscape integrity, and 31.13% of the watershed had little to no landscape integrity.

Several water quality constituents have been sampled by the Florida Department of Environmental Protection (DEP), SWFWMD, and the USGS. All sampling sites were located between the two USGS gaging stations mentioned above. Sample collection spanned different time periods between 1965 to the present, with most samples collected within the twenty years. In an exploratory water quality analysis by Applied Technology and Management and Janicki Environmental, Inc., constituents were grouped into broad classes including Nitrogen, Phosphorus, Chlorophyll, Physio-Chemical, Minerals and Metals, and Indicators of Water Clarity. Linear and logistic regressions were used to evaluate water chemistry trends for determining background characteristics. Nitrogen showed a positive relationship with flow, while the relationship between flow and phosphorus was mixed depending on the sample type and source. Physio-chemical properties typically demonstrated a negative relationship with flows. Minerals and metals typically showed a negative relationship with flow. Color, Total Organic Carbon, and Turbidity showed a positive relationship with flow and Dissolved Oxygen demonstrated a negative relationship with flow. No causation was presented other than the observed trends are not unusual in agriculture-dominated areas.

Some constituents have State water quality threshold limits, established by the DEP, that have occasionally been exceeded over the period of record. In their report, the District summarized results from the most recently adopted Verified List (of impaired water bodies), posted by the DEP on July 15, 2022. No Total Maximum Daily Loads (TMDLs) or Basin Management Action Plans (BMAPS) have been developed or initiated in the Charlie Creek watershed. However, medium priority has been generated for establishment of a TMDL for total phosphorus in the Charlie Creek above Peace River waterbody (Waterbody Identification, i.e., WBID, number 1763A). The Charlie Creek above Old Town Creek waterbody (WBID 1763D) was identified by the DEP as impaired for fecal coliform, and WBID 1763D was listed as impaired for macrophytes and total phosphorus. Several other DEP-designated waterbodies within the watershed (Charlie Creek above Oak Creek (WBID 1763B), Little Charlie Bowlegs (WBID 1857), and Fish Branch (WBID 1928) were placed on the study list for dissolved oxygen percent saturation threshold exceedances.

To support minimum flow development, extensive sampling within a 16-mile corridor along Charlie Creek was completed and additional information available for the study reach was considered. These efforts included HEC-RAS modeling, soils characterization, plant community assessments, evaluation of stream shoals, runs and pools and associated habitat availability; fish sampling, topographic surveying, and development of a digital elevation model (DEM).

HSW Engineering, Inc. conducted a study of the Charlie Creek riparian corridor in 2012 to better describe the composition and distribution of plant communities and hydrologic indicators across seven floodplain transects along Charlie Creek. Tree, shrub, and ground cover assessments were conducted along the transects. Four wetland communities were identified along sampled transects: floodplain swamp, bottomland forest, hydric hammock, and a drier upland hammock community. Within these areas, fifteen tree species were identified and assigned importance values. Forty-four (44) to seventy-six (76) elevation data points were collected at each of the transects. Charlie Creek had an average topographic gradient of 1.73 ft/mile and encompassed a relatively narrow floodplain with varying areas of forested wetlands along each transect. The floodplain profiles show complex topography, which is consistent with site observations that secondary channels or backflow depressions are separated from the creek channel flow-way by areas of higher elevation (HSW, 2012).

Soils along the floodplain cross-sections were evaluated for the presence of hydric or other flood indicators, as well as saturation and inundation condition. Key physical indicators of historical inundation were identified, including lichen or moss lines, trunk buttresses, and water marks, with lichen and moss lines being the most prevalent. Elevations were surveyed along transects to characterize conspicuous changes and heights of hydrologic indicators were recorded. The Charlie Creek basin is located within Southern Florida Flatwoods sub ecoregion of the Southern Coastal Plain, which is characterized by low, flat topography, over which water movement to natural streams, wetlands and ponds is very slow. The soils are relatively poorly drained, acidic and sandy.

The Florida Wildlife Commission (FWC) conducted periodic fish sampling from 2008-2011 along the lower 1.44mile stretch of Charlie Creek above its confluence with the Peace River. As of 2011, 3,275 fish have been documented by the FWC in Charlie Creek from 40 taxa, including non-native species. Historical fish samples have been collected in 1890, 1952, 1964, 1972, 1973, and 1986. It is obvious that Charlie Creek has not been sampled for fish to the extent as Horse Creek. Maintenance of fish habitat is a major component of minimum flow recommendations.

Palustrine and riverine habitats serve as valuable resources for natural communities. The description of existing flora and fauna and consideration of their habitat requirements is essential when establishing minimum flows. As noted in the District's minimum flows report," The DEP has conducted sporadic macroinvertebrate sampling within Charlie Creek during 32 events since 1993 using their Stream Habitat Assessment (HA) and Stream Condition Index (SCI) assessment methods. The HA method quantified the overall habitat quality by considering eight attributes known to impact stream biota, including: substrate diversity, substrate availability, water velocity, habitat smothering, artificial channelization, bank stability, riparian buffer zone width, and riparian zone vegetation quality. The SCI captures the capacity for flowing freshwater systems to support a balanced community, by classifying and quantifying benthic macroinvertebrates and identifying impairment relative to what may be expected with minimally disturbed conditions."

The District report also notes that "Data from 23 sampling events taken since the most recent SCI methodology update in 2012 suggests the upstream stations have "exceptional" biological health and the downstream site is "healthy." The accompanying HA scores, however, suggest suboptimal to marginal habitat at all sampled sites, with lowest scores for bank stability, substrate availability and habitat smothering. Available taxa from the DEP describes individuals from 122 taxa in their exploration of four stations in Charlie Creek over nine sampling dates from 1993 to 2006. "

1.4. Review Requirements and Overviews

Beginning with document delivery on June 27, 2023, the Peer review panel (Panel) was tasked to review the "Recommended Minimum Flows for Charlie Creek Draft Report, June 23, 2023," and all associated appendices. Specifically, the Panel was tasked with reviewing all scientific and technical data, methodologies, and model used to establish the recommended minimum flows for Charlie Creek. This included evaluating report conclusions, supporting data, all technical assumptions, and the procedures and analyses used.

1.4.1. **<u>Conclusions:</u>** The Panel was to determine whether the conclusion specified by the District concerning background information and effects of the recommended minimum flows are supported by the analyses presented in the report.

1.4.2. **<u>Support Data:</u>** The District relied on information from various public agencies and consultant studies. Numerous data sources were used to characterize the watershed and its response to various environmental changes to simulated withdrawals. Data were to be peer reviewed for collection procedures, adequacy, quality assurance and control. Some data were temporal, while other data involved field event collection. Some acquired data required certification, such as survey data. Other data required sampling implementation methods and standards. The Panel was required to determine if the best available data were used.

1.4.3. **<u>Technical Assumptions:</u>** The determination of minimum flows is based on analysis methods that require technical assumptions. For Charlie Creek, this included block flow analysis, allowable wetland inundation assumptions, water quality, land cover effects, habitats, habitat responses, etc. The Panel was to review that assumptions are stated clearly, reasonable, and consistent with available information. Qualified data were reviewed for either elimination or limited use.

1.4.4. **<u>Procedures and Analyses:</u>** The District relied on multiple data sources: habit transects, elevation transects, historical flow data, water quality modeling, etc. to develop relationships and expectations in regards to minimum flows effects. The Panel was to review that the procedures and analyses were appropriate and reasonable for determining the recommended minimum flows. The Panel was to determine if appropriate factors were applied, and that nuisances encountered were adequately addressed, if procedural processes and definitions were sufficiently documented to ensure repeatability of the results, and if procedures and analyses were performed so that conclusions could be derived from the results. Conclusions will be reviewed by the Panel to ensure they are supported by input information and output information generated from the modeling.

The District's draft minimum flows report and appendices were discussed by the Panel in four Microsoft Teams teleconferences that were open to the public and facilitated by the District between July 24, 2023, and August 7, 2023. An initial Peer Review Panel report was delivered to the District on August 14, 2023. The District provided an updated minimum flows report and a response document that addressed Panel suggestions on September 19, 2023. A final Panel teleconference (via Microsoft Teams) was held on September 25, 2023 to discuss the District's responses and report revisions. This meeting was also open to the public. All Panel communications occurred through use of a publicly accessible web forum, facilitated by the District. This final Peer Review Panel report summarizes the findings of the Panel.

2. Review of Minimum Flows Report

2.1. General

This section contains suggestions included in the initial Peer Review Ranel report to the District, delivered August The, 2023. The Panel found the District's draft minimum flows report to be well-organized. The minimum flows report includes applicable and pertinent data, appropriate numerical and statistical modeling, thorough analyses, and appropriate assumptions, along with reasonable conclusions. Caveats exist and are detailed below. Data and procedural enhancements have been recommended for future work. The Panel notes that findings from its final review of the District's proposed minimum flows for Charlie Creek is included in the last chapter of this final peer review report.

2.1.1. **<u>2.1.1. Supporting Data</u>** as described in section 1.4 were reviewed regarding appropriate collection, accuracy, term of record, amount of record, applicability for baseline characterization and assumptions. Data for the watershed were collected according to acceptable standards and where standards were questioned clarification or additional supporting data has been requested. For example, Land cover classifications should be expanded to include more detail about extractive lands.

Seven transects (**Figure 2.1**) were collected along Charlie Creek for determining the composition and distribution of plant communities, occurrence of hydric soils, and other hydrologic indicators. Elevation data were also collected in relation to these occurrences so that further analyses could be conducted by the District. Floodplain Swamp, Bottomland Forest, Hydric Hammock, and Upland Hammock were characterized. This information appeared sufficient to the Panel, but data were only collected in the lower 16-miles of the Creek.

Five sites were selected for collecting data for the System of Environmental Flow Analysis (SEFA) to provide the necessary channel habitat and hydraulic data to model potential changes in available suitable habitat for fish and invertebrates under flow reduction scenarios. Field data were collected during low, medium, and high flow ranges and at pool, run, and shoal habitats at each site. It has been requested that additional descriptions of these transect types be provided to improve repeatability for future efforts.

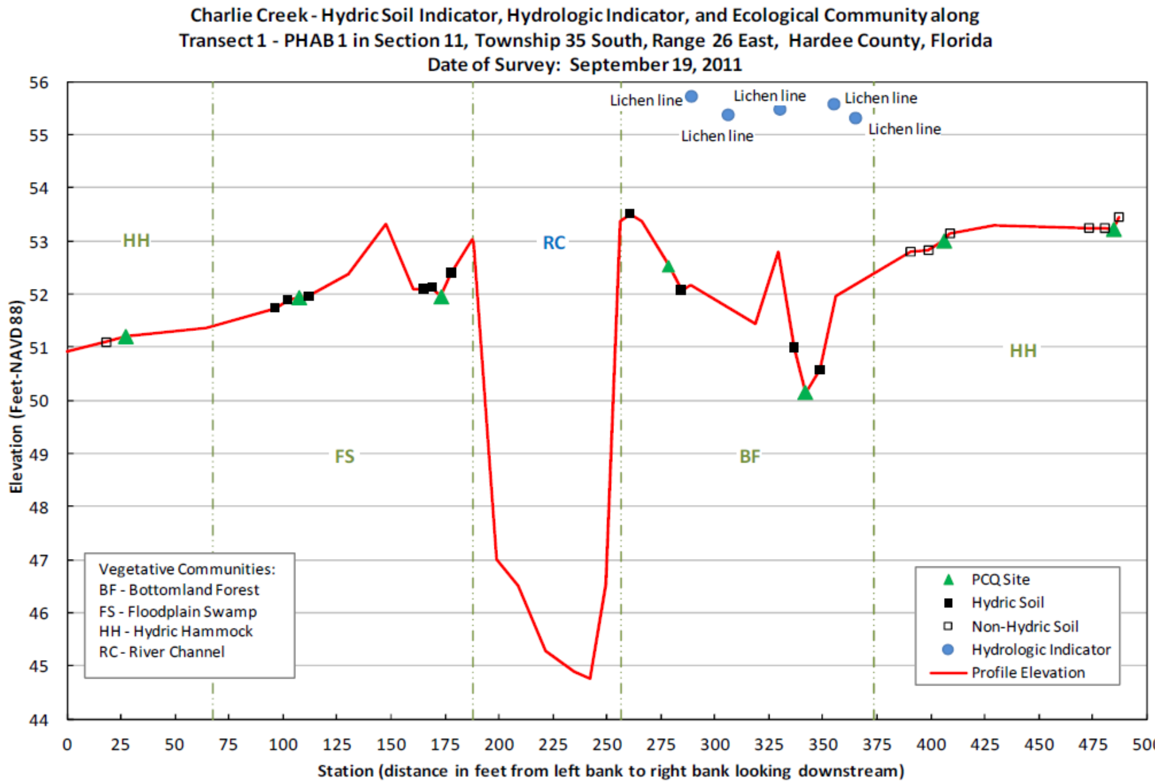


Figure 2.1: Elevation profile of soils, hydrologic indicators, and vegetation communities along Charlie Creek transect 1, Reproduced from 2012 HSW Report.

2.1.2. **Technical Assumptions** were made by the District based on the information generated for the watershed and creek. Assumptions made included: , anthropogenic impacts to flows primarily through pumping for public supply, mining and agricultural practices, instream creek habitat assessments, water quality considerations, and land cover descriptions for the overall watershed and stream corridors. In general, the technical assumptions were stated clearly and sound. Additional information has been recommended by the Panel for finer resolution and description of information concerning: land cover, soils, future modeling, sediment transport, wetland descriptions, and instream habitat definitions.

The 15% Change Criteria has ample precedent as described in Section 1.3.5 of the report, but embodies an underlying assumption that harm is incremental when in some cases it is threshold based. In future work the Panel would like to see sensitivity testing of minimum flows determinations based on 15% change criteria versus threshold-oriented event-based approaches. Event approaches are particularly useful regarding the genesis and sustenance of alluvial and fluvial surfaces in river corridors; and regarding pulsed thresholds in hydrology for wetland community type sorting related to water depth, inundation frequency, and hydroperiod.

Agricultural runoff is assumed to be a significant component of the determination of the recommended minimum flows. For Charlie Creek it has been determined that agricultural irrigation increases runoff volume and needs to be accounted for in the stream analyses. Components in agriculture related runoff include: soil characterization, methods of irrigation used due to efficiencies, and site drainage systems. Hydrogeologic considerations are also important due to infiltration; and subsurface and surface drainage to receiving water bodies and conveyances. Hydrologic Soil Classification provides technical information regarding water table depths, specific yield, and vertical hydraulic conductivities. Based on its initial review, the Panel requested additional information regarding the soil types encountered. In addition, it was noted that surface roughness is another component affecting runoff.

Seasonal-flow blocks have historically been used by the District for the purpose of establishing minimum flows. The blocks were first discussed by Flannery in 2002 and they have been utilized by the District for most stream minimum flows since. These blocks are based on typical seasonal variation of flows in streams in west central Florida and their use has been affirmed by peer reviews numerous times. The implementation of seasonal blocks is not without difficulty and is technically challenging. The District has recognized that seasonal transitions represent a statistical expectation and not an annual certainty. To better protect systems from low flows not aligned with seasonal expectations, the District has taken steps such as implementing a low-flow threshold without seasonal boundaries. More recently the District has suggested that flow-based blocks provide better protection to certain systems and first use this approach in the lower Peace River (Ghile et al. 2021) and is currently considering their use in the Little Manatee River (Holzwart et al. 2023). The document provides two instances from the lower Peace River report when flow-based blocks may be appropriate:

- Baseflow-dominated systems, for example, short, coastal rivers where discharge from spring vents accounts for much of the flow.
- In addition, flow-based blocks, which typically, but not always correspond with season periods, may be appropriate for establishing minimum flows in some systems.

The Panel agrees that flow-based blocks can provide better protection and believes the use of flow-based blocks has merit. However, section 2.5.2 of the report, where seasonal flows are discussed, describes the flows in Charlie Creek as following the “seasonal pattern of rainfall in west-central Florida”. No case is directly made that the system adheres to the cases described as appropriate for flow-based blocks. In their initial review, the panel recommended that the District either make the specific case that Charlie Creek belongs to one of the two categories above or make the generalized case that flow-based blocks offer better protection than season-based blocks and should be adopted in their stead. The District’s modified text sufficiently addresses the rational for the flow-based blocks to the satisfaction of the Panel.

2.1.3. **Procedures and Analyses** were conducted to generate relationships and trends for specific indicator responses in support of minimum flows development. Several interrelated analyses were conducted using Hydrologic Engineering Center – River Analysis System (HEC-RAS) by the United States Army Corps of Engineers. The SEFA software was used to predict minimum flow effects on suitable instream habitat and other environmental habit characteristics were analyzed as well.

The 2005 Digital Elevation Model (DEM) was used in combination of land survey data for the generation of some HEC-RAS cross sections along a 16-mile stretch of Charlie Creek. DEMs are notoriously inaccurate in highly vegetated areas, however, numerous laser flashes can penetrate the canopies with sufficient returns. A review of the Light Detection and Ranging (LiDAR) raw data returns can provide additional detailed information. Information regarding DEM accuracy along the stream corridor was requested in the Panel's initial review findings, through the review of the Survey Report associated with the DEM for quality control and assurance.

A single 1-D model option using HEC-RAS was performed to determine inundation depths and durations along the Charlie Creek corridor. This option is appropriate provided that no significant flow reversals occur and other dynamic effects occur in one direct and flows on the rising and falling hydrograph limbs are not significantly different (hysteresis). Flow distribution, Manning's N values, and overbank contribution to flows are also important components of the modeling. Flows were apportioned based on gage data and additional site monitoring, which was considered sufficient. Overbank conveyances or the lack thereof were determined by sensitivity analysis of elevation responses in calibrated and verified locations. Manning's N values were based on composite values due to meander and obstructions such as fences within the stream channel. The District made adjustments in the flow apportionment of the HEC-RAS model by INTERA 2018, by conducting linear regression analysis with the USGS gaging sites along with other flow adjustment factors. The Panel considers the HEC-RAS model adequate but notes that it does not take into account dynamic flow conditions.

For future minimum flow analyses, the Panel suggests using HEC-RAS 2D as a means for reducing potential errors related to selection of inactive flow assignments and sensitivity to user inputs of Manning's coefficient (n). HEC-RAS 2D is particularly valuable for systems like Charlie Creek that have a tremendous range of floodplain morphologies and complex, rough valleys in places consisting of large in-line depressions, wide strands lacking a well-defined alluvial channel, multiple and branching alluvial channels, floodplain chutes, valley flats, and high sandy alluvial ridges. The floodplain/river channel flow exchanges often occur at specific junctions in low spots along the alluvial ridge lines that are rarely captured well using a 1D cross-section series.

Aspects of fluvial geomorphology are covered indirectly in some areas distributed throughout the report and its Appendices. This is a core discipline in river study that can unify an overall conceptual model relating watershed and aquifer characteristics in hydrology, sediment transport, and water quality to the variability of pattern, dimension, and hydroecology of the river channel and its floodplain. There should be a foundational effort to gain a preliminary understanding of the fluvial geomorphology of the system from its headwaters to base level to inform further field study and model development. That information can be used to assure all critical and unique habitat types and functional zones are studied and sustained along the protected portions of the valley.

The Panel would like to see a study design, conceptual model descriptions, and adaptive management strategies draw explicitly from this discipline in future minimum flow determinations. Chapter 2 of this report, Physical and Hydrologic Description, has sections on the watershed, land use and cover, soils, climate, streamflow, and hydrogeology. A fluvial geomorphology section could be added to that chapter.

One potentially significant finding of the panel related to fluvial geomorphology is a sustained multi-decadal pattern of channel incision (degradation) at the stream channel near Gardner and channel shallowing (aggradation) at the USGS Charlie Creek near Crewsville, FL gage. Consistent with this pattern there is a rapid grade change and hydraulic profile drop through the middle of the study area at the Sweetwater Bridge. This pattern is consistent with a broad pattern of headcutting/channel degradation downstream or the Bridge and sediment accumulation/aggradation above it and is consistent with the grade changes occurring at the study area's long-term flow gages. There are other potential explanations for the pattern at the bridge though, so it is important to understand why this grade change occurs and whether it is part of a systematically non-stationarity of grade control in the study reach. That understanding may change perspectives regarding the vulnerability of select surfaces and habitats to flow reductions upstream versus downstream of that Bridge and the longevity of any conclusions drawn from HEC-RAS modeling or other hydraulic calculations like those used in SEFA.

A Conceptual Model could be provided that describes the essential underlying processes and relationships among the physical and hydrological conditions, water quality characteristics, and ecological resources described in Chapters 2, 3 and 4. It seems like something like this would fit well as a new Chapter 5, serving as a means to marshal the detailed system descriptions into a cohesive synopsis related to protecting processes as well as form. This chapter could also offer a preview of how the proposed minimum flows addresses the underlying processes as a nice setup for the subsequent chapters in the report describing the technical approach. The conceptual model could also be referenced and woven into how the environmental values are addressed in the narrative of Chapter 6, Section 5.

The concept should address the functional process zones (FPZ) found along the drainage network throughout the watershed and at the boundary of its downstream confluence. It should state which FPZs are included in the study area and why. For example, Charlie Creek alternates among several FPZs including seepage-based headwater streams draining portions of the Lake Wales Ridge to nearly perennial mid-order stream positions with alternating high-energy and low-energy valley segments varying in their channel pattern and size, alluvial floodplain features, wetland types, and water quality with abrupt transitions from one FPZ to another. The study area encompasses a subset of the systemwide FPZs located in the downstream third of the total valley leaving out most of the low-energy FPZs and some wetland types.

The conceptual model description should be synoptic where applicable. For example, more could have been synthesized and discussed regarding how the morphology of the studied sections and HEC-RAS model relate alluvial surfaces, floodplain soils, and floodplain vegetation to thresholds of water levels and flow volumes along the valley.

The proposed conceptual model development and new chapter is not required for this Charlie Creek minimum flows study as the Panel finds the study to be sufficiently multiple in its scientific disciplines and spatial scope, with some caveats described later. It appears that the study area was driven primarily by the position of the available long term gage records of the system, and the study locations were selected in part based on land-owner permission for access. That is an understandable use of the best available information, but it would be helpful to reviewers and interested parties to understand what was not included and why.

Floodplain vegetation communities, soils, and hydrologic indicators were sampled at seven transects in the study area as described in Section 4.4 and Appendix C of the minimum flows report. The available and prescribed biological field studies all center on downstream positions in the Charlie Creek watershed (macroinvertebrates, fish, vegetation/soils sections). Extensive portions of the mid-to-upper parts of the valley are not similarly assessed. The vegetation and soils transects intersect four forest types within perhaps three of the eight functional process zones (FPZ) of the valley. FPZs differ in their valley form, energy regimes, and fluvial/alluvial processes in ways that affect habitat substrates and biological communities in the channel and floodplain. At least two major floodplain community types are present in very wide and gradually sloped portions upstream of the study area, and were not monitored or described (emergent marsh; bottomland forest strands). At least one major aquatic community upstream of the project area was not described, also from within low gradient valley segments (wide and deep paralotic channels (e.g. lagoons)). The HEC-RAS model did not extend upvalley into these habitats. The monitored and modeled study area occurs in a relatively homogenous downstream reach of the river, encountering a subset of FPZs distributed in the mid-valley region, and none of those in the headwater reaches.

The Panel requested the District provide reasons for studying the lower valley only and suggests perhaps titling this as the 'Lower Charlie Creek Minimum Flows' based on the position of the study area's biological and modeling components and its comparative process zone homogeneity versus the broader range of FPZs occurring upstream adjacent to and within 7 miles of the study area. These systems should be acknowledged, and reasons for focusing on the selected sites explained. For future minimum flows work, this is the kind of characterization that a preliminary fluvial geomorphic assessment will daylight and inform the sampling strategy. Since the HEC-RAS model does not intersect with these FPZs the panel could not assess the likelihood the recommended minimum flows protects habitats upstream of the study area.

The structure of the four Flow Blocks (Figure 2.2) is well-conceived and protective of all Water Resource Values. This is a progressive and robust assessment. Blocks 1 and 2 were protected by evaluating multiple specific habitats and functional features in each block and were set using the most protective metrics at the most-sensitive location among multiple positions in the study area. The approach taken there is specific, prudent, balanced, and highly intuitive toward addressing the key functions in those blocks.

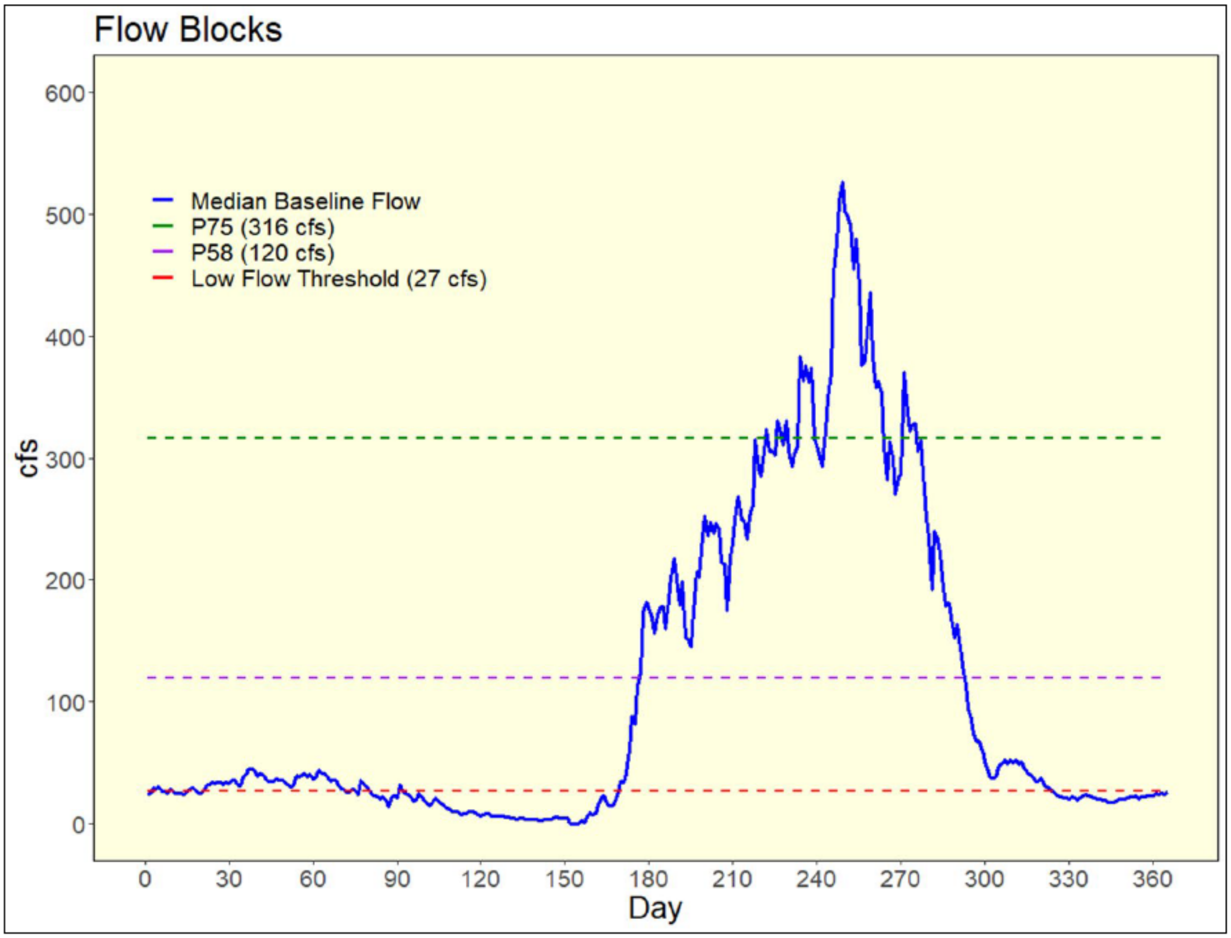


Figure 2.2: Flow Blocks superimposed on a hydrograph of median observed daily flow representing a typical calendar year. The horizontal lines represent Flow Block divisions.

Blocks 3A and 3B were derived primarily from a statistical analysis of the lower and upper portions of the floodplain area inundation, without directly addressing the requirements of specific habitats or processes in that part of the flow regime. Further, a block-specific average percent of flow reduction (PFR) was, respectively, recommended as the minimum flow for Blocks 3A and 3B. This results in a less protective approach versus using the highest flow in each block.

Block 3A includes the lowest-lying and most-deeply and frequently-wetted alluvial floodplain surfaces and communities that are wetted between the 58th and 75th percentile flow. This block straddles bankfull flow. Bankfull flow is perhaps the single most important discharge for sustaining in-stream channel pattern and dimension, and its distribution of habitat substrates. It warrants specific attention and appears to be indirectly but sufficiently protected by this approach in this case.

Block 3B contains habitats that occupy elevations associated with 75th to 99th percentile flow profiles. Substantial active alluvial surfaces occur above the average flow stages in that block and the uppermost alluvial substrates and associated biological communities may be unprotected at a 15% reduction of inundation area by using the PFR of the average flow in the block.

The Panel examined the results of the HEC-RAS model at the vegetation survey sections to confirm protection of each of the major floodplain habitats identified in the vegetation and soils study. The lower alluvial ridges close to the channel margin (AR4) and their associated hydric hammocks (Max Bed2) occur between the 95 th and 99 th flow percentiles (**Figure 2.3**). The highest alluvial ridges and upper alluvial valley flats (AR3) are mostly situated at elevations above the 99th percentile flow profile.

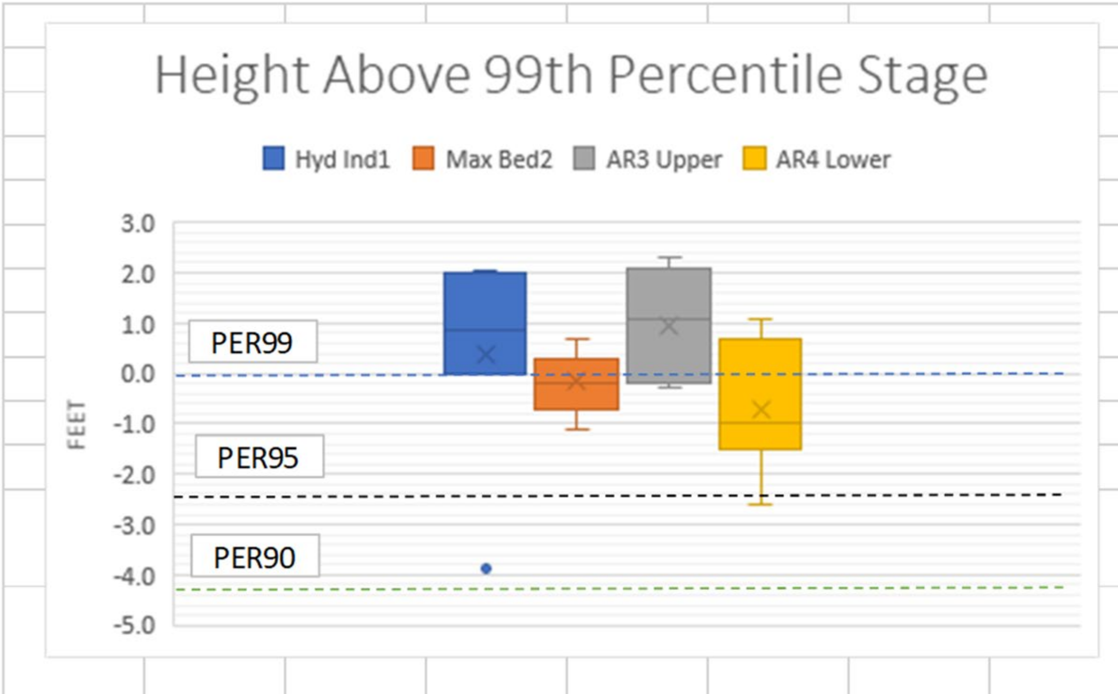


Figure 2.3: Charlie Creek Floodplain Community Relative Elevations to Flow Percentile

The District is to be commended for the specificity and wide blanket cast to protect features in Blocks 1 and 2, building upon proven precedents and adding to the sophistication of previous analyses. The methods used for Blocks 3A and 3B are also well thought out for seeking a simple and elegant evaluation method drawing from modeling results, but are not as multiple and as habitat-specific as in the approaches used in the lower in-stream blocks. There is greater uncertainty in this lack of multiple variables and spatial aggregation, and Block 3B has a considerable range of percent-of-flow reduction versus flow percentile across the flow range in the block.

For Block 3A, the Panel finds the narrow range of 12% to 11.1% percent-of-flow reduction does not warrant any further consideration as the result is insensitive to the method taken to select which percent of flow reduction to use within that range. However, Block 3B covers a range of approximately 11% to 6% flow reduction and more care is required in the selection of what part of this range is sufficiently protective of the surfaces and habitats spanning the associated flow range.

To provide greater assurance against significant harm to the upper-most habitats, the panel would like the District to consider splitting the upper portion of that Block into a third floodplain block, Block 3C. A visual break is apparent somewhere near the 94th flow percentile. A break near that position would better center the allowable flow reduction for the upper alluvial surfaces and habitats in the floodplain without unnecessarily restricting withdrawals throughout the entire range of existing Block 3B. Although relevant to the entire study area, this is particularly important for sustaining the upper terrace habitats downstream of the Sweetwater Bridge which may be systematically incising and thus particularly vulnerable to hydraulic abandonment under flow withdrawal scenarios. Block 3C was added by the District to provide better protection in the high flow environment.

The anticipated result would be mid-point floodplain inundation protections of the three main flood terraces in the system including the lowest alluvial surfaces such as the bankfull channel margins, lower backswamps, chutes, and deeper bottomlands (covered by existing Block 3A); middle terrace features including valley flats, lower alluvial ridges, and shallower backswamps (in the proposed reduced Block 3B); and the upper terrace's alluvial ridges and valley flats (in new Block 3C).

Sediment transport calculations were discussed in Section 6.5.8 of the report. This study is a new approach to evaluate the sediment transport environmental value using results from the HEC-RAS model. This assessment compared annual average sediment transport calculations derived from the baseline and proposed MFL flow records. The assessment determined that a 11% reduction in sediment transport would occur if the maximum allowable withdrawals occur. This adds to the weight of evidence that the multiple approaches taken to setting the minimum flows are also, in aggregate, protective of the sediment transport functions of the creek and its floodplain.

The report indicates a sediment transport calculation was made, citing use of the Enguland-Hansen equation. This equation was used to make at-a-station sediment-flow rating curves for multiple cross-sections and these calculated rating curves were used to generate a total bed material load transport mass for the flow period of record under baseline and minimum flow scenarios.

However, the Panel does not believe the sediment transport output is realistic. It rivals that of much larger rivers, like the Kissimmee. An accurate transport calculation requires knowledge of actual loads and most transport calculations, as in hydrology modeling, require calibration to measured loads. The sediment rating curves were purely mathematical and based on incipient motion occurring at shear 0.006 lb/ft2. Natural southwest Florida stream corridors develop significant shear strength in their banks and floodplain that establish much higher thresholds of motion. Even the streambed sand grains can sort, settle, and develop a thin surface armoring of coarser fragments and non-sand material (shells, phosphatic pebble, and fossil gravel) and self-compaction that retard incipient motion. These factors mean that applying a motion threshold for sand will over-predict transport by a large margin. Plus, sediment transport equations are somewhat notoriously unreliable and an order of magnitude accuracy is often deemed the best available outcome.

Therefore the panel suggests the District describe the calculation as a transport capacity study. It is not intended as a representation of actual available loads subject to transport, but represents the capacity of the system to transport up to the calculated load should that ever be delivered from various sources as sand.

The report requires more description of why the Enguland-Hansen equation was used, versus other methods. Use of the equation is justified by the narrative, but alternatives were not discussed, leaving the question open as to whether this was the best-available resource. While this is great way to derive more value from a HEC-RAS setup, there are relatively simple and more accurate methods to calculate actual loads if that was the District's intention - for example using the Rosgen FLOWSED-POWERSED method. That technique requires only a single sediment transport field measurement at or near bankfull discharge for calibration and is typically more accurate than use of the available sediment transport equations in HEC-RAS. In the latest report, the District acknowledged the lack of calibration of the Enguland-Hansen equation whereby it only provides an indication of general capacity of the Creek for sediment transport to the satisfaction of the Panel.

The Panel is not recommending invoking an alternative method for this minimum flows analyses for Chalie Creek, rather we are just providing some suggested considerations for development of future minimum flows. Another consideration is that some flow percentiles are more important than others for sediment distribution that maintains the pattern and dimension of instream habitat structure and floodplain surfaces and elevations. This includes bankfull flow, which is typically between the 70th and 90th percentile (on average 80th percentile in nearly perennial peninsular Florida's nearly perennial blackwater creeks). Bankfull flow not only governs the equilibrium of the main open channel, it drives the meander forces and thus grades the floodplain over time precluding it from simply rising above the streambed ad-infinitum. Bend migration is thus the mother of floodplain equilibrium.

Another important instream flow forms the inner berm channel. This is effectively a baseflow channel within the bankfull channel. It has its own meander pattern and habitat characteristics, and results from lateral bar formation. Its percentile association needs to be determined by field survey of the inner berm hydromorphology and HEC-RAS modeling, but a rough starting point might be the median flow (50th percentile).

Each flood terrace or floodplain alluvial surface above bankfull flow warrants separate inspection, including from highest to lowest elevations: alluvial ridges and older scroll ridges, valley flat on upper alluvially-active terrace, valley flat on lower active terrace, linear backswamp, chutes (secondary flood channels in high energy floodplains), oxbow wetlands and ponds. A consideration for work on future minimum flows would be to synthesize a 2D HEC-RAS model, careful field diagnosis and survey of key alluvial features, and mapping of these features based on a digital elevation model (DEM) and HEC-RAS output at specific flow profiles associated with thresholds of specific alluvial feature wetting.

For the Charlie Creek minimum flows the District may wish to examine if the calculated transport volumes at the 50th, 80th, and 99th percentiles result in less than a 15% transport capacity reduction at each value, but this may be a big ask at this point and the aggregate transport capacity method used is progressive and adds a protective layer of study to the overall investigation, so this is not a keystone recommendation. For the development of future minimum flows the Panel suggests careful targeting of the frequency and duration of channel forming and floodplain forming events tied directly to survey and hydraulic modeling as part of an event-based and multiple approach to sediment transport and deposition evaluations.

The Peace River Integrated Model (PRIM 2 Draft Report, 2022) was used to estimate runoff by reducing groundwater pumpage and noting the changes in stream flow. The model has recently been peer reviewed and approved for use. The PRIM 2 model is a surface and ground water integrated model for the Peace River watershed. The results of the model were used in the minimum flows analysis in determining "historical watershed conditions" without groundwater pumpage. The 50% reduction in groundwater pumpage simulated was doubled to estimate water use effects on Charlie Creek flows. Modeling of Charlie Creek indicates irrigation contributes to an in stream flow. As a result, the estimated flow increases were subtracted from the historical flow record. It is concluded that the District used the PRIM 2 model to determine irrigation effects and other use effects in Charlie Creek. The reported R^2 value (0.50-0.56) Table 4.2 of the PRIM 2 report regarding (simulated versus observed results) at the Gardner Gauge is low indicating that all variability is not explained by the model. The model has a bias toward under predicting flows in the creek (Table 4.4) of the report. The PRIM 2 model indicates that the average groundwater pumpage over the Charlie Creek basin is 1.54 inches per year. Irrigation amounts are based on the District's water use monitoring program.

Due to the hydrogeology of the area, there is little connection between the supply source for irrigation and the surficial aquifer. Drawdowns in the groundwater systems are muted in the surficial aquifer due to the confining layers. This is counter to karst unconfined aquifer systems, where water use would have a negative effect on flows and levels due to aquifer depletion that is transmitted to the surficial aquifer. The Panel agrees that the PRIM 2 model is the best available for determining runoff addition due to irrigation and other uses in Charlie Creek. Statistical results indicate that the model accounted for 50-56% of the variance with a bias toward decreased simulated flows (Table 4.4 and Appendix B, PRIM 2 Draft Report). It is probable that the irrigation effects are biased. More discussion in that regard should be provided.

3. SUMMARY OF FINDINGS

For their final review, the Peer Review Panel reviewed the updated report titled, "Recommended Minimum Flow for Charlie Creek Draft Report, Sept. 18, 2023," associated appendices, and a tabular summary of the District's response to the Panel's initial review (included in report Appendix).

The updated District report and responses addressed the Panel's suggestions for corrections and clarifications in the procedures used in the evaluation of the recommended minimum flows for Charlie Creek. The Panel found the report and associated analyses adequate for establishing the recommended minimum flows. The updated minimum flows report was approved by the Peer Review Panel.

4. REFERENCED LITERATURE

1. Deak, K. 2023. Charlie Creek Water Quality Analysis Using Generalized Linear Mixed Modeling. Technical Memo. Southwest Florida Water Management District, Revised August 2023.

2. Herrick, G. 2022. Charlie Creek SEFA memo. Southwest Water Management District. Brooksville, Florida.

3. HSW Engineering, Inc. (HSW). 2012. Characterization of elevation, soils, and vegetation relationships in the riparian corridors of Horse and Charlie Creeks. Final Report. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

4. HSW Engineering, Inc. (HSW). 2021. Physical habitat modeling using System for Environmental Flows Analysis (SEFA). Final Report. Prepared for the Southwest Florida Water Management District. Brooksville, Florida.

5. Peace River Integrated Modeling Project 2 (PRIM 2) Draft Report, HydroGeologic, November 2022..

6. INTERA, Inc. 2018. Charlie Creek HEC-RAS modeling and inundation mapping. Prepared for the Southwest Florida Water Management District. Brooksville, Florida.

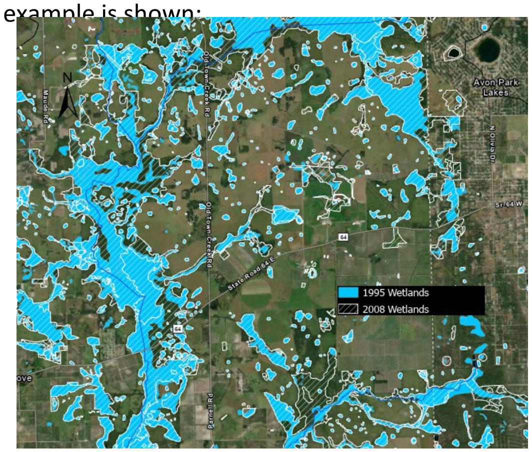
7. Janicki Environmental Inc. (JEI). 2019. Lower Peace River water quality study. Final Report. Prepared for Southwest Florida Water Management District. Brooksville, Florida.

8. SWFWMD, 2023. Recommended Minimum Flows for Charlie Creek Draft Report

Appendix
Spreadsheet of Specific Comments
For
Charlie Creek

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
1	HD	Pg. 12, Section 1.3.7	Need more description regarding "Adaptive Management"	Suggestive Wording: "Could include regulatory requirements, site specific site mitigation, conservation acquisition, etc. if warranted."	Additional language was added to section 1.3.7. to explain how adaptive management will be applied to minimum flows for Charlie Creek.	Yes
2	HD	Pg. 13, last Paragraph	USGS description of flow monitoring sites assessment would be useful	USGS description of flow monitoring sites assessment would be useful	Added in Section 2.5.	Yes
3	HD	Pg. 16, Section 2.21, and following relevant Figures	Mining shouldn't be listed under Urban land use	Add breakout for mining, since a permit has been submitted	The land use maps used in this section summarize the most recently completed District land use classification data (from 2020). In 2023, the Eastern Extension of Mosaic's South Fort Meade mine was approved by the Hardee County Board of County Commissioners. Additional text has been included to describe this change and a map was added to show the location of the planned mine in relation to the Charlie Creek watershed.	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
4	HD	Pg. 16, Section 2.21	Irrigation affects agricultural assessment of runoff interpretation due to management practices	Provide description of irrigation types	All existing water use permits for irrigated areas in the Charlie Creek watershed (n = 353) were queried from the SWFWMD WMIS database during the week of August 21, 2023. The irrigation type listed for each permit was recorded. The majority of water use permits for irrigated areas (n = 295) included citrus, irrigated by low volume spray. Most of the fruit and vegetable crops (melons, tomatoes, strawberries, squash, peppers, and cucumbers) were irrigated by drip with plastic, the exception being blueberries, (76% of their requested irrigation was to be delivered by drip without plastic). Permits for the irrigation of pasture and sod primarily requested irrigated by seepage Center pivot irrigation was requested for grain irrigation by two applicants. A brief description of this was included in the text of section 2.2.	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
5	HD	Pg. 19, Figure 2-5 pg. 19	Appears something has increase the wetland acreage in the watershed around the year 2000	Add discussion about the increase.	The increase in wetland acreage likely is a result of changing technologies and the connection of previously separated wetlands in the land use GIS files. The 1995 and 2008 wetland land use classifications were compared, over a satellite imagery overlay. The differences appear to be in wooded wetland habitat now being classified as fully connected wetlands. An example is shown: 	Yes
6	HD	Pg. 19, Table 2-1	Mining should be included in the table	Add Extractive classification, since it is now being considered	The table summarizes the most recent land use data available from the District (2020), which does not include the Extractive classification since mining was approved in 2023. These land use changes will be further considered in any future reevaluation of the system.	Yes
7	HD	Pg. 23, Section 2.3	Description of Soils in determining hydraulic characteristics	Are they sands, loams, clays, etc.	All SSURGO soils data compiled by the District was evaluated. The majority of soils were described as fine sands (61%) or sands (18%), with some muck (4%). The Bradenton-Felda-Chobee association accounted for 7% of soils and was noted to be frequently flooded. Additional descriptive text was included in section 2.3. Soil characteristics were also considered in PRIM2	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
8	HD	Pg. 23, Section 2.3	Poorly drained soils, would tend to indicate higher runoff not less	Review and indicate runoff response	The text in this section was modified to better reflect information provided in the HSW 2012 soil and vegetation survey.	Yes
9	HD	Pg 27, Figure 2-10	Rainfall Figure should probably be a bar graph	Convert to bar graph instead of continuous graph	Converted to bar graph.	Yes
10	HD	Pg.29, Section 2.4	Runoff inches compared to rainfall to allow comparison between rainfall and runoff	Add runoff average compared to rainfall average	Runoff (inches) added to Figure 2-9.	Yes
11	HD	Pg 29, Section 2.4, and Figure 2-13 reference	Observed downward trend in flows	Add possible explanation of downward trend between 1950 and 1980	Explanations added.	Yes
12	HD	Pg.27-28, Section 2.4	Formatting of Titles and Figures	Reformat for same page if possible	Fixed.	Yes
13	HD	Pg. 31, Section 2.5.3 and Table 2-2	Affects conclusion about anthropogenic influences that may not be supported by the data or the possibly of a different interpretation	No significant changes could possibly indicate a stable land use conditions rather than lack of anthropogenic influences	Fixed.	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
14	HD	Pg. 33, second paragraph	Horizontal, vertical hydraulic conductivities widely varied, and also the specific yield. How do these values compare to the SSURGO database?	Seems like the values provided are related to the interface between the SA, and the UFA for vertical conductivities while the horizontal represents horizontal fluxes to the creek or tributaries. Need to add verbiage to clarify.	The horizontal and vertical hydraulic conductivities and transmissivity are ranges for the surficial aquifers (not in the interface between SA and UFA). Text was added to clarify this point . Hydraulic conductivities were derived from SSURGO database but were slightly modified during calibration in some areas.	Yes
15	HD	Pg.35, Fig 2-17	Need location of ROMP well, appears that fluxes could be different depending on location in watershed?	Add location map	The location of the ROMP well has been added to Figure 2-2 and referenced in Section 2.6.	Yes
16	HD	Pg. 34-35	Figure Formatting	Correct Format for Title and Figure	Fixed.	Yes
17	HD	Pg. 37, Section 3.1, last paragraph	Source of fecal coliform, erosion, and phosphorus	Potential livestock within the stream?	The influence of livestock in and around the creek bed has been noted by consultants during field work. As it was not explicitly remarked upon by the DEP in their assessment of impaired waters, this anecdote is not included in the report.	Yes
18	HD	Pg. 44-45, Fig.Title and Figure	Title and Figures don't align	Align when reformatting report	Fixed.	Yes
19	HD	Pg 46, 2nd paragraph	Source of phosphorus	indigenous or anthropogenic	No source is provided in the DEP analysis of impairment for total phosphorus. It is likely a combination of indigenous and anthropogenic sources. Regardless of source, a statistically significant relationship with flow was identified, relevant to minimum flow development	Yes
20	HD	Pg. 49	Indicate when DO samples taken	Review data with time stamps	Grab samples for DO were not taken at the same time of day.	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
21	HD	Pg. 52-53	Table and Figure Labeling	Reformat for same page if possible	Fixed.	Yes
22	HD	Pg. 52-53	DO low concentration and saturation causes	COD and BOD, source and is this natural or anthropogenic?	The cause for low dissolved oxygen at station 2399 is unknown. Relevant to the development of minimum flows, no statistically significant relationship with flow was identified for this constituent at this station.	Yes
23	HD	Pg. 59-60, Section 4.1	It appears that this assessment indicates extreme bank disturbance	Potential livestock within the stream, source?	Anecdotal evidence of livestock trampling banks has been provided by consultants performing field reconnaissance, however, the District does not know whether this is true at the locations sampled by the DEP for their habitat assessments.	Yes
24	HD	Pg. 80, Table 5-1	Provide clarification	Add column which shows adjusted flows for MFL analysis for the average monthly	Added a column showing adjusted monthly flows.	Yes
25	HD	Pg. 78, last paragraph	How does a low R2 affect pumpage/runoff relationship?	Does monthly averaging reduce the potential error?	Correlation results for streamflow at the USGS Charlie Creek near Gardner, FL (No. 02296500) gage (R2 = 0.57) was slightly less than the target value 0.6. However, the accurate simulations of seasonal and pumping-induced head changes in the HAS and UFA indicated the model performed reasonably well in quantifying impacts of groundwater pumping on streamflow in the Peace River and its tributaries. It is important to note that the relative change between pumping and pumping off was used for adjustment of the historical gaged fl	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
26	HD	Pg. 78-80 verbiage concerning agriculture runoff estimates from pumpage	Need to know how much runoff is occurring compared to pumpage. Is this a conservative estimate of agriculture runoff due to groundwater.	Provide calculations that demonstrate runoff percentage to estimated water usage. This may support agricultural influence especially when compared to irrigation types	We do not see the need for such analysis for the following reasons: 1. Not all runoff flow directly into stream and for a pumping well located far away from streams, runoff from one cell could become evaporation or infiltration into the next cell; 2. the excess runoff from PRIM2 is not exclusively related to agricultural water use, it could also be related to water use for mining and public supply; and 3. along the boundary of the watershed there could be water transfer, i.e., water pumped out of the watershed applied in the watershed or vice versa.	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
27	HD	Pg. 91, Last paragraph	Is 16 Miles of Creek adequate for environmental impact analysis	Provide logic	As described in the District report and appendices, the Charlie Creek HEC-RAS model reach was delineated based on the need for upstream and downstream boundary conditions at long-term gaging stations. While the downstream gaging station at Gardner has been in operation since 1950, continuous data collection at the upstream station near Crewsville was first initiated in 2004, to support hydraulic model development for minimum flow purposes. Selection of the Crewsville site was presumably based on site accessibility, availability of sporadic historic, discrete flow and stage measurements at the site, and streamflow characteristics at the site. For SEFA analysis, even though it is almost always desirable to have more data at more sites, the habitats (shoals, pools and runs) studied at the 5 sites used in our analysis are sufficient for representing all habitats in the creek. Floodplain inundation is more sensitive to flow reductions in the lower segment where the creek is relatively incised and deep. Fish passage could be more sensitive to flow changes in the upstream portion of the creek. However, surface water withdrawals are not expected during Block 1, which was identified using the fish passage criterion, and the proposed minimum flow for this block is 100%. In addition, withdrawals from Charlie Creek under low flow conditions would be expected to impact an existing legal user, the PRMRWSA. So, the District believes the 16-mile studied segment of Charlie Creek that was modeled with HEC-RAS and evaluated for various minimum flow analyses is sufficient and reasonably representative for development of minimum flow recommendations for the system upstream of the Gardner gaging station.	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
28	HD	Pg. 92, 2nd paragraph	8 surveyed, and 28 digitized Cross Sections a reasonable definition of aquatic system	Any bias noted in the 2005 DEM elevations?	The DEM was verified by the Survey section against some surveyed elevations. INTERA also verified the DEM by comparing it against the surveyed points. A few DEMs containing erroneous data were identified and corrected in Horse Creek (not in Charlie Creek). The inaccurate DEM elevations were replaced by interpolations from surveyed data.	Yes
29	HD	Pg. 92, 1st paragraph	Use of 2005, 5-foot DEM	Include survey report, and how DEM compares to survey data for the same area or point.	Included (Appendix G). The 2005 DEM was developed by 3001 Northrop Grumman company. During the QA/QC processing, the District found some consistent bias between the LiDAR data and the District's survey data. After the company corrected the biases, the District verified the vertical accuracy and accepted the dataset. As mentioned above (comment 28), INTERA also verified the DEM by comparing it against the surveyed points in Horse and Charlie Creek. A few DEMs containing erroneous data were identified and corrected in Horse Creek.	Yes
30	HD	Pg. 92, 3rd paragraph	93 instead of 36 cross sections referenced	Review paragraph for typos	Yes, 41 in total.	Yes
31	HD	Appendix "F", pg. 33-34	Justification for Averaged Uniform Flow, 1-Dimensional, and Composite N value	Are fences across the creek, meander, and other items of significant effect for justification? Discussion needs to be added to text. Hysteresis.	This report was prepared in 2018 and justification was provided for implementing a composite N value to account for tortuous cross-sections, bed irregularities and obstructions (wires and debris).	Yes
32	HD	Pg. 104-106, Tables 5-5 and 5-6	What are the identifying characteristics of a pool, run, and shoal. Could not find in Appendices	Provide description of how the transect parts were identified and how they are important in habitat ratings.	Explanatory text and citation added to p. 105.	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
33	HD	Pg. 106, Table 5-6	No intercept in the regression, correlation is therefore redefined	Remove reference to correlation coefficients	Correlation coefficient removed.	Yes
34	HD	Pg. 128, 2nd paragraph	Horse should be Charlie	Change to Charlie	Changed.	Yes
35	HD	Pg. 129, Table 6-5	Should Arcadia be Gardner?	Change if appropriate	Changed.	Yes
36	HD	Pg. 133, Section 6.5.5	Should include ERP	Include ERP	Environmental resource permits were added to the description of District programs used to protect and maintain freshwater storage and supply in section 6.5.5.	Yes
37	HD	Pg. 135, Section 6.5.8	Sediment loads actual or potential, also what is the source? 169,176 tons/yr. seems unreasonable.	Suggest that the sediment loads are potential. May need better methodology	Fixed per Panel's recommendations	Yes
38	AM	Whole	The report is well organized and well written. It is as consumable as such a technical document can be and coupled with the appendix is thorough and represents the districts continued methodological improvements and commitment to the MFL process	N/A	N/A	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
39	AM	P. 9	The report notes that historically flow blocks have been calendar based (Discussion on page 122). The District then cites Ghile 2021 as introducing flow based blocks for the lower Peace River and Shell Creek. We have discussed horizontal vs vertical blocking for along time. In fact I would summarize the creation of the LFT as having emerged from concern over the adequacy of the vertical blocking. I think the argument for horizontal blocking is strong and I commend the district for setting aside the normal blocks on the Lower Peace River. But I think the very brief discussion in this report is shy of making the case for Horse Creek that was made for the Lower Peace. The Lower Peace river report says the following " For some baseflow-dominated systems, for example, short, coastal rivers where discharge from spring vents accounts for much of the flow, use of a seasonal, building-block approach may not be necessary." In addition, association of blocks with specific flow-ranges, which typically, but not always correspond with seasonal periods,	Explain why the vertical block are appropriate under the condition cited in the Peace River report or make the general case that all rivers should use the horizontal block.	The Lower Peace river report and most other District MFL reports discuss the utility of flow blocks for minimum flow development, in particular for runoff-dominated systems. However, for the Lower Peace River, flows between the 75% and 50% exceedance flows were insufficient for representing the seasonal, medium flow, block 2 during the 2007-2014 simulation period used for minimum flow analyses. This occurred due to the preponderance of out-of-season flows during block 2 in the simulated years. As a result, for the first time, the District initiated the use of flow-based blocks rather than fixed-date (seasonal) blocks for minimum flow development. For this same reason, the District has decided to use flow-based blocks rather than fixed-date blocks for its current minimum flow analyses. To better clarify use of this approach for Horse Creek and Charlie Creek, the second paragraph in Section 5.2 of the MFLs report for each creek has been modified as follows: ***"To help reduce unintended negative impacts on biological communities in years where flows are not well-matched to the fixed start and end dates of the calendar-based blocks, flow-based blocks were recently introduced by the District for*** **runoff-dominated systems. Flow-based blocks were used for** ***the reevaluation of the Lower Peace River minimum flows and development of minimum flows for Lower Shell Creek (Ghile et al. 2021), as well as for development of proposed minimum flows for the Little Manatee River (Holzwart et al. 2023). "***	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
			may be appropriate for establishing minimum flows for some systems." The Peace River Report went on to show that seasonal block two was not corresponding with flows over the 75%. I agree with the statements from the Lower Peace River Report. The application of the horizontal flow blocks to the Horse Creek is probably very reasonable. However, I feel the report has not made the case directly for the change the same was the Lower Peace report did. Further I am not certain the Peace River Report made the case for all rivers. So citing the lower Peace report feels insufficient since in my quick review of the lower Peace report I did not find the statement that would generalize the use of horizontal flow blocks to Horse Creek. Since it is not a short coastal river with many spring vents accounting for much of the flow I assume it is supported under the second condition in the Peace report where the flow blocks do not always correspond with the seasonal period. Please note I like the horizontal blocking and think it is reasonable.			

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
40	AM	P. 12	The claim of adaptive management in MFL documents is routine in most Districts. Further, the District's commitment to continued monitoring, learning, and re-evaluation (adaption) is evident in its actions. The Horse Creek Report defines adaptive management as 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 (Herrick et al. 2019)." . The citation is from the Districts Homosassa river re-evaluation when it says exactly the same. This citation leaves the reader feeling the approach is better defined in the original source, though the original source is similarly vague (though both cite Williams). The District certainly does these things but I believe the documents would be improved by an expanded description.	The report would benefit from additional discussion.	Additional language was added to section 1.3.7. to explain how adaptive management will be applied to minimum flows for Charlie Creek.	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
41	AM	P. 27-28	I can see Figure 2-10 and 2-11 are similar and made at the same time. But the bar graph and the smoothed solid work because of the AMOs smoothness and the fact that you can always see the movement between the bars. But 2-12 the "Flow" obscures the "Nino". It's hardly critical but line graphs would better depict this and allow the reader to better approximate how well the correlate over time.	consider a line graph.	Converted to a line graph.	Yes
42	AM	P. 29 (Seasonal flows at the bottom)	Above you conclude that horizontal blocks should be used rather than seasonal…But here you conclude "The typical seasonal distribution of flows in Charlie Creek follows the seasonal pattern of rainfall in west-central Florida, with high flows occurring during a four-month wet season".	Just make that case for horizontal blocks or state clearly above why.	In general terms, the horizontal (i.e., flow-based) and vertical (i.e., seasonal or calendar-based) block methods both account for seasonal patterns of rainfall and flow distributions. However, the flow-based block method better accounts for out-of-season flows for minimum flows development and implementation, i.e., it better addresses sensitivity of flow-related environmental factors regardless of inter or intra-annual flow variation.	Yes
43	AM	P. 42	Since you note in a single sentence that both the Linear and Logistic regressions use R^2 to quantify variation and report the R^2s later you should probably note here in a single sentence that the R^2 for the Logistics was a generalized R^2 and was rescaled for interpretability so the reader does not wonder what was reported.	Add a little detail to the report here. Just a sentence or two.	The original paragraph that briefly described the use of R^2 values for linear and logistic regression analysis was removed and replaced with clarifying text.	Yes

Comment No.	Peer Reviewer	Location in Initial Report	Reviewer's Comments	Reviewer's Recommended Action	District Response	Panel Accept Response (Yes/No)
44	AM	P.79	The baseline reconstruction take the difference in monthly averages from the 0% and 50% pumping reduction runs from PRIM2 and double it. Makes since if you expect a linear response. A 25% reduction was run but is barely mentioned. Can the case be made that the reduction from 50-100% is expected to be the same as the reductions from 0-50%...Was the 0, 25, 50 linear?	Add some language explaining why this is reasonable.	A paragraph was added to the report. The streamflow response to pumping reductions of 0%, 25%, and 50% predicted with the PRIM model was linear. For Lower Peace River we created a linear regression using three points and generated daily flows for a zero-pumping scenario. For the Horse and Charlie Creek analyses, we decided to double the 50% pumping impact to avoid the uncertainty associated with regression equations developed from only 3 points.	Yes
45	AM	P. 121	This was interesting. What the District did is reasonable in trying to maximize the total R^2 in an attempt to pick the three best linear segments. An alternative to consider would be maximizing the minimum R^2. A Max-Min formulation (commonly used in multiple objective optimization) would assure that your worst fit was as good as possible rather than maximizing the total (perhaps to the detriment of one). It might be appropriate here to provide proportional protection to all blocks since you use this to for defining 3a and 3b.	Consider a max-min formulation in the future if not this time.	A min-max formulation will be considered for future MFLs.	Yes

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46	AM	P. 134-135	The inclusion of the sediment transport WRV is laudable and improves the argument that the MFLs is protective of the Sediment transport WRV. Please clean up the language a little to be certain that it is clear this is transport potential and has not been demonstrated to be actual transport.	Improve text.	Fixed per Panel's recommendations.	Yes

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47	AM	Appendix G	The extension of the water chemistry to include mixed effect models is commendable and demonstrates the Districts commitment to continuous improvements in it's analysis. I believe this is an excellent and explainable procedure for this application because independence can often not be satisfied in environment data but also because they are a good choice for unbalanced data sets. McElreath (2020) argues that '[…] multilevel regression deserves to be the default form of regression. Papers that do not use multilevel models should have to justify not using a multilevel approach' (p. 15). (McElreath, R. Statistical rethinking: a Bayesian course with example in R and Stan. In Chapman & Hall/CRC Texts in Statistical Science Series, xvii, CRC Press, Boca Raton, FL. P. 469 Google Scholar Link. That said there are allot of tools available for classification.	N/A	The District notes and appreciates your comment.	Yes

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48	AM	P. 136/Appendix G	When you preform classification the cutoff for an outcome is typically prescribed by the user. Most programs default to a .50 but that threshold seldom is the best choice. I do not have a suggested value for you but consider your confusion matrix and generate sensitivities and specificity at varying cutoff levels and pick one which make sense. Perhaps it is .5 but the choice should be discussed and not left as the software default. The .5 is a good choice if the two errors are cost symmetric...which they might be considered if cost are unknown.	Addition discussion would benefit the reader and perhaps future MFL reports.	The 0.5 probability threshold was selected based on its common use as a standard, its previous application for a similar analysis by Janicki Environmental, Inc. on water quality constituents in the Chassahowitzka River, and due to lack of rationale for an alternative threshold. A clarifying sentence was added to the text in section 6.5.9 to explain this.	Yes
49	AM	Appendix G	Please clarify why the chose of four three month treatments. According to the text there are three seasonal blocks of varying length. Using those dates or approximate months would be consistent with the seasons identified in the text. Further, since the flow seasons would more likely correlate to agriculture usage they might provide more insight than four 3-month blocks.	Expand discussion	The blocks referenced in the text refer to seasonal flow patterns, with highest flows occurring in mid-June through October and low to medium flow occurring during the remainder of the year. Flows are already considered in the GLMMs. The three-month divisions (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec) were intended to capture other seasonal changes that may impact water quality directly or indirectly, including things like changes in photic period and intensity, biological activity, and evapotranspiration rates that can occur during traditional quarters of the year. Precedent for including four 3-month blocks was established in the analysis performed by Janicki Environmental, Inc. on the Chassahowitzka River water quality analysis. The inclusion of additional parameters or changing the definition of "season" in this work may be considered in future work. A sentence clarifying the intent of the seasonal term was added to the appendix.	Yes

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50	AM	P. 91 & 103	The HEC-RAS model and the SEFA model are located in a relatively short segment of Charlie Creek between the two gages. Charlie Creek (main stem) is estimated to be approximately 42 miles long in the report and the modeled area is approximately a 16 mile segment. While the need for the up and down stream gage is clear the question of weather the segment is representative of the basin seems unanswered. Because, the MFL is set at the downstream gage it is protective of all the upstream waters. The question is if the protection is sufficient or if there are more sensitive habitats upstream. For most MFLs, the modeled lengths and habitat assessment models are more disperse within the system. The District has used the best available information, and the information is sufficient and all reaches are protected to the levels established by the downstream habitats. But the panel notes that not all habitats are necessarily represented.		As described in the District report and appendices, the Charlie Creek HEC-RAS model reach was delineated based on the need for upstream and downstream boundary conditions at long-term gaging stations. While the downstream gaging station at Gardner has been in operation since 1950, continuous data collection at the upstream station near Crewsville was first initiated in 2004, to support hydraulic model development for minimum flow purposes. Selection of the Crewsville site was presumably based on site accessibility, availability of sporadic historic, discrete flow and stage measurements at the site, and streamflow characteristics at the site. For SEFA analysis, even though it is almost always desirable to have more data at more sites, the habitats (shoals, pools and runs) studied at the 5 sites used in our analysis are sufficient for representing all habitats in the creek. Floodplain~~s~~ inundation is more sensitive to flow reductions in the lower segment where the creek is relatively incised and deep. Fish passad think it is reasonable. hed to the fixed start and end dates of the calendar-based blocks, flow-based blocks were ~~r~~ecently introduced by the District for runoff-dominated systems. Flow-based blocks were used for the reevaluation of the Lower Peace River minimum flows and development of minimum flows for Lower Shell Creek (Ghile et al. 2021), as well as for development of proposed minimum flows for the Little Manatee River (Holzwart et al. 2023).”th HEC-RAS and evaluated for various minimum flow analyses is sufficient and reasonably representative for development of minimum flow recommendations for the system upstream of the Gardner gaging station..	Yes

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51	JK	p. 78-81	PRIM2 daily flow correlations were comparatively weak (R^2 = 0.57) for Charlie Creek at Gardner. Monthly average values were used to determine the effects of groundwater pumping, then adjustments made to the daily flow record by multiplying the monthly average percent differences by 2. No discussion of what error this may induce in the baseline flow record.	Discuss the likely amount of uncertainty in the baseline flow adjustments, at least in generic terms. This is one of several sources of uncertainty in a chain of calculations and measurements used to establish MFLs in all Blocks with potential interest regarding Block 3A and 3B protections which each relied on a single metric (flood area inundation) aggregated spatially along the entire study area. In contrast, Blocks 1 and 2 were protected by a more layered assessment of multiple metrics examined at multiple positions in the study area with the most sensitive metric at the most-sensitive position used to	On page 87, sources of uncertainty associated with the PRIM2 model were added. For the floodplain inundation, B3c is introduced at 93rd percentile to provide more protection for upland floodplain habitats. In the future, floodplain analysis by wetland types and at multiple location will be considered.	Yes

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				establish the MFL. This 'bundle of sticks' approach is conceivably less sensitive to cumulative measurement and modeling errors versus use of an 'eggs-in-one-basket' assessment that is spatially-aggregated single-variable. Additional comments regarding how to address uncertainty in Blocks 3A and 3B are provided elsewhere in my review.		

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52	JK	Graphics	Flow blocks and other matters are often depicted over the daily median flow hydrograph for the period of record. And this kind of hydrograph is used to compare measured, baseline, and MFL flows.	Use of median daily values suppresses visualization of flow extremes in the record, and the range-of-variability drives some important functions. I suggest also including flow duration curves based on the full range of daily average flows in the record for this report, with the flow blocks and flow volumes used to establish each allowable reduction in the block (example attached for Charlie Creek under Worksheet 'Charlie Creek' on MS Excel file 'FDC-Horse&Charlie Creek JHK'). Also, for future MFLs consider developing an Appendix using SWIDS. Those are useful for examining the frequency reductions of threshold	A flow duration curve is used in Chapter 5, Section 5.2. In addition, a flow duration curve with recommended minimum flows for all blocks is added in Chapter Section 6.4. The District is aware of the use of wetland-based Surface Water Inundation Signatures (SWIDS) for minimum flows development within Florida and will continue to consider their potential utility for future minimum flow determinations.	Yes