District Response to the Crystal River/Kings Bay MFLs Peer Review

February 21, 2017

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MINIMUM FLOW PEER REVIEW PROCESS

In October, November, and December 2016, the Southwest Florida Water Management District convened a panel for the independent, scientific peer review of minimum flows proposed for the Crystal River/Kings Bay system. The peer review panel, i.e., the Panel, consisted of a Chairperson, Steve Peene with Applied Technology & Management Inc., Panelist Ken Watson, with HSW Engineering Inc., and Panelist Adam Munson, a sub-contractor with Jones, Edmunds & Associates, Inc.

To support the Panel's review, District staff provided initial verbal and written responses to numerous Panel inquiries concerning the proposed minimum flows and their development. Most of these responses were incorporated into summary tables included as appendices to the Panel's final report titled, "Crystal River/Kings Bay Minimum Flow and Level Peer Review", that was submitted to the District on December 12, 2016. In some instances, the summary tables included in the Panel's final report contain Panelist references to staff's initial responses.

The Panel's final report has been posted on the District web site, made available upon request to interested parties, and will be provided to members of the District Governing Board. As directed by Section 373.042 of the Florida Statutes, the Governing Board is to give significant weight to the peer review Panel's final report when establishing minimum flows for the river system.

Staff has reviewed the Panel's final report and developed this document to summarize staff responses to Panel comments. The Panel's final report is reproduced here and amended with staff responses that are highlighted in blue. These responses are provided as replies to previously unanswered Panelist questions or comments and to describe activities that have been or will be undertaken in response to the Panelist's review and input. Yellow highlighting is used judiciously in this document to emphasize key points included in the Panel's final report and identify text from the Panel's report that is relevant to specific District responses. This District response document will be made available to all interested parties, including the District Governing Board.

CRYSTAL RIVER/KINGS BAY
MINIMUM FLOW AND LEVEL
PEER REVIEW

TWA NOS: 16TW0000363, 16TW0000364, AND 16TW0000411

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

DECEMBER 2016

Attachments

EXECUTIVE SUMMARY OF PEER REVIEW

The Southwest Florida Water Management District (District) contracted with an independent panel of experts to provide a technical peer review of the proposed Minimum Flows and Levels (MFL) for the Crystal River/Kings Bay Springs system. The Kings Bay/Crystal River system is located in Citrus County on Florida's Springs Coast. The system consists of Kings Bay, an approximately 600-acre estuarine embayment fed by more than 70 spring vents that discharge fresh to slightly saline water. From Kings Bay, the system flows out approximately 6 miles to the Gulf of Mexico through Crystal River. The system is tidally influenced throughout its extent.

Two critical components of the MFL analyses are: a hydrodynamic model developed by the District used to evaluate the changes in salinity and temperature under varied inflow conditions; and a methodology to calculate the submarine groundwater discharge (SGD) to the system. The SGD calculations constitute the long-term flows utilized as the basis for the MFL development. The U.S. Geological Survey (USGS) flow measurements on the system at Bagley Cove were deemed unreliable by the District.

The proposed MFL for the Kings Bay Crystal River system is based primarily on having less than a 15 percent change in salinity habitat (volume, shoreline length, and bottom area), with the key metric being a 15 percent change in the volume of water under 2 parts-per-thousand (ppt) salinity. Other metrics directly assessed included the volume of thermal manatee habitat, residence time, and some components of water quality. The flow reduction defined for the MFL was determined to be protective of these other components.

Overall, the Peer Review Panel supports the conclusions presented within the MFL report and the use of the salinity habitat as the primary metric. A key component of the MFL analyses, the hydrodynamic model, was generally found to be sufficiently developed and calibrated for use in evaluating the changes in the temperature and salinity as a function of SGD. Additionally, the methodology utilized for the calculating the SGD, while containing some degree of uncertainty and potential errors, represents the best available information for use in estimating the present and historical flows from the spring vents.

The Peer Review Panel did identify key comments/recommendations to improve the MFL report, supporting documentation, and associated analyses. The full document provides detailed comments and recommendations including grammatical edits. A summary of some of the key recommendations are listed below;

- The calculation and validation of the historical and present flows from the spring vents remain an issue for this system. The District has determined that the Bagley Cove data, collected by USGS, is not reliable. The SGD methodology developed by the District also has a level of uncertainty, and ancillary calculations of long-term flow using alternate methodologies do not fully support either the USGS or District calculations. The District needs to do a better job of identifying the uncertainty in both methods of flow determination and the limitations this creates.

Staff Response: Staff have analyzed USGS-reported Bagley Cove data and compared it with SGD estimated by the District with an empirical formula. As described in Chen (2014), the hydrodynamic model used for our minimum flow analyses was tested using reported Bagley Cove discharge as total SGD to the system. The results of this modeling effort showed poor agreement between model-predicted and measured salinities. This is because reported discharge for the Bagley Cove gage includes signals from wind action, storm surges, storages in Kings Bay, and interactions of these and other factors. These influences can be seen in the frequent negative daily and monthly mean values reported for the Bagley Cove site. Negative monthly discharge is clearly not indicative of spring flow into this system.

Given that Bagley Cove discharge record yields poor predictive capacity when used as input to the hydrodynamic model and includes negative daily and monthly means throughout the 2002 to 2016 period of record, the empirical-formula-derived SGD represents the best information available for estimating spring discharge to this system. Staff will emphasize this point in a revised version of the minimum flow report and will characterize the reported Bagley Cove discharge record as less suitable than the estimated SGD record for our minimum flow analyses, rather than “unreliable.” Staff notes that error in hydrodynamic model output is quantified on page 41 of the draft minimum flow report, where skill parameter and R^2 values are given for agreement between simulated output and measured data during the verification period of April 2007 to February 2010. Staff will expand upon discussion of these issues in the revised minimum flow report. We will also emphasize that

reevaluation efforts will focus on new data collection sites and approaches for better estimation of spring flow.

- The salinity habitat change analyses relied upon a system-wide assessment of change. The District should consider if any habitats aggregated into the volume, area and length categories should be further parsed. One recommendation is to consider the difference between sloped and sediment and vegetated shoreline and hardened vertical shoreline (i.e., seawall). The District should assess (for all habitats) if this type of parsing makes sense and would strengthen the MFL conclusions.

Staff Response: District staff agree, and are developing data for analysis of shoreline salinity based habitat changes that can be used to distinguish between vegetative, altered, and natural shoreline. This analyses may be completed for consideration in the minimum flow adoption process scheduled for completion by July 1, 2017 in accordance with Section 373.042(2)(a) of the Florida Statutes, or may be incorporated into the planned reevaluation of the minimum flow that is established for the system

- While the hydrodynamic model was deemed sufficient for use in determining the changes in salinity and temperature habitat as of function of SGD, there were some issues identified within the review that should be resolved before final submission of the MFL report and supporting documentation. Some specific issues include: evaluation of the sensitivity of the offshore boundary to changes in flows (initial results of this have been provided to the Peer Review Panel); removal of periods of the model runs from the calibration statistics where boundary data are not available; and more complete documentation of the volume of additional flow added into the model to account for seepage and as a tuning parameter for the model calibration.

Staff Response: District staff agree, and are working to address and implement the Panel's recommended changes and comments. Regarding boundary conditions, newly-run model scenarios indicate that a minor increase in salinity at the downstream boundary due to reduced flow has minimal, non-significant effects on model predictions used for the minimum flow analyses. This information will be included in the updated minimum flow report as will Panel suggested improvements concerning presentation of model calibration statistics and documentation of model-tuning or parameterization associated with seepage estimates.

A component of the Peer Review Panel scope of work was to provide an assessment of the MFL report and supporting documentation against specific listed criteria. These are outlined in Section 3 of the report. The findings of the Peer Review Panel are that, with the implementation of some of the edits/recommendations made within this report, there are no fatal flaws within the MFL report and supporting documentation relative to the specified criteria.

Staff Response: We are pleased that the Panel found “no fatal flaws”, indicating that the issues, comments, questions and concerns they identified may be addressed by the District to improve the minimum flows report, but are not considered necessary. As appropriate and indicated in this summary response document, suggested edits and other recommendations made by the Panel will be incorporated into future drafts of the minimum flows report. In addition, Panel recommendations will guide future assessments associated with the reevaluation of minimum flows that are expected to be adopted for the system in 2017.

1.0 INTRODUCTION

1.1 BACKGROUND AND SYSTEM DESCRIPTION

The Southwest Florida Water Management District (District) contracted with an independent panel of experts to provide a technical peer review of the proposed Minimum Flows and Levels (MFL) for the Crystal River/Kings Bay Springs system. The peer review panel includes:

- Dr. Steven Peene (panel chair)
- Dr. Ken Watson
- Dr. Adam Munson

The Kings Bay/Crystal River system is located in Citrus County on Florida's Springs Coast. The system consists of Kings Bay, an approximately 600-acre estuarine embayment fed by more than 70 spring vents that discharge fresh to slightly saline water. From Kings Bay, the system flows out approximately 6 miles to the Gulf of Mexico through Crystal River. Figure 1-1, taken from the MFL Report (SWFWMD, 2016), shows the layout of Kings Bay and Crystal River along with the locations of the numerous spring vents to the system. Based upon historic studies, the District has identified that the spring vents provide more than 99 percent of the freshwater entering the system in Kings Bay. Crystal River connects to the Gulf of Mexico at two locations: near Shell Island and through the Salt River (Figure 1-1).

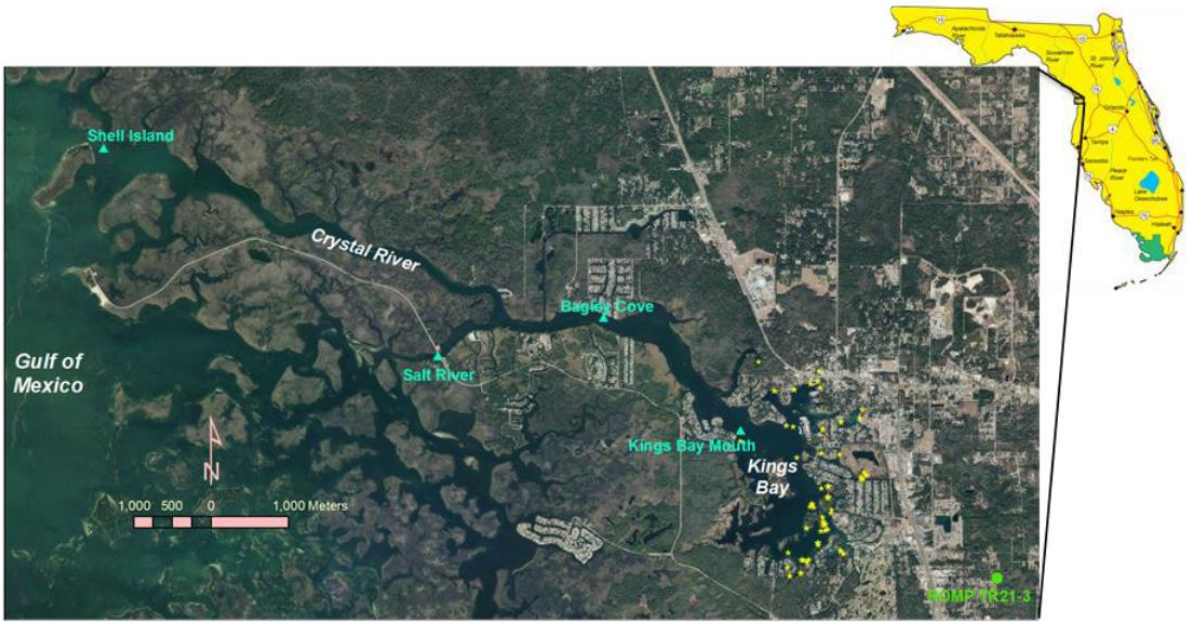

Figure 1-1. Location and Layout of Crystal River/Kings Bay System (SWFWMD, 2016)

The discharge from the spring vents derives from groundwater within the system's springshed. The Crystal River/Kings Bay springshed spans approximately 310 square miles in northern Citrus County (Figure 1-2).

Flow measurements within the system have consisted of long-term monitoring at Bagley Cove (see Figure 1-1) by the U.S. Geologic Survey (USGS) and more recent data the District collected on direct flows from the spring vents. USGS flow measurement techniques have been modified throughout their period of record and, as identified by discussions with USGS staff, changes are ongoing. Additional data collection has included water level and salinity measurements at Shell Island, Salt River, Bagley Cove, and the Kings Bay Mouth, along with groundwater levels at three wells located near Kings Bay (Figure 1-1).

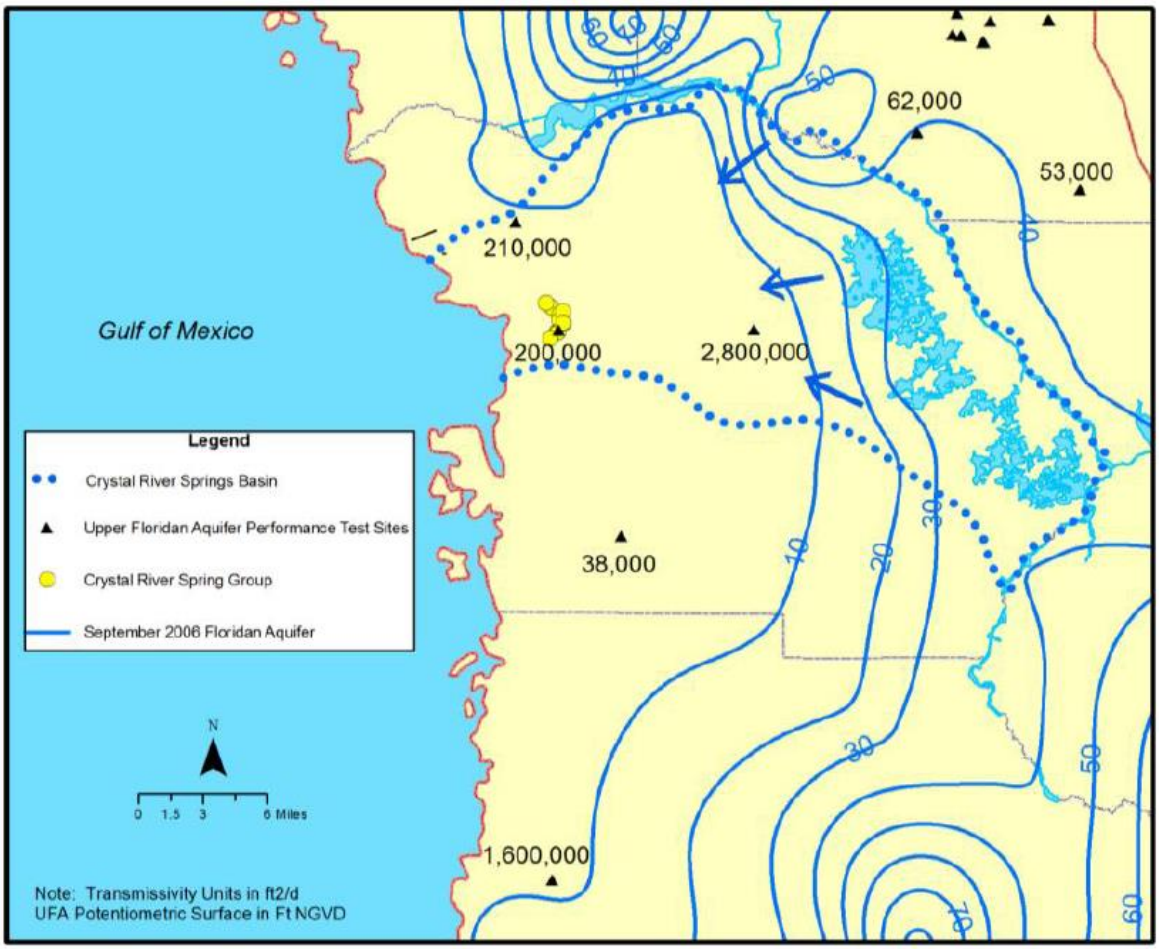

Figure 1-2. Extent of the Crystal River/Kings Bay Springshed (SWFWMD, 2016)

The accurate determination of the long-term total flow record is a critical component of the MFL development and is discussed in detail in the MFL report and supporting documentation. Discussions center on the use of the data from the USGS station at Bagley Cove (raw and tidally filtered) versus empirically derived direct flows from the spring vents based upon direct vent measurements and water levels in Crystal River and a nearby monitoring well.

A key component of the MFL development was a hydrodynamic model of the system that was utilized to assess the impacts of flow reductions from the spring vents on salinity and thermal habitat. The development, calibration, and application of the hydrodynamic model is discussed in detail in the MFL report and supporting documentation. The assessment of the development, calibration and application of the hydrodynamic model is a primary focus of the peer review.

The Florida Department of Environmental Protection (FDEP) has designated the Crystal River/Kings Bay system as a Class III surface water body, an Outstanding Florida Water (OFW), and a Surface Water Improvement and Management (SWIM) Priority Water Body. The Crystal River Springs group is also classified as an Outstanding Florida Spring. Key environmental resources in the area that were specifically targeted for protection in this MFL include submerged aquatic vegetation (SAV) as well as manatee thermal habitat. The MFL also examined water quality conditions in the system and the impacts of flow reductions on residence times.

The final MFL presented within the report was based on allowance of a 15 percent reduction in the volume of salinity habitat for the most sensitive salinity isohaline [2 parts per thousand (ppt)] using the hydrodynamic model. Based on the 15 percent habitat reduction, an allowable flow reduction of 12 percent was identified. Current water withdrawals are at or less than 2 percent of the baseline flow condition. Based on the comparison of the current withdrawals with the allowable, the MFL document concluded that no recovery strategy was needed.

1.2 REGULATORY BASIS FOR MFL AND PEER REVIEW

Florida Statutes (F.S.) mandate that the District must establish MFLs for state surface waters and aquifers within its boundaries for the purpose of protecting the water resources

and the ecology of the area from “significant harm.” Section 373.042, F.S., provides that the minimum flow for a given watercourse is the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area and the minimum water level is the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources or ecology of the area.

Section 373.042, F.S., also provides that MFLs shall be calculated using the best information available, that the Governing Board shall consider and may provide for non-consumptive uses in the establishment of MFLs and, when appropriate, MFLs may be calculated to reflect seasonal variation. The law also requires that when establishing MFLs, changes and structural alterations to watersheds, surface waters, and aquifers shall also be considered (Section 373.0421, F.S.). The State Water Resource Implementation Rules (Chapter 62-40, Florida Administrative Code) includes additional guidance for establishing 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:

a) Recreation, in and on the water;
b) Fish and wildlife habitats and the passage of fish;
c) Estuarine resources;
d) Transfer of detrital material;
e) Maintenance of freshwater storage and supply;
f) Aesthetic and scenic attributes;
g) Filtration and absorption of nutrients and other pollutants;
h) Sediment loads;
i) Water quality; and
j) Navigation.”

Section 373.042, F.S., also addresses independent scientific peer review of MFLs, specifying the review of all scientific or technical data, methodologies, and models, including all scientific and technical assumptions employed in each model, used to establish a minimum flow or minimum water level. In addition, the law requires that FDEP or the District Governing Board shall give significant weight to the final peer review panel report when establishing MFLs.

1.3 DOCUMENTS AND DATA UTILIZED IN THE PEER REVIEW

The following documents and data were provided to the panel members to be utilized in the peer review.

- Recommended Minimum Flow for the Crystal River/Kings Bay System – Draft Report for Peer Review (SWFWMD, 2016a)
- Chapter 6 – Appendices: Recommended Minimum Flow for the Crystal River/Kings Bay System – Draft Report for Peer Review (SWFWMD, 2016b)
- Estimate of Submarine Groundwater Discharge to Crystal River/Kings Bay in Florida with the Help of a Hydrodynamic Model (Chen, 2014)
- On the Estimation of Submarine Groundwater Discharge to Kings Bay (Chen, 2014)
- SWFWMD Presentation – King's Bay – Simulated Spring Flow History
- Northern District Groundwater Flow Model, Version 5.0 (SWFWMD, 2016c)
- Peer Review of the Northern District Model Version 5 and Predictive Simulations, October 10, 2016, Final Report (SWFWMD, 2016d)
- Comparison of Bagley Cove Qs (graphs developed by Dr. Chen of SWFWMD)
- Excel data files from Dr. Chen of Bagley Cove, Salt River, Kings Bay Mouth, and Shell Island measured flows, levels, temperature and conductivity.

1.4 PEER REVIEW PANEL SCOPE AND APPROACH

The Peer Review Panel was scoped to complete the following tasks as part of the MFL Peer Review:

- Review draft of the Crystal River/Kings Bay MFL Report along with available supporting documentation and data
- Participate in Public Meetings including:
    - Kickoff Meeting and Site Visit (November 4, 2016)
    - Web-Meetings (November 15,16, and 21, and December 5, 2016)
- Post written review comments and collaborate with other panelists to develop a single peer review panel report
- Review and provide support in development of meeting agendas and meeting summaries

Following the process outlined in the scope above, the following sections present the results, comments, and recommendations of the Peer Review Panel.

Section 2 of this report utilizes a tabular template (completed by each of the three peer reviewers) to meet the District's peer review requirements. The tabular comments are presented for each section of the MFL report, as well as key supporting documentation within the appendices. Narrative comments on various key aspects of the MFL report and supporting documentation, precedes the tabularized comments. The tabularized comments include the specific comment, whether the comment has significant impact on the conclusions of the MFL, and recommendations on how to address the comment.

Section 3 presents tabularized results of the panel member's comments concerning the District's peer review assessment criteria, which are outlined in Attachment A of this report. These criteria were specific scoped sub-tasks outlined by the District for the panel members to address.

Section 4 presents referenced literature.

2.0 REVIEW OF MFL REPORT, APPENDICES, AND EXTERNAL REPORTS

The following sections provide detailed review and comments on the MFL report and supporting documentation provided by the District for use by the Peer Review Panel. Section 2.1 presents the review of the MFL Report. Section 2.2 presents the review of the appendices and supporting documentation. A narrative review is provided relative to key aspects of the MFL development as identified by the review panel. Following the narrative comments, tables are provided for each Chapter of the report and for the supporting documentation with detailed comments, identifying if the comment is significant (i.e., impacts the MFL determination), and proposed action items to address the comments.

2.1 MFL REPORT

Specific components of the MFL report and supporting documentation were identified by the peer review panel as critical in the MFL development. These were identified for specific review and discussion. These included;

- Determination of the Submarine Groundwater Discharge
- Development, Calibration and Application of the Hydrodynamic Model

The following presents the reviewers discussion of these items. Following the narrative discussion, tables are provided with detailed comments from each of the reviewers along with the significance of the comment and recommendations for resolution.

Determination of Submarine Groundwater Discharge

Discharge measurements at USGS gage 02310750 Crystal River Near Crystal River FL (1964 to 1977) were determined to be unreliable and were not used in the MFL study. Average flow during that period was estimated to be 971 cfs. A new gage was activated in 2002 (USGS gage 02310747 Crystal River at Bagley Cove) and tidally adjusted average flow between 2002 and 2015 was calculated to be 447 cfs. This value is the result of adjustments made to the rating curves in 2011. The District concluded for the MFL that the Bagley Cove record, including the most recent adjustments, was unreliable for this MFL work. Discussions with USGS personnel identified that USGS has recently installed new instrumentation at Bagley Cove to obtain more complete data at the cross-section. In the future, a revised rating curve will be developed using the new data and new flow projections can be evaluated.

The District estimated an average flow of 374 cfs for the period of 1969 to 2015 using direct field flow measurements at select spring vents and at two channels which contain the input from multiple spring vents. The channel measurements were taken during July-August 2009. At this same time, water level measurements were collected at the mouth of Crystal river and in groundwater wells adjacent to Kings Bay. The District developed relationships between the water level measurements at the mouth, the water level in the wells and the measured flow at the channels. The relationships developed reflected approximately 60 percent of the flow coming into the system. The relationships were then extrapolated to the other vents to calculate the remaining 40 percent of flow. The flows were then checked using the hydrodynamic model to assure salinity predictions were reasonable and from those simulations a remaining approximately 10% additional flow was added to the system to account for seepage.

Staff Response: For clarification, the formula to predict submarine groundwater discharge relied on data from the mouth of Kings Bay at United States Geological Survey (USGS) gage #02310742. The Panel's report incorrectly notes that these data were collected at the "mouth of Crystal river" rather than the mouth of Kings Bay.

Based on the above, the MFL flow record and various metrics for developing the MFL are based on empirically derived results without verification against a complete gaged flow record, and the independent drivers are tidal stage, water temperature, and salinity; groundwater elevation at a tidally influenced well; and salinity assigned to spring flow.

The USGS results were defined as unreliable in the MFL document, but discussions with USGS personnel identified that USGS does not believe the data, following the 2011 corrections, and if averaged over a sufficient period, are unreliable. Additionally, the predictions from the Northern District Groundwater Model are closer to the long-term average from the USGS gage (450 cfs versus 447 cfs). Also, the USGS flow at Bagley Cove for the model time period (2006 to 2015) was about 354 cfs and the District estimated springs discharge was 332 cfs, or about a 6% less but reasonably similar.

Staff Response: In the original minimum flows report, the District stated that discharge estimates based on data collected at the USGS Bagley Cove gage (#02310747) are not reliable estimates of groundwater discharge for use in minimum flow analyses. Future drafts will clarify that the discharge reported for this gage is not objectively 'unreliable', as it is not the intent of the District to criticize the discharge reported by the USGS. However, we found reported discharge from this gage was inappropriate as an estimate of submarine groundwater discharge for our minimum flow analyses for two reasons: 1) Long-term negative values exist in reported daily and monthly averages, 2) discharge, when used as an input to the hydrodynamic model in a trial run, produced inferior model-verification results relative to those derived from model runs involving discharge estimates from the District-generated formula for estimating submarine groundwater discharge. The District was therefore able to make better predictions using the alternative estimates of submarine groundwater discharge described in the minimum flow report.

Looking at how the differences impact the MFL development, if the MFL results are used to estimate available water (i.e., 12% of say 374 cfs), then the result is conservative compared

to using the USGS estimated flow. However, if the MFL result is viewed as a flow (i.e., 88% of 374 cfs), then it is not conservative.

Staff Response: The recommended minimum flow is expressed as percent-of-flow, not as a specific flow value, and is thus conservative, as indicated in the first scenario described above by the Panel.

As there is a level of uncertainty with both the USGS gaged flow and the SWFWMD empirically derived flow, the MFL must note the uncertainty in both, recognize that the impact evaluation is a relative one, i.e., based on percent reductions, and identify that future efforts must be focused on verifying what the total flow into the system is.

Staff Response: Staff will further clarify the uncertainty in reported discharge at the Bagley Cove gage and estimated submarine groundwater discharge derived using the District empirical formula.

Hydrodynamic Model Development, Calibration and Application

A 3-dimensional hydrodynamic model was applied to the Crystal River/King's Bay system to simulate time dependent water levels, currents, salinity and temperature throughout the system. The model utilized is called UnLESS3D. This is an unstructured Cartesian grid model. Within the MFL Report Appendices a report entitled "An Evaluation of Effects of Flow Reduction on Salinity and Thermal Habitats and Transport Time Scales in Crystal River/Kings Bay" was provided. The report included write ups on the UnLESS3D model equations, the physical characteristics of the Crystal River/Kings Bay system and the available field data, the hydrodynamic model calibration and verification, the model scenarios for the flow reduction, and simulations based upon the sea level rise.

The hydrodynamic model boundary inputs include; tides, temperature and salinity at two boundaries (Salt River at the bridge and at the mouth of Crystal River where it meets the Gulf of Mexico); groundwater discharge, temperature and salinity at multiple vent locations along the eastern and southern ends of Kings Bay; and atmospheric forcing at the water surface. The data for the tidal boundaries came from measured data at the two locations. The groundwater discharge came from empirically derived submarine groundwater discharge (SGD) (see previous discussion) and the temperatures and salinities associated

with these inflows came from available measured data. As the modeled groundwater discharge includes inputs of water surface elevation at the mouth, this value is a dynamic parameter that is calculated for each model time step using the model equations. The atmospheric inputs came from measurements at a nearby meteorologic station.

The model was calibrated to data collected at two interior stations. The first station is at Bagley Cove. The Bagley Cove station is approximately two-thirds of the way up Crystal River between the mouth at the gulf and the entrance to Kings Bay. At the Bagley Cove station, continuous water level, salinity, discharge, and temperature data were available for the calibration. The salinity and temperature data at this station were from the bottom. The second station was located at the mouth of Kings Bay. This station had continuous water level, salinity and temperature data. The salinity and temperature data were at the bottom and surface. The total simulation period was a 34-month period (1037 days), from April 24, 2007 to February 23, 2010. The model was calibrated against real-time data of water level, salinity and temperature for a 150-day period during December 28, 2007 – May 26, 2008 after a spin-up run for 25 days. It was then verified for the remaining days before and after the 150-day calibration period.

Comparisons of the modeled and measured data are presented in the report along with statistics including the R^2 (correlation coefficient), the mean error, the mean absolute error, and the skill assessment. The following bullets discuss the evaluation of the calibration.

- Water Level: The graphical comparisons as well as the various statistical analyses are within acceptable ranges of error for the water level. Generally, the statistics show better than normal results.
- Salinity: The statistical analyses show that the calculated statistics of the errors are within acceptable ranges. The graphical plots show that the model generally captures the temporal and spatial changes in salinity in the system, indicating that the behavior of the salinity under varying tidal and flow conditions is reasonable.
- Temperature: The statistical analyses show that the calculated statistics of the errors are within acceptable ranges and generally better than usual. The graphical plots show that the model generally captures the temporal and spatial changes in temperature in the system, indicating that the behavior of the temperature under varying tidal and flow conditions is reasonable. One comment is that the model

results presented in the report should focus on the critical winter period so that the reader can see how the model performs graphically during this time.

Staff Response: Staff will include graphical presentation of these results in the revised minimum flow report.

- Cross-Sectional Flux: The comparisons of the simulated and measured cross-sectional flux shows that the model consistently under predicts the maximum flows passing at Bagley Cove. These maximums as seen in the data are generally short lived. Similar statistical analyses performed on the other data should be performed on the discharge data.

Examination of some of the results in the appendices identified that there are periods of time where the model boundary conditions were not available. During these periods the model was simply run through the two points (start and end of missing data) and used linear interpolation between as it ran. While most likely this is not causing significant issues with the model predictions outside of these periods and some period after, this is highly unusual and it is recommended that these periods be filled in as best as possible with reasonable forcing data, or these periods be taken out of the calibration/verification periods.

The hydrodynamic model was applied from October 6, 2006 through October 13, 2015 for the scenario analyses. This is a 9-year period where measured data were available for the forcing functions. The flow reductions were then applied through this period. One issue identified is that the boundary conditions at the mouth of Crystal River and at Salt River Bridge are not altered under the flow reductions. Examination of the salinity time series at these locations does show that they are influenced by the freshwater flow coming out of the system, i.e., they are close enough to shore to be impacted by the flows. A sensitivity analysis should be performed to determine the degree to which these boundaries are expected to increase in salinity overall as a result of the flow reductions. If the differences are significant, the model scenarios should be re-run with the increased downstream boundary salinities.

The hydrodynamic model has been applied to determine the change in volume, bottom area, and shoreline length associated with different salinity ranges, when modeled flows are

reduced. The criteria applied is a 15% reduction in the volume, area, or shoreline length of any one of the modeled salinity ranges. While it would be preferable to link changes in flow directly to changes in ecology, the difficulty of measuring or expressing this causality is well established and the use of habitat as a more easily measured proxy is reasonable. However, it is desirable to delineate habitat when reasonable since not all habitat offers equal ecologic benefit. This is consistent with the district historical mapping of wetland communities and substrate mapping used in riverine systems in conjunction with HEC-RAS and PHABSIM models. The challenges of the estuarine systems are different and the District has documented the difficulty with identify some community-specific thresholds in its discussion of SAV. However, the District should consider if any habitats aggregated into the volume, area and length categories should be further parsed. One recommendation is to consider the difference between sloped and sediment and vegetated shoreline and hardened vertical shoreline (i.e., seawall). While this may not alter the recommended MFL on Crystal River, it is suggested that, in other applications, there might exist unique or critical habitats that decline over 15% if they are aggregated into the broader categories of volume length and area.

The following tables present detailed comments by chapter and appendices and supporting documentation.

Table 2-1. Review of Executive Summary

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
1	SP	Paragraph 5	No – Because the data seem to not exist but could potentially be considered during re-evaluation.	The report states "These models allowed evaluation of salinity-based habitats, manatee thermal refuge, and residence time as potential indicators of significant harm. Each of these three factors are related to the 10 environmental values put forth in the State Water Resource Implementation Rule. Particular importance was placed on the effect of salinity on promoting submerged aquatic vegetation and reducing algal blooms to promote water clarity.". While the salinity intrusion and the thermal refuge were evaluated fully relative to the MFL development, the residence time and any potential impacts on the system water quality and algal blooms were not fully evaluated in relation to the MFL. This section should be reworded to reflect this.	At this time, based on discussions with District staff, it appears that data are not available to fully quantify the relationship between decreased residence time and specific water quality parameters impacted by residence time (i.e., Chl a). Based on this, the recommendation is that the District acknowledge in the MFL report that a full evaluation of the potential impacts on water quality are not feasible at this time and recommend that future work focus on attempting to quantify the impacts through additional data collection. Staff Response: Future drafts of the minimum flow report will acknowledge that water quality analysis for various parameters, including nutrient and chlorophyll a concentrations are not currently suitable for use in the development of criteria for setting the

Table 2-1. Review of Executive Summary					
Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					minimum flow, and will recommend that future work focus on data collection and analysis of water quality parameters. Water quality analyses performed for the recommended minimum flow were inconclusive with respect to relationships between chlorophyll a and flow. Similarly, there are no data analyses showing clear quantitative links between residence time and chlorophyll (algal blooms) in this system. However, the analysis in Table 3.5 shows that residence time will increase by 11% with a 12% decrease from baseline flow, which indicates that it is less sensitive than salinity. Previous analyses did not support direct linkage between discharge and chlorophyll a. However, there are known links between salinity and chlorophyll a in many lotic systems which support using salinity as a criterion for MFL development or assessment. Staff are continuing to

Table 2-1. Review of Executive Summary

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					assess water quality linkages to flow into and within the system and expect to complete a more thorough assessment of potential flow-related water quality as part of the planned minimum flow reevaluation.
2	SP	Paragraph 6	No	The report states "In addition to model outputs, we also investigated water quality measurements related to the recent Total Maximum Daily Loads established by the Florida Department of Environmental Protection. Our analysis found no consistent relationship between spring flow and water quality measurements for nitrogen, phosphorus, or dissolved oxygen. As such, these water quality measures were not considered as criteria for setting the minimum flow for this system." Chl a and/or other nuisance macro-algal species were not assessed and these are key parameters that may be impacted by the residence time changes.	See resolution recommended for Comment 1. Staff Response: See our response for Comment 1.

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				This will be outlined in more detailed comments in the specific chapters.	
3	KW	Executive Summary Page v	No	The sufficiency of manatee thermal habit as expressed may be arguable.	Reconsider how thermal habitat is evaluated. Staff Response: As discussed in Sections 3.2 and 4.3 of the draft minimum flow report, thermally-favorable habitat sufficient for the known population of manatees would exist in the Crystal River/Kings Bay system at even the highest flow reduction scenario (i.e., a 30% flow reduction) that we modeled. Given this finding, we believe that it is accurate to indicate that habitat sufficient for meeting manatee thermal requirements during cold periods should be available if the minimum flow requirement that natural flow not be reduced by more than 12% is met.
4	KW	Executive Summary Page v	No	Define the baseline time period.	Explicitly define. Staff Response: The baseline period is from October 6, 2006 to October 13,

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					2015. It is mentioned on Page 31 of the hydrodynamic model report (one of the appendixes). We add that in the referenced use of "baseline" in the executive summary of the draft minimum flow report is included to describe natural flow, i.e., flows expected in the absence of withdrawals, associated with the proposed minimum flow, that are associated with proposed minimum flow.

Table 2-2. Review of Chapter 1 – Introduction: Purpose and Background of MFL

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5	SP	Page 13, first paragraph	No	In the first sentence after the parenthesis, need to bring line back up.	Correct in report. Staff Response: This formatting error will be corrected in future drafts of the report.
6	SP	Page 14, Section 1.4.3, first paragraph	No	The text states "Starting in August 2002, tide-corrected flows have been continuously recorded in the river by the USGS at the Crystal River at Bagley Cove near Crystal River, FL gage #02310747". A more accurate description of the measured flows would be that USGS utilized their Index Velocity Method to calculate flows and reference the USGS publication on index velocity. Additionally, it may be appropriate to further elaborate on the potential errors in the previous flow measurements (prior to 2002).	Reword. Staff Response: Section 1.4.3 will be revised in future draft reports to indicate the U.S. Geological Survey estimates discharge at the Bagley Cove site using an index velocity approach and a reference to the most recent USGS Water Data Report for the site will be included. Staff notes that the second paragraph of Section 1.4.3 addresses potential errors associated with historic discharge estimates made at the downstream "Near Crystal River" site, citing the Yobbi (2014) report which include additional information on the potential errors and is included as an appendix to the minimum flow report.

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7	SP	Page 15, Section 1.4.3, 3rd paragraph	No	The document states “Based on the information described here, we concluded that discharge estimates based on the historic flow record for the Crystal River near Crystal River gage (#02310750), and the currently reported flows at the Crystal River at Bagley Cove gage #02310747 include a mixture of groundwater, stormwater runoff, and marine water, and are not reliable estimates of groundwater discharge from the Crystal River spring group for use in minimum flow analyses.” This is an overstatement on the issues with the USGS data. There is uncertainty with both the USGS and SWFWMD data. There is also evidence showing at times where each appears to agree with other analyses. The report should not discount the USGS data outright, but should acknowledge the uncertainty in both, state why, at this time, the SWFWMD data were used, and identify the need for more comprehensive verification of the actual flow.	Reword. Staff Response: The referenced sentence from Section 1.4.3 of the minimum flows report will be revised to note that staff do not consider the discharge reported by the U.S. Geological Survey “unreliable.” We will instead note that when used as input to the hydrodynamic model, these data yielded poorer model-verification results relative to those from model runs involving discharge values derived with the District-generated formula for estimating submarine groundwater discharge (SGD). The section text will also be revised to note that the SGD estimates, which are described in Sections 2-1 and 2-2, were used in the modeling described in Section 2-3. Additional text will also be included to highlight the ongoing methodological advancements concerning discharge measurement at the Bagley Cove gage site (i.e., the installation of new equipment for measuring channel velocities) and the recent and ongoing installation of two new sites for measuring flows in the bay, at the Saragassa Canal and Hunters Cove.
8	SP	Page 19, Figure 1-13	No	Need to identify the time scale (averaging) of these data, i.e., is this a plot of the annual averages or some type of running average. Given the tidal	Reword graph figure, title, or identify in text.

Table 2-2. Review of Chapter 1 – Introduction: Purpose and Background of MFL

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				signal identified in the later measurements, I assume these plots must be some form of averaged data.	Staff Response: The graphic caption will be reworded to indicate that these are monthly-averaged water levels.
9	SP	Page 25, Section 1.4.7.2, second to last paragraph	No	The text states "although 566 animals were observed in Kings Bay on a the extremely cold day of January 13, 2010 (Kleen 2014)." Grammatical fix.	Delete the "a." Staff Response: This has been fixed in the draft report.
10	SP	Page 32, Table 1-6	No	The table lists the water quality criteria for the system. While mentioned in the paragraphs above, the chl *a* criteria are not listed in the table. Also, the table needs to include the applicable criteria for Crystal River (1341I) including the Chl *a* criteria. Additionally, some of these criteria have time scales (i.e., annual mean, annual geometric mean) associated with them that need to be properly identified.	Include the appropriate time scales in the criteria table. Staff Response: The criteria table will be modified as suggested.

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11	SP	Page 35, Table 1-7	No	For the Recreation in and on the Water in the table, only protection of salinity habitats is identified. As manatee are a part of the recreational value of the system, manatee thermal refuge should be listed here also.	Reword. Staff Response: Table 1-7 in the report has been modified accordingly.
12	SP	Page 35, Table 1-7	No	Salinity habitats are identified for navigation. As this is a tidal system and water levels are dominated by tides rather than freshwater inflow, is this Use applicable to this system relative to freshwater withdrawal.	Potentially reword. Staff Response: Hydrilla beds were a hindrance to navigation in the past. Hydrilla are sensitive to salinity. This is explained in Section 1.7.10.
13	SP	Page 35, Section 1.7.1, first paragraph	No	As in the previous comment on Table 1-7, as manatee are part of recreation (as identified in the paragraph) the thermal analyses apply here.	Reword. Staff Response: District staff agree and will make appropriate changes to the report.
14	SP	Page 36, Section 1.7.4	No	After the second sentence, there appears to be text "*However, managing*." That should be deleted.	Delete text. Staff Response: This text has been deleted.

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15	SP	Page 36, Section 1.7.6	No	The text states "Residents and users of Kings Bay and Crystal River are concerned with water clarity and preventing / reducing algal blooms (Evans et al. 2007; SWFWMD 2015)." The text indicates that these issues are dealt with in the MFL through the salinity and thermal analyses. The analyses performed in this MFL do not directly address the issue of impacts of flow reduction on algal blooms. The model is used to evaluate the impacts of flow reduction on residence time, but no analyses are performed to relate flow and Chl *a*. Based upon conversations during the public meeting on this topic, it was identified that data at present are limited for this analysis, but efforts are underway to collect more. The text here may need to be modified to reflect this.	Reword, see suggestions in Comment 1. Staff Response (also see our response to Comment 1): Past analyses did not support direct link between discharge and chl a. However, there are known links between salinity and chlorophyll a in many systems which support using salinity as a criterion for MFL development or assessment. Further analyses addressing this issue will be completed as part of the planned minimum flow reevaluation.
16	SP	Page 37, Section 1.7.9	No	The previous comment on the evaluation of Chl *a* should also be addressed in this section.	Reword. See recommendations in Comment 1.

Table 2-2. Review of Chapter 1 – Introduction: Purpose and Background of MFL

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					Staff Response: See our response to Comment 1.
17	KW	Page 3, Section 1.3.2	No	Consider adding definitions for tidally filtered flow and spring/neap tides; throughout report change tide-corrected to tidally filtered.	Define terms. Staff Response: Definition for tidally filtered flow added. All instances of "tide-corrected" changed to "tidally filtered".
18	KW	Page 2, Section 1.3.1	No	Can harm to WRVs be measured or are we measuring criteria linked to harm – e.g., change in salinity?	Reword. Staff Response: Wording changed from "measure harm to environmental values" to "measure criteria linked to environmental values"
19	KW	Page 3, Section 1.3.2 and Page 66, Section 4.5	No	Consider adding an explanation of how an allowable flow reduction expressed as a percent flow reduction would be applied to the SGD "flow regime" per item #8 in Section 1.3.2 may be helpful.	Explain further. Staff Response: Explanation added to section 1.3.2.

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					The definition of "flow regime" was modified to include an explanation of how a percent of flow reduction preserves the flow regime.
20	KW	Page 3, Section 1.3.2	No	Do historical flows occur in the absence of withdrawal impacts? Historical flows would seem to include impacts.	Reword. Staff Response: Staff notes that in addition to the definition of "long-term" referenced in Section 1.3.2, Rule 40D-8.021 also defines "historic" as a "long-term period when there are no measurable impacts due to withdrawals and Structural Alterations are similar to current conditions." This information will be included in the definition for "baseline" included in the revised report.
21	KW	Page 5, Section 1.4	No	Maps of land surface topography within CR/KB watershed/springshed and KB bathymetry may be useful.	Consider adding graphic. Staff Response: A map of bathymetry will be included with brief description.

Table 2-2. Review of Chapter 1 – Introduction: Purpose and Background of MFL

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22	KW	Page 11, Section 1.4.1 Figure 1-5	No	Callout(s) for CR/KB may be helpful.	Add to figure. Staff Response: Comment noted by District Staff.
23	KW	Pages 12 13, Section 1.4.2	No	As a companion to Figures 1-6 and 1-7, a cumulative deviation plot might be helpful to show persistence. Annual rainfall volumes on Figure 1-6 would be useful. The Y-axis of Figure 1-7 is the departure from long-term average rainfall.	Consider adding graphic. Staff Response: Staff can add a cumulative departure graph to the report and will update the y-axis title on Figure 1-7.
24	KW	Page 14, Section 1.4.3	No	Are tide corrected flows recorded or calculated? Suggest changing tide corrected to tidally filtered.	Reword. Staff Response: Staff agrees that the term "tidally-filtered" is preferable to "tide-corrected" and will revise the report accordingly.
25	KW	Page 15, Section 1.4.3	Maybe	The two gages include runoff as part of flow measurement. The measured flows are stated to not be reliable estimates of groundwater discharge from the springs group. Is runoff otherwise included in the hydrodynamic model? How well do average tidally filtered flows (or unfiltered	Consider additional analysis now or in the future. Staff Response: Runoff contributes <1% of the total hydrologic loading to the system and was not included in the hydrodynamic model. It is,

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				over longer time periods) at Bagley Cove correlate with rainfall, perhaps based on weekly, monthly, or annual averages? This may be another way of evaluating tidally filtered flow records.	however, possible that measured Bagley Cove flow is somewhat correlated with seasonal or annual average rainfall. Although these correlations are expected to be weak, we will examine these potential relationships.
26	KW	Page 15, Section 1.4.3	Maybe	Has the USGS weighed in on the assertion that current gaged tidally filtered flow (and unfiltered flow) is unreliable? It would be useful to see the index-velocity ratings for the Bagley Cove station and open-channel sites G1 and G2.	Provide ratings. Staff Response: As mentioned by Dr. Peene, the USGS recognizes that there are issues with their flow measurement at Bagley Cove. They plan to further improve their flow measurement at Bagley Cove, including replacing the current ADCP with a new one. The District does not have the referenced index-velocity ratings but can obtain them from the USGS.
27	KW	Page 21, Section 1.4.4.1	No	How were "observed" CR Spring Group flows determined? The definition of mean error (enclosed by parentheses) is missing a "divided by…" term.	Reword. Staff Response: The values were estimated from a water budget of the

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					springshed. This information is contained within the NDM version 4 calibration report by HydoGeologic, Inc.
28	KW	Page 23, Section 1.4.6	No	The top paragraph is a little confusing – Crystal River group versus Crystal River Spring Group discussion. It may be useful to add a column in Table 1-2 for the withdrawals located within the CR/KB springshed.	Reword. Staff Response: Staff will modify the report to clarify the presentation of flow changes predicted with the NDM 5 model. The model withdrawals are those over the entire 10,000 square mile domain of the NDM in Table 1-2.
29	KW	Page 24, Section 1.4.7	No	Is Crystal River an impounded estuary or just the Kings Bay portion?	Explain. Staff Response: The term "impounded estuary" has been removed in favor of a clearer description of the system.
30	KW	Page 29, Section 1.5.1.1	No	Do the references regarding SAV salinity tolerance differentiate between bottom salinity and water-column average salinity?	Explain.

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					Staff Response: There are multiple references cited in this section. Some of which experimentally manipulated salinity in mesocosm experiments, some describe storm events, and others compared sites with varying salinity habitats. Our analysis included water column salinity and bottom salinity. District staff stand by the interpretation that salinity is an important driver of SAV distribution and abundance in Kings Bay.
31	KW	Page 34, Section 1.6.2	No	It may be useful to discuss the mean sea level trend NOAA has documented for one of the tide stations (e.g., Cedar Key) and impact on model and hindcasting.	Explain. Staff Response: Hindcasting was done with measured water level data that was historically affected by sea level. The mean sea level trend at Cedar Key is 1.97 millimeters/year with a 95% confidence interval of +/- 0.18 mm/yr based on monthly mean sea level data from 1914 to 2015 which is equivalent to a change of

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					0.65 feet in 100 years. Staff can add this information to this section and mention that hindcasted water levels in the bay based on historical water levels elsewhere will have been affected by past changes in sea level.
32	KW	Page 35, Section 1.7, Table 1.7, and Page 37, Section 1.7,	No	Clarify in the table that the factor evaluated for Sediment Load is the stability of bottom sediment. It is not clear (in table and text) how protection of native SAV is applicable to Navigation.	Clarify. Staff Response: Clarified in the table and text.
33	KW	Page 37, Section 1.7.8	No	Consider re-phrasing "positive impacts".	Reword. Staff Response: Rephrased.
34	AM	Page 4	No	The District does a good job providing some of the history and buttressing the 15% reduction criterion.	No action needed. Staff Response: District staff appreciate this feedback.
35	AM	Page 4	No	The District states "it is preferable when possible, to explicitly link reductions in flow to critical resources; this is the	Reword.

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				approach we used with our 15% resource reduction standard" Would it be more correct to say the District protects habitat than resource?	Staff Response: Ecologically, a "resource" is a broad term than may include habitat in addition to other substances such as food or nutrients. The 15% criterion could potentially be applied to any resource linked to flow.
36	AM	Page 24	Likely not	The District lists several habitats that are less mobile than others (i.e., Oysters Beds, Hydric Hammocks, and Mangroves). However, the report is not clear concerning the location of these habitats or that salinity changes that occur at their current location. If the goal is to protect these habitats in place, further discussion might be warranted.	Provide further discussion either explaining why it is not an issue or that while this is generally true, data for Crystal river do not exist to assess these habitat specifically. Staff Response: We plan to add analysis of vegetated shoreline to changes in shoreline salinity to address this problem. Shoreline vegetation is the only well-mapped data we could use to identify changes in habitat for sessile species.
37	AM	Page 24	No	Suggest referring to one plant by one name. *Vallisneria Americana* for	Word consistently.

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				example is listed as both Eelgrass and native wild celery.	Staff Response: We will simply not use a common name in the revised report.
38	AM	Page 24	No	The last sentence on the page is confusing and I only bring it up because it is contrary to a verbal statement during the field trip that Lynbya is declining.	In light of our conversations, this is not likely to change the outcome of the current MFL recommendation, but it Is related to the recreational value and to residence time, which has the potential of connecting flow to water quality. If there is evidence that Lynbya is diminishing in the bay, it should be documented in the report. Staff Response: Lyngyba is sensitive to salinity, and recent pulses in salinity due to storm surge from Hurricane Hermine had caused a recent die back in Lyngbya within the bay. This recent die back was mentioned during the peer review panel site visit. However, Lyngbya and other filamentous algae

Table 2-2. Review of Chapter 1 – Introduction: Purpose and Background of MFL

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					continue to be an ongoing issue in the bay.
39	AM	Page 28	No	Makes the case that it is important to manage shoreline habitat for emergent and shoreline species. This is true but the model contains significant hardened shore length (such as the sea walls in the finger canals near the three sisters), which possibly, because of their location within the bay, will not likely experience significant changes in what are likely to be low salinity conditions due to a reduction in flow. This may add to the shoreline length at low salinities and buffer the percent reduction calculated. It would be useful to run the model and isolate the cells that border naturally vegetated shoreline.	Dr. Chen has provided model output suggesting this issue not likely to change the MFL. However, where the District has the data to delineate markedly different habitats, it should consider disaggregation of the volume, area and length categories to provide more specific habitat protection. For example, as mentioned here, vertical hardened shoreline might be too different a habitat from vegetated shoreline to aggregate the two. Further, the District should review its available data and determine if further disaggregation is appropriate or feasible. Staff Response: The District is working on disaggregating shoreline length into different shoreline types.

Table 2-2. Review of Chapter 1 – Introduction: Purpose and Background of MFL

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					More data collection is needed to identify shoreline types along the finger channels associated with the bay.
40	AM	Page 32	No – Because the data seem to not exist but could potentially be considered during re-evaluation.	Question…. A significant water quality concern in the past at Crystal River was water clarity and thus in part chlorophyll. There is also a 4.4 microgram per liter target for chlorophyll-a in the river and 5.7 for Kings Bay. On Page 34 it is noted that Burghart and Peebles (2011) recommended that residence time be managed to limit phytoplankton blooms. Finally, the author's note that chlorophyll-a is potentially related to residence time and that substantial increases in residence time is potentially harmful. It is partially addressed in section 2.8 and table 2-6 and again in 3.4 and table 3-5 but perhaps a more full discussion of why it is not a factor in the MFL.	Buttress the current discussion. Staff Response (also see our response to Comment 1): Water quality analyses performed for draft minimum flow report were inconclusive with respect to chlorophyll a relationships to flow. However, staff are looking closely at water quality linkages to flow and expect to complete an enhanced water quality assessment as part of the planned minimum flow reevaluation.
41	AM	Page 32	No – Because the data seem	A recommendation for future work might be to understand how the increases in	See earlier recommendation, Comment 1.

Table 2-2. Review of Chapter 1 – Introduction: Purpose and Background of MFL

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
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			to not exist but could potentially be considered during re-evaluation.	ERT potentially correlate with environmental values (specifically Chl-a).	Staff Response: See our response to Comment 40.
42	AM	Page 35, Table 1-7	No	Aesthetic and scenic – Would include protection of natural shoreline vegetation.	Reword. Staff Response: Staff will add this to the report.

Table 2-3. Review of Chapter 2 – Methods

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
43	SP	Section 2.2	Maybe	The equations that are utilized to define all the flows into the system have some basic error associated with them as well as certain levels of uncertainty. For example, in Figure 2-4 looking at plot (a), it is clear that for the period when measured flows were available, there are errors in the estimated flow that would indicate that the model under-predicts the overall net flow out. This error is then carried through an additional level of uncertainty as the equations and coefficients are extrapolated out to other vents in the system. Based on these known errors and uncertainty, it would be important to developed additional ways to verify the total flows. This could be done using the Bagley data, if this data is demonstrated to be useful for this. Still working on the evaluation of the Bagley data. The equations are utilized to hindcast flows so some additional verification (beyond the model predictions of salinity) of the modeled flows would be beneficial.	The report needs to be more definitive in outlining the uncertainty associated with the SGD calculations and the errors in the various steps and how those might impact the calculated flows. The Figure 2-4a differences are a good example. The graph clearly shows there are errors between the predicted and measured flows at this cross-section. Simple visual inspection indicates that this error would tend to make the calculations under-predict the long-term net flow out. This relationship is then potentially extrapolated to other vents and this error carries over. Also, some more definitive discussion of the degree of variation in the direct vent measurements and how they were used to carry the calculations forward is needed. Again, highlighting how the errors might impact the ultimate flow calculation.

Table 2-3. Review of Chapter 2 – Methods

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				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					Staff Response: Just like any data collection and data fitting processes, there are errors associated with every step of these process we used to estimate SGD. Inevitably, there are some uncertainties in the SGD estimates used in the hydrodynamic model, which, combined with errors from other sources, eventually contribute to the uncertainties of the model results. A factor parameter is built in the hydrodynamic model that can be tuned to control the diffuse flux and allow the SGD uncertainties to be limited to a certain degree. Model calibrations using different values for this factor parameter suggested that the SGD uncertainty should be of the order of 20 cfs or less. As shown in the hydrodynamic model report (one of the appendixes), the final errors of simulated water levels, salinities, and temperatures are in ranges that are acceptable.

Table 2-3. Review of Chapter 2 – Methods

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
44	SP	Section 2.2	Maybe	The groundwater model predictions of flow from the springs group is on the order of 440 cfs under present conditions. The hindcast flows show averages more around 350 cfs. This further supports the need for verification of the total flow.	See previous recommendations on dealing with uncertainty in the flow measurements, i.e., Comment 43 Staff Response: The estimated SGD average was 355 cfs for the period 1/1/2002 through 10/13/2015. It was 332 cfs for the 9-year simulation period (10/6/2006 through 10/13/2015), and 374 cfs for the period between 11/5/1969 and 10/13/2015. Dr. Ken Watson calculated the average of USGS Bagley Cove flow to be 432 cfs and 354 cfs for the period of record (1/1/2002 through 11/15/2016) and for the 9-year model simulation period, respectively. Interestingly, the USGS Bagley Cove average was only about 7% greater than the estimated SGD average during the 9-year simulation period.

Table 2-3. Review of Chapter 2 – Methods

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
45	SP	Page 44, Section 2.3, Paragraph 2	No	The text identifies that the model statistics indicate that the model agrees well with measured data based on R2 values and other statistical analyses. I am in agreement with the statement that the statistics are reasonable given the type of data (continuous) being compared to for salinity and temperature.	No action required.
46	SP	Section 2.3, Paragraph 3	No	Based upon the materials in the appendix on the model, along with conversations with District Staff, there was around 10% of the flow that was utilized as a tuning parameter, i.e., to represent the unmeasured flows coming in through diffuse flow and flow from hairline fractures. Not sure if that was included in the flows presented in Table 2-1.	Clarify. Staff Response: Yes, the unmeasured flow quantity is included in Table 2-1. This portion of SGD contribution is 20 cfs or less, or about 6% of total SGD (please see our response to Comment 41). Correction: the 7.4% contribution on Page 24 of the hydrodynamic model report (one of the appendixes) is a mistake and should be changed to 6%.
47	SP	Section 2.3	Maybe	The salinity boundary conditions utilized for the scenario runs assume that there	Some results of sensitivity tests were provided by Dr. Chen showing that

Table 2-3. Review of Chapter 2 – Methods

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				will be no change in the salinity conditions at the locations of the boundaries from the reductions in flows. Need to test the validity of that assumption by doing some sensitivity tests on changes in that area based on flow reductions.	this issue would not have a significant impact on the MFL conclusions. Document the sensitivity tests in the report and/or the appendices. Staff Response: New model runs were conducted and it is estimated that the increase of salinity at the mouth of Crystal River is in the range of 0.05 psu (for a 2.5% flow reduction) to 0.77 psu (for a 30% flow reduction.) New scenario runs were conducted and results were analyzed. It was found that the minor increase of salinity at the downstream boundary due to reduced flow has only insignificant effects on the final results.
48	SP	Section 2.6	No	The section discusses analyses of water quality data through trend analyses as well as correlation of flow with water quality data. The methods identify that flows weren't available unless a hindcasting were done. As this was done ultimately for the MFL report, I	Clarify and address the issue of the availability of Chl a data for analyses. Staff Response: The district has chlorophyll a data and is conducting an ongoing analysis of this data with respect to flow. At the time of peer-

Table 2-3. Review of Chapter 2 – Methods

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				assume the water quality analyses were done before the hindcasting so they were not available. Additionally, the methods do not discuss analyses of Chl a data which are assumed to be part of the long-term monitoring. If these data were not available, the text should state that.	review draft development, there were no conclusive results of this analysis. Staff recommend further data collection and analysis for trends between Chl a and other water quality and quantity variables.
49	SP	Section 2.8	No	The method used for the residence time calculations were based on dye releases at specific times and tide conditions. The number of periods appear sufficient to characterize the residence times using dye. Another potential method would be to examine water age. This would allow the use of the complete simulation to examine the change in the overall water age in the same way salinity or temperature were evaluated, i.e., over the full simulation cycle.	Consider using the water age method, but if not feasible, the existing method is sufficient. In a re-evaluation, where more data are available for evaluation of the impacts of residence time on Chl a, consider using water age. Staff Response: The District will consider this recommendation as part of the planned minimum flow reevaluation.
50	KW	Page 40, Section 2.2	No	Reference to the third term (i.e., partial derivative) in Equation 1 relating to pressure is contrary to Equation 1 caption note and Chen (2014) report that	Clarify. Staff Response: The caption for Equation 1 will be revised. We note, that in the caption, long-term is roughly the time scale within which the

Table 2-3. Review of Chapter 2 – Methods

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				describe the term as relating to tidal flux. Define "long term".	2009 flow measurement was conducted.
51	KW	Page 41, Section 2.2	No	Would N be needed if the groundwater elevation at the "G" well were not influenced by tide? I.e., a true background well. Or is the term needed because of the short time frames being analyzed with the model?	Clarify. Staff Response: It is not clear what N the reviewer was referring to.
52	KW	Page 41, Section 2.2	No	Clarify that the flows from two subsets of springs, G1 with 3 springs and G2 with 8 springs, were evaluated to determine C1 and C2 for each group. Clarify that Figure 2-4 represents the flows from just 11 of the 70 springs and that Figure 2-5 represents the combined flow from all 70 springs.	Clarify. Staff Response: Yes, Fig. 2-4 represents 11 of 70 springs.
53	KW	Page 43, Section 2.2, Figure 2-5	No	The daily average line in the graph is missing,	Modify. Staff Response: This line is plotted with red color but is overlaid by other lines for most of the depicted time. The figure caption will be modified to note this plotting artifact.
54	KW	Page 43, Section 2.3	No	Is the vertical coordinate system a fixed z-grid or sigma grid? it is useful to know	Clarify.

Table 2-3. Review of Chapter 2 – Methods

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				when interpreting water-quality and AVF point velocity data collected using a fixed-position monitoring device.	Staff Response: It is a z-coordinate model.
55	KW	Page 44, Section 2.3	No	Is the diffuse flow about 10% or so? Runoff? Direct rainfall?	Clarify. Staff Response: Diffuse flow should be less than about 6%. Runoff and direct rainfall should not be greater than 1% of the total hydrologic loading to the estuary.
56	KW	Page 44, Section 2.3	No	It may be useful to mention spin up period for establishing a numerically balanced initial condition?	Clarify. Staff Response: For the 9-year simulation, the spin-up period is 26 days, from 10/6/2016 to 10/31/2016. It is mentioned on Page 33 of the hydrodynamic model report.
57	KW	Page 46, Section 2.3, Table 2.2	No	Is rainfall included as a meteorological input?	Clarify. Staff Response: No, it is not included as a meteorological input.
58	KW	Page 47, Section 2.4	No	A volume exceedance curve may be helpful.	Consider adding. Staff Response: Staff will consider adding a volume exceedance curve as

Table 2-3. Review of Chapter 2 – Methods

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					part of the planned minimum flow reevaluation.
59	KW	Page 47, Section 2.5	No	For what time period were instantaneous measurements of water temperature evaluated?	Clarify. Staff Response: Predicted, not measure instantaneous water temperatures were used to identify time periods during the model simulation period (October 6, 2006 through October 13, s005) with the smallest water volume and area available as refuge from chronic thermal stress.
60	KW	Page 47, Section 2.4	No	"averaged across time" how much time? Daily, POR?	Clarify. Staff Response: Averaged over the entire 9-year simulation period, excluding the first 26 days (spin-up period).
61	KW	Page 47, Section 2.4	No	How was shoreline length calculated?	Clarify. Staff Response: Shoreline was calculated based on bottom elevations at the four corners of a model grid and

Table 2-3. Review of Chapter 2 – Methods

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					the simulated water surface elevation. This is more thoroughly explained in Figure 2 on page 10 of the hydrodynamic model report (Chen 2016)
62	KW	Page 48, Section 2.6, second paragraph	No	It is not clear how many water quality samples are associated with concurrent measurements of both groundwater level and sea level versus the number of samples associated with measured values for GW level or sea level.	Clarify. Staff Response: Eighty-four percent of the matching discharge values were calculated values and sixteen percent were interpolated.
63	KW	Page 50, Section 2.7	No	It may be useful to compare the ACOE tide projections with the mean sea level change which has occurred over the past 9 and/or 46 years at the Cedar Key tide station.	Consider adding. Staff Response: The "low" projection by the USACOE is a linear continuation of the long term historical trend, which for Cedar Key is 1.97 mm/yr. The ACOE methods cited in the minimum flow report provide more detail about the sea level rise projections used for our analyses.

Table 2-3. Review of Chapter 2 – Methods

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
64	KW	Page 51, Section 2.8, Table 2.6	No	Explain the tide terminology (i.e., spring, neap, average) and whether neap and spring are winter-time lows or summer-time highs; explain the spring discharge percentiles (i.e., exceedance or non-exceedance).	Clarify. Staff Response: Spring tides are tides during new or full moon, while neap tides refer tides when the sun and moon are at right angles to each other. Average tides are those between spring and neap tides. The spring discharge percentiles presented in Table 2-6 are percent non-exceedance values. We will consider including footnotes to Table 2-6 to enhance understanding of the tabular information.
65	AM	General	No	No current concerns except the note about residence time above (Comment 39).	No action required.

Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
66	SP	Section 3.4, Table 3-5	Maybe	Table 3-5 shows that there are some relatively significant changes in residence time associated with the flow reductions. As such, the impact of these residence times on water quality (specifically algal blooms) could be important. This needs to be identified in the report and if data are insufficient to do this type of analyses, that needs to be stated.	See recommendations in previous comments. Staff Response: There is no data analysis showing a clear quantitative link between residence time and chlorophyll (algal blooms) in this system. However, the analysis in Table 3.5 shows that residence time will increase by 11% with a 12% decrease from baseline flow, which makes it less sensitive than salinity.
67	SP	Section 3.5	No	The analyses of the data do show that Chl a values are above the criteria a significant portion of the time. One issue is that the analyses should examine the Chl a against the time scale of the criteria, i.e., annual average time frame. If the data still show the system in violation, then the residence time becomes even more important.	If the criteria are going to be used in analyses, and presented in the report, they need to be used properly, accounting for the value and how the data should be compared to the value, i.e., time averaging, etc. Staff Response: The water quality analysis presented in the report is representative of an ongoing

Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					investigation of water quality data in the system. Staff will present an updated analysis as part of the planned minimum flow reevaluation, and will consider presenting annual average chlorophyll a concentrations along with relevant water quality standards.
68	SP	Section 3.5	Maybe	Analyses of correlations of nutrients and flow were presented, but no analyses of flow versus Chl a were presented.	See previous recommendations in dealing with evaluation of Chl a data. Staff Response: Analysis of Chlorophyll a vs. daily discharge did not reveal any significant trends that were consistent across the system. This analysis will be included as an appendix to the revised minimum flow report.
69	KW	Page 52, Section 3.1	No	Is the volume calculation across all layers? Or bottom layers for SAV for example or bottom area for benthic. Or does it matter? Well mixed?	Clarify. Staff Response: Yes, the volume calculation is across all model layers.

Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					The bottom area calculation used bottom-layer salinity. The model does not assume salinity to be well-mixed.
70	KW	Page 52, Section 3.1	No	Is bottom area in Table 3-1 associated with salinity in the bottom layer of the model?	Clarify. Staff Response: Yes.
71	KW	Page 52, Section 3.1	No	Confirm that the < 2 ppt includes the freshwater portions <0.5 ppt.	Confirm. Staff Response: Yes, it includes < 0.5 psu.
72	KW	Page 52, Section 3.1, Table 3.1	No	The values listed for <2 ppt appear to be inconsistent with values for preceding and succeeding salinities, although I can see how it is possible.	Confirm. Staff Response: The effect of flow reduction on salinity habitats is not necessarily monotonic. Table 3-1 shows that salinity habitats in the range of 1 – 2 psu are most sensitive to the flow reduction. We do not think there are any consistency issues associated with the information presented in the table.

Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
73	KW	Page 52, Section 3.1	No	Is average volume most appropriate? What about the change in the occurrences of high salinity, short term events - like the acute thermal refuge analysis?	Consider addressing. Staff Response: Staff considers use of central-tendency salinities (e.g., mean values) the most appropriate approach for identifying minimum flows.
74	KW	Page 53, Section 3.2 and elsewhere	No	The statements regarding the sufficiency of manatee thermal refuge for much larger populations may be overreaching; same for the two right-most columns that list manatee capacity in Table 3-3 on Page 54. As a reality check, do we think there would be no impact to manatee use of system if flows were reduced to levels such that the thermal refuge volume just exceeded the manatee space requirements? What about habitat volume reduced to twice the volume estimated to be needed? I agree that it would be difficult to make this metric a driver given the overall volume of suitable habitat. It seems that the assumption of a 15 % reduction in habitat causing significant	Consider rewording. Staff Response: We understand the recommended approach for documenting that change in manatee thermal refuge habitat is not a limiting factor for the existing manatee population and should therefore not be considered for minimum flow development. However, we think it is worthwhile to assess potential flow-related changes in thermal refuge as part of the minimum flow development process. We also note that the methods used for assessing manatee habitat needs in the Crystal River/Kings Bay System are consistent with other springs MFLs that have been established, peer reviewed and considered by state and

Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				harm is not appropriate in the case of manatee thermal refuge. Perhaps calculate the amount (as a percent) of habitat reduction needed to impact the known manatee population, and then state that manatee habitat is therefore not a limiting metric.	federal agency staff associated with manatee management.
75	KW	Page 53, Section 3.2, Figure 3.2, caption	No	The maps illustrate the spatial distribution of warm water, not volumes.	Reword. Staff Response: We note that these maps are three dimensional, with x, y, and z axes, and thus show volume, and are therefore labeled correctly. We do acknowledge, however, that a lack of scales presented for the axes limits the represented volumes to dimensionless values.
76	KW	Page 55, Section 3.3	No	Should the flow reduction be 12% not 9%; clarify that "habitat" is represented by volume of salinity <2 ppt as opposed to bottom area salinity <2 ppt.	Clarify. Staff Response: Text referring to a 9% reduction in flow refers to information that was included in a previous version of Table 3-4 but not included in the version of the table in the draft

Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					report. This error will be corrected in the revised minimum flow report, and text in Section 3.3 will be revised to indicate the modeled habitat changes discussed are based on water column volumes.
77	KW	Page 55, Section 3.3	No	The model input data for the 9-year simulation period reflect a sea level rise of about 0.06 feet, hence the baseline period includes some habitat loss attributable to sea level rise. This is not substantial but it may be useful to mention/discuss the sea level rise that occurred during the model and historic period.	Consider new language. Staff Response: Sea level rise is ongoing. Impacts to baseline flows are assessed as a percent-of-flow using a regional groundwater model. It is true that model input includes water level in Kings Bay which has increased due to sea level rise. These sea level rises would have impacted baseline flows as well, so the percent-of-flow method we used for assessing flow-related changes in salinity habitat accounts for this.
78	KW	Page 55, Section 3.4	No	Would looking at percentile flows be appropriate for salinity as well?	Consider adding.

Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					Staff Response: We could have assessed flow-related salinity habitat changes based on flow percentiles. However, we believe comparison of mean responses provides a reasonable approach for identifying the appropriate minimum flow.
79	KW	Page 56, Section 3.4, Table 3-5	No	Define the SGD percentiles as exceedances or non-exceedances.	Define. Staff Response: It is defined as non-exceedance. We will consider including footnotes to Table 2-6 to enhance understanding of the tabular information and also addressing this issue with revisions to the text included in Section 3.4
80	KW	Page 58, Section 3.5.2	No	Define "spring flow" and how it was determined (i.e., measured or calculated).	Define. Staff Response: In this section, spring flow used in the discussion is the daily average of the entire SGD entering Kings Bay. We will insert a parenthetic

Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					definition for springflow in the topic sentence of the paragraph preceding Table 3-8.
81	KW	Page 58, Section 3.5.2	No	Rephrase "over the time period" to "over the course of 91 dates…" similar to Figure 3-4 caption.	Reword. Staff Response: This will be rephrased for consistency.
82	AM	Page 52, Table 3-1	No	Table 3-1 is the linkage between the model and the ecology. As mentioned in the meeting, the District should consider including absolute volume, area, and length, and not just percent. How much habitat is being preserved and how much is being lost?	Dr. Chen has already provided the Panel these numbers. Recommend including them in the report. Staff Response: These values will be added to the revised minimum flow report.
83	AM	General	No	It would be interesting to understand the uncertainty in the model as it applies to length, area, and volume, though this information is not necessary for the purposes of using the model to recommend an MFL.	None – Just a note.

Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
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84	AM	General	No	The discussion of Manatee habitat is thorough enough to make compelling argument that Manatee habitat will not be limiting even if other habitat assumptions were used.	The manatee discussion is sometimes distracting from the factors that directly limit the MFL. However, manatees are also an important factor to many CR/KB stakeholders. Recommend considering if the manatee information should be compiled as a single appendix or left in the report. Staff Response: Many stakeholders are concerned about the manatee population of the southeastern United States. Manatee habitat is one of the primary factors we assess in setting minimum flows for spring systems that are accessible from coastal waters . Therefore, we find it appropriate to include discussion of potential flow-related changes in manatee habitat in the MFL report.

Table 2-5. Review of Chapter 4 – Discussion: Using Results to Set Minimum Flow

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
85	SP	Section 4.1, Paragraph 1, third sentence	No	There is an extra "the" in the sentence.	Delete text. Staff Response: This typographic error will be corrected in future drafts.
86	SP	Section 4.1	No	The estimated long-term flow for the 46-year period based on the hindcast flow projection from the modeled equations is 374 cfs. Based on the Bagley Cove site the median flow from 2002 to 2015 is 437 cfs. The output from the groundwater flow model for the present conditions is around 440 cfs. The text states "The cross-sectional flux through Bagley Cove is a combination of tidal fluxes, spring flows entering Kings Bay during the preceding 6 – 20 days, stormwater runoff, wind action, and nonlinear interactions among factors affecting circulation and transport processes in the estuary. Furthermore, these previous estimates of discharge do not match the water budget for the springshed, which is able to account for	Reword. Staff Response (also see our response to Comments 6, 26, 43 and 44): We will modify the discussion in the report to indicate that estimated submarine groundwater discharge is within 6 percent of the long-term average of the Bagley Cove flow measured by the USGS from 2006-2015.

Table 2-5. Review of Chapter 4 – Discussion: Using Results to Set Minimum Flow

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				455 cfs of spring flow from the Crystal River Springs group given 20 inches of recharge per year." While this statement is true for the previously uncorrected Bagley Cove data, it is not accurate relative to the corrected data, which in the text above it is stated that the median flow is 437 cfs, which does agree with the recharge rates. It is important to note that the methodology utilized to develop the modeled flow equations (index velocity measurements at G1 and G2) was the same as that utilized to measure the flows at the Bagley Station. The uncertainty in both measurements needs to be outlined in the report and the USGS gage flow not fully dismissed.	
87	SP	Section 4.4	No	Reiterate the comment that the analyses do not address the potential for changes in water quality (specifically Chl a) due to changes in residence time. If data are insufficient for this analysis at this time, which was identified through conversations with District personnel,	See previous recommendations on dealing with impact of residence time on Chl a. Staff Response: As stated in several of our responses above, there is no data or analysis linking residence time to Chl a concentration in the Crystal

Table 2-5. Review of Chapter 4 – Discussion: Using Results to Set Minimum Flow

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				then this should be stated within the report and identified for future evaluation.	River/Kings Bay System. This will be noted in the revised minimum flow report and identified for future evaluation.
88	KW	Page 62, Section 4.2	No	Resolve the possible inconsistency in Table 3-1 noted previously and revise text if necessary.	Check. Staff Response: As note in our response to Comment 72 above, we do not think there is any inconsistency in Table 3-1.
89	KW	Page 64, Section 4.3	No	It may be helpful to list the allowable flow reductions determined for the Homosassa (3%) and Weeki Wachee (10%).	Add reference. Staff Response: The MFLs for Homosassa and Weeki Wachee will be added to the first chapter of the report.
90	KW	Page 65, Section 4.4.2, paragraph beginning with "None of the vents…."	No	Clarify what "effect of date was removed" means.	Clarify. Staff Response: This is in reference to the residual analysis detailed in Figures 3-4 and 3-5. These figures will be cited in the noted sentence.

Table 2-5. Review of Chapter 4 – Discussion: Using Results to Set Minimum Flow

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
91	KW	Page 66, Section 4.5	No	The thermal refuge "is" (not "seems to be") more conservative regardless of the hypothetical manatee populations that might be supported.	Clarify. Staff Response: Habitat suitable for use as thermal refuge is more sensitive to flow-related change than the 2 ppt salinity-based habitat discusses in Section 4.5. However, the actual volume of useable thermal refuge required by the number of manatee visiting Kings Bay will be unimpacted by flow reductions of up to 40%. Staff will revise the report to further clarify this issue.
92	KW	Page 69, Section 5.7	No	Clarify that groundwater pumping impacts are from regional pumping.	Clarify. Staff Response: Table 1-2 has been modified to provide clarity to this issue.

Table 2-5. Review of Appendices and External Reports

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
93	KW	VHB (2010)	No	Report Appendixes A and B are missing. It would be useful to see the index-velocity ratings developed for open-channel locations G1 and G2.	Consider adding the ratings. Staff Response: Appendixes A and B to the VHB, Inc. report were delivered as MS Excel files, which can be provided upon request. The index-velocity ratings developed for G1 and G2 were not required as a delivery in the contract, but VHB, Inc. followed the same USGS procedure in developing these index-velocity ratings.
94	KW	Chen (2014) Pages 12 – 14 and Figures 4 and 5	No	Confirm if the graphics illustrate the total open-channel flow measured at locations G1 and G2 (i.e., spring flow plus the tidal flux component).	Confirm. Staff Response: The referenced figures depict net spring flow (measured flows minus tidal fluxes).

3.0 SUMMARY OF FINDINGS AND MFL REVIEW GUIDELINES RESPONSE

A component of the Peer Review Panel scope of work was to provide an assessment of the MFL report and supporting documentation against specific listed criteria. The following items outline those specific criteria.

1. Determine whether the conclusions in the Crystal River/Kings Bay springs system MFLs report are supported by the analyses presented.
2. Supporting Data and Information: Review the relevant data, and information that support the conclusions made in the report to determine whether:
    a. The data and information used were properly collected;
    b. Reasonable quality assurance assessments were performed on the data and information;
    c. Exclusion of available data from analyses was justified; and
    d. The data used were the best information available.
3. Technical Assumptions: Review the technical assumptions inherent to the analysis used in the Crystal River/Kings Bay springs system MFLs report to determine whether:
    a. The assumptions are clearly stated, reasonable and consistent with the best information available;
    b. The assumptions were eliminated to the extent possible, based on available information; and
    c. Other analyses that would require fewer assumptions but provide comparable or better results are available.
4. Procedures and Analyses: Review the procedures and analyses used in the Crystal River/Kings Bay system MFLs report to determine whether:
    a. The procedures and analyses were appropriate and reasonable, based on the best information available;
    b. The procedures and analyses incorporate all necessary factors;
    c. The procedures and analyses were correctly applied;
    d. The procedures and analyses are repeatable; and
    e. Conclusions based on the procedures and analyses are supported by the data.

5. If a proposed method used in the Crystal River/Kings Bay Springs system MFLs report is not scientifically reasonable, the CONSULTANT shall:
    a. List and describe scientific deficiencies and, if possible, evaluate the error associated with the deficiencies;
    b. Determine if the identified deficiencies can be remedied.
    c. If the identified deficiencies can be remedied, then describe the necessary remedies and an estimate of time and effort required to develop and implement each remedy.
    d. If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable. If an alternative method is identified, provide a qualitative assessment of the relative strengths and weaknesses of the alternative method(s) and the effort required to collect data necessary for implementation of the alternative methods.
6. If a given method or analyses used in the Crystal River/Kings Bay Springs system MFLs report is scientifically reasonable, but an alternative method is preferable, the CONSULTANT shall:
    a. List and describe the alternative scientifically reasonable method(s), and include a qualitative assessment of the effort required to collect data necessary for implementation of the alternative method(s).

Table 3-1 presents the detailed assessments by each of the Peer Review Panelists for each of the criteria. The findings of the Peer Review Panel are that, with the implementation of some of the edits/recommendations made within this report, there are no fatal flaws within the MFL report and supporting documentation relative to the specified criteria.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
Determine whether the conclusions in the Crystal River/Kings Bay Springs system MFLs report are supported by the analyses presented.			KW: The report documents a comprehensive and complex analysis that was concise and well done. Although conclusions are supported by analyses, an explanation of how an allowable flow reduction expressed as a percent flow reduction would be applied to the SGD "flow regime" per item #8 in Section 1.3.2 is not provided and may be helpful. Staff Response: See our response to Comment 19 in Table 2-2. AM: Overall the report is reasonable and the analysis presented is consistent with other MFL efforts within the District. At times the repost is inclusive of information which is ancillary to the MFL determination and that information could be shifted to the appendix and play a less prominent role in the report. Staff Response: During Panel meetings, the possibility of moving some water quality analyses to appendices was discussed. However, this conflicts with Panel advice to discuss chlorophyll a and residence time more thoroughly within the report. SP: Overall the MFL conclusions are supported by the analyses presented. One area in the report that need to be clarified is the present uncertainty in both available flow measurements (USGS and SWFWMD) and this needs to be reworded in the report along with recommendations for verification in future work. Another area is to recognize the potential impacts to water quality (specifically Chl a and residence time) and that at present the data are not available to quantify. Staff Response: See our responses to Comments 7 and 43 regarding discharge uncertainty and Comment 1 regarding residence time and chlorophyll.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
	2. Supporting Data and Information: Review the relevant data, and information that support the conclusions made in the report to determine whether:	a. The data and information used were properly collected;	KW: Much of the data used were collected by entities with established field SOPs and are presumed to have been properly collected. AM: A majority of the data have been collected by agencies other than SWFWMD or in the pursuit of other studies. However, all data seems to be collected by entities with trained samplers and SOPs and while, likely not error free, are likely to represent the best available data. SP: The data collected by the SWFWMD for this project appears to have been collected properly. Also the data from outside groups appears to have been collected properly based on existing protocols. Issues with the data are primarily related to limitations in collection methodology and processing.
		b. Reasonable quality assurance assessments were performed on the data and information;	KW: It may be helpful to prepare double-mass curves to characterize associations between rainfall, SGD, and river discharge reported by the USGS. Staff Response: Please see our response to Comment 25 within Table 2-2. SP: Saw no issues with the quality assurance on the data collected. More explanation (especially on the direct flow and vent measurements) of the uncertainty associated with the data should be provided.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
		c. Exclusion of available data from analyses was justified; and	KW: The data for the reported discharge for the Crystal River gage (#02310750) and for the USGS gage at Bagley Cove (#02310747) were determined to be unreliable estimates of groundwater discharge. Both gages record a mixture of groundwater, storm water runoff, and marine water. Tidal filtering is used in an attempt to exclude the marine water flux and, to the extent runoff is important, a means of accounting for runoff is needed. We take no exception to excluding the gage #2310705 data. However, we think the gage #02310747 data may be useable to help verify the groundwater discharge with either appropriate tide filtering or as an estimate of long term total freshwater discharge (i.e., groundwater discharge and surface water runoff). Staff Response: Tidally-filtered discharge reported at USGS gage #02310747 shows negative daily and monthly average values, which the District takes as sufficient evidence to exclude these data as estimates of freshwater discharge. Further, hydrodynamic modeling using this gage data was done, and showed inferior results see Chen (2014) as cited in MFL report. Note the USGS gage #02310750 (Crystal River near Crystal River with a period of record from 3/1/1964 to 9/30/1977) is incorrectly identified as #02310705 in the comment above. SP: There is clearly uncertainty in both sets of the data for the SGD (USGS and SWFWMD). Complete exclusion or dismissal of this data does not seem warranted. This would not alter how the analyses were performed, as it is recognized that the SWFWMD data works better in the analyses, but the report should identify the potential uncertainty in both and not just completely dismiss the USGS data. Staff Response: See responses pertaining to USGS data in Comments 6, 7, 26, and 86.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
		d. The data used were the best information available.	KW: In Section 1.4.4 it would be helpful to mention whether groundwater level data are available for locations in the springshed that are more distant from the CR/KB system and tidal influences. Bagley Cove gage data may be usable in some form. Staff Response: Groundwater level data are shown for Lecanto 7, Romp 21-2 and Romp 21-3, see Figures 1-12 and 1-13. Use of Bagley Cove data has been discussed in several of our responses above and will be further explained in revised MFL report. AM: Vegetation: The District provides some significant information from historic SAV studies. Because of the importance of SAV it is appropriate to include it in the report since this is presumably some of the habitat protected by the change in area and volume analysis. While SAV information is documented, the historic concern of filamentous algae could be more thoroughly addressed in the report or the appendix. Especially, if it is less of a concern than in the past as indicated during a field trip. Staff Response: See response to Comment 38. SP: The data used in the hydrodynamic modeling, and the calculation of the flows was the best available with the caveat of the comments on the USGS in earlier sub-tasks.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
	3. Technical Assumptions: Review the technical assumptions inherent to the analysis used in the Crystal River/Kings Bay springs system MFLs report to determine whether:	a. The assumptions are clearly stated, reasonable and consistent with the best information available;	KW: The definition of baseline and historical flows occurring" in the absence of withdrawal impacts" (i.e., Section 1.3.2) should be qualified. The baseline period of time should be clearly stated in the text. Staff Response: The flow definitions given in Section 1.3.2 are general definitions applying to all systems. This section is not meant to serve as a detailed description of methods. Groundwater impacts relative to baseline are shown in Table 1-2, where the baseline flow is reported for the year 2010 and 2014. Similarly, the baseline period used for assessment of flow-related changes in salinity and thermal-based habitats using the hydrodynamic model is discussed in Section 2.3 of the report. We plan to revise this discussion to more clearly identify the baseline period for the hydrodynamic modeling efforts and also note the baseline period in relevant sections of the results presented in Chapter 3. AM: The largest assumption is the 15% loss of habitat criteria as a harm threshold. This criterion has been discussed for well over a decade and it has continuously been determined to be reasonable and consistent with other environmental flow standards. SP: The assumptions are generally clearly stated and other than the complete exclusion of the USGS data are consistent with the best available information. The sensitivity associated with the offshore boundary for the hydrodynamic scenarios needs to be addressed to complete the analyses. Staff Response: As noted in our response to Comments 6, 7 and 47 above, USGS data for the Bagley Cove gage site and hydrodynamic boundary conditions will be discussed in more detail in future drafts.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
		b. The assumptions were eliminated to the extent possible, based on available information; and	KW: The assumption that 15% habitat reduction causing significant harm could be explicitly eliminated for manatee thermal refuge. Staff Response: Please see our responses above to Comments 3, 74, 84, and 91 regarding manatee thermal refuge. SP: No unjustified assumption eliminations were identified
		c. Other analyses that would require fewer assumptions but provide comparable or better results are available.	SP: No alternate analyses that would require fewer assumptions were identified through this review.
	4. Procedures and Analyses: Review the procedures and analyses used in the Crystal River/Kings Bay system MFLs report to determine whether:	a. The procedures and analyses were appropriate and reasonable, based on the best information available;	KW: The thermal analysis for manatee could be simplified and presented differently. Based on the space requirements of manatee, the known manatee population, and the available thermal refuge, the default 15% allowable reduction in habitat does not appear to be appropriate – i.e., a much greater reduction in habitat would be needed to cause significant harm and therefore a much greater reduction in flow would be allowable. This a relevant concept because it points out that scenario specific information should be used when available and that default values (i.e., 15 % reduction in habitat) should only be used in the absence of better information. In my view, the report correctly deduces that manatee thermal refuge is not a limiting metric for an MFL. Staff Response: Please see our responses above to Comments 3, 74, 84, and 91 regarding manatee thermal refuge. SP: The salinity habitat volume change determination was based upon the best available information. The exclusion of the manatee thermal habitat was based upon the best available information.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
		b. The procedures and analyses incorporate all necessary factors;	KW: It is unclear whether direct rainfall on the CR/KB system is an input variable in the hydrodynamic model (see Section 2.3). Staff Response: See our response to Comment 57 in Table 2-3 above. AM: As discussed during the third meeting natural shorelines should be delineated from hardened shoreline or that case should be made that they may appropriately substitute for one another as the location of isohalines shift. Staff Response: See our response to Comment 39 in Table 2-2 above.
		c. The procedures and analyses were correctly applied;	KW: Discuss procedure for estimating relative change in shoreline habitat. Staff Response: See our response to Comment 39 in Table 2-2 above.
		d. Limitations and imprecisions in the information were reasonably handled;	KW: Insufficient information is provided from the SGD regression analysis to evaluate the reasonableness of the SGD hindcasted for a 46-year period. It may be helpful to include plots of residuals vs. predictions and observed vs. predicted values. Staff Response. Model skill assessment results discussed in Section 2.2 are the best estimate of the reasonableness of SGD for use in this system. SP: The limitations in the flow calculations were not sufficiently identified in relation to the USGS flow measurements. Staff Response: See our responses to Comments 6, 7, 26, and 86 pertaining to USGS data.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
		e. The procedures and analyses are repeatable; and	SP: The procedures and analyses seem repeatable for all aspects. Further clarification of key analyses could be provided within the report and these are outlined in the detailed comments.
		f. Conclusions based on the procedures and analyses are supported by the data.	KW: Conclusions are supported by best available data and repeatable procedures and analyses. The relative flow reductions determined for a salinity regime <2 ppt (i.e., Table 3-1) appear inconsistent (although possible) with those for the <1 and <3 ppt regimes and should be checked. Staff Response: See response to Comment 72 regarding inconsistency in salinity response. SP: The conclusions relative to salinity habitat and manatee thermal habitat are supported by the analyses and the data. Conclusions on the lack of impact upon water quality in the system are not supported by the data because the key aspects, Chl a versus residence time changes is not presented. Staff Response: See response to Comment 1 regarding residence time and chlorophyll.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
5. If a proposed method used in the Crystal River/Kings Bay Springs system MFLs report is not scientifically reasonable, the CONSULTANT shall:	a. List and describe scientific deficiencies and, if possible, evaluate the error associated with the deficiencies; b. Determine if the identified deficiencies can be remedied. c. If the identified deficiencies can be remedied, then describe the necessary remedies and an estimate of time and effort required to develop and implement each remedy. d. If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable. If an alternative method is identified, provide a qualitative assessment of the relative strengths and weaknesses of the alternative method(s) and the effort required to collect data necessary for implementation of the alternative methods.		KW: Methods are scientifically reasonable. AM: While some methods seem debatable all methods incorporate uncertainty and the ones use by the district are reasonable. SP: The final verification of the total flow remains a deficiency, but at present there is no better data to be utilized. This should be identified as a future need for this system. SP: Another are identified as having some deficiency is the evaluation of the impacts to water quality. The deficiency is in the establishment of the relationship between flow reduction, residence times, and the water quality parameters (Chl a for example) that would be impacted by longer residence times. At present based upon discussions with District personnel, the data to support this analysis is not available. Within the report the District needs to first determine that there are not data that weren't used which might allow this analysis to be completed at this time. If not, then identify this as potential future work. Staff Response: See response to Comment 1 regarding residence time and chlorophyll.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
6. If a given method or analyses used in the Crystal River/Kings Bay Springs system MFLs report is scientifically reasonable, but an alternative method is preferable, the CONSULTANT shall:	a. List and describe the alternative scientifically reasonable method(s), and include a qualitative assessment of the effort required to collect data necessary for implementation of the alternative method(s).		KW: Percent change in habitat is appropriate for this system. By selecting the most conservative salinity regime, other salinity regimes are protected. SP: No preferred alternate method with the available data has been identified through this review.

Attachment A

MFL Review Guidelines

MFL Review Guidelines

1. Determine whether the conclusions in the Crystal River/Kings Bay Springs system MFLs report are supported by the analyses presented.
2. Supporting Data and Information: Review the relevant data, and information that support the conclusions made in the report to determine whether:
    a. The data and information used were properly collected;
    b. Reasonable quality assurance assessments were performed on the data and information;
    c. Exclusion of available data from analyses was justified; and
    d. The data used were the best information available.
3. Technical Assumptions: Review the technical assumptions inherent to the analysis used in the Crystal River/Kings Bay springs system MFLs report to determine whether:
    a. The assumptions are clearly stated, reasonable and consistent with the best information available;
    b. The assumptions were eliminated to the extent possible, based on available information; and
    c. Other analyses that would require fewer assumptions but provide comparable or better results are available.
4. Procedures and Analyses: Review the procedures and analyses used in the Crystal River/Kings Bay system MFLs report to determine whether:
    a. The procedures and analyses were appropriate and reasonable, based on the best information available;
    b. The procedures and analyses incorporate all necessary factors;
    c. The procedures and analyses were correctly applied;
    d. Limitations and imprecisions in the information were reasonably handled;
    e. The procedures and analyses are repeatable; and
    f. Conclusions based on the procedures and analyses are supported by the data.
5. If a proposed method used in the Crystal River/Kings Bay Springs system MFLs report is not scientifically reasonable, the CONSULTANT shall:
    a. List and describe scientific deficiencies and, if possible, evaluate the error associated with the deficiencies;
    b. Determine if the identified deficiencies can be remedied.

c. If the identified deficiencies can be remedied, then describe the necessary remedies and an estimate of time and effort required to develop and implement each remedy.
d. If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable. If an alternative method is identified, provide a qualitative assessment of the relative strengths and weaknesses of the alternative method(s) and the effort required to collect data necessary for implementation of the alternative methods.

6. If a given method or analyses used in the Crystal River/Kings Bay Springs system MFLs report is scientifically reasonable, but an alternative method is preferable, the CONSULTANT shall:
    a. List and describe the alternative scientifically reasonable method(s), and include a qualitative assessment of the effort required to collect data necessary for implementation of the alternative method(s).