A Review of

"Proposed Minimum Flows and Levels for the Middle Segment of the Peace River, from Zolfo Springs to Arcadia"

February 18, 2005 Draft by:

Ecological Evaluation Section
Resource Conservation and Development Department

Prepared by:

Douglas T. Shaw, Ph. D.
Clifford N. Dahm, Ph. D.
Stephen W. Golladay, Ph. D.

For:

Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899

June 2005

EXECUTIVE SUMMARY

This is a summary of the Scientific Peer Review Panel's ("Panel") evaluation of the scientific and technical data, assumptions, and methodologies used by the Southwest Florida Water Management District in the development of its proposed minimum flows and levels (MFLs) for the Middle Peace River from Zolfo Springs to Arcadia ("Report", SWFWMD 2005).

The Peer Review Panel has attempted to provide a critical review of the methods, data, and conclusions of the District. Overall, the Panel endorses the District's approach for setting MFLs in the Middle Peace River, and we find no serious flaws or errors in the methodology or findings documented in the Report. Assumptions of the approach are well documented and are reasonable given the amount and quality of data available. Tools and methods of analysis employed in this effort are appropriately used and utilize best available information. Conclusions in the Report are based on an impressive field data collection effort and sound application of findings from the scientific literature and previous investigations by District staff. The District has done a commendable job of incorporating the suggestions of past peer review, notably that for the Upper Peace River MFLs (Gore et al, 2002), in the proposed MFLs for the Middle Peace, including use of seasonal building blocks and the application of the Instream Flow Incremental Methodology. The District has also continued to apply and refine several concepts that were endorsed by previous peer review panels (Gore et al, 2002; Shaw et al, 2004). The Panel has provided suggestions for relatively minor changes or additions to the Middle Peace River Report that we feel will improve the repeatability of the methods, better justify the conclusions and ensure that resource protection goals are satisfied for overlooked species or unusual flow conditions.

The Panel finds particular merit with and strongly endorses several novel concepts incorporated in the Middle Peace MFLs. These include:

- Identifying ***two separate benchmark periods*** based on different phases of the Atlantic Multidecadal Oscillation (AMO) for identifying the most protective minimum flows
- Applying ***multiple, independent approaches*** to identify the most protective minimum flows in each seasonal block (*e.g.,* fish passage criteria *and* wetted perimeter analyses for Block 1 flows, PHABSIM modeling *and* woody habitat analyses for Block 2 flows, etc.)
- Specifying minimum flows in terms of allowable ***percent flow reductions*** that vary by season and flow conditions

The Panel recommends that the District continue to refine these concepts and that they should routinely be incorporated when setting future MFLs for rivers in Southwest Florida.

We applaud the District's commitment to periodic reassessment of the MFLs for the Middle Peace River and other water bodies as structural alterations or changes in watershed conditions occur. We strongly recommend, however, that the District begin

now to develop the process and methodology by which such reassessment would occur, and we suggest that such a process should be based on an adaptive management framework.

INTRODUCTION

The Southwest Florida Water Management District (SWFWMD) under Florida statutes provides for peer review of methodologies and studies that address the management of water resources within the jurisdiction of the District. The SWFWMD has been directed to establish minimum flows and levels (designated as MFLs) for priority water bodies within its boundaries. This directive is by virtue of SWFWMD's obligation to permit consumptive use of water and a legislative mandate to protect water resources from *significant harm*. According to the Water Resources Act of 1972, *minimum flows* are defined as "the minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area" (Section 373.042 F.S.). A *minimum level* is defined as "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 of the area." Statutes provide that MFLs shall be calculated using the *best available* information,

The process of analyzing minimum flows and levels for the Middle Peace River is built upon the analyses previously performed on the Upper Peace River (Southwest Florida Water Management District 2002) and peer reviewed by Gore et al. (2002). Establishment of minimum flows and levels generally is designed to define thresholds at which further withdrawals would produce significant harm to existing water resources and ecological conditions if these thresholds were exceeded in the future.

This review follows the organization of the Charge to the Peer Review Panel and the structure of the draft report. It is the job of the Peer Review Panel to assess the strengths and weaknesses of the overall approach, its conclusions, and recommendations. This review is provided to the District with our encouragement to continue and enhance the scientific basis that is firmly established for the decision-making process by the SWFWMD.

1.0 THE CHARGE

The charge to the Peer Review Panel contains five basic requirements:

1. Review the District's draft document used to develop provisional minimum levels and flows for the Middle Peace River.

2. Review documents and other materials supporting the concepts and data presented in the draft document.
3. Participate in an open (public) meeting at the District's Tampa Service Office for the purpose of discussing directly all issues and concerns regarding the draft report with a goal of developing this report.
4. Provide to the District a written report that includes a review of the data, methodologies, analyses, and conclusions outlined in the draft report.
5. Render follow-up services where required.

We understand that some statutory constraints and conditions affect the District's development of MLFs and that the Governing Board may have also established certain assumptions, conditions and legal and policy interpretations. These *givens* include:

1, the selection of water bodies or aquifers for which minimum levels have initially been set;
2. the determination of the baseline from which "significant harm" is to be determined by the reviewers;
3. the definition of what constitutes "significant harm" to the water resources or ecology of the area;
4. the consideration given to changes and structural alterations to watersheds, surface waters, and aquifers, and the effects and constraints that such changes or alterations have had or placed on the hydrology of a given watershed, surface water, or aquifer; and
5. the adopted method for establishing MFLs for other water bodies and aquifers.

In addition to the draft report and appendices, various types of supplementary data provided by the District also were examined as part of this review.

2.0 RESULTS OF THE PEER REVIEW

MFL Benchmarks and Resource Protection Goals

Benchmarks and the Atlantic Multidecadal Oscillation (AMO)

The report uses the five elements listed by Beecher (1990) as guidelines for developing minimum flows and levels (MFLs). These are a good set of guidelines. One guideline, the use of a benchmark period, needs to be coupled to the growing understanding of climate variability, the AMO, and river flow regimes in Florida. The draft report by Kelly (SWFWMD 2004) does an excellent job in demonstrating how various benchmark periods can yield very different answers with regards to flow regime when the AMO is in different modes. The analyses of AMO and streamflow relationships for Florida (SWFWMD, 2004) was previously peer reviewed and the findings of the draft report were strongly endorsed by the reviewers (Shaw et al, 2004). In Florida, the status of the AMO needs to be considered when MFLs are being set, especially given the strong

influence of the AMO on streamflow patterns, and when regulatory and other measures are being considered to sustain adequate flows and levels (Enfield et al. 2001). The District has fully embraced the climate-streamflow issue in developing the MFLs for the Middle Peace by evaluating and identifying limiting flow conditions for two separate benchmark periods (based on different phases of the AMO) for each approach described in the report. Recommended low-flow thresholds and percent flow reduction criteria are based on the most limiting of these benchmark periods to ensure adequate protection during periods when less rainfall and lower streamflow prevail. The peer review panel strongly endorses this approach and recommends that similar approaches should routinely be incorporated when setting MFLs for all rivers in Florida and that knowledge of AMO-streamflow relationships gained by District staff be widely disseminated to water managers throughout Florida and other parts of the eastern United States.

The MFL report for the Middle Peace River includes a convincing argument that observed trends in mid- to high-percentile flows in this segment of the river and its tributaries over the past several decades is largely the result of climate, rather than of land use changes in the watershed as has been previously concluded. These arguments and conclusions were peer reviewed in conjunction with the AMO streamflow report (SWFWMD, 2004), and were determined to be persuasive, soundly based on insights gained in analyzing AMO-streamflow patterns and well supported by data (Shaw et al, 2004). We believe this analysis adequately addresses issues of prior anthropogenic changes to the hydrologic regime of the Middle Peace River.

Building Block Approach

The SWFWMD has employed a building block approach in establishing MFLs on the Middle Peace (Gore et al. 2002, Postel and Richter 2003). The assumptions behind building block methods are based upon simple ecological theory. Organisms and communities occupying a river have evolved and adapted their life cycles to flow conditions over a long period of pre-development history (Stanford et al. 1996). Thus, with limited biological knowledge of specific flow requirements, the best alternative is to maintain or recreate the hydrologic[SWG1] conditions under which communities had existed prior to disturbance of the flow regime or allocation of instream flows. Building-block models are the "first-best-approximation" of adequate conditions to meet ecological needs. More often than not, resource agencies have hydrographic records for long periods of time, while little or no biological data are available.

Hydrological variability is the critical template for maintaining ecosystem integrity. The use of this natural variability as a guide for ecosystem management has been widely advocated (e.g. Richter et al. 1996). Although variability is a key to ecosystem maintenance, some sort of predictability of variation must be maintained. It must be realized that survival of aquatic communities is contained within the envelope of natural variability (Resh et al. 1988). In addition to the seasonal pattern of flow, such conditions as time, duration and intensity of extreme events, as well as the frequency and predictability of droughts and floods may also be significant environmental cues. Also, the frequency, duration, and intensity of higher and lower flows can affect channel

morphology and riparian vegetation, and thus change aquatic habitat. Indeed, the rate of change of these conditions must also be considered (Poff and Ward 1989, Davies et al. 1994, Richter et al. 1996, 1997).

Hydrologic variability is a critical component of the Middle Peace hydrograph, and three blocks are defined from the average long-term annual hydrograph. Block 1 considers the low flow period that occurs during the spring dry season, Block 2 considers the baseflow period during the cooler portion of the year when evapotranspiration rates are often at their lowest levels, and Block 3 considers the high flow period during the summer/fall wet season. This is a valid approach for setting MFLs because it accounts for expected seasonal variability during a typical year. By contrast, MFLs focused solely upon low flow conditions are inadequate for protecting important river and riparian ecosystem functions that occur at other times of the year which are often critical to the viability of aquatic organisms. The building block approach is based upon predictably varying hydrological conditions and is a rigorous and defensible approach for the establishment of protective MFLs for the Middle Peace. It also has the advantage of insuring a flow regime with the range of variability essential to the maintenance of stream structure and function.

However, one potential weakness of using building blocks with fixed beginning and ending dates, as was done for the Middle Peace, is that some important ecosystem functions may receive inadequate protection if an atypical or unusual water year occurs. For example, during strong El Niño cycles, Florida often receives more intense rains and higher streamflows during the winter and spring months, which are assumed to be low flow periods in the Middle Peace River. Conversely, less than average rainfall and streamflow may occur during the summer. This often results in an annual hydrograph that is seasonally reversed from the pattern assumed by the District's building blocks. It is not clear whether fish and other aquatic organisms in the Peace River utilize available habitat in the same way if high flows occur during the winter as they do if high flows occur in the summer, and additional research on this issue is probably warranted. Nevertheless, we commend District staff for specifying that the proposed low flow threshold should apply year around, not just during Block 1, and we recommend that staff re-evaluate proposed flow reduction criteria to determine whether all intended resource protection goals would be satisfied during El Niño events or other unusual hydrologic conditions.

Preventing Significant Harm – 15% Change in Habitat

The draft report for setting MFLs in the Middle Peace has chosen to use a 15% change in habitat availability as the threshold for defining significant harm. This value was chosen based upon the peer review report by Gore et al. (2002) for the SWFWMD report on setting MFLs for the Upper Peace (SWFWMD 2002). The report notes that percentage changes have ranged from 10-33% in other applications designed to prevent significant harm (Dunbar et al. 1998; Jowett 1998). The peer review panel feels that the 15% threshold selected for preventing significant harm is appropriate and prudent for the

Middle Peace. It should be acknowledged, however, that a 15% change in habitat availability based on a reduction in spatial extent of habitat (as was used in the PHABSIM analyses) may not be equivalent to a 15% change in habitat availability based on number of days a particular habitat is inundated (as was applied to the RALPH analyses).

Analytical Tools Used to Develop MFLs

HEC-RAS

The Hydrologic Engineering Centers River Analysis System (HEC-RAS) model is used for estimating one-dimensional steady-state water surface profiles in setting MFLs for the Middle Peace. HEC-RAS is a model developed by the US Army Corps of Engineers Hydrologic Engineering Center and is widely used, having previously replaced the HEC-2 model as the standard program for water surface profile calculations. The newest generation of the model (version 3.1.1) was used with a range of flows from the USGS Arcadia and Zolfo Springs gages to determine stage versus flow and wetted perimeter versus flow for numerous cross sections and shoal sites along the Middle Peace. This model has a history of being used to estimate minimum flows (Gore and Mead 2002).

The HEC-RAS model also was used in establishing MFLs for the Upper Peace (SWFWMD 2002). The concern expressed in the peer review of this report was that the hydraulic model needed to be linked to a biotic habitat model. This has been done in the report for the Middle Peace by use of the Physical Habitat Simulation (PHABSIM) model with key biota from the Middle Peace, and is also used in the fish passage and wetted perimeter analysis and with RALPH analyses of woody habitat and floodplain plant communities. This is an appropriate linking of models and makes for a more robust determination of MFLs.

The peer review panel deems the HEC-RAS model to be an appropriate tool for assessing flow-stage relationships along the Middle Peace. However, a more explicit discussion of the precision and accuracy of HEC-RAS in estimating water depths and sensitivity of depth calculations to changes in flow would be a helpful addition to the report and would improve our understanding of the sources of uncertainty inherent in the minimum flow recommendations. Also useful in a similar vein would be to include more information about how elevations of the USGS cross sections that form much of the basis for HEC-RAS calculations were determined, specifically whether elevations were field surveyed or taken from a digital elevation model and what are the associated standard errors of those data sets.

PHABSIM

The Instream Flow Incremental Methodology (IFIM) (Bovee et al. 1998) and its software, the Physical Habitat Simulation (PHABSIM) requires hydrological data plus the additional effort of determining the physical habitat requirements of target biota. There are five major hydraulic conditions that affect the distribution and ecological success of riverine biota. These are suspended load, bedload movement, turbulence, velocity

profile, and substratum interactions (near bed hydraulics). Singly, or in combination, changes in these conditions can alter distribution of biota and disrupt community structure. The interactions of these hydraulic conditions upon the morphology and behavior of the individual organisms govern the distribution of aquatic biota. The IFIM attempts to describe these interactions using a relatively simple modeling technique.

Traditionally, the IFIM technique has focused on habitat availability of target fish species. Gore and Nestler (1988) believe that habitat suitability curves can be thought of as surrogates for basic niches. Statzner et al. (1988) and Gore and Bryant (1990) have demonstrated that different macroinvertebrate life stages also require different hydraulic conditions to achieve completion of life cycles, just as fish species have very different spawning, incubation, and maintenance requirements. Most recently, Gore et al. (2001) demonstrated that inclusion of macroinvertebrate criteria often dramatically altered decisions on flow reservations[SWG2] versus those based upon analysis of fish species alone. By the same token, we recommend that the District evaluate whether additional habitat suitability curves should be developed and PHABSIM analyses be conducted for other species that may be more sensitive to hydrologic change than the three common centrarchid fishes identified in the Middle Peace report.

Changes in velocity distribution and substrate/cover characteristics at regular intervals, combined with stage/discharge relationships, provide the calibration data for PHABSIM. Habitat suitability curves were developed for spotted sunfish (*Lepomis punctatus*), largemouth bass (*Micropterus salmoides*), bluegill sunfish (*Lepomis macrochirus*), and macroinvertebrate community diversity (Gore et al. 2001; Stuber et al. 1982). These are appropriate species for consideration in the Middle Peace and their selection is validated by data presented on fish abundance in the appendix to the MFL report. The need for continued development and refinement of habitat suitability curves for these species and other species of concern remains a necessary long-term goal as noted below, but the peer review panel affirms that the best available information was used in the PHABSIM modeling for the Middle Peace River. This strengthens the specific recommendations for MFLs made in the report.

Over the long term, we recommend that the District focus research on evaluating and potentially developing habitat suitability information on additional species or groups of species that may be more sensitive to changes in the hydrologic regime. Of particular concern would be any listed, imperiled, or endemic species, species tracked by the Florida Natural Areas Inventory (FNAI) (e.g., ironcolor shiner, present in several tributaries of the Middle Peace), freshwater mussels, anadromous or catadromous fishes (e.g., American eel), marine fishes utilizing the freshwater portions of the river, and species with preferences for stream edges or banks that might be the first places to feel the effects of reduced flows. Similarly, it may be useful to develop better habitat suitability information for certain exotic species present in the Peace River (e.g., blue tilapia) to ensure that reduced flows do not *improve* habitat conditions for such species or facilitate their invasion of new habitat.

RALPH

Recent and Long-Term Positional Hydrographs (RALPH) plots and analyses were used in the report to identify the number of days from a defined period of record when flows or levels associated with a specific aquatic habitat or floodplain feature were equaled or exceeded. These analyses were applied at various river cross-sections and enable a quantitative assessment of how flow reductions of a certain magnitude would affect the number of days that certain flow characteristics would be met or exceeded. Examples are given in Figures 4-7 and 4-8 in the report. As a means of analysis and graphical visualization, the panel feels that the RALPH plots are an important enhancement to the presentation of MFLs for the Middle Peace River, and we recommend that the District continue to utilize and refine this tool for future MFL development.

Habitat Criteria and Characterization Methods Used to Develop MFLs

FISH PASSAGE

Fish passage was used to estimate flows sufficient to permit fish movement throughout the Middle Peace River. Flows of this magnitude would also likely permit recreation (i.e. canoeing) and presumably provide adequate water movement to prevent the most extreme adverse effects associated with intermittency (i.e. low dissolved oxygen, high temperature, and stagnation). A fish passage criterion of 0.6 ft was used based in part on size data from large-bodied fishes in Florida streams and minimum fish passage depths used in other instream flow settings elsewhere in the U.S. This criterion has been used to develop previous minimum flow plans (SWFWMD 2002) and has been found acceptable following peer review (Gore et al. 2002).

Flows adequate to maintain the fish passage criterion were estimated at stream cross sections using output from the HEC-RAS model. Water depth at the deepest part of the channel was used to establish the criterion. Fish passage criteria were established for both the Arcadia and Zolfo Springs gages. The peer review panel feels that the continued use of the 0.6 ft standard represents best available information and is reasonable and consistent with overall SWFWMD water allocation policy.

This notwithstanding, fish passage depths in the range of 0.5-0.8 ft were originally derived from requirements of migratory salmonids in cool, well oxygenated waters of the western U.S. The adequacy of these standards for use in Florida's warmwater streams has been questioned by resource managers (HSW, 2004). Although no definitive research has yet been conducted on this issue (Hill and Cichra, 2002), it is the emerging consensus that minimum depth criteria used in Florida need to be re-evaluated to ensure that they adequately prevent negative effects associated with low flows in warmwater ecosystems, including high water temperatures, low dissolved oxygen, algal blooms and increased predatory pressure, in addition to mere physical passage of fish. The peer review panel recommends that the District engage with researchers studying fish passage depths for warmwater streams and actively work to develop minimum fish passage criteria that are

more suitable for warmwater aquatic ecosystems and which go beyond the issue of simple physical passage to address other negative impacts of low flows.

It should also be noted that based on size data included in the appendix of the present report, a minimum depth of 0.6 ft is barely adequate for physical passage of several of the largest-bodied gamefish common to the Middle Peace River. Re-evaluation of fish size data and occurrence records for additional species that may be using (or may have historically used) shoal habitat on the Peace River may be warranted to ensure that minimum depth criteria are adequate for all species. For example, several records of gulf sturgeon (*Acipenser oxyrinchus desotoi*) occur in the lower Peace River and Charlotte Harbor, and although no upstream records for this species exist for the Middle Peace, this fish is known to spawn in other Gulf slope rivers in Florida at limestone shoals similar to those on the Peace. The District should evaluate whether minimum depth criteria used for sturgeon in other Florida rivers (e.g., the U.S. Fish and Wildlife Service has proposed a minimum depth of one meter or greater over shoals in the Apalachicola River to protect sturgeon spawning, J. Ziewitz, USFWS, Panama City, personal communication) would be appropriate for use in the Middle Peace as an alternative to the 0.6 ft minimum depth.

As a final note, one of the water resource functions the Middle Peace MFLs are intended to protect is recreational use of the river. This goal is cited in Chapter 3, but the issue is never discussed or developed further anywhere in the report. While the panel feels that 0.6 ft is most likely an adequate depth that will permit canoeing during low flow periods, this issue and discussion of appropriate minimum depth criteria should be further developed. If it is being assumed that recreation is mostly passive (e.g., canoeing) and that the low flow threshold based on fish passage or wetted perimeter analysis will also protect flows and levels for recreation, then the peer review panel recommends that this be explicitly stated and justified in the report. The justification, if possible, should cite figures on boating usage, minimum depths and widths needed for safe and enjoyable passage of canoes or other craft and include analysis demonstrating that those conditions would be satisfied by the proposed low threshold flows. It would also be helpful for evaluating the potential impacts to both recreation and ecological functions to include a plot of the proposed low-flow thresholds versus historic flows to provide context and perspective for the recommendations.

DAYS OF FLOODPLAIN INUNDATION

Low gradient streams, like the Middle Peace River, often have an extensive floodplain. Floodplains support complex and diverse plant communities whose distribution is determined by small changes in microtopography and average length of annual inundation or hydroperiod. Plant communities are often adapted to the average annual flow regime and decline if flood frequency is altered. Extensive floodplains are often critical to aquatic life. During floods river biota migrate into floodplains for foraging and spawning. In addition, periodic flooding stimulates biogeochemical transformations in floodplain soils which benefit both floodplain and riverine productivity.

The District has recognized the critical role of floods in proposing minimum flows for the Middle Peace River. Extensive vegetation and elevation surveys were used to characterize the structure of floodplains in the Middle Peace. HEC-RAS and RALPH plots/analysis were used to determine floodplain inundation patterns based on historical benchmark periods. This information was then used to estimate percent of flow reductions for Block 3 that would result in no more than a 15% reduction in the number of days of inundation. The analysis suggested that a stepped approach to water allocation during Block 3 would meet the established criteria.

The peer review panel feels that consideration of high flows and patterns of floodplain inundation is commendable. The use of a 15% reduction in the number of days of inundation is an appropriate criterion for water allocation and is consistent with the working definition of significant harm used in the report.

However, some modifications to the methodology and its presentation in the report would improve the repeatability of the analyses and our confidence in the results. First, the characterization of floodplain communities is a sometimes confusing mix of geomorphic settings (e.g., berm, river terrace, uplands) and plant communities (e.g., marsh, cypress, hardwood swamp, maple, etc.) that do not appear to conform to any standard scheme for community classification that is widely accepted in Florida; e.g., FNAI natural communities. Some categories would seem to overlap with or represent subsets of others (e.g., maple and hardwood swamp or wet hardwood hammock and perhaps seepage slope). More explanation is needed of the methods used for identifying and characterizing floodplain plant communities, including procedures for determining boundaries between communities, what diagnostic species are used to identify each community, whether the understory or overstory was primary in defining communities, and what system was used for assigning names to different plant communities. At a minimum, plant lists or a table of dominant or diagnostic species for each community should be included in the appendix and referenced in the main body of the report, and plant community names should be changed to conform to more accepted convention.

Second, while the analysis considers inundation to both the mean and 90^{th}-percentile (highest) ground elevations of the dominant wetland plant communities, it fails to consider the need for inundation over and above what would barely cover the ground surface. Not only would inundation to some minimum depth be necessary to permit fish passage into these communities, but is also necessary for maintaining productivity of the floodplain wetlands. We recommend redoing the analyses considering inundation of each community to some minimum depth above the mean ground elevation. The minimum depth selected could be the value selected for fish passage or a typical wet season depth for the type of community being analyzed. There are numerous references in the literature to normal or typical wet season inundation depths for various wetland community types in Florida (e.g., CH2M Hill, 1996; ESE, 1991). While the final flow reduction derived from this modified analysis may not differ appreciably from what is presented in the report, the analysis would be more ecologically defensible and perhaps more protective of wetland functions in the floodplain.

Third, a more thorough discussion of sources of uncertainty and how uncertainty was controlled or dealt with in this analysis, as well as more information on the range of variability of measured elevations, would be helpful additions to the report and would aid in interpreting the results. Including more of the RALPH plots in the main body of the text or at least making reference to such plots included in the Appendix would also improve readers' understanding of the results.

SNAG AND ROOT INUNDATION

Woody substrates (snags and exposed roots) are a critical habitat in most low gradient southeastern streams. Woody substrates are often the most productive habitat (on a unit area basis). Wood also provides shelter for freshwater fishes and basking sites for aquatic herpetofauna. Submerged wood is also important in biogeochemical transformation; as biofilms develop on submerged wood, carbon and nutrient processing are enhanced and overall stream metabolism is increased.

The District estimated the mean elevation of woody substrates using instream habitat cross-sections in the Middle Peace River. Then, an estimate of the average frequency of inundation was determined using the two benchmark periods. Data from the most recent period (1970-1999) was used because it was more conservative (i.e. it was a period of lower stream flow). This was compared with previously prescribed flow reductions in Blocks 1 and 3 to determine the overall effect on woody substrate inundation. These analyses were used to help determine the allowable flow allocation during Block 2 and then estimate flow allocations that would result in no more than 15% reduction in days of inundation over the entire year.

The peer review panel agrees with the District that woody substrates are a critical habitat in the Middle Peace River and that their duration of inundation should be considered in flow allocation strategies. The approach adopted by the District is reasonable and consistent with other recommendations made in the report.

As noted above for floodplain inundation analyses, a more thorough discussion of sources of uncertainty and how uncertainty was controlled or dealt with in this analysis, as well as more information on the range of variability of measured elevations, would be helpful additions to the report and would aid in interpreting the results. Including some more of the RALPH plots in the main body of the text or at least making reference to such plots included in the appendix would also improve readers' understanding of the results.

COMPLIANCE STANDARDS AND PROPOSED MINIMUM FLOWS

The peer review panel strongly endorses the District's proposed minimum flows for the Middle Peace River at Arcadia and Zolfo Springs and finds them to be based on sound science and best available information, subject to our comments and recommendations above. We believe that the use of two separate benchmark periods based on distinct

climate regimes and multiple assessment methods and habitat criteria for identifying the limiting flow reductions in each seasonal block gives additional confidence in the District's work and lends credibility to the results. We recommend that a similar methodological framework be adopted for developing all future MFLs. We commend the District for specifying minimum flows in terms of allowable percent flow reductions for different seasonal blocks and a low-flow threshold applicable at all times of the year. This "percent of flow approach" as it is called by instream flow analysts, combined with seasonal building blocks, has been recognized as one of the best ways of protecting multiple functions and values of river systems under a wide range of flow conditions (Postel and Richter, 2003). The proposed short and long term compliance standards proposed in the report are a pragmatic and logical means of implementing the findings of the report in a regulatory context.

We applaud the District's commitment to periodic reassessment of the MFLs for the Middle Peace River and other water bodies as structural alterations or substantial changes in watershed conditions occur. We strongly recommend, however, that the District begin now to develop the process and methodology by which such reassessment would occur. Specifically, we recommend that an adaptive management framework be adopted for evaluating compliance with the MFL, taking corrective action to reduce water withdrawals and triggering MFL reassessments when necessary. Such a framework should include ongoing evaluation of the effectiveness of the MFLs based on long term monitoring of key ecosystem and water resource values the MFL is intended to protect and periodic assessment of whether key assumptions inherent in the MFL development are still satisfied.

REFERENCES

Bovee, K.D., B.L. Lamb, J.M. Bartholow, C.B. Stalnaker, J. Taylor, and J. Henriksen. 1998. *Stream habitat analysis using the instream flow incremental methodology.* U.S. Geological Survey, Biol. Res. Div., Info. and Tech. Rpt. USGS/BRD-1998-004.

CH2M Hill. 1996. *Water Supply Needs and Sources Assessment Alternative Water Supply Strategies Investigation: Wetlands Impact, Mitigation and Planning Level Cost Estimating Procedure*, Special Publication SJ96-SP7, St. Johns River Water Management District, Palatka, Florida, July 1996, 196 p.

Davies, B.R., M.C. Thoms, K.F. Walker, J.H. O'Keeffe, and J.A. Gore. 1994. Dryland rivers: their ecology, conservation, and management. Pp. 484-511 *in:* P. Calow and G.E. Petts (eds.) The *Rivers Handbook. Volume 2.* Blackwell Scientific Publishers, London.

Dunbar, M.J., A. Gustard, M.C. Acreman, and C.R. Elliott. 1998. Overseas approaches to setting river flow objectives. Institute of Hydrology. Research and Development Technical Report W6-161. Oxon, England. 83 pp.

Enfield, D.B., A.M. Mestas-Nuñez, and P.J. Trimble. 2001. The Atlantic multidecadal oscillation and its relation to rainfall and river flows in the continental U.S. *Geophysical Research Letters* 28: 2077-2080.

Environmental Science and Engineering, Inc. (ESE). 1991. *Hydroperiods and waterlevel depths of freshwater wetlands in south Florida: A review of the scientific literature*. Final report prepared for South Florida Water Management District, West Palm Beach, Florida.

Gore, J.A., and R.M. Bryant, Jr. 1990. Temporal shifts in physical habitat of the crayfish, *Orconectes neglectus* (Faxon). *Hydrobiologia* 199: 131-142.

Gore, J.A., J.B. Layzer, and J. Mead. 2001. Macroinvertebrate instream flow studies after 20 years: a role in stream and river restoration. *Regulated Rivers* 17: 527-542.

Gore, J.A., and J. Mead. 2002. The Benefits and Dangers of Ecohydrological Models to Water Resource Management Decisions. *In: Ecohydrology: A New Paradigm* United Nations/UNESCO, Geneva and Cambridge University Press.

Gore, J.A., and J.M. Nestler. 1988. Instream flow studies in perspective. *Regulated Rivers* 2: 93-101.

Gore, J.A., C. Dahm, and C. Klimas. 2002. A review of "Upper Peace River: an analysis of minimum flows and levels". Prepared for the Southwest Florida Water Management District. Brooksville, FL.

Hill, J.E. and C.E. Cichra. 2002. *Minimum Flows and Levels Criteria Development, Evaluation of the Importance of Water Depth and Frequency of Water Levels/Flows on Fish Population Dynamics: Literature Review and Summary*, Special Publication SJ2002-SP1, St. Johns River Water Management District, Palatka, Florida, February 2002, 40 p.

HSW Engineering, Inc. 2004. *Evaluation of the Effects of the Proposed Minimum Flows and Levels Regime on Water Resource Values on the St. Johns River between SR528 and SR46*, Report prepared for St. Johns River Water Management District, Palatka, Florida, November 2004, 159 p..

Jowett, I.G. 1998. Hydraulic geometry of New Zealand rivers and its use as a preliminary method of habitat assessment. *Regulated Rivers* 14: 451-466.

Poff, N.L., and J.V. Ward. 1989. Implications of streamflow variability and predictability for lotic community structure: a regional analysis of streamflow patterns. *Canadian Journal of Fisheries and Aquatic Science* 46: 1805-1818.

Postel, S., and B. Richter. 2003. Rivers for Life: Managing Water for People and Nature. Island Press. Washington D.C. 253 pp.

Resh, V.H., A.V. Brown, A.P. Covich, M.E. Gurtz, H.W. Li, G.W. Minshall, S.R. Reice, A.L. Sheldon, J.B. Wallace, and R. Wissmar. 1988. The role of disturbance in stream ecology. *Journal of the North American Benthological Society* 7: 433-455.

Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Braun. 1996. A method for assessing hydrologic alteration within ecosystems. *Conservation Biology* 10: 1163-1174.

Richter, B.D., J.V. Baumgartner, R. Wiggington, and D.P. Braun. 1997. How much water does a river need? *Freshwater Biology* 37: 231-249.

Shaw, D.T., D.S. Gutzler, and C.N. Dahm. 2004. *Peer Review Comments on "Florida River Flow Patterns and the Atlantic Multidecadal Oscillation"* Report prepared for Southwest Florida Water Management District, December 2004, 10 p.

Southwest Florida Water Management District. 2005. Proposed minimum flows and levels for the middle segment of the Peace River, from Zolfo Springs to Arcadia.

Draft. Ecologic Evaluation Section. Resource Conservation and Development Department. Brooksville, FL.

Southwest Florida Water Management District 2004. Florida river flow patterns and the Atlantic Multidecadal Oscillation. Draft. Ecologic Evaluation Section. Resource Conservation and Development Department. Brooksville, FL.

Southwest Florida Water Management District 2002. Upper Peace River: an analysis of minimum flows and levels. Draft. Ecologic Evaluation Section. Resource Conservation and Development Department. Brooksville, FL.

Stanford, J.A., J.V. Ward, W.J. Liss, C.A. Frissell, R.N. Williams, J.A. Lichatowich, and C.C. Coutant. 1996. A general protocol for restoration of regulated rivers. *Regulated Rivers* 12: 391-413.

Statzner, B., J.A. Gore, and V.H. Resh. 1988. Hydraulic stream ecology: observed patterns and potential applications. *Journal of the North American Benthological Society* 7: 307-360.

Stuber, R.J., G. Gebhardt, and O.E. Maughan. 1982. Habitat suitability index models: largemouth bass. U.S. Fish and Wildlife Service. FWS/OBS – 82/10.16. U.S. Government Printing Office. Washington D.C.

Errata

The pagination for Chapter 2 in the table of contents is incorrect.
Figures for chapter 2 have incorrect page numbers in table of figures.
XI – compliance standard to compliance standards
XII – as a 10% to as 10%
1-2 – et. to et
1-3 – remove first "should" in 1)
1-3 – Hill et al to Hill et al.
1-3 – (typically to typically
1-5 – United State to United States
1-9 – combination of three to combination of these three
2-3 – double periods before and after the first full sentence
2-3 – or 49 to of 49
2-4 – 74 inches respectively to 74 inches, respectively
2-5 – aquifer systems occur to aquifer systems that occur
2-6 – decades to decades.
2-9 – is, comprised to is comprised
2-11 – purposed to purposes
2-15 – land use/cover, changed to land use/cover changed
2-21 – double periods
2-21 – in 1999 in 1999 to in 1999
2-24 – benchmark period to benchmark periods
2-25 – Kelly (2004) to Kelly (2004),
2-27 – move "in Florida" to after "a warm period"
2-27 – Conversely to Conversely,
2-28 – Table 2-6 – Drainage instead of Drinage
2-29 – decline flows to decline in flows
2-33 – level was to level at
2-33 – sub-basins if to sub-basins. If
2-33 – but should to but one should
2-33 – needed one to needed. One
2-33 – SDI – define acronym
2-34 – Further it to Further, it
2-34 – flows rat to flows at
2-36 – Figure 2-23 to Figure 2-23.
2-42 – American River to American Rivers
2-43 – the at Arcadia to the Arcadia
2-46 – if an apparent to if apparent
2-47 – Peace River sites to Peace River sites)
2-48 – at Arcadia concentrations were to at Arcadia
Tables 2-11 to 2-14 – state significance level in legend
3-1 – sentence starting with "The District" in first paragraph does not make sense
3-1 – Gore et al. to Gore et al. (2002)
3-2 – swimming wildlife to swimming, wildlife
3-6 – of this of habitat to of this habitat

3-6 – Junk et al.. to Junk et al.
3-6 – Wharton et. al. to Wharton et al.
4-1 – establishing to Establishing in chapter title
4-15 – Hydroraphs to Hydrographs
4-16 – Figure 4-8 – Title needs revision; legend has extra parenthesis, and 2% should be 20%
4-19 – FLgage to FL gage
4-20 – of a prescribed to of prescribed
4-22 – gage site to gage site.
4-22 – of a prescribed to of prescribed
5-1 – Peace River to Peace River.
5-4 – Figure 5-2 – (cfs to (cfs)
5-5 – stage are exhibit to stage exhibit
5-6 – Figure 5-4 – less the 50% to less than 50%
5-8 – less then to less than
5-8 – 15% of to 15% or
5-8 – inundated to inundate
5-8 – Block 3 for was to Block 3 was
5-12 – Table 5-4 – inundation to inundate
5-13 – a slightly more restrictive standards then to slightly more restrictive standards than
5-13 – last paragraph – multiple edits are needed
5-16 – threshold to thresholds; prescribe to prescribed; standards were to standard was; loss habitat to loss of habitat
5-17 – based a limiting to based on limiting
5-20 – Figure 5-13 – less the to less than
5-23 – Table 5-5 – flow is sufficient to flow sufficient
6-1 – Mississippi River: to Mississippi River.
6-2 – Dr. Patton – need initials rather than Dr.
6-2 – Arsdall jr. to Arsdall Jr.
6-8 – GD Grossman to G.D. Grossman
6-10 – italicize or underline Orthocladius calvus
6-12 – Water resource to Water Resource
6-13 – fife to life
6-18 – Whitehurst reference is incomplete
The SWFWMD (2004) reference concerning the AMO is missing from the references.
Be sure and include publisher and location for all books and reports.
Other minor editorial changes like commas are on my original but not included here.

Specific Editorial Comments (by page number in draft)

1. Title: Since minimum levels are not specified directly in this report, should you remove the word "Levels" from the title?
2. Page xi, 2nd paragraph, 3rd sentence: "for evaluation" should be "for evaluating"
3. Page xi, 3rd paragraph, 3rd sentence: "standard" should be "standards"
4. It should be explicitly stated in the executive summary that a 15% reduction in habitat availability, as measured by spatial extent or days of inundation, is considered significant or unacceptable harm.
5. Page xii, last paragraph, 1st sentence: "standard" should be "standards"
6. Page xii-xiii: the discussion of short and long term standards if difficult to understand without reading the rest of the document.
7. Page 1-3, last paragraph: delete the open parenthesis in the phrase "…St. Johns River Water Management District (typically…"
8. On page 1-4 it is stated that "…it is also implicit that some deviation from the purely natural or existing long-term hydrologic regime may occur before significant harm occurs." Staff should make it clear whether this is a working assumption, a concept explicitly stated in statute or rule, or a legal interpretation of statute or rule.
9. Page 2-3, 1st sentence: delete one of two periods at end of sentence.
10. Page 2-3, 1st and 2nd paragraphs: list of references includes no citation for Texas Instruments, 1976, but does include citations for Texas Instruments 1977 and 1978.
11. Page 2-5, 3rd paragraph: it would be helpful to include a couple of sentences here describing the portions of the river for which baseflow is influenced by groundwater and the relative contribution to baseflow of each of the three aquifer systems identified.
12. Page 2-8, Fig. 2-4: Does the "Mines" land use category include only active mines or does it also include land that will be mined in the future? Also please describe if possible what is included in the "Other Agriculture" land use category. My guess is that this is mostly semi-improved pasture and could perhaps be combined with the "Rangeland" category.
13. Page 2-9, 4th paragraph, last sentence: after "…lowering of lakes in the area" please add "by construction of outlet canals."
14. Page 2-29, 2nd paragraph: Please provide more explanation as to why the Payne Creek watershed "apparently discharges more water during low flows than would be anticipated for a watershed of its size…" Explanation of this "outlier" is important here in that it improves the credibility of the normalization method (i.e., dividing flows by watershed area) and because the Payne Creek sub-basin is previously stated as having the highest percentage of mined lands of any of the Middle Peace sub-basins.
15. Pages 2-30 & 2-31, Figs. 2-19 & 2-20: In the figure captions you should state that "WA" is "watershed area." This is not evident at first glance.
16. Page 2-32, 1st sentence: "lead" should be "led"

17. Page 2-33, line 4: delete the word "was" in the phrase "alpha level was exactly 0.1"
18. Page 2-33, 1st paragraph: The sentence "Hammett (1990) also included the Caloosahatchee Canal…" is not necessary to the argument and could be deleted.
19. Page 2-34, 1st paragraph, last sentence: "…a very low percentage at worst and considerably lower than the 17% referenced by SDI (2003)" kind of begs for a more justification.
20. Page 2-34, 2nd paragraph: in the sentence "it should be appreciated that the conclusions in this report" please replace "this report" with "the Hammett report"
21. Page 2-34, last paragraph, 2nd sentence: "Figure 2-26, upper panel" should be "Figure 2-22, upper panel"
22. Page 2-34, last paragraph, 3rd sentence: please add "as has been documented for other streams in this region." To the end of this sentence.
23. Pages 2-37 & 2-38, Figs. 2-23 & 2-24: please add "Mean annual streamflow in cubic feet per second" to the vertical axes of these graphs.
24. Page 2-41, 1st paragraph, 1st sentence: please change ""…have not been appreciable flow declines…" to "…have been no appreciable flow declines…" Also "can not" should be "cannot"
25. Page 2-43, 2nd paragraph and Table 2-9: can you provide more explanation as to why the Withlacoochee River is so different from the other streams with respect to the start and end times of the seasonal blocks. Simply discarding the Withlacoochee with no explanation makes it appear that confounding data is being subjectively discarded.
26. Section 2.5 is interesting reading and to a certain extent bolsters the arguments made earlier regarding flow trends. However, its relationship to the MFLs is not clear and needs some additional perspective to bring it in line with the thrust of this report. Otherwise, perhaps the issues associated with water quality deserve some mention in Section 2.4, but the bulk of this presentation could be moved to an appendix.
27. Page 2-46, section 2.5.2.1, 1st paragraph: What is the basis for the statement that background conditions for P for streams in the Bone Valley should be in the range of 0.1 and 0.5 mg/L?
28. Page 2-48, 1st paragraph: the statement "historically concentrations of 1.0 mg/l were commonly encountered at all sites…" may be a bit misleading. Should make it clear that this statement is based on the observed record since the late 1960s and does not imply that "natural" background levels were this high.
29. Page 2-48, Section 2.5.3, 1st paragraph, 1st sentence: "finding" should be "findings." Also the statement is made that an increasing trend in potassium is "one of the more interesting and unanticipated findings" but never really expands on this. Why is it interesting and unanticipated?
30. Page 3-1, Section 3.1, 1st paragraph, 3rd sentence: This sentence appears to be less a statement of goals than a restatement of the methodology.
31. Page 3-1, Section 3.1, 2nd paragraph: My read of the Gore at al (2002) report suggests that the quoted statement regarding a 15% loss of habitat as being a "significant impact" applies more narrowly to accepted practice in using

PHABSIM techniques, but not necessarily as a general rule for all instream flow analyses.

32. Page 3-2, 1st paragraph, last sentence: "less then" should be "less than"
33. Page 3-2, Section 3.2, 1st paragraph, 1st sentence: does this statement of the resources to be protected include any portions of the tributaries to the Middle Peace?
34. Page 3-3, list of resource management goals: item 2 appears to be a restatement of the methodology rather than a goal; item 5 – note that most research points to the need for not only maintenance of hydrologic connections between the river channel and the floodplain, but also maintenance of spatial extent and duration of flooding (hydroperiod) typical of floodplain plant communities to "ensure floodplain structure and function."
35. This chapter mentions "Recreational Use" (e.g., in the title of section 3.3.1) as a resource of the Middle Peace River intended to be protected by the MFLs, yet this issue is never discussed or developed anywhere in the report.
36. Page 3-4, Section 3.3.2: Needs a diagram of a river cross section to explain where in the cross section these inflection points typically occur.
37. Page 3-7, 3rd paragraph, 2nd sentence: it would be good to cite some of the published studies that are alluded to here
38. Section 4.2 general: it would be helpful to include a figure showing all types of cross sections on the same map. Do any of the cross sections established by District staff coincide with any of the USGS cross sections?
39. Page 4-3: Should explain how USGS cross sections were determined – were they obtained from topographic surveys in the field? Taken from a digital elevation model? Extracted from a topographic map?
40. Page 4-6, Section 4.2.4, 1st paragraph: provide a citation for the USGS Gap Analysis Program maps. Also provide a citation if possible for the "previous determinations of the landward extent of floodplain wetlands in the river corridor"
41. Page 4-6, last sentence: does "inundate" mean here to inundate such that water just barely covers the ground or is some depth of inundation assumed?
42. Page 4-10, 2nd full paragraph: it would be helpful to identify all of the flows that were modeled, either previously by the USGS or for the MFL analysis, in common units of cubic feet per second, either in this paragraph or a table.
43. In general the discussion of the PHABSIM analysis could use more explanation of the details involved. As is, it comes across as kind of a "black box" in the report, especially to readers who may be unfamiliar with this approach.
44. Page 4-13, Section 4.3.2.1: some example habitat suitability curves would be helpful here. More discussion of the details of the PHABSIM methodology would be useful here. Method comes across as a "black box" with little description of the mechanisms being modeled and the field measurements on which they are based.
45. Page 4-13, 2nd paragraph, 3rd sentence: "know as" should be "known as." Also in this paragraph
46. Page 4-14, 3rd paragraph, 1st sentence: "dominance" should be clarified. This is apparently referring to percent abundance, not necessarily biomass. Sentence should refer to the species list and pie charts in the appendix.

47. Page 4-14, 3rd paragraph, 3rd sentence: The names of the experts contacted and those who responded should be included in the appendix and referenced here.
48. Page 4-14, 3rd paragraph, last sentence: This sentence seems to be a bit of a stretch since the total number of respondents was only six (i.e., N=6, not really sufficient statistical basis for treating outliers in this manner).
49. Page 4-14, 4th paragraph: more justification for selecting these two species is warranted here. Also more explanation is needed regarding the habitat suitability information for invertebrates.
50. Page 4-15, 2nd line: please add "each year" following "number of days"
51. Page 4-16, Fig. 4-8: in the figure caption "2%" should be "20%"
52. Section 4.5 general: it would be helpful perspective to include a graph of identified minimum flows compared with historic flows at each of the streamflow gauge locations
53. Page 4-17, Section 4.5.1, 1st paragraph, 7th sentence: it is noted that where no apparent inflection points were identified between the lowest modeled flow and 200 cfs, the LWPIP was established at the lowest modeled flow. Although this may be conservatively protective, this decision appears arbitrary and perhaps not defensible since one could argue that lower flows could (or should) have been modeled. This kind of decision was made not only for the wetted perimeter analysis, but for other analyses as well and the statistical or other implications on the results of the analyses are not always clear.
54. Page 4-18, Fig. 4-9: please add an arrow from the label "131 cfs" to the inflection point on the graph.
55. Page 4-19, lines 1-2: Sentence: "For these sites, the flow requirement for fish passage was established at the lowest modeled flow." See comment 53 above. Were there any cross sections for which this default flow was chosen for both fish passage and wetted perimeter analyses?
56. Page 4-20, last paragraph, last sentence: "development of a…" should be "development of…"
57. Page 4-21, 1st paragraph: note that a 15% temporal reduction in habitat (i.e., number of days habitat is inundated) is not necessarily equivalent to a 15% spatial reduction in habitat and the use of the 15% criterion here is not necessarily justified by its use in the PHABSIM analyses. Also it would be helpful to know a bit more about the variability of measured elevations of snags and exposed roots. How consistent were these elevations?
58. Pages 5-1 to 5-3, Section 5.2 general: much of this information appears repetitive, but perhaps is necessary since this the chapter of the report on which most readers will focus.
59. Chapter 5 general: it would be helpful to depict the identified minimum flow prescriptions on graphs of historic streamflow records for selected "normal", wet and dry years, or for median daily flow hydrographs (as was done in the April 12, 2005 presentation to the peer review panel). For most of the analyses, it would also be helpful to provide more information on the variability of field measured elevations – i.e., for snag and exposed root habitat, floodplain plant communities and floodplain soils to facilitate more meaningful assessment of the robustness of the results and conclusions. Including some more of the RALPH plots in the

main body of the text or at least making reference to such plots included in the Appendix would also improve readers' understanding of the results.

60. Page 5-1, Section 5.2.1, 1st paragraph: see comments 53 and 55 above. Now it appears that the default to the lowest modeled flow was done at most cross sections instead of just some cross sections.
61. Page 5-2, top paragraph: please provide more justification that the "standard flow" prevents problems such as low DO levels.
62. Page 5-2, Figure 5-1: Can you provide more description of the three cross sections for which low flows are limiting in this figure? Are they shoals or some other hydraulic control points?
63. Page 5-3, 2nd paragraph: Please provide additional justification for excluding the results from cross section 246.1. Also in this paragraph and throughout the report, the phrase "maximization of channel bottom habitat with the least amount of flow" seems misleading. I'm not sure that anything is really being maximized.
64. Page 5-4, Section 5.2.3: sentence "…flows…may be expected to drop below the low flow thresholds naturally…" would be better supported and interpreted if the thresholds were shown on a plot of historic flows.
65. Page 5-5, 1st paragraph, line 3: the word "are" should be deleted from "…life stage are exhibit…"
66. Pages 5-6 & 5-7, Figs. 5-4 & 5-6: these figures are difficult to understand and interpret and contribute little to the overall discussion. Consider deleting them.
67. Pages 5-7 & 5-8, Section 5.4: the short term compliance standards are awkwardly written. For prescription 2 (at Arcadia) change "flow are between 67 and 75 cfs" to "flows are greater than 67 cfs and less than 75 cfs" For prescription 3, delete the word "reduction" and change the phrase to read " 10% of all flows are available for consumptive use when flows are greater than or equal to 75 cfs." Similar changes are needed for the Zolfo Springs prescriptions.
68. Page 5-8: Section 5.5 general: although the results are clear, it may seem counterintuitive to some readers that a lower percent flow reduction is allowed in Block 3 when flows are generally highest than in block 2. Some additional explanation may be helpful to explain this point. Also it would be helpful to include more RALPH plots the explain the results in this section.
69. Page 5-8, Section 5.5, line 12: "…less then…" should be "…less than…"
70. page 5-8, last sentence: delete the word "for" from the phrase "…Block 3 for was defined…"
71. Page 5-9, Section 5.5.1: note that there is no section 5.5.2, so this subsection heading may not be necessary
72. Page 5-9, Table 5-1: this table is confusing and should be deleted and replaced with a diagram showing plant community distribution along one or two representative (or hypothetical) stream-floodplain cross sections
73. Page 5-10, 2nd sentence below the table: Change the sentence to read: "Seepage slopes and the Maple community were underlain by muck or clay soil and were influenced by seepage, rather than flood deposition and overflow from the river."
74. Page 5-10, 3rd sentence below table: change "…stratified layers…" to "…stratified soil layers…"

75. Page 5-10, 2nd paragraph, 4th sentence: change to read "Mean flows…inundate the four dominant vegetation communities (wet hammock, river terrace, cypress, hardwood swamp).
76. Page 5-10, 2nd paragraph, 5th sentence: explain the significance of the "90th percentile elevations"
77. Page 5-11, Table 5-3: information on dominant or characteristic plant species for each community should be added to this table.
78. Page 5-12, Table 5-4: in the third row of the table "inundation" should be "inundate." Also explain why the elevation of "mucky soils" is different from the ground elevations of the communities in which it occurs.
79. Page 5-13, 1st paragraph: delete the last sentence in this paragraph
80. Page 5-13, 2nd paragraph, 1st sentence: "…number of days rivers flows reached a given flow" is awkwardly written. Same sentence "Figures 5-5 and 5-6" should be "Figures 5-7 and 5-8"
81. Page 5-13, 3rd paragraph, 1st sentence: "Figures 5-5 and 5-6" should be "Figures 5-7 and 5-8"
82. Page 5-13, 3rd paragraph, last complete sentence: "While other multiple…consumptive use." Delete this sentence.
83. Page 5-14 &5-15, Figs 5-7 & 5-8: Provide rationale for choosing a 13% and 11% flow reductions for the second step in each of these figures. Choice seems subjective.
84. Page 5-16, paragraph before Section 5.7: in last sentence, phrase "loss of days in given flows being achieved" is awkward
85. Pages 5-19 and 5-20, Figs. 5-11 and 5-13: these figures are difficult to understand and interpret and contribute little to the overall discussion. Consider deleting them.
86. Page 5-22, Fig. 5-15: show range or standard deviation of elevations for each feature.
87. Page 5-22, 1st paragraph, 2nd sentence: the huge range of flows needed to inundate exposed root habitat at just two sites suggests a high degree of variability in the elevations of these features. Please provide some idea regarding variability of measured root/snag elevations.
88. Page 5-23 , 1st paragraph general: this explanation will not be clear to many readers. Also on line 9 of this paragraph should be changed to read "…of 783 cfs**,** a flow reduction of 8% was used for Block 3 rather th**a**n **the** low flow step…"
89. Page 5-23, Table 5-5: it appears based on this table and subsequent discussion that the analysis of snag habitat was largely irrelevant to the MFLs.
90. Page 5-26, line 1: "…flow records for each site were altered…" should "altered" here be changed to "reduced"?
91. Appendix, Pages FD-4 and FD-5: please provide a citation for the source of this fish data.