A Review of

"Proposed Minimum Flows and Levels for the Upper Segment of the Hillsborough River, from Crystal Springs to Morris Bridge, and Crystal Springs"

January 30, 2007 Peer Review Draft

by

Ecological Evaluation Section
Resource Conservation and Development Department
Southwest Florida Water Management District

Prepared by:
Peer Review Panel:

Charles E. Cichra, Ph.D.
Clifford N. Dahm, Ph.D.
Allan Locke, Ph.D.
Douglas T. Shaw, Ph.D.
Mark Stewart, Ph.D.

July 2007

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 (District) in the development of proposed minimum flows and levels (MFLs) for the upper Hillsborough River and Crystal Springs.

The Panel continues to endorse the District's overall approach for setting MFLs in riverine ecosystems and finds particularly merit in the use of seasonal building blocks, multiple benchmark periods based on multi-decadal climate variability, the use of multiple analysis tools for protecting both low and high flow regimes and the expression of MFLs as percent flow reductions. Overall, the Panel finds the methodologies used are appropriate, even innovative. District staff members have clearly spent a great deal of time and effort trying to arrive at a scientifically reasonable set of recommendations and have largely succeeded.

However, the Panel continues to believe that the adequacy of the low-flow threshold and the use of a de facto significant harm criterion based on a 15% reduction in habitat availability has not been rigorously demonstrated and will remain presumptive until such time as the District commits to the monitoring and assessment necessary to determine whether these criteria are truly protective of the resource. We are concerned that the District to date has taken no visible steps to reduce the uncertainty and subjectivity associated with these criteria and urge them to move forward quickly to develop and implement an adaptive management framework that that will facilitate such assessments. In a similar vein, since the report concludes that "no further recovery strategy is warranted until the effect of the [Northern Tampa Bay] strategy can be fully evaluated" the Panel recommends that the draft MFL report be modified to include a thorough discussion of the methods that will be used to evaluate recovery and enable District staff to make informed decisions regarding the need for actions specifically focused on Crystal Springs.

The Panel is concerned about the discarding of ten years of U.S. Geological Survey streamflow data in the hydrologic analysis without convincing justification for doing so, and recommends that the wavelet analysis be re-run using the original "uncorrected" data. We also recommend an extensive re-write of several key sections of Chapter 2 to improve clarity and make the District's reasoning regarding findings and data interpretations more transparent to the reader.

We are puzzled by the assumption that 50% of the flow decline apparent in the flow of Crystal Springs is attributable to anthropogenic sources (i.e., groundwater extraction) without compelling justification, especially when the weight of evidence presented in the report suggests a percentage between 60 and 70%. Likewise, the formulation of the MFL for Crystal Springs as the mean spring flow that would cause the number of days that the low-flow threshold for the river is achieved to decline by no more than 15 percent appears contrary to the logic used to set the MFL for the river. For both issues the Panel

recommends that District staff re-evaluate these elements of the report and/or provide more explanation and discussion of the decisions made.

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 upper Hillsborough River is built upon the analyses previously performed on the Upper Peace River (SWFWMD 2002), peer reviewed by Gore et al. (2002), the Middle Peace River (SWFWMD, 2005a), peer reviewed by Shaw et al. (2005) and the Alafia and Myakka Rivers (SWFWMD, 2005b, c) peer reviewed by Cichra et al. (2005). The upper Hillsborough MFL methodologies incorporate many of the recommendations of these earlier peer reviews, as well as key improvements developed by District staff. 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 to enhance the scientific basis that is firmly established for the decision-making process by the SWFWMD. Extensive editorial comments and errata for the upper Hillsborough River MFL are provided as an Appendix.

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 upper Hillsborough River and Crystal Springs.
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

The general methodology employed in the setting of riverine MFLs by the SWFWMD has been reviewed in some detail and strongly endorsed by past peer reviews (e.g., Gore et al. 2002, Shaw et al. 2005, and Cichra et al. 2005). The efficacy of the approach has been well received in past peer reviews. Thus in this peer review the Panel has chosen to focus on new elements unique to the upper Hillsborough River and Crystal Springs MFLs, new insights on the District's approach and increased elaboration or emphasis on key findings from past peer reviews.

2.1 General Approach and Minimum Flows and Levels for the Upper Hillsborough River

MFL Benchmarks and Resource Protection Goals

Benchmarks and the Atlantic Multidecadal Oscillation (AMO)

The Panel continues to endorse and applaud the District's use of multiple benchmark periods for setting MFLs based on multi-decadal climate variability. Although the role of the Atlantic Multi-decadal Oscillation (AMO) in influencing various ecological and climate phenomena (e.g., tropical storm frequency) continues to be debated, the District's thorough analysis of climate-streamflow relationships in Florida (SWFWMD 2004) provides a firm foundation for applying these concepts to the development of MFLs for Florida's rivers. As with previous riverine MFLs beginning with those for the Middle Peace River (SWFWMD 2005a), the District has fully embraced the climate-streamflow issue in developing the MFLs for the upper Hillsborough River by evaluating and identifying limiting flow conditions for two separate benchmark periods based on different climate phases. Recommended low-flow thresholds and percent flow reduction criteria are based on the most conservative of these benchmark periods to ensure adequate protection during periods when less rainfall and lower streamflow prevail. The analysis of stream and spring flows in Chapter 2 of the draft report also does a good job of placing the hydrology of these systems in the context of climate variability and clearly illustrates how such variability is revealed in the data as thresholds or step changes. 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. To our knowledge, SWFWMD is the only water management entity to have adopted such a sophisticated and forward thinking approach for incorporating climate variability into instream flow determinations.

The Panel feels that the Upper Hillsborough River MFL report clearly demonstrates that there are "lower-flow" and "higher-flow" periods that persist for decades, and previous peer reviewed work by the District made a strong case that such long-term variability is linked to different phases of the AMO (SWFWMD, 2004; Shaw et al, 2004) . The decision to use the lower-flow period to set MFLs is appropriate, as this is conservative, and means that it is not necessary to try to predict the current or future climate cycle. However, the AMO label is not necessary to the analysis or the determination of the MFLs considered here, and pinning the MFL determination on a particular climate cycle potentially leaves the MFL determination open to challenge. We suggest simply referencing earlier District documents that propose the AMO link, and not making a big deal of it here. The hypothesized link with AMO has explanatory power, but no real predictive power. Although we are suggesting de-emphasizing the narrative connection with AMO, the panel strongly believes the idea of multidecadal variations in streamflow is valid.

Another important issue involving benchmarks that is unique to the upper Hillsborough MFL is the selection of flow records to use for the analysis and related assumptions about the degree of alteration that is believed to have occurred. In Section 5.3, page 5-4, it is stated, "*It is necessary to consider which of the three flow records is most appropriate based on the merits of the flow records,…*" Once the most appropriate flow record is chosen, then the flow recommendation becomes a reduction of that chosen flow record.

Choosing the benchmark condition is a point of great debate. If the goal is to have “no significant harm”, then choosing a “natural” benchmark or an already altered benchmark, in terms of flows, will yield two different results. Will both results achieve “no significant harm?” One would think this would not be the case. Therefore, choosing the benchmark becomes a very significant decision point as it directly impacts the flow recommendation. Using the 1970-1995 period as a ‘low-flow’ benchmark would seem to be conservative, although there are probably anthropogenic influences on the flows during this period. The 1940-1969 period appears to be a high-flow period, and using it as a benchmark for uninfluenced flows would be conservative, as this would assume higher flows prior to anthropogenic influence.

In Section 5.7.1, on page 5-17, it is stated, *“It was determined that the 50% altered flow record would be the choice for PHABSIM analysis.”* It is not clear to the Panel why this is the chosen starting point, in terms of flow, upon which the 15% habitat reduction metric is applied. Based on our review of the information presented in chapter 2, it appears that the weight of the evidence presented suggests that the anthropogenic effects at Crystal Springs represent as much 60-70% of the observed decline, rather than 50%. For example, on page 2-104, comparison with Silver Springs suggests a 68% anthropogenic effect at Crystal Spring, a similar result to that obtained with the z-score analysis. In fact, it seems that there are more results >60% than <60%, and that methods that analyze discharge directly give higher percents, suggesting a 60-75% anthropogenic effect at Crystal Springs. Comparison of spring flows gives 62-68% (z-score), 53-60% (wavelet 5-6 cfs in 1990 plus 3 cfs in 1965, but without the higher discharges of 1953-1963 included), and 68% (comparison of ‘wet’ and ‘dry’ cycles at Crystal and Silver Springs). Based on this evidence, the Panel strongly recommends the District consider using an anthropogenic effect of >60%, rather than 50%. Absent this, a more transparent explanation of the District’s reasoning here is essential. Otherwise, the decision to use 50% appears subjective.

Seasonal Building Blocks

The SWFWMD has continued to employ a seasonal building block approach (e.g., Postel and Richter 2003) in establishing MFLs for the upper Hillsborough River. 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, Bunn and Arthington 2002). Thus, with limited biological knowledge of specific flow requirements, the best alternative is to maintain or recreate the hydrological 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.

Seasonal hydrological variability is a critical component of the flow regime, 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, and which are often critical to the viability of aquatic organisms. In response to previous peer review comments (e.g., Shaw et al. 2005) the District now applies the low-flow threshold developed for block 1 year around, recognizing that low flow conditions can occur at any time. 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 upper Hillsborough River. It also has the advantage of insuring a flow regime with the range of variability essential to the maintenance of stream and river structure and function. Seasonal building blocks also remain a useful conceptual device for communicating MFLs to the public.

The Panel continues to endorse the District's approach. We note with interest, however, that the District study team encountered some difficulties in *a priori* assigning specific tools for specific flow blocks, and adequately addressed these difficulties. Nevertheless, as the District's methodology for setting riverine MFLs has evolved, the need for pre-defined seasonal blocks has become less clear. The Panel wonders whether applying all of the tools used to set MFLs described in the draft report to all weeks of the year and using the approach that has been employed in this and prior studies of basing compliance standards on the most conservative, or protective, factor would eliminate the need to pre-assign flow blocks.

Resource Protection Goals

Chapter 3 clearly lays out the goals, ecological resources of concern, and key habitat indicators for setting MFLs on the upper Hillsborough River. This discussion is appropriately drawn from past MFLs developed by the District and citations from a wide array of ecological literature. Emphasis here, as in other riverine MFLs in the SWFWMD, is on fish and invertebrate habitat and hydrologic connectivity, both upstream-downstream and laterally between channel and floodplain.

Though these characteristics of the river ecosystem are clearly important, they are but a subset of the factors specifically listed in Florida Statutes that should be considered when setting MFLs (62-40.473 *F.A.C.*). The list (reproduced in Chapter 1 of the draft report) includes recreation, fish and wildlife habitat and fish passage, estuarine resources, transfer of detrital material, maintenance of freshwater storage and supply, aesthetic and scenic attributes, filtration and absorption of nutrients and other pollutants, sediment loads, water quality and navigation. The draft report includes a clear and well justified argument for preserving ecologically meaningful elements of the flow regime, and at least some mention is made of setting low flow thresholds to protect passive recreation uses such as canoeing. However, the report never completely addresses how the proposed MFL or the District's approach addresses any of the other factors listed above or why only certain factors were selected for this water body. (Note that in at least one other water management district in Florida, draft MFLs are developed based on one or a few resource protection goals, then a separate assessment is conducted to evaluate how well the draft flows and levels address the protection needs of other factors such as recreation, water quality and sediment loads).

The Panel suggests that for the upper Hillsborough and other rivers of Florida there may be other important processes from the list that merit consideration by the District in setting MFLs. For example, should there be concern for maintaining a minimum dissolved oxygen level or sustaining temperature below some threshold? Such factors may be especially important in relation to setting the low-flow threshold, which is presently based solely on a presumptive fish passage criterion and an analysis of wetted perimeter.

Preventing Significant Harm – 15% Change in Habitat Availability

The draft report describes the metrics used to define *"the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area"* as stated in Florida statutes. The authors note that "significant harm" was not defined in statute. The District chose to interpret significant harm as: "the loss of flows associated with fish passage and maximization of stream bottom habitat with the least amount of flow and quantifiable reductions in habitat." Overall, this is a reasonable approach from an ecological perspective and likely satisfies the intent of the statute.

The authors state that, *"[in] general, instream flow analysts consider a loss of more than 15% habitat, as compared to undisturbed or current conditions, to be a significant impact on that population or assemblage."* The authors further note, in our opinion, correctly, that *"there are few 'bright lines' which can be relied upon to judge when 'significant harm' occurs. Rather loss of habitat in many cases occurs incrementally as flow decline, often without a clear inflection point or threshold."* Nevertheless, the 15% habitat loss criterion remains one of the least rigorous, most subjective aspects of the District's approach to setting MFLs. Justification for this threshold is based on common professional practice in interpreting the results of PHABSIM analyses (Gore at al. 2002), a review of relevant literature where reported percentage changes ranged from 10 to 33% and on previous peer reviews that found the 15% threshold to be "reasonable and prudent, especially given the absence of clear guidance in the statute or in the scientific literature on levels of change that would constitute significant harm…" (e.g., Shaw et al. 2005).

The draft upper Hillsborough report continues the District's practice of using a 15% change in habitat availability as the threshold for defining significant harm and now applies this threshold broadly to include both spatial and temporal loss of habitat or connectivity. The draft report also applies the criteria in a slightly different way to the proposed MFL for Crystal Springs by setting the minimum springflow such that there is no more than a 15% increase in the number of days that the low-flow threshold for the river is violated.

The Panel again acknowledges that the use of this criterion is rational and pragmatic, but also recognizes that the specific value of 15% is subjective and has only modest validation or support from the primary literature. Arguments can and likely will be made for both lower and higher percentages of habitat loss to be used for defining significant ecological harm. Other work has been done, in addition to the literature that is already cited, and the Panel believes it would be prudent to expand the literature review to gather as much additional supporting documentation as possible. Where lower or higher percentages have been used elsewhere, it would be illuminating to understand the rationale for these decisions (e.g., lower percentages used where imperiled or more sensitive species are concerned, higher percentages for more degraded systems, etc.).

More importantly, however, is the need for the District to commit the resources necessary to validate the presumption that a 15% decrease in spatial or temporal habitat availability or a 15% increase in violations of the low-flow threshold does not cause significant harm. The District would appear to be in an excellent position to implement monitoring, natural experiments and other analyses necessary to evaluate the effectiveness of this threshold and establish a framework for adaptive management. Several riverine MFLs have now been developed and adopted by the District using the same or similar criteria, and the infrastructure for field work used to develop these MFLs is still in place. The present drought conditions that prevail over most of Florida as this peer review is written would seem to make for ideal conditions for testing and evaluating assumptions regarding minimum flows. Several previous peer reviews have called on the District to collect additional site-specific data to validate and refine assumptions used in the development of MFLs (Cichra et al. 2005; Gore et al. 2002; Shaw et al. 2005), and the District has committed to periodic re-evaluation of its MFLs as structural changes or changes in the watershed warrant. Despite this, we have seen little evidence so far that the District is moving rapidly to implement the needed monitoring or assessment. The Panel strongly believes that without such follow-up, the 15% threshold remains a presumptive criterion vulnerable to legal and scientific challenge.

Analytical Tools Used to Develop MFLs

PHABSIM

Previous peer review reports have discussed at length and affirmed the District's use of the Instream Flow Incremental Methodology (IFIM) and the related PHABSIM software (Cichra et al. 2005; Gore et al. 2002; Shaw et al. 2005). The District likewise employs this methodology to the upper Hillsborough River, using habitat suitability curves for the same suite of three common *Centrarchid* fish species plus invertebrates that were used in developing MFLs for the Middle Peace, Myakka and Alafia Rivers. Overall, the District's use of the methodology and its description of the development of habitat suitability curves are consistent with standard practice and follow the recommendations of previous peer review.

Habitat suitability curves were developed for spotted sunfish (*Lepomis punctatus*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), and macroinvertebrate community diversity (Gore et al. 2001, Stuber et al. 1982). These are appropriate species for consideration in rivers of the southern Florida peninsula, and their selection is validated by reported fish abundance data for these rivers. However, the Panel notes that both bluegill and largemouth bass are habitat generalists and are not especially sensitive to changes in hydrologic regime. As such they may be rather poor choices for use in establishing MFLs, despite the merits of the IFIM/PHABSIM methodology. For example, it appears from Figure 4-3 that all four life stages of largemouth bass are relatively insensitive to changes in flow, and therefore changes in depth and velocity. Assuming there would be zero habitat at zero discharge, the river would in essence be a series of disconnected pools. Then adding the slightest amount of water to have barely a trickle over the hydraulic control results in a near optimal habitat condition. The amount of habitat at this "barely a trickle" flow is the same as at flows in the 940 cfs range. If the objective is to develop MFLs, then it is necessary to have a species that is much more sensitive to changes in flow.

In keeping with previous peer reviews, the Panel recommends that the District invest the resources necessary to evaluate whether additional habitat suitability curves should be developed and PHABSIM analyses be conducted for other species that may be more sensitive to hydrological change than those used here. Of particular concern would be any listed, imperiled, or endemic species, species tracked by the Florida Natural Areas Inventory (FNAI), wading birds and fish species with preferences for stream edges or banks that might be the first places to feel the effects of reduced flows. Species and communities in the upper Hillsborough basin tracked by FNAI include ironcolor shiner (*Notropis chalybaeus*), peninsular floater (a mussel, *Utterbackia peninsularis*), Chapman's sedge (a wetland plant, *Carex chapmanii*), bald eagle (*Haliaetus leucocephalus*) and hydric hammock, a natural community of the river's floodplain. (FNAI Element Occurrence Database, 2007).

In the draft report, Section 4.2.2, it is stated that cross sections were established for fish habitat at three sites and the reader is referred to Figure 4-1. As noted in the errata section, several sites mentioned in the narrative, including the "7R, Hillsborough River State Park, or Sergeant Park" are not labeled in the figure. It is not clear how many PHABSIM transects were used for each study site; however, we assume that there were three for each study site in keeping with standard practice. If that is the case, then there should be a description of how the habitat types (riffle / run / pool) represented by the three transects were in the same relative percent proportion for the entire study reach they are representing. For most studies where the PHABSIM models are used, it is fairly standard practice to show a detailed diagram of each study site with 5-7 transects needed per riffle-pool sequence.

It should be indicated if the time step is daily or weekly in Section 4.6.1, the last paragraph on page 4-19, for each benchmark period (e.g. 1940-1969) for the Block 1 time period (April 20 to June 24). It would also help to clarify that the 15% habitat reduction metric is the average habitat reduction for all the days, (or weeks if that is the time step) for April 20 to June 24 for the 1940-1969 benchmark period and similarly for the 1970-1995 benchmark period. For example, there are 2,349 days (81 days x 29 years) for the 1940-1969 benchmark period. During any one of these days, The habitat reduction could be greater than 15% during any one of these days, but it is not greater than 15% on average.

Habitat Criteria and Characterization Methods Used to Develop MFLs

FISH PASSAGE

The approach of defining a threshold for loss of fish habitat in terms of percent reduction of fish habitat and setting a low-flow threshold based on fish passage is consistent with today's understanding of maintaining self sufficient populations of fish that are able to move up and downstream and between different kinds of aquatic habitat.

Fish passage was used to estimate flows sufficient to permit fish movement throughout the upper Hillsborough River. Flows of this magnitude would also likely permit recreation (i.e., canoeing) though this is not substantiated in the draft report. 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 MFLs (SWFWMD 2002, 2005a, b, c) and has been found acceptable by previous peer reviewers (Gore et al. 2002; Cichra et al. 2005; Shaw et al. 2005).

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 and peer reviewers. 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 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. If flows were to be lowered due to consumptive use of water to depths of 0.6 ft, when depths would under natural flow conditions be much greater, would water quality issues arise? Of concern would be dissolved oxygen (DO) and temperature conditions near the limit of tolerance for fish and other aquatic life. If these questions cannot be answered at this point, then the Panel strongly suggests the District commit to studying what the fish passage criterion set as the low flow threshold means to the aquatic ecosystem (e.g., flow versus DO relationships, fish survival in pools, etc). Similar to the 15% habitat loss threshold discussed above, the minimum fish passage depth used by the District in this and previous MFLs is merely a presumptive criterion absent site-specific follow-up studies to evaluate ecological conditions under such a low-flow scenario.

In order to ensure there is 0.6 ft of water depth along the thalweg in the entire river reach being addressed, the authors would need to demonstrate that they have undertaken the necessary work to identify the most critical hydraulic control points in the river. This would presumably require a detailed survey of the thalweg for the entire river reach in question in order to determine this critical point of elevation. As the authors note, transects in pools or runs would not be in locations where this critical fish passage point is located. It would be on a rock ledge or other similar natural hydraulic control point. These are "critical" transects and are areas that go dry first as flows are lowered. Longitudinal studies of the thalweg may indeed have been done, but the Panel seeks assurances that the identification of hydraulic control points was done systematically as there is no documentation in the draft report of how control points were selected.

WETTED PERIMETER

The biological rationale for using the wetted perimeter, *"…the greatest amount of macroinvertebrate biomass per unit reach of stream occurs on the stream bottom…"* is sound, and it is widely accepted that a break point in the slope of the line represents the point at which there is an accelerated loss of habitat relative to reductions in flow. The authors also clearly point out that one of the difficulties in using this method is that there are no well defined break points in the slope (incorrectly referred to in the narrative as an "inflection point") more often than not. The results in Figure 5-2 are not surprising, and illustrate the difficulties with using the wetted perimeter method. Of all the reported transects, only one seemed to have a defined break point in the modeled flow range of interest. Difficulties encountered by the authors raise the question of how appropriate the use of this method is in a river like the Hillsborough River. The Instream Flow Council recommends this method should only be used in riffle mesohabitat types (Annear et al. 2004). If the transects, particularly the single transect at the Morris Bridge gage site where the low flow threshold value was determined, are located in riffles that are representative of food producing riffles in the river, then the basis for using the method should be adequate.

DAYS OF FLOODPLAIN INUNDATION

Low gradient rivers, like the upper Hillsborough, have extensive floodplains. 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 many forms of aquatic life. For example, river biota migrate onto floodplains for foraging and spawning during floods. 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 upper Hillsborough River. Extensive vegetation and elevation surveys were used to characterize the structure and floristic composition of floodplains. 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 floodplain inundation.

The Panel feels that consideration of high flows and patterns of floodplain inundation is commendable and documentation of methods in the draft report is excellent.

COMPLIANCE STANDARDS AND PROPOSED MINIMUM FLOWS

The compliance standards, or recommended instream flow prescription to prevent significant harm, are well articulated and clearly indicate that the "50% anthropogenic reduction scenario" was selected as the "natural flow scenario" upon which the percent flow reduction factors are applied. Figure 5-13 on page 5-25 is useful as it shows how the flow reduction factors are applied to each seasonal flow block. However, the blue line, *"…the calculated natural flow corrected for withdrawals"*, is very difficult to see (see Errata).

It is always a challenge to know how much information to include (e.g., tables and graphs) to illustrate what is a very complex subject matter to a wide array of potential readers. The Panel notes that flow duration curves, the common currency of hydrologists, are a useful way to present information of this type and may be beneficial to the reader in that the full range of flows that can occur in any given time step can be seen. It also is easy to see where the low flow threshold occurs in terms of a percent exceedance value and relative to historic natural low flows.

The peer review panel endorses the District's proposed minimum flows for the upper Hillsborough River and finds them to be based on sound science and best available information, subject to our comments and recommendations above. We believe that the consideration 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 represents best practice for determining instream flow needs and demonstrates a commitment to a comprehensive aquatic ecosystem approach to this very challenging issue. We again 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,” 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 pragmatic and logical means of implementing the findings of the report in a regulatory context.

It is interesting to note that ecosystem functions requiring higher flows tolerate a lower percent reduction than those for low flows, perhaps due to differences in the way the 15% habitat loss threshold is interpreted for different metrics (e.g., temporal loss of habitat with floodplain functions vs. spatial loss of habitat for PHABSIM). In Figure 5-8, it appears that a smooth curve can be fit to the data, suggesting that a max reduction of 5% could be set for flows above 1250 cfs. Nevertheless, the recommended percent flow reductions for the upper Hillsborough appear to be quite consistent with those prescribed for other rivers in the SWFWMD. In fact, a table comparing the flow reduction values for upper Hillsborough with those of other rivers in the SWFWMD with proposed or adopted MFLs might be useful to include in the report.

2.2 Analysis of Spring Flows and Chemistry

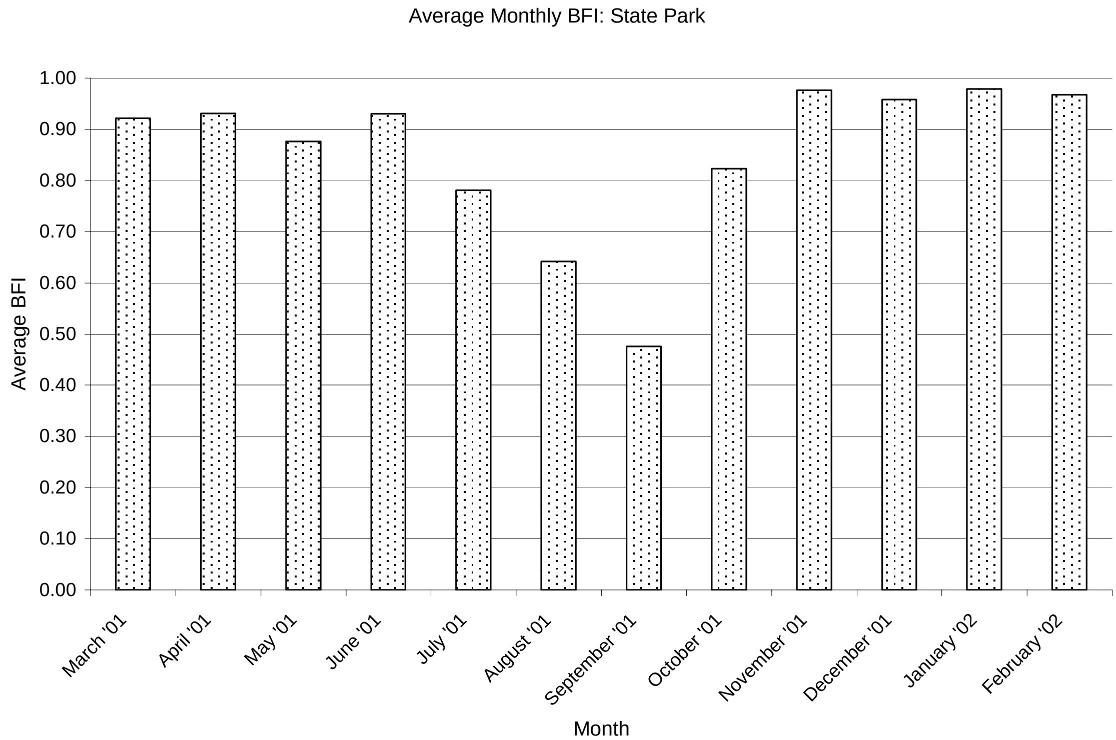
Chapter 2 of the draft report provides a thorough and lengthy overview of the basin. The background information is extensive with particularly good information on land use change and hydrology. The placing of the hydrology into the context of multidecadal climate variability is particularly forward thinking in terms of setting MFLs in systems where state changes are characterized by thresholds and step shifts. However, as noted above, the Panel would be more comfortable simply identifying the different climate periods, without ascribing them to a particular climate index, given uncertainty about how various climate oscillations combine to affect stream flow in this region and the lack of predictability of the different phases of such indices.

The narrative of chapter 2, especially section 2.6, is extremely difficult to follow and has been frustrating for several of the Panel members to review. Conclusions are often presented before the evidence, terminology is inconsistent, crucial explanations that would greatly aid understanding and improve clarity are missing and figures are often poorly labeled and poorly connected with the narrative. There is also a considerable amount of redundant and occasionally inconsistent narrative in this section. Some sections contain analysis, results and discussion all in one paragraph. If the analysis, results and discussion could be separated, if only within sections, it would make the report easier to read.

The Panel cautions the authors to be extremely careful to distinguish between conclusions drawn directly from the data and interpretations of results or data which are really hypotheses, not conclusions. One gets the feeling the authors are often arguing with themselves about what conclusions to make, but the salient points and findings of the work are lost among the data explorations, speculation, counter arguments and asides. Some important insights or assumptions are taken as common knowledge without further explanation, justification or citation, including the observation that the long-term mean and median of flow from springs should be the same, that the mean annual flows of different springs in central Florida should be highly correlated, despite differences in geologic setting, lag times or response to recharge events, and that Rainbow Springs is suitable as a reference for unimpacted spring flow. It is never completely clear in the text which Crystal Springs flow data set among the several that are analyzed early in section 2.6 are used for each of the analyses later in the same chapter. Additional, more specific recommendations are made in the errata section of this peer review. In short, the Panel believes the underlying work described in section 2.6, is likely sound, but clear communication of the approach and main findings, notably from pages 2-59 to 2-79 and from 2-104 to 2-107, is lacking. We recommend that the authors rewrite these sections and edit figures to improve clarity and eliminate inconsistencies, redundancies and extraneous arguments.

By contrast, the sections describing the use of the groundwater model and the wavelet approach for analyzing the springflow data in the frequency domain are much more clearly written, and the tables and figures are easy to understand and relate to the narrative. Both approaches appear technically sound and correctly applied. Of the three methods discussed -- wavelet, z-score, and model -- the wavelet and z-score analyses use actual flow data, whereas the model results do not. Therefore, the z-score and wavelet analyses should be given considerably more weight in this analysis than the model results.

These general findings notwithstanding, some important observations were drawn from our review of this chapter. In section 2.2.1, the text states that the mean flow of the river is 446 cfs. However, this flow is greater than daily flows much of the year. As with most hydrologic time series, the distribution of flow is non-normal and strongly skewed toward low flows.



Note also that base flow contributed more than 80% of flow for 9 months out of 12 for the period 3/01 to 2/02, including a very large flow event on 9/13/01 ('BFI' in the graph above is fraction of flow that is base flow). When base flow exceeds 80% of flow at the State Park gage (Hills River near Zephyrhills), total flow is usually less than 200 cfs, and often less than 100 cfs.

Regarding the hydrologic mass balance that is presented on pages 2-35 to 2-36, Several observations can be made:

- there is a 'recovery' of flows starting in the mid-1990s from the low-flow period of 1970-1995. This suggests that the decrease in flows between the 1940-1969 period and 1970-1995 are probably not all anthropogenic, although the 1996-97 partnership agreement began to decrease groundwater withdrawals in the late 90s.
- a mass balance analysis should yield reasonable results in this situation, as the volume of water available in the basin is derived largely from rainfall. In the Hillsborough Basin, there are wet season overflows from the Withlacoochee Basin, and there may be groundwater inflows from outside the surface water basin. On the other hand, there may be recharge to the Floridan Aquifer within the basin that is not discharged within the basin.

Having made those observations;

$P = ET + Q + GW_n + A_e$, where

P = precipitation
ET = evapotranspiration
Q = stream flow
GW_n = net ground water flux (out is +)

A_e = anthropogenic effect (out is +)
All values are in in/yr over the basin

Changing to differences;

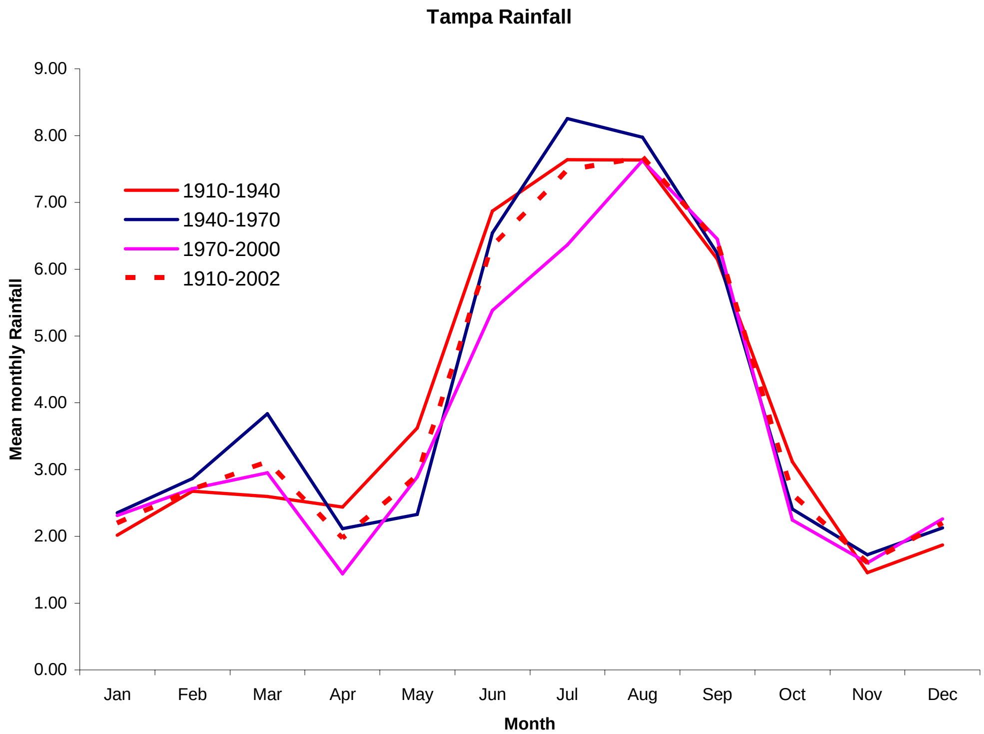
$dP = dET + dQ + dGW_n + dA_e$

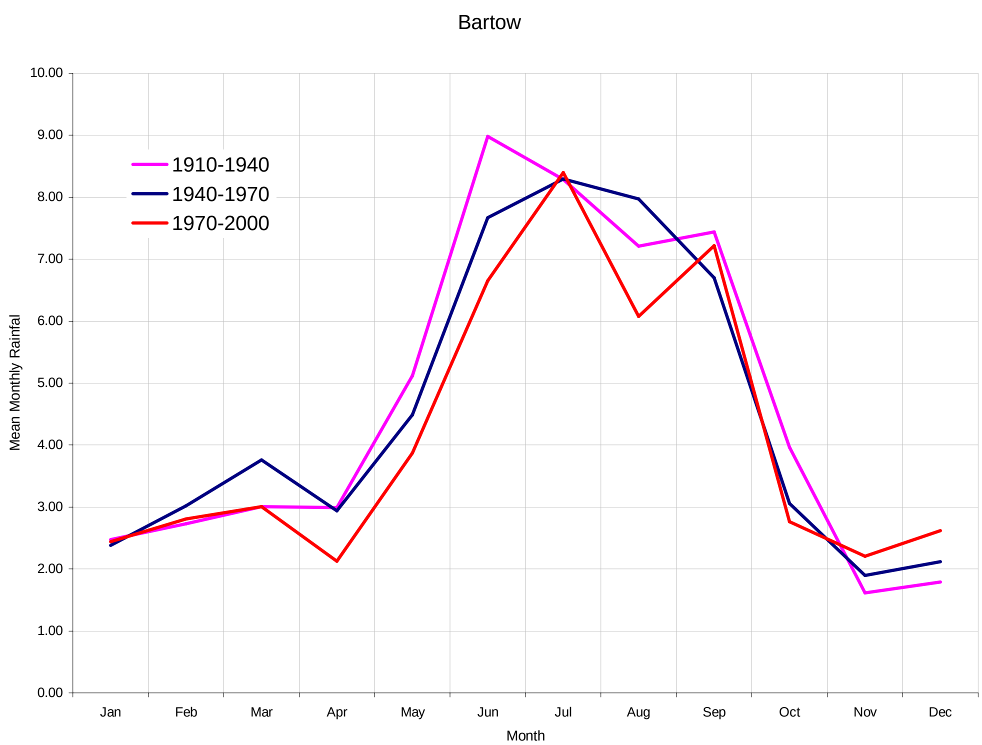
Inserting values from 1940-1969 versus 1970-1994;

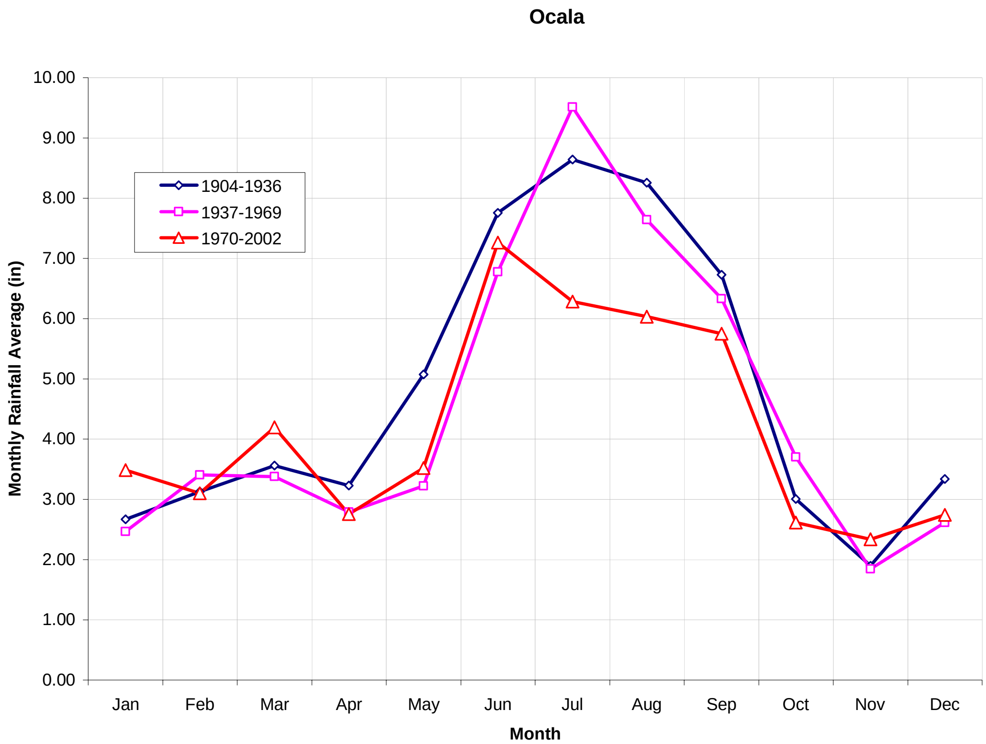
$-2 = (dET+dGW_n+dA_e) – 6.5$ -2” in P is from St Leo and HRSP

$+4.5 = (dET + dGW_n + dA_e)$

So, by the mass balance, either the decrease in rainfall caused an increase in ET, a decrease in ground water inflows, an increase in deep recharge, or an increase in anthropogenic effects, algebraically totaling 4.5 inches. For comparison, the amount of ground water pumped for potable use in the northern Tampa Bay region is roughly 4 inches. The text suggests that this result may be because the data may not be valid to differences of a few inches. However, those differences are then used in later analyses. The suggestion that summer rainfall may be part of the explanation may be valid, as there appears to be a decrease (albeit not statistically significant for the Hillsborough basin) in summer rainfall from the high-flow to low-flow periods, and possibly a slight increase in winter rainfall. This might suggest that summer rainfall, which generates the higher flows and roughly half the annual flow volume at the Zephyrhills gage, might have decreased more from 1970-1994 than indicated by the annual differences. However, anthropogenic effects can’t be dismissed, and we don’t think the District would want to question the credibility of the data set this early in the MFL report.


Tampa Rainfall
Mean monthly Rainfall
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1910-1940
1940-1970
1970-2000
1910-2002
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

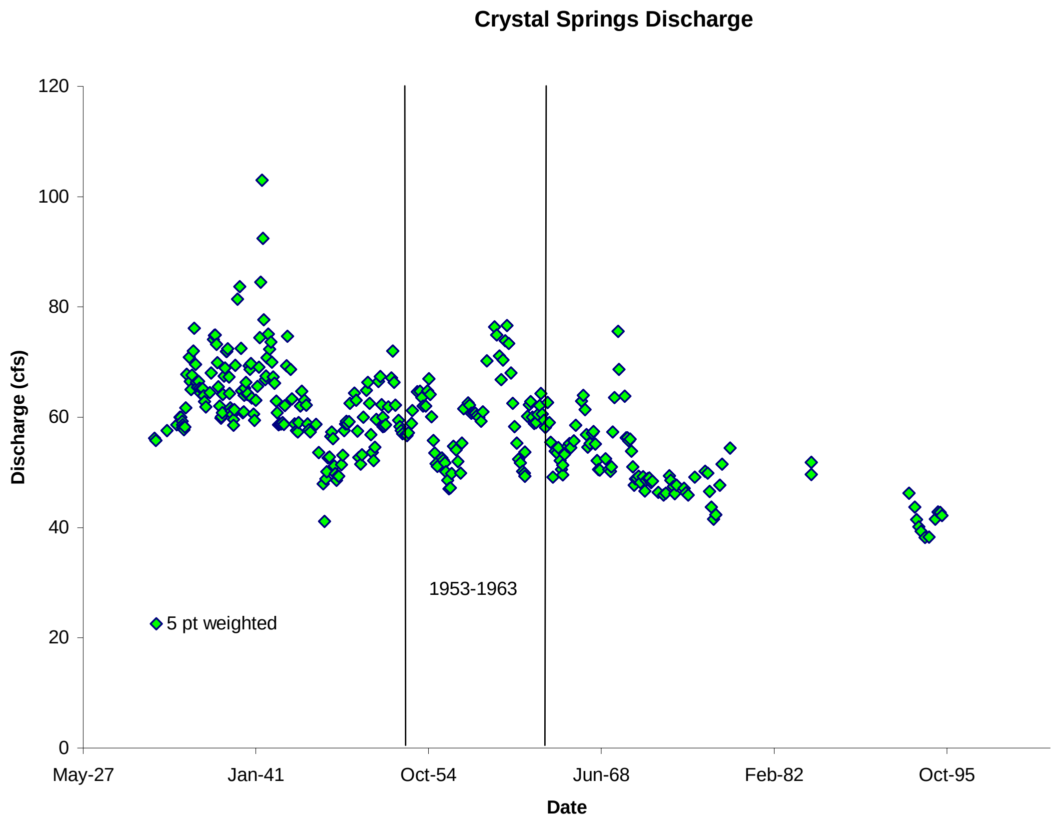

Bartow
Mean Monthly Rainfal
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1910-1940
1940-1970
1970-2000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month



The plots of discharge vs. time for Crystal Springs seem to suggest a moderate rate of decline in flow from the 1930s to about 1960, after which time a steeper decline begins. The total decline is from about 60 cfs to 40 cfs, with a suggestion of some recovery since about 2000. The Panel agrees that the measured values of discharge for Crystal Springs are problematic. The water quality database discharges are probably best, as they are direct measurements. It is uncertain what effect the structural modifications in the 1940s had on discharge and discussion of this issue in the text appears to be little more than speculation.

On page 2-63, the suggestion that later correlations support smaller anthropogenic influence can be turned around to say that the lack of correlation from 1935 to 1955 suggests a lack of regional influence during that period, which doesn't make much sense to the Panel. We conclude from this that it is difficult to conclude anything firm from the correlation patterns.

It is suggested that the Crystal Springs discharge data are in 'error' from 1953 to 1963. This is based on the wavelet analysis. A plot of the long-wavelength components seems to separate the 1953-1963 data from the rest of the record (Figures 2-53 – 2-56). On this basis, the data are 'corrected' by using the correlation between the Sharpes Ferry well and Crystal Springs to reconstruct the suspected data. However, unless there is some other really good reason to reject the data, throwing out 10 years of USGS stream gaging data is pretty radical and the Panel strongly cautions against such practice. A plot of the original data (below) does not show any 'anomaly', and the 1953-1963 data fall right in with data from earlier and later years. The only 'anomaly' in the original data is the higher discharges caused by the tropical storms of 1959 and 1960. This discharge peak shows up in discharge and rainfall records all over central Florida, so it is expected. The Panel suggests at a minimum redoing the wavelet analysis using the original, uncorrected data. "Correcting" the data has the effect of reducing discharges from Crystal Springs during a time when it has been assumed that anthropogenic effects were minimal. This biases later determinations of the anthropogenic effects.



Another section that requires additional attention is the section on river water and spring chemistry. The six pages of graphs of river chemistry trends for the upper Hillsborough River have three of the figure legends incorrectly identifying the variables being presented. In addition, figures 2-71, 2-72, 2-74, and 2-75 are not referenced in the text, and the description of these data in the six figures is terse and uninformative. There also are some significant problems with the chemistry data for Crystal Springs and some of the comparative springs. The monotonic trend in nitrate-nitrite nitrogen to values above 2.5 mg/L should be shown graphically in the report. Figures 2-77, 2-78, 2-79, 2-80, 2-82, 2-84, and 2-85 go unreferenced and described in the text, and legend and graphs are a mismatch for figure 2-78. Overall, the chemistry description needs a rewrite and many of the figure legends need correcting (see Errata).

Regarding comparisons of Crystal Springs and other springs in central Florida, very little justification is given for the assumption that flow from Rainbow Springs is unimpacted by anthropogenic effects, other than to show that the mean of its flows has remained relatively stable since the 1950s. Among other questions that could be raised, the extensive development that has occurred in the Rainbow springshed raises questions about whether recharge to the spring has been altered. More solid justification is needed in the draft report to support the District's assumption here. Also, in the water chemistry section, comparisons are made between Crystal Springs and several other springs in St. Johns River Water Management District, including Miami, Palm and Sanlando Springs. It should be noted that of these Palm and Sanlando springs are very close together, close enough to be considered by many to be different vents of the same spring system, perhaps limiting the usefulness of including both in the chemistry section. Nearby Miami Springs is a hydrogen sulfide-producing spring containing mats of sulfur-oxidizing bacteria, indicative of spring water that flows through geologic formations containing gypsum and exhibits significantly different water chemistry from typical "blue water" springs such as Crystal Springs.

2.3 Minimum Flows and Levels for Crystal Springs

The MFL for Crystal Springs is proposed as the mean/median spring flow that would cause the number of days that the 52 cfs low-flow threshold for the river to be achieved to decline by no more than fifteen percent. Focusing the Crystal Springs MFL on the river is logical and reasonable, especially given that the spring in question is no longer in a natural condition and has no true spring run in which the District could apply its river flow analysis tools. However, the Panel has concerns that the rationale for this proposal, and perhaps more importantly, assumptions made regarding possible alternative formulations of the MFL for Crystal Springs, are not well documented in the draft report. For example, it is not clear from the narrative why "it would not be appropriate to require that mean/median flow from Crystal Springs be maintained at 52 cfs…" This would seem to be a subjective decision not justified by the analysis or the discussion. On page 5-29, the report states that at low flow "essentially all flow" in the river is from Crystal Springs. If the low flow threshold based on fish habitat considerations is 52 cfs, and Crystal Springs provides all (or most) of the flow, we are puzzled why the minimum flow at Crystal Springs should not be 52 cfs.

The Panel is uneasy about setting an MFL for Crystal Springs that allows a 15% increase in the number of days the low-flow threshold in the river is violated. It would appear that this provides a loophole for water users to get around the low-flow threshold by withdrawing groundwater instead of surface water, but perhaps with additional discussion the rationale and implications of this proposal could be made clear. As was suggested above, this situation is another in which including a flow duration curve might help the reader better understand the implications of the spring MFL on the flow in the river. Again, the Panel urges the District to implement the necessary monitoring and evaluation to better understand what happens ecologically when the river falls to or below the low-flow threshold (minimum fish passage depth) and the implications on fish and aquatic life of a 15% increase in the time of excursion below this level.

In a similar vein, more discussion is needed regarding the closing paragraph of the report, where it is stated that "no further recovery strategy is warranted, until the effect of the existing [Northern Tampa Bay] strategy can be fully evaluated." The Panel has not reviewed the Northern Tampa Bay recovery plan, but hopes that it includes a rigorous plan for evaluating the effectiveness of any strategies that are implemented and is appropriately designed to enable District staff to make informed decisions regarding the need for additional recovery strategies, specifically for Crystal Springs. We suggest that additional discussion about these issues and appropriate citations be included in the draft report.

2.4 Evaluating Assumptions and Adaptive Management

We applaud the District's commitment to periodic reassessment of the MFLs for the upper Hillsborough River and other water bodies as structural alterations or substantial changes in watershed conditions occur. However, the Panel thinks that this commitment does not go far enough, and we are concerned that the District has so far taken no visible steps to assess some of the more uncertain and subjective elements of its MFL approach, namely the adequacy of the 15% habitat reduction criterion and the low flow threshold. We strongly recommend that the District begin now to develop and implement the process and methodology by which such assessment would occur. We recommend that an adaptive management framework be adopted for evaluating the effectiveness of the proposed MFLs for the upper Hillsborough and other rivers where similar MFLs have already been adopted. 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, specifically focusing on ecological conditions that occur at or near the low flow threshold and 15% habitat reduction scenarios.

REFERENCES

Bunn, S.E., and A.H. Arthington. 2002. Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. Environmental Management 30: 492-507.

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.

Cichra, C.E., C.N. Dahm, and D.T. Shaw. 2005. A Review of "Alafia River Minimum Flows and Levels Freshwater Segment including Lithia and Buckhorn Springs" March 21, 2005 Draft, and "Proposed Minimum Flows and Levels for the Upper Segment of the Myakka River, from Myakka City to SR72" August 10, 2005 Draft. 33 pp.

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.

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.

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.

Odum, H.T. 1957. Trophic structure and productivity of Silver Spring, Florida. Ecological Monographs 27: 55-112.

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 Sciences 46: 1805-1818.

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

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.

Shaw, D.T., C.N. Dahm, and S.W. Golladay. 2005. A Review of "Proposed Minimum Flows and Levels for the Middle Segment of the Peace River, from Zolfo Springs to Arcadia." Report prepared for Southwest Florida Water Management District, June 2005, 23 p.

Southwest Florida Water Management District. 2007. Proposed Minimum Flows and Levels for the Upper Segment of the Hillsborough River, from Crystal Springs to Morris Bridge, and Crystal Springs. Peer Review Draft, January 30, 2007. Ecologic Evaluation Section, Resource Conservation and Development Department. Brooksville, FL.

Southwest Florida Water Management District. 2005a. 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. 2005b. Alafia River Minimum Flows and Levels Freshwater Segment including Lithia and Buckhorn Springs. Draft – March 21, 2005. Ecologic Evaluation Section, Resource Conservation and Development Department. Brooksville, FL.

Southwest Florida Water Management District, 2005c. Proposed Minimum Flows and Levels for the Upper Segment of the Myakka River, from Myakka City to SR 72. Draft – August 10, 2005. 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 / Comments by Page Number in 01-30-07 upper Hillsborough MFL Draft Report

xiv	2nd paragraph, line 5 – add comma after “task”
xiv	2nd paragraph, last line - add “of” before “flows”
xiv	3rd paragraph, line 7 – hyphenate “low flow”
xiv	3rd paragraph, line 8 – hyphenate “wetted perimeter”
xiv	3rd paragraph, last line - add “(LFT)” after “low flow threshold”
xiv	4th paragraph, line 1 – hyphenate “low flow”
xiv	4th paragraph, line 3 – hyphenate “low flow”
xiv	4th paragraph, line 4 – remove capitalization from “Prescribed Flow Reduction”
xiv	4th paragraph, line 4 – hyphenate “low flow”
xv	1st line - “site” should be “sites”
xv	1st paragraph, line 7 – add comma after “(470 cfs)”
xv	2nd paragraph, line 1 – hyphenate “medium flow”
xv	2nd paragraph, last line – hyphenate “medium flow”
xv	3rd paragraph, line 5 – hyphenate “low flow”
xv	3rd paragraph, line 6 – add comma after “periods”
xv	3rd paragraph, 7 – change “the 15%” to “than 15%”
xv	4th paragraph, line 5 – change “short term-“ to “short-term”
xvii	line 10 – add comma after “For fieldwork”
1-1	1st paragraph, line 13 – change “”significant harm”” to “”significant harm,””
1-1	1st paragraph, line 15 - change “during next 20” to “during the next 20”
1-2	Section 1.2, 1st paragraph, line 2 – change “biolo0gists” to biologists”
1-3	Last paragraph, line 10 - Remove parenthesis before “typically”
1-6	1st complete paragraph, line 13 – hyphenate “high flow”
1-9	3rd paragraph, line 9 – change “of three” to “of the three”
2-2	Fig 2-1 - Show locations of rain gauges on this map
2-3	2nd line - “Hillsborough State Park” should be “Hillsborough River State Park”
2-3	1st paragraph, line 7 - “West” should be lower case
2-7	Last line – “e.g,” should be “e.g.,”
2-10	3rd line – add comma after “basis”
2-10	Delete space at beginning of table caption
2-10	Table 2-1 caption – hyphenate “432,176 acre”
2-10	Table 2-1 – delete “%” symbols throughout table
2-11	2nd line – Add “(Table 2-3, Figures 2-6, 2-7, and 2-8)” after “use”
2-12	Table 2-3 caption – hyphenate “202,873 acre”
2-12	Table 2-3 caption – change “periods,” to “periods:”
2-15	3rd line – add comma after “1990”
2-15	7th line – add “(Figures 2-10 and 2-11)” after “defined”
2-15	Table 2-4 caption – hyphenate “72,430 acre”
2-15	Table 2-4 caption – change “periods,” to “periods:”
2-18	6th line – add comma after “1972”
2-18	7th line – add comma after “1999”
2-18	8th line – add “(Figures 2-13 and 2-14)” after “35%”
2-18	Table 2-5 caption – hyphenate “45,674 acre”

2-21	6th line – add "(Table 2-6, Figures 2-15, 2-16, and 2-17)" after "1999"
2-21	Table 2-6 caption – hyphenate "111,199 acre"
2-24	4th line – change "is discussed" to "are discussed"
2-24	2nd paragraph under section 2.4.2, 1st sentence: "While much of Florida has a summer monsoon…" Strictly speaking, Florida does not experience a true monsoon. Perhaps should just call this a summer wet season or rainy season.
2-26	2nd paragraph, line 7 – add comma after "time"
2-26	3rd paragraph, line 9 – hyphenate "low flow"
2-26	3rd paragraph, line 10 – add comma after "Conversely"
2-27	Last paragraph, line 3 – "mainstem" is misspelled as "mainsterm"
2-28	Figure 2-19 - The identifier for site 3 is not on the mainstem of the Hillsborough River
2-30	Figure 2-21 – Change 4 "X"s to "Flow" in 2 labels at tops of 2 graphs
2-30	Bottom paragraph, line 1 – add commas after "River" and "Creek"
2-32	Figure 2-22 – use same Y-axis label on both graphs
2-33	Figure 2-23 – use same labels as those used in Figure 2-22 "Flow/WA (cfs/sq mile)"
2-33	Figure 2-23 – Legend: How did you decide when to remove or add flow to each day's flow reading?
2-35	2nd paragraph, line 6 – hyphenate "6.5 inch"
2-35	2nd paragraph, line 8 – hyphenate "4.8 inch"
2-36	Lines 2-3 - please delete parenthetical remark "which apparently we should not"
2-36	1st paragraph, last sentence - consider adding the following to the end of the sentence: "…high flows in this part of the watershed <u>or the inherent weaknesses in averaging a complex process like runoff over a large watershed."</u>
2-36	2nd paragraph – this paragraph presents the conclusion before any evidence is presented.
2-37	Table 2-7 - please spell out the entire year in the table; e.g., "1940" instead of "40" throughout to make more readable. Same for Table 2-8, p. 2-39, Table 2-13, p. 2-46, and Table 2-14, p. 2-48.
2-37	Table 2-7 - not cited in text
2-37	Table 2-7 – move column headings to right to match up with numbers. Same for Table 2-8, p. 2-39, Table 2-13, p. 2-46, Table 2-14, p. 2-48
2-37	Table 2-7 – give correct number of significant figures – last 2 rows of numbers. Same for Table 2-8, p. 2-39, Table 2-13, p. 2-46, Table 2-14, p. 2-48
2-39	Table 2-8 - not cited in text. A comment that applies to this table and to the entire text is that measured discharges are not valid to hundredths of cfs, so calculations based on measured flows aren't valid to many decimal places. Probably three significant figures is the limit.
2-40	Line 7 - "Mann-Whitney test results" instead of "Mann-Whitney tests results"
2-40	Statement "These results are an indication of an anthropogenic decrease presumably due to groundwater withdrawals" is not supported by any evidence at this point in the narrative. Similar concern about other statements near the end of that same paragraph.
2-41	Table 2-11 – delete the "%" signs from within the table. Add "% Exceedance" as new column heading

2-41	Table 2-11 – shift column headings to right to line up with the data in columns
2-44	2nd paragraph, line 6 – first word should be “of” rather than “off”
2-44	2nd paragraph, 1st sentence - please add “the” before “1970 to 1994 dry period”
2-44	2nd paragraph, last sentence: “a increase” should be “an increase”
2-44	3rd paragraph, 3rd sentence - “…most of this year” should be “…most of the year”
2-44	3rd paragraph, 4th sentence - insert a semi-colon after “however” This sentence should be rewritten – it doesn’t make sense as written.
2-44	3rd paragraph - you don’t need apostrophes before plurals of multiple years in eight places.
2-50	Line 3 - “Multidecal” should be “Multidecadal”
2-50	2nd paragraph, line 8 – “Table 2-15” should be “Table 2-17”
2-50	2nd paragraph, line 9 – “Table 2-16” should be “Table 2-18”
2-50	2nd paragraph, 2nd last line – “Table 2-15” should be “Table 2-17”
2-51	Line 2 – add “(Table 2-18)” after “(p=0.0855)”
2-52	Figure 2-30 – change first two X-axis labels to “Year”
2-52	Figure 2-30 – correct legend on right of all three graphs – “o”, “.”, and “..”
2-56	3rd paragraph - it may not make sense to some readers why blocks are defined by averaging dates from several rivers as opposed to using the data derived from the Hillsborough River itself. Should probably add a note saying that the District is attempting to define these blocks consistently for multiple rivers to clarify.
2-56	3rd paragraph, line 3 – “Table 2-12” should be “Table 2-19”
2-57	3rd paragraph, last line – “Table 2-13” should be “Table 2-20”
2-56	4th paragraph, 1st sentence - “USGA” should be “USGS”
2-57	Table 2-19 – Why is text in table bold?
2-58	1st paragraph, last line – change “rivers flow” to “river’s flow”
2-58	2nd paragraph, line 1 - change “springs” to “Springs” after Crystal
2-58	2nd paragraph, line 1 – delete apostrophe from “1940’s”
2-59	Section 2.6 – you might want to consider adding a sub-heading here signifying the discussion will be about the USGS water quality sampling database
2-59	Line 4 – change “vents feed” to “vents that feed”
2-59	Line 5 - “Floridian” should be “Floridan”
2-59	Last line – delete apostrophe from “1960’s”
2-60	Figures 2-33 and 2-34 – need better headings and labeling to link figures with narrative and with each other. Are the blue data points in Fig 2-34 the same as those in Fig 2-33? I had a lot of trouble following the narrative throughout Section 2.6 – see peer review comments. This needs a thorough rewrite, just stating the findings and important insights. Whole section seems to include a lot of what appears to be the author arguing with himself, which makes it very difficult to follow.
2-61	2nd paragraph, line 5 – add comma after record
2-61	Section 2.6.1, 1st paragraph, 2nd sentence: what is meant by “…the spring’s area.”? Language seems a bit sloppy.
2-61?	Section 2.6.1, 1st paragraph, last sentence - reference is made to the “HFR Section” of the appendix. This appendix was not included in our review draft.
2-61	Last paragraph - Delete sentence beginning “Increasing the head in the pool…” through the first sentence at the top of page 2-62 ending with “…significantly

higher in the pool." This discussion adds little to the report and is quite speculative.

2-62 Fig 2-35 caption - mention is made in the caption of the "spring run," but previously in the narrative it was noted that there is no defined spring run. Please reconcile language.

2-62 Section 2.6.2, 1st sentence - the word "assumption" should more appropriately be "hypothesis"

2-62 Section 2.6.2, last sentence on page - the word "bridged" is a little confusing. Perhaps "includes" is a better word choice.

2-62 Section 2.6.2, last sentence on page - the word "where" should be replaced with "when"

2-63 Line 6 – delete apostrophe from "1960's"

2-63 Line 9 - "lead" should be "led" or "resulted in"

2-63 1st paragraph – does this paragraph refer to Figure 2-38? If so, then add reference to table in this paragraph

2-63 2nd paragraph, line 10 – change "anthropogenic affects" to "anthropogenic effects"

2-63 2nd paragraph, line 10 – change "localized affects" to "localized effects"

2-66 Figure 2-38 legend and top titles – should these be "1955 to 1965" rather than "1935 to 1965"?

2-66 This figure (2-38) is not cited in the text

2-68 Section 2.6.3, 1st paragraph, 1st sentence - add …"as shown in Figures 2-33 through 2-35" to the end of this sentence. Add "It is likely that…" to the beginning of the 2nd sentence.

2-68 Section 2.6.3, 1st paragraph, sentence beginning "These approaches provided estimates of…" - "provided" should be "provide" and "ranged" should be "range."

2-68 3rd paragraph, line 3 – delete "When" at beginning of sentence

2-68 3rd paragraph, line 4 - add comma after "score analysis"

2-68 3rd paragraph, line 5 – add comma after "to 1975)"

2-68 3rd paragraph, line 9 – "It this data is…" should be "If these data are…"

2-69 Line 9 - "Stewart, et al 1971" should be "Stewart et al. 1971"

2-69 1st paragraph, last line - "Stewart et al occurred" should be "Stewart et al. (1971) occurred"

2-69 Section 2.6.3.1, 1st paragraph, 2nd sentence - "a couple of" seems sloppy language. Change to "certain" or even "several". Either would be better.

2-69 Last paragraph - the sentence "In order to make comparisons between the two, a good predictable relationship needs to exist between historic flows…" is vague. Comparisons between the "two" what? Relationship between historic flows and what? Also, delete the parenthetical remark "(climatic variability is eliminated…)" from this sentence as it is not needed.

2-70 2nd paragraph, line 13 – add "[" before "actual flow"

2-70 2nd paragraph, line 14 – add "]" after "period mean"

2-70 2nd paragraph, line 21 - "anthropogenic affect" should be "anthropogenic effect." The z-scores deviate in 1965, as do the discharges plotted from the USGS water quality database, which is expected as the z-scores are simply normalized values of the same data.

2-70 2nd paragraph, line 23 – "Figure 2-42" should be "Figures 36 to 39"?

2-70 2nd paragraph, lines 23-24 – The phrase "to overcome this confounding issue" doesn't sound very objective. Suggest rewording.

2-70 3rd paragraph, line 1 – "anthropogenic affects" should be "anthropogenic effects"

2-70 3rd paragraph, line 10 – add comma after "was different"

2-71 General – The word "data" is plural. The singular is "datum."

2-71 Line 7 – "Crystal z-scores" should be "Crystal Springs z-scores"

2-71 Line 15 - "anthropogenic affect" should be "anthropogenic effect"

2-71 Line 20 - "anthropogenic affect" should be "anthropogenic effect"

2-71 2nd paragraph, line 12 – "absent" should be "absence"

2-71 2nd paragraph - this is the first time that the Sharpes Ferry Monitoring Well is mentioned in the report. Describe the location or refer readers to a map.

2-71 Figures 2-45 to 2-48 and Table 2-23 need to be cited on this page (?)

2-71 Last sentence – "40-75%" should be "35-75%" or "approximately 40-75%"

2-73 Figures 2-40 and 2-41 top titles – delete extra space before "Rainbow River", need space before "(light blue)"

2-74 Figures 2-42 and 2-43 top titles – delete extra space before "Rainbow River", need space before "(light blue)"

2-75 Figure 2-44 top title – delete extra space before "Rainbow River", need space before "(light blue)"

2-76 Multiple changes of "affects" to "effects"

2-77 Figures 2-45 and 2-46 top titles – delete extra space before "Sharpes"

2-78 Figures 2-47 and 2-48 top titles – delete extra space before "Sharpes"

2-79 Multiple changes of "affects" to "effects"

2-80 Section 2.6.3.2 header - The personal communication cite is not necessary, especially since no affiliation or any other information is given that would allow a reader to contact R. Schultz or track this citation back to the source.

2-80 1st paragraph, line 5 – change "data is" to "data are"

2-80 2nd paragraph, line 2 – change "The data is" to "The data are"

2-80 2nd paragraph, lines 3 and 4 – change "high frequency portion, mid-frequencies and low frequencies." to "high frequency, mid-frequency, and low frequency portions."

2-80 2nd paragraph, lines 3 and 4 – change "data used is annual data, the…" to "data are annual in nature, the…"

2-80 4th paragraph, line 4 – "affects" should be "effects"

2-80 5th paragraph, line 5 – add comma after "data"

2-80 5th paragraph, line 6 – add comma after "plots"

2-80 5th paragraph, line 8 – change "data is" to "data are"

2-81 Line 1 – add comma after "crystals"

2-81 Lower graph – add X-axis label

2-81 Figure caption – add period to end of caption

2-81 1st paragraph below the figures, last sentence - statement is made that "it is generally agreed that there are no anthropogenic impacts at the well." This seems to be an unsupported assertion. Can you add a citation to support this?

2-81 Last paragraph, line 1 – add "(Figure 2-50)" to end of first sentence. That said, the reviewers do not agree that a 25-year cycle is apparent in the data nor that it is "most apparent" in the s3 crystal.
2-82 Figure 2-50 – right side of 3 graphs are cut off
2-82 Figure 2-50 – add X-axis labels to graphs
2-82 Figure caption – add period to end of caption
2-82 Line 3 – add comma after "data"
2-82 Line 4 – add comma after "data"
2-83 Top left graph – add "Rainfall (in)" as Y-axis label
2-83 Top right graph – flip Y-axis label
2-83 Bottom left graph – add "Water elevation (ft)" as Y-axis label
2-83 Bottom right graph – flip Y-axis label
2-83 Figure caption – add period to end of caption
2-83 Figure 2-51 - This figure is the first time that the term "filtered" is used. It should be explained in the caption that "filtered" means that the "noise" from crystals d1 and d2 have been removed.
2-83 1st paragraph, line 4 – add comma after "constant"
2-83 2nd paragraph, line 2 – change "Rainfall" to "rainfall"
2-83 2nd paragraph, line 3 – change "Rainbow" to "the Rainbow River"
2-84 Figure 2-52 – add "Cumulative Flow (cfs)" as Y-axis label
2-84 Figure 2-52 caption – add period to end of caption
2-84 Table 2-24 caption – add period to end of caption
2-84 Line 1 – change "Rainbow" to "The Rainbow River"
2-84 Last line – add "Springs" after "Crystal"
2-85 Top of page - please delete the sentence "Clearly something is occurring within the data." This is a throwaway and near-meaningless statement.
2-85 Figure 2-53 – add leading zeroes to two R-squared values
2-85 Last paragraph, line 1 – add comma after "Silver Springs"
2-85 Last paragraph, line 4 – change "r-squared" to "R-squared"
2-86 Figure 2-54 - add leading zero to R-squared value
2-86 Figures 2-54 and 2-55 captions – add period to end of captions
2-87 Figure 2-56 caption – add period to end of caption
2-87 1st period, line 8 – change "was used to…" to "were used to…"
2-87 2nd paragraph, line 1 – add comma after "data"
2-88 Table 2-25 caption – add period to end of caption
2-88 Table 2-25: Adjusted Crystal correlations for 1970-2003 should be shaded green like those for 1948-69.
2-88 1st paragraph, line 3 – change "springs" to "Springs"
2-88 2nd paragraph, line 1 – add comma after "2-59"
2-88 2nd paragraph, line 2 – change "is shown" to "are shown"
2-89 Figures 2-57 and 2-58 - The label "wavelet filtered data" should be in a consistent location and style in all figures where it is present. See also Figs 2-54-2-56.
2-89 Figure 2-57 – delete one of the periods (".") at the end of the caption
2-89 Figure 2-58 caption – add period at end of caption
2-89 Figures 2-57 and 2-58 - add leading zeroes to three R-squared values
2-90 Figure 2-59 caption – add period at end of caption

2-90 Figure 2-59 - add leading zeroes to two R-squared values

2-90 The formal term for this kind of regression model is “intervention model.” Also, please delete the sentence “This is similar to a model that takes into account wet and dry seasons.” This will be baffling to most readers.

2-91 Line 1 - change “to quantity” to “to the quantity”

2-91 3rd paragraph, line 5 – change “92%” to “0.92”

2-91 Figure 2-60 – change R-squared value from “=92%” to “=0.92”

2-92 Line 1 - change “affect” to “effect”

2-92 Line 2 – change “R-square” to “”R-squared”

2-92 Line 7 – add comma after “1990”

2-92 Add 1 or 2 blank lines between 1st paragraph and Figure 2-61

2-92 Figure 2-61 top title – change “Affect” to “Effect”

2-92 Figure 2-61 – How did you pick 1966 as the critical year from this graph?

2-92 Figure 2-61 caption – change “R-square” to “R-squared”

2-92 2nd paragraph, line 1 – add comma after “In general”

2-92 Last line – add comma after “2-26”

2-92 Table 2-26 caption – add period at end of caption

2-92 3rd paragraph, line 1 – change “Silver springs” to “Silver Springs”

2-93 last paragraph before section 2.6.3.3 beginning “Overall,…” Please delete entire paragraph. Entire books have been written about frequency domain transformations of hydrologic data. No need to act as if you are introducing these concepts to the world.

2-93 1st 3 pages of section 2.6.3.3 – delete right justification and use the same size font as used in the rest of the document

2-94 5th paragraph, last line – delete space before period at end of line

2-94 last paragraph, sentence “Model-wide mean error…” - add “(UFA)” following “Upper Floridan aquifers”

2-95 last line of text – delete space in “s hown”

2-99 4th paragraph, line 8 – delete italics from “*four*”

2-99 Last line – add comma after “i.e.”

2-100 Line 4 - change “Counties” to “counties”

2-100 Figure 2-66 - Even in color, the lines for “current conditions” and “upper Hill Basin w/o Pumpage (69 mgd)” are difficult to distinguish.

2-101 Figure 2-67 - the various time series lines in this figure are almost impossible to distinguish

2-103 Figure 2-69 - It would be helpful to identify county names on this map.

2-103 Section 2.6.4, line 1 – add comma after “As noted above”

2-104 1st paragraph, 3rd sentence - is poorly constructed. It should probably be turned into two sentences.

2-104 1st paragraph – It is not clear why all this material is being repeated here. Also in the 3rd sentence in this paragraph, “although” should be “however.” In the 4th sentence in this paragraph, please replace “determined (assumed)” with “estimated.”

2-104 2nd paragraph, 3rd sentence - the word “now” should be deleted

2-104 3rd paragraph, line 7 – change “St Johns WMD” to “St. Johns River WMD”

2-104 3rd paragraph, 4th line from end – add comma after “occurred”

2-104 3rd paragraph, 3rd line from end – add period after “etc”
2-105 Figure 2-70 – end of Y-axis label is cut off
2-106 Line 4 - change “withdrawal affect” to “withdrawal effect”
2-106 Line 5 – change “Corporation” to “Corp.” to be consistent with rest of text
2-106 Lines 11 and 13 – delete apostrophe from “1950’s”
2-106 3rd line above table caption – add comma after “in 1991”
2-106 3rd line from bottom – change “little affect on” to “little effect on”
2-107 You shouldn’t have to use language such as ‘it is admitted that it could be as much as 75%’. Makes it sound as if you feel guilty about something that you have to admit to.
2-107 last sentence before section 2.7 is completely unintelligible. Please rewrite for clarity.
2-107 2nd paragraph under Section 2.7, 4th sentence - please delete “;” between “section” and “rather”
2-108 Line 1 – add “(Figures 2-71 through 2-76)” after “versus flow’
2-108 Section 2.7.2.1, 2nd paragraph, line 6 – add “(Figure 2-71)” after “detected during this time”
2-108 Section 2.7.2.1, 2nd paragraph, line 10 – change “Kelly et. al.” to “Kelly et al.”
2-108 Section 2.7.2.1, 2nd paragraph, 6th sentence, please delete the word “actual.” For the last sentence, a citation is needed to support the claim that the mining industry has decreased its water use. Also it would be simpler to say “a considerable decrease in water use” rather than “a considerable improvement related to water use”
2-109 2nd paragraph, line 2 – add “(Figure 2-72)” after “over time”
2-109 3rd paragraph, line 9 – add “(Figure 2-74)” after “Hillsborough River”
2-109 3rd paragraph, line 10 – delete apostrophes from “1950’s” and “1970’s”
2-109 Figure 2-75 needs to be cited in the text. A discussion also needs to be added.
2-110 Bottom graph – add “(mg/l)” after “Parameter Residuals” on Y axis
2-110 Figure 2-71: scale of middle graph (P vs. flow) obscures any relationships that might be present at low flows. All we see is a dilution effect. There are possible similar problems with middle graphs in Figs 2-72 to 2-76.
2-111 Bottom graph – add “(mg/l N)” after “Parameter Residuals” on Y axis
2-111 Figure caption, first line – “Nitrate/Nitrite” should be “nitrate/nitrite”
2-111 Figure caption, last line – replace “phosphorus” with “nitrate or nitrate/nitrite”
2-112 Figure caption, line 3 – replace “phosphorus” with “potassium”
2-114 Middle graph – change “(umhos)” to “(umhos/cm)” in Y-axis label
2-114 Bottom graph – change “(mg/l)” to “(umhos/cm)” in Y-axis label
2-114 Figure caption, line 2 – replace “concentration” with “conductance”
2-115 Bottom graph – add “(mg/l)” after “Parameter Residuals” on Y axis
2-115 Figure caption, first line – add “concentrations” after “Fluoride”
2-115 Figure caption, line 3 – replace “conductance” with “fluoride concentration”
2-116 Delete first sentence on page. Also, citations are needed to support the assertions in the second paragraph regarding NOx trends and sources at Crystal Springs, especially where it is stated “…and has previously been documented for Crystal Springs.”

2-116 Paragraph (3) starting with "While…", line 5 – add "(Figures 2-77 through 2-87)" after "in the state" as most of these figures are not currently cited

2-116 3rd paragraph, last sentence: Miami Springs is used as an example where spring flows are increasing. Be aware that there are some data sets and graphs in circulation showing Miami Springs to have a sharply decreasing flow trend. It might be better to use a different spring as an example.

2-116 Last paragraph, line 6 – change "1970's" to "1970s"

2-116 Last paragraph, line 6 – add "(Figure 2-86)" after "were quite low"

2-116 Last paragraph, line 8 – change "inflection – see Figure 2-86)" to "inflection)"

2-116 Last paragraph, line 9 – change "1980's" to "1980s"

2-116 Last paragraph, line 10 – delete "see " at beginning of line

2-116 Last paragraph, in the sentence that starts "Rainbow Springs in Marion County…" - a citation is needed to support the information in the parenthetical remark. Otherwise, this is just speculation. Text in lines 12-13 should be changed from "…were probably taken at a slightly different…" to "…were taken at a different" Mike Mumma (UF Department of Fisheries and Aquatic Sciences may have cited this in his thesis) – there was a change in sites as documented in a USGS fax

2-117 1st line, parenthetical remark that begins on the previous page "(although this may be related to a change in how this stream is now rated)" needs a citation, even if just a personal communication with USGS staff.

2-117 Sentence beginning "One also has to wonder…" - "larger spring systems such as Rainbow River and Silver Springs" would be more precise if changed to "larger spring-fed systems such as Rainbow River and Silver River…"

2-117 2nd paragraph, line 11 - "been" should be changed to "be" at beginning of line

2-118 Bottom graph – add "(umhos/cm)" after "Parameter Residuals" in Y-axis label

2-118 Figure caption, first sentence – replace current sentence with "Conductance in water samples collected by the USGS at Crystal Springs"

2-118 Figure caption, line 3 – replace "concentrations" with "conductance"

2-119 Replace entire figure caption with "Time series plots of sulfate, chloride, and calcium concentrations in water samples collected by the USGS at Crystal Springs"

2-120 Figure caption – "Time series plot of" should be "Time series plots of flow and"

2-121 Figure caption – "Time series plot of" should be "Time series plots of flow and"

2-122 Figure caption – "Time series plot of" should be "Time series plots of flow and"

2-122 Figure caption – "Spring" should be "Springs"

2-123 Figure caption – "Time series plot of" should be "Time series plots of flow and"

2-123 Figure caption – "Spring" should be "Springs"

2-124 Figure caption – "Time series plot of" should be "Time series plots of flow and"

2-124 Figure caption – "Spring" should be "Springs"

2-125 Figure caption – "Time series plot of" should be "Time series plots of flow and"

2-126 Figure caption – "Time series plot of" should be "Time series plots of flow and"

2-126 Figure caption – "Spring" should be "Springs"

2-127 Figure caption – "Time series plot of" should be "Time series plots of flow and"

2-128 Figure caption – "Time series plot of" should be "Time series plots of flow and"

2-128 Figure caption – "Spring" should be "Springs"

3-2 1st paragraph, line 9 – change "then 20%" to "than 20%"

3-2 1st paragraph, last line – change "/freashwater/" to "/freshwater/"
3-2 1st paragraph, last sentence: "MFL for Matagorda Bay" is not correct. Strictly speaking, Texas has no "MFL" program. Please change this to the terminology used in Texas. Also, the web citation shown at the end of this sentence appears to be inactive or incorrect, possibly due to typos in the URL (but even correcting for what appear to be obvious typos, I was unable to link to this web document).
3-3 7th line from bottom – "low flow" should be hyphenated as these two words together are used as one adjective
3-4 Section 3.3.2, 1st paragraph, line 12 – "low flow" should be hyphenated
3-4 Section 3.3.3, line 1 – add comma after "flows"
3-4 Section 3.3.3, line 2 – add comma after "perimeter"
3-7 2nd paragraph, line 13 - change "potentially effect" to "potentially affect"
3-7 3rd paragraph, citations would be helpful to support the assertion in the first sentence (which I don't think is really correct) and as examples of the kind of "published inundation needs" referred to in the 2nd sentence. For the last sentence in this paragraph, you might also add "…or are areas within the floodplain sustained by locally high water tables."
3-7 Last paragraph, line 1 – add comma after "approach"
3-7 Last paragraph, line 2 – add comma after "functions"
4-1 1st paragraph, line 4 – hyphenate "low flow"
4-1 1st paragraph, line 6 – hyphenate "low flow"
4-2 Figure 4-1 - On this map, vegetative cross sections and gaging stations are both identified numerically and in some cases the labels for the vegetative cross sections obscure the labels or symbols for the gaging stations. Later, a slightly different numeric label is used in Fig 4-2 for the vegetative cross sections. "Site" (cross section?) "7R" is referred to in the narrative on page 4-3, but this site is not shown on Fig 4-1. It is, however, shown on Fig 4-2. All of which leads to confusion.
4-3 Section 4.2.1, line 1 – add comma after "geometry data"
4-3 Section 4.2.1, line 2 – add comma after "River"
4-3 Section 4.2.2, 1st paragraph - all important cross sections, referred to in this paragraph, should be identified on Fig 4-1.
4-3 Section 4.2.2, 1st paragraph, line 10 – "sergeant Parks" should be "Sergeant Park"
4-4 Line 1 – add commas after "Cross-sections" and "habitats"
4-6 Move page number to bottom of page
4-9 Section 4.3.2, line 1 - change "Gore et. al" to "Gore et al."
4-11 Figure 4-4, top title – delete "Adult" from beginning of title
4-13 Line 2 – add comma after "snags"
4-14 Figure 4-6, top title – add space between "400" and "cfs" in two places
4-14 Figure 4-6, top title – "Compaired should be "Compared"
4-16 1st paragraph, lines 3, 5, 7, and 10 – hyphenate "low flow"
4-16 2nd paragraph, line 12 – hyphenate "low flow"
4-16 2nd paragraph, line 16 – hyphenate "wetted perimeter"
4-16 3rd paragraph, line 5 – hyphenate "wetted perimeter"
4-17 1st paragraph, line 8 – change "Kelly et. al." to "Kelly et al."
4-18 Figure 4-8 – label the X and Y axes of the four graphs

4-19	Section 4.6.1, 1st paragraph, line 4 – add comma after “Zephyrhills gage”
4-19	Section 4.6.1, 2nd paragraph, line 1 - “trend” should be “tend”
4-19	Section 4.6.1, 2nd paragraph, line 2 - “affects” should be “effects”
4-19	Section 4.6.1, 3rd paragraph, line 1 – add comma after “River”
4-19	Section 4.6.1, 3rd paragraph, line 3 – add comma after “one”
4-19	Section 4.6.1, 3rd paragraph, line 5 – add comma after “report”
4-20	1st paragraph, line 5 – hyphenate “low flow”
4-20	2nd paragraph, line 3 – hyphenate “low flow”
4-20	3rd paragraph, line 3 – add comma at end of line after “gage”
4-20	3rd paragraph, last line – add “assumption” after “anthropogenic” in two places
4-20	Last paragraph, line 8 – hyphenate ‘low flow”
4-21	1st paragraph, last line – hyphenate “low flow”
4-22	Lots of redundant narrative in Chapter 4 throughout.
5-1	1st paragraph, lines 4 and 6 – hyphenate “low flow”
5-1	Section 5.2 heading – hyphenate ‘Low Flow”
5-1	2nd paragraph, lines 1, 2, and 5 – hyphenate “low flow”
5-3	Figure 5-2 caption, last line - change “shown the” to “shown for the”
5-3	Section 5.2.3 heading – hyphenate “Low Flow”
5-3	1st paragraph, lines 1, 3, 6, and 7 – hyphenate “low flow”
5-3	1st paragraph, line 3 – add “gage” after “Zephyrhills”
5-3	1st paragraph, last line – change “lose” to “loss”
5-4	3rd line from top of page - “show” should be “shown”
5-4	1st full paragraph beginning “The State Park site…” This entire paragraph makes little sense and could be deleted without loss of information. Much of the narrative on page 5-4 is redundant. If this paragraph is kept and reworded, all common names of fishes should be in lower case (i.e., spotted sunfish and largemouth bass) – five places
5-4	3rd paragraph, line 5 – add comma after “Therefore”
5-4	4th paragraph, line 1 – add comma after “MFLs”
5-4	4th paragraph, line 4 – add comma after “benchmark period”
5-4	4th paragraph, line 6 – capitalize “park”
5-6	Item 1 – hyphenate “low flow”
5-6	Section 5.4, last paragraph, line 2 – hyphenate “low flow”
5-7	Line 1 – add comma after “470 cfs”
5-7	Lines 1 to 2 – hyphenate “low flow”
5-7	Last paragraph, line 4 – add comma after “flows”
5-7	Last paragraph, line 5 – add comma after “banks”
5-8	Move page number to bottom of page
5-9	Table 5-2 caption – It should be noted that the percentages shown in the table are percent length along each transect, unless the numbers have been converted to an areal measure.
5-10	Table 5-3, text – “Palmetto” should not be capitalized in cell 3:2. Should “Americana” be capitalized in cells 2:2 and 2:3? Change “rean” to “near” in table cell 3:3
5-13	Line 2 – change “such soil horizon” to “such as soil horizon”
5-13	Table 5-5, cell 3:4 – change “indication prolonged” to “indicating prolonged”

5-14 Table 5-6, cell 1:3 - change “inundation” to “inundate”
5-15 2nd paragraph, line 11 - add comma after “To develop the plots”
5-15 2nd paragraph, 15 – change “to1999” to “to 1999”
5-15 3rd paragraph, line 2 – add comma after “reductions”
5-15 3rd paragraph, line 3 – add comma after “achieved”
5-15 3rd paragraph, line 3 – change “for Morris Bridge” to “for the Morris Bridge”
5-16 Figure 5-8 caption, line 2 – change “near Morris Bridge” to “near the Morris Bridge”
5-16 Last line of text - change “near Morris Bridge” to “near the Morris Bridge”
5-17 1st paragraph under section 5.7, next to last sentence - “conservative” could be more appropriately worded “protective”
5-18 Table 5-7 caption – change “Based” to “based”
5-19 1st paragraph, line 5 – hyphenate “long term”
5-21 Figure 5-12 - There are 12 transects shown in the figure, but a transect 13 is mentioned in the caption
5-21 1st paragraph, line 2 – hyphenate “medium flow”
5-22 2nd line from bottom of page – change “488cfs” to “488 cfs”
5-23 Table 5-8 caption, line 3 – change “site” to “sites”
5-23 Table 5-8 caption, last line – change “flow sufficient” to “flow is sufficient”
5-23 Table 5-8, 3rd footnote – change “then” to “than”
5-24 2nd line from top of page - would “acceptable” be better worded as “appropriate”?
5-25 Figure 5-13 caption, line 2 – change “Blocks 1, 2 and, 3” to “Blocks 1, 2, and 3”
5-25 Figure 5-13 - the blue line is not really visible in this graph
5-28 I realize that you have internalized the concept and terminology of the “southern river pattern water year” and its acronym “SRPWY”, but the rest of the world has not. Please change or convert to more familiar terminology like water year or calendar year.
5-28 4th line from the bottom of the page - change “no met” to “not met”
5-29 1st line of text – change “The Low Flow Cutoff…” to “The low-flow cutoff…”
5-29 1st line of text - change “based a consideration” to “based on a consideration”
5-29 Section 5.11: This may be a good place to reiterate that the head springs at Crystal Springs is not in natural condition and there is no defined spring run, preventing use of the methods employed in the attempt to set MFLs for Lithia and Buckhorn Springs or consideration of alternative methods suggested in the peer review for those MFLs.
5-29 Line 5 – add comma after “flow conditions”
5-30 Line 9 – change “60 cfs x .76).” to “60 cfs x 0.76).”
5-30 1st paragraph, last sentence: “is 4 cfs (2.5 mgd) and possibly 7 cfs (4 mgd)” would be less awkward if written instead as “is between 4 and 7 cfs (2.5 to 4 mgd)”
6-1 Annear et al., line 2 – delete period after “Management”
6-1 Berryman and Henigar, line 3 – change “Tampa Florida” to “Tampa, FL”
6-2 Bunn and Arthington, line 3 – change “Management.30” to “Management 30”
6-2 Champion and Starks, line 1 – change “2001The” to “2001. The”
6-3 Hickey, line 2 – Change “Florida” to “FL”
6-4 Jones et al. – combine lines 3 and 4 and change “Florida” to “FL.”
6-5 Manly et al., line 3 – change “London.” to “London, England.”

6-6	SWFWMD 1993 – change three commas to periods and “119 p.” to “Brooksville, FL. 119 pp.”
6-6	SWFWMD 1994 – change “1992,” to “1992. Brooksville, FL.“
6-7	Sepulveda, line 3 – change “130 p.” to “130 pp.”
6-7	Stanford et al., line 3 – “Regulated Rivers” should not be italicized
6-8	Weber and Perry – add volume and page numbers of article